TRNSYS 16

a TRaNsient SYstem Simulation program

Volume 4

Input - Output - Parameter Reference



Solar Energy Laboratory, Univ. of Wisconsin-Madison
http://sel.me.wisc.edu/trnsys

TRANSSOLAR Energietechnik GmbH
http://www.transsolar.com

CSTB – Centre Scientifique et Technique du Bâtiment
http://software.cstb.fr

TESS – Thermal Energy Systems Specialists
http://www.tess-inc.com

About This Manual

The information presented in this manual is intended to provide a detailed input – output – parameter reference for the Standard Component Library in TRNSYS 16. This manual is not intended to provide detailed reference information about the TRNSYS simulation software and its utility programs. More details can be found in other parts of the TRNSYS documentation set. The latest version of this manual is always available for registered users on the TRNSYS website (see here below).

Revision history

- 2004-09 For TRNSYS 16.00.0000
- 2005-02 For TRNSYS 16.00.0037
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Where to find more information

Further information about the program and its availability can be obtained from the TRNSYS website or from the TRNSYS coordinator at the Solar Energy Lab:

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Additional contributors who developed components that have been included in the Standard Library are listed in Volume 5.

Contributors to the building model (Type 56) and its interface (TRNBuild) are listed in Volume 6.

Contributors to the TRNSYS Simulation Studio are listed in Volume 2.

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4. INPUT - OUTPUT - PARAMETER REFERENCE

Introduction

This will be the file generated by exporting proformas to HTML

Changes between TRNSYS 15 and 16

Type9: Standard Data Reader

TRNSYS 15.x		TRNSYS 16	
PAR Nb	DESCRIPTION	PAR Nb	DESCRIPTION
1	1: read a user supplied data file where the first line of data corresponds to the simulation start time. -1: read a user supplied data file with (START/DELT-1) data lines are skipped before the simulation begins.	1	1: The first line in the data file is the simulation start time. Initial conditions are provided as instantaneous values for ALL variables (including the ones that are given as average values over the time step in the rest of the data file) 2: The first line in the data file is the simulation start time. Initial conditions are provided as instantaneous or averaged values over one timestep according to the options set for each variables 3. The first line in the data file corresponds to the first time step of the simulation. No initial values are provided in the file. 4: The first line in the data file corresponds to time = 0. If the simulation start is not 0, lines are skipped accordingly in the data file. Initial conditions are provided as instantaneous values for ALL variables (including the ones that are given as average values over the time step in the rest of the data file) 5: The first line in the data file corresponds to time = 0. If the simulation start is not 0, lines are skipped accordingly in the data file. Initial conditions are provided as instantaneous or averaged values over one timestep according to the options set for each variables 6. The first line in the data file corresponds to the first timestep in a year. If the simulation does not start at the beginning of the year, lines are skipped in the data file. No initial values are provided in the file
2	Number of header lines to skip before data begins	2	Number of header lines to skip before data begins
3	Total number of	3	Total number of columns that must be read from the

	columns that must be read from the data file		data file
4	The time interval at which data is provided.	4	The time interval at which data is provided.
5, 8, 11	Column number to read in data file…	5, 9, 13	Column number to read in data file…
6, 9, 12	Multiplication factor for the i^{th} value	6, 10, 14	Multiplication factor for the i^{th} value
7, 10, 13, etc.	Addition factor for the i^{th} value	7, 11, 15	Addition factor for the i^{th} value
		8, 12, 16, etc.	0: value is an average reported at the end of the time step. 1: value is instantaneous.
last -1	Logical unit number of the data file …	last -1	Logical unit number of the data file …
last	Formatted reading…	last	Formatted reading…

Type24: Integrator

TRNSYS 15.x		TRNSYS 16.x	
PAR NB	DESCRIPTION	PAR NB	DESCRIPTION
1	Time interval over which the values will be integrated…(optional, default is ∞)	1	Time interval over which the values will be integrated…(optional, default is ∞)
		2	0: the integration is reset at time intervals relative to the start time 1: the integration is reset at absolute time intervals.

Type25: Printer

TRNSYS 15.x		TRNSYS 16.x	
PAR NB	DESCRIPTION	PAR NB	DESCRIPTION
1	Time interval at which printing is to occur	1	Time interval at which printing is to occur
2	Time at which printing is to start	2	Time at which printing is to start
3	Time at which printing is to stop	3	Time at which printing is to stop
4	< 0, print to the list file > 0, logical unit number for output file	4	< 0, print to the list file > 0, logical unit number for output file
5	1: print user supplied units 2: print TRNSYS supplied units	5	1: print user supplied units 2: print TRNSYS supplied units
6	1: use spaces to delimit columns 2: use tabs to delimit columns	6	0: print at time intervals relative to the start time 1: print at absolute time intervals.
		7	< 0: overwrite the data file > 0: append to the data file
		8	< 0: do not print header (input file information) > 0: print header (input file information)
		9	0: use tabs to delimit columns 1: use spaces to delimit columns 2: use commas to delimit columns
		10	< 0: do not print labels as column headers > 0: print labels as column headers

Type28: Simulation Summary

The change is that Type 28 now has initial values. The proforma already had initial values but they were not written to the deck file. They should be written to the deck file in TRNSYS 16.
The code is backwards compatible (if there is a VERSION 15 statement it won't expect initial values).
Note that those initial values were added to simplify the TRNSYS syntax. Those values are actually ignored because they would prevent Type 28 from performing correct energy balances when some inputs are not integrated.

Type33: Psychrometrics

TRNSYS 15.x		TRNSYS 16.x	
PAR NB	DESCRIPTION	PAR NB	DESCRIPTION
1	Mode…	1	Mode…
2	Atmospheric pressure		
3	0: do not calculate wet bulb temperature 1: calculate wet bulb temperature	2	0: do not calculate wet bulb temperature 1: calculate wet bulb temperature
4	1: print only one warning per condition 2: print warnings at each time step	3	1: print only one warning per condition 2: print warnings at each time step

TRNSYS 15.x		TRNSYS 16.x	
INP. NB	DESCRIPTION	INP. NB	DESCRIPTION
1	Dry bulb temperature or humidity ratio	1	Dry bulb temperature or humidity ratio
2	Wet bulb temperature, RH, dew point temperature, humidity ratio, or enthalpy	2	Wet bulb temperature, RH, dew point temperature, humidity ratio, or enthalpy
		3	Atmospheric pressure

Type34: Overhang and Wing Wall Shading

TRNSYS 15.x		TRNSYS 16.x	
PAR NB	DESCRIPTION	PAR NB	DESCRIPTION
		1	0: Type34 radiation passed from Type16 1: Type34 radiation passed from Type68
1	Receiver height	2	Receiver height
2	Receiver width	3	Receiver width
3	Overhang projection	4	Overhang projection
4	Overhang gap	5	Overhang gap
5	Overhang left extension	6	Overhang left extension
6	Overhang right extension	7	Overhang right extension
7	Left wing wall projection	8	Left wing wall projection
8	Left wing wall gap	9	Left wing wall gap
9	Left wing wall top extension	10	Left wing wall top extension
10	Left wing wall bottom extension	11	Left wing wall bottom extension
11	Right wing wall projection	12	Right wing wall projection
12	Right wing wall gap	13	Right wing wall gap
13	Right wing wall top extension	14	Right wing wall top extension
14	Right wing wall bottom extension	15	Right wing wall bottom extension
15	Receiver azimuth	16	Receiver azimuth

TRNSYS 15.x	TRNSYS 16.x

INPUT NB	DESCRIPTION	INPUT NB	DESCRIPTION
1	Solar zenith angle	1	Solar zenith angle
2	Solar azimuth angle	2	Solar azimuth angle
3	Solar radiation incident on the horizontal	3	Solar radiation incident on the horizontal
4	Diffuse solar radiation on the horizontal	4	Diffuse solar radiation on the horizontal
5	Beam radiation on the receiver	5	Beam radiation on the receiver
6	Ground reflectivity	6	Ground reflectivity
		7	Incidence angle of solar radiation.

Type65: Online Plotter

TRNSYS 15.x		TRNSYS 16.x	
PAR NB	DESCRIPTION	PAR NB	DESCRIPTION
1	Nb of left axis variables	1	Number of left axis variables
2	Number of right axis variables	2	Number of right axis variables
3	Minimum value for left axis	3	Minimum value for left axis
4	Maximum value for left axis	4	Maximum value for left axis
5	Minimum value for right axis	5	Minimum value for right axis
6	Maximum value for right axis	6	Maximum value for right axis
7	Number of plots per simulation	7	Number of plots per simulation
8	Number of x-axis grid points per plot	8	Number of x-axis grid points per plot
9	< 0: do not display online > 0: display online	9	< 0: do not display online > 0: display online
10	< 0: no automatic output file > 10: logical unit for automatic output file	10	< 0: no automatic output file > 10: logical unit for automatic output file
		11	0: do not display units 1: display user supplied units 2: display TRNSYS supplied units
		12	0: tab delimit the output file 1: space delimit the output file 2: comma delimit the output file

TRNSYS 15.x		TRNSYS 16.x	
LABELS 5	DESCRIPTION	LABELS 3	DESCRIPTION
1 2	Units for left axis and units for right axis		
3	Left axis title	1	“text to appear along left axis”
4	Right axis title	2	“text to appear along right axis”
5	Online title	3	“test to appear as online title”

Type66: Calling EES

There were no parameters in Version 15. In TRNSYS 16, there are 4 parameters:

	Name	Dimension	Unit	Type	Range	Default
1	Input mode	Dimensionless	-	integer	[1;1]	0
	This parameter specifies how the EES model will be called. If set to 1, the EES model will be called at every time step and at every iteration. If set to 2, the first input is a control signal. The first input will not be sent to EES. Please refer to parameter 2 for information on the various ways that outputs can be treated in Input mode 2.					
2	Output mode	Dimensionless	-	real	[1;1]	0
	This parameter is only used in Input mode 2 (parameter 1 set to 2). In Input mode 2, the first input is not sent to EES but is a control signal. When that control signal is set to 0, the EES model will not be called. This parameter determines how outputs will be treated when the EES model is not called. 1: outputs are set to 0 if Input Mode is 2 and the first input is 0 2: outputs are set to predefined (parameter) values if Input Mode is 2 and the first input is 0 3: output values are held from the previous time step if Input Mode is 2 and the first input is 0					
3	Allowable wait	Time	s	real	[0;+Inf]	0
	The allowable amount of time that TRNSYS will allow EES before deciding that EES is non responsive. (Not implemented yet)					
4	Number of ouputs	Dimensionless	-	integer	[0;+Inf]	0
	The number of outputs that EES will be returning					

Type69: Sky temperature

There is no real change except that the code is stricter than in TRNSYS 15: In Mode 0 (calculate cloudiness), you MUST have 4 inputs. In mode 1 (read in cloudiness factor) you must have 5 inputs. Before the code used to accept 5 inputs in all cases and was just ignoring the 5th input in mode 0

Type90: Wind turbine

PAR(1) has become INPUT(1). This means the list of parameters and the list of inputs have changed (shifted by one).

TRNSYS 15.x		TRNSYS 16.x	
PAR NB	DESCRIPTION	PAR NB	DESCRIPTION
1	Mode	1	Site elevation
2	Site elevation	2	Data collection height
3	Data collection height	3	Hub height
4	Hub height	4	Turbine Power loss
5	Turbine Power loss	5	Number of turbines
6	Number of turbines	6	Logical unit for data file
7	Logical unit for data file		

TRNSYS 15.x		TRNSYS 16.x	
INPUT Nb	DESCRIPTION	INPUT Nb	DESCRIPTION
1	Wind velocity	1	Control signal
2	Ambient temperature	2	Wind velocity
3	Site shear exponent	3	Ambient temperature
4	Barometric pressure	4	Site shear exponent
		5	Barometric pressure

4.1. Controllers

4.1.1. 3-Stage Room Thermostat

4.1.1.1. 3-Stage Room Thermostat

Icon		TRNSYS Model	Type 8
Proforma	Controllers\3-Stage Room Thermostat\Type8.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Nb. of oscillations permitted	Dimensionless	-	integer	[1;99]	5
	The number of oscillations of the controller state allowed in one timestep before the output will be fixed and the solution found. -If the number of oscillations is set to an odd number, the control may bounce between two control states for successive timesteps. -If the number of oscillations is set to an even number, the control system may stay longer in one regime than actually intended. Refer to Section 4.4 of Volume 1 of the TRNSYS documentation set for more details on controller sticking.					
2	1st stage heating in 2nd stage?	Dimensionless	-	integer	[0;1]	1
	This controller will disable the first-stage heating system when the 2nd stage heating system comes on (0), or continue to operate the 1st stage heating system while the 2nd stage heating system is operating(1).					
3	Minimum primary source temperature	Temperature	C	real	[-Inf;+Inf]	20.0
	The minimum primary source temperature for source utilization. If the primary source temperature falls below this minimum temperature, the primary source will not be used, regardless of room temperature.					
4	Temperature for cooling	Temperature	C	real	[-Inf;+Inf]	25.0
	The room temperature above which the cooling system becomes active.					
5	1st stage heating temperature	Temperature	C	real	[-Inf;+Inf]	20.0
	The room temperature below which first stage heating is commanded.					
6	2nd stage heating temperature	Temperature	C	real	[-Inf;+Inf]	18.0
	The room temperature below which second stage heating is commanded.					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Room temperature	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the room being monitored by the controller.					
2	1st stage source temperature	Temperature	C	real	[-Inf;+Inf]	30.0
	The temperature of the primary (1st stage) heating system. This heating system will be used when 1st stage heating is required and this temperature is above the specified minimum temperature (Par. 3).					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Control signal for 1st stage heating	Dimensionless	-	real	[-Inf;+Inf]	0

	The control signal for first stage heating: 1 = 1st stage heating is required ; 0 = 1st stage heating is not required					
2	Control signal for 2nd stage heating	Dimensionless	-	real	[-Inf;+Inf]	0
	The control signal for the second stage heating equipment. 1 = 2nd stage heating is required ; 0 = 2nd stage heating is not required					
3	Control signal for cooling	Dimensionless	-	real	[-Inf;+Inf]	0
	The control signal for cooling systems. 1 = Cooling is required by the space ; 0 = Cooling is not required by the space					

4.1.1.2. w_ heating set back

Icon		TRNSYS Model	Type 8
Proforma	Controllers\3-Stage Room Thermostat\w_ heating set back\Type8a.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Nb. of oscillations permitted	Dimensionless	-	integer	[1;99]	5
	The number of oscillations of the controller state allowed in one timestep before the output will be fixed and the solution found. -If the number of oscillations is set to an odd number, the control may bounce between two control states for successive timesteps. -If the number of oscillations is set to an even number, the control system may stay longer in one regime than actually intended. Refer to Section 4.4 of Volume 1 of the TRNSYS documentation set for more details on controller sticking.					
2	1st stage heating in 2nd stage?	Dimensionless	-	integer	[0;1]	1
	This controller will disable the first-stage heating system when the 2nd stage heating system comes on (0), or continue to operate the 1st stage heating system while the 2nd stage heating system is operating(1).					
3	Minimum primary source temperature	Temperature	C	real	[-Inf;+Inf]	20.0
	The minimum primary source temperature for source utilization. If the primary source temperature falls below this minimum temperature, the primary source will not be used, regardless of room temperature.					
4	Temperature for cooling	Temperature	C	real	[-Inf;+Inf]	25.0
	The room temperature above which the cooling system becomes active.					
5	1st stage heating temperature	Temperature	C	real	[-Inf;+Inf]	20.0
	The room temperature below which first stage heating is commanded.					
6	2nd stage heating temperature	Temperature	C	real	[-Inf;+Inf]	18.0
	The room temperature below which second stage heating is commanded.					
7	Heating set back temperature difference	Temp. Difference	deltaC	real	[-Inf;+Inf]	2.0
	The set back temperature difference for heating. The first stage heating temperature is modified by the following relation: Th1,new = Th1 - Yset * DTset (See manual for further information on equation)					

INPUTS

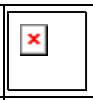
	Name	Dimension	Unit	Type	Range	Default
1	Room temperature	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the room being monitored by the controller.					
2	1st stage source temperature	Temperature	C	real	[-Inf;+Inf]	30.0
	The temperature of the primary (1st stage) heating system. This heating system will be used when 1st stage heating is required and this temperature is above the specified minimum temperature (Par. 3).					
3	Set back control function	Dimensionless	-	real	[-Inf;+inf]	1.0
	The set back control function. This input is usually connected to a forcing function output or an equation. This input is multiplied by the set back temperature (Par. 7) and used to modify the set point temperatures for heating.					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Control signal for 1st stage heating	Dimensionless	-	real	[-Inf;+Inf]	0

	The control signal for first stage heating: 1 = 1st stage heating is required ; 0 = 1st stage heating is not required					
2	Control signal for 2nd stage heating	Dimensionless	-	real	[-Inf;+Inf]	0
	The control signal for the second stage heating equipment. 1 = 2nd stage heating is required ; 0 = 2nd stage heating is not required					
3	Control signal for cooling	Dimensionless	-	real	[-Inf;+Inf]	0
	The control signal for cooling systems. 1 = Cooling is required by the space ; 0 = Cooling is not required by the space					

4.1.1.3. w_ heating set back and temp deadband

Icon		TRNSYS Model	Type 8
Proforma	Controllers\3-Stage Room Thermostat\w_ heating set back and temp deadband\Type8b.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Nb. of oscillations permitted	Dimensionless	-	integer	[1;99]	5
	The number of oscillations of the controller state allowed in one timestep before the output will be fixed and the solution found. -If the number of oscillations is set to an odd number, the control may bounce between two control states for successive timesteps. -If the number of oscillations is set to an even number, the control system may stay longer in one regime than actually intended. Refer to Section 4.4 of Volume 1 of the TRNSYS documentation set for more details on controller sticking.					
2	1st stage heating in 2nd stage?	Dimensionless	-	integer	[0;1]	1
	This controller will disable the first-stage heating system when the 2nd stage heating system comes on (0), or continue to operate the 1st stage heating system while the 2nd stage heating system is operating(1).					
3	Minimum primary source temperature	Temperature	C	real	[-Inf;+Inf]	20.0
	The minimum primary source temperature for source utilization. If the primary source temperature falls below this minimum temperature, the primary source will not be used, regardless of room temperature.					
4	Temperature for cooling	Temperature	C	real	[-Inf;+Inf]	25.0
	The room temperature above which the cooling system becomes active.					
5	1st stage heating temperature	Temperature	C	real	[-Inf;+Inf]	20.0
	The room temperature below which first stage heating is commanded.					
6	2nd stage heating temperature	Temperature	C	real	[-Inf;+Inf]	18.0
	The room temperature below which second stage heating is commanded.					
7	Heating set back temperature difference	Temp. Difference	deltaC	real	[-Inf;+Inf]	2.0
	The set back temperature difference for heating. The first stage heating temperature is modified by the following relation: Th1,new = Th1 - Yset * DTset (See manual for further information on equation)					
8	Temperature dead band	Temp. Difference	deltaC	real	[-Inf;+Inf]	2.0
	The dead band temperature difference of the controller. In this model, hysteresis effects can be modeled by use of this parameter. This parameter is used to modify the heating and cooling set temperatures: Th1,new = Th1 + Y1*DTdb - Yset*DTset Th2,new = Th2 + Y2*DTdb - Yset*DTset Tc,new = Tc - Y3*DTdb (See manual for further information on equations)					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Room temperature	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the room being monitored by the controller.					
2	1st stage source temperature	Temperature	C	real	[-Inf;+Inf]	30.0
	The temperature of the primary (1st stage) heating system. This heating system will be used when 1st stage heating is required and this temperature is above the specified minimum temperature (Par. 3).					
3	Set back control function	Dimensionless	-	real	[-Inf;+inf]	1.0
	The set back control function. This input is usually connected to a forcing function output or an equation. This					

	input is multiplied by the set back temperature (Par. 7) and used to modify the set point temperatures for heating.

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Control signal for 1st stage heating	Dimensionless	-	real	[-Inf;+Inf]	0
	The control signal for first stage heating: 1 = 1st stage heating is required ; 0 = 1st stage heating is not required					
2	Control signal for 2nd stage heating	Dimensionless	-	real	[-Inf;+Inf]	0
	The control signal for the second stage heating equipment. 1 = 2nd stage heating is required ; 0 = 2nd stage heating is not required					
3	Control signal for cooling	Dimensionless	-	real	[-Inf;+Inf]	0
	The control signal for cooling systems. 1 = Cooling is required by the space ; 0 = Cooling is not required by the space					

4.1.2. 5-Stage Room Thermostat

4.1.2.1. 5-Stage Room Thermostat

Icon		TRNSYS Model	Type 108
Proforma	Controllers\5-Stage Room Thermostat\Type108.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	No of oscillations permitted	Dimensionless	-	integer	[1;99]	5
	The number of oscillations of the controller state allowed in one timestep before the output will be fixed and the solution found. Set to an odd number to allow the controller to bounce between two control states for successive timesteps.					
2	1st stage heating in 2nd stage?	Dimensionless	-	integer	[0;1]	1
	This controller will disable the first-stage heating system when the 2nd stage heating system comes on (set this parameter to 0), or continue to operate the 1st stage heating system while the 2nd stage heating system is operating (set this parameter to 1).					
3	2nd stage heating in 3rd stage?	Dimensionless	-	integer	[0;1]	1
	This controller will disable the 2nd stage heating system when the third stage heating system comes on (set this parameter to 0) or continue to operate the 2nd stage heating system while the third stage heating system is operating (set this parameter to 1).					
4	1st stage heating in 3rd stage?	Dimensionless	-	integer	[0;1]	1
	This controller will disable the first stage heating system when in third stage heating system comes on (set this parameter to 0), or continue to operate the 1st stage heating system when the third stage heating system comes on (set this parameter to 1).					
5	1st stage cooling in 2nd stage?	Dimensionless	-	integer	[0;1]	1
	This controller will turn off the first stage cooling system when the second stage cooling system comes on (set this parameter to 0) or will continue to operate the first stage cooling system when the second stage cooling system comes on (set this parameter to 1).					
6	Temperature dead band	Temp. Difference	deltaC	real	[-Inf;+Inf]	2.0
	The dead band temperature difference of the controller. In this model, hysteresis effects can be modeled by use of this parameter. This parameter is used to modify the heating and cooling set temperatures based on the state of this controller at the previous timestep. If hysteresis is not desired for this controller, simply set this parameter to 0.0					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Monitoring temperature	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the room being monitored by the controller.					
2	1st stage heating setpoint	Temperature	C	real	[-Inf;+Inf]	20.0
	The room temperature below which first stage heating is commanded.					
3	2nd stage heating setpoint	Temperature	C	real	[-Inf;+Inf]	18.0
	The room temperature below which second stage heating is commanded.					
4	3rd stage heating setpoint	Temperature	C	real	[-Inf;+Inf]	16.0
	The room temperature below which third stage heating is commanded.					
5	1st stage cooling setpoint	Temperature	C	real	[-Inf;+Inf]	24.0

	The room temperature above which 1st stage cooling is commanded.					
6	2nd stage cooling setpoint	Temperature	C	real	[-Inf;+Inf]	26.0
	The room temperature above which 2nd stage cooling is commanded.					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Control signal for 1st stage heating	Dimensionless	-	integer	[0;1]	0
	The control signal for first stage heating: 1: 1st stage heating is required 0: 1st stage heating is not required					
2	Control signal for 2nd stage heating	Dimensionless	-	integer	[0;1]	0
	The control signal for the second stage heating equipment. 1: 2nd stage heating is required 0: 2nd stage heating is not required					
3	Control signal for 3rd stage heating	Dimensionless	-	integer	[0;1]	0
	The control signal for third stage heating: 0: 3rd stage heating is not required 1: 3rd stage heating is required					
4	Control signal for 1st stage cooling	Dimensionless	-	integer	[0;1]	0
	The control signal for 1st stage cooling: 1: 1st stage cooling is required 0: 1st stage cooling is not required					
5	Control signal for 2nd stage cooling	Dimensionless	-	integer	[0;1]	0
	The control signal for 2nd stage cooling: 1: 2nd stage cooling is required 0: 2nd stage cooling is not required					
6	Conditioning Signal	Dimensionless	-	integer	[0;1]	0
	If any of the heating or cooling signals is non-zero, this output will be set to 1. This output can be used to control a pump or fan.					
7	1st Stage Conditioning Signal	Dimensionless	-	integer	[0;1]	0
	If either the first stage heating or first stage cooling control signal is non-zero, this output will be set to 1. This output can be used as the input control signal for the first stage of a two-speeed pump or fan.					
8	2nd Stage Conditioning Signal	Dimensionless	-	integer	[0;1]	0
	If either the second stage heating or the second stage cooling control signal is non-zero, this output will be set to 1. This output can be used to control the second stage of a two-speed fan or pump.					

4.1.3. Differential Controller w_ Hysteresis

4.1.3.1. for Temperatures - Solver 0 (Successive Substitution) Control Strategy

Icon		TRNSYS Model	Type 2
Proforma	Controllers\Differential Controller w_ Hysteresis\for Temperatures\Solver 0 (Successive Substitution) Control Strategy\Type2b.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	No. of oscillations	Dimensionless	-	integer	[1;+Inf]	5
	The number of control oscillations allowed in one timestep before the controller is "Stuck" so that the calculations can be solved. This parameter should be set to an odd number so that short-term results are not biased. Refer to section 4.4 for more details on control theory in simulations. NOTE: Setting the number of oscillations to a positive number REQUIRES the use of solver 0 (Successive substitution) Use the "new control strategy" (NSTCK=0) with solver 1 (Powell's method)					
2	High limit cut-out	Temperature	C	real	[-Inf;+Inf]	100.0
	High limit cut-out: The controller will set the controller to the OFF position, regardless of the dead bands, if the temperature being monitored (Input 3) exceeds the high limit cut-out. The controller will remain OFF until the monitored temperature falls below the high limit cut-out temperature.					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Upper input temperature Th	Temperature	C	real	[-Inf;+Inf]	20.0
	Upper input temperature: The temperature difference that will be compared to the dead bands is Th (this input) minus Tl (Input 2). Refer to the abstract for more details.					
2	Lower input temperature Tl	Temperature	C	real	[-Inf;+Inf]	10.0
	Lower input temperature: The temperature difference that will be compared to the dead bands is Th (Input 1) minus Tl (this input). Refer to the abstract for more details.					
3	Monitoring temperature Tin	Temperature	C	real	[-Inf;+Inf]	20.0
	Temperature to monitor for high-limit cut-out checking. The controller signal will be set to OFF if this Input exceeds the high limit cut-out temperature (Parameter 4) The controller will remain OFF until this input falls below the high limit cut-out.					
4	Input control function	Dimensionless	-	real	[0;1]	0
	Input control function: The input control function is used to promote controller stability by the use of hysteresis. The control decision will be based on the dead band conditions and controller state at the previous timestep (this input). Refer to the abstract for more details on control theory. In most applications, the output control signal from this component is hooked up to this input.					
5	Upper dead band dT	Temp. Difference	Temp. Difference	real	[-Inf;+Inf]	0
6	Lower dead band dT	Temp. Difference	Temp. Difference	real	[-Inf;+Inf]	0

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Output control function	Dimensionless	-	real	[0.0;1.0]	0
	Output control function: The output control function may be ON (=1) or OFF (=0).					

4.1.3.2. for Temperatures - Solver 1 (Powell) Control Strategy

Icon		**TRNSYS Model**	Type 2
Proforma	Controllers\Differential Controller w_ Hysteresis\for Temperatures\Solver 1 (Powell) Control Strategy\Type2a.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	New control mode	Dimensionless	-	integer	[0;0]	0
	Control mode: To use the new control strategy, the first parameter must be set to 0. Do not change this parameter. Note that the new control strategy REQUIRES the use of solver 1 (Powell's method)					
2	High limit cut-out	Temperature	C	real	[-Inf;+Inf]	100.0
	High limit cut-out: The controller will set the controller to the OFF position, regardless of the dead bands, if the temperature being monitored (Input 3) exceeds the high limit cut-out. The controller will remain OFF until the monitored temperature falls below the high limit reset temperature (Parameter 5).					
3	High limit reset	Temperature	C	real	[-Inf;+Inf]	95.0
	The controller is equipped with a high limit cut-out which will turn the control signal OFF, regardless of temperature, if the monitored temperature (Input 3) is higher than the high limit cut-out (Parameter 4). The controller will remain off until the monitored temperature falls below the high limit reset.					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Upper input temperature Th	Temperature	C	real	[-Inf;+Inf]	20.0
	Upper input temperature: The temperature difference that will be compared to the dead bands is Th (this input) minus Tl (Input 2). Refer to the abstract for more details.					
2	Lower input temperature Tl	Temperature	C	real	[-Inf;+Inf]	10.0
	Lower input temperature: The temperature difference that will be compared to the dead bands is Th (Input 1) minus Tl (this input). Refer to the abstract for more details.					
3	Monitoring temperature Tin	Temperature	C	real	[-Inf;+Inf]	20.0
	Temperature to monitor for high-limit cut-out checking. The controller signal will be set to OFF if this Input exceeds the high limit cut-out temperature (Parameter 4) The controller will remain OFF until this input falls below the high limit cut-out.					
4	Input control function	Dimensionless	-	real	[0;1]	0
	Input control function: The input control function is used to promote controller stability by the use of hysteresis. The control decision will be based on the dead band conditions and controller state at the previous timestep (this input). Refer to the abstract for more details on control theory. In most applications, the output control signal of this component is hooked up to this input.					
5	Upper dead band dT	Dimensionless	Dimensionless	real	[-Inf;+Inf]	0
6	Lower dead band dT	Dimensionless	Dimensionless	real	[-Inf;+Inf]	0

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Output control function	Dimensionless	-	real	[0.0;1.0]	0
	Output control function: The output control function may be ON (=1) or OFF (=0).					

4.1.3.3. generic - Solver 0 (Successive Substitution) Control Strategy

Icon		**TRNSYS Model**	Type 2
Proforma	Controllers\Differential Controller w_ Hysteresis\generic\Solver 0 (Successive Substitution) Control Strategy\Type2d.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	No. of oscillations	Dimensionless	-	integer	[1;+Inf]	5
	The number of control oscillations allowed in one timestep before the controller is ""Stuck"" so that the calculations can be solved. This parameter should be set to an odd number so that short-term results are not biased. Refer to section 4.4 for more details on control theory in simulations. Note: This controller momde REQUIRES the use of SOLVER 0 (Successive substitution)					
2	High limit cut-out	any	any	real	[-Inf;+Inf]	100.0
	High limit cut-out: The controller will set the controller to the OFF position, regardless of the dead bands, if the temperature being monitored (Input 3) exceeds the high limit cut-out. The controller will remain OFF until the monitored temperature falls below the high limit cut-out temperature.					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Upper input value	any	any	real	[-Inf;+Inf]	20.0
	Upper input temperature: The temperature difference that will be compared to the dead bands is Th (this input) minus Tl (Input 2). Refer to the abstract for more details.					
2	Lower input value	any	any	real	[-Inf;+Inf]	10.0
	Lower input temperature: The temperature difference that will be compared to the dead bands is Th (Input 1) minus Tl (this input). Refer to the abstract for more details.					
3	Monitoring value	any	any	real	[-Inf;+Inf]	20.0
	Temperature to monitor for high-limit cut-out checking. The controller signal will be set to OFF if this Input exceeds the high limit cut-out temperature (Parameter 4) The controller will remain OFF until this input falls below the high limit cut-out.					
4	Input control function	Dimensionless	-	real	[0;1]	0
	Input control function: The input control function is used to promote controller stability by the use of hysteresis. The control decision will be based on the dead band conditions and controller state at the previous timestep (this input). Refer to the abstract for more details on control theory. In most applications, the output control signal from this component is hooked up to this input.					
5	Upper dead band	any	any	real	[-Inf;+Inf]	10.0
	The upper dead band temperature difference is used in the following way in the controller: The controller is ON if it was previously OFF and Th (Input 1) minus Tl (Input 2) is greater than the upper dead band. Otherwise the controller is OFF. The controller is ON if it was previously ON and Th (Input 1) minus Tl (Input 2) is greater than the lower dead band. Otherwise the controller is OFF. Upper dead band should be greater than the lower dead band in most applications. Refer to section 4.4 of Volume 1 of the TRNSYS documentation set for help in choosing optimal and stable values of the controller dead bands.					
6	Lower dead band	any	any	real	[-Inf;+Inf]	2.0
	The lower dead band temperature difference is used in the folllowing way in the controller: The controller is ON if it was previously ON and Th (Input 1) minus T (Input 2) is greater than the lower dead band. Otherwise the controller is OFF. The controller is ON if it was previously OFF and Th (Input 1) minus Tl (Input 2) is greater than the upper dead					

	band. Otherwise the controller is OFF. Refer to section 4.4 of Volume 1 of the TRNSYS documentation set for help in determining optimum and stable values of the controller dead bands. In most applications, the upper dead band should be greater than the lower dead band.

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Output control function	Dimensionless	-	real	[0.0;1.0]	0
	Output control function: The output control function may be ON (=1) or OFF (=0).					

4.1.3.4. generic - Solver 1 (Powell) Control Strategy

Icon		TRNSYS Model	Type 2
Proforma	Controllers\Differential Controller w_ Hysteresis\generic\Solver 1 (Powell) Control Strategy\Type2c.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	New control mode	Dimensionless	-	integer	[0;0]	0
	Control mode: To use the new control strategy, the first parameter must be set to 0. Do not change this parameter. Note: This controller mode REQUIRES the use of SOLVER 1 (Powell's method)					
2	High limit cut-out	any	any	real	[-Inf;+Inf]	100.0
	High limit cut-out: The controller will set the controller to the OFF position, regardless of the dead bands, if the temperature being monitored (Input 3) exceeds the high limit cut-out. The controller will remain OFF until the monitored temperature falls below the high limit reset temperature (Parameter 5).					
3	High limit reset	any	any	real	[-Inf;+Inf]	95.0
	The controller is equipped with a high limit cut-out which will turn the control signal OFF, regardless of temperature, if the monitored temperature (Input 3) is higher than the high limit cut-out (Parameter 4). The controller will remain off until the monitored temperature falls below the high limit reset.					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Upper input value	any	any	real	[-Inf;+Inf]	20.0
	Upper input temperature: The temperature difference that will be compared to the dead bands is Th (this input) minus Tl (Input 2). Refer to the abstract for more details.					
2	Lower input value	any	any	real	[-Inf;+Inf]	10.0
	Lower input temperature: The temperature difference that will be compared to the dead bands is Th (Input 1) minus Tl (this input). Refer to the abstract for more details.					
3	Monitoring value	any	any	real	[-Inf;+Inf]	20.0
	Temperature to monitor for high-limit cut-out checking. The controller signal will be set to OFF if this Input exceeds the high limit cut-out temperature (Parameter 4) The controller will remain OFF until this input falls below the high limit cut-out.					
4	Input control function	Dimensionless	-	real	[0;1]	0
	Input control function: The input control function is used to promote controller stability by the use of hysteresis. The control decision will be based on the dead band conditions and controller state at the previous timestep (this input). Refer to the abstract for more details on control theory. In most applications, the output control signal of this component is hooked up to this input.					
5	Upper dead band	any	any	real	[-Inf;+Inf]	10.0
	The upper dead band temperature difference is used in the following way in the controller: The controller is ON if it was previously OFF and Th (Input 1) minus Tl (Input 2) is greater than the upper dead band. Otherwise the controller is OFF. The controller is ON if it was previously ON and Th (Input 1) minus Tl (Input 2) is greater than the lower dead band. Otherwise the controller is OFF. Upper dead band should be greater than the lower dead band in most applications. Refer to section 4.4 of Volume 1 of the TRNSYS documentation set for help in choosing optimal and stable values of the controller dead bands.					
6	Lower dead band	any	any	real	[-Inf;+Inf]	2.0
	The lower dead band temperature difference is used in the folllowing way in the controller: The controller is ON if it was previously ON and Th (Input 1) minus T (Input 2) is greater than the lower dead band. Otherwise the controller is OFF.					

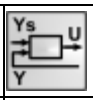
	The controller is ON if it was previously OFF and Th (Input 1) minus Tl (Input 2) is greater than the upper dead band. Otherwise the controller is OFF. Refer to section 4.4 of Volume 1 of the TRNSYS documentation set for help in determining optimum and stable values of the controller dead bands. In most applications, the upper dead band should be greater than the lower dead band.

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Output control function	Dimensionless	-	real	[0.0;1.0]	0
	Output control function: The output control function may be ON (=1) or OFF (=0).					

4.1.4. Iterative Feedback Controller

4.1.4.1. Iterative Feedback Controller

Icon		**TRNSYS Model**	Type 22
Proforma	Controllers\Iterative Feedback Controller\Type22.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	mode	Dimensionless	-	integer	[0;+Inf]	0
	Controller's operation mode. Not implemented yet (set to 0)					
2	Maximum number of oscillations	Dimensionless	-	integer	[0;+Inf]	0
	Number of iterations after which the controller's output will stick to its current value in order to promote convergence. If you set this parameter to 0 (or less), the controller will stick a few iterations before the maximum number of iterations set in the general simulation parameters, so TRNSYS gets a chance to converge at the current time step. Set this parameter to a very large value if you do not want this to happen.					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Setpoint	any	any	real	[-Inf;+Inf]	0
	ySet is the setpoint for the controlled variable. The controller will calculate the control signal that zeroes (or minimizes) the tracking error (e = y-ySet).					
2	Controlled variable	any	any	real	[-Inf;+Inf]	0
	y is the controlled variable that will track the setpoint (ySet).					
3	On / Off signal	Dimensionless	-	real	[-Inf;+Inf]	0
	ON / OFF signal for the controller. The control signal is always zero if onOff = 0, other values are interpreted as "ON".					
4	Minimum control signal	any	any	real	[-Inf;+Inf]	0
	Minimum value of the control signal. The controller will minimize the tracking error for uMin <= u <= uMax. uMin and uMax can be variable but you should always ensure that some values of u are acceptable. In other words, do not set uMin > uMax to switch the controller Off. You can use the onOff input for that purpose. uMin and uMax are used in the numerical algorithm and using realistic values rather than arbitrarily large numbers will improve the controller stability and speed.					
5	Maximum control signal	any	any	real	[-Inf;+Inf]	0
	Maximum value of the control signal. Please see the information on uMin for details.					
6	Threshold for non-zero output	any	any	real	[0;+Inf]	0
	This is the minimum control signal (absolute value) for which a non-zero output will be set. It is different from uMin (input(4)). Control values lower than uThreshold in absolute value will be zeroed. This can be used for example to model a pump that has a minimum operating flowrate: in that case uThreshold should be set to the minimum flowrate and uMin should be set to 0. Another example is a control signal where uMin = -100, uMax = 100 and uThreshold = 10. This means that values between -100 and 100 are acceptable but outputs lower than 10 in absolute value will be set to zero.					
7	Tolerance on tracking error	any	any	real	[-Inf;+Inf]	0
	Tolerance on the tracking error. The controller will stick to its current value (i.e. not attempt to further reduce the tracking error) if the tracking error is within this tolerance. Positive numbers are interpreted as a relative tolerance on y, negative numbers are interpreted as an absolute tolerance. 0 is acceptable.					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Control signal	any	any	real	[-Inf;+Inf]	0
	Control signal. This is the controller output					
2	Tracking error	any	any	real	[-Inf;+Inf]	0
	Tracking error (ySet-y)					
3	Controller status	Dimensionless	-	real	[-Inf;+Inf]	0
	Controller status. 0 means the controller is OFF. The following values are added to status to indicate the controller status: 1 if the controller is ON, 2 if the control signal is set to 0 because of the threshold value, 4 if it is constrained by the minimum value, 8 if it is constrained by the maximum value, 16 if it is stuck to its previous value, 32 if the tracking error is within the tolerance, and 64 if the slope of the (control signal, tracking error) curve is too steep and steps are cut in order to promote numerical convergence. All flags are summed so that the status for "ON, at the maximum value and within tolerance" is 1+8+32=41.					
4	Unsaturated control signal	any	any	real	[-Inf;+Inf]	0
	Unsaturated control signal: calculated value before taking the minimum and maximum boundaries into account. This output is mostly used for debugging purposes, the control signal (u) that should be connected to the controlled system is output 1.					

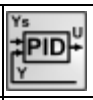
4.1.5. Microprocessor Controller

4.1.5.1. Microprocessor Controller

Icon		TRNSYS Model	Type 40
Proforma	Controllers\Microprocessor Controller\Type40.tmf		

4.1.6. PID Controller

4.1.6.1. PID Controller

Icon		TRNSYS Model	Type 23
Proforma	Controllers\PID Controller\Type23.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	mode	Dimensionless	-	integer	[0;1]	0
	Controller's operation mode. Mode 0 implements a "real-life" (i.e. non-iterative) controller which performs its calculations after "measuring" the system's outputs (i.e. after convergence in TRNSYS) and maintains its outputs at a constant level until the end of the next time step. Mode 1 implements an iterative controller that uses TRNSYS iterations to adjust its outputs. Mode 1 will usually provide a faster response at the expense of more iterations and the optimal parameters may be far from real-world values for a similar system. Mode 0 does not cause more TRNSYS iterations but it may require that you reduce the time step in order to obtain a satisfactory closed-loop response. Note that Type 22 (Iterative feedback controller) offers an alternative to mode 1 and is easier to configure).					
2	Maximum number of oscillations	Dimensionless	-	integer	[0;+Inf]	0
	(This parameter is ignored in mode 0) Number of iterations after which the controller's output will stick to its current value in order to promote convergence. If you set this parameter to 0 (or less), the controller will stick a few iterations before the maximum number of iterations set in the general simulation parameters, so TRNSYS gets a chance to converge at the current time step. Set this parameter to a very large value if you do not want this to happen.					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Setpoint	any	any	real	[-Inf;+Inf]	0
	ySet is the setpoint for the controlled variable. The controller will calculate the control signal that zeroes (or minimizes) the tracking error (e = ySet-y).					
2	Controlled variable	any	any	real	[-Inf;+Inf]	0
	y is the controlled variable that will track the setpoint (ySet).					
3	On / Off signal	Dimensionless	-	real	[-Inf;+Inf]	0
	ON / OFF signal for the controller. The control signal is always zero if onOff = 0, other values are interpreted as "ON".					
4	Minimum control signal	any	any	real	[-Inf;+Inf]	0
	Minimum value of the control signal. The controller saturates the calculated control signal to have uMin <= u <= uMax (uMax is input 5).					
5	Maximum control signal	any	any	real	[-Inf;+Inf]	0
	Minimum value of the control signal. The controller saturate the calculated control signal to have uMin <= u <= uMax (uMin is input 4).					
6	Threshold for non-zero output	any	any	real	[0;+Inf]	0
	This is the minimum control signal (absolute value) for which a non-zero output will be set. It is different from uMin (input(4)). Control values lower than uThreshold in absolute value will be zeroed. For example, this can be used to model a pump that has a minimum operating flowrate: in that case uThreshold should be set to the minimum flowrate and uMin should be set to 0. Another example is a control signal where uMin = -100, uMax = 100 and uThreshold = 10. This means that values between -100 and 100 are acceptable but values lower than 10 in absolute value will be set to zero.					

7	Gain constant	any	any	real	[-Inf;+Inf]	0
	This is the gain of the PID controller (Acts on the 3 parts of the signal: proportional, integral and derivative)					
8	Integral time	Time	hr	real	[0;+Inf]	0
	This is Ti, the integral (or reset) time of the controller. You can set Ti to 0 to disable integral control.					
9	Derivative time	Time	hr	real	[0;+Inf]	0
	This is Td, the derivative time of the controller. You can set Td to 0 to disable the derivative control.					
10	Tracking time for anti-windup	Time	hr	real	[-1;+Inf]	0
	Tracking (anti-windup) time constant. That time constant is used to de-saturate the integrator in case the control signal is saturated by the minimum, maximum or threshold values. 0 means no anti-windup (not recommended) and -1 means "use default value" (Tt = Ti). It is generally recommended to set Tt to 0.1 .. 1 Ti					
11	Fraction of ySet for proportional effect	Dimensionless	-	real	[0;1]	0
	b is the fraction of ySet used in the proportional effect: vp = Kc * (b*ySet-y). This parameter should be set between 0 and 1. Using values less than 1 allows for smoother transitions in case of fast setpoint changes but it will lead to a more slugish response to such a setpoint change.					
12	Fraction of ySet for derivative effect	Dimensionless	-	real	[0;1]	0
	g is the fraction of ySet used in the derivative effect, which is proportional to the derivative of (g*ySet-y). This parameter should be set to a value between 0 and 1. Using values less than 1 allows for smoother transitions in case of fast setpoint changes but it will lead to a more slugish response to such a setpoint change. Often in servo control g is 1 while in process control g is 0.					
13	High-frequency limit on derivative	Dimensionless	-	real	[0;+Inf]	0
	N is the high-frequency limit of the derivative gain. The derivative effect is basically multiplied by (Td/(Td+N delta_t)). N should be a positive number. N is usually set in the range [3 ; 20]. The default value is N=10.					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Control signal	any	any	real	[-Inf;+Inf]	0
	Control signal. This is the controller output					
2	Tracking error	any	any	real	[-Inf;+Inf]	0
	Tracking error (ySet-y)					
3	Unsaturated control signal	any	any	real	[-Inf;+Inf]	0
	Unsaturated control signal: calculated value before taking the minimum, maximum and threshold values into account. This output is mostly used for debugging purposes, the control signal (u) that should be connected to the controlled system is output 1.					
4	Proportional action	Dimensionless	-	real	[-Inf;+Inf]	0
	This is the part of the control signal that is proportional to the tracking error (before saturation)					
5	Integral action	Dimensionless	-	real	[-Inf;+Inf]	0
	This is the part of the control signal that is proportional to the integral of the tracking error (before saturation). Note that anti-windup has not been applied to this value.					
6	Derivative action	Dimensionless	-	real	[-Inf;+Inf]	0
	This is the part of the control signal that is proportional to the derivative of the tracking error (before saturation)					
7	Controller status	Dimensionless	-	real	[0;+Inf]	0
	Controller status. 0 means the controller is OFF. The following values are added to status to indicate the controller status: 1 if the controller is ON, 2 if the control signal is set to 0 because of the threshold value, 4 if it is constrained by the minimum value, 8 if it is constrained by the maximum value. All flags are summed so that the status for "ON, at the maximum value" is 1+8=9.					

4.2. Electrical

4.2.1. Batteries

4.2.1.1. Current as an input - Shepherd Equation

Icon		TRNSYS Model	Type 47
Proforma	Electrical\Batteries\Current as an input\Shepherd Equation\Type47d.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Mode	Dimensionless	-	integer	[4;4]	0
	Specify 4. Mode 4 corresponds to Shepherd equations, current given as input.					
2	Cell Energy Capacity	Electric Charge	Ah	real	[0;+Inf]	0
	Rated cell energy capacity. The battery capacity is obtained by multiplying the cell capacity by the number of cells in series and by the number of cells in parallel.					
3	Cells in parallel	Dimensionless	-	integer	[1;+Inf]	0
	Number of cells connected in parallel in the battery.					
4	Cells in series	Dimensionless	-	integer	[1;+Inf]	0
	Number of cells in series in the battery. A lead-acid battery cell has a rated voltage of 2V. So a 12V battery includes 6 cells in series, and a 24V battery includes 12 cells in series.					
5	Charging efficiency	Dimensionless	-	real	[0;1.0]	0
	The charging efficiency is typically high for low State of Charge (>=85%) but can drop below 50% for high State Of Charge (SOC higher than 90%). This model assumes a constant value.					
6	Max. current per cell charging	Electric current	amperes	real	[0;+Inf]	0
	Maximum allowed for cell charge current. This current should be set approximately to charge the battery in 5 hours ("C5"), i.e. 3.3 A if the cell capacity is 16.7 Ah. Too high values may lead to erroneous results. Use "C1" (i.e. 16.7 A for a 16.7 Ah cell) at most.					
7	Max. current per cell discharge	Electric current	amperes	real	[-Inf;0]	0
	Maximum allowed for cell discharge current (negative value). This current should be set approximately to discharge the battery in 5 hours ("C5"), i.e. 3.3 A if the cell capacity is 16.7 Ah. Too high values may lead to erroneous results. Use "C1" (i.e. 16.7 A for a 16.7 Ah cell) at most.					
8	Max. charge voltage per cell	Voltage	V	real	[1.8;2.8]	0
	The maximum allowed for each cell voltage in charge mode. Do not use values greater than 2.8V.					
9	Calculate discharge cutoff voltage	Dimensionless	-	real	[-1;+ Inf]	0
	Use -1 for automatic calculation of discharge cutoff voltage, or give a positive value. If the discharge cutoff voltage is given, it should be larger than 1.5V.					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Current	Electric Charge	Ah	real	[-Inf;+Inf]	0
	The current injected to the battery has a positive sign, while the current going from the battery to the load is negative.					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	State of charge	Electric Charge	Ah	real	[0;+Inf]	0
	The State Of Charge is expressed in the same units as the rated cell capacity (Ah). This value is given for one cell (all cells are assumed to be identical).					
2	Fractional state of charge	Dimensionless	-	real	[0;1]	0
	This is the ratio between the State Of Charge and the rated energy capacity.					
3	Power	Power	kJ/hr	real	[-Inf;+Inf]	0
	Power to (>0) or from (					
4	Power lost during charge	Power	kJ/hr	real	[-Inf;+Inf]	0
	Power loss. This is equal to (1-Efficiency)*Power when charging (0 else).					
5	Total current	Electric current	amperes	real	[-Inf;+Inf]	0
	Total current to (>0) or from the battery (					
6	Total voltage	Voltage	V	real	[-Inf;+Inf]	0
	Total voltage of the battery (Cell voltage * Nb of cells in series).					
7	Max. Power for charge	Power	kJ/hr	real	[-Inf;+Inf]	0
	Maximum power for battery charge (i.e. power corresponding to maximum charge current).					
8	Max. Power for discharge	Power	kJ/hr	real	[-Inf;+Inf]	0
	Maximum power for battery discharge (i.e. power corresponding to maximum discharge current) - Negative value.					
9	Discharge cutoff voltage (DCV)	Voltage	V	real	[-Inf;+Inf]	0
	Discharge cutoff voltage (computed if PAR(9)<0).					
10	Power corresponding to DCV	Power	kJ/hr	real	[-Inf;+Inf]	0
	Power corresponding to Discharge cutoff voltage.					
11	Charge cutoff voltage (CCV)	Voltage	V	real	[-Inf;+Inf]	0
	Charge cutoff voltage.					
12	Power corresponding to CCV	Power	kJ/hr	real	[-Inf;+Inf]	0
	Power corresponding to Charge cutoff voltage.					

DERIVATIVES

	Name	Dimension	Unit	Type	Range	Default
1	State of charge1	Electric Charge	Ah	real	[0;+Inf]	0
	Initial State Of Charge of one cell of the battery. This value should use the same units as parameter 2. The value is given for one cell. The SOC of the battery is obtained by multiplying this value by the number of cells.					

4.2.1.2. Current as an input - Shepherd modified Hyman Equation

Icon		TRNSYS Model	Type 47
Proforma	Electrical\Batteries\Current as an input\Shepherd modified Hyman Equation\Type47e.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Mode	Dimensionless	-	integer	[5;5]	0
	Specify 3. Mode 3 corresponds to Hyman (modified Shepherd) equations, current given as input.					
2	Cell Energy Capacity	Electric Charge	Ah	real	[0;+Inf]	0
	Rated cell energy capacity. The battery capacity is obtained by multiplying the cell capacity by the number of cells in series and by the number of cells in parallel.					
3	Cells in parallel	Dimensionless	-	integer	[1;+Inf]	0
	Number of cells connected in parallel in the battery.					
4	Cells in series	Dimensionless	-	integer	[1;+Inf]	0
	Number of cells in series in the battery. A lead-acid battery cell has a rated voltage of 2V. So a 12V battery includes 6 cells in series, and a 24V battery includes 12 cells in series.					
5	Charging efficiency	Dimensionless	-	real	[0;1.0]	0
	The charging efficiency is typically high for low State of Charge (>=85%) but can drop below 50% for high State Of Charge (SOC higher than 90%). This model assumes a constant value.					
6	Max. current per cell charging	Electric current	amperes	real	[0;+Inf]	0
	Maximum allowed for cell charge current. This current should be set approximately to charge the battery in 5 hours ("C5"), i.e. 3.3 A if the cell capacity is 16.7 Ah. Too high values may lead to erroneous results. Use "C1" (i.e. 16.7 A for a 16.7 Ah cell) at most.					
7	Max. current per cell discharge	Electric current	amperes	real	[-Inf;0]	0
	Maximum allowed for cell discharge current (negative value). This current should be set approximately to discharge the battery in 5 hours ("C5"), i.e. 3.3 A if the cell capacity is 16.7 Ah. Too high values may lead to erroneous results. Use "C1" (i.e. 16.7 A for a 16.7 Ah cell) at most.					
8	Max. charge voltage per cell	Voltage	V	real	[1.8;2.8]	0
	The maximum allowed for each cell voltage in charge mode. Do not use values greater than 2.8V.					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Current	Electric current	amperes	real	[-Inf;+Inf]	0
	The current injected to the battery has a positive sign, while the current going from the battery to the load is negative.					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	State of charge	Electric Charge	Ah	real	[-Inf;+Inf]	0
	The State Of Charge is expressed in the same units as the rated cell capacity (Ah). This value is given for one cell (all cells are assumed to be identical).					
2	Fractional state of charge	Dimensionless	-	real	[-Inf;+Inf]	0
	This is the ratio between the State Of Charge and the rated energy capacity.					
3	Power	Power	kJ/hr	real	[-Inf;+Inf]	0
	Power to (>0) or from (					

4	Power lost during charge	Power	kJ/hr	real	[-Inf;+Inf]	0
	Power lost. This is equal to (1-Efficiency)*Power when charging (0 else).					
5	Total current	Electric current	amperes	real	[-Inf;+Inf]	0
	Total current to (>0) or from the battery (					
6	Total voltage	Voltage	V	real	[-Inf;+Inf]	0
	Total voltage of the battery (Cell voltage * Nb of cells in series).					
7	Max. Power for charge	Power	kJ/hr	real	[-Inf;+Inf]	0
	Maximum power for battery charge (i.e. power corresponding to maximum charge current).					
8	Max. Power for discharge	Power	kJ/hr	real	[-Inf;+Inf]	0
	Maximum power for battery discharge (i.e. power corresponding to maximum discharge current) - Negative value.					
9	Discharge cutoff voltage (DCV)	Voltage	V	real	[-Inf;+Inf]	0
	Discharge cutoff voltage.					
10	Power corresponding to DCV	Power	kJ/hr	real	[-Inf;+Inf]	0
	Power corresponding to Discharge cutoff voltage.					
11	Charge cutoff voltage (CCV)	Voltage	V	real	[-Inf;+Inf]	0
	Charge cutoff voltage.					
12	Power corresponding to CCV	Power	kJ/hr	real	[-Inf;+Inf]	0
	Power corresponding to Charge cutoff voltage.					

DERIVATIVES

	Name	Dimension	Unit	Type	Range	Default
1	State of charge1	Electric Charge	Ah	real	[0;+Inf]	0
	Initial State Of Charge of one cell of the battery. This value should use the same units as parameter 2. The value is given for one cell. The SOC of the battery is obtained by multiplying this value by the number of cells.					

4.2.1.3. Power as an input - dQ_dt=P eff

Icon		TRNSYS Model	Type 47
Proforma	Electrical\Batteries\Power as an input\dQ_dt=P eff\Type47a.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Mode	Dimensionless	-	integer	[1;1]	0
	Specify 1. Mode 1 corresponds to a simple energy balance.					
2	Cell Energy Capacity	Energy	Wh	real	[0;+Inf]	0
	Rated Energy Capacity of each cell. The battery capacity is obtained by multiplying the cell capacity by the number of cells in series and by the number of cells in parallel.					
3	Cells in parallel	Dimensionless	-	integer	[1;+Inf]	0
	Number of cells connected in parallel in the battery.					
4	Cells in series	Dimensionless	-	integer	[1;+Inf]	0
	Number of cells in series in the battery. A lead-acid battery cell has a rated voltage of 2V. So a 12V battery includes 6 cells in series, and a 24V battery includes 12 cells in series.					
5	Charging efficiency	Dimensionless	-	real	[0;1.0]	0
	The charging efficiency is typically high for low State of Charge (>=85%) but can drop below 50% for high State Of Charge (SOC higher than 90%). This model assumes a constant value.					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Power to or from battery	Power	kJ/hr	real	[-Inf;+Inf]	0
	The power injected to the battery has a positive sign, while the power going from the battery to the load is negative.					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	State of charge	Energy	Wh	real	[0;+Inf]	0
	The State Of Charge is expressed in the same units as the rated cell capacity (Wh). This value is given for one cell (all cells are assumed to be identical).					
2	Fractional state of charge	Dimensionless	-	real	[0;1]	0
	This is the ratio between the State Of Charge and the rated energy capacity.					
3	Power	Power	kJ/hr	real	[-Inf;+Inf]	0
	Power to (>0) or from (					
4	Power lost during charge	Power	kJ/hr	real	[-Inf;+Inf]	0
	Power loss. This is equal to (1-Efficiency)*Power when charging (0 else).					

DERIVATIVES

	Name	Dimension	Unit	Type	Range	Default
1	State of charge1	Energy	Wh	real	[0;+Inf]	0
	Initial State Of Charge of one cell of the battery. This value should use the same units as parameter 2. The value is given for one cell. The SOC of the battery is obtained by multiplying this value by the number of cells.					

4.2.1.4. Power as an input - Shepherd Equation

Icon		TRNSYS Model	Type 47
Proforma	Electrical\Batteries\Power as an input\Shepherd Equation\Type47b.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Mode	Dimensionless	-	integer	[2;2]	0
	Specify 2. Mode 2 corresponds to Shepherd equations, power given as input.					
2	Cell Energy Capacity	Electric Charge	Ah	real	[0;+Inf]	0
	Rated cell energy capacity. The battery capacity is obtained by multiplying the cell capacity by the number of cells in series and by the number of cells in parallel.					
3	Cells in parallel	Dimensionless	-	integer	[1;+Inf]	0
	Number of cells connected in parallel in the battery.					
4	Cells in series	Dimensionless	-	integer	[1;+Inf]	0
	Number of cells in series in the battery. A lead-acid battery cell has a rated voltage of 2V. So a 12V battery includes 6 cells in series, and a 24V battery includes 12 cells in series.					
5	Charging efficiency	Dimensionless	-	real	[0;1.0]	0
	The charging efficiency is typically high for low State of Charge (>=85%) but can drop below 50% for high State Of Charge (SOC higher than 90%). This model assumes a constant value.					
6	Max. current per cell charging	Electric current	amperes	real	[0;+Inf]	0
	Maximum allowed for cell charge current. This current should be set approximately to charge the battery in 5 hours ("C5"), i.e. 3.3 A if the cell capacity is 16.7 Ah. Too high values may lead to erroneous results. Use "C1" (i.e. 16.7 A for a 16.7 Ah cell) at most.					
7	Max. current per cell discharge	Electric current	amperes	real	[-Inf;0]	0
	Maximum allowed for cell discharge current (negative value). This current should be set approximately to discharge the battery in 5 hours ("C5"), i.e. 3.3 A if the cell capacity is 16.7 Ah. Too high values may lead to erroneous results. Use "C1" (i.e. 16.7 A for a 16.7 Ah cell) at most.					
8	Max. charge voltage per cell	Voltage	V	real	[1.8;+2.8]	0
	The maximum allowed for each cell voltage in charge mode. Do no use values greater than 2.8V.					
9	Calculate discharge cutoff voltage	Dimensionless	-	real	[-1;2.5]	0
	Use -1 for automatic calculation of discharge cutoff voltage, or give a positive value. If the discharge cutoff voltage is given, it should be larger than 1.5V.					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Power to or from battery	Power	kJ/hr	real	[-inf;+Inf]	0
	The power injected to the battery has a positive sign, while the power going from the battery to the load is negative.					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	State of charge	Electric Charge	Ah	real	[0;+Inf]	0
	The State Of Charge is expressed in the same units as the rated cell capacity (Ah). This value is given for one cell (all cells are assumed to be identical).					
2	Fractional state of charge	Dimensionless	-	real	[-Inf;+Inf]	0
	This is the ratio between the State Of Charge and the rated energy capacity.					
3	Power	Power	kJ/hr	real	[-Inf;+Inf]	0

	Power to (>0) or from (					
4	Power lost during charge	Power	kJ/hr	real	[-Inf;+Inf]	0
	Power loss. This is equal to (1-Efficiency)*Power when charging (0 else).					
5	Total current	Electric current	amperes	real	[-Inf;+Inf]	0
	Total current to (>0) or from the battery (					
6	Total voltage	Voltage	V	real	[-Inf;+Inf]	0
	Total voltage of the battery (Cell voltage * Nb of cells in series).					
7	Max. Power for charge	Power	kJ/hr	real	[-Inf;+Inf]	0
	Maximum power for battery charge (i.e. power corresponding to maximum charge current).					
8	Max. Power for discharge	Power	kJ/hr	real	[-Inf;+Inf]	0
	Maximum power for battery discharge (i.e. power corresponding to maximum discharge current) - Negative value.					
9	Discharge cutoff voltage (DCV)	Voltage	V	real	[-Inf;+Inf]	0
	Discharge cutoff voltage (computed if PAR(9)<0).					
10	Power corresponding to DCV	Power	kJ/hr	real	[-Inf;+Inf]	0
	Power corresponding to Discharge cutoff voltage.					
11	Charge cutoff voltage (CCV)	Voltage	V	real	[-Inf;+Inf]	0
	Charge cutoff voltage.					
12	Power corresponding to CCV	Power	kJ/hr	real	[-Inf;+Inf]	0
	Power corresponding to Charge cutoff voltage.					

DERIVATIVES

	Name	Dimension	Unit	Type	Range	Default
1	State of charge1	Electric Charge	Ah	real	[0;+Inf]	0
	Initial State Of Charge of one cell of the battery. This value should use the same units as parameter 2. The value is given for one cell. The SOC of the battery is obtained by multiplying this value by the number of cells.					

4.2.1.5. Power as an input - Shepherd modified Hyman Equation

Icon		TRNSYS Model	Type 47
Proforma	Electrical\Batteries\Power as an input\Shepherd modified Hyman Equation\Type47c.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Mode	Dimensionless	-	integer	[3;3]	0
	Specify 3. Mode 3 corresponds to Hyman (modified Shepherd) equations, power given as input.					
2	Cell Energy Capacity	Electric Charge	Ah	real	[0;+Inf]	0
	Rated cell energy capacity. The battery capacity is obtained by multiplying the cell capacity by the number of cells in series and by the number of cells in parallel.					
3	Cells in parallel	Dimensionless	-	integer	[1;+Inf]	0
	Number of cells connected in parallel in the battery.					
4	Cells in series	Dimensionless	-	integer	[1;+Inf]	0
	Number of cells in series in the battery. A lead-acid battery cell has a rated voltage of 2V. So a 12V battery includes 6 cells in series, and a 24V battery includes 12 cells in series.					
5	Charging efficiency	Dimensionless	-	real	[0;1.0]	0
	The charging efficiency is typically high for low State of Charge (>=85%) but can drop below 50% for high State Of Charge (SOC higher than 90%). This model assumes a constant value.					
6	Max. current per cell charging	Electric current	amperes	real	[0;+Inf]	0
	Maximum allowed for cell charge current. This current should be set approximately to charge the battery in 5 hours ("C5"), i.e. 3.3 A if the cell capacity is 16.7 Ah. Too high values may lead to erroneous results. Use "C1" (i.e. 16.7 A for a 16.7 Ah cell) at most.					
7	Max. current per cell discharge	Electric current	amperes	real	[-Inf;0]	0
	Maximum allowed for cell discharge current (negative value). This current should be set approximately to discharge the battery in 5 hours ("C5"), i.e. 3.3 A if the cell capacity is 16.7 Ah. Too high values may lead to erroneous results. Use "C1" (i.e. 16.7 A for a 16.7 Ah cell) at most.					
8	Max. charge voltage per cell	Voltage	V	real	[1.8;2.8]	0
	The maximum allowed for each cell voltage in charge mode. Do no use values greater than 2.8V.					
9	Calculate discharge cutoff voltage	Dimensionless	-	real	[-1;2.5]	0
	Use -1 for automatic calculation of discharge cutoff voltage, or give a positive value. If the discharge cutoff voltage is given, it should be larger than 1.5V.					
10	Tolerance for iterative calculations	Electric current	amperes	real	[0;+Inf]	0
	Ic (charge)and Id (discharge) are calculated through an iterative process. This parameter gives the absolute tolerance on convergence check. The equation calculating V from P also requires iterations and the same value is used for the tolerance.					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Power to or from battery	Power	kJ/hr	real	[-Inf;+Inf]	0
	The power injected to the battery has a positive sign, while the power going from the battery to the load is negative.					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	State of charge	Electric Charge	Ah	real	[-Inf;+Inf]	0

	The State Of Charge is expressed in the same units as the rated cell capacity (Ah). This value is given for one cell (all cells are assumed to be identical).					
2	Fractional state of charge	Dimensionless	-	real	[-Inf;+Inf]	0
	This is the ratio between the State Of Charge and the rated energy capacity.					
3	Power	Power	kJ/hr	real	[-Inf;+Inf]	0
	Power to (>0) or from (					
4	Power lost during charge	Power	kJ/hr	real	[-Inf;+Inf]	0
	Power loss. This is equal to (1-Efficiency)*Power when charging (0 else).					
5	Total current	Electric current	amperes	real	[-Inf;+Inf]	0
	Total current to (>0) or from the battery (					
6	Total voltage	Voltage	V	real	[-Inf;+Inf]	0
	Total voltage of the battery (Cell voltage * Nb of cells in series).					
7	Max. Power for charge	Power	kJ/hr	real	[-Inf;+Inf]	0
	Maximum power for battery charge (i.e. power corresponding to maximum charge current).					
8	Max. Power for discharge	Power	kJ/hr	real	[-Inf;+Inf]	0
	Maximum power for battery discharge (i.e. power corresponding to maximum discharge current) - Negative value.					
9	Discharge cutoff voltage (DCV)	Voltage	V	real	[-Inf;+Inf]	0
	Discharge cutoff voltage (computed if PAR(9)<0).					
10	Power corresponding to DCV	Power	kJ/hr	real	[-Inf;+Inf]	0
	Power corresponding to Discharge cutoff voltage.					
11	Charge cutoff voltage (CCV)	Voltage	V	real	[-Inf;+Inf]	0
	Charge cutoff voltage.					
12	Power corresponding to CCV	Power	kJ/hr	real	[-Inf;+Inf]	0
	Power corresponding to Charge cutoff voltage.					

DERIVATIVES

	Name	Dimension	Unit	Type	Range	Default
1	State of charge1	Electric Charge	Ah	real	[0;+Inf]	0
	Initial State Of Charge of one cell of the battery. This value should use the same units as parameter 2. The value is given for one cell. The SOC of the battery is obtained by multiplying this value by the number of cells.					

4.2.1.6. With Gassing Current Effects

Icon		TRNSYS Model	Type 185
Proforma	Electrical\Batteries\With Gassing Current Effects\Type185.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	QBATNOM	any	any	real	[0;+Inf]	0
	Nominal capactiy of battery					
2	NCELLS	dimensionless	-	real	[1;+Inf]	0
	Number of cells in series.					
3	BATTYPE	dimensionless	-	real	[1;+Inf]	0
	Type of battery (no. in external file)					
4	Logical Unit for data file	dimensionless	-	real	[20;999]	0
	Logical unit for external battery parameter file					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	IBAT	Electric current	A	real	[-100;100]	0
	Total current inn/out of battery Charging = positive (+) current Discharging = negative (-) current					
2	TBAT	Temperature	C	real	[20;20]	0
	Battery temperature. All cells in a battery are assumed to hold the same temperature.					
3	SOC_INI	dimensionless	-	real	[0;100]	0
	State of Charge in percent (%). Only used in the initial zation of SOC at the first time step in the simulation.					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	UBAT	Voltage	V	real	[-Inf;+Inf]	0
	Voltage across battery terminals.					
2	SOC	dimensionless	-	real	[-Inf;+Inf]	0
	State of Charge in percent (%).					
3	QBAT	any	any	real	[-Inf;+Inf]	0
	Capacity of battery after charge/discharge					
4	UEQU	Voltage	V	real	[-Inf;+Inf]	0
	Equilibrium (resting) cell voltage.					
5	UPOL	Voltage	V	real	[-Inf;+Inf]	0
	Polarization cell voltage.					
6	IGAS	Electric current	amperes	real	[-Inf;+Inf]	0
	Gassing current per cell.					
7	PGAS	Power	W	real	[-Inf;+Inf]	0
	Power dissipated as a result of gassing.					
8	ICH	Electric current	A	real	[-Inf;+Inf]	0

	Charging current.					
9	PCH	Power	W	real	[-Inf;+Inf]	0
	Charging power.					
10	IDCH	Electric current	A	real	[-Inf;+Inf]	0
	Discharging current.					
11	PDCH	Power	W	real	[-Inf;+Inf]	0
	Discharging power.					
12	IDUMP	Electric current	A	real	[-Inf;+Inf]	0
	Dumped current. (Required to avoid complete battery overcharging.)					
13	IAUX	Electric current	A	real	[-Inf;+Inf]	0
	Auxiliary current required to prevent complete undercharging of the battery.					

EXTERNAL FILES

Question	File	Associated parameter
File with battery parameters	.\Examples\Data Files\Type185-BatteryWithGasingEffects.dat	Logical Unit for data file
Source file	.\SourceCode\Types\Type185.for	

4.2.2. Busbar

4.2.2.1. AC-busbar

Icon		TRNSYS Model	Type 188
Proforma	Electrical\Busbar\AC-busbar\Type188a.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	V_grid	Voltage	V	real	[200;66E3]	22E3
	Mini-grid voltage					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	P_WECS	Power	W	real	[0;+Inf]	10E6
	Power from wind energy conversion system (WECS)					
2	P_PV	Power	W	real	[0;+Inf]	10E3
	Power from photovoltaic (PV) system					
3	P_FC	Power	W	real	[0;+Inf]	0
	Power from fuel cell (FC) system					
4	P_RE	Power	W	real	[0;+Inf]	0
	Power from other renewable (RE) sources					
5	P_other	Power	W	real	[0;+Inf]	0
	Power from other sources (e.g., diesel gensets)					
6	P_ely	Power	W	real	[0;+Inf]	0
	Power to the electrolyzer system					
7	P_load	Power	W	real	[0;+Inf]	0
	Power to the user load					
8	P_aux	Power	W	real	[0;+Inf]	0
	Power to auxiliary equipment (e.g.,pumps, compressors, etc.)					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	P_grid	Power	W	real	[0;+Inf]	0
	Excess power available on the mini-grid (negative value is deficit power)					
2	U_grid	Voltage	V	real	[200;66E3]	0
	Mini-grid voltage					

4.2.3. Diesel Engine (DEGS)

4.2.3.1. DEGS Dispatch Controller

Icon		TRNSYS Model	Type 102
Proforma	Electrical\Diesel Engine (DEGS)\DEGS Dispatch Controller\Type102a.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	NMIN	dimensionless	-	integer	[0;5]	1
	Minimum allowable number of DEGS in operation					
2	NMAX	dimensionless	-	integer	[1;5]	0.2
	Maximum allowable number of DEGS in operation					
3	PRATED	Power	kW	real	[1;+Inf]	0
	Rated power of each DEGS					
4	XLOW	dimensionless	-	real	[0;1]	0
	Lower power set point, usually about 40-50% of rated power (X=P/Prated).					
5	XUP	dimensionless	-	real	[0;1]	0
	Upper power set point, usually 80-90% of rated power (X=P/Prated)					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	PLOAD	Power	W	real	[0;+Inf]	0
	Total load to be met by one or several DEGS					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	PDEGS	Power	W	real	[0;+Inf]	0
	Power set point for a single DEGS					
2	NDEGS	dimensionless	-	integer	[1;5]	0
	Total number of DEGS required to meet load.					

4.2.3.2. Generic Model

Icon		TRNSYS Model	Type 120
Proforma	Electrical\Diesel Engine (DEGS)\Generic Model\Type120a.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	MODE	dimensionless	-	integer	[1;1]	0
	1 = Generic Model, 2 = Specific DEGS					
2	FUELTYPE	dimensionless	-	integer	[1;6]	0
	1 = Diesel, 2 = LPG, 3 = Propane, 4 = Methane, 5 = Natural gas, 6 = Hydrogen					
3	PMAX	Power	kW	real	[0;+Inf]	0
	Maximum allowable power. Usually 20% above rated power.					
4	PMIN	Power	kW	real	[0;+Inf]	0
	Minimum allowable power. For a single DEGS placed in parallel with many DEGSs, this value is usually about 40% of rated power					
5	PRATED	Power	kW	real	[0;+Inf]	0
	Rated power in kW. Usually, 20% lower than rated power in kW and 20% lower than maximum allowable power (PMAX).					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	SWITCH	dimensionless	-	real	[0;1]	0
	ON/OFF-switch for the DEGS (1 = ON, 0 = OFF)					
2	P_SET	Power	W	real	[0;500000]	0
	Power set point for one single DEGS (signal from DEGS controller)					
3	NUNITS	dimensionless	-	integer	[0;100]	0
	Number of identical units in operation (needs to be decided by the DEGS controller)					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	PTOTAL	Power	W	real	[0;+Inf]	0
	Total power output					
2	V_LIQ	Volumetric Flow Rate	l/hr	real	[0;+Inf]	0
	Total liquid fuel consumption rate					
3	V_GAS	any	Nm3/h	real	[0;+Inf]	0
	Total gas fuel consumption rate					
4	ETA_FUEL	any	kWh/L	real	[0;+Inf]	0
	Fuel efficiency					
5	ETA_EL	dimensionless	-	real	[0;+Inf]	0
	Electrical efficiency					
6	Q_WASTE	Power	W	real	[0;+Inf]	0
	Total waste heat					

4.2.3.3. Specific DEGS

Icon		TRNSYS Model	Type 120
Proforma	Electrical\Diesel Engine (DEGS)\Specific DEGS\Type120b.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	MODE	dimensionless	-	integer	[2;2]	0
	1 = Generic Model, 2 = Specific DEGS					
2	FUELTYPE	dimensionless	-	integer	[1;6]	0
	1 = Diesel, 2 = LPG, 3 = Propane, 4 = Methane, 5 = Natural gas, 6 = Hydrogen					
3	PMAX	Power	kW	real	[0;+Inf]	0
	Maximum allowable power. Usually 20% above rated power.					
4	PMIN	Power	kW	real	[0;+Inf]	0
	Minimum allowable power. For a single DEGS placed in parallel with many DEGSs, this value is usually about 40% of rated power					
5	DEGSTYPE	dimensionless	-	integer	[1;+Inf]	0
	Type of DEGS (se data file for details)					
6	Logical unit for data file	dimensionless	-	integer	[30;999]	0
	Logical Unit identifier for external file					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	SWITCH	dimensionless	-	real	[0;1]	0
	ON/OFF-switch for the DEGS (1 = ON, 0 = OFF)					
2	P_SET	Power	W	real	[0;500000]	0
	Power set point for one single DEGS (signal from DEGS controller)					
3	NUNITS	dimensionless	-	integer	[0;100]	0
	Number of identical units in operation (needs to be decided by the DEGS controller)					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	PTOTAL	Power	W	real	[0;+Inf]	0
	Total power output					
2	V_LIQ	Volumetric Flow Rate	l/hr	real	[0;+Inf]	0
	Total liquid fuel consumption rate					
3	V_GAS	any	Nm3/h	real	[0;+Inf]	0
	Total gas fuel consumption rate					
4	ETA_FUEL	any	kWh/L	real	[0;+Inf]	0
	Fuel efficiency					
5	ETA_EL	dimensionless	-	real	[0;+Inf]	0
	Electrical efficiency					
6	Q_WASTE	Power	W	real	[0;+Inf]	0
	Total waste heat					

EXTERNAL FILES

Question	File	Associated parameter
File with DEGS-parameters	.\Examples\Data Files\Type120-DieselEngineGeneratorSet.dat	Logical unit for data file
Source file	.\SourceCode\Types\Type120.for	

4.2.4. Photovoltaic Panels

4.2.4.1. 5-Parameters Model according to DeSoto

Icon		TRNSYS Model	Type 194
Proforma	Electrical\Photovoltaic Panels\5-Parameters model\Type194a.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Mode	dimensionless	-	integer	[1;1]	1
2	Module short-circuit current at reference conditions	Electric current	amperes	real	[0;+Inf]	0
3	Module open-circuit voltage at reference conditions	Voltage	V	real	[0;+Inf]	0
4	Reference temperature	Temperature	K	real	[0;+Inf]	0
5	Reference insolation	Flux	W/m^2	real	[0;+Inf]	0
6	Module voltage at max power point and reference conditions	Voltage	V	real	[0;+Inf]	0
7	Module current at max power point and reference conditions	Electric current	amperes	real	[0;+Inf]	0
8	Temperature coeficient of Isc at (ref. cond)	any	any	real	[-Inf;+Inf]	0
9	Temperature coeficient of Voc (ref. cond.)	any	any	real	[-Inf;+Inf]	0
10	Number of cells wired in series	dimensionless	-	integer	[1;+Inf]	0
11	Number of modules in series	dimensionless	-	integer	[1;+Inf]	0
12	Number of modules in parallel	dimensionless	-	integer	[1;+Inf]	0
13	Module temperature at NOCT	Temperature	K	real	[0;+Inf]	0
14	Ambient temperature at NOCT	Temperature	K	real	[0;+Inf]	0
15	Insolation at NOCT	Flux	W/m^2	real	[0;+Inf]	0
16	Module area	Area	m^2	real	[0;+Inf]	0
17	tau-alpha product for normal incidence	dimensionless	-	real	[0;1]	0
18	Semiconductor bandgap	any	any	real	[-Inf;+Inf]	0
19	Value of parameter **a** at reference conditions	dimensionless	any	real	[0;+Inf]	1.9
20	Value of parameter **I_L** at reference conditions	Electric current	amperes	real	[0;+Inf]	5.4
21	Value of parametre **I_0** at reference conditions	Electric current	amperes	real	[0;+Inf]	0
22	Module series resistance	dimensionless	-	real	[-Inf;+Inf]	0.5
23	Shunt resistance at reference conditions	dimensionless	-	real	[-Inf;+Inf]	16
24	Calculate maximum power as outputs? (0=no, 1=yes)	dimensionless	-	boolean	[0,1]	1
	Extinction coefficient-thickness product of cover	dimensionless	-	real	[-	0.008

					Inf;+Inf]	

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Total incident radiation on horizontal	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
2	Ambient temperature	Temperature	K	real	[-Inf;+Inf]	0
3	Load voltage	Voltage	V	real	[-Inf;+Inf]	0
4	Ground reflectance	dimensionless	-	integer	[0;1]	0
5	Array slope	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
6	Beam radiation on horizontal	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
7	Incidence angle of beam radiation	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
8	Solar zenith angle	Direction (Angle)	degrees	real	[-Inf;+Inf]	0

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Array voltage	Voltage	V	real	[-Inf;+Inf]	0
2	Array current	Electric current	amperes	real	[-Inf;+Inf]	0
3	Array power	Power	W	real	[-Inf;+Inf]	0
4	Power at maximum power point	Power	W	real	[-Inf;+Inf]	0
5	Fraction of maximum power used	dimensionless	-	real	[-Inf;+Inf]	0
6	Voltage at MPP	Voltage	V	real	[-Inf;+Inf]	0
7	Current at MPP	Electric current	amperes	real	[-Inf;+Inf]	0
8	Open circuit voltage	Voltage	V	real	[-Inf;+Inf]	0
9	Short circuit current	Electric current	amperes	real	[-Inf;+Inf]	0
10	Array fill factor	dimensionless	-	real	[-Inf;+Inf]	0
11	Array temperature	Temperature	K	real	[-Inf;+Inf]	0
12	Conversion efficiency	dimensionless	-	real	[0;1]	0

4.2.4.2. Crystalline Modules

Icon		TRNSYS Model	Type 94
Proforma	Electrical\Photovoltaic Panels\Crystalline Modules\Type94a.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Module short-circuit current at reference conditions	Electric current	amperes	real	[0;+Inf]	0
2	Module open-circuit voltage at reference conditions	Voltage	V	real	[0;+Inf]	0
3	Reference temperature	Temperature	K	real	[0;+Inf]	0
4	Reference insolation	Flux	W/m^2	real	[0;+Inf]	0
5	Module voltage at max power point and reference conditions	Voltage	V	real	[0;+Inf]	0
6	Module current at max power point and reference conditions	Electric current	amperes	real	[0;+Inf]	0
7	Temperature coeficient of Isc at (ref. cond)	any	any	real	[-Inf;+Inf]	0
8	Temperature coeficient of Voc (ref. cond.)	any	any	real	[-Inf;+Inf]	0
9	Number of cells wired in series	dimensionless	-	integer	[1;+Inf]	0
10	Number of modules in series	dimensionless	-	integer	[1;+Inf]	0
11	Number of modules in parallel	dimensionless	-	integer	[1;+Inf]	0
12	Module temperature at NOCT	Temperature	K	real	[0;+Inf]	0
13	Ambient temperature at NOCT	Temperature	K	real	[0;+Inf]	0
14	Insolation at NOCT	Flux	W/m^2	real	[0;+Inf]	0
15	Module area	Area	m^2	real	[0;+Inf]	0
16	tau-alpha product for normal incidence	dimensionless	-	real	[0;1]	0
17	Semiconductor bandgap	any	any	real	[-Inf;+Inf]	0
18	Slope of IV curve at Isc	any	any	real	[0;0]	0
19	Module series resistance	any	any	real	[-Inf;+Inf]	0

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Total incident radiation	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
2	Ambient temperature	Temperature	K	real	[-Inf;+Inf]	0
3	Load voltage	Voltage	V	real	[-Inf;+Inf]	0
4	Flag for convergence promotion	dimensionless	-	integer	[0;1]	0
5	Array slope	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
6	Beam radiation	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
7	Diffuse radiation	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
8	Incidence angle of beam radiation	Direction (Angle)	degrees	real	[-Inf;+Inf]	0

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Array voltage	Voltage	V	real	[-Inf;+Inf]	0
2	Array current	Electric current	amperes	real	[-Inf;+Inf]	0
3	Array power	Power	W	real	[-Inf;+Inf]	0

4	Power at maximum power point	Power	W	real	[-Inf;+Inf]	0
5	Fraction of maximum power used	dimensionless	-	real	[-Inf;+Inf]	0
6	Voltage at MPP	Voltage	V	real	[-Inf;+Inf]	0
7	Current at MPP	Electric current	amperes	real	[-Inf;+Inf]	0
8	Open circuit voltage	Voltage	V	real	[-Inf;+Inf]	0
9	Short circuit current	Electric current	amperes	real	[-Inf;+Inf]	0
10	Array fill factor	dimensionless	-	real	[-Inf;+Inf]	0
11	Array temperature	Temperature	K	real	[-Inf;+Inf]	0

4.2.4.3. PV-Thermal Collectors - Concentrating Collectors - Constant Losses - Cell Operating V is input

Icon		TRNSYS Model	Type 50
Proforma	Electrical\Photovoltaic Panels\PV-Thermal Collectors\Concentrating Collectors\Constant Losses\Cell Operating V is input\Type50g.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Mode	dimensionless	-	integer	[7;7]	0
2	Collector Area	Area	m^2	real	[0;+Inf]	0
3	Ratio of aperture to absorber area	dimensionless	-	real	[0;1.0]	0
4	Fluid thermal capacitance	any	any	real	[0;+Inf]	0
5	Plate absorptance	dimensionless	-	real	[0;1.0]	0
6	fin efficiency area ratio	dimensionless	-	real	[0;1.0]	0
7	Back loss coefficient for no-flow condition	Heat Transfer Coeff.	W/m^2.K	real	[0;+Inf]	0
8	Thermal conductance between cells and absorber	Overall Loss Coefficient	kJ/hr.K	real	[0;+Inf]	0
9	Heat transfer coefficient	Heat Transfer Coeff.	W/m^2.K	real	[0;+Inf]	0
10	Cover plate transmittance	dimensionless	-	real	[0;1.0]	0
11	Front loss coefficient for cells	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[0;+Inf]	0
12	Logical unit for SOLCEL data file	dimensionless	-	integer	[10;30]	0

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Inlet fluid temperature	Temperature	C	real	[-Inf;+Inf]	0
2	Fluid mass flow rate	Flow Rate	kg/hr	real	[-Inf;+Inf]	0
3	Ambient temperature	Temperature	C	real	[-Inf;+Inf]	0
4	Incident radiation	Power	kJ/hr	real	[-Inf;+Inf]	0
5	Voltage applied to array	Voltage	V	real	[-Inf;+Inf]	0

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Outlet fluid temperature	Temperature	C	real	[-Inf;+Inf]	0
2	Fluid flowrate	Flow Rate	kg/hr	real	[-Inf;+Inf]	0
3	Rate of useful energy gain	Power	kJ/hr	real	[-Inf;+Inf]	0
4	Collector loss coefficient	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[-Inf;+Inf]	0
5	Transmittance-absorptance product	dimensionless	-	real	[-Inf;+Inf]	0
6	Electrical power output	Power	kJ/hr	real	[-Inf;+Inf]	0
7	Average cell temperature	Temperature	C	real	[-Inf;+Inf]	0
8	Apparent thermal loss coefficient	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[-Inf;+Inf]	0
9	Array voltage	Voltage	V	real	[-Inf;+Inf]	0
10	Array current	Electric current	amperes	real	[-Inf;+Inf]	0
11	Cell temperature at collector inlet	Temperature	C	real	[-Inf;+Inf]	0

EXTERNAL FILES

Question	File	Associated parameter
What is the logical unit number of the SOLCEL data?		Logical unit for SOLCEL data file
Source file	.\SourceCode\Types\Type50.for	

4.2.4.4. PV-Thermal Collectors - Concentrating Collectors - Constant Losses - No cell operating voltage

Icon		TRNSYS Model	Type 50
Proforma	Electrical\Photovoltaic Panels\PV-Thermal Collectors\Concentrating Collectors\Constant Losses\No cell operating voltage\Type50e.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Mode	dimensionless	-	integer	[5;5]	0
2	Collector Area	Area	m^2	real	[0;+Inf]	0
3	Ratio of aperture to absorber area	dimensionless	-	real	[0;1.0]	0
4	Fluid thermal capacitance	any	any	real	[0;+Inf]	0
5	Plate absorptance	dimensionless	-	real	[0;1.0]	0
6	fin efficiency area ratio	dimensionless	-	real	[0;1.0]	0
7	Back loss coefficient for no-flow condition	Heat Transfer Coeff.	W/m^2.K	real	[0;+Inf]	0
8	Thermal conductance between cells and absorber	Overall Loss Coefficient	kJ/hr.K	real	[0;+Inf]	0
9	Heat transfer coefficient	Heat Transfer Coeff.	W/m^2.K	real	[0;+Inf]	0
10	Cover plate transmittance	dimensionless	-	real	[0;1.0]	0
11	Front loss coefficient for cells	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[0;+Inf]	0
12	Logical unit for SOLCEL data file	dimensionless	-	integer	[10;30]	0

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Inlet fluid temperature	Temperature	C	real	[-Inf;+Inf]	0
2	Fluid mass flow rate	Flow Rate	kg/hr	real	[-Inf;+Inf]	0
3	Ambient temperature	Temperature	C	real	[-Inf;+Inf]	0
4	Incident radiation	Power	kJ/hr	real	[-Inf;+Inf]	0

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Outlet fluid temperature	Temperature	C	real	[-Inf;+Inf]	0
2	Fluid flowrate	Flow Rate	kg/hr	real	[-Inf;+Inf]	0
3	Rate of useful energy gain	Power	kJ/hr	real	[-Inf;+Inf]	0
4	Collector loss coefficient	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[-Inf;+Inf]	0
5	Transmittance-absorptance product	dimensionless	-	real	[-Inf;+Inf]	0
6	Electrical power output	Power	kJ/hr	real	[-Inf;+Inf]	0
7	Average cell temperature	Temperature	C	real	[-Inf;+Inf]	0
8	Apparent thermal loss coefficient	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[-Inf;+Inf]	0
9	Array voltage	Voltage	V	real	[-Inf;+Inf]	0
10	Array current	Electric current	amperes	real	[-Inf;+Inf]	0
11	Cell temperature at collector inlet	Temperature	C	real	[-Inf;+Inf]	0

EXTERNAL FILES

Question	File	Associated parameter
What is the logical unit number of the SOLCEL data?		Logical unit for SOLCEL data file
Source file	.\SourceCode\Types\Type50.for	

4.2.4.5. PV-Thermal Collectors - Concentrating Collectors - Top Loss f(Wind, Temp) - Cell operating voltage is input

Icon		TRNSYS Model	Type 50
Proforma	Electrical\Photovoltaic Panels\PV-Thermal Collectors\Concentrating Collectors\Top Loss f(Wind, Temp)\Cell operating voltage is input\Type50h.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Mode	dimensionless	-	integer	[6;6]	0
2	Collector Area	Area	m^2	real	[0;+Inf]	0
3	Ratio of aperture to absorber area	dimensionless	-	real	[0;1.0]	0
4	Fluid thermal capacitance	any	any	real	[0;+Inf]	0
5	Plate absorptance	dimensionless	-	real	[0;1.0]	0
6	Fin efficiency area ratio	dimensionless	-	real	[0;1.0]	0
7	Back loss coefficient for no-flow condition	Heat Transfer Coeff.	W/m^2.K	real	[0;+Inf]	0
8	Thermal conductance between cells and absorber	Overall Loss Coefficient	kJ/hr.K	real	[0;+Inf]	0
9	Heat transfer coefficient	Heat Transfer Coeff.	W/m^2.K	real	[0;+Inf]	0
10	Cover plate transmittance	dimensionless	-	real	[0;1.0]	0
11	Number of glass covers	dimensionless	-	integer	[0;3]	0
12	Absorber plate emittance	dimensionless	-	real	[0;1.0]	0
13	Logical unit for SOLCEL data	dimensionless	-	integer	[10;30]	0

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Inlet fluid temperature	Temperature	C	real	[-Inf;+Inf]	0
2	Fluid mass flow rate	Flow Rate	kg/hr	real	[-Inf;+Inf]	0
3	Ambient temperature	Temperature	C	real	[-Inf;+Inf]	0
4	Incident radiation	Power	kJ/hr	real	[-Inf;+Inf]	0
5	Wind speed	Velocity	m/s	real	[-Inf;+Inf]	0
6	Collector slope	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
7	Voltage applied to array	Voltage	V	real	[-Inf;+Inf]	0

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Outlet fluid temperature	Temperature	C	real	[-Inf;+Inf]	0
2	Fluid flowrate	Flow Rate	kg/hr	real	[-Inf;+Inf]	0
3	Rate of useful energy gain	Power	kJ/hr	real	[-Inf;+Inf]	0
4	Collector loss coefficient	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[-Inf;+Inf]	0
5	Transmittance-absorptance product	dimensionless	-	real	[-Inf;+Inf]	0
6	Electrical power output	Power	kJ/hr	real	[-Inf;+Inf]	0
7	Average cell temperature	Temperature	C	real	[-Inf;+Inf]	0

8	Apparent thermal loss coefficient	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[-Inf;+Inf]	0
9	Array voltage	Voltage	V	real	[-Inf;+Inf]	0
10	Array current	Electric current	amperes	real	[-Inf;+Inf]	0
11	Cell temperature at collector inlet	Temperature	C	real	[-Inf;+Inf]	0

EXTERNAL FILES

Question	File	Associated parameter
What is the logical unit of the SOLCEL data file?		Logical unit for SOLCEL data
Source file	.\SourceCode\Types\Type50.for	

4.2.4.6. PV-Thermal Collectors - Concentrating Collectors - Top Loss f(Wind, Temp) - No cell operating voltage

Icon		TRNSYS Model	Type 50
Proforma	Electrical\Photovoltaic Panels\PV-Thermal Collectors\Concentrating Collectors\Top Loss f(Wind, Temp)\No cell operating voltage\Type50f.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Mode	dimensionless	-	integer	[6;6]	0
2	Collector Area	Area	m^2	real	[0;+Inf]	0
3	Ratio of aperture to absorber area	dimensionless	-	real	[0;1.0]	0
4	Fluid thermal capacitance	any	any	real	[0;+Inf]	0
5	Plate absorptance	dimensionless	-	real	[0;1.0]	0
6	Fin efficiency area ratio	dimensionless	-	real	[0;1.0]	0
7	Back loss coefficient for no-flow condition	Heat Transfer Coeff.	W/m^2.K	real	[0;+Inf]	0
8	Thermal conductance between cells and absorber	Overall Loss Coefficient	kJ/hr.K	real	[0;+Inf]	0
9	Heat transfer coefficient	Heat Transfer Coeff.	W/m^2.K	real	[0;+Inf]	0
10	Cover plate transmittance	dimensionless	-	real	[0;1.0]	0
11	Number of glass covers	dimensionless	-	integer	[0;3]	0
12	Absorber plate emittance	dimensionless	-	real	[0;1.0]	0
13	Logical unit of SOLCEL data	dimensionless	-	integer	[10;30]	0

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Inlet fluid temperature	Temperature	C	real	[-Inf;+Inf]	0
2	Fluid mass flow rate	Flow Rate	kg/hr	real	[-Inf;+Inf]	0
3	Ambient temperature	Temperature	C	real	[-Inf;+Inf]	0
4	Incident radiation	Power	kJ/hr	real	[-Inf;+Inf]	0
5	Wind speed	Velocity	m/s	real	[-Inf;+Inf]	0
6	Collector slope	Direction (Angle)	degrees	real	[-Inf;+Inf]	0

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Outlet fluid temperature	Temperature	C	real	[-Inf;+Inf]	0
2	Fluid flowrate	Flow Rate	kg/hr	real	[-Inf;+Inf]	0
3	Rate of useful energy gain	Power	kJ/hr	real	[-Inf;+Inf]	0
4	Collector loss coefficient	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[-Inf;+Inf]	0
5	Transmittance-absorptance product	dimensionless	-	real	[-Inf;+Inf]	0
6	Electrical power output	Power	kJ/hr	real	[-Inf;+Inf]	0
7	Average cell temperature	Temperature	C	real	[-Inf;+Inf]	0
8	Apparent thermal loss coefficient	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[-Inf;+Inf]	0
9	Array voltage	Voltage	V	real	[-Inf;+Inf]	0

10	Array current	Electric current	amperes	real	[-Inf;+Inf]	0
11	Cell temperature at collector inlet	Temperature	C	real	[-Inf;+Inf]	0

EXTERNAL FILES

Question	File	Associated parameter
What is the logical unit of the SOLCEL data file?		
Source file	.\SourceCode\Types\Type50.for	

4.2.4.7. PV-Thermal Collectors - Flat Plate Collectors - Angular dependence of Transmitance

Icon		TRNSYS Model	Type 50
Proforma	Electrical\Photovoltaic Panels\PV-Thermal Collectors\Flat Plate Collectors\Angular dependence of Transmitance\Type50c.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Mode	dimensionless	-	integer	[3;3]	0
2	Collector Area	Area	m^2	real	[0;+Inf]	0
3	Collector Efficiency Factor	dimensionless	-	real	[0;1]	0
4	Fluid Thermal Capacitance	Specific Heat	kJ/kg.K	real	[-Inf;+Inf]	0
5	Collector plate absorptance	dimensionless	-	real	[0;1.0]	0
6	Number of glass covers	dimensionless	-	integer	[0;3]	0
7	Collector loss coefficient	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[-Inf;+Inf]	0
8	Extinction coefficient thickness product	dimensionless	-	real	[-Inf;+Inf]	0
9	Temperature coeficient of PV cell efficiency	any	any	real	[-Inf;+Inf]	0
10	Temperature for cell reference efficiency	Temperature	K	real	[-Inf;+Inf]	0
11	Packing factor	dimensionless	-	real	[0;1.0]	0

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Inlet fluid temperature	Temperature	C	real	[-Inf;+Inf]	0
2	Fluid mass flow rate	Flow Rate	kg/hr	real	[-Inf;+Inf]	0
3	Ambient temperature	Temperature	C	real	[-Inf;+Inf]	0
4	Incident beam radiation	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
5	Incident diffuse radiation	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
6	Incidence angle of beam radiation	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
7	Cell efficiency	dimensionless	-	real	[-Inf;+Inf]	0

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Outlet fluid temperature	Temperature	C	real	[-Inf;+Inf]	0
2	Fluid flowrate	Flow Rate	kg/hr	real	[-Inf;+Inf]	0
3	Rate of useful energy gain	Power	kJ/hr	real	[-Inf;+Inf]	0
4	Collector loss coefficient	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[-Inf;+Inf]	0
5	Transmittance-absorptance product	dimensionless	-	real	[-Inf;+Inf]	0
6	Electrical power output	Power	kJ/hr	real	[-Inf;+Inf]	0
7	Average cell temperature	Temperature	C	real	[-Inf;+Inf]	0
8	Apparent thermal loss coefficient	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[-Inf;+Inf]	0

4.2.4.8. PV-Thermal Collectors - Flat Plate Collectors - Constant Losses

Icon		TRNSYS Model	Type 50
Proforma	Electrical\Photovoltaic Panels\PV-Thermal Collectors\Flat Plate Collectors\Constant Losses\Type50a.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Mode	Dimensionless	-	integer	[1;1]	0
	Mode: Specify 1.					
2	Collector Area	Area	m^2	real	[0;+Inf]	0
	Total Collector Area.					
3	Collector Fin Efficiency Factor	Dimensionless	-	real	[0;1]	0
	F', Collector fin efficiency factor. At a particular location, F' is the ratio of the actual useful energy gain to the useful energy gain that would result if the collector absorbing surface had been at the local fluid temperature.					
4	Fluid Thermal Capacitance	Specific Heat	kJ/kg.K	real	[-Inf;+Inf]	0
	Fluid thermal capacitance.					
5	Collector plate absorptance	Dimensionless	-	real	[0;1]	0
	Collector plate absorptance (visible wavelength range).					
6	Collector loss coefficient	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[-Inf;+Inf]	0
	Collector loss coefficient, assumed to be constant.					
7	Cover transmittance	Dimensionless	-	real	[0;1]	0
	Cover transmittance (visible wavelength range).					
8	Temperature coefficient of solar cell efficiency	Dimensionless	-	real	[0;+Inf]	0
	C, Temperature coefficient of solar cell efficiency. Eff (T) = Eff(TRef) * (1-C*(T-TRef)).					
9	Reference temperature for cell efficiency	Temperature	C	real	[-Inf;+Inf]	0
	Reference temperature for solar cell efficiency.					
10	Packing factor	Dimensionless	-	real	[0;1]	0
	Packing factor: ratio of PV cell area to absorber area.					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Inlet fluid temperature	Temperature	C	real	[-Inf;+Inf]	0
	Inlet fluid temperature.					
2	Fluid mass flow rate	Flow Rate	kg/hr	real	[-Inf;+Inf]	0
	Fluid mass flowrate in the collector.					
3	Ambient temperature	Temperature	C	real	[-Inf;+Inf]	0
	Ambient temperature.					
4	Incident radiation	Power	kJ/hr	real	[-Inf;+Inf]	0
	Total solar radiation incident on the collector.					
5	Cell efficiency	Dimensionless	-	real	[0;1]	0
	PV Cell efficiency, [0-1] scale.					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Outlet fluid temperature	Temperature	C	real	[-Inf;+Inf]	0
2	Fluid flowrate	Flow Rate	kg/hr	real	[-Inf;+Inf]	0
3	Rate of useful energy gain	Power	kJ/hr	real	[-Inf;+Inf]	0
4	Collector loss coefficient	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[-Inf;+Inf]	0
5	transmitance-absorptance product	dimensionless	-	real	[-Inf;+Inf]	0
6	Electrical power output	Power	kJ/hr	real	[-Inf;+Inf]	0
7	Average cell temperature	Temperature	C	real	[-Inf;+Inf]	0
8	Apparent thermal loss coefficient	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[-Inf;+Inf]	0

4.2.4.9. PV-Thermal Collectors - Flat Plate Collectors - Loss=f(T,WS,G) and t=f(angle)

Icon		TRNSYS Model	Type 50
Proforma	Electrical\Photovoltaic Panels\PV-Thermal Collectors\Flat Plate Collectors\Loss=f(T,WS,G) and t=f(angle)\Type50d.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Mode	dimensionless	-	integer	[4;4]	0
2	Collector Area	Area	m^2	real	[0;+Inf]	0
3	Collector Efficiency Factor	dimensionless	-	real	[0;1]	0
4	Fluid Thermal Capacitance	Specific Heat	kJ/kg.K	real	[-Inf;+Inf]	0
5	Collector plate absorptance	dimensionless	-	real	[0;1.0]	0
6	Number of glass covers	dimensionless	-	integer	[0;10]	0
7	Collector plate emittance	dimensionless	-	real	[0;1.0]	0
8	Loss coefficient for bottom and edge losses	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[-Inf;+Inf]	0
9	Collector slope	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
10	Extinction coefficient thickness product	dimensionless	-	real	[-Inf;+Inf]	0
11	Temperature coefficient of PV cell efficiency	any	any	real	[-Inf;+Inf]	0
12	Temperature for cell reference efficiency	Temperature	K	real	[-Inf;+Inf]	0
13	Packing factor	dimensionless	-	real	[0;1.0]	0

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Inlet fluid temperature	Temperature	C	real	[-Inf;+Inf]	0
2	Fluid mass flow rate	Flow Rate	kg/hr	real	[-Inf;+Inf]	0
3	Ambient temperature	Temperature	C	real	[-Inf;+Inf]	0
4	Incident beam radiation	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
5	Incident diffuse radiation	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
6	Incidence angle of beam radiation	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
7	Windspeed	Velocity	m/s	real	[-Inf;+Inf]	0
8	Cell Efficiency at reference conditions	dimensionless	-	real	[-Inf;+Inf]	0

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Outlet fluid temperature	Temperature	C	real	[-Inf;+Inf]	0
2	Fluid flowrate	Flow Rate	kg/hr	real	[-Inf;+Inf]	0
3	Rate of useful energy gain	Power	kJ/hr	real	[-Inf;+Inf]	0
4	Collector loss coefficient	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[-Inf;+Inf]	0
5	Transmittance-absorptance product	dimensionless	-	real	[-Inf;+Inf]	0
6	Electrical power output	Power	kJ/hr	real	[-Inf;+Inf]	0
7	Average cell temperature	Temperature	C	real	[-Inf;+Inf]	0

8	Apparent thermal loss coefficient	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[-Inf;+Inf]	0

4.2.4.10. PV-Thermal Collectors - Flat Plate Collectors - Losses=f(Temp, wind, geometry)

Icon		TRNSYS Model	Type 50
Proforma	Electrical\Photovoltaic Panels\PV-Thermal Collectors\Flat Plate Collectors\Losses=f(Temp, wind, geometry)\Type50b.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Mode	Dimensionless	-	integer	[2;2]	0
	Mode: Specify 2.					
2	Collector Area	Area	m^2	real	[0;+Inf]	0
	Total Collector Area.					
3	Collector Fin Efficiency Factor	Dimensionless	-	real	[0;1]	0
	F', Collector fin efficiency factor. At a particular location, F' is the ratio of the actual useful energy gain to the useful energy gain that would result if the collector absorbing surface had been at the local fluid temperature.					
4	Fluid Thermal Capacitance	Specific Heat	kJ/kg.K	real	[-Inf;+Inf]	0
	Fluid thermal capacitance.					
5	Collector plate absorptance	Dimensionless	-	real	[0;1.0]	0
	Collector plate absorptance (visible wavelength range).					
6	Number of glass covers	Dimensionless	-	integer	[0;10]	0
	Number of glass covers.					
7	Collector plate emittance	Dimensionless	-	real	[0;1.0]	0
	Collector plate emittance (infra-red wavelength range).					
8	Loss coefficient for bottom and edge losses	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[0;+Inf]	0
	Thermal loss coefficient for bottom and edge losses.					
9	Collector slope	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
	Slope of the collector (0=horizontal).					
10	Transmittance	Dimensionless	-	real	[-Inf;+Inf]	0
	Cover transmittance (visible wavelength range).					
11	Temperature coefficient of PV cell efficiency	any	any	real	[0;+Inf]	0
	C, Temperature coefficient of solar cell efficiency. Eff (T) = Eff(TRef) * (1-C*(T-TRef)).					
12	Temperature for cell reference efficiency	Temperature	C	real	[-Inf;+Inf]	0
	Reference temperature for solar cell efficiency.					
13	Packing factor	Dimensionless	-	real	[0;1.0]	0
	Packing factor: ratio of PV cell area to absorber area.					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Inlet fluid temperature	Temperature	C	real	[-Inf;+Inf]	0
	Inlet fluid temperature.					
2	Fluid mass flow rate	Flow Rate	kg/hr	real	[-Inf;+Inf]	0

	Fluid mass flowrate in the collector.					
3	Ambient temperature	Temperature	C	real	[-Inf;+Inf]	0
	Ambient temperature.					
4	Incident radiation	Flux	W/m^2	real	[-Inf;+Inf]	0
	Total solar radiation incident on the collector.					
5	Windspeed	Velocity	m/s	real	[-Inf;+Inf]	0
	Wind speed.					
6	Cell Efficiency at reference conditions	Dimensionless	-	real	[0;1]	0
	PV Cell efficiency, [0-1] scale.					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Outlet fluid temperature	Temperature	C	real	[-Inf;+Inf]	0
2	Fluid flowrate	Flow Rate	kg/hr	real	[-Inf;+Inf]	0
3	Rate of useful energy gain	Power	kJ/hr	real	[-Inf;+Inf]	0
4	Collector loss coefficient	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[-Inf;+Inf]	0
5	Transmittance-absorptance product	dimensionless	-	real	[-Inf;+Inf]	0
6	Electrical power output	Power	kJ/hr	real	[-Inf;+Inf]	0
7	Average cell temperature	Temperature	C	real	[-Inf;+Inf]	0
8	Apparent thermal loss coefficient	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[-Inf;+Inf]	0

4.2.4.11. Thin Film Modules

Icon		TRNSYS Model	Type 94
Proforma	Electrical\Photovoltaic Panels\Thin Film Modules\Type94b.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Module short-circuit current at reference conditions	Electric current	amperes	real	[0;+Inf]	0
2	Module open-circuit voltage at reference conditions	Voltage	V	real	[0;+Inf]	0
3	Reference temperature	Temperature	K	real	[0;+Inf]	0
4	Reference insolation	Flux	W/m^2	real	[0;+Inf]	0
5	Module voltage at max power point and reference conditions	Voltage	V	real	[0;+Inf]	0
6	Module current at max power point and reference conditions	Electric current	amperes	real	[0;+Inf]	0
7	Temperature coeficient of Isc at (ref. cond))	any	any	real	[-Inf;+Inf]	0
8	Temperature coeficient of Voc (ref. cond.)	any	any	real	[-Inf;+Inf]	0
9	Number of cells wired in series	dimensionless	-	integer	[1;+Inf]	0
10	Number of modules in series	dimensionless	-	integer	[1;+Inf]	0
11	Number of modules in parallel	dimensionless	-	integer	[1;+Inf]	0
12	Module temperature at NOCT	Temperature	K	real	[0;+Inf]	0
13	Ambient temperature at NOCT	Temperature	K	real	[0;+Inf]	0
14	Insolation at NOCT	Flux	W/m^2	real	[0;+Inf]	0
15	Module area	Area	m^2	real	[0;+Inf]	0
16	tau-alpha product for normal incidence	dimensionless	-	real	[0;1]	0
17	Semiconductor bandgap	any	any	real	[-Inf;+Inf]	0
18	Slope of IV curve at Isc	any	any	real	[-Inf;0]	0
19	Module series resistance	any	any	real	[-Inf;+Inf]	0

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Total incident radiation	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
2	Ambient temperature	Temperature	K	real	[-Inf;+Inf]	0
3	Load voltage	Voltage	V	real	[-Inf;+Inf]	0
4	Flag for convergence promotion	dimensionless	-	integer	[0;1]	0
5	Array slope	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
6	Beam radiation	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
7	Diffuse radiation	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
8	Incidence angle of beam radiation	Direction (Angle)	degrees	real	[-Inf;+Inf]	0

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Array voltage	Voltage	V	real	[-Inf;+Inf]	0
2	Array current	Electric current	amperes	real	[-Inf;+Inf]	0
3	Array power	Power	W	real	[-Inf;+Inf]	0

4	Power at maximum power point	Power	W	real	[-Inf;+Inf]	0
5	Fraction of maximum power used	dimensionless	-	real	[-Inf;+Inf]	0
6	Voltage at MPP	Voltage	V	real	[-Inf;+Inf]	0
7	Current at MPP	Electric current	amperes	real	[-Inf;+Inf]	0
8	Open circuit voltage	Voltage	V	real	[-Inf;+Inf]	0
9	Short circuit current	Electric current	amperes	real	[-Inf;+Inf]	0
10	Array fill factor	dimensionless	-	real	[-Inf;+Inf]	0
11	Array temperature	Temperature	K	real	[-Inf;+Inf]	0

4.2.4.12. With Data File - MPPT=OFF - TCMODE=1

Icon		TRNSYS Model	Type 180
Proforma	Electrical\Photovoltaic Panels\With Data File\MPPT=OFF\TCMODE=1\Type180b.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	MPPT	dimensionless	-	integer	[0;0]	1
	Maximum Power Point Tracker Mode 0 = OFF 1 = ON					
2	TCMODE	dimensionless	-	integer	[1;1]	1
	PV cell temperature calculation mode TCMODE = 1 . Temperature is given as an input (input#7)					
3	NCSER	dimensionless	-	integer	[0;+Inf]	150
	Number of PV cells in series per PV module					
4	NMSER	dimensionless	-	real	[0;+Inf]	4
	Number of PV modules in series in PV array					
5	NMPAR	dimensionless	-	real	[0;+Inf]	14
	Number of PV modules in parallel in array					
6	AREA	Area	m^2	real	[0;+Inf]	1.50
	Area of single PV-module covered with PV cells.					
7	TAUALPHA	dimensionless	-	real	[-Inf;+Inf]	0.9
	Reflectance-absoptance of PV-cover TAU = Transmittance of PV-cover ALPHA = Fraction absorbed on the surface of the PV cell					
8	EGAP	Energy	eV	real	[0;10]	1.12
	Energy band gap for silicon					
9	RSH	any	any	real	[0;+Inf]	1E6
	Shunt resistance					
10	PVTYPE	dimensionless	-	integer	[1;100]	5
	Type of PV panel in PV-parameter file (called within component model).					
11	Logical Unit for data file	dimensionless	-	integer	[30;999]	80
	Logical Unit for file where the PV parameters are found.					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	PVMODE	dimensionless	-	integer	[0;1]	1
	The PVMODE determines whether the PV is switched on or off. 0 = OFF 1 = ON					
2	GT	Flux	W/m^2	real	[0;1500]	800
	The solar radiation flux on a surface.					
3	TCELL	Temperature	C	real	[-100;100]	10
	Temperature of the PV-cell array.					
4	VA_in	Voltage	V	real	[0;+Inf]	0
	Voltage across a PV-array					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	IA	Electric current	A	real	[-Inf;+Inf]	0
	Electric current produced by PV-array					
2	VA_out	Voltage	V	real	[-Inf;+Inf]	0
	Voltage across PV-array. VA_out = VA_in					
3	PA	Power	W	real	[-Inf;+Inf]	0
	Power produced by PV-array.					
4	ETA	dimensionless	-	real	[-Inf;+Inf]	0
	Efficiency of PV-array.					
5	TC	Temperature	C	real	[-Inf;+Inf]	0
	Temperature of PV-cells in array.					
6	ISCA	Electric current	A	real	[-Inf;+Inf]	0
	Short-circuit current of PV-array.					
7	VOCA	Voltage	V	real	[-Inf;+Inf]	0
	Open-circuit voltage of PV-array.					

EXTERNAL FILES

Question	File	Associated parameter
File with PV parameters	.\Examples\Data Files\Type180-PhotovoltaicModule.dat	Logical Unit for data file
Source file	.\SourceCode\Types\Type180.for	

4.2.4.13. With Data File - MPPT=OFF - TCMODE=2

Icon		TRNSYS Model	Type 180
Proforma	Electrical\Photovoltaic Panels\With Data File\MPPT=OFF\TCMODE=2\Type180d.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	MPPT	dimensionless	-	integer	[0;0]	1
	Maximum Power Point Tracker Mode 0 = OFF 1 = ON					
2	TCMODE	dimensionless	-	integer	[2;2]	1
	PV cell temperature calculation mode TCMODE = 2. The cell temperature is calculated based on an overall heat loss coefficient (UL)					
3	NCSER	dimensionless	-	integer	[0;+Inf]	150
	Number of PV cells in series per PV module					
4	NMSER	dimensionless	-	real	[0;+Inf]	4
	Number of PV modules in series in PV array					
5	NMPAR	dimensionless	-	real	[0;+Inf]	14
	Number of PV modules in parallel in array					
6	AREA	Area	m^2	real	[0;+Inf]	1.50
	Area of single PV-module covered with PV cells.					
7	TAUALPHA	dimensionless	-	real	[-Inf;+Inf]	0.9
	Reflectance-absoptance of PV-cover TAU = Transmittance of PV-cover ALPHA = Fraction absorbed on the surface of the PV cell					
8	EGAP	Energy	eV	real	[0;10]	1.12
	Energy band gap for silicon					
9	RSH	any	any	real	[0;+Inf]	1E6
	Shunt resistance					
10	PVTYPE	dimensionless	-	integer	[1;100]	5
	Type of PV panel in PV-parameter file (called within component model).					
11	Logical unit for data file	dimensionless	-	integer	[30;999]	80
	Logical Unit for file where the PV parameters are found.					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	PVMODE	dimensionless	-	integer	[0;1]	1
	The PVMODE determines whether the PV is switched on or off. 0 = OFF 1 = ON					
2	GT	Flux	W/m^2	real	[0;1500]	800
	The solar radiation flux on a surface.					
3	TAMB	Temperature	C	real	[-100;100]	10
	Temperature of the PV-cell array.					
4	VA_in	Voltage	V	real	[0;+Inf]	0
	Voltage across PV-array					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	IA	Electric current	A	real	[-Inf;+Inf]	0
	Electric current produced by PV-array					
2	VA_out	Voltage	V	real	[-Inf;+Inf]	0
	Voltage across PV-array VA_out=Va_in					
3	PA	Power	W	real	[-Inf;+Inf]	0
	Power produced by PV-array.					
4	ETA	dimensionless	-	real	[-Inf;+Inf]	0
	Efficiency of PV-array.					
5	TC	Temperature	C	real	[-Inf;+Inf]	0
	Temperature of PV-cells in array.					
6	ISCA	Electric current	A	real	[-Inf;+Inf]	0
	Short-circuit current of PV-array					
7	VOCA	Voltage	V	real	[-Inf;+Inf]	0
	Open-circuit voltage of PV-array					

EXTERNAL FILES

Question	File	Associated parameter
File with PV parameters	.\Examples\Data Files\Type180-PhotovoltaicModule.dat	Logical unit for data file
Source file	.\SourceCode\Types\Type180.for	

4.2.4.14. With Data File - MPPT=OFF - TCMODE=3

Icon		TRNSYS Model	Type 180
Proforma	Electrical\Photovoltaic Panels\With Data File\MPPT=OFF\TCMODE=3\Type180f.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	MPPT	dimensionless	-	integer	[0;0]	1
	Maximum Power Point Tracker Mode 0 = OFF 1 = ON					
2	TCMODE	dimensionless	-	integer	[3;3]	1
	PV cell temperature mode TCMODE = 3. The cell temperature is calculated based on an overall heat loss coefficient (UL) and a lumped thermal capacitance (CT)					
3	NCSER	dimensionless	-	integer	[0;+Inf]	150
	Number of PV cells in series per PV module					
4	NMSER	dimensionless	-	real	[0;+Inf]	4
	Number of PV modules in series in PV array					
5	NMPAR	dimensionless	-	real	[0;+Inf]	14
	Number of PV modules in parallel in array					
6	AREA	Area	m^2	real	[0;+Inf]	1.50
	Area of single PV-module covered with PV cells.					
7	TAUALPHA	dimensionless	-	real	[-Inf;+Inf]	0.9
	Reflectance-absoptance of PV-cover TAU = Transmittance of PV-cover ALPHA = Fraction absorbed on the surface of the PV cell					
8	EGAP	Energy	eV	real	[0;10]	1.12
	Energy band gap for silicon					
9	RSH	any	any	real	[0;+Inf]	1E6
	Shunt resistance					
10	PVTYPE	dimensionless	-	integer	[1;100]	5
	Type of PV panel in PV-parameter file (called within component model).					
11	Logical unit for data file	dimensionless	-	integer	[30;999]	80
	Logical Unit for file where the PV parameters are found.					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	PVMODE	dimensionless	-	integer	[0;1]	1
	The PVMODE determines whether the PV is switched on or off. 0 = OFF 1 = ON					
2	GT	Flux	W/m^2	real	[0;1500]	800
	The solar radiation flux on a surface.					
3	TAMB	Temperature	C	real	[-100;100]	10
	Temperature of the PV-cell array.					
4	VA_in	Voltage	V	real	[0;+Inf]	0

	Voltage across PV-array

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	IA	Electric current	A	real	[-Inf;+Inf]	0
	Electric current produced by PV-array					
2	VA_out	Voltage	V	real	[-Inf;+Inf]	0
	Voltage across PV-array. VA_out = VA_in					
3	PA	Power	W	real	[-Inf;+Inf]	0
	Power produced by PV-array.					
4	ETA	dimensionless	-	real	[-Inf;+Inf]	0
	Efficiency of PV-array.					
5	TC	Temperature	C	real	[-Inf;+Inf]	0
	Temperature of PV-cells in array.					
6	ISCA	Electric current	A	real	[-Inf;+Inf]	0
	Short-circuit current of PV-array					
7	VOCA	Voltage	V	real	[-Inf;+Inf]	0
	Open-circuit voltage of PV-array					

EXTERNAL FILES

Question	File	Associated parameter
File with PV parameters	.\Examples\Data Files\Type180-PhotovoltaicModule.dat	Logical unit for data file
Source file	.\SourceCode\Types\Type180.for	

4.2.4.15. With Data File - MPPT=ON - TCMODE=1

Icon		TRNSYS Model	Type 180
Proforma	Electrical\Photovoltaic Panels\With Data File\MPPT=ON\TCMODE=1\Type180a.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	MPPT	dimensionless	-	integer	[1;1]	1
	Maximum Power Point Tracker Mode 0 = OFF 1 = ON					
2	TCMODE	dimensionless	-	integer	[1;1]	1
	PV cell temperature calculation mode TCMODE = 1 . Temperature is given as input (input #7)					
3	NCSER	dimensionless	-	integer	[0;+Inf]	150
	Number of PV cells in series per PV module					
4	NMSER	dimensionless	-	real	[0;+Inf]	4
	Number of PV modules in series in PV array					
5	NMPAR	dimensionless	-	real	[0;+Inf]	14
	Number of PV modules in parallel in array					
6	AREA	Area	m^2	real	[0;+Inf]	1.50
	Area of single PV-module covered with PV cells.					
7	TAUALPHA	dimensionless	-	real	[-Inf;+Inf]	0.9
	Reflectance-absoptance of PV-cover TAU = Transmittance of PV-cover ALPHA = Fraction absorbed on the surface of the PV cell					
8	EGAP	Energy	eV	real	[0;10]	1.12
	Energy band gap for silicon					
9	RSH	any	any	real	[0;+Inf]	1E6
	Shunt resistance					
10	PVTYPE	dimensionless	-	integer	[1;100]	5
	Type of PV panel in PV-parameter file (called within component model).					
11	Logical unit for data file	dimensionless	-	integer	[30;999]	80
	Logical Unit for file where the PV parameters are found.					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	PVMODE	dimensionless	-	integer	[0;1]	1
	The PVMODE determines whether the PV is switched on or off. 0 = OFF 1 = ON					
2	GT	Flux	W/m^2	real	[0;1500]	800
	The solar radiation flux on a surface.					
3	TCELL	Temperature	C	real	[-100;100]	10
	Temperature of the PV-cell array.					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	IA	Electric current	A	real	[-Inf;+Inf]	0
	Electric current produced by PV-array					
2	VA	Voltage	V	real	[-Inf;+Inf]	0
	Voltage across PV-array					
3	PA	Power	W	real	[-Inf;+Inf]	0
	Power produced by PV-array.					
4	ETA	dimensionless	-	real	[-Inf;+Inf]	0
	Efficiency of PV-array.					
5	TC	Temperature	C	real	[-Inf;+Inf]	0
	Temperature of PV-cells in array.					
6	ISCA	Electric current	A	real	[-Inf;+Inf]	0
	Short-circuit current of PV-array					
7	VOCA	Voltage	V	real	[-Inf;+Inf]	0
	Open-circuit voltage of PV-array					

EXTERNAL FILES

Question	File	Associated parameter
File with PV parameters	.\Examples\Data Files\Type180-PhotovoltaicModule.dat	Logical unit for data file
Source file	.\SourceCode\Types\Type180.for	

4.2.4.16. With Data File - MPPT=ON - TCMODE=2

Icon		TRNSYS Model	Type 180
Proforma	Electrical\Photovoltaic Panels\With Data File\MPPT=ON\TCMODE=2\Type180c.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	MPPT	dimensionless	-	integer	[1;1]	1
	Maximum Power Point Tracker Mode 0 = OFF 1 = ON					
2	TCMODE	dimensionless	-	integer	[2;2]	1
	PV cell temperature calculation mode TCMODE = 2. The cell temperature is calculated based on an overall heat loss coefficient (UL)					
3	NCSER	dimensionless	-	integer	[0;+Inf]	150
	Number of PV cells in series per PV module					
4	NMSER	dimensionless	-	real	[0;+Inf]	4
	Number of PV modules in series in PV array					
5	NMPAR	dimensionless	-	real	[0;+Inf]	14
	Number of PV modules in parallel in array					
6	AREA	Area	m^2	real	[0;+Inf]	1.50
	Area of single PV-module covered with PV cells.					
7	TAUALPHA	dimensionless	-	real	[-Inf;+Inf]	0.9
	Reflectance-absoptance of PV-cover TAU = Transmittance of PV-cover ALPHA = Fraction absorbed on the surface of the PV cell					
8	EGAP	Energy	eV	real	[0;10]	1.12
	Energy band gap for silicon					
9	RSH	any	any	real	[0;+Inf]	1E6
	Shunt resistance					
10	PVTYPE	dimensionless	-	integer	[1;100]	5
	Type of PV panel in PV-parameter file (called within component model).					
11	Logical unit for data file	dimensionless	-	integer	[30;999]	80
	Logical Unit for file where the PV parameters are found.					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	PVMODE	dimensionless	-	integer	[0;1]	1
	The PVMODE determines whether the PV is switched on or off. 0 = OFF 1 = ON					
2	GT	Flux	W/m^2	real	[0;1500]	800
	The solar radiation flux on a surface.					
3	TAMB	Temperature	C	real	[-100;100]	10
	Temperature of the PV-cell array.					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	IA	Electric current	A	real	[-Inf;+Inf]	0
	Electric current produced by PV-array					
2	VA	Voltage	V	real	[-Inf;+Inf]	0
	Voltage across PV-array					
3	PA	Power	W	real	[-Inf;+Inf]	0
	Power produced by PV-array.					
4	ETA	dimensionless	-	real	[-Inf;+Inf]	0
	Efficiency of PV-array.					
5	TC	Temperature	C	real	[-Inf;+Inf]	0
	Temperature of PV-cells in array.					
6	ISCA	Electric current	A	real	[-Inf;+Inf]	0
	Short-circuit current of PV-array					
7	VOCA	Voltage	V	real	[-Inf;+Inf]	0
	Open-circuit voltage of PV-array					

EXTERNAL FILES

Question	File	Associated parameter
File with PV parameters	.\Examples\Data Files\Type180-PhotovoltaicModule.dat	Logical unit for data file
Source file	.\SourceCode\Types\Type180.for	

4.2.4.17. With Data File - MPPT=ON - TCMODE=3

Icon		TRNSYS Model	Type 180
Proforma	Electrical\Photovoltaic Panels\With Data File\MPPT=ON\TCMODE=3\Type180e.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	MPPT	dimensionless	-	integer	[1;1]	1
	Maximum Power Point Tracker Mode 0 = OFF 1 = ON					
2	TCMODE	dimensionless	-	integer	[3;3]	1
	PV cell temperature calculation mode TCMODE = 1. The cell temperature is calculated based on an overall heat loss coefficient (UL) and a lumped thermal capacitance (CT),					
3	NCSER	dimensionless	-	integer	[0;+Inf]	150
	Number of PV cells in series per PV module					
4	NMSER	dimensionless	-	real	[0;+Inf]	4
	Number of PV modules in series in PV array					
5	NMPAR	dimensionless	-	real	[0;+Inf]	14
	Number of PV modules in parallel in array					
6	AREA	Area	m^2	real	[0;+Inf]	1.50
	Area of single PV-module covered with PV cells.					
7	TAUALPHA	dimensionless	-	real	[-Inf;+Inf]	0.9
	Reflectance-absoptance of PV-cover TAU = Transmittance of PV-cover ALPHA = Fraction absorbed on the surface of the PV cell					
8	EGAP	Energy	eV	real	[0;10]	1.12
	Energy band gap for silicon					
9	RSH	any	any	real	[0;+Inf]	1E6
	Shunt resistance					
10	PVTYPE	dimensionless	-	integer	[1;100]	5
	Type of PV panel in PV-parameter file (called within component model).					
11	Logical unit for data file	dimensionless	-	integer	[30;999]	80
	Logical Unit for file where the PV parameters are found.					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	PVMODE	dimensionless	-	integer	[0;1]	1
	The PVMODE determines whether the PV is switched on or off. 0 = OFF 1 = ON					
2	GT	Flux	W/m^2	real	[0;1500]	800
	The solar radiation flux on a surface.					
3	TAMB	Temperature	C	real	[-100;100]	10
	Temperature of the PV-cell array.					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	IA	Electric current	A	real	[-Inf;+Inf]	0
	Electric current produced by PV-array					
2	VA	Voltage	V	real	[-Inf;+Inf]	0
	Voltage across PV-array					
3	PA	Power	W	real	[-Inf;+Inf]	0
	Power produced by PV-array.					
4	ETA	dimensionless	-	real	[-Inf;+Inf]	0
	Efficiency of PV-array.					
5	TC	Temperature	C	real	[-Inf;+Inf]	0
	Temperature of PV-cells in array.					
6	ISCA	Electric current	A	real	[-Inf;+Inf]	0
	Short-circuit current of PV-array					
7	VOCA	Voltage	V	real	[-Inf;+Inf]	0
	Open-circuit voltage of PV-array					

EXTERNAL FILES

Question	File	Associated parameter
File with PV parameters	.\Examples\Data Files\Type180-PhotovoltaicModule.dat	Logical unit for data file
Source file	.\SourceCode\Types\Type180.for	

4.2.5. Power Conditioning

4.2.5.1. Power INPUT is known

Icon		TRNSYS Model	Type 175
Proforma	Electrical\Power Conditioning\Power INPUT is known\Type175a.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Mode	dimensionless	-	integer	[1;1]	1
	Mode Mode = 1. P is given as input (input #3)					
2	Pn	Power	W	real	[1;2.0E6]	1.6E6
	Nominal power					
3	P0Pn	dimensionless	-	real	[0;1]	5.836E-3
	Idling constant, i.e., ratio between constant power loss (P0) and nominal power (Pn).					
4	Us	Voltage	V	real	[1;25]	2.06
	Set point voltage					
5	RiPn	any	V^2	real	[100;5000]	138.42
	Ohmic constant; product of internal resitance (Ri) and nominal power (Pn)					
6	MP	dimensionless	-	integer	[1;100]	1
	Number of units in parallel					
7	Paux	Power	W	real	[0;0.5]	0
	Auxiliiary power requirement					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Uin	Voltage	V	real	[0;1E5]	22E3
	Input voltage					
2	Uout_set	Voltage	V	real	[0;1E5]	130
	Output voltage					
3	P	Power	W	real	[0;1E8]	1E4
	Power					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Uout	Voltage	V	real	[0;1E5]	0
	Voltage output					
2	Iout	Electric current	A	real	[0;1E5]	0
	Current output					
3	Pout	Power	W	real	[0;1E8]	0
	Power output					
4	Eta	dimensionless	-	real	[0;1]	0
	Efficiency					

5	Uin	Voltage	V	real	[0;1E6]	0
	Voltage input					
6	Iin	Electric current	A	real	[0;1E5]	0
	Current input					
7	Pin	Power	W	real	[0;1E8]	0
	Power input					
8	Ploss	Power	W	real	[0;+inf]	0
	Power losses					
9	Paux_out	Power	W	real	[0;+inf]	0
	Auxiliary power					

4.2.5.2. Power OUTPUT is known

Icon		TRNSYS Model	Type 175
Proforma	Electrical\Power Conditioning\Power OUTPUT is known\Type175b.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Mode	dimensionless	-	integer	[2;2]	2
	Mode = 2. Power output (e.g., a user a load) is given as an input (input #3)					
2	Pn	Power	W	real	[1;1.0E6]	0.5E6
	Nominal power					
3	P0Pn	dimensionless	-	real	[0;1]	5.836E-3
	Idling constant, i.e., the ratio betweem the constant power losses (P0) and nominal power (Pn)					
4	Us	Voltage	V	real	[1;25]	2.06
	Set point voltage					
5	RiPn	any	V^2	real	[100;5000]	138.42
	Ohmic constant, product of internal resistance (Ri) and nominal power (Pn)					
6	MP	dimensionless	-	integer	[1;100]	1
	Number of units in parallel					
7	Paux	Power	W	real	[0;0.5]	0
	Auxiliary power requirement					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Uin	Voltage	V	real	[0;1E5]	230
	Voltage input					
2	Uout_set	Voltage	V	real	[0;1E5]	22E3
	Voltage output					
3	P	Power	W	real	[0;1E8]	1E4
	Power					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Uout	Voltage	V	real	[0;1E5]	0
	Voltage output					
2	Iout	Electric current	A	real	[0;1E5]	0
	Current output					
3	Pout	Power	W	real	[0;1E8]	0
	Power output					
4	Eta	dimensionless	-	real	[0;1]	0
	Efficiency					
5	Uin	Voltage	V	real	[0;1E5]	0
	Voltage input					
6	Iin	Electric current	A	real	[0;1E5]	0
	Current input					

7	Pin	Power	W	real	[0;1E8]	0
	Power input					
8	Ploss	Power	W	real	[0;+inf]	0
	Power losses					
9	Paux_out	Power	W	real	[0;+inf]	0
	Auxiliary power					

4.2.6. Regulators and Inverters

4.2.6.1. System w_ battery storage - Array V = Battery V

Icon		TRNSYS Model	Type 48
Proforma	Electrical\Regulators and Inverters\System w_ battery storage\Array V = Battery V\Type48d.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Mode	Dimensionless	-	integer	[3;3]	0
	Specify 3: Collector voltage equal to battery voltage, current instead of power distribution, monitoring of battery state of charge and voltage.					
2	Regulator efficiency	Dimensionless	-	real	[0;1]	0
	Regulator efficiency (e.g. use this for non-perfect max-power tracker efficiency).					
3	Inverter efficiency (DC to AC)	Dimensionless	-	real	[0;1]	0
	Inverter efficiency, DC to AC.					
4	High limit on fractional state of charge (FSOC)	Dimensionless	-	real	[0;1]	0
	High limit on fractional state of charge (FSOC). If FSOC is higher than this value, charging with the PV array is not allowed.					
5	Low limit on FSOC	Dimensionless	-	real	[0;1]	0
	Low limit on fractional state of charge (FSOC). If FSOC is lower than this value, discharging is not allowed.					
6	charge to discharge limit on FSOC	Dimensionless	-	real	[0;1]	0
	FB: Charge to discharge limit on fractional state of charge (FSOC). If FSOC < FB and the battery has been charging, then the battery must be on "total charge." On "total charge," first priority is given to recharging the battery with any array output, rather than sending the output to the load until FSOC > FB. Use FB					
7	Power output limit	Power	kJ/hr	real	[-Inf;+Inf]	0
	Output power capacity of inverter.					
8	Inverter efficiency (AC to DC)	Dimensionless	-	real	[0;1]	0
	Inverter efficiency, AC to DC.					
9	Current for grid charging of battery	Electric current	amperes	real	[-Inf;+Inf]	0
	Battery charge current when grid power is used for charging.					
10	Upper limit on FSOC for grid charging	Dimensionless	-	real	[0;1]	0
	High limit on fractional state of charge (FSOC). If FSOC is higher than this value, charging with the grid is not allowed.					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Input current	Electric current	amperes	real	[-Inf;+Inf]	0
	Current from solar PV array. In mode 3, the current of the PV is used array (Mode0, 1 and 2 use Power).					
2	Load power	Power	kJ/hr	real	[-Inf;+Inf]	0
	Power demanded by load (Attention: the PV current is used but the power has to be given for the load).					
3	Battery fractional state of charge	Dimensionless	-	real	[-Inf;+Inf]	0
	Battery fractional State Of Charge (FSOC).					
4	Battery voltage (BV)	Voltage	V	real	[-Inf;+Inf]	0

	Battery voltage (BV).					
5	Max battery input	Power	kJ/hr	real	[-Inf;+Inf]	0
	Maximum power for battery charge (i.e. power corresponding to maximum charge current) - Use battery output.					
6	Min. battery output	Power	kJ/hr	real	[-Inf;+Inf]	0
	Maximum power for battery discharge (i.e. power corresponding to maximum discharge current) - Negative value - Use battery output.					
7	lower limit on battery voltage	Voltage	V	real	[-Inf;+Inf]	0
	Lower limit on battery voltage during discharge - Use battery output.					
8	Power corresponding to BV	Power	kJ/hr	real	[-Inf;+Inf]	0
	Power corresponding to lower limit on battery voltage during discharge - Use battery output.					
9	High limit on BV	Voltage	V	real	[-Inf;+Inf]	0
	Higher limit on battery voltage during charge - Use battery output.					
10	Power corresponding to high limit on BV	Power	kJ/hr	real	[-Inf;+Inf]	0
	Power corresponding to higher limit on battery voltage during charge - Use battery output.					
11	Start time for grid battery charging	Time	hr	real	[-Inf;+Inf]	0
	t1: Time of the day at which battery charging with the grid can start (this assumes TIME=0 in the simulation is midnight). Use t1=t2 to allow charging at all times.					
12	Stop time for grid battery charging	Time	hr	real	[-Inf;+Inf]	0
	t2: Time of the day at which battery charging with the grid should stop (this assumes TIME=0 in the simulation is midnight) t2 < t1 is allowed (e.g. night charging from 22 to 7)					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Power in from generation	Power	kJ/hr	real	[-Inf;+Inf]	0
	Power from solar PV array.					
2	Power to or from battery	Power	kJ/hr	real	[-Inf;+Inf]	0
	Power to (>0) or from (					
3	Power to load	Power	kJ/hr	real	[-Inf;+Inf]	0
	Power to load.					
4	Dumped generated power	Power	kJ/hr	real	[-Inf;+Inf]	0
	PV Array power "dumped" or not collected due to full battery.					
5	Power from grid	Power	kJ/hr	real	[-Inf;+Inf]	0
	Power from electricity grid.					
6	Current in from generator	Electric current	amperes	real	[-Inf;+Inf]	0
	Current from solar PV array.					
7	Current to or from battery	Electric current	amperes	real	[-Inf;+Inf]	0
	Current to (>0) or from (					
8	Current to load	Electric current	amperes	real	[-Inf;+Inf]	0
	Current to load.					
9	Dumped generated current	Electric current	amperes	real	[-Inf;+Inf]	0
	PV Array Current "dumped" or not collected due to full battery.					
10	Current from grid	Electric current	amperes	real	[-Inf;+Inf]	0
	Current from electricity grid.					

4.2.6.2. System w_ battery storage - MPP Tracking - SOC and SOV monitoring

Icon		TRNSYS Model	Type 48
Proforma	Electrical\Regulators and Inverters\System w_ battery storage\MPP Tracking\SOC and SOV monitoring\Type48c.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Mode	Dimensionless	-	integer	[2;2]	0
	Specify 2: Peak-power tracking collector, battery, monitoring of battery state of charge and voltage.					
2	Regulator efficiency	Dimensionless	-	real	[0;1]	0
	Regulator efficiency (e.g. use this for non-perfect max-power tracker efficiency).					
3	Inverter efficiency (DC to AC)	Dimensionless	-	real	[0;1]	0
	Inverter efficiency, DC to AC.					
4	High limit on fractional state of charge (FSOC)	Dimensionless	-	real	[0;1]	0
	High limit on fractional state of charge (FSOC). If FSOC is higher than this value, charging with the PV array is not allowed.					
5	Low limit on FSOC	Dimensionless	-	real	[0;1]	0
	Low limit on fractional state of charge (FSOC). If FSOC is lower than this value, discharging is not allowed.					
6	charge to discharge limit on FSOC	Dimensionless	-	real	[0;1]	0
	FB: Charge to discharge limit on fractional state of charge (FSOC). If FSOC < FB and the battery has been charging, then the battery must be on "total charge." On "total charge," first priority is given to recharging the battery with any array output, rather than sending the output to the load until FSOC > FB. Use FB					
7	Power output limit	Power	kJ/hr	real	[-Inf;+Inf]	0
	Output power capacity of inverter.					
8	Inverter efficiency (AC to DC)	Dimensionless	-	real	[0;1]	0
	Inverter efficiency, AC to DC.					
9	Current for grid charging of battery	Electric current	amperes	real	[-Inf;+Inf]	0
	Battery charge current when grid power is used for charging.					
10	Upper limit on FSOC for grid charging	Dimensionless	-	real	[0;1]	0
	High limit on fractional state of charge (FSOC). If FSOC is higher than this value, charging with the grid is not allowed.					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Input power	Power	kJ/hr	real	[-Inf;+Inf]	0
	Power from solar PV array.					
2	Load power	Power	kJ/hr	real	[-Inf;+Inf]	0
	Power demanded by load.					
3	Battery fractional state of charge	Dimensionless	-	real	[-Inf;+Inf]	0
	Battery fractional State Of Charge (FSOC).					
4	Battery voltage (BV)	Voltage	V	real	[-Inf;+Inf]	0
	Battery voltage (BV).					
5	Max battery input	Power	kJ/hr	real	[-Inf;+Inf]	0

	Maximum power for battery charge (i.e. power corresponding to maximum charge current) - Use battery output.					
6	Min. battery output	Power	kJ/hr	real	[-Inf;+Inf]	0
	Maximum power for battery discharge (i.e. power corresponding to maximum discharge current) - Negative value - Use battery output.					
7	lower limit on battery voltage	Voltage	V	real	[-Inf;+Inf]	0
	Lower limit on battery voltage during discharge - Use battery output.					
8	Power corresponding to BV	Power	kJ/hr	real	[-Inf;+Inf]	0
	Power corresponding to lower limit on battery voltage during discharge - Use battery output.					
9	High limit on BV	Voltage	V	real	[-Inf;+Inf]	0
	Higher limit on battery voltage during charge - Use battery output.					
10	Power corresponding to high limit on BV	Power	kJ/hr	real	[-Inf;+Inf]	0
	Power corresponding to higher limit on battery voltage during charge - Use battery output.					
11	Start time for grid battery charging	Time	hr	real	[-Inf;+Inf]	0
	t1: Time of the day at which battery charging with the grid can start (this assumes TIME=0 in the simulation is midnight). Use t1=t2 to allow charging at all times					
12	Stop time for grid battery charging	Time	hr	real	[-Inf;+Inf]	0
	t2: Time of the day at which battery charging with the grid should stop (this assumes TIME=0 in the simulation is midnight) t2 < t1 is allowed (e.g. night charging from 22 to 7)					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Power in from generation	Power	kJ/hr	real	[-Inf;+Inf]	0
	Power from solar PV array.					
2	Power to or from battery	Power	kJ/hr	real	[-Inf;+Inf]	0
	Power to (>0) or from (					
3	Power to load	Power	kJ/hr	real	[-Inf;+Inf]	0
	Power to load.					
4	Dumped generated power	Power	kJ/hr	real	[-Inf;+Inf]	0
	PV Array power "dumped" or not collected due to full battery.					
5	Power from grid	Power	kJ/hr	real	[-Inf;+Inf]	0
	Power from electricity grid.					

4.2.6.3. System w_ battery storage - MPP Tracking - SOC monitoring only

Icon		TRNSYS Model	Type 48
Proforma	Electrical\Regulators and Inverters\System w_ battery storage\MPP Tracking\SOC monitoring only\Type48b.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Mode	Dimensionless	-	integer	[1;1]	0
	Specify 1: Peak-power tracking collector, battery, monitoring of state of charge.					
2	Regulator efficiency	Dimensionless	-	real	[0;1]	0
	Regulator efficiency (e.g. use this for non-perfect max-power tracker efficiency).					
3	Inverter efficiency	Dimensionless	-	real	[0;1]	0
	Inverter efficiency, DC to AC.					
4	High limit on fractional state of charge (FSOC)	Dimensionless	-	real	[0;1]	0
	High limit on fractional state of charge (FSOC). If FSOC is higher than this value, charging is not allowed.					
5	Low limit on FSOC	Dimensionless	-	real	[0;1]	0
	Low limit on fractional state of charge (FSOC). If FSOC is lower than this value, discharging is not allowed.					
6	charge to discharge limit on FSOC	Dimensionless	-	real	[0;1]	0
	FB: Charge to discharge limit on fractional state of charge (FSOC). If FSOC < FB and the battery has been charging, then the battery must be on "total charge." On "total charge," first priority is given to recharging the battery with any array output, rather than sending the output to the load until FSOC > FB. Use FB					
7	Inverter ouput power capacity	Power	kJ/hr	real	[-Inf;+Inf]	0
	Output power capacity of inverter.					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Input power	Power	kJ/hr	real	[-Inf;+Inf]	0
	Power from solar PV array.					
2	Load power	Power	kJ/hr	real	[-Inf;+Inf]	0
	Power demanded by load.					
3	Battery fractional state of charge	Dimensionless	-	real	[-Inf;+Inf]	0
	Battery fractional State Of Charge (FSOC).					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Power in from generation	Power	kJ/hr	real	[-Inf;+Inf]	0
	Power from solar PV array.					
2	Power to or from battery	Power	kJ/hr	real	[-Inf;+Inf]	0
	Power to (>0) or from (					
3	Power to load	Power	kJ/hr	real	[-Inf;+Inf]	0
	Power to load.					
4	Dumped generated power	Power	kJ/hr	real	[-Inf;+Inf]	0
	PV Array power "dumped" or not collected due to full battery.					

5	Power from grid	Power	kJ/hr	real	[-Inf;+Inf]	0
	Power from electricity grid.					

4.2.6.4. System w_o battery storage

Icon		TRNSYS Model	Type 48
Proforma	Electrical\Regulators and Inverters\System w_o battery storage\Type48a.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Mode	Dimensionless	-	integer	[0;0]	0
	Specify 0: Peak-power tracking collector, no battery, power is feedback to a utility.					
2	Efficiency	Dimensionless	-	real	[0;1]	0
	Regulator / inverter efficiency.					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Input power	Power	kJ/hr	real	[-Inf;+Inf]	0
	Power from charging device (e.g. solar PV array).					
2	Load power	Power	kJ/hr	real	[-Inf;+Inf]	0
	Power demanded by load.					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Power in	Power	kJ/hr	real	[-Inf;+Inf]	0
	Power from charging device (e.g. solar PV array).					
2	Power out	Power	kJ/hr	real	[-Inf;+Inf]	0
	Power sent to load.					
3	Excess power	Power	kJ/hr	real	[-Inf;+Inf]	0
	Power to or from utility (>0 if purchased,					

4.2.7. Wind Turbines

4.2.7.1. Wind Turbines

Icon		TRNSYS Model	Type 90
Proforma	Electrical\Wind Turbines\Type90.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Site elevation	Length	m	real	[-Inf;+Inf]	0
	Site elevation					
2	Data collection Height	Length	m	real	[0;+Inf]	0
	Data collection height					
3	Hub height	Length	m	real	[0;+Inf]	0
	Hub height of WECS, as installed on site					
4	Turbine power loss	any	any	real	[0;100]	0
	Miscellaneous losses					
5	Number of turbines	dimensionless	-	integer	[0;+Inf]	0
	Number of exactly similar turbines					
6	Logical unit of file containing power curve data	Dimensionless	-	integer	[30;999]	0
	Logical unit for external file containing WECS parameters					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Control signal	Dimensionless	-	integer	[0;1]	0
	A control signal for the wind turbine. CTRL = 0: WECS is OFF CTRL = 1: WECS is ON and providing power.					
2	Wind velocity	Velocity	m/s	real	[0;+Inf]	0
	Wind velocity					
3	Ambient temperature	Temperature	C	real	[-273.1;+Inf]	0
	Ambient temperature					
4	Site shear exponent	Dimensionless	-	real	[-0.06;0.30]	0
	Site wind shear exponent: -0.06 = inverted profile, 0.00 = neutral profile, 0.06 = open water, 0.10 = short grasses, 0.14 = 1/7-profile-common, 0.18 = low vegetation, 0.22 = forests, 0.26 = obstructed flows, 0.30 = rare					
5	Barometric pressure	Pressure	Pa	real	[0;+Inf]	0
	Barometric pressure					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Power Output	Power	W	real	[-Inf;+Inf]	0
	Power output					
2	Turbine hours	Time	hr	real	[-Inf;+Inf]	0
	Hours of continous wind turrbine operation					

3	Power coefficient	Dimensionless	-	real	[-Inf;+Inf]	0
	Power coefficient					

EXTERNAL FILES

Question	File	Associated parameter
File with WECS parameters?	.\Examples\Data Files\Type90-WindTurbine.dat	Logical unit of file containing power curve data
Source file	.\SourceCode\Types\Type90.for	

4.3. Heat Exchangers

4.3.1. Constant Effectiveness

4.3.1.1. Constant Effectiveness

Icon		**TRNSYS Model**	Type 91
Proforma	Heat Exchangers\Constant Effectiveness\Type91.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Heat exchanger effectiveness	Dimensionless	-	real	[0.0;1.0]	0.6
	The effectiveness of the heat exchanger. The effectiveness is a ratio of the actual heat exchanger heat transfer to the maximum possible heat transfer which could occur in the heat exchanger. Effectiveness = Q/Qmax					
2	Specific heat of hot side fluid	Specific Heat	kJ/kg.K	real	[0;+Inf]	4.19
	The specific heat of the fluid flowing through the hot-side of the heat exchanger.					
3	Specific heat of cold side fluid	Specific Heat	kJ/kg.K	real	[0;+Inf]	4.19
	The specific heat of the fluid flowing through the cold side of the heat exchanger.					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Hot side inlet temperature	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the fluid flowing into the hot side of the heat exchanger.					
2	Hot side flow rate	Flow Rate	kg/hr	real	[0;+Inf]	100.0
	The flow rate of the fluid flowing through the hot side of the heat exchanger.					
3	Cold side inlet temperature	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the fluid flowing into the cold side of the heat exchanger.					
4	Cold side flow rate	Flow Rate	kg/hr	real	[0;+Inf]	100.0
	The flow rate of fluid flowing through the cold side of the heat exchanger.					

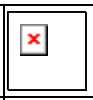
OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Hot-side outlet temperature	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid leaving the hot side of the heat exchanger.					
2	Hot-side flow rate	Flow Rate	kg/hr	real	[-Inf;+Inf]	0
	The flow rate of fluid exiting the hot side of the heat exchanger.					
3	Cold-side outlet temperature	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid leaving the cold side of the heat exchanger.					
4	Cold-side flow rate	Flow Rate	kg/hr	real	[-Inf;+Inf]	0
	The flow rate of fluid exiting the cold side of the heat exchanger.					

5	Heat transfer rate	Power	kJ/hr	real	[-Inf;+Inf]	0
	The total heat transfer rate between the fluids in the heat exchanger.					
6	Effectiveness	Dimensionless	-	real	[-Inf;+Inf]	0
	The effectiveness of the heat exchanger.					

4.3.2. Counter Flow

4.3.2.1. Counter Flow

Icon		TRNSYS Model	Type 5
Proforma	Heat Exchangers\Counter Flow\Type5b.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Counter flow mode	Dimensionless	-	integer	[2;2]	2
	The general heat exchanger model may operate in one of four configuration modes. Setting this parameter to 2 indicates a counter flow arrangement. Do not change this parameter.					
2	Specific heat of hot side fluid	Specific Heat	kJ/kg.K	real	[0;+Inf]	4.19
	The specific heat of the fluid flowing through the hot-side of the counter flow heat exchanger.					
3	Specific heat of cold side fluid	Specific Heat	kJ/kg.K	real	[0;+Inf]	4.19
	The specific heat of the fluid flowing through the cold side of the counter flow heat exchanger.					
4	Not used	Dimensionless	-	integer	[0;+Inf]	0

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Hot side inlet temperature	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the fluid flowing into the hot side of the counter flow heat exchanger.					
2	Hot side flow rate	Flow Rate	kg/hr	real	[0;+Inf]	100.0
	The flow rate of the fluid flowing through the hot side of the counter flow heat exchanger.					
3	Cold side inlet temperature	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the fluid flowing into the cold side of the counter flow heat exchanger.					
4	Cold side flow rate	Flow Rate	kg/hr	real	[0;+Inf]	100.0
	The flow rate of the fluid flowing through the cold side of the counter flow heat exchanger.					
5	Overall heat transfer coefficient of exchanger	Overall Loss Coefficient	kJ/hr.K	real	[0;+Inf]	10.0
	Overall heat transfer coefficient of the counter flow heat exchanger.					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Hot-side outlet temperature	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid leaving the hot side of the counter flow heat exchanger.					
2	Hot-side flow rate	Flow Rate	kg/hr	real	[-Inf;+Inf]	0
	The flow rate of fluid exiting the hot side of the counter flow heat exchanger.					
3	Cold-side outlet temperature	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid leaving the cold side of the counter flow heat exchanger.					
4	Cold-side flow rate	Flow Rate	kg/hr	real	[-Inf;+Inf]	0
	The flow rate of fluid exiting the cold side of the counter flow heat exchanger.					
5	Heat transfer rate	Power	kJ/hr	real	[-Inf;+Inf]	0
	The total heat transfer rate between the fluids in the counter flow heat exchanger.					

6	Effectiveness	Dimensionless	-	real	[-Inf;+Inf]	0
	The effectiveness of the counter flow heat exchanger.					

4.3.3. Cross Flow

4.3.3.1. Both Fluids Mixed

Icon		TRNSYS Model	Type 5
Proforma	Heat Exchangers\Cross Flow\Both Fluids Mixed\Type5f.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Cross flow mode	Dimensionless	-	integer	[6;6]	3
	The general heat exchanger model may operate in one of four configuration modes. Setting this parameter to 3 indicates a cross flow arrangement. Do not change this parameter.					
2	Specific heat of hot side fluid	Specific Heat	kJ/kg.K	real	[0;+Inf]	4.19
	The specific heat of the fluid flowing through the hot-side of the cross flow heat exchanger.					
3	Specific heat of cold side fluid	Specific Heat	kJ/kg.K	real	[0;+Inf]	4.19
	The specific heat of the fluid flowing through the cold side of the cross flow heat exchanger.					
4	Not Used	Dimensionless	-	integer	[0;+Inf]	0

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Hot side inlet temperature	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the fluid flowing into the hot side of the cross flow heat exchanger.					
2	Hot side flow rate	Flow Rate	kg/hr	real	[0;+Inf]	100.0
	The flow rate of the fluid flowing through the hot side of the cross flow heat exchanger.					
3	Cold side inlet temperature	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the fluid flowing into the cold side of the cross flow heat exchanger.					
4	Cold side flow rate	Flow Rate	kg/hr	real	[0;+Inf]	100.0
	The flow rate of the fluid flowing through the cold side of the cross flow heat exchanger.					
5	Overall heat transfer coefficient of exchanger	Overall Loss Coefficient	kJ/hr.K	real	[0;+Inf]	10.0
	Overall heat transfer coefficient of the cross flow heat exchanger.					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Hot-side outlet temperature	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid leaving the hot side of the cross flow heat exchanger.					
2	Hot-side flow rate	Flow Rate	kg/hr	real	[-Inf;+Inf]	0
	The flow rate of fluid exiting the hot side of the cross flow heat exchanger.					
3	Cold-side outlet temperature	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid leaving the cold side of the cross flow heat exchanger.					
4	Cold-side flow rate	Flow Rate	kg/hr	real	[-Inf;+Inf]	0
	The flow rate of fluid exiting the cold side of the cross flow heat exchanger.					
5	Heat transfer rate	Power	kJ/hr	real	[-Inf;+Inf]	0
	The total heat transfer rate between the fluids in the cross flow heat exchanger.					

6	Effectiveness	Dimensionless	-	real	[-Inf;+Inf]	0
	The effectiveness of the cross flow heat exchanger.					

4.3.3.2. Both Fluids Unmixed

Icon		TRNSYS Model	Type 5
Proforma	Heat Exchangers\Cross Flow\Both Fluids Unmixed\Type5e.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Cross flow mode	Dimensionless	-	integer	[5;5]	3
	The general heat exchanger model may operate in one of four configuration modes. Setting this parameter to 3 indicates a cross flow arrangement. Do not change this parameter.					
2	Specific heat of hot side fluid	Specific Heat	kJ/kg.K	real	[0;+Inf]	4.19
	The specific heat of the fluid flowing through the hot-side of the cross flow heat exchanger.					
3	Specific heat of cold side fluid	Specific Heat	kJ/kg.K	real	[0;+Inf]	4.19
	The specific heat of the fluid flowing through the cold side of the cross flow heat exchanger.					
4	Not Used	Dimensionless	-	integer	[0;+Inf]	0

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Hot side inlet temperature	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the fluid flowing into the hot side of the cross flow heat exchanger.					
2	Hot side flow rate	Flow Rate	kg/hr	real	[0;+Inf]	100.0
	The flow rate of the fluid flowing through the hot side of the cross flow heat exchanger.					
3	Cold side inlet temperature	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the fluid flowing into the cold side of the cross flow heat exchanger.					
4	Cold side flow rate	Flow Rate	kg/hr	real	[0;+Inf]	100.0
	The flow rate of the fluid flowing through the cold side of the cross flow heat exchanger.					
5	Overall heat transfer coefficient of exchanger	Overall Loss Coefficient	kJ/hr.K	real	[0;+Inf]	10.0
	Overall heat transfer coefficient of the cross flow heat exchanger.					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Hot-side outlet temperature	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid leaving the hot side of the cross flow heat exchanger.					
2	Hot-side flow rate	Flow Rate	kg/hr	real	[-Inf;+Inf]	0
	The flow rate of fluid exiting the hot side of the cross flow heat exchanger.					
3	Cold-side outlet temperature	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid leaving the cold side of the cross flow heat exchanger.					
4	Cold-side flow rate	Flow Rate	kg/hr	real	[-Inf;+Inf]	0
	The flow rate of fluid exiting the cold side of the cross flow heat exchanger.					
5	Heat transfer rate	Power	kJ/hr	real	[-Inf;+Inf]	0
	The total heat transfer rate between the fluids in the cross flow heat exchanger.					
6	Effectiveness	Dimensionless	-	real	[-Inf;+Inf]	0
	The effectiveness of the cross flow heat exchanger.					

4.3.3.3. Cold Side Mixed

Icon		TRNSYS Model	Type 5
Proforma	Heat Exchangers\Cross Flow\Cold Side Mixed\Type5c.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Cross flow mode	Dimensionless	-	integer	[3;3]	3
	The general heat exchanger model may operate in one of four configuration modes. Setting this parameter to 3 indicates a cross flow arrangement. Do not change this parameter.					
2	Specific heat of hot side fluid	Specific Heat	kJ/kg.K	real	[0;+Inf]	4.19
	The specific heat of the fluid flowing through the hot-side of the cross flow heat exchanger.					
3	Specific heat of cold side fluid	Specific Heat	kJ/kg.K	real	[0;+Inf]	4.19
	The specific heat of the fluid flowing through the cold side of the cross flow heat exchanger.					
4	Not Used	Dimensionless	-	integer	[0;+Inf]	0

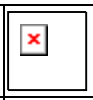
INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Hot side inlet temperature	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the fluid flowing into the hot side of the cross flow heat exchanger.					
2	Hot side flow rate	Flow Rate	kg/hr	real	[0;+Inf]	100.0
	The flow rate of the fluid flowing through the hot side of the cross flow heat exchanger.					
3	Cold side inlet temperature	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the fluid flowing into the cold side of the cross flow heat exchanger.					
4	Cold side flow rate	Flow Rate	kg/hr	real	[0;+Inf]	100.0
	The flow rate of the fluid flowing through the cold side of the cross flow heat exchanger.					
5	Overall heat transfer coefficient of exchanger	Overall Loss Coefficient	kJ/hr.K	real	[0;+Inf]	10.0
	Overall heat transfer coefficient of the cross flow heat exchanger.					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Hot-side outlet temperature	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid leaving the hot side of the cross flow heat exchanger.					
2	Hot-side flow rate	Flow Rate	kg/hr	real	[-Inf;+Inf]	0
	The flow rate of fluid exiting the hot side of the cross flow heat exchanger.					
3	Cold-side outlet temperature	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid leaving the cold side of the cross flow heat exchanger.					
4	Cold-side flow rate	Flow Rate	kg/hr	real	[-Inf;+Inf]	0
	The flow rate of fluid exiting the cold side of the cross flow heat exchanger.					
5	Heat transfer rate	Power	kJ/hr	real	[-Inf;+Inf]	0
	The total heat transfer rate between the fluids in the cross flow heat exchanger.					
6	Effectiveness	Dimensionless	-	real	[-Inf;+Inf]	0
	The effectiveness of the cross flow heat exchanger.					

4.3.3.4. Hot Side Mixed

Icon		TRNSYS Model	Type 5
Proforma	Heat Exchangers\Cross Flow\Hot Side Mixed\Type5d.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Cross flow mode	Dimensionless	-	integer	[4;4]	3
	The general heat exchanger model may operate in one of four configuration modes. Setting this parameter to 3 indicates a cross flow arrangement. Do not change this parameter.					
2	Specific heat of hot side fluid	Specific Heat	kJ/kg.K	real	[0;+Inf]	4.19
	The specific heat of the fluid flowing through the hot-side of the cross flow heat exchanger.					
3	Specific heat of cold side fluid	Specific Heat	kJ/kg.K	real	[0;+Inf]	4.19
	The specific heat of the fluid flowing through the cold side of the cross flow heat exchanger.					
4	Not Used	Dimensionless	-	integer	[0;+Inf]	0

INPUTS

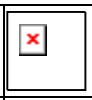
	Name	Dimension	Unit	Type	Range	Default
1	Hot side inlet temperature	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the fluid flowing into the hot side of the cross flow heat exchanger.					
2	Hot side flow rate	Flow Rate	kg/hr	real	[0;+Inf]	100.0
	The flow rate of the fluid flowing through the hot side of the cross flow heat exchanger.					
3	Cold side inlet temperature	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the fluid flowing into the cold side of the cross flow heat exchanger.					
4	Cold side flow rate	Flow Rate	kg/hr	real	[0;+Inf]	100.0
	The flow rate of the fluid flowing through the cold side of the cross flow heat exchanger.					
5	Overall heat transfer coefficient of exchanger	Overall Loss Coefficient	kJ/hr.K	real	[0;+Inf]	10.0
	Overall heat transfer coefficient of the cross flow heat exchanger.					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Hot-side outlet temperature	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid leaving the hot side of the cross flow heat exchanger.					
2	Hot-side flow rate	Flow Rate	kg/hr	real	[-Inf;+Inf]	0
	The flow rate of fluid exiting the hot side of the cross flow heat exchanger.					
3	Cold-side outlet temperature	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid leaving the cold side of the cross flow heat exchanger.					
4	Cold-side flow rate	Flow Rate	kg/hr	real	[-Inf;+Inf]	0
	The flow rate of fluid exiting the cold side of the cross flow heat exchanger.					
5	Heat transfer rate	Power	kJ/hr	real	[-Inf;+Inf]	0
	The total heat transfer rate between the fluids in the cross flow heat exchanger.					
6	Effectiveness	Dimensionless	-	real	[-Inf;+Inf]	0
	The effectiveness of the cross flow heat exchanger.					

4.3.4. Parallel Flow

4.3.4.1. Parallel Flow

Icon		TRNSYS Model	Type 5
Proforma	Heat Exchangers\Parallel Flow\Type5a.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Parallel flow mode	Dimensionless	-	integer	[1;1]	1
	The general heat exchanger model may operate in one of four configuration modes. Setting this parameter to 1 indicates a parallel flow arrangement. Do not change this parameter.					
2	Specific heat of hot side fluid	Specific Heat	kJ/kg.K	real	[0;+Inf]	4.19
	The specific heat of the fluid flowing through the hot-side of the heat exchanger.					
3	Specific heat of cold side fluid	Specific Heat	kJ/kg.K	real	[0;+Inf]	4.19
	The specific heat of the fluid flowing through the cold side of the parallel flow heat exchanger.					
4	Not Used	Dimensionless	-	integer	[0;+Inf]	0

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Hot side inlet temperature	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the fluid flowing into the hot side of the parallel flow heat exchanger.					
2	Hot side flow rate	Flow Rate	kg/hr	real	[0;+Inf]	100.0
	The flow rate of the fluid flowing through the hot side of the parallel flow heat exchanger.					
3	Cold side inlet temperature	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the fluid flowing into the cold side of the parallel flow heat exchanger.					
4	Cold side flow rate	Flow Rate	kg/hr	real	[0;+Inf]	100.0
	The flow rate of the fluid flowing through the cold side of the parallel flow heat exchanger.					
5	Overall heat transfer coefficient of exchanger	Overall Loss Coefficient	kJ/hr.K	real	[0;+Inf]	10.0
	Overall heat transfer coefficient of the parallel flow heat exchanger.					

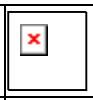
OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Hot-side outlet temperature	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid leaving the hot side of the parallel flow heat exchanger.					
2	Hot-side flow rate	Flow Rate	kg/hr	real	[-Inf;+Inf]	0
	The flow rate of fluid exiting the hot side of the parallel flow heat exchanger.					
3	Cold-side outlet temperature	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid leaving the cold side of the parallel flow heat exchanger.					
4	Cold-side flow rate	Flow Rate	kg/hr	real	[-Inf;+Inf]	0
	The flow rate of fluid exiting the cold side of the parallel flow heat exchanger.					
5	Heat transfer rate	Power	kJ/hr	real	[-Inf;+Inf]	0
	The total heat transfer rate between the fluids in the parallel flow heat exchanger.					

6	Effectiveness	Dimensionless	-	real	[-Inf;+Inf]	0
	The effectiveness of the parallel flow heat exchanger.					

4.3.5. Shell and Tube

4.3.5.1. Shell and Tube

Icon		TRNSYS Model	Type 5
Proforma	Heat Exchangers\Shell and Tube\Type5g.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Shell and Tube mode	Dimensionless	-	integer	[7;7]	3
	The general heat exchanger model may operate in one of four configuration modes. Setting this parameter to 3 indicates a cross flow arrangement. Do not change this parameter.					
2	Specific heat of hot side fluid	Specific Heat	kJ/kg.K	real	[0;+Inf]	4.19
	The specific heat of the fluid flowing through the hot-side of the cross flow heat exchanger.					
3	Specific heat of cold side fluid	Specific Heat	kJ/kg.K	real	[0;+Inf]	4.19
	The specific heat of the fluid flowing through the cold side of the cross flow heat exchanger.					
4	Number of Shell Passes	Dimensionless	-	integer	[1;+Inf]	0

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Hot side inlet temperature	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the fluid flowing into the hot side of the cross flow heat exchanger.					
2	Hot side flow rate	Flow Rate	kg/hr	real	[0;+Inf]	100.0
	The flow rate of the fluid flowing through the hot side of the cross flow heat exchanger.					
3	Cold side inlet temperature	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the fluid flowing into the cold side of the cross flow heat exchanger.					
4	Cold side flow rate	Flow Rate	kg/hr	real	[0;+Inf]	100.0
	The flow rate of the fluid flowing through the cold side of the cross flow heat exchanger.					
5	Overall heat transfer coefficient of exchanger	Overall Loss Coefficient	kJ/hr.K	real	[0;+Inf]	10.0
	Overall heat transfer coefficient of the cross flow heat exchanger.					

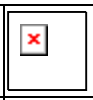
OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Hot-side outlet temperature	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid leaving the hot side of the cross flow heat exchanger.					
2	Hot-side flow rate	Flow Rate	kg/hr	real	[-Inf;+Inf]	0
	The flow rate of fluid exiting the hot side of the cross flow heat exchanger.					
3	Cold-side outlet temperature	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid leaving the cold side of the cross flow heat exchanger.					
4	Cold-side flow rate	Flow Rate	kg/hr	real	[-Inf;+Inf]	0
	The flow rate of fluid exiting the cold side of the cross flow heat exchanger.					
5	Heat transfer rate	Power	kJ/hr	real	[-Inf;+Inf]	0
	The total heat transfer rate between the fluids in the cross flow heat exchanger.					

6	Effectiveness	Dimensionless	-	real	[-Inf;+Inf]	0
	The effectiveness of the cross flow heat exchanger.					

4.3.6. Waste Heat Recovery

4.3.6.1. Waste Heat Recovery

Icon		TRNSYS Model	Type 17
Proforma	Heat Exchangers\Waste Heat Recovery\Type17.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Number of heat exchangers in WHR loop	Dimensionless	-	integer	[2;6]	3
	The total number of heat exchangers in the waste heat recovery system including the primary heat exchanger.					
2	Mass flow rate when pump is on	Flow Rate	kg/hr	real	[0.0;+Inf]	100.0
	The flow rate of fluid through the waste heat recovery loop when the waste heat recovery pump is on.					
3	Specific heat of fluid in WHR loop	Specific Heat	kJ/kg.K	real	[0.0;+Inf]	4.19
	The specific heat of the fluid flowing through the waste heat recovery heat exchanger loop.					
4	Number of controller oscillations	Dimensionless	-	integer	[1;+Inf]	7
	The number of oscillations of the waste heat recovery loop pump control signal allowed before the pumps are disabled for the timestep. This feature is used to promote convergence in systems where the waste heat recovery loop pump oscillates on and off in successive iterations in one timestep.					
5	Temperature tolerance	Temperature	C	real	[0.0;+Inf]	0.1
	The absolute convergence tolerance on the outlet temperature of the primary heat exchanger. Convergence is assumed when the outlet temperature of the hot side of the primary heat exchanger changes between successive iterations by less than this specified tolerance. If convergence problems are encountered, try loosening this tolerance.					
6	Mode for heat exchanger	Dimensionless	-	integer	[1;3]	1
	The heat exchanger mode for the specified heat exchanger. 1 = Parallel flow ; 2 = Counter flow ; 3 = Cross flow Heat exchanger 1 is the primary heat exchanger. Heat exchanger 2 is the heat exchanger closest downstream to the primary heat exchanger. Heat exchanger N is the heat exchanger closest upstream to the primary heat exchanger.					
7	Overall conductance for heat exchanger	Overall Loss Coefficient	kJ/hr.K	real	[0.0;+Inf]	1000.0
	The overall heat transfer conductance (UA) for the specified heat exchanger. Heat exchanger 1 is the primary heat exchanger. Heat exchanger 2 is the heat exchanger closest downstream to the primary heat exchanger.					
8	Specific heat of fluid entering HX	Specific Heat	kJ/kg.K	real	[0.0;+Inf]	0
	The specific heat of the fluid entering the cold side of the specified heat exchanger. Heat exchanger 1 is the primary heat exchanger. Heat exchanger 2 is the heat exchanger closest downstream to the primary heat exchanger.					
9	Control mode for heat exchanger	Dimensionless	-	integer	[1;3]	1
	The control mode for the specified heat exchanger. 1 = NO CONTROL: Energy is transferred into or out of the WHR loop whenever there is flow on both sides of the heat exchanger. In this mode, the minimum temperature difference parameter is ignored. External control is possible by the use of an external controller controlling the operation of the pump supplying the fluid to the non-WHR loop side of the heat exchanger. 2 = ENERGY RECOVERY: Energy is transferred into the WHR loop whenever the recovery stream inlet temperature is greater than the WHR inlet side temperature plus the minimum temperature difference parameter. Otherwise the conditions of the recovery stream outlet are set equal to those of the inlet and the					

	heat transfer is zero. This is not an option for the primary heat exchanger (heat exchanger 1). 3 = ENERGY DELIVERY: Energy is transferred from the WHR loop whenever the inlet to the WHR loop side of the heat exchanger is greater than the external stream inlet plus the minimum temperature difference parameter. Otherwise the conditions of the external stream outlet are set to those of the inlet and the heat transfer is zero. Heat exchanger 1 is the primary heat exchanger. Heat exchanger 2 is the heat exchanger closest downstream to the primary heat exchanger.					
10	Minimum temperature difference for WHR pump	Temp. Difference	deltaC	real	[0.0;+Inf]	0
	The minimum temperature difference between the hot and cold inlets to the specified heat exchanger necessary for WHR pump operation. This parameter is only used if the control mode parameter is set to 2 or 3 for the specified heat exchanger. Heat exchanger 1 is the primary heat exchanger. Heat exchanger 2 is the heat exchanger closest downstream to the primary heat exchanger.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
6-10	Number of heat exchangers in WHR loop		1	100

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Inlet temperature to HX	Temperature	C	real	[-Inf;+Inf]	20.0
	The inlet temperature of the fluid flowing through the non-WHR side of the specified heat exchanger. For heat exchanger 1 (the primary heat exchanger) this inlet temperature is the cold-side inlet temperature. Heat exchanger 2 is the heat exchanger closest downstream to the primary heat exchanger.					
2	Inlet flowrate to HX	Flow Rate	kg/hr	real	[0.0;+Inf]	100.0
	The flow rate of fluid flowing through the non-WHR side of the specified heat exchanger. For heat exchanger 1 (the primary heat exchanger), the inlet flowrate is the flowrate through the cold side of the primary heat exchanger.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
1-2	Number of heat exchangers in WHR loop		1	50

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Outlet temperature of HX	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid exiting the non-WHR loop side of the specified heat exchanger. Heat exchanger 1 is the primary heat exchanger. Heat exchanger 2 is the heat exchanger closest downstream to the primary heat exchanger.					
2	Outlet flow rate from HX	Flow Rate	kg/hr	real	[-Inf;+Inf]	0
	The flow rate of fluid exiting the non-WHR loop side of the specified heat exchanger. Heat exchanger 1 is the primary heat exchanger. Heat exchanger 2 is the heat exchanger closest downstream to the primary heat exchanger.					
3	Heat transfer rate across HX	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is transferred between the fluid streams in the specified heat exchanger. Heat exchanger 1 is the primary heat exchanger. Heat exchanger 2 is the heat exchanger closest downstream to the primary heat exchanger.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
1-3	Number of heat exchangers in WHR loop		1	50

4.4. HVAC

4.4.1. Absorption Chiller (Hot-Water Fired, Single Effect)

4.4.1.1. Absorption Chiller (Hot-Water Fired, Single Effect)

Icon		TRNSYS Model	Type 107
Proforma	HVAC\Absorption Chiller (Hot-Water Fired, Single Effect)\Type107.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Rated capacity	Power	kJ/hr	real	[0.0;+Inf]	0
	The capacity of the machine at its rated condition (typically 30C (85 F) inlet cooling water temperature and 7C (44 F) chilled water set point temperature). The data files associated with this model should be consistent with the rating conditions.					
2	Rated C.O.P.	Dimensionless	-	real	[0.0;+Inf]	0
	The COP of the chiller at its rated conditions (typically 30 C (85 F) inlet cooling water temperature and 7C (44 F) chilled water set point temperature). Make sure that the asociated files for this component are consistent with the rating conditions.					
3	Logical unit for S1 data file	Dimensionless	-	integer	[10;+Inf]	0
	The logical unit which will be ASSIGNed to the user-supplied data file containing the fraction of nominal capacity and fraction of design energy input data as a function of the inlet hot water temperature, the inlet cooling water temperature, the chilled water setpoint temperature, and the fraction of design load.					
4	Number of HW temperatures in S1 data file	Dimensionless	-	integer	[2;20]	0
	The number of hot water inlet temperatures for which catalog data is supplied in the data file.					
5	Number of CW steps in S1 data file	Dimensionless	-	integer	[2;20]	0
	The number of cooling water temperature steps contained in the required catalog data file.					
6	Number of CHW set points in S1 data file	Dimensionless	-	integer	[2;20]	0
	The number of chilled water setpoints for which catalog data is provided in the required data file (S1.dat).					
7	Number of load fractions in S1 data file	Dimensionless	-	integer	[2;20]	0
	The number of fractions of design load for which catalog data is provided in the required data file (S1.dat).					
8	HW fluid specific heat	Specific Heat	kJ/kg.K	real	[0.0;+Inf]	0
	The specific heat of the fluid (typically hot water) which will be used by the absorption chiller as the energy source for chiller operation.					
9	CHW fluid specific heat	Specific Heat	kJ/kg.K	real	[0.0;+Inf]	0
	The specific heat of the chilled water stream flowing through the chiller.					
10	CW fluid specific heat	Specific Heat	kJ/kg.K	real	[0.0;+Inf]	0
	The specific heat of the cooling water flow stream.					
11	Auxiliary electrical power	Power	kJ/hr	real	[0.0;+Inf]	0

	The auxiliary electrical power required by the absorption chiller while its operating (solution pumps, refrigerant pumps, etc.)

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Chilled water inlet temperature	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the chilled water stream entering the chiller.					
2	Chilled water flow rate	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	The mass flow rate at which chilled water enters the chiller.					
3	Cooling water inlet temperature	Temperature	C	real	[-Inf;+Inf]	0
	The temperature at which the cooling water flow stream enters the chiller.					
4	Cooling water flow rate	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	The mass flow rate at which the cooling fluid (typically water) enters the chiller.					
5	Hot water inlet temperature	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the inlet stream (typically hot water) which will be used as the energy source for chiller operation.					
6	Hot water flow rate	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	The flow rate of fluid (typically hot water) used as the energy source for chiller operation.					
7	CHW set point	Temperature	C	real	[-Inf;+Inf]	0
	The set-point temperature for the chilled water stream. If the chiller has the capacity to meet the current load, the chiller will modulate to meet the load and chilled water stream will leave at this temperature.					
8	Chiller control signal	Dimensionless	-	integer	[0.0;1.0]	0
	The control signal for the operation of the chiller. CTRL < 0.5 : chiller is OFF, CTRL >= 0.5 : chiller is ON					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Chilled water temperature	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the chilled water stream exiting the chiller.					
2	Chilled water flow rate	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	The flow rate of the chilled water stream exiting the chiller.					
3	Cooling water temperature	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the cooling flow stream exiting the chiller.					
4	Cooling water flow rate	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	The mass flow rate at which the cooling stream exits the chiller.					
5	Hot water outlet temperature	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the hot water stream exiting the absorption chiller.					
6	Hot water flow rate	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	The flow rate of fluid (typically hot water) exiting the chiller and used by the chiller for an energy source for chiller operation.					
7	Chilled water energy	Power	kJ/hr	real	[0.0;+Inf]	0
	The rate at which energy was removed from the chilled water flow stream during the timestep.					
8	Cooling water energy	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is rejected to the cooling water flow stream by the chiller					
9	Hot water energy	Power	kJ/hr	real	[0.0;+Inf]	0
	The rate at which energy was removed from the hot water flow in order to operate the absorption chiller.					
10	Electrical energy required	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which electrical energy was required in order to operate the absorption chiller (solution pumps, refrigerant pumps, etc.).					

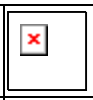
11	Fraction of nominal capacity	Dimensionless	-	real	[0.0;+Inf]	0
	The fraction of nominal capacity available to the chiller at the current timestep. The fraction of nominal capacity is interpolated from the required data file for this component (S1.dat) as a function of the entering cooling water temperature, the chilled water set-point temperature, the hot water inlet temperature, and the fraction of design load.					
12	Fraction of design energy input	Dimensionless	-	real	[0.0;1.0]	0
	The fraction of design energy input required by the chiller at the current timestep. The fraction of the energy input as compared to design conditions is interpolated from the required data file for this component (S1.dat) as a function of the entering cooling water temperature, the fraction of design load to be met by the chiller at the current timestep, the entering hot water temperature, and the chilled water set point temperature.					
13	C.O.P	Dimensionless	-	real	[0.0;+Inf]	0
	The coefficient of performane (C.O.P.) of the chiller at current conditions. The C.O.P. for this model is defined as the energy transferred from the chilled water stream divided by the sum of the electrical energy required by the chiller and the energy provided to the chiller by the inlet hot water flow stream.					

EXTERNAL FILES

Question	File	Associated parameter
File with fraction of design energy input data	.\Examples\Data Files\Type107-HotWaterFiredAbsorptionChiller.dat	Logical unit for S1 data file
Source file	.\SourceCode\Types\Type107.for	

4.4.2. Auxiliary Cooling Unit

4.4.2.1. Auxiliary Cooling Unit

Icon		TRNSYS Model	Type 92
Proforma	HVAC\Auxiliary Cooling Unit\Type92.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Maximum cooling rate	Power	kJ/hr	real	[-Inf;+Inf]	0
2	Specific heat of fluid	Specific Heat	kJ/kg.K	real	[0.0;+Inf]	0
3	Overall loss coefficient	Overall Loss Coefficient	kJ/hr.K	real	[0.0;+Inf]	0
4	Cooling device efficiency	dimensionless	-	real	[0;1.0]	0

INPUTS

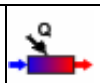
	Name	Dimension	Unit	Type	Range	Default
1	Inlet fluid temperature	Temperature	C	real	[-Inf;+Inf]	0
2	Fluid mass flow rate	Flow Rate	kg/hr	real	[-Inf;+Inf]	0
3	Control Function	dimensionless	-	integer	[0;1]	0
4	Set point temperature	Temperature	C	real	[-273.1;+Inf]	0
5	Temperature of surroundings	Temperature	C	real	[-Inf;+Inf]	0

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Outlet fluid temperature	Temperature	C	real	[-Inf;+Inf]	0
2	Outlet fluid flow rate	Flow Rate	kg/hr	real	[-Inf;+Inf]	0
3	Required cooling rate	Power	kJ/hr	real	[-Inf;+Inf]	0
4	Losses from the auxiliary cooling device	Power	kJ/hr	real	[-Inf;+Inf]	0
5	Rate of energy removed	Power	kJ/hr	real	[-Inf;+Inf]	0

4.4.3. Auxiliary Heaters

4.4.3.1. Auxiliary Heaters

Icon		TRNSYS Model	Type 6
Proforma	HVAC\Auxiliary Heaters\Type6.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Maximum heating rate	Power	kJ/hr	real	[-Inf;+Inf]	1000.0
	Maximum heating rate: The maximum possible energy transfer to the fluid stream. The maximum available energy transfer to the fluid stream will be the product of the maximum possible energy transfer and the conversion efficiency.					
2	Specific heat of fluid	Specific Heat	kJ/kg.K	real	[0.0;+Inf]	4.19
	Specific heat of fluid:					
3	Overall loss coefficient for heater during operation	Overall Loss Coefficient	kJ/hr.K	real	[0.0;+Inf]	0.0
	The loss coefficient (UA) from the heater during operation: During operation: Qloss = UA*(T-Tenv) + (1-efficiency)*Qmax During non-operation: Qloss = 0					
4	Efficiency of auxiliary heater	Dimensionless	-	real	[0.0;1.0]	1.0
	The thermal conversion efficiency of the auxiliary heater. Typical values: Electric Heater = 1.0 ; Natural Gas = 0.79					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Inlet fluid temperature	Temperature	C	real	[-Inf;+Inf]	20.0
	Inlet fluid temperature:					
2	Fluid mass flow rate	Flow Rate	kg/hr	real	[0.;+Inf]	100.0
	Inlet flow rate:					
3	Control Function	Dimensionless	-	integer	[0;1]	1
	Control function: Control function = 1 ---> Heater is on and providing energy to stream Control function = 0 ---> Heater is off The heater control function input requires either 1 or 0; proportional control signals (e.g. CF=0.53) will be interpretted as heater=off!					
4	Set point temperature	Temperature	C	real	[-273.1;+Inf]	20.0
	Temperature of surroundings (Tenv): Qloss = UA*(T-Tenv) + (1-efficiency)*Qmax					
5	Temperature of surroundings	Temperature	C	real	[-273.1;+Inf]	0

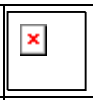
OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Outlet fluid temperature	Temperature	C	real	[-Inf;+Inf]	0
	Outlet temperature: If control=0 or mdot=0 or inlet temp > Tset then: Tout = Tin					

	Else Tout = (Qmax*Eff + mCpTin + UATenv - UATin/2)/(mCp + UA/2) Unless Tout > Tset then Tout = Tset					
2	Outlet fluid flow rate	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	Outlet flow rate: outlet flow rate = inlet flow rate					
3	Required heating rate	Power	kJ/hr	real	[-Inf;+Inf]	0
	Required heating rate: The power needed to heat the fluid to the set point temperature including losses and conversion inefficiencies. If Qaux = Qmax; unless Tout > Tset then Qaux = (mCp(Tset-Tin) + UA(T-Tenv))/efficiency					
4	Losses from the auxiliary heater	Power	kJ/hr	real	[-Inf;+Inf]	0
	Losses from the heater: Qloss = UA(T-Tenv) + (1-efficiency)*Qmax					
5	Rate of energy delivery to fluid stream	Power	kJ/hr	real	[-Inf;+Inf]	0
	Power to fluid stream: Qfluid = mCp*(Tout-Tin)					

4.4.4. Conditioning Equipment

4.4.4.1. 1 Independent Variable

Icon		TRNSYS Model	Type 42
Proforma	HVAC\Conditioning Equipment\1 Independent Variable\Type42c.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Logical unit	Dimensionless	-	integer	[10;30]	20
	The logical unit through which the performance data will be read. Every external file that TRNSYS reads to or writes from must be assigned a unique logical unit number in the TRNSYS input file.					
2	Number of independent variables	Dimensionless	-	integer	[1;1]	1
	The number of independent variables on which the equipment performance is dependent.					
3	Number of dependent variables	Dimensionless	-	integer	[1;5]	3
	The number of dependent performance variables to be read from the external performance data file.					
4	Number of values of independent variable	Dimensionless	-	integer	[1;10]	5
	The number of values of the independent variable for which peformance data is supplied in the external performance file.					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Control function	Dimensionless	-	real	[-Inf;+Inf]	1.0
	The control function for the equipment operation. The outputs from this component are simply the interpolated values from the data file multiplied by this control function.					
2	Independent variable	any	any	real	[-Inf;+Inf]	0.0
	The value of the independent variable on which the equipment performance depends.					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Value of dependent variable	any	any	real	[-Inf;+Inf]	0
	The value of the specified dependent equipment performance variable.					

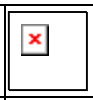
Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
1-1	Number of dependent variables		1	50

EXTERNAL FILES

Question	File	Associated parameter
Which file contains the performance data?	\TRNWIN\PERFORM.DAT	Logical unit
Source file	.\SourceCode\Types\Type42.for	

4.4.4.2. 2 Independent Variables

Icon		TRNSYS Model	Type 42
Proforma	HVAC\Conditioning Equipment\2 Independent Variables\Type42b.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Logical unit	Dimensionless	-	integer	[10;30]	20
	The logical unit through which the performance data will be read. Every external file that TRNSYS reads to or writes from must be assigned a unique logical unit number in the TRNSYS input file.					
2	Number of independent variables	Dimensionless	-	integer	[2;2]	2
	The number of independent variables on which the equipment performance is dependent.					
3	Number of dependent variables	Dimensionless	-	integer	[1;5]	3
	The number of dependent performance variables to be read from the external performance data file.					
4	Number of values of 1st independent variable	Dimensionless	-	integer	[1;10]	5
	The number of values of the first independent variable for which peformance data is supplied in the external performance file.					
5	Number of values of 2nd independent variable	Dimensionless	-	integer	[1;5]	5
	The number of values of the second independent variable for which performance data is supplied in the external performance data file.					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Control function	Dimensionless	-	real	[-Inf;+Inf]	1.0
	The control function for the equipment operation. The outputs from this component are simply the interpolated values from the data file multiplied by this control function.					
2	First independent variable	any	any	real	[-Inf;+Inf]	0.0
	The value of the first independent variable on which the equipment performance depends.					
3	Second independent variable	any	any	real	[-Inf;+Inf]	0.0
	The value of the second independent variable on which the equipment performance depends.					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Value of dependent variable	any	any	real	[-Inf;+Inf]	0
	The value of the specified dependent equipment performance variable.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
1-1	Number of dependent variables		1	50

EXTERNAL FILES

Question	File	Associated parameter
Which file contains the performance data?	\TRNWIN\PERFORM.DAT	Logical unit
Source file	.\SourceCode\Types\Type42.for	

4.4.4.3. 3 Independent Variables

Icon		TRNSYS Model	Type 42
Proforma	HVAC\Conditioning Equipment\3 Independent Variables\Type42a.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Logical unit	Dimensionless	-	integer	[10;30]	20
	The logical unit through which the performance data will be read. Every external file that TRNSYS reads to or writes from must be assigned a unique logical unit number in the TRNSYS input file.					
2	Number of independent variables	Dimensionless	-	integer	[3;3]	3
	The number of independent variables on which the equipment performance is dependent.					
3	Number of dependent variables	Dimensionless	-	integer	[1;5]	3
	The number of dependent performance variables to be read from the external performance data file.					
4	Number of values of 1st independent variable	Dimensionless	-	integer	[1;10]	5
	The number of values of the first independent variable for which peformance data is supplied in the external performance file.					
5	Number of values of 2nd independent variable	Dimensionless	-	integer	[1;5]	5
	The number of values of the second independent variable for which performance data is supplied in the external performance data file.					
6	Number of values of 3rd independent variable	Dimensionless	-	integer	[1;5]	3
	The number of values of the third independent variable for which perormance data is supplied in the external performance data file.					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Control function	Dimensionless	-	real	[-Inf;+Inf]	1.0
	The control function for the equipment operation. The outputs from this component are simply the interpolated values from the data file multiplied by this control function.					
2	First independent variable	any	any	real	[-Inf;+Inf]	0.0
	The value of the first independent variable on which the equipment performance depends.					
3	Second independent variable	any	any	real	[-Inf;+Inf]	0.0
	The value of the second independent variable on which the equipment performance depends.					
4	Third independent variable	any	any	real	[-Inf;+Inf]	0.0
	The value of the third independent variable on which the equipment performance depends.					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Value of dependent variable	any	any	real	[-Inf;+Inf]	0
	The value of the specified dependent equipment performance variable.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
1-1	Number of dependent variables		1	50

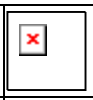
EXTERNAL FILES

Question	File	Associated parameter

Which file contains the performance data?		Logical unit
Source file	.\SourceCode\Types\Type42.for	

4.4.5. Cooling Coils

4.4.5.1. Detailed - Annular Fins

Icon		TRNSYS Model	Type 52
Proforma	HVAC\Cooling Coils\Detailed\Annular Fins\Type52a.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Calculation mode	Dimensionless	-	integer	[1;2]	2
	The detailed cooling coil component may operate in one of two modes. In mode 1, the coil is assumed to be either completely wet or completely dry. This mode tends to underpredict the total heat transfer. In mode 2, the percentage of dry coil is determined using a detailed approach.					
2	Number of rows	Dimensionless	-	integer	[1;+Inf]	7
	The number of heat exchanger rows (passes). Four or more rows are recommended.					
3	Number of tubes	Dimensionless	-	integer	[1;+Inf]	4
	The number of parallel tubes in each row of tubes.					
4	Duct height	Length	m	real	[0.0;+Inf]	1.0
	The height of the duct parallel to the tubes (used as the tube length).					
5	Duct width	Length	m	real	[0.0;+Inf]	1.0
	The width of the cooling coil duct (perpendicular to tubes).					
6	Outside tube diameter	Length	m	real	[0.0;+Inf]	0.025
	The outside diameter of the tubes containing the water stream.					
7	Inside tube diameter	Length	m	real	[0.0;+Inf]	0.02
	The inside diameter of one of the identical tubes carrying the chilled water.					
8	Tube thermal conductivity	Thermal Conductivity	kJ/hr.m.K	real	[0.0;+Inf]	500.0
	The thermal conductivity of the tube material.					
9	Fin thickness	Length	m	real	[0.0;+Inf]	0.01
	The thickness of an individual fin.					
10	Fin spacing	Length	m	real	[0.0;+Inf]	0.1
	The distance between individual fins.					
11	Number of fins	Dimensionless	-	integer	[0;+Inf]	25
	The number of fins on one tube and one pass.					
12	Fin thermal conductivity	Thermal Conductivity	kJ/hr.m.K	real	[0.0;+Inf]	700.0
	The thermal conductivity of the fin material.					
13	Fin mode	Dimensionless	-	integer	[2;2]	2
	Setting this parameter to 2 indicates to the cooling coil model that annular fins are to be used. Do not change this parameter.					
14	Diameter at fin tip	Length	m	real	[0.0;+Inf]	0.05
	The diameter of the fin at the tip.					
15	Tube spacing	Length	m	real	[0.0;+Inf]	0.35
	The distance between center lines of tube rows (parallel to air flow).					

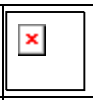
INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Inlet dry-bulb temperature	Temperature	C	real	[-Inf;+Inf]	22.0
	The dry bulb temperature of the air entering the cooling coil.					
2	Air inlet humidity ratio	Dimensionless	-	real	[-Inf;+Inf]	0.0
	The wet bulb temperature of the air entering the cooling coil.					
3	Flow rate of air	Flow Rate	kg/hr	real	[0.0;+Inf]	100.0
	the flow rate of air entering the cooling coil.					
4	Inlet water temperature	Temperature	C	real	[0.0;+Inf]	10.0
	The temperature of the chilled water entering the cooling coil.					
5	Flow rate of water	Flow Rate	kg/hr	real	[0.0;+Inf]	100.0
	The flow rate of chilled water entering the cooling coil.					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Outlet air temperature	Temperature	C	real	[-Inf;+Inf]	0
	The dry bulb temperature of the air exiting the cooling coil.					
2	Outlet air humidity ratio	Dimensionless	-	real	[-Inf;+Inf]	0
	The absolute humidity ratio (kg's of H2O / kg of dry air) of the air exiting the cooling coil.					
3	Air flow rate	Flow Rate	kg/hr	real	[-Inf;+Inf]	0
	The flow rate of air exiting the cooling coil.					
4	Outlet water temperature	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the chilled water exiting the cooling coil.					
5	Water flow rate	Flow Rate	kg/hr	real	[-Inf;+Inf]	0
	The flow rate of chilled water exiting the cooling coil.					
6	Total cooling rate	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is transferred from the air stream in the cooling coil.					
7	Sensible cooling rate	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which sensible energy is removed from the air stream in the cooling coil.					
8	Latent cooling rate	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which latent energy is removed from the moist air flow stream in the cooling coil.					
9	Dry coil fraction	Dimensionless	-	real	[-1.0;1.0]	0
	The fraction of the coil surface area that is dry. 0.0 ---> Completely wet 1.0 ---> Completely dry -1.0 ---> If simple analysis calculation mode is used (either wet or dry)					

4.4.5.2. Detailed - Rectangular Fins

Icon		TRNSYS Model	Type 52
Proforma	HVAC\Cooling Coils\Detailed\Rectangular Fins\Type52b.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Calculation mode	Dimensionless	-	integer	[1;2]	2
	The detailed cooling coil component may operate in one of two modes. In mode 1, the coil is assumed to be either completely wet or completely dry. This mode tends to underpredict the total heat transfer. In mode 2, the percentage of dry coil is determined using a detailed approach.					
2	Number of rows	Dimensionless	-	integer	[1;+Inf]	7
	The number of heat exchanger rows (passes). Four or more rows are recommended.					
3	Number of tubes	Dimensionless	-	integer	[1;+Inf]	4
	The number of parallel tubes in each row of tubes.					
4	Duct height	Length	m	real	[0.0;+Inf]	1.0
	The height of the duct parallel to the tubes (used as the tube length).					
5	Duct width	Length	m	real	[0.0;+Inf]	1.0
	The width of the cooling coil duct (perpendicular to tubes).					
6	Outside tube diameter	Length	m	real	[0.0;+Inf]	0.025
	The outside diameter of the tubes containing the water stream.					
7	Inside tube diameter	Length	m	real	[0.0;+Inf]	0.02
	The inside diameter of one of the identical tubes carrying the chilled water.					
8	Tube thermal conductivity	Thermal Conductivity	kJ/hr.m.K	real	[0.0;+Inf]	500.0
	The thermal conductivity of the tube material.					
9	Fin thickness	Length	m	real	[0.0;+Inf]	0.01
	The thickness of an individual fin.					
10	Fin spacing	Length	m	real	[0.0;+Inf]	0.1
	The distance between individual fins.					
11	Number of fins	Dimensionless	-	integer	[0;+Inf]	25
	The number of fins in the cooling coil circuit.					
12	Fin thermal conductivity	Thermal Conductivity	kJ/hr.m.K	real	[0.0;+Inf]	700.0
	The thermal conductivity of the fin material.					
13	Fin mode	Dimensionless	-	integer	[1;1]	1
	Setting this parameter to 1 indicates to the cooling coil model that rectangular fins are to be used. Do not change this parameter.					
14	Center to center distance	Length	m	real	[0.0;+Inf]	0.35
	The center to center distance between rows of tubes (perpendicular to air flow).					
15	Tube spacing	Length	m	real	[0.0;+Inf]	0.35
	The distance between center lines of tube rows (parallel to air flow).					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Inlet dry-bulb temperature	Temperature	C	real	[-Inf;+Inf]	22.0
	The dry bulb temperature of the air entering the cooling coil.					

2	Air inlet humidity ratio	Dimensionless	-	real	[-Inf;+Inf]	0.0
	The wet bulb temperature of the air entering the cooling coil.					
3	Flow rate of air	Flow Rate	kg/hr	real	[0.0;+Inf]	100.0
	the flow rate of air entering the cooling coil.					
4	Inlet water temperature	Temperature	C	real	[0.0;+Inf]	10.0
	The temperature of the chilled water entering the cooling coil.					
5	Flow rate of water	Flow Rate	kg/hr	real	[0.0;+Inf]	100.0
	The flow rate of chilled water entering the cooling coil.					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Outlet air temperature	Temperature	C	real	[-Inf;+Inf]	0
	The dry bulb temperature of the air exiting the cooling coil.					
2	Outlet air humidity ratio	Dimensionless	-	real	[-Inf;+Inf]	0
	The absolute humidity ratio (kg's of H2O / kg of dry air) of the air exiting the cooling coil.					
3	Air flow rate	Flow Rate	kg/hr	real	[-Inf;+Inf]	0
	The flow rate of air exiting the cooling coil.					
4	Outlet water temperature	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the chilled water exiting the cooling coil.					
5	Water flow rate	Flow Rate	kg/hr	real	[-Inf;+Inf]	0
	The flow rate of chilled water exiting the cooling coil.					
6	Total cooling rate	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is transferred from the air stream in the cooling coil.					
7	Sensible cooling rate	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which sensible energy is removed from the air stream in the cooling coil.					
8	Latent cooling rate	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which latent energy is removed from the moist air flow stream in the cooling coil.					
9	Dry coil fraction	Dimensionless	-	real	[-1.0;1.0]	0
	The fraction of the coil surface area that is dry. 0.0 ---> Completely wet 1.0 ---> Completely dry -1.0 ---> If simple analysis calculation mode is used (either wet or dry)					

4.4.5.3. Simplified

Icon		TRNSYS Model	Type 32
Proforma	HVAC\Cooling Coils\Simplified\Type32.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Number of rows	Dimensionless	-	integer	[1;+Inf]	7
	The number of rows deep of the cooling coil (the number of possible air paths).					
2	Number of coil circuits	Dimensionless	-	integer	[1;+Inf]	4
	The number of parallel cooling coil circuits (water flow tubes).					
3	Coil face area	Area	m^2	real	[0.0;+Inf]	1.0
	The face area of the coil (the area exposed to the entering air stream).					
4	Inside tube diameter	Length	m	real	[0.0;+Inf]	0.02
	The inside diameter of one of the identical tubes carrying the chilled water.					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Inlet dry-bulb temperature	Temperature	C	real	[-Inf;+Inf]	22.0
	The dry bulb temperature of the air entering the cooling coil.					
2	Inlet wet bulb temperature	Temperature	C	real	[-Inf;+Inf]	20.0
	The wet bulb temperature of the air entering the cooling coil.					
3	Flow rate of air	Flow Rate	kg/hr	real	[0.0;+Inf]	100.0
	the flow rate of air entering the cooling coil.					
4	Inlet water temperature	Temperature	C	real	[0.0;+Inf]	10.0
	The temperature of the chilled water entering the cooling coil.					
5	Flow rate of water	Flow Rate	kg/hr	real	[0.0;+Inf]	100.0
	The flow rate of chilled water entering the cooling coil.					

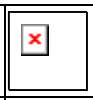
OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Outlet dry bulb temperature	Temperature	C	real	[-Inf;+Inf]	0
	The dry bulb temperature of the air exiting the cooling coil.					
2	Outlet wet bulb temperature	Temperature	C	real	[-Inf;+Inf]	0
	The wet bulb temperature of the air exiting the cooling coil.					
3	Air flow rate	Flow Rate	kg/hr	real	[-Inf;+Inf]	0
	The flow rate of air exiting the cooling coil.					
4	Outlet water temperature	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the chilled water exiting the cooling coil.					
5	Water flow rate	Flow Rate	kg/hr	real	[-Inf;+Inf]	0
	The flow rate of chilled water exiting the cooling coil.					
6	Sensible cooling rate	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which sensible energy is removed from the air stream in the cooling coil.					
7	Latent cooling rate	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which latent energy is removed from the moist air flow stream in the cooling coil.					

8	Total cooling rate	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is removed from the moist air stream in the cooling coil.					

4.4.6. Cooling Towers

4.4.6.1. External Performance File

Icon		TRNSYS Model	Type 51
Proforma	HVAC\Cooling Towers\External Performance File\Type51a.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Calculation mode	Dimensionless	-	integer	[2;2]	2
	Setting this parameter to 2 indicates to the general cooling tower component that the performance will be read from an external data file. Do not change this parameter.					
2	Flow geometry	Dimensionless	-	integer	[1;2]	1
	The flow geometry for the cooling tower: 1 ---> Counterflow geometry 2 ---> Crossflow geometry					
3	Number of tower cells	Dimensionless	-	integer	[1;8]	1
	How many identical tower cells make up the cooling tower?					
4	Maximum cell flow rate	Volumetric Flow Rate	m^3/hr	real	[0.0;+Inf]	40.0
	The maximum volumetric air flow rate for each cell.					
5	Fan power at maximum flow	Power	kW	real	[0.0;+Inf]	1.0
	The power consumed by one cell fan at the maximum volumetric air flow rate specified.					
6	Minimum cell flow rate	Volumetric Flow Rate	m^3/hr	real	[0.0;+Inf]	10.0
	The volumetric flow rate of air per cell below which the cell fan is turned off.					
7	Sump volume	Volumetric Flow Rate	m^3	real	[-1;+Inf]	1.0
	The sump volume for the cooling tower. Set this parameter to -1 if a steady state analysis is to be used for the sump temperature.					
8	Initial sump temperature	Temperature	C	real	[-Inf;+Inf]	15.0
	The temperature of the sump at the beginning of the simulation.					
9	Logical unit	Dimensionless	-	integer	[10;30]	23
	The logical unit through which the tower performance data will be read. Each external file that TRNSYS reads from or writes to must be assigned a unique logical unit in the TRNSYS input file.					
10	Number of data points	Dimensionless	-	real	[2;50]	10
	The number of data points that will be read from the external cooling tower performance data file.					
11	Print performance results?	Dimensionless	-	integer	[1;2]	1
	Should the results from the curve-fit and the performance data be written to the output file? 1 ---> Print the results to the output file 2 ---> Don't print the results					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Water inlet temperature	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the water entering the cooling tower.					
2	Inlet water flow rate	Flow Rate	kg/hr	real	[0.0;+Inf]	100.0

	The flow rate of water entering the cooling tower.					
3	Dry bulb temperature	Temperature	C	real	[-Inf;+Inf]	15.0
	The dry bulb temperature of the air entering the cooling tower.					
4	Wet bulb temperature	Temperature	C	real	[-Inf;+Inf]	12.0
	The wet bulb temperature of the air entering the cooling tower.					
5	Sump make-up temperature	Temperature	C	real	[-Inf;+Inf]	10.0
	The temperature of the replacement water entering the sump.					
6	Relative fan speed for cell	Dimensionless	-	real	[-1.0;1.0]	0.85
	The relative fan speed (fraction of maximum volumetric flow) of the specified tower cell. Set this input to -1 if the tower is operating in natural convection mode.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
6-6	Number of tower cells		1	50

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Sump temperature	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the tower sump.					
2	Sump flow rate	Flow Rate	kg/hr	real	[-Inf;+Inf]	0
	The flow rate of water exiting the tower sump.					
3	Fan power required	Power	kW	real	[-Inf;+Inf]	0
	The total fan power requirement for the cooling tower.					
4	Heat rejection rate	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is transferred to the air stream from the tower cells.					
5	Cell outlet temperature	Temperature	C	real	[-Inf;+Inf]	0
	The effective mixed outlet temperature of the water from the tower cells that is the inlet to the sump.					
6	Water loss rate	Flow Rate	kg/hr	real	[-Inf;+Inf]	0
	The rate at which water is evaporated into the air stream from the cooling tower cells.					
7	Outlet air dry bulb	Temperature	C	real	[-Inf;+Inf]	0
	The bulk dry bulb temperature of the air exiting the cooling tower.					
8	Outlet air wet bulb	Temperature	C	real	[-Inf;+Inf]	0
	The bulk wet bulb temperature of the air exiting the cooling tower.					
9	Outlet humidity ratio	Dimensionless	-	real	[-Inf;+Inf]	0
	The bulk humidity ratio (kg's of H2O / kg of dry air) of the air exiting the cooling tower.					
10	Outlet air fow rate	Flow Rate	kg/hr	real	[-Inf;+Inf]	0
	The flow rate of dry air exiting the cooling tower.					
11	Change in internal energy	Energy	kJ	real	[-Inf;+Inf]	0
	The change in internal energy of the sump since the beginning of the simulation. The internal energy change is an energy term and not an energy rate and therefore should not be integrated.					

EXTERNAL FILES

Question	File	Associated parameter
Which file contains the cooling tower performance data?		Logical unit
Source file	.\SourceCode\Types\Type51.for	

4.4.6.2. User-Supplied Coefficients

Icon		TRNSYS Model	Type 51
Proforma	HVAC\Cooling Towers\User-Supplied Coefficients\Type51b.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Calculation mode	Dimensionless	-	integer	[1;1]	1
	Setting this parameter to 1 indicates to the general cooling tower component that the user will supply the coefficients of the mass transfer relationship to be used in the analysis. Do not change this parameter.					
2	Flow geometry	Dimensionless	-	integer	[1;2]	1
	The flow geometry for the cooling tower: 1 ---> Counterflow geometry 2 ---> Crossflow geometry					
3	Number of tower cells	Dimensionless	-	integer	[1;8]	1
	How many identical tower cells make up the cooling tower?					
4	Maximum cell flow rate	Volumetric Flow Rate	m^3/hr	real	[0.0;+Inf]	40.0
	The maximum volumetric air flow rate for each cell.					
5	Fan power at maximum flow	Power	kW	real	[0.0;+Inf]	1.0
	The power consumed by one cell fan at the maximum volumetric air flow rate specified.					
6	Minimum cell flow rate	Volumetric Flow Rate	m^3/hr	real	[0.0;+Inf]	10.0
	The volumetric flow rate of air per cell below which the cell fan is turned off.					
7	Sump volume	Volumetric Flow Rate	m^3	real	[-1;+Inf]	1.0
	The sump volume for the cooling tower. Set this parameter to -1 if a steady state analysis is to be used for the sump temperature.					
8	Initial sump temperature	Temperature	C	real	[-Inf;+Inf]	15.0
	The temperature of the sump at the beginning of the simulation.					
9	Mass transfer constant	Dimensionless	-	real	[0.5;5.0]	2.3
	The constant used in the relationship between flow rate and heat transfer coefficient.					
10	Mass transfer exponent	Dimensionless	-	real	[-1.1;-0.35]	-0.72
	The exponent used in the relationship between the mass flow rate and the heat transfer coefficient.					
11	Print performance results?	Dimensionless	-	integer	[1;2]	1
	Should the results from the curve-fit and the performance data be written to the output file? 1 ---> Print the results to the output file 2 ---> Don't print the results					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Water inlet temperature	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the water entering the cooling tower.					
2	Inlet water flow rate	Flow Rate	kg/hr	real	[0.0;+Inf]	100.0
	The flow rate of water entering the cooling tower.					
3	Dry bulb temperature	Temperature	C	real	[-Inf;+Inf]	15.0
	The dry bulb temperature of the air entering the cooling tower.					
4	Wet bulb temperature	Temperature	C	real	[-Inf;+Inf]	12.0

	The wet bulb temperature of the air entering the cooling tower.					
5	Sump make-up temperature	Temperature	C	real	[-Inf;+Inf]	10.0
	The temperature of the replacement water entering the sump.					
6	Relative fan speed for cell	Dimensionless	-	real	[-1.0;1.0]	0.85
	The relative fan speed (fraction of maximum volumetric flow) of the specified tower cell. Set this input to -1 if the tower is operating in natural convection mode.					

Cycles

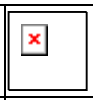
Variable Indices	Associated parameter	Interactive Question	Min	Max
6-6	Number of tower cells		1	50

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Sump temperature	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the tower sump.					
2	Sump flow rate	Flow Rate	kg/hr	real	[-Inf;+Inf]	0
	The flow rate of water exiting the tower sump.					
3	Fan power required	Power	kW	real	[-Inf;+Inf]	0
	The total fan power requirement for the cooling tower.					
4	Heat rejection rate	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is transferred to the air stream from the tower cells.					
5	Cell outlet temperature	Temperature	C	real	[-Inf;+Inf]	0
	The effective mixed outlet temperature of the water from the tower cells that is the inlet to the sump.					
6	Water loss rate	Flow Rate	kg/hr	real	[-Inf;+Inf]	0
	The rate at which water is evaporated into the air stream from the cooling tower cells.					
7	Outlet air dry bulb	Temperature	C	real	[-Inf;+Inf]	0
	The bulk dry bulb temperature of the air exiting the cooling tower.					
8	Outlet air wet bulb	Temperature	C	real	[-Inf;+Inf]	0
	The bulk wet bulb temperature of the air exiting the cooling tower.					
9	Outlet humidity ratio	Dimensionless	-	real	[-Inf;+Inf]	0
	The bulk humidity ratio (kg's of H2O / kg of dry air) of the air exiting the cooling tower.					
10	Outlet air fow rate	Flow Rate	kg/hr	real	[-Inf;+Inf]	0
	The flow rate of dry air exiting the cooling tower.					
11	Change in internal energy	Energy	kJ	real	[-Inf;+Inf]	0
	The change in internal energy of the sump since the beginning of the simulation. The internal energy change is an energy term and not an energy rate and therefore should not be integrated.					

4.4.7. Dual Source Heat Pumps

4.4.7.1. Dual Source Heat Pumps

Icon		**TRNSYS Model**	Type 20
Proforma	HVAC\Dual Source Heat Pumps\Type20.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Liquid source specific heat	Specific Heat	kJ/kg.K	real	[0.0;+Inf]	4.19
	The specific heat of the fluid from the liquid source.					
2	Flow rate of liquid source	Flow Rate	kg/hr	real	[0.0;+Inf]	100.0
	The flow rate of the liquid source when the pump is operating. This component includes a pump and controller and therefore sets the flow for the liquid source loop.					
3	Effectiveness-Cmin product	Overall Loss Coefficient	kJ/hr.K	real	[0.0;+Inf]	200.0
	The effectiveness-Cmin product of the heat exchanger used for direct liquid source heating. The effectiveness of a heat exchanger is defined as the ratio of heat transfer across the heat exchanger to the maximum possible heat transfer across the heat exchanger. The effectiveness therefore must be between 0 and 1. Cmin is defined as the minimum capacitance rate (flow rate * specific heat) of the two fluids flowing through the heat exchanger. The effectiveness-Cmin product is used to calculate the heat transfer to the room air when the heat pump is in direct liquid source heating mode: Qroom = EffCmin*(Tin - Troom) (See manual for further information on equation)					
4	Minimum temperature for direct liquid heating	Temperature	C	real	[-Inf;+Inf]	25.0
	The minimum temperature of the liquid source supply stream necessary to operate the heat pump in direct liquid source heating mode.					
5	Mimimum source temperature for liquid operation	Temperature	C	real	[-Inf;+Inf]	15.0
	The minimum temperature of the liquid supply necessary to operate the dual source heat pump using the liquid source.					
6	Minimum ambient temperature for air operation	Temperature	C	real	[-Inf;+Inf]	0.0
	The minimum ambient air temperature required to operate the dual source heat pump using the air source.					
7	Logical unit for liquid source data	Dimensionless	-	integer	[10;30]	15
	The logical unit through which the liquid source heat pump data is to be accessed. Each data file that TRNSYS opens must be assigned a unique logical unit.					
8	Logical unit for air source data	Dimensionless	-	integer	[10;30]	16
	The logical unit through which the air source heat pump data is to be accessed. Each external file that TRNSYS opens must be assigned to a unique logical unit.					
9	Nb. of liquid source data points	Dimensionless	-	integer	[2;10]	5
	The number of evaporator inlet temperature points contained in the external data file. For each evaporator inlet temperature, corresponding values of heat pump capacity, energy absorbed by the evaporator, and electrical energy consumption. The data is read in in free format, but must be input in a special order. The first values in the data file must be the evaporator temperatures in increasing order. Next are values of capacity, energy absorbed, and electrical input at the lowest evaporator temperature; followed by values at the next evaporator temperature, etc.					
10	Nb. of air source data points	Dimensionless	-	integer	[2;10]	5

	The number of evaporator inlet temperature points contained in the external data file. For each evaporator inlet temperature, corresponding values of heat pump capacity, energy absorbed by the evaporator, and electrical energy consumption. The data is read in in free format, but must be input in a special order. The first values in the data file must be the evaporator temperatures in increasing order. Next are values of capacity, energy absorbed, and electrical input at the lowest evaporator temperature; followed by values at the next evaporator temperature, etc.

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Liquid source temperature	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the liquid source stream.					
2	Flow rate of liquid source stream	Flow Rate	kg/hr	real	[0.0;+Inf]	100.0
	The flow rate of fluid returning to the dual source heat pump from the liquid source. This input is used for convergence checking only! The dual source heat pump component includes a pump that sets the flow rate for the liquid loop. This input if for convenience only.					
3	Ambient temperature	Temperature	C	real	[-Inf;+Inf]	10.0
	The temperature of the ambient air.					
4	Room temperature	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the room to which the heat pump supplies energy.					
5	Heating control function	Dimensionless	-	real	[0.0;1.0]	1.0
	The global control on the dual source heat pump. 0 = heat pump is off regardless of operating conditions 1 = heat pump is able to operate if the conditions dictate					

OUTPUTS

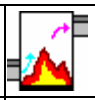
	Name	Dimension	Unit	Type	Range	Default
1	Temperature to heat source	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid returning to the liquid source.					
2	Flow rate to liquid source.	Flow Rate	kg/hr	real	[-Inf;+Inf]	0
	The flow rate of fluid returning to the liquid source. The flow rate is calculated by the dual source heat pump routine based on the parameter-specified flow rate and an internal control signal. This routine sets the flow for the liquid source loop!					
3	Heat transfer to room	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which heat is transferred to the room by the dual source heat pump component.					
4	Heat transfer by direct liquid source heating	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which heat is transferred across the heat exchanger to the room by direct liquid source heating.					
5	Energy absorbed by evaporator	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is absorbed by the evaporator of the dual source heat pump.					
6	Electrical energy requirement	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which electrical energy is required by the dual source heat pump to operate.					
7	COP	Dimensionless	-	real	[-Inf;+Inf]	0
	The Coefficient of Performance of the dual source heat pump. The COP is defined as: Energy supplied to room / energy required to operate heat pump					
8	Heating mode	Dimensionless	-	integer	[-Inf;+Inf]	0
	The heating mode that the dual source heat pump operated in during the timestep. 1 = Direct liquid source heating mode 2 = Liquid source heat pump heating mode 3 = Ambient air source heat pump heating mode 4 = No heating					

EXTERNAL FILES

Question	File	Associated parameter
Which file contains the liquid source heat pump data?		Logical unit for liquid source data
Which file contains the air source heat pump data?		Logical unit for air source data
Source file	.\SourceCode\Types\Type20.for	

4.4.8. Furnace

4.4.8.1. Humidity Ratio Inputs

Icon		TRNSYS Model	Type 121
Proforma	HVAC\Furnace\Humidity Ratio Inputs\Type121a.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Humidity mode	Dimensionless	-	integer	[1;1]	0
	This parameter indicates whether the inlet absolute humidity ration (mode=1) or the percent rel;ative humidity input will be used to calculate the inlet moist air state to this device.					
2	Surface area	Area	m^2	real	[0.;+Inf]	0
	The surface area to be used for thermal losses from the device.					

INPUTS

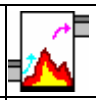
	Name	Dimension	Unit	Type	Range	Default
1	Inlet air temperature	Temperature	C	real	[-Inf;+Inf]	20.0
	The dry-bulb temperature of the air entering the auxiliary heater.					
2	Inlet air humidity ratio	Dimensionless	-	real	[0.0;0.45]	0.01
	The absolute humidity ratio of the air entering the auxiliary heater device.					
3	Not used (RH)	Percentage	% (base 100)	real	[0.;100.]	0
	The percent relative humidity of the air entering the auxiliary heater device.					
4	Air flow rate	Flow Rate	kg/hr	real	[0.;+Inf]	100.0
	The flow rate of dry air entering the auxiliary heater.					
5	Inlet air pressure	Pressure	atm	real	[0.;5.0]	0
	The absolute pressure of the air entering the device.					
6	Heating capacity	Power	kJ/hr	real	[0.0;+Inf]	0
	The maximum rate at which energy can be provided to the device in order to elevate the temperature of the air stream. This value includes the efficiency effects so the actual maximum heat transfer is less than that provided.					
7	Heat loss coefficient	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[0.0;+Inf]	0
	The heat transfer coefficient (U-value) from the device to its surroundings.					
8	Efficiency (fraction)	Percentage	Fraction	real	[0.0;1.0]	0
	The efficiency of the device in converting fuel to heat. Typical values: 1=Electric resistance, 0.7 to 0.9=Natural gas, propane etc.					
9	Control function	Dimensionless	-	real	[0.0;1.0]	1
	The control function for the device. 0 = Off, 1 = Running at full capacity unless restrained by the outlet temperature setpoint, 0 < x					
10	Air-side pressure drop	Pressure	atm	real	[0.0;+Inf]	0
	The pressure drop across the device for the air flow stream.					
11	Environment temperature	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of surroundings for loss calculations					
12	Setpoint temperature	Temperature	C	real	[-Inf;+Inf]	0

	The maximum outlet temperature of the air exiting the device.

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Outlet air temperature	Temperature	C	real	[-Inf;+Inf]	0
	The temperature (dry-bulb) of the air exiting the device.					
2	Outlet air humidity ratio	Dimensionless	-	real	[0.0;+0.45]	0
	The absolute humidity ratio of the air exiting the device.					
3	Outlet air %RH	Percentage	% (base 100)	real	[-Inf;+Inf]	0
	The percent relative humidity of the air exiting the device.					
4	Outlet air flow rate	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	The flow rate of dry air exiting the device.					
5	Outlet air pressure	Pressure	atm	real	[-Inf;+Inf]	0
	The absolute pressure of the air exiting the device.					
6	Required heating	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy must be supplied to the device in order to heat the air to its outlet temperature; including the effects of losses and conversion inefficiencies.					
7	Thermal losses	Power	kJ/hr	real	[-Inf;+Inf]	0
	Losses from the device to its surroundings (UA losses).					
8	Fluid energy	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is added to the air stream as it passes through the device.					

4.4.8.2. RH Inputs

Icon		TRNSYS Model	Type 121
Proforma	HVAC\Furnace\RH Inputs\Type121b.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Humidity mode	Dimensionless	-	integer	[2;2]	0
	This parameter indicates whether the inlet absolute humidity ration (mode=1) or the percent rel;ative humidity input will be used to calculate the inlet moist air state to this device.					
2	Surface area	Area	m^2	real	[0.;+Inf]	0
	The surface area to be used for thermal losses from the device.					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Inlet air temperature	Temperature	C	real	[-Inf;+Inf]	20.0
	The dry-bulb temperature of the air entering the auxiliary heater.					
2	Not used (w)	Dimensionless	-	real	[0.0;0.45]	0.01
	The absolute humidity ratio of the air entering the auxiliary heater device.					
3	Inlet air %RH	Percentage	% (base 100)	real	[0.;100.]	0
	The percent relative humidity of the air entering the auxiliary heater device.					
4	Air flow rate	Flow Rate	kg/hr	real	[0.;+Inf]	100.0
	The flow rate of dry air entering the auxiliary heater.					
5	Inlet air pressure	Pressure	atm	real	[0.;5.0]	0
	The absolute pressure of the air entering the device.					
6	Heating capacity	Power	kJ/hr	real	[0.0;+Inf]	0
	The maximum rate at which energy can be provided to the device in order to elevate the temperature of the air stream. This value includes the efficiency effects so the actual maximum heat transfer is less than that provided.					
7	Heat loss coefficient	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[0.0;+Inf]	0
	The heat transfer coefficient (U-value) from the device to its surroundings.					
8	Efficiency (fraction)	Percentage	Fraction	real	[0.0;1.0]	0
	The efficiency of the device in converting fuel to heat. Typical values: 1=Electric resistance, 0.7 to 0.9=Natural gas, propane etc.					
9	Control function	Dimensionless	-	real	[0.0;1.0]	1
	The control function for the device. 0 = Off, 1 = Running at full capacity unless restrained by the outlet temperature setpoint, 0 < x					
10	Air-side pressure drop	Pressure	atm	real	[0.0;+Inf]	0
	The pressure drop across the device for the air flow stream.					
11	Environment temperature	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of surroundings for loss calculations					
12	Setpoint temperature	Temperature	C	real	[-Inf;+Inf]	0
	The maximum outlet temperature of the air exiting the device.					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default

1	Outlet air temperature	Temperature	C	real	[-Inf;+Inf]	0
	The temperature (dry-bulb) of the air exiting the device.					
2	Outlet air humidity ratio	Dimensionless	-	real	[0.0;+0.45]	0
	The absolute humidity ratio of the air exiting the device.					
3	Outlet air %RH	Percentage	% (base 100)	real	[-Inf;+Inf]	0
	The percent relative humidity of the air exiting the device.					
4	Outlet air flow rate	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	The flow rate of dry air exiting the device.					
5	Outlet air pressure	Pressure	atm	real	[-Inf;+Inf]	0
	The absolute pressure of the air exiting the device.					
6	Required heating	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy must be supplied to the device in order to heat the air to its outlet temperature; including the effects of losses and conversion inefficiencies.					
7	Thermal losses	Power	kJ/hr	real	[-Inf;+Inf]	0
	Losses from the device to its surroundings (UA losses).					
8	Fluid energy	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is added to the air stream as it passes through the device.					

4.4.9. Parallel Chillers

4.4.9.1. Parallel Chillers

Icon		TRNSYS Model	Type 53
Proforma	HVAC\Parallel Chillers\Type53.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Overall motor efficiency	Dimensionless	-	real	[0.0;1.0]	0.85
	The overall motor plus gearbox efficiency for an individual chiller.					
2	Single chiller capacity	Power	kJ/hr	real	[0.0;+Inf]	5000.0
	The maximum cooling capacity for an individual chiller.					
3	Chiller surge limit	Power	kJ/hr	real	[0.0;+Inf]	1000.0
	The minimum cooling capacity (surge limit) for an individual chiller.					
4	Logical unit	Dimensionless	-	integer	[10;30]	24
	The logical unit through which the chiller performance data will be accessed. Every external file that TRNSYS writes to or reads from must be assigned a unique logical unit in the TRNSYS input file.					
5	Number of data points	Dimensionless	-	integer	[6;100]	10
	The number of chiller performance data points that are to be read from the external data file.					
6	Design load for data	Power	kJ/hr	real	[0.0;+Inf]	8000.0
	The specified design load with which the data is normalized.					
7	Design temperature difference	Temp. Difference	deltaC	real	[0.0;+Inf]	15.0
	The specified temperature difference between the condenser water outlet and the evaporator water outlet with which the data is normalized.					
8	Design power consumption	Power	kW	real	[0.0;+Inf]	20.0
	The power consumption associated with the design condition parameters with which the data is normalized.					
9	Condenser water specific heat	Specific Heat	kJ/kg.K	real	[0.0;+Inf]	4.190
	The specific heat of the water flowing through the condenser of the chiller.					
10	Evaporator water specific heat	Specific Heat	kJ/kg.K	real	[0.0;+Inf]	4.190
	The specific heat of the water flowing through the evaporator of the chiller.					
11	Print indicator	Dimensionless	-	integer	[1;2]	1
	Should the results of the curve-fit of the performance data be written to the output file? 1 ---> Print performance data and curve-fit results 2 ---> Do not print performance data or curve-fit results					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Chilled water set temperature	Temperature	C	real	[-Inf;+Inf]	10.0
	The set point temperature for the chilled water.					
2	Evaporator inlet temperature	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the water entering the evaporator of the chiller.					
3	Evaporator flow rate	Flow Rate	kg/hr	real	[0.0;+Inf]	100.0
	The flow rate of water entering the evaporator of the chiller.					

4	Condenser inlet temperature	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the water entering the condenser of the chiller.					
5	Condenser flow rate	Flow Rate	kg/hr	real	[0.0;+Inf]	100.0
	The flow rate of water entering the condenser of the chiller.					
6	Number of operating chillers	Dimensionless	-	integer	[0;+Inf]	3
	The number of chillers that are operating during the current timestep.					

OUTPUTS

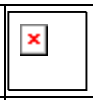
	Name	Dimension	Unit	Type	Range	Default
1	Evaporator outlet temperature	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the water exiting the evaporator of the chiller.					
2	Evaporator outlet flow rate	Flow Rate	kg/hr	real	[-Inf;+Inf]	0
	The flow rate of water exiting the evaporator of the chiller.					
3	Condenser outlet temperature	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the water exiting the condenser of the chiller.					
4	Condenser outlet flow rate	Flow Rate	kg/hr	real	[-Inf;+Inf]	0
	The flow rate of water exiting the condenser of the chiller.					
5	Chilled water load	Power	kJ/hr	real	[-Inf;+Inf]	0
	The total load that was met by the parallel chillers.					
6	Total chiller power	Power	kW	real	[-Inf;+Inf]	0
	The total power required by the parallel chillers to meet the load.					
7	Total heat rejection	Power	kJ/hr	real	[-Inf;+Inf]	0
	The total rate at which heat is rejected to the condensers of the chillers.					
8	COP	Dimensionless	-	real	[-Inf;+Inf]	0
	The average coefficient of performance of the parallel chillers over the timestep.					

EXTERNAL FILES

Question	File	Associated parameter
Which file contains the chiller performance data?		Logical unit
Source file	.\SourceCode\Types\Type53.for	

4.4.10. Part Load Performance

4.4.10.1. Linear with Load

Icon		TRNSYS Model	Type 43
Proforma	HVAC\Part Load Performance\Linear with Load\Type43b.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Slope of PLR function	Dimensionless	-	real	[-Inf;0.0]	-1.0
	The slope (rise over run) of the linear part load factor versus 1/duty cycle relationship. The Y-intercept of the line is assumed to be 1.0					

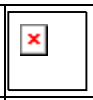
INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Energy to meet the load	Power	kJ/hr	real	[0.0;+Inf]	0.0
	The rate that energy must be supplied to meet the load.					
2	Full load capacity	Power	kJ/hr	real	[0.0;+Inf]	100.0
	The full load capacity of the heating or cooling equipment at the current operating conditions.					
3	Full load efficiency	Dimensionless	-	real	[0.0;+Inf]	0.75
	The full load efficiency or COP of the heating or cooling equipment at the current operating conditions.					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Energy removal rate	Power	kJ/hr	real	[-Inf;+Inf]	0
	Th rate at which energy is removed or delivered by the heating or cooling equipment.					
2	Purchased energy rate	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is purchased to operate the heating or cooling equipment.					
3	Part load factor	Dimensionless	-	real	[-Inf;+Inf]	0
	The part load factor for the heating or cooling equipment. The part load factor is defined as the ratio of the part load to full load efficiencies.					
4	Operating efficiency	Dimensionless	-	real	[-Inf;+Inf]	0
	The average operating efficiency (or COP) of the heating or cooling equipment.					

4.4.10.2. Performance from External File

Icon		TRNSYS Model	Type 43
Proforma	HVAC\Part Load Performance\Performance from External File\Type43a.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Logical unit	Dimensionless	-	integer	[10;30]	21
	The logical unit through which the part load performance data will be read. Every external file that TRNSYS reads to or writes from must be assigned a unique logical unit number in the TRNSYS input file.					
2	Number of data points	Dimensionless	-	integer	[1;10]	10
	The number of part load performance data points contained in the exernal data file.					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Energy to meet the load	Power	kJ/hr	real	[0.0;+Inf]	0.0
	The rate that energy must be supplied to meet the load.					
2	Full load capacity	Power	kJ/hr	real	[0.0;+Inf]	100.0
	The full load capacity of the heating or cooling equipment at the current operating conditions.					
3	Full load efficiency	Dimensionless	-	real	[0.0;+Inf]	0.75
	The full load efficiency or COP of the heating or cooling equipment at the current operating conditions.					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Energy removal rate	Power	kJ/hr	real	[-Inf;+Inf]	0
	Th rate at which energy is removed or delivered by the heating or cooling equipment.					
2	Purchased energy rate	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is purchased to operate the heating or cooling equipment.					
3	Part load factor	Dimensionless	-	real	[-Inf;+Inf]	0
	The part load factor for the heating or cooling equipment. The part load factor is defined as the ratio of the part load to full load efficiencies.					
4	Operating efficiency	Dimensionless	-	real	[-Inf;+Inf]	0
	The average operating efficiency (or COP) of the heating or cooling equipment.					

EXTERNAL FILES

Question	File	Associated parameter
Which file contains part-load performance data?		Logical unit
Source file	.\SourceCode\Types\Type43.for	

4.5. Hydrogen Systems

4.5.1. Compressed Gas Storage

4.5.1.1. Hydrogen - Ideal Gas

Icon		TRNSYS Model	Type 164
Proforma	Hydrogen Systems\Compressed Gas Storage\Hydrogen\Ideal Gas\Type164a.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	PMODE	dimensionless	-	integer	[1;1]	1
	Pressure mode (1=ideal, 2=real)					
2	PMAX	Pressure	bar	real	[0;500]	200
	Maximum allowable pressure					
3	VOL	Volume	m^3	real	[1;100000]	1E4
	Actual volume of pressure tank					
4	MOLAR	Molar Weight	g/mol	real	[0;100000]	2.016
	Molar weight of gas					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	VDOT_IN	Volumetric Flow Rate	m^3/hr	real	[0;100000]	5
	Inlet gas flow rate					
2	VDOT_OUT	Volumetric Flow Rate	m^3/s	real	[0;100000]	5
	Outlet gas flow rate					
3	TGAS	Temperature	C	real	[0;100]	20
	Temperature of gas					
4	PLEV_INI	dimensionless	-	real	[0;1]	0.4
	Initial pressure level					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	VGAS	any	Nm^3	real	[0;1000000]	0
	Volume of gas stored in tank (1 Nm3 = 1 Normal cubic meter at 0°C and 1 bar)					
2	PGAS	Pressure	bar	real	[0;1000000]	0
	Pressure of gas in tank					
3	PLEV	dimensionless	-	real	[0;1]	0
	Pressure level in tank					
4	VDOT_DUMP	Volumetric Flow Rate	m^3/s	real	[0;1000000]	0
	Dumped gas (through high pressure safety valve)					

4.5.1.2. Hydrogen - Real Gas

Icon		TRNSYS Model	Type 164
Proforma	Hydrogen Systems\Compressed Gas Storage\Hydrogen\Real Gas\Type164b.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	PMODE	dimensionless	-	integer	[2;2]	2
	Pressure mode (1=ideal gas, 2=real gas)					
2	PMAX	Pressure	bar	real	[0;700]	200
	Maximum allowable pressure					
3	VOL	Volume	m^3	real	[1;10000]	1E4
	Actual volume of pressure vessel					
4	MOLAR	Molar Weight	g/mol	real	[0;1000000]	2.016
	Molar weight of gas					
5	TCR	Temperature	C	real	[-273;1000000]	-240
	Criitical temperature of gas					
6	PCR	dimensionless	-	real	[0;1000000]	12.9
	Critical pressure of gas					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	VDOT_IN	Volumetric Flow Rate	m^3/hr	real	[0;1000000]	5
	Gas flow into storage tank					
2	VDOT_OUT	Volumetric Flow Rate	m^3/hr	real	[0;1000000]	5
	Gas flow out of storage tank					
3	TGAS	Temperature	C	real	[0;100]	20
	Temperature of gas					
4	PLEV_INI	dimensionless	-	real	[0;1]	0.4
	Initial pressure level					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	VGAS	any	Nm^3	real	[0;1000000]	0
	Volume of gas stored in tank (1 Nm3 = 1 Normal cubic meter at 0°C and 1 bar)					
2	PGAS	Pressure	bar	real	[0;1000000]	0
	Pressure in gas tank					
3	PLEV	dimensionless	-	real	[0;1]	0
	Pressure level in gas tank					
4	VDOT_DUMP	Volumetric Flow Rate	m^3/hr	real	[0;1000000]	0
	Gas flow vented to ambient (through high pressure safety valve)					

4.5.2. Compressor

4.5.2.1. Compressor

Icon		TRNSYS Model	Type 167
Proforma	Hydrogen Systems\Compressor\Type167.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	NPAR	Dimensionless	-	integer	[1;10]	0
2	STAGES	dimensionless	-	integer	[1;5]	0
3	C_P	any	any	real	[0;+inf]	0

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	SWITCH	Dimensionless	-	integer	[0;1]	0
2	P_IN	Pressure	BAR	real	[0;1000]	0
3	P_OUT	Pressure	BAR	real	[0;1300]	0
4	T_LOW	Temperature	C	real	[0;500]	0
5	V_IN	Volumetric Flow Rate	m^3/hr	real	[0;10000]	0

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	P_COMP	Power	W	real	[0;+Inf]	0
2	Q_COOL	Power	W	real	[0;+Inf]	0
3	T_HIGH	Temperature	C	real	[0;+Inf]	0
4	V_OUT	Volumetric Flow Rate	m^3/hr	real	[0;+Inf]	0
5	ETA_ISEN	dimensionless	-	real	[0;1]	0
6	P2	Pressure	BAR	real	[0;+Inf]	0
7	P3	Pressure	BAR	real	[0;+Inf]	0
8	P4	Pressure	BAR	real	[0;+Inf]	0
9	P5	Pressure	BAR	real	[0;+Inf]	0

4.5.3. Controllers

4.5.3.1. Electrolyzer - Constant Power Mode

Icon		TRNSYS Model	Type 100
Proforma	Hydrogen Systems\Controllers\Electrolyzer\Constant Power Mode\Type100b.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	MODE	dimensionless	-	integer	[2;2]	1
	Power mode (1=variable power, 2=fixed power)					
2	EL_LOW	dimensionless	-	real	[0;1]	0.2
	H2-storage level at which the electrolyzer is to be switched ON					
3	EL_UP	Dimensionless	-	real	[0;1]	0.8
	H2-storage level at which electrolyzer is to be switched OFF					
4	PIDLE	Power	W	real	[0;+inf]	400
	Minimum allowable idling power for electrolyzer (usually 20% of rated power)					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	SOC	Dimensionless	-	real	[0;1]	0.2
	H2-storage 'state of charge' (normalized pressure level)					
2	POWER	Power	W	real	[0;2000000]	1000
	Power to electrolyzer Mode 1: Excess power on mini-grid ; Mode 2: Full electrolyzer power					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	SWITCH	Dimensionless	-	integer	[0;1]	0
	Control signal (0=Idle, 1=full or variable power) Note! Care must be taken when directing this control signal to the electrolyzer. This control signalshould not always be connected to the electrolyzer. Instead the power set pointsignal (output#2) should be used instead.					
2	P_SP	Power	W	real	[0;2000000]	0
	Power set point signal Note! The electrolyzers are connected to the mini-grid via power conditioning equipment. Hence, the power set point signal should be directed to this equipment, and not to the electrolyzer itself.					

4.5.3.2. Electrolyzer - Variable Power Mode

Icon		TRNSYS Model	Type 100
Proforma	Hydrogen Systems\Controllers\Electrolyzer\Variable Power Mode\Type100a.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	MODE	dimensionless	-	integer	[1;1]	1
	Power mode (1=variable power, 2=fixed power)					
2	EL_LOW	dimensionless	-	real	[0;1]	0.2
	H2-storage level at which the electrolyzer is to be switched ON					
3	EL_UP	dimensionless	-	real	[0;1]	0.8
	H2-storage level at which electrolyzer is to be switched OFF					
4	PIDLE	Power	W	real	[0;+inf]	400
	Minimum allowable idling power for electrolyzer (usually 20% of rated power)					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	SOC	dimensionless	-	real	[0;1]	0.2
	H2-storage 'state of charge' (normalized pressure level)					
2	POWER	Power	W	real	[0;2000000]	1000
	Power to electrolyzer Mode 1: Excess power on mini-grid Mode 2: Full electrolyzer power					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	SWITCH	dimensionless	-	integer	[0;1]	0
	Control signal (0=Idle, 1=full or variable power) Note! Care must be taken when directing this control signal to the electrolyzer. This control signalshould not always be connected to the electrolyzer. Instead the power set pointsignal (output#2) should be used instead.					
2	P_SP	Power	W	real	[0;2000000]	0
	Power set point signal Note! The electrolyzers are connected to the mini-grid via power conditioning equipment. Hence, the power set point signal should be directed to this equipment, and not to the electrolyzer itself.					

4.5.3.3. Master Control

Icon		TRNSYS Model	Type 105
Proforma	Hydrogen Systems\Controllers\Master Control\Type105a.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	NMIN	dimensionless	-	integer	[0;5]	1
	Minimum allowable number of DEGS in operation					
2	NMAX	dimensionless	-	integer	[0;5]	0.2
	Maximum allowable number of DEGS in operation					
3	DEGSMAX	Power	W	real	[1;+Inf]	0
	Rated power of each DEGS					
4	PFCMIN	Power	W	real	[0;+Inf]	0
	Fuel cell idling power					
5	PFCMAX	Power	W	real	[0;+Inf]	0
	Rated fuel cell power					
6	PELYMIN	Power	W	real	[0;+Inf]	0
	Electrolyzer idling power					
7	PELYMAX	Power	W	real	[0;+Inf]	0
	Rated electrolyzer power					
8	EL_UP	any	%	real	[0;100]	0
	Upper SOC limit (H2-storage), i.e., ELY switched OFF (idle)					
9	EL_LOW	any	%	real	[0;100]	0
	Lower SOC limit (H2-storage), i.e., ELY switched ON after having been idling					
10	FC_UP	any	%	real	[0;100]	0
	Upper SOC limit (H2-storage), i.e., FC switched ON after having been idling					
11	FC_LOW	any	%	real	[0;100]	0
	Lower SOC limit (H2-storage), i.e., FC switched OFF (idle)					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	PLOAD	Power	W	real	[1;+Inf]	0
	Power demand (user load)					
2	PWECS	Power	W	real	[0;+Inf]	0
	Power from WECS					
3	SOC	any	any	real	[0;1]	0
	State of Charge (H2-storage)					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	PELY	Power	W	real	[1;+Inf]	0
	Power to electrolyzer					
2	PFC	Power	W	real	[0;+Inf]	0
	Power from fuel cell					

3	PDEGStot	Power	W	real	[0;+Inf]	0
	Total power from DEGS					
4	PDEGS1	Power	W	real	[0;+Inf]	0
	Power from one single DEGS					
5	NDEGS	dimensionless	-	real	[0;+Inf]	0
	Total number of identical DEGS in parallel operation					
6	PDUMP	Power	W	real	[0;+Inf]	0
	Power dumped (from the busbar)					
7	S_ELY	dimensionless	-	real	[0;1]	0
	Electrolyzer control state (0=OFF, 1=ON)					
8	S_FC	dimensionless	-	integer	[0;1]	0
	Fuel Cell control state (0=OFF, 1=ON)					

4.5.4. Electrolyzer

4.5.4.1. Advanced Alkaline - TMODE=1

Icon		TRNSYS Model	Type 160
Proforma	Hydrogen Systems\Electrolyzer\Advanced Alkaline\TMODE=1\Type160a.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	TMODE	dimensionless	-	real	[1;1]	1
	Temperature mode. TMODE=1. T is given as input (input #7) TMODE=2. T is calculated based on a simple quasi-static thermal model TMODE=3. T is calculated based on a complex lumped capacitance thermal model					
2	AREA	Area	m^2	real	[0.005;1]	0.25
	Area of electrode					
3	NCELLS	dimensionless	-	real	[1;200]	70
	Number of cells in series per stack					
4	NSTACKS	dimensionless	-	real	[1;10]	0
	Number of stacks in parallel per unit					
5	IDMAX	any	any	real	[0;1000]	1700
	Maximum alllowable current density per stack					
6	TMAX	Temperature	C	real	[0;100]	85
	Maximum allowable operating temperature					
7	UCMIN	Voltage	V	real	[1.229;2.2]	130
	Minimum allowable cell voltage					
8	R_T	Thermal Resistance	Thermal Resistance	real	[0;1000]	167
	Thermal resistance. Note! Only needed when using one of the two thermal models (TMODE=2 or 3)					
9	TAU_T	Time	hr	real	[0;500]	29
	Thermal time constant, TAU_T = C_T * R_T (See manual for further information on equation)					
10	ELYTYPE	Dimensionless	-	integer	[1;20]	4
	Type of electrolyzer listed in external file					
11	Logical Unit for data file	Dimensionless	-	integer	[30;999]	60
	Logical unit for external file with electrolyzer parameters					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	SWITCH	dimensionless	-	real	[0;1]	1
	Electrolyzer operating switch 0=OFF 1=ON					
2	IELY	Electric current	A	real	[0;2500]	100
	Current through single electrolyzer stack					

3	PELY	Pressure	bar	real	[1;100]	30
	Electrolyzer pressure Constant pressure is assumed; The main equations in the model are based on a constant pressure .					
4	TROOM	Temperature	C	real	[0;40]	20
	Ambient (or room) temperature					
5	TCOOLIN	Temperature	C	real	[5;20]	15
	Temperature of inlet cooling water					
6	VCOOL	Volumetric Flow Rate	m^3/hr	real	[0;1]	0.25
	Volumetric flow rate of cooling water					
7	TELY	Temperature	C	real	[0;100]	80
	Temperature of electrolyzer. The temperature is given as input #7 when running in TMODE=1					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	IELY_OUT	Electric current	A	real	[0;+inf]	0
	Current drawn by electrolyzer					
2	UELY	Voltage	V	real	[0;+inf]	0
	Total voltage across electrolyzer					
3	PTOT	Power	W	real	[0;+inf]	0
	Total power drawn by electrolyzer					
4	VDOT_H2	Volumetric Flow Rate	m^3/hr	real	[0;+inf]	0
	Hydrogen production rate					
5	VDOT_O2	Volumetric Flow Rate	m^3/hr	real	[0;+inf]	0
	Oxygen production rate					
6	ETA_TOT	dimensionless	-	real	[0;1]	0
	Overall efficiency					
7	ETA_E	dimensionless	-	real	[0;1]	0
	Energy efficiency					
8	ETA_F	dimensionless	-	real	[0;1]	0
	Faraday efficiency (i.e., current efficiency)					
9	QGEN	Power	W	real	[0;+inf]	0
	Heat generated by electrolyzer					
10	QLOSS	Power	W	real	[0;+inf]	0
	Heat losses from electrolyzer to ambient					
11	QCOOL	Power	W	real	[0;+inf]	0
	Auxiliary cooling					
12	QSTORE	Power	W	real	[0;+inf]	0
	Energy stotage rate					
13	TELY	Temperature	C	real	[0;100]	0
	Electrolyzer temperature					
14	TCOOLOUT	Temperature	C	real	[0;100]	0
	Temperature of cooling water outlet					
15	IDENSITY	any	any	real	[0;10000]	0
	Electrical current densisty					
16	UCELL	Voltage	V	real	[0;2]	0
	Voltage across a single cell					

17	UREV	Voltage	V	real	[0;2]	0
	Reversible voltage for a single cell					
18	UTN	Voltage	V	real	[0;2]	0
	Thermoneutral voltage for a single cell					

EXTERNAL FILES

Question	File	Associated parameter
File with electrolyzer parameters	.\Examples\Data Files\Type160-Electrolyzer.dat	Logical Unit for data file
Source file	.\SourceCode\Types\Type160.for	

4.5.4.2. Advanced Alkaline - TMODE=2

Icon		TRNSYS Model	Type 160
Proforma	Hydrogen Systems\Electrolyzer\Advanced Alkaline\TMODE=2\Type160b.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	TMODE	dimensionless	-	real	[2;2]	1
	Temperature mode. TMODE=1. T is given as input (input #7) TMODE=2. T is calculated based on a simple quasi-static thermal model TMODE=3. T is calculated based on a complex lumped capacitance thermal model					
2	AREA	Area	m^2	real	[0.005;1]	0.25
	Area of electrode					
3	NCELLS	dimensionless	-	real	[1;200]	70
	Number of cells in series per stack					
4	NSTACKS	dimensionless	-	real	[1;10]	0
	Number of stacks in parallel per unit					
5	IDMAX	any	any	real	[0;1000]	1700
	Maximum alllowable current density per stack					
6	TMAX	Temperature	C	real	[0;100]	85
	Maximum allowable operating temperature					
7	UCMIN	Voltage	V	real	[1.229;2.2]	130
	Minimum allowable cell voltage					
8	R_T	Thermal Resistance	K/W	real	[0;1000]	167
	Thermal resistance. Note! Only needed when using one of the two thermal models (TMODE=2 or 3)					
9	TAU_T	Time	hr	real	[0;500]	29
	Thermal time constant, TAU_T = C_T * R_T (See manual for further information on equation)					
10	ELYTYPE	dimensionless	-	integer	[1;20]	4
	Type of electrolyzer listed in external file					
11	Logical unit for data file	dimensionless	-	integer	[30;999]	60
	Logical unit for external file with electrolyzer parameters					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	SWITCH	dimensionless	-	real	[0;1]	1
	Electrolyzer operating switch 0=OFF 1=ON					
2	IELY	Electric current	A	real	[0;2500]	100
	Current through single electrolyzer stack					
3	PELY	Pressure	bar	real	[1;100]	30
	Electrolyzer pressure Constant pressure is assumed; The main equations in the model are based on a constant pressure .					
4	TROOM	Temperature	C	real	[0;40]	20

	Ambient (or room) temperature					
5	TCOOLIN	Temperature	C	real	[5;20]	15
	Temperature of inlet cooling water					
6	VCOOL	Volumetric Flow Rate	m^3/hr	real	[0;1]	0.25
	Volumetric flow rate of cooling water					
7	TELYINI	Temperature	C	real	[0;100]	80
	Initial electrolyzer temperature					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	IELY_OUT	Electric current	A	real	[0;+inf]	0
	Current drawn by electrolyzer					
2	UELY	Voltage	V	real	[0;+inf]	0
	Total voltage across electrolyzer					
3	PTOT	Power	W	real	[0;+inf]	0
	Total power drawn by electrolyzer					
4	VDOT_H2	Volumetric Flow Rate	m^3/hr	real	[0;+inf]	0
	Hydrogen production rate					
5	VDOT_O2	Volumetric Flow Rate	m^3/hr	real	[0;+inf]	0
	Oxygen production rate					
6	ETA_TOT	dimensionless	-	real	[0;1]	0
	Overall efficiency					
7	ETA_E	dimensionless	-	real	[0;1]	0
	Energy efficiency					
8	ETA_F	dimensionless	-	real	[0;1]	0
	Faraday efficiency (i.e., current efficiency)					
9	QGEN	Power	W	real	[0;+inf]	0
	Heat generated by electrolyzer					
10	QLOSS	Power	W	real	[0;+inf]	0
	Heat losses from electrolyzer to ambient					
11	QCOOL	Power	W	real	[0;+inf]	0
	Auxiliary cooling					
12	QSTORE	Power	W	real	[0;+inf]	0
	Energy stotage rate					
13	TELY	Temperature	C	real	[0;100]	0
	Electrolyzer temperature					
14	TCOOLOUT	Temperature	C	real	[0;100]	0
	Temperature of cooling water outlet					
15	IDENSITY	any	any	real	[0;10000]	0
	Electrical current densisty					
16	UCELL	Voltage	V	real	[0;2]	0
	Voltage across a single cell					
17	UREV	Voltage	V	real	[0;2]	0
	Reversible voltage for a single cell					
18	UTN	Voltage	V	real	[0;2]	0
	Thermoneutral voltage for a single cell					

EXTERNAL FILES

Question	File	Associated parameter
File with electrolyzer parameters	.\Examples\Data Files\Type160-Electrolyzer.dat	Logical unit for data file
Source file	.\SourceCode\Types\Type160.for	

4.5.4.3. Advanced Alkaline - TMODE=3

Icon		TRNSYS Model	Type 160
Proforma	Hydrogen Systems\Electrolyzer\Advanced Alkaline\TMODE=3\Type160c.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	TMODE	dimensionless	-	real	[3;3]	1
	Temperature mode. TMODE=1. T is given as input (input #7) TMODE=2. T is calculated based on a simple quasi-static thermal model TMODE=3. T is calculated based on a complex lumped capacitance thermal model					
2	AREA	Area	m^2	real	[0.005;1]	0.25
	Area of electrode					
3	NCELLS	dimensionless	-	real	[1;200]	70
	Number of cells in series per stack					
4	NSTACKS	dimensionless	-	real	[1;10]	0
	Number of stacks in parallel per unit					
5	IDMAX	any	any	real	[0;1000]	1700
	Maximum alllowable current density per stack					
6	TMAX	Temperature	C	real	[0;100]	85
	Maximum allowable operating temperature					
7	UCMIN	Voltage	V	real	[1.229;2.2]	130
	Minimum allowable cell voltage					
8	R_T	Thermal Resistance	K/W	real	[0;1000]	167
	Thermal resistance. Note! Only needed when using one of the two thermal models (TMODE=2 or 3)					
9	TAU_T	Time	hr	real	[0;500]	29
	Thermal time constant, TAU_T = C_T * R_T (See manual for further information on equation)					
10	ELYTYPE	dimensionless	-	integer	[1;20]	4
	Type of electrolyzer listed in external file					
11	Logical unit for data file	dimensionless	-	integer	[30;999]	60
	Logical unit for external file with electrolyzer parameters					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	SWITCH	dimensionless	-	real	[0;1]	1
	Electrolyzer operating switch 0=OFF 1=ON					
2	IELY	Electric current	A	real	[0;2500]	100
	Current through single electrolyzer stack					
3	PELY	Pressure	bar	real	[1;100]	30
	Electrolyzer pressure Constant pressure is assumed; The main equations in the model are based on a constant pressure .					
4	TROOM	Temperature	C	real	[0;40]	20

	Ambient (or room) temperature					
5	TCOOLIN	Temperature	C	real	[5;20]	15
	Temperature of inlet cooling water					
6	VCOOL	Volumetric Flow Rate	m^3/hr	real	[0;1]	0.25
	Volumetric flow rate of cooling water					
7	TELYINI	Temperature	C	real	[0;100]	80
	Initial electrolyzer temperature					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	IELY_OUT	Electric current	A	real	[0;+inf]	0
	Current drawn by electrolyzer					
2	UELY	Voltage	V	real	[0;+inf]	0
	Total voltage across electrolyzer					
3	PTOT	Power	W	real	[0;+inf]	0
	Total power drawn by electrolyzer					
4	VDOT_H2	Volumetric Flow Rate	m^3/hr	real	[0;+inf]	0
	Hydrogen production rate					
5	VDOT_O2	Volumetric Flow Rate	m^3/hr	real	[0;+inf]	0
	Oxygen production rate					
6	ETA_TOT	dimensionless	-	real	[0;1]	0
	Overall efficiency					
7	ETA_E	dimensionless	-	real	[0;1]	0
	Energy efficiency					
8	ETA_F	dimensionless	-	real	[0;1]	0
	Faraday efficiency (i.e., current efficiency)					
9	QGEN	Power	W	real	[0;+inf]	0
	Heat generated by electrolyzer					
10	QLOSS	Power	W	real	[0;+inf]	0
	Heat losses from electrolyzer to ambient					
11	QCOOL	Power	W	real	[0;+inf]	0
	Auxiliary cooling					
12	QSTORE	Power	W	real	[0;+inf]	0
	Energy stotage rate					
13	TELY	Temperature	C	real	[0;100]	0
	Electrolyzer temperature					
14	TCOOLOUT	Temperature	C	real	[0;100]	0
	Temperature of cooling water outlet					
15	IDENSITY	any	any	real	[0;10000]	0
	Electrical current densisty					
16	UCELL	Voltage	V	real	[0;2]	0
	Voltage across a single cell					
17	UREV	Voltage	V	real	[0;2]	0
	Reversible voltage for a single cell					
18	UTN	Voltage	V	real	[0;2]	0
	Thermoneutral voltage for a single cell					

EXTERNAL FILES

Question	File	Associated parameter
File with electrolyzer parameters	.\Examples\Data Files\Type160-Electrolyzer.dat	Logical unit for data file
Source file	.\SourceCode\Types\Type160.for	

4.5.5. Fuel Cells

4.5.5.1. AFC - Air-H2

Icon		TRNSYS Model	Type 173
Proforma	Hydrogen Systems\Fuel Cells\AFC\Air-H2\Type173a.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	OXMODE	dimensionless	-	integer	[1;1]	1
	OXmode=1. Air is provided to the cathode. OXmode=2. Pure oxygen is provided to the cathode.					
2	NMSER	dimensionless	-	integer	[1;100]	8000
	Number of FC modules in series per stack. NMSER gives the VOLTAGE RATING of the fuel cell.					
3	NSPAR	dimensionless	-	integer	[1;25]	0
	Number of stacks in parallel per FC unit. NSTACKS gives the CURRENT RATING of the fuel cell.					
4	A_ELEC	Area	cm^2	real	[25;2500]	0
	Electrode area.					
5	ETA_F	dimensionless	dimensionless	real	[0;1]	0.018
	Faraday efficiency = current efficiency.					
6	U_O	Voltage	V	real	[0;7.374]	0
	I-U curve coefficient #1: Open circuit voltage (on a per FC module basis).					
7	B_Tafel	any	V/dec	real	[0;1]	0
	I-U curve coefficient #2: Tafel slope (on a per FC module basis)					
8	R_OHM	any	ohm	real	[0;10]	0
	I-U curve coefficient #3: Resistance (on a per FC module basis).					
9	UC_MIN	Voltage	V	real	[0;1.229]	0
	Minimum cell voltage limit.					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	SWITCH	dimensionless	-	integer	[0;1]	1
	ON/OFF Switch. 0 = OFF, 1 = ON.					
2	IFC	Electric current	A	real	[0.01;5000]	90
	Total electrical current provided by FC unit.					
3	TSTACK	Temperature	C	real	[10;70]	80
	Nominal operating temperature for FC stack.					
4	p_H2	Pressure	BAR	real	[1;1]	3.014
	Hydrogen inlet pressure.					
5	p_air	Pressure	BAR	real	[1;1]	3.014
	Air inlet pressure.					
6	S_H2	dimensionless	-	real	[1;1.5]	2
	Stoichiometric ratio for hydrogen (H2). A stoichiometric ratio of 1 is the theoretical minimum H2 needed in a 100% complete reaction.					

	In practical systems some excess H2 is needed to assure a complete reaction. Example: 15% excess H2 fed to the anode equals as a stoichiometric ratio of 1.15					
7	S_O2	dimensionless	dimensionless	real	[1;5]	0
	Stoichiometric ratio for oxygen (O2). A stoichiometric ratio of 1 is the theoretical minimum of O2 needed in a 100% complete reaction. In practical systems some excess air or oxygen is needed to compete the reaction. Example: 150% excess oxygen to the cathode gives a stoichiometric ratio of 1.5					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	P_FC	Power	W	real	[0;+Inf]	0
	Total power output from FC unit.					
2	Ustack	Voltage	V	real	[0;+Inf]	0
	Voltage across each FC stack in parallel = Voltage across terminals of FC unit.					
3	ETA_E	dimensionless	-	real	[0;1]	0
	Energy efficiency.					
4	IFC_D	Current density	mA/cm^2	real	[0.1;500]	0
	Current density = Electrical current per square unit of area (cross-sectional area of electrode).					
5	Ucell	Voltage	V	real	[0.1;1.5]	0
	Voltage per cell.					
6	V_H2	any	Nm3/h	real	[0;+Inf]	0
	Total hydrogen consumption in Nm3/hr. 1 Nm3 = 1 normal cubic meter = 1 cubic meter of gas at 1 bar and 0°C.					
7	V_air	any	Nm3/h	real	[0;+Inf]	0
	Total air consumption in Nm3/hr. 1 Nm3 = 1 Normal cubic meter = 1 cubic meter at 1 bar and 0°C.					
8	Q_gen	Power	W	real	[0;+Inf]	0
	Total heat generated by FC unit.					

4.5.5.2. AFC - O2-H2

Icon		TRNSYS Model	Type 173
Proforma	Hydrogen Systems\Fuel Cells\AFC\O2-H2\Type173b.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	OXMODE	dimensionless	-	integer	[2;2]	1
	OXmode=1. Air is provided to the cathode. OXmode=2. Pure oxygen is provided to the cathode.					
2	NMSER	dimensionless	-	integer	[1;100]	8000
	Number of FC modules in series per stack. NMSER gives the VOLTAGE RATING of the fuel cell.					
3	NSPAR	dimensionless	-	integer	[1;25]	0
	Number of stacks in parallel per FC unit. NSTACKS gives the CURRENT RATING of the fuel cell.					
4	A_ELEC	Area	cm^2	real	[25;2500]	0
	Electrode area.					
5	ETA_F	dimensionless	dimensionless	real	[0;1]	0.018
	Faraday efficiency = current efficiency.					
6	U_O	Voltage	V	real	[0;7.374]	0
	I-U curve coefficient #1: Open circuit voltage (on a per FC module basis).					
7	B_Tafel	any	V/dec	real	[0;1]	0
	I-U curve coefficient #2: Tafel slope (on a per FC module basis)					
8	R_OHM	any	ohm	real	[0;10]	0
	I-U curve coefficient #3: Resistance (on a per FC module basis).					
9	UC_MIN	Voltage	V	real	[0;1.229]	0
	Minimum cell voltage limit.					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	SWITCH	dimensionless	-	integer	[0;1]	1
	ON/OFF Switch. 0 = OFF, 1 = ON.					
2	IFC	Electric current	A	real	[0.01;5000]	90
	Total electrical current provided by FC unit.					
3	TSTACK	Temperature	C	real	[10;70]	80
	Nominal operating temperature for FC stack.					
4	p_H2	Pressure	BAR	real	[1;1]	3.014
	Hydrogen inlet pressure.					
5	p_O2	Pressure	BAR	real	[1;1]	3.014
	Inlet pressure on cathode side (Oxygen).					
6	S_H2	dimensionless	-	real	[1;1.5]	2
	Stoichiometric ratio for hydrogen (H2). A stoichiometric ratio of 1 is the theoretical minimum H2 needed in a 100% complete reaction. In practical systems some excess H2 is needed to assure a complete reaction. Example: 15% excess H2 fed to the anode equals as a stoichiometric ratio of 1.15					
7	S_O2	dimensionless	dimensionless	real	[1;5]	0
	Stoichiometric ratio for oxygen (O2).					

	A stoichiometric ratio of 1 is the theoretical minimum of O2 needed in a 100% complete reaction. In practical systems some excess air or oxygen is needed to compete the reaction. Example: 150% excess oxygen to the cathode gives a stoichiometric ratio of 1.5

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	P_FC	Power	W	real	[0;+Inf]	0
	Total power output from FC unit.					
2	Ustack	Voltage	V	real	[0;+Inf]	0
	Voltage across each FC stack in parallel = Voltage across terminals of FC unit.					
3	ETA_E	dimensionless	-	real	[0;1]	0
	Energy efficiency.					
4	IFC_D	Current density	mA/cm^2	real	[0.1;500]	0
	Current density = Electrical current per square unit of area (cross-sectional area of electrode).					
5	Ucell	Voltage	V	real	[0.1;1.5]	0
	Voltage per cell.					
6	V_H2	any	Nm3/h	real	[0;+Inf]	0
	Total hydrogen consumption in Nm3/hr. 1 Nm3 = 1 normal cubic meter = 1 cubic meter of gas at 1 bar and 0°C.					
7	V_O2	any	Nm3/h	real	[0;+Inf]	0
	Total air consumption in Nm3/hr. 1 Nm3 = 1 Normal cubic meter = 1 cubic meter at 1 bar and 0°C.					
8	Q_gen	Power	W	real	[0;+Inf]	0
	Total heat generated by FC unit.					

4.5.5.3. PEMFC - Air-H2 - TMODE=1 - RTCTMODE=1

Icon		TRNSYS Model	Type 170
Proforma	Hydrogen Systems\Fuel Cells\PEMFC\Air-H2\TMODE=1\RTCTMODE=1\Type170a.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	OXMODE	dimensionless	-	integer	[1;1]	1
	OXmode=1. Air is provided to the cathode. OXmode=2. Pure oxygen is provided to the cathode.					
2	TMODE	dimensionless	-	integer	[1;1]	2
	Temperature mode. TMODE = 1: TSTACK is a constant. TSTACKout = TSTACKin. TMODE = 2: TSTACK is calculated based on a set point temperature: TSTACKout=(TNEW+TOLD)/2 TNEW = TSTACKin is the set point temperature. TOLD = the temperature in the previous time step. In TMODE=2 it is assumed that the fuel cell reaches TSTACKin during the current time step.					
3	NCELLS	dimensionless	-	real	[1;100]	8000
	Number of cells in series per stack. NCELLS gives the VOLTAGE RATING of the fuel cell.					
4	NSTACKS	dimensionless	-	real	[1;25]	0
	Number of stacks in parallel per FC unit. NSTACKS gives the CURRENT RATING of the fuel cell.					
5	A_PEM	Area	cm^2	real	[25;10000]	0
	Electrode area of PEM. Note: A_PEM < A_CELL.					
6	T_PEM	Length	cm	real	[0.010;0.0118]	0.018
	Proton Exchange Membrane (PEM) thickness. One single FC consists of a MEA sandwiched between 2 bipolar plates. Note: T_PEM << T_CELL. (MEA = Cathode + PEM + Amode = Membrane Electrode Assembly)					
7	GAMMA	dimensionless	dimensionless	real	[0.0;1.2]	1.2
	Transport number for water. 0.0 = Well hydrated PEM. 1.2 = Water deficient, or lean water PEM.					
8	UC_MIN	Voltage	V	real	[0;1.6]	0.4
	Minimum allowable cell voltage.					
9	IC_MAX	Current density	mA/m^2	real	[0;1500]	700
	Maximum allowable current density.					
10	RTCTMODE	dimensionless	-	real	[1;1]	0
	Mode for calculating the overall thermal resistance (R_T) and capacitance (C_t) of a single FC stack. 1 = Simple: Few FC geometry and thermal parameters needed. 2 = Detailed : Several FC geometry and thermal parameters needed. 3 = Experimental: R_t & C_t provided.					
11	H_AIR	Heat Transfer Coeff.	W/m^2.K	real	[5;250]	0
	Heat transfer coefficient from FC stack to ambient air. 5-50 = natural convection. 50-250 = forced convection.					
12	A_CELL	Area	cm^2	real	[30;15000]	0
	Cross-sectional area of a single fuel cell. A single FC consists of an MEA sandwiched between two bipolar plates. Note: A_CELL > A_PEM. (MEA = Cathode + PEM + Anode = Membrane Electrode Assembly).					
13	T_CELL	Length	cm	real	[0.25;5]	0

	Thickness of one single fuel cell. One single FC conists of an MEA sandwiched between 2 bipolar plates. Note: T_CELL >> T_PEM.

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	SWITCH	dimensionless	-	integer	[0;1]	1
	ON/OFF Switch. 0 = OFF 1 = ON.					
2	IFC	Electric current	A	real	[0.01;5000]	90
	Total electrical current provided by fuel cell unit.					
3	TSTACKin	Temperature	C	real	[10;90]	80
	Set point temperature for FC stack. TMODE=1: Constant temperature where TSTACKin = TSTACKout. TMODE=2. Calculated temperature: TSTACKin = TSTACKsetpoint					
4	p_H2_in	Pressure	BAR	real	[0.1;10]	3.014
	Hydrogen inlet pressure.					
5	p_O2_in	Pressure	BAR	real	[0.1;20]	3.014
	Inlet pressure on cathode side (Oxygen or Air).					
6	S_H2	dimensionless	-	real	[1;1.5]	2
	Stoichiometric ratio for hydrogen (H2). A stoichiometric ratio of 1 is the theoretical minimum H2 needed in a 100% complete reaction. In practical systems some excess H2 is needed to assure a complete reaction. Example: 15% excess H2 fed to the anode equals as a stoichiometric ratio of 1.15					
7	S_O2	dimensionless	dimensionless	real	[1;5]	0
	Stoichiometric ratio for oxygen (O2). A stoichiometric ratio of 1 is the theoretical minimum of O2 needed in a 100% complete reaction. In practical systems some excess air or oxygen is needed to compete the reaction. Example: 150% excess oxygen to the cathode gives a stoichiometric ratio of 1.5					
8	Tamb	Temperature	C	real	[0;60]	25
	Ambient air temperature. The air directly surrounding the FC stack is usually the air in a room or a container.					
9	TCWin	Temperature	C	real	[0;30]	15
	Cooling water inlet temperature.					
10	DELTATCW	Temperature	C	real	[5;30]	20
	Temperature rise in cooling water, as it passes through the fuel cell. DELTATCW=TCWout-TCWout					
11	Xevap	dimensionless	-	real	[0;1]	0.25
	Evaporation rate of process water produced in the fuel cell					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	P_FC	Power	W	real	[0;+Inf]	0
	Total power output from FC unit.					
2	Ustack	Voltage	V	real	[0;+Inf]	0
	Voltage across each FC stack in parallel = Voltage across terminals of FC unit.					
3	eta_e	dimensionless	-	real	[0;1]	0
	Energy efficiency.					
4	IFC_D	Current density	mA/cm^2	real	[0.1;2000]	0
	Current density = Electrical current per square unit of area (cross-sectional area of PEM).					

5	Ucell	Voltage	V	real	[0.1;1.5]	0
	Voltage per cell.					
6	V_H2	Volumetric Flow Rate	m^3/hr	real	[0;+Inf]	0
	Total hydrogen consumption in Nm3/hr. 1 Nm3 = 1 normal cubic meter = 1 cubic meter of gas at 1 bar and 0°C.					
7	V_air	Volumetric Flow Rate	m^3/hr	real	[0;+Inf]	0
	Total air consumption in Nm3/hr. 1 Nm3 = 1 Normal cubic meter = 1 cubic meter at 1 bar and 0°C.					
8	Q_gen	Power	W	real	[0;+Inf]	0
	Total heat generated by FC unit.					
9	Q_cool	Power	W	real	[0;+Inf]	0
	Total auxiliary cooling demand for FC unit.					
10	Q_loss	Power	W	real	[0;+Inf]	0
	Total heat loss to the ambient					
11	Q_evap	Power	W	real	[0;+Inf]	0
	Total heat lossed due to evaporation.					
12	Q_heat	Power	W	real	[0;+Inf]	0
	Total auxiliary heating demand for FC unit.					
13	V_cool	Volumetric Flow Rate	m^3/hr	real	[0;+Inf]	0
	Total required cooling water flow rate for FC unit.					
14	TSTACKout	Temperature	C	real	[0;100]	0
	Average FC stack temperature over last time step. TMODE=1. Constant temperature: TSTACKout = TSTACKin (INPUT #3). TMODE=2. Calculated temperature: TSTACKout = (TNEW+TOLD)/2.					
15	R_t	any	K/W	real	[0;+Inf]	0
	Thermal resitance for one single stack of the FC unit. R_t = 1/UA_FC, where UA_FC = Overall heat loss coefficient for the fuel cell.					
16	C_t	Specific Energy	J/kg	real	[0;+Inf]	0
	Thermal capacitance for one single stack of the FC unit.					

4.5.5.4. PEMFC - Air-H2 - TMODE=1 - RTCTMODE=2

		**TRNSYS Model**	Type 170
Proforma	Hydrogen Systems\Fuel Cells\PEMFC\Air-H2\TMODE=1\RTCTMODE=2\Type170b.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	OXMODE	dimensionless	-	integer	[1;1]	1
	OXmode=1. Air is provided to the cathode. OXmode=2. Pure oxygen is provided to the cathode.					
2	TMODE	dimensionless	-	integer	[1;1]	2
	Temperature mode. TMODE = 1: TSTACK is a constant. TSTACKout = TSTACKin. TMODE = 2: TSTACK is calculated based on a set point temperature: TSTACKout=(TNEW+TOLD)/2 TNEW = TSTACKin is the set point temperature. TOLD = the temperature in the previous time step. In TMODE=2 it is assumed that the fuel cell reaches TSTACKin during the current time step.					
3	NCELLS	dimensionless	-	real	[1;100]	8000
	Number of cells in series per stack. NCELLS gives the VOLTAGE RATING of the fuel cell.					
4	NSTACKS	dimensionless	-	real	[1;25]	0
	Number of stacks in parallel per FC unit. NSTACKS gives the CURRENT RATING of the fuel cell.					
5	A_PEM (dummy)	Area	cm^2	real	[232;232]	0
	Electrode area of PEM. Note: A_PEM < A_CELL. Not needed in RTCTMODE=2.					
6	T_PEM	Length	cm	real	[0.010;0.0118]	0.018
	Proton Exchange Membrane (PEM) thickness. One single FC consists of a MEA sandwiched between 2 bipolar plates. Note: T_PEM << T_CELL. (MEA = Cathode + PEM + Amode = Membrane Electrode Assembly)					
7	GAMMA	dimensionless	dimensionless	real	[0.0;1.2]	1.2
	Transport number for water. 0.0 = Well hydrated PEM. 1.2 = Water deficient, or lean water PEM.					
8	UC_MIN	Voltage	V	real	[0;1.6]	0.4
	Minimum allowable cell voltage.					
9	IC_MAX	Current density	mA/m^2	real	[0;1500]	700
	Maximum allowable current density.					
10	RTCTMODE	dimensionless	-	real	[2;2]	0
	Mode for calculating the overall thermal resistance (R_T) and capacitance (C_t) of a single FC stack. 1 = Simple: Few FC geometry and thermal parameters needed. 2 = Detailed : Several FC geometry and thermal parameters needed. 3 = Experimental: R_t & C_t provided.					
11	H_AIR	Heat Transfer Coeff.	W/m^2.K	real	[5;250]	0
	Heat transfer coefficient from FC stack to ambient air. 5-50 = natural convection. 50-250 = forced convection.					
12	H_PEM	Length	cm	real	[1;100]	0
	Height of PEM, i.e., one side of a rectangular PEM (Note! A_PEM is a dummy parameter)					
13	W_PEM	Length	cm	real	[1;100]	0
	Width of PEM, i.e., one side of a rectangular PEM (Note! A_PEM is a dummy parameter)					

14	T_CELL	Length	cm	real	[0.25;5]	0
	Thickness of one singel fuel cell, where a cell consists of a MEA sandwiched between two bipolar plates. T_CELL >> T_PEM.					
15	H_CELL	Length	cm	real	[1.2;120]	0
	Height of a single fuel cell, i.e., one side of a rectangular cell. H_CELL > H_PEM.					
16	W_CELL	Length	cm	real	[1.2;120]	0
	Width of a single fuel cell, i.e., one side of a rectangular cell. W_CELL > W_PEM					
17	T_PLATE	Length	cm	real	[0.25;10]	0
	Thickness of end plate (supporting plate) of PEMFC-stack					
18	H_PLATE	Length	cm	real	[1.5;150]	0
	Height of end plate, i.e., one side of a rectangular end plate. H_PLATE > H_CELL					
19	W_PLATE	Length	cm	real	[1.5;150]	0
	Width of end plate, i.e., one side of rectangular end plate. W_PLATE > W_CELL					
20	K_CELL	Thermal Conductivity	W/m.K	real	[5;50]	0
	Thermal conductivity of cell material (graphite is default).					
21	RHO_CELL (dummy)	Density	kg/m^3	real	[2250;2250]	0
	Density of cell material (graphite is default). Not needed in TMODE=1.					
22	CP_CELL (dummy)	Specific Heat	J/kg.K	real	[710;710]	0
	Specific heat of cell material (graphite is default). Not needed in TMODE=1.					
23	K_PLATE	Thermal Conductivity	W/m.K	real	[10;200]	0
	Thermal conductivity of end plate material (stainless steel is default)					
24	RHOPLATE (dummy)	Density	kg/m^3	real	[7850;7850]	0
	Density of end plate material (stainless steel is default). Not needed in TMODE=1.					
25	CP_PLATE (dummy)	Specific Heat	J/kg.K	real	[450;450]	0
	Specific heat of end plate material (stainless steel is default). Not needed in TMODE=1.					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	SWITCH	dimensionless	-	integer	[0;1]	1
	ON/OFF Switch. 0 = OFF 1 = ON.					
2	IFC	Electric current	A	real	[0.01;5000]	90
	Total electrical current provided by fuel cell unit.					
3	TSTACKin	Temperature	C	real	[10;90]	80
	Set point temperature for FC stack. TMODE=1: Constant temperature where TSTACKin = TSTACKout. TMODE=2. Calculated temperature: TSTACKin = TSTACKsetpoint					
4	p_H2_in	Pressure	BAR	real	[0.1;10]	3.014
	Hydrogen inlet pressure.					
5	p_O2_in	Pressure	BAR	real	[0.1;20]	3.014
	Inlet pressure on cathode side (Oxygen or Air).					
6	S_H2	dimensionless	-	real	[1;1.5]	2
	Stoichiometric ratio for hydrogen (H2). A stoichiometric ratio of 1 is the theoretical minimum H2 needed in a 100% complete reaction. In practical systems some excess H2 is needed to assure a complete reaction. Example: 15% excess H2 fed to the anode equals as a stoichiometric ratio of 1.15					
7	S_O2	dimensionless	dimensionless	real	[1;5]	0
	Stoichiometric ratio for oxygen (O2).					

	A stoichiometric ratio of 1 is the theoretical minimum of O2 needed in a 100% complete reaction. In practical systems some excess air or oxygen is needed to compete the reaction. Example: 150% excess oxygen to the cathode gives a stoichiometric ratio of 1.5					
8	Tamb	Temperature	C	real	[0;60]	25
	Ambient air temperature. The air directly surrounding the FC stack is usually the air in a room or a container.					
9	TCWin	Temperature	C	real	[0;30]	15
	Cooling water inlet temperature.					
10	DELTATCW	Temperature	C	real	[5;30]	20
	Temperature rise in cooling water, as it passes through the fuel cell. DELTATCW=TCWout-TCWout					
11	Xevap	dimensionless	-	real	[0;1]	0.25
	Evaporation rate of process water produced in the fuel cell					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	P_FC	Power	W	real	[0;+Inf]	0
	Total power output from FC unit.					
2	Ustack	Voltage	V	real	[0;+Inf]	0
	Voltage across each FC stack in parallel = Voltage across terminals of FC unit.					
3	eta_e	dimensionless	-	real	[0;1]	0
	Energy efficiency.					
4	IFC_D	Current density	mA/cm^2	real	[0.1;2000]	0
	Current density = Electrical current per square unit of area (cross-sectional area of PEM).					
5	Ucell	Voltage	V	real	[0.1;1.5]	0
	Voltage per cell.					
6	V_H2	Volumetric Flow Rate	m^3/hr	real	[0;+Inf]	0
	Total hydrogen consumption in Nm3/hr. 1 Nm3 = 1 normal cubic meter = 1 cubic meter of gas at 1 bar and 0°C.					
7	V_air	Volumetric Flow Rate	m^3/hr	real	[0;+Inf]	0
	Total air consumption in Nm3/hr. 1 Nm3 = 1 Normal cubic meter = 1 cubic meter at 1 bar and 0°C.					
8	Q_gen	Power	W	real	[0;+Inf]	0
	Total heat generated by FC unit.					
9	Q_cool	Power	W	real	[0;+Inf]	0
	Total auxiliary cooling demand for FC unit.					
10	Q_loss	Power	W	real	[0;+Inf]	0
	Total heat loss to the ambient					
11	Q_evap	Power	W	real	[0;+Inf]	0
	Total heat lossed due to evaporation.					
12	Q_heat	Power	W	real	[0;+Inf]	0
	Total auxiliary heating demand for FC unit.					
13	V_cool	Volumetric Flow Rate	m^3/hr	real	[0;+Inf]	0
	Total required cooling water flow rate for FC unit.					
14	TSTACKout	Temperature	C	real	[0;100]	0
	Average FC stack temperature over last time step. TMODE=1. Constant temperature: TSTACKout = TSTACKin (INPUT #3). TMODE=2. Calculated temperature: TSTACKout = (TNEW+TOLD)/2.					
15	R_t	any	K/W	real	[0;+Inf]	0

	Thermal resitance for one single stack of the FC unit. R_t = 1/UA_FC, where UA_FC = Overall heat loss coefficient for the fuel cell.					
16	C_t	Specific Energy	J/kg	real	[0;+Inf]	0
	Thermal capacitance for one single stack of the FC unit.					

4.5.5.5. PEMFC - Air-H2 - TMODE=1 - RTCTMODE=3

Icon		TRNSYS Model	Type 170
Proforma	Hydrogen Systems\Fuel Cells\PEMFC\Air-H2\TMODE=1\RTCTMODE=3\Type170c.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	OXMODE	dimensionless	-	integer	[1;1]	1
	OXmode=1. Air is provided to the cathode. OXmode=2. Pure oxygen is provided to the cathode.					
2	TMODE	dimensionless	-	integer	[1;1]	2
	Temperature mode. TMODE = 1: TSTACK is a constant. TSTACKout = TSTACKin. TMODE = 2: TSTACK is calculated based on a set point temperature: TSTACKout=(TNEW+TOLD)/2 TNEW = TSTACKin is the set point temperature. TOLD = the temperature in the previous time step. In TMODE=2 it is assumed that the fuel cell reaches TSTACKin during the current time step.					
3	NCELLS	dimensionless	-	real	[1;100]	8000
	Number of cells in series per stack. NCELLS gives the VOLTAGE RATING of the fuel cell.					
4	NSTACKS	dimensionless	-	real	[1;25]	0
	Number of stacks in parallel per FC unit. NSTACKS gives the CURRENT RATING of the fuel cell.					
5	A_PEM	Area	cm^2	real	[25;10000]	0
	Electrode area of PEM. Note: A_PEM < A_CELL.					
6	T_PEM	Length	cm	real	[0.010;0.0118]	0.018
	Proton Exchange Membrane (PEM) thickness. One single FC consists of a MEA sandwiched between 2 bipolar plates. Note: T_PEM << T_CELL. (MEA = Cathode + PEM + Amode = Membrane Electrode Assembly)					
7	GAMMA	dimensionless	dimensionless	real	[0.0;1.2]	1.2
	Transport number for water. 0.0 = Well hydrated PEM. 1.2 = Water deficient, or lean water PEM.					
8	UC_MIN	Voltage	V	real	[0;1.6]	0.4
	Minimum allowable cell voltage.					
9	IC_MAX	Current density	mA/m^2	real	[0;1500]	700
	Maximum allowable current density.					
10	RTCTMODE	dimensionless	-	real	[3;3]	0
	Mode for calculating the overall thermal resistance (R_T) and capacitance (C_t) of a single FC stack. 1 = Simple: Few FC geometry and thermal parameters needed. 2 = Detailed : Several FC geometry and thermal parameters needed. 3 = Experimental: R_t & C_t provided.					
11	Rt	any	K/W	real	[0.010;1.0]	0
	Thermal resistance for a single FC stack. Rt = 1/UA, where UA = overall heat loss coefficient					
12	Ct (dummy)	Specific Energy	J/kg	real	[32197;32197]	0
	Thermal capacitance per FC stack. Not needed in TMODE=1.					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	SWITCH	dimensionless	-	integer	[0;1]	1

	ON/OFF Switch. 0 = OFF 1 = ON.					
2	IFC	Electric current	A	real	[0.01;5000]	90
	Total electrical current provided by fuel cell unit.					
3	TSTACKin	Temperature	C	real	[10;90]	80
	Set point temperature for FC stack. TMODE=1: Constant temperature where TSTACKin = TSTACKout. TMODE=2. Calculated temperature: TSTACKin = TSTACKsetpoint					
4	p_H2_in	Pressure	BAR	real	[0.1;10]	3.014
	Hydrogen inlet pressure.					
5	p_O2_in	Pressure	BAR	real	[0.1;20]	3.014
	Inlet pressure on cathode side (Oxygen or Air).					
6	S_H2	dimensionless	-	real	[1;1.5]	2
	Stoichiometric ratio for hydrogen (H2). A stoichiometric ratio of 1 is the theoretical minimum H2 needed in a 100% complete reaction. In practical systems some excess H2 is needed to assure a complete reaction. Example: 15% excess H2 fed to the anode equals as a stoichiometric ratio of 1.15					
7	S_O2	dimensionless	dimensionless	real	[1;5]	0
	Stoichiometric ratio for oxygen (O2). A stoichiometric ratio of 1 is the theoretical minimum of O2 needed in a 100% complete reaction. In practical systems some excess air or oxygen is needed to compete the reaction. Example: 150% excess oxygen to the cathode gives a stoichiometric ratio of 1.5					
8	Tamb	Temperature	C	real	[0;60]	25
	Ambient air temperature. The air directly surrounding the FC stack is usually the air in a room or a container.					
9	TCWin	Temperature	C	real	[0;30]	15
	Cooling water inlet temperature.					
10	DELTATCW	Temperature	C	real	[5;30]	20
	Temperature rise in cooling water, as it passes through the fuel cell. DELTATCW=TCWout-TCWout					
11	Xevap	dimensionless	-	real	[0;1]	0.25
	Evaporation rate of process water produced in the fuel cell					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	P_FC	Power	W	real	[0;+Inf]	0
	Total power output from FC unit.					
2	Ustack	Voltage	V	real	[0;+Inf]	0
	Voltage across each FC stack in parallel = Voltage across terminals of FC unit.					
3	eta_e	dimensionless	-	real	[0;1]	0
	Energy efficiency.					
4	IFC_D	Current density	mA/cm^2	real	[0.1;2000]	0
	Current density = Electrical current per square unit of area (cross-sectional area of PEM).					
5	Ucell	Voltage	V	real	[0.1;1.5]	0
	Voltage per cell.					
6	V_H2	Volumetric Flow Rate	m^3/hr	real	[0;+Inf]	0
	Total hydrogen consumption in Nm3/hr. 1 Nm3 = 1 normal cubic meter = 1 cubic meter of gas at 1 bar and 0°C.					
7	V_air	Volumetric Flow Rate	m^3/hr	real	[0;+Inf]	0

	Total air consumption in Nm3/hr. 1 Nm3 = 1 Normal cubic meter = 1 cubic meter at 1 bar and 0°C.					
8	Q_gen	Power	W	real	[0;+Inf]	0
	Total heat generated by FC unit.					
9	Q_cool	Power	W	real	[0;+Inf]	0
	Total auxiliary cooling demand for FC unit.					
10	Q_loss	Power	W	real	[0;+Inf]	0
	Total heat loss to the ambient					
11	Q_evap	Power	W	real	[0;+Inf]	0
	Total heat lossed due to evaporation.					
12	Q_heat	Power	W	real	[0;+Inf]	0
	Total auxiliary heating demand for FC unit.					
13	V_cool	Volumetric Flow Rate	m^3/hr	real	[0;+Inf]	0
	Total required cooling water flow rate for FC unit.					
14	TSTACKout	Temperature	C	real	[0;100]	0
	Average FC stack temperature over last time step. TMODE=1. Constant temperature: TSTACKout = TSTACKin (INPUT #3). TMODE=2. Calculated temperature: TSTACKout = (TNEW+TOLD)/2.					
15	R_t	any	K/W	real	[0;+Inf]	0
	Thermal resitance for one single stack of the FC unit. R_t = 1/UA_FC, where UA_FC = Overall heat loss coefficient for the fuel cell.					
16	C_t	Specific Energy	J/kg	real	[0;+Inf]	0
	Thermal capacitance for one single stack of the FC unit.					

4.5.5.6. PEMFC - Air-H2 - TMODE=2 - RTCTMODE=1

Icon		TRNSYS Model	Type 170
Proforma	Hydrogen Systems\Fuel Cells\PEMFC\Air-H2\TMODE=2\RTCTMODE=1\Type170d.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	OXMODE	dimensionless	-	integer	[1;1]	1
	OXmode=1. Air is provided to the cathode. OXmode=2. Pure oxygen is provided to the cathode.					
2	TMODE	dimensionless	-	integer	[2;2]	2
	Temperature mode. TMODE = 1: TSTACK is a constant. TSTACKout = TSTACKin. TMODE = 2: TSTACK is calculated based on a set point temperature: TSTACKout=(TNEW+TOLD)/2 TNEW = TSTACKin is the set point temperature. TOLD = the temperature in the previous time step. In TMODE=2 it is assumed that the fuel cell reaches TSTACKin during the current time step.					
3	NCELLS	dimensionless	-	real	[1;100]	8000
	Number of cells in series per stack. NCELLS gives the VOLTAGE RATING of the fuel cell.					
4	NSTACKS	dimensionless	-	real	[1;25]	0
	Number of stacks in parallel per FC unit. NSTACKS gives the CURRENT RATING of the fuel cell.					
5	A_PEM	Area	cm^2	real	[25;10000]	0
	Electrode area of PEM. Note: A_PEM < A_CELL.					
6	T_PEM	Length	cm	real	[0.010;0.0118]	0.018
	Proton Exchange Membrane (PEM) thickness. One single FC consists of a MEA sandwiched between 2 bipolar plates. Note: T_PEM << T_CELL. (MEA = Cathode + PEM + Amode = Membrane Electrode Assembly)					
7	GAMMA	dimensionless	dimensionless	real	[0.0;1.2]	1.2
	Transport number for water. 0.0 = Well hydrated PEM. 1.2 = Water deficient, or lean water PEM.					
8	UC_MIN	Voltage	V	real	[0;1.6]	0.4
	Minimum allowable cell voltage.					
9	IC_MAX	Current density	mA/m^2	real	[0;1500]	700
	Maximum allowable current density.					
10	RTCTMODE	dimensionless	-	real	[1;1]	0
	Mode for calculating the overall thermal resistance (R_T) and capacitance (C_t) of a single FC stack. 1 = Simple: Few FC geometry and thermal parameters needed. 2 = Detailed : Several FC geometry and thermal parameters needed. 3 = Experimental: R_t & C_t provided.					
11	H_AIR	Heat Transfer Coeff.	W/m^2.K	real	[5;250]	0
	Heat transfer coefficient from FC stack to ambient air. 5-50 = natural convection. 50-250 = forced convection.					
12	A_CELL	Area	cm^2	real	[30;15000]	0
	Cross-sectional area of a single fuel cell. A single FC consists of an MEA sandwiched between two bipolar plates. Note: A_CELL > A_PEM. (MEA = Cathode + PEM + Anode = Membrane Electrode Assembly).					
13	T_CELL	Length	cm	real	[0.25;5]	0

	Thickness of one single fuel cell. One single FC conists of an MEA sandwiched between 2 bipolar plates. Note: T_CELL >> T_PEM.

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	SWITCH	dimensionless	-	integer	[0;1]	1
	ON/OFF Switch. 0 = OFF 1 = ON.					
2	IFC	Electric current	A	real	[0.01;5000]	90
	Total electrical current provided by fuel cell unit.					
3	TSTACKin	Temperature	C	real	[10;90]	80
	Set point temperature for FC stack. TMODE=1: Constant temperature where TSTACKin = TSTACKout. TMODE=2. Calculated temperature: TSTACKin = TSTACKsetpoint					
4	p_H2_in	Pressure	BAR	real	[0.1;10]	3.014
	Hydrogen inlet pressure.					
5	p_O2_in	Pressure	BAR	real	[0.1;20]	3.014
	Inlet pressure on cathode side (Oxygen or Air).					
6	S_H2	dimensionless	-	real	[1;1.5]	2
	Stoichiometric ratio for hydrogen (H2). A stoichiometric ratio of 1 is the theoretical minimum H2 needed in a 100% complete reaction. In practical systems some excess H2 is needed to assure a complete reaction. Example: 15% excess H2 fed to the anode equals as a stoichiometric ratio of 1.15					
7	S_O2	dimensionless	dimensionless	real	[1;5]	0
	Stoichiometric ratio for oxygen (O2). A stoichiometric ratio of 1 is the theoretical minimum of O2 needed in a 100% complete reaction. In practical systems some excess air or oxygen is needed to compete the reaction. Example: 150% excess oxygen to the cathode gives a stoichiometric ratio of 1.5					
8	Tamb	Temperature	C	real	[0;60]	25
	Ambient air temperature. The air directly surrounding the FC stack is usually the air in a room or a container.					
9	TCWin	Temperature	C	real	[0;30]	15
	Cooling water inlet temperature.					
10	DELTATCW	Temperature	C	real	[5;30]	20
	Temperature rise in cooling water, as it passes through the fuel cell. DELTATCW=TCWout-TCWout					
11	Xevap	dimensionless	-	real	[0;1]	0.25
	Evaporation rate of process water produced in the fuel cell					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	P_FC	Power	W	real	[0;+Inf]	0
	Total power output from FC unit.					
2	Ustack	Voltage	V	real	[0;+Inf]	0
	Voltage across each FC stack in parallel = Voltage across terminals of FC unit.					
3	eta_e	dimensionless	-	real	[0;1]	0
	Energy efficiency.					
4	IFC_D	Current density	mA/cm^2	real	[0.1;2000]	0
	Current density = Electrical current per square unit of area (cross-sectional area of PEM).					

5	Ucell	Voltage	V	real	[0.1;1.5]	0
	Voltage per cell.					
6	V_H2	Volumetric Flow Rate	m^3/hr	real	[0;+Inf]	0
	Total hydrogen consumption in Nm3/hr. 1 Nm3 = 1 normal cubic meter = 1 cubic meter of gas at 1 bar and 0°C.					
7	V_air	Volumetric Flow Rate	m^3/hr	real	[0;+Inf]	0
	Total air consumption in Nm3/hr. 1 Nm3 = 1 Normal cubic meter = 1 cubic meter at 1 bar and 0°C.					
8	Q_gen	Power	W	real	[0;+Inf]	0
	Total heat generated by FC unit.					
9	Q_cool	Power	W	real	[0;+Inf]	0
	Total auxiliary cooling demand for FC unit.					
10	Q_loss	Power	W	real	[0;+Inf]	0
	Total heat loss to the ambient					
11	Q_evap	Power	W	real	[0;+Inf]	0
	Total heat lossed due to evaporation.					
12	Q_heat	Power	W	real	[0;+Inf]	0
	Total auxiliary heating demand for FC unit.					
13	V_cool	Volumetric Flow Rate	m^3/hr	real	[0;+Inf]	0
	Total required cooling water flow rate for FC unit.					
14	TSTACKout	Temperature	C	real	[0;100]	0
	Average FC stack temperature over last time step. TMODE=1. Constant temperature: TSTACKout = TSTACKin (INPUT #3). TMODE=2. Calculated temperature: TSTACKout = (TNEW+TOLD)/2.					
15	R_t	any	K/W	real	[0;+Inf]	0
	Thermal resitance for one single stack of the FC unit. R_t = 1/UA_FC, where UA_FC = Overall heat loss coefficient for the fuel cell.					
16	C_t	Specific Energy	J/kg	real	[0;+Inf]	0
	Thermal capacitance for one single stack of the FC unit.					

4.5.5.7. PEMFC - Air-H2 - TMODE=2 - RTCTMODE=2

Icon		TRNSYS Model	Type 170
Proforma	Hydrogen Systems\Fuel Cells\PEMFC\Air-H2\TMODE=2\RTCTMODE=2\Type170e.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	OXMODE	dimensionless	-	integer	[1;1]	1
	OXmode=1. Air is provided to the cathode. OXmode=2. Pure oxygen is provided to the cathode.					
2	TMODE	dimensionless	-	integer	[2;2]	2
	Temperature mode. TMODE = 1: TSTACK is a constant. TSTACKout = TSTACKin. TMODE = 2: TSTACK is calculated based on a set point temperature: TSTACKout=(TNEW+TOLD)/2 TNEW = TSTACKin is the set point temperature. TOLD = the temperature in the previous time step. In TMODE=2 it is assumed that the fuel cell reaches TSTACKin during the current time step.					
3	NCELLS	dimensionless	-	real	[1;100]	8000
	Number of cells in series per stack. NCELLS gives the VOLTAGE RATING of the fuel cell.					
4	NSTACKS	dimensionless	-	real	[1;25]	0
	Number of stacks in parallel per FC unit. NSTACKS gives the CURRENT RATING of the fuel cell.					
5	A_PEM	Area	cm^2	real	[10;10000]	0
	Electrode area of PEM. Note: A_PEM < A_CELL.					
6	T_PEM	Length	cm	real	[0.010;0.0118]	0.018
	Proton Exchange Membrane (PEM) thickness. One single FC consists of a MEA sandwiched between 2 bipolar plates. Note: T_PEM << T_CELL. (MEA = Cathode + PEM + Amode = Membrane Electrode Assembly)					
7	GAMMA	dimensionless	dimensionless	real	[0.0;1.2]	1.2
	Transport number for water. 0.0 = Well hydrated PEM. 1.2 = Water deficient, or lean water PEM.					
8	UC_MIN	Voltage	V	real	[0;1.6]	0.4
	Minimum allowable cell voltage.					
9	IC_MAX	Current density	mA/m^2	real	[0;1500]	700
	Maximum allowable current density.					
10	RTCTMODE	dimensionless	-	real	[2;2]	0
	Mode for calculating the overall thermal resistance (R_T) and capacitance (C_t) of a single FC stack. 1 = Simple: Few FC geometry and thermal parameters needed. 2 = Detailed : Several FC geometry and thermal parameters needed. 3 = Experimental: R_t & C_t provided.					
11	H_AIR	Heat Transfer Coeff.	W/m^2.K	real	[5;250]	0
	Heat transfer coefficient from FC stack to ambient air. 5-50 = natural convection. 50-250 = forced convection.					
12	H_PEM	Length	cm	real	[1;100]	0
	Height of PEM, i.e., one side of a rectangular PEM (Note! A_PEM is a dummy parameter)					
13	W_PEM	Length	cm	real	[1;100]	0
	Width of PEM, i.e., one side of a rectangular PEM (Note! A_PEM is a dummy parameter)					

14	T_CELL	Length	cm	real	[0.25;5]	0
	Thickness of one singel fuel cell, where a cell consists of a MEA sandwiched between two bipolar plates. T_CELL >> T_PEM.					
15	H_CELL	Length	cm	real	[1.2;120]	0
	Height of a single fuel cell, i.e., one side of a rectangular cell. H_CELL > H_PEM.					
16	W_CELL	Length	cm	real	[1.2;120]	0
	Width of a single fuel cell, i.e., one side of a rectangular cell. W_CELL > W_PEM					
17	T_PLATE	Length	cm	real	[0.25;10]	0
	Thickness of end plate (supporting plate) of PEMFC-stack					
18	H_PLATE	Length	cm	real	[1.5;150]	0
	Height of end plate, i.e., one side of a rectangular end plate. H_PLATE > H_CELL					
19	W_PLATE	Length	cm	real	[1.5;150]	0
	Width of end plate, i.e., one side of rectangular end plate. W_PLATE > W_CELL					
20	K_CELL	Thermal Conductivity	W/m.K	real	[5;50]	0
	Thermal conductivity of cell material (graphite is default).					
21	RHO_CELL	Density	kg/m^3	real	[1000;3500]	0
	Density of cell material (graphite is default).					
22	CP_CELL	Specific Heat	J/kg.K	real	[300;1500]	0
	Specific heat of cell material (graphite is default)					
23	K_PLATE	Thermal Conductivity	W/m.K	real	[10;200]	0
	Thermal conductivity of end plate material (stainless steel is default)					
24	RHOPLATE	Density	kg/m^3	real	[2000;20000]	0
	Density of end plate material (stainless steel is default).					
25	CP_PLATE	Specific Heat	J/kg.K	real	[150;1500]	0
	Specific heat of end plate material (stainless steel is default).					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	SWITCH	dimensionless	-	integer	[0;1]	1
	ON/OFF Switch. 0 = OFF 1 = ON.					
2	IFC	Electric current	A	real	[0.01;5000]	90
	Total electrical current provided by fuel cell unit.					
3	TSTACKin	Temperature	C	real	[10;90]	80
	Set point temperature for FC stack. TMODE=1: Constant temperature where TSTACKin = TSTACKout. TMODE=2. Calculated temperature: TSTACKin = TSTACKsetpoint					
4	p_H2_in	Pressure	BAR	real	[0.1;10]	3.014
	Hydrogen inlet pressure.					
5	p_O2_in	Pressure	BAR	real	[0.1;20]	3.014
	Inlet pressure on cathode side (Oxygen or Air).					
6	S_H2	dimensionless	-	real	[1;1.5]	2
	Stoichiometric ratio for hydrogen (H2). A stoichiometric ratio of 1 is the theoretical minimum H2 needed in a 100% complete reaction. In practical systems some excess H2 is needed to assure a complete reaction. Example: 15% excess H2 fed to the anode equals as a stoichiometric ratio of 1.15					
7	S_O2	dimensionless	dimensionless	real	[1;5]	0
	Stoichiometric ratio for oxygen (O2).					

	A stoichiometric ratio of 1 is the theoretical minimum of O2 needed in a 100% complete reaction. In practical systems some excess air or oxygen is needed to compete the reaction. Example: 150% excess oxygen to the cathode gives a stoichiometric ratio of 1.5					
8	Tamb	Temperature	C	real	[0;60]	25
	Ambient air temperature. The air directly surrounding the FC stack is usually the air in a room or a container.					
9	TCWin	Temperature	C	real	[0;30]	15
	Cooling water inlet temperature.					
10	DELTATCW	Temperature	C	real	[5;30]	20
	Temperature rise in cooling water, as it passes through the fuel cell. DELTATCW=TCWout-TCWout					
11	Xevap	dimensionless	-	real	[0;1]	0.25
	Evaporation rate of process water produced in the fuel cell					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	P_FC	Power	W	real	[0;+Inf]	0
	Total power output from FC unit.					
2	Ustack	Voltage	V	real	[0;+Inf]	0
	Voltage across each FC stack in parallel = Voltage across terminals of FC unit.					
3	eta_e	dimensionless	-	real	[0;1]	0
	Energy efficiency.					
4	IFC_D	Current density	mA/cm^2	real	[0.1;2000]	0
	Current density = Electrical current per square unit of area (cross-sectional area of PEM).					
5	Ucell	Voltage	V	real	[0.1;1.5]	0
	Voltage per cell.					
6	V_H2	Volumetric Flow Rate	m^3/hr	real	[0;+Inf]	0
	Total hydrogen consumption in Nm3/hr. 1 Nm3 = 1 normal cubic meter = 1 cubic meter of gas at 1 bar and 0°C.					
7	V_air	Volumetric Flow Rate	m^3/hr	real	[0;+Inf]	0
	Total air consumption in Nm3/hr. 1 Nm3 = 1 Normal cubic meter = 1 cubic meter at 1 bar and 0°C.					
8	Q_gen	Power	W	real	[0;+Inf]	0
	Total heat generated by FC unit.					
9	Q_cool	Power	W	real	[0;+Inf]	0
	Total auxiliary cooling demand for FC unit.					
10	Q_loss	Power	W	real	[0;+Inf]	0
	Total heat loss to the ambient					
11	Q_evap	Power	W	real	[0;+Inf]	0
	Total heat lossed due to evaporation.					
12	Q_heat	Power	W	real	[0;+Inf]	0
	Total auxiliary heating demand for FC unit.					
13	V_cool	Volumetric Flow Rate	m^3/hr	real	[0;+Inf]	0
	Total required cooling water flow rate for FC unit.					
14	TSTACKout	Temperature	C	real	[0;100]	0
	Average FC stack temperature over last time step. TMODE=1. Constant temperature: TSTACKout = TSTACKin (INPUT #3). TMODE=2. Calculated temperature: TSTACKout = (TNEW+TOLD)/2.					
15	R_t	any	K/W	real	[0;+Inf]	0

	Thermal resitance for one single stack of the FC unit. R_t = 1/UA_FC, where UA_FC = Overall heat loss coefficient for the fuel cell.					
16	C_t	Specific Energy	J/kg	real	[0;+Inf]	0
	Thermal capacitance for one single stack of the FC unit.					

4.5.5.8. PEMFC - Air-H2 - TMODE=2 - RTCTMODE=3

Icon		TRNSYS Model	Type 170
Proforma	Hydrogen Systems\Fuel Cells\PEMFC\Air-H2\TMODE=2\RTCTMODE=3\Type170f.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	OXMODE	dimensionless	-	integer	[1;1]	1
	OXmode=1. Air is provided to the cathode. OXmode=2. Pure oxygen is provided to the cathode.					
2	TMODE	dimensionless	-	integer	[2;2]	2
	Temperature mode. TMODE = 1: TSTACK is a constant. TSTACKout = TSTACKin. TMODE = 2: TSTACK is calculated based on a set point temperature: TSTACKout=(TNEW+TOLD)/2 TNEW = TSTACKin is the set point temperature. TOLD = the temperature in the previous time step. In TMODE=2 it is assumed that the fuel cell reaches TSTACKin during the current time step.					
3	NCELLS	dimensionless	-	real	[1;100]	8000
	Number of cells in series per stack. NCELLS gives the VOLTAGE RATING of the fuel cell.					
4	NSTACKS	dimensionless	-	real	[1;25]	0
	Number of stacks in parallel per FC unit. NSTACKS gives the CURRENT RATING of the fuel cell.					
5	A_PEM	Area	cm^2	real	[25;10000]	0
	Electrode area of PEM. Note: A_PEM < A_CELL.					
6	T_PEM	Length	cm	real	[0.010;0.0118]	0.018
	Proton Exchange Membrane (PEM) thickness. One single FC consists of a MEA sandwiched between 2 bipolar plates. Note: T_PEM << T_CELL. (MEA = Cathode + PEM + Amode = Membrane Electrode Assembly)					
7	GAMMA	dimensionless	dimensionless	real	[0.0;1.2]	1.2
	Transport number for water. 0.0 = Well hydrated PEM. 1.2 = Water deficient, or lean water PEM.					
8	UC_MIN	Voltage	V	real	[0;1.6]	0.4
	Minimum allowable cell voltage.					
9	IC_MAX	Current density	mA/m^2	real	[0;1500]	700
	Maximum allowable current density.					
10	RTCTMODE	dimensionless	-	real	[3;3]	0
	Mode for calculating the overall thermal resistance (R_T) and capacitance (C_t) of a single FC stack. 1 = Simple: Few FC geometry and thermal parameters needed. 2 = Detailed : Several FC geometry and thermal parameters needed. 3 = Experimental: R_t & C_t provided.					
11	Rt	any	K/W	real	[0.01;1]	0
	Thermal resistance for a single FC stack. Rt = 1/UA, where UA = overall heat loss coefficient					
12	Ct	Specific Energy	J/kg	real	[10;1000000]	0
	Thermal capacitance per FC stack.					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	SWITCH	dimensionless	-	integer	[0;1]	1

	ON/OFF Switch. 0 = OFF 1 = ON.					
2	IFC	Electric current	A	real	[0.01;5000]	90
	Total electrical current provided by fuel cell unit.					
3	TSTACKin	Temperature	C	real	[10;90]	80
	Set point temperature for FC stack. TMODE=1: Constant temperature where TSTACKin = TSTACKout. TMODE=2. Calculated temperature: TSTACKin = TSTACKsetpoint					
4	p_H2_in	Pressure	BAR	real	[0.1;10]	3.014
	Hydrogen inlet pressure.					
5	p_O2_in	Pressure	BAR	real	[0.1;20]	3.014
	Inlet pressure on cathode side (Oxygen or Air).					
6	S_H2	dimensionless	-	real	[1;1.5]	2
	Stoichiometric ratio for hydrogen (H2). A stoichiometric ratio of 1 is the theoretical minimum H2 needed in a 100% complete reaction. In practical systems some excess H2 is needed to assure a complete reaction. Example: 15% excess H2 fed to the anode equals as a stoichiometric ratio of 1.15					
7	S_O2	dimensionless	dimensionless	real	[1;5]	0
	Stoichiometric ratio for oxygen (O2). A stoichiometric ratio of 1 is the theoretical minimum of O2 needed in a 100% complete reaction. In practical systems some excess air or oxygen is needed to compete the reaction. Example: 150% excess oxygen to the cathode gives a stoichiometric ratio of 1.5					
8	Tamb	Temperature	C	real	[0;60]	25
	Ambient air temperature. The air directly surrounding the FC stack is usually the air in a room or a container.					
9	TCWin	Temperature	C	real	[0;30]	15
	Cooling water inlet temperature.					
10	DELTATCW	Temperature	C	real	[5;30]	20
	Temperature rise in cooling water, as it passes through the fuel cell. DELTATCW=TCWout-TCWout					
11	Xevap	dimensionless	-	real	[0;1]	0.25
	Evaporation rate of process water produced in the fuel cell					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	P_FC	Power	W	real	[0;+Inf]	0
	Total power output from FC unit.					
2	Ustack	Voltage	V	real	[0;+Inf]	0
	Voltage across each FC stack in parallel = Voltage across terminals of FC unit.					
3	eta_e	dimensionless	-	real	[0;1]	0
	Energy efficiency.					
4	IFC_D	Current density	mA/cm^2	real	[0.1;2000]	0
	Current density = Electrical current per square unit of area (cross-sectional area of PEM).					
5	Ucell	Voltage	V	real	[0.1;1.5]	0
	Voltage per cell.					
6	V_H2	Volumetric Flow Rate	m^3/hr	real	[0;+Inf]	0
	Total hydrogen consumption in Nm3/hr. 1 Nm3 = 1 normal cubic meter = 1 cubic meter of gas at 1 bar and 0°C.					
7	V_air	Volumetric Flow Rate	m^3/hr	real	[0;+Inf]	0

	Total air consumption in Nm3/hr. 1 Nm3 = 1 Normal cubic meter = 1 cubic meter at 1 bar and 0°C.					
8	Q_gen	Power	W	real	[0;+Inf]	0
	Total heat generated by FC unit.					
9	Q_cool	Power	W	real	[0;+Inf]	0
	Total auxiliary cooling demand for FC unit.					
10	Q_loss	Power	W	real	[0;+Inf]	0
	Total heat loss to the ambient					
11	Q_evap	Power	W	real	[0;+Inf]	0
	Total heat lossed due to evaporation.					
12	Q_heat	Power	W	real	[0;+Inf]	0
	Total auxiliary heating demand for FC unit.					
13	V_cool	Volumetric Flow Rate	m^3/hr	real	[0;+Inf]	0
	Total required cooling water flow rate for FC unit.					
14	TSTACKout	Temperature	C	real	[0;100]	0
	Average FC stack temperature over last time step. TMODE=1. Constant temperature: TSTACKout = TSTACKin (INPUT #3). TMODE=2. Calculated temperature: TSTACKout = (TNEW+TOLD)/2.					
15	R_t	any	K/W	real	[0;+Inf]	0
	Thermal resitance for one single stack of the FC unit. R_t = 1/UA_FC, where UA_FC = Overall heat loss coefficient for the fuel cell.					
16	C_t	Specific Energy	J/kg	real	[0;+Inf]	0
	Thermal capacitance for one single stack of the FC unit.					

4.5.5.9. PEMFC - O2-H2 - TMODE=1 - RTCTMODE=1

Icon		TRNSYS Model	Type 170
Proforma	Hydrogen Systems\Fuel Cells\PEMFC\O2-H2\TMODE=1\RTCTMODE=1\Type170g.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	OXMODE	dimensionless	-	integer	[2;2]	1
	OXmode=1. Air is provided to the cathode. OXmode=2. Pure oxygen is provided to the cathode.					
2	TMODE	dimensionless	-	integer	[1;1]	2
	Temperature mode. TMODE = 1: TSTACK is a constant. TSTACKout = TSTACKin. TMODE = 2: TSTACK is calculated based on a set point temperature: TSTACKout=(TNEW+TOLD)/2 TNEW = TSTACKin is the set point temperature. TOLD = the temperature in the previous time step. In TMODE=2 it is assumed that the fuel cell reaches TSTACKin during the current time step.					
3	NCELLS	dimensionless	-	real	[1;100]	8000
	Number of cells in series per stack. NCELLS gives the VOLTAGE RATING of the fuel cell.					
4	NSTACKS	dimensionless	-	real	[1;25]	0
	Number of stacks in parallel per FC unit. NSTACKS gives the CURRENT RATING of the fuel cell.					
5	A_PEM	Area	cm^2	real	[25;10000]	0
	Electrode area of PEM. Note: A_PEM < A_CELL.					
6	T_PEM	Length	cm	real	[0.010;0.0118]	0.018
	Proton Exchange Membrane (PEM) thickness. One single FC consists of a MEA sandwiched between 2 bipolar plates. Note: T_PEM << T_CELL. (MEA = Cathode + PEM + Amode = Membrane Electrode Assembly)					
7	GAMMA	dimensionless	dimensionless	real	[0.0;1.2]	1.2
	Transport number for water. 0.0 = Well hydrated PEM. 1.2 = Water deficient, or lean water PEM.					
8	UC_MIN	Voltage	V	real	[0;1.6]	0.4
	Minimum allowable cell voltage.					
9	IC_MAX	Current density	mA/m^2	real	[0;1500]	700
	Maximum allowable current density.					
10	RTCTMODE	dimensionless	-	real	[1;1]	0
	Mode for calculating the overall thermal resistance (R_T) and capacitance (C_t) of a single FC stack. 1 = Simple: Few FC geometry and thermal parameters needed. 2 = Detailed : Several FC geometry and thermal parameters needed. 3 = Experimental: R_t & C_t provided.					
11	H_AIR	Heat Transfer Coeff.	W/m^2.K	real	[5;250]	0
	Heat transfer coefficient from FC stack to ambient air. 5-50 = natural convection. 50-250 = forced convection.					
12	A_CELL	Area	cm^2	real	[30;15000]	0
	Cross-sectional area of a single fuel cell. A single FC consists of an MEA sandwiched between two bipolar plates. Note: A_CELL > A_PEM. (MEA = Cathode + PEM + Anode = Membrane Electrode Assembly).					
13	T_CELL	Length	cm	real	[0.25;5]	0

	Thickness of one single fuel cell. One single FC conists of an MEA sandwiched between 2 bipolar plates. Note: T_CELL >> T_PEM.

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	SWITCH	dimensionless	-	integer	[0;1]	1
	ON/OFF Switch. 0 = OFF 1 = ON.					
2	IFC	Electric current	A	real	[0.01;5000]	90
	Total electrical current provided by fuel cell unit.					
3	TSTACKin	Temperature	C	real	[10;90]	80
	Set point temperature for FC stack. TMODE=1: Constant temperature where TSTACKin = TSTACKout. TMODE=2. Calculated temperature: TSTACKin = TSTACKsetpoint					
4	p_H2_in	Pressure	BAR	real	[0.1;10]	3.014
	Hydrogen inlet pressure.					
5	p_O2_in	Pressure	BAR	real	[0.1;20]	3.014
	Inlet pressure on cathode side (Oxygen or Air).					
6	S_H2	dimensionless	-	real	[1;1.5]	2
	Stoichiometric ratio for hydrogen (H2). A stoichiometric ratio of 1 is the theoretical minimum H2 needed in a 100% complete reaction. In practical systems some excess H2 is needed to assure a complete reaction. Example: 15% excess H2 fed to the anode equals as a stoichiometric ratio of 1.15					
7	S_O2	dimensionless	dimensionless	real	[1;5]	0
	Stoichiometric ratio for oxygen (O2). A stoichiometric ratio of 1 is the theoretical minimum of O2 needed in a 100% complete reaction. In practical systems some excess air or oxygen is needed to compete the reaction. Example: 150% excess oxygen to the cathode gives a stoichiometric ratio of 1.5					
8	Tamb	Temperature	C	real	[0;60]	25
	Ambient air temperature. The air directly surrounding the FC stack is usually the air in a room or a container.					
9	TCWin	Temperature	C	real	[0;30]	15
	Cooling water inlet temperature.					
10	DELTATCW	Temperature	C	real	[5;30]	20
	Temperature rise in cooling water, as it passes through the fuel cell. DELTATCW=TCWout-TCWout					
11	Xevap	dimensionless	-	real	[0;1]	0.25
	Evaporation rate of process water produced in the fuel cell					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	P_FC	Power	W	real	[0;+Inf]	0
	Total power output from FC unit.					
2	Ustack	Voltage	V	real	[0;+Inf]	0
	Voltage across each FC stack in parallel = Voltage across terminals of FC unit.					
3	eta_e	dimensionless	-	real	[0;1]	0
	Energy efficiency.					
4	IFC_D	Current density	mA/cm^2	real	[0.1;2000]	0
	Current density = Electrical current per square unit of area (cross-sectional area of PEM).					

5	Ucell	Voltage	V	real	[0.1;1.5]	0
	Voltage per cell.					
6	V_H2	Volumetric Flow Rate	m^3/hr	real	[0;+Inf]	0
	Total hydrogen consumption in Nm3/hr. 1 Nm3 = 1 normal cubic meter = 1 cubic meter of gas at 1 bar and 0°C.					
7	V_air	Volumetric Flow Rate	m^3/hr	real	[0;+Inf]	0
	Total air consumption in Nm3/hr. 1 Nm3 = 1 Normal cubic meter = 1 cubic meter at 1 bar and 0°C.					
8	Q_gen	Power	W	real	[0;+Inf]	0
	Total heat generated by FC unit.					
9	Q_cool	Power	W	real	[0;+Inf]	0
	Total auxiliary cooling demand for FC unit.					
10	Q_loss	Power	W	real	[0;+Inf]	0
	Total heat loss to the ambient					
11	Q_evap	Power	W	real	[0;+Inf]	0
	Total heat lossed due to evaporation.					
12	Q_heat	Power	W	real	[0;+Inf]	0
	Total auxiliary heating demand for FC unit.					
13	V_cool	Volumetric Flow Rate	m^3/hr	real	[0;+Inf]	0
	Total required cooling water flow rate for FC unit.					
14	TSTACKout	Temperature	C	real	[0;100]	0
	Average FC stack temperature over last time step. TMODE=1. Constant temperature: TSTACKout = TSTACKin (INPUT #3). TMODE=2. Calculated temperature: TSTACKout = (TNEW+TOLD)/2.					
15	R_t	any	K/W	real	[0;+Inf]	0
	Thermal resitance for one single stack of the FC unit. R_t = 1/UA_FC, where UA_FC = Overall heat loss coefficient for the fuel cell.					
16	C_t	Specific Energy	J/kg	real	[0;+Inf]	0
	Thermal capacitance for one single stack of the FC unit.					

4.5.5.10. PEMFC - O2-H2 - TMODE=1 - RTCTMODE=2

Icon		TRNSYS Model	Type 170
Proforma	Hydrogen Systems\Fuel Cells\PEMFC\O2-H2\TMODE=1\RTCTMODE=2\Type170h.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	OXMODE	dimensionless	-	integer	[2;2]	1
	OXmode=1. Air is provided to the cathode. OXmode=2. Pure oxygen is provided to the cathode.					
2	TMODE	dimensionless	-	integer	[1;1]	2
	Temperature mode. TMODE = 1: TSTACK is a constant. TSTACKout = TSTACKin. TMODE = 2: TSTACK is calculated based on a set point temperature: TSTACKout=(TNEW+TOLD)/2 TNEW = TSTACKin is the set point temperature. TOLD = the temperature in the previous time step. In TMODE=2 it is assumed that the fuel cell reaches TSTACKin during the current time step.					
3	NCELLS	dimensionless	-	real	[1;100]	8000
	Number of cells in series per stack. NCELLS gives the VOLTAGE RATING of the fuel cell.					
4	NSTACKS	dimensionless	-	real	[1;25]	0
	Number of stacks in parallel per FC unit. NSTACKS gives the CURRENT RATING of the fuel cell.					
5	A_PEM (dummy)	Area	cm^2	real	[232;232]	0
	Electrode area of PEM. Note: A_PEM < A_CELL. Not needed in RTCTMODE=2.					
6	T_PEM	Length	cm	real	[0.010;0.0118]	0.018
	Proton Exchange Membrane (PEM) thickness. One single FC consists of a MEA sandwiched between 2 bipolar plates. Note: T_PEM << T_CELL. (MEA = Cathode + PEM + Amode = Membrane Electrode Assembly)					
7	GAMMA	dimensionless	dimensionless	real	[0.0;1.2]	1.2
	Transport number for water. 0.0 = Well hydrated PEM. 1.2 = Water deficient, or lean water PEM.					
8	UC_MIN	Voltage	V	real	[0;1.6]	0.4
	Minimum allowable cell voltage.					
9	IC_MAX	Current density	mA/m^2	real	[0;1500]	700
	Maximum allowable current density.					
10	RTCTMODE	dimensionless	-	real	[2;2]	0
	Mode for calculating the overall thermal resistance (R_T) and capacitance (C_t) of a single FC stack. 1 = Simple: Few FC geometry and thermal parameters needed. 2 = Detailed : Several FC geometry and thermal parameters needed. 3 = Experimental: R_t & C_t provided.					
11	H_AIR	Heat Transfer Coeff.	W/m^2.K	real	[5;250]	0
	Heat transfer coefficient from FC stack to ambient air. 5-50 = natural convection. 50-250 = forced convection.					
12	H_PEM	Length	cm	real	[1;100]	0
	Height of PEM, i.e., one side of a rectangular PEM (Note! A_PEM is a dummy parameter)					
13	W_PEM	Length	cm	real	[1;100]	0
	Width of PEM, i.e., one side of a rectangular PEM (Note! A_PEM is a dummy parameter)					

14	T_CELL	Length	cm	real	[0.25;5]	0
	Thickness of one singel fuel cell, where a cell consists of a MEA sandwiched between two bipolar plates. T_CELL >> T_PEM.					
15	H_CELL	Length	cm	real	[1.2;120]	0
	Height of a single fuel cell, i.e., one side of a rectangular cell. H_CELL > H_PEM.					
16	W_CELL	Length	cm	real	[1.2;120]	0
	Width of a single fuel cell, i.e., one side of a rectangular cell. W_CELL > W_PEM					
17	T_PLATE	Length	cm	real	[0.25;10]	0
	Thickness of end plate (supporting plate) of PEMFC-stack					
18	H_PLATE	Length	cm	real	[1.5;150]	0
	Height of end plate, i.e., one side of a rectangular end plate. H_PLATE > H_CELL					
19	W_PLATE	Length	cm	real	[1.5;150]	0
	Width of end plate, i.e., one side of rectangular end plate. W_PLATE > W_CELL					
20	K_CELL	Thermal Conductivity	W/m.K	real	[5;50]	0
	Thermal conductivity of cell material (graphite is default).					
21	RHO_CELL (dummy)	Density	kg/m^3	real	[2250;2250]	0
	Density of cell material (graphite is default). Not needed in TMODE=1.					
22	CP_CELL (dummy)	Specific Heat	J/kg.K	real	[710;710]	0
	Specific heat of cell material (graphite is default). Not needed in TMODE=1.					
23	K_PLATE	Thermal Conductivity	W/m.K	real	[10;200]	0
	Thermal conductivity of end plate material (stainless steel is default)					
24	RHOPLATE (dummy)	Density	kg/m^3	real	[7850;7850]	0
	Density of end plate material (stainless steel is default). Not needed in TMODE=1.					
25	CP_PLATE (dummy)	Specific Heat	J/kg.K	real	[450;450]	0
	Specific heat of end plate material (stainless steel is default). Not needed in TMODE=1.					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	SWITCH	dimensionless	-	integer	[0;1]	1
	ON/OFF Switch. 0 = OFF 1 = ON.					
2	IFC	Electric current	A	real	[0.01;5000]	90
	Total electrical current provided by fuel cell unit.					
3	TSTACKin	Temperature	C	real	[10;90]	80
	Set point temperature for FC stack. TMODE=1: Constant temperature where TSTACKin = TSTACKout. TMODE=2. Calculated temperature: TSTACKin = TSTACKsetpoint					
4	p_H2_in	Pressure	BAR	real	[0.1;10]	3.014
	Hydrogen inlet pressure.					
5	p_O2_in	Pressure	BAR	real	[0.1;20]	3.014
	Inlet pressure on cathode side (Oxygen or Air).					
6	S_H2	dimensionless	-	real	[1;1.5]	2
	Stoichiometric ratio for hydrogen (H2). A stoichiometric ratio of 1 is the theoretical minimum H2 needed in a 100% complete reaction. In practical systems some excess H2 is needed to assure a complete reaction. Example: 15% excess H2 fed to the anode equals as a stoichiometric ratio of 1.15					
7	S_O2	dimensionless	dimensionless	real	[1;5]	0
	Stoichiometric ratio for oxygen (O2).					

	A stoichiometric ratio of 1 is the theoretical minimum of O2 needed in a 100% complete reaction. In practical systems some excess air or oxygen is needed to compete the reaction. Example: 150% excess oxygen to the cathode gives a stoichiometric ratio of 1.5					
8	Tamb	Temperature	C	real	[0;60]	25
	Ambient air temperature. The air directly surrounding the FC stack is usually the air in a room or a container.					
9	TCWin	Temperature	C	real	[0;30]	15
	Cooling water inlet temperature.					
10	DELTATCW	Temperature	C	real	[5;30]	20
	Temperature rise in cooling water, as it passes through the fuel cell. DELTATCW=TCWout-TCWout					
11	Xevap	dimensionless	-	real	[0;1]	0.25
	Evaporation rate of process water produced in the fuel cell					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	P_FC	Power	W	real	[0;+Inf]	0
	Total power output from FC unit.					
2	Ustack	Voltage	V	real	[0;+Inf]	0
	Voltage across each FC stack in parallel = Voltage across terminals of FC unit.					
3	eta_e	dimensionless	-	real	[0;1]	0
	Energy efficiency.					
4	IFC_D	Current density	mA/cm^2	real	[0.1;2000]	0
	Current density = Electrical current per square unit of area (cross-sectional area of PEM).					
5	Ucell	Voltage	V	real	[0.1;1.5]	0
	Voltage per cell.					
6	V_H2	Volumetric Flow Rate	m^3/hr	real	[0;+Inf]	0
	Total hydrogen consumption in Nm3/hr. 1 Nm3 = 1 normal cubic meter = 1 cubic meter of gas at 1 bar and 0°C.					
7	V_air	Volumetric Flow Rate	m^3/hr	real	[0;+Inf]	0
	Total air consumption in Nm3/hr. 1 Nm3 = 1 Normal cubic meter = 1 cubic meter at 1 bar and 0°C.					
8	Q_gen	Power	W	real	[0;+Inf]	0
	Total heat generated by FC unit.					
9	Q_cool	Power	W	real	[0;+Inf]	0
	Total auxiliary cooling demand for FC unit.					
10	Q_loss	Power	W	real	[0;+Inf]	0
	Total heat loss to the ambient					
11	Q_evap	Power	W	real	[0;+Inf]	0
	Total heat lossed due to evaporation.					
12	Q_heat	Power	W	real	[0;+Inf]	0
	Total auxiliary heating demand for FC unit.					
13	V_cool	Volumetric Flow Rate	m^3/hr	real	[0;+Inf]	0
	Total required cooling water flow rate for FC unit.					
14	TSTACKout	Temperature	C	real	[0;100]	0
	Average FC stack temperature over last time step. TMODE=1. Constant temperature: TSTACKout = TSTACKin (INPUT #3). TMODE=2. Calculated temperature: TSTACKout = (TNEW+TOLD)/2.					
15	R_t	any	K/W	real	[0;+Inf]	0

	Thermal resitance for one single stack of the FC unit. R_t = 1/UA_FC, where UA_FC = Overall heat loss coefficient for the fuel cell.					
16	C_t	Specific Energy	J/kg	real	[0;+Inf]	0
	Thermal capacitance for one single stack of the FC unit.					

4.5.5.11. PEMFC - O2-H2 - TMODE=1 - RTCTMODE=3

Icon		TRNSYS Model	Type 170
Proforma	Hydrogen Systems\Fuel Cells\PEMFC\O2-H2\TMODE=1\RTCTMODE=3\Type170i.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	OXMODE	dimensionless	-	integer	[2;2]	1
	OXmode=1. Air is provided to the cathode. OXmode=2. Pure oxygen is provided to the cathode.					
2	TMODE	dimensionless	-	integer	[1;1]	2
	Temperature mode. TMODE = 1: TSTACK is a constant. TSTACKout = TSTACKin. TMODE = 2: TSTACK is calculated based on a set point temperature: TSTACKout=(TNEW+TOLD)/2 TNEW = TSTACKin is the set point temperature. TOLD = the temperature in the previous time step. In TMODE=2 it is assumed that the fuel cell reaches TSTACKin during the current time step.					
3	NCELLS	dimensionless	-	real	[1;100]	8000
	Number of cells in series per stack. NCELLS gives the VOLTAGE RATING of the fuel cell.					
4	NSTACKS	dimensionless	-	real	[1;25]	0
	Number of stacks in parallel per FC unit. NSTACKS gives the CURRENT RATING of the fuel cell.					
5	A_PEM	Area	cm^2	real	[25;10000]	0
	Electrode area of PEM. Note: A_PEM < A_CELL.					
6	T_PEM	Length	cm	real	[0.010;0.0118]	0.018
	Proton Exchange Membrane (PEM) thickness. One single FC consists of a MEA sandwiched between 2 bipolar plates. Note: T_PEM << T_CELL. (MEA = Cathode + PEM + Amode = Membrane Electrode Assembly)					
7	GAMMA	dimensionless	dimensionless	real	[0.0;1.2]	1.2
	Transport number for water. 0.0 = Well hydrated PEM. 1.2 = Water deficient, or lean water PEM.					
8	UC_MIN	Voltage	V	real	[0;1.6]	0.4
	Minimum allowable cell voltage.					
9	IC_MAX	Current density	mA/m^2	real	[0;1500]	700
	Maximum allowable current density.					
10	RTCTMODE	dimensionless	-	real	[3;3]	0
	Mode for calculating the overall thermal resistance (R_T) and capacitance (C_t) of a single FC stack. 1 = Simple: Few FC geometry and thermal parameters needed. 2 = Detailed : Several FC geometry and thermal parameters needed. 3 = Experimental: R_t & C_t provided.					
11	Rt	any	K/W	real	[0.01;1.0]	0
	Thermal resistance for a single FC stack. Rt = 1/UA, where UA = overall heat loss coefficient					
12	Ct (dummy)	Specific Energy	J/kg	real	[32197;32197]	0
	Thermal capacitance per FC stack. Not needed in TMODE=1.					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	SWITCH	dimensionless	-	integer	[0;1]	1

	ON/OFF Switch. 0 = OFF 1 = ON.					
2	IFC	Electric current	A	real	[0.01;5000]	90
	Total electrical current provided by fuel cell unit.					
3	TSTACKin	Temperature	C	real	[10;90]	80
	Set point temperature for FC stack. TMODE=1: Constant temperature where TSTACKin = TSTACKout. TMODE=2. Calculated temperature: TSTACKin = TSTACKsetpoint					
4	p_H2_in	Pressure	BAR	real	[0.1;10]	3.014
	Hydrogen inlet pressure.					
5	p_O2_in	Pressure	BAR	real	[0.1;20]	3.014
	Inlet pressure on cathode side (Oxygen or Air).					
6	S_H2	dimensionless	-	real	[1;1.5]	2
	Stoichiometric ratio for hydrogen (H2). A stoichiometric ratio of 1 is the theoretical minimum H2 needed in a 100% complete reaction. In practical systems some excess H2 is needed to assure a complete reaction. Example: 15% excess H2 fed to the anode equals as a stoichiometric ratio of 1.15					
7	S_O2	dimensionless	dimensionless	real	[1;5]	0
	Stoichiometric ratio for oxygen (O2). A stoichiometric ratio of 1 is the theoretical minimum of O2 needed in a 100% complete reaction. In practical systems some excess air or oxygen is needed to compete the reaction. Example: 150% excess oxygen to the cathode gives a stoichiometric ratio of 1.5					
8	Tamb	Temperature	C	real	[0;60]	25
	Ambient air temperature. The air directly surrounding the FC stack is usually the air in a room or a container.					
9	TCWin	Temperature	C	real	[0;30]	15
	Cooling water inlet temperature.					
10	DELTATCW	Temperature	C	real	[5;30]	20
	Temperature rise in cooling water, as it passes through the fuel cell. DELTATCW=TCWout-TCWout					
11	Xevap	dimensionless	-	real	[0;1]	0.25
	Evaporation rate of process water produced in the fuel cell					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	P_FC	Power	W	real	[0;+Inf]	0
	Total power output from FC unit.					
2	Ustack	Voltage	V	real	[0;+Inf]	0
	Voltage across each FC stack in parallel = Voltage across terminals of FC unit.					
3	eta_e	dimensionless	-	real	[0;1]	0
	Energy efficiency.					
4	IFC_D	Current density	mA/cm^2	real	[0.1;2000]	0
	Current density = Electrical current per square unit of area (cross-sectional area of PEM).					
5	Ucell	Voltage	V	real	[0.1;1.5]	0
	Voltage per cell.					
6	V_H2	Volumetric Flow Rate	m^3/hr	real	[0;+Inf]	0
	Total hydrogen consumption in Nm3/hr. 1 Nm3 = 1 normal cubic meter = 1 cubic meter of gas at 1 bar and 0°C.					
7	V_air	Volumetric Flow Rate	m^3/hr	real	[0;+Inf]	0

	Total air consumption in Nm3/hr. 1 Nm3 = 1 Normal cubic meter = 1 cubic meter at 1 bar and 0°C.					
8	Q_gen	Power	W	real	[0;+Inf]	0
	Total heat generated by FC unit.					
9	Q_cool	Power	W	real	[0;+Inf]	0
	Total auxiliary cooling demand for FC unit.					
10	Q_loss	Power	W	real	[0;+Inf]	0
	Total heat loss to the ambient					
11	Q_evap	Power	W	real	[0;+Inf]	0
	Total heat lossed due to evaporation.					
12	Q_heat	Power	W	real	[0;+Inf]	0
	Total auxiliary heating demand for FC unit.					
13	V_cool	Volumetric Flow Rate	m^3/hr	real	[0;+Inf]	0
	Total required cooling water flow rate for FC unit.					
14	TSTACKout	Temperature	C	real	[0;100]	0
	Average FC stack temperature over last time step. TMODE=1. Constant temperature: TSTACKout = TSTACKin (INPUT #3). TMODE=2. Calculated temperature: TSTACKout = (TNEW+TOLD)/2.					
15	R_t	any	K/W	real	[0;+Inf]	0
	Thermal resitance for one single stack of the FC unit. R_t = 1/UA_FC, where UA_FC = Overall heat loss coefficient for the fuel cell.					
16	C_t	Specific Energy	J/kg	real	[0;+Inf]	0
	Thermal capacitance for one single stack of the FC unit.					

4.5.5.12. PEMFC - O2-H2 - TMODE=2 - RTCTMODE=1

Icon		TRNSYS Model	Type 170
Proforma	Hydrogen Systems\Fuel Cells\PEMFC\O2-H2\TMODE=2\RTCTMODE=1\Type170j.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	OXMODE	dimensionless	-	integer	[2;2]	1
	OXmode=1. Air is provided to the cathode. OXmode=2. Pure oxygen is provided to the cathode.					
2	TMODE	dimensionless	-	integer	[2;2]	2
	Temperature mode. TMODE = 1: TSTACK is a constant. TSTACKout = TSTACKin. TMODE = 2: TSTACK is calculated based on a set point temperature: TSTACKout=(TNEW+TOLD)/2 TNEW = TSTACKin is the set point temperature. TOLD = the temperature in the previous time step. In TMODE=2 it is assumed that the fuel cell reaches TSTACKin during the current time step.					
3	NCELLS	dimensionless	-	real	[1;100]	8000
	Number of cells in series per stack. NCELLS gives the VOLTAGE RATING of the fuel cell.					
4	NSTACKS	dimensionless	-	real	[1;25]	0
	Number of stacks in parallel per FC unit. NSTACKS gives the CURRENT RATING of the fuel cell.					
5	A_PEM	Area	cm^2	real	[25;10000]	0
	Electrode area of PEM. Note: A_PEM < A_CELL.					
6	T_PEM	Length	cm	real	[0.010;0.0118]	0.018
	Proton Exchange Membrane (PEM) thickness. One single FC consists of a MEA sandwiched between 2 bipolar plates. Note: T_PEM << T_CELL. (MEA = Cathode + PEM + Amode = Membrane Electrode Assembly)					
7	GAMMA	dimensionless	dimensionless	real	[0.0;1.2]	1.2
	Transport number for water. 0.0 = Well hydrated PEM. 1.2 = Water deficient, or lean water PEM.					
8	UC_MIN	Voltage	V	real	[0;1.6]	0.4
	Minimum allowable cell voltage.					
9	IC_MAX	Current density	mA/m^2	real	[0;1500]	700
	Maximum allowable current density.					
10	RTCTMODE	dimensionless	-	real	[1;1]	0
	Mode for calculating the overall thermal resistance (R_T) and capacitance (C_t) of a single FC stack. 1 = Simple: Few FC geometry and thermal parameters needed. 2 = Detailed : Several FC geometry and thermal parameters needed. 3 = Experimental: R_t & C_t provided.					
11	H_AIR	Heat Transfer Coeff.	W/m^2.K	real	[5;250]	0
	Heat transfer coefficient from FC stack to ambient air. 5-50 = natural convection. 50-250 = forced convection.					
12	A_CELL	Area	cm^2	real	[30;15000]	0
	Cross-sectional area of a single fuel cell. A single FC consists of an MEA sandwiched between two bipolar plates. Note: A_CELL > A_PEM. (MEA = Cathode + PEM + Anode = Membrane Electrode Assembly).					
13	T_CELL	Length	cm	real	[0.25;5]	0

	Thickness of one single fuel cell. One single FC conists of an MEA sandwiched between 2 bipolar plates. Note: T_CELL >> T_PEM.

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	SWITCH	dimensionless	-	integer	[0;1]	1
	ON/OFF Switch. 0 = OFF 1 = ON.					
2	IFC	Electric current	A	real	[0.01;5000]	90
	Total electrical current provided by fuel cell unit.					
3	TSTACKin	Temperature	C	real	[10;90]	80
	Set point temperature for FC stack. TMODE=1: Constant temperature where TSTACKin = TSTACKout. TMODE=2. Calculated temperature: TSTACKin = TSTACKsetpoint					
4	p_H2_in	Pressure	BAR	real	[0.1;10]	3.014
	Hydrogen inlet pressure.					
5	p_O2_in	Pressure	BAR	real	[0.1;20]	3.014
	Inlet pressure on cathode side (Oxygen or Air).					
6	S_H2	dimensionless	-	real	[1;1.5]	2
	Stoichiometric ratio for hydrogen (H2). A stoichiometric ratio of 1 is the theoretical minimum H2 needed in a 100% complete reaction. In practical systems some excess H2 is needed to assure a complete reaction. Example: 15% excess H2 fed to the anode equals as a stoichiometric ratio of 1.15					
7	S_O2	dimensionless	dimensionless	real	[1;5]	0
	Stoichiometric ratio for oxygen (O2). A stoichiometric ratio of 1 is the theoretical minimum of O2 needed in a 100% complete reaction. In practical systems some excess air or oxygen is needed to compete the reaction. Example: 150% excess oxygen to the cathode gives a stoichiometric ratio of 1.5					
8	Tamb	Temperature	C	real	[0;60]	25
	Ambient air temperature. The air directly surrounding the FC stack is usually the air in a room or a container.					
9	TCWin	Temperature	C	real	[0;30]	15
	Cooling water inlet temperature.					
10	DELTATCW	Temperature	C	real	[5;30]	20
	Temperature rise in cooling water, as it passes through the fuel cell. DELTATCW=TCWout-TCWout					
11	Xevap	dimensionless	-	real	[0;1]	0.25
	Evaporation rate of process water produced in the fuel cell					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	P_FC	Power	W	real	[0;+Inf]	0
	Total power output from FC unit.					
2	Ustack	Voltage	V	real	[0;+Inf]	0
	Voltage across each FC stack in parallel = Voltage across terminals of FC unit.					
3	eta_e	dimensionless	-	real	[0;1]	0
	Energy efficiency.					
4	IFC_D	Current density	mA/cm^2	real	[0.1;2000]	0
	Current density = Electrical current per square unit of area (cross-sectional area of PEM).					

5	Ucell	Voltage	V	real	[0.1;1.5]	0
	Voltage per cell.					
6	V_H2	Volumetric Flow Rate	m^3/hr	real	[0;+Inf]	0
	Total hydrogen consumption in Nm3/hr. 1 Nm3 = 1 normal cubic meter = 1 cubic meter of gas at 1 bar and 0°C.					
7	V_air	Volumetric Flow Rate	m^3/hr	real	[0;+Inf]	0
	Total air consumption in Nm3/hr. 1 Nm3 = 1 Normal cubic meter = 1 cubic meter at 1 bar and 0°C.					
8	Q_gen	Power	W	real	[0;+Inf]	0
	Total heat generated by FC unit.					
9	Q_cool	Power	W	real	[0;+Inf]	0
	Total auxiliary cooling demand for FC unit.					
10	Q_loss	Power	W	real	[0;+Inf]	0
	Total heat loss to the ambient					
11	Q_evap	Power	W	real	[0;+Inf]	0
	Total heat lossed due to evaporation.					
12	Q_heat	Power	W	real	[0;+Inf]	0
	Total auxiliary heating demand for FC unit.					
13	V_cool	Volumetric Flow Rate	m^3/hr	real	[0;+Inf]	0
	Total required cooling water flow rate for FC unit.					
14	TSTACKout	Temperature	C	real	[0;100]	0
	Average FC stack temperature over last time step. TMODE=1. Constant temperature: TSTACKout = TSTACKin (INPUT #3). TMODE=2. Calculated temperature: TSTACKout = (TNEW+TOLD)/2.					
15	R_t	any	K/W	real	[0;+Inf]	0
	Thermal resitance for one single stack of the FC unit. R_t = 1/UA_FC, where UA_FC = Overall heat loss coefficient for the fuel cell.					
16	C_t	Specific Energy	J/kg	real	[0;+Inf]	0
	Thermal capacitance for one single stack of the FC unit.					

4.5.5.13. PEMFC - O2-H2 - TMODE=2 - RTCTMODE=2

Icon		TRNSYS Model	Type 170
Proforma	Hydrogen Systems\Fuel Cells\PEMFC\O2-H2\TMODE=2\RTCTMODE=2\Type170k.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	OXMODE	dimensionless	-	integer	[2;2]	1
	OXmode=1. Air is provided to the cathode. OXmode=2. Pure oxygen is provided to the cathode.					
2	TMODE	dimensionless	-	integer	[2;2]	2
	Temperature mode. TMODE = 1: TSTACK is a constant. TSTACKout = TSTACKin. TMODE = 2: TSTACK is calculated based on a set point temperature: TSTACKout=(TNEW+TOLD)/2 TNEW = TSTACKin is the set point temperature. TOLD = the temperature in the previous time step. In TMODE=2 it is assumed that the fuel cell reaches TSTACKin during the current time step.					
3	NCELLS	dimensionless	-	real	[1;100]	8000
	Number of cells in series per stack. NCELLS gives the VOLTAGE RATING of the fuel cell.					
4	NSTACKS	dimensionless	-	real	[1;25]	0
	Number of stacks in parallel per FC unit. NSTACKS gives the CURRENT RATING of the fuel cell.					
5	A_PEM	Area	cm^2	real	[10;10000]	0
	Electrode area of PEM. Note: A_PEM < A_CELL.					
6	T_PEM	Length	cm	real	[0.010;0.0118]	0.018
	Proton Exchange Membrane (PEM) thickness. One single FC consists of a MEA sandwiched between 2 bipolar plates. Note: T_PEM << T_CELL. (MEA = Cathode + PEM + Amode = Membrane Electrode Assembly)					
7	GAMMA	dimensionless	dimensionless	real	[0.0;1.2]	1.2
	Transport number for water. 0.0 = Well hydrated PEM. 1.2 = Water deficient, or lean water PEM.					
8	UC_MIN	Voltage	V	real	[0;1.6]	0.4
	Minimum allowable cell voltage.					
9	IC_MAX	Current density	mA/m^2	real	[0;1500]	700
	Maximum allowable current density.					
10	RTCTMODE	dimensionless	-	real	[2;2]	0
	Mode for calculating the overall thermal resistance (R_T) and capacitance (C_t) of a single FC stack. 1 = Simple: Few FC geometry and thermal parameters needed. 2 = Detailed : Several FC geometry and thermal parameters needed. 3 = Experimental: R_t & C_t provided.					
11	H_AIR	Heat Transfer Coeff.	W/m^2.K	real	[5;250]	0
	Heat transfer coefficient from FC stack to ambient air. 5-50 = natural convection. 50-250 = forced convection.					
12	H_PEM	Length	cm	real	[1;100]	0
	Height of PEM, i.e., one side of a rectangular PEM (Note! A_PEM is a dummy parameter)					
13	W_PEM	Length	cm	real	[1;100]	0
	Width of PEM, i.e., one side of a rectangular PEM (Note! A_PEM is a dummy parameter)					

14	T_CELL	Length	cm	real	[0.25;5]	0
	Thickness of one singel fuel cell, where a cell consists of a MEA sandwiched between two bipolar plates. T_CELL >> T_PEM.					
15	H_CELL	Length	cm	real	[1.2;120]	0
	Height of a single fuel cell, i.e., one side of a rectangular cell. H_CELL > H_PEM.					
16	W_CELL	Length	cm	real	[1.2;120]	0
	Width of a single fuel cell, i.e., one side of a rectangular cell. W_CELL > W_PEM					
17	T_PLATE	Length	cm	real	[0.25;10]	0
	Thickness of end plate (supporting plate) of PEMFC-stack					
18	H_PLATE	Length	cm	real	[1.5;150]	0
	Height of end plate, i.e., one side of a rectangular end plate. H_PLATE > H_CELL					
19	W_PLATE	Length	cm	real	[1.5;150]	0
	Width of end plate, i.e., one side of rectangular end plate. W_PLATE > W_CELL					
20	K_CELL	Thermal Conductivity	W/m.K	real	[5;50]	0
	Thermal conductivity of cell material (graphite is default).					
21	RHO_CELL	Density	kg/m^3	real	[1000;3500]	0
	Density of cell material (graphite is default).					
22	CP_CELL	Specific Heat	J/kg.K	real	[300;1500]	0
	Specific heat of cell material (graphite is default)					
23	K_PLATE	Thermal Conductivity	W/m.K	real	[10;200]	0
	Thermal conductivity of end plate material (stainless steel is default)					
24	RHOPLATE	Density	kg/m^3	real	[2000;20000]	0
	Density of end plate material (stainless steel is default).					
25	CP_PLATE	Specific Heat	J/kg.K	real	[150;1500]	0
	Specific heat of end plate material (stainless steel is default).					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	SWITCH	dimensionless	-	integer	[0;1]	1
	ON/OFF Switch. 0 = OFF 1 = ON.					
2	IFC	Electric current	A	real	[0.01;5000]	90
	Total electrical current provided by fuel cell unit.					
3	TSTACKin	Temperature	C	real	[10;90]	80
	Set point temperature for FC stack. TMODE=1: Constant temperature where TSTACKin = TSTACKout. TMODE=2. Calculated temperature: TSTACKin = TSTACKsetpoint					
4	p_H2_in	Pressure	BAR	real	[0.1;10]	3.014
	Hydrogen inlet pressure.					
5	p_O2_in	Pressure	BAR	real	[0.1;20]	3.014
	Inlet pressure on cathode side (Oxygen or Air).					
6	S_H2	dimensionless	-	real	[1;1.5]	2
	Stoichiometric ratio for hydrogen (H2). A stoichiometric ratio of 1 is the theoretical minimum H2 needed in a 100% complete reaction. In practical systems some excess H2 is needed to assure a complete reaction. Example: 15% excess H2 fed to the anode equals as a stoichiometric ratio of 1.15					
7	S_O2	dimensionless	dimensionless	real	[1;5]	0
	Stoichiometric ratio for oxygen (O2).					

	A stoichiometric ratio of 1 is the theoretical minimum of O2 needed in a 100% complete reaction. In practical systems some excess air or oxygen is needed to compete the reaction. Example: 150% excess oxygen to the cathode gives a stoichiometric ratio of 1.5					
8	Tamb	Temperature	C	real	[0;60]	25
	Ambient air temperature. The air directly surrounding the FC stack is usually the air in a room or a container.					
9	TCWin	Temperature	C	real	[0;30]	15
	Cooling water inlet temperature.					
10	DELTATCW	Temperature	C	real	[5;30]	20
	Temperature rise in cooling water, as it passes through the fuel cell. DELTATCW=TCWout-TCWout					
11	Xevap	dimensionless	-	real	[0;1]	0.25
	Evaporation rate of process water produced in the fuel cell					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	P_FC	Power	W	real	[0;+Inf]	0
	Total power output from FC unit.					
2	Ustack	Voltage	V	real	[0;+Inf]	0
	Voltage across each FC stack in parallel = Voltage across terminals of FC unit.					
3	eta_e	dimensionless	-	real	[0;1]	0
	Energy efficiency.					
4	IFC_D	Current density	mA/cm^2	real	[0.1;2000]	0
	Current density = Electrical current per square unit of area (cross-sectional area of PEM).					
5	Ucell	Voltage	V	real	[0.1;1.5]	0
	Voltage per cell.					
6	V_H2	Volumetric Flow Rate	m^3/hr	real	[0;+Inf]	0
	Total hydrogen consumption in Nm3/hr. 1 Nm3 = 1 normal cubic meter = 1 cubic meter of gas at 1 bar and 0°C.					
7	V_air	Volumetric Flow Rate	m^3/hr	real	[0;+Inf]	0
	Total air consumption in Nm3/hr. 1 Nm3 = 1 Normal cubic meter = 1 cubic meter at 1 bar and 0°C.					
8	Q_gen	Power	W	real	[0;+Inf]	0
	Total heat generated by FC unit.					
9	Q_cool	Power	W	real	[0;+Inf]	0
	Total auxiliary cooling demand for FC unit.					
10	Q_loss	Power	W	real	[0;+Inf]	0
	Total heat loss to the ambient					
11	Q_evap	Power	W	real	[0;+Inf]	0
	Total heat lossed due to evaporation.					
12	Q_heat	Power	W	real	[0;+Inf]	0
	Total auxiliary heating demand for FC unit.					
13	V_cool	Volumetric Flow Rate	m^3/hr	real	[0;+Inf]	0
	Total required cooling water flow rate for FC unit.					
14	TSTACKout	Temperature	C	real	[0;100]	0
	Average FC stack temperature over last time step. TMODE=1. Constant temperature: TSTACKout = TSTACKin (INPUT #3). TMODE=2. Calculated temperature: TSTACKout = (TNEW+TOLD)/2.					
15	R_t	any	K/W	real	[0;+Inf]	0

	Thermal resitance for one single stack of the FC unit. R_t = 1/UA_FC, where UA_FC = Overall heat loss coefficient for the fuel cell.					
16	C_t	Specific Energy	J/kg	real	[0;+Inf]	0
	Thermal capacitance for one single stack of the FC unit.					

4.5.5.14. PEMFC - O2-H2 - TMODE=2 - RTCTMODE=3

Icon		TRNSYS Model	Type 170
Proforma	Hydrogen Systems\Fuel Cells\PEMFC\O2-H2\TMODE=2\RTCTMODE=3\Type170l.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	OXMODE	dimensionless	-	integer	[2;2]	1
	OXmode=1. Air is provided to the cathode. OXmode=2. Pure oxygen is provided to the cathode.					
2	TMODE	dimensionless	-	integer	[2;2]	2
	Temperature mode. TMODE = 1: TSTACK is a constant. TSTACKout = TSTACKin. TMODE = 2: TSTACK is calculated based on a set point temperature: TSTACKout=(TNEW+TOLD)/2 TNEW = TSTACKin is the set point temperature. TOLD = the temperature in the previous time step. In TMODE=2 it is assumed that the fuel cell reaches TSTACKin during the current time step.					
3	NCELLS	dimensionless	-	real	[1;100]	8000
	Number of cells in series per stack. NCELLS gives the VOLTAGE RATING of the fuel cell.					
4	NSTACKS	dimensionless	-	real	[1;25]	0
	Number of stacks in parallel per FC unit. NSTACKS gives the CURRENT RATING of the fuel cell.					
5	A_PEM	Area	cm^2	real	[25;10000]	0
	Electrode area of PEM. Note: A_PEM < A_CELL.					
6	T_PEM	Length	cm	real	[0.010;0.0118]	0.018
	Proton Exchange Membrane (PEM) thickness. One single FC consists of a MEA sandwiched between 2 bipolar plates. Note: T_PEM << T_CELL. (MEA = Cathode + PEM + Amode = Membrane Electrode Assembly)					
7	GAMMA	dimensionless	dimensionless	real	[0.0;1.2]	1.2
	Transport number for water. 0.0 = Well hydrated PEM. 1.2 = Water deficient, or lean water PEM.					
8	UC_MIN	Voltage	V	real	[0;1.6]	0.4
	Minimum allowable cell voltage.					
9	IC_MAX	Current density	mA/m^2	real	[0;1500]	700
	Maximum allowable current density.					
10	RTCTMODE	dimensionless	-	real	[3;3]	0
	Mode for calculating the overall thermal resistance (R_T) and capacitance (C_t) of a single FC stack. 1 = Simple: Few FC geometry and thermal parameters needed. 2 = Detailed : Several FC geometry and thermal parameters needed. 3 = Experimental: R_t & C_t provided.					
11	Rt	any	K/W	real	[0.01;1.0]	0
	Thermal resistance for a single FC stack. Rt = 1/UA, where UA = overall heat loss coefficient					
12	Ct	Specific Energy	J/kg	real	[10;1000000]	0
	Thermal capacitance per FC stack.					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	SWITCH	dimensionless	-	integer	[0;1]	1

	ON/OFF Switch. 0 = OFF 1 = ON.					
2	IFC	Electric current	A	real	[0.01;5000]	90
	Total electrical current provided by fuel cell unit.					
3	TSTACKin	Temperature	C	real	[10;90]	80
	Set point temperature for FC stack. TMODE=1: Constant temperature where TSTACKin = TSTACKout. TMODE=2. Calculated temperature: TSTACKin = TSTACKsetpoint					
4	p_H2_in	Pressure	BAR	real	[0.1;10]	3.014
	Hydrogen inlet pressure.					
5	p_O2_in	Pressure	BAR	real	[0.1;20]	3.014
	Inlet pressure on cathode side (Oxygen or Air).					
6	S_H2	dimensionless	-	real	[1;1.5]	2
	Stoichiometric ratio for hydrogen (H2). A stoichiometric ratio of 1 is the theoretical minimum H2 needed in a 100% complete reaction. In practical systems some excess H2 is needed to assure a complete reaction. Example: 15% excess H2 fed to the anode equals as a stoichiometric ratio of 1.15					
7	S_O2	dimensionless	dimensionless	real	[1;5]	0
	Stoichiometric ratio for oxygen (O2). A stoichiometric ratio of 1 is the theoretical minimum of O2 needed in a 100% complete reaction. In practical systems some excess air or oxygen is needed to compete the reaction. Example: 150% excess oxygen to the cathode gives a stoichiometric ratio of 1.5					
8	Tamb	Temperature	C	real	[0;60]	25
	Ambient air temperature. The air directly surrounding the FC stack is usually the air in a room or a container.					
9	TCWin	Temperature	C	real	[0;30]	15
	Cooling water inlet temperature.					
10	DELTATCW	Temperature	C	real	[5;30]	20
	Temperature rise in cooling water, as it passes through the fuel cell. DELTATCW=TCWout-TCWout					
11	Xevap	dimensionless	-	real	[0;1]	0.25
	Evaporation rate of process water produced in the fuel cell					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	P_FC	Power	W	real	[0;+Inf]	0
	Total power output from FC unit.					
2	Ustack	Voltage	V	real	[0;+Inf]	0
	Voltage across each FC stack in parallel = Voltage across terminals of FC unit.					
3	eta_e	dimensionless	-	real	[0;1]	0
	Energy efficiency.					
4	IFC_D	Current density	mA/cm^2	real	[0.1;2000]	0
	Current density = Electrical current per square unit of area (cross-sectional area of PEM).					
5	Ucell	Voltage	V	real	[0.1;1.5]	0
	Voltage per cell.					
6	V_H2	Volumetric Flow Rate	m^3/hr	real	[0;+Inf]	0
	Total hydrogen consumption in Nm3/hr. 1 Nm3 = 1 normal cubic meter = 1 cubic meter of gas at 1 bar and 0°C.					
7	V_air	Volumetric Flow Rate	m^3/hr	real	[0;+Inf]	0

	Total air consumption in Nm3/hr. 1 Nm3 = 1 Normal cubic meter = 1 cubic meter at 1 bar and 0°C.					
8	Q_gen	Power	W	real	[0;+Inf]	0
	Total heat generated by FC unit.					
9	Q_cool	Power	W	real	[0;+Inf]	0
	Total auxiliary cooling demand for FC unit.					
10	Q_loss	Power	W	real	[0;+Inf]	0
	Total heat loss to the ambient					
11	Q_evap	Power	W	real	[0;+Inf]	0
	Total heat lossed due to evaporation.					
12	Q_heat	Power	W	real	[0;+Inf]	0
	Total auxiliary heating demand for FC unit.					
13	V_cool	Volumetric Flow Rate	m^3/hr	real	[0;+Inf]	0
	Total required cooling water flow rate for FC unit.					
14	TSTACKout	Temperature	C	real	[0;100]	0
	Average FC stack temperature over last time step. TMODE=1. Constant temperature: TSTACKout = TSTACKin (INPUT #3). TMODE=2. Calculated temperature: TSTACKout = (TNEW+TOLD)/2.					
15	R_t	any	K/W	real	[0;+Inf]	0
	Thermal resitance for one single stack of the FC unit. R_t = 1/UA_FC, where UA_FC = Overall heat loss coefficient for the fuel cell.					
16	C_t	Specific Energy	J/kg	real	[0;+Inf]	0
	Thermal capacitance for one single stack of the FC unit.					

4.6. Hydronics

4.6.1. Fans

4.6.1.1. Single Speed - Humidity Ratio Inputs

Icon		TRNSYS Model	Type 112
Proforma	Hydronics\Fans\Single Speed\Humidity Ratio Inputs\Type112a.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Humidity mode	Dimensionless	-	integer	[1;1]	0
	This parameter indicates whether the calculation will be based on the inlet humidity ratio input (mode=1) or the inlet relative humidity input (mode=2).					
2	Rated flow rate	Flow Rate	kg/hr	real	[0.0;+Inf]	100.0
	The rated flow rate of dry air through the fan when operating.					
3	Rated power	Power	kJ/hr	real	[0.0;+Inf]	1000.0
	The fan power consumption during operation.					
4	Motor efficiency	Dimensionless	-	real	[0.0;1.0]	0.10
	The efficiency of the fan motor. This efficiency is used to calculate the amount of heat added to the air stream.					
5	Motor heat loss fraction	Dimensionless	-	real	[0.;1.0]	0
	The fraction of the motor heat loss transferred to the air stream. The motor heat loss is calculated by subtracting the efficiency of the motor from 1 and multiplying the resultant quantity by the power consumption. Typical values are 0 for motors mounted outside the air stream and 1 for motors mounted within the air stream.					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Inlet air temperature	Temperature	C	real	[-Inf;+Inf]	20.0
	The dry-bulb temperature of the air entering the fan.					
2	Inlet air humidity ratio	Dimensionless	-	real	[0.0;+0.45]	0.01
	The absolute humidity ratio of the air entering the fan.					
3	Not used (RH)	Percentage	% (base 100)	real	[0.;100.]	0
	The percent relative humidity of the air entering the fan.					
4	Air flow rate	Flow Rate	kg/hr	real	[0.0;+Inf]	100.0
	The flow rate of the air (dry) entering the fan. This input is not used by this component except for convergence checking.					
5	Inlet air pressure	Pressure	atm	real	[0.;5.]	0
	The inlet air pressure (absolute).					
6	Control signal	Dimensionless	-	real	[0.0;1.0]	1.0
	The input control signal to the fan.= 0.5 - the fan in ON					
7	Air-side pressure increase	Pressure	atm	real	[0.;+Inf]	0
	The increase in air-side pressure for the fan. This value should be set to zero when the fan is off.					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Outlet air temperature	Temperature	C	real	[-Inf;+Inf]	0
	The outlet air dry-bulb temperature from the fan.					
2	Outlet humidity ratio	Dimensionless	-	real	[0.0;0.45]	0
	The absolute humidity ratio of the air exiting the fan. In all cases, the exiting humidity ratio is set to the inlet air humidity ratio.					
3	Outlet air %RH	Percentage	% (base 100)	real	[0.;100.]	0
	The percent relative humidity of the air exiting the fan.					
4	Outlet flow rate	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	The flow rate of dry air exiting the fan					
5	Outlet air pressure	Pressure	atm	real	[0.;5.]	0
	The absolute presure of the air exiting the fan.					
6	Power consumption	Power	kJ/hr	real	[-Inf;+Inf]	0
	The power consumed by the fan.					
7	Air heat transfer	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which heat is transferred to the air by the fan operation. This value may include motor heat loss if the motor is located within the airstream.					
8	Ambient heat transfer	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is transferred to the environment from the fan. This value is calculated by subtracting the heat transfer to the air stream from the total fan power.					

4.6.1.2. Single Speed - No Humidity

Icon		TRNSYS Model	Type 3
Proforma	Hydronics\Fans\Single Speed\No Humidity\Type3a.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Maximum flow rate	Flow Rate	kg/hr	real	[0.0;+Inf]	100.0
	The maximum flow rate through the fan. The outlet flow rate is simply the maximum flow rate (this parameter) multiplied by the inlet control signal (Input 3).					
2	Fluid specific heat	Specific Heat	kJ/kg.K	real	[0.0;+Inf]	4.190
	The specific heat of the fluid flowing through the fan. The specific heat is used to determine the temperture rise of the fluid through the fan using the following relation: Tout = Tin + (f*Power)/(mdot Cp) (See manual for further information on equation)					
3	Maximum power	Power	kJ/hr	real	[0.0;+Inf]	1000.0
	The maximum fan power consumption. The actual fan power will be the maximum fan power multiplied by a function of the input control signal. See the abstract for more details on calculated fan power.					
4	Conversion coefficient	Dimensionless	-	real	[0.0;1.0]	0.10
	The fraction of fan power that is converted to fluid thermal energy. Tout = Tin + (f * Power)/(mdot * Cp) (See manual for further information on equation)					
5	Power coefficient	Dimensionless	-	real	[-Inf;+Inf]	0.5
	To specify a non-linear relationship between fan power and fluid flow rate, the user must enter the coefficients of the polynomial: Power = Pmax * (co + c1*gamma + c2*gamma^2 + c3*gamma^3 + ci*gamma^i) (See manual for further information on equation)					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
5-5		How many coefficients in the polynomial relating fan power to fluid flow rate?	1	20

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Inlet fluid temperature	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the fluid entering the fan.					
2	Inlet mass flow rate	Flow Rate	kg/hr	real	[0.0;+Inf]	100.0
	The flow rate of the fluid entering the fan. This input is not used by this component except for convergence checking. The outlet flow rate depends on the maximum flow rate and the input control signal. This input is just for visualization purposes.					
3	Control signal	Dimensionless	-	real	[0.0;1.0]	1.0
	The input control signal to the fan. The flow rate and power are calculated from knowledge of this input: mout = mmax * gamma Power = f(Pmax,gamma) (See manual for further information on equation)					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default

1	Outlet fluid temperature	Temperature	C	real	[-Inf;+Inf]	0
	The outlet fluid temperature from the fan. Tout = Tin + (f*Power)/(mdot*Cp) (See manual for further information on equation)					
2	Outlet flow rate	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	The outlet fluid flowrate. The outlet flow rate is calculated by: mout = mmax * gamma (See manual for further information on equation)					
3	Power consumption	Power	kJ/hr	real	[-Inf;+Inf]	0
	The power consumed by the fan. The fan power is calculated from either a linear relationship with flow rate or by a polynomial expression relating fan power to control signal, depending on the parameters supplied by the user.					

4.6.1.3. Single Speed - No Humidity - No Power Coefficients

Icon		TRNSYS Model	Type 3
Proforma	Hydronics\Fans\Single Speed\No Humidity - No Power Coefficients\Type3c.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Maximum flow rate	Flow Rate	kg/hr	real	[0.0;+Inf]	100.0
	The maximum flow rate through the fan. The outlet flow rate is simply the maximum flow rate (this parameter) multiplied by the inlet control signal (Input 3).					
2	Fluid specific heat	Specific Heat	kJ/kg.K	real	[0.0;+Inf]	4.190
	The specific heat of the fluid flowing through the fan. The specific heat is used to determine the temperture rise of the fluid through the fan using the following relation: Tout = Tin + (f*Power)/(mdot Cp) (See manual for further information on equation)					
3	Maximum power	Power	kJ/hr	real	[0.0;+Inf]	1000.0
	The maximum fan power consumption. The actual fan power will be the maximum fan power multiplied by a function of the input control signal. See the abstract for more details on calculated fan power.					
4	Conversion coefficient	Dimensionless	-	real	[0.0;1.0]	0.10
	The fraction of fan power that is converted to fluid thermal energy. Tout = Tin + (f * Power)/(mdot * Cp) (See manual for further information on equation)					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Inlet fluid temperature	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the fluid entering the fan.					
2	Inlet mass flow rate	Flow Rate	kg/hr	real	[0.0;+Inf]	100.0
	The flow rate of the fluid entering the fan. This input is not used by this component except for convergence checking. The outlet flow rate depends on the maximum flow rate and the input control signal. This input is just for visualization purposes.					
3	Control signal	Dimensionless	-	real	[0.0;1.0]	1.0
	The input control signal to the fan. The flow rate and power are calculated from knowledge of this input: mout = mmax * gamma Power = f(Pmax,gamma) (See manual for further information on equation)					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Outlet fluid temperature	Temperature	C	real	[-Inf;+Inf]	0
	The outlet fluid temperature from the fan. Tout = Tin + (f*Power)/(mdot*Cp) (See manual for further information on equation)					
2	Outlet flow rate	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	The outlet fluid flowrate. The outlet flow rate is calculated by: mout = mmax * gamma (See manual for further information on equation)					
3	Power consumption	Power	kJ/hr	real	[-Inf;+Inf]	0
	The power consumed by the fan. The fan power is calculated from either a linear relationship with flow rate or					

	by a polynomial expression relating fan power to control signal, depending on the parameters supplied by the user.

4.6.1.4. Single Speed - Relative Humidity Inputs

Icon		TRNSYS Model	Type 112
Proforma	Hydronics\Fans\Single Speed\Relative Humidity Inputs\Type112b.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Humidity mode	Dimensionless	-	integer	[2;2]	0
	This parameter indicates whether the calculation will be based on the inlet humidity ratio input (mode=1) or the inlet relative humidity input (mode=2).					
2	Rated flow rate	Flow Rate	kg/hr	real	[0.0;+Inf]	100.0
	The rated flow rate of dry air through the fan when operating.					
3	Rated power	Power	kJ/hr	real	[0.0;+Inf]	1000.0
	The fan power consumption during operation.					
4	Motor efficiency	Dimensionless	-	real	[0.0;1.0]	0.10
	The efficiency of the fan motor. This efficiency is used to calculate the amount of heat added to the air stream.					
5	Motor heat loss fraction	Dimensionless	-	real	[0.;1.0]	0
	The fraction of the motor heat loss transferred to the air stream. The motor heat loss is calculated by subtracting the efficiency of the motor from 1 and multiplying the resultant quantity by the power consumption. Typical values are 0 for motors mounted outside the air stream and 1 for motors mounted within the air stream.					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Inlet air temperature	Temperature	C	real	[-Inf;+Inf]	20.0
	The dry-bulb temperature of the air entering the fan.					
2	Not used (w)	Dimensionless	-	real	[0.0;+0.45]	0.01
	The absolute humidity ratio of the air entering the fan.					
3	Inlet air %RH	Percentage	% (base 100)	real	[0.;100.]	0
	The percent relative humidity of the air entering the fan.					
4	Air flow rate	Flow Rate	kg/hr	real	[0.0;+Inf]	100.0
	The flow rate of the air (dry) entering the fan. This input is not used by this component except for convergence checking.					
5	Inlet air pressure	Pressure	atm	real	[0.;5.]	0
	The inlet air pressure (absolute).					
6	Control signal	Dimensionless	-	real	[0.0;1.0]	1.0
	The input control signal to the fan.= 0.5 - the fan in ON					
7	Air-side pressure increase	Pressure	atm	real	[0.;+Inf]	0
	The increase in air-side pressure for the fan. This value should be set to zero when the fan is off.					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Outlet air temperature	Temperature	C	real	[-Inf;+Inf]	0
	The outlet air dry-bulb temperature from the fan.					
2	Outlet humidity ratio	Dimensionless	-	real	[0.0;0.45]	0
	The absolute humidity ratio of the air exiting the fan. In all cases, the exiting humidity ratio is set to the inlet air humidity ratio.					

3	Outlet air %RH	Percentage	% (base 100)	real	[0.;100.]	0
	The percent relative humidity of the air exiting the fan.					
4	Outlet flow rate	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	The flow rate of dry air exiting the fan					
5	Outlet air pressure	Pressure	atm	real	[0.;5.]	0
	The absolute presure of the air exiting the fan.					
6	Power consumption	Power	kJ/hr	real	[-Inf;+Inf]	0
	The power consumed by the fan.					
7	Air heat transfer	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which heat is transferred to the air by the fan operation. This value may include motor heat loss if the motor is located within the airstream.					
8	Ambient heat transfer	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is transferred to the environment from the fan. This value is calculated by subtracting the heat transfer to the air stream from the total fan power.					

4.6.1.5. Variable Speed - Humidity Ratio Inputs

Icon		TRNSYS Model	Type 111
Proforma	Hydronics\Fans\Variable Speed\Humidity Ratio Inputs\Type111a.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Humidity mode	Dimensionless	-	integer	[1;1]	0
	This parameter indicates whether the calculation will be based on the inlet humidity ratio input (mode=1) or the inlet relative humidity input (mode=2).					
2	Rated flow rate	Flow Rate	kg/hr	real	[0.0;+Inf]	100.0
	The maximum (rated) flow rate of dry air through the fan when operating at full-speed.					
3	Rated power	Power	kJ/hr	real	[0.0;+Inf]	1000.0
	The rated fan power consumption when the fan is operating at full-speed.					
4	Motor efficiency	Dimensionless	-	real	[0.0;1.0]	0.10
	The efficiency of the fan motor. This efficiency is used to calculate the amount of heat added to the air stream.					
5	Motor heat loss fraction	Dimensionless	-	real	[0.;1.0]	0
	The fraction of the motor heat loss transferred to the air stream. The motor heat loss is calculated by subtracting the efficiency of the motor from 1 and multiplying the resultant quantity by the power consumption. Typical values are 0 for motors mounted outside the air stream and 1 for motors mounted within the air stream.					
6	Number of power coefficients	Dimensionless	-	integer	[1;+Inf]	0
	The number of polynomial multipliers that will be supplied relating the normalized fan power to the normalized fan flow rate.					
7	Power coefficient	Dimensionless	-	real	[-Inf;+Inf]	0
	The value of the polynomial multiplier for the relationship between normalized fan power and normalized fan flow rate.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
7-7	Number of power coefficients		1	100

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Inlet air temperature	Temperature	C	real	[-Inf;+Inf]	20.0
	The dry-bulb temperature of the air entering the fan.					
2	Inlet air humidity ratio	Dimensionless	-	real	[0.0;+0.45]	0.01
	The absolute humidity ratio of the air entering the fan.					
3	Not used (RH)	Percentage	% (base 100)	real	[0.;100.]	0
	The percent relative humidity of the air entering the fan.					
4	Air flow rate	Flow Rate	kg/hr	real	[0.0;+Inf]	100.0
	The flow rate of the air (dry) entering the fan. This input is not used by this component except for convergence checking.					
5	Inlet air pressure	Pressure	atm	real	[0.;5.]	0
	The inlet air pressure (absolute).					
6	Control signal	Dimensionless	-	real	[0.0;1.0]	1.0
	The input control signal to the fan: 0 = Off, 1 = On at Full_Speed, 0 < Y < 1 - Modulating operation					

7	Air-side pressure increase	Pressure	atm	real	[0.;+Inf]	0
	The increase in air-side pressure for the fan. This value should be set to zero when the fan is off.					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Outlet air temperature	Temperature	C	real	[-Inf;+Inf]	0
	The outlet air dry-bulb temperature from the fan.					
2	Outlet humidity ratio	Dimensionless	-	real	[0.0;0.45]	0
	The absolute humidity ratio of the air exiting the fan. In all cases, the exiting humidity ratio is set to the inlet air humidity ratio.					
3	Outlet air %RH	Percentage	% (base 100)	real	[0.;100.]	0
	The percent relative humidity of the air exiting the fan.					
4	Outlet flow rate	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	The flow rate of dry air exiting the fan					
5	Outlet air pressure	Pressure	atm	real	[0.;5.]	0
	The absolute presure of the air exiting the fan.					
6	Power consumption	Power	kJ/hr	real	[-Inf;+Inf]	0
	The power consumed by the fan.					
7	Air heat transfer	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which heat is transferred to the air by the fan operation. This value may include motor heat loss if the motor is located within the airstream.					
8	Ambient heat transfer	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is transferred to the environment from the fan. This value is calculated by subtracting the heat transfer to the air stream from the total fan power.					

4.6.1.6. Variable Speed - RH Inputs

Icon		TRNSYS Model	Type 111
Proforma	Hydronics\Fans\Variable Speed\RH Inputs\Type111b.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Humidity mode	Dimensionless	-	integer	[2;2]	0
	This parameter indicates whether the calculation will be based on the inlet humidity ratio input (mode=1) or the inlet relative humidity input (mode=2).					
2	Rated flow rate	Flow Rate	kg/hr	real	[0.0;+Inf]	100.0
	The maximum (rated) flow rate of dry air through the fan when operating at full-speed.					
3	Rated power	Power	kJ/hr	real	[0.0;+Inf]	1000.0
	The rated fan power consumption when the fan is operating at full-speed.					
4	Motor efficiency	Dimensionless	-	real	[0.0;1.0]	0.10
	The efficiency of the fan motor. This efficiency is used to calculate the amount of heat added to the air stream.					
5	Motor heat loss fraction	Dimensionless	-	real	[0.;1.0]	0
	The fraction of the motor heat loss transferred to the air stream. The motor heat loss is calculated by subtracting the efficiency of the motor from 1 and multiplying the resultant quantity by the power consumption. Typical values are 0 for motors mounted outside the air stream and 1 for motors mounted within the air stream.					
6	Number of power coefficients	Dimensionless	-	integer	[1;+Inf]	0
	The number of polynomial multipliers that will be supplied relating the normalized fan power to the normalized fan flow rate.					
7	Power coefficient	Dimensionless	-	real	[-Inf;+Inf]	0
	The value of the polynomial multiplier for the relationship between normalized fan power and normalized fan flow rate.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
7-7	Number of power coefficients		1	100

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Inlet air temperature	Temperature	C	real	[-Inf;+Inf]	20.0
	The dry-bulb temperature of the air entering the fan.					
2	Not used (w)	Dimensionless	-	real	[0.0;+0.45]	0.01
	The absolute humidity ratio of the air entering the fan.					
3	Inlet air %RH	Percentage	% (base 100)	real	[0.;100.]	0
	The percent relative humidity of the air entering the fan.					
4	Air flow rate	Flow Rate	kg/hr	real	[0.0;+Inf]	100.0
	The flow rate of the air (dry) entering the fan. This input is not used by this component except for convergence checking.					
5	Inlet air pressure	Pressure	atm	real	[0.;5.]	0
	The inlet air pressure (absolute).					
6	Control signal	Dimensionless	-	real	[0.0;1.0]	1.0
	The input control signal to the fan: 0 = Off, 1 = On at Full_Speed, 0 < Y < 1 - Modulating operation					

7	Air-side pressure increase	Pressure	atm	real	[0.;+Inf]	0
	The increase in air-side pressure for the fan. This value should be set to zero when the fan is off.					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Outlet air temperature	Temperature	C	real	[-Inf;+Inf]	0
	The outlet air dry-bulb temperature from the fan.					
2	Outlet humidity ratio	Dimensionless	-	real	[0.0;0.45]	0
	The absolute humidity ratio of the air exiting the fan. In all cases, the exiting humidity ratio is set to the inlet air humidity ratio.					
3	Outlet air %RH	Percentage	% (base 100)	real	[0.;100.]	0
	The percent relative humidity of the air exiting the fan.					
4	Outlet flow rate	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	The flow rate of dry air exiting the fan					
5	Outlet air pressure	Pressure	atm	real	[0.;5.]	0
	The absolute presure of the air exiting the fan.					
6	Power consumption	Power	kJ/hr	real	[-Inf;+Inf]	0
	The power consumed by the fan.					
7	Air heat transfer	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which heat is transferred to the air by the fan operation. This value may include motor heat loss if the motor is located within the airstream.					
8	Ambient heat transfer	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is transferred to the environment from the fan. This value is calculated by subtracting the heat transfer to the air stream from the total fan power.					

4.6.2. Flow Diverter

4.6.2.1. Moist Air

Icon		TRNSYS Model	Type 11
Proforma	Hydronics\Flow Diverter\Moist Air\Type11e.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Controlled flow diverter mode	Dimensionless	-	integer	[7;7]	7
	This parameter indicated to the general model that a controlled flow diverter using moist air as the working fluid is to be modeled. Do not change this parameter.					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Inlet temperature	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the moist air entering the inlet of the flow diverter.					
2	Inlet humidity ratio	Dimensionless	-	real	[0.0;0.5]	0.006
	The absolute humidity ratio of the air entering the controlled flow diverter. The absoulte humidity ratio is defined as: w = kg's of H20/kg of dry air					
3	Inlet flow rate	Flow Rate	kg/hr	real	[0.0;+Inf]	100.0
	The flow rate of moist air entering the inlet of the flow diverter.					
4	Control signal	Dimensionless	-	real	[0.0;1.0]	0.5
	The input control signal. The control signal sets the position of a damper controlling the proportion of fluid to each exit. mdot,1 = mdot,in * (1-Y) mdot,2 = mdot,in * Y (See manual for further information on equation)					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Temperature at outlet 1	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the moist air exiting through the first outlet of the flow diverter. The first outlet temperature is set to the inlet temperature for all cases.					
2	Humidity ratio at outlet 1	Dimensionless	-	real	[-Inf;+Inf]	0
	The absolute humidity ratio of the air exiting through the first outlet of the controlled flow diverter. The outlet humidity ratio is set to the inlet humidity ratio for all cases.					
3	Flow rate at outlet 1	Flow Rate	kg/hr	real	[-Inf;+Inf]	0
	The flow rate of moist air leaving the first outlet of the controlled flow diverter. The first outlet flow rate is: mdot,1 = mdot,in * (1-Y) (See manual for further information on equation)					
4	Temperature at outlet 2	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the moist air exiting through the second outlet of the flow diverter. The temperature at the second outlet is set to the inlet temperature for all cases.					

5	Humidity ratio at outlet 2	Dimensionless	-	real	[-Inf;+Inf]	0
	The humidity ratio of the air exiting the controlled flow diverter through the second outlet. The outlet humidity ratio is set to the inlet humidity ratio for all cases.					
6	Flow rate at outlet 2	Flow Rate	kg/hr	real	[-Inf;+Inf]	0
	The flow rate of moist air exiting the flow diverter through the second outlet. The flow rate through the second outlet is: mdot,2 = mdot,in * Y (See manual for further information on equation)					

4.6.2.2. Other Fluids

Icon		TRNSYS Model	Type 11
Proforma	Hydronics\Flow Diverter\Other Fluids\Type11f.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Controlled flow diverter mode	Dimensionless	-	integer	[2;2]	2
	This parameter indicated to the general model that a controlled flow diverter is to be modeled. Do not change this parameter.					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Inlet temperature	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the fluid entering the inlet of the flow diverter.					
2	Inlet flow rate	Flow Rate	kg/hr	real	[0.0;+Inf]	100.0
	The flow rate of fluid entering the inlet of the flow diverter.					
3	Control signal	Dimensionless	-	real	[0.0;1.0]	0.5
	The input control signal. The control signal sets the position of a damper controlling the proportion of fluid to each exit. mdot,1 = mdot,in * (1-Y) mdot,2 = mdot,in * Y (See manual for further information on equation)					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Temperature at outlet 1	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid exiting through the first outlet of the flow diverter. The first outlet temperature is set to the inlet temperature for all cases.					
2	Flow rate at outlet 1	Flow Rate	kg/hr	real	[-Inf;+Inf]	0
	The flow rate of fluid leaving the first outlet of the controlled flow diverter. The first outlet flow rate is: mdot,1 = mdot,in * (1-Y) (See manual for further information on equation)					
3	Temperature at outlet 2	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid exiting through the second outlet of the flow diverter. The temperature at the second outlet is set to the inlet temperature for all cases.					
4	Flow rate at outlet 2	Flow Rate	kg/hr	real	[-Inf;+Inf]	0
	The flow rate of fluid exiting the flow diverter through the second outlet. The flow rate through the second outlet is: mdot,2 = mdot,in * Y (See manual for further information on equation)					

4.6.3. Flow Mixer

4.6.3.1. Moist Air

Icon		TRNSYS Model	Type 11
Proforma	Hydronics\Flow Mixer\Moist Air\Type11c.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Controlled flow mixer mode	Dimensionless	-	integer	[8;8]	8
	This parameter indicates to the general model that a controlled flow mixer mixing moist air streams is to be modeled. Do not change this parameter.					

INPUTS

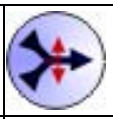
	Name	Dimension	Unit	Type	Range	Default
1	Temperature at inlet 1	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the moist air entering the first inlet of the controlled flow mixer.					
2	Humidity ratio at inlet 1	Dimensionless	-	real	[0.0;0.5]	0.006
	The absolute humidity ratio of the moist air entering the first inlet of the controlled flow mixer. The absolute humidity ratio is defined as: w = kg's H20/kg of dry air					
3	Flow rate at inlet 1	Flow Rate	kg/hr	real	[0.0;+Inf]	100.0
	The flow rate of moist air entering the first inlet of the controlled flow mixer.					
4	Temperature at inlet 2	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the moist air entering the controlled flow mixer at the second inlet.					
5	Humidity ratio at inlet 2	Dimensionless	-	real	[0.0;0.5]	0.006
	The absolute humidity ratio of the moist air entering the second inlet of the controlled flow mixer. The absolute humidity ratio is defined as: w = kg's H20/kg of dry air					
6	Flow rate at inlet 2	Flow Rate	kg/hr	real	[0.0;+Inf]	100.0
	The flow rate of moist air entering the second inlet of the controlled flow mixer.					
7	Control signal	Dimensionless	-	real	[0.0;1.0]	0.5
	The control signal for the controlled flow mixer. The controlled flow mixer uses the control signal to proportion the amount of flow from each of the inlets. mdot,out = mdot,in,1 * (1-Y) + mdot,in,2 * Y (See manual for further information on equation)					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Outlet temperature	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the moist air leaving the controlled flow mixer. The temperature is computed by: Tout = (Tin,1*min,1*(1-Y)+Tin,2*min,2*Y)/(min,1*(1-Y)+min,2*Y) (See manual for further information on equation)					
2	Outlet humidity ratio	Dimensionless	-	real	[-Inf;+Inf]	0
	The absolute humidity ratio of the moist air exiting the controlled flow mixer. The humidity ratio is calculated by:					

	Wout = (Win,1*min,1*(1-Y)+Win,2*min,2*Y)/(min,1*(1-Y)+min,2*Y) (See manual for further information on equation)					
3	Outlet flow rate	Flow Rate	kg/hr	real	[-Inf;+Inf]	0
	The flow rate of moist air leaving the controlled flow mixer. The flow rate is calculated by: mout = min,1*(1-Y) + min,2*(Y) (See manual for further information on equation)					

4.6.3.2. Other Fluids

Icon		TRNSYS Model	Type 11
Proforma	Hydronics\Flow Mixer\Other Fluids\Type11d.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Controlled flow mixer mode	Dimensionless	-	integer	[3;3]	3
	This parameter indicates to the general model that a controlled flow mixer is to be modeled. Do not change this parameter.					

INPUTS

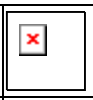
	Name	Dimension	Unit	Type	Range	Default
1	Temperature at inlet 1	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the fluid entering the first inlet of the controlled flow mixer.					
2	Flow rate at inlet 1	Flow Rate	kg/hr	real	[0.0;+Inf]	100.0
	The flow rate of fluid entering the first inlet of the controlled flow mixer.					
3	Temperature at inlet 2	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the fluid entering the controlled flow mixer at the second inlet.					
4	Flow rate at inlet 2	Flow Rate	kg/hr	real	[0.0;+Inf]	100.0
	The flow rate of fluid entering the second inlet of the controlled flow mixer.					
5	Control signal	Dimensionless	-	real	[0.0;1.0]	0.5
	The control signal for the controlled flow mixer. The controlled flow mixer uses the control signal to proportion the amount of flow from each of the inlets. mdot,out = mdot,in,1 * (1 - Y) + mdot,in,2 * Y (See manual for further information on equation)					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Outlet temperature	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid leaving the controlled flow mixer. The temperature is computed by: Tout = (Tin,1*min,1*(1-Y)+Tin,2*min,2*Y)/(min,1*(1-Y)+min,2*Y) (See manual for further information on equation)					
2	Outlet flow rate	Flow Rate	kg/hr	real	[-Inf;+Inf]	0
	The flow rate of fluid leaving the controlled flow mixer. The flow rate is calculated by: mout = min,1*(1-Y) + min,2*(Y) (See manual for further information on equation)					

4.6.4. Pipe_Duct

4.6.4.1. Pipe_Duct

Icon		TRNSYS Model	Type 31
Proforma	Hydronics\Pipe_Duct\Type31.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Inside diameter	Length	m	real	[0.0;+Inf]	0.2
	The inside diameter of the pipe. If a square duct is to be modeled, this parameter should be set to an equivalent diameter which gives the same surface area.					
2	Pipe length	Length	m	real	[0.0;+Inf]	1.0
	The length of the pipe to be considered.					
3	Loss coefficient	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[0.0;+Inf]	3.0
	The heat transfer coefficient for thermal losses to the environment based on the inside pipe surface area.					
4	Fluid density	Density	kg/m^3	real	[0.0;+Inf]	1000.0
	The density of the fluid in the pipe/duct.					
5	Fluid specific heat	Specific Heat	kJ/kg.K	real	[0.0;+Inf]	4.190
	The specific heat of the fluid in the pipe/duct.					
6	Initial fluid temperature	Temperature	C	real	[-Inf;+Inf]	10.0
	The temperature of the fluid in the pipe at the beginning of the simulation.					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Inlet temperature	Temperature	C	real	[-Inf;+Inf]	10.0
	The temperature of the fluid flowing into the pipe/duct.					
2	Inlet flow rate	Flow Rate	kg/hr	real	[0.0;+Inf]	100.0
	The flow rate of fluid entering the pipe/duct.					
3	Environment temperature	Temperature	C	real	[-Inf;+Inf]	10.0
	The temperature of the environment in which the pipe/duct is located.					

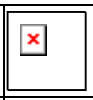
OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Outlet temperature	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid exiting the pipe/duct.					
2	Outlet flow rate	Flow Rate	kg/hr	real	[-Inf;+Inf]	0
	The flow rate of fluid exiting the pipe/duct.					
3	Environment losses	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is lost to the environment from the pipe/duct.					
4	Energy to pipe/duct	Power	kJ/hr	real	[-Inf;+Inf]	0
	The net rate at which energy is transferred to the pipe by the flow stream.					
5	Change in internal energy	Energy	kJ	real	[-Inf;+Inf]	0
	The change in internal energy of the pipe/duct since the beginning of the simulation. This output should not be					

	integrated as it is an energy term and not an energy rate term.					
6	Average temperature	Temperature	C	real	[-Inf;+Inf]	0
	The average temperature of the fluid in the pipe/duct over the timestep.					

4.6.5. Pressure Relief Valve

4.6.5.1. Pressure Relief Valve

Icon		TRNSYS Model	Type 13
Proforma	Hydronics\Pressure Relief Valve\Type13.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Boiling point of fluid	Temperature	C	real	[0;+Inf]	100.0
	The boiling temperature of the fluid.					
2	Specific heat of fluid	Specific Heat	kJ/kg.K	real	[0;+Inf]	4.19
	The specific heat of the fluid.					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Inlet fluid temperature	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the fluid entering either the pipe (pipe relief valve) or the tank (tank relief valve).					
2	Inlet flow rate	Flow Rate	kg/hr	real	[0;+Inf]	100.0
	The flow rate of fluid entering the pipe (pipe relief valve) or the tank (tank relief valve).					
3	Comparison temperature	Temperature	C	real	[-Inf;+Inf]	20.0
	If a pipe relief valve is to be modeled, set this input the same as the inlet temperature input. In this way, the relief valve will discard energy when the entering fluid reaches the boiling temperature. If instead a tank relief valve is to be modeled, set this input to the top segment of the storage tank. In this manner, boiling fluid is allowed to enter the tank and energy will only be discarded when the top of the tank begins to boil.					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Outlet temperature	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid in question. If Tcomp > Tboil and Tin > Tboil then: Tout = Tboil Else Tout = Tin (See manual for further information on equation)					
2	Outlet flow rate	Flow Rate	kg/hr	real	[-Inf;+Inf]	0
	The exiting flow rate of fluid. In this model the loss of mass due to venting is assumed negligible. Therefore the outlet flow rate is always set equal to the inlet flow rate.					
3	Rate of energy 'discarded'	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate of energy which is discarded to keep the fluid at the boiling point. Qboil = mdot * Cp * (Tin - Tboil) (See manual for further information on equation)					

4.6.6. Pumps

4.6.6.1. Single Speed

Icon		TRNSYS Model	Type 114
Proforma	Hydronics\Pumps\Single Speed\Type114.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Rated flow rate	Flow Rate	kg/hr	real	[0.0;+Inf]	100.0
	The flow rate of fluid through the pump when operating.					
2	Fluid specific heat	Specific Heat	kJ/kg.K	real	[0.;+Inf]	0
	The specific heat of the fluid flowing through the device.					
3	Rated power	Power	kJ/hr	real	[0.0;+Inf]	1000.0
	The pump power consumption during operation.					
4	Motor heat loss fraction	Dimensionless	-	real	[0.;1.0]	0
	The fraction of the motor heat loss transferred to the fluid stream. The motor heat loss is calculated by subtracting the efficiency of the motor from 1 and multiplying the resultant quantity by the power consumption. Typical values for this parameter are 0 for motors mounted outside the fluid stream and 1 for motors mounted within the fluid stream.					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Inlet fluid temperature	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the fluid entering the device					
2	Inlet fluid flow rate	Flow Rate	kg/hr	real	[0.0;+Inf]	100.0
	The flow rate of fluid entering the device. This input is not used by this component except for convergence checking.					
3	Control signal	Dimensionless	-	real	[0.0;1.0]	1.0
	The input control signal to the pump: = 0.5 - the pump is ON					
4	Overall pump efficiency	Dimensionless	-	real	[0.;1.]	0
	The overall efficiency of the pump. The overall pump efficiency includes the inefficiencies due to the motor and shaft friction. The overall pump efficiency must be less than the motor efficiency. The lower the efficiency the greater the amount of power consumed and the greater the heat transfer to the fluid and/or ambient.					
5	Motor efficiency	Dimensionless	-	real	[0.;1.]	0
	The efficiency of the pump motor. The motor efficiency must be greater than the overall pump efficiency. The lower the motor efficiency the greater the amount of power consumed and the greater the heat transfer to the fluid and/or ambient.					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Outlet fluid temperature	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid exiting the device.					
2	Outlet flow rate	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	The flow rate of fluid exiting the device.					

3	Power consumption	Power	kJ/hr	real	[-Inf;+Inf]	0
	The power consumed by the pump.					
4	Fluid heat transfer	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which heat is transferred to the fluid by the pump operation.					
5	Environment heat transfer	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which heat is transferred from the pump to the environment. This value is simply the pump power minus the heat transfer directly to the fluid.					

4.6.6.2. Single Speed

Icon		TRNSYS Model	Type 3
Proforma	Hydronics\Pumps\Single Speed\Type3b.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Maximum flow rate	Flow Rate	kg/hr	real	[0.0;+Inf]	100.0
	The maximum flow rate through the pump. The outlet flow rate is simply the maximum flow rate (this parameter) multiplied by the inlet control signal (Input 3).					
2	Fluid specific heat	Specific Heat	kJ/kg.K	real	[0.0;+Inf]	4.190
	The specific heat of the fluid flowing through the pump. The specific heat is used to determine the temperture rise of the fluid through the pump using the following relation: Tout = Tin + (f*Power)/(mdot Cp) (See manual for further information on equation)					
3	Maximum power	Power	kJ/hr	real	[0.0;+Inf]	1000.0
	The maximum pump power consumption. The actual pump power will be the maximum pump power multiplied by a function of the input control signal. See the abstract for more details on calculated pump power.					
4	Conversion coefficient	Dimensionless	-	real	[0.0;1.0]	0.10
	The fraction of pump power that is converted to fluid thermal energy. Tout = Tin + (f * Power)/(mdot * Cp) (See manual for further information on equation)					
5	Power coefficient	Dimensionless	-	real	[-Inf;+Inf]	0.5
	Power coefficient: To specify a non-linear relationship between pump power and fluid flow rate, the user must enter the coefficients of the polynomial: Power = Pmax * (co + c1*gamma + c2*gamma^2 + c3*gamma^3 + ci*gamma^i) (See manual for further information on equation)					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
5-5		How many coefficients in the polynomial relating pump power to fluid flow rate?	1	20

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Inlet fluid temperature	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the fluid entering the pump.					
2	Inlet mass flow rate	Flow Rate	kg/hr	real	[0.0;+Inf]	100.0
	The flow rate of the fluid entering the pump. This input is not used by this component except for convergence checking. The outlet flow rate depends on the maximum flow rate and the input control signal. This input is just for visualization purposes.					
3	Control signal	Dimensionless	-	real	[0.0;1.0]	1.0
	The input control signal to the pump. The flow rate and power are calculated from knowledge of this input: mout = mmax * gamma Power = f(Pmax,gamma) (See manual for further information on equation)					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Outlet fluid temperature	Temperature	C	real	[-Inf;+Inf]	0
	The outlet fluid temperature from the pump. Tout = Tin + (f*Power)/(mdot*Cp) (See manual for further information on equation)					
2	Outlet flow rate	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	The outlet fluid flowrate. The outlet flow rate is calculated by: mout = mmax * gamma (See manual for further information on equation)					
3	Power consumption	Power	kJ/hr	real	[0.0;+Inf]	0
	The power consumed by the pump. The pump power is calculated from either a linear relationshipwith flow rate or by a polynomial expression relating pump power to control signal, depending on the parameters supplied by the user.					

4.6.6.3. Single Speed - No Powercoefficients

Icon		TRNSYS Model	Type 3
Proforma	Hydronics\Pumps\Single Speed - No Powercoefficients\Type3d.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Maximum flow rate	Flow Rate	kg/hr	real	[0.0;+Inf]	100.0
	The maximum flow rate through the pump. The outlet flow rate is simply the maximum flow rate (this parameter) multiplied by the inlet control signal (Input 3).					
2	Fluid specific heat	Specific Heat	kJ/kg.K	real	[0.0;+Inf]	4.190
	The specific heat of the fluid flowing through the pump. The specific heat is used to determine the temperture rise of the fluid through the pump using the following relation: Tout = Tin + (f*Power)/(mdot Cp) (See manual for further information on equation)					
3	Maximum power	Power	kJ/hr	real	[0.0;+Inf]	1000.0
	The maximum pump power consumption. The actual pump power will be the maximum pump power multiplied by a function of the input control signal. See the abstract for more details on calculated pump power.					
4	Conversion coefficient	Dimensionless	-	real	[0.0;1.0]	0.10
	The fraction of pump power that is converted to fluid thermal energy. Tout = Tin + (f * Power)/(mdot * Cp) (See manual for further information on equation)					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Inlet fluid temperature	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the fluid entering the pump.					
2	Inlet mass flow rate	Flow Rate	kg/hr	real	[0.0;+Inf]	100.0
	The flow rate of the fluid entering the pump. This input is not used by this component except for convergence checking. The outlet flow rate depends on the maximum flow rate and the input control signal. This input is just for visualization purposes.					
3	Control signal	Dimensionless	-	real	[0.0;1.0]	1.0
	The input control signal to the pump. The flow rate and power are calculated from knowledge of this input: mout = mmax * gamma Power = f(Pmax,gamma) (See manual for further information on equation)					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Outlet fluid temperature	Temperature	C	real	[-Inf;+Inf]	0
	The outlet fluid temperature from the pump. Tout = Tin + (f*Power)/(mdot*Cp) (See manual for further information on equation)					
2	Outlet flow rate	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	The outlet fluid flowrate. The outlet flow rate is calculated by: mout = mmax * gamma (See manual for further information on equation)					
3	Power consumption	Power	kJ/hr	real	[0.0;+Inf]	0
	The power consumed by the pump. The pump power is calculated from either a linear relationshipwith flow rate					

	or by a polynomial expression relating pump power to control signal, depending on the parameters supplied by the user.

4.6.6.4. Variable Speed

Icon		TRNSYS Model	Type 110
Proforma	Hydronics\Pumps\Variable Speed\Type110.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Rated flow rate	Flow Rate	kg/hr	real	[0.0;+Inf]	100.0
	The flow rate of fluid through the pump when operating.					
2	Fluid specific heat	Specific Heat	kJ/kg.K	real	[0.;+Inf]	0
	The specific heat of the fluid flowing through the device.					
3	Rated power	Power	kJ/hr	real	[0.0;+Inf]	1000.0
	The pump power consumption during operation.					
4	Motor heat loss fraction	Dimensionless	-	real	[0.;1.0]	0
	The fraction of the motor heat loss transferred to the fluid stream. The motor heat loss is calculated by subtracting the efficiency of the motor from 1 and multiplying the resultant quantity by the power consumption. Typical values for this parameter are 0 for motors mounted outside the fluid stream and 1 for motors mounted within the fluid stream.					
5	Number of power coefficients	Dimensionless	-	real	[1;25]	0
	The number of polynomial multipliers that will be supplied relating the normalized pump power to the normalized pump flow rate (input control signal).					
6	Power coefficient	Power	kJ/hr	real	[-Inf;+Inf]	0
	The value of the polynomial multiplier for the relationship between normalized pump power and normalized pump flow rate (input control signal).					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
6-6	Number of power coefficients		1	100

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Inlet fluid temperature	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the fluid entering the device					
2	Inlet fluid flow rate	Flow Rate	kg/hr	real	[0.0;+Inf]	100.0
	The flow rate of fluid entering the device. This input is not used by this component except for convergence checking.					
3	Control signal	Dimensionless	-	real	[0.0;1.0]	1.0
	The input control signal to the pump: = 0.5 - the pump is ON					
4	Total pump efficiency	Dimensionless	-	real	[0.;1.]	0
	The overall efficiency of the pump. The overall pump efficiency includes the inefficiencies due to the motor and shaft friction. The overall pump efficiency must be less than the motor efficiency. The lower the efficiency the greater the amount of power consumed and the greater the heat transfer to the fluid and/or ambient.					
5	Motor efficiency	Dimensionless	-	real	[0.;1.]	0
	The efficiency of the pump motor. The motor efficiency must be greater than the overall pump efficiency. The lower the motor efficiency the greater the amount of power consumed and the greater the heat transfer to the fluid and/or ambient.					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Outlet fluid temperature	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid exiting the device.					
2	Outlet flow rate	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	The flow rate of fluid exiting the device.					
3	Power consumption	Power	kJ/hr	real	[-Inf;+Inf]	0
	The power consumed by the pump.					
4	Fluid heat transfer	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which heat is transferred to the fluid by the pump operation.					
5	Environment heat transfer	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which heat is transferred from the pump to the environment. This value is simply the pump power minus the heat transfer directly to the fluid.					

4.6.7. Tee-Piece

4.6.7.1. Moist Air

Icon		TRNSYS Model	Type 11
Proforma	Hydronics\Tee-Piece\Moist Air\Type11g.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Tee piece mode	Dimensionless	-	integer	[6;6]	6
	This parameter indicates to the general model that a tee piece mixing moist air is to be modeled. Do not change this parameter.					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Temperature at inlet 1	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the moist air entering the first inlet of the tee piece.					
2	Humidity ratio at inlet 1	Dimensionless	-	real	[0.0;0.5]	0.006
	The absolute humidity ratio of the air entering the first inlet of the tee piece. The absolute humidity ratio is defined as: w = kg's H20/kg of dry air					
3	Flow rate at inlet 1	Flow Rate	kg/hr	real	[0.0;+Inf]	100.0
	The flow rate of moist air entering the first inlet of the tee piece.					
4	Temperature at inlet 2	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the moist air entering the tee piece at the second inlet.					
5	Humidity ratio at inlet 2	Dimensionless	-	real	[0.0;0.5]	0.006
	The absolute humidity ratio of the moist air entering the second inlet of the tee piece. The absolute humidity ratio is defined as: w = kg's H20/kg of dry air					
6	Flow rate at inlet 2	Flow Rate	kg/hr	real	[0.0;+Inf]	100.0
	The flow rate of moist air entering the second inlet of the tee piece.					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Outlet temperature	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the moist air leaving the tee piece. Under no flow conditions, the temperature at the outlet will be set to the minimum temperature of the two inlet streams. For this reason, control decisions should not be based on this output.					
2	Outlet humidity ratio	Dimensionless	-	real	[-Inf;+Inf]	0
	The absolute humidity ratio of the moist air exiting the tee piece. Under no flow conditions, the outlet humidity ratio will be set to the humidity ratio of the fluid with the lowest temperature. For this reason, control decisions should not be based on this output.					
3	Outlet flow rate	Flow Rate	kg/hr	real	[-Inf;+Inf]	0
	The flow rate of moist air leaving the tee piece.					

4.6.7.2. Other Fluids

Icon		TRNSYS Model	Type 11
Proforma	Hydronics\Tee-Piece\Other Fluids\Type11h.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Tee piece mode	Dimensionless	-	integer	[1;1]	1
	This parameter indicates to the general model that a simple tee piece is to be modeled. Do not change this parameter.					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Temperature at inlet 1	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the fluid entering the first inlet of the tee piece.					
2	Flow rate at inlet 1	Flow Rate	kg/hr	real	[0.0;+Inf]	100.0
	The flow rate of fluid entering the first inlet of the tee piece.					
3	Temperature at inlet 2	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the fluid entering the tee piece at the second inlet.					
4	Flow rate at inlet 2	Flow Rate	kg/hr	real	[0.0;+Inf]	100.0
	The flow rate of fluid entering the second inlet of the tee piece.					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Outlet temperature	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the mixed fluid leaving the tee piece. If the tee piece is under no flow conditions, the outlet temperature will be set to the minimum of the two inlet temperatures. For this reason, control decisions should not be based on this outlet temperature.					
2	Outlet flow rate	Flow Rate	kg/hr	real	[-Inf;+Inf]	0
	The flow rate of mixed fluid leaving the tee piece.					

4.6.8. Tempering Valve

4.6.8.1. Moist Air

Icon		TRNSYS Model	Type 11
Proforma	Hydronics\Tempering Valve\Moist Air\Type11a.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Tempering valve mode	Dimensionless	-	integer	[9;10]	9
	This parameter indicates to the general model that a tempering valve is to be modeled. If this parameter is set to 9, the entire flow stream will be sent through the first outlet if the inlet temperature is less than the heat source temperature. If this parameter is set to 10, the entire flow stream will instead be sent through the second outlet if the inlet temperature is less than the heat source temperature.					
2	Nb. of oscillations allowed	Dimensionless	-	integer	[1;+Inf]	7
	To promote simulation convergence, the internal control signal, which is calculated by a ratio of fluid temperatures, will stay constant after this set number of control oscillations has been reached.					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Inlet temperature	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the moist air entering the inlet of the tempering valve. In most cases, this input is connected to the temperature of the moist air used to cool the flow of the hot storage air flow stream down to the set point.					
2	Inlet humidity ratio	Dimensionless	-	real	[0.0;0.5]	0.006
	The absolute humidity ratio of the moist air entering the inlet of the tempering valve. The absolute humidity ratio is defined as: w = kg's of H20/kg of dry air					
3	Inlet flow rate	Flow Rate	kg/hr	real	[0.0;+Inf]	100.0
	The flow rate of moist air entering the inlet of the tempering valve.					
4	Heat source temperature	Temperature	C	real	[-Inf;+Inf]	55.0
	The temperature of the moist air exiting the heat source that is to be cooled by the addition of air from the tempering valve component. This temperature is used to determine how much of the moist air entering the tempering valve will be sent to the heat source and how much of the moist air will be diverted to mix with the air exiting the heat source.					
5	Set point temperature	Temperature	C	real	[-Inf;+Inf]	0
	The temperature below which the heat source air stream is to be kept at all times. The heat source air stream temperature will be kept at the set point temperature (if possible) by the diversion of air from the inlet of the heat source to a mixing component at the exit of the heat source.					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Temperature at outlet 1	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the moist air exiting through the first outlet of the tempering valve. The first outlet temperature is set to the inlet temperature for all cases. This output is typically hooked up to the temperature of the inlet air stream to the heat source.					
2	Humidity ratio at outlet 1	Dimensionless	-	real	[-Inf;+Inf]	0
	The absolute humidity ratio of the air exiting through the first outlet of the tempering valve. The outlet humidity					

	ratio is set to the inlet humidity ratio for all cases.					
3	Flowrate at outlet 1	Flow Rate	kg/hr	real	[-Inf;+Inf]	0
	The flow rate of moist air leaving the first outlet of the tempering valve. This flow rate is typically hooked up to the inlet flow rate of the heat source. The first outlet flowrate is: mdot,1 = mdot,in * Y (See manual for further information on equation)					
4	Temperature at outlet 2	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the moist air exiting through the second outlet of the tempering valve. The temperature at the second outlet is set to the inlet temperature for all cases. In most cases, this temperature is hooked up to a mixing valve component mixing the air from the 2nd outlet of this component and the heat source exiting air stream.					
5	Humidity ratio at outlet 2	Dimensionless	-	real	[-Inf;+Inf]	0
	The humidity ratio of the air exiting the tempering valve through the second outlet. The outlet humidity ratio is set to the inlet humidity ratio for all cases.					
6	Flowrate at outlet 2	Flow Rate	kg/hr	real	[-Inf;+Inf]	0
	The flow rate of moist air exiting the tempering valve through the second outlet. This flow rate is commonly hooked up to the inlet flow rate of a mixing valve component mixing the air from the heat source with the air from the second outlet of this tempering valve. The flowrate through the second outlet is: mdot,2 = mdot,in * (1 - Y) (See manual for further information on equation)					
7	Control function	Dimensionless	-	real	[-Inf;+Inf]	0
	The calculated fraction of air exiting through the first outlet of the tempering valve. The fraction is defined as: Y = mdot,1 / mdot,in (See manual for further information on equation)					

4.6.8.2. Other Fluids

Icon		TRNSYS Model	Type 11
Proforma	Hydronics\Tempering Valve\Other Fluids\Type11b.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Tempering valve mode	Dimensionless	-	integer	[4;5]	4
	This parameter indicates to the general model that a tempering valve is to be modeled. If this parameter is set to 4, the entire flow stream will be sent through the first outlet if the inlet temperature is less than the heat source temperature. If this parameter is set to 5, the entire flow stream will instead be sent through the second outlet if the inlet temperature is less than the heat source temperature.					
2	Nb. of oscillations allowed	Dimensionless	-	integer	[1;+Inf]	7
	To promote simulation convergence, the internal control signal, which is calculated by a ratio of fluid temperatures, will stay constant after this set number of control oscillations has been reached.					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Inlet temperature	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the fluid entering the inlet of the tempering valve. In most cases, this input is connected to the temperature of the fluid used to cool the flow of hot storage fluid down to the set point (which is typically the inlet temperature to the heat source).					
2	Inlet flow rate	Flow Rate	kg/hr	real	[0.0;+Inf]	100.0
	The flow rate of fluid entering the inlet of the tempering valve.					
3	Heat source temperature	Temperature	C	real	[-Inf;+Inf]	55.0
	The temperature of the fluid exiting the heat source that is to be cooled by the addition of fluid from the tempering valve component. This temperature is used to determine how much of the fluid entering the tempering valve will be sent to the heat source and how much of the fluid will be diverted to mix with the fluid exiting the heat source.					
4	Set point temperature	Temperature	C	real	[-Inf;+Inf]	0
	The temperature below which the heat source flow stream is to be kept at all times. The heat source flow stream temperature will be kept at or below the set point temperature (if possible) by the diversion of cooler fluid from the inlet of the heat source to a mixing component at the exit of the heat source.					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Temperature at outlet 1	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid exiting through the first outlet of the tempering valve. The first outlet temperature is set to the inlet temperature for all cases. This output is typically hooked up to the temperature of the inlet flow stream to the heat source.					
2	Flowrate at outlet 1	Flow Rate	kg/hr	real	[-Inf;+Inf]	0
	The flow rate of fluid leaving the first outlet of the tempering valve. This flow rate is typically hooked up to the inlet flow rate of the heat source. The first outlet flowrate is: mdot,1 = mdot,in * Y (See manual for further information on equation)					
3	Temperature at outlet 2	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid exiting through the second outlet of the flow diverter. The temperature at the second outlet is set to the inlet temperature for all cases. In most cases, this temperature is hooked up to a mixing valve component mixing the flow from the 2nd outlet of this component and the heat source exiting flow stream.					

4	Flow rate at outlet 2	Flow Rate	kg/hr	real	[-Inf;+Inf]	0
	The flow rate of fluid exiting the tempering valve through the second outlet. This flow rate is typically hooked up to an inlet flow rate of a mixing valve component mixing this flow stream and the flow stream of exiting heat source fluid. The flow rate from the second outlet is calculated by: mdot,2 = (1-Y) * mdot,in (See manual for further information on equation)					
5	Control function	Dimensionless	-	real	[-Inf;+Inf]	0
	The calculated fraction of fluid exiting through the first outlet of the tempering valve. The fraction is defined as: Y = mdot,1 / mdot,in (See manual for further information on equation)					

4.7. Loads and Structures

4.7.1. Attached Sunspace

4.7.1.1. Additional Thermal Mass

Icon		**TRNSYS Model**	Type 37
Proforma	Loads and Structures\Attached Sunspace\Additional Thermal Mass\Type37a.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Wall height	Length	m	real	[0.0;+Inf]	3.0
	The vertical distance between the floor and the intersection of the upper glazing with the back wall of the sunspace.					
2	Wall thickness	Length	m	real	[0.0;+Inf]	0.4
	The thickness of the back wall of the attached sunspace.					
3	Length of floor	Length	m	real	[0.0;+Inf]	5.0
	The horizontal distance between the back wall and the intersection of the lower glazing with the floor of the sunspace.					
4	Floor thickness	Length	m	real	[0.0;+Inf]	0.2
	The thickness of the floor of the attached sunspace.					
5	Width of sunspace	Length	m	real	[0.0;+Inf]	5.0
	The width of the attached sunspace.					
6	Lower glazing projection	Length	m	real	[0.0;+Inf]	2.5
	The horizontal distance from the intersection of the lower glazing and the floor to the intersection of the upper and lower glazings.					
7	Glazing intersection height	Length	m	real	[0.0;+Inf]	2.0
	The vertical distance between the floor and the intersection of the upper and lower glazings.					
8	Number of wall nodes	Dimensionless	-	integer	[2;+Inf]	4
	The number of nodes that the wall will be divided into for the finite difference scheme used to solve the wall heat transfer.					
9	Number of floor nodes	Dimensionless	-	integer	[2;+Inf]	4
	The number of nodes that the floor of the sunspace will be divided into for the finite difference scheme used to solve the floor heat transfer.					
10	Wall thermal conductivity	Thermal Conductivity	kJ/hr.m.K	real	[0.0;+Inf]	2.0
	The effective thermal conductivity of the back wall of the attached sunspace.					
11	Floor thermal conductivity	Thermal Conductivity	kJ/hr.m.K	real	[0.0;+Inf]	2.0
	The effective thermal conductivity of the floor of the sunspace.					
12	Wall specific capacitance	any	any	real	[0.0;+Inf]	1000.0
	The density - specific heat product of the back wall of the attached sunspace.					
13	Floor specific capacitance	any	any	real	[0.0;+Inf]	2000.0
	The density - specific heat product of the material comprising the floor of the sunspace.					

14	Wall solar absorptance	Dimensionless	-	real	[0.0;1.0]	0.7
	The solar absorptance of the back wall of the attached sunspace. The absorptance is defined as the ratio of the radiation absorbed by a surface to the total incident radiation upon the surface and therefore, must be between 0 and 1.					
15	Wall emittance	Dimensionless	-	real	[0.0;1.0]	0.7
	The infrared emittance of the back wall of the sunspace. The emittance is defined as the ratio of the radiation emitted by the surface to the radiation emitted by a blackbody (the perfect emitter) at the same temperature. The emittance must be between 0 and 1 by definition.					
16	Floor solar absorptance	Dimensionless	-	real	[0.0;1.0]	0.5
	The absorptance of the floor material to solar radiation. The absorptance is defined as the ratio of the radiation absorbed by a surface to the total radiation incident upon the surface and therefore, must be between 0 and 1.					
17	Floor emittance	Dimensionless	-	real	[0.0;1.0]	0.3
	The infrared emittance of the floor of the sunspace. The emittance is defined as the ratio of the radiation emitted by the surface to the radiation emitted by a blackbody (the perfect emitter)at the same temperature. By definition, the emittance must be between 0 and 1.					
18	Number of glazings	Dimensionless	-	integer	[1;+Inf]	2
	The number of identical glazings that make up either the upper or lower glazing surfaces.					
19	Glazing emittance	Dimensionless	-	real	[0.0;1.0]	0.2
	The infrared emittance of one of the identical glazings comprising the upper or lower glazed surfaces. The emittance is defined as the ratio of the radiation emitted by a surface to the radiation emitted by a blackbody (the perfect emitter) at the same temperature. By definition, the emittance must be between 0 and 1.					
20	Extinction	Dimensionless	-	real	[0.0;1.0]	0.0026
	The product of the extinction coefficient and the thickness for one of the idntical glazings comprising either the upper or lower glazed surfaces (KL product).					
21	Refractive index	Dimensionless	-	real	[0.0;+Inf]	1.526
	The index of refraction of one of the identical glazings comprising either the upper or lower glazed surfaces.					
22	R-value of glazing	Dimensionless	-	real	[0.0;+Inf]	0.5
	The R-value of the upper or lower glazing not including the effects of convection at the inside or outside surfaces. The R-value of a material is the inverse of the overall heat transfer coefficient of the material (R = 1/U).					
23	R-value of night insulation	Dimensionless	-	real	[0.0;+Inf]	1.0
	The R-value of the night insulation material not including convection at the inside and outside surfaces. The R-value of a material is simply the inverse of the overall heat transfer coefficient (R = 1/U).					
24	R-value of floor insulation	Dimensionless	-	real	[0.0;+Inf]	1.5
	The R-value of the insulation located between the floor of the sunspace and the ground. The R-value of a material is simply the inverse of the overall heat transfer coefficient of the material (R = 1/U).					
25	Infiltration (ACH)	Dimensionless	-	real	[0.0;+Inf]	0.75
	The infiltration of the sunspace expressed in the number of air changes per hour. 1 airchange per hour implies that in one hours time, the entire volume of air will have been replaced by air at ambient conditions.					
26	Opaque fraction	Dimensionless	-	real	[0.0;1.0]	0.15
	The fraction of the glazing surface that is considered to be opaque to solar radiation.					
27	Initial temperature	Temperature	C	real	[-Inf;+Inf]	15.0
	The temperature of the wall and floor nodes at the beginning of the simulation.					
28	R-value of ground	Dimensionless	-	real	[0.0;+Inf]	0.4
	The effective R-value of the ground. The R-value of a material is simply the inverse of the overall heat transfer coefficient of a surface (R = 1/U).					
29	Height of additional mass	Length	m	real	[0.0;+Inf]	0.5
	The average height of the additional thermal mass to be considered in the sunspace.					
30	Width of additional mass	Length	m	real	[0.0;+Inf]	1.5
	The average width of the additional thermal mass to be considered in the sunspace.					

31	Capacitance of additional mass	Thermal Capacitance	kJ/K	real	[0.0;+Inf]	250.0
	The thermal capacitnace of the additional mass to be considered in the attached sunspace.					
32	Surface area of additional mass	Area	m^2	real	[0.0;+Inf]	5.0
	The surface area of the additional thermal mass considered in the attached sunspace.					
33	Absorptance of additional mass	Dimensionless	-	real	[0.0;1.0]	0.9
	The absorptance of the additional thermal mass considered in the attached sunspace to solar radiation. The absorptance is defined to be the ratio of the amount of radiation absorbed by a surface to the total radiation incident upon the surface and therefore, must be between 0 and 1.					
34	Emittance of additional mass	Dimensionless	-	real	[0.0;1.0]	0.8
	The infrared emittance of the the additional thermal mass considered in the attached sunspace. The emittance is defined to be the ratio of the radiation emitted by a surface to the radiation emitted by a blackbody (the perfect emitter) at the same temperature. By definition, the emittance must be between 0 and 1.					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Venting control function	Dimensionless	-	real	[-1.0;+1.0]	0.0
	The control function for ventilation of the sunspace: -1 ---> Vent the sunspace air to the attached room 0 ---> No ventilation 1 --->Vent the sunspace air to the ambient					
2	Night insulation control	Dimensionless	-	real	[0.0;1.0]	0.0
	The control function for the glazing night insulation: 0 ---> Night insulation not in place 1 ---> Night insulation in place					
3	Ground temperature	Temperature	C	real	[-Inf;+Inf]	5.0
	The temperature of the ground beneath the floor of the sunspace.					
4	Ambient temperature	Temperature	C	real	[-Inf;+Inf]	0.0
	The temperature of the ambient air.					
5	Room temperature	Temperature	C	real	[-Inf;+Inf]	22.0
	The temperature of the room on the far side of the back wall of the attached sunspace.					
6	Glazing to ambient convection coeff.	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[0.0;+Inf]	25.0
	The convection coefficient between the outer glazing and the ambient.					
7	Wall to room convection coeff.	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[0.0;+Inf]	11.0
	The convection coefficient between the far side of the back wall of the sunspace and the room on the far side of the back wall of the sunspace.					
8	Floor to sunspace convection coeff.	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[0.0;+Inf]	8.0
	The convection coefficient between the sunspace air and the floor of the sunspace.					
9	Wall to sunspace convection coeff.	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[0.0;+Inf]	11.0
	The convection coefficient between the back wall of the sunspace and the sunspace air.					
10	Glass to sunspace convection coeff.	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[0.0;+Inf]	13.0
	The convection coefficient between the inner surfaces of the upper and lower glazings to the sunspace air.					
11	Beam on upper glazing	Flux	kJ/hr.m^2	real	[0.0;+Inf]	0.0
	The beam radiation incident on the upper glazing of the sunspace per unit area.					
12	Diffuse on upper glazing	Flux	kJ/hr.m^2	real	[0.0;+Inf]	0.0
	The diffuse solar radiation incident upon the upper glazing of the sunspace per unit area.					

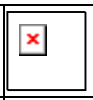
13	Beam on lower glazing	Flux	kJ/hr.m^2	real	[0.0;+Inf]	0.0
	The beam solar radiation incident upon the lower glazing of the sunspace per unit area.					
14	Diffuse on lower glazing	Flux	kJ/hr.m^2	real	[0.0;+Inf]	0.0
	The diffuse solar radiation incident upon the lower glazing of the sunspace per unit area.					
15	Upper glazing incidence angle	Direction (Angle)	degrees	real	[0.0;90.0]	10.0
	The angle of incidence of the beam radiation upon the upper glazing of the sunspace.					
16	Lower glazing incidence angle	Direction (Angle)	degrees	real	[0.0;90.0]	10.0
	The angle of incidence of beam radiation upon the lower glazing of the sunpace.					
17	Solar zenith angle	Direction (Angle)	degrees	real	[0.0;90.0]	10.0
	The solar zenith angle is defined as the angle between the vertical and the line of sight of the sun.					
18	Solar azimuth angle	Direction (Angle)	degrees	real	[-360.0;360.0]	0.0
	The solar azimuth angle is defined as the angle between the local meridian and the projection of the line of sight of the sun onto the horizontal plane. Zero is facing the equator, west is positve (90), while east is negative (-90).					
19	Ventilation flow rate	Flow Rate	kg/hr	real	[0.0;+Inf]	0.0
	The flow rate of ventilation air to the sunspace.					
20	Auxiliary to sunspace	Power	kJ/hr	real	[-Inf;+Inf]	0.0
	The rate at which auxiliary energy is added to the sunspace.					
21	Mass to sunspace convection coeff.	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[0.0;+Inf]	6.0
	The convection coefficient between the additional thermal mass in the sunspace and the air in the sunspace.					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Sunspace temperature	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the air in the sunspace.					
2	Flow rate of ventialtion air	Flow Rate	kg/hr	real	[-Inf;+Inf]	0
	The flow rate at which ventilation air exits the sunspace.					
3	Inside glazing temperature	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the inner surface of the glazings of the sunspace.					
4	Inside wall temperature	Temperature	C	real	[-Inf;+Inf]	0
	The temperature at the inside surface of the back wall of the sunspace.					
5	Inside floor temperature	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the upper surface of the floor.					
6	Heat transfer to room	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is transferred to the attached room from the sunspace; includes both conduction and ventilation.					
7	Conduction to room	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is transferred across the wall separating the room and the sunspace.					
8	Environment losses	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is lost to the environment from the sunspace; includes window conduction and ventilation.					
9	Conduction losses through glazing	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is conducted through the glazings to the environment.					
10	Ground losses	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is transferred from the sunspace through the floor to the ground.					
11	Solar transmitted to room	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which solar energy is passed through the glazings of the sunspace.					

12	Solar absorption rate	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which solar radiation is absorbed by the walls, floor, and the additional mass if present.					
13	Rate of internal energy change	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate of change of the internal energy of the sunspace. The rate of change of the internal energy is a rate quantity and should be integrated if an energy balance is to be performed.					

4.7.1.2. No Additional Thermal Mass

Icon		TRNSYS Model	Type 37
Proforma	Loads and Structures\Attached Sunspace\No Additional Thermal Mass\Type37b.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Wall height	Length	m	real	[0.0;+Inf]	3.0
	The vertical distance between the floor and the intersection of the upper glazing with the back wall of the sunspace.					
2	Wall thickness	Length	m	real	[0.0;+Inf]	0.4
	The thickness of the back wall of the attached sunspace.					
3	Length of floor	Length	m	real	[0.0;+Inf]	5.0
	The horizontal distance between the back wall and the intersection of the lower glazing with the floor of the sunspace.					
4	Floor thickness	Length	m	real	[0.0;+Inf]	0.2
	The thickness of the floor of the attached sunspace.					
5	Width of sunspace	Length	m	real	[0.0;+Inf]	5.0
	The width of the attached sunspace.					
6	Lower glazing projection	Length	m	real	[0.0;+Inf]	2.5
	The horizontal distance from the intersection of the lower glazing and the floor to the intersection of the upper and lower glazings.					
7	Glazing intersection height	Length	m	real	[0.0;+Inf]	2.0
	The vertical distance between the floor and the intersection of the upper and lower glazings.					
8	Number of wall nodes	Dimensionless	-	integer	[2;+Inf]	4
	The number of nodes that the wall will be divided into for the finite difference scheme used to solve the wall heat transfer.					
9	Number of floor nodes	Dimensionless	-	integer	[2;+Inf]	4
	The number of nodes that the floor of the sunspace will be divided into for the finite difference scheme used to solve the floor heat transfer.					
10	Wall thermal conductivity	Thermal Conductivity	kJ/hr.m.K	real	[0.0;+Inf]	2.0
	The effective thermal conductivity of the back wall of the attached sunspace.					
11	Floor thermal conductivity	Thermal Conductivity	kJ/hr.m.K	real	[0.0;+Inf]	2.0
	The effective thermal conductivity of the floor of the sunspace.					
12	Wall specific capacitance	any	any	real	[0.0;+Inf]	1000.0
	The density - specific heat product of the back wall of the attached sunspace.					
13	Floor specific capacitance	any	any	real	[0.0;+Inf]	2000.0
	The density - specific heat product of the material comprising the floor of the sunspace.					
14	Wall solar absorptance	Dimensionless	-	real	[0.0;1.0]	0.7
	The solar absorptance of the back wall of the attached sunspace. The absorptance is defined as the ratio of the radiation absorbed by a surface to the total incident radiation upon the surface and therefore, must be between 0 and 1.					
15	Wall emittance	Dimensionless	-	real	[0.0;1.0]	0.7
	The infrared emittance of the back wall of the sunspace. The emittance is defined as the ratio of the radiation emitted by the surface to the radiation emitted by a blackbody (the perfect emitter) at the same temperature. The emittance must be between 0 and 1 by definition.					
16	Floor solar absorptance	Dimensionless	-	real	[0.0;1.0]	0.5

	The absorptance of the floor material to solar radiation. The absorptance is defined as the ratio of the radiation absorbed by a surface to the total radiation incident upon the surface and therefore, must be between 0 and 1.					
17	Floor emittance	Dimensionless	-	real	[0.0;1.0]	0.3
	The infrared emittance of the floor of the sunspace. The emittance is defined as the ratio of the radiation emitted by the surface to the radiation emitted by a blackbody (the perfect emitter)at the same temperature. By definition, the emittance must be between 0 and 1.					
18	Number of glazings	Dimensionless	-	integer	[1;+Inf]	2
	The number of identical glazings that make up either the upper or lower glazing surfaces.					
19	Glazing emittance	Dimensionless	-	real	[0.0;1.0]	0.2
	The infrared emittance of one of the identical glazings comprising the upper or lower glazed surfaces. The emittance is defined as the ratio of the radiation emitted by a surface to the radiation emitted by a blackbody (the perfect emitter) at the same temperature. By definition, the emittance must be between 0 and 1.					
20	Extinction	Dimensionless	-	real	[0.0;1.0]	0.0026
	The product of the extinction coefficient and the thickness for one of the idntical glazings comprising either the upper or lower glazed surfaces (KL product).					
21	Refractive index	Dimensionless	-	real	[0.0;+Inf]	1.526
	The index of refraction of one of the identical glazings comprising either the upper or lower glazed surfaces.					
22	R-value of glazing	Dimensionless	-	real	[0.0;+Inf]	0.5
	The R-value of the upper or lower glazing not including the effects of convection at the inside or outside surfaces. The R-value of a material is the inverse of the overall heat transfer coefficient of the material (R = 1/U).					
23	R-value of night insulation	Dimensionless	-	real	[0.0;+Inf]	1.0
	The R-value of the night insulation material not including convection at the inside and outside surfaces. The R-value of a material is simply the inverse of the overall heat transfer coefficient (R = 1/U).					
24	R-value of floor insulation	Dimensionless	-	real	[0.0;+Inf]	1.5
	The R-value of the insulation located between the floor of the sunspace and the ground. The R-value of a material is simply the inverse of the overall heat transfer coefficient of the material (R = 1/U).					
25	Infiltration (ACH)	Dimensionless	-	real	[0.0;+Inf]	0.75
	The infiltration of the sunspace expressed in the number of air changes per hour. 1 airchange per hour implies that in one hours time, the entire volume of air will have been replaced by air at ambient conditions.					
26	Opaque fraction	Dimensionless	-	real	[0.0;1.0]	0.15
	The fraction of the glazing surface that is considered to be opaque to solar radiation.					
27	Initial temperature	Temperature	C	real	[-Inf;+Inf]	15.0
	The temperature of the wall and floor nodes at the beginning of the simulation.					
28	R-value of ground	Dimensionless	-	real	[0.0;+Inf]	0.4
	The effective R-value of the ground. The R-value of a material is simply the inverse of the overall heat transfer coefficient of a surface (R = 1/U).					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Venting control function	Dimensionless	-	real	[-1.0;+1.0]	0.0
	The control function for ventilation of the sunspace: -1 ---> Vent the sunspace air to the attached room 0 ---> No ventilation 1 --->Vent the sunspace air to the ambient					
2	Night insulation control	Dimensionless	-	real	[0.0;1.0]	0.0
	The control function for the glazing night insulation: 0 ---> Night insulation not in place 1 ---> Night insulation in place					
3	Ground temperature	Temperature	C	real	[-Inf;+Inf]	5.0

	The temperature of the ground beneath the floor of the sunspace.					
4	Ambient temperature	Temperature	C	real	[-Inf;+Inf]	0.0
	The temperature of the ambient air.					
5	Room temperature	Temperature	C	real	[-Inf;+Inf]	22.0
	The temperature of the room on the far side of the back wall of the attached sunspace.					
6	Glazing to ambient convection coeff.	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[0.0;+Inf]	25.0
	The convection coefficient between the outer glazing and the ambient.					
7	Wall to room convection coeff.	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[0.0;+Inf]	11.0
	The convection coefficient between the far side of the back wall of the sunspace and the room on the far side of the back wall of the sunspace.					
8	Floor to sunspace convection coeff.	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[0.0;+Inf]	8.0
	The convection coefficient between the sunspace air and the floor of the sunspace.					
9	Wall to sunspace convection coeff.	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[0.0;+Inf]	11.0
	The convection coefficient between the back wall of the sunspace and the sunspace air.					
10	Glass to sunspace convection coeff.	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[0.0;+Inf]	13.0
	The convection coefficient between the inner surfaces of the upper and lower glazings to the sunspace air.					
11	Beam on upper glazing	Flux	kJ/hr.m^2	real	[0.0;+Inf]	0.0
	The beam radiation incident on the upper glazing of the sunspace per unit area.					
12	Diffuse on upper glazing	Flux	kJ/hr.m^2	real	[0.0;+Inf]	0.0
	The diffuse solar radiation incident upon the upper glazing of the sunspace per unit area.					
13	Beam on lower glazing	Flux	kJ/hr.m^2	real	[0.0;+Inf]	0.0
	The beam solar radiation incident upon the lower glazing of the sunspace per unit area.					
14	Diffuse on lower glazing	Flux	kJ/hr.m^2	real	[0.0;+Inf]	0.0
	The diffuse solar radiation incident upon the lower glazing of the sunspace per unit area.					
15	Upper glazing incidence angle	Direction (Angle)	degrees	real	[0.0;90.0]	10.0
	The angle of incidence of the beam radiation upon the upper glazing of the sunspace.					
16	Lower glazing incidence angle	Direction (Angle)	degrees	real	[0.0;90.0]	10.0
	The angle of incidence of beam radiation upon the lower glazing of the sunpace.					
17	Solar zenith angle	Direction (Angle)	degrees	real	[0.0;90.0]	10.0
	The solar zenith angle is defined as the angle between the vertical and the line of sight of the sun.					
18	Solar azimuth angle	Direction (Angle)	degrees	real	[-360.0;360.0]	0.0
	The solar azimuth angle is defined as the angle between the local meridian and the projection of the line of sight of the sun onto the horizontal plane. Zero is facing the equator, west is positve (90), while east is negative (-90).					
19	Ventilation flow rate	Flow Rate	kg/hr	real	[0.0;+Inf]	0.0
	The flow rate of ventilation air to the sunspace.					
20	Auxiliary to sunspace	Power	kJ/hr	real	[-Inf;+Inf]	0.0
	The rate at which auxiliary energy is added to the sunspace.					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Sunspace temperature	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the air in the sunspace.					
2	Flow rate of ventialtion air	Flow Rate	kg/hr	real	[-Inf;+Inf]	0

	The flow rate at which ventilation air exits the sunspace.					
3	Inside glazing temperature	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the inner surface of the glazings of the sunspace.					
4	Inside wall temperature	Temperature	C	real	[-Inf;+Inf]	0
	The temperature at the inside surface of the back wall of the sunspace.					
5	Inside floor temperature	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the upper surface of the floor.					
6	Heat transfer to room	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is transferred to the attached room from the sunspace; includes both conduction and ventilation.					
7	Conduction to room	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is transferred across the wall separating the room and the sunspace.					
8	Environment losses	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is lost to the environment from the sunspace; includes window conduction and ventilation.					
9	Conduction losses through glazing	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is conducted through the glazings to the environment.					
10	Ground losses	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is transferred from the sunspace through the floor to the ground.					
11	Solar transmitted to room	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which solar energy is passed through the glazings of the sunspace.					
12	Solar absorption rate	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which solar radiation is absorbed by the walls, floor, and the additional mass if present.					
13	Rate of internal energy change	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate of change of the internal energy of the sunspace. The rate of change of the internal energy is a rate quantity and should be integrated if an energy balance is to be performed.					

4.7.2. Multi-Zone Building

4.7.2.1. With Standard Output Files

Icon		TRNSYS Model	Type 56
Proforma	Loads and Structures\Multi-Zone Building\With Standard Output Files\Type56a.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Logical unit for building description file (.bui)	Dimensionless	-	integer	[30;999]	0
	The logical unit through which the building description file will be read. Each external file that TRNSYS reads from or writes to must be assigned a unique logical unit number in the TRNSYS input file. The building description file is created by the PREBID program and typically has a .BLD extension.					
2	Star network calculation switch	Dimensionless	-	integer	[0;1]	0
	This parameter indicates whether the star network calculations should be performed only at the beginning of the simulation (=0) or at every timestep (=1). For most simulations, the star network can be calculated just at the beginning of the simulation. However, if the convective heat transfer coefficient at the inside surface of any of the walls in the building is variable (not a constant value), this parameter should be set to 1.					
3	Weighting factor for operative temperature	Dimensionless	-	real	[0.0;1.0]	0
	The weighting factor for the operative room temperature. The operative room temperature is a function of both the air and surface temperatures in the zone: Top = Aop*Tair + (1-Aop)*Tsurf (See manual for further information on equation) This temperature is used most often in room comfort analysis simulations.					
4	Logical unit for monthly summary	Dimensionless	-	integer	[30;999]	0
5	Logical unit for hourly temperatures	Dimensionless	-	integer	[30;999]	0
6	Logical unit for hourly loads	Dimensionless	-	integer	[30;999]	0

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Inputs - to update attach files in "External Files" tab	any	any	real	[-Inf;+Inf]	0.0
	The specified input which is described in the building information file (.INF extension typically).					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Outputs - to update attach files in "External Files" tab	any	any	real	[-Inf;+Inf]	0
	The specified output which is described in the building information file (.INF extension typically).					

EXTERNAL FILES

Question	File	Associated parameter
Building description file (*.bui)		Logical unit for building description file (.bui)
Monthly Summary File	Bldg-Monthly.out	Logical unit for monthly summary
Hourly Temperatures	Bldg-HourlyTemp.out	Logical unit for hourly temperatures
Hourly Loads	Bldg-HourlyLoads.out	Logical unit for hourly loads
Source file	.\SourceCode\Type56\OpenSource\Open_TYPE56.for	

4.7.2.2. Without Standard Output Files

Icon		TRNSYS Model	Type 56
Proforma	Loads and Structures\Multi-Zone Building\Without Standard Output Files\Type56b.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Logical unit for building description file (.bui)	Dimensionless	-	integer	[30;999]	0
	The logical unit through which the building description file will be read. Each external file that TRNSYS reads from or writes to must be assigned a unique logical unit number in the TRNSYS input file. The building description file is created by the PREBID program and typically has a .BLD extension.					
2	Star network calculation switch	Dimensionless	-	integer	[0;1]	0
	This parameter indicates whether the star network calculations should be performed only at the beginning of the simulation (=0) or at every timestep (=1). For most simulations, the star network can be calculated just at the beginning of the simulation. However, if the convective heat transfer coefficient at the inside surface of any of the walls in the building is variable (not a constant value), this parameter should be set to 1.					
3	Weighting factor for operative temperature	Dimensionless	-	real	[0.0;1.0]	0
	The weighting factor for the operative room temperature. The operative room temperature is a function of both the air and surface temperatures in the zone: Top = Aop*Tair + (1-Aop)*Tsurf (See manual for further information on equation) This temperature is used most often in room comfort analysis simulations.					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Inputs - to update attach files in "External Files" tab	any	any	real	[-Inf;+Inf]	0.0
	The specified input which is described in the building information file (.INF extension typically).					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Outputs - to update attach files in "External Files" tab	any	any	real	[-Inf;+Inf]	0
	The specified output which is described in the building information file (.INF extension typically).					

EXTERNAL FILES

Question	File	Associated parameter
Building description file (*.bui)		Logical unit for building description file (.bui)
Source file	.\SourceCode\Type56\OpenSource\Open_TYPE56.for	

4.7.3. Overhang and Wingwall Shading

4.7.3.1. Overhang and Wingwall Shading

Icon		TRNSYS Model	Type 34
Proforma	Loads and Structures\Overhang and Wingwall Shading\Type34.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Upstream component mode	Dimensionless	-	boolean	[0;1]	0
	This parameter tells Type 34 whether or not the view factor to the sky has already been taken into account in the diffuse radiation, which depends on the component to which input 4 is connected 0: Radiation comes from Type 16 (radiation processor) or Type 109 (combined data reader and radiation processor), view factor has not been taken into account 1: Radiation comes from Type 68 (mask), view factor has already been taken into account Technical explanation: The difference is in the view factor of the sky behind the window. Type34 assumes a vertical orientation for the window. In doing that, it knows that a window with no overhangs or projections can only see half the sky so the sky view factor that it calculates is: ShadedVF = 0.5 - OverhangEffects - WingwallEffects Type68 allows for the window to be sloped and calculates its sky view factor accordingly. If the window is vertical and there are no obstructions in front of the window, then its calculated view factor is 0.5 and the radiation that has been passed through Type68 will already be cut down accordingly. If you then want to include the effect of an overhang using Type34, you have already accounted for the 0.5 in the ShadedVF equation above, so you need to use instead: ShadedVF = 1.0 - OverhangEffects - WingwallEffects so that you don't account for the fraction of the sky that is behind the window twice.					
2	Receiver height	Length	m	real	[0.0;+Inf]	1.5
	The height of the receiver.					
3	Receiver width	Length	m	real	[0.0;+Inf]	1.0
	The width of the receiver.					
4	Overhang projection	Length	m	real	[0.0;+Inf]	1.0
	The length of the overhead projection; measured in the plane of the overhead projection. Refer to Figure 4.8.4.1 for more details.					
5	Overhang gap	Length	m	real	[0.0;+Inf]	0.5
	The distance between the top of the receiver and the intersection of the overhang with the plane containing the receiver.					
6	Overhang left extension	Length	m	real	[0.0;+Inf]	0.5
	The horizontal distance between the left edge of the receiver and theleft edge of the overhang.					
7	Overhang right extension	Length	m	real	[0.0;+Inf]	0.5
	The horizontal distance between the right edge of the receiver and theright edge of the overhang.					
8	Left wingwall projection	Length	m	real	[0.0;+Inf]	1.0
	The length of the left wingwall projection; measured in the plane ofthe left wingwall.					
9	Left wingwall gap	Length	m	real	[0.0;+Inf]	0.5
	The horizontal distance between the left edge of the receiver and thestart of the left wingwall.					
10	Left wingwall top extension	Length	m	real	[0.0;+Inf]	0.5
	The vertical distance between the top of the receiver and the topof the wingwall.					

11	Left wingwall bottom extension	Length	m	real	[0.0;+Inf]	0.5
	The vertical distance between the bottom of the receiver and the bottom of the left wingwall.					
12	Right wingwall projection	Length	m	real	[0.0;+Inf]	1.0
	The length of the right wingwall; measured in the plane of the wingwall.					
13	Right wingwall gap	Length	m	real	[0.0;+Inf]	0.5
	The horizontal distance between the right side of the receiver and the beginning of the right wingwall.					
14	Right wingwall top extension	Length	m	real	[0.0;+Inf]	0.5
	The vertical distance between the top of the receiver and the top ofthe right wingwall.					
15	Right wingwall bottom extension	Length	m	real	[0.0;+Inf]	0.5
	The vertical distance between the bottom of the receiver and thebottom of the right wingwall.					
16	Receiver azimuth	Direction (Angle)	degrees	real	[-360;+360]	0.0
	The surface azimuth of the receiver. The azimuth is defined as the angle between the local meridian and the projection of the line ofsight of the surface. Zero is facing the equator, west is positve (90)and east is negative (-90).					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Solar zenith angle	Direction (Angle)	degrees	real	[0.0;90.0]	45.0
	The solar zenith angle is the angle between the vertical and theprojection of the line of sight of the sun.					
2	Solar azimuth angle	Direction (Angle)	degrees	real	[-360;360.0]	0.0
	The solar azimuth angle is the angle between the local meridian andthe projection of the line of sight of the sun onto the horizontal plane.					
3	Total horizontal radiation	Flux	kJ/hr.m^2	real	[0.0;+Inf]	0.0
	The total radiation (beam + sky difuse + ground reflected diffuse)incident upon a horizontal surface per unit area.					
4	Horizontal diffuse radiation	Flux	kJ/hr.m^2	real	[0.0;+Inf]	0.0
	The diffuse radiation incident upon a horizontal surface per unitarea.					
5	Beam radiation on surface	Flux	kJ/hr.m^2	real	[0.0;+Inf]	0.0
	The beam radiation per unit area incident upon the receiver surface.					
6	Ground reflectance	dimensionless	-	real	[0.0;1.0]	0.2
	The reflectance of the ground above which the receiver is positioned.The reflectance is a ratio of the radiation reflected to the totalradiation incident upon a surface and therefore must be between 0and 1. Typical values are 0.2 for ground not covered by snow, and 0.7for snow-covered ground.					
7	Incidence angle of direct radiation	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
	Incidence angle of direct radiation on the receiver surface					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Incident receiver radiation	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The average total solar radiation (beam + sky diffuse + ground reflected diffuse) incident on the shaded receiver per unit area.					
2	Beam radiation on receiver	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The average beam radiation incident upon the receiver per unit area.					
3	Sky diffuse on receiver	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The average sky diffuse radiation incident upon the shaded receiver per unit area.					
4	Ground reflected diffuse	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The average ground reflected diffuse radiation incident upon theshaded receiver per unit area.					

5	Direct beam fraction	dimensionless	-	real	[-Inf;+Inf]	0
	The fraction of the receiver surface which is irradiated by directbeam radiation.					
6	View factor to sky	dimensionless	-	real	[-Inf;+Inf]	0
	The view factor from the receiver surface to the sky.					
7	View factor to ground	dimensionless	-	real	[-Inf;+Inf]	0
	The view factor from the receiver to the ground.					
8	View factor to overhang	dimensionless	-	real	[-Inf;+Inf]	0
	The view factor from the receiver surface to the overhang.					
9	View factor to left wingwall	dimensionless	-	real	[-Inf;+Inf]	0
	The view factor from the receiver to the left wingwall.					
10	View factor to right wingwall	dimensionless	-	real	[-Inf;+Inf]	0
	The view factor from the receiver surface to the right wingwall.					
11	Fraction of solar shading	Dimensionless	-	real	[0;1]	0
	This is the fraction of solar shading. This number, in the [0;1] range, is computed as:FSS = 1 - (Shaded radiation / Total radiation)Its value is 0 for a non-shaded surface, 1 for a completely shaded surface.This output can be used as "external shading factor" in Type56 to approximate shading effects on a window.					
12	Angle of incidence	Direction (Angle)	degrees	real	[-Inf;+Inf]	0

4.7.4. Pitched Roof and Attic

4.7.4.1. Pitched Roof and Attic

Icon		TRNSYS Model	Type 18
Proforma	Loads and Structures\Pitched Roof and Attic\Type18.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Collector on roof?	Dimensionless	-	integer	[-1;1]	1
	Is there a solar collector on the surface of the roof facing south? -1 --> there is not a collector on the south facing roof 1 --> there is a collector on the south facing roof If there is not a collector on the roof surface, users should set the loss coefficient from the back and edge of the collector to 0.0 (Par. 11) and the collector outlet temperature to a constant (Input 7).					
2	Ceiling insulation	Dimensionless	-	integer	[1;4]	3
	The pitched roof and attic model assumes that there is a 2""x12"" joist system between the room and the attic. This parameter is used to inform the model how much insulation is between the joists (refer to Figure 4.8.2.1 of section 4.8.2 of Volume 1 of the TRNSYS documentation set for more details). 1 = 3 inches of ceiling insulation 2 = 6 inches of ceiling insulation 3 = 9 inches of ceiling insulation 4 = 12 inches of ceiling insulation					
3	Absorptance of roof	Dimensionless	-	real	[0.0;1.0]	0.7
	The absorptance of the roof surfaces not covered by the solar collector. The absorptance is defined as the ratio of absorbed radiation to total incident radiation and therefore must be between 0 and 1.					
4	Emittance of roof surface	Dimensionless	-	real	[0.0;1.0]	0.9
	The emittance of the roof surface not covered by the solar collector. The emittance is defined as the ratio of emitted radiation from the surface to the radiation emitted by a black body (the perfect emitter) at the same temperature.					
5	Area of south surface	Area	m^2	real	[0.0;+Inf]	10.0
	The area of the south-facing roof surface.					
6	Area of east surface	Area	m^2	real	[0.0;+Inf]	10.0
	The area of the east-facing roof surface.					
7	Area of north surface	Area	m^2	real	[0.0;+Inf]	10.0
	The area of the north-facing roof surface.					
8	Area of west surface	Area	m^2	real	[0.0;+Inf]	10.0
	The area of the west-facing roof surface.					
9	Ceiling area	Area	m^2	real	[0.0;+Inf]	25.0
	The area of the ceiling separating the room from the attic.					
10	Attic infiltration rate	Volumetric Flow Rate	m^3/hr	real	[0.0;+Inf]	1.0
	The rate of infiltration of ambient air into the attic space.					
11	Collector back and edge loss coeff.	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[0.0;+Inf]	0.0
	The thermal loss coefficient of the back and edges of the solar collector. The back and edge losses from the collector are assumed to be transmitted to the roof surface. If there is not a collector on the roof surface, set this parameter to 0.0.					

12	Slope of south surface	Direction (Angle)	degrees	real	[0.0;90.0]	30.0
	The slope of the south surface measured from horizontal. 0 = horizontal surface ; 90 = vertical south facing surface					
13	Slope of north surface	Direction (Angle)	degrees	real	[0.0;90.0]	30.0
	The slope of the north roof surface measured from the horizontal. 0 = horizontal ; 90 = vertical facing north					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Ambient temperature	Temperature	C	real	[-Inf;+Inf]	10.0
	The temperature of the ambient air.					
2	Total solar on south surface	Flux	kJ/hr.m^2	real	[0.0;+Inf]	0.0
	The rate of total solar radiation per unit area incident upon the south roof surface. This input is typically hooked up to the radiation processor component.					
3	Total solar on east surface	Flux	kJ/hr.m^2	real	[0.0;+Inf]	0.0
	The rate of total solar radiation per unit area incident upon the east roof surface. This input is typically hooked to the radiation processor component.					
4	Total solar on north surface	Flux	kJ/hr.m^2	real	[0.0;+Inf]	0.0
	The rate of total solar radiation per unit area incident upon the north roof surface. This input is typically hooked to the radiation processor component.					
5	Total solar on west surface	Flux	kJ/hr.m^2	real	[0.0;+Inf]	0.0
	The rate of total solar radiation per unit area incident upon the west roof surface. This input is typically hooked to the radiation processor component.					
6	Wind speed	Velocity	m/s	real	[0.0;+Inf]	2.0
	The speed of the wind flowing over the roof surface.					
7	Collector outlet temperature	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid leaving the solar collector on the roof surface. If there is not a collector on the roof surface, set this input to a constant value.					
8	Room temperature	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the room above which the attic is located. This input can be hooked up to a zone model output or assumed to be a constant.					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Ceiling heat transfer rate	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which heat is transferred from the room to the attic space.					
2	Effective sol-air temperature	Temperature	C	real	[-Inf;+Inf]	0
	The effective sol-air temperature of the roof surfaces and infiltration air. The effective sol-air temperature is calculated as a function of the sol-air temperature of the various roof surfaces and the infiltration rate and is used to drive the heat flux equation.					

4.7.5. Single Zone Models

4.7.5.1. Detailed Single Zone (Type19) - Additional Outputs (Optional) - Energy Rate Control

Icon		**TRNSYS Model**	Type -19
Proforma	Loads and Structures\Single Zone Models\Detailed Single Zone (Type19)\Additional Outputs (Optional)\Energy Rate Control\Outs19-E.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Number of additional outputs	Dimensionless	-	integer	[1;10]	1
	How many additional outputs are desired for the TYPE 19 Single Zone Model? For each desired surface output, the surface number and type of desired output must be supplied by the user.					
2	Type of additional output	Dimensionless	-	integer	[1;5]	1
	The type of additional output that is desired. The available output types are: 1 = Inside surface temperature (C) 2 = Equivalent inside room temperature (the temperature which in the absence of radiative exchange would give the same heat transfer as actually occurs) (C) 3 = Absorbed radiative gains by the surface from solar, lights, people (kJ/hr/m2) 4 = Energy convected to room from surface (kJ/hr) 5 = Radiative gains to surface due to infrared exchange with all other surfaces (kJ/hr)					
3	Surface number for additional output	Dimensionless	-	integer	[1;15]	1
	The surface number associated with the desired additional output.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
2-3	Number of additional outputs		1	50

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Zone temperature	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the zone in question. (Repeated for convenience)					
2	Zone humidity ratio	Dimensionless	-	real	[-Inf;+Inf]	0
	The absolute humidity ratio of the zone in question. The absolute humidity ratio is defined as the ratio of the mass of water in a volume of air to the mass of the air (kg's H2O / kg of dry air). (Repeated for convenience)					
3	Convection gains	Power	kJ/hr	real	[-Inf;+Inf]	0
	The energy gain to the zone due to convection from all surfaces that define the zone. (Repeated for convenience)					
4	People gains	Power	kJ/hr	real	[-Inf;+Inf]	0
	The sensible energy gain to the zone due to convection from people inside the zone. The gain due to people is calculated from knowledge of the number of people in the zone and their associated activity level. (Repeated for convenience)					
5	Infiltration gains	Power	kJ/hr	real	[-Inf;+Inf]	0
	The sensible energy gains to the zone due to infiltration from the environment. The sensible energy gains are calculated from the zone temperature, the ambient temperature and knowledge of the infiltration rate. (Repeated for convenience)					

6	Ventilation gains	Power	kJ/hr	real	[-Inf;+Inf]	0
	The sensible energy gains to the zone due to the ventilation air stream. The ventilation energy gain is calculated from the zone temperature, the ventilation supply temperature, and the ventilation flow rate. (Repeated for convenience)					
7	Sensible load	Power	kJ/hr	real	[-Inf;+Inf]	0
	The sensible load on the zone. The sensible load is defined as the energy required by auxiliary heating or cooling equipment in order to keep the zone temperature within the comfort zone. Cooling is positive while heating is negative. (Repeated for convenience)					
8	Latent load	Power	kJ/hr	real	[-Inf;+Inf]	0
	The latent load on the zone. The latent load is defined as the energy required to keep the humidity level within the comfort region. Dehumidification is a positive latent load, while humidification is a negative latent load. (Repeated for convenience)					
9	Maximum cooling load	Power	kJ/hr	real	[-Inf;+Inf]	0
	The maximum cooling load on the zone during the timestep. (Repeated for convenience)					
10	Maximum heating load	Power	kJ/hr	real	[-Inf;+Inf]	0
	The maximum heating load for the zone during the timestep. (Repeated for convenience)					
11	Additional output	any	any	real	[-Inf;+Inf]	0
	The specified additional output. Care should be taken when using the additional outputs as the magnitude and unit of the output are NOT carried with the output, making input-output checking impossible for these outputs.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
11-11	Number of additional outputs		1	50

4.7.5.2. Detailed Single Zone (Type19) - Additional Outputs (Optional) - Temperature Level Control

Icon		TRNSYS Model	Type -19
Proforma	Loads and Structures\Single Zone Models\Detailed Single Zone (Type19)\Additional Outputs (Optional)\Temperature Level Control\Outs19-T.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Number of additional outputs	Dimensionless	-	integer	[1;10]	1
	How many additional outputs are desired for the TYPE 19 Single Zone Model? For each desired surface output, the surface number and type of desired output must be supplied by the user.					
2	Type of additional output	Dimensionless	-	integer	[1;5]	1
	The type of additional output that is desired. The available output types are: 1 = Inside surface temperature (C) 2 = Equivalent inside room temperature (the temperature which in the absence of radiative exchange would give the same heat transfer as actually occurs) (C) 3 = Absorbed radiative gains by the surface from solar, lights, people (kJ/hr/m2) 4 = Energy convected to room from surface (kJ/hr) 5 = Radiative gains to surface due to infrared exchange with all other surfaces (kJ/hr)					
3	Surface number for additional output	Dimensionless	-	integer	[1;15]	1
	The surface number associated with the desired additional output.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
2-3	Number of additional outputs		1	50

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Zone temperature	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the zone in question. (Repeated for convenience)					
2	Zone humidity ratio	Dimensionless	-	real	[-Inf;+Inf]	0
	The absolute humidity ratio of the zone in question. The absolute humidity ratio is defined as the ratio of the mass of water in a volume of air to the mass of the air (kg's H2O / kg of dry air). (Repeated for convenience)					
3	Convection gains	Power	kJ/hr	real	[-Inf;+Inf]	0
	The energy gain to the zone due to convection from all surfaces that define the zone. (Repeated for convenience)					
4	People gains	Power	kJ/hr	real	[-Inf;+Inf]	0
	The sensible energy gain to the zone due to convection from people inside the zone. The gain due to people is calculated from knowledge of the number of people in the zone and their associated activity level. (Repeated for convenience)					
5	Infiltration gains	Power	kJ/hr	real	[-Inf;+Inf]	0
	The sensible energy gains to the zone due to infiltration from the environment. The sensible energy gains are calculated from the zone temperature, the ambient temperature and knowledge of the infiltration rate. (Repeated for convenience)					
6	Ventilation gains	Power	kJ/hr	real	[-Inf;+Inf]	0
	The sensible energy gains to the zone due to the ventilation air stream. The ventilation energy gain is calculated from the zone temperature, the ventilation supply temperature, and the ventilation flow rate. (Repeated for convenience)					

7	Not Used (sensible load)	Dimensionless	-	real	[-Inf;+Inf]	0
	This output is not used in temperature level control.					
8	Not Used (latent load)	Dimensionless	-	real	[-Inf;+Inf]	0
	This output is not used in temperature level control.					
9	Not Used (cooling load)	Dimensionless	-	real	[-Inf;+Inf]	0
	This output is not used in temperature level control.					
10	Not Used (heating load)	Dimensionless	-	real	[-Inf;+Inf]	0
	This output is not used in temperature level control.					
11	Additional output	any	any	real	[-Inf;+Inf]	0
	The specified additional output. Care should be taken when using the additional outputs as the magnitude and unit of the output are NOT carried with the output, making input-output checking impossible for these outputs.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
11-11	Number of additional outputs		1	50

4.7.5.3. Detailed Single Zone (Type19) - Geometry Modes (Choose 1) - Area Ratio Method

Icon		**TRNSYS Model**	Type -19
Proforma	Loads and Structures\Single Zone Models\Detailed Single Zone (Type19)\Geometry Modes (Choose 1)\Area Ratio Method\Geom0.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Geometry mode	Dimensionless	-	integer	[0;0]	0
	This parameter specifies to the general single zone model that the view factors will be determined using area ratios. Although this is not a correct procedure (and is not recommended), it may be adequate when the inside surfaces are close in temperature and infrared energy exchange is not significant. Do not change this parameter.					

4.7.5.4. Detailed Single Zone (Type19) - Geometry Modes (Choose 1) - Rectangular Parallelpiped Method

Icon		**TRNSYS Model**	Type -19
Proforma	Loads and Structures\Single Zone Models\Detailed Single Zone (Type19)\Geometry Modes (Choose 1)\Rectangular Parallelpiped Method\Geom1.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Geometry mode	Dimensionless	-	integer	[1;1]	1
	This parameter specifies to the general single zone model that the view factors for the walls of the zone will be determined using the geometry of a parallelpiped. Additional parameters are required when using this mode to specify the location of window and door surfaces on a wall. Do not change this parameter.					
2	Height of enclosure	Length	m	real	[0.0;+Inf]	3.0
	The height of the walls in the enclosure (zone). (See manual for further information.)					
3	Width of enclosure	Length	m	real	[0.0;+Inf]	10.0
	The width of the enclosure (zone). (See manual for further information.)					
4	Length of enclosure	Length	m	real	[0.0;+Inf]	10.0
	The length of the enclosure (zone). (See manual for further information.)					
5	Wall surface number for IW1	Dimensionless	-	integer	[1;15]	1
	The surface number of the vertical wall associated with IW1 in the figure below. This wall should have dimensions of height x width. (See manual for further information.)					
6	Wall surface number for IW2	Dimensionless	-	integer	[1;15]	2
	The surface number of the vertical wall associated with IW2 in the figure below. This wall should have dimensions of height x length. (See manual for further information.)					
7	Wall surface number for IW3	Dimensionless	-	integer	[1;15]	3
	The surface number of the vertical wall associated with IW3 in the figure below. This wall should have dimensions of height x width. (See manual for further information.)					
8	Wall surface number for IW4	Dimensionless	-	integer	[1;15]	4
	The surface number of the vertical wall associated with IW4 in the figure below. This wall should have dimensions of height x length. (See manual for further information.)					
9	Surface number of floor	Dimensionless	-	integer	[1;15]	5
	The surface number of the floor. Refer to the figure below for more details. Make sure that the floor has dimensions of width x length. (See manual for further information.)					
10	Surface number of ceiling	Dimensionless	-	integer	[1;15]	6
	The surface number of the ceiling. Refer to the figure below for more details. Make sure that the ceiling has dimensions of width x length. (See manual for further information.)					
11	Number of windows,doors on walls	Dimensionless	-	integer	[0;9]	1
	The number of windows and doors that are located on wall surfaces. For each wall or window that is located on another wall surface, the height, width, and relative wall position will have to be specified.					
12	Surface number of window,door	Dimensionless	-	integer	[1;15]	7
	The surface number associated with the door or window in question.					
13	Wall surface number of window,door	Dimensionless	-	integer	[1;15]	1
	The surface number of the wall on which the specified window,door is located.					
14	Horizontal placement for window,door	Length	m	real	[0.0;+Inf]	1.0
	The horizontal distance (Xwd) from the left edge of the wall surface to the left edge of the specified window,door as viewed from inside the enclosure. (See manual for further information.)					

15	Vertical placement for window,door	Length	m	real	[0.0;+Inf]	1.0
	The horizontal distance (Ywd) from the bottom edge of the wall surface to the bottom edge of the specified window,door. (See manual for further information.)					
16	Height of window,door	Length	m	real	[0.0;+Inf]	2.0
	The height of the specified window,door. (See manual for further information.)					
17	Width of window,door	Length	m	real	[0.0;+Inf]	2.0
	The width of the specified window,door. (See manual for further information.)					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
12-17	Number of windows,doors on walls		1	50

4.7.5.5. Detailed Single Zone (Type19) - Geometry Modes (Choose 1) - User Defined View Factors

Icon		**TRNSYS Model**	Type -19
Proforma	Loads and Structures\Single Zone Models\Detailed Single Zone (Type19)\Geometry Modes (Choose 1)\User Defined View Factors\Geom2.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Geometry mode	Dimensionless	-	integer	[2;2]	2
	This parameter specifies to the general single zone model that the view factors will be entered by the user. Do not change this parameter.					
2	View factor	Dimensionless	-	real	[0.0;1.0]	0.33
	The specified surface to surface view factor. The view factor Fij is defined as the fraction of radiation leaving surface i which is intercepted by surface j. View factors for different surface geometries may be found in many heat transfer handbooks. For the TYPE 19 Single Zone Model, the view factors must be entered in a special format. For example, if a 4 surface zone is to have its view factors entered by the user, the following parameters would be required: View factor 1: F12 View factor 2: F13 View factor 3: F14 View factor 4: F23 View factor 5: F24 View factor 6: F34 In all, N*(N-1)/2 view factors are required for a zone with N surfaces.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
2-2		How many view factor will be entered? (N*(N-1)/2) (N=#Surfaces)	1	105

4.7.5.6. Detailed Single Zone (Type19) - Surfaces - Walls - Conduction Input Wall

Icon		**TRNSYS Model**	Type -19
Proforma	Loads and Structures\Single Zone Models\Detailed Single Zone (Type19)\Surfaces\Walls\Conduction Input Wall\CondWall.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Surface number	Dimensionless	-	integer	[1;15]	1
	A unique integer identifying the surface number associated with this conduction input wall. No two surfaces may have the same surface number!!					
2	Conduction wall specification	Dimensionless	-	integer	[4;4]	4
	Specifies to the general single zone model that the heat transfer rate at the inner surface of this wall will be provided as an input to this model. Do not change this parameter.					
3	Wall area	Area	m^2	real	[0.0;+Inf]	20.0
	The overall inside surface area (excluding windows and doors that are specified as separate surfaces) of this conduction input wall.					
4	Interior solar reflectance	Dimensionless	-	real	[0.0;1.0]	0.5
	The reflectance to solar radiation of the inside surface of this wall. The reflectance of a surface is defined as the ratio of the reflected solar radiation by the surface to the total incident solar radiation upon the surface and, therefore, must be between 0 and 1.					
5	Inside convection coefficient	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[0.0;+Inf]	9.5785
	The convection coefficient at the inside surface of this conduction-input wall. This convection coefficient SHOULD NOT include the radiative resistance at the inner surface. Unless some detailed information about this wall is known, the default value of 9.5785 kJ/hr.m2.K should be used!					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Heat transfer rate at inner surface	Power	kJ/hr	real	[0.0;+Inf]	0.0
	The rate at which energy is transferred into the zone at the inside surface of this conduction-input wall.					

4.7.5.7. Detailed Single Zone (Type19) - Surfaces - Walls - Exterior Walls - Standard ASHRAE Wall

Icon		TRNSYS Model	Type -19
Proforma	Loads and Structures\Single Zone Models\Detailed Single Zone (Type19)\Surfaces\Walls\Exterior Walls\Standard ASHRAE Wall\AWall.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Surface number	Dimensionless	-	integer	[1;15]	1
	A unique integer identifying the surface number associated with this specified exterior wall. No two surfaces may have the same surface number!!					
2	Exterior wall specification	Dimensionless	-	integer	[1;1]	1
	Specifies to the general single zone model that this wall interacts with the ambient conditions and is to be considered as an exterior surface. Do not change this parameter.					
3	Wall area	Area	m^2	real	[0.0;+Inf]	20.0
	The overall inside surface area (excluding windows and doors that are specified as separate surfaces) of this exterior wall.					
4	Interior solar reflectance	Dimensionless	-	real	[0.0;1.0]	0.5
	The reflectance to solar radiation of the inside surface of this exterior wall. The reflectance of a surface is defined as the ratio of the reflected solar radiation by the surface to the total incident solar radiation upon the surface and, therefore, must be between 0 and 1.					
5	Exterior solar absorptance	Dimensionless	-	real	[0.0;1.0]	0.7
	The absorptance of solar radiation of the exterior surface. The absorptance is defined as the ratio of the absorbed solar radiation by a surface to the total solar radiation incident upon the surface and, therefore, must be between 0 and 1.					
6	ASHRAE table number	Dimensionless	-	integer	[2;2]	2
	This parameter is used to inform the general model that the exterior wall description will be entered from a specific ASHRAE table. Do not change this parameter. In this case, the wall description will be chosen from either Table 4.8.3.8 or Table 4.8.3.9 of TRNSYS Volume 1.					
7	Table entry number	Dimensionless	-	integer	[1;144]	37
	The entry in either Table 4.9.3.8 or Table 4.8.3.9 of Volume 1 of the TRNSYS documentation set corresponding to the chosen exterior wall. The tables are repeated below for convenience. (See manual for further information for table on available wall descriptions for Type 19)					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Incident solar radiation	Flux	kJ/hr.m^2	real	[0.0;+Inf]	0.0
	The total (beam + sky diffuse + ground reflected diffuse) incident solar radiation upon the exterior wall per unit area.					

4.7.5.8. Detailed Single Zone (Type19) - Surfaces - Walls - Exterior Walls - User Defined Layers

Icon		**TRNSYS Model**	Type -19
Proforma	Loads and Structures\Single Zone Models\Detailed Single Zone (Type19)\Surfaces\Walls\Exterior Walls\User Defined Layers\PWall.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Surface number	Dimensionless	-	integer	[1;15]	1
	A unique integer identifying the surface number associated with this exterior wall. No two surfaces may have the same surface number!!					
2	Exterior wall specification	Dimensionless	-	integer	[1;1]	1
	Specifies to the general single zone model that this wall interacts with the ambient conditions and is to be considered as an exterior surface. Do not change this parameter.					
3	Wall area	Area	m^2	real	[0.0;+Inf]	20.0
	The overall inside surface area (excluding windows and doors that are specified as separate surfaces) of this exterior wall.					
4	Interior solar reflectance	Dimensionless	-	real	[0.0;1.0]	0.5
	The reflectance to solar radiation of the inside surface of this exterior wall. The reflectance of a surface is defined as the ratio of the reflected solar radiation by the surface to the total incident solar radiation upon the surface and, therefore, must be between 0 and 1.					
5	Exterior solar absorptance	Dimensionless	-	real	[0.0;1.0]	0.7
	The absorptance of solar radiation of the exterior surface. The absorptance is defined as the ratio of the absorbed solar radiation by a surface to the total solar radiation incident upon the surface and, therefore, must be between 0 and 1.					
6	Transfer function specification	Dimensionless	-	integer	[4;4]	4
	This parameter is used to inform the general model that the exterior wall will be described by specification of its transfer function coefficients.					
7	Inside convection coefficient	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[0.0;+Inf]	9.5785
	The inside convection coefficent for the exterior wall. This convection coefficient DOES NOT include the radiative resistance. Unless some detailed information about the surface is known, the default value should be used.					
8	Number of B coefficients	Dimensionless	-	integer	[0;15]	3
	The number of B transfer function coefficients that will be entered for this exterior wall. Refer to the output of the PREP program for a listing of the transfer function coefficients for the wall in question. The B transfer function coefficients relate the history of the sol-air temperature for this surface.					
9	Number of C coefficients	Dimensionless	-	integer	[0;15]	5
	The number of C transfer function coefficients that will be entered for this exterior wall. Refer to the output from the PREP program for a list of the transfer functions for this exterior wall. The C transfer function coefficients relate the history of the equivalent zone air temperature for this exterior wall.					
10	Number of D coefficients	Dimensionless	-	integer	[0;15]	5
	The number of D transfer function coefficients that will be entered for this exterior wall. Refer to the output of the PREP program for a listing of the transfer functions for this exterior wall. The D transfer function coefficients relate the history of the heat flux for this surface.					
11	B coefficient	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[-Inf;+Inf]	0.0
	The specified B transfer coefficient of the exterior wall. The first B-coefficient represents b0, the coefficient of the current sol-air temperature. The Nth coefficient represents b(N-1), the coefficient of the (N-1)th previous					

	hours' sol-air temperature.					
12	C coefficient	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[-Inf;+Inf]	0.0
	The specified C transfer coefficient of the exterior wall. The first C coefficient represents c0, the coefficient of the current equivalent zone air temperature. The Nth coefficient represents c(N-1), the coefficient of the (N-1)th previous hours' equivalent zone air temperature.					
13	D coefficient	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[-Inf;+Inf]	0.0
	The specified D transfer coefficient of the exterior wall. The first D coefficient represents d1, the coefficient of the previous hours heat flux. The Nth coeffcient represents dN, the coefficient of the Nth previous hours' heat flux.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
11-11	Number of B coefficients		1	50
12-12	Number of C coefficients		1	50
13-13	Number of D coefficients		1	50

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Incident solar radiation	Flux	kJ/hr.m^2	real	[0.0;+Inf]	0.0
	The total (beam + sky diffuse + ground reflected diffuse) incident solar radiation upon the exterior wall per unit area.					

4.7.5.9. Detailed Single Zone (Type19) - Surfaces - Walls - Interior Partitions - Standard ASHRAE Partition

Icon		**TRNSYS Model**	Type -19
Proforma	Loads and Structures\Single Zone Models\Detailed Single Zone (Type19)\Surfaces\Walls\Interior Partitions\Standard ASHRAE Partition\APart.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Surface number	Dimensionless	-	integer	[1;15]	1
	A unique integer identifying the surface number associated with this interior partition. No two surfaces may have the same surface number!!					
2	Interior partition specification	Dimensionless	-	integer	[2;2]	2
	Specifies to the general single zone model that this wall is exposed to identical conditions at both surfaces. With this criteria, the wall is adiabatic at the centerline.					
3	Wall area	Area	m^2	real	[0.0;+Inf]	20.0
	The overall inside surface area of the interior partition. If both sides of the partition are exposed to the inside of the zone, the user should specify the area to include both faces of the partition.					
4	Interior solar reflectance	Dimensionless	-	real	[0.0;1.0]	0.5
	The reflectance to solar radiation of the surface of this interior partition. The reflectance of a surface is defined as the ratio of the reflected solar radiation by the surface to the total incident solar radiation upon the surface and, therefore, must be between 0 and 1.					
5	Not used	Dimensionless	-	real	[0.0;1.0]	0.7
	The absorptance of solar radiation of the exterior surface is not used when specifying an interior partition. The absorptance is defined as the ratio of the absorbed solar radiation by a surface to the total solar radiation incident upon the surface and, therefore, must be between 0 and 1.					
6	ASHRAE table number	Dimensionless	-	integer	[3;3]	3
	This parameter is used to inform the general model that the interior partition description will be entered from a specific ASHRAE table. Do not change this parameter. In this case, the partition description will be chosen from either Table 4.8.3.10 or Table 4.8.3.11 of TRNSYS Volume 1.					
7	Table entry number	Dimensionless	-	integer	[1;47]	23
	The entry in either Table 4.9.3.10 or Table 4.8.3.11 of Volume 1 of the TRNSYS documentation set corresponding to the chosen interior partition. The tables are repeated below for convenience. (See manual for further information for a table of available interior partitition, floor and ceiling descriptions for Type 19.)					

4.7.5.10. Detailed Single Zone (Type19) - Surfaces - Walls - Interior Partitions - User Defined Layers

Icon		**TRNSYS Model**	Type -19
Proforma	Loads and Structures\Single Zone Models\Detailed Single Zone (Type19)\Surfaces\Walls\Interior Partitions\User Defined Layers\PPart.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Surface number	Dimensionless	-	integer	[1;15]	1
	A unique integer identifying the surface number associated with this interior partition. No two surfaces may have the same surface number!!					
2	Interior partition specification	Dimensionless	-	integer	[2;2]	2
	Specifies to the general single zone model that this wall is exposed to identical conditions at both surfaces. With this criteria, the wall is adiabatic at the centerline.					
3	Wall area	Area	m^2	real	[0.0;+Inf]	20.0
	The overall inside surface area of the interior partition. If both sides of the partition are exposed to the inside of the zone, the user should specify the area to include both faces of the partition.					
4	Interior solar reflectance	Dimensionless	-	real	[0.0;1.0]	0.5
	The reflectance to solar radiation of the surface of this interior partition. The reflectance of a surface is defined as the ratio of the reflected solar radiation by the surface to the total incident solar radiation upon the surface and, therefore, must be between 0 and 1.					
5	Not used	Dimensionless	-	real	[0.0;1.0]	0.7
	The absorptance of solar radiation of the exterior surface is not used when specifying an interior partition. The absorptance is defined as the ratio of the absorbed solar radiation by a surface to the total solar radiation incident upon the surface and, therefore, must be between 0 and 1.					
6	Transfer function specification	Dimensionless	-	integer	[4;4]	4
	This parameter is used to inform the general model that the interior partition will be described by specification of its transfer function coefficients.					
7	Inside convection coefficient	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[0.0;+Inf]	9.5785
	The inside convection coefficent for the interior partition. This convection coefficient DOES NOT include the radiative resistance. Unless some detailed information about the surface is known, the default value should be used.					
8	Number of B coefficients	Dimensionless	-	integer	[0;15]	3
	The number of B transfer function coefficients that will be entered for this interior partition. Refer to the output of the PREP program for a listing of the transfer function coefficients for the wall in question. The B transfer function coefficients relate the history of the sol-air temperature for this surface.					
9	Number of C coefficients	Dimensionless	-	integer	[0;15]	5
	The number of C transfer function coefficients that will be entered for this interior partition. Refer to the output from the PREP program for a list of the transfer functions for this partition. The C transfer function coefficients relate the history of the equivalent zone air temperature for this partition.					
10	Number of D coefficients	Dimensionless	-	integer	[0;15]	5
	The number of D transfer function coefficients that will be entered for this interior partition. Refer to the output of the PREP program for a listing of the transfer functions for this partition. The D transfer function coefficients relate the history of the heat flux for this surface.					
11	B coefficient	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[-Inf;+Inf]	0.0
	The specified B transfer coefficient of the interior partition. The first B-coefficient represents b0, the coefficient of the current sol-air temperature. The Nth coefficient represents b(N-1), the coefficient of the (N-1)th previous					

	hours' sol-air temperature.					
12	C coefficient	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[-Inf;+Inf]	0.0
	The specified C transfer coefficient of the interior partition. The first C coefficient represents c0, the coefficient of the current equivalent zone air temperature. The Nth coefficient represents c(N-1), the coefficient of the (N-1)th previous hours' equivalent zone air temperature.					
13	D coefficient	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[-Inf;+Inf]	0.0
	The specified D transfer coefficient of the interior partition. The first D coefficient represents d1, the coefficient of the previous hours heat flux. The Nth coeffcient represents dN, the coefficient of the Nth previous hours' heat flux.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
11-11	Number of B coefficients		1	50
12-12	Number of C coefficients		1	50
13-13	Number of D coefficients		1	50

4.7.5.11. Detailed Single Zone (Type19) - Surfaces - Walls - Roofs - Standard ASHRAE Roof

Icon		TRNSYS Model	Type -19
Proforma	Loads and Structures\Single Zone Models\Detailed Single Zone (Type19)\Surfaces\Walls\Roofs\Standard ASHRAE Roof\ARoof.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Surface number	Dimensionless	-	integer	[1;15]	1
	A unique integer identifying the surface number associated with this roof. No two surfaces may have the same surface number!!					
2	Roof specification	Dimensionless	-	integer	[1;1]	1
	Specifies to the general single zone model that this roof interacts with the ambient conditions and is to be considered as an exterior surface. Do not change this parameter.					
3	Roof area	Area	m^2	real	[0.0;+Inf]	20.0
	The overall inside surface area (excluding windows and doors that are specified as separate surfaces) of this roof.					
4	Interior solar reflectance	Dimensionless	-	real	[0.0;1.0]	0.5
	The reflectance to solar radiation of the inside surface of this roof. The reflectance of a surface is defined as the ratio of the reflected solar radiation by the surface to the total incident solar radiation upon the surface and, therefore, must be between 0 and 1.					
5	Exterior solar absorptance	Dimensionless	-	real	[0.0;1.0]	0.7
	The absorptance of solar radiation of the exterior surface of the roof. The absorptance is defined as the ratio of the absorbed solar radiation by a surface to the total solar radiation incident upon the surface and, therefore, must be between 0 and 1.					
6	ASHRAE table number	Dimensionless	-	integer	[1;1]	1
	This parameter is used to inform the general model that the roof description will be entered from a specific ASHRAE table. Do not change this parameter. In this case, the roof description will be chosen from either Table 4.8.3.6 or Table 4.8.3.7 of TRNSYS volume 1.					
7	Table entry number	Dimensionless	-	integer	[1;95]	37
	The entry in either Table 4.9.3.6 or Table 4.8.3.7 of Volume 1 of the TRNSYS documentation set corresponding to the chosen roof type. The tables are repeated below for convenience. (See manual for further information for table of available roof descriptions for Type 19.)					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Incident radiation	Flux	kJ/hr.m^2	real	[0.0;+Inf]	0.0
	The total (beam + sky diffuse + ground reflected diffuse) incident solar radiation upon the roof per unit area.					

4.7.5.12. Detailed Single Zone (Type19) - Surfaces - Walls - Roofs - User Defined Layers

Icon		TRNSYS Model	Type -19
Proforma	Loads and Structures\Single Zone Models\Detailed Single Zone (Type19)\Surfaces\Walls\Roofs\User Defined Layers\PRoof.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Surface number	Dimensionless	-	integer	[1;15]	1
	A unique integer identifying the surface number associated with this roof. No two surfaces may have the same surface number!!					
2	Roof specification	Dimensionless	-	integer	[1;1]	1
	Specifies to the general single zone model that this roof interacts with the ambient conditions and is to be considered as an exterior surface. Do not change this parameter.					
3	Roof area	Area	m^2	real	[0.0;+Inf]	20.0
	The overall inside surface area (excluding windows and doors that are specified as separate surfaces) of this roof.					
4	Interior solar reflectance	Dimensionless	-	real	[0.0;1.0]	0.5
	The reflectance to solar radiation of the inside surface of this roof. The reflectance of a surface is defined as the ratio of the reflected solar radiation by the surface to the total incident solar radiation upon the surface and, therefore, must be between 0 and 1.					
5	Exterior solar absorptance	Dimensionless	-	real	[0.0;1.0]	0.7
	The absorptance of solar radiation of the exterior surface of the roof. The absorptance is defined as the ratio of the absorbed solar radiation by a surface to the total solar radiation incident upon the surface and, therefore, must be between 0 and 1.					
6	Transfer function specification	Dimensionless	-	integer	[4;4]	4
	This parameter is used to inform the general model that the roof will be described by specification of its transfer function coefficients.					
7	Inside convection coefficient	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[0.0;+Inf]	9.5785
	The inside convection coefficent for the roof. This convection coefficient DOES NOT include the radiative resistance. Unless some detailed information about the surface is known, the default value should be used.					
8	Number of B coefficients	Dimensionless	-	integer	[0;15]	3
	The number of B transfer function coefficients that will be entered for this roof. Refer to the output of the PREP program for a listing of the transfer function coefficients for the roof in question. The B transfer function coefficients relate the history of the sol-air temperature for this surface.					
9	Number of C coefficients	Dimensionless	-	integer	[0;15]	5
	The number of C transfer function coefficients that will be entered for this roof. Refer to the output from the PREP program for a list of the transfer functions for this roof. The C transfer function coefficients relate the history of the equivalent zone air temperature for this roof.					
10	Number of D coefficients	Dimensionless	-	integer	[0;15]	5
	The number of D transfer function coefficients that will be entered for this roof. Refer to the output of the PREP program for a listing of the transfer functions for this roof. The D transfer function coefficients relate the history of the heat flux for this surface.					
11	B coefficient	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[-Inf;+Inf]	0.0
	The specified B transfer coefficient of the roof. The first B-coefficient represents b0, the coefficient of the current sol-air temperature. The Nth coefficient represents b(N-1), the coefficient of the (N-1)th previous hours' sol-air temperature.					

12	C coefficient	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[-Inf;+Inf]	0.0
	The specified C transfer coefficient of the roof. The first C coefficient represents c0, the coefficient of the current equivalent zone air temperature. The Nth coefficient represents c(N-1), the coefficient of the (N-1)th previous hours' equivalent zone air temperature.					
13	D coefficient	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[-Inf;+Inf]	0.0
	The specified D transfer coefficient of the roof. The first D coefficient represents d1, the coefficient of the previous hours heat flux. The Nth coeffcient represents dN, the coefficient of the Nth previous hours' heat flux.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
11-11	Number of B coefficients		1	50
12-12	Number of C coefficients		1	50
13-13	Number of D coefficients		1	50

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Incident radiation	Flux	kJ/hr.m^2	real	[0.0;+Inf]	0.0
	The total (beam + sky diffuse + ground reflected diffuse) incident solar radiation upon the roof per unit area.					

4.7.5.13. Detailed Single Zone (Type19) - Surfaces - Walls - Zone Separation Wall - Standard ASHRAE Wall

Icon		**TRNSYS Model**	Type -19
Proforma	Loads and Structures\Single Zone Models\Detailed Single Zone (Type19)\Surfaces\Walls\Zone Separation Wall\Standard ASHRAE Wall\AZsep.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Surface number	Dimensionless	-	integer	[1;15]	1
	A unique integer identifying the surface number associated with this zone separation wall. No two surfaces may have the same surface number!!					
2	Zone separation specification	Dimensionless	-	integer	[3;3]	3
	Specifies to the general single zone model that this wall interacts with another zone. Do not change this parameter.					
3	Wall area	Area	m^2	real	[0.0;+Inf]	20.0
	The overall inside surface area of this zone separation wall (1-face).					
4	Interior solar reflectance	Dimensionless	-	real	[0.0;1.0]	0.5
	The reflectance to solar radiation of the inside surface of this zone separation wall. The reflectance of a surface is defined as the ratio of the reflected solar radiation by the surface to the total incident solar radiation upon the surface and, therefore, must be between 0 and 1.					
5	Not used	Dimensionless	-	real	[0.0;1.0]	0.7
	The absorptance of solar radiation of the exterior surface is not used in the zone separation wall. The absorptance is defined as the ratio of the absorbed solar radiation by a surface to the total solar radiation incident upon the surface and, therefore, must be between 0 and 1.					
6	ASHRAE table number	Dimensionless	-	integer	[3;3]	3
	This parameter is used to inform the general model that the zone separation wall description will be entered from a specific ASHRAE table. In this case, the wall description will be chosen from either Table 4.8.3.10 or Table 4.8.3.11 of TRNSYS Volume 1.					
7	Table entry number	Dimensionless	-	integer	[1;47]	47
	The entry in either Table 4.9.3.10 or Table 4.8.3.11 of Volume 1 of the TRNSYS documentation set corresponding to the chosen zone separation wall. The tables are repeated below for convenience.					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Equivalent zone temperature	Temperature	C	real	[-Inf;+Inf]	22.0
	The equivalent zone temperature of the zone on the far side of the specified zone separation wall. The equivalent temperature is the inside air temperature which, in the absence of radiative exchange at the inside surface, gives the same heat transfer as actually occurs. This input is usually hooked up to one of the optional outputs from another TYPE 19 component.					
2	Temperature of adjacent zone	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the zone adjacent to the zone separation wall.					
3	Additional conductane	Overall Loss Coefficient	kJ/hr.K	real	[-Inf;+Inf]	0.0
	The single zone model allows for an additional conductance between the current zone and the zone adjacent to the zone separation wall. The greater the conductance, the greater the thermal interaction between the zones. This input allows for tremendous flexibility in the modeling of the thermal interaction between the two zones.					

4.7.5.14. Detailed Single Zone (Type19) - Surfaces - Walls - Zone Separation Wall - User Defined Layers

Icon		**TRNSYS Model**	Type -19
Proforma	Loads and Structures\Single Zone Models\Detailed Single Zone (Type19)\Surfaces\Walls\Zone Separation Wall\User Defined Layers\PZsep.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Surface number	Dimensionless	-	integer	[1;15]	1
	A unique integer identifying the surface number associated with this zone separation wall. No two surfaces may have the same surface number!!					
2	Zone separation specification	Dimensionless	-	integer	[3;3]	3
	Specifies to the general single zone model that this wall interacts with another zone. Do not change this parameter.					
3	Wall area	Area	m^2	real	[0.0;+Inf]	20.0
	The overall inside surface area of this zone separation wall.					
4	Interior solar reflectance	Dimensionless	-	real	[0.0;1.0]	0.5
	The reflectance to solar radiation of the inside surface of this zone separation wall. The reflectance of a surface is defined as the ratio of the reflected solar radiation by the surface to the total incident solar radiation upon the surface and, therefore, must be between 0 and 1.					
5	Not used	Dimensionless	-	real	[0.0;1.0]	0.7
	The absorptance of solar radiation of the exterior surface is not used in the zone separation wall. The absorptance is defined as the ratio of the absorbed solar radiation by a surface to the total solar radiation incident upon the surface and, therefore, must be between 0 and 1.					
6	Transfer function specification	Dimensionless	-	integer	[4;4]	4
	This parameter is used to inform the general model that the zone separation wall will be described by specification of its transfer function coefficients.					
7	Inside convection coefficient	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[0.0;+Inf]	9.5785
	The inside convection coefficent for the zone separation wall. This convection coefficient DOES NOT include the radiative resistance. Unless some detailed information about the surface is known, the default value should be used.					
8	Number of B coefficients	Dimensionless	-	integer	[0;15]	3
	The number of B transfer function coefficients that will be entered for this zone separation wall. Refer to the output of the PREP program for a listing of the transfer function coefficients for the wall in question. The B transfer function coefficients relate the history of the sol-air temperature for this surface.					
9	Number of C coefficients	Dimensionless	-	integer	[0;15]	5
	The number of C transfer function coefficients that will be entered for this zone separation wall. Refer to the output from the PREP program for a list of the transfer functions for this wall. The C transfer function coefficients relate the history of the equivalent zone air temperature for this wall.					
10	Number of D coefficients	Dimensionless	-	integer	[0;15]	5
	The number of D transfer function coefficients that will be entered for this zone separation wall. Refer to the output of the PREP program for a listing of the transfer functions for this wall. The D transfer function coefficients relate the history of the heat flux for this surface.					
11	B coefficient	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[-Inf;+Inf]	0.0
	The specified B transfer coefficient of the zone separation wall. The first B-coefficient represents b0, the coefficient of the current sol-air temperature. The Nth coefficient represents b(N-1), the coefficient of the (N-1)th previous hours' sol-air temperature.					

12	C coefficient	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[-Inf;+Inf]	0.0
	The specified C transfer coefficient of the zone separation wall. The first C coefficient represents c0, the coefficient of the current equivalent zone air temperature. The Nth coefficient represents c(N-1), the coefficient of the (N-1)th previous hours' equivalent zone air temperature.					
13	D coefficient	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[-Inf;+Inf]	0.0
	The specified D transfer coefficient of the zone separation wall. The first D coefficient represents d1, the coefficient of the previous hours heat flux. The Nth coeffcient represents dN, the coefficient of the Nth previous hours' heat flux.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
11-11	Number of B coefficients		1	50
12-12	Number of C coefficients		1	50
13-13	Number of D coefficients		1	50

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Equivalent zone temperature	Temperature	C	real	[-Inf;+Inf]	22.0
	The equivalent zone temperature of the zone on the far side of the specified zone separation wall. The equivalent temperature is the inside air temperature which, in the absence of radiative exchange at the inside surface, gives the same heat transfer as actually occurs. This input is usually hooked up to one of the optional outputs from another TYPE 19 component.					
2	Temperature of adjacent zone	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the zone adjacent to the zone separation wall.					
3	Additional conductane	Overall Loss Coefficient	kJ/hr.K	real	[-Inf;+Inf]	0.0
	The single zone model allows for an additional conductance between the current zone and the zone adjacent to the zone separation wall. The greater the conductance, the greater the thermal interaction between the zones. This input allows for tremendous flexibility in the modeling of the thermal interaction between the two zones.					

4.7.5.15. Detailed Single Zone (Type19) - Surfaces - Windows - Transmittance as Input

Icon		TRNSYS Model	Type -19
Proforma	Loads and Structures\Single Zone Models\Detailed Single Zone (Type19)\Surfaces\Windows\Transmittance as Input\19Wind-2.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Surface number	Dimensionless	-	integer	[1;15]	1
	A unique integer identifying the surface number associated with this window. No two surfaces may have the same surface number!!					
2	Window specification	Dimensionless	-	integer	[5;5]	5
	Specifies to the general single zone model that this window interacts with the ambient conditions and is to be considered as an exterior surface. Do not change this parameter.					
3	Window area	Area	m^2	real	[0.0;+Inf]	20.0
	The overall inside surface area of this window.					
4	Window mode	Dimensionless	-	integer	[1;1]	1
	This parameter indicates to the general single zone model that this window will calculate the solar and thermal energy transfer internally. Do not change this parameter.					
5	Diffuse transmittance	Dimensionless	-	real	[0.0;1.0]	0.6
	The transmittance of the window to diffuse solar radiation. The transmittance of a surface is defined as the ratio of energy transmitted by the surface to the total energy incident upon the surface and, therefore, must be between 0 and 1.					
6	Inside convection coefficient	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[0.0;+Inf]	9.5785
	The inside convection coefficient for the window. This convection coefficient DOES NOT include the radiative resistance. Unless some detailed information about the window heat transfer is known, the default value should be used.					
7	Number of illuminated surfaces	Dimensionless	-	integer	[0;15]	1
	The number of surfaces upon which the beam radiation from this window strikes. For each illuminated surface, the fraction of beam radiation striking this surface will have to be entered.					
8	Beam-struck surface	Dimensionless	-	integer	[1;15]	1
	The unique surface number of the surface that the beam radiation strikes. Beam-struck surface 1 refers to the surface number of the surface which is first struck by beam radiation.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
8-8	Number of illuminated surfaces		1	50

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Incident solar radiation	Flux	kJ/hr.m^2	real	[0.0;+Inf]	0.0
	The total (beam + sky diffuse + ground reflected diffuse) incident solar radiation upon the window per unit area.					
2	Incident beam radiation	Flux	kJ/hr.m^2	real	[0.0;4871.0]	0.0
	The beam radiation incident upon the window surface per unit area.					
3	Transmittance	Dimensionless	-	real	[0.0;1.0]	0.6
	The overall trnsmittance of the window to solar radiation. The transmittance of the window is defined as the ratio of solar energy transmitted through the window to the total incident radiation upon the window and,					

	therefore, must be between 0 and 1.					
4	Loss coefficient	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[0.0;+Inf]	3.0
	The loss coefficient of the window plus any night insulation. This loss coefficient should not include the convection resistance at the inner or outer surfaces.					
5	Fraction striking illuminated surface	Dimensionless	-	real	[0.0;1.0]	0.2
	The fraction of beam radiation that strikes the first illuminated surface specified in the parameter list. For example, if 1/2 the beam radiation stikes the floor first (surface number 6 for example) and the other 1/2strikes the back wall (surface number 9 for example), then: -the parameter Number of Illuminated Surface would be equal to 2 -the parameter Beam-Struck Surface 1 would be set to 6 -the parameter Beam-Struck Surface 2 would be set to 9 -the input Fraction Striking Illuminated Surface 1 (which in this case is surface number 6) would be 0.5 -the input Fraction Striking Illuminated Surface 2 (which in this case is surface number 9) would be 0.5					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
5-5	Number of illuminated surfaces		1	50

4.7.5.16. Detailed Single Zone (Type19) - Surfaces - Windows - Transmittance Calculated Internally

Icon		**TRNSYS Model**	Type -19
Proforma	Loads and Structures\Single Zone Models\Detailed Single Zone (Type19)\Surfaces\Windows\Transmittance Calculated Internally\19Wind-1.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Surface number	Dimensionless	-	integer	[1;15]	1
	A unique integer identifying the surface number associated with this window. No two surfaces may have the same surface number!!					
2	Window specification	Dimensionless	-	integer	[5;5]	5
	Specifies to the general single zone model that this window interacts with the ambient conditions and is to be considered as an exterior surface. Do not change this parameter.					
3	Window area	Area	m^2	real	[0.0;+Inf]	20.0
	The overall inside surface area of this window.					
4	Window mode	Dimensionless	-	integer	[2;2]	2
	This parameter indicates to the general single zone model that this window will take as inputs the solar and thermal energy transfer. Do not change this parameter.					
5	Diffuse transmittance	Dimensionless	-	real	[0.0;1.0]	0.6
	The transmittance of the window to diffuse solar radiation. The transmittance of a surface is defined as the ratio of energy transmitted by the surface to the total energy incident upon the surface and, therefore, must be between 0 and 1.					
6	Inside convection coefficient	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[0.0;+Inf]	9.5785
	The inside convection coefficient for the window. This convection coefficient DOES NOT include the radiative resistance. Unless some detailed information about the window heat transfer is known, the default value should be used.					
7	Number of illuminated surfaces	Dimensionless	-	integer	[0;15]	1
	The number of surfaces upon which the beam radiation from this window strikes. For each illuminated surface, the fraction of beam radiation striking this surface will have to be entered.					
8	Beam-struck surface	Dimensionless	-	integer	[1;15]	1
	The unique surface number of the surface that the beam radiation strikes. Beam-struck surface 1 refers to the surface number of the surface which is first struck by beam radiation.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
8-8	Number of illuminated surfaces		1	50

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Total solar through window	Power	kJ/hr	real	[0.0;+Inf]	0.0
	The rate at which total (beam + sky diffuse + ground reflected diffuse) solar radiation passes through the window.					
2	Beam radiation through window	Power	kJ/hr	real	[0.0;+Inf]	0.0
	The rate at which beam radiation passes through the window.					
3	Thermal energy gain	Power	kJ/hr	real	[-Inf;+Inf]	0.0
	The rate at which thermal energy is transferred to the zone through the window.					

4	Fraction striking illuminated surface	Dimensionless	-	real	[0.0;1.0]	0.2
	The fraction of beam radiation that strikes the first illuminated surface specified in the parameter list. For example, if 1/2 the beam radiation stikes the floor first (surface number 6 for example) and the other 1/2strikes the back wall (surface number 9 for example), then: -the parameter Number of Illuminated Surface would be equal to 2 -the parameter Beam-Struck Surface 1 would be set to 6 -the parameter Beam-Struck Surface 2 would be set to 9 -the input Fraction Striking Illuminated Surface 1 (which in this case is surface number 6) would be 0.5 -the input Fraction Striking Illuminated Surface 2 (which in this case is surface number 9) would be 0.5					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
4-4	Number of illuminated surfaces		1	50

4.7.5.17. Detailed Single Zone (Type19) - Zone (Must Choose 1) - Energy rate Control

Icon		**TRNSYS Model**	Type 19
Proforma	Loads and Structures\Single Zone Models\Detailed Single Zone (Type19)\Zone (Must Choose 1)\Energy rate Control\ERZone.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Energy rate control	Dimensionless	-	integer	[1;1]	1
	The single zone model may operate in either energy rate control or in temperature level control. In energy rate control, the space is assumed to always stay within the specified temperature and humidity ranges. The energy required to stay within these ranges is output from this component and is independent of any heating or cooling equipment operation. Do not change this parameter.					
2	Volume of air	Volumetric Flow Rate	m^3	real	[0.0;+Inf]	15000
	The volume of air in the zone. The volume of air in the zone is used solely to calculate the moisture capacitance of the zone. Artificially increasing this volume to account for additional moisture capacitance of furnishings etc. will not affect the other calculations and is recommended.					
3	Infiltration constant 1	Dimensionless	-	real	[-Inf;+Inf]	0.10
	The infiltration flow rate to the zone is calculated from an empirical relationship of the form: minfl = rho*vol*(K1 + K2*(Tamb-Tzone) + K3*WV) (See manual for further information on equation) ASHRAE recommends the following values for these constants: K1 K2 K3 Tight construction ---> 0.1 0.011 0.034 Medium construction ---> 0.1 0.017 0.049 Loose construction ---> 0.1 0.023 0.07 Tight construction is defined as a new building where special precautions have been taken to prevent infiltration. Medium construction is defined as conventional construction procedures. Loose construction is defined as evidence of poor construction on older buildings where joints have separated.					
4	Infiltration constant 2	Dimensionless	-	real	[-Inf;+Inf]	0.10
	The infiltration flow rate to the zone is calculated from an empirical relationship of the form: minfl = rho*vol*(K1 + K2*(Tamb-Tzone) + K3*WV) (See manual for further information on equation) ASHRAE recommends the following values for these constants: K1 K2 K3 Tight construction ---> 0.1 0.011 0.034 Medium construction ---> 0.1 0.017 0.049 Loose construction ---> 0.1 0.023 0.07 Tight construction is defined as a new building where special precautions have been taken to prevent infiltration. Medium construction is defined as conventional construction procedures. Loose construction is defined as evidence of poor construction on older buildings where joints have separated.					
5	Infiltration constant 3	Dimensionless	-	real	[-Inf;+Inf]	0.10
	The infiltration flow rate to the zone is calculated from an empirical relationship of the form: minfl = rho*vol*(K1 + K2*(Tamb-Tzone) + K3*WV) (See manual for further information on equation) ASHRAE recommends the following values for these constants: K1 K2 K3 Tight construction ---> 0.1 0.011 0.034 Medium construction ---> 0.1 0.017 0.049					

	Loose construction ---> 0.1 0.023 0.07 Tight construction is defined as a new building where special precautions have been taken to prevent infiltration. Medium construction is defined as conventional construction procedures. Loose construction is defined as evidence of poor construction on older buildings where joints have separated.					
6	Capacitance	Dimensionless	-	real	[0.0;+Inf]	800000.0
	The effective thermal capacitance of the room air and furnishings plus any mass not considered with the transfer functions.					
7	Total number of surfaces	Dimensionless	-	real	[1;15]	5
	The total number of surface comprising the zone.					
8	Initial room temperature	Temperature	C	real	[-Inf;+Inf]	20.0
	The initial temperature of the zone. This initial temperature is also used to calculate the inside radiation coefficients which are assumed to remain constant over the simulation. Refer to equation 4.8.3.7 in Volume 1 of the TRNSYS documentation set for more details.					
9	Initial room humidity ratio	Dimensionless	-	real	[0.00;0.5]	0.006
	The absolute humidity ratio of the zone air at the beginning of the simulation. The absolute humidity ratio is defined as: humidity ratio = kg's of water / kg of dry air					
10	Heating set point	Temperature	C	real	[-Inf;+Inf]	22.0
	The temperature above which the zone will be maintained for the simulation. If the calculated zone temperature falls below this set point temperature, the temperature will be raised to the set point and the energy required to raise the zone to the set point will be set as an output.					
11	Cooling set point	Temperature	C	real	[-Inf;+Inf]	25.0
	The temperature below which the zone temperature will be maintained for the simulation. If the calculated zone temperature is above this set point, the zone temperature will be set to the set point temperature and the energy required to achieve this setpoint will be set as an output.					
12	Humidification set point	Dimensionless	-	real	[0.00;0.5]	0.006
	The humidity ratio above which the zone air will be maintained for the simulation. If the zone humidity ratio is calculated to be below this set point, the zone humidity ratio will be raised to the set point and the energy required to achieve this set point will be set as an output.					
13	Dehumidification set point	Dimensionless	-	real	[0.00;0.5]	0.008
	The humidity ratio below which the store air will be maintained for the simulation. If the caculated zone humidity ratio is above this set point, the humidity ratio will be set to this set point and the energy required to achieve this set point will be set as an output.					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Ambient temperature	Temperature	C	real	[-Inf;+Inf]	10.0
	The temperature of the ambient air.					
2	Ambient humidity ratio	Dimensionless	-	real	[0.00;0.5]	0.005
	The absolute humidity ratio of the ambient air. The absolute humidity ratio is defined as: humidity ratio = kg's of water / kg of dry air					
3	Ventilation stream temperature	Temperature	C	real	[-Inf;+Inf]	25.0
	The temperature of the ventilation air being supplied to the zone.					
4	Ventilation flow rate	Flow Rate	kg/hr	real	[0.0;+Inf]	30.0
	The flow rate of the ventilation flow stream to the zone.					
5	Ventilation humidity ratio	Dimensionless	-	real	[0.000;0.5]	0.005
	The absolute humidity ratio of the ventilation flow stream. The humidity ratio is defined as: humidity ratio = kg's of water / kg of dry air					
6	Rate of moisture gain	Flow Rate	kg/hr	real	[-Inf;+Inf]	10.0
	The rate of moisture gain in the space excluding the effects of people.					

7	Number of people in zone	Dimensionless	-	integer	[0;+Inf]	12
	The number of people in the zone during the timestep. The number of people will be used to calculate the internal gains.					
8	Activity level of people	Dimensionless	-	integer	[1;11]	4
	The average activity level of the people in the zone. The activity level and the number of people in the zone will be used to calculate the internal gains due to people. 1 = Seated at rest (reading, watching tv) 2 = Seated, very light work (writing) 3 = Seated (eating) 4 = Seated, light work (typing) 5 = Standing, light work, or walking slowly 6 = Light bench work 7 = Walking, light machine work 8 = Bowling 9 = Moderate dancing 10 = Heavy work, heavy machine work, lifting 11 = Heavy work, athletics Refer to table 4.8.3.2 for more details.					
9	Radiative gains	Power	kJ/hr	real	[-Inf;+Inf]	0.0
	The radiative energy input due to lights, equipment, etc. Do not include people in this input as 30% of the gains by people is already assumed to be radiative.					
10	Other internal gains	Power	kJ/hr	real	[-Inf;+Inf]	0.0
	The rate of energy transfer to the zone due to internal gains other than people or lights.					
11	Wind speed	Velocity	m/s	real	[0.0;+Inf]	2.0
	The speed of the wind flowing past the zone.					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Zone temperature	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the zone in question.					
2	Zone humidity ratio	Dimensionless	-	real	[0.00;0.1]	0
	The absolute humidity ratio of the zone in question. The absolute humidity ratio is defined as the ratio of the mass of water in a volume of air to the mass of the air (kg's H2O / kg of dry air).					
3	Convection gains	Power	kJ/hr	real	[-Inf;+Inf]	0
	The energy gain to the zone due to convection from all surfaces that define the zone.					
4	People gains	Power	kJ/hr	real	[-Inf;+Inf]	0
	The sensible energy gain to the zone due to convection from people inside the zone. The gain due to people is calculated from knowledge of the number of people in the zone and their associated activity level.					
5	Infiltration gains	Power	kJ/hr	real	[-Inf;+Inf]	0
	The sensible energy gains to the zone due to infiltration from the environment. The sensible energy gains are calculated from the zone temperature, the ambient temperature and knowledge of the infiltration rate.					
6	Ventilation gains	Power	kJ/hr	real	[-Inf;+Inf]	0
	The sensible energy gains to the zone due to the ventilation air stream. The ventilation energy gain is calculated from the zone temperature, the ventilation supply temperature, and the ventilation flow rate.					
7	Sensible load	Power	kJ/hr	real	[-Inf;+Inf]	0
	The sensible load on the zone. The sensible load is defined as the energy required by auxiliary heating or cooling equipment in order to keep the zone temperature within the comfort zone. Cooling is positive while heating is negative.					
8	Latent load	Power	kJ/hr	real	[-Inf;+Inf]	0
	The latent load on the zone. The latent load is defined as the energy required to keep the humidity level within the comfort region. Dehumidification is a positive latent load, while humidification is a negative latent load.					
9	Maximum cooling load	Power	kJ/hr	real	[-Inf;+Inf]	0

	The maximum cooling load on the zone during the timestep.					
10	Maximum heating load	Power	kJ/hr	real	[-Inf;+Inf]	0
	The maximum heating load for the zone during the timestep.					

SPECIAL CARDS

Name	Question	Answer
ASSIGN	Please specify the name of the file containing the ASHRAE Transfer Function coefficients; followed by a space and the number 8.	\TRNWIN\ASHRAE.COF 8

4.7.5.18. Detailed Single Zone (Type19) - Zone (Must Choose 1) - Temperature Level Control

Icon		**TRNSYS Model**	Type 19
Proforma	Loads and Structures\Single Zone Models\Detailed Single Zone (Type19)\Zone (Must Choose 1)\Temperature Level Control\TLZone.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Temperature level control	Dimensionless	-	integer	[2;2]	2
	The single zone model may operate in either energy rate control or in temperature level control. In energy rate control, the space is assumed to always stay within the specified temperature and humidity ranges. The energy required to stay within these ranges is output from this component and is independent of any heating or cooling equipment operation. Do not change this parameter.					
2	Volume of air	Volumetric Flow Rate	m^3	real	[0.0;+Inf]	15000
	The volume of air in the zone. The volume of air in the zone is used solely to calculate the moisture capacitance of the zone. Artificially increasing this volume to account for additional moisture capacitance of furnishings etc. will not affect the other calculations and is recommended.					
3	Infiltration constant 1	Dimensionless	-	real	[-Inf;+Inf]	0.10
	The infiltration flow rate to the zone is calculated from an empirical relationship of the form: minfl = rho*vol*(K1 + K2*(Tamb-Tzone) + K3*WV) (See manual for further information on equation) ASHRAE recommends the following values for these constants: K1 K2 K3 Tight construction ---> 0.1 0.011 0.034 Medium construction ---> 0.1 0.017 0.049 Loose construction ---> 0.1 0.023 0.07 Tight construction is defined as a new building where special precautions have been taken to prevent infiltration. Medium construction is defined as conventional construction procedures. Loose construction is defined as evidence of poor construction on older buildings where joints have separated.					
4	Infiltration constant 2	Dimensionless	-	real	[-Inf;+Inf]	0.10
	The infiltration flow rate to the zone is calculated from an empirical relationship of the form: minfl = rho*vol*(K1 + K2*(Tamb-Tzone) + K3*WV) (See manual for further information on equation) ASHRAE recommends the following values for these constants: K1 K2 K3 Tight construction ---> 0.1 0.011 0.034 Medium construction ---> 0.1 0.017 0.049 Loose construction ---> 0.1 0.023 0.07 Tight construction is defined as a new building where special precautions have been taken to prevent infiltration. Medium construction is defined as conventional construction procedures. Loose construction is defined as evidence of poor construction on older buildings where joints have separated.					
5	Infiltration constant 3	Dimensionless	-	real	[-Inf;+Inf]	0.10
	The infiltration flow rate to the zone is calculated from an empirical relationship of the form: minfl = rho*vol*(K1 + K2*(Tamb-Tzone) + K3*WV) (See manual for further information on equation) ASHRAE recommends the following values for these constants: K1 K2 K3 Tight construction ---> 0.1 0.011 0.034 Medium construction ---> 0.1 0.017 0.049					

	Loose construction ---> 0.1 0.023 0.07 Tight construction is defined as a new building where special precautions have been taken to prevent infiltration. Medium construction is defined as conventional construction procedures. Loose construction is defined as evidence of poor construction on older buildings where joints have separated.					
6	Capacitance	Dimensionless	-	real	[0.0;+Inf]	800000.0
	The effective thermal capacitance of the room air and furnishings plus any mass not considered with the transfer functions.					
7	Total number of surfaces	Dimensionless	-	real	[1;15]	5
	The total number of surface comprising the zone.					
8	Initial room temperature	Temperature	C	real	[-Inf;+Inf]	20.0
	The initial temperature of the zone. This initial temperature is also used to calculate the inside radiation coefficients which are assumed to remain constant over the simulation. Refer to equation 4.8.3.7 in Volume 1 of the TRNSYS documentation set for more details.					
9	Initial room humidity ratio	Dimensionless	-	real	[0.00;0.5]	0.006
	The absolute humidity ratio of the zone air at the beginning of the simulation. The absolute humidity ratio is defined as: humidity ratio = kg's of water / kg of dry air					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Ambient temperature	Temperature	C	real	[-Inf;+Inf]	10.0
	The temperature of the ambient air.					
2	Ambient humidity ratio	Dimensionless	-	real	[0.00;0.5]	0.005
	The absolute humidity ratio of the ambient air. The absolute humidity ratio is defined as: humidity ratio = kg's of water / kg of dry air					
3	Ventilation stream temperature	Temperature	C	real	[-Inf;+Inf]	25.0
	The temperature of the ventilation air being supplied to the zone.					
4	Ventilation flow rate	Flow Rate	kg/hr	real	[0.0;+Inf]	30.0
	The flow rate of the ventilation flow stream to the zone.					
5	Ventilation humidity ratio	Dimensionless	-	real	[0.000;0.5]	0.005
	The absolute humidity ratio of the ventilation flow stream. The humidity ratio is defined as: humidity ratio = kg's of water / kg of dry air					
6	Rate of moisture gain	Flow Rate	kg/hr	real	[-Inf;+Inf]	10.0
	The rate of moisture gain in the space excluding the effects of people.					
7	Number of people in zone	Dimensionless	-	integer	[0;+Inf]	12
	The number of people in the zone during the timestep. The number of people will be used to calculate the internal gains.					
8	Activity level of people	Dimensionless	-	integer	[1;11]	4
	The average activity level of the people in the zone. The activity level and the number of people in the zone will be used to calculate the internal gains due to people. 1 = Seated at rest (reading, watching tv) 2 = Seated, very light work (writing) 3 = Seated (eating) 4 = Seated, light work (typing) 5 = Standing, light work, or walking slowly 6 = Light bench work 7 = Walking, light machine work 8 = Bowling 9 = Moderate dancing 10 = Heavy work, heavy machine work, lifting 11 = Heavy work, athletics Refer to table 4.8.3.2 for more details.					

9	Radiative gains	Power	kJ/hr	real	[-Inf;+Inf]	0.0
	The radiative energy input due to lights, equipment, etc. Do not include people in this input as 30% of the gains by people is already assumed to be radiative.					
10	Other internal gains	Power	kJ/hr	real	[-Inf;+Inf]	0.0
	The rate of energy transfer to the zone due to internal gains other than people or lights.					
11	Wind speed	Velocity	m/s	real	[0.0;+Inf]	2.0
	The speed of the wind flowing past the zone.					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Zone temperature	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the zone in question.					
2	Zone humidity ratio	Dimensionless	-	real	[0.00;0.1]	0
	The absolute humidity ratio of the zone in question. The absolute humidity ratio is defined as the ratio of the mass of water in a volume of air to the mass of the air (kg's H2O / kg of dry air).					
3	Convection gains	Power	kJ/hr	real	[-Inf;+Inf]	0
	The energy gain to the zone due to convection from all surfaces that define the zone.					
4	People gains	Power	kJ/hr	real	[-Inf;+Inf]	0
	The sensible energy gain to the zone due to convection from people inside the zone. The gain due to people is calculated from knowledge of the number of people in the zone and their associated activity level.					
5	Infiltration gains	Power	kJ/hr	real	[-Inf;+Inf]	0
	The sensible energy gains to the zone due to infiltration from the environment. The sensible energy gains are calculated from the zone temperature, the ambient temperature and knowledge of the infiltration rate.					
6	Ventilation gains	Power	kJ/hr	real	[-Inf;+Inf]	0
	The sensible energy gains to the zone due to the ventilation air stream. The ventilation energy gain is calculated from the zone temperature, the ventilation supply temperature, and the ventilation flow rate.					

SPECIAL CARDS

Name	Question	Answer
ASSIGN	Please specify the name of the file containing the ASHRAE Transfer Function coefficients; followed by a space and an 8.	\TRNWIN\ASHRAE.COF 8

4.7.5.19. Energy (Degree Day) Space Load (Type12) - Energy Rate Control - Heating and Cooling

Icon		**TRNSYS Model**	Type 12
Proforma	Loads and Structures\Single Zone Models\Energy (Degree Day) Space Load (Type12)\Energy Rate Control\Heating and Cooling\Type12b.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Heating and cooling mode	Dimensionless	-	integer	[3;3]	3
	The heating and cooling mode specifies to the general energy/degree-hour house model that the heating and cooling loads should both be calculated using energy rate control. Do not change this parameter.					
2	Overall conductance of house	Overall Loss Coefficient	kJ/hr.K	real	[0.0;+Inf]	1000.0
	The overall conductance for heat loss from the house. The thermal losses from the house are calculated by: Qloss = UA *(Thouse - Tamb) - Qgain (See manual for further information on equation)					
3	House thermal capacitance	Thermal Capacitance	kJ/K	real	[0.0;+Inf]	10000.0
	The effective lumped thermal capacitance of the house. For computational stability this number should be chosen so that the maximum swing of room temperature in a timestep is on the order of the controller dead band ranges.					
4	Initial room temperature	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the house at the beginning of the simulation.					
5	Specific heat of source fluid	Specific Heat	kJ/kg.K	real	[0.0;+Inf]	4.19
	The specific heat of the fluid flowing into the hot source side of the heat exchanger.					
6	Effectiveness-Cmin product	Overall Loss Coefficient	kJ/hr.K	real	[0.0;+Inf]	200.0
	The effectiveness-Cmin product of the load heat exchanger. The effectiveness is a measure of the efficiency of the heat exchanger and is defined as the heat transfer across the heat exchanger divided by the maximum possible heat transfer and therefore must be between 0 and 1. Cmin is the minimum capacitance rate (flow rate * specific heat) of the two fluids flowing through the heat exchanger. The effectiveness-Cmin product will be used to calculate the heat transfer to the room from the source stream: Qhx = EffCmin * (Tin - Thouse) (See manual for further information on equation)					
7	Heating set point	Temperature	C	real	[-Inf;+Inf]	22.0
	The temperature at which the house will be maintained during the heating season.					
8	Cooling set point	Temperature	C	real	[-Inf;+Inf]	25.0
	The temperature at which the house will be maintained during the cooling season.					
9	Latent heat ratio	Dimensionless	-	real	[0.0;1.0]	0.23
	When degree-day loads are used for air conditioning calculations, ASHRAE suggests multiplying the sensible load by a constant factor to account for latent loads. This parameter is used for this purpose. ASHRAE recommends latent load to sensible load ratios of about 0.3 or a latent heat ratio of 0.23. The total and latent cooling loads are calculated as: Qcool = Qsens/(1-LHR) Qlat = Qcool - Qsens (See manual for further information on equations)					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Inlet temperature	Temperature	C	real	[-Inf;+Inf]	0

	The temperature of the fluid flowing from the heat source into the hot side of the load heat exchanger.					
2	Inlet flow rate	Flow Rate	kg/hr	real	[0.0;+Inf]	100.0
	The flow rate of fluid entering the hot side of the heat exchanger from the heat source.					
3	Ambient temperature	Temperature	C	real	[-Inf;+Inf]	10.0
	The temperature of the environment surrounding the house.					
4	Internal gains	Power	kJ/hr	real	[-Inf;+Inf]	0
	The time variant internal gains in the house. The gains will be subtracted from the house thermal losses in order to calculate the amount of energy required by the house to maintain the set point temperature: Qrequired = Qloss - Qgain					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Temperature to heat source	Temperature	C	real	[-Inf;+Inf]	0
	The temperature exiting the hot-side of the heat exchanger and returning to the heat source. The temperature to the heat source is calculated from knowledge of the inlet source temperature, the heat exchanger heat transfer, and the flow rate: Tout = Tin - Qhx/mdot/Cp (See manual for further information on equation)					
2	Flow rate to heat source	Flow Rate	kg/hr	real	[-Inf;+Inf]	0
	The flow rate of fluid returning to the heat source from the heat exchanger.					
3	Heating load	Power	kJ/hr	real	[-Inf;+Inf]	0
	The instantaneous heating load of the house. The heating load is calculated by the following relation: Qload = UA*(Thouse-Tamb) - Qgain (See manual for further information on equation)					
4	Average house temperature	Temperature	C	real	[-Inf;+Inf]	0
	The average temperature of the house over the timestep.					
5	Heat transfer rate across HX	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which heat is transferred between the fluid streams in the heat exchanger. The heat transfer rate is calculated by: Qhx = EffCmin*(Tin - Thouse) (See manual for further information on equation)					
6	Required auxiliary rate	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which auxiliary heat is required to keep the house at the heating set point temperature.					
7	Sensible load	Power	kJ/hr	real	[-Inf;+Inf]	0
	The instantaneous sensible load on the house for the timestep.					
8	Latent load	Power	kJ/hr	real	[-Inf;+Inf]	0
	The instantaneous latent load on the house for the timestep.					

4.7.5.20. Energy (Degree Day) Space Load (Type12) - Energy Rate Control - Heating Only

Icon		TRNSYS Model	Type 12
Proforma	Loads and Structures\Single Zone Models\Energy (Degree Day) Space Load (Type12)\Energy Rate Control\Heating Only\Type12a.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Auxiliary heat mode	Dimensionless	-	integer	[1;2]	1
	The energy/degree-hour house may operate in one of two auxiliary heat modes: 1 = Parallel Auxiliary: auxiliary energy makes up only that part of the load which cannot be extracted from the inlet flow stream. 2 = Series Auxiliary: auxiliary supplies the entire load via a bypass circuit when the inlet flow stream cannot meet the load					
2	Overall conductance of house	Overall Loss Coefficient	kJ/hr.K	real	[0.0;+Inf]	1000.0
	The overall conductance for heat loss from the house. The thermal losses from the house are calculated by: Qloss = UA *(Thouse - Tamb) - Qgain (See manual for further information on equation)					
3	House set point temperature	Temperature	C	real	[-Inf;+Inf]	22.0
	The temperature at which the house is to be maintained during the heating season.					
4	Flow rate when pump is operating	Flow Rate	kg/hr	real	[0.0;+Inf]	100.0
	The fluid flow rate when the pump is operational. The energy/degree-hour house routine will turn on the pump when the house requires heating and the source stream is hotter than the room temperature in parallel auxiliary mode. In series auxiliary mode, the pump will only be turn on when the source stream is sufficient to meet the entire heating load.					
5	Specific heat of source fluid	Specific Heat	kJ/kg.K	real	[0.0;+Inf]	4.19
	The specific heat of the fluid flowing into the hot source side of the heat exchanger.					
6	Effectiveness-Cmin product	Overall Loss Coefficient	kJ/hr.K	real	[0.0;+Inf]	200.0
	The effectiveness-Cmin product of the load heat exchanger. The effectiveness is a measure of the efficiency of the heat exchanger and is defined as the heat transfer across the heat exchanger divided by the maximum possible heat transfer and therefore must be between 0 and 1. Cmin is the minimum capacitance rate (flow rate * specific heat) of the two fluids flowing through the heat exchanger. The effectiveness-Cmin product will be used to calculate the heat transfer to the room from the source stream: Qhx = EffCmin * (Tin - Thouse) (See manual for further information on equation)					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Inlet temperature	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid flowing from the heat source into the hot side of the load heat exchanger.					
2	Inlet flow rate	Flow Rate	kg/hr	real	[0.0;+Inf]	100.0
	The flow rate of fluid entering the hot side of the heat exchanger from the heat source. ***This input is used only for convergence checking. This component includes a pump and therefore sets the flow rate for the fluid loop.					
3	Ambient temperature	Temperature	C	real	[-Inf;+Inf]	10.0
	The temperature of the environment surrounding the house.					
4	Internal gains	Power	kJ/hr	real	[-Inf;+Inf]	0
	The time variant internal gains in the house. The gains will be subtracted from the house thermal losses in order to calculate the amount of energy required by the house to maintain the set point temperature:					

	Qrequired = Qloss - Qgain

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Temperature to heat source	Temperature	C	real	[-Inf;+Inf]	0
	The temperature exiting the hot-side of the heat exchanger and returning to the heat source. The temperature to the heat source is calculated from knowledge of the inlet source temperature, the heat exchanger heat transfer, and the pump flow rate: Tout = Tin - Qhx/mdot/Cp (See manual for further information on equation)					
2	Flow rate to heat source	Flow Rate	kg/hr	real	[-Inf;+Inf]	0
	The flow rate of source fluid returning to the heat source. This component includes a pump and therefore sets the flowrate for the fluid loop. In parallel auxiliary heating mode, the outlet flow rate is zero when no house heating is required or the inlet source temperature is less than the house temperature. In series auxiliary heating mode, the flow rate is zero unless the source flow is sufficient to meet the entire heating load of the house. For either auxiliary mode, the outlet flow rate is the parameter-specified flow rate otherwise.					
3	Heating load	Power	kJ/hr	real	[-Inf;+Inf]	0
	The instantaneous heating load of the house. The heating load is calculated by the following relation: Qload = UA*(Thouse-Tamb) - Qgain (See manual for further information on equation)					
4	Average house temperature	Temperature	C	real	[-Inf;+Inf]	0
	The average temperature of the house. In this mode, it is assumed that the load is always exactly met. Therefore the average house temperature will always be the set point temperature for heating.					
5	Heat transfer rate across HX	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which heat is transferred between the fluid streams in the heat exchanger. The heat transfer rate is calculated by: Qhx = Min(Qrequired, EffCmin*(Tin - Thouse)) (See manual for further information on equation)					
6	Required auxiliary rate	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which auxiliary energy is required to keep the house at the set point temperature. In parallel auxiliary mode, the required auxiliary heating rate is the total required heating rate minus the heating rate supplied by the source fluid. In series auxiliary mode, the auxiliary is 0 if the source flow is sufficient to meet the entire house heating load or the entire house heating load otherwise.					

4.7.5.21. Energy (Degree Day) Space Load (Type12) - Temperature Level Control

Icon		TRNSYS Model	Type 12
Proforma	Loads and Structures\Single Zone Models\Energy (Degree Day) Space Load (Type12)\Temperature Level Control\Type12c.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Temperature level control	Dimensionless	-	integer	[4;4]	4
	The temperature level control mode specifies to the general energy/degree-hour house model that the house temperature is allowed to float. Do not change this parameter.					
2	Overall conductance of house	Overall Loss Coefficient	kJ/hr.K	real	[0.0;+Inf]	1000.0
	The overall conductance for heat loss from the house. The thermal losses from the house are calculated by: Qloss = UA *(Thouse - Tamb) - Qgain (See manual for further information on equation)					
3	House thermal capacitance	Thermal Capacitance	kJ/K	real	[0.0;+Inf]	10000.0
	The effective lumped thermal capacitance of the house. For computational stability this number should be chosen so that the maximum swing of room temperature in a timestep is on the order of the controller dead band ranges.					
4	Initial room temperature	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the house at the beginning of the simulation.					
5	Specific heat of source fluid	Specific Heat	kJ/kg.K	real	[0.0;+Inf]	4.19
	The specific heat of the fluid flowing into the hot source side of the heat exchanger.					
6	Effectiveness-Cmin product	Overall Loss Coefficient	kJ/hr.K	real	[0.0;+Inf]	200.0
	The effectiveness-Cmin product of the load heat exchanger. The effectiveness is a measure of the efficiency of the heat exchanger and is defined as the heat transfer across the heat exchanger divided by the maximum possible heat transfer and therefore must be between 0 and 1. Cmin is the minimum capacitance rate (flow rate * specific heat) of the two fluids flowing through the heat exchanger. The effectiveness-Cmin product will be used to calculate the heat transfer to the room from the source stream: Qhx = EffCmin * (Tin - Thouse) (See manual for further information on equation)					
7	Latent heat ratio	Dimensionless	-	real	[0.0;1.0]	0.23
	When degree-day loads are used for air conditioning calculations, ASHRAE suggests multiplying the sensible load by a constant factor to account for latent loads. This parameter is used for this purpose. ASHRAE recommends latent load to sensible load ratios of about 0.3 or a latent heat ratio of 0.23. The total and latent cooling loads are calculated as: Qcool = Qsens/(1-LHR) Qlat = Qcool - Qsens (See manual for further information on equations)					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Inlet temperature	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid flowing from the heat source into the hot side of the load heat exchanger.					
2	Inlet flow rate	Flow Rate	kg/hr	real	[0.0;+Inf]	100.0
	The flow rate of fluid entering the hot side of the heat exchanger from the heat source.					
3	Ambient temperature	Temperature	C	real	[-Inf;+Inf]	10.0

	The temperature of the environment surrounding the house.					
4	Internal gains	Power	kJ/hr	real	[-Inf;+Inf]	0.0
	The time variant internal gains in the house. The gains will be subtracted from the house thermal losses in order to calculate the amount of energy required by the house to maintain the set point temperature: Qrequired = Qloss - Qgain					
5	Auxiliary heat input	Power	kJ/hr	real	[-Inf;+Inf]	0.0
	The rate at which auxiliary heat is added to the house.					
6	Cooling input	Power	kJ/hr	real	[-Inf;+Inf]	0.0
	The rate at which cooling energy is removed from the house.					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Temperature to heat source	Temperature	C	real	[-Inf;+Inf]	0
	The temperature exiting the hot-side of the heat exchanger and returning to the heat source. The temperature to the heat source is calculated from knowledge of the inlet source temperature, the heat exchanger heat transfer, and the pump flow rate: Tout = Tin - Qhx/mdot/Cp (See manual for further information on equation)					
2	Flow rate to heat source	Flow Rate	kg/hr	real	[-Inf;+Inf]	0
	The flow rate of source fluid returning to the heat source.					
3	Heating load	Power	kJ/hr	real	[-Inf;+Inf]	0
	The instantaneous heating load on the house. The heating load is calculated by the following relation: Qload = UA*(Thouse - Tamb) - Qgain (See manual for further information on equation)					
4	Average house temperature	Temperature	C	real	[-Inf;+Inf]	0
	The average temperature of the house over the timestep.					
5	Heat transfer rate across HX	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which heat is transferred between the fluid streams in the heat exchanger. The heat transfer rate is calculated by: Qhx = EffCmin*(Tin - Thouse)) (See manual for further information on equation)					
6	Required auxiliary rate	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which auxiliary heat has been added to the house.					
7	Sensible load	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which sensible cooling was provided to the house.					
8	Latent load	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate of latent cooling supplied to the house.					

4.7.5.22. Lumped Capacitance Building (Type 88)

Icon		TRNSYS Model	Type 88
Proforma	Loads and Structures\Single Zone Models\Lumped Capacitance Building (Type 88)\Type88.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Building loss coefficient	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[-Inf;+Inf]	1
2	Building capacitance	any	any	real	[0.0;+Inf]	1000.0
	The overall conductance for heat loss from the house. The thermal losses from the house are calculated by: Qloss = UA *(Thouse - Tamb) - Qgain (See manual for further information on equation)					
3	Specific heat of building air	Specific Heat	kJ/kg.K	real	[-Inf;+Inf]	22.0
	The temperature at which the house is to be maintained during the heating season.					
4	Density of building air	Density	kg/m^3	real	[0.0;+Inf]	100.0
	The fluid flow rate when the pump is operational. The energy/degree-hour house routine will turn on the pump when the house requires heating and the source stream is hotter than the room temperature in parallel auxiliary mode. In series auxiliary mode, the pump will only be turn on when the source stream is sufficient to meet the entire heating load.					
5	Building surface area	Area	m^2	real	[0.0;+Inf]	4.19
	The specific heat of the fluid flowing into the hot source side of the heat exchanger.					
6	Building volume	Volumetric Flow Rate	m^3	real	[0.0;+Inf]	200.0
	The effectiveness-Cmin product of the load heat exchanger. The effectiveness is a measure of the efficiency of the heat exchanger and is defined as the heat transfer across the heat exchanger divided by the maximum possible heat transfer and therefore must be between 0 and 1. Cmin is the minimum capacitance rate (flow rate * specific heat) of the two fluids flowing through the heat exchanger. The effectiveness-Cmin product will be used to calculate the heat transfer to the room from the source stream: Qhx = EffCmin * (Tin - Thouse) (See manual for further information on equation)					
7	Humidity ratio multiplier	Dimensionless	-	real	[-Inf;+Inf]	0
8	Initial temperature	Temperature	C	real	[-Inf;+Inf]	0
9	Initial humidity ratio	Dimensionless	-	real	[-Inf;+Inf]	0
10	Latent heat of vaporization	Dimensionless	-	real	[-Inf;+Inf]	0

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Temperature of ventilation air	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid flowing from the heat source into the hot side of the load heat exchanger.					
2	Humidity ratio of ventilation air	Dimensionless	-	real	[0.0;+Inf]	100.0
	The flow rate of fluid entering the hot side of the heat exchanger from the heat source. ***This input is used only for convergence checking. This component includes a pump and therefore sets the flow rate for the fluid loop.					
3	Ventilation mass flow rate	Flow Rate	kg/hr	real	[-Inf;+Inf]	10.0
	The temperature of the environment surrounding the house.					
4	Ambient temperature	Temperature	C	real	[-Inf;+Inf]	0
	The time variant internal gains in the house. The gains will be subtracted from the house thermal losses in order to calculate the amount of energy required by the house to maintain the set point temperature: Qrequired = Qloss - Qgain					

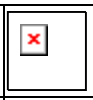
5	Ambient humidity ratio	Dimensionless	-	real	[-Inf;+Inf]	0
6	Mass flow rate of infiltration air	Flow Rate	kg/hr	real	[-Inf;+Inf]	0
7	Rate of energy gain from lights	Power	kJ/hr	real	[-Inf;+Inf]	0
8	Rate of energy from equipment	Power	kJ/hr	real	[-Inf;+Inf]	0
9	Rate of sensible energy gain from people	Power	kJ/hr	real	[-Inf;+Inf]	0
10	Rate of humidity gain	Flow Rate	kg/hr	real	[-Inf;+Inf]	0

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Zone temperature	Temperature	C	real	[-Inf;+Inf]	0
	The temperature exiting the hot-side of the heat exchanger and returning to the heat source. The temperature to the heat source is calculated from knowledge of the inlet source temperature, the heat exchanger heat transfer, and the pump flow rate: Tout = Tin - Qhx/mdot/Cp (See manual for further information on equation)					
2	Zone humidity ratio	Dimensionless	-	real	[-Inf;+Inf]	0
	The flow rate of source fluid returning to the heat source. This component includes a pump and therefore sets the flowrate for the fluid loop. In parallel auxiliary heating mode, the outlet flow rate is zero when no house heating is required or the inlet source temperature is less than the house temperature. In series auxiliary heating mode, the flow rate is zero unless the source flow is sufficient to meet the entire heating load of the house. For either auxiliary mode, the outlet flow rate is the parameter-specified flow rate otherwise.					
3	Mass flow rate of ventilation rate	Flow Rate	kg/hr	real	[-Inf;+Inf]	0
	The instantaneous heating load of the house. The heating load is calculated by the following relation: Qload = UA*(Thouse-Tamb) - Qgain (See manual for further information on equation)					
4	Mass flow rate of infiltration air1	Flow Rate	kg/hr	real	[-Inf;+Inf]	0
	The average temperature of the house. In this mode, it is assumed that the load is always exactly met. Therefore the average house temperature will always be the set point temperature for heating.					
5	Sensible energy gain from infiltration	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which heat is transferred between the fluid streams in the heat exchanger. The heat transfer rate is calculated by: Qhx = Min(Qrequired, EffCmin*(Tin - Thouse)) (See manual for further information on equation)					
6	Latent energy gain from infiltration	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which auxiliary energy is required to keep the house at the set point temperature. In parallel auxiliary mode, the required auxiliary heating rate is the total required heating rate minus the heating rate supplied by the source fluid. In series auxiliary mode, the auxiliary is 0 if the source flow is sufficient to meet the entire house heating load or the entire house heating load otherwise.					
7	Sensible energy gain from ventilation	Power	kJ/hr	real	[-Inf;+Inf]	0
8	Latent energy gain from ventilation	Power	kJ/hr	real	[-Inf;+Inf]	0
9	Condensation Energy	Power	kJ/hr	real	[-Inf;+Inf]	0
	The amount of energy contained in the condensation assumed to drain from the zone if the calculated humidity ratio is greater than the saturation humidity ratio.					

4.7.6. Thermal Storage Wall

4.7.6.1. Flowrate as Input, Transmittance Calculated Internally

Icon		**TRNSYS Model**	Type 36
Proforma	Loads and Structures\Thermal Storage Wall\Flowrate as Input, Transmittance Calculated Internally\Type36c.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Mode	Dimensionless	-	integer	[3;3]	3
	Setting this parameter to 3 indicates to the general thermal storage wall model that the air flow rate will be set as an input and the transmittance will be calculated internally.					
2	Wall height	Length	m	real	[0.0;+Inf]	3
	The height of the thermal storage wall.					
3	Wall width	Length	m	real	[0.0;+Inf]	2.0
	The width of the thermal storage wall.					
4	Wall thickness	Length	m	real	[0.0;+Inf]	0.3
	The thickness of the thermal storage wall.					
5	Wall conductivity	Thermal Conductivity	kJ/hr.m.K	real	[0.0;+Inf]	2.0
	The effective thermal conductivity of the thermal storage wall.					
6	Specific capacitance of wall	any	any	real	[0.0;+Inf]	3000.0
	The product of the wall density and wall specific heat.					
7	Wall solar absorptance	Dimensionless	-	real	[0.0;1.0]	0.7
	The solar absorptance of the thermal storage wall. The absorptance is a ratio of the radiation absorbed by a surface to the total radiation incident upon the surface, and therefore, must be between 0 and 1.					
8	Wall emittance	Dimensionless	-	real	[0.0;1.0]	0.8
	The emittance of the outside surface of the thermal storage wall. The emittance is defined as the ratio of the radiation emitted by a surface to the radiation emitted by a black body (the perfect emitter) at the same temperature. The emittance must therefore be between 0 and 1.					
9	Glazing emittance	Dimensionless	-	real	[0.0;1.0]	0.1
	The emittance of the glazing material. The emittance is defined as the ratio of radiation emitted by a surface to the radiation emited by a black body (the perfect emitter) at the same temperature. The emittance must therefore be between 0 and 1.					
10	Number of glazings	Dimensionless	-	integer	[1;+Inf]	1
	The number of identical glass covers on the thermal storage wall.					
11	Spacing between wall and glazing	Length	m	real	[0.0;+Inf]	0.1
	The distance between the outside surface of the thermal storage wall and the first glazing cover.					
12	Extinction	Dimensionless	-	real	[0.0;+Inf]	0.0026
	The product of the extinction coefficient and the glazing thickness for one of the identical glass covers of the thermal storage wall (KL product).					
13	Refractive index	Dimensionless	-	real	[0.0;+Inf]	1.526
	The index of refraction of one of the identical glass covers of the thermal storage wall.					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Control function	Dimensionless	-	integer	[-1;+1]	0
	The control function determines whether mass flow of air is allowed and to what sink the air is exchanged. If the control signal = 1, the air in the gap is exchanged with air from the room. If the control signal = -1, the air in the gap is exchanged with air from the ambient. If the control signal is neither 1 nor -1, there is assumed to be no air flow through the gap.					
2	Room temperature	Temperature	C	real	[-Inf;+Inf]	10
	The temperature of the air in the room to which the thermal storage wall is attached.					
3	Ambient temperature	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the ambient air.					
4	Wind speed	Velocity	m/s	real	[0.0;+Inf]	1.0
	The speed of the wind across the outside surface of the thermal storage wall.					
5	Outside loss coefficient	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[-Inf;+Inf]	20.0
	The overall heat transfer coefficient from the first glazing of the thermal storage wall to the ambient.					
6	Inside loss coefficient	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[0.0;+Inf]	11.0
	The overall loss coefficient from the inside wall surface to the room.					
7	Total radiation	Flux	kJ/hr.m^2	real	[0.0;+Inf]	0.0
	The total solar radiation (beam + sky diffuse + ground reflected diffuse) incident upon the thermal storage wall per unit area.					
8	Beam radiation	Flux	kJ/hr.m^2	real	[0.0;+Inf]	0.0
	The beam radiation incident on the outer glazing of the thermal storage wall per unit area.					
9	Incidence angle	Direction (Angle)	degrees	real	[0.0;90.0]	10.0
	The angle of incidence of beam radiation on the outer glazing of the thermal storage wall.					
10	Inlet air flow rate	Flow Rate	kg/hr	real	[0.0;+Inf]	1.0
	The flow rate of air through the gap in the thermal storage wall.					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Energy flow to room	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is transferred to the room from the thermal storage wall (includes ventilation and wall heat transfer).					
2	Internal energy change rate	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate of change of the wall internal energy with respect to time (dU/dt). This output is a rate quantity and should be integrated if an energy balance is to be done.					
3	Solar absorption rate	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which solar energy is absorbd by the thermal storage wall.					
4	Thermal losses	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is lost from the thermal storage wall to the ambient.					
5	Wall to room heat transfer	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is transferred from the inside wall surface to the room.					
6	Glazing to ambient heat transfer	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is transferred from the first glazing to the ambient.					
7	Ventilation energy flow	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is transferred due to the flow rate of air through the gap.					
8	Air flow rate	Flow Rate	kg/hr	real	[-Inf;+Inf]	0
	The flow rate of air through the gap in the thermal storage wall.					
9	Outlet air temperature	Temperature	C	real	[-Inf;+Inf]	0

	The temperature of the air exiting the gap in the thermal storage wall.					
10	Temperature of first glazing	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the first glazing of the thermal storage wall.					
11	Temperature of wall node	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the specified wall node. Wall node 1 is defined to be the temperature of the outside surface of the wall. Wall node N, where N is the number of wall nodes specified in the derivatives section, is defined to be the temperature of the inside surface of the wall.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
11-11		How many nodes should be used to model the wall?	3	10

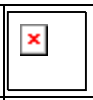
DERIVATIVES

	Name	Dimension	Unit	Type	Range	Default
1	Initial temperature of wall node	Temperature	C	real	[-Inf;+Inf]	0
	The initial temperature of the specified wall node. Wall node 1 is defined to be the outside surface of the wall. Wall node N, where N is the total number of wall nodes specified, is defined to be the inside surface of the wall.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
1-1		How many nodes should be used to model the wall?	3	10

4.7.6.2. Flowrate Calculated Internally, Transmittance as Input

Icon		TRNSYS Model	Type 36
Proforma	Loads and Structures\Thermal Storage Wall\Flowrate Calculated Internally, Transmittance as Input\Type36b.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Mode	Dimensionless	-	integer	[2;2]	2
	Setting this parameter to 2 indicates to the general thermal storage wall model that the air flow rate will be calculated internally and the transmittance will be set as an input.					
2	Wall height	Length	m	real	[0.0;+Inf]	3
	The height of the thermal storage wall.					
3	Wall width	Length	m	real	[0.0;+Inf]	2.0
	The width of the thermal storage wall.					
4	Wall thickness	Length	m	real	[0.0;+Inf]	0.3
	The thickness of the thermal storage wall.					
5	Wall conductivity	Thermal Conductivity	kJ/hr.m.K	real	[0.0;+Inf]	2.0
	The effective thermal conductivity of the thermal storage wall.					
6	Specific capacitance of wall	any	any	real	[0.0;+Inf]	3000.0
	The product of the wall density and wall specific heat.					
7	Wall solar absorptance	Dimensionless	-	real	[0.0;1.0]	0.7
	The solar absorptance of the thermal storage wall. The absorptance is a ratio of the radiation absorbed by a surface to the total radiation incident upon the surface, and therefore, must be between 0 and 1.					
8	Wall emittance	Dimensionless	-	real	[0.0;1.0]	0.8
	The emittance of the outside surface of the thermal storage wall. The emittance is defined as the ratio of the radiation emitted by a surface to the radiation emitted by a black body (the perfect emitter) at the same temperature. The emittance must therefore be between 0 and 1.					
9	Glazing emittance	Dimensionless	-	real	[0.0;1.0]	0.1
	The emittance of the glazing material. The emittance is defined as the ratio of radiation emitted by a surface to the radiation emited by a black body (the perfect emitter) at the same temperature. The emittance must therefore be between 0 and 1.					
10	Number of glazings	Dimensionless	-	integer	[1;+Inf]	1
	The number of identical glass covers on the thermal storage wall.					
11	Spacing between wall and glazing	Length	m	real	[0.0;+Inf]	0.1
	The distance between the outside surface of the thermal storage wall and the first glazing cover.					
12	Vent outlet area	Area	m^2	real	[0.0;+Inf]	0.25
	The total outlet area of the vent.					
13	Distance between vents	Length	m	real	[0.0;+Inf]	2.0
	The vertical distance between the inlet and outlet vents in the thermal storage wall.					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Control function	Dimensionless	-	integer	[-1;+1]	0
	The control function determines whether mass flow of air is allowed and to what sink the air is exchanged. If the control signal = 1, the air in the gap is exchanged with air from the room.					

	If the control signal = -1, the air in the gap is exchanged with air from the ambient. If the control signal is neither 1 nor -1, there is assumed to be no air flow through the gap.					
2	Room temperature	Temperature	C	real	[-Inf;+Inf]	10
	The temperature of the air in the room to which the thermal storage wall is attached.					
3	Ambient temperature	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the ambient air.					
4	Wind speed	Velocity	m/s	real	[0.0;+Inf]	1.0
	The speed of the wind across the outside surface of the thermal storage wall.					
5	Outside loss coefficient	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[-Inf;+Inf]	20.0
	The overall heat transfer coefficient from the first glazing of the thermal storage wall to the ambient.					
6	Inside loss coefficient	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[0.0;+Inf]	11.0
	The overall loss coefficient from the inside wall surface to the room.					
7	Total radiation	Flux	kJ/hr.m^2	real	[0.0;+Inf]	0.0
	The total solar radiation (beam + sky diffuse + ground reflected diffuse) incident upon the thermal storage wall per unit area.					
8	Glazing transmittance	Dimensionless	-	real	[0.0;1.0]	0.8
	The transmittance of one of the identical glazings covering the thermal storage wall. The transmittance is defined as the ratio of the radiation transmitted through a surface to the total radiation incident upon the surface and therefore, must be between 0 and 1.					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Energy flow to room	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is transferred to the room from the thermal storage wall (includes ventilation and wall heat transfer).					
2	Internal energy change rate	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate of change of the wall internal energy with respect to time (dU/dt). This output is a rate quantity and should be integrated if an energy balance is to be done.					
3	Solar absorption rate	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which solar energy is absorbd by the thermal storage wall.					
4	Thermal losses	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is lost from the thermal storage wall to the ambient.					
5	Wall to room heat transfer	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is transferred from the inside wall surface to the room.					
6	Glazing to ambient heat transfer	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is transferred from the first glazing to the ambient.					
7	Ventilation energy flow	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is transferred due to the flow rate of air through the gap.					
8	Air flow rate	Flow Rate	kg/hr	real	[-Inf;+Inf]	0
	The flow rate of air through the gap in the thermal storage wall.					
9	Outlet air temperature	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the air exiting the gap in the thermal storage wall.					
10	Temperature of first glazing	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the first glazing of the thermal storage wall.					
11	Temperature of wall node	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the specified wall node. Wall node 1 is defined to be the temperature of the outside surface of the wall. Wall node N, where N is the number of wall nodes specified in the derivatives section, is defined to be the temperature of the inside surface of the wall.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
11-11		How many nodes should be used to model the wall?	3	10

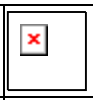
DERIVATIVES

	Name	Dimension	Unit	Type	Range	Default
1	Initial temperature of wall node	Temperature	C	real	[-Inf;+Inf]	0
	The initial temperature of the specified wall node. Wall node 1 is defined to be the outside surface of the wall. Wall node N, where N is the total number of wall nodes specified, is defined to be the inside surface of the wall.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
1-1		How many nodes should be used to model the wall?	3	10

4.7.6.3. Flowrate, Transmittance as Inputs

Icon		TRNSYS Model	Type 36
Proforma	Loads and Structures\Thermal Storage Wall\Flowrate, Transmittance as Inputs\Type36a.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Mode	Dimensionless	-	integer	[1;1]	1
	Setting this parameter to 1 indicates to the general thermal storage wall model that the air flow rate and the transmittance will be set as inputs.					
2	Wall height	Length	m	real	[0.0;+Inf]	3
	The height of the thermal storage wall.					
3	Wall width	Length	m	real	[0.0;+Inf]	2.0
	The width of the thermal storage wall.					
4	Wall thickness	Length	m	real	[0.0;+Inf]	0.3
	The thickness of the thermal storage wall.					
5	Wall conductivity	Thermal Conductivity	kJ/hr.m.K	real	[0.0;+Inf]	2.0
	The effective thermal conductivity of the thermal storage wall.					
6	Wall specific capacitance	any	any	real	[0.0;+Inf]	3000.0
	The product of the wall density and wall specific heat.					
7	Wall solar absorptance	Dimensionless	-	real	[0.0;1.0]	0.7
	The solar absorptance of the thermal storage wall. The absorptance is a ratio of the radiation absorbed by a surface to the total radiation incident upon the surface, and therefore, must be between 0 and 1.					
8	Wall emittance	Dimensionless	-	real	[0.0;1.0]	0.8
	The emittance of the outside surface of the thermal storage wall. The emittance is defined as the ratio of the radiation emitted by a surface to the radiation emitted by a black body (the perfect emitter) at the same temperature. The emittance must therefore be between 0 and 1.					
9	Glazing emittance	Dimensionless	-	real	[0.0;1.0]	0.1
	The emittance of the glazing material. The emittance is defined as the ratio of radiation emitted by a surface to the radiation emited by a black body (the perfect emitter) at the same temperature. The emittance must therefore be between 0 and 1.					
10	Number of glazings	Dimensionless	-	integer	[1;+Inf]	1
	The number of identical glass covers on the thermal storage wall.					
11	Spacing between wall and glazing	Length	m	real	[0.0;+Inf]	0.1
	The distance between the outside surface of the thermal storage wall and the first glazing cover.					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Control function	Dimensionless	-	integer	[-1;+1]	0
	The control function determines whether mass flow of air is allowed and to what sink the air is exchanged. If the control signal = 1, the air in the gap is exchanged with air from the room. If the control signal = -1, the air in the gap is exchanged with air from the ambient. If the control signal is neither 1 nor -1, there is assumed to be no air flow through the gap.					
2	Room temperature	Temperature	C	real	[-Inf;+Inf]	10
	The temperature of the air in the room to which the thermal storage wall is attached.					
3	Ambient temperature	Temperature	C	real	[-Inf;+Inf]	0

	The temperature of the ambient air.					
4	Wind speed	Velocity	m/s	real	[0.0;+Inf]	1.0
	The speed of the wind across the outside surface of the thermal storage wall.					
5	Outside loss coefficient	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[-Inf;+Inf]	20.0
	The overall heat transfer coefficient from the first glazing of the thermal storage wall to the ambient.					
6	Inside loss coefficient	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[0.0;+Inf]	11.0
	The overall loss coefficient from the inside wall surface to the room.					
7	Total radiation	Flux	kJ/hr.m^2	real	[0.0;+Inf]	0.0
	The total solar radiation (beam + sky diffuse + ground reflected diffuse) incident upon the thermal storage wall per unit area.					
8	Glazing transmittance	Dimensionless	-	real	[0.0;1.0]	0.8
	The transmittance of one of the identical glazings covering the thermal storage wall. The transmittance is defined as the ratio of the radiation transmitted through a surface to the total radiation incident upon the surface and therefore, must be between 0 and 1.					
9	Inlet air flow rate	Flow Rate	kg/hr	real	[0.0;+Inf]	1.0
	The flow rate of air through the gap in the thermal storage wall.					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Energy flow to room	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is transferred to the room from the thermal storage wall (includes ventilation and wall heat transfer).					
2	Internal energy change rate	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate of change of the wall internal energy with respect to time (dU/dt). This output is a rate quantity and should be integrated if an energy balance is to be done.					
3	Solar absorption rate	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which solar energy is absorbd by the thermal storage wall.					
4	Thermal losses	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is lost from the thermal storage wall to the ambient.					
5	Wall to room heat transfer	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is transferred from the inside wall surface to the room.					
6	Glazing to ambient heat transfer	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is transferred from the first glazing to the ambient.					
7	Ventilation energy flow	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is transferred due to the flow rate of air through the gap.					
8	Air flow rate	Flow Rate	kg/hr	real	[-Inf;+Inf]	0
	The flow rate of air through the gap in the thermal storage wall.					
9	Outlet air temperature	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the air exiting the gap in the thermal storage wall.					
10	Temperature of first glazing	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the first glazing of the thermal storage wall.					
11	Temperature of wall node	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the specified wall node. Wall node 1 is defined to be the temperature of the outside surface of the wall. Wall node N, where N is the number of wall nodes specified in the derivatives section, is defined to be the temperature of the inside surface of the wall.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
11-11		How many nodes should be used to model the wall?	3	10

DERIVATIVES

	Name	Dimension	Unit	Type	Range	Default
1	Initial temperature of wall node	Temperature	C	real	[-Inf;+Inf]	0
	The initial temperature of the specified wall node. Wall node 1 is defined to be the outside surface of the wall. Wall node N, where N is the total number of wall nodes specified, is defined to be the inside surface of the wall.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
1-1		How many nodes should be used to model the wall?	3	10

4.7.6.4. Flowrate, Transmittance Calculated Internally

Icon		TRNSYS Model	Type 36
Proforma	Loads and Structures\Thermal Storage Wall\Flowrate, Transmittance Calculated Internally\Type36d.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Mode	Dimensionless	-	integer	[4;4]	4
	Setting this parameter to 4 indicates to the general thermal storage wall model that the air flow rate and the transmittance will be calculated internally.					
2	Wall height	Length	m	real	[0.0;+Inf]	3
	The height of the thermal storage wall.					
3	Wall width	Length	m	real	[0.0;+Inf]	2.0
	The width of the thermal storage wall.					
4	Wall thickness	Length	m	real	[0.0;+Inf]	0.3
	The thickness of the thermal storage wall.					
5	Wall conductivity	Thermal Conductivity	kJ/hr.m.K	real	[0.0;+Inf]	2.0
	The effective thermal conductivity of the thermal storage wall.					
6	Specific capacitance of wall	any	any	real	[0.0;+Inf]	3000.0
	The product of the wall density and wall specific heat.					
7	Wall solar absorptance	Dimensionless	-	real	[0.0;1.0]	0.7
	The solar absorptance of the thermal storage wall. The absorptance is a ratio of the radiation absorbed by a surface to the total radiation incident upon the surface, and therefore, must be between 0 and 1.					
8	Wall emittance	Dimensionless	-	real	[0.0;1.0]	0.8
	The emittance of the outside surface of the thermal storage wall. The emittance is defined as the ratio of the radiation emitted by a surface to the radiation emitted by a black body (the perfect emitter) at the same temperature. The emittance must therefore be between 0 and 1.					
9	Glazing emittance	Dimensionless	-	real	[0.0;1.0]	0.1
	The emittance of the glazing material. The emittance is defined as the ratio of radiation emitted by a surface to the radiation emited by a black body (the perfect emitter) at the same temperature. The emittance must therefore be between 0 and 1.					
10	Number of glazings	Dimensionless	-	integer	[1;+Inf]	1
	The number of identical glass covers on the thermal storage wall.					
11	Spacing between wall and glazing	Length	m	real	[0.0;+Inf]	0.1
	The distance between the outside surface of the thermal storage wall and the first glazing cover.					
12	Extinction	Dimensionless	-	real	[0.0;+Inf]	0.0026
	The product of the extinction coefficient and the glazing thickness for one of the identical glass covers of the thermal storage wall (KL product).					
13	Refractive index	Dimensionless	-	real	[0.0;+Inf]	1.526
	The index of refraction of one of the identical glass covers of the thermal storage wall.					
14	Vent outlet area	Area	m^2	real	[0.0;+Inf]	0.25
	The total outlet area of the vent.					
15	Distance between vents	Length	m	real	[0.0;+Inf]	2.0
	The vertical distance between the inlet and outlet vents in the thermal storage wall.					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Control function	Dimensionless	-	integer	[-1;+1]	0
	The control function determines whether mass flow of air is allowed and to what sink the air is exchanged. If the control signal = 1, the air in the gap is exchanged with air from the room. If the control signal = -1, the air in the gap is exchanged with air from the ambient. If the control signal is neither 1 nor -1, there is assumed to be no air flow through the gap.					
2	Room temperature	Temperature	C	real	[-Inf;+Inf]	10
	The temperature of the air in the room to which the thermal storage wall is attached.					
3	Ambient temperature	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the ambient air.					
4	Wind speed	Velocity	m/s	real	[0.0;+Inf]	1.0
	The speed of the wind across the outside surface of the thermal storage wall.					
5	Outside loss coefficient	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[-Inf;+Inf]	20.0
	The overall heat transfer coefficient from the first glazing of the thermal storage wall to the ambient.					
6	Inside loss coefficient	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[0.0;+Inf]	11.0
	The overall loss coefficient from the inside wall surface to the room.					
7	Total radiation	Flux	kJ/hr.m^2	real	[0.0;+Inf]	0.0
	The total solar radiation (beam + sky diffuse + ground reflected diffuse) incident upon the thermal storage wall per unit area.					
8	Beam radiation	Flux	kJ/hr.m^2	real	[0.0;+Inf]	0.0
	The beam radiation incident on the outer glazing of the thermal storage wall per unit area.					
9	Incidence angle	Direction (Angle)	degrees	real	[0.0;90.0]	10.0
	The angle of incidence of beam radiation on the outer glazing of the thermal storage wall.					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Energy flow to room	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is transferred to the room from the thermal storage wall (includes ventilation and wall heat transfer).					
2	Internal energy change rate	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate of change of the wall internal energy with respect to time (dU/dt). This output is a rate quantity and should be integrated if an energy balance is to be done.					
3	Solar absorption rate	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which solar energy is absorbd by the thermal storage wall.					
4	Thermal losses	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is lost from the thermal storage wall to the ambient.					
5	Wall to room heat transfer	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is transferred from the inside wall surface to the room.					
6	Glazing to ambient heat transfer	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is transferred from the first glazing to the ambient.					
7	Ventilation energy flow	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is transferred due to the flow rate of air through the gap.					
8	Air flow rate	Flow Rate	kg/hr	real	[-Inf;+Inf]	0
	The flow rate of air through the gap in the thermal storage wall.					
9	Outlet air temperature	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the air exiting the gap in the thermal storage wall.					
10	Temperature of first glazing	Temperature	C	real	[-Inf;+Inf]	0

	The temperature of the first glazing of the thermal storage wall.					
11	Temperature of wall node	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the specified wall node. Wall node 1 is defined to be the temperature of the outside surface of the wall. Wall node N, where N is the number of wall nodes specified in the derivatives section, is defined to be the temperature of the inside surface of the wall.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
11-11		How many nodes should be used to model the wall?	3	10

DERIVATIVES

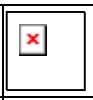
	Name	Dimension	Unit	Type	Range	Default
1	Initial temperature of wall node	Temperature	C	real	[-Inf;+Inf]	0
	The initial temperature of the specified wall node. Wall node 1 is defined to be the outside surface of the wall. Wall node N, where N is the total number of wall nodes specified, is defined to be the inside surface of the wall.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
1-1		How many nodes should be used to model the wall?	3	10

4.7.7. Window

4.7.7.1. Measured Data

Icon		TRNSYS Model	Type 35
Proforma	Loads and Structures\Window\Measured Data\Type35a.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Window mode	Dimensionless	-	integer	[1;1]	1
	Setting this parameter to 1 informs the general window component that the transmittance is to be supplied as an input.					
2	Area	Area	m^2	real	[0.0;+Inf]	1.50
	The area of the window.					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Room temperature	Temperature	C	real	[-Inf;+Inf]	22.0
	The temperature of the room in which the window is located.					
2	Ambient temperature	Temperature	C	real	[-Inf;+Inf]	10.0
	The temperature of the environment to which the window is subjected.					
3	Loss coefficient	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[0.0;+Inf]	3.0
	The heat transfer coefficient of the window. Typical values may be found in the ASHRAE Handbook of Fundamentals.					
4	Total solar radiation	Flux	kJ/hr.m^2	real	[0.0;+Inf]	0.0
	The total solar radiation (beam + sky diffuse + ground reflected diffuse) incident upon the window per unit area.					
5	Window transmittance	Dimensionless	-	real	[0.0;1.0]	0.65
	The average transmittance of the window over the timestep. The transmittance is defined as the ratio of transmitted radiation to the total incident solar radiation and therefore must be between 0 and 1.					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Energy flow to room	Power	kJ/hr	real	[-Inf;+Inf]	0
	The net rate at which energy is transferred to the room. This quantity includes both transmitted solar radiation and heat transfer to the environment.					
2	Solar radiation to room	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which solar radiation is transmitted to the room through the window.					
3	Thermal energy to room	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate of thermal energy transfer to the room from the environment.					

4.7.7.2. Theoretical

Icon		TRNSYS Model	Type 35
Proforma	Loads and Structures\Window\Theoretical\Type35b.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Window mode	Dimensionless	-	integer	[2;2]	2
	Setting this parameter to 2 informs the general window component that the transmittance is to be calculated as a function of the material properties.					
2	Area	Area	m^2	real	[0.0;+Inf]	1.50
	The area of the window.					
3	Number of glazings	Dimensionless	-	integer	[1;+Inf]	1
	The number of identical glazings in the window to be modeled.					
4	Extinction	Dimensionless	-	real	[0.0;+Inf]	0.0026
	The product of the extinction coefficient of one of the identical glazings and the thickness of the glazing (KL product).					
5	Refractive index	Dimensionless	-	real	[0.0;+Inf]	1.526
	The index of refraction of one of the identical glazings of the window.					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Room temperature	Temperature	C	real	[-Inf;+Inf]	22.0
	The temperature of the room in which the window is located.					
2	Ambient temperature	Temperature	C	real	[-Inf;+Inf]	10.0
	The temperature of the environment to which the window is subjected.					
3	Loss coefficient	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[0.0;+Inf]	3.0
	The heat transfer coefficient of the window. Typical values may be found in the ASHRAE Handbook of Fundamentals.					
4	Total solar radiation	Flux	kJ/hr.m^2	real	[0.0;+Inf]	0.0
	The total solar radiation (beam + sky diffuse + ground reflected diffuse) incident upon the window per unit area.					
5	Beam radiation	Flux	kJ/hr.m^2	real	[0.0;+Inf]	0.0
	The beam radiation per unit area incident upon the window surface.					
6	Incidence angle	Direction (Angle)	degrees	real	[0.0;+90.0]	20.0
	The angle of incidence of beam radiation on the window surface.					

OUTPUTS

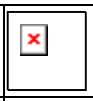
	Name	Dimension	Unit	Type	Range	Default
1	Energy flow to room	Power	kJ/hr	real	[-Inf;+Inf]	0
	The net rate at which energy is transferred to the room. This quantity includes both transmitted solar radiation and heat transfer to the environment.					
2	Solar radiation to room	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which solar radiation is transmitted to the room through the window.					
3	Thermal energy to room	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate of thermal energy transfer to the room from the environment.					
4	Beam energy to room	Power	kJ/hr	real	[-Inf;+Inf]	0

	The rate at which beam solar radiation enters the room.					
5	Overall transmittance	Dimensionless	-	real	[-Inf;+Inf]	0
	The overall transmittance of the window to solar radiation.					
6	Beam transmittance	Dimensionless	-	real	[-Inf;+Inf]	0
	The transmittance of the window to beam radiation.					
7	Diffuse transmittance	Dimensionless	-	real	[-Inf;+Inf]	0
	The transmittance of the window to sky diffuse and ground reflected solar radiation.					

4.8. Obsolete

4.8.1. Absorption Air Conditioners (Type7)

4.8.1.1. Energy Rate Control

Icon		TRNSYS Model	Type 7
Proforma	Obsolete\Absorption Air Conditioners (Type7)\Energy Rate Control\Type7b.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Chiller model	Dimensionless	-	integer	[1;2]	1
	Users have the choice of using correlations from one of two commercially availbale Lithium Bromide - Water absorption chillers: 1= Use correlations from the Arkla Model WFC-7.5; a nominal 7.5 ton machine. 2 = Use correlations from the Yazaki Model WF-36; a nominal 3-ton machine.					
2	Auxiliary heat mode	Dimensionless	-	integer	[1;4]	1
	The chiller model has 4 possibilities for auxiliary heating; series heat auxiliary, parallel heat auxiliary, series/parallel auxiliary, and no auxiliary. See the abstract for more details. Choose one of the following control strategies: 4 = energy rate control with no auxiliary 3 = energy rate control with series/parallel auxiliary 2 = energy rate control with parallel auxiliary 1 = energy rate control with series auxiliary					
3	Nominal capacity	Power	kJ/hr	real	[0.0;+Inf]	37980.0
	The nominal capacity of the absorption chiller. The correlations will be scaled up or down depending on the capacity.					
4	Minimum primary temperature for cooling	Temperature	C	real	[-Inf;+Inf]	76.7
	The minimum primary source temperature required for cooling. This temperature is used if the auxiliary heat mode (Par. 2) is set to no auxiliary (4). In this case, the chiller will cease to operate if the generator source stream falls below this minimum temperature. This temperature is also used to calculate whether the primary source will be used in the other three auxiliary modes. Refer to the abstract for more details.					
5	Controller dead band	Temp. Difference	deltaC	real	[0.0;+Inf]	5.0
	The dead band temperature difference for the primary source controller. The controller for the primary source works in the following manner: If the primary source was on at the last timestep: Primary is on if primary source temperature is greater than the minimum temperature and off otherwise If the primary source was off at the last timestep: Primary is on if primary source temperature is greater than the minimum temperature + the controller deadband and off otherwise The minimum temperature is the maximum of 76.7 C or the minimum primary source temperature (Par. 4).					
6	Auxiliary heat temperature	Temperature	C	real	[-Inf;+Inf]	85.0
	The temperature of the auxiliary heat supply. To provide cooling when the primary source temperature is not high enough, three auxiliary heat modes are included in this component. In series heat auxiliary, the firing water stream from the primary source is raised to a set temperature (this parameter) when auxiliary is required. The					

	heated stream passes through the generator and is then returned to the primary source. In parallel heat auxiliary, only one heat source is used at a time. When the firing water temperature is too low, all the energy needed to run the chiller is provided by an auxiliary flow loop and the primary source is bypassed. In series/parallel auxiliary mode, parallel auxiliary is used when the primary source temperature is below a set changeover temperature (Par. 8), and series auxiliary is used when the primary source temperature is above the changeover temperature. This parameter should be considered to be the minimum temperature required for the chiller to operate efficiently.					
7	Cooling tower approach	Temperature	C	real	[0.0;+Inf]	8.0
	The cooling tower for the absorption chiller is 'modeled' using a constant approach to ambient wet bulb temperature. This method gives a modeled condensing water temperature of: Condensing temp. = Wet bulb temp. + Cooling tower approach					
8	Crossover temperature for auxiliary	Temperature	C	real	[-Inf;+Inf]	80.0
	The crossover temperature for auxiliary heating when in the series/parallel auxiliary heating mode. The primary source is used when its temperature is above this crossover temperature and and the auxiliary source is used when the primary source temperature is below this crossover temperature.					

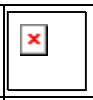
INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Primary source temperature	Temperature	C	real	[-Inf;+Inf]	90.0
	The temperature of the primary source hot water supplied to the generator of the absorption chiller.					
2	Firing water flow rate	Flow Rate	kg/hr	real	[0.0;+Inf]	100.0
	The flow rate of firing water supplied to the generator of the absorption chiller. ATTENTION: This input is used for visualization and convergence checking purposes only. This component sets the flowrate					
3	Wet bulb temperature	Temperature	C	real	[-Inf;+Inf]	18.0
	The ambient wet bulb temperature to which cooling tower is subjected.					
4	Cooling required	Power	kJ/hr	real	[-Inf;+Inf]	0.0
	The cooling load to be met by the absorption chiller. In energy rate control, the absorption chiller will exactly meet this load (if possible) responding instantly to changing operating conditions.					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Hot water return temperature	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the firing water as it leaves the generator of the absorption chiller.					
2	Hot water flowrate	Flow Rate	kg/hr	real	[-Inf;+Inf]	0
	The flow rate of hot firing water leaving the generator of the absorption chiller.					
3	Cooling rate	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate of cooling provided by the absorption chiller.					
4	Generator heat flow	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate of energy transferred from the firing water to the generator of the absorption chiller.					
5	Required auxiliary energy	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate of auxiliary energy required to keep the absorption chiller operating.					

4.8.1.2. Temperature Level Control

Icon		TRNSYS Model	Type 7
Proforma	Obsolete\Absorption Air Conditioners (Type7)\Temperature Level Control\Type7a.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Chiller model	Dimensionless	-	integer	[1;2]	1
	Users have the choice of using correlations from one of two commercially availbale Lithium Bromide - Water absorption chillers: 1= Use correlations from the Arkla Model WFC-7.5; a nominal 7.5 ton machine. 2 = Use correlations from the Yazaki Model WF-36; a nominal 3-ton machine.					
2	Auxiliary heat mode	Dimensionless	-	integer	[-4;-1]	-1
	The chiller model has 4 possibilities for auxiliary heating; series heat auxiliary, parallel heat auxiliary, series/parallel auxiliary, and no auxiliary. See the abstract for more details. Choose one of the following control strategies: -4 = temperature level control with no auxiliary -3 = temperature level control with series/parallel auxiliary -2 = temperature level control with parallel auxiliary -1 = temperature level control with series auxiliary					
3	Nominal capacity	Power	kJ/hr	real	[0.0;+Inf]	37980.0
	The nominal capacity of the absorption chiller. The correlations will be scaled up or down depending on the capacity.					
4	Start-up time constant	Time	hr	real	[-Inf;+Inf]	0.133
	The start-up time constant for the chiller. In temperature level control, the transients associated with start-up and shut down are considered. If the time constant is set less than zero, the nominal value for the Arkla chiller will be used (0.133 hours). The time constants are used to calculate the generator temperature as a function of time.					
5	Cooldown time constant	Time	hr	real	[-Inf;+Inf]	1.05
	The time constant associated with the cool down of the absorption chiller. In temperature level control, the transients associated with start-up and cool down are considered. If the cooldown time constant is set less than zero, the default value for the Arkla chiller will be used (1.05 hours). The time constants are required to calculate the generator temperature as a function of time.					
6	Initial generator temperature	Temperature	C	real	[-Inf;+Inf]	25.0
	The initial temperatue of the generator in the absorption cycle. If the generator temperature falls below a critical generator temperature, no refrigeration will take place. The initial generator temperature is required to solve the differential equation relating heat input to generator temperature.					
7	Minimum primary temperature for cooling	Temperature	C	real	[-Inf;+Inf]	76.7
	The minimum primary source temperature required for cooling. This temperature is used if the auxiliary heat mode (Par. 2) is set to no auxiliary (-4). In this case, the chiller will cease to operate if the generator source stream falls below this minimum temperature. This temperature is also used to calculate whether the primary source will be used in the other three auxiliary modes. Refer to the abstract for more details.					
8	Controller dead band	Temp. Difference	deltaC	real	[0.0;+Inf]	5.0
	The dead band temperature difference for the primary source controller. The controller for the primary source works in the following manner: If the primary source was on at the last timestep: Primary is on if primary source temperature is greater than the minimum temperature and off otherwise If the primary source was off at the last timestep: Primary is on if primary source temperature is greater than the minimum temperature + the controller deadband and off otherwise The minimum temperature is the maximum of 76.7 C or the minimum primary source temperature (Par. 7).					

9	Auxiliary heat temperature	Temperature	C	real	[-Inf;+Inf]	85.0
	The temperature of the auxiliary heat supply. To provide cooling when the primary source temperature is not high enough, three auxiliary heat modes are included in this component. In series heat auxiliary, the firing water stream from the primary source is raised to a set temperature (this parameter) when auxiliary is required. The heated stream passes through the generator and is then returned to the primary source. In parallel heat auxiliary, only one heat source is used at a time. When the firing water temperature is too low, all the energy needed to run the chiller is provided by an auxiliary flow loop and the primary source is bypassed. In series/parallel auxiliary mode, parallel auxiliary is used when the primary source temperature is below a set changeover temperature (Par. 11), and series auxiliary is used when the primary source temperature is above the changeover temperature. This parameter should be considered to be the minimum temperature required for the chiller to operate efficiently.					
10	Cooling tower approach	Temperature	C	real	[0.0;+Inf]	8.0
	The cooling tower for the absorption chiller is 'modeled' using a constant approach to ambient wet bulb temperature. This method gives a modeled condensing water temperature of: Condensing temp. = Wet bulb temp. + Cooling tower approach					
11	Crossover temperature for auxiliary	Temperature	C	real	[-Inf;+Inf]	80.0
	The crossover temperature for auxiliary heating when in the series/parallel auxiliary heating mode. The primary source is used when its temperature is above this crossover temperature and and the auxiliary source is used when the primary source temperature is below this crossover temperature.					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Primary source temperature	Temperature	C	real	[-Inf;+Inf]	90.0
	The temperature of the primary source hot water supplied to the generator of the absorption chiller.					
2	Firing water flow rate	Flow Rate	kg/hr	real	[0.0;+Inf]	100.0
	The flow rate of firing water supplied to the generator of the absorption chiller. ATTENTION: This input is used for visualization and convergence checking purposes only. This component sets the flowrate					
3	Wet bulb temperature	Temperature	C	real	[-Inf;+Inf]	18.0
	The ambient wet bulb temperature to which cooling tower is subjected.					
4	Ambient temperature	Temperature	C	real	[-Inf;+Inf]	22.0
	The ambient temperature to which the absorption chiller is subjected.					
5	Control signal	Dimensionless	-	integer	[0;1]	1
	The input control signal to the absorption chiller. A control signal of 1 indicates that the chiller is enabled to operate. A control signal of 0 indicates that the chiller is not enabled (off).					
6	2nd stage control signal	Dimensionless	-	integer	[0;1]	1
	In temperaure level control, the auxiliary energy system is enabled whenever the primary source temperature falls below the auxiliary temperature and either the 2nd stage control signal is equal to 1 or the primary system is disabled.					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Hot water return temperature	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the firing water as it leaves the generator of the absorption chiller.					
2	Hot water flowrate	Flow Rate	kg/hr	real	[-Inf;+Inf]	0
	The flow rate of firing water leaving the generator of the absorption chiller.					
3	Cooling rate	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate of cooling provided by the absorption chiller.					
4	Generator heat flow	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate of energy transfererred from the firing water to the generator of the absorption chiller.					
5	Required auxiliary energy	Power	kJ/hr	real	[-Inf;+Inf]	0

	The rate of auxiliary energy required to keep the absorption chiller operating.

4.8.2. Calling External DLLs (Type61)

4.8.2.1. Calling External DLLs (Type61)

Icon		TRNSYS Model	Type 61
Proforma	Obsolete\Calling External DLLs (Type61)\Type61.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Parameter	any	any	real	[-Inf;+Inf]	0

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
1-1		How many PARAMETERS does the external component requre?	1	50

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Input	any	any	real	[-Inf;+Inf]	0

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
1-1		How many INPUTS does the external component require?	1	50

OUTPUTS

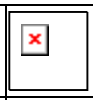
	Name	Dimension	Unit	Type	Range	Default
1	Output	any	any	real	[-Inf;+Inf]	0

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
1-1		How many OUTPUTS does the external component produce?	1	50

4.8.3. Convergence Promoter (Type44)

4.8.3.1. Convergence Promoter (Type44)

Icon		**TRNSYS Model**	Type 44
Proforma	Obsolete\Convergence Promoter (Type44)\Type44.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Number of calls before promotion	Dimensionless	-	integer	[1;+Inf]	7
	The number of times that this component is called before convergence is promoted using a numerical technique.					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Input to be promoted	any	any	real	[-Inf;+Inf]	0.0
	The input which is to be used to promote convergence.					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Estimate of variable	any	any	real	[-Inf;+Inf]	0
	The new estimate of the variable for which convergence is being promoted.					

4.8.4. CSTB Weather Data - TRNSYS 15 (Type9)

4.8.4.1. CSTB Weather Data - TRNSYS 15 (Type9)

Icon		TRNSYS Model	Type 9
Proforma	Obsolete\CSTB Weather Data - TRNSYS 15 (Type9)\Type9f.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Mode	dimensionless	-	integer	[6;6]	-2
	The mode of the data reader. In this model, the mode should be set to -1 indicating that the routine is to read a user's data file where N lines are to be skipped in the data file. N = (Simulation start time/data timestep) - 1 Do not change this parameter.					
2	Header lines to skip	dimensionless	-	real	[0;0]	0
3	No. of values to read	dimensionless	-	integer	[13;13]	13
	How many values are to be read from each line of the data file? If only the 1st, 2nd and 6th values are desired, the model must still read 6 values in this mode.					
4	Time interval of data	Time	hr	real	[1.0;1.0]	1.0
	At what interval of time is the data recorded in the data file? Hourly = 1.0 Daily = 24.0 The data time interval must be an integer multiplier of the simulation timestep. For example if the simulation timestep is 15 minutes, the data time interval could be 15 minutes, half an hour, an hour etc..					
5	Don't interpolate 1	dimensionless	-	integer	[-1;-1]	-1
	This parameter indicates whether the variable in question should be interpolated or not. If the parameter is less than zero, the variable will have its units converted using the next two parameters and NOT be interpolated. If the parameter is greater than zero, the variable will have its units converted using the next two parameters and be interpolated. **** NOTE - THE ABSOLUTE VALUE OF THIS PARAMETER SHOULD INDICATE WHICH VARIBALE IT IS. FOR EXAMPLE, IF THIS PARAMETER WAS -1, IT INDICATES THAT THIS IS THE FIRST VALUE BEING READ FROM THE DATA FILE AND THAT THIS VARIABLE IS NOT TO BE INTERPOLATED. Radiation values should NOT be interpolated - this is the function of the radiation processor.					
6	Multiplication factor 1	dimensionless	-	real	[1;1]	1
	The multiplication factor for the value that was specified in the previous parameter. OUTPUT(i) = VALUE(i) * multiplication factor + addition factor					
7	Addition factor 1	dimensionless	-	real	[0;0]	0
	The addition factor for the value specified in the parameter two before this one. OUTPUT(i) = VALUE(i) * multiplication factor + addition factor					
8	Average value 1	dimensionless	-	real	[0;0]	0
9	Don't interpolate 2	dimensionless	-	integer	[-1;-1]	-2

10	Mult-2	dimensionless	-	real	[1.0;1.0]	1.0
11	Add-2	dimensionless	-	real	[0;0]	0
12	Average value 2	dimensionless	-	real	[0;0]	0
13	Don't interpolate 3	dimensionless	-	integer	[-1;-1]	-3
14	Mult-3	dimensionless	-	real	[1.0;1.0]	1.0
15	Add-3	dimensionless	-	real	[0.0;0.0]	0.0
16	Average value 3	dimensionless	-	real	[0;0]	0
17	Don't interpolate 4	dimensionless	-	integer	[-1;-1]	-4
18	Mult-4 : Wh/m2 -> kJ/m2	dimensionless	-	real	[3.6;3.6]	3.6
19	Add-4	dimensionless	-	real	[0.0;0.0]	0.0
20	Average value 4	dimensionless	-	real	[0;0]	0
21	Don't interpolate 5	dimensionless	-	integer	[-1;-1]	-5
22	Mult-5 : Wh/m2 -> kJ/m2	dimensionless	-	real	[3.6;3.6]	3.6
23	Add-5	dimensionless	-	real	[0.0;0.0]	0.0
24	Average value 5	dimensionless	-	real	[0;0]	0
25	Don't interpolate 6	dimensionless	-	integer	[-1;-1]	-6
26	Mult-6 : Wh/m2 -> kJ/m2	dimensionless	-	real	[3.6;3.6]	3.6
27	Add-6	dimensionless	-	real	[0.0;0.0]	0.0
28	Average value 6	dimensionless	-	real	[0;0]	0
29	Don't interpolate 7	dimensionless	-	integer	[-1;-1]	-7
30	Mult-7	dimensionless	-	real	[1.0;1.0]	1.0
31	Add-7	dimensionless	-	real	[0.0;0.0]	0.0
32	Average value 7	dimensionless	-	real	[0;0]	0
33	Don't interpolate 8	dimensionless	-	integer	[-1;-1]	-8
34	Mult-8	dimensionless	-	real	[1.0;1.0]	1.0
35	Add-8	dimensionless	-	real	[0.0;0.0]	0.0
36	Average value 8	dimensionless	-	real	[0;0]	0
37	Don't interpolate 9	dimensionless	-	integer	[-1;-1]	-9
38	Mult-9	dimensionless	-	real	[1.0;1.0]	1.0
39	Add-9	dimensionless	-	real	[0.0;0.0]	0.0
40	Average value 9	dimensionless	-	real	[0;0]	0
41	Don't interpolate 10	dimensionless	-	integer	[-1;-1]	-10
42	Mult-10	dimensionless	-	real	[1.0;1.0]	1.0
43	Add-10	dimensionless	-	real	[0.0;0.0]	0.0
44	Average value 10	dimensionless	-	real	[0;0]	0
45	Don't interpolate 11	dimensionless	-	real	[-1;-1]	-11
46	Mult-11	dimensionless	-	real	[1.0;1.0]	1.0
47	Add-11	dimensionless	-	real	[0.0;0.0]	0.0
48	Average value 11	dimensionless	-	real	[0;0]	0
49	Don't interpolate 12	dimensionless	-	real	[-1;-1]	-12
50	Mult-12	dimensionless	-	real	[1.0;1.0]	1.0
51	Add-12	dimensionless	-	real	[0.0;0.0]	0.0
52	Average value 12	dimensionless	-	real	[0;0]	0

53	Don't interpolate 13	dimensionless	-	real	[-1;-1]	-13
54	Mult-13	dimensionless	-	real	[1.0;1.0]	1.0
55	Add-13	dimensionless	-	real	[0.0;0.0]	0.0
56	Average value 13	dimensionless	-	real	[0;0]	0
57	Logical unit	dimensionless	-	integer	[1;999]	14
	The logical unit through which the data file will be opened.					
58	Not used	dimensionless	-	integer	[-1;-1]	-1
	This parameter is not used in this mode and should not be changed.					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	1-Month	any	any	real	[-Inf;+Inf]	0
	First value read from data file.					
2	2-Day	any	any	real	[-Inf;+Inf]	0
	Second value read from data file (if PAR 2 > 1).					
3	3-Hour	any	any	real	[-Inf;+Inf]	0
	Third value read from data file (if PAR 2 > 2).					
4	4-Global horizontal radiation	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	Fourth value read from data file (if PAR 2 > 3).					
5	5-Direct horizontal radiation	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	Fifth value read from data file (if PAR 2 > 4).					
6	6-Diffuse horizontal radiation	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	Sixth value read from data file (if PAR 2 > 5).					
7	7-Dry bulb temperature	Temperature	C	real	[-Inf;+Inf]	0
	Seventh value read from data file (if PAR 2 > 6).					
8	8-Sky Temperature	Temperature	C	real	[-Inf;+Inf]	0
	Eigth value read from data file (if PAR 2 > 7)					
9	9-Relative Humidity	dimensionless	-	real	[-Inf;+Inf]	0
	Ninth value read from data file (if PAR 2 > 8).					
10	10-Total nebulosity	any	any	real	[-Inf;+Inf]	0
	Tenth value read from data file (if PAR 2 > 9).					
11	11 - not used	Pressure	Pa	real	[-Inf;+Inf]	0
	Eleventh value read from data file (if PAR 2 > 10).					
12	12 - not used	Velocity	m/s	real	[-Inf;+Inf]	0
	Twelfth value read from data file (if PAR 2 > 11).					
13	13 - not used	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
	Thirteenth value read from data file (if PAR 2 > 12).					
14	14 - not used	any	any	real	[-Inf;+Inf]	0
	Fourteenth value read from data file (if PAR 2 > 13).					
15	15 - not used	any	any	real	[-Inf;+Inf]	0
	Fifteenth value read from data file (if PAR 2 > 14).					
16	16 - not used	any	any	real	[-Inf;+Inf]	0
	Sixteenth value read from data file (if PAR 2 > 15).					
17	17 - not used	any	any	real	[-Inf;+Inf]	0
	Seventeenth value read from data file (if PAR 2 > 16).					
18	18 - not used	dimensionless	-	real	[-Inf;+Inf]	0

19	19 - not used	dimensionless	-	real	[-Inf;+Inf]	0
20	20 - not used	dimensionless	-	real	[-Inf;+Inf]	0
21	21 - not used	dimensionless	-	real	[-Inf;+Inf]	0
22	22 - not used	dimensionless	-	real	[-Inf;+Inf]	0
23	23 - not used	dimensionless	-	real	[-Inf;+Inf]	0
24	24 - not used	dimensionless	-	real	[-Inf;+Inf]	0
25	25 - not used	dimensionless	-	real	[-Inf;+Inf]	0
26	26 - not used	dimensionless	-	real	[-Inf;+Inf]	0
27	27 - not used	dimensionless	-	real	[-Inf;+Inf]	0
28	28 - not used	dimensionless	-	real	[-Inf;+Inf]	0
29	29 - not used	dimensionless	-	real	[-Inf;+Inf]	0
30	30 - not used	dimensionless	-	real	[-Inf;+Inf]	0
31	31 - not used	dimensionless	-	real	[-Inf;+Inf]	0
32	32 - not used	dimensionless	-	real	[-Inf;+Inf]	0
33	33 - not used	dimensionless	-	real	[-Inf;+Inf]	0
34	34 - not used	dimensionless	-	real	[-Inf;+Inf]	0
35	35 - not used	dimensionless	-	real	[-Inf;+Inf]	0
36	36 - not used	dimensionless	-	real	[-Inf;+Inf]	0
37	37 - not used	dimensionless	-	real	[-Inf;+Inf]	0
38	38 - not used	dimensionless	-	real	[-Inf;+Inf]	0
39	39 - not used	dimensionless	-	real	[-Inf;+Inf]	0
40	40 - not used	dimensionless	-	real	[-Inf;+Inf]	0
41	41 - not used	dimensionless	-	real	[-Inf;+Inf]	0
42	42 - not used	dimensionless	-	real	[-Inf;+Inf]	0
43	43 - not used	dimensionless	-	real	[-Inf;+Inf]	0
44	44 - not used	dimensionless	-	real	[-Inf;+Inf]	0
45	45 - not used	dimensionless	-	real	[-Inf;+Inf]	0
46	46 - not used	dimensionless	-	real	[-Inf;+Inf]	0
47	47 - not used	dimensionless	-	real	[-Inf;+Inf]	0
48	48 - not used	dimensionless	-	real	[-Inf;+Inf]	0
49	49 - not used	dimensionless	-	real	[-Inf;+Inf]	0
50	50 - not used	dimensionless	-	real	[-Inf;+Inf]	0
51	51 - not used	dimensionless	-	real	[-Inf;+Inf]	0
52	52 - not used	dimensionless	-	real	[-Inf;+Inf]	0
53	53 - not used	dimensionless	-	real	[-Inf;+Inf]	0
54	54 - not used	dimensionless	-	real	[-Inf;+Inf]	0
55	55 - not used	dimensionless	-	real	[-Inf;+Inf]	0
56	56 - not used	dimensionless	-	real	[-Inf;+Inf]	0
57	57 - not used	dimensionless	-	real	[-Inf;+Inf]	0
58	58 - not used	dimensionless	-	real	[-Inf;+Inf]	0
59	59 - not used	dimensionless	-	real	[-Inf;+Inf]	0
60	60 - not used	dimensionless	-	real	[-Inf;+Inf]	0
61	61 - not used	dimensionless	-	real	[-Inf;+Inf]	0

62	62 - not used	dimensionless	-	real	[-Inf;+Inf]	0
63	63 - not used	dimensionless	-	real	[-Inf;+Inf]	0
64	64 - not used	dimensionless	-	real	[-Inf;+Inf]	0
65	65 - not used	dimensionless	-	real	[-Inf;+Inf]	0
66	66 - not used	dimensionless	-	real	[-Inf;+Inf]	0
67	67 - not used	dimensionless	-	real	[-Inf;+Inf]	0
68	68 - not used	dimensionless	-	real	[-Inf;+Inf]	0
69	69 - not used	dimensionless	-	real	[-Inf;+Inf]	0
70	70 - not used	dimensionless	-	real	[-Inf;+Inf]	0
71	71 - not used	dimensionless	-	real	[-Inf;+Inf]	0
72	72 - not used	dimensionless	-	real	[-Inf;+Inf]	0
73	73 - not used	dimensionless	-	real	[-Inf;+Inf]	0
74	74 - not used	dimensionless	-	real	[-Inf;+Inf]	0
75	75 - not used	dimensionless	-	real	[-Inf;+Inf]	0
76	76 - not used	dimensionless	-	real	[-Inf;+Inf]	0
77	77 - not used	dimensionless	-	real	[-Inf;+Inf]	0
78	78 - not used	dimensionless	-	real	[-Inf;+Inf]	0
79	79 - not used	dimensionless	-	real	[-Inf;+Inf]	0
80	80 - not used	dimensionless	-	string	[-Inf;+Inf]	0
81	81 - not used	dimensionless	-	real	[-Inf;+Inf]	0
82	82 - not used	dimensionless	-	real	[-Inf;+Inf]	0
83	83 - not used	dimensionless	-	real	[-Inf;+Inf]	0
84	84 - not used	dimensionless	-	real	[-Inf;+Inf]	0
85	85 - not used	dimensionless	-	real	[-Inf;+Inf]	0
86	86 - not used	dimensionless	-	real	[-Inf;+Inf]	0
87	87 - not used	dimensionless	-	real	[-Inf;+Inf]	0
88	88 - not used	dimensionless	-	real	[-Inf;+Inf]	0
89	89 - not used	dimensionless	-	real	[-Inf;+Inf]	0
	Eighteenth value read from data file (if PAR 2 = 18).					
90	90 - not used	dimensionless	-	real	[-Inf;+Inf]	0
	The time that the values were last read from the data file. This output is intended to be hooked up to the radiation processor.					
91	91 - not used	dimensionless	-	real	[-Inf;+Inf]	0
92	92 - not used	dimensionless	-	real	[-Inf;+Inf]	0
93	93 - not used	dimensionless	-	real	[-Inf;+Inf]	0
94	94 - not used	dimensionless	-	real	[-Inf;+Inf]	0
95	95 - not used	dimensionless	-	real	[-Inf;+Inf]	0
96	96 - not used	dimensionless	-	real	[-Inf;+Inf]	0
97	97 - not used	dimensionless	-	real	[-Inf;+Inf]	0
98	98 - not used - not used	dimensionless	-	real	[-Inf;+Inf]	0
99	Time of last read	dimensionless	-	real	[-Inf;+Inf]	0
100	Time of next read	Time	hr	real	[-Inf;+Inf]	0
	The time at which the next values will be read from the data file. This output is intended to be hooked up to the radiation processor.					

101	Value at next timestep	any	any	real	[-Inf;+Inf]	0
	The value of the listed output at the next timestep.					

Cycles

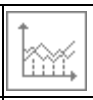
Variable Indices	Associated parameter	Interactive Question	Min	Max
101-101	No. of values to read		1	50

EXTERNAL FILES

Question	File	Associated parameter
Which file contains the data to be read by this component?	.\Examples\Weather Data\Nice.dat	Logical unit
Source file	.\SourceCode\Types\Type9.for	

4.8.5. Plotter (Type26)

4.8.5.1. Plotter (Type26)

Icon		TRNSYS Model	Type 26
Proforma	Obsolete\Plotter (Type26)\Type26.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Plotting interval	Time	hr	real	[-12;+Inf]	1
	The time interval at which the inputs are to be plotted. Specifiying a negative parameter indicates that the absoulte value of this parameter will be used to specify the print interval in months.					
2	Time to start plotting	Time	hr	real	[0;+Inf]	0
	The hour of the year at which plotting is to begin.					
3	Time to stop plotting	Time	hr	real	[0;+Inf]	8760
	The hour of the year at which plotting is to stop.					
4	Scaling Mode	Dimensionless	-	integer	[-1;+1]	1
	The scaling mode for the plotter component: -1 --> Scale all inputs individually +1 --> Use the same scale for all inputs					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Input to be plotted	any	any		[-Inf;+Inf]	label
	The input to be plotted. Use the initial value box for the label associated with the input (up to 6 characters).					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
1-1		How many inputs are to be plotted by this plotting device?	1	5

4.8.6. Radiation Processors With Smoothing (Type16)

4.8.6.1. Beam and Diffuse Known (Mode=3)

Icon		TRNSYS Model	Type 16
Proforma	Obsolete\Radiation Processors With Smoothing (Type16)\Beam and Diffuse Known (Mode=3)\Type16f.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Horiz. radiation mode	Dimensionless	-	integer	[3;3]	4
	See the general description for an explanation of all horizontal radiation modes. This proforma corresponds to Mode 3 (Horizontal Beam and Diffuse Radiation Known)					
2	Tracking mode	Dimensionless	-	integer	[1;4]	1
	Surface Tracking Mode: 1 = Fixed surface 2 = Single axis tracking; vertical axis, fixed slope, variable azimuth 3 = Single axis tracking; axis parallel to surface 4 = Two-axis tracking Refer to the abstract for more details.					
3	Tilted surface mode	Dimensionless	-	integer	[1;4]	3
	Tilted Surface Rdaition Mode: 1 = Isotropic sky model 2 = Hay and Davies model 3 = Reindl model 4 = Perez model Refer to the abstract for more details					
4	Starting day	Time	day	real	[1;+Inf]	1
	The day of the year corresponding to the simulation start time. Every time the simulation start time is changed, the starting day must be changed or the radiation calculations will be inaccurate. A commonly used workaround to set the starting day to the correct value in all circumstances is to add the following lines to the "simulations cards" (in "Assembly/Control Cards"): EQUATIONS 1 STARTDAY=INT(START/24)+1 (START is a default TRNSYS variable) You can then set the Type of this parameter to "String" and type in STARTDAY for the value.					
5	Latitude	Dimensionless	-	real	[-90.0;90.0]	43.10
	The latitude of the location being investigated.					
6	Solar constant	Flux	kJ/hr.m^2	real	[0.0;+Inf]	4871.0
	The solar constant.					
7	Shift in solar time	Direction (Angle)	degrees	real	[-40;30]	0.0
	Since many of the calculations made in transforming insolation on a horizontal surface depend on the time of day, it is important that the correct solar time be used. This parameter is used to account for the differences between solar time and local time. The equation for the shift parameter is: SHIFT = Lst - Lloc where Lst is the standard meridian for the local time zone, and Lloc is the longitude of the location in question. Longitude angles are positive towards West, negative towards East. (See manual for examples and additional notes.)					

8	Not used	Dimensionless	-	integer	[1;1]	2
	This parameter is not used in this mode of the radiation processor.					
9	Solar time?	Dimensionless	-	integer	[-1;+1]	-1
	If the radiation data being supplied to the radiation processor is at even intervals of solar time (as the TMY data is) then this parameter should be set to a negative number so that the 7th parameter (Shift in Solar Time) is ignored. If the data being supplied is at even intervals of local time, this value should be set positive so that the seventh parameter is used.					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Beam radiation on horizontal	Flux	kJ/hr.m^2	real	[0.0;+Inf]	0.0
	The total radiation on a horizontal surface.					
2	Diffuse radiation on horizontal	Flux	kJ/hr.m^2	real	[0.0;+Inf]	0
3	Time of last data read	Time	hr	real	[0.0;+Inf]	0.0
	The time of the last reading of the external file containing the weather data. Typically from the 19th Output of the data reader component.					
4	Time of next data read	Time	hr	real	[0.0;+Inf]	1.0
	The time that the next weather information will be read from the external data file. This input is typicall hooked up the the 20th Output of the data reader component.					
5	Ground reflectance	Dimensionless	-	real	[0.0;1.0]	0.2
	The reflectance of the ground above which the surface is located. Typical values are 0.2 for ground not covered by snow and 0.7 for ground covered by snow.					
6	Slope of surface	Direction (Angle)	degrees	real	[-360;+360]	0.0
	The slope of the surface or tracking axis. The slope is positive when tilted in the direction of the azimuth. 0 = Horizontal ; 90 = Vertical facing toward azimuth Refer to the abstract for details on slope specification for tracking surfaces.					
7	Azimuth of surface	Direction (Angle)	degrees	real	[-360;+360]	0.0
	The solar azimuth angle is the angle between the local meridian and the projection of the line of sight of the sun onto the horizontal plane. The reference is as follows: 0 = Facing equator 90 = Facing West 180 (or -180) = Facing away from the equator -90 (or 270) = Facing East (See manual for examples) Refer to the abstract for details on the azimuth parameter for tracking surfaces.					
8	Beam radiation on horizontal at next timestep	Flux	kJ/hr.m^2	real	[0;+Inf]	0
9	Diffuse radiation at next timestep	Flux	kJ/hr.m^2	real	[0;+Inf]	0

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
6-7		How many surfaces are to be evaluated by this radiation processor?	1	8

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Extraterrestrial on horizontal	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The extraterrestrial radiation on a horizontal surface.					
2	Solar zenith angle	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
	The zenith angle is the angle between the vertical and the line of sight of the sun.					

3	Solar azimuth angle	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
	The solar azimuth angle is defined as being the angle between the local meridian and the projection of the line of sight of the sun onto the horizontal plane.					
4	Total horizontal radiation	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The total radiation incident on a horizontal surface. The total radiation is equal to the beam radiation + sky diffuse radiation + ground reflected diffuse radiation.					
5	Beam radiation on horizontal	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
6	Horizontal diffuse radiation	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The diffuse radiation (sky only) on a horizontal surface.					
7	Total radiation on surface 1	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The total radiation on the tilted surface (beam + sky diffuse + ground reflected diffuse).					
8	Beam radiation on surface 1	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The beam radiation on the first surface specified.					
9	Sky diffuse on surface 1	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The sky diffuse radiation incident on the first surface specified.					
10	Incidence angle for surface 1	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
	The angle of incidence of the beam radiation on the first surface specified.					
11	Slope of surface 1	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
	The slope of the first surface specified.					
12	Total radiation on surface 2	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The total radiation (beam + sky diffuse + ground reflected diffuse) on the second surface that was specified.					
13	Beam radiation on surface 2	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The beam radiation incident on the second specified surface.					
14	Sky diffuse on surface 2	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
15	Incidence angle of surface 2	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
	The angle of incidence of the beam radiation on the second surface specified.					
16	Slope of surface 2	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
17	Total radiation on surface 3	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The total radiation (beam + sky diffuse + ground reflected diffuse) incident on the third surface specified.					
18	Beam radiation on surface 3	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The beam radiation on the third surface specified.					
19	Sky diffuse on surface 3	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
20	Incidence angle of surface 3	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
	The angle of incidence of the beam radiation on the third surface specified.					
21	Slope of surface 3	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
22	Total radiation on surface 4	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The total radiation (beam + sky diffuse + ground reflected diffuse) incident on the fourth surface specified.					
23	Beam radiation on surface 4	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The beam radiation incident on the fourth surface specified.					
24	Sky diffuse on surface 4	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The angle of incidence of the beamradiation on the fourth surface specified.					
25	Incidence angle of surface 4	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
26	Slope of surface 4	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
27	Total radiation on surface 5	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
28	Beam radiation on surface 5	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
29	Sky diffuse radiation on surface 5	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0

30	Incidence angle of surface 5	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
31	Slope of surface 5	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
32	Total radiation on surface 6	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
33	Beam radiation on surface 6	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
34	Sky diffuse radiation on surface 6	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
35	Incidence angle of surface 6	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
36	Slope of surface 6	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
37	Total radiation on surface 7	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
38	Beam radiation on surface 7	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
39	Sky diffuse radiation on surface 7	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
40	Incidence angle of surface 7	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
41	Slope of surface 7	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
42	Total radiation on surface 8	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
43	Beam radiation on surface 8	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
44	Sky diffuse radiation on surface 8	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
45	Incidence angle of surface 8	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
46	Slope of surface 8	Direction (Angle)	degrees	real	[-Inf;+Inf]	0

4.8.6.2. Total Horiz Only Known (Mode=1)

Icon		TRNSYS Model	Type 16
Proforma	Obsolete\Radiation Processors With Smoothing (Type16)\Total Horiz Only Known (Mode=1)\Type16b.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Horiz. radiation mode	Dimensionless	-	integer	[1;1]	4
	See the general description for an explanation of all horizontal radiation modes. This proforma corresponds to Mode 1 (Only Horizontal Known, Reduced Reindl Correlation)					
2	Tracking mode	Dimensionless	-	integer	[1;4]	1
	Surface Tracking Mode: 1 = Fixed surface 2 = Single axis tracking; vertical axis, fixed slope, variable azimuth 3 = Single axis tracking; axis parallel to surface 4 = Two-axis tracking Refer to the abstract for more details.					
3	Tilted surface mode	Dimensionless	-	integer	[1;4]	3
	Tilted Surface Rdaition Mode: 1 = Isotropic sky model 2 = Hay and Davies model 3 = Reindl model 4 = Perez model Refer to the abstract for more details					
4	Starting day	Time	day	real	[1;+Inf]	1
	The day of the year corresponding to the simulation start time. Every time the simulation start time is changed, the starting day must be changed or the radiation calculations will be inaccurate. A commonly used workaround to set the starting day to the correct value in all circumstances is to add the following lines to the "simulations cards" (in "Assembly/Control Cards"): EQUATIONS 1 STARTDAY=INT(START/24)+1 (START is a default TRNSYS variable) You can then set the Type of this parameter to "String" and type in STARTDAY for the value.					
5	Latitude	Dimensionless	-	real	[-90.0;90.0]	43.10
	The latitude of the location being investigated.					
6	Solar constant	Flux	kJ/hr.m^2	real	[0.0;+Inf]	4871.0
	The solar constant.					
7	Shift in solar time	Direction (Angle)	degrees	real	[-40;30]	0.0
	Since many of the calculations made in transforming insolation on a horizontal surface depend on the time of day, it is important that the correct solar time be used. This parameter is used to account for the differences between solar time and local time. The equation for the shift parameter is: SHIFT = Lst - Lloc where Lst is the standard meridian for the local time zone, and Lloc is the longitude of the location in question. Longitude angles are positive towards West, negative towards East. (See manual for examples and additional notes.)					
8	Not used	Dimensionless	-	integer	[1;1]	2
	This parameter is not used in this mode of the radiation processor.					
9	Solar time?	Dimensionless	-	integer	[-1;+1]	-1
	If the radiation data being supplied to the radiation processor is at even intervals of solar time (as the TMY data is) then this parameter should be set to a negative number so that the 7th parameter (Shift in Solar Time) is					

	ignored. If the data being supplied is at even intervals of local time, this value should be set positive so that the seventh parameter is used.

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Radiation on horizontal	Flux	kJ/hr.m^2	real	[0.0;+Inf]	0.0
	The total radiation on a horizontal surface.					
2	Time of last data read	Time	hr	real	[0.0;+Inf]	0.0
	The time of the last reading of the external file containing the weather data. Typically from the 19th Output of the data reader component.					
3	Time of next data read	Time	hr	real	[0.0;+Inf]	1.0
	The time that the next weather information will be read from the external data file. This input is typicall hooked up the the 20th Output of the data reader component.					
4	Ground reflectance	Dimensionless	-	real	[0.0;1.0]	0.2
	The reflectance of the ground above which the surface is located. Typical values are 0.2 for ground not covered by snow and 0.7 for ground covered by snow.					
5	Slope of surface	Direction (Angle)	degrees	real	[-360;+360]	0.0
	The slope of the surface or tracking axis. The slope is positive when tilted in the direction of the azimuth. 0 = Horizontal ; 90 = Vertical facing toward azimuth Refer to the abstract for details on slope specification for tracking surfaces.					
6	Azimuth of surface	Direction (Angle)	degrees	real	[-360;+360]	0.0
	The solar azimuth angle is the angle between the local meridian and the projection of the line of sight of the sun onto the horizontal plane. The reference is as follows: 0 = Facing equator 90 = Facing West 180 (or -180) = Facing away from the equator -90 (or 270) = Facing East (See manual for examples) Refer to the abstract for details on the azimuth parameter for tracking surfaces.					
7	Radiation on horizontal at next timestep	Flux	kJ/hr.m^2	real	[0;+Inf]	0

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
5-6		How many surfaces are to be evaluated by this radiation processor?	1	8

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Extraterrestrial on horizontal	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The extraterrestrial radiation on a horizontal surface.					
2	Solar zenith angle	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
	The zenith angle is the angle between the vertical and the line of sight of the sun.					
3	Solar azimuth angle	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
	The solar azimuth angle is defined as being the angle between the local meridian and the projection of the line of sight of the sun onto the horizontal plane.					
4	Total horizontal radiation	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The total radiation incident on a horizontal surface. The total radiation is equal to the beam radiation + sky diffuse radiation + ground reflected diffuse radiation.					
5	Beam radiation on horizontal	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
6	Horizontal diffuse radiation	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0

	The diffuse radiation (sky only) on a horizontal surface.					
7	Total radiation on surface 1	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The total radiation on the tilted surface (beam + sky diffuse + ground reflected diffuse).					
8	Beam radiation on surface 1	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The beam radiation on the first surface specified.					
9	Sky diffuse on surface 1	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The sky diffuse radiation incident on the first surface specified.					
10	Incidence angle for surface 1	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
	The angle of incidence of the beam radiation on the first surface specified.					
11	Slope of surface 1	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
	The slope of the first surface specified.					
12	Total radiation on surface 2	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The total radiation (beam + sky diffuse + ground reflected diffuse) on the second surface that was specified.					
13	Beam radiation on surface 2	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The beam radiation incident on the second specified surface.					
14	Sky diffuse on surface 2	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
15	Incidence angle of surface 2	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
	The angle of incidence of the beam radiation on the second surface specified.					
16	Slope of surface 2	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
17	Total radiation on surface 3	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The total radiation (beam + sky diffuse + ground reflected diffuse) incident on the third surface specified.					
18	Beam radiation on surface 3	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The beam radiation on the third surface specified.					
19	Sky diffuse on surface 3	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
20	Incidence angle of surface 3	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
	The angle of incidence of the beam radiation on the third surface specified.					
21	Slope of surface 3	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
22	Total radiation on surface 4	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The total radiation (beam + sky diffuse + ground reflected diffuse) incident on the fourth surface specified.					
23	Beam radiation on surface 4	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The beam radiation incident on the fourth surface specified.					
24	Sky diffuse on surface 4	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The angle of incidence of the beamradiation on the fourth surface specified.					
25	Incidence angle of surface 4	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
26	Slope of surface 4	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
27	Total radiation on surface 5	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
28	Beam radiation on surface 5	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
29	Sky diffuse radiation on surface 5	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
30	Incidence angle of surface 5	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
31	Slope of surface 5	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
32	Total radiation on surface 6	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
33	Beam radiation on surface 6	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
34	Sky diffuse radiation on surface 6	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
35	Incidence angle of surface 6	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
36	Slope of surface 6	Direction (Angle)	degrees	real	[-Inf;+Inf]	0

37	Total radiation on surface 7	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
38	Beam radiation on surface 7	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
39	Sky diffuse radiation on surface 7	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
40	Incidence angle of surface 7	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
41	Slope of surface 7	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
42	Total radiation on surface 8	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
43	Beam radiation on surface 8	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
44	Sky diffuse radiation on surface 8	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
45	Incidence angle of surface 8	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
46	Slope of surface 8	Direction (Angle)	degrees	real	[-Inf;+Inf]	0

4.8.6.3. Total Horiz Temp and Humidity Known (Mode=2)

Icon		TRNSYS Model	Type 16
Proforma	Obsolete\Radiation Processors With Smoothing (Type16)\Total Horiz Temp and Humidity Known (Mode=2)\Type16d.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Horiz. radiation mode	Dimensionless	-	integer	[2;2]	4
	See the general description for an explanation of all horizontal radiation modes. This proforma corresponds to Mode 2 (Total Horizontal Radiation, Temperature and Humidity Known, Full Reindl Correlation)					
2	Tracking mode	Dimensionless	-	integer	[1;4]	1
	Surface Tracking Mode: 1 = Fixed surface 2 = Single axis tracking; vertical axis, fixed slope, variable azimuth 3 = Single axis tracking; axis parallel to surface 4 = Two-axis tracking Refer to the abstract for more details.					
3	Tilted surface mode	Dimensionless	-	integer	[1;4]	3
	Tilted Surface Rdaition Mode: 1 = Isotropic sky model 2 = Hay and Davies model 3 = Reindl model 4 = Perez model Refer to the abstract for more details					
4	Starting day	Time	day	real	[1;+Inf]	1
	The day of the year corresponding to the simulation start time. Every time the simulation start time is changed, the starting day must be changed or the radiation calculations will be inaccurate. A commonly used workaround to set the starting day to the correct value in all ircumstances is to add the following lines to the "simulations cards" (in "Assembly/Control Cards"): EQUATIONS 1 STARTDAY=INT(START/24)+1 (START is a default TRNSYS variable) You can then set the Type of this parameter to "String" and type in STARTDAY for the value.					
5	Latitude	Dimensionless	-	real	[-90.0;90.0]	43.10
	The latitude of the location being investigated.					
6	Solar constant	Flux	kJ/hr.m^2	real	[0.0;+Inf]	4871.0
	The solar constant.					
7	Shift in solar time	Direction (Angle)	degrees	real	[-40;30]	0.0
	Since many of the calculations made in transforming insolation on a horizontal surface depend on the time of day, it is important that the correct solar time be used. This parameter is used to account for the differences between solar time and local time. The equation for the shift parameter is: SHIFT = Lst - Lloc where Lst is the standard meridian for the local time zone, and Lloc is the longitude of the location in question. Longitude angles are positive towards West, negative towards East. (See manual for examples and additional notes.)					
8	Not used	Dimensionless	-	integer	[1;1]	2
	This parameter is not used in this mode of the radiation processor.					
9	Solar time?	Dimensionless	-	integer	[-1;+1]	-1
	If the radiation data being supplied to the radiation processor is at even intervals of solar time (as the TMY data					

	is) then this parameter should be set to a negative number so that the 7th parameter (Shift in Solar Time) is ignored. If the data being supplied is at even intervals of local time, this value should be set positive so that the seventh parameter is used.

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Radiation on horizontal	Flux	kJ/hr.m^2	real	[0.0;+Inf]	0.0
	The total radiation on a horizontal surface.					
2	Ambient temperature	Temperature	C	real	[-273.1;+Inf]	0
3	Relative humidity	Dimensionless	-	real	[0;100]	0
4	Time of last data read	Time	hr	real	[0.0;+Inf]	0.0
	The time of the last reading of the external file containing the weather data. Typically from the 19th Output of the data reader component.					
5	Time of next data read	Time	hr	real	[0.0;+Inf]	1.0
	The time that the next weather information will be read from the external data file. This input is typicall hooked up the the 20th Output of the data reader component.					
6	Ground reflectance	Dimensionless	-	real	[0.0;1.0]	0.2
	The reflectance of the ground above which the surface is located. Typical values are 0.2 for ground not covered by snow and 0.7 for ground covered by snow.					
7	Slope of surface	Direction (Angle)	degrees	real	[-360;+360]	0.0
	The slope of the surface or tracking axis. The slope is positive when tilted in the direction of the azimuth. 0 = Horizontal ; 90 = Vertical facing toward azimuth Refer to the abstract for details on slope specification for tracking surfaces.					
8	Azimuth of surface	Direction (Angle)	degrees	real	[-360;+360]	0.0
	The solar azimuth angle is the angle between the local meridian and the projection of the line of sight of the sun onto the horizontal plane. The reference is as follows: 0 = Facing equator 90 = Facing West 180 (or -180) = Facing away from the equator -90 (or 270) = Facing East (See manual for examples) Refer to the abstract for details on the azimuth parameter for tracking surfaces.					
9	Radiation on horizontal at next timestep	Flux	kJ/hr.m^2	real	[0.0;+Inf]	0

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
7-8		How many surfaces are to be evaluated by this radiation processor?	1	8

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Extraterrestrial on horizontal	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The extraterrestrial radiation on a horizontal surface.					
2	Solar zenith angle	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
	The zenith angle is the angle between the vertical and the line of sight of the sun.					
3	Solar azimuth angle	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
	The solar azimuth angle is defined as being the angle between the local meridian and the projection of the line of sight of the sun onto the horizontal plane.					
4	Total horizontal radiation	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The total radiation incident on a horizontal surface. The total radiation is equal to the beam radiation + sky					

	diffuse radiation + ground reflected diffuse radiation.					
5	Beam radiation on horizontal	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
6	Horizontal diffuse radiation	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The diffuse radiation (sky only) on a horizontal surface.					
7	Total radiation on surface 1	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The total radiation on the tilted surface (beam + sky diffuse + ground reflected diffuse).					
8	Beam radiation on surface 1	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The beam radiation on the first surface specified.					
9	Sky diffuse on surface 1	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The sky diffuse radiation incident on the first surface specified.					
10	Incidence angle for surface 1	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
	The angle of incidence of the beam radiation on the first surface specified.					
11	Slope of surface 1	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
	The slope of the first surface specified.					
12	Total radiation on surface 2	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The total radiation (beam + sky diffuse + ground reflected diffuse) on the second surface that was specified.					
13	Beam radiation on surface 2	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The beam radiation incident on the second specified surface.					
14	Sky diffuse on surface 2	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
15	Incidence angle of surface 2	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
	The angle of incidence of the beam radiation on the second surface specified.					
16	Slope of surface 2	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
17	Total radiation on surface 3	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The total radiation (beam + sky diffuse + ground reflected diffuse) incident on the third surface specified.					
18	Beam radiation on surface 3	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The beam radiation on the third surface specified.					
19	Sky diffuse on surface 3	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
20	Incidence angle of surface 3	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
	The angle of incidence of the beam radiation on the third surface specified.					
21	Slope of surface 3	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
22	Total radiation on surface 4	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The total radiation (beam + sky diffuse + ground reflected diffuse) incident on the fourth surface specified.					
23	Beam radiation on surface 4	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The beam radiation incident on the fourth surface specified.					
24	Sky diffuse on surface 4	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The angle of incidence of the beamradiation on the fourth surface specified.					
25	Incidence angle of surface 4	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
26	Slope of surface 4	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
27	Total radiation on surface 5	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
28	Beam radiation on surface 5	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
29	Sky diffuse radiation on surface 5	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
30	Incidence angle of surface 5	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
31	Slope of surface 5	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
32	Total radiation on surface 6	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
33	Beam radiation on surface 6	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0

34	Sky diffuse radiation on surface 6	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
35	Incidence angle of surface 6	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
36	Slope of surface 6	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
37	Total radiation on surface 7	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
38	Beam radiation on surface 7	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
39	Sky diffuse radiation on surface 7	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
40	Incidence angle of surface 7	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
41	Slope of surface 7	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
42	Total radiation on surface 8	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
43	Beam radiation on surface 8	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
44	Sky diffuse radiation on surface 8	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
45	Incidence angle of surface 8	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
46	Slope of surface 8	Direction (Angle)	degrees	real	[-Inf;+Inf]	0

4.8.6.4. Total Horiz, Direct Normal Known (Mode=4)

Icon		TRNSYS Model	Type 16
Proforma	Obsolete\Radiation Processors With Smoothing (Type16)\Total Horiz, Direct Normal Known (Mode=4)\Type16h.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Horiz. radiation mode	Dimensionless	-	integer	[4;4]	4
	See the general description for an explanation of all horizontal radiation modes. This proforma corresponds to Mode 4 (Total Horizontal and Normal Beam Radiation Known)					
2	Tracking mode	Dimensionless	-	integer	[1;4]	1
	Surface Tracking Mode: 1 = Fixed surface 2 = Single axis tracking; vertical axis, fixed slope, variable azimuth 3 = Single axis tracking; axis parallel to surface 4 = Two-axis tracking Refer to the abstract for more details.					
3	Tilted surface mode	Dimensionless	-	integer	[1;4]	3
	Tilted Surface Rdaition Mode: 1 = Isotropic sky model 2 = Hay and Davies model 3 = Reindl model 4 = Perez model Refer to the abstract for more details					
4	Starting day	Time	day	real	[1;+Inf]	1
	The day of the year corresponding to the simulation start time. Every time the simulation start time is changed, the starting day must be changed or the radiation calculations will be inaccurate. A commonly used workaround to set the starting day to the correct value in all circumstances is to add the following lines to the "simulations cards" (in "Assembly/Control Cards"): EQUATIONS 1 STARTDAY=INT(START/24)+1 (START is a default TRNSYS variable) You can then set the Type of this parameter to "String" and type in STARTDAY for the value.					
5	Latitude	Dimensionless	-	real	[-90.0;90.0]	43.10
	The latitude of the location being investigated.					
6	Solar constant	Flux	kJ/hr.m^2	real	[0.0;+Inf]	4871.0
	The solar constant.					
7	Shift in solar time	Direction (Angle)	degrees	real	[-40;30]	0.0
	Since many of the calculations made in transforming insolation on a horizontal surface depend on the time of day, it is important that the correct solar time be used. This parameter is used to account for the differences between solar time and local time. The equation for the shift parameter is: SHIFT = Lst - Lloc where Lst is the standard meridian for the local time zone, and Lloc is the longitude of the location in question. Longitude angles are positive towards West, negative towards East. (See manual for examples and additional notes.)					
8	Not used	Dimensionless	-	integer	[1;1]	2
	This parameter is not used in this mode of the radiation processor.					
9	Solar time?	Dimensionless	-	integer	[-1;+1]	-1
	If the radiation data being supplied to the radiation processor is at even intervals of solar time (as the TMY data					

	is) then this parameter should be set to a negative number so that the 7th parameter (Shift in Solar Time) is ignored. If the data being supplied is at even intervals of local time, this value should be set positive so that the seventh parameter is used.

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Total radiation on horizontal1	Flux	kJ/hr.m^2	real	[0.0;+Inf]	0.0
	The total radiation on a horizontal surface.					
2	Direct normal beam radiation	Flux	kJ/hr.m^2	real	[0.0;+Inf]	0
	Beam radiation on a surface oriented towards the sun					
3	Time of last data read	Time	hr	real	[0.0;+Inf]	0.0
	The time of the last reading of the external file containing the weather data. Typically from the 19th Output of the data reader component.					
4	Time of next data read	Time	hr	real	[0.0;+Inf]	1.0
	The time that the next weather information will be read from the external data file. This input is typicall hooked up the the 20th Output of the data reader component.					
5	Ground reflectance	Dimensionless	-	real	[0.0;1.0]	0.2
	The reflectance of the ground above which the surface is located. Typical values are 0.2 for ground not covered by snow and 0.7 for ground covered by snow.					
6	Slope of surface	Direction (Angle)	degrees	real	[-360;+360]	0.0
	The slope of the surface or tracking axis. The slope is positive when tilted in the direction of the azimuth. 0 = Horizontal ; 90 = Vertical facing toward azimuth Refer to the abstract for details on slope specification for tracking surfaces.					
7	Azimuth of surface	Direction (Angle)	degrees	real	[-360;+360]	0.0
	The solar azimuth angle is the angle between the local meridian and the projection of the line of sight of the sun onto the horizontal plane. The reference is as follows: 0 = Facing equator 90 = Facing West 180 (or -180) = Facing away from the equator -90 (or 270) = Facing East (See manual for examples) Refer to the abstract for details on the azimuth parameter for tracking surfaces.					
8	Total radiation on horizontal at next timestep	Flux	kJ/hr.m^2	real	[0;+Inf]	0
9	Direct Normal beam radiation at next timestep	Flux	kJ/hr.m^2	real	[0;+Inf]	0

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
6-7		How many surfaces are to be evaluated by this radiation processor?	1	8

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Extraterrestrial on horizontal	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The extraterrestrial radiation on a horizontal surface.					
2	Solar zenith angle	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
	The zenith angle is the angle between the vertical and the line of sight of the sun.					
3	Solar azimuth angle	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
	The solar azimuth angle is defined as being the angle between the local meridian and the projection of the line of sight of the sun onto the horizontal plane.					

4	Total horizontal radiation	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The total radiation incident on a horizontal surface. The total radiation is equal to the beam radiation + sky diffuse radiation + ground reflected diffuse radiation.					
5	Beam radiation on horizontal	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
6	Horizontal diffuse radiation	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The diffuse radiation (sky only) on a horizontal surface.					
7	Total radiation on surface 1	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The total radiation on the tilted surface (beam + sky diffuse + ground reflected diffuse).					
8	Beam radiation on surface 1	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The beam radiation on the first surface specified.					
9	Sky diffuse on surface 1	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The sky diffuse radiation incident on the first surface specified.					
10	Incidence angle for surface 1	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
	The angle of incidence of the beam radiation on the first surface specified.					
11	Slope of surface 1	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
	The slope of the first surface specified.					
12	Total radiation on surface 2	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The total radiation (beam + sky diffuse + ground reflected diffuse) on the second surface that was specified.					
13	Beam radiation on surface 2	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The beam radiation incident on the second specified surface.					
14	Sky diffuse on surface 2	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
15	Incidence angle of surface 2	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
	The angle of incidence of the beam radiation on the second surface specified.					
16	Slope of surface 2	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
17	Total radiation on surface 3	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The total radiation (beam + sky diffuse + ground reflected diffuse) incident on the third surface specified.					
18	Beam radiation on surface 3	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The beam radiation on the third surface specified.					
19	Sky diffuse on surface 3	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
20	Incidence angle of surface 3	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
	The angle of incidence of the beam radiation on the third surface specified.					
21	Slope of surface 3	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
22	Total radiation on surface 4	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The total radiation (beam + sky diffuse + ground reflected diffuse) incident on the fourth surface specified.					
23	Beam radiation on surface 4	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The beam radiation incident on the fourth surface specified.					
24	Sky diffuse on surface 4	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The angle of incidence of the beamradiation on the fourth surface specified.					
25	Incidence angle of surface 4	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
26	Slope of surface 4	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
27	Total radiation on surface 5	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
28	Beam radiation on surface 5	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
29	Sky diffuse radiation on surface 5	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
30	Incidence angle of surface 5	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
31	Slope of surface 5	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
32	Total radiation on surface 6	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0

33	Beam radiation on surface 6	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
34	Sky diffuse radiation on surface 6	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
35	Incidence angle of surface 6	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
36	Slope of surface 6	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
37	Total radiation on surface 7	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
38	Beam radiation on surface 7	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
39	Sky diffuse radiation on surface 7	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
40	Incidence angle of surface 7	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
41	Slope of surface 7	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
42	Total radiation on surface 8	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
43	Beam radiation on surface 8	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
44	Sky diffuse radiation on surface 8	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
45	Incidence angle of surface 8	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
46	Slope of surface 8	Direction (Angle)	degrees	real	[-Inf;+Inf]	0

4.8.6.5. Total Horiz, Horiz Diffuse Known (Mode=5)

Icon		TRNSYS Model	Type 16
Proforma	Obsolete\Radiation Processors With Smoothing (Type16)\Total Horiz, Horiz Diffuse Known (Mode=5)\Type16j.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Horiz. radiation mode	Dimensionless	-	integer	[5;5]	4
	See the general description for an explanation of all horizontal radiation modes. This proforma corresponds to Mode 5 (Total Horizontal and Diffuse Horizontal Radiation Known)					
2	Tracking mode	Dimensionless	-	integer	[1;4]	1
	Surface Tracking Mode: 1 = Fixed surface 2 = Single axis tracking; vertical axis, fixed slope, variable azimuth 3 = Single axis tracking; axis parallel to surface 4 = Two-axis tracking Refer to the abstract for more details.					
3	Tilted surface mode	Dimensionless	-	integer	[1;4]	3
	Tilted Surface Rdaition Mode: 1 = Isotropic sky model 2 = Hay and Davies model 3 = Reindl model 4 = Perez model Refer to the abstract for more details					
4	Starting day	Time	day	real	[1;+Inf]	1
	The day of the year corresponding to the simulation start time. Every time the simulation start time is changed, the starting day must be changed or the radiation calculations will be inaccurate. A commonly used workaround to set the starting day to the correct value in all circumstances is to add the following lines to the "simulations cards" (in "Assembly/Control Cards"): EQUATIONS 1 STARTDAY=INT(START/24)+1 (START is a default TRNSYS variable) You can then set the Type of this parameter to "String" and type in STARTDAY for the value.					
5	Latitude	Dimensionless	-	real	[-90.0;90.0]	43.10
	The latitude of the location being investigated.					
6	Solar constant	Flux	kJ/hr.m^2	real	[0.0;+Inf]	4871.0
	The solar constant.					
7	Shift in solar time	Direction (Angle)	degrees	real	[-40;30]	0.0
	Since many of the calculations made in transforming insolation on a horizontal surface depend on the time of day, it is important that the correct solar time be used. This parameter is used to account for the differences between solar time and local time. The equation for the shift parameter is: SHIFT = Lst - Lloc where Lst is the standard meridian for the local time zone, and Lloc is the longitude of the location in question. Longitude angles are positive towards West, negative towards East. (See manual for examples and additional notes)					
8	Not used	Dimensionless	-	integer	[1;1]	2
	This parameter is not used in this mode of the radiation processor.					
9	Solar time?	Dimensionless	-	integer	[-1;+1]	-1
	If the radiation data being supplied to the radiation processor is at even intervals of solar time (as the TMY data					

	is) then this parameter should be set to a negative number so that the 7th parameter (Shift in Solar Time) is ignored. If the data being supplied is at even intervals of local time, this value should be set positive so that the seventh parameter is used.

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Total radiation on horizontal1	Flux	kJ/hr.m^2	real	[0.0;+Inf]	0.0
	The total radiation on a horizontal surface.					
2	Diffuse radiation on horizontal	Flux	kJ/hr.m^2	real	[0.0;+Inf]	0
3	Time of last data read	Time	hr	real	[0.0;+Inf]	0.0
	The time of the last reading of the external file containing the weather data. Typically from the 19th Output of the data reader component.					
4	Time of next data read	Time	hr	real	[0.0;+Inf]	1.0
	The time that the next weather information will be read from the external data file. This input is typicall hooked up the the 20th Output of the data reader component.					
5	Ground reflectance	Dimensionless	-	real	[0.0;1.0]	0.2
	The reflectance of the ground above which the surface is located. Typical values are 0.2 for ground not covered by snow and 0.7 for ground covered by snow.					
6	Slope of surface	Direction (Angle)	degrees	real	[-360;+360]	0.0
	The slope of the surface or tracking axis. The slope is positive when tilted in the direction of the azimuth. 0 = Horizontal ; 90 = Vertical facing toward azimuth Refer to the abstract for details on slope specification for tracking surfaces.					
7	Azimuth of surface	Direction (Angle)	degrees	real	[-360;+360]	0.0
	The solar azimuth angle is the angle between the local meridian and the projection of the line of sight of the sun onto the horizontal plane. The reference is as follows: 0 = Facing equator 90 = Facing West 180 (or -180) = Facing away from the equator -90 (or 270) = Facing East (See manual for examples) Refer to the abstract for details on the azimuth parameter for tracking surfaces.					
8	Total radiation on horizontal at next timestep	Flux	kJ/hr.m^2	real	[0;+Inf]	0
9	Diffuse radiation at next timestep	Flux	kJ/hr.m^2	real	[0;+Inf]	0

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
6-7		How many surfaces are to be evaluated by this radiation processor?	1	8

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Extraterrestrial on horizontal	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The extraterrestrial radiation on a horizontal surface.					
2	Solar zenith angle	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
	The zenith angle is the angle between the vertical and the line of sight of the sun.					
3	Solar azimuth angle	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
	The solar azimuth angle is defined as being the angle between the local meridian and the projection of the line of sight of the sun onto the horizontal plane.					
4	Total horizontal radiation	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The total radiation incident on a horizontal surface. The total radiation is equal to the beam radiation + sky					

	diffuse radiation + ground reflected diffuse radiation.					
5	Beam radiation on horizontal	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
6	Horizontal diffuse radiation	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The diffuse radiation (sky only) on a horizontal surface.					
7	Total radiation on surface 1	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The total radiation on the tilted surface (beam + sky diffuse + ground reflected diffuse).					
8	Beam radiation on surface 1	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The beam radiation on the first surface specified.					
9	Sky diffuse on surface 1	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The sky diffuse radiation incident on the first surface specified.					
10	Incidence angle for surface 1	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
	The angle of incidence of the beam radiation on the first surface specified.					
11	Slope of surface 1	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
	The slope of the first surface specified.					
12	Total radiation on surface 2	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The total radiation (beam + sky diffuse + ground reflected diffuse) on the second surface that was specified.					
13	Beam radiation on surface 2	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The beam radiation incident on the second specified surface.					
14	Sky diffuse on surface 2	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
15	Incidence angle of surface 2	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
	The angle of incidence of the beam radiation on the second surface specified.					
16	Slope of surface 2	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
17	Total radiation on surface 3	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The total radiation (beam + sky diffuse + ground reflected diffuse) incident on the third surface specified.					
18	Beam radiation on surface 3	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The beam radiation on the third surface specified.					
19	Sky diffuse on surface 3	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
20	Incidence angle of surface 3	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
	The angle of incidence of the beam radiation on the third surface specified.					
21	Slope of surface 3	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
22	Total radiation on surface 4	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The total radiation (beam + sky diffuse + ground reflected diffuse) incident on the fourth surface specified.					
23	Beam radiation on surface 4	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The beam radiation incident on the fourth surface specified.					
24	Sky diffuse on surface 4	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The angle of incidence of the beamradiation on the fourth surface specified.					
25	Incidence angle of surface 4	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
26	Slope of surface 4	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
27	Total radiation on surface 5	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
28	Beam radiation on surface 5	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
29	Sky diffuse radiation on surface 5	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
30	Incidence angle of surface 5	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
31	Slope of surface 5	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
32	Total radiation on surface 6	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
33	Beam radiation on surface 6	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0

34	Sky diffuse radiation on surface 6	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
35	Incidence angle of surface 6	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
36	Slope of surface 6	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
37	Total radiation on surface 7	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
38	Beam radiation on surface 7	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
39	Sky diffuse radiation on surface 7	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
40	Incidence angle of surface 7	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
41	Slope of surface 7	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
42	Total radiation on surface 8	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
43	Beam radiation on surface 8	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
44	Sky diffuse radiation on surface 8	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
45	Incidence angle of surface 8	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
46	Slope of surface 8	Direction (Angle)	degrees	real	[-Inf;+Inf]	0

4.9. Output

4.9.1. Economics

4.9.1.1. Detailed Analysis

Icon		TRNSYS Model	Type 29
Proforma	Output\Economics\Detailed Analysis\Type29b.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Economic analysis mode	Dimensionless	-	integer	[2;2]	2
	This parameter indicates to the general economics component that thedetailed analysis method should be used to evaluate the inputs.					
2	Collector area	Area	m^2	real	[0.0;+Inf]	50.0
	The area of the solar collector array.					
3	Area dependent costs	dimensionless	-	real	[0.0;+Inf]	200.0
	The total area dependent costs for the solar system ($/m^2). These costs include the cost of the collector and part of the cost of thethermal storage equipment.					
4	Fixed costs	dimensionless	-	real	[0.0;+Inf]	4000.0
	The total cost ($) of the equipment which is independent of thecollector area. Examples are costs for piping or ducts, controls,blowers, etc					
5	Performance degradation	dimensionless	-	real	[0.0;100.0]	5.0
	The percentage of thermal degradation per year of the solar system(percent per year).					
6	Period of analysis	dimensionless	-	real	[1.0;+Inf]	20.0
	The period of economic analysis (in years) that is to be used inevaluating the solar system.					
7	Down payment	dimensionless	-	real	[0.0;100.0]	20.0
	What percentage of the total system investment was given as a downpayment for the purchase of the system.					
8	Mortgage interest rate	dimensionless	-	real	[0.0;+Inf]	9.0
	The interest rate on the mortgage for the solar system (percent peryear).					
9	Term of loan	dimensionless	-	real	[0.0;+Inf]	10.0
	The period of the loan taken out for the solar system (years).					
10	Market discount rate	dimensionless	-	real	[0.0;+Inf]	6.0
	The nominal market discount rate.					
11	Extra costs in year 1	dimensionless	-	real	[0.0;+Inf]	5.0
	The extra insurance, maintenance, etc. required by the solar systemin the first year expressed as a perentage of the initial investment.					
12	Inflation rate	dimensionless	-	real	[0.0;100.0]	2.0
	The general inflation rate (percentage).					
13	Income tax rate	dimensionless	-	real	[0.0;100.0]	45.0
	The effective combined federal and state income tax rate (percentage).This income tax rate is assumed constant through the analysis.					

14	Property taxes	dimensionless	-	real	[0.0;+Inf]	5.0
	The true property tax rate per dollar of original investment(percentage).					
15	Propert tax increase	dimensionless	-	real	[0.0;+Inf]	1.0
	The property tax inflation rate (percent per year).					
16	Calculate rate of return?	dimensionless	-	integer	[1;2]	1
	Should the economics rotuine calculate the rate of return on thesolar investment. 1 ---> Calculate the rate of return 2 ---> Don't calculate the rate of return					
17	Resale value	dimensionless	-	real	[0.0;+Inf]	20.0
	The ratio of salvage value to the initial investment expressed as apercentage.					
18	Income producing building?	dimensionless	-	integer	[1;2]	2
	Is the building on which the solar system investment was made anincome producing building? In other words, is thi building a commercial building or a non-commercial building? 0 ---> Non-commercial building 1 ---> Commercial building					
19	Depreciation scheme	dimensionless	-	integer	[1;4]	1
	Which depreciation scheme is to be used on the investment? 1 ---> Straight line 2 ---> Declining balance 3 ---> Sum of years digits 4 ---> None					
20	Percent of straight line	dimensionless	-	real	[0.0;+Inf]	80.0
	If the depreciation schedule was specified as declining balancedepreciation, what percentage of straight line depreciation should beused?					
21	Useful life	dimensionless	-	real	[0.0;+Inf]	8.0
	What is the useful life of the equipment for depreciation purposes(years)?					
22	Auxiliary fuel inflation rate	dimensionless	-	real	[0.0;+Inf]	2.0
	The inflation rate of the fuel used in the auxiliary (backup) system(percent per year).					
23	Fuel inflation rate	dimensionless	-	real	[0.0;+Inf]	3.0
	The inflation rate of the fuel used in the conventional system(percent per year).					
24	Economic output	dimensionless	-	integer	[1;2]	1
	What type of economic output is desired: 1 ---> Print out results yearly 2 ---> Print only the cumulative results					
25	List the parameters?	dimensionless	-	integer	[1;2]	1
	Should the economic output include a listing of the parameters usedin the analysis? 1 ---> Print the parametrs 2 ---> Do not print the parameters					
26	Consider federal tax credits?	dimensionless	-	integer	[1;2]	2
	Should the economic analysis consider federal tax credits? 1 ---> Consider federal tax credits 2 ---> Do not consider federal tax credits					
27	State tax credit in tier 1	dimensionless	-	real	[0.0;+Inf]	5.0
	The state tax credit in tier 1 (percent).					
28	State tax credit in tier 2	dimensionless	-	real	[0.0;+Inf]	3.0
	The state tax credit in tier two (percent).					
29	Tier 1 break	dimensionless	-	real	[0.0;+Inf]	5000
	The break between the first and second tiers of the state tax creditsystem (dollars).					
30	Maximum credit point	dimensionless	-	real	[0.0;+Inf]	10000
	The maximum amount of purchase that is eligible for a state taxcredit (dollars).					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	1st year auxiliary cost	Dimensionless	-	real	[0.0;+Inf]	0.0
	The integrated cost ($) of the auxiliary (back up) system for thefirst year.					
2	1st year load cost	Dimensionless	-	real	[0.0;+Inf]	0.0
	The integrated cost of the total load for the first year i.e., thetotal fuel cost if the solar system was not used ($).					

3	First year load	Energy	kJ	real	[0.0;+Inf]	0.0
	The total load for the firt year of operation.					

4.9.1.2. P1,P2 Method

Icon		TRNSYS Model	Type 29
Proforma	Output\Economics\P1,P2 Method\Type29a.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Economic analysis mode	Dimensionless	-	integer	[1;1]	1
	Thisparameter indicates to the general economics component that the P1,P2 method should be used to evaluate the inputs.					
2	Collector area	Area	m^2	real	[0.0;+Inf]	50.0
	The area of the solar collector array.					
3	Area dependent costs	Dimensionless	-	real	[0.0;+Inf]	200.0
	The total area dependent costs for the solar system ($/m^2). These costs include the cost of the collector and part of the cost of the thermal storage equipment.					
4	Fixed costs	Dimensionless	-	real	[0.0;+Inf]	4000.0
	The total cost ($) of the equipment which is independent of the collector area. Examples are costs for piping or ducts, controls, blowers, etc					
5	P1 factor	Dimensionless	-	real	[0.0;+Inf]	20.0
	The P1 factor in the P1,P2 analysis method. The P1 factor is defined as the ratio of the life cycle fuel cost savings to the first year fuel cost savings.					
6	P2 factor	Dimensionless	-	real	[0.0;+Inf]	0.6630
	The P2 factor in the P1,P2 economic analysis method. The P2 factor is defined as the ratio of the life cycle expenditures incurred because of the additional capital investment to the initial capital investment.					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	1st year auxiliary cost	Dimensionless	-	real	[0.0;+Inf]	0.0
	The integrated cost ($) of the auxiliary (back up) system for the first year.					
2	1st year load cost	Dimensionless	-	real	[0.0;+Inf]	0.0
	The integrated cost of the total load for the first year i.e., the total fuel cost if the solar system was not used.					

4.9.2. Histogram Plotter

4.9.2.1. Time Intervals - Results to External File

Icon		**TRNSYS Model**	Type 27
Proforma	Output\Histogram Plotter\Time Intervals\Results to External File\Type27a.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Use time intervals	Dimensionless	-	integer	[2;2]	2
	The mode parameter set to 2 indicates to the general histogram plotter component that the user will specify time ranges as parameters. This component will then plot the total integrated values of the input that were present within each of the corresponding time intervals.					
2	Plotting interval	Time	hr	real	[-12;+Inf]	1
	The time interval at which histogram plotting is to occur. If this parameter is specified as a negative number, the absolute value of this parameter will be used to set the plot interval in months.					
3	Reset interval	Time	hr	real	[-12;+Inf]	-1
	The time interval after which the histogram results will be plotted and the totals reset for the next time interval. If this parameter is set to a negative number, the absolute value of this parameter will be used to set the reset interval in months.					
4	Starting hour for plot	Time	hr	real	[0;+Inf]	0
	The hour of the year at which histogram plotting is to begin.					
5	Final hour for plotting	Time	hr	real	[0;+Inf]	8760.
	The hour of the year at which histogram plotting is to stop.					
6	Beginning of range for input	Time	hr	real	[0;+Inf]	0
	The beginning of the time range for the specified input.					
7	End of range for input	Time	hr	real	[0;+Inf]	24.0
	The end of the time range for the specified input.					
8	Number of interval in range	Dimensionless	-	integer	[1;24]	24
	The number of time intervals the that them time range for the specified input is to be divided into. For proper operation of this component, the user should specify the beginning time interval, the ending time interval, and the number of intervals such that an integer number of time steps occur in each time interval!					
9	Logical unit	Dimensionless	-	real	[10;30]	18
	The logical unit to which the histogram results will be sent. Each external file specified in the TRNSYS input file must be assigned to a unique logical unit number.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
6-8		How many inputs are to be evaluated by the histogram plotter?	1	10

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Input to be histogrammed	any	any		[-Inf;+Inf]	0.0
	The input to be evaluated by the histogram plotter.					

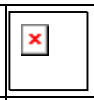
Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
1-1		How many inputs are to be evaluated by the histogram plotter?	1	10

EXTERNAL FILES

Question	File	Associated parameter
Which file should the histogram results be sent to?	***.hst	Logical unit
Source file	.\SourceCode\Types\Type27.for	

4.9.2.2. Time Intervals - Results to List File

Icon		TRNSYS Model	Type 27
Proforma	Output\Histogram Plotter\Time Intervals\Results to List File\Type27b.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Use time intervals	Dimensionless	-	integer	[2;2]	2
	The mode parameter set to 2 indicates to the general histogram plotter component that the user will specify time ranges as parameters. This component will then plot the total integrated values of the input that were present within each of the corresponding time intervals.					
2	Plotting interval	Time	hr	real	[-12;+Inf]	1
	The time interval at which histogram plotting is to occur. If this parameter is specified as a negative number, the absolute value of this parameter will be used to set the plot interval in months.					
3	Reset interval	Time	hr	real	[-12;+Inf]	-1
	The time interval after which the histogram results will be plotted and the totals reset for the next time interval. If this parameter is set to a negative number, the absolute value of this parameter will be used to set the reset interval in months.					
4	Starting hour for plot	Time	hr	real	[0;+Inf]	0
	The hour of the year at which histogram plotting is to begin.					
5	Final hour for plotting	Time	hr	real	[0;+Inf]	8760.
	The hour of the year at which histogram plotting is to stop.					
6	Beginning of range for input	Time	hr	real	[0;+Inf]	0
	The beginning of the time range for the specified input.					
7	End of range for input	Time	hr	real	[0;+Inf]	24.0
	The end of the time range for the specified input.					
8	Number of interval in range	Dimensionless	-	integer	[1;24]	24
	The number of time intervals the that them time range for the specified input is to be divided into. For proper operation of this component, the user should specify the beginning time interval, the ending time interval, and the number of intervals such that an integer number of time steps occur in each time interval!					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
6-8		How many inputs are to be evaluated by the histogram plotter?	1	10

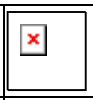
INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Input to be histogrammed	any	any		[-Inf;+Inf]	0.0
	The input to be evaluated by the histogram plotter.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
1-1		How many inputs are to be evaluated by the histogram plotter?	1	10

4.9.2.3. Value Intervals - Results to External File

Icon		TRNSYS Model	Type 27
Proforma	Output\Histogram Plotter\Value Intervals\Results to External File\Type27c.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Mode 1 operation	Dimensionless	-	integer	[1;1]	1
	The mode parameter set to 1 indicates to the general histogram plotter component that the user will specify value ranges as parameters. This component will then plot the total integrated time in hours that the input variable was within each of the corresponding intervals.					
2	Plotting interval	Time	hr	real	[-12;+Inf]	1
	The time interval at which histogram plotting is to occur. If this parameter is specified as a negative number, the absolute value of this parameter will be used to set the plot interval in months.					
3	Reset interval	Time	hr	real	[-12;+Inf]	-1
	The time interval after which the histogram results will be plotted and the totals reset for the next time interval. If this parameter is set to a negative number, the absolute value of this parameter will be used to set the reset interval in months.					
4	Starting hour for plot	Time	hr	real	[0;+Inf]	0
	The hour of the year at which histogram plotting is to begin.					
5	Final hour for plotting	Time	hr	real	[0;+Inf]	8760.
	The hour of the year at which histogram plotting is to stop.					
6	Beginning of range for input	any	any	real	[-Inf;+Inf]	0
	The beginning of the value range for the specified input.					
7	End of range for input	any	any	real	[-Inf;+Inf]	100.0
	The end of the value range for the specified input.					
8	Number of interval in range	Dimensionless	-	integer	[1;24]	24
	The number of intervals the value range for the specified input is to be divided into.					
9	Logical unit	Dimensionless	-	integer	[10;30]	18
	Each external file that TRNSYS writes to or reads from must be assigned to a unique logical unit in the TRNSYS input file.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
6-8		How many inputs are to be evaluated by the histogram plotter?	1	10

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Input to be histogrammed	any	any		[-Inf;+Inf]	0.0
	The input to be evaluated by the histogram plotter.					

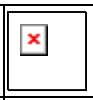
Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
1-1		How many inputs are to be evaluated by the histogram plotter?	1	10

EXTERNAL FILES

Question	File	Associated parameter
Which file should contain the histogram results?	***.hst	Logical unit
Source file	.\SourceCode\Types\Type27.for	

4.9.2.4. Value Intervals - Results to List File

Icon		TRNSYS Model	Type 27
Proforma	Output\Histogram Plotter\Value Intervals\Results to List File\Type27d.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Mode 1 operation	Dimensionless	-	integer	[1;1]	1
	The mode parameter set to 1 indicates to the general histogram plotter component that the user will specify value ranges as parameters. This component will then plot the total integrated time in hours that the input variable was within each of the corresponding intervals.					
2	Plotting interval	Time	hr	real	[-12;+Inf]	1
	The time interval at which histogram plotting is to occur. If this parameter is specified as a negative number, the absolute value of this parameter will be used to set the plot interval in months.					
3	Reset interval	Time	hr	real	[-12;+Inf]	-1
	The time interval after which the histogram results will be plotted and the totals reset for the next time interval. If this parameter is set to a negative number, the absolute value of this parameter will be used to set the reset interval in months.					
4	Starting hour for plot	Time	hr	real	[0;+Inf]	0
	The hour of the year at which histogram plotting is to begin.					
5	Final hour for plotting	Time	hr	real	[0;+Inf]	8760.
	The hour of the year at which histogram plotting is to stop.					
6	Beginning of range for input	any	any	real	[-Inf;+Inf]	0
	The beginning of the value range for the specified input.					
7	End of range for input	any	any	real	[-Inf;+Inf]	100.0
	The end of the value range for the specified input.					
8	Number of interval in range	Dimensionless	-	integer	[1;24]	24
	The number of intervals the value range for the specified input is to be divided into.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
6-8		How many inputs are to be evaluated by the histogram plotter?	1	10

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Input to be histogrammed	any	any		[-Inf;+Inf]	0.0
	The input to be evaluated by the histogram plotter.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
1-1		How many inputs are to be evaluated by the histogram plotter?	1	10

4.9.3. Online Plotter

4.9.3.1. Online Plotter With File - No Units

Icon		TRNSYS Model	Type 65
Proforma	Output\Online Plotter\Online Plotter With File\No Units\Type65c.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Nb. of left-axis variables	Dimensionless	-	integer	[0;10]	2
	The number of variables that will be plotted using the left Y-axis for scaling purposes.					
2	Nb. of right-axis variables	Dimensionless	-	integer	[0;10]	2
	The number of variables that will be plotted using the right axis for scaling purposes.					
3	Left axis minimum	Dimensionless	-	real	[-Inf;+Inf]	0.0
	The minimum value for the left Y-axis.					
4	Left axis maximum	Dimensionless	-	real	[-Inf;+Inf]	1000.0
	The maximum value for the left Y-axis.					
5	Right axis minimum	Dimensionless	-	real	[-Inf;+Inf]	0.0
	The minimum value for the right Y-axis.					
6	Right axis maximum	Dimensionless	-	real	[-Inf;+Inf]	1000.0
	The maximum value for the right Y-axis.					
7	Number of plots per simulation	Dimensionless	-	integer	[-1;+Inf]	0
	Number of plots per simulation. Use -1 for monthly plots.					
8	X-axis gridpoints	Dimensionless	-	integer	[1;+Inf]	7
	The number of grid points that the X-axis (time) will be divided into.					
9	Shut off Online w/o removing	Dimensionless	-	integer	[-1;0]	0
	This parameter can be used to shut off the ONLINE without removing from the assembly panel / input file, according to the following rules: -1 : don't display online >=0 : display online					
10	Logical Unit for output file	Dimensionless	-	integer	[30;Inf]	0
	This parameter sets the Fortran Logical Unit (File reference number) of the output file. It is used internally by TRNSYS to refer to the file. This parameter will automatically be assigned to a unique value by the TRNSYS Studio					
11	Output file units	Dimensionless	-	integer	[0;0]	0
	This parameter controls the way variable units are printed. The value of 0 means that no units will be printed to the output file.					
12	Output file delimiter	Dimensionless	-	integer	[0;2]	0
	This parameter controls the delimiter used in the output file: 0: use tabs to delimit columns 1: use spaces to delimit columns 2: use commas to delimit columns					

INPUTS

	Name	Dimension	Unit	Type	Range	Default

1	Left axis variable	any	any	string	[-Inf;+Inf]	label
	The specified variable which is to be plotted using the left Y-axis for scaling purposes					
2	Right axis variable	any	any	string	[-Inf;+Inf]	label
	The specified variable which is to be plotted using the right Y-axis for scaling purposes					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
1-1	Nb. of left-axis variables		1	100
2-2	Nb. of right-axis variables		1	100

SPECIAL CARDS

Name	Question	Answer
LABELS	Labels used by this online plotter (leave to 3)	3
	Left axis title (enclose in double quotes)	"Temperatures"
	Right axis title (enclose in quotes)	"Heat transfer rates"
	Online plot title (tab name if several plotters are used)	"Graph 1"

EXTERNAL FILES

Question	File	Associated parameter
What file should the online print to?	***.plt	Logical Unit for output file
Source file	.\SourceCode\Types\Type65.for	

4.9.3.2. Online Plotter With File - TRNSYS-Supplied Units

Icon		TRNSYS Model	Type 65
Proforma	Output\Online Plotter\Online Plotter With File\TRNSYS-Supplied Units\Type65a.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Nb. of left-axis variables	Dimensionless	-	integer	[0;10]	2
	The number of variables that will be plotted using the left Y-axis for scaling purposes.					
2	Nb. of right-axis variables	Dimensionless	-	integer	[0;10]	2
	The number of variables that will be plotted using the right axis for scaling purposes.					
3	Left axis minimum	Dimensionless	-	real	[-Inf;+Inf]	0.0
	The minimum value for the left Y-axis.					
4	Left axis maximum	Dimensionless	-	real	[-Inf;+Inf]	1000.0
	The maximum value for the left Y-axis.					
5	Right axis minimum	Dimensionless	-	real	[-Inf;+Inf]	0.0
	The minimum value for the right Y-axis.					
6	Right axis maximum	Dimensionless	-	real	[-Inf;+Inf]	1000.0
	The maximum value for the right Y-axis.					
7	Number of plots per simulation	Dimensionless	-	integer	[-1;+Inf]	0
	Number of plots per simulation. Use -1 for monthly plots.					
8	X-axis gridpoints	Dimensionless	-	integer	[1;+Inf]	7
	The number of grid points that the X-axis (time) will be divided into.					
9	Shut off Online w/o removing	Dimensionless	-	integer	[-1;0]	0
	This parameter can be used to shut off the ONLINE without removing from the assembly panel / input file, according to the following rules: -1 : don't display online >=0 : display online					
10	Logical Unit for output file	Dimensionless	-	integer	[30;Inf]	0
	This parameter sets the Fortran Logical Unit (File reference number) of the output file. It is used internally by TRNSYS to refer to the file. This parameter will automatically be assigned to a unique value by the TRNSYS Studio					
11	Output file units	Dimensionless	-	integer	[2;2]	0
	This parameter controls the way variable units are printed: the value of 2 means that printed units will be the default units provided by TRNSYS.					
12	Output file delimiter	Dimensionless	-	integer	[0;2]	0
	This parameter controls the delimiter used in the output file: 0: use tabs to delimit columns 1: use spaces to delimit columns 2: use commas to delimit columns					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Left axis variable	any	any	string	[-Inf;+Inf]	label
	The specified variable which is to be plotted using the left Y-axis for scaling purposes					
2	Right axis variable	any	any	string	[-Inf;+Inf]	label
	The specified variable which is to be plotted using the right Y-axis for scaling purposes					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
1-1	Nb. of left-axis variables		1	100
2-2	Nb. of right-axis variables		1	100

SPECIAL CARDS

Name	Question	Answer
LABELS	Labels used by this online plotter (leave to 3)	3
	Left axis title (enclose in double quotes)	"Temperatures"
	Right axis title (enclose in double quotes)	"Heat transfer rates"
	Plot title (tab name if several plotters are used	"Graph 1"

EXTERNAL FILES

Question	File	Associated parameter
What file should the online print to?	***.plt	Logical Unit for output file
Source file	.\SourceCode\Types\Type65.for	

4.9.3.3. Online Plotter With File - User-Supplied Units

Icon		TRNSYS Model	Type 65
Proforma	Output\Online Plotter\Online Plotter With File\User-Supplied Units\Type65b.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Nb. of left-axis variables	Dimensionless	-	integer	[0;10]	2
	The number of variables that will be plotted using the left Y-axis for scaling purposes.					
2	Nb. of right-axis variables	Dimensionless	-	integer	[0;10]	2
	The number of variables that will be plotted using the right axis for scaling purposes.					
3	Left axis minimum	Dimensionless	-	real	[-Inf;+Inf]	0.0
	The minimum value for the left Y-axis.					
4	Left axis maximum	Dimensionless	-	real	[-Inf;+Inf]	1000.0
	The maximum value for the left Y-axis.					
5	Right axis minimum	Dimensionless	-	real	[-Inf;+Inf]	0.0
	The minimum value for the right Y-axis.					
6	Right axis maximum	Dimensionless	-	real	[-Inf;+Inf]	1000.0
	The maximum value for the right Y-axis.					
7	Number of plots per simulation	Dimensionless	-	integer	[-1;+Inf]	0
	Number of plots per simulation. Use -1 for monthly plots.					
8	X-axis gridpoints	Dimensionless	-	integer	[1;+Inf]	7
	The number of grid points that the X-axis (time) will be divided into.					
9	Shut off Online w/o removing	Dimensionless	-	integer	[-1;0]	0
	This parameter can be used to shut off the ONLINE without removing from the assembly panel / input file, according to the following rules: -1 : don't display online >=0 : display online					
10	Logical Unit for output file	Dimensionless	-	integer	[30;Inf]	0
	This parameter sets the Fortran Logical Unit (File reference number) of the output file. It is used internally by TRNSYS to refer to the file. This parameter will automatically be assigned to a unique value by the TRNSYS Studio					
11	Output file units	Dimensionless	-	integer	[1;1]	0
	This parameter controls the way variable units are printed: The value of 1 means that user-supplied units will be printed. You must provide those units for each plotted/printed variables in the "special cards" tab					
12	Output file delimiter	Dimensionless	-	integer	[0;2]	0
	This parameter controls the delimiter used in the output file: 0: use tabs to delimit columns 1: use spaces to delimit columns 2: use commas to delimit columns					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Left axis variable	any	any	string	[-Inf;+Inf]	label
	The specified variable which is to be plotted using the left Y-axis for scaling purposes					
2	Right axis variable	any	any	string	[-Inf;+Inf]	label
	The specified variable which is to be plotted using the right Y-axis for scaling purposes					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
1-1	Nb. of left-axis variables		1	100
2-2	Nb. of right-axis variables		1	100

SPECIAL CARDS

Name	Question	Answer
	Enter units for each variable to be plotted/printed, separated by spaces. You must provide as many unit strings as there are plotted/printed variables	°C °C kJ/h kJ/h
LABELS	Labels used by this online plotter (leave to 3)	3
	Left axis title (enclose in double quotes)	"Temperatures"
	Right axis title (enclose in double quotes)	"Heat transfer rates"
	Plot title (tab name if several plotters are used)	"Graph 1"

EXTERNAL FILES

Question	File	Associated parameter
What file should the online print to?	***.plt	Logical Unit for output file
Source file	.\SourceCode\Types\Type65.for	

4.9.3.4. Online Plotter Without File

Icon		TRNSYS Model	Type 65
Proforma	Output\Online Plotter\Online Plotter Without File\Type65d.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Nb. of left-axis variables	Dimensionless	-	integer	[0;10]	2
	The number of variables that will be plotted using the left Y-axis for scaling purposes.					
2	Nb. of right-axis variables	Dimensionless	-	integer	[0;10]	2
	The number of variables that will be plotted using the right axis for scaling purposes.					
3	Left axis minimum	Dimensionless	-	real	[-Inf;+Inf]	0.0
	The minimum value for the left Y-axis.					
4	Left axis maximum	Dimensionless	-	real	[-Inf;+Inf]	1000.0
	The maximum value for the left Y-axis.					
5	Right axis minimum	Dimensionless	-	real	[-Inf;+Inf]	0.0
	The minimum value for the right Y-axis.					
6	Right axis maximum	Dimensionless	-	real	[-Inf;+Inf]	1000.0
	The maximum value for the right Y-axis.					
7	Number of plots per simulation	Dimensionless	-	integer	[-1;+Inf]	0
	Number of plots per simulation. Use -1 for monthly plots.					
8	X-axis gridpoints	Dimensionless	-	integer	[1;+Inf]	7
	The number of grid points that the X-axis (time) will be divided into.					
9	Shut off Online w/o removing	Dimensionless	-	integer	[-1;0]	0
	This parameter can be used to shut off the ONLINE without removing from the assembly panel / input file, according to the following rules: -1 : don't display online >=0 : display online					
10	Logical unit for output file	Dimensionless	-	integer	[-1;-1]	0
	This parameter is not used in this mode since no ouptut file is created. Please use the "online plotter with file" if you want to simultaneously plot the data and print it to a file.					
11	Output file units	Dimensionless	-	integer	[0;0]	0
	This parameter is not used in this mode since no output file is created					
12	Output file delimiter	Dimensionless	-	integer	[0;0]	0
	This parameter is not used in this mode since no output file is created					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Left axis variable	any	any	string	[-Inf;+Inf]	label
	The specified variable which is to be plotted using the left Y-axis for scaling purposes					
2	Right axis variable	any	any	string	[-Inf;+Inf]	label
	The specified variable which is to be plotted using the right Y-axis for scaling purposes					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
1-1	Nb. of left-axis variables		1	100

2-2	Nb. of right-axis variables		1	100

SPECIAL CARDS

Name	Question	Answer
LABELS	Labels used by this online plotter (leave to 3)	3
	Left axis title (enclose in double quotes)	"Temperatures"
	Right axis title (enclose in double quotes)	"Heat transfer rates"
	Plot title (tab name if several plotters are used)	"Graph 1"

4.9.4. Printer

4.9.4.1. No Units

Icon		TRNSYS Model	Type 25
Proforma	Output\Printer\No Units\Type25c.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Printing interval	Time	hr	real	[-12;+Inf]	1
	The time interval at which printing is to occur. If the time interval is less than zero, then the print interval will be measured in the absolute value of this parameter expressed in months. Examples: 1: print every hour -1: print every month The default value (STEP) is a TRNSYS parameter equal to the simulation time step					
2	Start time	Time	hr	real	[0;+Inf]	0
	The time of the year in hours at which printing is to start. The default value (START) is a TRNSYS parameter equal to the simulation start time					
3	Stop time	Time	hr	real	[0;+Inf]	8760
	The time of the year in hours at which printing is to stop. The default value (STOP) is a TRNSYS parameter equal to the simulation stop time					
4	Logical unit	Dimensionless	-	integer	[30;999]	17
	This parameter sets the Fortran Logical Unit (File reference number) of the output file. It is used internally by TRNSYS to refer to the file. This parameter will automatically be assigned to a unique value by the TRNSYS Studio					
5	Units printing mode	Dimensionless	-	integer	[0;0]	0
	This parameter is set to 0, so no units are printed to the output file					
6	Relative or absolute start time	Dimensionless	-	integer	[0;1]	0
	This parameter controls whether the print intervals are relative or absolute 0: print at time intervals relative to the simulation start time 1: print at absolute time intervals For example, if the simulation start time is 0.5, the simulation time step is 0.25 and the printing time step is 1: If this parameter is set to 0, printing will occur at 0.5, 1.5, 2.5, etc. If this parameter is set to 1, printing will occur at 1, 2, 3, etc.					
7	Overwrite or Append	Dimensionless	-	integer	[-1;1]	0
	This parameter decides whether the file is appended to or overwritten: -1: Overwrite the output file 1: Append to the output file					
8	Print header	Dimensionless	-	integer	[-1;1]	0
	This parameters decides whether or not a header with input file information will be printed to the output file or not -1: Do not print header 1: Print header					
9	Delimiter	Dimensionless	-	integer	[0;2]	0
	This parameter controls the delimiter used in the output file: 0: use tabs to delimit columns 1: use spaces to delimit columns					

	2: use commas to delimit columns					
10	Print labels	Dimensionless	-	integer	[-1;1]	0
	This parameter decides whether or not labels (variable descriptors) should be printed as column headers: -1: Do not print descriptors 1: Print descriptors					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Input to be printed	any	any	string	[-Inf;+Inf]	label
	Input to be printed					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
1-1		How many variables are to be printed by this component?	1	100

EXTERNAL FILES

Question	File	Associated parameter
Output file for printed results	***.out	Logical unit
Source file	.\SourceCode\Types\Type25.for	

4.9.4.2. TRNSYS-Supplied Units

Icon		TRNSYS Model	Type 25
Proforma	Output\Printer\TRNSYS-Supplied Units\Type25a.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Printing interval	Time	hr	real	[-12;+Inf]	1
	The time interval at which printing is to occur. If the time interval is less than zero, then the print interval will be measured in the absolute value of this parameter expressed in months. Examples: 1: print every hour -1: print every month The default value (STEP) is a TRNSYS parameter equal to the simulation time step					
2	Start time	Time	hr	real	[0;+Inf]	0
	The time of the year in hours at which printing is to start. The default value (START) is a TRNSYS parameter equal to the simulation start time					
3	Stop time	Time	hr	real	[0;+Inf]	8760
	The time of the year in hours at which printing is to stop. The default value (STOP) is a TRNSYS parameter equal to the simulation stop time					
4	Logical unit	Dimensionless	-	integer	[30;999]	17
	This parameter sets the Fortran Logical Unit (File reference number) of the output file. It is used internally by TRNSYS to refer to the file. This parameter will automatically be assigned to a unique value by the TRNSYS Studio					
5	Units printing mode	Dimensionless	-	integer	[2;2]	0
	This parameter is set to 2, so TRNSYS-supplied units are printed to the output file					
6	Relative or absolute start time	Dimensionless	-	integer	[0;1]	0
	This parameter controls whether the print intervals are relative or absolute 0: print at time intervals relative to the simulation start time 1: print at absolute time intervals For example, if the simulation start time is 0.5, the simulation time step is 0.25 and the printing time step is 1: If this parameter is set to 0, printing will occur at 0.5, 1.5, 2.5, etc. If this parameter is set to 1, printing will occur at 1, 2, 3, etc.					
7	Overwrite or Append	Dimensionless	-	integer	[-1;1]	0
	This parameter decides whether the file is appended to or overwritten: -1: Overwrite the output file 1: Append to the output file					
8	Print header	Dimensionless	-	integer	[-1;1]	0
	This parameters decides whether or not a header with input file information will be printed to the output file or not -1: Do not print header 1: Print header					
9	Delimiter	Dimensionless	-	integer	[0;2]	0
	This parameter controls the delimiter used in the output file: 0: use tabs to delimit columns 1: use spaces to delimit columns 2: use commas to delimit columns					
10	Print labels	Dimensionless	-	integer	[-1;1]	0
	This parameter decides whether or not labels (variable descriptors) should be printed as column headers: -1: Do not print descriptors					

	1: Print descriptors

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Input to be printed	any	any	string	[-Inf;+Inf]	label
	Input to be printed					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
1-1		How many variables are to be printed by this component?	1	100

EXTERNAL FILES

Question	File	Associated parameter
Output File for printed results	***.out	Logical unit
Source file	.\SourceCode\Types\Type25.for	

4.9.4.3. User-Supplied Units

Icon		TRNSYS Model	Type 25
Proforma	Output\Printer\User-Supplied Units\Type25b.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Printing interval	Time	hr	real	[-12;+Inf]	1
	The time interval at which printing is to occur. If the time interval is less than zero, then the print interval will be measured in the absolute value of this parameter expressed in months. Examples: 1: print every hour -1: print every month The default value (STEP) is a TRNSYS parameter equal to the simulation time step					
2	Start time	Time	hr	real	[0;+Inf]	0
	The time of the year in hours at which printing is to start. The default value (START) is a TRNSYS parameter equal to the simulation start time					
3	Stop time	Time	hr	real	[0;+Inf]	8760
	The time of the year in hours at which printing is to stop. The default value (STOP) is a TRNSYS parameter equal to the simulation stop time					
4	Logical unit	Dimensionless	-	integer	[30;999]	17
	This parameter sets the Fortran Logical Unit (File reference number) of the output file. It is used internally by TRNSYS to refer to the file. This parameter will automatically be assigned to a unique value by the TRNSYS Studio					
5	Units printing mode	Dimensionless	-	integer	[1;1]	0
	This parameter is set to 1, so that user-supplied units are printed to the output file (you have to provide those units in the "special cards" tab)					
6	Relative or absolute start time	Dimensionless	-	integer	[0;1]	0
	This parameter controls whether the print intervals are relative or absolute 0: print at time intervals relative to the simulation start time 1: print at absolute time intervals For example, if the simulation start time is 0.5, the simulation time step is 0.25 and the printing time step is 1: If this parameter is set to 0, printing will occur at 0.5, 1.5, 2.5, etc. If this parameter is set to 1, printing will occur at 1, 2, 3, etc.					
7	Overwrite or Append	Dimensionless	-	integer	[-1;1]	0
	This parameter decides whether the file is appended to or overwritten: -1: Overwrite the output file 1: Append to the output file					
8	Print header	Dimensionless	-	integer	[-1;1]	0
	This parameters decides whether or not a header with input file information will be printed to the output file or not -1: Do not print header 1: Print header					
9	Delimiter	Dimensionless	-	integer	[0;2]	0
	This parameter controls the delimiter used in the output file: 0: use tabs to delimit columns 1: use spaces to delimit columns 2: use commas to delimit columns					
10	Print labels	Dimensionless	-	integer	[-1;1]	0
	This parameter decides whether or not labels (variable descriptors) should be printed as column headers:					

	-1: Do not print descriptors 1: Print descriptors

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Input to be printed	any	any	string	[-Inf;+Inf]	label
	Input to be printed					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
1-1		How many variables are to be printed by this component?	1	100

SPECIAL CARDS

Name	Question	Answer
	Enter units for each variable to be printed, separated by spaces. You MUST provide as many unit strings as there are variables	Unit1 Unit2 Unit3 Unit4 Unit5 Unit6 Unit7 Unit8 Unit9 Unit10

EXTERNAL FILES

Question	File	Associated parameter
Output file for printed results	***.out	Logical unit
Source file	.\SourceCode\Types\Type25.for	

4.9.5. Simulation Summary

4.9.5.1. Results to External File - With Energy Balance

Icon		TRNSYS Model	Type 28
Proforma	Output\Simulation Summary\Results to External File\With Energy Balance\Type28a.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Summary interval	Time	hr	real	[-12;+Inf]	24.0
	The time interval after which the summaries will printed and reset. Specifiying a negative parameter indicates that the absolute value of the parameter will be used to specify the rest time in months.					
2	Summary start time	Time	hr	real	[0.0;+Inf]	0.0
	The hour of the year at which the summary is to begin.					
3	Summary stop time	Time	hr	real	[0.0;+Inf]	8760.0
	The hour of the year at which the summary is to stop.					
4	Logical unit for the output file	Dimensionless	-	integer	[31;999]	19
	This parameter sets the Fortran Logical Unit (File reference number) of the output file. It is used internally by TRNSYS to refer to the file. This parameter will automatically be assigned to a unique value by the TRNSYS Studio					
5	Output mode	Dimensionless	-	integer	[1;2]	1
	The output mode for the simulation summary component: 1: Table with heading for the whole simulation (external file) or Individual tables for each summary (Lst file) 2: Table with a single heading for every 12 sets of summaries (best adapted to monthly summaries)					
6	Operation code	Dimensionless	-	real	[-Inf;+Inf]	0
	The reverse polish operation code that will be used to manipulate the parameters and inputs to produce the outputs. The parameter list may also contain constants to be used in the summary. If this is the first operation code, either enter the number of inputs that should not be integrated, or use an operation code <= 0 to put an input on parameter on the stack.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
6-6		How many operation codes are required to complete the summary?	1	500

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Summary input	any	any	real	[-Inf;+Inf]	0.0
	The specified input to be used in the simulation summary.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
1-1		How many inputs are required by the simulation summary?	1	250

SPECIAL CARDS

Name	Question	Answer

LABELS	Number of printed outputs	2
	Label for each of the outputs (space-separated)	Output1 Output2
CHECK	Energy balance operation codes (space-separated)	0.05 1 -2

EXTERNAL FILES

Question	File	Associated parameter
File for the summary results	***.sum	Logical unit for the output file
Source file	.\SourceCode\Types\Type28.f90	

4.9.5.2. Results to External File - Without Energy Balance

Icon		TRNSYS Model	Type 28
Proforma	Output\Simulation Summary\Results to External File\Without Energy Balance\Type28b.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Summary interval	Time	hr	real	[-12;+Inf]	24.0
	The time interval after which the summaries will printed and reset. Specifiying a negative parameter indicates that the absolute value of the parameter will be used to specify the rest time in months.					
2	Summary start time	Time	hr	real	[0.0;+Inf]	0.0
	The hour of the year at which the summary is to begin.					
3	Summary stop time	Time	hr	real	[0.0;+Inf]	8760.0
	The hour of the year at which the summary is to stop.					
4	Logical unit for the output file	Dimensionless	-	integer	[31;999]	19
	This parameter sets the Fortran Logical Unit (File reference number) of the output file. It is used internally by TRNSYS to refer to the file. This parameter will automatically be assigned to a unique value by the TRNSYS Studio					
5	Output mode	Dimensionless	-	integer	[1;2]	1
	The output mode for the simulation summary component: 1: Table with heading for the whole simulation (external file) or Individual tables for each summary (Lst file) 2: Table with a single heading for every 12 sets of summaries (best adapted to monthly summaries)					
6	Operation code	Dimensionless	-	real	[-Inf;+Inf]	0
	The reverse polish operation code that will be used to manipulate the parameters and inputs to produce the outputs. The parameter list may also contain constants to be used in the summary. If this is the first operation code, either enter the number of inputs that should not be integrated, or use an operation code <= 0 to put an input on parameter on the stack.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
6-6		How many operation codes are required to complete the summary?	1	500

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Summary input	any	any	real	[-Inf;+Inf]	0.0
	The specified input to be used in the simulation summary.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
1-1		How many inputs are required by the simulation summary?	1	250

SPECIAL CARDS

Name	Question	Answer
LABELS	Number of printed outputs	2
	Label for each of the outputs (space-separated)	Output1 Output2

EXTERNAL FILES

Question	File	Associated parameter
File for the summary results	***.sum	Logical unit for the output file
Source file	.\SourceCode\Types\Type28.f90	

4.9.5.3. Results to List File - With Energy Balance

Icon		TRNSYS Model	Type 28
Proforma	Output\Simulation Summary\Results to List File\With Energy Balance\Type28c.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Summary interval	Time	hr	real	[-12;+Inf]	24.0
	The time interval after which the summaries will printed and reset. Specifiying a negative parameter indicates that the absolute value of the parameter will be used to specify the rest time in months.					
2	Summary start time	Time	hr	real	[0.0;+Inf]	0.0
	The hour of the year at which the summary is to begin.					
3	Summary stop time	Time	hr	real	[0.0;+Inf]	8760.0
	The hour of the year at which the summary is to stop.					
4	Not used - Logical unit for the output file	Dimensionless	-	integer	[-1;-1]	19
	This parameter tells the component that results are to be printed to the listing file rather than to an external file. Use other modes if you want to print results to an external file					
5	Output mode	Dimensionless	-	integer	[1;2]	1
	The output mode for the simulation summary component: 1: Table with heading for the whole simulation (external file) or Individual tables for each summary (Lst file) 2: Table with a single heading for every 12 sets of summaries (best adapted to monthly summaries)					
6	Operation code	Dimensionless	-	real	[-Inf;+Inf]	0
	The reverse polish operation code that will be used to manipulate the parameters and inputs to produce the outputs. The parameter list may also contain constants to be used in the summary. If this is the first operation code, either enter the number of inputs that should not be integrated, or use an operation code <= 0 to put an input on parameter on the stack.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
6-6		How many operation codes are required to complete the summary?	1	500

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Summary input	any	any	real	[-Inf;+Inf]	0.0
	The specified input to be used in the simulation summary.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
1-1		How many inputs are required by the simulation summary?	1	250

SPECIAL CARDS

Name	Question	Answer
LABELS	Number of printed outputs	2
	Label for each of the outputs (space-separated)	Output1 Output2
CHECK	Energy balance operation codes (space-separated)	0.05 1 -2

4.9.5.4. Results to List File - Without Energy Balance

Icon		TRNSYS Model	Type 28
Proforma	Output\Simulation Summary\Results to List File\Without Energy Balance\Type28d.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Summary interval	Time	hr	real	[-12;+Inf]	24.0
	The time interval after which the summaries will printed and reset. Specifiying a negative parameter indicates that the absolute value of the parameter will be used to specify the rest time in months.					
2	Summary start time	Time	hr	real	[0.0;+Inf]	0.0
	The hour of the year at which the summary is to begin.					
3	Summary stop time	Time	hr	real	[0.0;+Inf]	8760.0
	The hour of the year at which the summary is to stop.					
4	Not used - Logical unit for the output file	Dimensionless	-	integer	[-1;-1]	19
	This parameter tells the component that results are to be printed to the listing file rather than to an external file. Use other modes if you want to print results to an external file					
5	Output mode	Dimensionless	-	integer	[1;2]	1
	The output mode for the simulation summary component: 1: Table with heading for the whole simulation (external file) or Individual tables for each summary (Lst file) 2: Table with a single heading for every 12 sets of summaries (best adapted to monthly summaries)					
6	Operation code	Dimensionless	-	real	[-Inf;+Inf]	0
	The reverse polish operation code that will be used to manipulate the parameters and inputs to produce the outputs. The parameter list may also contain constants to be used in the summary. If this is the first operation code, either enter the number of inputs that should not be integrated, or use an operation code <= 0 to put an input on parameter on the stack.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
6-6		How many operation codes are required to complete the summary?	1	500

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Summary input	any	any	real	[-Inf;+Inf]	0.0
	The specified input to be used in the simulation summary.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
1-1		How many inputs are required by the simulation summary?	1	250

SPECIAL CARDS

Name	Question	Answer
LABELS	Number of printed outputs	2
	Label for each of the outputs (space-separated)	Output1 Output2

4.10. Physical Phenomena

4.10.1. Collector Array Shading

4.10.1.1. Flat Plate Arrays

Icon		**TRNSYS Model**	Type 30
Proforma	Physical Phenomena\Collector Array Shading\Flat Plate Arrays\Type30a.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Flat-plate mode	Dimensionless	-	integer	[1;1]	1
	This parameter indicates to the general collector array shading component that the shading is to be calculated for a flat-plate collector array.					
2	Collector height	Length	m	real	[0.0;+Inf]	1.35
	The height of one of the identical solar collectors in the array. The height specified here should be independent of the collector slope (the true height of the collector).					
3	Collector row length	Length	m	real	[0.0;+Inf]	10.0
	The length of one row of the solar collector array.					
4	Collector slope	Direction (Angle)	degrees	real	[-360;+360]	45.0
	The slope of the collector array surface. The slope is considered positive when the collector surface faces the surface azimuth.					
5	Collector row separation	Length	m	real	[0.0;+Inf]	3.0
	The distance between rows of the flat-plate solar collector array (measured on the horizontal plane).					
6	Number of rows	Dimensionless	-	integer	[1;+Inf]	5
	The number of identical rows of solar collectors in the array.					
7	Collector array azimuth	Direction (Angle)	degrees	real	[-360;+360]	0.0
	The collector array surface azimuth. The surface azimuth is defined as the angle between the local meridian and the line of sight of the collector surface onto the horizontal plane. Zero surface azimuth is facing the equator, west is positive (90), east is negative (-90).					
8	Slope of collector field	Direction (Angle)	degrees	real	[-90;+90]	10.0
	The slope of the field on which the collector array is situated. Slope is positive when the surface is tilted toward the azimuth, negative otherwise.					

INPUTS

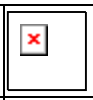
	Name	Dimension	Unit	Type	Range	Default
1	Tilted surface radiation	Flux	kJ/hr.m^2	real	[0.0;+Inf]	0.0
	The total radiation (beam + sky diffuse + ground reflected diffuse) incident upon the unshaded collector surface per unit area.					
2	Incident beam radiation	Flux	kJ/hr.m^2	real	[0.0;+Inf]	0.0
	The beam radiation incident upon the unshaded collector surface per unit area.					
3	Solar zenith angle	Direction (Angle)	degrees	real	[0.0;90.0]	45.0

	The solar zenith angle is the angle between the vertical and the line of sight of the sun. This is 90 minus the angle between the sun and the horizontal (solar altitude angle).					
4	Solar azimuth angle	Direction (Angle)	degrees	real	[-360;+360]	0.0
	The solar azimuth angle is the angle between the local meridian and the projection of the line of sight of the sun onto the horizontal plane. Zero solar azimuth is facing the equator, west is positive (90) while east is negative (-90).					
5	Total horizontal radiation	Flux	kJ/hr.m^2	real	[0.0;+Inf]	0.0
	The total radiation (beam + sky diffuse + ground reflected diffuse) incident on a horizontal surface per unit area.					
6	Horizontal diffuse radiation	Flux	kJ/hr.m^2	real	[0.0;+Inf]	0.0
	The diffuse radiation incident upon a horizontal surface per unit area.					
7	Beam radiation on field	Flux	kJ/hr.m^2	real	[0.0;+Inf]	0.0
	The beam radiation per unit area incident upon a surface with the slope of the field on which the collector array is situated.					
8	Ground reflectance	Dimensionless	-	real	[0.0;1.0]	0.2
	The reflectance of the ground above which the solar collector array is situated. The reflectance is a ratio of the amount of radiation reflected by the surface to the total radiation incident upon the surface and therefore must be between 0 and 1. Typical values are 0.2 for ground not covered by snow and 0.7 for snow-covered ground.					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Total shaded radiation	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The total solar radiation (beam + sky diffuse + ground reflected diffuse) incident upon the collector surface per unit area including the effects of shading.					
2	Shaded beam radiation	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The beam radiation incident upon the collector surface per unit area including the effects of shading.					
3	Shaded diffuse radiation	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The diffuse radiation incident upon the collector surface per unit area including the effects of shading.					
4	Shaded diffuse radiation: sky portion	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The sky diffuse radiation incident upon the collector surface per unit area including the effects of shading.					
5	Shaded diffuse radiation: ground reflected portion	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The ground reflected diffuse radiation incident upon the collector surface per unit area including the effects of shading.					

4.10.1.2. Parabolic Trough Arrays - Axes in Plane of Surface

Icon		TRNSYS Model	Type 30
Proforma	Physical Phenomena\Collector Array Shading\Parabolic Trough Arrays\Axes in Plane of Surface\Type30b.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Parabolic trough mode	Dimensionless	-	integer	[2;2]	2
	This parameter indicates to the general collector array shading component that the shading is to be calculated for a single-axis tracking parabolic trough array.					
2	Axis orientation	Dimensionless	-	integer	[1;1]	1
	The orientation of the parabolic trough axis. Setting this parameter to 1 indicates that the parabolic trough axes have the same slope and azimuth as the place containing the axes.					
3	Collector axes separation	Length	m	real	[0.0;+Inf]	3.0
	The distance between tracking axes of the single axis tracking collectors.					
4	Aperture width	Length	m	real	[0.0;+Inf]	0.75
	The width of the aperture of one of the identical parabolic trough collectors.					
5	Number of rows	Dimensionless	-	integer	[1;+Inf]	5
	The number of identical rows of solar collectors in the array.					
6	Slope of axes plane	Direction (Angle)	degrees	real	[0.0;90.0]	90.0
	The slope of the plane containing the tracking axes. Slope is positive when the surface is tilted toward the azimuth, negative otherwise.					
7	Azimuth of axes plane	Direction (Angle)	degrees	real	[-360;+360]	0.0
	The azimuth of the plane containing the collector tracking axis. The azimuth is defined as the angle between the local meridian and the line of sight of the collector tracking axis. 0=facing equator, 90 = facing west, -90 = facing east					

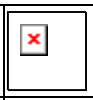
INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Incident beam radiation	Flux	kJ/hr.m^2	real	[0.0;+Inf]	0.0
	The beam radiation incident upon the unshaded collector surface per unit area.					
2	Collector slope	Direction (Angle)	degrees	real	[-360;+360]	30.0
	The slope of the collector surface in degrees.					
3	Collector azimuth	Direction (Angle)	degrees	real	[-360;+360]	0.0
	The azimuth of the solar collector surface.					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Shaded beam radiation	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The beam radiation incident upon the collector surface per unit area including the effects of shading.					
2	Shading fraction	Dimensionless	-	real	[-Inf;+Inf]	0
	The fraction of the collector surface which is shaded.					

4.10.1.3. Parabolic Trough Arrays - Horizontal Axes

Icon		TRNSYS Model	Type 30
Proforma	Physical Phenomena\Collector Array Shading\Parabolic Trough Arrays\Horizontal Axes\Type30c.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Parabolic trough mode	Dimensionless	-	integer	[2;2]	2
	This parameter indicates to the general collector array shading component that the shading is to be calculated for a single-axis tracking parabolic trough array.					
2	Axis orientation	Dimensionless	-	integer	[2;2]	2
	The orientation of the parabolic trough axis. Setting this parameter to 2 indicates that the parabolic trough axes have horizontal axes.					
3	Collector axes separation	Length	m	real	[0.0;+Inf]	3.0
	The distance between tracking axes of the single axis tracking collectors.					
4	Aperture width	Length	m	real	[0.0;+Inf]	0.75
	The width of the aperture of one of the identical parabolic trough collectors.					
5	Number of rows	Dimensionless	-	integer	[1;+Inf]	5
	The number of identical rows of solar collectors in the array.					
6	Slope of axes plane	Direction (Angle)	degrees	real	[0.0;90.0]	90.0
	The slope of the plane containing the tracking axes. Slope is positive when the surface is tilted toward the azimuth, negative otherwise.					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Incident beam radiation	Flux	kJ/hr.m^2	real	[0.0;+Inf]	0.0
	The beam radiation incident upon the unshaded collector surface per unit area.					
2	Collector slope	Direction (Angle)	degrees	real	[-360;+360]	30.0
	The slope of the collector surface in degrees.					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Shaded beam radiation	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The beam radiation incident upon the collector surface per unit area including the effects of shading.					
2	Shading fraction	Dimensionless	-	real	[-Inf;+Inf]	0
	The fraction of the collector surface which is shaded.					

4.10.2. Convection Coefficient Calculation

4.10.2.1. Horizontal Surface - Default Coefficients

Icon		TRNSYS Model	Type 80
Proforma	Physical Phenomena\Convection Coefficient Calculation\Horizontal Surface\Default Coefficients\Type80a.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Surface Type	dimensionless	dimensionless	integer	[1;1]	0
2	Number of Surfaces	dimensionless	dimensionless	real	[1;+Inf]	0

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Air temp near floor surface	Temperature	C	real	[-273;+Inf]	0
2	Air temp. near ceiling surface	Temperature	C	real	[-273;+Inf]	0
3	Temp of floor surface	Temperature	C	real	[-273;+Inf]	0
4	Temp of ceiling surface	Temperature	C	real	[-273;+Inf]	0

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
1-4	Number of Surfaces		1	50

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	convective coefficient for floor surface	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[-Inf;+Inf]	0
2	Convective coefficient for ceiling surface	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[-Inf;+Inf]	0

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
1-2	Number of Surfaces		1	50

4.10.2.2. Horizontal Surface - User Defined Coefficients

Icon		TRNSYS Model	Type 80
Proforma	Physical Phenomena\Convection Coefficient Calculation\Horizontal Surface\User Defined Coefficients\Type80b.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Surface Type	dimensionless	-	integer	[-1;-1]	0
2	Number of Surfaces	dimensionless	-	real	[1;+Inf]	0
3	Constant for floor warmer than air	dimensionless	-	real	[-Inf;+Inf]	0
4	Exponent for floor warmer than air	dimensionless	-	real	[-Inf;+Inf]	0
5	Constant for ceiling warmer than air	dimensionless	-	real	[-Inf;+Inf]	0
6	Exponent for ceiling warmer than air	dimensionless	-	real	[-Inf;+Inf]	0
7	Constant for floor cooler than air	dimensionless	-	real	[-Inf;+Inf]	0
8	Exponent for floor cooler than air	dimensionless	-	real	[-Inf;+Inf]	0
9	Constant for ceiling cooler than air	dimensionless	-	real	[-Inf;+Inf]	0
10	Exponent for ceiling cooler than air	dimensionless	-	real	[-Inf;+Inf]	0

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Air temp near floor surface	Temperature	C	real	[-273;+Inf]	0
2	Air temp. near ceiling surface	Temperature	C	real	[-273;+Inf]	0
3	Temp of floor surface	Temperature	C	real	[-273;+Inf]	0
4	Temp of ceiling surface	Temperature	C	real	[-273;+Inf]	0

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
1-4	Number of Surfaces		1	50

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	convective coefficient for floor surface	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[-Inf;+Inf]	0
2	Convective coefficient for ceiling surface	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[-Inf;+Inf]	0

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
1-2	Number of Surfaces		1	50

4.10.2.3. Vertical Surface - Default Coefficients

Icon		TRNSYS Model	Type 80
Proforma	Physical Phenomena\Convection Coefficient Calculation\Vertical Surface\Default Coefficients\Type80c.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Surface Type	dimensionless	-	integer	[2;2]	0
2	Number of Surfaces	dimensionless	-	real	[1;+Inf]	0

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Air temp. in front of vertical surface	Temperature	C	real	[-273;+Inf]	0
2	Air temp. behind vertical surface	Temperature	C	real	[-273;+Inf]	0
3	Temperature of surface	Temperature	C	real	[-273;+Inf]	0
4	Not used	Temperature	C	real	[-273;+Inf]	0

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
1-4	Number of Surfaces		1	50

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Convective coefficient for front side of surface	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[-Inf;+Inf]	0
2	Convective coefficient for back side of surface	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[-Inf;+Inf]	0

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
1-2	Number of Surfaces		1	50

4.10.2.4. Vertical Surface - User Defined Coefficients

Icon		TRNSYS Model	Type 80
Proforma	Physical Phenomena\Convection Coefficient Calculation\Vertical Surface\User Defined Coefficients\Type80d.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Surface Type	dimensionless	-	integer	[-2;-2]	0
2	Number of Surfaces	dimensionless	-	real	[1;+Inf]	0
3	userdefined Constant for alpa_conv calculation vertical surface	dimensionless	-	real	[-Inf;+Inf]	0
4	userdefined Exponent for alpha_conv calculation vertical surface	dimensionless	-	real	[-Inf;+Inf]	0

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Air temp in front of vertical surface	Temperature	C	real	[-273;+Inf]	0
2	Air temp. behind vertical surface	Temperature	C	real	[-273;+Inf]	0
3	Temp of vertical surface	Temperature	C	real	[-273;+Inf]	0
4	Not used	Temperature	C	real	[-273;+Inf]	0

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
1-4	Number of Surfaces		1	50

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Convective coefficient for front side of vert. surf.	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[-Inf;+Inf]	0
2	Convective coefficient for back side of vert. surf.	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[-Inf;+Inf]	0

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
1-2	Number of Surfaces		1	50

4.10.3. Radiation Processors

4.10.3.1. Beam and Diffuse Known (Mode=3)

Icon		TRNSYS Model	Type 16
Proforma	Physical Phenomena\Radiation Processors\Beam and Diffuse Known (Mode=3)\Type16e.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Horiz. radiation mode	Dimensionless	-	integer	[3;3]	4
	Horizontal Radiation Mode: See the general description for an explanation of all horizontal radiation modes. This proforma corresponds to Mode 3 (Horizontal Beam and Diffuse Radiation Known)					
2	Tracking mode	Dimensionless	-	integer	[1;4]	1
	Surface Tracking Mode: 1 = Fixed surface 2 = Single axis tracking; vertical axis, fixed slope, variable azimuth 3 = Single axis tracking; axis parallel to surface 4 = Two-axis tracking Refer to the abstract for more details					
3	Tilted surface mode	Dimensionless	-	integer	[1;4]	3
	Tilted Surface Rdaition Mode: 1 = Isotropic sky model 2 = Hay and Davies model 3 = Reindl model 4 = Perez model Refer to the abstract for more details					
4	Starting day	Time	day	real	[1;+Inf]	1
	The day of the year corresponding to the simulation start time. Every time the simulation start time is changed, the starting day must be changed or the radiation calculations will be inaccurate. A commonly used workaround to set the starting day to the correct value in all ircumstances is to add the following lines to the "simulations cards" (in "Assembly/Control Cards"): EQUATIONS 1 STARTDAY=INT(START/24)+1 (START is a default TRNSYS variable) You can then set the Type of this parameter to "String" and type in STARTDAY for the value.					
5	Latitude	Dimensionless	-	real	[-90.0;90.0]	43.10
	The latitude of the location being investigated.					
6	Solar constant	Flux	kJ/hr.m^2	real	[0.0;+Inf]	4871.0
	The solar constant.					
7	Shift in solar time	Direction (Angle)	degrees	real	[-40;30]	0.0
	The shift in solar time (ignored for true solar time, see parameter 9). Since many of the calculations made in transforming insolation on a horizontal surface depend on the time of day, it is important that the correct solar time be used. This parameter is used to account for the differences between solar time and local time. The equation for the shift parameter is: SHIFT = Lst - Lloc where Lst is the standard meridian for the local time zone, and Lloc is the longitude of the location in question. Longitude angles are positive towards West, negative towards East. Examples: Stuttgart, DE: Long.= 9°11' East, LSM=15° East (UTC+1), Shift=-15-(-9.18)=-5.82					

	Madison, WI (US): Long.=89°24' West, LSM= 90° West (UTC-6), shift=90-89.4=0.6 Note that Type 89 prints a notice to the listing file with the correct settings for Type 16. You can check your settings using that information.					
8	Not used	Dimensionless	-	integer	[2;2]	2
	This parameter is not used in this mode of the radiation processor.					
9	Solar time?	Dimensionless	-	integer	[-1;+1]	-1
	If the radiation data being supplied to the radiation processor is at even intervals of solar time (as the TMY data is) then this parameter should be set to a negative number so that the 7th parameter (Shift in Solar Time) is ignored. If the data being supplied is at even intervals of local time, this value should be set positive so that the seventh parameter is used.					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Beam radiation on horizontal	Flux	kJ/hr.m^2	real	[0.0;+Inf]	0.0
	The total radiation on a horizontal surface.					
2	Diffuse radiation on horizontal	Flux	kJ/hr.m^2	real	[0.0;+Inf]	0
3	Time of last data read	Time	hr	real	[0.0;+Inf]	0.0
	The time of the last reading of the external file containing the weather data. Typically from the 19th Output of the data reader component.					
4	Time of next data read	Time	hr	real	[0.0;+Inf]	1.0
	The time that the next weather information will be read from the external data file. This input is typicall hooked up the the 20th Output of the data reader component.					
5	Ground reflectance	Dimensionless	-	real	[0.0;1.0]	0.2
	The reflectance of the ground above which the surface is located. Typical values are 0.2 for ground not covered by snow and 0.7 for ground covered by snow.					
6	Slope of surface	Direction (Angle)	degrees	real	[-360;+360]	0.0
	The slope of the surface or tracking axis. The slope is positive when tilted in the direction of the azimuth. 0 = Horizontal ; 90 = Vertical facing toward azimuth Refer to the abstract for details on slope specification for tracking surfaces.					
7	Azimuth of surface	Direction (Angle)	degrees	real	[-360;+360]	0.0
	The solar azimuth angle is the angle between the local meridian and the projection of the line of sight of the sun onto the horizontal plane. The reference is as follows: 0 = Facing equator 90 = Facing West 180 (or -180) = Facing away from the equator -90 (or 270) = Facing East (See manual for examples) Refer to the abstract for details on the azimuth parameter for tracking surfaces.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
6-7		How many surfaces are to be evaluated by this radiation processor?	1	8

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Extraterrestrial on horizontal	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The extraterrestrial radiation on a horizontal surface.					
2	Solar zenith angle	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
	The zenith angle is the angle between the vertical and the line of sight of the sun.					
3	Solar azimuth angle	Direction (Angle)	degrees	real	[-Inf;+Inf]	0

	The solar azimuth angle is defined as being the angle between the local meridian and the projection of the line of sight of the sun onto the horizontal plane.					
4	Total horizontal radiation	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The total radiation incident on a horizontal surface. The total radiation is equal to the beam radiation + sky diffuse radiation + ground reflected diffuse radiation.					
5	Beam radiation on horizontal	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
6	Horizontal diffuse radiation	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The diffuse radiation (sky only) on a horizontal surface.					
7	Total radiation on surface 1	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The total radiation on the tilted surface (beam + sky diffuse + ground reflected diffuse).					
8	Beam radiation on surface 1	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The beam radiation on the first surface specified.					
9	Sky diffuse on surface 1	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The sky diffuse radiation incident on the first surface specified.					
10	Incidence angle for surface 1	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
	The angle of incidence of the beam radiation on the first surface specified.					
11	Slope of surface 1	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
	The slope of the first surface specified.					
12	Total radiation on surface 2	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The total radiation (beam + sky diffuse + ground reflected diffuse) on the second surface that was specified.					
13	Beam radiation on surface 2	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The beam radiation incident on the second specified surface.					
14	Sky diffuse on surface 2	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
15	Incidence angle of surface 2	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
	The angle of incidence of the beam radiation on the second surface specified.					
16	Slope of surface 2	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
17	Total radiation on surface 3	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The total radiation (beam + sky diffuse + ground reflected diffuse) incident on the third surface specified.					
18	Beam radiation on surface 3	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The beam radiation on the third surface specified.					
19	Sky diffuse on surface 3	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
20	Incidence angle of surface 3	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
	The angle of incidence of the beam radiation on the third surface specified.					
21	Slope of surface 3	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
22	Total radiation on surface 4	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The total radiation (beam + sky diffuse + ground reflected diffuse) incident on the fourth surface specified.					
23	Beam radiation on surface 4	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The beam radiation incident on the fourth surface specified.					
24	Sky diffuse on surface 4	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The angle of incidence of the beamradiation on the fourth surface specified.					
25	Incidence angle of surface 4	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
26	Slope of surface 4	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
27	Total radiation on surface 5	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
28	Beam radiation on surface 5	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
29	Sky diffuse radiation on surface 5	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
30	Incidence angle of surface 5	Direction (Angle)	degrees	real	[-Inf;+Inf]	0

31	Slope of surface 5	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
32	Total radiation on surface 6	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
33	Beam radiation on surface 6	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
34	Sky diffuse radiation on surface 6	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
35	Incidence angle of surface 6	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
36	Slope of surface 6	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
37	Total radiation on surface 7	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
38	Beam radiation on surface 7	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
39	Sky diffuse radiation on surface 7	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
40	Incidence angle of surface 7	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
41	Slope of surface 7	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
42	Total radiation on surface 8	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
43	Beam radiation on surface 8	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
44	Sky diffuse radiation on surface 8	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
45	Incidence angle of surface 8	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
46	Slope of surface 8	Direction (Angle)	degrees	real	[-Inf;+Inf]	0

4.10.3.2. Total Horiz Only Known (Mode=1)

Icon		TRNSYS Model	Type 16
Proforma	Physical Phenomena\Radiation Processors\Total Horiz Only Known (Mode=1)\Type16a.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Horiz. radiation mode	Dimensionless	-	integer	[1;1]	4
	Horizontal Radiation Mode: See the general description for an explanation of all horizontal radiation modes. This proforma corresponds to Mode 1 (Only Horizontal Known, Reduced Reindl Correlation)					
2	Tracking mode	Dimensionless	-	integer	[1;4]	1
	Surface Tracking Mode: 1 = Fixed surface 2 = Single axis tracking; vertical axis, fixed slope, variable azimuth 3 = Single axis tracking; axis parallel to surface 4 = Two-axis tracking Refer to the abstract for more details.					
3	Tilted surface mode	Dimensionless	-	integer	[1;4]	3
	Tilted Surface Rdaition Mode: 1 = Isotropic sky model 2 = Hay and Davies model 3 = Reindl model 4 = Perez model Refer to the abstract for more details					
4	Starting day	Time	day	real	[1;+Inf]	1
	The day of the year corresponding to the simulation start time. Every time the simulation start time is changed, the starting day must be changed or the radiation calculations will be inaccurate. A commonly used workaround to set the starting day to the correct value in all circumstances is to add the following lines to the "simulations cards" (in "Assembly/Control Cards"): EQUATIONS 1 STARTDAY=INT(START/24)+1 (START is a default TRNSYS variable) You can then set the Type of this parameter to "String" and type in STARTDAY for the value.					
5	Latitude	dimensionless	-	real	[-90.0;90.0]	43.10
	The latitude of the location being investigated.					
6	Solar constant	Flux	kJ/hr.m^2	real	[0.0;+Inf]	4871.0
	The solar constant.					
7	Shift in solar time	Direction (Angle)	degrees	real	[-40;30]	0.0
	The shift in solar time (ignored for true solar time, see parameter 9). Since many of the calculations made in transforming insolation on a horizontal surface depend on the time of day, it is important that the correct solar time be used. This parameter is used to account for the differences between solar time and local time. The equation for the shift parameter is: SHIFT = Lst - Lloc where Lst is the standard meridian for the local time zone, and Lloc is the longitude of the location in question. Longitude angles are positive towards West, negative towards East. Examples: Stuttgart, DE: Long.= 9°11' East, LSM=15° East (UTC+1), Shift=-15-(-9.18)=-5.82 Madison, WI (US): Long.=89°24' West, LSM= 90° West (UTC-6), shift=90-89.4=0.6 Note that Type 89 prints a notice to the listing file with the correct settings for Type 16. You can check your settings using that information.					
8	Not used	dimensionless	-	integer	[2;2]	2

	This parameter is not used in this mode of the radiation processor.					
9	Solar time?	dimensionless	-	integer	[-1;+1]	-1
	If the radiation data being supplied to the radiation processor is at even intervals of solar time (as the TMY data is) then this parameter should be set to a negative number so that the 7th parameter (Shift in Solar Time) is ignored. If the data being supplied is at even intervals of local time, this value should be set positive so that the seventh parameter is used.					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Radiation on horizontal	Flux	kJ/hr.m^2	real	[0.0;+Inf]	0.0
	The total radiation on a horizontal surface.					
2	Time of last data read	Time	hr	real	[0.0;+Inf]	0.0
	The time of the last reading of the external file containing the weather data. Typically from the 19th Output of the data reader component.					
3	Time of next data read	Time	hr	real	[0.0;+Inf]	1.0
	The time that the next weather information will be read from the external data file. This input is typicall hooked up the the 20th Output of the data reader component.					
4	Ground reflectance	Dimensionless	-	real	[0.0;1.0]	0.2
	The reflectance of the ground above which the surface is located. Typical values are 0.2 for ground not covered by snow and 0.7 for ground covered by snow.					
5	Slope of surface	Direction (Angle)	degrees	real	[-360;+360]	0.0
	The slope of the surface or tracking axis. The slope is positive when tilted in the direction of the azimuth. 0 = Horizontal ; 90 = Vertical facing toward azimuth Refer to the abstract for details on slope specification for tracking surfaces.					
6	Azimuth of surface	Direction (Angle)	degrees	real	[-360;+360]	0.0
	The solar azimuth angle is the angle between the local meridian and the projection of the line of sight of the sun onto the horizontal plane. The reference is as follows: 0 = Facing equator 90 = Facing West 180 (or -180) = Facing away from the equator -90 (or 270) = Facing East (See manual for examples) Refer to the abstract for details on the azimuth parameter for tracking surfaces.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
5-6		How many surfaces are to be evaluated by this radiation processor?	1	8

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Extraterrestrial on horizontal	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The extraterrestrial radiation on a horizontal surface.					
2	Solar zenith angle	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
	The zenith angle is the angle between the vertical and the line of sight of the sun.					
3	Solar azimuth angle	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
	The solar azimuth angle is defined as being the angle between the local meridian and the projection of the line of sight of the sun onto the horizontal plane.					
4	Total horizontal radiation	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0

	The total radiation incident on a horizontal surface. The total radiation is equal to the beam radiation + sky diffuse radiation + ground reflected diffuse radiation.					
5	Beam radiation on horizontal	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
6	Horizontal diffuse radiation	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The diffuse radiation (sky only) on a horizontal surface.					
7	Total radiation on surface 1	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The total radiation on the tilted surface (beam + sky diffuse + ground reflected diffuse).					
8	Beam radiation on surface 1	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The beam radiation on the first surface specified.					
9	Sky diffuse on surface 1	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The sky diffuse radiation incident on the first surface specified.					
10	Incidence angle for surface 1	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
	The angle of incidence of the beam radiation on the first surface specified.					
11	Slope of surface 1	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
	The slope of the first surface specified.					
12	Total radiation on surface 2	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The total radiation (beam + sky diffuse + ground reflected diffuse) on the second surface that was specified.					
13	Beam radiation on surface 2	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The beam radiation incident on the second specified surface.					
14	Sky diffuse on surface 2	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
15	Incidence angle of surface 2	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
	The angle of incidence of the beam radiation on the second surface specified.					
16	Slope of surface 2	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
17	Total radiation on surface 3	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The total radiation (beam + sky diffuse + ground reflected diffuse) incident on the third surface specified.					
18	Beam radiation on surface 3	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The beam radiation on the third surface specified.					
19	Sky diffuse on surface 3	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
20	Incidence angle of surface 3	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
	The angle of incidence of the beam radiation on the third surface specified.					
21	Slope of surface 3	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
22	Total radiation on surface 4	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The total radiation (beam + sky diffuse + ground reflected diffuse) incident on the fourth surface specified.					
23	Beam radiation on surface 4	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The beam radiation incident on the fourth surface specified.					
24	Sky diffuse on surface 4	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The angle of incidence of the beamradiation on the fourth surface specified.					
25	Incidence angle of surface 4	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
26	Slope of surface 4	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
27	Total radiation on surface 5	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
28	Beam radiation on surface 5	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
29	Sky diffuse radiation on surface 5	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
30	Incidence angle of surface 5	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
31	Slope of surface 5	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
32	Total radiation on surface 6	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
33	Beam radiation on surface 6	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0

34	Sky diffuse radiation on surface 6	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
35	Incidence angle of surface 6	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
36	Slope of surface 6	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
37	Total radiation on surface 7	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
38	Beam radiation on surface 7	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
39	Sky diffuse radiation on surface 7	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
40	Incidence angle of surface 7	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
41	Slope of surface 7	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
42	Total radiation on surface 8	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
43	Beam radiation on surface 8	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
44	Sky diffuse radiation on surface 8	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
45	Incidence angle of surface 8	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
46	Slope of surface 8	Direction (Angle)	degrees	real	[-Inf;+Inf]	0

4.10.3.3. Total Horiz Temp and Humidity Known (Mode=2)

Icon		TRNSYS Model	Type 16
Proforma	Physical Phenomena\Radiation Processors\Total Horiz Temp and Humidity Known (Mode=2)\Type16c.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Horiz. radiation mode	Dimensionless	-	integer	[2;2]	4
	See the general description for an explanation of all horizontal radiation modes. This proforma corresponds to Mode 2 (Total Horizontal Radiation, Temperature and Humidity Known, Full Reindl Correlation)					
2	Tracking mode	Dimensionless	-	integer	[1;4]	1
	Surface Tracking Mode: 1 = Fixed surface 2 = Single axis tracking; vertical axis, fixed slope, variable azimuth 3 = Single axis tracking; axis parallel to surface 4 = Two-axis tracking Refer to the abstract for more details.					
3	Tilted surface mode	Dimensionless	-	integer	[1;4]	3
	Tilted Surface Rdaition Mode: 1 = Isotropic sky model 2 = Hay and Davies model 3 = Reindl model 4 = Perez model Refer to the abstract for more details					
4	Starting day	Time	day	real	[1;+Inf]	1
	The day of the year corresponding to the simulation start time. Every time the simulation start time is changed, the starting day must be changed or the radiation calculations will be inaccurate. A commonly used workaround to set the starting day to the correct value in all circumstances is to add the following lines to the "simulations cards" (in "Assembly/Control Cards"): EQUATIONS 1 STARTDAY=INT(START/24)+1 (START is a default TRNSYS variable) You can then set the Type of this parameter to "String" and type in STARTDAY for the value.					
5	Latitude	Dimensionless	-	real	[-90.0;90.0]	43.10
	The latitude of the location being investigated.					
6	Solar constant	Flux	kJ/hr.m^2	real	[0.0;+Inf]	4871.0
	The solar constant.					
7	Shift in solar time	Direction (Angle)	degrees	real	[-40;30]	0.0
	The shift in solar time (ignored for true solar time, see parameter 9). Since many of the calculations made in transforming insolation on a horizontal surface depend on the time of day, it is important that the correct solar time be used. This parameter is used to account for the differences between solar time and local time. The equation for the shift parameter is: SHIFT = Lst - Lloc where Lst is the standard meridian for the local time zone, and Lloc is the longitude of the location in question. Longitude angles are positive towards West, negative towards East. Examples: Stuttgart, DE: Long.= 9°11' East, LSM=15° East (UTC+1), Shift=-15-(-9.18)=-5.82 Madison, WI (US): Long.=89°24' West, LSM= 90° West (UTC-6), shift=90-89.4=0.6 Note that Type 89 prints a notice to the listing file with the correct settings for Type 16. You can check your settings using that information.					
8	Not used	Dimensionless	-	integer	[2;2]	2

	This parameter is not used in this mode of the radiation processor.					
9	Solar time?	Dimensionless	-	integer	[-1;+1]	-1
	If the radiation data being supplied to the radiation processor is at even intervals of solar time (as the TMY data is) then this parameter should be set to a negative number so that the 7th parameter (Shift in Solar Time) is ignored. If the data being supplied is at even intervals of local time, this value should be set positive so that the seventh parameter is used.					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Radiation on horizontal	Flux	kJ/hr.m^2	real	[0.0;+Inf]	0.0
	The total radiation on a horizontal surface.					
2	Ambient temperature	Temperature	C	real	[-273.1;+Inf]	0
3	Relative humidity	Dimensionless	-	real	[0;100]	0
4	Time of last data read	Time	hr	real	[0.0;+Inf]	0.0
	The time of the last reading of the external file containing the weather data. Typically from the 19th Output of the data reader component.					
5	Time of next data read	Time	hr	real	[0.0;+Inf]	1.0
	The time that the next weather information will be read from the external data file. This input is typicall hooked up the the 20th Output of the data reader component.					
6	Ground reflectance	Dimensionless	-	real	[0.0;1.0]	0.2
	The reflectance of the ground above which the surface is located. Typical values are 0.2 for ground not covered by snow and 0.7 for ground covered by snow.					
7	Slope of surface	Direction (Angle)	degrees	real	[-360;+360]	0.0
	The slope of the surface or tracking axis. The slope is positive when tilted in the direction of the azimuth. 0 = Horizontal ; 90 = Vertical facing toward azimuth Refer to the abstract for details on slope specification for tracking surfaces.					
8	Azimuth of surface	Direction (Angle)	degrees	real	[-360;+360]	0.0
	The solar azimuth angle is the angle between the local meridian and the projection of the line of sight of the sun onto the horizontal plane. The reference is as follows: 0 = Facing equator 90 = Facing West 180 (or -180) = Facing away from the equator -90 (or 270) = Facing East (See manual for examples.) Refer to the abstract for details on the azimuth parameter for tracking surfaces.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
7-8		How many surfaces are to be evaluated by this radiation processor?	1	8

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Extraterrestrial on horizontal	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The extraterrestrial radiation on a horizontal surface.					
2	Solar zenith angle	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
	The zenith angle is the angle between the vertical and the line of sight of the sun.					
3	Solar azimuth angle	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
	The solar azimuth angle is defined as being the angle between the local meridian and the projection of the line of sight of the sun onto the horizontal plane.					
4	Total horizontal radiation	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0

	The total radiation incident on a horizontal surface. The total radiation is equal to the beam radiation + sky diffuse radiation + ground reflected diffuse radiation.					
5	Beam radiation on horizontal	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
6	Horizontal diffuse radiation	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The diffuse radiation (sky only) on a horizontal surface.					
7	Total radiation on surface 1	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The total radiation on the tilted surface (beam + sky diffuse + ground reflected diffuse).					
8	Beam radiation on surface 1	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The beam radiation on the first surface specified.					
9	Sky diffuse on surface 1	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The sky diffuse radiation incident on the first surface specified.					
10	Incidence angle for surface 1	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
	The angle of incidence of the beam radiation on the first surface specified.					
11	Slope of surface 1	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
	The slope of the first surface specified.					
12	Total radiation on surface 2	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The total radiation (beam + sky diffuse + ground reflected diffuse) on the second surface that was specified.					
13	Beam radiation on surface 2	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The beam radiation incident on the second specified surface.					
14	Sky diffuse on surface 2	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
15	Incidence angle of surface 2	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
	The angle of incidence of the beam radiation on the second surface specified.					
16	Slope of surface 2	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
17	Total radiation on surface 3	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The total radiation (beam + sky diffuse + ground reflected diffuse) incident on the third surface specified.					
18	Beam radiation on surface 3	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The beam radiation on the third surface specified.					
19	Sky diffuse on surface 3	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
20	Incidence angle of surface 3	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
	The angle of incidence of the beam radiation on the third surface specified.					
21	Slope of surface 3	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
22	Total radiation on surface 4	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The total radiation (beam + sky diffuse + ground reflected diffuse) incident on the fourth surface specified.					
23	Beam radiation on surface 4	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The beam radiation incident on the fourth surface specified.					
24	Sky diffuse on surface 4	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The angle of incidence of the beamradiation on the fourth surface specified.					
25	Incidence angle of surface 4	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
26	Slope of surface 4	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
27	Total radiation on surface 5	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
28	Beam radiation on surface 5	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
29	Sky diffuse radiation on surface 5	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
30	Incidence angle of surface 5	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
31	Slope of surface 5	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
32	Total radiation on surface 6	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
33	Beam radiation on surface 6	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0

34	Sky diffuse radiation on surface 6	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
35	Incidence angle of surface 6	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
36	Slope of surface 6	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
37	Total radiation on surface 7	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
38	Beam radiation on surface 7	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
39	Sky diffuse radiation on surface 7	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
40	Incidence angle of surface 7	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
41	Slope of surface 7	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
42	Total radiation on surface 8	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
43	Beam radiation on surface 8	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
44	Sky diffuse radiation on surface 8	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
45	Incidence angle of surface 8	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
46	Slope of surface 8	Direction (Angle)	degrees	real	[-Inf;+Inf]	0

4.10.3.4. Total Horiz, Direct Normal Known (Mode=4)

Icon		TRNSYS Model	Type 16
Proforma	Physical Phenomena\Radiation Processors\Total Horiz, Direct Normal Known (Mode=4)\Type16g.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Horiz. radiation mode	Dimensionless	-	integer	[4;4]	4
	See the general description for an explanation of all horizontal radiation modes. This proforma corresponds to Mode 4 (Total Horizontal and Normal Beam Radiation Known)					
2	Tracking mode	Dimensionless	-	integer	[1;4]	1
	Surface Tracking Mode: 1 = Fixed surface 2 = Single axis tracking; vertical axis, fixed slope, variable azimuth 3 = Single axis tracking; axis parallel to surface 4 = Two-axis tracking Refer to the abstract for more details.					
3	Tilted surface mode	Dimensionless	-	integer	[1;4]	3
	Tilted Surface Rdaition Mode: 1 = Isotropic sky model 2 = Hay and Davies model 3 = Reindl model 4 = Perez model Refer to the abstract for more details					
4	Starting day	Time	day	real	[1;+Inf]	1
	The day of the year corresponding to the simulation start time. Every time the simulation start time is changed, the starting day must be changed or the radiation calculations will be inaccurate. A commonly used workaround to set the starting day to the correct value in all circumstances is to add the following lines to the "simulations cards" (in "Assembly/Control Cards"): EQUATIONS 1 STARTDAY=INT(START/24)+1 (START is a default TRNSYS variable) You can then set the Type of this parameter to "String" and type in STARTDAY for the value.					
5	Latitude	Dimensionless	-	real	[-90.0;90.0]	43.10
	The latitude of the location being investigated.					
6	Solar constant	Flux	kJ/hr.m^2	real	[0.0;+Inf]	4871.0
	The solar constant.					
7	Shift in solar time	Direction (Angle)	degrees	real	[-40;30]	0.0
	The shift in solar time (ignored for true solar time, see parameter 9). Since many of the calculations made in transforming insolation on a horizontal surface depend on the time of day, it is important that the correct solar time be used. This parameter is used to account for the differences between solar time and local time. The equation for the shift parameter is: SHIFT = Lst - Lloc where Lst is the standard meridian for the local time zone, and Lloc is the longitude of the location in question. Longitude angles are positive towards West, negative towards East. Examples: Stuttgart, DE: Long.= 9°11' East, LSM=15° East (UTC+1), Shift=-15-(-9.18)=-5.82 Madison, WI (US): Long.=89°24' West, LSM= 90° West (UTC-6), shift=90-89.4=0.6 Note that Type 89 prints a notice to the listing file with the correct settings for Type 16. You can check your settings using that information.					
8	Not used	Dimensionless	-	integer	[2;2]	2
	This parameter is not used in this mode of the radiation processor.					

9	Solar time?	Dimensionless	-	integer	[-1;+1]	-1
	If the radiation data being supplied to the radiation processor is at even intervals of solar time (as the TMY data is) then this parameter should be set to a negative number so that the 7th parameter (Shift in Solar Time) is ignored. If the data being supplied is at even intervals of local time, this value should be set positive so that the seventh parameter is used.					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Total radiation on horizontal surface	Flux	kJ/hr.m^2	real	[0.0;+Inf]	0.0
	The total radiation on a horizontal surface.					
2	Direct normal beam radiation	Flux	kJ/hr.m^2	real	[0.0;+Inf]	0
	Beam radiation on a surface oriented towards the sun					
3	Time of last data read	Time	hr	real	[0.0;+Inf]	0.0
	The time of the last reading of the external file containing the weather data. Typically from the 19th Output of the data reader component.					
4	Time of next data read	Time	hr	real	[0.0;+Inf]	1.0
	The time that the next weather information will be read from the external data file. This input is typicall hooked up the the 20th Output of the data reader component.					
5	Ground reflectance	Dimensionless	-	real	[0.0;1.0]	0.2
	The reflectance of the ground above which the surface is located. Typical values are 0.2 for ground not covered by snow and 0.7 for ground covered by snow.					
6	Slope of surface	Direction (Angle)	degrees	real	[-360;+360]	0.0
	The slope of the surface or tracking axis. The slope is positive when tilted in the direction of the azimuth. 0 = Horizontal ; 90 = Vertical facing toward azimuth Refer to the abstract for details on slope specification for tracking surfaces.					
7	Azimuth of surface	Direction (Angle)	degrees	real	[-360;+360]	0.0
	The solar azimuth angle is the angle between the local meridian and the projection of the line of sight of the sun onto the horizontal plane. The reference is as follows: 0 = Facing equator 90 = Facing West 180 (or -180) = Facing away from the equator -90 (or 270) = Facing East (See manual for examples) Refer to the abstract for details on the azimuth parameter for tracking surfaces.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
6-7		How many surfaces are to be evaluated by this radiation processor?	1	8

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Extraterrestrial on horizontal	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The extraterrestrial radiation on a horizontal surface.					
2	Solar zenith angle	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
	The zenith angle is the angle between the vertical and the line of sight of the sun.					
3	Solar azimuth angle	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
	The solar azimuth angle is defined as being the angle between the local meridian and the projection of the line of sight of the sun onto the horizontal plane.					
4	Total horizontal radiation	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0

	The total radiation incident on a horizontal surface. The total radiation is equal to the beam radiation + sky diffuse radiation + ground reflected diffuse radiation.					
5	Beam radiation on horizontal	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
6	Horizontal diffuse radiation	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The diffuse radiation (sky only) on a horizontal surface.					
7	Total radiation on surface 1	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The total radiation on the tilted surface (beam + sky diffuse + ground reflected diffuse).					
8	Beam radiation on surface 1	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The beam radiation on the first surface specified.					
9	Sky diffuse on surface 1	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The sky diffuse radiation incident on the first surface specified.					
10	Incidence angle for surface 1	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
	The angle of incidence of the beam radiation on the first surface specified.					
11	Slope of surface 1	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
	The slope of the first surface specified.					
12	Total radiation on surface 2	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The total radiation (beam + sky diffuse + ground reflected diffuse) on the second surface that was specified.					
13	Beam radiation on surface 2	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The beam radiation incident on the second specified surface.					
14	Sky diffuse on surface 2	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
15	Incidence angle of surface 2	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
	The angle of incidence of the beam radiation on the second surface specified.					
16	Slope of surface 2	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
17	Total radiation on surface 3	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The total radiation (beam + sky diffuse + ground reflected diffuse) incident on the third surface specified.					
18	Beam radiation on surface 3	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The beam radiation on the third surface specified.					
19	Sky diffuse on surface 3	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
20	Incidence angle of surface 3	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
	The angle of incidence of the beam radiation on the third surface specified.					
21	Slope of surface 3	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
22	Total radiation on surface 4	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The total radiation (beam + sky diffuse + ground reflected diffuse) incident on the fourth surface specified.					
23	Beam radiation on surface 4	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The beam radiation incident on the fourth surface specified.					
24	Sky diffuse on surface 4	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The angle of incidence of the beamradiation on the fourth surface specified.					
25	Incidence angle of surface 4	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
26	Slope of surface 4	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
27	Total radiation on surface 5	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
28	Beam radiation on surface 5	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
29	Sky diffuse radiation on surface 5	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
30	Incidence angle of surface 5	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
31	Slope of surface 5	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
32	Total radiation on surface 6	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
33	Beam radiation on surface 6	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0

34	Sky diffuse radiation on surface 6	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
35	Incidence angle of surface 6	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
36	Slope of surface 6	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
37	Total radiation on surface 7	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
38	Beam radiation on surface 7	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
39	Sky diffuse radiation on surface 7	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
40	Incidence angle of surface 7	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
41	Slope of surface 7	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
42	Total radiation on surface 8	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
43	Beam radiation on surface 8	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
44	Sky diffuse radiation on surface 8	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
45	Incidence angle of surface 8	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
46	Slope of surface 8	Direction (Angle)	degrees	real	[-Inf;+Inf]	0

4.10.3.5. Total Horiz, Horiz Diffuse Known (Mode=5)

Icon		TRNSYS Model	Type 16
Proforma	Physical Phenomena\Radiation Processors\Total Horiz, Horiz Diffuse Known (Mode=5)\Type16i.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Horiz. radiation mode	Dimensionless	-	integer	[5;5]	4
	See the general description for an explanation of all horizontal radiation modes. This proforma corresponds to Mode 5 (Total Horizontal and Diffuse Horizontal Radiation Known)					
2	Tracking mode	Dimensionless	-	integer	[1;4]	1
	Surface Tracking Mode: 1 = Fixed surface 2 = Single axis tracking; vertical axis, fixed slope, variable azimuth 3 = Single axis tracking; axis parallel to surface 4 = Two-axis tracking Refer to the abstract for more details.					
3	Tilted surface mode	Dimensionless	-	integer	[1;4]	3
	Tilted Surface Rdaition Mode: 1 = Isotropic sky model 2 = Hay and Davies model 3 = Reindl model 4 = Perez model Refer to the abstract for more details					
4	Starting day	Time	day	real	[1;+Inf]	1
	The day of the year corresponding to the simulation start time. Every time the simulation start time is changed, the starting day must be changed or the radiation calculations will be inaccurate. A commonly used workaround to set the starting day to the correct value in all circumstances is to add the following lines to the "simulations cards" (in "Assembly/Control Cards"): EQUATIONS 1 STARTDAY=INT(START/24)+1 (START is a default TRNSYS variable) You can then set the Type of this parameter to "String" and type in STARTDAY for the value.					
5	Latitude	Dimensionless	-	real	[-90.0;90.0]	43.10
	The latitude of the location being investigated.					
6	Solar constant	Flux	kJ/hr.m^2	real	[0.0;+Inf]	4871.0
	The solar constant.					
7	Shift in solar time	Direction (Angle)	degrees	real	[-40;30]	0.0
	The shift in solar time (ignored for true solar time, see parameter 9). Since many of the calculations made in transforming insolation on a horizontal surface depend on the time of day, it is important that the correct solar time be used. This parameter is used to account for the differences between solar time and local time. The equation for the shift parameter is: SHIFT = Lst - Lloc where Lst is the standard meridian for the local time zone, and Lloc is the longitude of the location in question. Longitude angles are positive towards West, negative towards East. Examples: Stuttgart, DE: Long.= 9°11' East, LSM=15° East (UTC+1), Shift=-15-(-9.18)=-5.82 Madison, WI (US): Long.=89°24' West, LSM= 90° West (UTC-6), shift=90-89.4=0.6 Note that Type 89 prints a notice to the listing file with the correct settings for Type 16. You can check your settings using that information.					
8	Not used	Dimensionless	-	integer	[2;2]	2
	This parameter is not used in this mode of the radiation processor.					

9	Solar time?	Dimensionless	-	integer	[-1;+1]	-1
	If the radiation data being supplied to the radiation processor is at even intervals of solar time (as the TMY data is) then this parameter should be set to a negative number so that the 7th parameter (Shift in Solar Time) is ignored. If the data being supplied is at even intervals of local time, this value should be set positive so that the seventh parameter is used.					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Total radiation on horizontal1	Flux	kJ/hr.m^2	real	[0.0;+Inf]	0.0
	The total radiation on a horizontal surface.					
2	Diffuse radiation on horizontal	Flux	kJ/hr.m^2	real	[0.0;+Inf]	0
3	Time of last data read	Time	hr	real	[0.0;+Inf]	0.0
	The time of the last reading of the external file containing the weather data. Typically from the 19th Output of the data reader component.					
4	Time of next data read	Time	hr	real	[0.0;+Inf]	1.0
	The time that the next weather information will be read from the external data file. This input is typicall hooked up the the 20th Output of the data reader component.					
5	Ground reflectance	Dimensionless	-	real	[0.0;1.0]	0.2
	The reflectance of the ground above which the surface is located. Typical values are 0.2 for ground not covered by snow and 0.7 for ground covered by snow.					
6	Slope of surface	Direction (Angle)	degrees	real	[-360;+360]	0.0
	The slope of the surface or tracking axis. The slope is positive when tilted in the direction of the azimuth. 0 = Horizontal ; 90 = Vertical facing toward azimuth Refer to the abstract for details on slope specification for tracking surfaces.					
7	Azimuth of surface	Direction (Angle)	degrees	real	[-360;+360]	0.0
	The solar azimuth angle is the angle between the local meridian and the projection of the line of sight of the sun onto the horizontal plane. The reference is as follows: 0 = Facing equator 90 = Facing West 180 (or -180) = Facing away from the equator -90 (or 270) = Facing East (See manual for examples.) Refer to the abstract for details on the azimuth parameter for tracking surfaces.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
6-7		How many surfaces are to be evaluated by this radiation processor?	1	8

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Extraterrestrial on horizontal	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The extraterrestrial radiation on a horizontal surface.					
2	Solar zenith angle	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
	The zenith angle is the angle between the vertical and the line of sight of the sun.					
3	Solar azimuth angle	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
	The solar azimuth angle is defined as being the angle between the local meridian and the projection of the line of sight of the sun onto the horizontal plane.					
4	Total horizontal radiation	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The total radiation incident on a horizontal surface. The total radiation is equal to the beam radiation + sky					

	diffuse radiation + ground reflected diffuse radiation.					
5	Beam radiation on horizontal	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
6	Horizontal diffuse radiation	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The diffuse radiation (sky only) on a horizontal surface.					
7	Total radiation on surface 1	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The total radiation on the tilted surface (beam + sky diffuse + ground reflected diffuse).					
8	Beam radiation on surface 1	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The beam radiation on the first surface specified.					
9	Sky diffuse on surface 1	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The sky diffuse radiation incident on the first surface specified.					
10	Incidence angle for surface 1	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
	The angle of incidence of the beam radiation on the first surface specified.					
11	Slope of surface 1	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
	The slope of the first surface specified.					
12	Total radiation on surface 2	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The total radiation (beam + sky diffuse + ground reflected diffuse) on the second surface that was specified.					
13	Beam radiation on surface 2	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The beam radiation incident on the second specified surface.					
14	Sky diffuse on surface 2	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
15	Incidence angle of surface 2	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
	The angle of incidence of the beam radiation on the second surface specified.					
16	Slope of surface 2	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
17	Total radiation on surface 3	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The total radiation (beam + sky diffuse + ground reflected diffuse) incident on the third surface specified.					
18	Beam radiation on surface 3	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The beam radiation on the third surface specified.					
19	Sky diffuse on surface 3	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
20	Incidence angle of surface 3	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
	The angle of incidence of the beam radiation on the third surface specified.					
21	Slope of surface 3	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
22	Total radiation on surface 4	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The total radiation (beam + sky diffuse + ground reflected diffuse) incident on the fourth surface specified.					
23	Beam radiation on surface 4	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The beam radiation incident on the fourth surface specified.					
24	Sky diffuse on surface 4	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The angle of incidence of the beamradiation on the fourth surface specified.					
25	Incidence angle of surface 4	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
26	Slope of surface 4	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
27	Total radiation on surface 5	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
28	Beam radiation on surface 5	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
29	Sky diffuse radiation on surface 5	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
30	Incidence angle of surface 5	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
31	Slope of surface 5	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
32	Total radiation on surface 6	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
33	Beam radiation on surface 6	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0

34	Sky diffuse radiation on surface 6	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
35	Incidence angle of surface 6	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
36	Slope of surface 6	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
37	Total radiation on surface 7	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
38	Beam radiation on surface 7	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
39	Sky diffuse radiation on surface 7	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
40	Incidence angle of surface 7	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
41	Slope of surface 7	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
42	Total radiation on surface 8	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
43	Beam radiation on surface 8	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
44	Sky diffuse radiation on surface 8	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
45	Incidence angle of surface 8	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
46	Slope of surface 8	Direction (Angle)	degrees	real	[-Inf;+Inf]	0

4.10.4. Shading Masks

4.10.4.1. Shading on Opening

Icon		TRNSYS Model	Type 68
Proforma	Physical Phenomena\Shading Masks\Type68.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Logical unit for data file	Dimensionless	-	integer	[10;+Inf]	0
	Type68 reads a file containing the angular heights of obstructions that shade openings. Two types of angle are needed. Surface angles (alpha) are measured in the same coordinates as the TRNSYS standard for solar angles. Thus in the Northern Hemisphere South = 0, North = -180, East = -90 and West = 90 (in the Southern hemisphere, South. Obstruction anglular heights (beta) are given for each surface angle. !!! ATTENTION !!! 1. The maximum line length is 160 characters. Longer lines will be truncated with unpredictable results 2. Opening ID's should be integer numbers in ascending order 3. The azimuth angles (alpha) for which obstruction angles are given are relative to the surface azimuth, not absolute The format of the data file should be (assuming you use the maximum number of azimuth angles, i.e. 20): --- OPEN_ID1 OPEN_ID2 OPEN_ID3 ... OPEN_IDN Slope_1 Slope_2 Slope_3 ... Slope_N Azimuth_1 Azimuth_2 Azimuth_3 ... Azimuth_N -180 -162 -144 -126 -108 -90 -72 -54 -36 -18 0 18 36 54 72 90 108 126 144 162 beta1 at alpha1 for OPEN_ID1 (i.e. obstruction angle fora relative azimuth of beta2 at alpha2 for OPEN_ID1 beta3 at alpha3 for OPEN_ID1 ... beta1 at alpha1 for OPEN_ID2 beta2 at alpha2 for OPEN_ID2 beta3 at alpha3 for OPEN_ID2 ... betaN at alphaN for OPEN_IDn ********** Type68 takes two inputs which give the angle of the sun and return two outputs for each opening in the file. The first ouput is the fraction of diffuse radation that is visible from the opening. The second output for each opening is a flag which has a value of 1 if the beam radiation is visible from the opening and 0 if it is not.					
2	Number of openings in file	dimensionless	-	integer	[1;40]	0
3	Number of surface angles	dimensionless	-	integer	[1;20]	0

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Solar azimuth angle	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
	The solar azimuth angle is the angle between the local meridian and the projection of the line of sight of the sun onto the horizontal plane. The reference is as follows: 0 = Facing equator 90 = Facing West 180 (or -180) = Facing away from the equator -90 (or 270) = Facing East (See manual for examples.)					

2	Solar zenith angle	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
	The zenith angle is the angle between the vertical and the line of sight of the sun.					
3	Beam radiation for opening	Flux	kJ/hr.m^2	real	[0;+Inf]	0
	Beam (or direct) radiation corresponding to the orientation of the opening. (Usually output of Solar Radiation Processor).					
4	Diffuse radiation for opening	Flux	kJ/hr.m^2	real	[0;+Inf]	0
	Diffuse radiation corresponding to the orientation of the opening. (Usually output of Solar Radiation Processor).					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
3-4	Number of openings in file		1	100

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Solar altitude angle	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
	Angular height of the direct line between the opening's center and the sun versus the horizontal.					
2	Fraction of beam visible for surf.	Dimensionless	Dimensionless	real	[-Inf;+Inf]	0
	Flag = 1 if beam radiation is visisble for this opening, otherwise = 0.					
3	Shaded beam rad. for surf.	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	Beam radiation for this surface, taking shading into account.					
4	Fraction of diffuse visible for surf.	dimensionless	-	real	[-Inf;+Inf]	0
	Number between 0 and 1 which gives the fraction of diffuse radiation visible from the opening. 0 indicates no diffuse radiation is visible and 1 indicates that all the shading has no influence (i.e., all the diffuse radiation normally visible by the window is indeed visible).					
5	Shaded diffuse rad. on surf.	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	Diffuse radiation for this surface, taking shading into account.					
6	Shaded total rad. for surf.	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	Total radiation for this opening, taking shading into account.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
2-6	Number of openings in file		1	100

EXTERNAL FILES

Question	File	Associated parameter
Which file contains the angular obstruction data?	.\Examples\Data Files\Type68-ShadingMasks.dat	Logical unit for data file
Source file	.\SourceCode\Types\Type68.for	

4.10.4.2. Shading By External Object on Opening and Horizontal

Icon		**TRNSYS Model**	Type 67
Proforma	Physical Phenomena\Shading Masks\Type67.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default

1	Logical unit for data file	Dimensionless	-	integer	[10;+Inf]	0
2	Number of openings in file	dimensionless	-	integer	[1;40]	0
3	Number of surface angles	dimensionless	-	integer	[1;20]	0

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Solar azimuth angle	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
	The solar azimuth angle is the angle between the local meridian and the projection of the line of sight of the sun onto the horizontal plane. The reference is as follows: 0 = Facing equator 90 = Facing West 180 (or -180) = Facing away from the equator -90 (or 270) = Facing East (See manual for examples.)					
2	Solar zenith angle	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
	The zenith angle is the angle between the vertical and the line of sight of the sun.					
3	Total radiation on horizontal	Flux	kJ/hr.m^2	real	[0;+Inf]	0
	The total solar radiation (beam+diffuse) incident on a horizontal surface.					
4	Diffuse radiation on horizontal	Flux	kJ/hr.m^2	real	[0;+Inf]	0
	The amount of diffuse radiation incident on a horizontal surface					
5	Beam radiation for opening	Flux	kJ/hr.m^2	real	[0;+Inf]	0
	Beam (or direct) radiation corresponding to the orientation of the opening. (Usually output of Solar Radiation Processor).					
6	Diffuse radiation for opening	Flux	kJ/hr.m^2	real	[0;+Inf]	0
	Diffuse radiation corresponding to the orientation of the opening. (Usually output of Solar Radiation Processor).					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
5-6	Number of openings in file		1	100

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Solar altitude angle	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
	Angular height of the direct line between the opening's center and the sun versus the horizontal.					
2	Fraction of beam visible for surf.	Dimensionless	Dimensionless	real	[-Inf;+Inf]	0
	Flag = 1 if beam radiation is visisble for this opening, otherwise = 0.					
3	Shaded beam rad. for surf.	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	Beam radiation for this surface, taking shading into account.					
4	Fraction of diffuse visible for surf.	dimensionless	-	real	[-Inf;+Inf]	0
	Number between 0 and 1 which gives the fraction of diffuse radiation visible from the opening. 0 indicates no diffuse radiation is visible and 1 indicates that all the shading has no influence (i.e., all the diffuse radiation normally visible by the window is indeed visible).					
5	Shaded diffuse rad. on surf.	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	Diffuse radiation for this surface, taking shading into account.					
6	Shaded total rad. for surf.	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	Total radiation for this opening, taking shading into account.					
7	Fraction of beam visible on horiz. for mask	dimensionless	-	real	[-Inf;+Inf]	0
	Flag = 1 if beam radiation is visisble for this opening, otherwise = 0.					

8	Shaded beam rad. on horiz. for mask	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	Beam radiation on the horizontal taking shading by this opening's mask into account					
9	Fraction of diffuse visible on horiz. for mask	dimensionless	-	real	[-Inf;+Inf]	0
	Number between 0 and 1 which gives the fraction of diffuse radiation visible from the horizontal given this opening's mask 0 indicates no diffuse radiation is visible and 1 indicates that all the shading has no influence (i.e., all the diffuse radiation normally visible by the window is indeed visible).					
10	Shaded diffuse rad. on horiz. for mask	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	Diffuse radiation on the horizontal taking shading by this opening's mask into account.					
11	Shaded total rad. on horiz. for mask	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	Total radiation on the horizontal taking shading by this opening's mask into account.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
2-11	Number of openings in file		1	100

EXTERNAL FILES

Question	File	Associated parameter
Which file contains the angular obstruction data?	.\Examples\Data Files\Type67-ShadingMasks.dat	Logical unit for data file
Source file	.\SourceCode\Types\Type67.for	

4.10.4.3. Shading By External Object with Single Shading Mask

Icon		**TRNSYS Model**	Type 64
Proforma	Physical Phenomena\Shading Masks\Type64.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Logical unit for data file	Dimensionless	-	integer	[10;+Inf]	0
2	Number of openingse	dimensionless	-	integer	[1;40]	0
3	Number of surface angles	dimensionless	-	integer	[1;20]	0

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Solar azimuth angle	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
	The solar azimuth angle is the angle between the local meridian and the projection of the line of sight of the sun onto the horizontal plane. The reference is as follows: 0 = Facing equator 90 = Facing West 180 (or -180) = Facing away from the equator -90 (or 270) = Facing East (See manual for examples.)					
2	Solar zenith angle	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
	The zenith angle is the angle between the vertical and the line of sight of the sun.					
3	Total radiation on horizontal	Flux	kJ/hr.m^2	real	[0;+Inf]	0
	The total solar radiation (beam+diffuse) incident on a horizontal surface.					
4	Diffuse radiation on horizontal	Flux	kJ/hr.m^2	real	[0;+Inf]	0

	The amount of diffuse radiation incident on a horizontal surface					
5	Beam radiation for opening	Flux	kJ/hr.m^2	real	[0;+Inf]	0
	Beam (or direct) radiation corresponding to the orientation of the opening. (Usually output of Solar Radiation Processor).					
6	Diffuse radiation for opening	Flux	kJ/hr.m^2	real	[0;+Inf]	0
	Diffuse radiation corresponding to the orientation of the opening. (Usually output of Solar Radiation Processor).					
7	Slope of opening	Direction	degree	real	[-inf;+Inf]	0
	Slope of opening					
8	Azimuth of opening	Direction	degree	real	[-inf;+Inf]	0
	Azimuth of opening					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
5-8	Number of openings		1	100

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Solar altitude angle	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
	Angular height of the direct line between the opening's center and the sun versus the horizontal.					
2	Fraction of beam visible for surf.	Dimensionless	Dimensionless	real	[-Inf;+Inf]	0
	Flag = 1 if beam radiation is visisble for this opening, otherwise = 0.					
3	Shaded beam rad. for surf.	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	Beam radiation for this surface, taking shading into account.					
4	Fraction of diffuse visible for surf.	dimensionless	-	real	[-Inf;+Inf]	0
	Number between 0 and 1 which gives the fraction of diffuse radiation visible from the opening. 0 indicates no diffuse radiation is visible and 1 indicates that all the shading has no influence (i.e., all the diffuse radiation normally visible by the window is indeed visible).					
5	Shaded diffuse rad. on surf.	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	Diffuse radiation for this surface, taking shading into account.					
6	Shaded total rad. for surf.	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	Total radiation for this opening, taking shading into account.					
7	Fraction of beam visible on horiz. for mask	dimensionless	-	real	[-Inf;+Inf]	0
	Flag = 1 if beam radiation is visisble for this opening, otherwise = 0.					
8	Shaded beam rad. on horiz. for mask	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	Beam radiation on the horizontal taking shading by this opening's mask into account					
9	Fraction of diffuse visible on horiz. for mask	dimensionless	-	real	[-Inf;+Inf]	0
	Number between 0 and 1 which gives the fraction of diffuse radiation visible from the horizontal given this opening's mask 0 indicates no diffuse radiation is visible and 1 indicates that all the shading has no influence (i.e., all the diffuse radiation normally visible by the window is indeed visible).					
10	Shaded diffuse rad. on horiz. for mask	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	Diffuse radiation on the horizontal taking shading by this opening's mask into account.					
11	Shaded total rad. on horiz. for mask	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	Total radiation on the horizontal taking shading by this opening's mask into account.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
2-11	Number of openings		1	100

EXTERNAL FILES

Question	File	Associated parameter
Which file contains the angular obstruction data?	.\Examples\Data Files\Type68-ShadingMasks.dat	Logical unit for data file
Source file	.\SourceCode\Types\Type68.for	

4.10.5. Simple Ground Temperature Model

4.10.5.1. Simple Ground Temperature Model

Icon		TRNSYS Model	Type 77
Proforma	Physical Phenomena\Simple Ground Temperature Model\Type77.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Number of temperature nodes	dimensionless	-	integer	[1;25]	1
	The number of temperatures that will be output from the model. For each output temperature desired, the user has to specify the depth at which the output temperature should be calculated. These depths should be entered in parameters 8 to 7 + N, where N is the number of temperature nodes (this parameter).					
2	Mean surface temperature	Temperature	C	real	[-Inf;+Inf]	10.0
	The mean (average) surface temperature of the ground during the year. The temperature of the ground at an infinite depth will be this temperature. This temperature is typically the average annual air temperature for the given location					
3	Amplitude of surface temperature	Temp. Difference	deltaC	real	[-Inf;+Inf]	5.0
	The amplitude of the surface temperature function throughout the year. The maximum temperature of the surface will be TMEAN+TAMPL					
4	Time shift	Time	day	integer	[-365;365]	30
	The time difference (in days) between the beginning of the calendar year and the occurence of the minimum surface temperature.					
5	Soil thermal conductivity	Thermal Conductivity	kJ/hr.m.K	real	[0.0;+Inf]	8.72
	The thermal conductivity of the soil for which the temperature is being calculated.					
6	Soil density	Density	kg/m^3	real	[0.0;+Inf]	3200.0
	The density of the soil for which the temperatures are being calculated.					
7	Soil specific heat	Specific Heat	kJ/kg.K	real	[0.0;+Inf]	0.84
	The specific heat of the soil for which the temperature is being calculated.					
8	Depth at point	Length	m	real	[0.0;+Inf]	0.25
	The depth of the soil at which the temperature for this node should be evaluated. 0=Surface					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
8-8	Number of temperature nodes		1	50

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Soil Temperature at Node	Temperature	C	real	[-Inf;+Inf]	0
	The soil temperature at the specified depth for this node.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
1-1	Number of temperature nodes		1	50

4.10.6. Sky Temperature

4.10.6.1. calculate cloudiness factor

Icon		TRNSYS Model	Type 69
Proforma	Physical Phenomena\Sky Temperature\calculate cloudiness factor\Type69b.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	mode for cloudiness factor	dimensionless	-	integer	[0;0]	0
2	height over sea level	Length	m	real	[0;+Inf]	0

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Ambient temperature	Temperature	C	real	[-Inf;+Inf]	0
2	Dew point temperature at ambient conditions	Temperature	C	real	[-Inf;+Inf]	20
3	Beam radiation on the horizontal	Flux	kJ/hr.m^2	real	[0;+Inf]	0
4	Diffuse radiation on the horizontal	Flux	kJ/hr.m^2	real	[0;+Inf]	0

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Fictive sky temperature	Temperature	C	real	[-Inf;+Inf]	0
2	Cloudiness factor of the sky	dimensionless	-	real	[0;100]	0

4.10.6.2. read in cloudiness factor

Icon		TRNSYS Model	Type 69
Proforma	Physical Phenomena\Sky Temperature\read in cloudiness factor\Type69a.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	mode for cloudiness factor	dimensionless	-	integer	[1;+INF]	1
2	height over sea level	Length	m	real	[0;+Inf]	0

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Ambient temperature	Temperature	C	real	[-Inf;+Inf]	0
2	Dew point temperature at ambient conditions	Temperature	C	real	[-Inf;+Inf]	20
3	Beam radiation on the horizontal	Flux	kJ/hr.m^2	real	[0;+Inf]	0
4	Diffuse radiation on the horizontal	Flux	kJ/hr.m^2	real	[0;+Inf]	0
5	Cloudiness factor - sky	dimensionless	-	real	[0;1]	0

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Fictive sky temperature	Temperature	C	real	[-Inf;+Inf]	0
2	Cloudiness factor of the sky	dimensionless	-	real	[0;100]	0

4.10.7. Thermodynamic Properties

4.10.7.1. Psychrometrics - Dry Bulb and Dew Point Known

Icon		TRNSYS Model	Type 33
Proforma	Physical Phenomena\Thermodynamic Properties\Psychrometrics\Dry Bulb and Dew Point Known\Type33d.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Psychrometrics mode	dimensionless	-	integer	[3;3]	3
	This mode indicates to the general psychrometrics routine that thedry bulb temperature and the dew point temperature will be used tocalculate the remaining moist air properties.					
2	Wet bulb mode	dimensionless	-	integer	[0;1]	1
	Should the wet bulb temperature be calculated as an output if it is not supplied as one of the inputs? 0 ---> Do not calculate the wet bulb temperature 1 ---> Calculate the wet bulb temperatureIf the wet bulb temperature is not required as an output, this parameter should be set to zero to reduce the required computational effort.					
3	Error mode	dimensionless	-	integer	[1;2]	2
	The error mode indicates the error handling procedure to the generalpsychrometrics routine: 1 ---> Only one warning condition will be printed throughout the simulation 2 ---> Warnings will be printed every timestep that warning conditions occur					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Dry bulb temp.	Temperature	C	real	[-Inf;+Inf]	22.0
	The dry bulb temperature of the air.					
2	Dew point temp.	Temperature	C	real	[-Inf;+Inf]	20.0
	The dew point temperature of the air.					
3	Pressure	Pressure	atm	real	[0;+Inf]	0
	Total system pressure, i.e. atmospheric pressure for ambient conditions					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Humidity ratio	dimensionless	-	real	[-Inf;+Inf]	0
	The absolute humidity ratio of the moist air (kg's H2O / kg of dry air).					
2	Wet bulb temperature	Temperature	C	real	[-Inf;+Inf]	0
	The wet bulb temperature of the moist air.					
3	Enthalpy	Specific Energy	kJ/kg	real	[-Inf;+Inf]	0
	The enthalpy of the moist air.					
4	Density of mixture	Density	kg/m^3	real	[-Inf;+Inf]	0
	The density of the air-water mixture.					
5	Density of dry air	Density	kg/m^3	real	[-Inf;+Inf]	0
	The density of the dry air only.					
6	Percent relative humidity	dimensionless	-	real	[-Inf;+Inf]	0
	The percent relative humidity of the moist air.					

7	Dry bulb temperature	Temperature	C	real	[-Inf;+Inf]	0
	The dry bulb temperature of the moist air.					
8	Dew point temperature.	Temperature	C	real	[-Inf;+Inf]	0
	The dew point temperature of the moist air.					
9	Status	dimensionless	-	integer	[-Inf;+Inf]	0
	A warning flag indicating improper conditions input to this unit. 0 ---> No warning 1 ---> A pressure greater than 5 atmospheres was specified 2 ---> The given enthalpy is less than that possible for the given humidity ratio 3 ---> A humidity ratio less than zero was specified 4 ---> A wet bulb temperature was supplied that is greater than the dry bulb temperature 5 ---> A dew point temperature was supplied that is greater than the dry bulb temperature 6 ---> A wet bulb temperature lower than that for dry air has been specified 7 ---> A relative humidity less than 0 percent has been specified 8 ---> A relative humidity greater than 100 percent has been specified 9 ---> A humidity ratio has been specified that is greater than the humidity ratio for saturated air at the given temperature10 ---> An enthalpy has been specified that is greater than the enthalpy for saturated air at the given temperature11 ---> An enthalpy has been specified that is less than the enthalpy for dry air at the given temperature12 ---> Correlation out of range - check the input values13 ---> Correlation out of range - check the input values					

4.10.7.2. Psychrometrics - Dry Bulb and Enthalpy Known

Icon		TRNSYS Model	Type 33
Proforma	Physical Phenomena\Thermodynamic Properties\Psychrometrics\Dry Bulb and Enthalpy Known\Type33b.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Psychrometrics mode	dimensionless	-	integer	[5;5]	5
	This mode indicates to the general psychrometrics routine that thedry bulb temperature and the enthalpy of the moist air will be used tocalculate the remaining moist air properties.					
2	Wet bulb mode	dimensionless	-	integer	[0;1]	1
	Should the wet bulb temperature be calculated as an output if it is not supplied as one of the inputs? 0 ---> Do not calculate the wet bulb temperature 1 ---> Calculate the wet bulb temperatureIf the wet bulb temperature is not required as an output, this parameter should be set to zero to reduce the required computational effort.					
3	Error mode	dimensionless	-	integer	[1;2]	2
	The error mode indicates the error handling procedure to the generalpsychrometrics routine: 1 ---> Only one warning condition will be printed throughout the simulation 2 ---> Warnings will be printed every timestep that warning conditions occur					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Dry bulb temp.	Temperature	C	real	[-Inf;+Inf]	22.0
	The dry bulb temperature of the air.					
2	Enthalpy of air	Specific Energy	kJ/kg	real	[0.0;+Inf]	45.0
	The enthalpy of the moist air.					
3	Pressure	Pressure	atm	real	[0;+Inf]	0
	Total system pressure, i.e. atmospheric pressure for ambient conditions					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Humidity ratio	dimensionless	-	real	[-Inf;+Inf]	0
	The absolute humidity ratio of the moist air (kg's H2O / kg of dry air).					
2	Wet bulb temperature	Temperature	C	real	[-Inf;+Inf]	0
	The wet bulb temperature of the moist air.					
3	Enthalpy	Specific Energy	kJ/kg	real	[-Inf;+Inf]	0
	The enthalpy of the moist air.					
4	Density of mixture	Density	kg/m^3	real	[-Inf;+Inf]	0
	The density of the air-water mixture.					
5	Density of dry air	Density	kg/m^3	real	[-Inf;+Inf]	0
	The density of the dry air only.					
6	Percent relative humidity	dimensionless	-	real	[-Inf;+Inf]	0
	The percent relative humidity of the moist air.					
7	Dry bulb temperature	Temperature	C	real	[-Inf;+Inf]	0
	The dry bulb temperature of the moist air.					
8	Dew point temperature.	Temperature	C	real	[-Inf;+Inf]	0
	The dew point temperature of the moist air.					

9	Status	dimensionless	-	integer	[-Inf;+Inf]	0
	A warning flag indicating improper conditions input to this unit. 0 ---> No warning 1 ---> A pressure greater than 5 atmospheres was specified 2 ---> The given enthalpy is less than that possible for the given humidity ratio 3 ---> A humidity ratio less than zero was specified 4 ---> A wet bulb temperature was supplied that is greater than the dry bulb temperature 5 ---> A dew point temperature was supplied that is greater than the dry bulb temperature 6 ---> A wet bulb temperature lower than that for dry air has been specified 7 ---> A relative humidity less than 0 percent has been specified 8 ---> A relative humidity greater than 100 percent has been specified 9 ---> A humidity ratio has been specified that is greater than the humidity ratio for saturated air at the given temperature10 ---> An enthalpy has been specified that is greater than the enthalpy for saturated air at the given temperature11 ---> An enthalpy has been specified that is less than the enthalpy for dry air at the given temperature12 ---> Correlation out of range - check the input values13 ---> Correlation out of range - check the input values					

4.10.7.3. Psychrometrics - Dry Bulb and Humidity Ratio Known

Icon		TRNSYS Model	Type 33
Proforma	Physical Phenomena\Thermodynamic Properties\Psychrometrics\Dry Bulb and Humidity Ratio Known\Type33c.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Psychrometrics mode	dimensionless	-	integer	[4;4]	4
	This mode indicates to the general psychrometrics routine that thedry bulb temperature and the absolute humidity ratio will be used tocalculate the remaining moist air properties.					
2	Wet bulb mode	dimensionless	-	integer	[0;1]	1
	Should the wet bulb temperature be calculated as an output if it is not supplied as one of the inputs? 0 ---> Do not calculate the wet bulb temperature 1 ---> Calculate the wet bulb temperatureIf the wet bulb temperature is not required as an output, this parameter should be set to zero to reduce the required computational effort.					
3	Error mode	dimensionless	-	integer	[1;2]	2
	The error mode indicates the error handling procedure to the generalpsychrometrics routine: 1 ---> Only one warning condition will be printed throughout the simulation 2 ---> Warnings will be printed every timestep that warning conditions occur					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Dry bulb temp.	Temperature	C	real	[-Inf;+Inf]	22.0
	The dry bulb temperature of the air.					
2	Absolute humidity ratio	dimensionless	-	real	[0.0;0.5]	0.006
	The absolute humidity ratio of the moist air (kg's H2O / kg dry air).					
3	Pressure	Pressure	atm	real	[0;+Inf]	0
	Total system pressure, i.e. atmospheric pressure for ambient conditions					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Humidity ratio	dimensionless	-	real	[-Inf;+Inf]	0
	The absolute humidity ratio of the moist air (kg's H2O / kg of dry air).					
2	Wet bulb temperature	Temperature	C	real	[-Inf;+Inf]	0
	The wet bulb temperature of the moist air.					
3	Enthalpy	Specific Energy	kJ/kg	real	[-Inf;+Inf]	0
	The enthalpy of the moist air.					
4	Density of mixture	Density	kg/m^3	real	[-Inf;+Inf]	0
	The density of the air-water mixture.					
5	Density of dry air	Density	kg/m^3	real	[-Inf;+Inf]	0
	The density of the dry air only.					
6	Percent relative humidity	dimensionless	-	real	[-Inf;+Inf]	0
	The percent relative humidity of the moist air.					
7	Dry bulb temperature	Temperature	C	real	[-Inf;+Inf]	0
	The dry bulb temperature of the moist air.					
8	Dew point temperature.	Temperature	C	real	[-Inf;+Inf]	0
	The dew point temperature of the moist air.					

9	Status	dimensionless	-	integer	[-Inf;+Inf]	0
	A warning flag indicating improper conditions input to this unit. 0 ---> No warning 1 ---> A pressure greater than 5 atmospheres was specified 2 ---> The given enthalpy is less than that possible for the given humidity ratio 3 ---> A humidity ratio less than zero was specified 4 ---> A wet bulb temperature was supplied that is greater than the dry bulb temperature 5 ---> A dew point temperature was supplied that is greater than the dry bulb temperature 6 ---> A wet bulb temperature lower than that for dry air has been specified 7 ---> A relative humidity less than 0 percent has been specified 8 ---> A relative humidity greater than 100 percent has been specified 9 ---> A humidity ratio has been specified that is greater than the humidity ratio for saturated air at the given temperature10 ---> An enthalpy has been specified that is greater than the enthalpy for saturated air at the given temperature11 ---> An enthalpy has been specified that is less than the enthalpy for dry air at the given temperature12 ---> Correlation out of range - check the input values13 ---> Correlation out of range - check the input values					

4.10.7.4. Psychrometrics - Dry Bulb and Relative Humidity Known

Icon		TRNSYS Model	Type 33
Proforma	Physical Phenomena\Thermodynamic Properties\Psychrometrics\Dry Bulb and Relative Humidity Known\Type33e.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Psychrometrics mode	dimensionless	-	integer	[2;2]	2
	This mode indicates to the general psychrometrics routine that thedry bulb temperature and the percent realtive humidity will be used tocalculate the remaining moist air properties.					
2	Wet bulb mode	dimensionless	-	integer	[0;1]	1
	Should the wet bulb temperature be calculated as an output if it is not supplied as one of the inputs? 0 ---> Do not calculate the wet bulb temperature 1 ---> Calculate the wet bulb temperatureIf the wet bulb temperature is not required as an output, this parameter should be set to zero to reduce the required computational effort.					
3	Error mode	dimensionless	-	integer	[1;2]	2
	The error mode indicates the error handling procedure to the generalpsychrometrics routine: 1 ---> Only one warning condition will be printed throughout the simulation 2 ---> Warnings will be printed every timestep that warning conditions occur					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Dry bulb temp.	Temperature	C	real	[-Inf;+Inf]	22.0
	The dry bulb temperature of the air.					
2	Percent relative humidity	dimensionless	-	real	[0.0;100.0]	60.0
	The percent relative humidity of the moist air.					
3	Pressure	Pressure	atm	real	[0;+Inf]	0
	Total system pressure, i.e. atmospheric pressure for ambient conditions					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Humidity ratio	dimensionless	-	real	[-Inf;+Inf]	0
	The absolute humidity ratio of the moist air (kg's H2O / kg of dry air).					
2	Wet bulb temperature	Temperature	C	real	[-Inf;+Inf]	0
	The wet bulb temperature of the moist air.					
3	Enthalpy	Specific Energy	kJ/kg	real	[-Inf;+Inf]	0
	The enthalpy of the moist air.					
4	Density of mixture	Density	kg/m^3	real	[-Inf;+Inf]	0
	The density of the air-water mixture.					
5	Density of dry air	Density	kg/m^3	real	[-Inf;+Inf]	0
	The density of the dry air only.					
6	Percent relative humidity	dimensionless	-	real	[-Inf;+Inf]	0
	The percent relative humidity of the moist air.					
7	Dry bulb temperature	Temperature	C	real	[-Inf;+Inf]	0
	The dry bulb temperature of the moist air.					
8	Dew point temperature.	Temperature	C	real	[-Inf;+Inf]	0

	The dew point temperature of the moist air.					
9	Status	dimensionless	-	integer	[-Inf;+Inf]	0
	A warning flag indicating improper conditions input to this unit. 0 ---> No warning 1 ---> A pressure greater than 5 atmospheres was specified 2 ---> The given enthalpy is less than that possible for the given humidity ratio 3 ---> A humidity ratio less than zero was specified 4 ---> A wet bulb temperature was supplied that is greater than the dry bulb temperature 5 ---> A dew point temperature was supplied that is greater than the dry bulb temperature 6 ---> A wet bulb temperature lower than that for dry air has been specified 7 ---> A relative humidity less than 0 percent has been specified 8 ---> A relative humidity greater than 100 percent has been specified 9 ---> A humidity ratio has been specified that is greater than the humidity ratio for saturated air at the given temperature10 ---> An enthalpy has been specified that is greater than the enthalpy for saturated air at the given temperature11 ---> An enthalpy has been specified that is less than the enthalpy for dry air at the given temperature12 ---> Correlation out of range - check the input values13 ---> Correlation out of range - check the input values					

4.10.7.5. Psychrometrics - Dry Bulb and Wet Bulb Known

Icon		TRNSYS Model	Type 33
Proforma	Physical Phenomena\Thermodynamic Properties\Psychrometrics\Dry Bulb and Wet Bulb Known\Type33f.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Psychrometrics mode	dimensionless	-	integer	[1;1]	1
	This mode indicates to the general psychrometrics routine that thedry bulb temperature and the wet bulb temperature will be used tocalculate the remaining moist air properties.					
2	Wet bulb mode	dimensionless	-	integer	[0;1]	1
	Should the wet bulb temperature be calculated as an output if it is not supplied as one of the inputs? 0 ---> Do not calculate the wet bulb temperature 1 ---> Calculate the wet bulb temperatureIf the wet bulb temperature is not required as an output, this parameter should be set to zero to reduce the required computational effort.					
3	Error mode	dimensionless	-	integer	[1;2]	2
	The error mode indicates the error handling procedure to the generalpsychrometrics routine: 1 ---> Only one warning condition will be printed throughout the simulation 2 ---> Warnings will be printed every timestep that warning conditions occur					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Dry bulb temp.	Temperature	C	real	[-Inf;+Inf]	22.0
	The dry bulb temperature of the air.					
2	Wet bulb temp.	Temperature	C	real	[-Inf;+Inf]	20.0
	The wet bulb temperature of the air.					
3	Pressure	Pressure	atm	real	[0;+Inf]	0
	Total system pressure, i.e. atmospheric pressure for ambient conditions					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Humidity ratio	dimensionless	-	real	[-Inf;+Inf]	0
	The absolute humidity ratio of the moist air (kg's H2O / kg of dry air).					
2	Wet bulb temperature	Temperature	C	real	[-Inf;+Inf]	0
	The wet bulb temperature of the moist air.					
3	Enthalpy	Specific Energy	kJ/kg	real	[-Inf;+Inf]	0
	The enthalpy of the moist air.					
4	Density of mixture	Density	kg/m^3	real	[-Inf;+Inf]	0
	The density of the air-water mixture.					
5	Density of dry air	Density	kg/m^3	real	[-Inf;+Inf]	0
	The density of the dry air only.					
6	Percent relative humidity	dimensionless	-	real	[-Inf;+Inf]	0
	The percent relative humidity of the moist air.					
7	Dry bulb temperature	Temperature	C	real	[-Inf;+Inf]	0
	The dry bulb temperature of the moist air.					
8	Dew point temperature.	Temperature	C	real	[-Inf;+Inf]	0
	The dew point temperature of the moist air.					

9	Status	dimensionless	-	integer	[-Inf;+Inf]	0
	A warning flag indicating improper conditions input to this unit. 0 ---> No warning 1 ---> A pressure greater than 5 atmospheres was specified 2 ---> The given enthalpy is less than that possible for the given humidity ratio 3 ---> A humidity ratio less than zero was specified 4 ---> A wet bulb temperature was supplied that is greater than the dry bulb temperature 5 ---> A dew point temperature was supplied that is greater than the dry bulb temperature 6 ---> A wet bulb temperature lower than that for dry air has been specified 7 ---> A relative humidity less than 0 percent has been specified 8 ---> A relative humidity greater than 100 percent has been specified 9 ---> A humidity ratio has been specified that is greater than the humidity ratio for saturated air at the given temperature10 ---> An enthalpy has been specified that is greater than the enthalpy for saturated air at the given temperature11 ---> An enthalpy has been specified that is less than the enthalpy for dry air at the given temperature12 ---> Correlation out of range - check the input values13 ---> Correlation out of range - check the input values					

4.10.7.6. Psychrometrics - Humidity ratio and Enthalpy Known

Icon		TRNSYS Model	Type 33
Proforma	Physical Phenomena\Thermodynamic Properties\Psychrometrics\Humidity ratio and Enthalpy Known\Type33a.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Psychrometrics mode	dimensionless	-	integer	[6;6]	6
	This mode indicates to the general psychrometrics routine that theabsolute humidity ratio and the enthalpy will be used to calculate the remaining moist air properties.					
2	Wet bulb mode	dimensionless	-	integer	[0;1]	1
	Should the wet bulb temperature be calculated as an output if it is not supplied as one of the inputs? 0 ---> Do not calculate the wet bulb temperature 1 ---> Calculate the wet bulb temperatureIf the wet bulb temperature is not required as an output, this parameter should be set to zero to reduce the required computational effort.					
3	Error mode	dimensionless	-	integer	[1;2]	2
	The error mode indicates the error handling procedure to the generalpsychrometrics routine: 1 ---> Only one warning condition will be printed throughout the simulation 2 ---> Warnings will be printed every timestep that warning conditions occur					

INPUTS

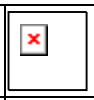
	Name	Dimension	Unit	Type	Range	Default
1	Absolute humidity ratio	dimensionless	-	real	[0.0;+0.5]	0.006
	The absolute humidity ratio of the moist air (kg's H2O / kg dry air).					
2	Enthalpy of air	Specific Energy	kJ/kg	real	[-Inf;+Inf]	40.0
	The enthalpy of the moist air.					
3	Pressure	Pressure	atm	real	[0;+Inf]	0
	Total system pressure, i.e. atmospheric pressure for ambient conditions					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Humidity ratio	dimensionless	-	real	[-Inf;+Inf]	0
	The absolute humidity ratio of the moist air (kg's H2O / kg of dry air).					
2	Wet bulb temperature	Temperature	C	real	[-Inf;+Inf]	0
	The wet bulb temperature of the moist air.					
3	Enthalpy	Specific Energy	kJ/kg	real	[-Inf;+Inf]	0
	The enthalpy of the moist air.					
4	Density of mixture	Density	kg/m^3	real	[-Inf;+Inf]	0
	The density of the air-water mixture.					
5	Density of dry air	Density	kg/m^3	real	[-Inf;+Inf]	0
	The density of the dry air only.					
6	Percent relative humidity	dimensionless	-	real	[-Inf;+Inf]	0
	The percent relative humidity of the moist air.					
7	Dry bulb temperature	Temperature	C	real	[-Inf;+Inf]	0
	The dry bulb temperature of the moist air.					
8	Dew point temperature.	Temperature	C	real	[-Inf;+Inf]	0
	The dew point temperature of the moist air.					

9	Status	dimensionless	-	integer	[-Inf;+Inf]	0
	A warning flag indicating improper conditions input to this unit. 0 ---> No warning 1 ---> A pressure greater than 5 atmospheres was specified 2 ---> The given enthalpy is less than that possible for the given humidity ratio 3 ---> A humidity ratio less than zero was specified 4 ---> A wet bulb temperature was supplied that is greater than the dry bulb temperature 5 ---> A dew point temperature was supplied that is greater than the dry bulb temperature 6 ---> A wet bulb temperature lower than that for dry air has been specified 7 ---> A relative humidity less than 0 percent has been specified 8 ---> A relative humidity greater than 100 percent has been specified 9 ---> A humidity ratio has been specified that is greater than the humidity ratio for saturated air at the given temperature10 ---> An enthalpy has been specified that is greater than the enthalpy for saturated air at the given temperature11 ---> An enthalpy has been specified that is less than the enthalpy for dry air at the given temperature12 ---> Correlation out of range - check the input values13 ---> Correlation out of range - check the input values					

4.10.7.7. Refrigerant and Steam Properties

Icon		TRNSYS Model	Type 58
Proforma	Physical Phenomena\Thermodynamic Properties\Refrigerant and Steam Properties\Type58.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Refrigerant for state	Dimensionless	-	integer	[11;718]	12
	The identification number of the refrigerant for the specified state: 11 = Properties for R-11 12 = Properties for R-12 13 = Properties for R-13 14 = Properties for R-14 22 = Properties for R-22 114 = Properties for R-114 134 = Properties for R-134A 500 = Properties for R-500 502 = Properties for R-502 717 = Properties for Ammonia 718 = Properties for Steam					
2	1st property type for state	Dimensionless	-	integer	[1;7]	1
	The number of the first property corresponding to the specified state: 1 = Input i is a temperature (C) 2 = Input i is a pressure (kPa) 3 = Input i is an enthalpy (kJ/kg) 4 = Input i is an entropy (kJ/kg.K) 5 = Input i is a quality (0 to 1) 6 = Input i is a specific volume (m^3/kg) 7 = Input i is an internal energy (kJ/kg) Two unique properties (ie temperature and enthalpy) must be supplied in order to calculate the state of the fluid.					
3	2nd property type for state	Dimensionless	-	integer	[1;7]	3
	The number of the second property corresponding to the specified state: 1 = Input (2*i) is a temperature (C) 2 = Input (2*i) is a pressure (kPa) 3 = Input (2*1) is an enthalpy (kJ/kg) 4 = Input (2*1) is an entropy (kJ/kg.K) 5 = Input (2*i) is a quality (0 to 1) 6 = Input (2*i) is a specific volume (m^3/kg) 7 = Input (2*i) is an internal energy (kJ/kg) Two unique properties (ie temperature and enthalpy) must be supplied in order to calculate the state properties of the fluid.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
1-3		How many sets of state properties are to be calculated?	1	10

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	1st property for state	any	any	real	[-Inf;+Inf]	0.0
	The value of the first property required to calculate the remaining state propertiesof the fluid. For example, if parameter (3*(i-1)+2 is set to 1 (temperature), this input must be connected to the temperature of the fluid specified by parameter (3*(i-1)+1).					

2	2nd property for state	any	any	real	[-Inf;+Inf]	0.0
	The value of the second property required to calculate the remaining state properties of the fluid specified. For example, if parameter (3*(i-1)+3) is set to 3 (enthalpy) then this input must be the enthalpy of the fluid specified in parameter (3*(i-1)+1).					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
1-2		How many sets of state properties are to be calculated?	1	10

OUTPUTS

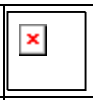
	Name	Dimension	Unit	Type	Range	Default
1	Temperature at state	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid specified in parameter 3*(i-1)+1.					
2	Pressure at state	Pressure	kPa	real	[-Inf;+Inf]	0
	The pressure of the fluid specified in parameter 3*(i-1)+1.					
3	Enthalpy at state	Specific Energy	kJ/kg	real	[-Inf;+Inf]	0
	The enthalpy of the fluid specified in parameter 3*(i-1)+1.					
4	Entropy at state	Specific Heat	kJ/kg.K	real	[-Inf;+Inf]	0
	The entropy of the fluid specified in parameter 3*(i-1)+1.					
5	Quality at state	Dimensionless	-	real	[-Inf;+Inf]	0
	The quality of the fluid specified in parameter 3*(i-1)+1.					
6	Specific volume at state	Specific Volume	m^3/kg	real	[-Inf;+Inf]	0
	The specific volume of the fluid specified in parameter 3*(i-1)+1.					
7	Internal energy at state	Specific Energy	kJ/kg	real	[-Inf;+Inf]	0
	The internal energy of the fluid specified in parameter 3*(i-1)+1.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
1-7		How many sets of state properties are to be calculated?	1	10

4.10.8. Weather Generators

4.10.8.1. Default Random Number Seeds

Icon		TRNSYS Model	Type 54
Proforma	Physical Phenomena\Weather Generators\Default Random Number Seeds\Type54a.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Weather file units	Dimensionless	-	integer	[1;2]	1
	An indicator to the weather generator model of the units contained in the external file of monthly averages. 1 ----> SI Units 2 ----> English Units If either of the default monthly average files are used (WDATA.DAT or NREL.DAT) this parameter must be set to 1.					
2	Logical unit	Dimensionless	-	integer	[10;30]	25
	The logical unit through which the external weather data file will be accessed. Each file that TRNSYS writes to or reads from must be assigned a unique logical unit in the TRNSYS input file.					
3	City number	Dimensionless	-	integer	[1;+Inf]	100
	The identification number (listed in the weather data file) given to the city for which the weather will be generated. Weather File = WDATA.DAT Weather File = NREL.DAT (See manual for city identification numbers.)					
4	Temperature model	Dimensionless	-	integer	[1;2]	2
	The type of temperature model to be used in the generation of the weather: 1 ---> Stochastic model 2 ---> Cosine model See the abstract for more details on the appropriate choice of temperature model for your simulation.					
5	Hourly radiation correction	Dimensionless	-	integer	[1;2]	1
	Should the calculated values of solar radiation be autocorrelated? 1 ---> Yes 2 ---> No See the abstract for more details on the autocorrelation of radiation values.					
6	Use default seeds	Dimensionless	-	integer	[1;1]	1
	Setting this parameter to 1 indicates to the general weather generator component that the default random number seeds should be used. Do not change this parameter.					
7	Average January windspeed	Velocity	m/s	real	[0.0;+Inf]	4.0
	The average windspeed for the month of January. A default value of 9 should be used if windspeed data is not available.					
8	Average February windspeed	Velocity	m/s	real	[0.0;+Inf]	4.0
	The average windspeed for the month of February. A default value of 9 should be used if windspeed data is not available.					
9	Average March windspeed	Velocity	m/s	real	[0.0;+Inf]	4.0
	The average windspeed for the month of March. A default value of 9 should be used if windspeed data is not available.					
10	Average April windspeed	Velocity	m/s	real	[0.0;+Inf]	4.0
	The average windspeed for the month of April. A default value of 9 should be used if windspeed data is not					

	available.					
11	Average May windspeed	Velocity	m/s	real	[0.0;+Inf]	4.0
	The average windspeed for the month of May. A default value of 9 should be used if windspeed data is not available.					
12	Average June windspeed	Velocity	m/s	real	[0.0;+Inf]	4.0
	The average windspeed for the month of June. A default value of 9 should be used if windspeed data is not available.					
13	Average July windspeed	Velocity	m/s	real	[0.0;+Inf]	4.0
	The average windspeed for the month of July. A default value of 9 should be used if windspeed data is not available.					
14	Average August windspeed	Velocity	m/s	real	[0.0;+Inf]	4.0
	The average windspeed for the month of August. A default value of 9 should be used if windspeed data is not available.					
15	Average September windspeed	Velocity	m/s	real	[0.0;+Inf]	4.0
	The average windspeed for the month of September. A default value of 9 should be used if windspeed data is not available.					
16	Average October windspeed	Velocity	m/s	real	[0.0;+Inf]	4.0
	The average windspeed for the month of October. A default value of 9 should be used if windspeed data is not available.					
17	Average November windspeed	Velocity	m/s	real	[0.0;+Inf]	4.0
	The average windspeed for the month of November. A default value of 9 should be used if windspeed data is not available.					
18	Average December windspeed	Velocity	m/s	real	[0.0;+Inf]	4.0
	The average windspeed for the month of December. A default value of 9 should be used if windspeed data is not available.					
19	Altitude	Length	m	real	[0.0;+Inf]	0.0
	The altitude of the city for which the weather will be generated. A default value of 0 (sea level) should be used if no data is available.					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Month of the year	Dimensionless	-	integer	[-Inf;+Inf]	0
	The month of the year. (Not interpolated for timesteps less than 1 hour)					
2	Day of the month	Time	day	real	[-Inf;+Inf]	0
	The day of the month corresponding to the current timestep (not interpolated for timesteps less than 1 hour).					
3	Hour	Time	hr	real	[-Inf;+Inf]	0
	The hour of the year. (Interpolated at timesteps less than 1 hour)					
4	Dry bulb temperature	Temperature	C	real	[-Inf;+Inf]	0
	The dry bulb (ambient) temperature. (Interpolated at timestep less than one hour)					
5	Dew point temperature	Temperature	C	real	[-Inf;+Inf]	0
	The dew point temperature of the ambient air (interpolated at timesteps less than 1 hour).					
6	Percent relative humidity	Dimensionless	-	real	[-Inf;+Inf]	0
	The relative humidity of the ambient air expressed as a percentage (interpolated at timesteps less than 1 hour).					
7	Global horizontal radiation	Flux	kJ/hr.m^2	real	[0.0;+Inf]	0
	The global solar radiation on a horizontal surface integrated over the previous hour. (Not interpolated at timesteps less than one hour - use radiation processor to interpolate solar radiation)					
8	Direct normal radiation	Flux	kJ/hr.m^2	real	[0.0;+Inf]	0
	The direct normal solar radiation integrated over the previous hour. (Not interpolated at timesteps less than 1 hour - use radiation processor to interpolate solar radiation)					

9	Diffuse radiation	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The diffuse solar radiation integrated over the previous hour. (Not interpolated at timesteps less than 1 hour - use radiation processor to interpolate solar radiation)					
10	Wind velocity	Velocity	m/s	real	[0.0;+Inf]	0
	The velocity of the wind. (Interpolated at timesteps of less than one hour)					
11	Output 11 not used	Dimensionless	-	real	[-Inf;+Inf]	0
12	Output 12 not used	dimensionless	-	real	[-Inf;+Inf]	0
13	Output 13 not used	dimensionless	-	real	[-Inf;+Inf]	0
14	Output 14 not used	dimensionless	-	real	[-Inf;+Inf]	0
15	Output 15 not used	dimensionless	-	real	[-Inf;+Inf]	0
16	Output 16 not used	dimensionless	-	real	[-Inf;+Inf]	0
17	Output 17 not used	dimensionless	-	real	[-Inf;+Inf]	0
18	Output 18 not used	dimensionless	-	real	[-Inf;+Inf]	0
19	Output 19 not used	dimensionless	-	real	[-Inf;+Inf]	0
20	Output 20 not used	dimensionless	-	real	[-Inf;+Inf]	0
21	Output 21 not used	dimensionless	-	real	[-Inf;+Inf]	0
22	Output 22 not used	dimensionless	-	real	[-Inf;+Inf]	0
23	Output 23 not used	dimensionless	-	real	[-Inf;+Inf]	0
24	Output 24 not used	dimensionless	-	real	[-Inf;+Inf]	0
25	Output 25 not used	dimensionless	-	real	[-Inf;+Inf]	0
26	Output 26 not used	dimensionless	-	real	[-Inf;+Inf]	0
27	Output 27 not used	dimensionless	-	real	[-Inf;+Inf]	0
28	Output 28 not used	dimensionless	-	real	[-Inf;+Inf]	0
29	Output 29 not used	dimensionless	-	real	[-Inf;+Inf]	0
30	Output 30 not used	dimensionless	-	real	[-Inf;+Inf]	0
31	Output 31 not used	dimensionless	-	real	[-Inf;+Inf]	0
32	Output 32 not used	dimensionless	-	real	[-Inf;+Inf]	0
33	Output 33 not used	dimensionless	-	real	[-Inf;+Inf]	0
34	Output 34 not used	dimensionless	-	real	[-Inf;+Inf]	0
35	Output 35 not used	dimensionless	-	real	[-Inf;+Inf]	0
36	Output 36 not used	dimensionless	-	real	[-Inf;+Inf]	0
37	Output 37 not used	dimensionless	-	real	[-Inf;+Inf]	0
38	Output 38 not used	dimensionless	-	real	[-Inf;+Inf]	0
39	Output 39 not used	dimensionless	-	real	[-Inf;+Inf]	0
40	Output 40 not used	dimensionless	-	real	[-Inf;+Inf]	0
41	Output 41 not used	dimensionless	-	real	[-Inf;+Inf]	0
42	Output 42 not used	dimensionless	-	real	[-Inf;+Inf]	0
43	Output 43 not used	dimensionless	-	real	[-Inf;+Inf]	0
44	Output 44 not used	dimensionless	-	real	[-Inf;+Inf]	0
45	Output 45 not used	dimensionless	-	real	[-Inf;+Inf]	0
46	Output 46 not used	dimensionless	-	real	[-Inf;+Inf]	0
47	Output 47 not used	dimensionless	-	real	[-Inf;+Inf]	0
48	Output 48 not used	dimensionless	-	real	[-Inf;+Inf]	0
49	Output 49 not used	dimensionless	-	real	[-Inf;+Inf]	0

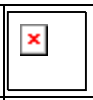
50	Output 50 not used	dimensionless	-	real	[-Inf;+Inf]	0
51	Output 51 not used	dimensionless	-	real	[-Inf;+Inf]	0
52	Output 52 not used	dimensionless	-	real	[-Inf;+Inf]	0
53	Output 53 not used	dimensionless	-	real	[-Inf;+Inf]	0
54	Output 54 not used	dimensionless	-	real	[-Inf;+Inf]	0
55	Output 55 not used	dimensionless	-	real	[-Inf;+Inf]	0
56	Output 56 not used	dimensionless	-	real	[-Inf;+Inf]	0
57	Output 57 not used	dimensionless	-	real	[-Inf;+Inf]	0
58	Output 58 not used	dimensionless	-	real	[-Inf;+Inf]	0
59	Output 59 not used	dimensionless	-	real	[-Inf;+Inf]	0
60	Output 60 not used	dimensionless	-	real	[-Inf;+Inf]	0
61	Output 61 not used	dimensionless	-	real	[-Inf;+Inf]	0
62	Output 62 not used	dimensionless	-	real	[-Inf;+Inf]	0
63	Output 63 not used	dimensionless	-	real	[-Inf;+Inf]	0
64	Output 64 not used	dimensionless	-	real	[-Inf;+Inf]	0
65	Output 65 not used	dimensionless	-	real	[-Inf;+Inf]	0
66	Output 66 not used	dimensionless	-	real	[-Inf;+Inf]	0
67	Output 67 not used	dimensionless	-	real	[-Inf;+Inf]	0
68	Output 68 not used	dimensionless	-	real	[-Inf;+Inf]	0
69	Output 69 not used	dimensionless	-	real	[-Inf;+Inf]	0
70	Output 70 not used	dimensionless	-	real	[-Inf;+Inf]	0
71	Output 71 not used	dimensionless	-	real	[-Inf;+Inf]	0
72	Output 72 not used	dimensionless	-	real	[-Inf;+Inf]	0
73	Output 73 not used	dimensionless	-	real	[-Inf;+Inf]	0
74	Output 74 not used	dimensionless	-	real	[-Inf;+Inf]	0
75	Output 75 not used	dimensionless	-	real	[-Inf;+Inf]	0
76	Output 76 not used	dimensionless	-	real	[-Inf;+Inf]	0
77	Output 77 not used	dimensionless	-	real	[-Inf;+Inf]	0
78	Output 78 not used	dimensionless	-	real	[-Inf;+Inf]	0
79	Output 79 not used	dimensionless	-	real	[-Inf;+Inf]	0
80	Output 80 not used	dimensionless	-	real	[-Inf;+Inf]	0
81	Output 81 not used	dimensionless	-	real	[-Inf;+Inf]	0
82	Output 82 not used	dimensionless	-	real	[-Inf;+Inf]	0
83	Output 83 not used	dimensionless	-	real	[-Inf;+Inf]	0
84	Output 84 not used	dimensionless	-	real	[-Inf;+Inf]	0
85	Output 85 not used1	dimensionless	-	real	[-Inf;+Inf]	0
86	Output 86 not used	dimensionless	-	real	[-Inf;+Inf]	0
87	Output 87 not used	dimensionless	-	real	[-Inf;+Inf]	0
88	Output 88 not used	dimensionless	-	real	[-Inf;+Inf]	0
89	Output 89 not used	dimensionless	-	real	[-Inf;+Inf]	0
90	Output 90 not used	dimensionless	-	real	[-Inf;+Inf]	0
91	Output 91 not used	dimensionless	-	real	[-Inf;+Inf]	0
92	Output 92 not used	dimensionless	-	real	[-Inf;+Inf]	0

93	Output 93 not used	dimensionless	-	real	[-Inf;+Inf]	0
94	Output 94 not used	dimensionless	-	real	[-Inf;+Inf]	0
95	Output 95 not used	dimensionless	-	real	[-Inf;+Inf]	0
96	Output 96 not used	dimensionless	-	real	[-Inf;+Inf]	0
97	Output 97 not used	dimensionless	-	real	[-Inf;+Inf]	0
98	Output 98 not used	dimensionless	-	real	[-Inf;+Inf]	0
99	Time of last read	Time	hr	real	[0;+Inf]	0
	The time at which the last values were read from the data file. This output is to be used strictly with the TYPE 16 radiation processor Input 19.					
100	Time of next read	Time	hr	real	[0;+Inf]	0
	Thetime at which the next values will be read from the data file. This output is to be strictly used with the radiation processor Input 20.					
101	Month at next timestep	Dimensionless	-	real	[-Inf;+Inf]	0
	The month of the year at the next timestep.					
102	Day at next timestep	Time	day	real	[-Inf;+Inf]	0
	The day of the month corresponding to the next timestep (not interpolated at timesteps less than 1 hour).					
103	Hour at next timestep	Time	hr	real	[0;+Inf]	0
	The hour of the year at the next timestep.					
104	Dry bulb at next timestep	Temperature	C	real	[-Inf;+Inf]	0
	The dry bulb (ambient) temperature at the next timestep.					
105	Dew point at next timestep	Temperature	C	real	[-Inf;+Inf]	0
	The dew point temperature of the ambient air at the next timestep (interpolated at timesteps of less than 1 hour).					
106	Relative humidity at next timestep	Dimensionless	-	real	[-Inf;+Inf]	0
	The percent relative humidity of the ambient air at the next timestep (interpolated at timesteps of less than 1 hour).					
107	Global horiz. at next timestep	Flux	kJ/hr.m^2	real	[0;+Inf]	0
	Global horizontal surface radiation at the next timestep. Used with the smoothing option in he radiation processor.					
108	Direct normal at next timestep	Flux	kJ/hr.m^2	real	[0;+Inf]	0
	Direct normal solar radiation at the next timestep. Used with the radiation smoothing option in the radiation processor component.					
109	Diffuse at next timestep	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The diffuse solar radiation at the next timestep. This output is typically used with the radiation smoothing option in the radiation processor component.					
110	Wind velocity at next timestep	Velocity	m/s	real	[0.0;+Inf]	0
	The wind velocity at the next timestep.					

EXTERNAL FILES

Question	File	Associated parameter
Which file contains the monthly average weather data?	.\Examples\Data Files\Type54-WeatherGenerator.dat	Logical unit
Source file	.\SourceCode\Types\Type54.for	

4.10.8.2. Default Random Number Seeds - No External File

Icon		TRNSYS Model	Type 54
Proforma	Physical Phenomena\Weather Generators\Default Random Number Seeds\No External File\TYPE54c.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Weather file units	Dimensionless	-	integer	[1;2]	1
	An indicator to the weather generator model of the units contained in the external file of monthly averages. 1 ----> SI Units 2 ----> English Units If either of the default monthly average files are used (WDATA.DAT or NREL.DAT) this parameter must be set to 1.					
2	Logical unit - not used	Dimensionless	-	integer	[-1;-1]	25
	The logical unit through which the external weather data file will be accessed. Each file that TRNSYS writes to or reads from must be assigned a unique logical unit in the TRNSYS input file. By setting this value to -1, the user indicates that the values are provided in the input file as PARAMETERS to the model instead of in an external file.					
3	City number - not used	Dimensionless	-	integer	[1;+Inf]	100
	The identification number (listed in the weather data file) given to the city for which the weather will be generated. Weather File = WDATA.DAT þ Weather File = NREL.DAT (See manual for city identification numbers.)					
4	Temperature model	Dimensionless	-	integer	[1;2]	2
	The type of temperature model to be used in the generation of the weather: 1 ---> Stochastic model 2 ---> Cosine model See the abstract for more details on the appropriate choice of temperature model for your simulation.					
5	Hourly radiation correction	Dimensionless	-	integer	[1;2]	1
	Should the calculated values of solar radiation be autocorrelated? 1 ---> Yes 2 ---> No See the abstract for more details on the autocorrelation of radiation values.					
6	Use default seeds	Dimensionless	-	integer	[1;1]	1
	Setting this parameter to 1 indicates to the general weather generator component that the default random number seeds should be used. Do not change this parameter.					
7	Average January windspeed	Velocity	m/s	real	[0.0;+Inf]	4.0
	The average windspeed for the month of January. A default value of 9 should be used if wind speed data is not available.					
8	Average February windspeed	Velocity	m/s	real	[0.0;+Inf]	4.0
	The average windspeed for the month of February. A default value of 9 should be used if windspeed data is not available.					
9	Average March windspeed	Velocity	m/s	real	[0.0;+Inf]	4.0
	The average windspeed for the month of March. A default value of 9 should be used if windspeed data is not available.					
10	Average April windspeed	Velocity	m/s	real	[0.0;+Inf]	4.0
	The average windspeed for the month of April. A default value of 9 should be used if windspeed data is not available.					

11	Average May windspeed	Velocity	m/s	real	[0.0;+Inf]	4.0
	The average windspeed for the month of May. A default value of 9 should be used if windspeed data is not available.					
12	Average June windspeed	Velocity	m/s	real	[0.0;+Inf]	4.0
	The average windspeed for the month of June. A default value of 9 should be used if windspeed data is not available.					
13	Average July windspeed	Velocity	m/s	real	[0.0;+Inf]	4.0
	The average windspeed for the month of July. A default value of 9 should be used if windspeed data is not available.					
14	Average August windspeed	Velocity	m/s	real	[0.0;+Inf]	4.0
	The average windspeed for the month of August. A default value of 9 should be used if windspeed data is not available.					
15	Average September windspeed	Velocity	m/s	real	[0.0;+Inf]	4.0
	The average windspeed for the month of September. A default value of 9 should be used if windspeed data is not available.					
16	Average October windspeed	Velocity	m/s	real	[0.0;+Inf]	4.0
	The average windspeed for the month of October. A default value of 9 should be used if windspeed data is not available.					
17	Average November windspeed	Velocity	m/s	real	[0.0;+Inf]	4.0
	The average windspeed for the month of November. A default value of 9 should be used if windspeed data is not available.					
18	Average December windspeed	Velocity	m/s	real	[0.0;+Inf]	4.0
	The average windspeed for the month of December. A default value of 9 should be used if windspeed data is not available.					
19	Altitude	Length	m	real	[0.0;+Inf]	0.0
	The altitude of the city for which the weather will be generated. A default value of 0 (sea level) should be used if no data is available.					
20	Latitude	Dimensionless	-	real	[-Inf;+Inf]	0
	The latitude of the location. North of the equator is taken as positive, south as negative.					
21	Average January daily solar	any	any	real	[0;+Inf]	0
	The amount of solar radiation incident on the horizontal during the average day in January					
22	Average February daily solar	any	any	real	[0;+Inf]	0
	The amount of solar radiation incident on the horizontal during the average day in February					
23	Average March daily solar	any	any	real	[0;+Inf]	0
	The amount of solar radiation incident on the horizontal during the average day in March					
24	Average April daily solar	any	any	real	[0;+Inf]	0
	The amount of solar radiation incident on the horizontal during the average day in April					
25	Average May daily solar	any	any	real	[0;+Inf]	0
	The amount of solar radiation incident on the horizontal during the average day in May					
26	Average June daily solar	any	any	real	[0;+Inf]	0
	The amount of solar radiation incident on the horizontal during the average day in June					
27	Average July daily solar	any	any	real	[0;+Inf]	0
	The amount of solar radiation incident on the horizontal during the average day in July					
28	Average August daily solar	any	any	real	[0;+Inf]	0
	The amount of solar radiation incident on the horizontal during the average day in August					
29	Average September daily solar	any	any	real	[0;+Inf]	0
	The amount of solar radiation incident on the horizontal during the average day in September					
30	Average October daily solar	any	any	real	[0;+Inf]	0
	The amount of solar radiation incident on the horizontal during the average day in October					

31	Average November daily solar	any	any	real	[0;+Inf]	0
	The amount of solar radiation incident on the horizontal during the average day in November					
32	Average December daily solar	any	any	real	[0;+Inf]	0
	The amount of solar radiation incident on the horizontal during the average day in December					
33	Average January humidity ratio	Dimensionless	-	real	[0;+Inf]	0
	The average humidity ratio (kgH2O/kgAir) in January					
34	Average February humidity ratio	Dimensionless	-	real	[0;+Inf]	0
	The average humidity ratio (kgH2O/kgAir) in February					
35	Average March humidity ratio	Dimensionless	-	real	[0;+Inf]	0
	The average humidity ratio (kgH2O/kgAir) in March					
36	Average April humidity ratio	Dimensionless	-	real	[0;+Inf]	0
	The average humidity ratio (kgH2O/kgAir) in April					
37	Average May humidity ratio	Dimensionless	-	real	[0;+Inf]	0
	The average humidity ratio (kgH2O/kgAir) in May					
38	Average June humidity ratio	Dimensionless	-	real	[0;+Inf]	0
	The average humidity ratio (kgH2O/kgAir) in June					
39	Average July humidity ratio	Dimensionless	-	real	[0;+Inf]	0
	The average humidity ratio (kgH2O/kgAir) in July					
40	Average August humidity ratio	Dimensionless	-	real	[0;+Inf]	0
	The average humidity ratio (kgH2O/kgAir) in August					
41	Average September humidity ratio	Dimensionless	-	real	[0;+Inf]	0
	The average humidity ratio (kgH2O/kgAir) in September					
42	Average October humidity ratio	Dimensionless	-	real	[0;+Inf]	0
	The average humidity ratio (kgH2O/kgAir) in October					
43	Average November humidity ratio	Dimensionless	-	real	[0;+Inf]	0
	The average humidity ratio (kgH2O/kgAir) in November					
44	Average December humidity ratio	Dimensionless	-	real	[0;+Inf]	0
	The average humidity ratio (kgH2O/kgAir) in December					
45	Average January temperature	Temperature	C	real	[-Inf;+Inf]	0
	The average dry bulb temperature in January.					
46	Average February temperature	Temperature	C	real	[-Inf;+Inf]	0
	The average dry bulb temperature in February					
47	Average March temperature	Temperature	C	real	[-Inf;+Inf]	0
	The average dry bulb temperature in March					
48	Average April temperature	Temperature	C	real	[-Inf;+Inf]	0
	The average dry bulb temperature in April					
49	Average May temperature	Temperature	C	real	[-Inf;+Inf]	0
	The average dry bulb temperature in May					
50	Average June temperature	Temperature	C	real	[-Inf;+Inf]	0
	The average dry bulb temperature in June					
51	Average July temperature	Temperature	C	real	[-Inf;+Inf]	0
	The average dry bulb temperature in July					
52	Average August temperature	Temperature	C	real	[-Inf;+Inf]	0
	The average dry bulb temperature in August					
53	Average September temperature	Temperature	C	real	[-Inf;+Inf]	0
	The average dry bulb temperature in September					

54	Average October temperature	Temperature	C	real	[-Inf;+Inf]	0
	The average dry bulb temperature in October					
55	Average November temperature	Temperature	C	real	[-Inf;+Inf]	0
	The average dry bulb temperature in November					
56	Average December temperature	Temperature	C	real	[-Inf;+Inf]	0
	The average dry bulb temperature in December					

OUTPUTS

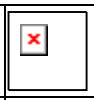
	Name	Dimension	Unit	Type	Range	Default
1	Month of the year	Dimensionless	-	integer	[-Inf;+Inf]	0
	The month of the year. (Not interpolated for timesteps less than 1 hour)					
2	Day of the month	Time	day	real	[-Inf;+Inf]	0
	The day of the month corresponding to the current timestep (not interpolated for timesteps less than 1 hour).					
3	Hour	Time	hr	real	[-Inf;+Inf]	0
	The hour of the year. (Interpolated at timesteps less than 1 hour)					
4	Dry bulb temperature	Temperature	C	real	[-Inf;+Inf]	0
	The dry bulb (ambient) temperature. (Interpolated at timestep less than one hour)					
5	Dew point temperature	Temperature	C	real	[-Inf;+Inf]	0
	The dew point temperature of the ambient air (interpolated at timesteps less than 1 hour).					
6	Percent relative humidity	Dimensionless	-	real	[-Inf;+Inf]	0
	The relative humidity of the ambient air expressed as a percentage (interpolated at timesteps less than 1 hour).					
7	Global horizontal radiation	Flux	kJ/hr.m^2	real	[0.0;+Inf]	0
	The global solar radiation on a horizontal surface integrated over the previous hour. (Not interpolated at timesteps less than one hour - use radiation processor to interpolate solar radiation)					
8	Direct normal radiation	Flux	kJ/hr.m^2	real	[0.0;+Inf]	0
	The direct normal solar radiation integrated over the previous hour. (Not interpolated at timesteps less than 1 hour - use radiation processor to interpolate solar radiation)					
9	Diffuse radiation	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The diffuse solar radiation integrated over the previous hour. (Not interpolated at timesteps less than 1 hour - use radiation processor to interpolate solar radiation)					
10	Wind velocity	Velocity	m/s	real	[0.0;+Inf]	0
	The velocity of the wind. (Interpolated at timesteps of less than one hour)					
11	Output 11 not used	Dimensionless	-	real	[-Inf;+Inf]	0
12	Output 12 not used	Dimensionless	-	real	[-Inf;+Inf]	0
13	Output 13 not used	dimensionless	-	real	[-Inf;+Inf]	0
14	Output 14 not used	dimensionless	-	real	[-Inf;+Inf]	0
15	Output 15 not used	dimensionless	-	real	[-Inf;+Inf]	0
16	Output 16 not used	dimensionless	-	real	[-Inf;+Inf]	0
17	Output 17 not used	dimensionless	-	real	[-Inf;+Inf]	0
18	Output 18 not used	dimensionless	-	real	[-Inf;+Inf]	0
19	Output 19 not used	dimensionless	-	real	[-Inf;+Inf]	0
20	Output 20 not used	dimensionless	-	real	[-Inf;+Inf]	0
21	Output 21 not used	dimensionless	-	real	[-Inf;+Inf]	0
22	Output 22 not used	dimensionless	-	real	[-Inf;+Inf]	0
23	Output 23 not used	dimensionless	-	real	[-Inf;+Inf]	0
24	Output 24 not used	dimensionless	-	real	[-Inf;+Inf]	0

25	Output 25 not used	dimensionless	-	real	[-Inf;+Inf]	0
26	Output 26 not used	dimensionless	-	real	[-Inf;+Inf]	0
27	Output 27 not used	dimensionless	-	real	[-Inf;+Inf]	0
28	Output 28 not used	dimensionless	-	real	[-Inf;+Inf]	0
29	Output 29 not used	dimensionless	-	real	[-Inf;+Inf]	0
30	Output 30 not used	dimensionless	-	real	[-Inf;+Inf]	0
31	Output 31 not used	dimensionless	-	real	[-Inf;+Inf]	0
32	Output 32 not used	dimensionless	-	real	[-Inf;+Inf]	0
33	Output 33 not used	dimensionless	-	real	[-Inf;+Inf]	0
34	Output 34 not used	dimensionless	-	real	[-Inf;+Inf]	0
35	Output 35 not used	dimensionless	-	real	[-Inf;+Inf]	0
36	Output 36 not used	dimensionless	-	real	[-Inf;+Inf]	0
37	Output 37 not used	dimensionless	-	real	[-Inf;+Inf]	0
38	Output 38 not used	dimensionless	-	real	[-Inf;+Inf]	0
39	Output 39 not used	dimensionless	-	real	[-Inf;+Inf]	0
40	Output 40 not used	dimensionless	-	real	[-Inf;+Inf]	0
41	Output 41 not used	dimensionless	-	real	[-Inf;+Inf]	0
42	Output 42 not used	dimensionless	-	real	[-Inf;+Inf]	0
43	Output 43 not used	dimensionless	-	real	[-Inf;+Inf]	0
44	Output 44 not used	dimensionless	-	real	[-Inf;+Inf]	0
45	Output 45 not used	dimensionless	-	real	[-Inf;+Inf]	0
46	Output 46 not used	dimensionless	-	real	[-Inf;+Inf]	0
47	Output 47 not used	dimensionless	-	real	[-Inf;+Inf]	0
48	Output 48 not used	dimensionless	-	real	[-Inf;+Inf]	0
49	Output 49 not used	dimensionless	-	real	[-Inf;+Inf]	0
50	Output 50 not used	dimensionless	-	real	[-Inf;+Inf]	0
51	Output 51 not used	dimensionless	-	real	[-Inf;+Inf]	0
52	Output 52 not used	dimensionless	-	real	[-Inf;+Inf]	0
53	Output 53 not used	dimensionless	-	real	[-Inf;+Inf]	0
54	Output 54 not used	dimensionless	-	real	[-Inf;+Inf]	0
55	Output 55 not used	dimensionless	-	real	[-Inf;+Inf]	0
56	Output 56 not used	dimensionless	-	real	[-Inf;+Inf]	0
57	Output 57 not used	dimensionless	-	real	[-Inf;+Inf]	0
58	Output 58 not used	dimensionless	-	real	[-Inf;+Inf]	0
59	Output 59 not used	dimensionless	-	real	[-Inf;+Inf]	0
60	Output 60 not used	dimensionless	-	real	[-Inf;+Inf]	0
61	Output 61 not used	dimensionless	-	real	[-Inf;+Inf]	0
62	Output 62 not used	dimensionless	-	real	[-Inf;+Inf]	0
63	Output 63 not used	dimensionless	-	real	[-Inf;+Inf]	0
64	Output 64 not used	dimensionless	-	real	[-Inf;+Inf]	0
65	Output 65 not used	dimensionless	-	real	[-Inf;+Inf]	0
66	Output 66 not used	dimensionless	-	real	[-Inf;+Inf]	0
67	Output 67 not used	dimensionless	-	real	[-Inf;+Inf]	0

68	Output 68 not used	dimensionless	-	real	[-Inf;+Inf]	0
69	Output 69 not used	dimensionless	-	real	[-Inf;+Inf]	0
70	Output 70 not used	dimensionless	-	real	[-Inf;+Inf]	0
71	Output 71 not used	dimensionless	-	real	[-Inf;+Inf]	0
72	Output 72 not used	dimensionless	-	real	[-Inf;+Inf]	0
73	Output 73 not used	dimensionless	-	real	[-Inf;+Inf]	0
74	Output 74 not used	dimensionless	-	real	[-Inf;+Inf]	0
75	Output 75 not used	dimensionless	-	real	[-Inf;+Inf]	0
76	Output 76 not used	dimensionless	-	real	[-Inf;+Inf]	0
77	Output 77 not used	dimensionless	-	real	[-Inf;+Inf]	0
78	Output 78 not used	dimensionless	-	real	[-Inf;+Inf]	0
79	Output 79 not used	dimensionless	-	real	[-Inf;+Inf]	0
80	Output 80 not used	dimensionless	-	real	[-Inf;+Inf]	0
81	Output 81 not used	dimensionless	-	real	[-Inf;+Inf]	0
82	Output 82 not used	dimensionless	-	real	[-Inf;+Inf]	0
83	Output 83 not used	dimensionless	-	real	[-Inf;+Inf]	0
84	Output 84 not used	dimensionless	-	real	[-Inf;+Inf]	0
85	Output 85 not used1	dimensionless	-	real	[-Inf;+Inf]	0
86	Output 86 not used	dimensionless	-	real	[-Inf;+Inf]	0
87	Output 87 not used	dimensionless	-	real	[-Inf;+Inf]	0
88	Output 88 not used	dimensionless	-	real	[-Inf;+Inf]	0
89	Output 89 not used	dimensionless	-	real	[-Inf;+Inf]	0
90	Output 90 not used	dimensionless	-	real	[-Inf;+Inf]	0
91	Output 91 not used	dimensionless	-	real	[-Inf;+Inf]	0
92	Output 92 not used	dimensionless	-	real	[-Inf;+Inf]	0
93	Output 93 not used	dimensionless	-	real	[-Inf;+Inf]	0
94	Output 94 not used	dimensionless	-	real	[-Inf;+Inf]	0
95	Output 95 not used	dimensionless	-	real	[-Inf;+Inf]	0
96	Output 96 not used	dimensionless	-	real	[-Inf;+Inf]	0
97	Output 97 not used	dimensionless	-	real	[-Inf;+Inf]	0
98	Output 98 not used	dimensionless	-	real	[-Inf;+Inf]	0
99	Time of last read	Time	hr	real	[0;+Inf]	0
	The time at which the last values were read from the data file. This output is to be used strictly with the TYPE 16 radiation processor Input 19.					
100	Time of next read	Time	hr	real	[0;+Inf]	0
	Thetime at which the next values will be read from the data file. This output is to be strictly used with the radiation processor Input 20.					
101	Month at next timestep	Dimensionless	-	real	[-Inf;+Inf]	0
	The month of the year at the next timestep.					
102	Day at next timestep	Time	day	real	[-Inf;+Inf]	0
	The day of the month corresponding to the next timestep (not interpolated at timesteps less than 1 hour).					
103	Hour at next timestep	Time	hr	real	[0;+Inf]	0
	The hour of the year at the next timestep.					
104	Dry bulb at next timestep	Temperature	C	real	[-Inf;+Inf]	0
	The dry bulb (ambient) temperature at the next timestep.					

105	Dew point at next timestep	Temperature	C	real	[-Inf;+Inf]	0
	The dew point temperature of the ambient air at the next timestep (interpolated at timesteps of less than 1 hour).					
106	Relative humidity at next timestep	Dimensionless	-	real	[-Inf;+Inf]	0
	The percent relative humidity of the ambient air at the next timestep (interpolated at timesteps of less than 1 hour).					
107	Global horiz. at next timestep	Flux	kJ/hr.m^2	real	[0;+Inf]	0
	Global horizontal surface radiation at the next timestep. Used with the smoothing option in he radiation processor.					
108	Direct normal at next timestep	Flux	kJ/hr.m^2	real	[0;+Inf]	0
	Direct normal solar radiation at the next timestep. Used with the radiation smoothing option in the radiation processor component.					
109	Diffuse at next timestep	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The diffuse solar radiation at the next timestep. This output is typically used with the radiation smoothing option in the radiation processor component.					
110	Wind velocity at next timestep	Velocity	m/s	real	[0.0;+Inf]	0
	The wind velocity at the next timestep.					

4.10.8.3. User-Supplied Random Number Seeds

Icon		TRNSYS Model	Type 54
Proforma	Physical Phenomena\Weather Generators\User-Supplied Random Number Seeds\Type54b.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Weather file units	Dimensionless	-	integer	[1;2]	1
	An indicator to the weather generator model of the units contained in the external file of monthly averages. 1 ----> SI Units 2 ----> English Units If either of the default monthly average files are used (WDATA.DAT or NREL.DAT) this parameter must be set to 1.					
2	Logical unit	Dimensionless	-	integer	[10;30]	25
	The logical unit through which the external weather data file will be accessed. Each file that TRNSYS writes to or reads from must be assigned a unique logical unit in the TRNSYS input file.					
3	City number	Dimensionless	-	integer	[1;+Inf]	100
	The identification number (listed in the weather data file) given to the city for which the weather will be generated. Weather File = WDATA.DAT þ Weather File = NREL.DAT (See manual for city identification numbers.)					
4	Temperature model	Dimensionless	-	integer	[1;2]	2
	The type of temperature model to be used in the generation of the weather: 1 ---> Stochastic model 2 ---> Cosine model See the abstract for more details on the appropriate choice of temperature model for your simulation.					
5	Hourly radiation correction	Dimensionless	-	integer	[1;2]	1
	Should the calculated values of solar radiation be autocorrelated? 1 ---> Yes 2 ---> No See the abstract for more details on the autocorrelation of radiation values.					
6	Use default seeds	Dimensionless	-	integer	[2;2]	2
	Setting this parameter to 1 indicates to the general weather generator component that the default random number seeds should be used. Do not change this parameter.					
7	Starting random seed 1	Dimensionless	-	real	[-1.0;1.0]	0.654387
	The first random number seed for the starting positions in the sequences.					
8	Starting random seed 2	Dimensionless	-	real	[-1.0;1.0]	0.268344
	The second random number seed for the starting positions in the sequences.					
9	Hourly radiation seed 1	Dimensionless	-	real	[-1.0;+1.0]	-0.542936
	The first random number seed for the generation of the hourly radiation values.					
10	Hourly radiation seed 2	Dimensionless	-	real	[-1.0;+1.0]	0.835275
	The second random number seed for the generation of the hourly radiation values.					
11	Hourly temperature seed 1	Dimensionless	-	real	[-1.0;+1.0]	-0.174732
	The first random number seed for the generation of the hourly dry bulb temperatures.					
12	Hourly temperature seed 2	Dimensionless	-	real	[-1.0;+1.0]	0.16378
	The second random number seed for the generation of the hourly dry bulb temperatures.					
13	Hourly wind speed seed 1	Dimensionless	-	real	[-1.0;+1.0]	0.643575

	The first random number seed for the generation of the hourly wind speed data.					
14	Hourly wind speed seed 2	Dimensionless	-	real	[-1.0;+1.0]	0.982356
	The second random number seed for the generation of the hourly wind speed data.					
15	Average January windspeed	Velocity	m/s	real	[0.0;+Inf]	4.0
	The average windspeed for the month of January. A default value of 9 should be used if windspeed data is not available.					
16	Average February windspeed	Velocity	m/s	real	[0.0;+Inf]	4.0
	The average windspeed for the month of February. A default value of 9 should be used if windspeed data is not available.					
17	Average March windspeed	Velocity	m/s	real	[0.0;+Inf]	4.0
	The average windspeed for the month of March. A default value of 9 should be used if windspeed data is not available.					
18	Average April windspeed	Velocity	m/s	real	[0.0;+Inf]	4.0
	The average windspeed for the month of April. A default value of 9 should be used if windspeed data is not available.					
19	Average May windspeed	Velocity	m/s	real	[0.0;+Inf]	4.0
	The average windspeed for the month of May. A default value of 9 should be used if windspeed data is not available.					
20	Average June windspeed	Velocity	m/s	real	[0.0;+Inf]	4.0
	The average windspeed for the month of June. A default value of 9 should be used if windspeed data is not available.					
21	Average July windspeed	Velocity	m/s	real	[0.0;+Inf]	4.0
	The average windspeed for the month of July. A default value of 9 should be used if windspeed data is not available.					
22	Average August windspeed	Velocity	m/s	real	[0.0;+Inf]	4.0
	The average windspeed for the month of August. A default value of 9 should be used if windspeed data is not available.					
23	Average September windspeed	Velocity	m/s	real	[0.0;+Inf]	4.0
	The average windspeed for the month of September. A default value of 9 should be used if windspeed data is not available.					
24	Average October windspeed	Velocity	m/s	real	[0.0;+Inf]	4.0
	The average windspeed for the month of October. A default value of 9 should be used if windspeed data is not available.					
25	Average November windspeed	Velocity	m/s	real	[0.0;+Inf]	4.0
	The average windspeed for the month of November. A default value of 9 should be used if windspeed data is not available.					
26	Average December windspeed	Velocity	m/s	real	[0.0;+Inf]	4.0
	The average windspeed for the month of December. A default value of 9 should be used if windspeed data is not available.					
27	Altitude	Length	m	real	[0.0;+Inf]	0.0
	The altitude of the city for which the weather will be generated. A default value of 0 (sea level) should be used if no data is available.					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Month of the year	Dimensionless	-	integer	[-Inf;+Inf]	0
	The month of the year. (Not interpolated for timesteps less than 1 hour)					
2	Day of the month	Time	day	real	[-Inf;+Inf]	0
	The day of the month corresponding to the current timestep (not interpolated for timesteps less than 1 hour).					
3	Hour	Time	hr	real	[-Inf;+Inf]	0

	The hour of the year. (Interpolated at timesteps less than 1 hour)					
4	Dry bulb temperature	Temperature	C	real	[-Inf;+Inf]	0
	The dry bulb (ambient) temperature. (Interpolated at timestep less than one hour)					
5	Dew point temperature	Temperature	C	real	[-Inf;+Inf]	0
	The dew point temperature of the ambient air (interpolated at timesteps less than 1 hour).					
6	Percent relative humidity	Dimensionless	-	real	[-Inf;+Inf]	0
	The relative humidity of the ambient air expressed as a percentage (interpolated at timesteps less than 1 hour).					
7	Global horizontal radiation	Flux	kJ/hr.m^2	real	[0.0;+Inf]	0
	The global solar radiation on a horizontal surface integrated over the previous hour. (Not interpolated at timesteps less than one hour - use radiation processor to interpolate solar radiation)					
8	Direct normal radiation	Flux	kJ/hr.m^2	real	[0.0;+Inf]	0
	The direct normal solar radiation integrated over the previous hour. (Not interpolated at timesteps less than 1 hour - use radiation processor to interpolate solar radiation)					
9	Diffuse radiation	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The diffuse solar radiation integrated over the previous hour. (Not interpolated at timesteps less than 1 hour - use radiation processor to interpolate solar radiation)					
10	Wind velocity	Velocity	m/s	real	[0.0;+Inf]	0
	The velocity of the wind. (Interpolated at timesteps of less than one hour)					
11	Output 11 not used	Dimensionless	-	real	[-Inf;+Inf]	0
12	Output 12 not used	Dimensionless	-	real	[-Inf;+Inf]	0
13	Output 13 not used	dimensionless	-	real	[-Inf;+Inf]	0
14	Output 14 not used	dimensionless	-	real	[-Inf;+Inf]	0
15	Output 15 not used	dimensionless	-	real	[-Inf;+Inf]	0
16	Output 16 not used	dimensionless	-	real	[-Inf;+Inf]	0
17	Output 17 not used	dimensionless	-	real	[-Inf;+Inf]	0
18	Output 18 not used	dimensionless	-	real	[-Inf;+Inf]	0
19	Output 19 not used	dimensionless	-	real	[-Inf;+Inf]	0
20	Output 20 not used	dimensionless	-	real	[-Inf;+Inf]	0
21	Output 21 not used	dimensionless	-	real	[-Inf;+Inf]	0
22	Output 22 not used	dimensionless	-	real	[-Inf;+Inf]	0
23	Output 23 not used	dimensionless	-	real	[-Inf;+Inf]	0
24	Output 24 not used	dimensionless	-	real	[-Inf;+Inf]	0
25	Output 25 not used	dimensionless	-	real	[-Inf;+Inf]	0
26	Output 26 not used	dimensionless	-	real	[-Inf;+Inf]	0
27	Output 27 not used	dimensionless	-	real	[-Inf;+Inf]	0
28	Output 28 not used	dimensionless	-	real	[-Inf;+Inf]	0
29	Output 29 not used	dimensionless	-	real	[-Inf;+Inf]	0
30	Output 30 not used	dimensionless	-	real	[-Inf;+Inf]	0
31	Output 31 not used	dimensionless	-	real	[-Inf;+Inf]	0
32	Output 32 not used	dimensionless	-	real	[-Inf;+Inf]	0
33	Output 33 not used	dimensionless	-	real	[-Inf;+Inf]	0
34	Output 34 not used	dimensionless	-	real	[-Inf;+Inf]	0
35	Output 35 not used	dimensionless	-	real	[-Inf;+Inf]	0
36	Output 36 not used	dimensionless	-	real	[-Inf;+Inf]	0

37	Output 37 not used	dimensionless	-	real	[-Inf;+Inf]	0
38	Output 38 not used	dimensionless	-	real	[-Inf;+Inf]	0
39	Output 39 not used	dimensionless	-	real	[-Inf;+Inf]	0
40	Output 40 not used	dimensionless	-	real	[-Inf;+Inf]	0
41	Output 41 not used	dimensionless	-	real	[-Inf;+Inf]	0
42	Output 42 not used	dimensionless	-	real	[-Inf;+Inf]	0
43	Output 43 not used	dimensionless	-	real	[-Inf;+Inf]	0
44	Output 44 not used	dimensionless	-	real	[-Inf;+Inf]	0
45	Output 45 not used	dimensionless	-	real	[-Inf;+Inf]	0
46	Output 46 not used	dimensionless	-	real	[-Inf;+Inf]	0
47	Output 47 not used	dimensionless	-	real	[-Inf;+Inf]	0
48	Output 48 not used	dimensionless	-	real	[-Inf;+Inf]	0
49	Output 49 not used	dimensionless	-	real	[-Inf;+Inf]	0
50	Output 50 not used	dimensionless	-	real	[-Inf;+Inf]	0
51	Output 51 not used	dimensionless	-	real	[-Inf;+Inf]	0
52	Output 52 not used	dimensionless	-	real	[-Inf;+Inf]	0
53	Output 53 not used	dimensionless	-	real	[-Inf;+Inf]	0
54	Output 54 not used	dimensionless	-	real	[-Inf;+Inf]	0
55	Output 55 not used	dimensionless	-	real	[-Inf;+Inf]	0
56	Output 56 not used	dimensionless	-	real	[-Inf;+Inf]	0
57	Output 57 not used	dimensionless	-	real	[-Inf;+Inf]	0
58	Output 58 not used	dimensionless	-	real	[-Inf;+Inf]	0
59	Output 59 not used	dimensionless	-	real	[-Inf;+Inf]	0
60	Output 60 not used	dimensionless	-	real	[-Inf;+Inf]	0
61	Output 61 not used	dimensionless	-	real	[-Inf;+Inf]	0
62	Output 62 not used	dimensionless	-	real	[-Inf;+Inf]	0
63	Output 63 not used	dimensionless	-	real	[-Inf;+Inf]	0
64	Output 64 not used	dimensionless	-	real	[-Inf;+Inf]	0
65	Output 65 not used	dimensionless	-	real	[-Inf;+Inf]	0
66	Output 66 not used	dimensionless	-	real	[-Inf;+Inf]	0
67	Output 67 not used	dimensionless	-	real	[-Inf;+Inf]	0
68	Output 68 not used	dimensionless	-	real	[-Inf;+Inf]	0
69	Output 69 not used	dimensionless	-	real	[-Inf;+Inf]	0
70	Output 70 not used	dimensionless	-	real	[-Inf;+Inf]	0
71	Output 71 not used	dimensionless	-	real	[-Inf;+Inf]	0
72	Output 72 not used	dimensionless	-	real	[-Inf;+Inf]	0
73	Output 73 not used	dimensionless	-	real	[-Inf;+Inf]	0
74	Output 74 not used	dimensionless	-	real	[-Inf;+Inf]	0
75	Output 75 not used	dimensionless	-	real	[-Inf;+Inf]	0
76	Output 76 not used	dimensionless	-	real	[-Inf;+Inf]	0
77	Output 77 not used	dimensionless	-	real	[-Inf;+Inf]	0
78	Output 78 not used	dimensionless	-	real	[-Inf;+Inf]	0
79	Output 79 not used	dimensionless	-	real	[-Inf;+Inf]	0

80	Output 80 not used	dimensionless	-	real	[-Inf;+Inf]	0
81	Output 81 not used	dimensionless	-	real	[-Inf;+Inf]	0
82	Output 82 not used	dimensionless	-	real	[-Inf;+Inf]	0
83	Output 83 not used	dimensionless	-	real	[-Inf;+Inf]	0
84	Output 84 not used	dimensionless	-	real	[-Inf;+Inf]	0
85	Output 85 not used	dimensionless	-	real	[-Inf;+Inf]	0
86	Output 86 not used	dimensionless	-	real	[-Inf;+Inf]	0
87	Output 87 not used	dimensionless	-	real	[-Inf;+Inf]	0
88	Output 88 not used	dimensionless	-	real	[-Inf;+Inf]	0
89	Output 89 not used	dimensionless	-	real	[-Inf;+Inf]	0
90	Output 90 not used	dimensionless	-	real	[-Inf;+Inf]	0
91	Output 91 not used	dimensionless	-	real	[-Inf;+Inf]	0
92	Output 92 not used	dimensionless	-	real	[-Inf;+Inf]	0
93	Output 93 not used	dimensionless	-	real	[-Inf;+Inf]	0
94	Output 94 not used	dimensionless	-	real	[-Inf;+Inf]	0
95	Output 95 not used	dimensionless	-	real	[-Inf;+Inf]	0
96	Output 96 not used	dimensionless	-	real	[-Inf;+Inf]	0
97	Output 97 not used	dimensionless	-	real	[-Inf;+Inf]	0
98	Output 98 not used	dimensionless	-	real	[-Inf;+Inf]	0
99	Time of last read	Time	hr	real	[0;+Inf]	0
	The time at which the last values were read from the data file. This output is to be used strictly with the TYPE 16 radiation processor Input 19.					
100	Time of next read	Time	hr	real	[0;+Inf]	0
	Thetime at which the next values will be read from the data file. This output is to be strictly used with the radiation processor Input 20.					
101	Month at next timestep	Dimensionless	-	real	[-Inf;+Inf]	0
	The month of the year at the next timestep.					
102	Day at next timestep	Time	day	real	[-Inf;+Inf]	0
	The day of the month corresponding to the next timestep (not interpolated at timesteps less than 1 hour).					
103	Hour at next timestep	Time	hr	real	[0;+Inf]	0
	The hour of the year at the next timestep.					
104	Dry bulb at next timestep	Temperature	C	real	[-Inf;+Inf]	0
	The dry bulb (ambient) temperature at the next timestep.					
105	Dew point at next timestep	Temperature	C	real	[-Inf;+Inf]	0
	The dew point temperature of the ambient air at the next timestep (interpolated at timesteps of less than 1 hour).					
106	Relative humidity at next timestep	Dimensionless	-	real	[-Inf;+Inf]	0
	The percent relative humidity of the ambient air at the next timestep (interpolated at timesteps of less than 1 hour).					
107	Global horiz. at next timestep	Flux	kJ/hr.m^2	real	[0;+Inf]	0
	Global horizontal surface radiation at the next timestep. Used with the smoothing option in he radiation processor.					
108	Direct normal at next timestep	Flux	kJ/hr.m^2	real	[0;+Inf]	0
	Direct normal solar radiation at the next timestep. Used with the radiation smoothing option in the radiation processor component.					
109	Diffuse at next timestep	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0

	The diffuse solar radiation at the next timestep. This output is typically used with the radiation smoothing option in the radiation processor component.					
110	Wind velocity at next timestep	Velocity	m/s	real	[0.0;+Inf]	0
	The wind velocity at the next timestep.					

EXTERNAL FILES

Question	File	Associated parameter
Which file contains the monthly average weather data?	.\Examples\Data Files\Type54-WeatherGenerator.dat	Logical unit
Source file	.\SourceCode\Types\Type54.for	

4.10.8.4. User-Supplied Random Number Seeds - No External File

Icon		TRNSYS Model	Type 54
Proforma	Physical Phenomena\Weather Generators\User-Supplied Random Number Seeds\No External File\TYPE54d.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Weather file units	Dimensionless	-	integer	[1;2]	1
	An indicator to the weather generator model of the units contained in the external file of monthly averages. 1 ----> SI Units 2 ----> English Units If either of the default monthly average files are used (WDATA.DAT or NREL.DAT) this parameter must be set to 1.					
2	Logical unit - not used	Dimensionless	-	integer	[-1;-1]	25
	The logical unit through which the external weather data file will be accessed. Each file that TRNSYS writes to or reads from must be assigned a unique logical unit in the TRNSYS input file. By setting this value to -1, the user indicates that the values are provided in the input file as PARAMETERS to the model instead of in an external file.					
3	City number - not used	Dimensionless	-	integer	[1;+Inf]	100
	The identification number (listed in the weather data file) given to the city for which the weather will be generated. Weather File = WDATA.DAT þ Weather File = NREL.DAT (See manual for city identification numbers.)					
4	Temperature model	Dimensionless	-	integer	[1;2]	0
	The type of temperature model to be used in the generation of the weather: 1---> Stochastic model 2---> Cosine model See the abstract for more details on the appropriate choice of temperature model for your simulation.					
5	Hourly radiation correction	Dimensionless	-	integer	[1;2]	1
	Should the calculated values of solar radiation be autocorrelated? 1 ---> Yes 2 ---> No See the abstract for more details on the autocorrelation of radiation values.					
6	Use default seeds	Dimensionless	-	integer	[2;2]	2
	Setting this parameter to 1 indicates to the general weather generator component that the default random number seeds should be used. Do not change this parameter.					
7	Starting random seed 1	Dimensionless	-	real	[-1.0;1.0]	0.654387
	The first random number seed for the starting positions in the sequences.					
8	Starting random seed 2	Dimensionless	-	real	[-1.0;1.0]	0.268344
	The second random number seed for the starting positions in the sequences.					
9	Hourly radiation seed 1	Dimensionless	-	real	[-1.0;+1.0]	-0.542936
	The first random number seed for the generation of the hourly radiation values.					
10	Hourly radiation seed 2	Dimensionless	-	real	[-1.0;+1.0]	0.835275
	The second random number seed for the generation of the hourly radiation values.					
11	Hourly temperature seed 1	Dimensionless	-	real	[-1.0;+1.0]	-0.174732
	The first random number seed for the generation of the hourly dry bulb temperatures.					

12	Hourly temperature seed 2	Dimensionless	-	real	[-1.0;+1.0]	0.16378
	The second random number seed for the generation of the hourly dry bulb temperatures.					
13	Hourly wind speed seed 1	Dimensionless	-	real	[-1.0;+1.0]	0.643575
	The first random number seed for the generation of the hourly wind speed data.					
14	Hourly wind speed seed 2	Dimensionless	-	real	[-1.0;+1.0]	0.982356
	The second random number seed for the generation of the hourly wind speed data.					
15	Average January windspeed	Velocity	m/s	real	[0.0;+Inf]	4.0
	The average windspeed for the month of January. A default value of 9 should be used if windspeed data is not available.					
16	Average February windspeed	Velocity	m/s	real	[0.0;+Inf]	4.0
	The average windspeed for the month of February. A default value of 9 should be used if windspeed data is not available.					
17	Average March windspeed	Velocity	m/s	real	[0.0;+Inf]	4.0
	The average windspeed for the month of March. A default value of 9 should be used if windspeed data is not available.					
18	Average April windspeed	Velocity	m/s	real	[0.0;+Inf]	4.0
	The average windspeed for the month of April. A default value of 9 should be used if windspeed data is not available.					
19	Average May windspeed	Velocity	m/s	real	[0.0;+Inf]	4.0
	The average windspeed for the month of May. A default value of 9 should be used if windspeed data is not available.					
20	Average June windspeed	Velocity	m/s	real	[0.0;+Inf]	4.0
	The average windspeed for the month of June. A default value of 9 should be used if windspeed data is not available.					
21	Average July windspeed	Velocity	m/s	real	[0.0;+Inf]	4.0
	The average windspeed for the month of July. A default value of 9 should be used if windspeed data is not available.					
22	Average August windspeed	Velocity	m/s	real	[0.0;+Inf]	4.0
	The average windspeed for the month of August. A default value of 9 should be used if windspeed data is not available.					
23	Average September windspeed	Velocity	m/s	real	[0.0;+Inf]	4.0
	The average windspeed for the month of September. A default value of 9 should be used if windspeed data is not available.					
24	Average October windspeed	Velocity	m/s	real	[0.0;+Inf]	4.0
	The average windspeed for the month of October. A default value of 9 should be used if windspeed data is not available.					
25	Average November windspeed	Velocity	m/s	real	[0.0;+Inf]	4.0
	The average windspeed for the month of November. A default value of 9 should be used if windspeed data is not available.					
26	Average December windspeed	Velocity	m/s	real	[0.0;+Inf]	4.0
	The average windspeed for the month of December. A default value of 9 should be used if windspeed data is not available.					
27	Altitude	Length	m	real	[0.0;+Inf]	0.0
	The altitude of the city for which the weather will be generated. A default value of 0 (sea level) should be used if no data is available.					
28	Latitude	Dimensionless	-	real	[-Inf;+Inf]	0
29	Average January daily solar	any	any	real	[0;+Inf]	0
	The amount of solar radiation incident on the horizontal during the average day in January					
30	Average February daily solar	any	any	real	[0;+Inf]	0

	The amount of solar radiation incident on the horizontal during the average day in February					
31	Average March daily solar	any	any	real	[0;+Inf]	0
	The amount of solar radiation incident on the horizontal during the average day in March					
32	Average April daily solar	any	any	real	[0;+Inf]	0
	The amount of solar radiation incident on the horizontal during the average day in April					
33	Average May daily solar	any	any	real	[0;+Inf]	0
	The amount of solar radiation incident on the horizontal during the average day in May					
34	Average June daily solar	any	any	real	[0;+Inf]	0
	The amount of solar radiation incident on the horizontal during the average day in June					
35	Average July daily solar	any	any	real	[0;+Inf]	0
	The amount of solar radiation incident on the horizontal during the average day in July					
36	Average August daily solar	any	any	real	[0;+Inf]	0
	The amount of solar radiation incident on the horizontal during the average day in August					
37	Average September daily solar	any	any	real	[0;+Inf]	0
	The amount of solar radiation incident on the horizontal during the average day in September					
38	Average October daily solar	any	any	real	[0;+Inf]	0
	The amount of solar radiation incident on the horizontal during the average day in October					
39	Average November daily solar	any	any	real	[0;+Inf]	0
	The amount of solar radiation incident on the horizontal during the average day in November					
40	Average December daily solar	any	any	real	[0;+Inf]	0
	The amount of solar radiation incident on the horizontal during the average day in December					
41	Average January humidity ratio	Dimensionless	-	real	[0;+Inf]	0
	The average absolute humidity ratio (kgH2O/kgAir) in January.					
42	Average February humidity ratio	Dimensionless	-	real	[0;+Inf]	0
	The average absolute humidity ratio (kgH2O/kgAir) in February					
43	Average March humidity ratio	Dimensionless	-	real	[0;+Inf]	0
	The average absolute humidity ratio (kgH2O/kgAir) in March					
44	Average April humidity ratio	Dimensionless	-	real	[0;+Inf]	0
	The average absolute humidity ratio (kgH2O/kgAir) in April					
45	Average May humidity ratio	Dimensionless	-	real	[0;+Inf]	0
	The average absolute humidity ratio (kgH2O/kgAir) in May					
46	Average June humidity ratio	Dimensionless	-	real	[0;+Inf]	0
	The average absolute humidity ratio (kgH2O/kgAir) in June					
47	Average July humidity ratio	Dimensionless	-	real	[0;+Inf]	0
	The average absolute humidity ratio (kgH2O/kgAir) in July					
48	Average August humidity ratio	Dimensionless	-	real	[0;+Inf]	0
	The average absolute humidity ratio (kgH2O/kgAir) in August					
49	Average September humidity ratio	Dimensionless	-	real	[0;+Inf]	0
	The average absolute humidity ratio (kgH2O/kgAir) in September					
50	Average October humidity ratio	Dimensionless	-	real	[0;+Inf]	0
	The average absolute humidity ratio (kgH2O/kgAir) in October					
51	Average November humidity ratio	Dimensionless	-	real	[0;+Inf]	0
	The average absolute humidity ratio (kgH2O/kgAir) in November					
52	Average December humidity ratio	Dimensionless	-	real	[0;+Inf]	0
	The average absolute humidity ratio (kgH2O/kgAir) in December					
53	Average January temperature	Temperature	C	real	[0;+Inf]	0

	The average dry bulb temperature in January					
54	Average February temperature	Temperature	C	real	[0;+Inf]	0
55	Average March temperature	Temperature	C	real	[0;+Inf]	0
56	Average April temperature	Temperature	C	real	[0;+Inf]	0
57	Average May temperature	Temperature	C	real	[0;+Inf]	0
58	Average June temperature	Temperature	C	real	[0;+Inf]	0
59	Average July temperature	Temperature	C	real	[0;+Inf]	0
60	Average August temperature	Temperature	C	real	[0;+Inf]	0
61	Average September temperature	Temperature	C	real	[0;+Inf]	0
62	Average October temperature	Temperature	C	real	[0;+Inf]	0
63	Average November temperature	Temperature	C	real	[0;+Inf]	0
64	Average December temperature	Temperature	C	real	[0;+Inf]	0

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Month of the year	Dimensionless	-	integer	[-Inf;+Inf]	0
	The month of the year. (Not interpolated for timesteps less than 1 hour)					
2	Day of the month	Time	day	real	[-Inf;+Inf]	0
	The day of the month corresponding to the current timestep (not interpolated for timesteps less than 1 hour).					
3	Hour	Time	hr	real	[-Inf;+Inf]	0
	The hour of the year. (Interpolated at timesteps less than 1 hour)					
4	Dry bulb temperature	Temperature	C	real	[-Inf;+Inf]	0
	The dry bulb (ambient) temperature. (Interpolated at timestep less than one hour)					
5	Dew point temperature	Temperature	C	real	[-Inf;+Inf]	0
	The dew point temperature of the ambient air (interpolated at timesteps less than 1 hour).					
6	Percent relative humidity	Dimensionless	-	real	[-Inf;+Inf]	0
	The relative humidity of the ambient air expressed as a percentage (interpolated at timesteps less than 1 hour).					
7	Global horizontal radiation	Flux	kJ/hr.m^2	real	[0.0;+Inf]	0
	The global solar radiation on a horizontal surface integrated over the previous hour. (Not interpolated at timesteps less than one hour - use radiation processor to interpolate solar radiation)					
8	Direct normal radiation	Flux	kJ/hr.m^2	real	[0.0;+Inf]	0
	The direct normal solar radiation integrated over the previous hour. (Not interpolated at timesteps less than 1 hour - use radiation processor to interpolate solar radiation)					
9	Diffuse radiation	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The diffuse solar radiation integrated over the previous hour. (Not interpolated at timesteps less than 1 hour - use radiation processor to interpolate solar radiation)					
10	Wind velocity	Velocity	m/s	real	[0.0;+Inf]	0
	The velocity of the wind. (Interpolated at timesteps of less than one hour)					
11	Output 11 not used	Dimensionless	-	real	[-Inf;+Inf]	0
12	Output 12 not used	dimensionless	-	real	[-Inf;+Inf]	0
13	Output 13 not used	dimensionless	-	real	[-Inf;+Inf]	0
14	Output 14 not used	dimensionless	-	real	[-Inf;+Inf]	0
15	Output 15 not used	dimensionless	-	real	[-Inf;+Inf]	0
16	Output 16 not used	dimensionless	-	real	[-Inf;+Inf]	0
17	Output 17 not used	dimensionless	-	real	[-Inf;+Inf]	0

18	Output 18 not used	dimensionless	-	real	[-Inf;+Inf]	0
19	Output 19 not used	dimensionless	-	real	[-Inf;+Inf]	0
20	Output 20 not used	dimensionless	-	real	[-Inf;+Inf]	0
21	Output 21 not used	dimensionless	-	real	[-Inf;+Inf]	0
22	Output 22 not used	dimensionless	-	real	[-Inf;+Inf]	0
23	Output 23 not used	dimensionless	-	real	[-Inf;+Inf]	0
24	Output 24 not used	dimensionless	-	real	[-Inf;+Inf]	0
25	Output 25 not used	dimensionless	-	real	[-Inf;+Inf]	0
26	Output 26 not used	dimensionless	-	real	[-Inf;+Inf]	0
27	Output 27 not used	dimensionless	-	real	[-Inf;+Inf]	0
28	Output 28 not used	dimensionless	-	real	[-Inf;+Inf]	0
29	Output 29 not used	dimensionless	-	real	[-Inf;+Inf]	0
30	Output 30 not used	dimensionless	-	real	[-Inf;+Inf]	0
31	Output 31 not used	dimensionless	-	real	[-Inf;+Inf]	0
32	Output 32 not used	dimensionless	-	real	[-Inf;+Inf]	0
33	Output 33 not used	dimensionless	-	real	[-Inf;+Inf]	0
34	Output 34 not used	dimensionless	-	real	[-Inf;+Inf]	0
35	Output 35 not used	dimensionless	-	real	[-Inf;+Inf]	0
36	Output 36 not used	dimensionless	-	real	[-Inf;+Inf]	0
37	Output 37 not used	dimensionless	-	real	[-Inf;+Inf]	0
38	Output 38 not used	dimensionless	-	real	[-Inf;+Inf]	0
39	Output 39 not used	dimensionless	-	real	[-Inf;+Inf]	0
40	Output 40 not used	dimensionless	-	real	[-Inf;+Inf]	0
41	Output 41 not used	dimensionless	-	real	[-Inf;+Inf]	0
42	Output 42 not used	dimensionless	-	real	[-Inf;+Inf]	0
43	Output 43 not used	dimensionless	-	real	[-Inf;+Inf]	0
44	Output 44 not used	dimensionless	-	real	[-Inf;+Inf]	0
45	Output 45 not used	dimensionless	-	real	[-Inf;+Inf]	0
46	Output 46 not used	dimensionless	-	real	[-Inf;+Inf]	0
47	Output 47 not used	dimensionless	-	real	[-Inf;+Inf]	0
48	Output 48 not used	dimensionless	-	real	[-Inf;+Inf]	0
49	Output 49 not used	dimensionless	-	real	[-Inf;+Inf]	0
50	Output 50 not used	dimensionless	-	real	[-Inf;+Inf]	0
51	Output 51 not used	dimensionless	-	real	[-Inf;+Inf]	0
52	Output 52 not used	dimensionless	-	real	[-Inf;+Inf]	0
53	Output 53 not used	dimensionless	-	real	[-Inf;+Inf]	0
54	Output 54 not used	dimensionless	-	real	[-Inf;+Inf]	0
55	Output 55 not used	dimensionless	-	real	[-Inf;+Inf]	0
56	Output 56 not used	dimensionless	-	real	[-Inf;+Inf]	0
57	Output 57 not used	dimensionless	-	real	[-Inf;+Inf]	0
58	Output 58 not used	dimensionless	-	real	[-Inf;+Inf]	0
59	Output 59 not used	dimensionless	-	real	[-Inf;+Inf]	0
60	Output 60 not used	dimensionless	-	real	[-Inf;+Inf]	0

61	Output 61 not used	dimensionless	-	real	[-Inf;+Inf]	0
62	Output 62 not used	dimensionless	-	real	[-Inf;+Inf]	0
63	Output 63 not used	dimensionless	-	real	[-Inf;+Inf]	0
64	Output 64 not used	dimensionless	-	real	[-Inf;+Inf]	0
65	Output 65 not used	dimensionless	-	real	[-Inf;+Inf]	0
66	Output 66 not used	dimensionless	-	real	[-Inf;+Inf]	0
67	Output 67 not used	dimensionless	-	real	[-Inf;+Inf]	0
68	Output 68 not used	dimensionless	-	real	[-Inf;+Inf]	0
69	Output 69 not used	dimensionless	-	real	[-Inf;+Inf]	0
70	Output 70 not used	dimensionless	-	real	[-Inf;+Inf]	0
71	Output 71 not used	dimensionless	-	real	[-Inf;+Inf]	0
72	Output 72 not used	dimensionless	-	real	[-Inf;+Inf]	0
73	Output 73 not used	dimensionless	-	real	[-Inf;+Inf]	0
74	Output 74 not used	dimensionless	-	real	[-Inf;+Inf]	0
75	Output 75 not used	dimensionless	-	real	[-Inf;+Inf]	0
76	Output 76 not used	dimensionless	-	real	[-Inf;+Inf]	0
77	Output 77 not used	dimensionless	-	real	[-Inf;+Inf]	0
78	Output 78 not used	dimensionless	-	real	[-Inf;+Inf]	0
79	Output 79 not used	dimensionless	-	real	[-Inf;+Inf]	0
80	Output 80 not used	dimensionless	-	real	[-Inf;+Inf]	0
81	Output 81 not used	dimensionless	-	real	[-Inf;+Inf]	0
82	Output 82 not used	dimensionless	-	real	[-Inf;+Inf]	0
83	Output 83 not used	dimensionless	-	real	[-Inf;+Inf]	0
84	Output 84 not used	dimensionless	-	real	[-Inf;+Inf]	0
85	Output 85 not used	dimensionless	-	real	[-Inf;+Inf]	0
86	Output 86 not used	dimensionless	-	real	[-Inf;+Inf]	0
87	Output 87 not used	dimensionless	-	real	[-Inf;+Inf]	0
88	Output 88 not used	dimensionless	-	real	[-Inf;+Inf]	0
89	Output 89 not used	dimensionless	-	real	[-Inf;+Inf]	0
90	Output 90 not used	dimensionless	-	real	[-Inf;+Inf]	0
91	Output 91 not used	dimensionless	-	real	[-Inf;+Inf]	0
92	Output 92 not used	dimensionless	-	real	[-Inf;+Inf]	0
93	Output 93 not used	dimensionless	-	real	[-Inf;+Inf]	0
94	Output 94 not used	dimensionless	-	real	[-Inf;+Inf]	0
95	Output 95 not used	dimensionless	-	real	[-Inf;+Inf]	0
96	Output 96 not used	dimensionless	-	real	[-Inf;+Inf]	0
97	Output 97 not used	dimensionless	-	real	[-Inf;+Inf]	0
98	Output 98 not used	dimensionless	-	real	[-Inf;+Inf]	0
99	Time of last read	Time	hr	real	[0;+Inf]	0
	The time at which the last values were read from the data file. This output is to be used strictly with the TYPE 16 radiation processor Input 19.					
100	Time of next read	Time	hr	real	[0;+Inf]	0
	Thetime at which the next values will be read from the data file. This output is to be strictly used with the radiation processor Input 20.					

101	Month at next timestep	Dimensionless	-	real	[-Inf;+Inf]	0
	The month of the year at the next timestep.					
102	Day at next timestep	Time	day	real	[-Inf;+Inf]	0
	The day of the month corresponding to the next timestep (not interpolated at timesteps less than 1 hour).					
103	Hour at next timestep	Time	hr	real	[0;+Inf]	0
	The hour of the year at the next timestep.					
104	Dry bulb at next timestep	Temperature	C	real	[-Inf;+Inf]	0
	The dry bulb (ambient) temperature at the next timestep.					
105	Dew point at next timestep	Temperature	C	real	[-Inf;+Inf]	0
	The dew point temperature of the ambient air at the next timestep (interpolated at timesteps of less than 1 hour).					
106	Relative humidity at next timestep	Dimensionless	-	real	[-Inf;+Inf]	0
	The percent relative humidity of the ambient air at the next timestep (interpolated at timesteps of less than 1 hour).					
107	Global horiz. at next timestep	Flux	kJ/hr.m^2	real	[0;+Inf]	0
	Global horizontal surface radiation at the next timestep. Used with the smoothing option in he radiation processor.					
108	Direct normal at next timestep	Flux	kJ/hr.m^2	real	[0;+Inf]	0
	Direct normal solar radiation at the next timestep. Used with the radiation smoothing option in the radiation processor component.					
109	Diffuse at next timestep	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The diffuse solar radiation at the next timestep. This output is typically used with the radiation smoothing option in the radiation processor component.					
110	Wind velocity at next timestep	Velocity	m/s	real	[0.0;+Inf]	0
	The wind velocity at the next timestep.					

4.11. Solar Thermal Collectors

4.11.1. CPC Collector

4.11.1.1. CPC Collector

Icon		**TRNSYS Model**	Type 74
Proforma	Solar Thermal Collectors\CPC Collector\Type74.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Number in series	Dimensionless	-	integer	[1;+Inf]	1
	The solar collector model can simulate an array of identical solar collectors hooked up in series. This parameter is used to specify how many collectors are hooked up in a series arrangement where the outlet of the first collector is the inlet to the second collector.					
2	Collector area	Area	m^2	real	[0.0;+Inf]	2.0
	The total area of the solar collector array consistent with the supplied efficiency parameters (typically gross area and not net area).					
3	Fluid specific heat	Specific Heat	kJ/kg.K	real	[0.0;+Inf]	4.190
	The specific heat of the fluid flowing through the solar collector array.					
4	Collector fin efficiency factor	Dimensionless	-	real	[0.0;+1.0]	0.7
	The fin efficiency is a measure of the heat transfer from the fin to the maximum possible heat transfer from the fin. The maximum heat transfer from the fin would occur if the fin was uniformly at the base temperature. Refer to: ASHRAE Standard 93-77 for details on the fin efficiency					
5	Overall Loss Coefficient	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[0.0;+Inf]	3.0
	The loss coefficient of the solar collector per unit aperature area.					
6	Wall reflectivity	Dimensionless	-	real	[0.0;1.0]	0.9
	The reflectivity of the walls of the CPC collector. The reflectivity is a ratio of the reflected radiation to the toal incident radiation.					
7	Half-acceptance angle	Direction (Angle)	degrees	real	[0.0;+90.0]	45.0
	The half-acceptance angle of the CPC collector. The CPC collects both beam and diffuse radiation which approach the aperature within the critical angle, or half-acceptance angle. Refer to figures 4.2.1.3 and 4.2.1.4 of Volume 1 of the TRNSYS reference set for more details.					
8	Truncation ratio	Dimensionless	-	real	[0.0;+1.0]	0.7
	A full CPC is one in which the walls extend upward to a height h which gives an aperature area of 1/sin(half-acceptance angle) times the absorber area. Optimal concentration is achieved in a full CPC, but a very large reflector is required. Most CPC's are truncated to some fraction of this height hbar. Truncation ratio = hbar/h					
9	Axis orientation	Dimensionless	-	integer	[1;2]	1
	The orientation of the receiver axis: 1 = receiver axis is horizontal and in a plane with a slope of Input 11 (Transverse) 2 = receiver axis has same slope and azimuth as mounting surface (Longitudinal)					
10	Absorptance of absorber plate	Dimensionless	-	real	[0.0;1.0]	0.8
	The absorptance of the absorber plate of the solar collector. The absorptance is a ratio of the amount of					

	radiation absorbed by a surface to the total radiation incident on the surface.					
11	Number of covers	Dimensionless	-	integer	[1;+Inf]	1
	The number of glass covers covering the solar collector absorber plate.					
12	Index of refraction of cover	Dimensionless	-	real	[0.0;+Inf]	1.526
	The index of refraction of the material covering the solar collector absorber plate.					
13	Extinction coeff. thickness product	Dimensionless	-	real	[0.0;1.0]	0.0026
	The product of the extinction coefficient and the thickness of one of the glazings covering the solar collector absorber plate.					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Inlet temperature	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the fluid entering the the solar collector.					
2	Inlet flowrate	Flow Rate	kg/hr	real	[0.0;+Inf]	100.0
	The flow rate of the fluid entering the solar collector.					
3	Ambient temperature	Temperature	C	real	[-Inf;+Inf]	10.0
	The temperature of the environment in which the solar collector is located. This temperature will be used for loss calculations.					
4	Incident radiation	Flux	kJ/hr.m^2	real	[0.0;+Inf]	0.
	The total (beam + diffuse) radiation incident on the plane of the solar collector per unit area. This input is commonly hooked up to the TYPE 16 "total radiation on surface 1" output.					
5	Horizontal radiation	Flux	kJ/hr.m^2	real	[0.0;+Inf]	0.0
	The total radiation incident upon a horizontal surface. Includes beam radiation, sky diffuse radiation, and ground reflected diffuse radiation.					
6	Horizontal diffuse	Flux	kJ/hr.m^2	real	[0.0;+Inf]	0.0
	The diffuse radiation on a horizontal surface.					
7	Ground reflectance	Dimensionless	-	real	[0.0;1.0]	0.2
	The reflectance of the surface above which the solar collector is located. The ground reflectance is defined as the ratio of reflected radiation to total incident radiation. Typical values are 0.2 for ground not covered by snow and 0.7 for snow-covered ground.					
8	Incidence angle	Direction (Angle)	degrees	real	[-360;+360]	20.0
	The angle of incidence of beam radiation on the collector surface.					
9	Zenith angle	Direction (Angle)	degrees	real	[-360;+360]	0.0
	The solar zenith angle is the angle between the vertical and the line of sight of the sun. This is 90 minus the angle between the sun and the horizontal.					
10	Solar azimuth angle	Direction (Angle)	degrees	real	[-360;+360]	0.0
	The solar azimuth angle is the angle between the local meridian and the projection of the line of sight of the sun onto the horizontal plane. Zero solar azimuth is facing the equator, 90 is facing west, 180 is facing directly away from the equator, and -90 is facing east.					
11	Collector slope	Direction (Angle)	degrees	real	[-360;+360]	0
	The angle between the plane of the collector surface and the horizontal. The slope is positive when facing the direction of the surface azimuth. 0 = Horizontal; 90 = Vertical facing Azimuth As a general rule, the performance is somewhat optimized when the slope is set equal to the latitude.					
12	Collector azimuth angle	Direction (Angle)	degrees	real	[-360;+360]	0
	The collector azimuth angle is the angle between the local meridian and the projection of the line of sight of the collector. Zero collector azimuth is facing the equator, 90 is facing west, 180 is facing directly away from the equator and -90 is facing east.					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Outlet temperature	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid exiting the solar collector array.					
2	Outlet flowrate	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	The flowrate of the fluid exiting the solar collecor array. In this model: mdot,in = mdot,out					
3	Useful energy gain	Power	kJ/hr	real	[0.0;+Inf]	0
	The rate of useful energy gain by the solar collector fluid: Qu = mdot * Cp * (Tout - Tin)					

4.11.2. Evacuated Tube Collector

4.11.2.1. Evacuated Tube Collector

Icon		TRNSYS Model	Type 71
Proforma	Solar Thermal Collectors\Evacuated Tube Collector\Type71.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Number in series	Dimensionless	-	integer	[1;+Inf]	1
	The solar collector model can simulate an array of identical solar collectors hooked up in series. This parameter is used to specify how many collectors are hooked up in a series arrangement where the output of the first collector is the inlet to the second collector.					
2	Collector area	Area	m^2	real	[0.0;+Inf]	2.0
	The total area of the solar collector array consistent with the supplied efficiency parameters (typically gross area and not net area).					
3	Fluid specific heat	Specific Heat	kJ/kg.K	real	[0.0;+Inf]	4.190
	The specific heat of the fluid flowing through the solar collector array.					
4	Efficiency mode	Dimensionless	-	integer	[1;3]	0.7
	The collector efficiency equation can be written as a function of the inlet, average or outlet temperature. Specify 1 if the collector efficiency parameters are given as a function of the inlet temperature Specify 2 for a function of the collector average temperature Specify 3 for a function of the collector outlet temperature					
5	Flow rate at test conditions	Flow/area	kg/hr.m^2	real	[0.0;+Inf]	3.0
	Collector Flow rate per unit area for efficiency test conditions					
6	Intercept efficiency	Dimensionless	-	real	[0.0;1.0]	0.7
	This parameter is the y intercept of the collector efficiency curve versus the temperature difference / radiation ratio In equation form, this parameter is a0 in the following eq: Eff = a0 - a1 * (Tc-Tamb)/Rad. - a2 * (Tc-Tamb)^2 / Rad. where Tc is the collector inlet, average or outlet temperature according to parameter 4					
7	Negative of first order efficiency coeficient	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[0.0;+Inf]	0.8
	This parameter is the slope of the collector efficiency curve versus the temperature difference / radiation ratio In equation form, this parameter is a1 in the following eq: Eff. = a0 - a1 * (Tc-Tamb)/Rad. - a2 * (Tc-Tamb)^2 /Rad. Where Tc is the collector inlet, average or outlet temperature according to parameter 4					
8	Negative of second order efficiency coeficient	Temp. Dependent Loss Coeff.	kJ/hr.m^2.K^2	integer	[0.0;+Inf]	1
	This parameter is the curvature of the efficiency curve versus the temperature difference / radiation ratio In equation form, this parameter is a2 in the following eq: Eff. = a0 - a1 * (Tc-Tamb) /Rad.- a2 * (Tc-Tamb)^2/Rad where Tc is the collector inlet, average or outlet temperature according to parameter 4					
9	Logical unit of file containing biaxial IAM data	Dimensionless	-	integer	[10;100]	1.526
	FORTRAN Logical unit for file containing biaxial IAM data Make sure that each logical unit specified in an assembly is unique					
10	Number of longitudinal angles for	Dimensionless	-	integer	[1;+Inf]	0

	which IAMs are provided					
	Number of data points for the IAM (longitudinal direction)					
11	Number of transverse angles for which IAMs are provided	Dimensionless	-	integer	[1;+Inf]	0
	Number of data points for the IAM (transverse direction)					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Inlet temperature	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the fluid entering the the solar collector.					
2	Inlet flowrate	Flow Rate	kg/hr	real	[0.0;+Inf]	100.0
	The flow rate of the fluid entering the solar collector.					
3	Ambient temperature	Temperature	C	real	[-Inf;+Inf]	10.0
	The temperature of the environment in which the solar collector is located. This temperature will be used for loss calculations.					
4	Incident radiation	Flux	kJ/hr.m^2	real	[0.0;+Inf]	0.
	The total (beam + diffuse) radiation incident on the plane of the solar collector per unit area. This input is commonly hooked up to the TYPE 16 "total radiation on surface 1" output.					
5	Incident diffuse radiation	Flux	W/m^2	real	[0.0;+Inf]	0.0
	The incident diffuse solar radiation in the plane of the collector, per unit area					
6	Solar incidence angle	Direction (Angle)	degrees	real	[-360;+360]	0.0
	Incidence angle of beam radiation on the collector's surface					
7	Solar zenith angle	Direction (Angle)	degrees	real	[-360;+360]	0.0
	The solar zenith angle is the angle between the vertical and the line of sight of the sun					
8	Solar azimuth angle	Direction (Angle)	degrees	real	[-360;+360]	0.2
	The solar azimuth angle is the angle between the local meridian and the projection of the line of sight of the sun onto the horizontal plane					
9	Collector slope	Direction (Angle)	degrees	real	[-360;+360]	20.0
	The slope of the collector is the angle between the collector surface and the horizontal 0= horizontal The angle is positive when facing towards the collector surface azimuth As a general rule, the performance of the collector is somewhat optimiszed when the sollector slope is set to the latitude					
10	Collector azimuth	Direction (Angle)	degrees	real	[-360;+360]	0
	The collector surface azimuth is the angle between the local meridian and the projection of the normal to the surface onto the horizontal plane 0 = facing the equator 90 = facing West 180 = facing South in northern hemisphere, North in Southern hemisphere 270 = facing East					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Outlet temperature	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid exiting the solar collector array.					
2	Outlet flowrate	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	The flowrate of the fluid exiting the solar collecor array. In this model: mdot,in = mdot,out					
3	Useful energy gain	Power	kJ/hr	real	[0.0;+Inf]	0
	The rate of useful energy gain by the solar collector fluid: Qu = mdot * Cp * (Tout - Tin)					

EXTERNAL FILES

Question	File	Associated parameter
What file contains the 2D IAM data?		Logical unit of file containing biaxial IAM data
Source file	.\SourceCode\Types\Type71.for	

4.11.3. Performance Map Collector

4.11.3.1. 2nd-Order Incidence Angle Modifiers

Icon		TRNSYS Model	Type 72
Proforma	Solar Thermal Collectors\Performance Map Collector\2nd-Order Incidence Angle Modifiers\Type72b.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Number in series	Dimensionless	-	integer	[1;+Inf]	1
	The solar collector model can simulate an array of identical solar collectors hooked up in series. This parameter is used to specify how many collectors are hooked up in a series arrangement where the outlet of the first collector is the inlet of the second collector etc.					
2	Collector area	Area	m^2	real	[0.0;+Inf]	2.0
	The total area of the solar collector array consistent with the supplied efficiency parameters (typically gross area and not net area).					
3	Fluid specific heat	Specific Heat	kJ/kg.K	real	[0.0;+Inf]	4.190
	The specific heat of the fluid flowing through the solar collector array.					
4	Efficiency mode	Dimensionless	-	integer	[1;3]	1
	The solar collector efficiency equation can be written as either a function of the collector inlet temperature, the collector outlet temperaure, or the collector average temperature. If the efficiency parameters are given as a function of the inlet temperature; specify 1. If the efficiency parameters are given as a function of the average temperature; specify 2. If the efficiency parameters are given as a function of the outlet temperature, specify 3.					
5	Logical Unit	Dimensionless	-	integer	[30;999]	12
	The FORTRAN logical unit through which the thermal performance data will be read. Make sure that each logical unit number specified in the assembly is a unique number.					
6	Number of DT/IT points	Dimensionless	-	integer	[1;10]	5
	Number of DT/IT points (NDT): The number of data points for collector efficiency vs. DT/IT that are to be considered for each value of wind speed and radiation level provided.					
7	Number of radiation curves	Dimensionless	-	integer	[1;5]	3
	Number of radiation curves (NIT): The number of collector efficiency vs. DT/IT curves for different levels of radiation.					
8	Number of wind speed curves	Dimensionless	-	integer	[1;5]	1
	Number of wind speed curves (NW): How many values of windspeed are supplied in the external data file for which NIT vs. DT/IT curves are provided.					
9	Optical mode 2	Dimensionless	-	integer	[2;2]	1
	The solar collector model can modify the efficiency parameters by 1 of 4 methods. This parameter specifies that the second-order ASHRAE incidence angle modifiers should be used. This parameter should not be changed.					
10	1st-order IAM	Dimensionless	-	real	[0.0;1.0]	0.1
	Collector tests are usually performed on clear days at normal incidence so that the transmittance-absorptance product is nearly the normal incidence value for beam radiation. The intercept efficiency is corrected for non-normal solar incidence by the use of a modifying factor of the form: Modifier = 1 - b0 * S - b1 * S^2 This parameter is b0 in the above equation.					

11	2nd-order IAM	Dimensionless	-	real	[-1.0;+1.0]	0.0
	Collector tests are generally performed on clear days at normal incidence so that the transmittance-absorptance product is nearly the normal incidence value for beam radiation. The intercept efficiency is corrected for non-normal solar ncidence by a modifying factor of the form: Modifier = 1 - bo * S - b1 * S^2 where S = 1/cos(incidence angle) -1 This parameter is b1 in the above equation.					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Inlet temperature	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the fluid entering the the solar collector.					
2	Inlet flowrate	Flow Rate	kg/hr	real	[0.0;+Inf]	100.0
	The flow rate of the fluid entering the solar collector.					
3	Ambient temperature	Temperature	C	real	[-Inf;+Inf]	10.0
	The temperature of the environment in which the solar collector is located. This temperature will be used for loss calculations.					
4	Incident radiation	Flux	kJ/hr.m^2	real	[0.0;+Inf]	0.
	The total (beam + diffuse) radiation incident on the plane of the solar collector per unit area. This input is commonly hooked up to the TYPE 16 "total radiation on surface 1" output.					
5	Windspeed	Velocity	m/s	real	[0.0;+Inf]	0.0
	The speed of the wind flowing across the solar collector array.					
6	Total horizontal radiation	Flux	kJ/hr.m^2	real	[0.0;+Inf]	0.0
	The total horizontal radiation (beam + diffuse) per unit area. This input is typically hooked to the fourth output of the TYPE 16 radiation processor.					
7	Horizontal diffuse radiation	Flux	kJ/hr.m^2	real	[0.0;+Inf]	0.0
	The horizontal diffuse radiation. This input is typically hooked up to the fifth output of the TYPE 16 solar radiation processor.					
8	Ground reflectance	Dimensionless	-	real	[0.0;1.0]	0.2
	The reflectance of the surface above which the solar collector is positioned. Typical values are 0.2 for ground not covered by snow and 0.7 for snow-covered ground. The reflectance is the ratio of refelcted radiation to total incident radiation and therefore must be between 0 and 1.					
9	Incidence angle	Direction (Angle)	degrees	real	[-360;+360]	45.0
	Angle of incidence of beam radiation on surface.					
10	Collector slope	Direction (Angle)	degrees	real	[-360;+360]	0.
	The slope of the collector surface. The slope is defined as the angle between the surface and the horizontal. 0 = Horizontal Slope is positive when surface is tilted in the direction of the surface azimuth. As a general rule, performance is somewhat optimized when the collector slope is set to the latitude.					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Outlet temperature	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid exiting the solar collector array.					
2	Outlet flowrate	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	The flowrate of the fluid exiting the solar collecor array. In this model: mdot,in = mdot,out					
3	Useful energy gain	Power	kJ/hr	real	[0.0;+Inf]	0
	The rate of useful energy gain by the solar collector fluid: Qu = mdot * Cp * (Tout - Tin)					

EXTERNAL FILES

Question	File	Associated parameter
Which file contains the thermal performance map for this collector?	.\Examples\Data Files\Type72-PerformanceMapCollector-EfficiencyData.dat	Logical Unit
Source file	.\SourceCode\Types\Type72.for	

4.11.3.2. Biaxial Incidence Angle Modifiers

Icon		TRNSYS Model	Type 72
Proforma	Solar Thermal Collectors\Performance Map Collector\Biaxial Incidence Angle Modifiers\Type72e.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Number in series	Dimensionless	-	integer	[1;+Inf]	1
	The solar collector model can simulate an array of identical solar collectors hooked up in series. This parameter is used to specify how many collectors are hooked up in a series arrangement where the outlet of the first collector is the inlet of the second collector etc.					
2	Collector area	Area	m^2	real	[0.0;+Inf]	2.0
	The total area of the solar collector array consistent with the supplied efficiency parameters (typically gross area and not net area).					
3	Fluid specific heat	Specific Heat	kJ/kg.K	real	[0.0;+Inf]	4.190
	The specific heat of the fluid flowing through the solar collector array.					
4	Efficiency mode	Dimensionless	-	integer	[1;3]	1
	The solar collector efficiency equation can be written as either a function of the collector inlet temperature, the collector outlet temperaure, or the collector average temperature. If the efficiency parameters are given as a function of the inlet temperature; specify 1. If the efficiency parameters are given as a function of the average temperature; specify 2. If the efficiency parameters are given as a function of the outlet temperature, specify 3.					
5	Logical Unit	Dimensionless	-	integer	[30;999]	12
	The FORTRAN logical unit through which the thermal performance data will be read. Make sure that each logical unit number specified in the assembly is a unique number.					
6	Number of DT/IT points	Dimensionless	-	integer	[1;10]	5
	Number of DT/IT points (NDT): The number of data points for collector efficiency vs. DT/IT that are to be considered for each value of wind speed and radiation level provided.					
7	Number of radiation curves	Dimensionless	-	integer	[1;5]	3
	Number of radiation curves (NIT): The number of collector efficiency vs. DT/IT curves for different levels of radiation.					
8	Number of wind speed curves	Dimensionless	-	integer	[1;5]	1
	Number of wind speed curves (NW): How many values of windspeed are supplied in the external data file for which NIT vs. DT/IT curves are provided.					
9	Optical mode 5	Dimensionless	-	integer	[5;5]	4
	The solar collector model can modify the efficiency parameters by 1 of 4 methods. This parameter specifies that the biaxial incidence angle modifier data is to be read from an external data file. See the abstract for more details. This parameter should not be changed.					
10	Logical unit	Dimensionless	-	integer	[30;999]	11
	The FORTRAN logical unit through which the biaxial incidence angle modifer data will be read. Make sure that each logical unit specified in the assembly is a unique number.					
11	Number of values	Dimensionless	-	integer	[2;10]	5
	How many values of incidence angle, with their associated biaxial modifier data, are contained in the external data file? The number of angles must be between 2 and 10.					

INPUTS

	Name	Dimension	Unit	Type	Range	Default

1	Inlet temperature	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the fluid entering the the solar collector.					
2	Inlet flowrate	Flow Rate	kg/hr	real	[0.0;+Inf]	100.0
	The flow rate of the fluid entering the solar collector.					
3	Ambient temperature	Temperature	C	real	[-Inf;+Inf]	10.0
	The temperature of the environment in which the solar collector is located. This temperature will be used for loss calculations.					
4	Incident radiation	Flux	kJ/hr.m^2	real	[0.0;+Inf]	0.
	The total (beam + diffuse) radiation incident on the plane of the solar collector per unit area. This input is commonly hooked up to the TYPE 16 "total radiation on surface 1" output.					
5	Windspeed	Velocity	m/s	real	[0.0;+Inf]	0.0
	The speed of the wind flowing across the solar collector array.					
6	Total horizontal radiation	Flux	kJ/hr.m^2	real	[0.0;+Inf]	0.0
	The total horizontal radiation (beam + diffuse) per unit area. This input is typically hooked to the fourth output of the TYPE 16 radiation processor.					
7	Horizontal diffuse radiation	Flux	kJ/hr.m^2	real	[0.0;+Inf]	0.0
	The horizontal diffuse radiation. This input is typically hooked up to the fifth output of the TYPE 16 solar radiation processor.					
8	Ground reflectance	Dimensionless	-	real	[0.0;1.0]	0.2
	The reflectance of the surface above which the solar collector is positioned. Typical values are 0.2 for ground not covered by snow and 0.7 for snow-covered ground. The reflectance is the ratio of refelcted radiation to total incident radiation and therefore must be between 0 and 1.					
9	Incidence angle	Direction (Angle)	degrees	real	[-360;+360]	45.0
	Angle of incidence of beam radiation on surface.					
10	Collector slope	Direction (Angle)	degrees	real	[-360;+360]	0.
	The slope of the collector surface. The slope is defined as the angle between the surface of the collector and the horizontal. 0 = Horizontal; 90 = Vertical facing azimuth; -90 = vertical facing away from azimuth (see radiation processor for discussion of surface azimuth). Slope is positive when surface is tilted in the direction of the surface azimuth. As a general rule, performance is somewhat optimized when the collector slope is set to the latitude.					
11	Collector azimuth	Direction (Angle)	degrees	real	[-360;360]	0

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Outlet temperature	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid exiting the solar collector array.					
2	Outlet flowrate	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	The flowrate of the fluid exiting the solar collecor array. In this model: mdot,in = mdot,out					
3	Useful energy gain	Power	kJ/hr	real	[0.0;+Inf]	0
	The rate of useful energy gain by the solar collector fluid: Qu = mdot * Cp * (Tout - Tin)					

EXTERNAL FILES

Question	File	Associated parameter
Which file contains the thermal performance data ?	.\Examples\Data Files\Type72-PerformanceMapCollector-EfficiencyData.dat	Logical Unit
What is the name of the file containing the biaxial incidence angle modifier data?	.\Examples\Data Files\Type72-PerformanceMapCollector-IAMData-	Logical unit

	OpticalMode5.dat	
Source file	.\SourceCode\Types\Type72.for	

4.11.3.3. Cover and Absorber Properties

Icon		TRNSYS Model	Type 72
Proforma	Solar Thermal Collectors\Performance Map Collector\Cover and Absorber Properties\Type72d.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Number in series	Dimensionless	-	integer	[1;+Inf]	1
	The solar collector model can simulate an array of identical solar collectors hooked up in series. This parameter is used to specify how many collectors are hooked up in a series arrangement where the outlet of the first collector is the inlet of the second collector etc.					
2	Collector area	Area	m^2	real	[0.0;+Inf]	2.0
	The total area of the solar collector array consistent with the supplied efficiency parameters (typically gross area and not net area).					
3	Fluid specific heat	Specific Heat	kJ/kg.K	real	[0.0;+Inf]	4.190
	The specific heat of the fluid flowing through the solar collector array.					
4	Efficiency mode	Dimensionless	-	integer	[1;3]	1
	The solar collector efficiency equation can be written as either a function of the collector inlet temperature, the collector outlet temperaure, or the collector average temperature. If the efficiency parameters are given as a function of the inlet temperature; specify 1. If the efficiency parameters are given as a function of the average temperature; specify 2. If the efficiency parameters are given as a function of the outlet temperature, specify 3.					
5	Logical Unit	Dimensionless	-	integer	[30;999]	12
	The FORTRAN logical unit through which the thermal performance data will be read. Make sure that each logical unit number specified in the assembly is a unique number.					
6	Number of DT/IT points	Dimensionless	-	integer	[1;10]	5
	Number of DT/IT points (NDT): The number of data points for collector efficiency vs. DT/IT that are to be considered for each value of wind speed and radiation level provided.					
7	Number of radiation curves	Dimensionless	-	integer	[1;5]	3
	Number of radiation curves (NIT): The number of collector efficiency vs. DT/IT curves for different levels of radiation.					
8	Number of wind speed curves	Dimensionless	-	integer	[1;5]	1
	Number of wind speed curves (NW): How many values of windspeed are supplied in the external data file for which NIT vs. DT/IT curves are provided.					
9	Optical mode 4	Dimensionless	-	integer	[4;4]	3
	The solar collector model can modify the efficiency parameters by 1 of 4 methods. This parameter specifies that the incidence angle modifiers are to be calculated from the collector properties using the TRNSYS utility subroutine TALF (section 3.4.3 of Volume 1 of the TRNSYS documentation set). See the abstract for more details. This parameter should not be changed.					
10	Plate absorptance	Dimensionless	-	real	[0.0;1.0]	0.7
	The absorptance of the collector absorber plate. Since this quantity is a ratio of absorbed radiation to total radiation; the value must be between 0 and 1. Typical values of plate absorptance can be found from: Solar Enginnering of Thermal Processes, Duffie and Beckman, Wiley-Interscience, New York, 1980.					
11	No. of identical covers	Dimensionless	-	real	[1;+Inf]	1
	The number of identical glass covers on the solar collector. The number of covers will be used to calculate the transmittance-absorptance product using Fresnel's equation.					
12	Index of refraction	Dimensionless	-	real	[0.0;+Inf]	1.526
	Index of refraction of 1 glazing covering the solar collector.					

13	Extinction	Dimensionless	-	real	[0.0;1.0]	0.0026
	The product of the extinction coefficient and cover thickness for 1 of the glazings covering the solar collector.					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Inlet temperature	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the fluid entering the the solar collector.					
2	Inlet flowrate	Flow Rate	kg/hr	real	[0.0;+Inf]	100.0
	The flow rate of the fluid entering the solar collector.					
3	Ambient temperature	Temperature	C	real	[-Inf;+Inf]	10.0
	The temperature of the environment in which the solar collector is located. This temperature will be used for loss calculations.					
4	Incident radiation	Flux	kJ/hr.m^2	real	[0.0;+Inf]	0.
	The total (beam + diffuse) radiation incident on the plane of the solar collector per unit area. This input is commonly hooked up the TYPE 16 "total radiation on surface 1" output.					
5	Windspeed	Velocity	m/s	real	[0.0;+Inf]	0.0
	The speed of the wind flowing across the solar collector array.					
6	Total horizontal radiation	Flux	kJ/hr.m^2	real	[0.0;+Inf]	0.0
	The total horizontal radiation (beam + diffuse) per unit area. This input is typically hooked to the fourth output of the TYPE 16 radiation processor.					
7	Horizontal diffuse radiation	Flux	kJ/hr.m^2	real	[0.0;+Inf]	0.0
	The horizontal diffuse radiation. This input is typically hooked up to the fifth output of the TYPE 16 solar radiation processor.					
8	Ground reflectance	Dimensionless	-	real	[0.0;1.0]	0.2
	The reflectance of the surface above which the solar collector is positioned. Typical values are 0.2 for ground not covered by snow and 0.7 for snow-covered ground. The reflectance is the ratio of refelcted radiation to total incident radiation and therefore must be between 0 and 1.					
9	Incidence angle	Direction (Angle)	degrees	real	[-360;+360]	45.0
	Angle of incidence of beam radiation on surface.					
10	Collector slope	Direction (Angle)	degrees	real	[-360;+360]	0.
	The slope of the collector surface. The slope is defined as the angle between the surface of the collector and the horizontal. 0 = Horizontal; 90 = Vertical facing azimuth; -90 = vertical facing away from azimuth (see radiation processor for discussion of surface azimuth). Slope is positive when surface is tilted in the direction of the . As a general rule, performance is somewhat optimized when the collector slope is set to the latitude.					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Outlet temperature	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid exiting the solar collector array.					
2	Outlet flowrate	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	The flowrate of the fluid exiting the solar collecor array. In this model: mdot,in = mdot,out					
3	Useful energy gain	Power	kJ/hr	real	[0.0;+Inf]	0
	The rate of useful energy gain by the solar collector fluid: Qu = mdot * Cp * (Tout - Tin)					

EXTERNAL FILES

Question	File	Associated parameter

Which file contains the thermal performance map for this collector?	.\Examples\Data Files\Type72-PerformanceMapCollector-EfficiencyData.dat	Logical Unit
Source file	.\SourceCode\Types\Type72.for	

4.11.3.4. Modifers=f(Incidence Angle)

Icon		TRNSYS Model	Type 72
Proforma	Solar Thermal Collectors\Performance Map Collector\Modifers=f(Incidence Angle)\Type72c.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Number in series	Dimensionless	-	integer	[1;+Inf]	1
	The solar collector model can simulate an array of identical solar collectors hooked up in series. This parameter is used to specify how many collectors are hooked up in a series arrangement where the outlet of the first collector is the inlet of the second collector etc.					
2	Collector area	Area	m^2	real	[0.0;+Inf]	2.0
	The total area of the solar collector array consistent with the supplied efficiency parameters (typically gross area and not net area).					
3	Fluid specific heat	Specific Heat	kJ/kg.K	real	[0.0;+Inf]	4.190
	The specific heat of the fluid flowing through the solar collector array.					
4	Efficiency mode	Dimensionless	-	integer	[1;3]	1
	The solar collector efficiency equation can be written as either a function of the collector inlet temperature, the collector outlet temperaure, or the collector average temperature. If the efficiency parameters are given as a function of the inlet temperature; specify 1. If the efficiency parameters are given as a function of the average temperature; specify 2. If the efficiency parameters are given as a function of the outlet temperature, specify 3.					
5	Logical Unit	Dimensionless	-	integer	[30;999]	12
	The FORTRAN logical unit through which the thermal performance data will be read. Make sure that each logical unit number specified in the assembly is a unique number.					
6	Number of DT/IT points	Dimensionless	-	integer	[1;10]	5
	Number of DT/IT points (NDT): The number of data points for collector efficiency vs. DT/IT that are to be considered for each value of wind speed and radiation level provided.					
7	Number of radiation curves	Dimensionless	-	integer	[1;5]	3
	Number of radiation curves (NIT): The number of collector efficiency vs. DT/IT curves for different levels of radiation.					
8	Number of wind speed curves	Dimensionless	-	integer	[1;5]	1
	Number of wind speed curves (NW): How many values of windspeed are supplied in the external data file for which NIT vs. DT/IT curves are provided.					
9	Optical mode 3	Dimensionless	-	integer	[3;3]	2
	The solar collector model can modify the efficiency parameters by 1 of 4 methods. This parameter specifies that the incidence angle modifiers are to be read from an external data file containing between 2 and 10 sets of incidence angles and their corresponding modifiers. See the abstract for more details. This parameter should not be changed.					
10	Logical unit	Dimensionless	-	real	[30;999]	10
	The logical unit through which the incidence angle modifier will be read. Make sure that each logical unit specified in the assembly is a unique number.					
11	No. of IAM's in file	Dimensionless	-	real	[2;10]	5
	How many values of incidence angle, with their associated IAM's, are contained in the file to be read by the collector subroutine? The number of incidence angles supplied must be between 2 and 10.					

INPUTS

	Name	Dimension	Unit	Type	Range	Default

1	Inlet temperature	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the fluid entering the the solar collector.					
2	Inlet flowrate	Flow Rate	kg/hr	real	[0.0;+Inf]	100.0
	The flow rate of the fluid entering the solar collector.					
3	Ambient temperature	Temperature	C	real	[-Inf;+Inf]	10.0
	The temperature of the environment in which the solar collector is located. This temperature will be used for loss calculations.					
4	Incident radiation	Flux	kJ/hr.m^2	real	[0.0;+Inf]	0.
	The total (beam + diffuse) radiation incident on the plane of the solar collector per unit area. This input is commonly hooked up the TYPE 16 "total radiation on surface 1" output.					
5	Windspeed	Velocity	m/s	real	[0.0;+Inf]	0.0
	The speed of the wind flowing across the solar collector array.					
6	Total horizontal radiation	Flux	kJ/hr.m^2	real	[0.0;+Inf]	0.0
	The total horizontal radiation (beam + diffuse) per unit area. This input is typically hooked to the fourth output of the TYPE 16 radiation processor.					
7	Horizontal diffuse radiation	Flux	kJ/hr.m^2	real	[0.0;+Inf]	0.0
	The horizontal diffuse radiation. This input is typically hooked up to the fifth output of the TYPE 16 solar radiation processor.					
8	Ground reflectance	Dimensionless	-	real	[0.0;1.0]	0.2
	The reflectance of the surface above which the solar collector is positioned. Typical values are 0.2 for ground not covered by snow and 0.7 for snow-covered ground. The reflectance is the ratio of refelcted radiation to total incident radiation and therefore must be between 0 and 1.					
9	Incidence angle	Direction (Angle)	degrees	real	[-360;+360]	45.0
	Angle of incidence of beam radiation on surface.					
10	Collector slope	Direction (Angle)	degrees	real	[-360;+360]	0.
	The slope of the collector surface. The slope is defined as the angle between the surface and the horizontal. 0 = Horizontal Slope is positive when surface is tilted in the direction of the surface azimuth. As a general rule, performance is somewhat optimized when the collector slope is set to the latitude.					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Outlet temperature	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid exiting the solar collector array.					
2	Outlet flowrate	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	The flowrate of the fluid exiting the solar collecor array. In this model: mdot,in = mdot,out					
3	Useful energy gain	Power	kJ/hr	real	[0.0;+Inf]	0
	The rate of useful energy gain by the solar collector fluid: Qu = mdot * Cp * (Tout - Tin)					

EXTERNAL FILES

Question	File	Associated parameter
Which file contains the thermal performance data ?	.\Examples\Data Files\Type72-PerformanceMapCollector-EfficiencyData.dat	Logical Unit
Which file contains the incidence angle modifier data ?	.\Examples\Data Files\Type72-PerformanceMapCollector-IAMData-OpticalMode3.dat	Logical unit
Source file	.\SourceCode\Types\Type72.for	

4.11.3.5. No Incidence Angle Modification

Icon		TRNSYS Model	Type 72
Proforma	Solar Thermal Collectors\Performance Map Collector\No Incidence Angle Modification\Type72a.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Number in series	Dimensionless	-	integer	[1;+Inf]	1
	The solar collector model can simulate an array of identical solar collectors hooked up in series. This parameter is used to specify how many collectors are hooked up in a series arrangement where the outlet of the first collector is the inlet of the second collector etc.					
2	Collector area	Area	m^2	real	[0.0;+Inf]	2.0
	The total area of the solar collector array consistent with the supplied efficiency parameters (typically gross area and not net area).					
3	Fluid specific heat	Specific Heat	kJ/kg.K	real	[0.0;+Inf]	4.190
	The specific heat of the fluid flowing through the solar collector array.					
4	Efficiency mode	Dimensionless	-	integer	[1;3]	1
	The solar collector efficiency equation can be written as either a function of the collector inlet temperature, the collector outlet temperaure, or the collector average temperature. If the efficiency parameters are given as a function of the inlet temperature; specify 1. If the efficiency parameters are given as a function of the average temperature; specify 2. If the efficiency parameters are given as a function of the outlet temperature, specify 3.					
5	Logical Unit	Dimensionless	-	integer	[30;999]	12
	The FORTRAN logical unit through which the thermal performance data will be read. Make sure that each logical unit number specified in the assembly is a unique number.					
6	Number of DT/IT points	Dimensionless	-	integer	[1;10]	5
	Number of DT/IT points (NDT): The number of data points for collector efficiency vs. DT/IT that are to be considered for each value of wind speed and radiation level provided.					
7	Number of radiation curves	Dimensionless	-	integer	[1;5]	3
	Number of radiation curves (NIT): The number of collector efficiency vs. DT/IT curves for different levels of radiation.					
8	Number of wind speed curves	Dimensionless	-	integer	[1;5]	1
	Number of wind speed curves (NW): How many values of windspeed are supplied in the external data file for which NIT vs. DT/IT curves are provided.					
9	Optical Mode 1	Dimensionless	-	integer	[1;1]	0
	This parameter specifies that no incidence angle modification should be used. Do not change this parameter.					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Inlet temperature	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the fluid entering the the solar collector.					
2	Inlet flowrate	Flow Rate	kg/hr	real	[0.0;+Inf]	100.0
	The flow rate of the fluid entering the solar collector.					
3	Ambient temperature	Temperature	C	real	[-Inf;+Inf]	10.0
	The temperature of the environment in which the solar collector is located. This temperature will be used for loss calculations.					
4	Incident radiation	Flux	kJ/hr.m^2	real	[0.0;+Inf]	0.

	The total (beam + diffuse) radiation incident on the plane of the solar collector per unit area. This input is commonly hooked up to the TYPE 16 "total radiation on surface 1" output					
5	Windspeed	Velocity	m/s	real	[0.0;+Inf]	0.0
	The speed of the wind flowing across the solar collector array.					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Outlet temperature	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid exiting the solar collector array.					
2	Outlet flowrate	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	The flowrate of the fluid exiting the solar collecor array. In this model: mdot,in = mdot,out					
3	Useful energy gain	Power	kJ/hr	real	[0.0;+Inf]	0
	The rate of useful energy gain by the solar collector fluid: Qu = mdot * Cp * (Tout - Tin)					

EXTERNAL FILES

Question	File	Associated parameter
Which file contains the thermal performance map for this collector?	.\Examples\Data Files\Type72-PerformanceMapCollector-EfficiencyData.dat	Logical Unit
Source file	.\SourceCode\Types\Type72.for	

4.11.4. Quadratic Efficiency Collector

4.11.4.1. 2nd-Order Incidence Angle Modifiers

Icon		**TRNSYS Model**	Type 1
Proforma	Solar Thermal Collectors\Quadratic Efficiency Collector\2nd-Order Incidence Angle Modifiers\Type1b.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Number in series	Dimensionless	-	integer	[1;+Inf]	1
	The solar collector model can simulate an array of identical solar collectors hooked up in series. This parameter is used to specify how many collectors are hooked up in a series arrangement (outlet of first collector = inlet of second collector etc.). To account for a series arrangement, the efficiency parameters are multiplied by a modifying function as decribed in equation 4.2.1.12 of Volume 1 of the TRNSYS documentation set.					
2	Collector area	Area	m^2	real	[0.0;+Inf]	2.0
	The total area of the solar collector array consistent with the supplied efficiency parameters (typically gross area and not net area).					
3	Fluid specific heat	Specific Heat	kJ/kg.K	real	[0.0;+Inf]	4.190
	The specific heat of the fluid flowing through the solar collector array.					
4	Efficiency mode	Dimensionless	-	integer	[1;3]	1
	The solar collector efficiency equation can be written as either a function of the collector inlet temperature, the collector outlet temperaure, or the collector average temperature. If the efficiency parameters are given as a function of the inlet temperature; specify 1. If the efficiency parameters are given as a function of the average temperature; specify 2. If the efficiency parameters are given as a function of the outlet temperature, specify 3. Refer to pages 4.2.1-4 through 4.2.1-8 of Volume 1 of the TRNSYS documentation set.					
5	Tested flow rate	Flow/area	kg/hr.m^2	real	[0.0;+Inf]	50.0
	The flow rate per unit area at which the collector was tested in order to determine the collector efficiency parameters. If no test was performed to get the efficiency parameters, set the tested flow rate equal to the flow rate under current operating conditions.					
6	Intercept efficiency	Dimensionless	-	real	[0.0;1.0]	0.7
	ASHRAE collector tests are often presented as curves of efficiciency vs. (Tin-Tamb)/It with intercept FrTan, slope FrUl and curvature FrUl/T. This parameter is the y-intercept of the collector efficiency vs. the temperaure difference/radiation ratio curve (FrTan). In equation form, this parameter is a0 in the collector efficiency equation: Eff. = a0 - a1*(Tin-Tamb)/Radiation - a2 * ((Tin-Tamb)^2)/Radiation Refer to page 4.2.1-4 of Volume 1 of the TRNSYS documentation set for more details.					
7	Efficiency slope	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[-Inf;+Inf]	15
	ASHRAE collector tests are ofetn presented as plots of efficiency vs. (Tin-Tamb)/It with intercept of FrTan, slope of FrUl and curvature of FrUl/T. This parameter is the slope of the slope of the efficiency vs. (Tin-Tamb)/It curve. In equation form, this parameter is a1 in the equation: Eff. = a0 - a1*(Tin-Tamb)/It - a2*((Tin-Tamb)^2)/It Refer to page 4.2.1-4 of Volume 1 of the TRNSYS documentation set for more details.					
8	Efficiency curvature	Temp. Dependent Loss Coeff.	kJ/hr.m^2.K^2	real	[-Inf;+Inf]	0.0
	ASHRAE collector tests are often presented as plots of efficiency vs. (Tin-Tamb)/It with intercept FrTan, slope FrUl, and curvature FrUl/T. This parameter is the curvature of the efficiency curve. In equation form this parameter is a2 of the collector efficiency equation: Eff. = a0 - a1 * (Tin-Tamb)/It - a2 * ((Tin-Tamb)^2)/It If the plot of efficiency is a straight line, set this parameter to 0.0. Refer to page 4.2.1-4 of Volume 1 of the					

	TRNSYS documentation set for more details.					
9	Optical mode 2	Dimensionless	-	integer	[2;2]	1
	The solar collector model can modify the efficiency parameters by 1 of 4 methods. This parameter specifies that the second-order ASHRAE incidence angle modifiers should be used. This parameter should not be changed.					
10	1st-order IAM	Dimensionless	-	real	[0.0;1.0]	0.1
	Collector tests are usually performed on clear days at normal incidence so that the transmittance-absorptance product is nearly the normal incidence value for beam radiation. The intercept efficiency is corrected for non-normal solar incidence by the use of a modifying factor of the form: Modifier = 1 - b0 * S - b1 * S^2 This parameter is b0 in the above equation.					
11	2nd-order IAM	Dimensionless	-	real	[-1.0;+1.0]	0.0
	Collector tests are generally performed on clear days at normal incidence so that the transmittance-absorptance product is nearly the normal incidence value for beam radiation. The intercept efficiency is corrected for non-normal solar ncidence by a modifying factor of the form: Modifier = 1 - bo * S - b1 * S^2 where S = 1/cos(incidence angle) -1 This parameter is b1 in the above equation.					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Inlet temperature	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the fluid entering the the solar collector.					
2	Inlet flowrate	Flow Rate	kg/hr	real	[0.0;+Inf]	100.0
	The flow rate of the fluid entering the solar collector.					
3	Ambient temperature	Temperature	C	real	[-Inf;+Inf]	10.0
	The temperature of the environment in which the solar collector is located. This temperature will be used for loss calculations.					
4	Incident radiation	Flux	kJ/hr.m^2	real	[0.0;+Inf]	0.
	The total (beam + diffuse) radiation incident on the plane of the solar collector per unit area. This input is commonly hooked up to the TYPE 16 "total radiation on surface 1" output.					
5	Total horizontal radiation	Flux	kJ/hr.m^2	real	[0.0;+Inf]	0.0
	The total horizontal radiation (beam + diffuse) per unit area. This input is typically hooked to the fourth output of the TYPE 16 radiation processor.					
6	Horizontal diffuse radiation	Flux	kJ/hr.m^2	real	[0.0;+Inf]	0.0
	The horizontal diffuse radiation. This input is typically hooked up to the fifth output of the TYPE 16 solar radiation processor.					
7	Ground reflectance	Dimensionless	-	real	[0.0;1.0]	0.2
	The reflectance of the surface above which the solar collector is positioned. Typical values are 0.2 for ground not covered by snow and 0.7 for snow-covered ground. The reflectance is the ratio of refelcted radiation to total incident radiation and therefore must be between 0 and 1.					
8	Incidence angle	Direction (Angle)	degrees	real	[-360;+360]	45.0
	Angle of incidence of beam radiation on surface.					
9	Collector slope	Direction (Angle)	degrees	real	[-360;+360]	0.
	The slope of the collector surface. The slope is defined as the angle between the surface and the horizontal. 0 = Horizontal Slope is positive when surface is tilted in the direction of the surface azimuth. As a general rule, performance is somewhat optimized when the collector slope is set to the latitude.					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Outlet temperature	Temperature	C	real	[-Inf;+Inf]	0

	The temperature of the fluid exiting the solar collector array.					
2	Outlet flowrate	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	The flowrate of the fluid exiting the solar collecor array. In this model: mdot,in = mdot,out					
3	Useful energy gain	Power	kJ/hr	real	[0.0;+Inf]	0
	The rate of useful energy gain by the solar collector fluid: Qu = mdot * Cp * (Tout - Tin)					

4.11.4.2. Biaxial Incidence Angle Modifiers

Icon		TRNSYS Model	Type 1
Proforma	Solar Thermal Collectors\Quadratic Efficiency Collector\Biaxial Incidence Angle Modifiers\Type1e.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Number in series	Dimensionless	-	integer	[1;+Inf]	1
	The solar collector model can simulate an array of identical solar collectors hooked up in series. This parameter is used to specify how many collectors are hooked up in a series arrangement (outlet of first collector = inlet of second collector etc.). To account for a series arrangement, the efficiency parameters are multiplied by a modifying function as decribed in equation 4.2.1.12 of Volume 1 of the TRNSYS documentation set.					
2	Collector area	Area	m^2	real	[0.0;+Inf]	2.0
	The total area of the solar collector array consistent with the supplied efficiency parameters (typically gross area and not net area).					
3	Fluid specific heat	Specific Heat	kJ/kg.K	real	[0.0;+Inf]	4.190
	The specific heat of the fluid flowing through the solar collector array.					
4	Efficiency mode	Dimensionless	-	integer	[1;3]	1
	The solar collector efficiency equation can be written as either a function of the collector inlet temperature, the collector outlet temperaure, or the collector average temperature. If the efficiency parameters are given as a function of the inlet temperature; specify 1. If the efficiency parameters are given as a function of the average temperature; specify 2. If the efficiency parameters are given as a function of the outlet temperature, specify 3. Refer to pages 4.2.1-4 through 4.2.1-8 of Volume 1 of the TRNSYS documentation set.					
5	Tested flow rate	Flow/area	kg/hr.m^2	real	[0.0;+Inf]	50.0
	The flow rate per unit area at which the collector was tested in order to determine the collector efficiency parameters. If no test was performed to get the efficiency parameters, set the tested flow rate equal to the flow rate under current operating conditions.					
6	Intercept efficiency	Dimensionless	-	real	[0.0;1.0]	0.7
	ASHRAE collector tests are often presented as curves of efficiciency vs. (Tin-Tamb)/It with intercept FrTan, slope FrUl and curvature FrUl/T. This parameter is the y-intercept of the collector efficiency vs. the temperaure difference/radiation ratio curve (FrTan). In equation form, this parameter is a0 in the collector efficiency equation: Eff. = a0 - a1*(Tin-Tamb)/Radiation - a2 * ((Tin-Tamb)^2)/Radiation Refer to page 4.2.1-4 of Volume 1 of the TRNSYS documentation set for more details.					
7	Efficiency slope	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[-Inf;+Inf]	15
	ASHRAE collector tests are ofetn presented as plots of efficiency vs. (Tin-Tamb)/It with intercept of FrTan, slope of FrUl and curvature of FrUl/T. This parameter is the slope of the slope of the efficiency vs. (Tin-Tamb)/It curve. In equation form, this parameter is a1 in the equation: Eff. = a0 - a1*(Tin-Tamb)/It - a2*((Tin-Tamb)^2)/It Refer to page 4.2.1-4 of Volume 1 of the TRNSYS documentation set for more details.					
8	Efficiency curvature	Temp. Dependent Loss Coeff.	kJ/hr.m^2.K^2	real	[-Inf;+Inf]	0.0
	ASHRAE collector tests are often presented as plots of efficiency vs. (Tin-Tamb)/It with intercept FrTan, slope FrUl, and curvature FrUl/T. This parameter is the curvature of the efficiency curve. In equation form this parameter is a2 of the collector efficiency equation: Eff. = a0 - a1 * (Tin-Tamb)/It - a2 * ((Tin-Tamb)^2)/It If the plot of efficiency is a straight line, set this parameter to 0.0. Refer to page 4.2.1-4 of Volume 1 of the TRNSYS documentation set for more details.					
9	Optical mode 5	Dimensionless	-	integer	[5;5]	4
	The solar collector model can modify the efficiency parameters by 1 of 4 methods. This parameter specifies that the biaxial incidence angle modifier data is to be read from an external data file. See the abstract for more details.					

	This parameter should not be changed.					
10	Logical unit	Dimensionless	-	integer	[10;30]	11
	The FORTRAN logical unit through which the biaxial incidence angle modifer data will be read. Make sure that each logical unit specified in the assembly is a unique number.					
11	Number of values	Dimensionless	-	integer	[2;10]	5
	How many values of incidence angle, with their associated biaxial modifier data, are contained in the external data file? The number of angles must be between 2 and 10.					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Inlet temperature	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the fluid entering the the solar collector.					
2	Inlet flowrate	Flow Rate	kg/hr	real	[0.0;+Inf]	100.0
	The flow rate of the fluid entering the solar collector.					
3	Ambient temperature	Temperature	C	real	[-Inf;+Inf]	10.0
	The temperature of the environment in which the solar collector is located. This temperature will be used for loss calculations.					
4	Incident radiation	Flux	kJ/hr.m^2	real	[0.0;+Inf]	0.
	The total (beam + diffuse) radiation incident on the plane of the solar collector per unit area. This input is commonly hooked up to the TYPE 16 "total radiation on surface 1" output.					
5	Total horizontal radiation	Flux	kJ/hr.m^2	real	[0.0;+Inf]	0.0
	The total horizontal radiation (beam + diffuse) per unit area. This input is typically hooked to the fourth output of the TYPE 16 radiation processor.					
6	Horizontal diffuse radiation	Flux	kJ/hr.m^2	real	[0.0;+Inf]	0.0
	The horizontal diffuse radiation. This input is typically hooked up to the fifth output of the TYPE 16 solar radiation processor.					
7	Ground reflectance	Dimensionless	-	real	[0.0;1.0]	0.2
	The reflectance of the surface above which the solar collector is positioned. Typical values are 0.2 for ground not covered by snow and 0.7 for snow-covered ground. The reflectance is the ratio of refelcted radiation to total incident radiation and therefore must be between 0 and 1.					
8	Incidence angle	Direction (Angle)	degrees	real	[-360;+360]	45.0
	Angle of incidence of beam radiation on surface.					
9	Collector slope	Direction (Angle)	degrees	real	[-360;+360]	0.
	The slope of the collector surface. The slope is defined as the angle between the surface of the collector and the horizontal. 0 = Horizontal; 90 = Vertical facing azimuth; -90 = vertical facing away from azimuth (see radiation processor for discussion of surface azimuth). Slope is positive when surface is tilted in the direction of the surface azimuth. As a general rule, performance is somewhat optimized when the collector slope is set to the latitude.					
10	Collector azimuth	Direction (Angle)	degrees	real	[-180;180]	0

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Outlet temperature	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid exiting the solar collector array.					
2	Outlet flowrate	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	The flowrate of the fluid exiting the solar collecor array. In this model: mdot,in = mdot,out					
3	Useful energy gain	Power	kJ/hr	real	[0.0;+Inf]	0
	The rate of useful energy gain by the solar collector fluid: Qu = mdot * Cp * (Tout - Tin)					

EXTERNAL FILES

Question	File	Associated parameter
What is the name of the file containing the biaxial incidence angle modifier data?	.\Examples\Data Files\Type1-FlatPlateCollector-IAMData-OpticalMode5.dat	Logical unit
Source file	.\SourceCode\Types\Type1.for	

4.11.4.3. Cover and Absorber Properties

Icon		TRNSYS Model	Type 1
Proforma	Solar Thermal Collectors\Quadratic Efficiency Collector\Cover and Absorber Properties\Type1d.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Number in series	Dimensionless	-	integer	[1;+Inf]	1
	The solar collector model can simulate an array of identical solar collectors hooked up in series. This parameter is used to specify how many collectors are hooked up in a series arrangement (outlet of first collector = inlet of second collector etc.). To account for a series arrangement, the efficiency parameters are multiplied by a modifying function as decribed in equation 4.2.1.12 of Volume 1 of the TRNSYS documentation set.					
2	Collector area	Area	m^2	real	[0.0;+Inf]	2.0
	The total area of the solar collector array consistent with the supplied efficiency parameters (typically gross area and not net area).					
3	Fluid specific heat	Specific Heat	kJ/kg.K	real	[0.0;+Inf]	4.190
	The specific heat of the fluid flowing through the solar collector array.					
4	Efficiency mode	Dimensionless	-	integer	[1;3]	1
	The solar collector efficiency equation can be written as either a function of the collector inlet temperature, the collector outlet temperaure, or the collector average temperature. If the efficiency parameters are given as a function of the inlet temperature; specify 1. If the efficiency parameters are given as a function of the average temperature; specify 2. If the efficiency parameters are given as a function of the outlet temperature, specify 3. Refer to pages 4.2.1-4 through 4.2.1-8 of Volume 1 of the TRNSYS documentation set.					
5	Tested flow rate	Flow/area	kg/hr.m^2	real	[0.0;+Inf]	50.0
	The flow rate per unit area at which the collector was tested in order to determine the collector efficiency parameters. If no test was performed to get the efficiency parameters, set the tested flow rate equal to the flow rate under current operating conditions.					
6	Intercept efficiency	Dimensionless	-	real	[0.0;1.0]	0.7
	ASHRAE collector tests are often presented as curves of efficiciency vs. (Tin-Tamb)/It with intercept FrTan, slope FrUl and curvature FrUl/T. This parameter is the y-intercept of the collector efficiency vs. the temperaure difference/radiation ratio curve (FrTan). In equation form, this parameter is a0 in the collector efficiency equation: Eff. = a0 - a1*(Tin-Tamb)/Radiation - a2 * ((Tin-Tamb)^2)/Radiation Refer to page 4.2.1-4 of Volume 1 of the TRNSYS documentation set for more details.					
7	Efficiency slope	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[-Inf;+Inf]	15
	ASHRAE collector tests are ofetn presented as plots of efficiency vs. (Tin-Tamb)/It with intercept of FrTan, slope of FrUl and curvature of FrUl/T. This parameter is the slope of the slope of the efficiency vs. (Tin-Tamb)/It curve. In equation form, this parameter is a1 in the equation: Eff. = a0 - a1*(Tin-Tamb)/It - a2*((Tin-Tamb)^2)/It Refer to page 4.2.1-4 of Volume 1 of the TRNSYS documentation set for more details.					
8	Efficiency curvature	Temp. Dependent Loss Coeff.	kJ/hr.m^2.K^2	real	[-Inf;+Inf]	0.0
	ASHRAE collector tests are often presented as plots of efficiency vs. (Tin-Tamb)/It with intercept FrTan, slope FrUl, and curvature FrUl/T. This parameter is the curvature of the efficiency curve. In equation form this parameter is a2 of the collector efficiency equation: Eff. = a0 - a1 * (Tin-Tamb)/It - a2 * ((Tin-Tamb)^2)/It If the plot of efficiency is a straight line, set this parameter to 0.0. Refer to page 4.2.1-4 of Volume 1 of the TRNSYS documentation set for more details.					
9	Optical mode 4	Dimensionless	-	integer	[4;4]	3
	The solar collector model can modify the efficiency parameters by 1 of 4 methods. This parameter specifies that the incidence angle modifiers are to be calculated from the collector properties using the TRNSYS utility					

	subroutine TALF (section 3.4.3 of Volume 1 of the TRNSYS documentation set). See the abstract for more details. This parameter should not be changed.					
10	Plate absorptance	Dimensionless	-	real	[0.0;1.0]	0.7
	The absorptance of the collector absorber plate. Since this quantity is a ratio of absorbed radiation to total radiation; the value must be between 0 and 1. Typical values of plate absorptance can be found from: Solar Enginnering of Thermal Processes, Duffie and Beckman, Wiley-Interscience, New York, 1980.					
11	No. of identical covers	Dimensionless	-	real	[1;+Inf]	1
	The number of identical glass covers on the solar collector. The number of covers will be used to calculate the transmittance-absorptance product using Fresnel's equation.					
12	Index of refraction	Dimensionless	-	real	[0.0;+Inf]	1.526
	Index of refraction of 1 glazing covering the solar collector.					
13	Extinction	Dimensionless	-	real	[0.0;1.0]	0.0026
	The product of the extinction coefficient and cover thickness for 1 of the glazings covering the solar collector.					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Inlet temperature	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the fluid entering the the solar collector.					
2	Inlet flowrate	Flow Rate	kg/hr	real	[0.0;+Inf]	100.0
	The flow rate of the fluid entering the solar collector.					
3	Ambient temperature	Temperature	C	real	[-Inf;+Inf]	10.0
	The temperature of the environment in which the solar collector is located. This temperature will be used for loss calculations.					
4	Incident radiation	Flux	kJ/hr.m^2	real	[0.0;+Inf]	0.
	The total (beam + diffuse) radiation incident on the plane of the solar collector per unit area. This input is commonly hooked up to the TYPE 16 "total radiation on surface 1" output.					
5	Total horizontal radiation	Flux	kJ/hr.m^2	real	[0.0;+Inf]	0.0
	The total horizontal radiation (beam + diffuse) per unit area. This input is commonly hooked to the "total radiation on horizontal" output of a Type16 radiation processor.					
6	Horizontal diffuse radiation	Flux	kJ/hr.m^2	real	[0.0;+Inf]	0.0
	The horizontal diffuse radiation. This input is typically hooked up to the "diffuse radiation on the horizontal" output of a TYPE 16 solar radiation processor.					
7	Ground reflectance	Dimensionless	-	real	[0.0;1.0]	0.2
	The reflectance of the surface above which the solar collector is positioned. Typical values are 0.2 for ground not covered by snow and 0.7 for snow-covered ground. The reflectance is the ratio of refelcted radiation to total incident radiation and therefore must be between 0 and 1.					
8	Incidence angle	Direction (Angle)	degrees	real	[-360;+360]	45.0
	Angle of incidence of beam radiation on surface.					
9	Collector slope	Direction (Angle)	degrees	real	[-360;+360]	0.
	The slope of the collector surface. The slope is defined as the angle between the surface of the collector and the horizontal. 0 = Horizontal; 90 = Vertical facing azimuth; -90 = vertical facing away from azimuth (see radiation processor for discussion of surface azimuth). Slope is positive when surface is tilted in the direction of the surface azimuth. As a general rule, performance is somewhat optimized when the collector slope is set to the latitude.					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Outlet temperature	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid exiting the solar collector array.					

2	Outlet flowrate	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	The flowrate of the fluid exiting the solar collecor array. In this model: mdot,in = mdot,out					
3	Useful energy gain	Power	kJ/hr	real	[0.0;+Inf]	0
	The rate of useful energy gain by the solar collector fluid: Qu = mdot * Cp * (Tout - Tin)					

4.11.4.4. Modifers=f(Incidence Angle)

Icon		TRNSYS Model	Type 1
Proforma	Solar Thermal Collectors\Quadratic Efficiency Collector\Modifers=f(Incidence Angle)\Type1c.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Number in series	Dimensionless	-	integer	[1;+Inf]	1
	The solar collector model can simulate an array of identical solar collectors hooked up in series. This parameter is used to specify how many collectors are hooked up in a series arrangement (outlet of first collector = inlet of second collector etc.). To account for a series arrangement, the efficiency parameters are multiplied by a modifying function as decribed in equation 4.2.1.12 of Volume 1 of the TRNSYS documentation set.					
2	Collector area	Area	m^2	real	[0.0;+Inf]	2.0
	The total area of the solar collector array consistent with the supplied efficiency parameters (typically gross area and not net area).					
3	Fluid specific heat	Specific Heat	kJ/kg.K	real	[0.0;+Inf]	4.190
	The specific heat of the fluid flowing through the solar collector array.					
4	Efficiency mode	Dimensionless	-	integer	[1;3]	1
	The solar collector efficiency equation can be written as either a function of the collector inlet temperature, the collector outlet temperaure, or the collector average temperature. If the efficiency parameters are given as a function of the inlet temperature; specify 1. If the efficiency parameters are given as a function of the average temperature; specify 2. If the efficiency parameters are given as a function of the outlet temperature, specify 3. Refer to pages 4.2.1-4 through 4.2.1-8 of Volume 1 of the TRNSYS documentation set.					
5	Tested flow rate	Flow/area	kg/hr.m^2	real	[0.0;+Inf]	50.0
	The flow rate per unit area at which the collector was tested in order to determine the collector efficiency parameters. If no test was performed to get the efficiency parameters, set the tested flow rate equal to the flow rate under current operating conditions.					
6	Intercept efficiency	Dimensionless	-	real	[0.0;1.0]	0.7
	ASHRAE collector tests are often presented as curves of efficiciency vs. (Tin-Tamb)/It with intercept FrTan, slope FrUl and curvature FrUl/T. This parameter is the y-intercept of the collector efficiency vs. the temperaure difference/radiation ratio curve (FrTan). In equation form, this parameter is a0 in the collector efficiency equation: Eff. = a0 - a1*(Tin-Tamb)/Radiation - a2 * ((Tin-Tamb)^2)/Radiation Refer to page 4.2.1-4 of Volume 1 of the TRNSYS documentation set for more details.					
7	Efficiency slope	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[-Inf;+Inf]	15
	ASHRAE collector tests are ofetn presented as plots of efficiency vs. (Tin-Tamb)/It with intercept of FrTan, slope of FrUl and curvature of FrUl/T. This parameter is the slope of the slope of the efficiency vs. (Tin-Tamb)/It curve. In equation form, this parameter is a1 in the equation: Eff. = a0 - a1*(Tin-Tamb)/It - a2*((Tin-Tamb)^2)/It Refer to page 4.2.1-4 of Volume 1 of the TRNSYS documentation set for more details.					
8	Efficiency curvature	Temp. Dependent Loss Coeff.	kJ/hr.m^2.K^2	real	[-Inf;+Inf]	0.0
	ASHRAE collector tests are often presented as plots of efficiency vs. (Tin-Tamb)/It with intercept FrTan, slope FrUl, and curvature FrUl/T. This parameter is the curvature of the efficiency curve. In equation form this parameter is a2 of the collector efficiency equation: Eff. = a0 - a1 * (Tin-Tamb)/It - a2 * ((Tin-Tamb)^2)/It If the plot of efficiency is a straight line, set this parameter to 0.0. Refer to page 4.2.1-4 of Volume 1 of the TRNSYS documentation set for more details.					
9	Optical mode 3	Dimensionless	-	integer	[3;3]	2
	The solar collector model can modify the efficiency parameters by 1 of 4 methods. This parameter specifies that the incidence angle modifiers are to be read from an external data file containing between 2 and 10 sets					

	of incidence angles and their corresponding modifiers. See the abstract for more details. This parameter should not be changed.					
10	Logical unit	Dimensionless	-	real	[30;999]	10
	The logical unit through which the incidence angle modifier data will be read. Make sure that each logical unit specified in the assembly is unique.					
11	No. of IAM's in file	Dimensionless	-	real	[2;10]	5
	How many values of incidence angle, with their associated IAM's, are contained in the file to be read by the collector subroutine? The number of incidence angles supplied must be between 2 and 10.					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Inlet temperature	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the fluid entering the the solar collector.					
2	Inlet flowrate	Flow Rate	kg/hr	real	[0.0;+Inf]	100.0
	The flow rate of the fluid entering the solar collector.					
3	Ambient temperature	Temperature	C	real	[-Inf;+Inf]	10.0
	The temperature of the environment in which the solar collector is located. This temperature will be used for loss calculations.					
4	Incident radiation	Flux	kJ/hr.m^2	real	[0.0;+Inf]	0.
	The total (beam + diffuse) radiation incident on the plane of the solar collector per unit area. This input is commonly hooked up to the TYPE 16 "total radiation on surface 1" output.					
5	Total horizontal radiation	Flux	kJ/hr.m^2	real	[0.0;+Inf]	0.0
	The total horizontal radiation (beam + diffuse) per unit area. This input is typically hooked to the fourth output of the TYPE 16 radiation processor.					
6	Horizontal diffuse radiation	Flux	kJ/hr.m^2	real	[0.0;+Inf]	0.0
	The horizontal diffuse radiation. This input is typically hooked up to the fifth output of the TYPE 16 solar radiation processor.					
7	Ground reflectance	Dimensionless	-	real	[0.0;1.0]	0.2
	The reflectance of the surface above which the solar collector is positioned. Typical values are 0.2 for ground not covered by snow and 0.7 for snow-covered ground. The reflectance is the ratio of refelcted radiation to total incident radiation and therefore must be between 0 and 1.					
8	Incidence angle	Direction (Angle)	degrees	real	[-360;+360]	45.0
	Angle of incidence of beam radiation on surface.					
9	Collector slope	Direction (Angle)	degrees	real	[-360;+360]	0.
	The slope of the collector surface. The slope is defined as the angle between the surface and the horizontal. 0 = Horizontal Slope is positive when surface is tilted in the direction of the surface azimuth. As a general rule, performance is somewhat optimized when the collector slope is set to the latitude.					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Outlet temperature	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid exiting the solar collector array.					
2	Outlet flowrate	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	The flowrate of the fluid exiting the solar collecor array. In this model: mdot,in = mdot,out					
3	Useful energy gain	Power	kJ/hr	real	[0.0;+Inf]	0
	The rate of useful energy gain by the solar collector fluid: Qu = mdot * Cp * (Tout - Tin)					

EXTERNAL FILES

Question	File	Associated parameter
Which file contains the incidence angle modifier data?	.\Examples\Data Files\Type1-FlatPlateCollector-IAMData-OpticalMode3.dat	Logical unit
Source file	.\SourceCode\Types\Type1.for	

4.11.4.5. No Incidence Angle Modification

Icon		TRNSYS Model	Type 1
Proforma	Solar Thermal Collectors\Quadratic Efficiency Collector\No Incidence Angle Modification\Type1a.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Number in series	Dimensionless	-	integer	[1;+Inf]	1
	The solar collector model can simulate an array of identical solar collectors hooked up in series. This parameter is used to specify how many collectors are hooked up in a series arrangement (outlet of first collector = inlet of second collector etc.). To account for a series arrangement, the efficiency parameters are multiplied by a modifying function as decribed in equation 4.2.1.12 of Volume 1 of the TRNSYS documentation set.					
2	Collector area	Area	m^2	real	[0.0;+Inf]	2.0
	The total area of the solar collector array consistent with the supplied efficiency parameters (typically gross area and not net area).					
3	Fluid specific heat	Specific Heat	kJ/kg.K	real	[0.0;+Inf]	4.190
	The specific heat of the fluid flowing through the solar collector array.					
4	Efficiency mode	Dimensionless	-	integer	[1;3]	1
	The solar collector efficiency equation can be written as either a function of the collector inlet temperature, the collector outlet temperaure, or the collector average temperature. If the efficiency parameters are given as a function of the inlet temperature; specify 1. If the efficiency parameters are given as a function of the average temperature; specify 2. If the efficiency parameters are given as a function of the outlet temperature, specify 3. Refer to pages 4.2.1-4 through 4.2.1-8 of Volume 1 of the TRNSYS documentation set.					
5	Tested flow rate	Flow/area	kg/hr.m^2	real	[0.0;+Inf]	50.0
	The flow rate per unit area at which the collector was tested in order to determine the collector efficiency parameters. If no test was performed to get the efficiency parameters, set the tested flow rate equal to the flow rate under current operating conditions.					
6	Intercept efficiency	Dimensionless	-	real	[0.0;1.0]	0.7
	ASHRAE collector tests are often presented as curves of efficiciency vs. (Tin-Tamb)/It with intercept FrTan, slope FrUl and curvature FrUl/T. This parameter is the y-intercept of the collector efficiency vs. the temperaure difference/radiation ratio curve (FrTan). In equation form, this parameter is a0 in the collector efficiency equation: Eff. = a0 - a1*(Tin-Tamb)/Radiation - a2 * ((Tin-Tamb)^2)/Radiation Refer to page 4.2.1-4 of Volume 1 of the TRNSYS documentation set for more details.					
7	Efficiency slope	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[-Inf;+Inf]	15
	ASHRAE collector tests are ofetn presented as plots of efficiency vs. (Tin-Tamb)/It with intercept of FrTan, slope of FrUl and curvature of FrUl/T. This parameter is the slope of the slope of the efficiency vs. (Tin-Tamb)/It curve. In equation form, this parameter is a1 in the equation: Eff. = a0 - a1*(Tin-Tamb)/It - a2*((Tin-Tamb)^2)/It Refer to page 4.2.1-4 of Volume 1 of the TRNSYS documentation set for more details.					
8	Efficiency curvature	Temp. Dependent Loss Coeff.	kJ/hr.m^2.K^2	real	[-Inf;+Inf]	0.0
	ASHRAE collector tests are often presented as plots of efficiency vs. (Tin-Tamb)/It with intercept FrTan, slope FrUl, and curvature FrUl/T. This parameter is the curvature of the efficiency curve. In equation form this parameter is a2 of the collector efficiency equation: Eff. = a0 - a1 * (Tin-Tamb)/It - a2 * ((Tin-Tamb)^2)/It If the plot of efficiency is a straight line, set this parameter to 0.0. Refer to page 4.2.1-4 of Volume 1 of the TRNSYS documentation set for more details.					
9	Optical Mode 1	Dimensionless	-	integer	[1;1]	0
	This parameter specifies that no incidence angle modification should be used. Do not change this parameter.					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Inlet temperature	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the fluid entering the the solar collector.					
2	Inlet flowrate	Flow Rate	kg/hr	real	[0.0;+Inf]	100.0
	The flow rate of the fluid entering the solar collector.					
3	Ambient temperature	Temperature	C	real	[-Inf;+Inf]	10.0
	The temperature of the environment in which the solar collector is located. This temperature will be used for loss calculations.					
4	Incident radiation	Flux	kJ/hr.m^2	real	[0.0;+Inf]	0.
	The total (beam + diffuse) radiation incident on the plane of the solar collector per unit area. This input is commonly hooked up to the TYPE 16 "total radiation on surface 1" output.					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Outlet temperature	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid exiting the solar collector array.					
2	Outlet flowrate	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	The flowrate of the fluid exiting the solar collecor array. In this model: mdot,in = mdot,out					
3	Useful energy gain	Power	kJ/hr	real	[0.0;+Inf]	0
	The rate of useful energy gain by the solar collector fluid: Qu = mdot * Cp * (Tout - Tin)					

4.11.5. Theoretical Flat-Plate Collector

4.11.5.1. Theoretical Flat-Plate Collector

Icon		TRNSYS Model	Type 73
Proforma	Solar Thermal Collectors\Theoretical Flat-Plate Collector\Type73.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Number in series	Dimensionless	-	integer	[1;+Inf]	1
	The solar collector model can simulate an array of identical solar collectors hooked up in series. This parameter is used to specify how many collectors are hooked up in a series arrangement where the output of the first collector is the inlet to the second collector.					
2	Collector area	Area	m^2	real	[0.0;+Inf]	2.0
	The total area of the solar collector array consistent with the supplied efficiency parameters (typically gross area and not net area).					
3	Fluid specific heat	Specific Heat	kJ/kg.K	real	[0.0;+Inf]	4.190
	The specific heat of the fluid flowing through the solar collector array.					
4	Collector fin efficiency factor	Dimensionless	-	real	[0.0;+1.0]	0.7
	The fin efficiency is a measure of the heat transfer from the fin to the maximum possible heat transfer from the fin. The maximum heat transfer from the fin would occur if the fin was uniformly at the base temperature. Refer to: ASHRAE Standard 93-77 for details on the fin efficiency					
5	Bottom, edge loss coefficient	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[0.0;+Inf]	3.0
	The loss coefficient for the bottom and edges of the solar collector per unit aperature area.					
6	Absorber plate emittance	Dimensionless	-	real	[0.0;1.0]	0.7
	The emittance of the absorber plate of the solar collector. The emittance, or emissivity, is defined as the ratio of the radiation emitted by the surface in question to the radiation emitted by a blackbody (the perfect emitter) at the same temperature. This property is used to calculate radiation losses from the collector.					
7	Absorptance of absorber plate	Dimensionless	-	real	[0.0;1.0]	0.8
	The absorptance of the absorber plate of the solar collector. The absorptance is a ratio of the amount of radiation absorbed by a surface to the total radiation incident on the surface.					
8	Number of covers	Dimensionless	-	integer	[1;+Inf]	1
	The number of glass covers covering the solar collector absorber plate.					
9	Index of refraction of cover	Dimensionless	-	real	[0.0;+Inf]	1.526
	The index of refraction of the material covering the solar collector absorber plate.					
10	Extinction coeff. thickness product	Dimensionless	-	real	[0.0;1.0]	0.0026
	The product of the extinction coefficient and the thickness of one of the glazings covering the solar collector absorber plate.					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Inlet temperature	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the fluid entering the the solar collector.					
2	Inlet flowrate	Flow Rate	kg/hr	real	[0.0;+Inf]	100.0
	The flow rate of the fluid entering the solar collector.					

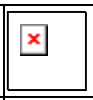
3	Ambient temperature	Temperature	C	real	[-Inf;+Inf]	10.0
	The temperature of the environment in which the solar collector is located. This temperature will be used for loss calculations.					
4	Incident radiation	Flux	kJ/hr.m^2	real	[0.0;+Inf]	0.
	The total (beam + diffuse) radiation incident on the plane of the solar collector per unit area. This input is commonly hooked up to the TYPE 16 "total radiation on surface 1" output.					
5	Windspeed	Velocity	m/s	real	[0.0;+Inf]	0.0
	The speed of the wind flowing across the solar collector array.					
6	Horizontal radiation	Flux	kJ/hr.m^2	real	[0.0;+Inf]	0.0
	The total radiation incident upon a horizontal surface. Includes beam radiation, sky diffuse radiation, and ground reflected diffuse radiation.					
7	Horizontal diffuse	Flux	kJ/hr.m^2	real	[0.0;+Inf]	0.0
	The diffuse radiation on a horizontal surface.					
8	Ground reflectance	Dimensionless	-	real	[0.0;1.0]	0.2
	The reflectance of the surface above which the solar collector is located. The ground reflectance is defined as the ratio of reflected radiation to total incident radiation. Typical values are 0.2 for ground not covered by snow and 0.7 for snow-covered ground.					
9	Incidence angle	Direction (Angle)	degrees	real	[-360;+360]	20.0
	The angle of incidence of beam radiation on the collector surface.					
10	Collector slope	Direction (Angle)	degrees	real	[-360;+360]	0
	The angle between the plane of the collector surface and the horizontal. The slope is positive when facing the direction of the surface azimuth. 0 = Horizontal; 90 = Vertical facing Azimuth As a general rule, the performance is somewhat optimized when the slope is set equal to the latitude.					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Outlet temperature	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid exiting the solar collector array.					
2	Outlet flowrate	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	The flowrate of the fluid exiting the solar collecor array. In this model: mdot,in = mdot,out					
3	Useful energy gain	Power	kJ/hr	real	[0.0;+Inf]	0
	The rate of useful energy gain by the solar collector fluid: Qu = mdot * Cp * (Tout - Tin)					

4.11.6. Thermosyphon Collector with Integral Storage

4.11.6.1. External File for Head vs. Flowrate

Icon		**TRNSYS Model**	Type 45
Proforma	Solar Thermal Collectors\Thermosyphon Collector with Integral Storage\External File for Head vs. Flowrate\Type45.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Collector area	Area	m^2	real	[0.0;+Inf]	2.0
	The area of the solar collector array consistent with the supplied efficiency parameters (typically gross area and not net area).					
2	Intercept efficiency	Dimensionless	-	real	[0.0;1.0]	0.7
	ASHRAE collector tests are often presented as curves of efficiciency vs. (Tin-Tamb)/It with intercept FrTan and slope FrUl. This parameter is the y-intercept of the collector efficiency vs. the temperaure difference/radiation ratio curve (FrTan). In equation form, this parameter is a0 in the collector efficiency equation: Eff. = a0 - a1*(Tin-Tamb)/Radiation Refer to page 4.2.1-4 of Volume 1 of the TRNSYS documentation set for more details.					
3	Efficiency slope	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[-Inf;+Inf]	15
	ASHRAE collector tests are ofetn presented as plots of efficiency vs. (Tin-Tamb)/It with intercept of FrTan and slope of FrUl. This parameter is the slope of the slope of the efficiency vs.(Tin-Tamb)/It curve. In equation form, this parameter is a1 in the equation: Eff. = a0 - a1*(Tin-Tamb)/It Refer to page 4.2.1-4 of Volume 1 of the TRNSYS documentation set for more details.					
4	Tested flow rate	Flow/area	kg/hr.m^2	real	[0.0;+Inf]	50.0
	The flow rate per unit area at which the collector was tested in order to determine the collector efficiency parameters. If no test was performed to get the efficiency parameters, set the tested flow rate equal to the flow rate under current operating conditions.					
5	Incidence angle modifier constant	Dimensionless	-	real	[0.0;1.0]	0.1
	Collector tests are usually performed on clear days at normal incidence so that the transmittance-absorptance product is nearly the normal incidence value for beam radiation. The intercept efficiency is corrected for non-normal solar incidence by the use of a modifying factor of the form: Modifier = 1 - b0 * S (See manual for further information on equation)					
6	Collector slope	Direction (Angle)	degrees	real	[-360;+360]	45.0
	The slope of the solar collector. The slope is measured from the horizontal and is considered positive when tilted toward the surface azimuth.					
7	Logical unit	Dimensionless	-	integer	[10;30]	22
	The logical unit number of the file which contains the collector head vs. flowrate data (head is in meters of water). Every external file that TRNSYS reads from or writes to must be assigned a unique logical unit number in the TRNSYS input file.					
8	Number of data points	Dimensionless	-	integer	[2;10]	5
	The number of data points of collector head vs. flowrate that are contained in the external data file.					
9	Riser diameter	Length	m	real	[0.0;+Inf]	0.2
	The diamter of the collector risers.					
10	Header diameter	Length	m	real	[0.0;+Inf]	0.2

	The diameter of the collector headers.					
11	Header length	Length	m	real	[0.0;+Inf]	1.0
	The length of the collector headers.					
12	Number of collector nodes	Dimensionless	-	integer	[1;+Inf]	5
	The number of equal sized nodes that the collector will be divided into for the thermal head calculations.					
13	Collector inlet to outlet distance	Length	m	real	[0.0;+Inf]	0.75
	The vertical distance between the collector inlet and the collector outlet.					
14	Collector inlet to tank outlet distance	Length	m	real	[0.0;+Inf]	0.25
	The vertical distance between the outlet of the tank and the inlet of the collector.					
15	Collector inlet diameter	Length	m	real	[0.0;+Inf]	0.2
	The diameter of the inlet pipe of the collector.					
16	Length of collector inlet	Length	m	real	[0.0;+Inf]	1.0
	The length of the collector inlet pipe.					
17	Number of inlet bends	Dimensionless	-	real	[-Inf;+Inf]	4.0
	The number of equivalent right-angle bends in the collector inlet pipe.					
18	Inlet pipe loss coefficient	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[0.0;+Inf]	1.0
	The loss coefficient of the collector inlet pipe plus insulation.					
19	Collector outlet diameter	Length	m	real	[0.0;+Inf]	0.2
	The diameter of the collector outlet pipe.					
20	Length of collector outlet	Length	m	real	[0.0;+Inf]	1.0
	The length of the collector outlet piping.					
21	Number of outlet bends	Dimensionless	-	real	[0.0;+Inf]	4.0
	The number of equivalent right-angle bends in the collector outlet piping.					
22	Outlet pipe loss coefficient	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[0.0;+Inf]	1.0
	The loss coefficient of the collector outlet piping plus insulation.					
23	Inlet position mode	Dimensionless	-	integer	[1;2]	1
	The auxiliary storage tank may operate in one of two modes in determining the inlet positions of the flow streams. Mode 1 indicates that the heat source flow enters the tank in a fixed location and the flow mixes with adjacent segments if the temperature is within 1/2 degree. In Mode 2, the tank has variable inlet positions and new segments are inserted at the levels which produce no temperature inversions. This allows for a maximum degree of stratification.					
24	Tank volume	Volumetric Flow Rate	m^3	real	[0.0;+Inf]	0.35
	The actual volume of the storage tank (not the nominal value).					
25	Tank height	Length	m	real	[0.0;+Inf]	1.2
	The height of the storage tank if vertical, or the diameter of the storage tank if horizontal.					
26	Height of collector return	Length	m	real	[0.0;+Inf]	1.0
	The vertical distance between the bottom of the storage tank and the inlet of the hot-side flow stream.					
27	Fluid specific heat	Specific Heat	kJ/kg.K	real	[0.0;+Inf]	4.190
	The specific heat of the fluid contained in the storage tank.					
28	Fluid density	Density	kg/m^3	real	[0.0;+Inf]	1000.0
	The density of the fluid contained in the storage tank.					
29	Thermal conductivity	Thermal Conductivity	kJ/hr.m.K	real	[0.0;+Inf]	1.5
	The effective thermal conductivity of the fluid and the walls of the thermal storage tank (0 = no conduction).					
30	Tank configuration	Dimensionless	-	integer	[1;2]	1
	The configuration of the thermal storage tank: 1 ---> Vertical cylinder ; 2 ---> Horizontal cylinder					

31	Overall Loss Coefficient	Overall Loss Coefficient	kJ/hr.K	real	[0.0;+Inf]	5.0
	The overall loss coefficient (UA) for the storage tank.					
32	Insulation ratio	Dimensionless	-	real	[0.0;+Inf]	1.0
	The ratio of the thickness of the top insulation to the side insulation for vertical tanks, or the ratio of the insulation thickness of the top insulation to the bottom insulation of a horizontal cylindrical tank (set this ratio to 1 if the tank has a concentric insulation jacket).					
33	Initial temperature	Temperature	C	real	[-Inf;+Inf]	30.0
	The initial temperature of the preheat portion of the thermal storage tank.					
34	Maximum heating rate	Power	kJ/hr	real	[0.0;+Inf]	16200
	The maximum rate at which energy can be added to the thermal storage tank from the auxiliary heating element. If there is no element present in the tank, set this parameter to 0.					
35	Auxiliary height	Length	m	real	[0.0;+Inf]	0.5
	The height of the auxiliary heater element above the bottom of the storage tank.					
36	Thermostat height	Length	m	real	[0.0;+Inf]	0.75
	The height of the thermostat for the auxiliary heater above the bottom of the storage tank.					
37	Set point temperature	Temperature	C	real	[-Inf;+Inf]	55.0
	The set point temperature for the auxiliary heating element. The thermostat will enable the heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb and continue to heat the fluid until it reaches the set point temperature. Tset = this parameter; Tdb = temperature deadband					
38	Temperature deadband	Temp. Difference	deltaC	real	[0.0;+Inf]	5.0
	The dead band temperature difference for the auxiliary heating element. The thermostat will enable the heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb and continue to heat the fluid until it reaches the set point temperature. (See manual for further information on equation)					
39	Flue loss coefficient	Overall Loss Coefficient	kJ/hr.K	real	[0.0;+Inf]	0.0
	The overall loss coefficient (UA) for heat loss to the flue when the auxiliary heater is off. This parameter is used to model gas heated storage tanks and should be set to zero if there is no flue.					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Total incident radiation	Flux	kJ/hr.m^2	real	[0.0;+Inf]	0.0
	The total (beam + sky diffuse + ground reflected diffuse) radiation incident on the solar collector per unit area.					
2	Total horizontal radiation	Flux	kJ/hr.m^2	real	[0.0;+Inf]	0.0
	The total horizontal radiation (beam + diffuse) per unit area. This input is typically hooked to the fourth output of the TYPE 16 radiation processor.					
3	Horizontal diffuse radiation	Flux	kJ/hr.m^2	real	[0.0;+Inf]	0.0
	The horizontal diffuse radiation. This input is typically hooked up to the fifth output of the TYPE 16 solar radiation processor.					
4	Incidence angle	Direction (Angle)	degrees	real	[-360;360.0]	45.0
	The angle of incidence of beam radiation on the collector surface.					
5	Ground reflectance	Dimensionless	-	real	[0.0;1.0]	0.2
	The reflectance of the surface above which the solar collector is positioned. Typical values are 0.2 for ground not covered by snow and 0.7 for snow-covered ground. The reflectance is the ratio of refelcted radiation to total incident radiation and therefore must be between 0 and 1.					
6	Ambient temperature	Temperature	C	real	[-Inf;+Inf]	10.0
	The temperature of the environment to which the solar collector is exposed.					
7	Replacement temperature	Temperature	C	real	[-Inf;+Inf]	20.0

	The temperature of the replacement fluid flowing into the bottom of the storage tank.					
8	Load flowrate	Flow Rate	kg/hr	real	[0.0;+Inf]	100.0
	The flowrate of replacement fluid flowing into the bottom of the storage tank. An equal amount of fluid is assumed to flow from the top of the tank to meet the load.					
9	Environment temperature	Temperature	C	real	[-Inf;+Inf]	22.0
	The temperature of the environment in which the storage tank is located.					
10	Control signal	Dimensionless	-	real	[0.0;1.0]	0.0
	The control signal for the auxiliary heating element. The available power for the heating element will be this input multiplied by the maximum power for the element. If an auxiliary heater is not desired for the simulation, set this input to a constant of 0.0 or set the maximum power for the element to 0.0					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Temperature to tank	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid flowing into the storage tank from the collector.					
2	Useful energy from collector	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate of energy transfer to the collector fluid in the collector (does not include pipe heat losses).					
3	Temperature to collector	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid flowing from the bottom of the storage tank and returning to the collector (the bottom node temperature).					
4	Flowrate to collector	Flow Rate	kg/hr	real	[-Inf;+Inf]	0
	The flow rate of fluid exiting the bottom of the storage tank to return to the collector.					
5	Temperature to load	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid flowing from the top of the storage tank to the load (the temperature of the top node).					
6	Flowrate to load	Flow Rate	kg/hr	real	[-Inf;+Inf]	0
	The flow rate of fluid exiting the tank at the top to meet the load.					
7	Thermal losses	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate of thermal energy loss to the environment.					
8	Energy rate to load	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is removed from the tank to supply the load. The energy rate to the load is calculated by: Qload = mdot,load * Cp * (Ttop - Treplace) (See manual for further information on equation)					
9	Internal energy change	Energy	kJ	real	[-Inf;+Inf]	0
	The internal energy change of the tank relative to its initial condition. This output should not be integrated as it is an energy quantity and not an energy rate.					
10	Auxiliary heating rate	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy was added to the thermal storage tank by the auxiliary heater.					
11	Energy rate from heat source	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate of energy transfer from the heat source to the storage tank. The rate is calculated from: Qin = mdot,source * Cp * (Thot - Ttosource) (See manual for further information on equation)					
12	Average tank temperature	Temperature	C	real	[-Inf;+Inf]	0
	The average temperature of the fluid in the storage tank over the timestep.					

EXTERNAL FILES

Question	File	Associated parameter
Which file contains the head vs. flowrate data?		Logical unit

Source file	.\SourceCode\Types\Type45.for

4.11.6.2. Head vs Flowrate Calculated Internally

Icon		**TRNSYS Model**	Type 45
Proforma	Solar Thermal Collectors\Thermosyphon Collector with Integral Storage\Head vs Flowrate Calculated Internally\Type45a.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Collector area	Area	m^2	real	[0.0;+Inf]	2.0
	The area of the solar collector array consistent with the supplied efficiency parameters (typically gross area and not net area).					
2	Intercept efficiency	Dimensionless	-	real	[0.0;1.0]	0.7
	ASHRAE collector tests are often presented as curves of efficiciency vs. (Tin-Tamb)/It with intercept FrTan and slope FrUl. This parameter is the y-intercept of the collector efficiency vs. the temperaure difference/radiation ratio curve (FrTan). In equation form, this parameter is a0 in the collector efficiency equation: Eff. = a0 - a1*(Tin-Tamb)/Radiation Refer to page 4.2.1-4 of Volume 1 of the TRNSYS documentation set for more details.					
3	Efficiency slope	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[-Inf;+Inf]	15
	ASHRAE collector tests are ofetn presented as plots of efficiency vs. (Tin-Tamb)/It with intercept of FrTan and slope of FrUl. This parameter is the slope of the slope of the efficiency vs.(Tin-Tamb)/It curve. In equation form, this parameter is a1 in the equation: Eff. = a0 - a1*(Tin-Tamb)/It Refer to page 4.2.1-4 of Volume 1 of the TRNSYS documentation set for more details.					
4	Tested flow rate	Flow/area	kg/hr.m^2	real	[0.0;+Inf]	50.0
	The flow rate per unit area at which the collector was tested in order to determine the collector efficiency parameters. If no test was performed to get the efficiency parameters, set the tested flow rate equal to the flow rate under current operating conditions.					
5	Incidence angle modifier constant	Dimensionless	-	real	[0.0;1.0]	0.1
	Collector tests are usually performed on clear days at normal incidence so that the transmittance-absorptance product is nearly the normal incidence value for beam radiation. The intercept efficiency is corrected for non-normal solar incidence by the use of a modifying factor of the form: Modifier = 1 - b0 * S (See manual for further information on equation)					
6	Collector slope	Direction (Angle)	degrees	real	[-360;+360]	45.0
	The slope of the solar collector. The slope is measured from the horizontal and is considered positive when tilted toward the surface azimuth.					
7	Internal pressure drop calculation	Dimensionless	-	integer	[-1;-1]	-1
	By being less than 0, this parameter indicates to the component subroutine that the presure drop should be calculated internally. Do not change this parameter.					
8	Number of parallel collector risers	Dimensionless	-	integer	[2;10]	5
	The number of parallel collector risers; used for flow vs head calculations.					
9	Riser diameter	Length	m	real	[0.0;+Inf]	0.2
	The diamter of the collector risers.					
10	Header diameter	Length	m	real	[0.0;+Inf]	0.2
	The diameter of the collector headers.					
11	Header length	Length	m	real	[0.0;+Inf]	1.0
	The length of the collector headers.					

12	Number of collector nodes	Dimensionless	-	integer	[1;+Inf]	5
	The number of equal sized nodes that the collector will be divided into for the thermal head calculations.					
13	Collector inlet to outlet distance	Length	m	real	[0.0;+Inf]	0.75
	The vertical distance between the collector inlet and the collector outlet.					
14	Collector inlet to tank outlet distance	Length	m	real	[0.0;+Inf]	0.25
	The vertical distance between the outlet of the tank and the inlet of the collector.					
15	Collector inlet diameter	Length	m	real	[0.0;+Inf]	0.2
	The diameter of the inlet pipe of the collector.					
16	Length of collector inlet	Length	m	real	[0.0;+Inf]	1.0
	The length of the collector inlet pipe.					
17	Number of inlet bends	Dimensionless	-	real	[-Inf;+Inf]	4.0
	The number of equivalent right-angle bends in the collector inlet pipe.					
18	Inlet pipe loss coefficient	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[0.0;+Inf]	1.0
	The loss coefficient of the collector inlet pipe plus insulation.					
19	Collector outlet diameter	Length	m	real	[0.0;+Inf]	0.2
	The diameter of the collector outlet pipe.					
20	Length of collector outlet	Length	m	real	[0.0;+Inf]	1.0
	The length of the collector outlet piping.					
21	Number of outlet bends	Dimensionless	-	real	[0.0;+Inf]	4.0
	The number of equivalent right-angle bends in the collector outlet piping.					
22	Outlet pipe loss coefficient	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[0.0;+Inf]	1.0
	The loss coefficient of the collector outlet piping plus insulation.					
23	Inlet position mode	Dimensionless	-	integer	[1;2]	1
	The auxiliary storage tank may operate in one of two modes in determining the inlet positions of the flow streams. Mode 1 indicates that the heat source flow enters the tank in a fixed location and the flow mixes with adjacent segments if the temperature is within 1/2 degree. In Mode 2, the tank has variable inlet positions and new segments are inserted at the levels which produce no temperature inversions. This allows for a maximum degree of stratification.					
24	Tank volume	Volumetric Flow Rate	m^3	real	[0.0;+Inf]	0.35
	The actual volume of the storage tank (not the nominal value).					
25	Tank height	Length	m	real	[0.0;+Inf]	1.2
	The height of the storage tank if vertical, or the diameter of the storage tank if horizontal.					
26	Height of collector return	Length	m	real	[0.0;+Inf]	1.0
	The vertical distance between the bottom of the storage tank and the inlet of the hot-side flow stream.					
27	Fluid specific heat	Specific Heat	kJ/kg.K	real	[0.0;+Inf]	4.190
	The specific heat of the fluid contained in the storage tank.					
28	Fluid density	Density	kg/m^3	real	[0.0;+Inf]	1000.0
	The density of the fluid contained in the storage tank.					
29	Thermal conductivity	Thermal Conductivity	kJ/hr.m.K	real	[0.0;+Inf]	1.5
	The effective thermal conductivity of the fluid and the walls of the thermal storage tank (0 = no conduction).					
30	Tank configuration	Dimensionless	-	integer	[1;2]	1
	The configuration of the thermal storage tank: 1 ---> Vertical cylinder ; 2 ---> Horizontal cylinder					
31	Overall Loss Coefficient	Overall Loss Coefficient	kJ/hr.K	real	[0.0;+Inf]	5.0
	The overall loss coefficient (UA) for the storage tank.					
32	Insulation ratio	Dimensionless	-	real	[0.0;+Inf]	1.0

	The ratio of the thickness of the top insulation to the side insulation for vertical tanks, or the ratio of the insulation thickness of the top insulation to the bottom insulation of a horizontal cylindrical tank (set this ratio to 1 if the tank has a concentric insulation jacket).					
33	Initial temperature	Temperature	C	real	[-Inf;+Inf]	30.0
	The initial temperature of the preheat portion of the thermal storage tank.					
34	Maximum heating rate	Power	kJ/hr	real	[0.0;+Inf]	16200
	The maximum rate at which energy can be added to the thermal storage tank from the auxiliary heating element. If there is no element present in the tank, set this parameter to 0.					
35	Auxiliary height	Length	m	real	[0.0;+Inf]	0.5
	The height of the auxiliary heater element above the bottom of the storage tank.					
36	Thermostat height	Length	m	real	[0.0;+Inf]	0.75
	The height of the thermostat for the auxiliary heater above the bottom of the storage tank.					
37	Set point temperature	Temperature	C	real	[-Inf;+Inf]	55.0
	The set point temperature for the auxiliary heating element. The thermostat will enable the heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb and continue to heat the fluid until it reaches the set point temperature. Tset = this parameter; Tdb = temperature deadband					
38	Temperature deadband	Temp. Difference	deltaC	real	[0.0;+Inf]	5.0
	The dead band temperature difference for the auxiliary heating element. The thermostat will enable the heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb and continue to heat the fluid until it reaches the set point temperature. (See manual for further information on equation)					
39	Flue loss coefficient	Overall Loss Coefficient	kJ/hr.K	real	[0.0;+Inf]	0.0
	The overall loss coefficient (UA) for heat loss to the flue when the auxiliary heater is off. This parameter is used to model gas heated storage tanks and should be set to zero if there is no flue.					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Total incident radiation	Flux	kJ/hr.m^2	real	[0.0;+Inf]	0.0
	The total (beam + sky diffuse + ground reflected diffuse) radiation incident on the solar collector per unit area.					
2	Total horizontal radiation	Flux	kJ/hr.m^2	real	[0.0;+Inf]	0.0
	The total horizontal radiation (beam + diffuse) per unit area. This input is typically hooked to the fourth output of the TYPE 16 radiation processor.					
3	Horizontal diffuse radiation	Flux	kJ/hr.m^2	real	[0.0;+Inf]	0.0
	The horizontal diffuse radiation. This input is typically hooked up to the fifth output of the TYPE 16 solar radiation processor.					
4	Incidence angle	Direction (Angle)	degrees	real	[-360;360.0]	45.0
	The angle of incidence of beam radiation on the collector surface.					
5	Ground reflectance	Dimensionless	-	real	[0.0;1.0]	0.2
	The reflectance of the surface above which the solar collector is positioned. Typical values are 0.2 for ground not covered by snow and 0.7 for snow-covered ground. The reflectance is the ratio of refelcted radiation to total incident radiation and therefore must be between 0 and 1.					
6	Ambient temperature	Temperature	C	real	[-Inf;+Inf]	10.0
	The temperature of the environment to which the solar collector is exposed.					
7	Replacement temperature	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the replacement fluid flowing into the bottom of the storage tank.					
8	Load flowrate	Flow Rate	kg/hr	real	[0.0;+Inf]	100.0
	The flowrate of replacement fluid flowing into the bottom of the storage tank. An equal amount of fluid is					

	assumed to flow from the top of the tank to meet the load.					
9	Environment temperature	Temperature	C	real	[-Inf;+Inf]	22.0
	The temperature of the environment in which the storage tank is located.					
10	Control signal	Dimensionless	-	real	[0.0;1.0]	0.0
	The control signal for the auxiliary heating element. The available power for the heating element will be this input multiplied by the maximum power for the element. If an auxiliary heater is not desired for the simulation, set this input to a constant of 0.0 or set the maximum power for the element to 0.0					

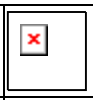
OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Temperature to tank	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid flowing into the storage tank from the collector.					
2	Useful energy from collector	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate of energy transfer to the collector fluid in the collector (does not include pipe heat losses).					
3	Temperature to collector	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid flowing from the bottom of the storage tank and returning to the collector (the bottom node temperature).					
4	Flowrate to collector	Flow Rate	kg/hr	real	[-Inf;+Inf]	0
	The flow rate of fluid exiting the bottom of the storage tank to return to the collector.					
5	Temperature to load	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid flowing from the top of the storage tank to the load (the temperature of the top node).					
6	Flowrate to load	Flow Rate	kg/hr	real	[-Inf;+Inf]	0
	The flow rate of fluid exiting the tank at the top to meet the load.					
7	Thermal losses	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate of thermal energy loss to the environment.					
8	Energy rate to load	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is removed from the tank to supply the load. The energy rate to the load is calculated by: Qload = mdot,load * Cp * (Ttop - Treplace) (See manual for further information on equation)					
9	Internal energy change	Energy	kJ	real	[-Inf;+Inf]	0
	The internal energy change of the tank relative to its initial condition. This output should not be integrated as it is an energy quantity and not an energy rate.					
10	Auxiliary heating rate	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy was added to the thermal storage tank by the auxiliary heater.					
11	Energy rate from heat source	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate of energy transfer from the heat source to the storage tank. The rate is calculated from: Qin = mdot,source * Cp * (Thot - Ttosource) (See manual for further information on equation)					
12	Average tank temperature	Temperature	C	real	[-Inf;+Inf]	0
	The average temperature of the fluid in the storage tank over the timestep.					

4.12. Thermal Storage

4.12.1. Detailed Fluid Storage Tank

4.12.1.1. Horizontal Cylinder - Non-Uniform Losses and Heights - 1 Inlet, 1 Outlet

Icon		**TRNSYS Model**	Type 60
Proforma	Thermal Storage\Detailed Fluid Storage Tank\Horizontal Cylinder\Non-Uniform Losses and Heights\1 Inlet, 1 Outlet\Type60m.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	User-specified inlet positions	Dimensionless	-	integer	[1;2]	2
	The auxiliary storage tank may operate in one of two modes in determining the inlet positions of the flow streams. In this mode (2), the user must specify the locations (nodes) of the entering flow streams. Do not change this parameter.					
2	Tank volume	Volumetric Heat Capacitance	m^3	real	[0.0;+Inf]	0.35
	The actual volume of the storage tank (not the nominal value).					
3	Tank height	Length	m	real	[0.0;+Inf]	1.25
	The height of the storage tank. If the tank is a horizontal cylinder, this parameter should be set to the diameter of the storage tank.					
4	Horizontal cylinder	Length	m	integer	[-2;-2]	-2
	By setting this parameter to -2, the user is specifying that the tank is cylindrical with a horizontal orientation (laying on its side). Do not change this parameter.					
5	Height of flow inlet 1	Length	m	real	[0.0;+Inf]	1.25
	The height of the first inlet above the bottom of the tank. Make sure that this value is between 0 and the total height of the tank.					
6	Height of flow outlet 1	Length	m	real	[0.0;+Inf]	0.0
	The height of the first outlet from the storage tank above the bottom of the tank. Make sure that this value is between 0 and the total height of the tank.					
7	Not used (inlet 2)	Dimensionless	-	integer	[-1;-1]	-1
	This parameter must be set to -1 to indicate to the general storage tank model that there is only one inlet to this tank.					
8	Not used (outlet 2)	Dimensionless	-	integer	[-1;-1]	-1
	This parameter should be set to a value of -1 to indicate to the general storage tank model that there is only one outlet from this tank.					
9	Fluid specific heat	Specific Heat	kJ/kg.K	real	[0.0;+Inf]	4.190
	The specific heat of the fluid contained in the storage tank.					
10	Fluid density	Density	kg/m^3	real	[0.0;+Inf]	1000.0
	The density of the fluid contained in the storage tank.					
11	Tank loss coefficient	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[0.0;+Inf]	3.0

	The average tank loss coefficient per unit area. Different loss coefficients for each node can be modeled by use of the incremental loss coefficient parameters.					
12	Fluid thermal conductivity	Thermal Conductivity	kJ/hr.m.K	real	[0.0;+Inf]	1.40
	The thermal conductivity of the fluid contained in the storage tank.					
13	Destratification conductivity	Thermal Conductivity	kJ/hr.m.K	real	[0.0;+Inf]	0.0
	To model de-stratification due to mixing at node interfaces and conduction along the tank wall, the user may enter this additional conductivity parameter. The additional conductivity term is added to the conductivity of the tank fluid and is applied to all nodes. For rough calculations, one may calculate this parameter as the thermal conductivity of the tank wall times the cross sectional area of the tank wall divided by the cross sectional area of the fluid in the storage tank.					
14	Boiling temperature	Temperature	C	real	[-Inf;+Inf]	100.0
	The boiling point temperature of the fluid contained in the storage tank.					
15	Auxiliary heater mode	Dimensionless	-	integer	[1;2]	1
	The auxiliary heater may be operated in one of two modes: 1 = Master/Slave Relation: The lower heating element is only enabled when the upper heating element is satisified. In this mode, only one heater may be on at any instant of time. This is a common design in residential electric hot water tanks. 2 = Both Enabled: In this mode, both heaters may be on simultaneously. This allows for significantly quicker heating of the water, but at a much higher electrical demand.					
16	Height of 1st aux. heater	Length	m	real	[0.0;+Inf]	1.0
	The height of the first auxiliary heater element above the bottom of the storage tank. If there are no auxiliary heaters, set this parameter and the thermostat height parameter to any value between 0 anf the total tank height. Then simply set either the maximum heating rate or the control signal for this heating element to a constant value of 0.					
17	Height of 1st thermostat	Length	m	real	[0.0;+Inf]	1.25
	The height of the thermostat for the first heating element above the bottom of the storage tank. If there are no heating elements, simply set this parameter to any value between 0 and the total tank height. Then set either the maximum heating rate or the control signal for this heating element to a constant value of 0.					
18	Set point temperature for element 1	Temperature	C	real	[-Inf;+Inf]	55.0
	The set point temperature for the specified heating element. The thermostat will enable the heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb and continue to heat the fluid until it reaches the set point temperature. Tset = this parameter; Tdb = next parameter					
19	Deadband for heating element 1	Temp. Difference	deltaC	real	[-Inf;+Inf]	5.0
	The dead band temperature difference for the specified heating element. The thermostat will enable the heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb and continue to heat the fluid until it reaches the set point temperature. Where Tset = previous parameter; Tdb = this parameter					
20	Maximum heating rate of element 1	Power	kJ/hr	real	[0.0;+Inf]	16200.0
	The maximum heating rate of the heating element. If the specified heating element is to not to be used for the simulation, set the maximum power to 0.					
21	Height of heating element 2	Length	m	integer	[1;15]	1
	The node containing the specified auxiliary heating element. Make sure that the specified node for the heater is between 1 and the total number of nodes specified. Node 1 is the topmost node in the tank.					
22	Height of thermostat 2	Length	m	integer	[1;15]	1
	The node containing the thermostat for the specified auxiliary heater. The thermostat is typically either located in the same node as the heating element or in a node located above the element. Node 1 is the topmost node in the tank.					
23	Set point temperature for element 2	Temperature	C	real	[-Inf;+Inf]	55.0
	The set point temperature for the specified heating element. The thermostat will enable the heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb and continue to					

	heat the fluid until it reaches the set point temperature. Tset = this parameter; Tdb = next parameter					
24	Deadband for heating element 2	Temp. Difference	deltaC	real	[0.0;+Inf]	5.0
	The dead band temperature difference for the specified heating element. The thermostat will enable the heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb and continue to heat the fluid until it reaches the set point temperature.Where Tset = previous parameter; Tdb = this parameter					
25	Maximum heating rate of element 2	Power	kJ/hr	real	[0.0;+Inf]	16200
	The maximum heating rate of the heating element. If the specified heating element is to not to be used for the simulation, set the maximum power to 0.					
26	Overall loss coefficient for gas flue	Overall Loss Coefficient	kJ/hr.K	real	[0.0;+Inf]	0.0
	The overall loss coefficient of the gas flue when the tank is not being heated. If this tank is not being heated by gas, simply set this parameter to 0.0 and the next parameter (flue temperature) to any reasonable value.					
27	Flue temperature	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the gas flue when the tank is not being heated. This parameter is used tto calculate the losses from the storage to the flue when the tank is not being heated. If the tank is not heated witth gas, simply set this parameter to any reasonable value and set the previous parameter (flue loss coefficient) to 0.					
28	Fraction of critical timestep	Dimensionless	-	integer	[1;1000]	6
	To minimize numerical errors, the TYPE 60 tank model uses its own internal time step. This has the advantage of results being unaffected by the size of the TRNSYS time step. The model internally computes the critical Euler time step. The user then chooses the fraction of the critical time step that will be used. Increasing this parameter will increase the accuracy of the model, but decrease the simulation speed. A value of 6 represents an excellent compromise between accuracy and speed for most simulations.					
29	Gas heater?	Dimensionless	-	integer	[0;+Inf]	1
	This parameter indicates to the general storage tank model whether the tank is heated with electric elements, with a gas flue, or with a combination of gas and electric. 0 = Both heater are electric 1 = Auxiliary heater #2 is gas					
30	Number of internal heat exchangers	Dimensionless	-	integer	[0;3]	1
	The number of internal heat exchangers that are contained within the storage tank. For each internal heat exchanger, the user must specify 12 parameters that describe the heat exchanger.					
31	Node heights supplied	Dimensionless	-	integer	[1;1]	1
	This parameter indicates to the general storage taank model that the user will be supplying the height of all the nodes in the storage tank. The number of nodes is controlled by the number of derivatives supplied. Do not change this parameter.					
32	Additional loss coeff's supplied	Dimensionless	-	integer	[1;1]	1
	This parameter indicates to the general storagee tank model that the user will be specifying the value of the incremental loss coefficients for each node in the storage tank. The number of nodes is controlled by the number of supplied derivatives. Do not change this parameter.					
33	HX Fluid Indicator	Dimensionless	-	integer	[1;3]	1
	The fluid contained in the first internal heat exchanger: 1=Water 2=Propylene Glycol 3=Ethylene Glycol					
34	Fraction of glycol	Dimensionless	-	real	[0.0;1.0]	0.75
	The fraction of glycol contained in the internal heat exchanger fluid by volume. If the previous parameter is set to 1 (water), this parameter is ignored. If the previous parameter is set to propylene glycol (2), this parameter may range from 0 to 1. If the previous parameter indicates ethylene glycol (3), this parameter may range from 0.55 to 0.85.					
35	Heat exchanger inside diameter	Length	m	real	[0.0;+Inf]	0.01

	The inside diameter of the pipe comprising the internal heat exchanger.					
36	Heat exchanger outside diameter	Length	m	real	[0.0;+Inf]	0.012
	The outside diameter of the pipe comprising the internal heat exchanger.					
37	Heat exchanger fin diameter	Length	m	real	[0.0;+Inf]	0.012
	The diameter of the fins on the outside pipe surface of the internal heat exchanger. If there are no fins (a smooth tube), set this parameter equal to the previous parameter (heat exchanger outside diameter).					
38	Total surface area of heat exchanger	Area	m^2	real	[0.0;+Inf]	1.0
	The total outside surface area of the internal heat exchanger.					
39	Fins per meter for heat exchanger	Dimensionless	-	integer	[0;+Inf]	100
	The number of fins per unit length (meter) on the outside surface of the internal heat exchanger pipe. This parameter is ignored for smooth tubes.					
40	Heat exchanger length	Length	m	real	[0.0;+Inf]	2.0
	The total length of internal heat exchanger pipe immersed within the storage tank fluid.					
41	Heat exchanger wall conductivity	Thermal Conductivity	kJ/hr.m.K	real	[0.0;+Inf]	1.40
	The conductivity of the heat exchanger wall including any applicable contact resistance. Contact resistance would be present with a double wall heat exchanger where the heat exchaanger is a tube within a tube design.					
42	Heat exchanger material conductivity	Thermal Conductivity	kJ/hr.m.K	real	[0.0;+Inf]	1.40
	The thermal conductivity of the material which comprises the internal heat exchanger.					
43	Height of heat exchanger inlet	Length	m	real	[0.0;+Inf]	0.00
	The height above the bottom of the storage tank of the inlet of the internal heat exchanger.					
44	Height of heat exchanger outlet	Length	m	real	[0.0;+Inf]	1.25
	The height of the outlet of the internal heat exchanger from the tank above the bottom of the storage tank.					
45	Height of node	Length	m	real	[0.0;+Inf]	0.25
	The height of the specified node. The number of nodes is controlled by the number of derivatives supplied to the model.					
46	Additional loss coefficient for node	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[-Inf;+Inf]	0.00
	The additional loss coefficient for the specified node. The total loss coefficient for each node will be the average loss coefficient (specified much earlier) plus this incremental loss coefficient. Incremental loss coefficients are typically used when one section of the tank is more heavily insulated than other sections or to account for thermal shorts due to pipes and fittings.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
33-44	Number of internal heat exchangers		1	50
45-46		How many temperature levels (nodes) should be used in the tank?	1	50

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Flow rate at inlet 1	Flow Rate	kg/hr	real	[-2;+Inf]	0.0
	The flow rate entering the storage tank at the first inlet.					
2	Flow rate at outlet 1	Flow Rate	kg/hr	real	[-2;+Inf]	-2

	The flow rate of fluid exiting the storage tank from the first outlet. One of the outlet flow rates MUST be specified as a constant value of -2 to indicate that the outlet flow rate will be determined from a mass balance on the constant volume storage tank.					
3	Not used (flow inlet 2)	Dimensionless	-	integer	[-1;-1]	-1
	This input should be set to a constant value of -1 to indicate to the general storage tank model that the tank has only 1 inlet.					
4	Not used (flow outlet 2)	Dimensionless	-	integer	[-1;-1]	-1
	This input should be set to a constant value of -1 to indicate to the general storage tank moel that there is only one outlet from this tank.					
5	Temperature at inlet 1	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the fluid entering the storage tank at the first inlet.					
6	Not used (temp inlet 2)	Temperature	C	real	[-Inf;+Inf]	20.0
	This input is not used in this mode of the storage tank model.					
7	Environment temperature	Temperature	C	real	[-Inf;+Inf]	22.0
	The temperature of the environment in which the storage tank is located.					
8	Control signal for element 1	Dimensionless	-	real	[0.0;1.0]	1.0
	The control signal for the specified auxiliary heating element. The available power for the heating element will be this input multiplied by the maximum power for the element. If an auxiliary heater is not desired for the simulation, set this input to a constant of 0.0 or set the maximum power for the element to 0.0					
9	Control signal for element 2	Dimensionless	-	real	[0.0;1.0]	1.0
	The control signal for the specified auxiliary heating element. The available power for the heating element will be this input multiplied by the maximum power for the element. If an auxiliary heater is not desired for the simulation, set this input to a constant of 0.0 or set the maximum power for the element to 0.0					
10	Flow rate for heat exchanger	Flow Rate	kg/hr	real	[0.0;+Inf]	0.0
	The flow rate through the specified internal heat exchanger.					
11	Inlet temperature for heat exchanger	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature at the inlet of the specified internal heat exchanger.					
12	Nusselt constant for heat exchanger	Dimensionless	-	real	[0.0;+Inf]	0.50
	The natural convection coefficient between the storage fluid and the internal heat exchanger wall is modeled with an equation of the form: h = Nu * k / do ; Nu = C * Ra^n (See mathematical reference for details) A typical value for C is about 0.5 and n is usually 0.25.					
13	Nusselt exponent for heat exchanger	Dimensionless	-	real	[-Inf;+Inf]	0.25
	The natural convection coefficient between the storage fluid and the internal heat exchanger wall is modeled with an equation of the form: h = Nu * k / do ; Nu = C * Ra^n (See mathematical reference for details) A typical value for C is about 0.5 and n is usually 0.25.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
10-13	Number of internal heat exchangers		1	50

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Flowrate at inlet 1	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	The flow rate of fluid into the storage tank at inlet 1.					
2	Flowrate at outlet 1	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	The flow rate of fluid exiting the storage tank through outlet 1.					
3	Not used (inlet 2 flow)	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	This output should not be used in this mode of the storage tank model.					

4	Not used (outlet 2 flow)	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	This output should not be used in this model of the storage tank model.					
5	Temperature of outlet flow 1	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid exiting the storage tank through outlet 1.					
6	Not used (temp flow 2)	Temperature	C	real	[-Inf;+Inf]	0
	This output should not be used in this model of the storage tank model.					
7	Thermal losses	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate of thermal energy loss to the environment. Includes the vented energy if a boiling condition is reached.					
8	Energy supplied by inlet 1	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is added to the storage tank by the entrance of the fluid through inlet 1.					
9	Energy removed by outlet 1	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is removed from the storage tank by the exiting of fluid through outlet 1.					
10	Not used (energy inlet 2)	Power	kJ/hr	real	[-Inf;+Inf]	0
	This output should not be used in this mode of the storage tank model.					
11	Not used (energy outlet 2)	Power	kJ/hr	real	[-Inf;+Inf]	0
	This output should not be used in this mode of the storage tank model.					
12	Auxiliary heating rate	Power	kJ/hr	real	[-Inf;+Inf]	0
	The average rate at which power was added to the tank by BOTH auxiliary heaters.					
13	Element 1 power	Power	kJ/hr	real	[-Inf;+Inf]	0
	The average power supplied to the storage tank over the timestep by the first heating element specified in the parameter list.					
14	Element 2 power	Power	kJ/hr	real	[-Inf;+Inf]	0
	The average power over the timestep supplied to the tank by the second auxiliary heater specified in the parameter list.					
15	Losses to gas flue	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is removed from the storage tank through losses to the gas flue (while the tank is not being charged by the gas flue).					
16	Internal energy change	Energy	kJ	real	[-Inf;+Inf]	0
	The change in internal energy of the tank from the beginning of the simulation.					
17	Average tank temperature	Temperature	C	real	[-Inf;+Inf]	0
	The average temperature of the fluid in the storage tank over the timestep.					
18	Static pressure difference - inlet 1	Pressure	kPa	real	[-Inf;+Inf]	0
	The static pressure difference between the top of the tank and the first inlet port.					
19	Static pressure difference - outlet 1	Pressure	kPa	real	[-Inf;+Inf]	0
	The static pressure difference between the top of the tank and the first outlet port.					
20	Not used (pressure inlet 2)	Pressure	kPa	real	[-Inf;+Inf]	0
	This output should not be used in this mode of the storage tnk model.					
21	Not used (pressure outlet 2)	Pressure	kPa	real	[-Inf;+Inf]	0
	This output should not be used in this mode of the storage tank model.					
22	Energy input from heat exchanger	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is added to the storage tank from the specified internal heat exchanger.					
23	Temperature of fluid exiting heat exchanger	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid exiting the specified internal heat exchanger.					
24	Tank temperature at outlet of heat exchanger	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the storage tank at the outlet of the specified internal heat exchanger.					

25	LMTD of heat exchanger	Temperature	C	real	[-Inf;+Inf]	0
	The average log mean temperature difference of the specified internal heat exchanger over the timestep.					
26	UA of heat exchanger	Overall Loss Coefficient	kJ/hr.K	real	[0.0;+Inf]	0
	The average overall heat transfer coefficient of the specified internal heat exchanger over the timestep.					
27	Tank temperature - top	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid at the top of the storage tank.					
28	Tank temperature - bottom	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid at the bottom of the storage tank.					
29	Temperature of node 1+	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the specified node.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
22-26	Number of internal heat exchangers		1	50
29-29		Besides the top and bottom nodes, how many other nodes are there?	1	48

DERIVATIVES

	Name	Dimension	Unit	Type	Range	Default
1	Initial temperature of node	Temperature	C	real	[-Inf;+Inf]	0
	The initial temperature of the specified node.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
1-1		How many temperature levels (nodes) should be used in the tank?	1	50

4.12.1.2. Horizontal Cylinder - Non-Uniform Losses and Heights - 1 Inlet, 2 Outlets

Icon		TRNSYS Model	Type 60
Proforma	Thermal Storage\Detailed Fluid Storage Tank\Horizontal Cylinder\Non-Uniform Losses and Heights\1 Inlet, 2 Outlets\Type60p.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	User-specified inlet positions	Dimensionless	-	integer	[1;2]	2
	The auxiliary storage tank may operate in one of two modes in determining the inlet positions of the flow streams. In this mode (2), the user must specify the locations (nodes) of the entering flow streams. Do not change this parameter.					
2	Tank volume	Volumetric Flow Rate	m^3/s	real	[0.0;+Inf]	0.35
	The actual volume of the storage tank (not the nominal value).					
3	Tank height	Length	m	real	[0.0;+Inf]	1.25
	The height of the storage tank. If the tank is a horizontal cylinder, this parameter should be set to the diameter of the storage tank.					
4	Horizontal cylinder	Length	m	integer	[-2;-2]	-2
	By setting this parameter to -2, the user is specifying that the tank is cylindrical with a horizontal orientation (laying on its side). Do not change this parameter.					
5	Height of flow inlet 1	Length	m	real	[0.0;+Inf]	1.25
	The height of the first inlet above the bottom of the tank. Make sure that this value is between 0 and the total height of the tank.					
6	Height of flow outlet 1	Length	m	real	[0.0;+Inf]	0.0
	The height of the first outlet from the storage tank above the bottom of the tank. Make sure that this value is between 0 and the total height of the tank.					
7	Not used (inlet 2)	Dimensionless	-	integer	[-1;-1]	-1
	This parameter must be set to -1 to indicate to the general storage tank model that there is only one inlet to this tank.					
8	Height of flow outlet 2	Length	m	real	[0.0;+Inf]	1.25
	The height of the 2nd outlet from the storage tank above the bottom of the tank. Make sure that this value is between 0 and the total height of the storage tank.					
9	Fluid specific heat	Specific Heat	kJ/kg.K	real	[0.0;+Inf]	4.190
	The specific heat of the fluid contained in the storage tank.					
10	Fluid density	Density	kg/m^3	real	[0.0;+Inf]	1000.0
	The density of the fluid contained in the storage tank.					
11	Tank loss coefficient	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[0.0;+Inf]	3.0
	The average tank loss coefficient per unit area. Different loss coefficients for each node can be modeled by use of the incremental loss coefficient parameters.					
12	Fluid thermal conductivity	Thermal Conductivity	kJ/hr.m.K	real	[0.0;+Inf]	1.40
	The thermal conductivity of the fluid contained in the storage tank.					
13	Destratification conductivity	Thermal Conductivity	kJ/hr.m.K	real	[0.0;+Inf]	0.0
	To model de-stratification due to mixing at node interfaces and conduction along the tank wall, the user may enter this additional conductivity parameter. The additional conductivity term is added to the conductivity of the tank fluid and is applied to all nodes. For rough calculations, one may calculate this parameter as the thermal conductivity of the tank wall times the cross sectional area of the tank wall divided by the cross sectional area					

	of the fluid in the storage tank.					
14	Boiling temperature	Temperature	C	real	[-Inf;+Inf]	100.0
	The boiling point temperature of the fluid contained in the storage tank.					
15	Auxiliary heater mode	Dimensionless	-	integer	[1;2]	1
	The auxiliary heater may be operated in one of two modes: 1 = Master/Slave Relation: The lower heating element is only enabled when the upper heating element is satisified. In this mode, only one heater may be on at any instant of time. This is a common design in residential electric hot water tanks. 2 = Both Enabled: In this mode, both heaters may be on simultaneously. This allows for significantly quicker heating of the water, but at a much higher electrical demand.					
16	Height of 1st aux. heater	Length	m	real	[0.0;+Inf]	1.0
	The height of the first auxiliary heater element above the bottom of the storage tank. If there are no auxiliary heaters, set this parameter and the thermostat height parameter to any value between 0 anf the total tank height. Then simply set either the maximum heating rate or the control signal for this heating element to a constant value of 0.					
17	Height of 1st thermostat	Length	m	real	[0.0;+Inf]	1.25
	The height of the thermostat for the first heating element above the bottom of the storage tank. If there are no heating elements, simply set this parameter to any value between 0 and the total tank height. Then set either the maximum heating rate or the control signal for this heating element to a constant value of 0.					
18	Set point temperature for element 1	Temperature	C	real	[-Inf;+Inf]	55.0
	The set point temperature for the specified heating element. The thermostat will enable the heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb and continue to heat the fluid until it reaches the set point temperature. Tset = this parameter; Tdb = next parameter					
19	Deadband for heating element 1	Temp. Difference	deltaC	real	[-Inf;+Inf]	5.0
	The dead band temperature difference for the specified heating element. The thermostat will enable the heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb and continue to heat the fluid until it reaches the set point temperature. Where Tset = previous parameter; Tdb = this parameter					
20	Maximum heating rate of element 1	Power	kJ/hr	real	[0.0;+Inf]	16200.0
	The maximum heating rate of the heating element. If the specified heating element is to not to be used for the simulation, set the maximum power to 0.					
21	Hight of heating element 2	Length	m	integer	[1;15]	1
	The node containing the specified auxiliary heating element. Make sure that the specified node for the heater is between 1 and the total number of nodes specified. Node 1 is the topmost node in the tank.					
22	Height of thermostat 2	Length	m	integer	[1;15]	1
	The node containing the thermostat for the specified auxiliary heater. The thermostat is typically either located in the same node as the heating element or in a node located above the element. Node 1 is the topmost node in the tank.					
23	Set point temperature for element 2	Temperature	C	real	[-Inf;+Inf]	55.0
	The set point temperature for the specified heating element. The thermostat will enable the heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb and continue to heat the fluid until it reaches the set point temperature. Tset = this parameter; Tdb = next parameter					
24	Deadband for heating element 2	Temp. Difference	deltaC	real	[0.0;+Inf]	5.0
	The dead band temperature difference for the specified heating element. The thermostat will enable the					

	heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb and continue to heat the fluid until it reaches the set point temperature. Where Tset = previous parameter; Tdb = this parameter					
25	Maximum heating rate of element 2	Power	kJ/hr	real	[0.0;+Inf]	16200
	The maximum heating rate of the heating element. If the specified heating element is to not to be used for the simulation, set the maximum power to 0.					
26	Overall loss coefficient for gas flue	Overall Loss Coefficient	kJ/hr.K	real	[0.0;+Inf]	0.0
	The overall loss coefficient of the gas flue when the tank is not being heated. If this tank is not being heated by gas, simply set this parameter to 0.0 and the next parameter (flue temperature) to any reasonable value.					
27	Flue temperature	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the gas flue when the tank is not being heated. This parameter is used tto calculate the losses from the storage to the flue when the tank is not being heated. If the tank is not heated witth gas, simply set this parameter to any reasonable value and set the previous parameter (flue loss coefficient) to 0.					
28	Fraction of critical timestep	Dimensionless	-	integer	[1;1000]	6
	To minimize numerical errors, the TYPE 60 tank model uses its own internal time step. This has the advantage of results being unaffected by the size of the TRNSYS time step. The model internally computes the critical Euler time step. The user then chooses the fraction of the critical time step that will be used. Increasing this parameter will increase the accuracy of the model, but decrease the simulation speed. A value of 6 represents an excellent compromise between accuracy and speed for most simulations.					
29	Gas heater?	Dimensionless	-	integer	[0;+Inf]	1
	This parameter indicates to the general storage tank model whether the tank is heated with electric elements, with a gas flue, or with a combination of gas and electric. 0 = Both heater are electric 1 = Auxiliary heater #2 is gas (setting the maximum heating rate of the first heating element to zero or non-zero dictates whether the tank also has an electric element).					
30	Number of internal heat exchangers	Dimensionless	-	integer	[0;3]	1
	The number of internal heat exchangers that are contained within the storage tank. For each internal heat exchanger, the user must specify 12 parameters that describe the heat exchanger.					
31	Node heights supplied	Dimensionless	-	integer	[1;1]	1
	This parameter indicates to the general storage taank model that the user will be supplying the height of all the nodes in the storage tank. The number of nodes is controlled by the number of derivatives supplied. Do not change this parameter.					
32	Additional loss coeff's supplied	Dimensionless	-	integer	[1;1]	1
	This parameter indicates to the general storagee tank model that the user will be specifying the value of the incremental loss coefficients for each node in the storage tank. The number of nodes is controlled by the number of supplied derivatives. Do not change this parameter.					
33	HX Fluid Indicator	Dimensionless	-	integer	[1;3]	1
	The fluid contained in the first internal heat exchanger: 1=Water 2=Propylene Glycol 3=Ethylene Glycol These fluids are contained in the internal heat exchanger and are not mixed with the storage fluid.					
34	Fraction of glycol	Dimensionless	-	real	[0.0;1.0]	0.75
	The fraction of glycol contained in the internal heat exchanger fluid by volume. If the previous parameter is set to 1 (water), this parameter is ignored. If the previous parameter is set to propylene glycol (2), this parameter may range from 0 to 1. If the previous parameter indicates ethylene glycol (3), this parameter may range from 0.55 to 0.85.					
35	Heat exchanger inside diameter	Length	m	real	[0.0;+Inf]	0.01
	The inside diameter of the pipe comprising the internal heat exchanger.					
36	Heat exchanger outside	Length	m	real	[0.0;+Inf]	0.012

	diameter					
	The outside diameter of the pipe comprising the internal heat exchanger.					
37	Heat exchanger fin diameter	Length	m	real	[0.0;+Inf]	0.012
	The diameter of the fins on the outside pipe surface of the internal heat exchanger. If there are no fins (a smooth tube), set this parameter equal to the previous parameter (heat exchanger outside diameter).					
38	Total surface area of heat exchanger	Area	m^2	real	[0.0;+Inf]	1.0
	The total outside surface area of the internal heat exchanger.					
39	Fins per meter for heat exchanger	Dimensionless	-	integer	[0;+Inf]	100
	The number of fins per unit length (meter) on the outside surface of the internal heat exchanger pipe. This parameter is ignored for smooth tubes.					
40	Heat exchanger length	Length	m	real	[0.0;+Inf]	2.0
	The total length of internal heat exchanger pipe immersed within the storage tank fluid.					
41	Heat exchanger wall conductivity	Thermal Conductivity	kJ/hr.m.K	real	[0.0;+Inf]	1.40
	The conductivity of the heat exchanger wall including any applicable contact resistance. Contact resistance would be present with a double wall heat exchanger where the heat exchaanger is a tube within a tube design.					
42	Heat exchanger material conductivity	Thermal Conductivity	kJ/hr.m.K	real	[0.0;+Inf]	1.40
	The thermal conductivity of the material which comprises the internal heat exchanger.					
43	Height of heat exchanger inlet	Length	m	real	[0.0;+Inf]	0.00
	The height above the bottom of the storage tank of the inlet of the internal heat exchanger.					
44	Height of heat exchanger outlet	Length	m	real	[0.0;+Inf]	1.25
	The height of the outlet of the internal heat exchanger from the tank above the bottom of the storage tank.					
45	Height of node	Length	m	real	[0.0;+Inf]	0.25
	The height of the specified node. The number of nodes is controlled by the number of derivatives supplied to the model.					
46	Additional loss coefficient for node	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[-Inf;+Inf]	0.00
	The additional loss coefficient for the specified node. The total loss coefficient for each node will be the average loss coefficient (specified much earlier) plus this incremental loss coefficient. Incremental loss coefficients are typically used when one section of the tank is more heavily insulated than other sections or to account for thermal shorts due to pipes and fittings.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
33-44	Number of internal heat exchangers		1	50
45-46		How many temperature levels (nodes) should be used in the tank?	1	50

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Flow rate at inlet 1	Flow Rate	kg/hr	real	[-2;+Inf]	0.0
	The flow rate entering the storage tank at the first inlet.					
2	Flow rate at outlet 1	Flow Rate	kg/hr	real	[-2;+Inf]	0.0
	The flow rate of fluid exiting the storage tank from the first outlet. One of the outlet flow rates MUST be specified as a constant value of -2 to indicate that the outlet flow rate will be determined from a mass balance on the constant volume storage tank.					

3	Not used (flow inlet 2)	Dimensionless	-	integer	[-1;-1]	-1
	This input should be set to a constant value of -1 to indicate to the general storage tank model that the tank has only 1 inlet.					
4	Flow rate at outlet 2	Flow Rate	kg/hr	real	[-2;+Inf]	-2
	The flow rate of fluid exiting ths storage tank from the second outlet. One of the outlet flow rates MUST be set to a constant value of -2 to indicate that the outlet flow rate will be determined from a mass balance on the constant volume storage tank.					
5	Temperature at inlet 1	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the fluid entering the storage tank at the first inlet.					
6	Not used (temp inlet 2)	Temperature	C	real	[-Inf;+Inf]	20.0
	This input is not used in this mode of the storage tank model.					
7	Environment temperature	Temperature	C	real	[-Inf;+Inf]	22.0
	The temperature of the environment in which the storage tank is located.					
8	Control signal for element 1	Dimensionless	-	real	[0.0;1.0]	1.0
	The control signal for the specified auxiliary heating element. The available power for the heating element will be this input multiplied by the maximum power for the element. If an auxiliary heater is not desired for the simulation, set this input to a constant of 0.0 or set the maximum power for the element to 0.0					
9	Control signal for element 2	Dimensionless	-	real	[0.0;1.0]	1.0
	The control signal for the specified auxiliary heating element. The available power for the heating element will be this input multiplied by the maximum power for the element. If an auxiliary heater is not desired for the simulation, set this input to a constant of 0.0 or set the maximum power for the element to 0.0					
10	Flow rate for heat exchanger	Flow Rate	kg/hr	real	[0.0;+Inf]	0.0
	The flow rate through the specified internal heat exchanger.					
11	Inlet temperature for heat exchanger	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature at the inlet of the specified internal heat exchanger.					
12	Nusselt constant for heat exchanger	Dimensionless	-	real	[0.0;+Inf]	0.50
	The natural convection coefficient between the storage fluid and the internal heat exchanger wall is modeled with an equation of the form: h = Nu * k / do ; Nu = C * Ra^n (See mathematical reference for details) Typical value for C is about 0.5 and n is usually 0.25.					
13	Nusselt exponent for heat exchanger	Dimensionless	-	real	[-Inf;+Inf]	0.25
	The natural convection coefficient between the storage fluid and the internal heat exchanger wall is modeled with an equation of the form: h = Nu * k / do ; Nu = C * Ra^n (See mathematical reference for details) Typical value for C is about 0.5 and n is usually 0.25.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
10-13	Number of internal heat exchangers		1	50

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Flowrate at inlet 1	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	The flow rate of fluid into the storage tank at inlet 1.					
2	Flowrate at outlet 1	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	The flow rate of fluid exiting the storage tank through outlet 1.					
3	Not used (inlet 2 flow)	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	This output should not be used in this mode of the storage tank model.					
4	Flowrate at outlet 2	Flow Rate	kg/hr	real	[0.0;+Inf]	0

	The flowrate of fluid exiting the storage tank through outlet 2.					
5	Temperature of outlet flow 1	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid exiting the storage tank through outlet 1.					
6	Temperature of outlet flow 2	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid exiting the storage tank through outlet 2.					
7	Thermal losses	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate of thermal energy loss to the environment. Includes the vented energy if a boiling condition is reached.					
8	Energy supplied by inlet 1	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is added to the storage tank by the entrance of the fluid through inlet 1.					
9	Energy removed by outlet 1	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is removed from the storage tank by the exiting of fluid through outlet 1.					
10	Not used (energy inlet 2)	Power	kJ/hr	real	[-Inf;+Inf]	0
	This output should not be used in this mode of the storage tank model.					
11	Energy removed by outlet 2	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is removed from the storage tank by the exiting of fluid through outlet 2.					
12	Auxiliary heating rate	Power	kJ/hr	real	[-Inf;+Inf]	0
	The average rate at which power was added to the tank by BOTH auxiliary heaters.					
13	Element 1 power	Power	kJ/hr	real	[-Inf;+Inf]	0
	The average power supplied to the storage tank over the timestep by the first heating element specified in the parameter list.					
14	Element 2 power	Power	kJ/hr	real	[-Inf;+Inf]	0
	The average power over the timestep supplied to the tank by the second auxiliary heater specified in the parameter list.					
15	Losses to gas flue	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is removed from the storage tank through losses to the gas flue (while the tank is not being charged by the gas flue).					
16	Internal energy change	Energy	kJ	real	[-Inf;+Inf]	0
	The change in internal energy of the tank from the beginning of the simulation.					
17	Average tank temperature	Temperature	C	real	[-Inf;+Inf]	0
	The average temperature of the fluid in the storage tank over the timestep.					
18	Static pressure difference - inlet 1	Pressure	kPa	real	[-Inf;+Inf]	0
	The static pressure difference between the top of the tank and the first inlet port.					
19	Static pressure difference - outlet 1	Pressure	kPa	real	[-Inf;+Inf]	0
	The static pressure difference between the top of the tank and the first outlet port.					
20	Not used (presure inlet 2)	Pressure	kPa	real	[-Inf;+Inf]	0
	This output should not be used in this mode of the storage tnk model.					
21	Static pressure difference - outlet 2	Pressure	kPa	real	[-Inf;+Inf]	0
	The static pressure difference between the top of the tank and the second outlet port.					
22	Energy input from heat exchanger	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is added to the storage tank from the specified internal heat exchanger.					
23	Temperature of fluid exiting heat exchanger	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid exiting the specified internal heat exchanger.					
24	Tank temperature at outlet of heat exchanger	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the storage tank at the outlet of the specified internal heat exchanger.					
25	LMTD of heat exchanger	Temperature	C	real	[-Inf;+Inf]	0
	The average log mean temperature difference of the specified internal heat exchanger over the timestep.					

26	UA of heat exchanger	Overall Loss Coefficient	kJ/hr.K	real	[0.0;+Inf]	0
	The average overall heat transfer coefficient of the specified internal heat exchanger over the timestep.					
27	Tank temperature - top	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid at the top of the storage tank.					
28	Tank temperature - bottom	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid at the bottom of the storage tank.					
29	Temperature of node 1+	Temperature	C	real	[-Inf;+Inf]	0
	Temperature of node 1+ The temperature of the specified node.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
22-26	Number of internal heat exchangers		1	50
29-29		Besides the top and bottom nodes, how many other nodes are there?	1	13

DERIVATIVES

	Name	Dimension	Unit	Type	Range	Default
1	Initial temperature of node	Temperature	C	real	[-Inf;+Inf]	0
	The initial temperature of the specified node.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
1-1		How many temperature levels (nodes) should be used in the tank?	1	50

4.12.1.3. Horizontal Cylinder - Non-Uniform Losses and Heights - 2 Inlets, 1 Outlet

Icon		TRNSYS Model	Type 60
Proforma	Thermal Storage\Detailed Fluid Storage Tank\Horizontal Cylinder\Non-Uniform Losses and Heights\2 Inlets, 1 Outlet\Type60o.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	User-specified inlet positions	Dimensionless	-	integer	[1;2]	2
	The auxiliary storage tank may operate in one of two modes in determining the inlet positions of the flow streams. In this mode (2), the user must specify the locations (nodes) of the entering flow streams. Do not change this parameter.					
2	Tank volume	Volumetric Flow Rate	m^3	real	[0.0;+Inf]	0.35
	The actual volume of the storage tank (not the nominal value).					
3	Tank height	Length	m	real	[0.0;+Inf]	1.25
	The height of the storage tank. If the tank is a horizontal cylinder, this parameter should be set to the diameter of the storage tank.					
4	Horizontal cylinder	Length	m	integer	[-2;-2]	-2
	By setting this parameter to -2, the user is specifying that the tank is cylindrical with a horizontal orientation (laying on its side). Do not change this parameter.					
5	Height of flow inlet 1	Length	m	real	[0.0;+Inf]	1.25
	The height of the first inlet above the bottom of the tank. Make sure that this value is between 0 and the total height of the tank.					
6	Height of flow outlet 1	Length	m	real	[0.0;+Inf]	0.0
	The height of the first outlet from the storage tank above the bottom of the tank. Make sure that this value is between 0 and the total height of the tank.					
7	Height of flow inlet 2	Length	m	real	[0.0;+Inf]	0.0
	The height of the second inlet to the staorage tank above the bottom of the tank. Make sure that this value is between 0 and the total height of the storage tank.					
8	Not Used (outlet 2)	Dimensionless	-	integer	[-1;-1]	-1
	This parameter should be set to a value of -1 to indicate to the general storage tank model that there is only one outlet from the tank.					
9	Fluid specific heat	Specific Heat	kJ/kg.K	real	[0.0;+Inf]	4.190
	The specific heat of the fluid contained in the storage tank.					
10	Fluid density	Density	kg/m^3	real	[0.0;+Inf]	1000.0
	The density of the fluid contained in the storage tank.					
11	Tank loss coefficient	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[0.0;+Inf]	3.0
	The average tank loss coefficient per unit area. Different loss coefficients for each node can be modeled by use of the incremental loss coefficient parameters.					
12	Fluid thermal conductivity	Thermal Conductivity	kJ/hr.m.K	real	[0.0;+Inf]	1.40
	The thermal conductivity of the fluid contained in the storage tank.					
13	Destratification conductivity	Thermal Conductivity	kJ/hr.m.K	real	[0.0;+Inf]	0.0
	To model de-stratification due to mixing at node interfaces and conduction along the tank wall, the user may enter this additional conductivity parameter. The additional conductivity term is added to the conductivity of the tank fluid and is applied to all nodes. For rough calculations, one may calculate this parameter as the thermal conductivity of the tank wall times the cross sectional area of the tank wall divided by the cross sectional area					

	of the fluid in the storage tank.					
14	Boiling temperature	Temperature	C	real	[-Inf;+Inf]	100.0
	The boiling point temperature of the fluid contained in the storage tank.					
15	Auxiliary heater mode	Dimensionless	-	integer	[1;2]	1
	The auxiliary heater may be operated in one of two modes: 1 = Master/Slave Relation: The lower heating element is only enabled when the upper heating element is satisified. In this mode, only one heater may be on at any instant of time. This is a common design in residential electric hot water tanks. 2 = Both Enabled: In this mode, both heaters may be on simultaneously. This allows for significantly quicker heating of the water, but at a much higher electrical demand.					
16	Height of 1st aux. heater	Length	m	real	[0.0;+Inf]	1.0
	The height of the first auxiliary heater element above the bottom of the storage tank. If there are no auxiliary heaters, set this parameter and the thermostat height parameter to any value between 0 anf the total tank height. Then simply set either the maximum heating rate or the control signal for this heating element to a constant value of 0.					
17	Height of 1st thermostat	Length	m	real	[0.0;+Inf]	1.25
	The height of the thermostat for the first heating element above the bottom of the storage tank. If there are no heating elements, simply set this parameter to any value between 0 and the total tank height. Then set either the maximum heating rate or the control signal for this heating element to a constant value of 0.					
18	Set point temperature for element 1	Temperature	C	real	[-Inf;+Inf]	55.0
	The set point temperature for the specified heating element. The thermostat will enable the heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb and continue to heat the fluid until it reaches the set point temperature. Tset = this parameter; Tdb = next parameter					
19	Deadband for heating element 1	Temp. Difference	deltaC	real	[-Inf;+Inf]	5.0
	The dead band temperature difference for the specified heating element. The thermostat will enable the heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb and continue to heat the fluid until it reaches the set point temperature. Where Tset = previous parameter; Tdb = this parameter					
20	Maximum heating rate of element 1	Power	kJ/hr	real	[0.0;+Inf]	16200.0
	The maximum heating rate of the heating element. If the specified heating element is to not to be used for the simulation, set the maximum power to 0.					
21	Height of heating element 2	Length	m	integer	[1;15]	1
	The node containing the specified auxiliary heating element. Make sure that the specified node for the heater is between 1 and the total number of nodes specified. Node 1 is the topmost node in the tank.					
22	Height of thermostat 2	Length	m	integer	[1;15]	1
	The node containing the thermostat for the specified auxiliary heater. The thermostat is typically either located in the same node as the heating element or in a node located above the element. Node 1 is the topmost node in the tank.					
23	Set point temperature for element 2	Temperature	C	real	[-Inf;+Inf]	55.0
	The set point temperature for the specified heating element. The thermostat will enable the heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb and continue to heat the fluid until it reaches the set point temperature. Tset = this parameter; Tdb = next parameter					
24	Deadband for heating element 2	Temp. Difference	deltaC	real	[0.0;+Inf]	5.0
	The dead band temperature difference for the specified heating element. The thermostat will enable the					

	heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb and continue to heat the fluid until it reaches the set point temperature. Where Tset = previous parameter; Tdb = this parameter					
25	Maximum heating rate of element 2	Power	kJ/hr	real	[0.0;+Inf]	16200
	The maximum heating rate of the heating element. If the specified heating element is to not to be used for the simulation, set the maximum power to 0.					
26	Overall loss coefficient for gas flue	Overall Loss Coefficient	kJ/hr.K	real	[0.0;+Inf]	0.0
	The overall loss coefficient of the gas flue when the tank is not being heated. If this tank is not being heated by gas, simply set this parameter to 0.0 and the next parameter (flue temperature) to any reasonable value.					
27	Flue temperature	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the gas flue when the tank is not being heated. This parameter is used tto calculate the losses from the storage to the flue when the tank is not being heated. If the tank is not heated witth gas, simply set this parameter to any reasonable value and set the previous parameter (flue loss coefficient) to 0.					
28	Fraction of critical timestep	Dimensionless	-	integer	[1;1000]	6
	To minimize numerical errors, the TYPE 60 tank model uses its own internal time step. This has the advantage of results being unaffected by the size of the TRNSYS time step. The model internally computes the critical Euler time step. The user then chooses the fraction of the critical time step that will be used. Increasing this parameter will increase the accuracy of the model, but decrease the simulation speed. A value of 6 represents an excellent compromise between accuracy and speed for most simulations.					
29	Gas heater?	Dimensionless	-	integer	[0;+Inf]	1
	This parameter indicates to the general storage tank model whether the tank is heated with electric elements, with a gas flue, or with a combination of gas and electric. 0 = Both heater are electric 1 = Auxiliary heater #2 is gas (setting the maximum heating rate of the first heating element to zero or non-zero dictates whether the tank also has an electric element).					
30	Number of internal heat exchangers	Dimensionless	-	integer	[0;3]	1
	The number of internal heat exchangers that are contained within the storage tank. For each internal heat exchanger, the user must specify 12 parameters that describe the heat exchanger.					
31	Node heights supplied	Dimensionless	-	integer	[1;1]	1
	This parameter indicates to the general storage taank model that the user will be supplying the height of all the nodes in the storage tank. The number of nodes is controlled by the number of derivatives supplied. Do not change this parameter.					
32	Additional loss coeff's supplied	Dimensionless	-	integer	[1;1]	1
	This parameter indicates to the general storagee tank model that the user will be specifying the value of the incremental loss coefficients for each node in the storage tank. The number of nodes is controlled by the number of supplied derivatives. Do not change this parameter.					
33	HX Fluid Indicator	Dimensionless	-	integer	[1;3]	1
	The fluid contained in the first internal heat exchanger: 1=Water ; 2=Propylene Glycol ; 3=Ethylene Glycol These fluids are contained in the internal heat exchanger and are not mixed with the storage fluid.					
34	Fraction of glycol	Dimensionless	-	real	[0.0;1.0]	0.75
	The fraction of glycol contained in the internal heat exchanger fluid by volume. If the previous parameter is set to 1 (water), this parameter is ignored. If the previous parameter is set to propylene glycol (2), this parameter may range from 0 to 1. If the previous parameter indicates ethylene glycol (3), this parameter may range from 0.55 to 0.85.					
35	Heat exchanger inside diameter	Length	m	real	[0.0;+Inf]	0.01
	The inside diameter of the pipe comprising the internal heat exchanger.					
36	Heat exchanger outside diameter	Length	m	real	[0.0;+Inf]	0.012
	The outside diameter of the pipe comprising the internal heat exchanger.					

37	Heat exchanger fin diameter	Length	m	real	[0.0;+Inf]	0.012
	The diameter of the fins on the outside pipe surface of the internal heat exchanger. If there are no fins (a smooth tube), set this parameter equal to the previous parameter (heat exchanger outside diameter).					
38	Total surface area of heat exchanger	Area	m^2	real	[0.0;+Inf]	1.0
	The total outside surface area of the internal heat exchanger.					
39	Fins per meter for heat exchanger	Dimensionless	-	integer	[0;+Inf]	100
	The number of fins per unit length (meter) on the outside surface of the internal heat exchanger pipe. This parameter is ignored for smooth tubes.					
40	Heat exchanger length	Length	m	real	[0.0;+Inf]	2.0
	The total length of internal heat exchanger pipe immersed within the storage tank fluid.					
41	Heat exchanger wall conductivity	Thermal Conductivity	kJ/hr.m.K	real	[0.0;+Inf]	1.40
	The conductivity of the heat exchanger wall including any applicable contact resistance. Contact resistance would be present with a double wall heat exchanger where the heat exchaanger is a tube within a tube design.					
42	Heat exchanger material conductivity	Thermal Conductivity	kJ/hr.m.K	real	[0.0;+Inf]	1.40
	The thermal conductivity of the material which comprises the internal heat exchanger.					
43	Height of heat exchanger inlet	Length	m	real	[0.0;+Inf]	0.00
	The height above the bottom of the storage tank of the inlet of the internal heat exchanger.					
44	Height of heat exchanger outlet	Length	m	real	[0.0;+Inf]	1.25
	The height of the outlet of the internal heat exchanger from the tank above the bottom of the storage tank.					
45	Height of node	Length	m	real	[0.0;+Inf]	0.25
	The height of the specified node. The number of nodes is controlled by the number of derivatives supplied to the model.					
46	Additional loss coefficient for node	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[-Inf;+Inf]	0.00
	The additional loss coefficient for the specified node. The total loss coefficient for each node will be the average loss coefficient (specified much earlier) plus this incremental loss coefficient. Incremental loss coefficients are typically used when one section of the tank is more heavily insulated than other sections or to account for thermal shorts due to pipes and fittings.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
33-44	Number of internal heat exchangers		1	50
45-46		How many temperature levels (nodes) should be used in the tank?	1	50

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Flow rate at inlet 1	Flow Rate	kg/hr	real	[-2;+Inf]	0.0
	The flow rate entering the storage tank at the first inlet.					
2	Flow rate at outlet 1	Flow Rate	kg/hr	real	[-2;+Inf]	-2
	The flow rate of fluid exiting the storage tank from the first outlet. One of the outlet flow rates MUST be specified as a constant value of -2 to indicate that the outlet flow rate will be determined from a mass balance on the constant volume storage tank.					
3	Flow rate at inlet 2	Flow Rate	kg/hr	real	[-2;+Inf]	0.0
	The flow rate of fluid entering the storage tank at the second inlet.					

4	Not used (outlet 2)	Dimensionless	-	integer	[-1;-1]	-1
	This input must be set to a constant value of -1 to inform the general storage tank model that there is only one outlet from the tank.					
5	Temperature at inlet 1	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the fluid entering the storage tank at the first inlet.					
6	Temperature at inlet 2	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the fluid entering the storage tank at the second inlet.					
7	Environment temperature	Temperature	C	real	[-Inf;+Inf]	22.0
	The temperature of the environment in which the storage tank is located.					
8	Control signal for element 1	Dimensionless	-	real	[0.0;1.0]	1.0
	The control signal for the specified auxiliary heating element. The available power for the heating element will be this input multiplied by the maximum power for the element. If an auxiliary heater is not desired for the simulation, set this input to a constant of 0.0 or set the maximum power for the element to 0.0					
9	Control signal for element 2	Dimensionless	-	real	[0.0;1.0]	1.0
	The control signal for the specified auxiliary heating element. The available power for the heating element will be this input multiplied by the maximum power for the element. If an auxiliary heater is not desired for the simulation, set this input to a constant of 0.0 or set the maximum power for the element to 0.0					
10	Flow rate for heat exchanger	Flow Rate	kg/hr	real	[0.0;+Inf]	0.0
	The flow rate through the specified internal heat exchanger.					
11	Inlet temperature for heat exchanger	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature at the inlet of the specified internal heat exchanger.					
12	Nusselt constant for heat exchanger	Dimensionless	-	real	[0.0;+Inf]	0.50
	The natural convection coefficient between the storage fluid and the internal heat exchanger wall is modeled with an equation of the form: h = Nu * k / do ; Nu = C * Ra^n (See mathematical reference for details) Typical value for C is about 0.5 and n is usually 0.25.					
13	Nusselt exponent for heat exchanger	Dimensionless	-	real	[-Inf;+Inf]	0.25
	The natural convection coefficient between the storage fluid and the internal heat exchanger wall is modeled with an equation of the form: h = Nu * k / do ; Nu = C * Ra^n (See mathematical reference for details) Typical value for C is about 0.5 and n is usually 0.25.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
10-13	Number of internal heat exchangers		1	50

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Flowrate at inlet 1	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	The flow rate of fluid into the storage tank at inlet 1.					
2	Flowrate at outlet 1	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	The flow rate of fluid exiting the storage tank through outlet 1.					
3	Flowrate at inlet 2	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	The flow rate of fluid entering the storage tank through inlet 2.					
4	Not used in this mode	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	This output is not available in this mode.					
5	Temperature of outlet flow 1	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid exiting the storage tank through outlet 1.					
6	Not used (temp at outlet 2)	Temperature	C	real	[-Inf;+Inf]	0
	This output should not be used in this mode of the storage tank.					

7	Thermal losses	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate of thermal energy loss to the environment. Includes the vented energy if a boiling condition is reached.					
8	Energy supplied by inlet 1	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is added to the storage tank by the entrance of the fluid through inlet 1.					
9	Energy removed by outlet 1	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is removed from the storage tank by the exiting of fluid through outlet 1.					
10	Energy supllied by inlet 2	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is added to the storage tank by the entrance of the fluid through inlet 2.					
11	Not used (energy outlet 2)	Power	kJ/hr	real	[-Inf;+Inf]	0
	This output should not be used in this mode of the storage tank model.					
12	Auxiliary heating rate	Power	kJ/hr	real	[-Inf;+Inf]	0
	The average rate at which power was added to the tank by BOTH auxiliary heaters.					
13	Element 1 power	Power	kJ/hr	real	[-Inf;+Inf]	0
	The average power supplied to the storage tank over the timestep by the first heating element specified in the parameter list.					
14	Element 2 power	Power	kJ/hr	real	[-Inf;+Inf]	0
	The average power over the timestep supplied to the tank by the second auxiliary heater specified in the parameter list.					
15	Losses to gas flue	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is removed from the storage tank through losses to the gas flue (while the tank is not being charged by the gas flue).					
16	Internal energy change	Energy	kJ	real	[-Inf;+Inf]	0
	The change in internal energy of the tank from the beginning of the simulation.					
17	Average tank temperature	Temperature	C	real	[-Inf;+Inf]	0
	The average temperature of the fluid in the storage tank over the timestep.					
18	Static pressure difference - inlet 1	Pressure	kPa	real	[-Inf;+Inf]	0
	The static pressure difference between the top of the tank and the first inlet port.					
19	Static pressure difference - outlet 1	Pressure	kPa	real	[-Inf;+Inf]	0
	The static pressure difference between the top of the tank and the first outlet port.					
20	Static pressure difference - inlet 2	Pressure	kPa	real	[-Inf;+Inf]	0
	The static pressure difference between the top of the tank and the second inlet port.					
21	Not used (pressure outlet 2)	Pressure	kPa	real	[-Inf;+Inf]	0
	This output should not be used in this mode of the storage tank model.					
22	Energy input from heat exchanger	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is added to the storage tank from the specified internal heat exchanger.					
23	Temperature of fluid exiting heat exchanger	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid exiting the specified internal heat exchanger.					
24	Tank temperature at outlet of heat exchanger	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the storage tank at the outlet of the specified internal heat exchanger.					
25	LMTD of heat exchanger	Temperature	C	real	[-Inf;+Inf]	0
	The average log mean temperature difference of the specified internal heat exchanger over the timestep.					
26	UA of heat exchanger	Overall Loss Coefficient	kJ/hr.K	real	[0.0;+Inf]	0
	The average overall heat transfer coefficient of the specified internal heat exchanger over the timestep.					
27	Tank temperature - top	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid at the top of the storage tank.					

28	Tank temperature - bottom	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid at the bottom of the storage tank.					
29	Temperature of node 1+	Temperature	C	real	[-Inf;+Inf]	0
	Temperature of node 1+ The temperature of the specified node.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
22-26	Number of internal heat exchangers		1	50
29-29		Besides the top and bottom nodes, how many other nodes are there?	1	13

DERIVATIVES

	Name	Dimension	Unit	Type	Range	Default
1	Initial temperature of node	Temperature	C	real	[-Inf;+Inf]	0
	The initial temperature of the specified node.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
1-1		How many temperature levels (nodes) should be used in the tank?	1	50

4.12.1.4. Horizontal Cylinder - Non-Uniform Losses and Heights - 2 Inlets, 2 Outlets

Icon		TRNSYS Model	Type 60
Proforma	Thermal Storage\Detailed Fluid Storage Tank\Horizontal Cylinder\Non-Uniform Losses and Heights\2 Inlets, 2 Outlets\Type60n.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	User-specified inlet positions	Dimensionless	-	integer	[1;2]	2
	The auxiliary storage tank may operate in one of two modes in determining the inlet positions of the flow streams. In this mode (2), the user must specify the locations (nodes) of the entering flow streams. Do not change this parameter.					
2	Tank volume	Volumetric Flow Rate	m^3	real	[0.0;+Inf]	0.35
	The actual volume of the storage tank (not the nominal value).					
3	Tank height	Length	m	real	[0.0;+Inf]	1.25
	The height of the storage tank. If the tank is a horizontal cylinder, this parameter should be set to the diameter of the storage tank.					
4	Horizontal cylinder	Length	m	integer	[-2;-2]	-2
	By setting this parameter to -2, the user is specifying that the tank is cylindrical with a horizontal orientation (laying on its side). Do not change this parameter.					
5	Height of flow inlet 1	Length	m	real	[0.0;+Inf]	1.25
	The height of the first inlet above the bottom of the tank. Make sure that this value is between 0 and the total height of the tank.					
6	Height of flow outlet 1	Length	m	real	[0.0;+Inf]	0.0
	The height of the first outlet from the storage tank above the bottom of the tank. Make sure that this value is between 0 and the total height of the tank.					
7	Height of flow inlet 2	Length	m	real	[0.0;+Inf]	0.0
	The height of the second inlet to the staorage tank above the bottom of the tank. Make sure that this value is between 0 and the total height of the storage tank.					
8	Height of flow outlet 2	Length	m	real	[0.0;+Inf]	1.25
	The height of the 2nd outlet from the storage tank above the bottom of the tank. Make sure that this value is between 0 and the total height of the storage tank.					
9	Fluid specific heat	Specific Heat	kJ/kg.K	real	[0.0;+Inf]	4.190
	The specific heat of the fluid contained in the storage tank.					
10	Fluid density	Density	kg/m^3	real	[0.0;+Inf]	1000.0
	The density of the fluid contained in the storage tank.					
11	Tank loss coefficient	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[0.0;+Inf]	3.0
	The average tank loss coefficient per unit area. Different loss coefficients for each node can be modeled by use of the incremental loss coefficient parameters.					
12	Fluid thermal conductivity	Thermal Conductivity	kJ/hr.m.K	real	[0.0;+Inf]	1.40
	The thermal conductivity of the fluid contained in the storage tank.					
13	Destratification conductivity	Thermal Conductivity	kJ/hr.m.K	real	[0.0;+Inf]	0.0
	To model de-stratification due to mixing at node interfaces and conduction along the tank wall, the user may enter this additional conductivity parameter. The additional conductivity term is added to the conductivity of the tank fluid and is applied to all nodes. For rough calculations, one may calculate this parameter as the thermal conductivity of the tank wall times the cross sectional area of the tank wall divided by the cross sectional area					

	of the fluid in the storage tank.					
14	Boiling temperature	Temperature	C	real	[-Inf;+Inf]	100.0
	The boiling point temperature of the fluid contained in the storage tank.					
15	Auxiliary heater mode	Dimensionless	-	integer	[1;2]	1
	The auxiliary heater may be operated in one of two modes: 1 = Master/Slave Relation: The lower heating element is only enabled when the upper heating element is satisified. In this mode, only one heater may be on at any instant of time. This is a common design in residential electric hot water tanks. 2 = Both Enabled: In this mode, both heaters may be on simultaneously. This allows for significantly quicker heating of the water, but at a much higher electrical demand.					
16	Height of 1st aux. heater	Length	m	real	[0.0;+Inf]	1.0
	The height of the first auxiliary heater element above the bottom of the storage tank. If there are no auxiliary heaters, set this parameter and the thermostat height parameter to any value between 0 anf the total tank height. Then simply set either the maximum heating rate or the control signal for this heating element to a constant value of 0.					
17	Height of 1st thermostat	Length	m	real	[0.0;+Inf]	1.25
	The height of the thermostat for the first heating element above the bottom of the storage tank. If there are no heating elements, simply set this parameter to any value between 0 and the total tank height. Then set either the maximum heating rate or the control signal for this heating element to a constant value of 0.					
18	Set point temperature for element 1	Temperature	C	real	[-Inf;+Inf]	55.0
	The set point temperature for the specified heating element. The thermostat will enable the heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb and continue to heat the fluid until it reaches the set point temperature. Tset = this parameter; Tdb = next parameter					
19	Deadband for heating element 1	Temp. Difference	deltaC	real	[-Inf;+Inf]	5.0
	The dead band temperature difference for the specified heating element. The thermostat will enable the heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb and continue to heat the fluid until it reaches the set point temperature. Where Tset = previous parameter; Tdb = this parameter					
20	Maximum heating rate of element 1	Power	kJ/hr	real	[0.0;+Inf]	16200.0
	The maximum heating rate of the heating element. If the specified heating element is to not to be used for the simulation, set the maximum power to 0.					
21	Height of heating element 2	Length	m	integer	[1;15]	1
	The node containing the specified auxiliary heating element. Make sure that the specified node for the heater is between 1 and the total number of nodes specified. Node 1 is the topmost node in the tank.					
22	Height of thermostat 2	Length	m	integer	[1;15]	1
	The node containing the thermostat for the specified auxiliary heater. The thermostat is typically either located in the same node as the heating element or in a node located above the element. Node 1 is the topmost node in the tank.					
23	Set point temperature for element 2	Temperature	C	real	[-Inf;+Inf]	55.0
	The set point temperature for the specified heating element. The thermostat will enable the heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb and continue to heat the fluid until it reaches the set point temperature. Tset = this parameter; Tdb = next parameter					
24	Deadband for heating element 2	Temp. Difference	deltaC	real	[0.0;+Inf]	5.0
	The dead band temperature difference for the specified heating element. The thermostat will enable the					

	heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb and continue to heat the fluid until it reaches the set point temperature. Where Tset = previous parameter; Tdb = this parameter					
25	Maximum heating rate of element 2	Power	kJ/hr	real	[0.0;+Inf]	16200
	The maximum heating rate of the heating element. If the specified heating element is to not to be used for the simulation, set the maximum power to 0.					
26	Overall loss coefficient for gas flue	Overall Loss Coefficient	kJ/hr.K	real	[0.0;+Inf]	0.0
	The overall loss coefficient of the gas flue when the tank is not being heated. If this tank is not being heated by gas, simply set this parameter to 0.0 and the next parameter (flue temperature) to any reasonable value.					
27	Flue temperature	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the gas flue when the tank is not being heated. This parameter is used tto calculate the losses from the storage to the flue when the tank is not being heated. If the tank is not heated witth gas, simply set this parameter to any reasonable value and set the previous parameter (flue loss coefficient) to 0.					
28	Fraction of critical timestep	Dimensionless	-	integer	[1;1000]	6
	To minimize numerical errors, the TYPE 60 tank model uses its own internal time step. This has the advantage of results being unaffected by the size of the TRNSYS time step. The model internally computes the critical Euler time step. The user then chooses the fraction of the critical time step that will be used. Increasing this parameter will increase the accuracy of the model, but decrease the simulation speed. A value of 6 represents an excellent compromise between accuracy and speed for most simulations.					
29	Gas heater?	Dimensionless	-	integer	[0;+Inf]	1
	This parameter indicates to the general storage tank model whether the tank is heated with electric elements, with a gas flue, or with a combination of gas and electric. 0 = Both heater are electric 1 = Auxiliary heater #2 is gas (setting the maximum heating rate of the first heating element to zero or non-zero dictates whether the tank also has an electric element).					
30	Number of internal heat exchangers	Dimensionless	-	integer	[0;3]	1
	The number of internal heat exchangers that are contained within the storage tank. For each internal heat exchanger, the user must specify 12 parameters that describe the heat exchanger.					
31	Node heights supplied	Dimensionless	-	integer	[1;1]	1
	This parameter indicates to the general storage taank model that the user will be supplying the height of all the nodes in the storage tank. The number of nodes is controlled by the number of derivatives supplied. Do not change this parameter.					
32	Additional loss coeff's supplied	Dimensionless	-	integer	[1;1]	1
	This parameter indicates to the general storagee tank model that the user will be specifying the value of the incremental loss coefficients for each node in the storage tank. The number of nodes is controlled by the number of supplied derivatives. Do not change this parameter.					
33	HX Fluid Indicator	Dimensionless	-	integer	[1;3]	1
	The fluid contained in the first internal heat exchanger: 1=Water ; 2=Propylene Glycol ; 3=Ethylene Glycol These fluids are contained in the internal heat exchanger and are not mixed with the storage fluid.					
34	Fraction of glycol	Dimensionless	-	real	[0.0;1.0]	0.75
	The fraction of glycol contained in the internal heat exchanger fluid by volume. If the previous parameter is set to 1 (water), this parameter is ignored. If the previous parameter is set to propylene glycol (2), this parameter may range from 0 to 1. If the previous parameter indicates ethylene glycol (3), this parameter may range from 0.55 to 0.85.					
35	Heat exchanger inside diameter	Length	m	real	[0.0;+Inf]	0.01
	The inside diameter of the pipe comprising the internal heat exchanger.					
36	Heat exchanger outside diameter	Length	m	real	[0.0;+Inf]	0.012
	The outside diameter of the pipe comprising the internal heat exchanger.					

37	Heat exchanger fin diameter	Length	m	real	[0.0;+Inf]	0.012
	The diameter of the fins on the outside pipe surface of the internal heat exchanger. If there are no fins (a smooth tube), set this parameter equal to the previous parameter (heat exchanger outside diameter).					
38	Total surface area of heat exchanger	Area	m^2	real	[0.0;+Inf]	1.0
	The total outside surface area of the internal heat exchanger.					
39	Fins per meter for heat exchanger	Dimensionless	-	integer	[0;+Inf]	100
	The number of fins per unit length (meter) on the outside surface of the internal heat exchanger pipe. This parameter is ignored for smooth tubes.					
40	Heat exchanger length	Length	m	real	[0.0;+Inf]	2.0
	The total length of internal heat exchanger pipe immersed within the storage tank fluid.					
41	Heat exchanger wall conductivity	Thermal Conductivity	kJ/hr.m.K	real	[0.0;+Inf]	1.40
	The conductivity of the heat exchanger wall including any applicable contact resistance. Contact resistance would be present with a double wall heat exchanger where the heat exchaanger is a tube within a tube design.					
42	Heat exchanger material conductivity	Thermal Conductivity	kJ/hr.m.K	real	[0.0;+Inf]	1.40
	The thermal conductivity of the material which comprises the internal heat exchanger.					
43	Height of heat exchanger inlet	Length	m	real	[0.0;+Inf]	0.00
	The height above the bottom of the storage tank of the inlet of the internal heat exchanger.					
44	Height of heat exchanger outlet	Length	m	real	[0.0;+Inf]	1.25
	The height of the outlet of the internal heat exchanger from the tank above the bottom of the storage tank.					
45	Height of node	Length	m	real	[0.0;+Inf]	0.25
	The height of the specified node. The number of nodes is controlled by the number of derivatives supplied to the model.					
46	Additional loss coefficient for node	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[-Inf;+Inf]	0.00
	The additional loss coefficient for the specified node. The total loss coefficient for each node will be the average loss coefficient (specified much earlier) plus this incremental loss coefficient. Incremental loss coefficients are typically used when one section of the tank is more heavily insulated than other sections or to account for thermal shorts due to pipes and fittings.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
33-44	Number of internal heat exchangers		1	50
45-46		How many temperature levels (nodes) should be used in the tank?	1	50

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Flow rate at inlet 1	Flow Rate	kg/hr	real	[-Inf;+Inf]	0.0
	The flow rate entering the storage tank at the first inlet.					
2	Flow rate at outlet 1	Flow Rate	kg/hr	real	[-2;+Inf]	0.0
	The flow rate of fluid exiting the storage tank from the first outlet. One of the outlet flow rates MUST be specified as a constant value of -2 to indicate that the outlet flow rate will be determined from a mass balance on the constant volume storage tank.					
3	Flow rate at inlet 2	Flow Rate	kg/hr	real	[-Inf;+Inf]	0.0
	The flow rate of fluid entering the storage tank at the second inlet.					

4	Flow rate at outlet 2	Flow Rate	kg/hr	real	[-2;+Inf]	-2
	The flow rate of fluid exiting ths storage tank from the second outlet. One of the outlet flow rates MUST be set to a constant value of -2 to indicate that the outlet flow rate will be determined from a mass balance on the constant volume storage tank.					
5	Temperature at inlet 1	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the fluid entering the storage tank at the first inlet.					
6	Temperature at inlet 2	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the fluid entering the storage tank at the second inlet.					
7	Environment temperature	Temperature	C	real	[-Inf;+Inf]	22.0
	The temperature of the environment in which the storage tank is located.					
8	Control signal for element 1	Dimensionless	-	real	[0.0;1.0]	1.0
	The control signal for the specified auxiliary heating element. The available power for the heating element will be this input multiplied by the maximum power for the element. If an auxiliary heater is not desired for the simulation, set this input to a constant of 0.0 or set the maximum power for the element to 0.0					
9	Control signal for element 2	Dimensionless	-	real	[0.0;1.0]	1.0
	The control signal for the specified auxiliary heating element. The available power for the heating element will be this input multiplied by the maximum power for the element. If an auxiliary heater is not desired for the simulation, set this input to a constant of 0.0 or set the maximum power for the element to 0.0					
10	Flow rate for heat exchanger	Flow Rate	kg/hr	real	[0.0;+Inf]	0.0
	The flow rate through the specified internal heat exchanger.					
11	Inlet temperature for heat exchanger	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature at the inlet of the specified internal heat exchanger.					
12	Nusselt constant for heat exchanger	Dimensionless	-	real	[0.0;+Inf]	0.50
	The natural convection coefficient between the storage fluid and the internal heat exchanger wall is modeled with an equation of the form: h = Nu * k / do ; Nu = C * Ra^n (See mathematical reference for details) Typical value for C is about 0.5 and n is usually 0.25.					
13	Nusselt exponent for heat exchanger	Dimensionless	-	real	[-Inf;+Inf]	0.25
	The natural convection coefficient between the storage fluid and the internal heat exchanger wall is modeled with an equation of the form: h = Nu * k / do ; Nu = C * Ra^n (See mathematical reference for details) Typical value for C is about 0.5 and n is usually 0.25.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
10-13	Number of internal heat exchangers		1	50

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Flowrate at inlet 1	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	The flow rate of fluid into the storage tank at inlet 1.					
2	Flowrate at outlet 1	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	The flow rate of fluid exiting the storage tank through outlet 1.					
3	Flowrate at inlet 2	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	The flow rate of fluid entering the storage tank through inlet 2.					
4	Flowrate at outlet 2	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	The flowrate of fluid exiting the storage tank through outlet 2.					
5	Temperature of outlet flow 1	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid exiting the storage tank through outlet 1.					
6	Temperature of outlet flow 2	Temperature	C	real	[-Inf;+Inf]	0

	The temperature of the fluid exiting the storage tank through outlet 2.					
7	Thermal losses	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate of thermal energy loss to the environment. Includes the vented energy if a boiling condition is reached.					
8	Energy supplied by inlet 1	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is added to the storage tank by the entrance of the fluid through inlet 1.					
9	Energy removed by outlet 1	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is removed from the storage tank by the exiting of fluid through outlet 1.					
10	Energy supllied by inlet 2	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is added to the storage tank by the entrance of the fluid through inlet 2.					
11	Energy removed by outlet 2	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is removed from the storage tank by the exiting of fluid through outlet 2.					
12	Auxiliary heating rate	Power	kJ/hr	real	[-Inf;+Inf]	0
	The average rate at which power was added to the tank by BOTH auxiliary heaters.					
13	Element 1 power	Power	kJ/hr	real	[-Inf;+Inf]	0
	The average power supplied to the storage tank over the timestep by the first heating element specified in the parameter list.					
14	Element 2 power	Power	kJ/hr	real	[-Inf;+Inf]	0
	The average power over the timestep supplied to the tank by the second auxiliary heater specified in the parameter list.					
15	Losses to gas flue	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is removed from the storage tank through losses to the gas flue (while the tank is not being charged by the gas flue).					
16	Internal energy change	Energy	kJ	real	[-Inf;+Inf]	0
	The change in internal energy of the tank from the beginning of the simulation.					
17	Average tank temperature	Temperature	C	real	[-Inf;+Inf]	0
	The average temperature of the fluid in the storage tank over the timestep.					
18	Static pressure difference - inlet 1	Pressure	kPa	real	[-Inf;+Inf]	0
	The static pressure difference between the top of the tank and the first inlet port.					
19	Static pressure difference - outlet 1	Pressure	kPa	real	[-Inf;+Inf]	0
	The static pressure difference between the top of the tank and the first outlet port.					
20	Static pressure difference - inlet 2	Pressure	kPa	real	[-Inf;+Inf]	0
	The static pressure difference between the top of the tank and the second inlet port.					
21	Static pressure difference - outlet 2	Pressure	kPa	real	[-Inf;+Inf]	0
	The static pressure difference between the top of the tank and the second outlet port.					
22	Energy input from heat exchanger	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is added to the storage tank from the specified internal heat exchanger.					
23	Temperature of fluid exiting heat exchanger	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid exiting the specified internal heat exchanger.					
24	Tank temperature at outlet of heat exchanger	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the storage tank at the outlet of the specified internal heat exchanger.					
25	LMTD of heat exchanger	Temperature	C	real	[-Inf;+Inf]	0
	The average log mean temperature difference of the specified internal heat exchanger over the timestep.					
26	UA of heat exchanger	Overall Loss Coefficient	kJ/hr.K	real	[0.0;+Inf]	0
	The average overall heat transfer coefficient of the specified internal heat exchanger over the timestep.					
27	Tank temperature - top	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid at the top of the storage tank.					

28	Tank temperature - bottom	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid at the bottom of the storage tank.					
29	Temperature of node 1+	Temperature	C	real	[-Inf;+Inf]	0
	Temperature of node 1+ The temperature of the specified node.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
22-26	Number of internal heat exchangers		1	50
29-29		Besides the top and bottom nodes, how many other nodes are there?	1	13

DERIVATIVES

	Name	Dimension	Unit	Type	Range	Default
1	Initial temperature of node	Temperature	C	real	[-Inf;+Inf]	0
	The initial temperature of the specified node.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
1-1		How many temperature levels (nodes) should be used in the tank?	1	50

4.12.1.5. Horizontal Cylinder - Uniform Losses and Node Heights - 1 Inlet, 1 Outlet

Icon		**TRNSYS Model**	Type 60
Proforma	Thermal Storage\Detailed Fluid Storage Tank\Horizontal Cylinder\Uniform Losses and Node Heights\1 Inlet, 1 Outlet\Type60l.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	User-specified inlet positions	Dimensionless	-	integer	[1;2]	2
	The auxiliary storage tank may operate in one of two modes in determining the inlet positions of the flow streams. In this mode (2), the user must specify the locations (nodes) of the entering flow streams. Do not change this parameter.					
2	Tank volume	Volumetric Flow Rate	m^3	real	[0.0;+Inf]	0.35
	The actual volume of the storage tank (not the nominal value).					
3	Tank height	Length	m	real	[0.0;+Inf]	1.25
	The height of the storage tank. If the tank is a horizontal cylinder, this parameter should be set to the diameter of the storage tank.					
4	Horizontal cylinder	Length	m	integer	[-2;-2]	-2
	By setting this parameter to -2, the user is specifying that the tank is cylindrical with a horizontal orientation (laying on its side). Do not change this parameter.					
5	Height of flow inlet 1	Length	m	real	[0.0;+Inf]	1.25
	The height of the first inlet above the bottom of the tank. Make sure that this value is between 0 and the total height of the tank.					
6	Height of flow outlet 1	Length	m	real	[0.0;+Inf]	0.0
	The height of the first outlet from the storage tank above the bottom of the tank. Make sure that this value is between 0 and the total height of the tank.					
7	Not used (inlet 2)	Dimensionless	-	integer	[-1;-1]	-1
	This parameter must be set to -1 to indicate to the general storage tank model that there is only one inlet to this tank.					
8	Not used (outlet 2)	Dimensionless	-	integer	[-1;-1]	-1
	This parameter should be set to a value of -1 to indicate to the general storage tank model that there is only one outlet from this tank.					
9	Fluid specific heat	Specific Heat	kJ/kg.K	real	[0.0;+Inf]	4.190
	The specific heat of the fluid contained in the storage tank.					
10	Fluid density	Density	kg/m^3	real	[0.0;+Inf]	1000.0
	The density of the fluid contained in the storage tank.					
11	Tank loss coefficient	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[0.0;+Inf]	3.0
	The average tank loss coefficient per unit area. Different loss coefficients for each node can be modeled by use of the incremental loss coefficient parameters.					
12	Fluid thermal conductivity	Thermal Conductivity	kJ/hr.m.K	real	[0.0;+Inf]	1.40
	The thermal conductivity of the fluid contained in the storage tank.					
13	Destratification conductivity	Thermal Conductivity	kJ/hr.m.K	real	[0.0;+Inf]	0.0
	To model de-stratification due to mixing at node interfaces and conduction along the tank wall, the user may enter this additional conductivity parameter. The additional conductivity term is added to the conductivity of the tank fluid and is applied to all nodes. For rough calculations, one may calculate this parameter as the thermal conductivity of the tank wall times the cross sectional area of the tank wall divided by the cross sectional area					

	of the fluid in the storage tank.					
14	Boiling temperature	Temperature	C	real	[-Inf;+Inf]	100.0
	The boiling point temperature of the fluid contained in the storage tank.					
15	Auxiliary heater mode	Dimensionless	-	integer	[1;2]	1
	The auxiliary heater may be operated in one of two modes: 1 = Master/Slave Relation: The lower heating element is only enabled when the upper heating element is satisified. In this mode, only one heater may be on at any instant of time. This is a common design in residential electric hot water tanks. 2 = Both Enabled: In this mode, both heaters may be on simultaneously. This allows for significantly quicker heating of the water, but at a much higher electrical demand.					
16	Height of 1st aux. heater	Length	m	real	[0.0;+Inf]	1.0
	The height of the first auxiliary heater element above the bottom of the storage tank. If there are no auxiliary heaters, set this parameter and the thermostat height parameter to any value between 0 anf the total tank height. Then simply set either the maximum heating rate or the control signal for this heating element to a constant value of 0.					
17	Height of 1st thermostat	Length	m	real	[0.0;+Inf]	1.25
	The height of the thermostat for the first heating element above the bottom of the storage tank. If there are no heating elements, simply set this parameter to any value between 0 and the total tank height. Then set either the maximum heating rate or the control signal for this heating element to a constant value of 0.					
18	Set point temperature for element 1	Temperature	C	real	[-Inf;+Inf]	55.0
	The set point temperature for the specified heating element. The thermostat will enable the heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb and continue to heat the fluid until it reaches the set point temperature. Tset = this parameter; Tdb = next parameter					
19	Deadband for heating element 1	Temp. Difference	deltaC	real	[-Inf;+Inf]	5.0
	The dead band temperature difference for the specified heating element. The thermostat will enable the heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb and continue to heat the fluid until it reaches the set point temperature. Where Tset = previous parameter; Tdb = this parameter					
20	Maximum heating rate of element 1	Power	kJ/hr	real	[0.0;+Inf]	16200.0
	The maximum heating rate of the heating element. If the specified heating element is to not to be used for the simulation, set the maximum power to 0.					
21	Height of heating element 2	Length	m	integer	[1;15]	1
	The node containing the specified auxiliary heating element. Make sure that the specified node for the heater is between 1 and the total number of nodes specified. Node 1 is the topmost node in the tank.					
22	Height of thermostat 2	Length	m	integer	[1;15]	1
	The node containing the thermostat for the specified auxiliary heater. The thermostat is typically either located in the same node as the heating element or in a node located above the element. Node 1 is the topmost node in the tank.					
23	Set point temperature for element 2	Temperature	C	real	[-Inf;+Inf]	55.0
	The set point temperature for the specified heating element. The thermostat will enable the heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb and continue to heat the fluid until it reaches the set point temperature. Tset = this parameter; Tdb = next parameter					
24	Deadband for heating element 2	Temp. Difference	deltaC	real	[0.0;+Inf]	5.0
	The dead band temperature difference for the specified heating element. The thermostat will enable the					

	heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb and continue to heat the fluid until it reaches the set point temperature. Where Tset = previous parameter; Tdb = this parameter					
25	Maximum heating rate of element 2	Power	kJ/hr	real	[0.0;+Inf]	16200
	The maximum heating rate of the heating element. If the specified heating element is to not to be used for the simulation, set the maximum power to 0.					
26	Overall loss coefficient for gas flue	Overall Loss Coefficient	kJ/hr.K	real	[0.0;+Inf]	0.0
	The overall loss coefficient of the gas flue when the tank is not being heated. If this tank is not being heated by gas, simply set this parameter to 0.0 and the next parameter (flue temperature) to any reasonable value.					
27	Flue temperature	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the gas flue when the tank is not being heated. This parameter is used tto calculate the losses from the storage to the flue when the tank is not being heated. If the tank is not heated witth gas, simply set this parameter to any reasonable value and set the previous parameter (flue loss coefficient) to 0.					
28	Fraction of critical timestep	Dimensionless	-	integer	[1;1000]	6
	To minimize numerical errors, the TYPE 60 tank model uses its own internal time step. This has the advantage of results being unaffected by the size of the TRNSYS time step. The model internally computes the critical Euler time step. The user then chooses the fraction of the critical time step that will be used. Increasing this parameter will increase the accuracy of the model, but decrease the simulation speed. A value of 6 represents an excellent compromise between accuracy and speed for most simulations.					
29	Gas heater?	Dimensionless	-	integer	[0;+Inf]	1
	This parameter indicates to the general storage tank model whether the tank is heated with electric elements, with a gas flue, or with a combination of gas and electric. 0 = Both heater are electric 1 = Auxiliary heater #2 is gas (setting the maximum heating rate of the first heating element to zero or non-zero dictates whether the tank also has an electric element).					
30	Number of internal heat exchangers	Dimensionless	-	integer	[0;3]	1
	The number of internal heat exchangers that are contained within the storage tank. For each internal heat exchanger, the user must specify 12 parameters that describe the heat exchanger.					
31	Equal sized nodes	Dimensionless	-	integer	[0;0]	0
	This parameter indicates to the general storage tank model that all the temperature nodes should have the identical size . The number of nodes is controlled by the number of derivatives supplied. Do not change this parameter.					
32	Uniform tank losses	Dimensionless	-	integer	[0;0]	0
	This parameter indicates to the general storage tank model that the user will not be specifying the value of the incremental loss coefficients for each node in the storage tank (uniform losses from the tank is the results). The number of nodes is controlled by the number of supplied derivatives. Do not change this parameter.					
33	HX Fluid Indicator	Dimensionless	-	integer	[1;3]	1
	The fluid contained in the first internal heat exchanger: 1=Water ; 2=Propylene Glycol ; 3=Ethylene Glycol These fluids are contained in the internal heat exchanger and are not mixed with the storage fluid.					
34	Fraction of glycol	Dimensionless	-	real	[0.0;1.0]	0.75
	The fraction of glycol contained in the internal heat exchanger fluid by volume. If the previous parameter is set to 1 (water), this parameter is ignored. If the previous parameter is set to propylene glycol (2), this parameter may range from 0 to 1. If the previous parameter indicates ethylene glycol (3), this parameter may range from 0.55 to 0.85.					
35	Heat exchanger inside diameter	Length	m	real	[0.0;+Inf]	0.01
	The inside diameter of the pipe comprising the internal heat exchanger.					
36	Heat exchanger outside diameter	Length	m	real	[0.0;+Inf]	0.012
	The outside diameter of the pipe comprising the internal heat exchanger.					

37	Heat exchanger fin diameter	Length	m	real	[0.0;+Inf]	0.012
	The diameter of the fins on the outside pipe surface of the internal heat exchanger. If there are no fins (a smooth tube), set this parameter equal to the previous parameter (heat exchanger outside diameter).					
38	Total surface area of heat exchanger	Area	m^2	real	[0.0;+Inf]	1.0
	The total outside surface area of the internal heat exchanger.					
39	Fins per meter for heat exchanger	Dimensionless	-	integer	[0;+Inf]	100
	The number of fins per unit length (meter) on the outside surface of the internal heat exchanger pipe. This parameter is ignored for smooth tubes.					
40	Heat exchanger length	Length	m	real	[0.0;+Inf]	2.0
	The total length of internal heat exchanger pipe immersed within the storage tank fluid.					
41	Heat exchanger wall conductivity	Thermal Conductivity	kJ/hr.m.K	real	[0.0;+Inf]	1.40
	The conductivity of the heat exchanger wall including any applicable contact resistance. Contact resistance would be present with a double wall heat exchanger where the heat exchaanger is a tube within a tube design.					
42	Heat exchanger material conductivity	Thermal Conductivity	kJ/hr.m.K	real	[0.0;+Inf]	1.40
	The thermal conductivity of the material which comprises the internal heat exchanger.					
43	Height of heat exchanger inlet	Length	m	real	[0.0;+Inf]	0.00
	The height above the bottom of the storage tank of the inlet of the internal heat exchanger.					
44	Height of heat exchanger outlet	Length	m	real	[0.0;+Inf]	1.25
	The height of the outlet of the internal heat exchanger from the tank above the bottom of the storage tank.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
33-44	Number of internal heat exchangers		1	50

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Flow rate at inlet 1	Flow Rate	kg/hr	real	[-2;+Inf]	0.0
	The flow rate entering the storage tank at the first inlet.					
2	Flow rate at outlet 1	Flow Rate	kg/hr	real	[-2;+Inf]	-2
	The flow rate of fluid exiting the storage tank from the first outlet. One of the outlet flow rates MUST be specified as a constant value of -2 to indicate that the outlet flow rate will be determined from a mass balance on the constant volume storage tank.					
3	Not used (flow inlet 2)	Dimensionless	-	integer	[-1;-1]	-1
	This input should be set to a constant value of -1 to indicate to the general storage tank model that the tank has only 1 inlet.					
4	Not used (flow outlet 2)	Dimensionless	-	integer	[-1;-1]	-1
	This input should be set to a constant value of -1 to indicate to the general storage tank moel that there is only one outlet from this tank.					
5	Temperature at inlet 1	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the fluid entering the storage tank at the first inlet.					
6	Not used (temp inlet 2)	Temperature	C	real	[-Inf;+Inf]	20.0
	This input is not used in this mode of the storage tank model.					
7	Environment temperature	Temperature	C	real	[-Inf;+Inf]	22.0
	The temperature of the environment in which the storage tank is located.					
8	Control signal for element 1	Dimensionless	-	real	[0.0;1.0]	1.0
	The control signal for the specified auxiliary heating element. The available power for the heating element will					

	be this input multiplied by the maximum power for the element. If an auxiliary heater is not desired for the simulation, set this input to a constant of 0.0 or set the maximum power for the element to 0.0					
9	Control signal for element 2	Dimensionless	-	real	[0.0;1.0]	1.0
	The control signal for the specified auxiliary heating element. The available power for the heating element will be this input multiplied by the maximum power for the element. If an auxiliary heater is not desired for the simulation, set this input to a constant of 0.0 or set the maximum power for the element to 0.0					
10	Flow rate for heat exchanger	Flow Rate	kg/hr	real	[0.0;+Inf]	0.0
	The flow rate through the specified internal heat exchanger.					
11	Inlet temperature for heat exchanger	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature at the inlet of the specified internal heat exchanger.					
12	Nusselt constant for heat exchanger	Dimensionless	-	real	[0.0;+Inf]	0.50
	The natural convection coefficient between the storage fluid and the internal heat exchanger wall is modeled with an equation of the form: h = Nu * k / do ; Nu = C * Ra^n (See mathematical reference for details) Typical value for C is about 0.5 and n is usually 0.25.					
13	Nusselt exponent for heat exchanger	Dimensionless	-	real	[-Inf;+Inf]	0.25
	The natural convection coefficient between the storage fluid and the internal heat exchanger wall is modeled with an equation of the form: h = Nu * k / do ; Nu = C * Ra^n (See mathematical reference for details) Typical value for C is about 0.5 and n is usually 0.25.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
10-13	Number of internal heat exchangers		1	50

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Flowrate at inlet 1	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	The flow rate of fluid into the storage tank at inlet 1.					
2	Flowrate at outlet 1	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	The flow rate of fluid exiting the storage tank through outlet 1.					
3	Not used (inlet 2 flow)	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	This output should not be used in this mode of the storage tank model.					
4	Not used (outlet 2 flow)	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	This output should not be used in this model of the storage tank model.					
5	Temperature of outlet flow 1	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid exiting the storage tank through outlet 1.					
6	Not used (temp flow 2)	Temperature	C	real	[-Inf;+Inf]	0
	This output should not be used in this model of the storage tank model.					
7	Thermal losses	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate of thermal energy loss to the environment. Includes the vented energy if a boiling condition is reached.					
8	Energy supplied by inlet 1	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is added to the storage tank by the entrance of the fluid through inlet 1.					
9	Energy removed by outlet 1	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is removed from the storage tank by the exiting of fluid through outlet 1.					
10	Not used (energy inlet 2)	Power	kJ/hr	real	[-Inf;+Inf]	0
	This output should not be used in this mode of the storage tank model.					

11	Not used (energy outlet 2)	Power	kJ/hr	real	[-Inf;+Inf]	0
	This output should not be used in this mode of the storage tank model.					
12	Auxiliary heating rate	Power	kJ/hr	real	[-Inf;+Inf]	0
	The average rate at which power was added to the tank by BOTH auxiliary heaters.					
13	Element 1 power	Power	kJ/hr	real	[-Inf;+Inf]	0
	The average power supplied to the storage tank over the timestep by the first heating element specified in the parameter list.					
14	Element 2 power	Power	kJ/hr	real	[-Inf;+Inf]	0
	The average power over the timestep supplied to the tank by the second auxiliary heater specified in the parameter list.					
15	Losses to gas flue	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is removed from the storage tank through losses to the gas flue (while the tank is not being charged by the gas flue).					
16	Internal energy change	Energy	kJ	real	[-Inf;+Inf]	0
	The change in internal energy of the tank from the beginning of the simulation.					
17	Average tank temperature	Temperature	C	real	[-Inf;+Inf]	0
	The average temperature of the fluid in the storage tank over the timestep.					
18	Static pressure difference - inlet 1	Pressure	kPa	real	[-Inf;+Inf]	0
	The static pressure difference between the top of the tank and the first inlet port.					
19	Static pressure difference - outlet 1	Pressure	kPa	real	[-Inf;+Inf]	0
	The static pressure difference between the top of the tank and the first outlet port.					
20	Not used (pressure inlet 2)	Pressure	kPa	real	[-Inf;+Inf]	0
	This output should not be used in this mode of the storage tnk model.					
21	Not used (pressure outlet 2)	Pressure	kPa	real	[-Inf;+Inf]	0
	This output should not be used in this mode of the storage tank model.					
22	Energy input from heat exchanger	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is added to the storage tank from the specified internal heat exchanger.					
23	Temperature of fluid exiting heat exchanger	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid exiting the specified internal heat exchanger.					
24	Tank temperature at outlet of heat exchanger	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the storage tank at the outlet of the specified internal heat exchanger.					
25	LMTD of heat exchanger	Temperature	C	real	[-Inf;+Inf]	0
	The average log mean temperature difference of the specified internal heat exchanger over the timestep.					
26	UA of heat exchanger	Overall Loss Coefficient	kJ/hr.K	real	[0.0;+Inf]	0
	The average overall heat transfer coefficient of the specified internal heat exchanger over the timestep.					
27	Tank temperature - top	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid at the top of the storage tank.					
28	Tank temperature - bottom	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid at the bottom of the storage tank.					
29	Temperature of node 1+	Temperature	C	real	[-Inf;+Inf]	0
	Temperature of node 1+ The temperature of the specified node.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
22-26	Number of internal heat		1	50

	exchangers			
29-29		Besides the top and bottom nodes, how many other nodes are there?	1	13

DERIVATIVES

	Name	Dimension	Unit	Type	Range	Default
1	Initial temperature of node	Temperature	C	real	[-Inf;+Inf]	0
	The initial temperature of the specified node.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
1-1		How many temperature levels (nodes) should be used in the tank?	1	50

4.12.1.6. Horizontal Cylinder - Uniform Losses and Node Heights - 1 Inlet, 2 Outlets

Icon		TRNSYS Model	Type 60
Proforma	Thermal Storage\Detailed Fluid Storage Tank\Horizontal Cylinder\Uniform Losses and Node Heights\1 Inlet, 2 Outlets\Type60i.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	User-specified inlet positions	Dimensionless	-	integer	[1;2]	2
	The auxiliary storage tank may operate in one of two modes in determining the inlet positions of the flow streams. In this mode (2), the user must specify the locations (nodes) of the entering flow streams. Do not change this parameter.					
2	Tank volume	Volumetric Flow Rate	m^3	real	[0.0;+Inf]	0.35
	The actual volume of the storage tank (not the nominal value).					
3	Tank height	Length	m	real	[0.0;+Inf]	1.25
	The height of the storage tank. If the tank is a horizontal cylinder, this parameter should be set to the diameter of the storage tank.					
4	Horizontal cylinder	Length	m	integer	[-2;-2]	-2
	By setting this parameter to -2, the user is specifying that the tank is cylindrical with a horizontal orientation (laying on its side). Do not change this parameter.					
5	Height of flow inlet 1	Length	m	real	[0.0;+Inf]	1.25
	The height of the first inlet above the bottom of the tank. Make sure that this value is between 0 and the total height of the tank.					
6	Height of flow outlet 1	Length	m	real	[0.0;+Inf]	0.0
	The height of the first outlet from the storage tank above the bottom of the tank. Make sure that this value is between 0 and the total height of the tank.					
7	Not used (inlet 2)	Dimensionless	-	integer	[-1;-1]	-1
	This parameter must be set to -1 to indicate to the general storage tank model that there is only one inlet to this tank.					
8	Height of flow outlet 2	Length	m	real	[0.0;+Inf]	1.25
	The height of the 2nd outlet from the storage tank above the bottom of the tank. Make sure that this value is between 0 and the total height of the storage tank.					
9	Fluid specific heat	Specific Heat	kJ/kg.K	real	[0.0;+Inf]	4.190
	The specific heat of the fluid contained in the storage tank.					
10	Fluid density	Density	kg/m^3	real	[0.0;+Inf]	1000.0
	The density of the fluid contained in the storage tank.					
11	Tank loss coefficient	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[0.0;+Inf]	3.0
	The average tank loss coefficient per unit area. Different loss coefficients for each node can be modeled by use of the incremental loss coefficient parameters.					
12	Fluid thermal conductivity	Thermal Conductivity	kJ/hr.m.K	real	[0.0;+Inf]	1.40
	The thermal conductivity of the fluid contained in the storage tank.					
13	Destratification conductivity	Thermal Conductivity	kJ/hr.m.K	real	[0.0;+Inf]	0.0
	To model de-stratification due to mixing at node interfaces and conduction along the tank wall, the user may enter this additional conductivity parameter. The additional conductivity term is added to the conductivity of the tank fluid and is applied to all nodes. For rough calculations, one may calculate this parameter as the thermal conductivity of the tank wall times the cross sectional area of the tank wall divided by the cross sectional area					

	of the fluid in the storage tank.					
14	Boiling temperature	Temperature	C	real	[-Inf;+Inf]	100.0
	The boiling point temperature of the fluid contained in the storage tank.					
15	Auxiliary heater mode	Dimensionless	-	integer	[1;2]	1
	The auxiliary heater may be operated in one of two modes: 1 = Master/Slave Relation: The lower heating element is only enabled when the upper heating element is satisified. In this mode, only one heater may be on at any instant of time. This is a common design in residential electric hot water tanks. 2 = Both Enabled: In this mode, both heaters may be on simultaneously. This allows for significantly quicker heating of the water, but at a much higher electrical demand.					
16	Height of 1st aux. heater	Length	m	real	[0.0;+Inf]	1.0
	The height of the first auxiliary heater element above the bottom of the storage tank. If there are no auxiliary heaters, set this parameter and the thermostat height parameter to any value between 0 anf the total tank height. Then simply set either the maximum heating rate or the control signal for this heating element to a constant value of 0.					
17	Height of 1st thermostat	Length	m	real	[0.0;+Inf]	1.25
	The height of the thermostat for the first heating element above the bottom of the storage tank. If there are no heating elements, simply set this parameter to any value between 0 and the total tank height. Then set either the maximum heating rate or the control signal for this heating element to a constant value of 0.					
18	Set point temperature for element 1	Temperature	C	real	[-Inf;+Inf]	55.0
	The set point temperature for the specified heating element. The thermostat will enable the heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb and continue to heat the fluid until it reaches the set point temperature. Tset = this parameter; Tdb = next parameter					
19	Deadband for heating element 1	Temp. Difference	deltaC	real	[-Inf;+Inf]	5.0
	The dead band temperature difference for the specified heating element. The thermostat will enable the heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb and continue to heat the fluid until it reaches the set point temperature. Where Tset = previous parameter; Tdb = this parameter					
20	Maximum heating rate of element 1	Power	kJ/hr	real	[0.0;+Inf]	16200.0
	The maximum heating rate of the heating element. If the specified heating element is to not to be used for the simulation, set the maximum power to 0.					
21	Height of heating element 2	Length	m	integer	[1;15]	1
	The node containing the specified auxiliary heating element. Make sure that the specified node for the heater is between 1 and the total number of nodes specified. Node 1 is the topmost node in the tank.					
22	Height of thermostat 2	Length	m	integer	[1;15]	1
	The node containing the thermostat for the specified auxiliary heater. The thermostat is typically either located in the same node as the heating element or in a node located above the element. Node 1 is the topmost node in the tank.					
23	Set point temperature for element 2	Temperature	C	real	[-Inf;+Inf]	55.0
	The set point temperature for the specified heating element. The thermostat will enable the heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb and continue to heat the fluid until it reaches the set point temperature. Tset = this parameter; Tdb = next parameter					
24	Deadband for heating element 2	Temp. Difference	deltaC	real	[0.0;+Inf]	5.0
	The dead band temperature difference for the specified heating element. The thermostat will enable the					

	heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb and continue to heat the fluid until it reaches the set point temperature. Where Tset = previous parameter; Tdb = this parameter					
25	Maximum heating rate of element 2	Power	kJ/hr	real	[0.0;+Inf]	16200
	The maximum heating rate of the heating element. If the specified heating element is to not to be used for the simulation, set the maximum power to 0.					
26	Overall loss coefficient for gas flue	Overall Loss Coefficient	kJ/hr.K	real	[0.0;+Inf]	0.0
	The overall loss coefficient of the gas flue when the tank is not being heated. If this tank is not being heated by gas, simply set this parameter to 0.0 and the next parameter (flue temperature) to any reasonable value.					
27	Flue temperature	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the gas flue when the tank is not being heated. This parameter is used tto calculate the losses from the storage to the flue when the tank is not being heated. If the tank is not heated witth gas, simply set this parameter to any reasonable value and set the previous parameter (flue loss coefficient) to 0.					
28	Fraction of critical timestep	Dimensionless	-	integer	[1;1000]	6
	To minimize numerical errors, the TYPE 60 tank model uses its own internal time step. This has the advantage of results being unaffected by the size of the TRNSYS time step. The model internally computes the critical Euler time step. The user then chooses the fraction of the critical time step that will be used. Increasing this parameter will increase the accuracy of the model, but decrease the simulation speed. A value of 6 represents an excellent compromise between accuracy and speed for most simulations.					
29	Gas heater?	Dimensionless	-	integer	[0;+Inf]	1
	This parameter indicates to the general storage tank model whether the tank is heated with electric elements, with a gas flue, or with a combination of gas and electric. 0 = Both heater are electric 1 = Auxiliary heater #2 is gas (setting the maximum heating rate of the first heating element to zero or non-zero dictates whether the tank also has an electric element).					
30	Number of internal heat exchangers	Dimensionless	-	integer	[0;3]	1
	The number of internal heat exchangers that are contained within the storage tank. For each internal heat exchanger, the user must specify 12 parameters that describe the heat exchanger.					
31	Equal node sizes	Dimensionless	-	integer	[0;0]	0
	This parameter indicates to the general storage tank model that the tank should be divided into nodes of equal size. The number of nodes is controlled by the number of derivatives supplied. Do not change this parameter.					
32	Uniform tank losses	Dimensionless	-	integer	[0;0]	0
	This parameter indicates to the general storage tank model that each node in the storagetank should have an identical loss coefficient. The number of nodes is controlled by the number of supplied derivatives. Do not change this parameter.					
33	HX Fluid Indicator	Dimensionless	-	integer	[1;3]	1
	The fluid contained in the first internal heat exchanger: 1=Water ; 2=Propylene Glycol ; 3=Ethylene Glycol These fluids are contained in the internal heat exchanger and are not mixed with the storage fluid.					
34	Fraction of glycol	Dimensionless	-	real	[0.0;1.0]	0.75
	The fraction of glycol contained in the internal heat exchanger fluid by volume. If the previous parameter is set to 1 (water), this parameter is ignored. If the previous parameter is set to propylene glycol (2), this parameter may range from 0 to 1. If the previous parameter indicates ethylene glycol (3), this parameter may range from 0.55 to 0.85.					
35	Heat exchanger inside diameter	Length	m	real	[0.0;+Inf]	0.01
	The inside diameter of the pipe comprising the internal heat exchanger.					
36	Heat exchanger outside diameter	Length	m	real	[0.0;+Inf]	0.012
	The outside diameter of the pipe comprising the internal heat exchanger.					

37	Heat exchanger fin diameter	Length	m	real	[0.0;+Inf]	0.012
	The diameter of the fins on the outside pipe surface of the internal heat exchanger. If there are no fins (a smooth tube), set this parameter equal to the previous parameter (heat exchanger outside diameter).					
38	Total surface area of heat exchanger	Area	m^2	real	[0.0;+Inf]	1.0
	The total outside surface area of the internal heat exchanger.					
39	Fins per meter for heat exchanger	Dimensionless	-	integer	[0;+Inf]	100
	The number of fins per unit length (meter) on the outside surface of the internal heat exchanger pipe. This parameter is ignored for smooth tubes.					
40	Heat exchanger length	Length	m	real	[0.0;+Inf]	2.0
	The total length of internal heat exchanger pipe immersed within the storage tank fluid.					
41	Heat exchanger wall conductivity	Thermal Conductivity	kJ/hr.m.K	real	[0.0;+Inf]	1.40
	The conductivity of the heat exchanger wall including any applicable contact resistance. Contact resistance would be present with a double wall heat exchanger where the heat exchaanger is a tube within a tube design.					
42	Heat exchanger material conductivity	Thermal Conductivity	kJ/hr.m.K	real	[0.0;+Inf]	1.40
	The thermal conductivity of the material which comprises the internal heat exchanger.					
43	Height of heat exchanger inlet	Length	m	real	[0.0;+Inf]	0.00
	The height above the bottom of the storage tank of the inlet of the internal heat exchanger.					
44	Height of heat exchanger outlet	Length	m	real	[0.0;+Inf]	1.25
	The height of the outlet of the internal heat exchanger from the tank above the bottom of the storage tank.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
33-44	Number of internal heat exchangers		1	50

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Flow rate at inlet 1	Flow Rate	kg/hr	real	[-2;+Inf]	0.0
	The flow rate entering the storage tank at the first inlet.					
2	Flow rate at outlet 1	Flow Rate	kg/hr	real	[-2;+Inf]	0.0
	The flow rate of fluid exiting the storage tank from the first outlet. One of the outlet flow rates MUST be specified as a constant value of -2 to indicate that the outlet flow rate will be determined from a mass balance on the constant volume storage tank.					
3	Not used (flow inlet 2)	Dimensionless	-	integer	[-1;-1]	-1
	This input should be set to a constant value of -1 to indicate to the general storage tank model that the tank has only 1 inlet.					
4	Flow rate at outlet 2	Flow Rate	kg/hr	real	[-2;+Inf]	-2
	The flow rate of fluid exiting ths storage tank from the second outlet. One of the outlet flow rates MUST be set to a constant value of -2 to indicate that the outlet flow rate will be determined from a mass balance on the constant volume storage tank.					
5	Temperature at inlet 1	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the fluid entering the storage tank at the first inlet.					
6	Not used (temp inlet 2)	Temperature	C	real	[-Inf;+Inf]	20.0
	This input is not used in this mode of the storage tank model.					
7	Environment temperature	Temperature	C	real	[-Inf;+Inf]	22.0
	The temperature of the environment in which the storage tank is located.					
8	Control signal for element 1	Dimensionless	-	real	[0.0;1.0]	1.0

	The control signal for the specified auxiliary heating element. The available power for the heating element will be this input multiplied by the maximum power for the element. If an auxiliary heater is not desired for the simulation, set this input to a constant of 0.0 or set the maximum power for the element to 0.0					
9	Control signal for element 2	Dimensionless	-	real	[0.0;1.0]	1.0
	The control signal for the specified auxiliary heating element. The available power for the heating element will be this input multiplied by the maximum power for the element. If an auxiliary heater is not desired for the simulation, set this input to a constant of 0.0 or set the maximum power for the element to 0.0					
10	Flow rate for heat exchanger	Flow Rate	kg/hr	real	[0.0;+Inf]	0.0
	The flow rate through the specified internal heat exchanger.					
11	Inlet temperature for heat exchanger	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature at the inlet of the specified internal heat exchanger.					
12	Nusselt constant for heat exchanger	Dimensionless	-	real	[0.0;+Inf]	0.50
	The natural convection coefficient between the storage fluid and the internal heat exchanger wall is modeled with an equation of the form: h = Nu * k / do ; Nu = C * Ra^n (See mathematical reference for details) Typical value for C is about 0.5 and n is usually 0.25.					
13	Nusselt exponent for heat exchanger	Dimensionless	-	real	[-Inf;+Inf]	0.25
	The natural convection coefficient between the storage fluid and the internal heat exchanger wall is modeled with an equation of the form: h = Nu * k / do ; Nu = C * Ra^n (See mathematical reference for details) Typical value for C is about 0.5 and n is usually 0.25.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
10-13	Number of internal heat exchangers		1	50

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Flowrate at inlet 1	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	The flow rate of fluid into the storage tank at inlet 1.					
2	Flowrate at outlet 1	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	The flow rate of fluid exiting the storage tank through outlet 1.					
3	Not used (inlet 2 flow)	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	This output should not be used in this mode of the storage tank model.					
4	Flowrate at outlet 2	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	The flowrate of fluid exiting the storage tank through outlet 2.					
5	Temperature of outlet flow 1	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid exiting the storage tank through outlet 1.					
6	Temperature of outlet flow 2	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid exiting the storage tank through outlet 2.					
7	Thermal losses	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate of thermal energy loss to the environment. Includes the vented energy if a boiling condition is reached.					
8	Energy supplied by inlet 1	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is added to the storage tank by the entrance of the fluid through inlet 1.					
9	Energy removed by outlet 1	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is removed from the storage tank by the exiting of fluid through outlet 1.					
10	Not used (energy inlet 2)	Power	kJ/hr	real	[-Inf;+Inf]	0
	This output should not be used in this mode of the storage tank model.					

11	Energy removed by outlet 2	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is removed from the storage tank by the exiting of fluid through outlet 2.					
12	Auxiliary heating rate	Power	kJ/hr	real	[-Inf;+Inf]	0
	The average rate at which power was added to the tank by BOTH auxiliary heaters.					
13	Element 1 power	Power	kJ/hr	real	[-Inf;+Inf]	0
	The average power supplied to the storage tank over the timestep by the first heating element specified in the parameter list.					
14	Element 2 power	Power	kJ/hr	real	[-Inf;+Inf]	0
	The average power over the timestep supplied to the tank by the second auxiliary heater specified in the parameter list.					
15	Losses to gas flue	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is removed from the storage tank through losses to the gas flue (while the tank is not being charged by the gas flue).					
16	Internal energy change	Energy	kJ	real	[-Inf;+Inf]	0
	The change in internal energy of the tank from the beginning of the simulation.					
17	Average tank temperature	Temperature	C	real	[-Inf;+Inf]	0
	The average temperature of the fluid in the storage tank over the timestep.					
18	Static pressure difference - inlet 1	Pressure	kPa	real	[-Inf;+Inf]	0
	The static pressure difference between the top of the tank and the first inlet port.					
19	Static pressure difference - outlet 1	Pressure	kPa	real	[-Inf;+Inf]	0
	The static pressure difference between the top of the tank and the first outlet port.					
20	Not used (presure inlet 2)	Pressure	kPa	real	[-Inf;+Inf]	0
	This output should not be used in this mode of the storage tnk model.					
21	Static pressure difference - outlet 2	Pressure	kPa	real	[-Inf;+Inf]	0
	The static pressure difference between the top of the tank and the second outlet port.					
22	Energy input from heat exchanger	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is added to the storage tank from the specified internal heat exchanger.					
23	Temperature of fluid exiting heat exchanger	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid exiting the specified internal heat exchanger.					
24	Tank temperature at outlet of heat exchanger	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the storage tank at the outlet of the specified internal heat exchanger.					
25	LMTD of heat exchanger	Temperature	C	real	[-Inf;+Inf]	0
	The average log mean temperature difference of the specified internal heat exchanger over the timestep.					
26	UA of heat exchanger	Overall Loss Coefficient	kJ/hr.K	real	[0.0;+Inf]	0
	The average overall heat transfer coefficient of the specified internal heat exchanger over the timestep.					
27	Tank temperature - top	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid at the top of the storage tank.					
28	Tank temperature - bottom	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid at the bottom of the storage tank.					
29	Temperature of node 1+	Temperature	C	real	[-Inf;+Inf]	0
	Temperature of node 1+ The temperature of the specified node.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
22-26	Number of internal heat		1	50

	exchangers			
29-29		Besides the top and bottom nodes, how many other nodes are there?	1	13

DERIVATIVES

	Name	Dimension	Unit	Type	Range	Default
1	Initial temperature of node	Temperature	C	real	[-Inf;+Inf]	0
	The initial temperature of the specified node.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
1-1		How many temperature levels (nodes) should be used in the tank?	1	50

4.12.1.7. Horizontal Cylinder - Uniform Losses and Node Heights - 2 Inlets, 1 Outlet

Icon		TRNSYS Model	Type 60
Proforma	Thermal Storage\Detailed Fluid Storage Tank\Horizontal Cylinder\Uniform Losses and Node Heights\2 Inlets, 1 Outlet\Type60j.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	User-specified inlet positions	Dimensionless	-	integer	[1;2]	2
	The auxiliary storage tank may operate in one of two modes in determining the inlet positions of the flow streams. In this mode (2), the user must specify the locations (nodes) of the entering flow streams. Do not change this parameter.					
2	Tank volume	Volumetric Flow Rate	m^3	real	[0.0;+Inf]	0.35
	The actual volume of the storage tank (not the nominal value).					
3	Tank height	Length	m	real	[0.0;+Inf]	1.25
	The height of the storage tank. If the tank is a horizontal cylinder, this parameter should be set to the diameter of the storage tank.					
4	Horizontal cylinder	Length	m	integer	[-2;-2]	-2
	By setting this parameter to -2, the user is specifying that the tank is cylindrical with a horizontal orientation (laying on its side). Do not change this parameter.					
5	Height of flow inlet 1	Length	m	real	[0.0;+Inf]	1.25
	The height of the first inlet above the bottom of the tank. Make sure that this value is between 0 and the total height of the tank.					
6	Height of flow outlet 1	Length	m	real	[0.0;+Inf]	0.0
	The height of the first outlet from the storage tank above the bottom of the tank. Make sure that this value is between 0 and the total height of the tank.					
7	Height of flow inlet 2	Length	m	real	[0.0;+Inf]	0.0
	The height of the second inlet to the staorage tank above the bottom of the tank. Make sure that this value is between 0 and the total height of the storage tank.					
8	Not Used (outlet 2)	Dimensionless	-	integer	[-1;-1]	-1
	This parameter should be set to a value of -1 to indicate to the general storage tank model that there is only one outlet from the tank.					
9	Fluid specific heat	Specific Heat	kJ/kg.K	real	[0.0;+Inf]	4.190
	The specific heat of the fluid contained in the storage tank.					
10	Fluid density	Density	kg/m^3	real	[0.0;+Inf]	1000.0
	The density of the fluid contained in the storage tank.					
11	Tank loss coefficient	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[0.0;+Inf]	3.0
	The average tank loss coefficient per unit area. Different loss coefficients for each node can be modeled by use of the incremental loss coefficient parameters.					
12	Fluid thermal conductivity	Thermal Conductivity	kJ/hr.m.K	real	[0.0;+Inf]	1.40
	The thermal conductivity of the fluid contained in the storage tank.					
13	Destratification conductivity	Thermal Conductivity	kJ/hr.m.K	real	[0.0;+Inf]	0.0
	To model de-stratification due to mixing at node interfaces and conduction along the tank wall, the user may enter this additional conductivity parameter. The additional conductivity term is added to the conductivity of the tank fluid and is applied to all nodes. For rough calculations, one may calculate this parameter as the thermal conductivity of the tank wall times the cross sectional area of the tank wall divided by the cross sectional area					

	of the fluid in the storage tank.					
14	Boiling temperature	Temperature	C	real	[-Inf;+Inf]	100.0
	The boiling point temperature of the fluid contained in the storage tank.					
15	Auxiliary heater mode	Dimensionless	-	integer	[1;2]	1
	The auxiliary heater may be operated in one of two modes: 1 = Master/Slave Relation: The lower heating element is only enabled when the upper heating element is satisified. In this mode, only one heater may be on at any instant of time. This is a common design in residential electric hot water tanks. 2 = Both Enabled: In this mode, both heaters may be on simultaneously. This allows for significantly quicker heating of the water, but at a much higher electrical demand.					
16	Height of 1st aux. heater	Length	m	real	[0.0;+Inf]	1.0
	The height of the first auxiliary heater element above the bottom of the storage tank. If there are no auxiliary heaters, set this parameter and the thermostat height parameter to any value between 0 anf the total tank height. Then simply set either the maximum heating rate or the control signal for this heating element to a constant value of 0.					
17	Height of 1st thermostat	Length	m	real	[0.0;+Inf]	1.25
	The height of the thermostat for the first heating element above the bottom of the storage tank. If there are no heating elements, simply set this parameter to any value between 0 and the total tank height. Then set either the maximum heating rate or the control signal for this heating element to a constant value of 0.					
18	Set point temperature for element 1	Temperature	C	real	[-Inf;+Inf]	55.0
	The set point temperature for the specified heating element. The thermostat will enable the heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb and continue to heat the fluid until it reaches the set point temperature. Tset = this parameter; Tdb = next parameter					
19	Deadband for heating element 1	Temp. Difference	deltaC	real	[-Inf;+Inf]	5.0
	The dead band temperature difference for the specified heating element. The thermostat will enable the heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb and continue to heat the fluid until it reaches the set point temperature. Where Tset = previous parameter; Tdb = this parameter					
20	Maximum heating rate of element 1	Power	kJ/hr	real	[0.0;+Inf]	16200.0
	The maximum heating rate of the heating element. If the specified heating element is to not to be used for the simulation, set the maximum power to 0.					
21	Height of heating element 2	Length	m	integer	[1;15]	1
	The node containing the specified auxiliary heating element. Make sure that the specified node for the heater is between 1 and the total number of nodes specified. Node 1 is the topmost node in the tank.					
22	Height of thermostat 2	Length	m	integer	[1;15]	1
	The node containing the thermostat for the specified auxiliary heater. The thermostat is typically either located in the same node as the heating element or in a node located above the element. Node 1 is the topmost node in the tank.					
23	Set point temperature for element 2	Temperature	C	real	[-Inf;+Inf]	55.0
	The set point temperature for the specified heating element. The thermostat will enable the heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb and continue to heat the fluid until it reaches the set point temperature. Tset = this parameter; Tdb = next parameter					
24	Deadband for heating element 2	Temp. Difference	deltaC	real	[0.0;+Inf]	5.0
	The dead band temperature difference for the specified heating element. The thermostat will enable the					

	heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb and continue to heat the fluid until it reaches the set point temperature. Where Tset = previous parameter; Tdb = this parameter					
25	Maximum heating rate of element 2	Power	kJ/hr	real	[0.0;+Inf]	16200
	The maximum heating rate of the heating element. If the specified heating element is to not to be used for the simulation, set the maximum power to 0.					
26	Overall loss coefficient for gas flue	Overall Loss Coefficient	kJ/hr.K	real	[0.0;+Inf]	0.0
	The overall loss coefficient of the gas flue when the tank is not being heated. If this tank is not being heated by gas, simply set this parameter to 0.0 and the next parameter (flue temperature) to any reasonable value.					
27	Flue temperature	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the gas flue when the tank is not being heated. This parameter is used tto calculate the losses from the storage to the flue when the tank is not being heated. If the tank is not heated witth gas, simply set this parameter to any reasonable value and set the previous parameter (flue loss coefficient) to 0.					
28	Fraction of critical timestep	Dimensionless	-	integer	[1;1000]	6
	To minimize numerical errors, the TYPE 60 tank model uses its own internal time step. This has the advantage of results being unaffected by the size of the TRNSYS time step. The model internally computes the critical Euler time step. The user then chooses the fraction of the critical time step that will be used. Increasing this parameter will increase the accuracy of the model, but decrease the simulation speed. A value of 6 represents an excellent compromise between accuracy and speed for most simulations.					
29	Gas heater?	Dimensionless	-	integer	[0;+Inf]	1
	This parameter indicates to the general storage tank model whether the tank is heated with electric elements, with a gas flue, or with a combination of gas and electric. 0 = Both heater are electric 1 = Auxiliary heater #2 is gas (setting the maximum heating rate of the first heating element to zero or non-zero dictates whether the tank also has an electric element).					
30	Number of internal heat exchangers	Dimensionless	-	integer	[0;3]	1
	The number of internal heat exchangers that are contained within the storage tank. For each internal heat exchanger, the user must specify 12 parameters that describe the heat exchanger.					
31	Equal node sizes	Dimensionless	-	integer	[0;0]	0
	This parameter indicates to the general storage tank model that the tank should be divided into nodes of equal size. The number of nodes is controlled by the number of derivatives supplied. Do not change this parameter.					
32	Uniform tank losses	Dimensionless	-	integer	[0;0]	0
	This parameter indicates to the general storage tank model that the tank should have uniform loss coefficients for each node. The number of nodes is controlled by the number of supplied derivatives. Do not change this parameter.					
33	HX Fluid Indicator	Dimensionless	-	integer	[1;3]	1
	The fluid contained in the first internal heat exchanger: 1=Water ; 2=Propylene Glycol ; 3=Ethylene Glycol These fluids are contained in the internal heat exchanger and are not mixed with the storage fluid.					
34	Fraction of glycol	Dimensionless	-	real	[0.0;1.0]	0.75
	The fraction of glycol contained in the internal heat exchanger fluid by volume. If the previous parameter is set to 1 (water), this parameter is ignored. If the previous parameter is set to propylene glycol (2), this parameter may range from 0 to 1. If the previous parameter indicates ethylene glycol (3), this parameter may range from 0.55 to 0.85.					
35	Heat exchanger inside diameter	Length	m	real	[0.0;+Inf]	0.01
	The inside diameter of the pipe comprising the internal heat exchanger.					
36	Heat exchanger outside diameter	Length	m	real	[0.0;+Inf]	0.012
	The outside diameter of the pipe comprising the internal heat exchanger.					

37	Heat exchanger fin diameter	Length	m	real	[0.0;+Inf]	0.012
	The diameter of the fins on the outside pipe surface of the internal heat exchanger. If there are no fins (a smooth tube), set this parameter equal to the previous parameter (heat exchanger outside diameter).					
38	Total surface area of heat exchanger	Area	m^2	real	[0.0;+Inf]	1.0
	The total outside surface area of the internal heat exchanger.					
39	Fins per meter for heat exchanger	Dimensionless	-	integer	[0;+Inf]	100
	The number of fins per unit length (meter) on the outside surface of the internal heat exchanger pipe. This parameter is ignored for smooth tubes.					
40	Heat exchanger length	Length	m	real	[0.0;+Inf]	2.0
	The total length of internal heat exchanger pipe immersed within the storage tank fluid.					
41	Heat exchanger wall conductivity	Thermal Conductivity	kJ/hr.m.K	real	[0.0;+Inf]	1.40
	The conductivity of the heat exchanger wall including any applicable contact resistance. Contact resistance would be present with a double wall heat exchanger where the heat exchaanger is a tube within a tube design.					
42	Heat exchanger material conductivity	Thermal Conductivity	kJ/hr.m.K	real	[0.0;+Inf]	1.40
	The thermal conductivity of the material which comprises the internal heat exchanger.					
43	Height of heat exchanger inlet	Length	m	real	[0.0;+Inf]	0.00
	The height above the bottom of the storage tank of the inlet of the internal heat exchanger.					
44	Height of heat exchanger outlet	Length	m	real	[0.0;+Inf]	1.25
	The height of the outlet of the internal heat exchanger from the tank above the bottom of the storage tank.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
33-44	Number of internal heat exchangers		1	50

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Flow rate at inlet 1	Flow Rate	kg/hr	real	[-2;+Inf]	0.0
	The flow rate entering the storage tank at the first inlet.					
2	Flow rate at outlet 1	Flow Rate	kg/hr	real	[-2;+Inf]	-2
	The flow rate of fluid exiting the storage tank from the first outlet. One of the outlet flow rates MUST be specified as a constant value of -2 to indicate that the outlet flow rate will be determined from a mass balance on the constant volume storage tank.					
3	Flow rate at inlet 2	Flow Rate	kg/hr	real	[-2;+Inf]	0.0
	The flow rate of fluid entering the storage tank at the second inlet.					
4	Not used (outlet 2)	Dimensionless	-	integer	[-1;-1]	-1
	This input must be set to a constant value of -1 to inform the general storage tank model that there is only one outlet from the tank.					
5	Temperature at inlet 1	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the fluid entering the storage tank at the first inlet.					
6	Temperature at inlet 2	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the fluid entering the storage tank at the second inlet.					
7	Environment temperature	Temperature	C	real	[-Inf;+Inf]	22.0
	The temperature of the environment in which the storage tank is located.					
8	Control signal for element 1	Dimensionless	-	real	[0.0;1.0]	1.0
	The control signal for the specified auxiliary heating element. The available power for the heating element will be this input multiplied by the maximum power for the element. If an auxiliary heater is not desired for the					

	simulation, set this input to a constant of 0.0 or set the maximum power for the element to 0.0					
9	Control signal for element 2	Dimensionless	-	real	[0.0;1.0]	1.0
	The control signal for the specified auxiliary heating element. The available power for the heating element will be this input multiplied by the maximum power for the element. If an auxiliary heater is not desired for the simulation, set this input to a constant of 0.0 or set the maximum power for the element to 0.0					
10	Flow rate for heat exchanger	Flow Rate	kg/hr	real	[0.0;+Inf]	0.0
	The flow rate through the specified internal heat exchanger.					
11	Inlet temperature for heat exchanger	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature at the inlet of the specified internal heat exchanger.					
12	Nusselt constant for heat exchanger	Dimensionless	-	real	[0.0;+Inf]	0.50
	The natural convection coefficient between the storage fluid and the internal heat exchanger wall is modeled with an equation of the form: h = Nu * k / do ; Nu = C * Ra^n (See mathematical reference for details) Typical value for C is about 0.5 and n is usually 0.25.					
13	Nusselt exponent for heat exchanger	Dimensionless	-	real	[-Inf;+Inf]	0.25
	The natural convection coefficient between the storage fluid and the internal heat exchanger wall is modeled with an equation of the form: h = Nu * k / do ; Nu = C * Ra^n (See mathematical reference for details) Typical value for C is about 0.5 and n is usually 0.25.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
10-13	Number of internal heat exchangers		1	50

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Flowrate at inlet 1	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	The flow rate of fluid into the storage tank at inlet 1.					
2	Flowrate at outlet 1	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	The flow rate of fluid exiting the storage tank through outlet 1.					
3	Flowrate at inlet 2	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	The flow rate of fluid entering the storage tank through inlet 2.					
4	Not used in this mode	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	This output is not available in this mode.					
5	Temperature of outlet flow 1	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid exiting the storage tank through outlet 1.					
6	Not used (temp at outlet 2)	Temperature	C	real	[-Inf;+Inf]	0
	This output should not be used in this mode of the storage tank.					
7	Thermal losses	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate of thermal energy loss to the environment. Includes the vented energy if a boiling condition is reached.					
8	Energy supplied by inlet 1	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is added to the storage tank by the entrance of the fluid through inlet 1.					
9	Energy removed by outlet 1	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is removed from the storage tank by the exiting of fluid through outlet 1.					
10	Energy supllied by inlet 2	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is added to the storage tank by the entrance of the fluid through inlet 2.					
11	Not used (energy outlet 2)	Power	kJ/hr	real	[-Inf;+Inf]	0

	This output should not be used in this mode of the storage tank model.					
12	Auxiliary heating rate	Power	kJ/hr	real	[-Inf;+Inf]	0
	The average rate at which power was added to the tank by BOTH auxiliary heaters.					
13	Element 1 power	Power	kJ/hr	real	[-Inf;+Inf]	0
	The average power supplied to the storage tank over the timestep by the first heating element specified in the parameter list.					
14	Element 2 power	Power	kJ/hr	real	[-Inf;+Inf]	0
	The average power over the timestep supplied to the tank by the second auxiliary heater specified in the parameter list.					
15	Losses to gas flue	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is removed from the storage tank through losses to the gas flue (while the tank is not being charged by the gas flue).					
16	Internal energy change	Energy	kJ	real	[-Inf;+Inf]	0
	The change in internal energy of the tank from the beginning of the simulation.					
17	Average tank temperature	Temperature	C	real	[-Inf;+Inf]	0
	The average temperature of the fluid in the storage tank over the timestep.					
18	Static pressure difference - inlet 1	Pressure	kPa	real	[-Inf;+Inf]	0
	The static pressure difference between the top of the tank and the first inlet port.					
19	Static pressure difference - outlet 1	Pressure	kPa	real	[-Inf;+Inf]	0
	The static pressure difference between the top of the tank and the first outlet port.					
20	Static pressure difference - inlet 2	Pressure	kPa	real	[-Inf;+Inf]	0
	The static pressure difference between the top of the tank and the second inlet port.					
21	Not used (pressure outlet 2)	Pressure	kPa	real	[-Inf;+Inf]	0
	This output should not be used in this mode of the storage tank model.					
22	Energy input from heat exchanger	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is added to the storage tank from the specified internal heat exchanger.					
23	Temperature of fluid exiting heat exchanger	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid exiting the specified internal heat exchanger.					
24	Tank temperature at outlet of heat exchanger	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the storage tank at the outlet of the specified internal heat exchanger.					
25	LMTD of heat exchanger	Temperature	C	real	[-Inf;+Inf]	0
	The average log mean temperature difference of the specified internal heat exchanger over the timestep.					
26	UA of heat exchanger	Overall Loss Coefficient	kJ/hr.K	real	[0.0;+Inf]	0
	The average overall heat transfer coefficient of the specified internal heat exchanger over the timestep.					
27	Tank temperature - top	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid at the top of the storage tank.					
28	Tank temperature - bottom	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid at the bottom of the storage tank.					
29	Temperature of node 1+	Temperature	C	real	[-Inf;+Inf]	0
	Temperature of node 1+ The temperature of the specified node.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
22-26	Number of internal heat exchangers		1	50
29-29		Besides the top and bottom nodes, how many other	1	13

		nodes are there?		

DERIVATIVES

	Name	Dimension	Unit	Type	Range	Default
1	Initial temperature of node	Temperature	C	real	[-Inf;+Inf]	0
	The initial temperature of the specified node.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
1-1		How many temperature levels (nodes) should be used in the tank?	1	50

4.12.1.8. Horizontal Cylinder - Uniform Losses and Node Heights - 2 Inlets, 2 Outlets

Icon		TRNSYS Model	Type 60
Proforma	Thermal Storage\Detailed Fluid Storage Tank\Horizontal Cylinder\Uniform Losses and Node Heights\2 Inlets, 2 Outlets\Type60k.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	User-specified inlet positions	Dimensionless	-	integer	[1;2]	2
	The auxiliary storage tank may operate in one of two modes in determining the inlet positions of the flow streams. In this mode (2), the user must specify the locations (nodes) of the entering flow streams. Do not change this parameter.					
2	Tank volume	Volumetric Flow Rate	m^3	real	[0.0;+Inf]	0.35
	The actual volume of the storage tank (not the nominal value).					
3	Tank height	Length	m	real	[0.0;+Inf]	1.25
	The height of the storage tank. If the tank is a horizontal cylinder, this parameter should be set to the diameter of the storage tank.					
4	Horizontal cylinder	Length	m	integer	[-2;-2]	-2
	By setting this parameter to -2, the user is specifying that the tank is cylindrical with a horizontal orientation (laying on its side). Do not change this parameter.					
5	Height of flow inlet 1	Length	m	real	[0.0;+Inf]	1.25
	The height of the first inlet above the bottom of the tank. Make sure that this value is between 0 and the total height of the tank.					
6	Height of flow outlet 1	Length	m	real	[0.0;+Inf]	0.0
	The height of the first outlet from the storage tank above the bottom of the tank. Make sure that this value is between 0 and the total height of the tank.					
7	Height of flow inlet 2	Length	m	real	[0.0;+Inf]	0.0
	The height of the second inlet to the staorage tank above the bottom of the tank. Make sure that this value is between 0 and the total height of the storage tank.					
8	Height of flow outlet 2	Length	m	real	[0.0;+Inf]	1.25
	The height of the 2nd outlet from the storage tank above the bottom of the tank. Make sure that this value is between 0 and the total height of the storage tank.					
9	Fluid specific heat	Specific Heat	kJ/kg.K	real	[0.0;+Inf]	4.190
	The specific heat of the fluid contained in the storage tank.					
10	Fluid density	Density	kg/m^3	real	[0.0;+Inf]	1000.0
	The density of the fluid contained in the storage tank.					
11	Tank loss coefficient	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[0.0;+Inf]	3.0
	The average tank loss coefficient per unit area. Different loss coefficients for each node can be modeled by use of the incremental loss coefficient parameters.					
12	Fluid thermal conductivity	Thermal Conductivity	kJ/hr.m.K	real	[0.0;+Inf]	1.40
	The thermal conductivity of the fluid contained in the storage tank.					
13	Destratification conductivity	Thermal Conductivity	kJ/hr.m.K	real	[0.0;+Inf]	0.0
	To model de-stratification due to mixing at node interfaces and conduction along the tank wall, the user may enter this additional conductivity parameter. The additional conductivity term is added to the conductivity of the tank fluid and is applied to all nodes. For rough calculations, one may calculate this parameter as the thermal conductivity of the tank wall times the cross sectional area of the tank wall divided by the cross sectional area					

	of the fluid in the storage tank.					
14	Boiling temperature	Temperature	C	real	[-Inf;+Inf]	100.0
	The boiling point temperature of the fluid contained in the storage tank.					
15	Auxiliary heater mode	Dimensionless	-	integer	[1;2]	1
	The auxiliary heater may be operated in one of two modes: 1 = Master/Slave Relation: The lower heating element is only enabled when the upper heating element is satisified. In this mode, only one heater may be on at any instant of time. This is a common design in residential electric hot water tanks. 2 = Both Enabled: In this mode, both heaters may be on simultaneously. This allows for significantly quicker heating of the water, but at a much higher electrical demand.					
16	Height of 1st aux. heater	Length	m	real	[0.0;+Inf]	1.0
	The height of the first auxiliary heater element above the bottom of the storage tank. If there are no auxiliary heaters, set this parameter and the thermostat height parameter to any value between 0 anf the total tank height. Then simply set either the maximum heating rate or the control signal for this heating element to a constant value of 0.					
17	Height of 1st thermostat	Length	m	real	[0.0;+Inf]	1.25
	The height of the thermostat for the first heating element above the bottom of the storage tank. If there are no heating elements, simply set this parameter to any value between 0 and the total tank height. Then set either the maximum heating rate or the control signal for this heating element to a constant value of 0.					
18	Set point temperature for element 1	Temperature	C	real	[-Inf;+Inf]	55.0
	The set point temperature for the specified heating element. The thermostat will enable the heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb and continue to heat the fluid until it reaches the set point temperature. Tset = this parameter; Tdb = next parameter					
19	Deadband for heating element 1	Temp. Difference	deltaC	real	[-Inf;+Inf]	5.0
	The dead band temperature difference for the specified heating element. The thermostat will enable the heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb and continue to heat the fluid until it reaches the set point temperature. Where Tset = previous parameter; Tdb = this parameter					
20	Maximum heating rate of element 1	Power	kJ/hr	real	[0.0;+Inf]	16200.0
	The maximum heating rate of the heating element. If the specified heating element is to not to be used for the simulation, set the maximum power to 0.					
21	Height of heating element 2	Length	m	integer	[1;15]	1
	The node containing the specified auxiliary heating element. Make sure that the specified node for the heater is between 1 and the total number of nodes specified. Node 1 is the topmost node in the tank.					
22	Height of thermostat 2	Length	m	integer	[1;15]	1
	The node containing the thermostat for the specified auxiliary heater. The thermostat is typically either located in the same node as the heating element or in a node located above the element. Node 1 is the topmost node in the tank.					
23	Set point temperature for element 2	Temperature	C	real	[-Inf;+Inf]	55.0
	The set point temperature for the specified heating element. The thermostat will enable the heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb and continue to heat the fluid until it reaches the set point temperature. Tset = this parameter; Tdb = next parameter					
24	Deadband for heating element 2	Temp. Difference	deltaC	real	[0.0;+Inf]	5.0
	The dead band temperature difference for the specified heating element. The thermostat will enable the					

	heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb and continue to heat the fluid until it reaches the set point temperature. Where Tset = previous parameter; Tdb = this parameter					
25	Maximum heating rate of element 2	Power	kJ/hr	real	[0.0;+Inf]	16200
	The maximum heating rate of the heating element. If the specified heating element is to not to be used for the simulation, set the maximum power to 0.					
26	Overall loss coefficient for gas flue	Overall Loss Coefficient	kJ/hr.K	real	[0.0;+Inf]	0.0
	The overall loss coefficient of the gas flue when the tank is not being heated. If this tank is not being heated by gas, simply set this parameter to 0.0 and the next parameter (flue temperature) to any reasonable value.					
27	Flue temperature	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the gas flue when the tank is not being heated. This parameter is used tto calculate the losses from the storage to the flue when the tank is not being heated. If the tank is not heated witth gas, simply set this parameter to any reasonable value and set the previous parameter (flue loss coefficient) to 0.					
28	Fraction of critical timestep	Dimensionless	-	integer	[1;1000]	6
	To minimize numerical errors, the TYPE 60 tank model uses its own internal time step. This has the advantage of results being unaffected by the size of the TRNSYS time step. The model internally computes the critical Euler time step. The user then chooses the fraction of the critical time step that will be used. Increasing this parameter will increase the accuracy of the model, but decrease the simulation speed. A value of 6 represents an excellent compromise between accuracy and speed for most simulations.					
29	Gas heater?	Dimensionless	-	integer	[0;+Inf]	1
	This parameter indicates to the general storage tank model whether the tank is heated with electric elements, with a gas flue, or with a combination of gas and electric. 0 = Both heater are electric 1 = Auxiliary heater #2 is gas (setting the maximum heating rate of the first heating element to zero or non-zero dictates whether the tank also has an electric element).					
30	Number of internal heat exchangers	Dimensionless	-	integer	[0;3]	1
	The number of internal heat exchangers that are contained within the storage tank. For each internal heat exchanger, the user must specify 12 parameters that describe the heat exchanger.					
31	Equal sized nodes	Dimensionless	-	integer	[0;0]	0
	This parameter indicates to the general storage taank model that the tank should be divided into nodes of the same size. The number of nodes is controlled by the number of derivatives supplied. Do not change this parameter.					
32	Uniform tank losses	Dimensionless	-	integer	[0;0]	0
	This parameter indicates to the general storagee tank model that the tank will have uniform loss coefficients for each node. The number of nodes is controlled by the number of supplied derivatives. Do not change this parameter.					
33	HX Fluid Indicator	Dimensionless	-	integer	[1;3]	1
	The fluid contained in the first internal heat exchanger: 1=Water ; 2=Propylene Glycol ; 3=Ethylene Glycol These fluids are contained in the internal heat exchanger and are not mixed with the storage fluid.					
34	Fraction of glycol	Dimensionless	-	real	[0.0;1.0]	0.75
	The fraction of glycol contained in the internal heat exchanger fluid by volume. If the previous parameter is set to 1 (water), this parameter is ignored. If the previous parameter is set to propylene glycol (2), this parameter may range from 0 to 1. If the previous parameter indicates ethylene glycol (3), this parameter may range from 0.55 to 0.85.					
35	Heat exchanger inside diameter	Length	m	real	[0.0;+Inf]	0.01
	The inside diameter of the pipe comprising the internal heat exchanger.					
36	Heat exchanger outside diameter	Length	m	real	[0.0;+Inf]	0.012
	The outside diameter of the pipe comprising the internal heat exchanger.					

37	Heat exchanger fin diameter	Length	m	real	[0.0;+Inf]	0.012
	The diameter of the fins on the outside pipe surface of the internal heat exchanger. If there are no fins (a smooth tube), set this parameter equal to the previous parameter (heat exchanger outside diameter).					
38	Total surface area of heat exchanger	Area	m^2	real	[0.0;+Inf]	1.0
	The total outside surface area of the internal heat exchanger.					
39	Fins per meter for heat exchanger	Dimensionless	-	integer	[0;+Inf]	100
	The number of fins per unit length (meter) on the outside surface of the internal heat exchanger pipe. This parameter is ignored for smooth tubes.					
40	Heat exchanger length	Length	m	real	[0.0;+Inf]	2.0
	The total length of internal heat exchanger pipe immersed within the storage tank fluid.					
41	Heat exchanger wall conductivity	Thermal Conductivity	kJ/hr.m.K	real	[0.0;+Inf]	1.40
	The conductivity of the heat exchanger wall including any applicable contact resistance. Contact resistance would be present with a double wall heat exchanger where the heat exchaanger is a tube within a tube design.					
42	Heat exchanger material conductivity	Thermal Conductivity	kJ/hr.m.K	real	[0.0;+Inf]	1.40
	The thermal conductivity of the material which comprises the internal heat exchanger.					
43	Height of heat exchanger inlet	Length	m	real	[0.0;+Inf]	0.00
	The height above the bottom of the storage tank of the inlet of the internal heat exchanger.					
44	Height of heat exchanger outlet	Length	m	real	[0.0;+Inf]	1.25
	The height of the outlet of the internal heat exchanger from the tank above the bottom of the storage tank.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
33-44	Number of internal heat exchangers		1	50

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Flow rate at inlet 1	Flow Rate	kg/hr	real	[-Inf;+Inf]	0.0
	The flow rate entering the storage tank at the first inlet.					
2	Flow rate at outlet 1	Flow Rate	kg/hr	real	[-2;+Inf]	0.0
	The flow rate of fluid exiting the storage tank from the first outlet. One of the outlet flow rates MUST be specified as a constant value of -2 to indicate that the outlet flow rate will be determined from a mass balance on the constant volume storage tank.					
3	Flow rate at inlet 2	Flow Rate	kg/hr	real	[-Inf;+Inf]	0.0
	The flow rate of fluid entering the storage tank at the second inlet.					
4	Flow rate at outlet 2	Flow Rate	kg/hr	real	[-2;+Inf]	-2
	The flow rate of fluid exiting ths storage tank from the second outlet. One of the outlet flow rates MUST be set to a constant value of -2 to indicate that the outlet flow rate will be determined from a mass balance on the constant volume storage tank.					
5	Temperature at inlet 1	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the fluid entering the storage tank at the first inlet.					
6	Temperature at inlet 2	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the fluid entering the storage tank at the second inlet.					
7	Environment temperature	Temperature	C	real	[-Inf;+Inf]	22.0
	The temperature of the environment in which the storage tank is located.					
8	Control signal for element 1	Dimensionless	-	real	[0.0;1.0]	1.0
	The control signal for the specified auxiliary heating element. The available power for the heating element will					

	be this input multiplied by the maximum power for the element. If an auxiliary heater is not desired for the simulation, set this input to a constant of 0.0 or set the maximum power for the element to 0.0					
9	Control signal for element 2	Dimensionless	-	real	[0.0;1.0]	1.0
	The control signal for the specified auxiliary heating element. The available power for the heating element will be this input multiplied by the maximum power for the element. If an auxiliary heater is not desired for the simulation, set this input to a constant of 0.0 or set the maximum power for the element to 0.0					
10	Flow rate for heat exchanger	Flow Rate	kg/hr	real	[0.0;+Inf]	0.0
	The flow rate through the specified internal heat exchanger.					
11	Inlet temperature for heat exchanger	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature at the inlet of the specified internal heat exchanger.					
12	Nusselt constant for heat exchanger	Dimensionless	-	real	[0.0;+Inf]	0.50
	The natural convection coefficient between the storage fluid and the internal heat exchanger wall is modeled with an equation of the form: h = Nu * k / do ; Nu = C * Ra^n (See mathematical reference for details) Typical value for C is about 0.5 and n is usually 0.25.					
13	Nusselt exponent for heat exchanger	Dimensionless	-	real	[-Inf;+Inf]	0.25
	The natural convection coefficient between the storage fluid and the internal heat exchanger wall is modeled with an equation of the form: h = Nu * k / do ; Nu = C * Ra^n (See mathematical reference for details) Typical value for C is about 0.5 and n is usually 0.25.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
10-13	Number of internal heat exchangers		1	50

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Flowrate at inlet 1	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	The flow rate of fluid into the storage tank at inlet 1.					
2	Flowrate at outlet 1	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	The flow rate of fluid exiting the storage tank through outlet 1.					
3	Flowrate at inlet 2	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	The flow rate of fluid entering the storage tank through inlet 2.					
4	Flowrate at outlet 2	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	The flowrate of fluid exiting the storage tank through outlet 2.					
5	Temperature of outlet flow 1	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid exiting the storage tank through outlet 1.					
6	Temperature of outlet flow 2	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid exiting the storage tank through outlet 2.					
7	Thermal losses	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate of thermal energy loss to the environment. Includes the vented energy if a boiling condition is reached.					
8	Energy supplied by inlet 1	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is added to the storage tank by the entrance of the fluid through inlet 1.					
9	Energy removed by outlet 1	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is removed from the storage tank by the exiting of fluid through outlet 1.					
10	Energy supllied by inlet 2	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is added to the storage tank by the entrance of the fluid through inlet 2.					
11	Energy removed by outlet 2	Power	kJ/hr	real	[-Inf;+Inf]	0

	The rate at which energy is removed from the storage tank by the exiting of fluid through outlet 2.					
12	Auxiliary heating rate	Power	kJ/hr	real	[-Inf;+Inf]	0
	The average rate at which power was added to the tank by BOTH auxiliary heaters.					
13	Element 1 power	Power	kJ/hr	real	[-Inf;+Inf]	0
	The average power supplied to the storage tank over the timestep by the first heating element specified in the parameter list.					
14	Element 2 power	Power	kJ/hr	real	[-Inf;+Inf]	0
	The average power over the timestep supplied to the tank by the second auxiliary heater specified in the parameter list.					
15	Losses to gas flue	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is removed from the storage tank through losses to the gas flue (while the tank is not being charged by the gas flue).					
16	Internal energy change	Energy	kJ	real	[-Inf;+Inf]	0
	The change in internal energy of the tank from the beginning of the simulation.					
17	Average tank temperature	Temperature	C	real	[-Inf;+Inf]	0
	The average temperature of the fluid in the storage tank over the timestep.					
18	Static pressure difference - inlet 1	Pressure	kPa	real	[-Inf;+Inf]	0
	The static pressure difference between the top of the tank and the first inlet port.					
19	Static pressure difference - outlet 1	Pressure	kPa	real	[-Inf;+Inf]	0
	The static pressure difference between the top of the tank and the first outlet port.					
20	Static pressure difference - inlet 2	Pressure	kPa	real	[-Inf;+Inf]	0
	The static pressure difference between the top of the tank and the second inlet port.					
21	Static pressure difference - outlet 2	Pressure	kPa	real	[-Inf;+Inf]	0
	The static pressure difference between the top of the tank and the second outlet port.					
22	Energy input from heat exchanger	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is added to the storage tank from the specified internal heat exchanger.					
23	Temperature of fluid exiting heat exchanger	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid exiting the specified internal heat exchanger.					
24	Tank temperature at outlet of heat exchanger	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the storage tank at the outlet of the specified internal heat exchanger.					
25	LMTD of heat exchanger	Temperature	C	real	[-Inf;+Inf]	0
	The average log mean temperature difference of the specified internal heat exchanger over the timestep.					
26	UA of heat exchanger	Overall Loss Coefficient	kJ/hr.K	real	[0.0;+Inf]	0
	The average overall heat transfer coefficient of the specified internal heat exchanger over the timestep.					
27	Tank temperature - top	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid at the top of the storage tank.					
28	Tank temperature - bottom	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid at the bottom of the storage tank.					
29	Temperature of node 1+	Temperature	C	real	[-Inf;+Inf]	0
	Temperature of node 1+ The temperature of the specified node.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
22-26	Number of internal heat exchangers		1	50
29-29		Besides the top and bottom nodes, how many other	1	13

		nodes are there?		

DERIVATIVES

	Name	Dimension	Unit	Type	Range	Default
1	Initial temperature of node	Temperature	C	real	[-Inf;+Inf]	0
	The initial temperature of the specified node.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
1-1		How many temperature levels (nodes) should be used in the tank?	1	50

4.12.1.9. Uniform Cross Section - Non-Uniform Losses and Heights - 1 Inlet, 1 Outlet

Icon		TRNSYS Model	Type 60
Proforma	Thermal Storage\Detailed Fluid Storage Tank\Uniform Cross Section\Non-Uniform Losses and Heights\1 Inlet, 1 Outlet\Type60u.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	User-specified inlet positions	Dimensionless	-	integer	[1;2]	2
	The auxiliary storage tank may operate in one of two modes in determining the inlet positions of the flow streams. In this mode (2), the user must specify the locations (nodes) of the entering flow streams. Do not change this parameter.					
2	Tank volume	Volumetric Flow Rate	m^3	real	[0.0;+Inf]	0.35
	The actual volume of the storage tank (not the nominal value).					
3	Tank height	Length	m	real	[0.0;+Inf]	1.25
	The height of the storage tank. If the tank is a horizontal cylinder, this parameter should be set to the diameter of the storage tank.					
4	Tank perimeter	Length	m	real	[0.0;+Inf]	3.0
	The perimeter length for the uniform cross-section tank.					
5	Height of flow inlet 1	Length	m	real	[0.0;+Inf]	1.25
	The height of the first inlet above the bottom of the tank. Make sure that this value is between 0 and the total height of the tank.					
6	Height of flow outlet 1	Length	m	real	[0.0;+Inf]	0.0
	The height of the first outlet from the storage tank above the bottom of the tank. Make sure that this value is between 0 and the total height of the tank.					
7	Not used (inlet 2)	Dimensionless	-	integer	[-1;-1]	-1
	This parameter must be set to -1 to indicate to the general storage tank model that there is only one inlet to this tank.					
8	Not used (outlet 2)	Dimensionless	-	integer	[-1;-1]	-1
	This parameter should be set to a value of -1 to indicate to the general storage tank model that there is only one outlet from this tank.					
9	Fluid specific heat	Specific Heat	kJ/kg.K	real	[0.0;+Inf]	4.190
	The specific heat of the fluid contained in the storage tank.					
10	Fluid density	Density	kg/m^3	real	[0.0;+Inf]	1000.0
	The density of the fluid contained in the storage tank.					
11	Tank loss coefficient	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[0.0;+Inf]	3.0
	The average tank loss coefficient per unit area. Different loss coefficients for each node can be modeled by use of the incremental loss coefficient parameters.					
12	Fluid thermal conductivity	Thermal Conductivity	kJ/hr.m.K	real	[0.0;+Inf]	1.40
	The thermal conductivity of the fluid contained in the storage tank.					
13	Destratification conductivity	Thermal Conductivity	kJ/hr.m.K	real	[0.0;+Inf]	0.0
	To model de-stratification due to mixing at node interfaces and conduction along the tank wall, the user may enter this additional conductivity parameter. The additional conductivity term is added to the conductivity of the tank fluid and is applied to all nodes. For rough calculations, one may calculate this parameter as the thermal conductivity of the tank wall times the cross sectional area of the tank wall divided by the cross sectional area of the fluid in the storage tank.					

14	Boiling temperature	Temperature	C	real	[-Inf;+Inf]	100.0
	The boiling point temperature of the fluid contained in the storage tank.					
15	Auxiliary heater mode	Dimensionless	-	integer	[1;2]	1
	The auxiliary heater may be operated in one of two modes: 1 = Master/Slave Relation: The lower heating element is only enabled when the upper heating element is satisified. In this mode, only one heater may be on at any instant of time. This is a common design in residential electric hot water tanks. 2 = Both Enabled: In this mode, both heaters may be on simultaneously. This allows for significantly quicker heating of the water, but at a much higher electrical demand.					
16	Height of 1st aux. heater	Length	m	real	[0.0;+Inf]	1.0
	The height of the first auxiliary heater element above the bottom of the storage tank. If there are no auxiliary heaters, set this parameter and the thermostat height parameter to any value between 0 anf the total tank height. Then simply set either the maximum heating rate or the control signal for this heating element to a constant value of 0.					
17	Height of 1st thermostat	Length	m	real	[0.0;+Inf]	1.25
	The height of the thermostat for the first heating element above the bottom of the storage tank. If there are no heating elements, simply set this parameter to any value between 0 and the total tank height. Then set either the maximum heating rate or the control signal for this heating element to a constant value of 0.					
18	Set point temperature for element 1	Temperature	C	real	[-Inf;+Inf]	55.0
	The set point temperature for the specified heating element. The thermostat will enable the heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb and continue to heat the fluid until it reaches the set point temperature. Tset = this parameter; Tdb = next parameter					
19	Deadband for heating element 1	Temp. Difference	deltaC	real	[-Inf;+Inf]	5.0
	The dead band temperature difference for the specified heating element. The thermostat will enable the heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb and continue to heat the fluid until it reaches the set point temperature. Where Tset = previous parameter; Tdb = this parameter					
20	Maximum heating rate of element 1	Power	kJ/hr	real	[0.0;+Inf]	16200.0
	The maximum heating rate of the heating element. If the specified heating element is to not to be used for the simulation, set the maximum power to 0.					
21	Height of heating element 2	Length	m	integer	[1;15]	1
	The node containing the specified auxiliary heating element. Make sure that the specified node for the heater is between 1 and the total number of nodes specified. Node 1 is the topmost node in the tank.					
22	Height of thermostat 2	Length	m	integer	[1;15]	1
	The node containing the thermostat for the specified auxiliary heater. The thermostat is typically either located in the same node as the heating element or in a node located above the element. Node 1 is the topmost node in the tank.					
23	Set point temperature for element 2	Temperature	C	real	[-Inf;+Inf]	55.0
	The set point temperature for the specified heating element. The thermostat will enable the heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb and continue to heat the fluid until it reaches the set point temperature. Tset = this parameter; Tdb = next parameter					
24	Deadband for heating element 2	Temp. Difference	deltaC	real	[0.0;+Inf]	5.0
	The dead band temperature difference for the specified heating element. The thermostat will enable the heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb					

	and continue to heat the fluid until it reaches the set point temperature. Where Tset = previous parameter; Tdb = this parameter					
25	Maximum heating rate of element 2	Power	kJ/hr	real	[0.0;+Inf]	16200
	The maximum heating rate of the heating element. If the specified heating element is to not to be used for the simulation, set the maximum power to 0.					
26	Overall loss coefficient for gas flue	Overall Loss Coefficient	kJ/hr.K	real	[0.0;+Inf]	0.0
	The overall loss coefficient of the gas flue when the tank is not being heated. If this tank is not being heated by gas, simply set this parameter to 0.0 and the next parameter (flue temperature) to any reasonable value.					
27	Flue temperature	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the gas flue when the tank is not being heated. This parameter is used tto calculate the losses from the storage to the flue when the tank is not being heated. If the tank is not heated witth gas, simply set this parameter to any reasonable value and set the previous parameter (flue loss coefficient) to 0.					
28	Fraction of critical timestep	Dimensionless	-	integer	[1;1000]	6
	To minimize numerical errors, the TYPE 60 tank model uses its own internal time step. This has the advantage of results being unaffected by the size of the TRNSYS time step. The model internally computes the critical Euler time step. The user then chooses the fraction of the critical time step that will be used. Increasing this parameter will increase the accuracy of the model, but decrease the simulation speed. A value of 6 represents an excellent compromise between accuracy and speed for most simulations.					
29	Gas heater?	Dimensionless	-	integer	[0;+Inf]	1
	This parameter indicates to the general storage tank model whether the tank is heated with electric elements, with a gas flue, or with a combination of gas and electric. 0 = Both heater are electric 1 = Auxiliary heater #2 is gas (setting the maximum heating rate of the first heating element to zero or non-zero dictates whether the tank also has an electric element).					
30	Number of internal heat exchangers	Dimensionless	-	integer	[0;3]	1
	The number of internal heat exchangers that are contained within the storage tank. For each internal heat exchanger, the user must specify 12 parameters that describe the heat exchanger.					
31	Node heights supplied	Dimensionless	-	integer	[1;1]	1
	This parameter indicates to the general storage taank model that the user will be supplying the height of all the nodes in the storage tank. The number of nodes is controlled by the number of derivatives supplied. Do not change this parameter.					
32	Additional loss coeff's supplied	Dimensionless	-	integer	[1;1]	1
	This parameter indicates to the general storagee tank model that the user will be specifying the value of the incremental loss coefficients for each node in the storage tank. The number of nodes is controlled by the number of supplied derivatives. Do not change this parameter.					
33	HX Fluid Indicator	Dimensionless	-	integer	[1;3]	1
	The fluid contained in the first internal heat exchanger: 1=Water ; 2=Propylene Glycol ; 3=Ethylene Glycol These fluids are contained in the internal heat exchanger and are not mixed with the storage fluid.					
34	Fraction of glycol	Dimensionless	-	real	[0.0;1.0]	0.75
	The fraction of glycol contained in the internal heat exchanger fluid by volume. If the previous parameter is set to 1 (water), this parameter is ignored. If the previous parameter is set to propylene glycol (2), this parameter may range from 0 to 1. If the previous parameter indicates ethylene glycol (3), this parameter may range from 0.55 to 0.85.					
35	Heat exchanger inside diameter	Length	m	real	[0.0;+Inf]	0.01
	The inside diameter of the pipe comprising the internal heat exchanger.					
36	Heat exchanger outside diameter	Length	m	real	[0.0;+Inf]	0.012
	The outside diameter of the pipe comprising the internal heat exchanger.					
37	Heat exchanger fin diameter	Length	m	real	[0.0;+Inf]	0.012

	The diameter of the fins on the outside pipe surface of the internal heat exchanger. If there are no fins (a smooth tube), set this parameter equal to the previous parameter (heat exchanger outside diameter).					
38	Total surface area of heat exchanger	Area	m^2	real	[0.0;+Inf]	1.0
	The total outside surface area of the internal heat exchanger.					
39	Fins per meter for heat exchanger	Dimensionless	-	integer	[0;+Inf]	100
	The number of fins per unit length (meter) on the outside surface of the internal heat exchanger pipe. This parameter is ignored for smooth tubes.					
40	Heat exchanger length	Length	m	real	[0.0;+Inf]	2.0
	The total length of internal heat exchanger pipe immersed within the storage tank fluid.					
41	Heat exchanger wall conductivity	Thermal Conductivity	kJ/hr.m.K	real	[0.0;+Inf]	1.40
	The conductivity of the heat exchanger wall including any applicable contact resistance. Contact resistance would be present with a double wall heat exchanger where the heat exchaanger is a tube within a tube design.					
42	Heat exchanger material conductivity	Thermal Conductivity	kJ/hr.m.K	real	[0.0;+Inf]	1.40
	The thermal conductivity of the material which comprises the internal heat exchanger.					
43	Height of heat exchanger inlet	Length	m	real	[0.0;+Inf]	0.00
	The height above the bottom of the storage tank of the inlet of the internal heat exchanger.					
44	Height of heat exchanger outlet	Length	m	real	[0.0;+Inf]	1.25
	The height of the outlet of the internal heat exchanger from the tank above the bottom of the storage tank.					
45	Height of node	Length	m	real	[0.0;+Inf]	0.25
	The height of the specified node. The number of nodes is controlled by the number of derivatives supplied to the model.					
46	Additional loss coefficient for node	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[-Inf;+Inf]	0.00
	The additional loss coefficient for the specified node. The total loss coefficient for each node will be the average loss coefficient (specified much earlier) plus this incremental loss coefficient. Incremental loss coefficients are typically used when one section of the tank is more heavily insulated than other sections or to account for thermal shorts due to pipes and fittings.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
33-44	Number of internal heat exchangers		1	50
45-46		How many temperature levels (nodes) should be used in the tank?	1	50

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Flow rate at inlet 1	Flow Rate	kg/hr	real	[-2;+Inf]	0.0
	The flow rate entering the storage tank at the first inlet.					
2	Flow rate at outlet 1	Flow Rate	kg/hr	real	[-2;+Inf]	-2
	The flow rate of fluid exiting the storage tank from the first outlet. One of the outlet flow rates MUST be specified as a constant value of -2 to indicate that the outlet flow rate will be determined from a mass balance on the constant volume storage tank.					
3	Not used (flow inlet 2)	Dimensionless	-	integer	[-1;-1]	-1
	This input should be set to a constant value of -1 to indicate to the general storage tank model that the tank has only 1 inlet.					

4	Not used (flow outlet 2)	Dimensionless	-	integer	[-1;-1]	-1
	This input should be set to a constant value of -1 to indicate to the general storage tank moel that there is only one outlet from this tank.					
5	Temperature at inlet 1	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the fluid entering the storage tank at the first inlet.					
6	Not used (temp inlet 2)	Temperature	C	real	[-Inf;+Inf]	20.0
	This input is not used in this mode of the storage tank model.					
7	Environment temperature	Temperature	C	real	[-Inf;+Inf]	22.0
	The temperature of the environment in which the storage tank is located.					
8	Control signal for element 1	Dimensionless	-	real	[0.0;1.0]	1.0
	The control signal for the specified auxiliary heating element. The available power for the heating element will be this input multiplied by the maximum power for the element. If an auxiliary heater is not desired for the simulation, set this input to a constant of 0.0 or set the maximum power for the element to 0.0					
9	Control signal for element 2	Dimensionless	-	real	[0.0;1.0]	1.0
	The control signal for the specified auxiliary heating element. The available power for the heating element will be this input multiplied by the maximum power for the element. If an auxiliary heater is not desired for the simulation, set this input to a constant of 0.0 or set the maximum power for the element to 0.0					
10	Flow rate for heat exchanger	Flow Rate	kg/hr	real	[0.0;+Inf]	0.0
	The flow rate through the specified internal heat exchanger.					
11	Inlet temperature for heat exchanger	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature at the inlet of the specified internal heat exchanger.					
12	Nusselt constant for heat exchanger	Dimensionless	-	real	[0.0;+Inf]	0.50
	The natural convection coefficient between the storage fluid and the internal heat exchanger wall is modeled with an equation of the form: h = Nu * k / do ; Nu = C * Ra^n (See mathematical reference for details) Typical value for C is about 0.5 and n is usually 0.25.					
13	Nusselt exponent for heat exchanger	Dimensionless	-	real	[-Inf;+Inf]	0.25
	The natural convection coefficient between the storage fluid and the internal heat exchanger wall is modeled with an equation of the form: h = Nu * k / do ; Nu = C * Ra^n (See mathematical reference for details) Typical value for C is about 0.5 and n is usually 0.25.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
10-13	Number of internal heat exchangers		1	50

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Flowrate at inlet 1	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	The flow rate of fluid into the storage tank at inlet 1.					
2	Flowrate at outlet 1	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	The flow rate of fluid exiting the storage tank through outlet 1.					
3	Not used (inlet 2 flow)	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	This output should not be used in this mode of the storage tank model.					
4	Not used (outlet 2 flow)	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	This output should not be used in this model of the storage tank model.					
5	Temperature of outlet flow 1	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid exiting the storage tank through outlet 1.					
6	Not used (temp flow 2)	Temperature	C	real	[-Inf;+Inf]	0
	This output should not be used in this model of the storage tank model.					

7	Thermal losses	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate of thermal energy loss to the environment. Includes the vented energy if a boiling condition is reached.					
8	Energy supplied by inlet 1	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is added to the storage tank by the entrance of the fluid through inlet 1.					
9	Energy removed by outlet 1	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is removed from the storage tank by the exiting of fluid through outlet 1.					
10	Not used (energy inlet 2)	Power	kJ/hr	real	[-Inf;+Inf]	0
	This output should not be used in this mode of the storage tank model.					
11	Not used (energy outlet 2)	Power	kJ/hr	real	[-Inf;+Inf]	0
	This output should not be used in this mode of the storage tank model.					
12	Auxiliary heating rate	Power	kJ/hr	real	[-Inf;+Inf]	0
	The average rate at which power was added to the tank by BOTH auxiliary heaters.					
13	Element 1 power	Power	kJ/hr	real	[-Inf;+Inf]	0
	The average power supplied to the storage tank over the timestep by the first heating element specified in the parameter list.					
14	Element 2 power	Power	kJ/hr	real	[-Inf;+Inf]	0
	The average power over the timestep supplied to the tank by the second auxiliary heater specified in the parameter list.					
15	Losses to gas flue	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is removed from the storage tank through losses to the gas flue (while the tank is not being charged by the gas flue).					
16	Internal energy change	Energy	kJ	real	[-Inf;+Inf]	0
	The change in internal energy of the tank from the beginning of the simulation.					
17	Average tank temperature	Temperature	C	real	[-Inf;+Inf]	0
	The average temperature of the fluid in the storage tank over the timestep.					
18	Static pressure difference - inlet 1	Pressure	kPa	real	[-Inf;+Inf]	0
	The static pressure difference between the top of the tank and the first inlet port.					
19	Static pressure difference - outlet 1	Pressure	kPa	real	[-Inf;+Inf]	0
	The static pressure difference between the top of the tank and the first outlet port.					
20	Not used (pressure inlet 2)	Pressure	kPa	real	[-Inf;+Inf]	0
	This output should not be used in this mode of the storage tnk model.					
21	Not used (pressure outlet 2)	Pressure	kPa	real	[-Inf;+Inf]	0
	This output should not be used in this mode of the storage tank model.					
22	Energy input from heat exchanger	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is added to the storage tank from the specified internal heat exchanger.					
23	Temperature of fluid exiting heat exchanger	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid exiting the specified internal heat exchanger.					
24	Tank temperature at outlet of heat exchanger	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the storage tank at the outlet of the specified internal heat exchanger.					
25	LMTD of heat exchanger	Temperature	C	real	[-Inf;+Inf]	0
	The average log mean temperature difference of the specified internal heat exchanger over the timestep.					
26	UA of heat exchanger	Overall Loss Coefficient	kJ/hr.K	real	[0.0;+Inf]	0
	The average overall heat transfer coefficient of the specified internal heat exchanger over the timestep.					
27	Tank temperature - top	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid at the top of the storage tank.					

28	Tank temperature - bottom	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid at the bottom of the storage tank.					
29	Temperature of node 1+	Temperature	C	real	[-Inf;+Inf]	0
	Temperature of node 1+ The temperature of the specified node.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
22-26	Number of internal heat exchangers		1	50
29-29		Besides the top and bottom nodes, how many other nodes are there?	1	13

DERIVATIVES

	Name	Dimension	Unit	Type	Range	Default
1	Initial temperature of node	Temperature	C	real	[-Inf;+Inf]	0
	The initial temperature of the specified node.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
1-1		How many temperature levels (nodes) should be used in the tank?	1	50

4.12.1.10. Uniform Cross Section - Non-Uniform Losses and Heights - 1 Inlet, 2 Outlets

Icon		TRNSYS Model	Type 60
Proforma	Thermal Storage\Detailed Fluid Storage Tank\Uniform Cross Section\Non-Uniform Losses and Heights\1 Inlet, 2 Outlets\Type60x.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	User-specified inlet positions	Dimensionless	-	integer	[1;2]	2
	The auxiliary storage tank may operate in one of two modes in determining the inlet positions of the flow streams. In this mode (2), the user must specify the locations (nodes) of the entering flow streams. Do not change this parameter.					
2	Tank volume	Volumetric Flow Rate	m^3	real	[0.0;+Inf]	0.35
	The actual volume of the storage tank (not the nominal value).					
3	Tank height	Length	m	real	[0.0;+Inf]	1.25
	The height of the storage tank. If the tank is a horizontal cylinder, this parameter should be set to the diameter of the storage tank.					
4	Tank perimeter	Length	m	real	[0.0;+Inf]	3.0
	The perimeter length for the uniform cross-section tank.					
5	Height of flow inlet 1	Length	m	real	[0.0;+Inf]	1.25
	The height of the first inlet above the bottom of the tank. Make sure that this value is between 0 and the total height of the tank.					
6	Height of flow outlet 1	Length	m	real	[0.0;+Inf]	0.0
	The height of the first outlet from the storage tank above the bottom of the tank. Make sure that this value is between 0 and the total height of the tank.					
7	Not used (inlet 2)	Dimensionless	-	integer	[-1;-1]	-1
	This parameter must be set to -1 to indicate to the general storage tank model that there is only one inlet to this tank.					
8	Height of flow outlet 2	Length	m	real	[0.0;+Inf]	1.25
	The height of the 2nd outlet from the storage tank above the bottom of the tank. Make sure that this value is between 0 and the total height of the storage tank.					
9	Fluid specific heat	Specific Heat	kJ/kg.K	real	[0.0;+Inf]	4.190
	The specific heat of the fluid contained in the storage tank.					
10	Fluid density	Density	kg/m^3	real	[0.0;+Inf]	1000.0
	The density of the fluid contained in the storage tank.					
11	Tank loss coefficient	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[0.0;+Inf]	3.0
	The average tank loss coefficient per unit area. Different loss coefficients for each node can be modeled by use of the incremental loss coefficient parameters.					
12	Fluid thermal conductivity	Thermal Conductivity	kJ/hr.m.K	real	[0.0;+Inf]	1.40
	The thermal conductivity of the fluid contained in the storage tank.					
13	Destratification conductivity	Thermal Conductivity	kJ/hr.m.K	real	[0.0;+Inf]	0.0
	To model de-stratification due to mixing at node interfaces and conduction along the tank wall, the user may enter this additional conductivity parameter. The additional conductivity term is added to the conductivity of the tank fluid and is applied to all nodes. For rough calculations, one may calculate this parameter as the thermal conductivity of the tank wall times the cross sectional area of the tank wall divided by the cross sectional area of the fluid in the storage tank.					

14	Boiling temperature	Temperature	C	real	[-Inf;+Inf]	100.0
	The boiling point temperature of the fluid contained in the storage tank.					
15	Auxiliary heater mode	Dimensionless	-	integer	[1;2]	1
	The auxiliary heater may be operated in one of two modes: 1 = Master/Slave Relation: The lower heating element is only enabled when the upper heating element is satisified. In this mode, only one heater may be on at any instant of time. This is a common design in residential electric hot water tanks. 2 = Both Enabled: In this mode, both heaters may be on simultaneously. This allows for significantly quicker heating of the water, but at a much higher electrical demand.					
16	Height of 1st aux. heater	Length	m	real	[0.0;+Inf]	1.0
	The height of the first auxiliary heater element above the bottom of the storage tank. If there are no auxiliary heaters, set this parameter and the thermostat height parameter to any value between 0 anf the total tank height. Then simply set either the maximum heating rate or the control signal for this heating element to a constant value of 0.					
17	Height of 1st thermostat	Length	m	real	[0.0;+Inf]	1.25
	The height of the thermostat for the first heating element above the bottom of the storage tank. If there are no heating elements, simply set this parameter to any value between 0 and the total tank height. Then set either the maximum heating rate or the control signal for this heating element to a constant value of 0.					
18	Set point temperature for element 1	Temperature	C	real	[-Inf;+Inf]	55.0
	The set point temperature for the specified heating element. The thermostat will enable the heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb and continue to heat the fluid until it reaches the set point temperature. Tset = this parameter; Tdb = next parameter					
19	Deadband for heating element 1	Temp. Difference	deltaC	real	[-Inf;+Inf]	5.0
	The dead band temperature difference for the specified heating element. The thermostat will enable the heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb and continue to heat the fluid until it reaches the set point temperature. Where Tset = previous parameter; Tdb = this parameter					
20	Maximum heating rate of element 1	Power	kJ/hr	real	[0.0;+Inf]	16200.0
	The maximum heating rate of the heating element. If the specified heating element is to not to be used for the simulation, set the maximum power to 0.					
21	Height of heating element 2	Length	m	integer	[1;15]	1
	The node containing the specified auxiliary heating element. Make sure that the specified node for the heater is between 1 and the total number of nodes specified. Node 1 is the topmost node in the tank.					
22	Height of thermostat 2	Length	m	integer	[1;15]	1
	The node containing the thermostat for the specified auxiliary heater. The thermostat is typically either located in the same node as the heating element or in a node located above the element. Node 1 is the topmost node in the tank.					
23	Set point temperature for element 2	Temperature	C	real	[-Inf;+Inf]	55.0
	The set point temperature for the specified heating element. The thermostat will enable the heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb and continue to heat the fluid until it reaches the set point temperature. Tset = this parameter; Tdb = next parameter					
24	Deadband for heating element 2	Temp. Difference	deltaC	real	[0.0;+Inf]	5.0
	The dead band temperature difference for the specified heating element. The thermostat will enable the heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb					

	and continue to heat the fluid until it reaches the set point temperature. Where Tset = previous parameter; Tdb = this parameter					
25	Maximum heating rate of element 2	Power	kJ/hr	real	[0.0;+Inf]	16200
	The maximum heating rate of the heating element. If the specified heating element is to not to be used for the simulation, set the maximum power to 0.					
26	Overall loss coefficient for gas flue	Overall Loss Coefficient	kJ/hr.K	real	[0.0;+Inf]	0.0
	The overall loss coefficient of the gas flue when the tank is not being heated. If this tank is not being heated by gas, simply set this parameter to 0.0 and the next parameter (flue temperature) to any reasonable value.					
27	Flue temperature	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the gas flue when the tank is not being heated. This parameter is used tto calculate the losses from the storage to the flue when the tank is not being heated. If the tank is not heated witth gas, simply set this parameter to any reasonable value and set the previous parameter (flue loss coefficient) to 0.					
28	Fraction of critical timestep	Dimensionless	-	integer	[1;1000]	6
	To minimize numerical errors, the TYPE 60 tank model uses its own internal time step. This has the advantage of results being unaffected by the size of the TRNSYS time step. The model internally computes the critical Euler time step. The user then chooses the fraction of the critical time step that will be used. Increasing this parameter will increase the accuracy of the model, but decrease the simulation speed. A value of 6 represents an excellent compromise between accuracy and speed for most simulations.					
29	Gas heater?	Dimensionless	-	integer	[0;+Inf]	1
	This parameter indicates to the general storage tank model whether the tank is heated with electric elements, with a gas flue, or with a combination of gas and electric. 0 = Both heater are electric 1 = Auxiliary heater #2 is gas (setting the maximum heating rate of the first heating element to zero or non-zero dictates whether the tank also has an electric element).					
30	Number of internal heat exchangers	Dimensionless	-	integer	[0;3]	1
	The number of internal heat exchangers that are contained within the storage tank. For each internal heat exchanger, the user must specify 12 parameters that describe the heat exchanger.					
31	Node heights supplied	Dimensionless	-	integer	[1;1]	1
	This parameter indicates to the general storage taank model that the user will be supplying the height of all the nodes in the storage tank. The number of nodes is controlled by the number of derivatives supplied. Do not change this parameter.					
32	Additional loss coeff's supplied	Dimensionless	-	integer	[1;1]	1
	This parameter indicates to the general storagee tank model that the user will be specifying the value of the incremental loss coefficients for each node in the storage tank. The number of nodes is controlled by the number of supplied derivatives. Do not change this parameter.					
33	HX Fluid Indicator	Dimensionless	-	integer	[1;3]	1
	The fluid contained in the first internal heat exchanger: 1=Water ; 2=Propylene Glycol ; 3=Ethylene Glycol These fluids are contained in the internal heat exchanger and are not mixed with the storage fluid.					
34	Fraction of glycol	Dimensionless	-	real	[0.0;1.0]	0.75
	The fraction of glycol contained in the internal heat exchanger fluid by volume. If the previous parameter is set to 1 (water), this parameter is ignored. If the previous parameter is set to propylene glycol (2), this parameter may range from 0 to 1. If the previous parameter indicates ethylene glycol (3), this parameter may range from 0.55 to 0.85.					
35	Heat exchanger inside diameter	Length	m	real	[0.0;+Inf]	0.01
	The inside diameter of the pipe comprising the internal heat exchanger.					
36	Heat exchanger outside diameter	Length	m	real	[0.0;+Inf]	0.012
	The outside diameter of the pipe comprising the internal heat exchanger.					
37	Heat exchanger fin diameter	Length	m	real	[0.0;+Inf]	0.012

	The diameter of the fins on the outside pipe surface of the internal heat exchanger. If there are no fins (a smooth tube), set this parameter equal to the previous parameter (heat exchanger outside diameter).					
38	Total surface area of heat exchanger	Area	m^2	real	[0.0;+Inf]	1.0
	The total outside surface area of the internal heat exchanger.					
39	Fins per meter for heat exchanger	Dimensionless	-	integer	[0;+Inf]	100
	The number of fins per unit length (meter) on the outside surface of the internal heat exchanger pipe. This parameter is ignored for smooth tubes.					
40	Heat exchanger length	Length	m	real	[0.0;+Inf]	2.0
	The total length of internal heat exchanger pipe immersed within the storage tank fluid.					
41	Heat exchanger wall conductivity	Thermal Conductivity	kJ/hr.m.K	real	[0.0;+Inf]	1.40
	The conductivity of the heat exchanger wall including any applicable contact resistance. Contact resistance would be present with a double wall heat exchanger where the heat exchaanger is a tube within a tube design.					
42	Heat exchanger material conductivity	Thermal Conductivity	kJ/hr.m.K	real	[0.0;+Inf]	1.40
	The thermal conductivity of the material which comprises the internal heat exchanger.					
43	Height of heat exchanger inlet	Length	m	real	[0.0;+Inf]	0.00
	The height above the bottom of the storage tank of the inlet of the internal heat exchanger.					
44	Height of heat exchanger outlet	Length	m	real	[0.0;+Inf]	1.25
	The height of the outlet of the internal heat exchanger from the tank above the bottom of the storage tank.					
45	Height of node	Length	m	real	[0.0;+Inf]	0.25
	The height of the specified node. The number of nodes is controlled by the number of derivatives supplied to the model.					
46	Additional loss coefficient for node	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[-Inf;+Inf]	0.00
	The additional loss coefficient for the specified node. The total loss coefficient for each node will be the average loss coefficient (specified much earlier) plus this incremental loss coefficient. Incremental loss coefficients are typically used when one section of the tank is more heavily insulated than other sections or to account for thermal shorts due to pipes and fittings.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
33-44	Number of internal heat exchangers		1	50
45-46		How many temperature levels (nodes) should be used in the tank?	1	50

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Flow rate at inlet 1	Flow Rate	kg/hr	real	[-2;+Inf]	0.0
	The flow rate entering the storage tank at the first inlet.					
2	Flow rate at outlet 1	Flow Rate	kg/hr	real	[-2;+Inf]	0.0
	The flow rate of fluid exiting the storage tank from the first outlet. One of the outlet flow rates MUST be specified as a constant value of -2 to indicate that the outlet flow rate will be determined from a mass balance on the constant volume storage tank.					
3	Not used (flow inlet 2)	Dimensionless	-	integer	[-1;-1]	-1
	This input should be set to a constant value of -1 to indicate to the general storage tank model that the tank has only 1 inlet.					

4	Flow rate at outlet 2	Flow Rate	kg/hr	real	[-2;+Inf]	-2
	The flow rate of fluid exiting ths storage tank from the second outlet. One of the outlet flow rates MUST be set to a constant value of -2 to indicate that the outlet flow rate will be determined from a mass balance on the constant volume storage tank.					
5	Temperature at inlet 1	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the fluid entering the storage tank at the first inlet.					
6	Not used (temp inlet 2)	Temperature	C	real	[-Inf;+Inf]	20.0
	This input is not used in this mode of the storage tank model.					
7	Environment temperature	Temperature	C	real	[-Inf;+Inf]	22.0
	The temperature of the environment in which the storage tank is located.					
8	Control signal for element 1	Dimensionless	-	real	[0.0;1.0]	1.0
	The control signal for the specified auxiliary heating element. The available power for the heating element will be this input multiplied by the maximum power for the element. If an auxiliary heater is not desired for the simulation, set this input to a constant of 0.0 or set the maximum power for the element to 0.0					
9	Control signal for element 2	Dimensionless	-	real	[0.0;1.0]	1.0
	The control signal for the specified auxiliary heating element. The available power for the heating element will be this input multiplied by the maximum power for the element. If an auxiliary heater is not desired for the simulation, set this input to a constant of 0.0 or set the maximum power for the element to 0.0					
10	Flow rate for heat exchanger	Flow Rate	kg/hr	real	[0.0;+Inf]	0.0
	The flow rate through the specified internal heat exchanger.					
11	Inlet temperature for heat exchanger	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature at the inlet of the specified internal heat exchanger.					
12	Nusselt constant for heat exchanger	Dimensionless	-	real	[0.0;+Inf]	0.50
	The natural convection coefficient between the storage fluid and the internal heat exchanger wall is modeled with an equation of the form: h = Nu * k / do ; Nu = C * Ra^n (See mathematical reference for details) Typical value for C is about 0.5 and n is usually 0.25.					
13	Nusselt exponent for heat exchanger	Dimensionless	-	real	[-Inf;+Inf]	0.25
	The natural convection coefficient between the storage fluid and the internal heat exchanger wall is modeled with an equation of the form: h = Nu * k / do ; Nu = C * Ra^n (See mathematical reference for details) Typical value for C is about 0.5 and n is usually 0.25.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
10-13	Number of internal heat exchangers		1	50

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Flowrate at inlet 1	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	The flow rate of fluid into the storage tank at inlet 1.					
2	Flowrate at outlet 1	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	The flow rate of fluid exiting the storage tank through outlet 1.					
3	Not used (inlet 2 flow)	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	This output should not be used in this mode of the storage tank model.					
4	Flowrate at outlet 2	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	The flowrate of fluid exiting the storage tank through outlet 2.					
5	Temperature of outlet flow 1	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid exiting the storage tank through outlet 1.					

6	Temperature of outlet flow 2	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid exiting the storage tank through outlet 2.					
7	Thermal losses	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate of thermal energy loss to the environment. Includes the vented energy if a boiling condition is reached.					
8	Energy supplied by inlet 1	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is added to the storage tank by the entrance of the fluid through inlet 1.					
9	Energy removed by outlet 1	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is removed from the storage tank by the exiting of fluid through outlet 1.					
10	Not used (energy inlet 2)	Power	kJ/hr	real	[-Inf;+Inf]	0
	This output should not be used in this mode of the storage tank model.					
11	Energy removed by outlet 2	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is removed from the storage tank by the exiting of fluid through outlet 2.					
12	Auxiliary heating rate	Power	kJ/hr	real	[-Inf;+Inf]	0
	The average rate at which power was added to the tank by BOTH auxiliary heaters.					
13	Element 1 power	Power	kJ/hr	real	[-Inf;+Inf]	0
	The average power supplied to the storage tank over the timestep by the first heating element specified in the parameter list.					
14	Element 2 power	Power	kJ/hr	real	[-Inf;+Inf]	0
	The average power over the timestep supplied to the tank by the second auxiliary heater specified in the parameter list.					
15	Losses to gas flue	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is removed from the storage tank through losses to the gas flue (while the tank is not being charged by the gas flue).					
16	Internal energy change	Energy	kJ	real	[-Inf;+Inf]	0
	The change in internal energy of the tank from the beginning of the simulation.					
17	Average tank temperature	Temperature	C	real	[-Inf;+Inf]	0
	The average temperature of the fluid in the storage tank over the timestep.					
18	Static pressure difference - inlet 1	Pressure	kPa	real	[-Inf;+Inf]	0
	The static pressure difference between the top of the tank and the first inlet port.					
19	Static pressure difference - outlet 1	Pressure	kPa	real	[-Inf;+Inf]	0
	The static pressure difference between the top of the tank and the first outlet port.					
20	Not used (presure inlet 2)	Pressure	kPa	real	[-Inf;+Inf]	0
	This output should not be used in this mode of the storage tnk model.					
21	Static pressure difference - outlet 2	Pressure	kPa	real	[-Inf;+Inf]	0
	The static pressure difference between the top of the tank and the second outlet port.					
22	Energy input from heat exchanger	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is added to the storage tank from the specified internal heat exchanger.					
23	Temperature of fluid exiting heat exchanger	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid exiting the specified internal heat exchanger.					
24	Tank temperature at outlet of heat exchanger	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the storage tank at the outlet of the specified internal heat exchanger.					
25	LMTD of heat exchanger	Temperature	C	real	[-Inf;+Inf]	0
	The average log mean temperature difference of the specified internal heat exchanger over the timestep.					
26	UA of heat exchanger	Overall Loss Coefficient	kJ/hr.K	real	[0.0;+Inf]	0
	The average overall heat transfer coefficient of the specified internal heat exchanger over the timestep.					

27	Tank temperature - top	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid at the top of the storage tank.					
28	Tank temperature - bottom	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid at the bottom of the storage tank.					
29	Temperature of node 1+	Temperature	C	real	[-Inf;+Inf]	0
	Temperature of node 1+ The temperature of the specified node.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
22-26	Number of internal heat exchangers		1	50
29-29		Besides the top and bottom nodes, how many other nodes are there?	1	13

DERIVATIVES

	Name	Dimension	Unit	Type	Range	Default
1	Initial temperature of node	Temperature	C	real	[-Inf;+Inf]	0
	The initial temperature of the specified node.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
1-1		How many temperature levels (nodes) should be used in the tank?	1	50

4.12.1.11. Uniform Cross Section - Non-Uniform Losses and Heights - 2 Inlets, 1 Outlet

Icon		TRNSYS Model	Type 60
Proforma	Thermal Storage\Detailed Fluid Storage Tank\Uniform Cross Section\Non-Uniform Losses and Heights\2 Inlets, 1 Outlet\Type60w.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	User-specified inlet positions	Dimensionless	-	integer	[1;2]	2
	The auxiliary storage tank may operate in one of two modes in determining the inlet positions of the flow streams. In this mode (2), the user must specify the locations (nodes) of the entering flow streams. Do not change this parameter.					
2	Tank volume	Volumetric Flow Rate	m^3	real	[0.0;+Inf]	0.35
	The actual volume of the storage tank (not the nominal value).					
3	Tank height	Length	m	real	[0.0;+Inf]	1.25
	The height of the storage tank. If the tank is a horizontal cylinder, this parameter should be set to the diameter of the storage tank.					
4	Tank perimeter	Length	m	real	[0.0;+Inf]	3.0
	The perimeter length for the uniform cross-section tank.					
5	Height of flow inlet 1	Length	m	real	[0.0;+Inf]	1.25
	The height of the first inlet above the bottom of the tank. Make sure that this value is between 0 and the total height of the tank.					
6	Height of flow outlet 1	Length	m	real	[0.0;+Inf]	0.0
	The height of the first outlet from the storage tank above the bottom of the tank. Make sure that this value is between 0 and the total height of the tank.					
7	Height of flow inlet 2	Length	m	real	[0.0;+Inf]	0.0
	The height of the second inlet to the staorage tank above the bottom of the tank. Make sure that this value is between 0 and the total height of the storage tank.					
8	Not Used (outlet 2)	Dimensionless	-	integer	[-1;-1]	-1
	This parameter should be set to a value of -1 to indicate to the general storage tank model that there is only one outlet from the tank.					
9	Fluid specific heat	Specific Heat	kJ/kg.K	real	[0.0;+Inf]	4.190
	The specific heat of the fluid contained in the storage tank.					
10	Fluid density	Density	kg/m^3	real	[0.0;+Inf]	1000.0
	The density of the fluid contained in the storage tank.					
11	Tank loss coefficient	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[0.0;+Inf]	3.0
	The average tank loss coefficient per unit area. Different loss coefficients for each node can be modeled by use of the incremental loss coefficient parameters.					
12	Fluid thermal conductivity	Thermal Conductivity	kJ/hr.m.K	real	[0.0;+Inf]	1.40
	The thermal conductivity of the fluid contained in the storage tank.					
13	Destratification conductivity	Thermal Conductivity	kJ/hr.m.K	real	[0.0;+Inf]	0.0
	To model de-stratification due to mixing at node interfaces and conduction along the tank wall, the user may enter this additional conductivity parameter. The additional conductivity term is added to the conductivity of the tank fluid and is applied to all nodes. For rough calculations, one may calculate this parameter as the thermal conductivity of the tank wall times the cross sectional area of the tank wall divided by the cross sectional area of the fluid in the storage tank.					

14	Boiling temperature	Temperature	C	real	[-Inf;+Inf]	100.0
	The boiling point temperature of the fluid contained in the storage tank.					
15	Auxiliary heater mode	Dimensionless	-	integer	[1;2]	1
	The auxiliary heater may be operated in one of two modes: 1 = Master/Slave Relation: The lower heating element is only enabled when the upper heating element is satisified. In this mode, only one heater may be on at any instant of time. This is a common design in residential electric hot water tanks. 2 = Both Enabled: In this mode, both heaters may be on simultaneously. This allows for significantly quicker heating of the water, but at a much higher electrical demand.					
16	Height of 1st aux. heater	Length	m	real	[0.0;+Inf]	1.0
	The height of the first auxiliary heater element above the bottom of the storage tank. If there are no auxiliary heaters, set this parameter and the thermostat height parameter to any value between 0 anf the total tank height. Then simply set either the maximum heating rate or the control signal for this heating element to a constant value of 0.					
17	Height of 1st thermostat	Length	m	real	[0.0;+Inf]	1.25
	The height of the thermostat for the first heating element above the bottom of the storage tank. If there are no heating elements, simply set this parameter to any value between 0 and the total tank height. Then set either the maximum heating rate or the control signal for this heating element to a constant value of 0.					
18	Set point temperature for element 1	Temperature	C	real	[-Inf;+Inf]	55.0
	The set point temperature for the specified heating element. The thermostat will enable the heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb and continue to heat the fluid until it reaches the set point temperature. Tset = this parameter; Tdb = next parameter					
19	Deadband for heating element 1	Temp. Difference	deltaC	real	[-Inf;+Inf]	5.0
	The dead band temperature difference for the specified heating element. The thermostat will enable the heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb and continue to heat the fluid until it reaches the set point temperature. Where Tset = previous parameter; Tdb = this parameter					
20	Maximum heating rate of element 1	Power	kJ/hr	real	[0.0;+Inf]	16200.0
	The maximum heating rate of the heating element. If the specified heating element is to not to be used for the simulation, set the maximum power to 0.					
21	Height of heating element 2	Length	m	integer	[1;15]	1
	The node containing the specified auxiliary heating element. Make sure that the specified node for the heater is between 1 and the total number of nodes specified. Node 1 is the topmost node in the tank.					
22	Height of thermostat 2	Length	m	integer	[1;15]	1
	The node containing the thermostat for the specified auxiliary heater. The thermostat is typically either located in the same node as the heating element or in a node located above the element. Node 1 is the topmost node in the tank.					
23	Set point temperature for element 2	Temperature	C	real	[-Inf;+Inf]	55.0
	The set point temperature for the specified heating element. The thermostat will enable the heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb and continue to heat the fluid until it reaches the set point temperature. Tset = this parameter; Tdb = next parameter					
24	Deadband for heating element 2	Temp. Difference	deltaC	real	[0.0;+Inf]	5.0
	The dead band temperature difference for the specified heating element. The thermostat will enable the heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb					

	and continue to heat the fluid until it reaches the set point temperature. Where Tset = previous parameter; Tdb = this parameter					
25	Maximum heating rate of element 2	Power	kJ/hr	real	[0.0;+Inf]	16200
	The maximum heating rate of the heating element. If the specified heating element is to not to be used for the simulation, set the maximum power to 0.					
26	Overall loss coefficient for gas flue	Overall Loss Coefficient	kJ/hr.K	real	[0.0;+Inf]	0.0
	The overall loss coefficient of the gas flue when the tank is not being heated. If this tank is not being heated by gas, simply set this parameter to 0.0 and the next parameter (flue temperature) to any reasonable value.					
27	Flue temperature	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the gas flue when the tank is not being heated. This parameter is used tto calculate the losses from the storage to the flue when the tank is not being heated. If the tank is not heated witth gas, simply set this parameter to any reasonable value and set the previous parameter (flue loss coefficient) to 0.					
28	Fraction of critical timestep	Dimensionless	-	integer	[1;1000]	6
	To minimize numerical errors, the TYPE 60 tank model uses its own internal time step. This has the advantage of results being unaffected by the size of the TRNSYS time step. The model internally computes the critical Euler time step. The user then chooses the fraction of the critical time step that will be used. Increasing this parameter will increase the accuracy of the model, but decrease the simulation speed. A value of 6 represents an excellent compromise between accuracy and speed for most simulations.					
29	Gas heater?	Dimensionless	-	integer	[0;+Inf]	1
	This parameter indicates to the general storage tank model whether the tank is heated with electric elements, with a gas flue, or with a combination of gas and electric. 0 = Both heater are electric 1 = Auxiliary heater #2 is gas (setting the maximum heating rate of the first heating element to zero or non-zero dictates whether the tank also has an electric element).					
30	Number of internal heat exchangers	Dimensionless	-	integer	[0;3]	1
	The number of internal heat exchangers that are contained within the storage tank. For each internal heat exchanger, the user must specify 12 parameters that describe the heat exchanger.					
31	Node heights supplied	Dimensionless	-	integer	[1;1]	1
	This parameter indicates to the general storage taank model that the user will be supplying the height of all the nodes in the storage tank. The number of nodes is controlled by the number of derivatives supplied. Do not change this parameter.					
32	Additional loss coeff's supplied	Dimensionless	-	integer	[1;1]	1
	This parameter indicates to the general storagee tank model that the user will be specifying the value of the incremental loss coefficients for each node in the storage tank. The number of nodes is controlled by the number of supplied derivatives. Do not change this parameter.					
33	HX Fluid Indicator	Dimensionless	-	integer	[1;3]	1
	The fluid contained in the first internal heat exchanger: 1=Water ; 2=Propylene Glycol ; 3=Ethylene Glycol These fluids are contained in the internal heat exchanger and are not mixed with the storage fluid.					
34	Fraction of glycol	Dimensionless	-	real	[0.0;1.0]	0.75
	The fraction of glycol contained in the internal heat exchanger fluid by volume. If the previous parameter is set to 1 (water), this parameter is ignored. If the previous parameter is set to propylene glycol (2), this parameter may range from 0 to 1. If the previous parameter indicates ethylene glycol (3), this parameter may range from 0.55 to 0.85.					
35	Heat exchanger inside diameter	Length	m	real	[0.0;+Inf]	0.01
	The inside diameter of the pipe comprising the internal heat exchanger.					
36	Heat exchanger outside diameter	Length	m	real	[0.0;+Inf]	0.012
	The outside diameter of the pipe comprising the internal heat exchanger.					
37	Heat exchanger fin diameter	Length	m	real	[0.0;+Inf]	0.012

	The diameter of the fins on the outside pipe surface of the internal heat exchanger. If there are no fins (a smooth tube), set this parameter equal to the previous parameter (heat exchanger outside diameter).					
38	Total surface area of heat exchanger	Area	m^2	real	[0.0;+Inf]	1.0
	The total outside surface area of the internal heat exchanger.					
39	Fins per meter for heat exchanger	Dimensionless	-	integer	[0;+Inf]	100
	The number of fins per unit length (meter) on the outside surface of the internal heat exchanger pipe. This parameter is ignored for smooth tubes.					
40	Heat exchanger length	Length	m	real	[0.0;+Inf]	2.0
	The total length of internal heat exchanger pipe immersed within the storage tank fluid.					
41	Heat exchanger wall conductivity	Thermal Conductivity	kJ/hr.m.K	real	[0.0;+Inf]	1.40
	The conductivity of the heat exchanger wall including any applicable contact resistance. Contact resistance would be present with a double wall heat exchanger where the heat exchaanger is a tube within a tube design.					
42	Heat exchanger material conductivity	Thermal Conductivity	kJ/hr.m.K	real	[0.0;+Inf]	1.40
	The thermal conductivity of the material which comprises the internal heat exchanger.					
43	Height of heat exchanger inlet	Length	m	real	[0.0;+Inf]	0.00
	The height above the bottom of the storage tank of the inlet of the internal heat exchanger.					
44	Height of heat exchanger outlet	Length	m	real	[0.0;+Inf]	1.25
	The height of the outlet of the internal heat exchanger from the tank above the bottom of the storage tank.					
45	Height of node	Length	m	real	[0.0;+Inf]	0.25
	The height of the specified node. The number of nodes is controlled by the number of derivatives supplied to the model.					
46	Additional loss coefficient for node	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[-Inf;+Inf]	0.00
	The additional loss coefficient for the specified node. The total loss coefficient for each node will be the average loss coefficient (specified much earlier) plus this incremental loss coefficient. Incremental loss coefficients are typically used when one section of the tank is more heavily insulated than other sections or to account for thermal shorts due to pipes and fittings.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
33-44	Number of internal heat exchangers		1	50
45-46		How many temperature levels (nodes) should be used in the tank?	1	50

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Flow rate at inlet 1	Flow Rate	kg/hr	real	[-2;+Inf]	0.0
	The flow rate entering the storage tank at the first inlet.					
2	Flow rate at outlet 1	Flow Rate	kg/hr	real	[-2;+Inf]	-2
	The flow rate of fluid exiting the storage tank from the first outlet. One of the outlet flow rates MUST be specified as a constant value of -2 to indicate that the outlet flow rate will be determined from a mass balance on the constant volume storage tank.					
3	Flow rate at inlet 2	Flow Rate	kg/hr	real	[-2;+Inf]	0.0
	The flow rate of fluid entering the storage tank at the second inlet.					
4	Not used (outlet 2)	Dimensionless	-	integer	[-1;-1]	-1

	This input must be set to a constant value of -1 to inform the general storage tank model that there is only one outlet from the tank.					
5	Temperature at inlet 1	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the fluid entering the storage tank at the first inlet.					
6	Temperature at inlet 2	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the fluid entering the storage tank at the second inlet.					
7	Environment temperature	Temperature	C	real	[-Inf;+Inf]	22.0
	The temperature of the environment in which the storage tank is located.					
8	Control signal for element 1	Dimensionless	-	real	[0.0;1.0]	1.0
	The control signal for the specified auxiliary heating element. The available power for the heating element will be this input multiplied by the maximum power for the element. If an auxiliary heater is not desired for the simulation, set this input to a constant of 0.0 or set the maximum power for the element to 0.0					
9	Control signal for element 2	Dimensionless	-	real	[0.0;1.0]	1.0
	The control signal for the specified auxiliary heating element. The available power for the heating element will be this input multiplied by the maximum power for the element. If an auxiliary heater is not desired for the simulation, set this input to a constant of 0.0 or set the maximum power for the element to 0.0					
10	Flow rate for heat exchanger	Flow Rate	kg/hr	real	[0.0;+Inf]	0.0
	The flow rate through the specified internal heat exchanger.					
11	Inlet temperature for heat exchanger	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature at the inlet of the specified internal heat exchanger.					
12	Nusselt constant for heat exchanger	Dimensionless	-	real	[0.0;+Inf]	0.50
	The natural convection coefficient between the storage fluid and the internal heat exchanger wall is modeled with an equation of the form: h = Nu * k / do ; Nu = C * Ra^n (See mathematical reference for details) Typical value for C is about 0.5 and n is usually 0.25.					
13	Nusselt exponent for heat exchanger	Dimensionless	-	real	[-Inf;+Inf]	0.25
	The natural convection coefficient between the storage fluid and the internal heat exchanger wall is modeled with an equation of the form: h = Nu * k / do ; Nu = C * Ra^n (See mathematical reference for details) Typical value for C is about 0.5 and n is usually 0.25.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
10-13	Number of internal heat exchangers		1	50

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Flowrate at inlet 1	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	The flow rate of fluid into the storage tank at inlet 1.					
2	Flowrate at outlet 1	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	The flow rate of fluid exiting the storage tank through outlet 1.					
3	Flowrate at inlet 2	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	The flow rate of fluid entering the storage tank through inlet 2.					
4	Not used in this mode	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	This output is not available in this mode.					
5	Temperature of outlet flow 1	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid exiting the storage tank through outlet 1.					
6	Not used (temp at outlet 2)	Temperature	C	real	[-Inf;+Inf]	0
	This output should not be used in this mode of the storage tank.					
7	Thermal losses	Power	kJ/hr	real	[-Inf;+Inf]	0

	The rate of thermal energy loss to the environment. Includes the vented energy if a boiling condition is reached.					
8	Energy supplied by inlet 1	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is added to the storage tank by the entrance of the fluid through inlet 1.					
9	Energy removed by outlet 1	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is removed from the storage tank by the exiting of fluid through outlet 1.					
10	Energy supllied by inlet 2	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is added to the storage tank by the entrance of the fluid through inlet 2.					
11	Not used (energy outlet 2)	Power	kJ/hr	real	[-Inf;+Inf]	0
	This output should not be used in this mode of the storage tank model.					
12	Auxiliary heating rate	Power	kJ/hr	real	[-Inf;+Inf]	0
	The average rate at which power was added to the tank by BOTH auxiliary heaters.					
13	Element 1 power	Power	kJ/hr	real	[-Inf;+Inf]	0
	The average power supplied to the storage tank over the timestep by the first heating element specified in the parameter list.					
14	Element 2 power	Power	kJ/hr	real	[-Inf;+Inf]	0
	The average power over the timestep supplied to the tank by the second auxiliary heater specified in the parameter list.					
15	Losses to gas flue	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is removed from the storage tank through losses to the gas flue (while the tank is not being charged by the gas flue).					
16	Internal energy change	Energy	kJ	real	[-Inf;+Inf]	0
	The change in internal energy of the tank from the beginning of the simulation.					
17	Average tank temperature	Temperature	C	real	[-Inf;+Inf]	0
	The average temperature of the fluid in the storage tank over the timestep.					
18	Static pressure difference - inlet 1	Pressure	kPa	real	[-Inf;+Inf]	0
	The static pressure difference between the top of the tank and the first inlet port.					
19	Static pressure difference - outlet 1	Pressure	kPa	real	[-Inf;+Inf]	0
	The static pressure difference between the top of the tank and the first outlet port.					
20	Static pressure difference - inlet 2	Pressure	kPa	real	[-Inf;+Inf]	0
	The static pressure difference between the top of the tank and the second inlet port.					
21	Not used (pressure outlet 2)	Pressure	kPa	real	[-Inf;+Inf]	0
	This output should not be used in this mode of the storage tank model.					
22	Energy input from heat exchanger	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is added to the storage tank from the specified internal heat exchanger.					
23	Temperature of fluid exiting heat exchanger	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid exiting the specified internal heat exchanger.					
24	Tank temperature at outlet of heat exchanger	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the storage tank at the outlet of the specified internal heat exchanger.					
25	LMTD of heat exchanger	Temperature	C	real	[-Inf;+Inf]	0
	The average log mean temperature difference of the specified internal heat exchanger over the timestep.					
26	UA of heat exchanger	Overall Loss Coefficient	kJ/hr.K	real	[0.0;+Inf]	0
	The average overall heat transfer coefficient of the specified internal heat exchanger over the timestep.					
27	Tank temperature - top	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid at the top of the storage tank.					
28	Tank temperature - bottom	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid at the bottom of the storage tank.					

29	Temperature of node 1+	Temperature	C	real	[-Inf;+Inf]	0
	Temperature of node 1+ The temperature of the specified node.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
22-26	Number of internal heat exchangers		1	50
29-29		Besides the top and bottom nodes, how many other nodes are there?	1	13

DERIVATIVES

	Name	Dimension	Unit	Type	Range	Default
1	Initial temperature of node	Temperature	C	real	[-Inf;+Inf]	0
	The initial temperature of the specified node.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
1-1		How many temperature levels (nodes) should be used in the tank?	1	50

4.12.1.12. Uniform Cross Section - Non-Uniform Losses and Heights - 2 Inlets, 2 Outlets

Icon		TRNSYS Model	Type 60
Proforma	Thermal Storage\Detailed Fluid Storage Tank\Uniform Cross Section\Non-Uniform Losses and Heights\2 Inlets, 2 Outlets\Type60v.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	User-specified inlet positions	Dimensionless	-	integer	[1;2]	2
	The auxiliary storage tank may operate in one of two modes in determining the inlet positions of the flow streams. In this mode (2), the user must specify the locations (nodes) of the entering flow streams. Do not change this parameter.					
2	Tank volume	Volumetric Flow Rate	m^3	real	[0.0;+Inf]	0.35
	The actual volume of the storage tank (not the nominal value).					
3	Tank height	Length	m	real	[0.0;+Inf]	1.25
	The height of the storage tank. If the tank is a horizontal cylinder, this parameter should be set to the diameter of the storage tank.					
4	Tank perimeter	Length	m	real	[0.0;+Inf]	3.0
	The perimeter length for the uniform cross-section tank.					
5	Height of flow inlet 1	Length	m	real	[0.0;+Inf]	1.25
	The height of the first inlet above the bottom of the tank. Make sure that this value is between 0 and the total height of the tank.					
6	Height of flow outlet 1	Length	m	real	[0.0;+Inf]	0.0
	The height of the first outlet from the storage tank above the bottom of the tank. Make sure that this value is between 0 and the total height of the tank.					
7	Height of flow inlet 2	Length	m	real	[0.0;+Inf]	0.0
	The height of the second inlet to the staorage tank above the bottom of the tank. Make sure that this value is between 0 and the total height of the storage tank.					
8	Height of flow outlet 2	Length	m	real	[0.0;+Inf]	1.25
	The height of the 2nd outlet from the storage tank above the bottom of the tank. Make sure that this value is between 0 and the total height of the storage tank.					
9	Fluid specific heat	Specific Heat	kJ/kg.K	real	[0.0;+Inf]	4.190
	The specific heat of the fluid contained in the storage tank.					
10	Fluid density	Density	kg/m^3	real	[0.0;+Inf]	1000.0
	The density of the fluid contained in the storage tank.					
11	Tank loss coefficient	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[0.0;+Inf]	3.0
	The average tank loss coefficient per unit area. Different loss coefficients for each node can be modeled by use of the incremental loss coefficient parameters.					
12	Fluid thermal conductivity	Thermal Conductivity	kJ/hr.m.K	real	[0.0;+Inf]	1.40
	The thermal conductivity of the fluid contained in the storage tank.					
13	Destratification conductivity	Thermal Conductivity	kJ/hr.m.K	real	[0.0;+Inf]	0.0
	To model de-stratification due to mixing at node interfaces and conduction along the tank wall, the user may enter this additional conductivity parameter. The additional conductivity term is added to the conductivity of the tank fluid and is applied to all nodes. For rough calculations, one may calculate this parameter as the thermal conductivity of the tank wall times the cross sectional area of the tank wall divided by the cross sectional area of the fluid in the storage tank.					

14	Boiling temperature	Temperature	C	real	[-Inf;+Inf]	100.0
	The boiling point temperature of the fluid contained in the storage tank.					
15	Auxiliary heater mode	Dimensionless	-	integer	[1;2]	1
	The auxiliary heater may be operated in one of two modes: 1 = Master/Slave Relation: The lower heating element is only enabled when the upper heating element is satisified. In this mode, only one heater may be on at any instant of time. This is a common design in residential electric hot water tanks. 2 = Both Enabled: In this mode, both heaters may be on simultaneously. This allows for significantly quicker heating of the water, but at a much higher electrical demand.					
16	Height of 1st aux. heater	Length	m	real	[0.0;+Inf]	1.0
	The height of the first auxiliary heater element above the bottom of the storage tank. If there are no auxiliary heaters, set this parameter and the thermostat height parameter to any value between 0 anf the total tank height. Then simply set either the maximum heating rate or the control signal for this heating element to a constant value of 0.					
17	Height of 1st thermostat	Length	m	real	[0.0;+Inf]	1.25
	The height of the thermostat for the first heating element above the bottom of the storage tank. If there are no heating elements, simply set this parameter to any value between 0 and the total tank height. Then set either the maximum heating rate or the control signal for this heating element to a constant value of 0.					
18	Set point temperature for element 1	Temperature	C	real	[-Inf;+Inf]	55.0
	The set point temperature for the specified heating element. The thermostat will enable the heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb and continue to heat the fluid until it reaches the set point temperature. Tset = this parameter; Tdb = next parameter					
19	Deadband for heating element 1	Temp. Difference	deltaC	real	[-Inf;+Inf]	5.0
	The dead band temperature difference for the specified heating element. The thermostat will enable the heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb and continue to heat the fluid until it reaches the set point temperature. Where Tset = previous parameter; Tdb = this parameter					
20	Maximum heating rate of element 1	Power	kJ/hr	real	[0.0;+Inf]	16200.0
	The maximum heating rate of the heating element. If the specified heating element is to not to be used for the simulation, set the maximum power to 0.					
21	Height of heating element 2	Length	m	integer	[1;15]	1
	The node containing the specified auxiliary heating element. Make sure that the specified node for the heater is between 1 and the total number of nodes specified. Node 1 is the topmost node in the tank.					
22	Height of thermostat 2	Length	m	integer	[1;15]	1
	The node containing the thermostat for the specified auxiliary heater. The thermostat is typically either located in the same node as the heating element or in a node located above the element. Node 1 is the topmost node in the tank.					
23	Set point temperature for element 2	Temperature	C	real	[-Inf;+Inf]	55.0
	The set point temperature for the specified heating element. The thermostat will enable the heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb and continue to heat the fluid until it reaches the set point temperature. Tset = this parameter; Tdb = next parameter					
24	Deadband for heating element 2	Temp. Difference	deltaC	real	[0.0;+Inf]	5.0
	The dead band temperature difference for the specified heating element. The thermostat will enable the heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb					

	and continue to heat the fluid until it reaches the set point temperature. Where Tset = previous parameter; Tdb = this parameter					
25	Maximum heating rate of element 2	Power	kJ/hr	real	[0.0;+Inf]	16200
	The maximum heating rate of the heating element. If the specified heating element is to not to be used for the simulation, set the maximum power to 0.					
26	Overall loss coefficient for gas flue	Overall Loss Coefficient	kJ/hr.K	real	[0.0;+Inf]	0.0
	The overall loss coefficient of the gas flue when the tank is not being heated. If this tank is not being heated by gas, simply set this parameter to 0.0 and the next parameter (flue temperature) to any reasonable value.					
27	Flue temperature	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the gas flue when the tank is not being heated. This parameter is used tto calculate the losses from the storage to the flue when the tank is not being heated. If the tank is not heated witth gas, simply set this parameter to any reasonable value and set the previous parameter (flue loss coefficient) to 0.					
28	Fraction of critical timestep	Dimensionless	-	integer	[1;1000]	6
	To minimize numerical errors, the TYPE 60 tank model uses its own internal time step. This has the advantage of results being unaffected by the size of the TRNSYS time step. The model internally computes the critical Euler time step. The user then chooses the fraction of the critical time step that will be used. Increasing this parameter will increase the accuracy of the model, but decrease the simulation speed. A value of 6 represents an excellent compromise between accuracy and speed for most simulations.					
29	Gas heater?	Dimensionless	-	integer	[0;+Inf]	1
	This parameter indicates to the general storage tank model whether the tank is heated with electric elements, with a gas flue, or with a combination of gas and electric. 0 = Both heater are electric 1 = Auxiliary heater #2 is gas (setting the maximum heating rate of the first heating element to zero or non-zero dictates whether the tank also has an electric element).					
30	Number of internal heat exchangers	Dimensionless	-	integer	[0;3]	1
	The number of internal heat exchangers that are contained within the storage tank. For each internal heat exchanger, the user must specify 12 parameters that describe the heat exchanger.					
31	Node heights supplied	Dimensionless	-	integer	[1;1]	1
	This parameter indicates to the general storage taank model that the user will be supplying the height of all the nodes in the storage tank. The number of nodes is controlled by the number of derivatives supplied. Do not change this parameter.					
32	Additional loss coeff's supplied	Dimensionless	-	integer	[1;1]	1
	This parameter indicates to the general storagee tank model that the user will be specifying the value of the incremental loss coefficients for each node in the storage tank. The number of nodes is controlled by the number of supplied derivatives. Do not change this parameter.					
33	HX Fluid Indicator	Dimensionless	-	integer	[1;3]	1
	The fluid contained in the first internal heat exchanger: 1=Water ; 2=Propylene Glycol ; 3=Ethylene Glycol These fluids are contained in the internal heat exchanger and are not mixed with the storage fluid.					
34	Fraction of glycol	Dimensionless	-	real	[0.0;1.0]	0.75
	The fraction of glycol contained in the internal heat exchanger fluid by volume. If the previous parameter is set to 1 (water), this parameter is ignored. If the previous parameter is set to propylene glycol (2), this parameter may range from 0 to 1. If the previous parameter indicates ethylene glycol (3), this parameter may range from 0.55 to 0.85.					
35	Heat exchanger inside diameter	Length	m	real	[0.0;+Inf]	0.01
	The inside diameter of the pipe comprising the internal heat exchanger.					
36	Heat exchanger outside diameter	Length	m	real	[0.0;+Inf]	0.012
	The outside diameter of the pipe comprising the internal heat exchanger.					
37	Heat exchanger fin diameter	Length	m	real	[0.0;+Inf]	0.012

	The diameter of the fins on the outside pipe surface of the internal heat exchanger. If there are no fins (a smooth tube), set this parameter equal to the previous parameter (heat exchanger outside diameter).					
38	Total surface area of heat exchanger	Area	m^2	real	[0.0;+Inf]	1.0
	The total outside surface area of the internal heat exchanger.					
39	Fins per meter for heat exchanger	Dimensionless	-	integer	[0;+Inf]	100
	The number of fins per unit length (meter) on the outside surface of the internal heat exchanger pipe. This parameter is ignored for smooth tubes.					
40	Heat exchanger length	Length	m	real	[0.0;+Inf]	2.0
	The total length of internal heat exchanger pipe immersed within the storage tank fluid.					
41	Heat exchanger wall conductivity	Thermal Conductivity	kJ/hr.m.K	real	[0.0;+Inf]	1.40
	The conductivity of the heat exchanger wall including any applicable contact resistance. Contact resistance would be present with a double wall heat exchanger where the heat exchaanger is a tube within a tube design.					
42	Heat exchanger material conductivity	Thermal Conductivity	kJ/hr.m.K	real	[0.0;+Inf]	1.40
	The thermal conductivity of the material which comprises the internal heat exchanger.					
43	Height of heat exchanger inlet	Length	m	real	[0.0;+Inf]	0.00
	The height above the bottom of the storage tank of the inlet of the internal heat exchanger.					
44	Height of heat exchanger outlet	Length	m	real	[0.0;+Inf]	1.25
	The height of the outlet of the internal heat exchanger from the tank above the bottom of the storage tank.					
45	Height of node	Length	m	real	[0.0;+Inf]	0.25
	The height of the specified node. The number of nodes is controlled by the number of derivatives supplied to the model.					
46	Additional loss coefficient for node	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[-Inf;+Inf]	0.00
	The additional loss coefficient for the specified node. The total loss coefficient for each node will be the average loss coefficient (specified much earlier) plus this incremental loss coefficient. Incremental loss coefficients are typically used when one section of the tank is more heavily insulated than other sections or to account for thermal shorts due to pipes and fittings.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
33-44	Number of internal heat exchangers		1	50
45-46		How many temperature levels (nodes) should be used in the tank?	1	50

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Flow rate at inlet 1	Flow Rate	kg/hr	real	[-Inf;+Inf]	0.0
	The flow rate entering the storage tank at the first inlet.					
2	Flow rate at outlet 1	Flow Rate	kg/hr	real	[-2;+Inf]	0.0
	The flow rate of fluid exiting the storage tank from the first outlet. One of the outlet flow rates MUST be specified as a constant value of -2 to indicate that the outlet flow rate will be determined from a mass balance on the constant volume storage tank.					
3	Flow rate at inlet 2	Flow Rate	kg/hr	real	[-Inf;+Inf]	0.0
	The flow rate of fluid entering the storage tank at the second inlet.					
4	Flow rate at outlet 2	Flow Rate	kg/hr	real	[-2;+Inf]	-2

	The flow rate of fluid exiting ths storage tank from the second outlet. One of the outlet flow rates MUST be set to a constant value of -2 to indicate that the outlet flow rate will be determined from a mass balance on the constant volume storage tank.					
5	Temperature at inlet 1	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the fluid entering the storage tank at the first inlet.					
6	Temperature at inlet 2	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the fluid entering the storage tank at the second inlet.					
7	Environment temperature	Temperature	C	real	[-Inf;+Inf]	22.0
	The temperature of the environment in which the storage tank is located.					
8	Control signal for element 1	Dimensionless	-	real	[0.0;1.0]	1.0
	The control signal for the specified auxiliary heating element. The available power for the heating element will be this input multiplied by the maximum power for the element. If an auxiliary heater is not desired for the simulation, set this input to a constant of 0.0 or set the maximum power for the element to 0.0					
9	Control signal for element 2	Dimensionless	-	real	[0.0;1.0]	1.0
	The control signal for the specified auxiliary heating element. The available power for the heating element will be this input multiplied by the maximum power for the element. If an auxiliary heater is not desired for the simulation, set this input to a constant of 0.0 or set the maximum power for the element to 0.0					
10	Flow rate for heat exchanger	Flow Rate	kg/hr	real	[0.0;+Inf]	0.0
	The flow rate through the specified internal heat exchanger.					
11	Inlet temperature for heat exchanger	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature at the inlet of the specified internal heat exchanger.					
12	Nusselt constant for heat exchanger	Dimensionless	-	real	[0.0;+Inf]	0.50
	The natural convection coefficient between the storage fluid and the internal heat exchanger wall is modeled with an equation of the form: h = Nu * k / do ; Nu = C * Ra^n (See mathematical reference for details) Typical value for C is about 0.5 and n is usually 0.25.					
13	Nusselt exponent for heat exchanger	Dimensionless	-	real	[-Inf;+Inf]	0.25
	The natural convection coefficient between the storage fluid and the internal heat exchanger wall is modeled with an equation of the form: h = Nu * k / do ; Nu = C * Ra^n (See mathematical reference for details) Typical value for C is about 0.5 and n is usually 0.25.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
10-13	Number of internal heat exchangers		1	50

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Flowrate at inlet 1	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	The flow rate of fluid into the storage tank at inlet 1.					
2	Flowrate at outlet 1	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	The flow rate of fluid exiting the storage tank through outlet 1.					
3	Flowrate at inlet 2	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	The flow rate of fluid entering the storage tank through inlet 2.					
4	Flowrate at outlet 2	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	The flowrate of fluid exiting the storage tank through outlet 2.					
5	Temperature of outlet flow 1	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid exiting the storage tank through outlet 1.					
6	Temperature of outlet flow 2	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid exiting the storage tank through outlet 2.					

7	Thermal losses	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate of thermal energy loss to the environment. Includes the vented energy if a boiling condition is reached.					
8	Energy supplied by inlet 1	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is added to the storage tank by the entrance of the fluid through inlet 1.					
9	Energy removed by outlet 1	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is removed from the storage tank by the exiting of fluid through outlet 1.					
10	Energy supllied by inlet 2	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is added to the storage tank by the entrance of the fluid through inlet 2.					
11	Energy removed by outlet 2	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is removed from the storage tank by the exiting of fluid through outlet 2.					
12	Auxiliary heating rate	Power	kJ/hr	real	[-Inf;+Inf]	0
	The average rate at which power was added to the tank by BOTH auxiliary heaters.					
13	Element 1 power	Power	kJ/hr	real	[-Inf;+Inf]	0
	The average power supplied to the storage tank over the timestep by the first heating element specified in the parameter list.					
14	Element 2 power	Power	kJ/hr	real	[-Inf;+Inf]	0
	The average power over the timestep supplied to the tank by the second auxiliary heater specified in the parameter list.					
15	Losses to gas flue	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is removed from the storage tank through losses to the gas flue (while the tank is not being charged by the gas flue).					
16	Internal energy change	Energy	kJ	real	[-Inf;+Inf]	0
	The change in internal energy of the tank from the beginning of the simulation.					
17	Average tank temperature	Temperature	C	real	[-Inf;+Inf]	0
	The average temperature of the fluid in the storage tank over the timestep.					
18	Static pressure difference - inlet 1	Pressure	kPa	real	[-Inf;+Inf]	0
	The static pressure difference between the top of the tank and the first inlet port.					
19	Static pressure difference - outlet 1	Pressure	kPa	real	[-Inf;+Inf]	0
	The static pressure difference between the top of the tank and the first outlet port.					
20	Static pressure difference - inlet 2	Pressure	kPa	real	[-Inf;+Inf]	0
	The static pressure difference between the top of the tank and the second inlet port.					
21	Static pressure difference - outlet 2	Pressure	kPa	real	[-Inf;+Inf]	0
	The static pressure difference between the top of the tank and the second outlet port.					
22	Energy input from heat exchanger	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is added to the storage tank from the specified internal heat exchanger.					
23	Temperature of fluid exiting heat exchanger	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid exiting the specified internal heat exchanger.					
24	Tank temperature at outlet of heat exchanger	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the storage tank at the outlet of the specified internal heat exchanger.					
25	LMTD of heat exchanger	Temperature	C	real	[-Inf;+Inf]	0
	The average log mean temperature difference of the specified internal heat exchanger over the timestep.					
26	UA of heat exchanger	Overall Loss Coefficient	kJ/hr.K	real	[0.0;+Inf]	0
	The average overall heat transfer coefficient of the specified internal heat exchanger over the timestep.					
27	Tank temperature - top	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid at the top of the storage tank.					

28	Tank temperature - bottom	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid at the bottom of the storage tank.					
29	Temperature of node 1+	Temperature	C	real	[-Inf;+Inf]	0
	Temperature of node 1+ The temperature of the specified node.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
22-26	Number of internal heat exchangers		1	50
29-29		Besides the top and bottom nodes, how many other nodes are there?	1	13

DERIVATIVES

	Name	Dimension	Unit	Type	Range	Default
1	Initial temperature of node	Temperature	C	real	[-Inf;+Inf]	0
	The initial temperature of the specified node.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
1-1		How many temperature levels (nodes) should be used in the tank?	1	50

4.12.1.13. Uniform Cross Section - Uniform Losses and Node Heights - 1 Inlet, 1 Outlet

Icon		TRNSYS Model	Type 60
Proforma	Thermal Storage\Detailed Fluid Storage Tank\Uniform Cross Section\Uniform Losses and Node Heights\1 Inlet, 1 Outlet\Type60t.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	User-specified inlet positions	Dimensionless	-	integer	[1;2]	2
	The auxiliary storage tank may operate in one of two modes in determining the inlet positions of the flow streams. In this mode (2), the user must specify the locations (nodes) of the entering flow streams. Do not change this parameter.					
2	Tank volume	Volumetric Flow Rate	m^3	real	[0.0;+Inf]	0.35
	The actual volume of the storage tank (not the nominal value).					
3	Tank height	Length	m	real	[0.0;+Inf]	1.25
	The height of the storage tank. If the tank is a horizontal cylinder, this parameter should be set to the diameter of the storage tank.					
4	Tank perimeter	Length	m	real	[0.0;+Inf]	3.0
	The perimeter length for the uniform cross-section tank.					
5	Height of flow inlet 1	Length	m	real	[0.0;+Inf]	1.25
	The height of the first inlet above the bottom of the tank. Make sure that this value is between 0 and the total height of the tank.					
6	Height of flow outlet 1	Length	m	real	[0.0;+Inf]	0.0
	The height of the first outlet from the storage tank above the bottom of the tank. Make sure that this value is between 0 and the total height of the tank.					
7	Not used (inlet 2)	Dimensionless	-	integer	[-1;-1]	-1
	This parameter must be set to -1 to indicate to the general storage tank model that there is only one inlet to this tank.					
8	Not used (outlet 2)	Dimensionless	-	integer	[-1;-1]	-1
	This parameter should be set to a value of -1 to indicate to the general storage tank model that there is only one outlet from this tank.					
9	Fluid specific heat	Specific Heat	kJ/kg.K	real	[0.0;+Inf]	4.190
	The specific heat of the fluid contained in the storage tank.					
10	Fluid density	Density	kg/m^3	real	[0.0;+Inf]	1000.0
	The density of the fluid contained in the storage tank.					
11	Tank loss coefficient	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[0.0;+Inf]	3.0
	The average tank loss coefficient per unit area. Different loss coefficients for each node can be modeled by use of the incremental loss coefficient parameters.					
12	Fluid thermal conductivity	Thermal Conductivity	kJ/hr.m.K	real	[0.0;+Inf]	1.40
	The thermal conductivity of the fluid contained in the storage tank.					
13	Destratification conductivity	Thermal Conductivity	kJ/hr.m.K	real	[0.0;+Inf]	0.0
	To model de-stratification due to mixing at node interfaces and conduction along the tank wall, the user may enter this additional conductivity parameter. The additional conductivity term is added to the conductivity of the tank fluid and is applied to all nodes. For rough calculations, one may calculate this parameter as the thermal conductivity of the tank wall times the cross sectional area of the tank wall divided by the cross sectional area of the fluid in the storage tank.					

14	Boiling temperature	Temperature	C	real	[-Inf;+Inf]	100.0
	The boiling point temperature of the fluid contained in the storage tank.					
15	Auxiliary heater mode	Dimensionless	-	integer	[1;2]	1
	The auxiliary heater may be operated in one of two modes: 1 = Master/Slave Relation: The lower heating element is only enabled when the upper heating element is satisified. In this mode, only one heater may be on at any instant of time. This is a common design in residential electric hot water tanks. 2 = Both Enabled: In this mode, both heaters may be on simultaneously. This allows for significantly quicker heating of the water, but at a much higher electrical demand.					
16	Height of 1st aux. heater	Length	m	real	[0.0;+Inf]	1.0
	The height of the first auxiliary heater element above the bottom of the storage tank. If there are no auxiliary heaters, set this parameter and the thermostat height parameter to any value between 0 anf the total tank height. Then simply set either the maximum heating rate or the control signal for this heating element to a constant value of 0.					
17	Height of 1st thermostat	Length	m	real	[0.0;+Inf]	1.25
	The height of the thermostat for the first heating element above the bottom of the storage tank. If there are no heating elements, simply set this parameter to any value between 0 and the total tank height. Then set either the maximum heating rate or the control signal for this heating element to a constant value of 0.					
18	Set point temperature for element 1	Temperature	C	real	[-Inf;+Inf]	55.0
	The set point temperature for the specified heating element. The thermostat will enable the heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb and continue to heat the fluid until it reaches the set point temperature. Tset = this parameter; Tdb = next parameter					
19	Deadband for heating element 1	Temp. Difference	deltaC	real	[-Inf;+Inf]	5.0
	The dead band temperature difference for the specified heating element. The thermostat will enable the heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb and continue to heat the fluid until it reaches the set point temperature. Where Tset = previous parameter; Tdb = this parameter					
20	Maximum heating rate of element 1	Power	kJ/hr	real	[0.0;+Inf]	16200.0
	The maximum heating rate of the heating element. If the specified heating element is to not to be used for the simulation, set the maximum power to 0.					
21	Height of heating element 2	Length	m	integer	[1;15]	1
	The node containing the specified auxiliary heating element. Make sure that the specified node for the heater is between 1 and the total number of nodes specified. Node 1 is the topmost node in the tank.					
22	Height of thermostat 2	Length	m	integer	[1;15]	1
	The node containing the thermostat for the specified auxiliary heater. The thermostat is typically either located in the same node as the heating element or in a node located above the element. Node 1 is the topmost node in the tank.					
23	Set point temperature for element 2	Temperature	C	real	[-Inf;+Inf]	55.0
	The set point temperature for the specified heating element. The thermostat will enable the heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb and continue to heat the fluid until it reaches the set point temperature. Tset = this parameter; Tdb = next parameter					
24	Deadband for heating element 2	Temp. Difference	deltaC	real	[0.0;+Inf]	5.0
	The dead band temperature difference for the specified heating element. The thermostat will enable the heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb					

	and continue to heat the fluid until it reaches the set point temperature. Where Tset = previous parameter; Tdb = this parameter					
25	Maximum heating rate of element 2	Power	kJ/hr	real	[0.0;+Inf]	16200
	The maximum heating rate of the heating element. If the specified heating element is to not to be used for the simulation, set the maximum power to 0.					
26	Overall loss coefficient for gas flue	Overall Loss Coefficient	kJ/hr.K	real	[0.0;+Inf]	0.0
	The overall loss coefficient of the gas flue when the tank is not being heated. If this tank is not being heated by gas, simply set this parameter to 0.0 and the next parameter (flue temperature) to any reasonable value.					
27	Flue temperature	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the gas flue when the tank is not being heated. This parameter is used tto calculate the losses from the storage to the flue when the tank is not being heated. If the tank is not heated witth gas, simply set this parameter to any reasonable value and set the previous parameter (flue loss coefficient) to 0.					
28	Fraction of critical timestep	Dimensionless	-	integer	[1;1000]	6
	To minimize numerical errors, the TYPE 60 tank model uses its own internal time step. This has the advantage of results being unaffected by the size of the TRNSYS time step. The model internally computes the critical Euler time step. The user then chooses the fraction of the critical time step that will be used. Increasing this parameter will increase the accuracy of the model, but decrease the simulation speed. A value of 6 represents an excellent compromise between accuracy and speed for most simulations.					
29	Gas heater?	Dimensionless	-	integer	[0;+Inf]	1
	This parameter indicates to the general storage tank model whether the tank is heated with electric elements, with a gas flue, or with a combination of gas and electric. 0 = Both heater are electric 1 = Auxiliary heater #2 is gas (setting the maximum heating rate of the first heating element to zero or non-zero dictates whether the tank also has an electric element).					
30	Number of internal heat exchangers	Dimensionless	-	integer	[0;3]	1
	The number of internal heat exchangers that are contained within the storage tank. For each internal heat exchanger, the user must specify 12 parameters that describe the heat exchanger.					
31	Equal sized nodes	Dimensionless	-	integer	[0;0]	0
	This parameter indicates to the general storage tank model that all the temperature nodes should have the identical size . The number of nodes is controlled by the number of derivatives supplied. Do not change this parameter.					
32	Uniform tank losses	Dimensionless	-	integer	[0;0]	0
	This parameter indicates to the general storage tank model that the user will not be specifying the value of the incremental loss coefficients for each node in the storage tank (uniform losses from the tank is the results). The number of nodes is controlled by the number of supplied derivatives. Do not change this parameter.					
33	HX Fluid Indicator	Dimensionless	-	integer	[1;3]	1
	The fluid contained in the first internal heat exchanger: 1=Water ; 2=Propylene Glycol ; 3=Ethylene Glycol These fluids are contained in the internal heat exchanger and are not mixed with the storage fluid.					
34	Fraction of glycol	Dimensionless	-	real	[0.0;1.0]	0.75
	The fraction of glycol contained in the internal heat exchanger fluid by volume. If the previous parameter is set to 1 (water), this parameter is ignored. If the previous parameter is set to propylene glycol (2), this parameter may range from 0 to 1. If the previous parameter indicates ethylene glycol (3), this parameter may range from 0.55 to 0.85.					
35	Heat exchanger inside diameter	Length	m	real	[0.0;+Inf]	0.01
	The inside diameter of the pipe comprising the internal heat exchanger.					
36	Heat exchanger outside diameter	Length	m	real	[0.0;+Inf]	0.012
	The outside diameter of the pipe comprising the internal heat exchanger.					
37	Heat exchanger fin diameter	Length	m	real	[0.0;+Inf]	0.012

	The diameter of the fins on the outside pipe surface of the internal heat exchanger. If there are no fins (a smooth tube), set this parameter equal to the previous parameter (heat exchanger outside diameter).					
38	Total surface area of heat exchanger	Area	m^2	real	[0.0;+Inf]	1.0
	The total outside surface area of the internal heat exchanger.					
39	Fins per meter for heat exchanger	Dimensionless	-	integer	[0;+Inf]	100
	The number of fins per unit length (meter) on the outside surface of the internal heat exchanger pipe. This parameter is ignored for smooth tubes.					
40	Heat exchanger length	Length	m	real	[0.0;+Inf]	2.0
	The total length of internal heat exchanger pipe immersed within the storage tank fluid.					
41	Heat exchanger wall conductivity	Thermal Conductivity	kJ/hr.m.K	real	[0.0;+Inf]	1.40
	The conductivity of the heat exchanger wall including any applicable contact resistance. Contact resistance would be present with a double wall heat exchanger where the heat exchaanger is a tube within a tube design.					
42	Heat exchanger material conductivity	Thermal Conductivity	kJ/hr.m.K	real	[0.0;+Inf]	1.40
	The thermal conductivity of the material which comprises the internal heat exchanger.					
43	Height of heat exchanger inlet	Length	m	real	[0.0;+Inf]	0.00
	The height above the bottom of the storage tank of the inlet of the internal heat exchanger.					
44	Height of heat exchanger outlet	Length	m	real	[0.0;+Inf]	1.25
	The height of the outlet of the internal heat exchanger from the tank above the bottom of the storage tank.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
33-44	Number of internal heat exchangers		1	50

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Flow rate at inlet 1	Flow Rate	kg/hr	real	[-2;+Inf]	0.0
	The flow rate entering the storage tank at the first inlet.					
2	Flow rate at outlet 1	Flow Rate	kg/hr	real	[-2;+Inf]	-2
	The flow rate of fluid exiting the storage tank from the first outlet. One of the outlet flow rates MUST be specified as a constant value of -2 to indicate that the outlet flow rate will be determined from a mass balance on the constant volume storage tank.					
3	Not used (flow inlet 2)	Dimensionless	-	integer	[-1;-1]	-1
	This input should be set to a constant value of -1 to indicate to the general storage tank model that the tank has only 1 inlet.					
4	Not used (flow outlet 2)	Dimensionless	-	integer	[-1;-1]	-1
	This input should be set to a constant value of -1 to indicate to the general storage tank moel that there is only one outlet from this tank.					
5	Temperature at inlet 1	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the fluid entering the storage tank at the first inlet.					
6	Not used (temp inlet 2)	Temperature	C	real	[-Inf;+Inf]	20.0
	This input is not used in this mode of the storage tank model.					
7	Environment temperature	Temperature	C	real	[-Inf;+Inf]	22.0
	The temperature of the environment in which the storage tank is located.					
8	Control signal for element 1	Dimensionless	-	real	[0.0;1.0]	1.0
	The control signal for the specified auxiliary heating element. The available power for the heating element will be this input multiplied by the maximum power for the element. If an auxiliary heater is not desired for the					

	simulation, set this input to a constant of 0.0 or set the maximum power for the element to 0.0					
9	Control signal for element 2	Dimensionless	-	real	[0.0;1.0]	1.0
	The control signal for the specified auxiliary heating element. The available power for the heating element will be this input multiplied by the maximum power for the element. If an auxiliary heater is not desired for the simulation, set this input to a constant of 0.0 or set the maximum power for the element to 0.0					
10	Flow rate for heat exchanger	Flow Rate	kg/hr	real	[0.0;+Inf]	0.0
	The flow rate through the specified internal heat exchanger.					
11	Inlet temperature for heat exchanger	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature at the inlet of the specified internal heat exchanger.					
12	Nusselt constant for heat exchanger	Dimensionless	-	real	[0.0;+Inf]	0.50
	The natural convection coefficient between the storage fluid and the internal heat exchanger wall is modeled with an equation of the form: h = Nu * k / do ; Nu = C * Ra^n (See mathematical reference for details) Typical value for C is about 0.5 and n is usually 0.25.					
13	Nusselt exponent for heat exchanger	Dimensionless	-	real	[-Inf;+Inf]	0.25
	The natural convection coefficient between the storage fluid and the internal heat exchanger wall is modeled with an equation of the form: h = Nu * k / do ; Nu = C * Ra^n (See mathematical reference for details) Typical value for C is about 0.5 and n is usually 0.25.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
10-13	Number of internal heat exchangers		1	50

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Flowrate at inlet 1	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	The flow rate of fluid into the storage tank at inlet 1.					
2	Flowrate at outlet 1	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	The flow rate of fluid exiting the storage tank through outlet 1.					
3	Not used (inlet 2 flow)	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	This output should not be used in this mode of the storage tank model.					
4	Not used (outlet 2 flow)	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	This output should not be used in this model of the storage tank model.					
5	Temperature of outlet flow 1	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid exiting the storage tank through outlet 1.					
6	Not used (temp flow 2)	Temperature	C	real	[-Inf;+Inf]	0
	This output should not be used in this model of the storage tank model.					
7	Thermal losses	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate of thermal energy loss to the environment. Includes the vented energy if a boiling condition is reached.					
8	Energy supplied by inlet 1	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is added to the storage tank by the entrance of the fluid through inlet 1.					
9	Energy removed by outlet 1	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is removed from the storage tank by the exiting of fluid through outlet 1.					
10	Not used (energy inlet 2)	Power	kJ/hr	real	[-Inf;+Inf]	0
	This output should not be used in this mode of the storage tank model.					
11	Not used (energy outlet 2)	Power	kJ/hr	real	[-Inf;+Inf]	0
	This output should not be used in this mode of the storage tank model.					

12	Auxiliary heating rate	Power	kJ/hr	real	[-Inf;+Inf]	0
	The average rate at which power was added to the tank by BOTH auxiliary heaters.					
13	Element 1 power	Power	kJ/hr	real	[-Inf;+Inf]	0
	The average power supplied to the storage tank over the timestep by the first heating element specified in the parameter list.					
14	Element 2 power	Power	kJ/hr	real	[-Inf;+Inf]	0
	The average power over the timestep supplied to the tank by the second auxiliary heater specified in the parameter list.					
15	Losses to gas flue	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is removed from the storage tank through losses to the gas flue (while the tank is not being charged by the gas flue).					
16	Internal energy change	Energy	kJ	real	[-Inf;+Inf]	0
	The change in internal energy of the tank from the beginning of the simulation.					
17	Average tank temperature	Temperature	C	real	[-Inf;+Inf]	0
	The average temperature of the fluid in the storage tank over the timestep.					
18	Static pressure difference - inlet 1	Pressure	kPa	real	[-Inf;+Inf]	0
	The static pressure difference between the top of the tank and the first inlet port.					
19	Static pressure difference - outlet 1	Pressure	kPa	real	[-Inf;+Inf]	0
	The static pressure difference between the top of the tank and the first outlet port.					
20	Not used (pressure inlet 2)	Pressure	kPa	real	[-Inf;+Inf]	0
	This output should not be used in this mode of the storage tnk model.					
21	Not used (pressure outlet 2)	Pressure	kPa	real	[-Inf;+Inf]	0
	This output should not be used in this mode of the storage tank model.					
22	Energy input from heat exchanger	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is added to the storage tank from the specified internal heat exchanger.					
23	Temperature of fluid exiting heat exchanger	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid exiting the specified internal heat exchanger.					
24	Tank temperature at outlet of heat exchanger	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the storage tank at the outlet of the specified internal heat exchanger.					
25	LMTD of heat exchanger	Temperature	C	real	[-Inf;+Inf]	0
	The average log mean temperature difference of the specified internal heat exchanger over the timestep.					
26	UA of heat exchanger	Overall Loss Coefficient	kJ/hr.K	real	[0.0;+Inf]	0
	The average overall heat transfer coefficient of the specified internal heat exchanger over the timestep.					
27	Tank temperature - top	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid at the top of the storage tank.					
28	Tank temperature - bottom	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid at the bottom of the storage tank.					
29	Temperature of node 1+	Temperature	C	real	[-Inf;+Inf]	0
	Temperature of node 1+ The temperature of the specified node.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
22-26	Number of internal heat exchangers		1	50
29-29		Besides the top and bottom nodes, how many other nodes are there?	1	13

DERIVATIVES

	Name	Dimension	Unit	Type	Range	Default
1	Initial temperature of node	Temperature	C	real	[-Inf;+Inf]	0
	The initial temperature of the specified node.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
1-1		How many temperature levels (nodes) should be used in the tank?	1	50

4.12.1.14. Uniform Cross Section - Uniform Losses and Node Heights - 1 Inlet, 2 Outlets

Icon		TRNSYS Model	Type 60
Proforma	Thermal Storage\Detailed Fluid Storage Tank\Uniform Cross Section\Uniform Losses and Node Heights\1 Inlet, 2 Outlets\Type60q.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	User-specified inlet positions	Dimensionless	-	integer	[1;2]	2
	The auxiliary storage tank may operate in one of two modes in determining the inlet positions of the flow streams. In this mode (2), the user must specify the locations (nodes) of the entering flow streams. Do not change this parameter.					
2	Tank volume	Volumetric Flow Rate	m^3	real	[0.0;+Inf]	0.35
	The actual volume of the storage tank (not the nominal value).					
3	Tank height	Length	m	real	[0.0;+Inf]	1.25
	The height of the storage tank. If the tank is a horizontal cylinder, this parameter should be set to the diameter of the storage tank.					
4	Tank perimeter	Length	m	real	[0.0;+Inf]	3.0
	The perimeter length for the uniform cross-section tank.					
5	Height of flow inlet 1	Length	m	real	[0.0;+Inf]	1.25
	The height of the first inlet above the bottom of the tank. Make sure that this value is between 0 and the total height of the tank.					
6	Height of flow outlet 1	Length	m	real	[0.0;+Inf]	0.0
	The height of the first outlet from the storage tank above the bottom of the tank. Make sure that this value is between 0 and the total height of the tank.					
7	Not used (inlet 2)	Dimensionless	-	integer	[-1;-1]	-1
	This parameter must be set to -1 to indicate to the general storage tank model that there is only one inlet to this tank.					
8	Height of flow outlet 2	Length	m	real	[0.0;+Inf]	1.25
	The height of the 2nd outlet from the storage tank above the bottom of the tank. Make sure that this value is between 0 and the total height of the storage tank.					
9	Fluid specific heat	Specific Heat	kJ/kg.K	real	[0.0;+Inf]	4.190
	The specific heat of the fluid contained in the storage tank.					
10	Fluid density	Density	kg/m^3	real	[0.0;+Inf]	1000.0
	The density of the fluid contained in the storage tank.					
11	Tank loss coefficient	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[0.0;+Inf]	3.0
	The average tank loss coefficient per unit area. Different loss coefficients for each node can be modeled by use of the incremental loss coefficient parameters.					
12	Fluid thermal conductivity	Thermal Conductivity	kJ/hr.m.K	real	[0.0;+Inf]	1.40
	The thermal conductivity of the fluid contained in the storage tank.					
13	Destratification conductivity	Thermal Conductivity	kJ/hr.m.K	real	[0.0;+Inf]	0.0
	To model de-stratification due to mixing at node interfaces and conduction along the tank wall, the user may enter this additional conductivity parameter. The additional conductivity term is added to the conductivity of the tank fluid and is applied to all nodes. For rough calculations, one may calculate this parameter as the thermal conductivity of the tank wall times the cross sectional area of the tank wall divided by the cross sectional area of the fluid in the storage tank.					

14	Boiling temperature	Temperature	C	real	[-Inf;+Inf]	100.0
	The boiling point temperature of the fluid contained in the storage tank.					
15	Auxiliary heater mode	Dimensionless	-	integer	[1;2]	1
	The auxiliary heater may be operated in one of two modes: 1 = Master/Slave Relation: The lower heating element is only enabled when the upper heating element is satisified. In this mode, only one heater may be on at any instant of time. This is a common design in residential electric hot water tanks. 2 = Both Enabled: In this mode, both heaters may be on simultaneously. This allows for significantly quicker heating of the water, but at a much higher electrical demand.					
16	Height of 1st aux. heater	Length	m	real	[0.0;+Inf]	1.0
	The height of the first auxiliary heater element above the bottom of the storage tank. If there are no auxiliary heaters, set this parameter and the thermostat height parameter to any value between 0 anf the total tank height. Then simply set either the maximum heating rate or the control signal for this heating element to a constant value of 0.					
17	Height of 1st thermostat	Length	m	real	[0.0;+Inf]	1.25
	The height of the thermostat for the first heating element above the bottom of the storage tank. If there are no heating elements, simply set this parameter to any value between 0 and the total tank height. Then set either the maximum heating rate or the control signal for this heating element to a constant value of 0.					
18	Set point temperature for element 1	Temperature	C	real	[-Inf;+Inf]	55.0
	The set point temperature for the specified heating element. The thermostat will enable the heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb and continue to heat the fluid until it reaches the set point temperature. Tset = this parameter; Tdb = next parameter					
19	Deadband for heating element 1	Temp. Difference	deltaC	real	[-Inf;+Inf]	5.0
	The dead band temperature difference for the specified heating element. The thermostat will enable the heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb and continue to heat the fluid until it reaches the set point temperature. Where Tset = previous parameter; Tdb = this parameter					
20	Maximum heating rate of element 1	Power	kJ/hr	real	[0.0;+Inf]	16200.0
	The maximum heating rate of the heating element. If the specified heating element is to not to be used for the simulation, set the maximum power to 0.					
21	Height of heating element 2	Length	m	integer	[1;15]	1
	The node containing the specified auxiliary heating element. Make sure that the specified node for the heater is between 1 and the total number of nodes specified. Node 1 is the topmost node in the tank.					
22	Height of thermostat 2	Length	m	integer	[1;15]	1
	The node containing the thermostat for the specified auxiliary heater. The thermostat is typically either located in the same node as the heating element or in a node located above the element. Node 1 is the topmost node in the tank.					
23	Set point temperature for element 2	Temperature	C	real	[-Inf;+Inf]	55.0
	The set point temperature for the specified heating element. The thermostat will enable the heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb and continue to heat the fluid until it reaches the set point temperature. Tset = this parameter; Tdb = next parameter					
24	Deadband for heating element 2	Temp. Difference	deltaC	real	[0.0;+Inf]	5.0
	The dead band temperature difference for the specified heating element. The thermostat will enable the heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb					

	and continue to heat the fluid until it reaches the set point temperature. Where Tset = previous parameter; Tdb = this parameter					
25	Maximum heating rate of element 2	Power	kJ/hr	real	[0.0;+Inf]	16200
	The maximum heating rate of the heating element. If the specified heating element is to not to be used for the simulation, set the maximum power to 0.					
26	Overall loss coefficient for gas flue	Overall Loss Coefficient	kJ/hr.K	real	[0.0;+Inf]	0.0
	The overall loss coefficient of the gas flue when the tank is not being heated. If this tank is not being heated by gas, simply set this parameter to 0.0 and the next parameter (flue temperature) to any reasonable value.					
27	Flue temperature	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the gas flue when the tank is not being heated. This parameter is used tto calculate the losses from the storage to the flue when the tank is not being heated. If the tank is not heated witth gas, simply set this parameter to any reasonable value and set the previous parameter (flue loss coefficient) to 0.					
28	Fraction of critical timestep	Dimensionless	-	integer	[1;1000]	6
	To minimize numerical errors, the TYPE 60 tank model uses its own internal time step. This has the advantage of results being unaffected by the size of the TRNSYS time step. The model internally computes the critical Euler time step. The user then chooses the fraction of the critical time step that will be used. Increasing this parameter will increase the accuracy of the model, but decrease the simulation speed. A value of 6 represents an excellent compromise between accuracy and speed for most simulations.					
29	Gas heater?	Dimensionless	-	integer	[0;+Inf]	1
	This parameter indicates to the general storage tank model whether the tank is heated with electric elements, with a gas flue, or with a combination of gas and electric. 0 = Both heater are electric 1 = Auxiliary heater #2 is gas (setting the maximum heating rate of the first heating element to zero or non-zero dictates whether the tank also has an electric element).					
30	Number of internal heat exchangers	Dimensionless	-	integer	[0;3]	1
	The number of internal heat exchangers that are contained within the storage tank. For each internal heat exchanger, the user must specify 12 parameters that describe the heat exchanger.					
31	Equal node sizes	Dimensionless	-	integer	[0;0]	0
	This parameter indicates to the general storage tank model that the tank should be divided into nodes of equal size. The number of nodes is controlled by the number of derivatives supplied. Do not change this parameter.					
32	Uniform tank losses	Dimensionless	-	integer	[0;0]	0
	This parameter indicates to the general storage tank model that each node in the storagetank should have an identical loss coefficient. The number of nodes is controlled by the number of supplied derivatives. Do not change this parameter.					
33	HX Fluid Indicator	Dimensionless	-	integer	[1;3]	1
	The fluid contained in the first internal heat exchanger: 1=Water ; 2=Propylene Glycol ; 3=Ethylene Glycol These fluids are contained in the internal heat exchanger and are not mixed with the storage fluid.					
34	Fraction of glycol	Dimensionless	-	real	[0.0;1.0]	0.75
	The fraction of glycol contained in the internal heat exchanger fluid by volume. If the previous parameter is set to 1 (water), this parameter is ignored. If the previous parameter is set to propylene glycol (2), this parameter may range from 0 to 1. If the previous parameter indicates ethylene glycol (3), this parameter may range from 0.55 to 0.85.					
35	Heat exchanger inside diameter	Length	m	real	[0.0;+Inf]	0.01
	The inside diameter of the pipe comprising the internal heat exchanger.					
36	Heat exchanger outside diameter	Length	m	real	[0.0;+Inf]	0.012
	The outside diameter of the pipe comprising the internal heat exchanger.					
37	Heat exchanger fin diameter	Length	m	real	[0.0;+Inf]	0.012
	The diameter of the fins on the outside pipe surface of the internal heat exchanger. If there are no fins (a					

	smooth tube), set this parameter equal to the previous parameter (heat exchanger outside diameter).					
38	Total surface area of heat exchanger	Area	m^2	real	[0.0;+Inf]	1.0
	The total outside surface area of the internal heat exchanger.					
39	Fins per meter for heat exchanger	Dimensionless	-	integer	[0;+Inf]	100
	The number of fins per unit length (meter) on the outside surface of the internal heat exchanger pipe. This parameter is ignored for smooth tubes.					
40	Heat exchanger length	Length	m	real	[0.0;+Inf]	2.0
	The total length of internal heat exchanger pipe immersed within the storage tank fluid.					
41	Heat exchanger wall conductivity	Thermal Conductivity	kJ/hr.m.K	real	[0.0;+Inf]	1.40
	The conductivity of the heat exchanger wall including any applicable contact resistance. Contact resistance would be present with a double wall heat exchanger where the heat exchaanger is a tube within a tube design.					
42	Heat exchanger material conductivity	Thermal Conductivity	kJ/hr.m.K	real	[0.0;+Inf]	1.40
	The thermal conductivity of the material which comprises the internal heat exchanger.					
43	Height of heat exchanger inlet	Length	m	real	[0.0;+Inf]	0.00
	The height above the bottom of the storage tank of the inlet of the internal heat exchanger.					
44	Height of heat exchanger outlet	Length	m	real	[0.0;+Inf]	1.25
	The height of the outlet of the internal heat exchanger from the tank above the bottom of the storage tank.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
33-44	Number of internal heat exchangers		1	50

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Flow rate at inlet 1	Flow Rate	kg/hr	real	[-2;+Inf]	0.0
	The flow rate entering the storage tank at the first inlet.					
2	Flow rate at outlet 1	Flow Rate	kg/hr	real	[-2;+Inf]	0.0
	The flow rate of fluid exiting the storage tank from the first outlet. One of the outlet flow rates MUST be specified as a constant value of -2 to indicate that the outlet flow rate will be determined from a mass balance on the constant volume storage tank.					
3	Not used (flow inlet 2)	Dimensionless	-	integer	[-1;-1]	-1
	This input should be set to a constant value of -1 to indicate to the general storage tank model that the tank has only 1 inlet.					
4	Flow rate at outlet 2	Flow Rate	kg/hr	real	[-2;+Inf]	-2
	The flow rate of fluid exiting ths storage tank from the second outlet. One of the outlet flow rates MUST be set to a constant value of -2 to indicate that the outlet flow rate will be determined from a mass balance on the constant volume storage tank.					
5	Temperature at inlet 1	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the fluid entering the storage tank at the first inlet.					
6	Not used (temp inlet 2)	Temperature	C	real	[-Inf;+Inf]	20.0
	This input is not used in this mode of the storage tank model.					
7	Environment temperature	Temperature	C	real	[-Inf;+Inf]	22.0
	The temperature of the environment in which the storage tank is located.					
8	Control signal for element 1	Dimensionless	-	real	[0.0;1.0]	1.0
	The control signal for the specified auxiliary heating element. The available power for the heating element will be this input multiplied by the maximum power for the element. If an auxiliary heater is not desired for the					

	simulation, set this input to a constant of 0.0 or set the maximum power for the element to 0.0					
9	Control signal for element 2	Dimensionless	-	real	[0.0;1.0]	1.0
	The control signal for the specified auxiliary heating element. The available power for the heating element will be this input multiplied by the maximum power for the element. If an auxiliary heater is not desired for the simulation, set this input to a constant of 0.0 or set the maximum power for the element to 0.0					
10	Flow rate for heat exchanger	Flow Rate	kg/hr	real	[0.0;+Inf]	0.0
	The flow rate through the specified internal heat exchanger.					
11	Inlet temperature for heat exchanger	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature at the inlet of the specified internal heat exchanger.					
12	Nusselt constant for heat exchanger	Dimensionless	-	real	[0.0;+Inf]	0.50
	The natural convection coefficient between the storage fluid and the internal heat exchanger wall is modeled with an equation of the form: h = Nu * k / do ; Nu = C * Ra^n (See mathematical reference for details) Typical value for C is about 0.5 and n is usually 0.25.					
13	Nusselt exponent for heat exchanger	Dimensionless	-	real	[-Inf;+Inf]	0.25
	The natural convection coefficient between the storage fluid and the internal heat exchanger wall is modeled with an equation of the form: h = Nu * k / do ; Nu = C * Ra^n (See mathematical reference for details) Typical value for C is about 0.5 and n is usually 0.25.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
10-13	Number of internal heat exchangers		1	50

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Flowrate at inlet 1	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	The flow rate of fluid into the storage tank at inlet 1.					
2	Flowrate at outlet 1	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	The flow rate of fluid exiting the storage tank through outlet 1.					
3	Not used (inlet 2 flow)	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	This output should not be used in this mode of the storage tank model.					
4	Flowrate at outlet 2	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	The flowrate of fluid exiting the storage tank through outlet 2.					
5	Temperature of outlet flow 1	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid exiting the storage tank through outlet 1.					
6	Temperature of outlet flow 2	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid exiting the storage tank through outlet 2.					
7	Thermal losses	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate of thermal energy loss to the environment. Includes the vented energy if a boiling condition is reached.					
8	Energy supplied by inlet 1	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is added to the storage tank by the entrance of the fluid through inlet 1.					
9	Energy removed by outlet 1	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is removed from the storage tank by the exiting of fluid through outlet 1.					
10	Not used (energy inlet 2)	Power	kJ/hr	real	[-Inf;+Inf]	0
	This output should not be used in this mode of the storage tank model.					
11	Energy removed by outlet 2	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is removed from the storage tank by the exiting of fluid through outlet 2.					

12	Auxiliary heating rate	Power	kJ/hr	real	[-Inf;+Inf]	0
	The average rate at which power was added to the tank by BOTH auxiliary heaters.					
13	Element 1 power	Power	kJ/hr	real	[-Inf;+Inf]	0
	The average power supplied to the storage tank over the timestep by the first heating element specified in the parameter list.					
14	Element 2 power	Power	kJ/hr	real	[-Inf;+Inf]	0
	The average power over the timestep supplied to the tank by the second auxiliary heater specified in the parameter list.					
15	Losses to gas flue	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is removed from the storage tank through losses to the gas flue (while the tank is not being charged by the gas flue).					
16	Internal energy change	Energy	kJ	real	[-Inf;+Inf]	0
	The change in internal energy of the tank from the beginning of the simulation.					
17	Average tank temperature	Temperature	C	real	[-Inf;+Inf]	0
	The average temperature of the fluid in the storage tank over the timestep.					
18	Static pressure difference - inlet 1	Pressure	kPa	real	[-Inf;+Inf]	0
	The static pressure difference between the top of the tank and the first inlet port.					
19	Static pressure difference - outlet 1	Pressure	kPa	real	[-Inf;+Inf]	0
	The static pressure difference between the top of the tank and the first outlet port.					
20	Not used (presure inlet 2)	Pressure	kPa	real	[-Inf;+Inf]	0
	This output should not be used in this mode of the storage tnk model.					
21	Static pressure difference - outlet 2	Pressure	kPa	real	[-Inf;+Inf]	0
	The static pressure difference between the top of the tank and the second outlet port.					
22	Energy input from heat exchanger	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is added to the storage tank from the specified internal heat exchanger.					
23	Temperature of fluid exiting heat exchanger	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid exiting the specified internal heat exchanger.					
24	Tank temperature at outlet of heat exchanger	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the storage tank at the outlet of the specified internal heat exchanger.					
25	LMTD of heat exchanger	Temperature	C	real	[-Inf;+Inf]	0
	The average log mean temperature difference of the specified internal heat exchanger over the timestep.					
26	UA of heat exchanger	Overall Loss Coefficient	kJ/hr.K	real	[0.0;+Inf]	0
	The average overall heat transfer coefficient of the specified internal heat exchanger over the timestep.					
27	Tank temperature - top	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid at the top of the storage tank.					
28	Tank temperature - bottom	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid at the bottom of the storage tank.					
29	Temperature of node 1+	Temperature	C	real	[-Inf;+Inf]	0
	Temperature of node 1+ The temperature of the specified node.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
22-26	Number of internal heat exchangers		1	50
29-29		Besides the top and bottom nodes, how many other nodes are there?	1	13

DERIVATIVES

	Name	Dimension	Unit	Type	Range	Default
1	Initial temperature of node	Temperature	C	real	[-Inf;+Inf]	0
	The initial temperature of the specified node.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
1-1		How many temperature levels (nodes) should be used in the tank?	1	50

4.12.1.15. Uniform Cross Section - Uniform Losses and Node Heights - 2 Inlets, 1 Outlet

Icon		TRNSYS Model	Type 60
Proforma	Thermal Storage\Detailed Fluid Storage Tank\Uniform Cross Section\Uniform Losses and Node Heights\2 Inlets, 1 Outlet\Type60r.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	User-specified inlet positions	Dimensionless	-	integer	[1;2]	2
	The auxiliary storage tank may operate in one of two modes in determining the inlet positions of the flow streams. In this mode (2), the user must specify the locations (nodes) of the entering flow streams. Do not change this parameter.					
2	Tank volume	Volumetric Flow Rate	m^3	real	[0.0;+Inf]	0.35
	The actual volume of the storage tank (not the nominal value).					
3	Tank height	Length	m	real	[0.0;+Inf]	1.25
	The height of the storage tank. If the tank is a horizontal cylinder, this parameter should be set to the diameter of the storage tank.					
4	Tank perimeter	Length	m	real	[0.0;+Inf]	3.0
	The perimeter length for the uniform cross-section tank.					
5	Height of flow inlet 1	Length	m	real	[0.0;+Inf]	1.25
	The height of the first inlet above the bottom of the tank. Make sure that this value is between 0 and the total height of the tank.					
6	Height of flow outlet 1	Length	m	real	[0.0;+Inf]	0.0
	The height of the first outlet from the storage tank above the bottom of the tank. Make sure that this value is between 0 and the total height of the tank.					
7	Height of flow inlet 2	Length	m	real	[0.0;+Inf]	0.0
	The height of the second inlet to the staorage tank above the bottom of the tank. Make sure that this value is between 0 and the total height of the storage tank.					
8	Not Used (outlet 2)	Dimensionless	-	integer	[-1;-1]	-1
	This parameter should be set to a value of -1 to indicate to the general storage tank model that there is only one outlet from the tank.					
9	Fluid specific heat	Specific Heat	kJ/kg.K	real	[0.0;+Inf]	4.190
	The specific heat of the fluid contained in the storage tank.					
10	Fluid density	Density	kg/m^3	real	[0.0;+Inf]	1000.0
	The density of the fluid contained in the storage tank.					
11	Tank loss coefficient	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[0.0;+Inf]	3.0
	The average tank loss coefficient per unit area. Different loss coefficients for each node can be modeled by use of the incremental loss coefficient parameters.					
12	Fluid thermal conductivity	Thermal Conductivity	kJ/hr.m.K	real	[0.0;+Inf]	1.40
	The thermal conductivity of the fluid contained in the storage tank.					
13	Destratification conductivity	Thermal Conductivity	kJ/hr.m.K	real	[0.0;+Inf]	0.0
	To model de-stratification due to mixing at node interfaces and conduction along the tank wall, the user may enter this additional conductivity parameter. The additional conductivity term is added to the conductivity of the tank fluid and is applied to all nodes. For rough calculations, one may calculate this parameter as the thermal conductivity of the tank wall times the cross sectional area of the tank wall divided by the cross sectional area of the fluid in the storage tank.					

14	Boiling temperature	Temperature	C	real	[-Inf;+Inf]	100.0
	The boiling point temperature of the fluid contained in the storage tank.					
15	Auxiliary heater mode	Dimensionless	-	integer	[1;2]	1
	The auxiliary heater may be operated in one of two modes: 1 = Master/Slave Relation: The lower heating element is only enabled when the upper heating element is satisified. In this mode, only one heater may be on at any instant of time. This is a common design in residential electric hot water tanks. 2 = Both Enabled: In this mode, both heaters may be on simultaneously. This allows for significantly quicker heating of the water, but at a much higher electrical demand.					
16	Height of 1st aux. heater	Length	m	real	[0.0;+Inf]	1.0
	The height of the first auxiliary heater element above the bottom of the storage tank. If there are no auxiliary heaters, set this parameter and the thermostat height parameter to any value between 0 anf the total tank height. Then simply set either the maximum heating rate or the control signal for this heating element to a constant value of 0.					
17	Height of 1st thermostat	Length	m	real	[0.0;+Inf]	1.25
	The height of the thermostat for the first heating element above the bottom of the storage tank. If there are no heating elements, simply set this parameter to any value between 0 and the total tank height. Then set either the maximum heating rate or the control signal for this heating element to a constant value of 0.					
18	Set point temperature for element 1	Temperature	C	real	[-Inf;+Inf]	55.0
	The set point temperature for the specified heating element. The thermostat will enable the heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb and continue to heat the fluid until it reaches the set point temperature. Tset = this parameter; Tdb = next parameter					
19	Deadband for heating element 1	Temp. Difference	deltaC	real	[-Inf;+Inf]	5.0
	The dead band temperature difference for the specified heating element. The thermostat will enable the heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb and continue to heat the fluid until it reaches the set point temperature. Where Tset = previous parameter; Tdb = this parameter					
20	Maximum heating rate of element 1	Power	kJ/hr	real	[0.0;+Inf]	16200.0
	The maximum heating rate of the heating element. If the specified heating element is to not to be used for the simulation, set the maximum power to 0.					
21	Height ofheating element 2	Length	m	integer	[1;15]	1
	The node containing the specified auxiliary heating element. Make sure that the specified node for the heater is between 1 and the total number of nodes specified. Node 1 is the topmost node in the tank.					
22	Height of thermostat 2	Length	m	integer	[1;15]	1
	The node containing the thermostat for the specified auxiliary heater. The thermostat is typically either located in the same node as the heating element or in a node located above the element. Node 1 is the topmost node in the tank.					
23	Set point temperature for element 2	Temperature	C	real	[-Inf;+Inf]	55.0
	The set point temperature for the specified heating element. The thermostat will enable the heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb and continue to heat the fluid until it reaches the set point temperature. Tset = this parameter; Tdb = next parameter					
24	Deadband for heating element 2	Temp. Difference	deltaC	real	[0.0;+Inf]	5.0
	The dead band temperature difference for the specified heating element. The thermostat will enable the heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb					

	and continue to heat the fluid until it reaches the set point temperature. Where Tset = previous parameter; Tdb = this parameter					
25	Maximum heating rate of element 2	Power	kJ/hr	real	[0.0;+Inf]	16200
	The maximum heating rate of the heating element. If the specified heating element is to not to be used for the simulation, set the maximum power to 0.					
26	Overall loss coefficient for gas flue	Overall Loss Coefficient	kJ/hr.K	real	[0.0;+Inf]	0.0
	The overall loss coefficient of the gas flue when the tank is not being heated. If this tank is not being heated by gas, simply set this parameter to 0.0 and the next parameter (flue temperature) to any reasonable value.					
27	Flue temperature	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the gas flue when the tank is not being heated. This parameter is used tto calculate the losses from the storage to the flue when the tank is not being heated. If the tank is not heated witth gas, simply set this parameter to any reasonable value and set the previous parameter (flue loss coefficient) to 0.					
28	Fraction of critical timestep	Dimensionless	-	integer	[1;1000]	6
	To minimize numerical errors, the TYPE 60 tank model uses its own internal time step. This has the advantage of results being unaffected by the size of the TRNSYS time step. The model internally computes the critical Euler time step. The user then chooses the fraction of the critical time step that will be used. Increasing this parameter will increase the accuracy of the model, but decrease the simulation speed. A value of 6 represents an excellent compromise between accuracy and speed for most simulations.					
29	Gas heater?	Dimensionless	-	integer	[0;+Inf]	1
	This parameter indicates to the general storage tank model whether the tank is heated with electric elements, with a gas flue, or with a combination of gas and electric. 0 = Both heater are electric 1 = Auxiliary heater #2 is gas (setting the maximum heating rate of the first heating element to zero or non-zero dictates whether the tank also has an electric element).					
30	Number of internal heat exchangers	Dimensionless	-	integer	[0;3]	1
	The number of internal heat exchangers that are contained within the storage tank. For each internal heat exchanger, the user must specify 12 parameters that describe the heat exchanger.					
31	Equal node sizes	Dimensionless	-	integer	[0;0]	0
	This parameter indicates to the general storage tank model that the tank should be divided into nodes of equal size. The number of nodes is controlled by the number of derivatives supplied. Do not change this parameter.					
32	Uniform tank losses	Dimensionless	-	integer	[0;0]	0
	This parameter indicates to the general storage tank model that the tank should have uniform loss coefficients for each node. The number of nodes is controlled by the number of supplied derivatives. Do not change this parameter.					
33	HX Fluid Indicator	Dimensionless	-	integer	[1;3]	1
	The fluid contained in the first internal heat exchanger: 1=Water ; 2=Propylene Glycol ; 3=Ethylene Glycol These fluids are contained in the internal heat exchanger and are not mixed with the storage fluid.					
34	Fraction of glycol	Dimensionless	-	real	[0.0;1.0]	0.75
	The fraction of glycol contained in the internal heat exchanger fluid by volume. If the previous parameter is set to 1 (water), this parameter is ignored. If the previous parameter is set to propylene glycol (2), this parameter may range from 0 to 1. If the previous parameter indicates ethylene glycol (3), this parameter may range from 0.55 to 0.85.					
35	Heat exchanger inside diameter	Length	m	real	[0.0;+Inf]	0.01
	The inside diameter of the pipe comprising the internal heat exchanger.					
36	Heat exchanger outside diameter	Length	m	real	[0.0;+Inf]	0.012
	The outside diameter of the pipe comprising the internal heat exchanger.					
37	Heat exchanger fin diameter	Length	m	real	[0.0;+Inf]	0.012
	The diameter of the fins on the outside pipe surface of the internal heat exchanger. If there are no fins (a					

	smooth tube), set this parameter equal to the previous parameter (heat exchanger outside diameter).					
38	Total surface area of heat exchanger	Area	m^2	real	[0.0;+Inf]	1.0
	The total outside surface area of the internal heat exchanger.					
39	Fins per meter for heat exchanger	Dimensionless	-	integer	[0;+Inf]	100
	The number of fins per unit length (meter) on the outside surface of the internal heat exchanger pipe. This parameter is ignored for smooth tubes.					
40	Heat exchanger length	Length	m	real	[0.0;+Inf]	2.0
	The total length of internal heat exchanger pipe immersed within the storage tank fluid.					
41	Heat exchanger wall conductivity	Thermal Conductivity	kJ/hr.m.K	real	[0.0;+Inf]	1.40
	The conductivity of the heat exchanger wall including any applicable contact resistance. Contact resistance would be present with a double wall heat exchanger where the heat exchaanger is a tube within a tube design.					
42	Heat exchanger material conductivity	Thermal Conductivity	kJ/hr.m.K	real	[0.0;+Inf]	1.40
	The thermal conductivity of the material which comprises the internal heat exchanger.					
43	Height of heat exchanger inlet	Length	m	real	[0.0;+Inf]	0.00
	The height above the bottom of the storage tank of the inlet of the internal heat exchanger.					
44	Height of heat exchanger outlet	Length	m	real	[0.0;+Inf]	1.25
	The height of the outlet of the internal heat exchanger from the tank above the bottom of the storage tank.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
33-44	Number of internal heat exchangers		1	50

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Flow rate at inlet 1	Flow Rate	kg/hr	real	[-2;+Inf]	0.0
	The flow rate entering the storage tank at the first inlet.					
2	Flow rate at outlet 1	Flow Rate	kg/hr	real	[-2;+Inf]	-2
	The flow rate of fluid exiting the storage tank from the first outlet. One of the outlet flow rates MUST be specified as a constant value of -2 to indicate that the outlet flow rate will be determined from a mass balance on the constant volume storage tank.					
3	Flow rate at inlet 2	Flow Rate	kg/hr	real	[-2;+Inf]	0.0
	The flow rate of fluid entering the storage tank at the second inlet.					
4	Not used (outlet 2)	Dimensionless	-	integer	[-1;-1]	-1
	This input must be set to a constant value of -1 to inform the general storage tank model that there is only one outlet from the tank.					
5	Temperature at inlet 1	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the fluid entering the storage tank at the first inlet.					
6	Temperature at inlet 2	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the fluid entering the storage tank at the second inlet.					
7	Environment temperature	Temperature	C	real	[-Inf;+Inf]	22.0
	The temperature of the environment in which the storage tank is located.					
8	Control signal for element 1	Dimensionless	-	real	[0.0;1.0]	1.0
	The control signal for the specified auxiliary heating element. The available power for the heating element will be this input multiplied by the maximum power for the element. If an auxiliary heater is not desired for the simulation, set this input to a constant of 0.0 or set the maximum power for the element to 0.0					
9	Control signal for element 2	Dimensionless	-	real	[0.0;1.0]	1.0

	The control signal for the specified auxiliary heating element. The available power for the heating element will be this input multiplied by the maximum power for the element. If an auxiliary heater is not desired for the simulation, set this input to a constant of 0.0 or set the maximum power for the element to 0.0					
10	Flow rate for heat exchanger	Flow Rate	kg/hr	real	[0.0;+Inf]	0.0
	The flow rate through the specified internal heat exchanger.					
11	Inlet temperature for heat exchanger	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature at the inlet of the specified internal heat exchanger.					
12	Nusselt constant for heat exchanger	Dimensionless	-	real	[0.0;+Inf]	0.50
	The natural convection coefficient between the storage fluid and the internal heat exchanger wall is modeled with an equation of the form: h = Nu * k / do ; Nu = C * Ra^n (See mathematical reference for details) Typical value for C is about 0.5 and n is usually 0.25.					
13	Nusselt exponent for heat exchanger	Dimensionless	-	real	[-Inf;+Inf]	0.25
	The natural convection coefficient between the storage fluid and the internal heat exchanger wall is modeled with an equation of the form: h = Nu * k / do ; Nu = C * Ra^n (See mathematical reference for details) Typical value for C is about 0.5 and n is usually 0.25.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
10-13	Number of internal heat exchangers		1	50

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Flowrate at inlet 1	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	The flow rate of fluid into the storage tank at inlet 1.					
2	Flowrate at outlet 1	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	The flow rate of fluid exiting the storage tank through outlet 1.					
3	Flowrate at inlet 2	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	The flow rate of fluid entering the storage tank through inlet 2.					
4	Not used in this mode	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	This output is not available in this mode.					
5	Temperature of outlet flow 1	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid exiting the storage tank through outlet 1.					
6	Not used (temp at outlet 2)	Temperature	C	real	[-Inf;+Inf]	0
	This output should not be used in this mode of the storage tank.					
7	Thermal losses	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate of thermal energy loss to the environment. Includes the vented energy if a boiling condition is reached.					
8	Energy supplied by inlet 1	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is added to the storage tank by the entrance of the fluid through inlet 1.					
9	Energy removed by outlet 1	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is removed from the storage tank by the exiting of fluid through outlet 1.					
10	Energy supllied by inlet 2	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is added to the storage tank by the entrance of the fluid through inlet 2.					
11	Not used (energy outlet 2)	Power	kJ/hr	real	[-Inf;+Inf]	0
	This output should not be used in this mode of the storage tank model.					
12	Auxiliary heating rate	Power	kJ/hr	real	[-Inf;+Inf]	0
	The average rate at which power was added to the tank by BOTH auxiliary heaters.					

13	Element 1 power	Power	kJ/hr	real	[-Inf;+Inf]	0
	The average power supplied to the storage tank over the timestep by the first heating element specified in the parameter list.					
14	Element 2 power	Power	kJ/hr	real	[-Inf;+Inf]	0
	The average power over the timestep supplied to the tank by the second auxiliary heater specified in the parameter list.					
15	Losses to gas flue	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is removed from the storage tank through losses to the gas flue (while the tank is not being charged by the gas flue).					
16	Internal energy change	Energy	kJ	real	[-Inf;+Inf]	0
	The change in internal energy of the tank from the beginning of the simulation.					
17	Average tank temperature	Temperature	C	real	[-Inf;+Inf]	0
	The average temperature of the fluid in the storage tank over the timestep.					
18	Static pressure difference - inlet 1	Pressure	kPa	real	[-Inf;+Inf]	0
	The static pressure difference between the top of the tank and the first inlet port.					
19	Static pressure difference - outlet 1	Pressure	kPa	real	[-Inf;+Inf]	0
	The static pressure difference between the top of the tank and the first outlet port.					
20	Static pressure difference - inlet 2	Pressure	kPa	real	[-Inf;+Inf]	0
	The static pressure difference between the top of the tank and the second inlet port.					
21	Not used (pressure outlet 2)	Pressure	kPa	real	[-Inf;+Inf]	0
	This output should not be used in this mode of the storage tank model.					
22	Energy input from heat exchanger	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is added to the storage tank from the specified internal heat exchanger.					
23	Temperature of fluid exiting heat exchanger	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid exiting the specified internal heat exchanger.					
24	Tank temperature at outlet of heat exchanger	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the storage tank at the outlet of the specified internal heat exchanger.					
25	LMTD of heat exchanger	Temperature	C	real	[-Inf;+Inf]	0
	The average log mean temperature difference of the specified internal heat exchanger over the timestep.					
26	UA of heat exchanger	Overall Loss Coefficient	kJ/hr.K	real	[0.0;+Inf]	0
	The average overall heat transfer coefficient of the specified internal heat exchanger over the timestep.					
27	Tank temperature - top	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid at the top of the storage tank.					
28	Tank temperature - bottom	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid at the bottom of the storage tank.					
29	Temperature of node 1+	Temperature	C	real	[-Inf;+Inf]	0
	Temperature of node 1+ The temperature of the specified node.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
22-26	Number of internal heat exchangers		1	50
29-29		Besides the top and bottom nodes, how many other nodes are there?	1	13

DERIVATIVES

	Name	Dimension	Unit	Type	Range	Default
1	Initial temperature of node	Temperature	C	real	[-Inf;+Inf]	0
	The initial temperature of the specified node.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
1-1		How many temperature levels (nodes) should be used in the tank?	1	50

4.12.1.16. Uniform Cross Section - Uniform Losses and Node Heights - 2 Inlets, 2 Outlets

Icon		TRNSYS Model	Type 60
Proforma	Thermal Storage\Detailed Fluid Storage Tank\Uniform Cross Section\Uniform Losses and Node Heights\2 Inlets, 2 Outlets\Type60s.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	User-specified inlet positions	Dimensionless	-	integer	[1;2]	2
	The auxiliary storage tank may operate in one of two modes in determining the inlet positions of the flow streams. In this mode (2), the user must specify the locations (nodes) of the entering flow streams. Do not change this parameter.					
2	Tank volume	Volumetric Flow Rate	m^3	real	[0.0;+Inf]	0.35
	The actual volume of the storage tank (not the nominal value).					
3	Tank height	Length	m	real	[0.0;+Inf]	1.25
	The height of the storage tank. If the tank is a horizontal cylinder, this parameter should be set to the diameter of the storage tank.					
4	Tank perimeter	Length	m	real	[0.0;+Inf]	3.0
	The perimeter length for the uniform cross-section tank.					
5	Height of flow inlet 1	Length	m	real	[0.0;+Inf]	1.25
	The height of the first inlet above the bottom of the tank. Make sure that this value is between 0 and the total height of the tank.					
6	Height of flow outlet 1	Length	m	real	[0.0;+Inf]	0.0
	The height of the first outlet from the storage tank above the bottom of the tank. Make sure that this value is between 0 and the total height of the tank.					
7	Height of flow inlet 2	Length	m	real	[0.0;+Inf]	0.0
	The height of the second inlet to the staorage tank above the bottom of the tank. Make sure that this value is between 0 and the total height of the storage tank.					
8	Height of flow outlet 2	Length	m	real	[0.0;+Inf]	1.25
	The height of the 2nd outlet from the storage tank above the bottom of the tank. Make sure that this value is between 0 and the total height of the storage tank.					
9	Fluid specific heat	Specific Heat	kJ/kg.K	real	[0.0;+Inf]	4.190
	The specific heat of the fluid contained in the storage tank.					
10	Fluid density	Density	kg/m^3	real	[0.0;+Inf]	1000.0
	The density of the fluid contained in the storage tank.					
11	Tank loss coefficient	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[0.0;+Inf]	3.0
	The average tank loss coefficient per unit area. Different loss coefficients for each node can be modeled by use of the incremental loss coefficient parameters.					
12	Fluid thermal conductivity	Thermal Conductivity	kJ/hr.m.K	real	[0.0;+Inf]	1.40
	The thermal conductivity of the fluid contained in the storage tank.					
13	Destratification conductivity	Thermal Conductivity	kJ/hr.m.K	real	[0.0;+Inf]	0.0
	To model de-stratification due to mixing at node interfaces and conduction along the tank wall, the user may enter this additional conductivity parameter. The additional conductivity term is added to the conductivity of the tank fluid and is applied to all nodes. For rough calculations, one may calculate this parameter as the thermal conductivity of the tank wall times the cross sectional area of the tank wall divided by the cross sectional area of the fluid in the storage tank.					

14	Boiling temperature	Temperature	C	real	[-Inf;+Inf]	100.0
	The boiling point temperature of the fluid contained in the storage tank.					
15	Auxiliary heater mode	Dimensionless	-	integer	[1;2]	1
	The auxiliary heater may be operated in one of two modes: 1 = Master/Slave Relation: The lower heating element is only enabled when the upper heating element is satisified. In this mode, only one heater may be on at any instant of time. This is a common design in residential electric hot water tanks. 2 = Both Enabled: In this mode, both heaters may be on simultaneously. This allows for significantly quicker heating of the water, but at a much higher electrical demand.					
16	Height of 1st aux. heater	Length	m	real	[0.0;+Inf]	1.0
	The height of the first auxiliary heater element above the bottom of the storage tank. If there are no auxiliary heaters, set this parameter and the thermostat height parameter to any value between 0 anf the total tank height. Then simply set either the maximum heating rate or the control signal for this heating element to a constant value of 0.					
17	Height of 1st thermostat	Length	m	real	[0.0;+Inf]	1.25
	The height of the thermostat for the first heating element above the bottom of the storage tank. If there are no heating elements, simply set this parameter to any value between 0 and the total tank height. Then set either the maximum heating rate or the control signal for this heating element to a constant value of 0.					
18	Set point temperature for element 1	Temperature	C	real	[-Inf;+Inf]	55.0
	The set point temperature for the specified heating element. The thermostat will enable the heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb and continue to heat the fluid until it reaches the set point temperature. Tset = this parameter; Tdb = next parameter					
19	Deadband for heating element 1	Temp. Difference	deltaC	real	[-Inf;+Inf]	5.0
	The dead band temperature difference for the specified heating element. The thermostat will enable the heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb and continue to heat the fluid until it reaches the set point temperature. Where Tset = previous parameter; Tdb = this parameter					
20	Maximum heating rate of element 1	Power	kJ/hr	real	[0.0;+Inf]	16200.0
	The maximum heating rate of the heating element. If the specified heating element is to not to be used for the simulation, set the maximum power to 0.					
21	Height of heating element 2	Length	m	integer	[1;15]	1
	The node containing the specified auxiliary heating element. Make sure that the specified node for the heater is between 1 and the total number of nodes specified. Node 1 is the topmost node in the tank.					
22	Height of thermostat 2	Length	m	integer	[1;15]	1
	The node containing the thermostat for the specified auxiliary heater. The thermostat is typically either located in the same node as the heating element or in a node located above the element. Node 1 is the topmost node in the tank.					
23	Set point temperature for element 2	Temperature	C	real	[-Inf;+Inf]	55.0
	The set point temperature for the specified heating element. The thermostat will enable the heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb and continue to heat the fluid until it reaches the set point temperature. Tset = this parameter; Tdb = next parameter					
24	Deadband for heating element 2	Temp. Difference	deltaC	real	[0.0;+Inf]	5.0
	The dead band temperature difference for the specified heating element. The thermostat will enable the heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb					

	and continue to heat the fluid until it reaches the set point temperature. Where Tset = previous parameter; Tdb = this parameter					
25	Maximum heating rate of element 2	Power	kJ/hr	real	[0.0;+Inf]	16200
	The maximum heating rate of the heating element. If the specified heating element is to not to be used for the simulation, set the maximum power to 0.					
26	Overall loss coefficient for gas flue	Overall Loss Coefficient	kJ/hr.K	real	[0.0;+Inf]	0.0
	The overall loss coefficient of the gas flue when the tank is not being heated. If this tank is not being heated by gas, simply set this parameter to 0.0 and the next parameter (flue temperature) to any reasonable value.					
27	Flue temperature	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the gas flue when the tank is not being heated. This parameter is used tto calculate the losses from the storage to the flue when the tank is not being heated. If the tank is not heated witth gas, simply set this parameter to any reasonable value and set the previous parameter (flue loss coefficient) to 0.					
28	Fraction of critical timestep	Dimensionless	-	integer	[1;1000]	6
	To minimize numerical errors, the TYPE 60 tank model uses its own internal time step. This has the advantage of results being unaffected by the size of the TRNSYS time step. The model internally computes the critical Euler time step. The user then chooses the fraction of the critical time step that will be used. Increasing this parameter will increase the accuracy of the model, but decrease the simulation speed. A value of 6 represents an excellent compromise between accuracy and speed for most simulations.					
29	Gas heater?	Dimensionless	-	integer	[0;+Inf]	1
	This parameter indicates to the general storage tank model whether the tank is heated with electric elements, with a gas flue, or with a combination of gas and electric. 0 = Both heater are electric 1 = Auxiliary heater #2 is gas (setting the maximum heating rate of the first heating element to zero or non-zero dictates whether the tank also has an electric element).					
30	Number of internal heat exchangers	Dimensionless	-	integer	[0;3]	1
	The number of internal heat exchangers that are contained within the storage tank. For each internal heat exchanger, the user must specify 12 parameters that describe the heat exchanger.					
31	Equal sized nodes	Dimensionless	-	integer	[0;0]	0
	This parameter indicates to the general storage taank model that the tank should be divided into nodes of the same size. The number of nodes is controlled by the number of derivatives supplied. Do not change this parameter.					
32	Uniform tank losses	Dimensionless	-	integer	[0;0]	0
	This parameter indicates to the general storagee tank model that the tank will have uniform loss coefficients for each node. The number of nodes is controlled by the number of supplied derivatives. Do not change this parameter.					
33	HX Fluid Indicator	Dimensionless	-	integer	[1;3]	1
	The fluid contained in the first internal heat exchanger: 1=Water ; 2=Propylene Glycol ; 3=Ethylene Glycol These fluids are contained in the internal heat exchanger and are not mixed with the storage fluid.					
34	Fraction of glycol	Dimensionless	-	real	[0.0;1.0]	0.75
	The fraction of glycol contained in the internal heat exchanger fluid by volume. If the previous parameter is set to 1 (water), this parameter is ignored. If the previous parameter is set to propylene glycol (2), this parameter may range from 0 to 1. If the previous parameter indicates ethylene glycol (3), this parameter may range from 0.55 to 0.85.					
35	Heat exchanger inside diameter	Length	m	real	[0.0;+Inf]	0.01
	The inside diameter of the pipe comprising the internal heat exchanger.					
36	Heat exchanger outside diameter	Length	m	real	[0.0;+Inf]	0.012
	The outside diameter of the pipe comprising the internal heat exchanger.					
37	Heat exchanger fin diameter	Length	m	real	[0.0;+Inf]	0.012

	The diameter of the fins on the outside pipe surface of the internal heat exchanger. If there are no fins (a smooth tube), set this parameter equal to the previous parameter (heat exchanger outside diameter).					
38	Total surface area of heat exchanger	Area	m^2	real	[0.0;+Inf]	1.0
	The total outside surface area of the internal heat exchanger.					
39	Fins per meter for heat exchanger	Dimensionless	-	integer	[0;+Inf]	100
	The number of fins per unit length (meter) on the outside surface of the internal heat exchanger pipe. This parameter is ignored for smooth tubes.					
40	Heat exchanger length	Length	m	real	[0.0;+Inf]	2.0
	The total length of internal heat exchanger pipe immersed within the storage tank fluid.					
41	Heat exchanger wall conductivity	Thermal Conductivity	kJ/hr.m.K	real	[0.0;+Inf]	1.40
	The conductivity of the heat exchanger wall including any applicable contact resistance. Contact resistance would be present with a double wall heat exchanger where the heat exchaanger is a tube within a tube design.					
42	Heat exchanger material conductivity	Thermal Conductivity	kJ/hr.m.K	real	[0.0;+Inf]	1.40
	The thermal conductivity of the material which comprises the internal heat exchanger.					
43	Height of heat exchanger inlet	Length	m	real	[0.0;+Inf]	0.00
	The height above the bottom of the storage tank of the inlet of the internal heat exchanger.					
44	Height of heat exchanger outlet	Length	m	real	[0.0;+Inf]	1.25
	The height of the outlet of the internal heat exchanger from the tank above the bottom of the storage tank.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
33-44	Number of internal heat exchangers		1	50

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Flow rate at inlet 1	Flow Rate	kg/hr	real	[-Inf;+Inf]	0.0
	The flow rate entering the storage tank at the first inlet.					
2	Flow rate at outlet 1	Flow Rate	kg/hr	real	[-2;+Inf]	0.0
	The flow rate of fluid exiting the storage tank from the first outlet. One of the outlet flow rates MUST be specified as a constant value of -2 to indicate that the outlet flow rate will be determined from a mass balance on the constant volume storage tank.					
3	Flow rate at inlet 2	Flow Rate	kg/hr	real	[-Inf;+Inf]	0.0
	The flow rate of fluid entering the storage tank at the second inlet.					
4	Flow rate at outlet 2	Flow Rate	kg/hr	real	[-2;+Inf]	-2
	The flow rate of fluid exiting ths storage tank from the second outlet. One of the outlet flow rates MUST be set to a constant value of -2 to indicate that the outlet flow rate will be determined from a mass balance on the constant volume storage tank.					
5	Temperature at inlet 1	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the fluid entering the storage tank at the first inlet.					
6	Temperature at inlet 2	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the fluid entering the storage tank at the second inlet.					
7	Environment temperature	Temperature	C	real	[-Inf;+Inf]	22.0
	The temperature of the environment in which the storage tank is located.					
8	Control signal for element 1	Dimensionless	-	real	[0.0;1.0]	1.0
	The control signal for the specified auxiliary heating element. The available power for the heating element will be this input multiplied by the maximum power for the element. If an auxiliary heater is not desired for the					

	simulation, set this input to a constant of 0.0 or set the maximum power for the element to 0.0					
9	Control signal for element 2	Dimensionless	-	real	[0.0;1.0]	1.0
	The control signal for the specified auxiliary heating element. The available power for the heating element will be this input multiplied by the maximum power for the element. If an auxiliary heater is not desired for the simulation, set this input to a constant of 0.0 or set the maximum power for the element to 0.0					
10	Flow rate for heat exchanger	Flow Rate	kg/hr	real	[0.0;+Inf]	0.0
	The flow rate through the specified internal heat exchanger.					
11	Inlet temperature for heat exchanger	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature at the inlet of the specified internal heat exchanger.					
12	Nusselt constant for heat exchanger	Dimensionless	-	real	[0.0;+Inf]	0.50
	The natural convection coefficient between the storage fluid and the internal heat exchanger wall is modeled with an equation of the form: h = Nu * k / do ; Nu = C * Ra^n (See mathematical reference for details) Typical value for C is about 0.5 and n is usually 0.25.					
13	Nusselt exponent for heat exchanger	Dimensionless	-	real	[-Inf;+Inf]	0.25
	The natural convection coefficient between the storage fluid and the internal heat exchanger wall is modeled with an equation of the form: h = Nu * k / do ; Nu = C * Ra^n (See mathematical reference for details) Typical value for C is about 0.5 and n is usually 0.25.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
10-13	Number of internal heat exchangers		1	50

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Flowrate at inlet 1	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	The flow rate of fluid into the storage tank at inlet 1.					
2	Flowrate at outlet 1	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	The flow rate of fluid exiting the storage tank through outlet 1.					
3	Flowrate at inlet 2	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	The flow rate of fluid entering the storage tank through inlet 2.					
4	Flowrate at outlet 2	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	The flowrate of fluid exiting the storage tank through outlet 2.					
5	Temperature of outlet flow 1	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid exiting the storage tank through outlet 1.					
6	Temperature of outlet flow 2	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid exiting the storage tank through outlet 2.					
7	Thermal losses	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate of thermal energy loss to the environment. Includes the vented energy if a boiling condition is reached.					
8	Energy supplied by inlet 1	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is added to the storage tank by the entrance of the fluid through inlet 1.					
9	Energy removed by outlet 1	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is removed from the storage tank by the exiting of fluid through outlet 1.					
10	Energy supllied by inlet 2	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is added to the storage tank by the entrance of the fluid through inlet 2.					
11	Energy removed by outlet 2	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is removed from the storage tank by the exiting of fluid through outlet 2.					

12	Auxiliary heating rate	Power	kJ/hr	real	[-Inf;+Inf]	0
	The average rate at which power was added to the tank by BOTH auxiliary heaters.					
13	Element 1 power	Power	kJ/hr	real	[-Inf;+Inf]	0
	The average power supplied to the storage tank over the timestep by the first heating element specified in the parameter list.					
14	Element 2 power	Power	kJ/hr	real	[-Inf;+Inf]	0
	The average power over the timestep supplied to the tank by the second auxiliary heater specified in the parameter list.					
15	Losses to gas flue	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is removed from the storage tank through losses to the gas flue (while the tank is not being charged by the gas flue).					
16	Internal energy change	Energy	kJ	real	[-Inf;+Inf]	0
	The change in internal energy of the tank from the beginning of the simulation.					
17	Average tank temperature	Temperature	C	real	[-Inf;+Inf]	0
	The average temperature of the fluid in the storage tank over the timestep.					
18	Static pressure difference - inlet 1	Pressure	kPa	real	[-Inf;+Inf]	0
	The static pressure difference between the top of the tank and the first inlet port.					
19	Static pressure difference - outlet 1	Pressure	kPa	real	[-Inf;+Inf]	0
	The static pressure difference between the top of the tank and the first outlet port.					
20	Static pressure difference - inlet 2	Pressure	kPa	real	[-Inf;+Inf]	0
	The static pressure difference between the top of the tank and the second inlet port.					
21	Static pressure difference - outlet 2	Pressure	kPa	real	[-Inf;+Inf]	0
	The static pressure difference between the top of the tank and the second outlet port.					
22	Energy input from heat exchanger	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is added to the storage tank from the specified internal heat exchanger.					
23	Temperature of fluid exiting heat exchanger	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid exiting the specified internal heat exchanger.					
24	Tank temperature at outlet of heat exchanger	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the storage tank at the outlet of the specified internal heat exchanger.					
25	LMTD of heat exchanger	Temperature	C	real	[-Inf;+Inf]	0
	The average log mean temperature difference of the specified internal heat exchanger over the timestep.					
26	UA of heat exchanger	Overall Loss Coefficient	kJ/hr.K	real	[0.0;+Inf]	0
	The average overall heat transfer coefficient of the specified internal heat exchanger over the timestep.					
27	Tank temperature - top	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid at the top of the storage tank.					
28	Tank temperature - bottom	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid at the bottom of the storage tank.					
29	Temperature of node 1+	Temperature	C	real	[-Inf;+Inf]	0
	Temperature of node 1+ The temperature of the specified node.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
22-26	Number of internal heat exchangers		1	50
29-29		Besides the top and bottom nodes, how many other nodes are there?	1	13

DERIVATIVES

	Name	Dimension	Unit	Type	Range	Default
1	Initial temperature of node	Temperature	C	real	[-Inf;+Inf]	0
	The initial temperature of the specified node.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
1-1		How many temperature levels (nodes) should be used in the tank?	1	50

4.12.1.17. Vertical Cylinder - Non-Uniform Losses and Heights - 1 Inlet, 1 Outlet

Icon		**TRNSYS Model**	Type 60
Proforma	Thermal Storage\Detailed Fluid Storage Tank\Vertical Cylinder\Non-Uniform Losses and Heights\1 Inlet, 1 Outlet\Type60e.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	User-specified inlet positions	Dimensionless	-	integer	[1;2]	2
	The auxiliary storage tank may operate in one of two modes in determining the inlet positions of the flow streams. In this mode (2), the user must specify the locations (nodes) of the entering flow streams. Do not change this parameter.					
2	Tank volume	Volumetric Flow Rate	m^3	real	[0.0;+Inf]	0.35
	The actual volume of the storage tank (not the nominal value).					
3	Tank height	Length	m	real	[0.0;+Inf]	1.25
	The height of the storage tank. If the tank is a horizontal cylinder, this parameter should be set to the diameter of the storage tank.					
4	Tank perimeter	Length	m	integer	[-1;-1]	-1
	By setting this parameter to -1, the user is specifying that the tank is cylindrical with a vertical orientation (standing up). Do not change this parameter.					
5	Height of flow inlet 1	Length	m	real	[0.0;+Inf]	1.25
	The height of the first inlet above the bottom of the tank. Make sure that this value is between 0 and the total height of the tank.					
6	Height of flow outlet 1	Length	m	real	[0.0;+Inf]	0.0
	The height of the first outlet from the storage tank above the bottom of the tank. Make sure that this value is between 0 and the total height of the tank.					
7	Not used (inlet 2)	Dimensionless	-	integer	[-1;-1]	-1
	This parameter must be set to -1 to indicate to the general storage tank model that there is only one inlet to this tank.					
8	Not used (outlet 2)	Dimensionless	-	integer	[-1;-1]	-1
	This parameter should be set to a value of -1 to indicate to the general storage tank model that there is only one outlet from this tank.					
9	Fluid specific heat	Specific Heat	kJ/kg.K	real	[0.0;+Inf]	4.190
	The specific heat of the fluid contained in the storage tank.					
10	Fluid density	Density	kg/m^3	real	[0.0;+Inf]	1000.0
	The density of the fluid contained in the storage tank.					
11	Tank loss coefficient	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[0.0;+Inf]	3.0
	The average tank loss coefficient per unit area. Different loss coefficients for each node can be modeled by use of the incremental loss coefficient parameters.					
12	Fluid thermal conductivity	Thermal Conductivity	kJ/hr.m.K	real	[0.0;+Inf]	1.40
	The thermal conductivity of the fluid contained in the storage tank.					
13	Destratification conductivity	Thermal Conductivity	kJ/hr.m.K	real	[0.0;+Inf]	0.0
	To model de-stratification due to mixing at node interfaces and conduction along the tank wall, the user may enter this additional conductivity parameter. The additional conductivity term is added to the conductivity of the tank fluid and is applied to all nodes. For rough calculations, one may calculate this parameter as the thermal conductivity of the tank wall times the cross sectional area of the tank wall divided by the cross sectional area					

	of the fluid in the storage tank.					
14	Boiling temperature	Temperature	C	real	[-Inf;+Inf]	100.0
	The boiling point temperature of the fluid contained in the storage tank.					
15	Auxiliary heater mode	Dimensionless	-	integer	[1;2]	1
	The auxiliary heater may be operated in one of two modes: 1 = Master/Slave Relation: The lower heating element is only enabled when the upper heating element is satisified. In this mode, only one heater may be on at any instant of time. This is a common design in residential electric hot water tanks. 2 = Both Enabled: In this mode, both heaters may be on simultaneously. This allows for significantly quicker heating of the water, but at a much higher electrical demand.					
16	Height of 1st aux. heater	Length	m	real	[0.0;+Inf]	1.0
	The height of the first auxiliary heater element above the bottom of the storage tank. If there are no auxiliary heaters, set this parameter and the thermostat height parameter to any value between 0 anf the total tank height. Then simply set either the maximum heating rate or the control signal for this heating element to a constant value of 0.					
17	Height of 1st thermostat	Length	m	real	[0.0;+Inf]	1.25
	The height of the thermostat for the first heating element above the bottom of the storage tank. If there are no heating elements, simply set this parameter to any value between 0 and the total tank height. Then set either the maximum heating rate or the control signal for this heating element to a constant value of 0.					
18	Set point temperature for element 1	Temperature	C	real	[-Inf;+Inf]	55.0
	The set point temperature for the specified heating element. The thermostat will enable the heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb and continue to heat the fluid until it reaches the set point temperature. Tset = this parameter; Tdb = next parameter					
19	Deadband for heating element 1	Temp. Difference	deltaC	real	[-Inf;+Inf]	5.0
	The dead band temperature difference for the specified heating element. The thermostat will enable the heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb and continue to heat the fluid until it reaches the set point temperature. Where Tset = previous parameter; Tdb = this parameter					
20	Maximum heating rate of element 1	Power	kJ/hr	real	[0.0;+Inf]	16200.0
	The maximum heating rate of the heating element. If the specified heating element is to not to be used for the simulation, set the maximum power to 0.					
21	Height of heating element 2	Length	m	real	[0.0;+Inf]	1
	Height of heating element 2 above the tank bottom					
22	Height of thermostat 2	Length	m	real	[0.0;+Inf]	1
	Height of 2nd thermostat above the tank bottom					
23	Set point temperature for element 2	Temperature	C	real	[-Inf;+Inf]	55.0
	The set point temperature for the specified heating element. The thermostat will enable the heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb and continue to heat the fluid until it reaches the set point temperature. Tset = this parameter; Tdb = next parameter					
24	Deadband for heating element 2	Temp. Difference	deltaC	real	[0.0;+Inf]	5.0
	The dead band temperature difference for the specified heating element. The thermostat will enable the heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb and continue to heat the fluid until it reaches the set point temperature.					

	Where Tset = previous parameter; Tdb = this parameter					
25	Maximum heating rate of element 2	Power	kJ/hr	real	[0.0;+Inf]	16200
	The maximum heating rate of the heating element. If the specified heating element is to not to be used for the simulation, set the maximum power to 0.					
26	Overall loss coefficient for gas flue	Overall Loss Coefficient	kJ/hr.K	real	[0.0;+Inf]	0.0
	The overall loss coefficient of the gas flue when the tank is not being heated. If this tank is not being heated by gas, simply set this parameter to 0.0 and the next parameter (flue temperature) to any reasonable value.					
27	Flue temperature	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the gas flue when the tank is not being heated. This parameter is used tto calculate the losses from the storage to the flue when the tank is not being heated. If the tank is not heated witth gas, simply set this parameter to any reasonable value and set the previous parameter (flue loss coefficient) to 0.					
28	Fraction of critical timestep	Dimensionless	-	integer	[1;1000]	6
	To minimize numerical errors, the TYPE 60 tank model uses its own internal time step. This has the advantage of results being unaffected by the size of the TRNSYS time step. The model internally computes the critical Euler time step. The user then chooses the fraction of the critical time step that will be used. Increasing this parameter will increase the accuracy of the model, but decrease the simulation speed. A value of 6 represents an excellent compromise between accuracy and speed for most simulations.					
29	Gas heater?	Dimensionless	-	integer	[0;+Inf]	1
	This parameter indicates to the general storage tank model whether the tank is heated with electric elements, with a gas flue, or with a combination of gas and electric. 0 = Both heater are electric 1 = Auxiliary heater #2 is gas (setting the maximum heating rate of the first heating element to zero or non-zero dictates whether the tank also has an electric element).					
30	Number of internal heat exchangers	Dimensionless	-	integer	[0;3]	1
	The number of internal heat exchangers that are contained within the storage tank. For each internal heat exchanger, the user must specify 12 parameters that describe the heat exchanger.					
31	Node heights supplied	Dimensionless	-	integer	[1;1]	1
	This parameter indicates to the general storage taank model that the user will be supplying the height of all the nodes in the storage tank. The number of nodes is controlled by the number of derivatives supplied. Do not change this parameter.					
32	Additional loss coeff's supplied	Dimensionless	-	integer	[1;1]	1
	This parameter indicates to the general storagee tank model that the user will be specifying the value of the incremental loss coefficients for each node in the storage tank. The number of nodes is controlled by the number of supplied derivatives. Do not change this parameter.					
33	HX Fluid Indicator	Dimensionless	-	integer	[1;3]	1
	The fluid contained in the first internal heat exchanger: 1=Water ; 2=Propylene Glycol ; 3=Ethylene Glycol These fluids are contained in the internal heat exchanger and are not mixed with the storage fluid.					
34	Fraction of glycol	Dimensionless	-	real	[0.0;1.0]	0.75
	The fraction of glycol contained in the internal heat exchanger fluid by volume. If the previous parameter is set to 1 (water), this parameter is ignored. If the previous parameter is set to propylene glycol (2), this parameter may range from 0 to 1. If the previous parameter indicates ethylene glycol (3), this parameter may range from 0.55 to 0.85.					
35	Heat exchanger inside diameter	Length	m	real	[0.0;+Inf]	0.01
	The inside diameter of the pipe comprising the internal heat exchanger.					
36	Heat exchanger outside diameter	Length	m	real	[0.0;+Inf]	0.012
	The outside diameter of the pipe comprising the internal heat exchanger.					
37	Heat exchanger fin diameter	Length	m	real	[0.0;+Inf]	0.012
	The diameter of the fins on the outside pipe surface of the internal heat exchanger. If there are no fins (a					

	smooth tube), set this parameter equal to the previous parameter (heat exchanger outside diameter).					
38	Total surface area of heat exchanger	Area	m^2	real	[0.0;+Inf]	1.0
	The total outside surface area of the internal heat exchanger.					
39	Fins per meter for heat exchanger	Dimensionless	-	integer	[0;+Inf]	100
	The number of fins per unit length (meter) on the outside surface of the internal heat exchanger pipe. This parameter is ignored for smooth tubes.					
40	Heat exchanger length	Length	m	real	[0.0;+Inf]	2.0
	The total length of internal heat exchanger pipe immersed within the storage tank fluid.					
41	Heat exchanger wall conductivity	Thermal Conductivity	kJ/hr.m.K	real	[0.0;+Inf]	1.40
	The conductivity of the heat exchanger wall including any applicable contact resistance. Contact resistance would be present with a double wall heat exchanger where the heat exchaanger is a tube within a tube design.					
42	Heat exchanger material conductivity	Thermal Conductivity	kJ/hr.m.K	real	[0.0;+Inf]	1.40
	The thermal conductivity of the material which comprises the internal heat exchanger.					
43	Height of heat exchanger inlet	Length	m	real	[0.0;+Inf]	0.00
	The height above the bottom of the storage tank of the inlet of the internal heat exchanger.					
44	Height of heat exchanger outlet	Length	m	real	[0.0;+Inf]	1.25
	The height of the outlet of the internal heat exchanger from the tank above the bottom of the storage tank.					
45	Height of node	Length	m	real	[0.0;+Inf]	0.25
	The height of the specified node. The number of nodes is controlled by the number of derivatives supplied to the model.					
46	Additional loss coefficient for node	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[-Inf;+Inf]	0.00
	The additional loss coefficient for the specified node. The total loss coefficient for each node will be the average loss coefficient (specified much earlier) plus this incremental loss coefficient. Incremental loss coefficients are typically used when one section of the tank is more heavily insulated than other sections or to account for thermal shorts due to pipes and fittings.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
33-44	Number of internal heat exchangers		1	50
45-46		How many temperature levels (nodes) should be used in the tank?	1	50

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Flow rate at inlet 1	Flow Rate	kg/hr	real	[-2;+Inf]	0.0
	The flow rate entering the storage tank at the first inlet.					
2	Flow rate at outlet 1	Flow Rate	kg/hr	real	[-2;+Inf]	-2
	The flow rate of fluid exiting the storage tank from the first outlet. One of the outlet flow rates MUST be specified as a constant value of -2 to indicate that the outlet flow rate will be determined from a mass balance on the constant volume storage tank.					
3	Not used (flow inlet 2)	Dimensionless	-	integer	[-1;-1]	-1
	This input should be set to a constant value of -1 to indicate to the general storage tank model that the tank has only 1 inlet.					
4	Not used (flow outlet 2)	Dimensionless	-	integer	[-1;-1]	-1

	This input should be set to a constant value of -1 to indicate to the general storage tank moel that there is only one outlet from this tank.					
5	Temperature at inlet 1	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the fluid entering the storage tank at the first inlet.					
6	Not used (temp inlet 2)	Temperature	C	real	[-Inf;+Inf]	20.0
	This input is not used in this mode of the storage tank model.					
7	Environment temperature	Temperature	C	real	[-Inf;+Inf]	22.0
	The temperature of the environment in which the storage tank is located.					
8	Control signal for element 1	Dimensionless	-	real	[0.0;1.0]	1.0
	The control signal for the specified auxiliary heating element. The available power for the heating element will be this input multiplied by the maximum power for the element. If an auxiliary heater is not desired for the simulation, set this input to a constant of 0.0 or set the maximum power for the element to 0.0					
9	Control signal for element 2	Dimensionless	-	real	[0.0;1.0]	1.0
	The control signal for the specified auxiliary heating element. The available power for the heating element will be this input multiplied by the maximum power for the element. If an auxiliary heater is not desired for the simulation, set this input to a constant of 0.0 or set the maximum power for the element to 0.0					
10	Flow rate for heat exchanger	Flow Rate	kg/hr	real	[0.0;+Inf]	0.0
	The flow rate through the specified internal heat exchanger.					
11	Inlet temperature for heat exchanger	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature at the inlet of the specified internal heat exchanger.					
12	Nusselt constant for heat exchanger	Dimensionless	-	real	[0.0;+Inf]	0.50
	The natural convection coefficient between the storage fluid and the internal heat exchanger wall is modeled with an equation of the form: h = Nu * k / do ; Nu = C * Ra^n (See mathematical reference for details) Typical value for C is about 0.5 and n is usually 0.25.					
13	Nusselt exponent for heat exchanger	Dimensionless	-	real	[-Inf;+Inf]	0.25
	The natural convection coefficient between the storage fluid and the internal heat exchanger wall is modeled with an equation of the form: h = Nu * k / do ; Nu = C * Ra^n (See mathematical reference for details) Typical value for C is about 0.5 and n is usually 0.25.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
10-13	Number of internal heat exchangers		1	50

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Flowrate at inlet 1	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	The flow rate of fluid into the storage tank at inlet 1.					
2	Flowrate at outlet 1	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	The flow rate of fluid exiting the storage tank through outlet 1.					
3	Not used (inlet 2 flow)	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	This output should not be used in this mode of the storage tank model.					
4	Not used (outlet 2 flow)	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	This output should not be used in this model of the storage tank model.					
5	Temperature of outlet flow 1	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid exiting the storage tank through outlet 1.					
6	Not used (temp flow 2)	Temperature	C	real	[-Inf;+Inf]	0
	This output should not be used in this model of the storage tank model.					
7	Thermal losses	Power	kJ/hr	real	[-Inf;+Inf]	0

	The rate of thermal energy loss to the environment. Includes the vented energy if a boiling condition is reached.					
8	Energy supplied by inlet 1	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is added to the storage tank by the entrance of the fluid through inlet 1.					
9	Energy removed by outlet 1	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is removed from the storage tank by the exiting of fluid through outlet 1.					
10	Not used (energy inlet 2)	Power	kJ/hr	real	[-Inf;+Inf]	0
	This output should not be used in this mode of the storage tank model.					
11	Not used (energy outlet 2)	Power	kJ/hr	real	[-Inf;+Inf]	0
	This output should not be used in this mode of the storage tank model.					
12	Auxiliary heating rate	Power	kJ/hr	real	[-Inf;+Inf]	0
	The average rate at which power was added to the tank by BOTH auxiliary heaters.					
13	Element 1 power	Power	kJ/hr	real	[-Inf;+Inf]	0
	The average power supplied to the storage tank over the timestep by the first heating element specified in the parameter list.					
14	Element 2 power	Power	kJ/hr	real	[-Inf;+Inf]	0
	The average power over the timestep supplied to the tank by the second auxiliary heater specified in the parameter list.					
15	Losses to gas flue	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is removed from the storage tank through losses to the gas flue (while the tank is not being charged by the gas flue).					
16	Internal energy change	Energy	kJ	real	[-Inf;+Inf]	0
	The change in internal energy of the tank from the beginning of the simulation.					
17	Average tank temperature	Temperature	C	real	[-Inf;+Inf]	0
	The average temperature of the fluid in the storage tank over the timestep.					
18	Static pressure difference - inlet 1	Pressure	kPa	real	[-Inf;+Inf]	0
	The static pressure difference between the top of the tank and the first inlet port.					
19	Static pressure difference - outlet 1	Pressure	kPa	real	[-Inf;+Inf]	0
	The static pressure difference between the top of the tank and the first outlet port.					
20	Not used (pressure inlet 2)	Pressure	kPa	real	[-Inf;+Inf]	0
	This output should not be used in this mode of the storage tnk model.					
21	Not used (pressure outlet 2)	Pressure	kPa	real	[-Inf;+Inf]	0
	This output should not be used in this mode of the storage tank model.					
22	Energy input from heat exchanger	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is added to the storage tank from the specified internal heat exchanger.					
23	Temperature of fluid exiting heat exchanger	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid exiting the specified internal heat exchanger.					
24	Tank temperature at outlet of heat exchanger	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the storage tank at the outlet of the specified internal heat exchanger.					
25	LMTD of heat exchanger	Temperature	C	real	[-Inf;+Inf]	0
	The average log mean temperature difference of the specified internal heat exchanger over the timestep.					
26	UA of heat exchanger	Overall Loss Coefficient	kJ/hr.K	real	[0.0;+Inf]	0
	The average overall heat transfer coefficient of the specified internal heat exchanger over the timestep.					
27	Tank temperature - top	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid at the top of the storage tank.					
28	Tank temperature - bottom	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid at the bottom of the storage tank.					

29	Temperature of node 1+	Temperature	C	real	[-Inf;+Inf]	0
	Temperature of node 1+ The temperature of the specified node.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
22-26	Number of internal heat exchangers		1	50
29-29		Besides the top and bottom nodes, how many other nodes are there?	1	13

DERIVATIVES

	Name	Dimension	Unit	Type	Range	Default
1	Initial temperature of node	Temperature	C	real	[-Inf;+Inf]	0
	The initial temperature of the specified node.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
1-1		How many temperature levels (nodes) should be used in the tank?	1	50

4.12.1.18. Vertical Cylinder - Non-Uniform Losses and Heights - 1 Inlet, 2 Outlets

Icon		TRNSYS Model	Type 60
Proforma	Thermal Storage\Detailed Fluid Storage Tank\Vertical Cylinder\Non-Uniform Losses and Heights\1 Inlet, 2 Outlets\Type60h.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	User-specified inlet positions	Dimensionless	-	integer	[1;2]	2
	The auxiliary storage tank may operate in one of two modes in determining the inlet positions of the flow streams. In this mode (2), the user must specify the locations (nodes) of the entering flow streams. Do not change this parameter.					
2	Tank volume	Volumetric Flow Rate	m^3	real	[0.0;+Inf]	0.35
	The actual volume of the storage tank (not the nominal value).					
3	Tank height	Length	m	real	[0.0;+Inf]	1.25
	The height of the storage tank. If the tank is a horizontal cylinder, this parameter should be set to the diameter of the storage tank.					
4	Tank perimeter	Length	m	integer	[-1;-1]	-1
	By setting this parameter to -1, the user is specifying that the tank is cylindrical with a vertical orientation (standing up). Do not change this parameter.					
5	Height of flow inlet 1	Length	m	real	[0.0;+Inf]	1.25
	The height of the first inlet above the bottom of the tank. Make sure that this value is between 0 and the total height of the tank.					
6	Height of flow outlet 1	Length	m	real	[0.0;+Inf]	0.0
	The height of the first outlet from the storage tank above the bottom of the tank. Make sure that this value is between 0 and the total height of the tank.					
7	Not used (inlet 2)	Dimensionless	-	integer	[-1;-1]	-1
	This parameter must be set to -1 to indicate to the general storage tank model that there is only one inlet to this tank.					
8	Height of flow outlet 2	Length	m	real	[0.0;+Inf]	1.25
	The height of the 2nd outlet from the storage tank above the bottom of the tank. Make sure that this value is between 0 and the total height of the storage tank.					
9	Fluid specific heat	Specific Heat	kJ/kg.K	real	[0.0;+Inf]	4.190
	The specific heat of the fluid contained in the storage tank.					
10	Fluid density	Density	kg/m^3	real	[0.0;+Inf]	1000.0
	The density of the fluid contained in the storage tank.					
11	Tank loss coefficient	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[0.0;+Inf]	3.0
	The average tank loss coefficient per unit area. Different loss coefficients for each node can be modeled by use of the incremental loss coefficient parameters.					
12	Fluid thermal conductivity	Thermal Conductivity	kJ/hr.m.K	real	[0.0;+Inf]	1.40
	The thermal conductivity of the fluid contained in the storage tank.					
13	Destratification conductivity	Thermal Conductivity	kJ/hr.m.K	real	[0.0;+Inf]	0.0
	To model de-stratification due to mixing at node interfaces and conduction along the tank wall, the user may enter this additional conductivity parameter. The additional conductivity term is added to the conductivity of the tank fluid and is applied to all nodes. For rough calculations, one may calculatethis parameter as the thermal conductivity of the tank wall times the cross sectional area of the tank wall divided by the cross sectional area					

	of the fluid in the storage tank.					
14	Boiling temperature	Temperature	C	real	[-Inf;+Inf]	100.0
	The boiling point temperature of the fluid contained in the storage tank.					
15	Auxiliary heater mode	Dimensionless	-	integer	[1;2]	1
	The auxiliary heater may be operated in one of two modes: 1 = Master/Slave Relation: The lower heating element is only enabled when the upper heating element is satisified. In this mode, only one heater may be on at any instant of time. This is a common design in residential electric hot water tanks. 2 = Both Enabled: In this mode, both heaters may be on simultaneously. This allows for significantly quicker heating of the water, but at a much higher electrical demand.					
16	Height of 1st aux. heater	Length	m	real	[0.0;+Inf]	1.0
	The height of the first auxiliary heater element above the bottom of the storage tank. If there are no auxiliary heaters, set this parameter and the thermostat height parameter to any value between 0 anf the total tank height. Then simply set either the maximum heating rate or the control signal for this heating element to a constant value of 0.					
17	Height of 1st thermostat	Length	m	real	[0.0;+Inf]	1.25
	The height of the thermostat for the first heating element above the bottom of the storage tank. If there are no heating elements, simply set this parameter to any value between 0 and the total tank height. Then set either the maximum heating rate or the control signal for this heating element to a constant value of 0.					
18	Set point temperature for element 1	Temperature	C	real	[-Inf;+Inf]	55.0
	The set point temperature for the specified heating element. The thermostat will enable the heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb and continue to heat the fluid until it reaches the set point temperature. Tset = this parameter; Tdb = next parameter					
19	Deadband for heating element 1	Temp. Difference	deltaC	real	[-Inf;+Inf]	5.0
	The dead band temperature difference for the specified heating element. The thermostat will enable the heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb and continue to heat the fluid until it reaches the set point temperature. Where Tset = previous parameter; Tdb = this parameter					
20	Maximum heating rate of element 1	Power	kJ/hr	real	[0.0;+Inf]	16200.0
	The maximum heating rate of the heating element. If the specified heating element is to not to be used for the simulation, set the maximum power to 0.					
21	Height of heating element 2	Dimensionless	-	real	[0.0;+Inf]	1
	Height of heating element 2 above the tank bottom					
22	Height of thermostat 2	Dimensionless	-	real	[0.0;+Inf]	1
	Height of thermostat 2 above the tank bottom					
23	Set point temperature for element 2	Temperature	C	real	[-Inf;+Inf]	55.0
	The set point temperature for the specified heating element. The thermostat will enable the heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb and continue to heat the fluid until it reaches the set point temperature. Tset = this parameter; Tdb = next parameter					
24	Deadband for heating element 2	Temp. Difference	deltaC	real	[0.0;+Inf]	5.0
	The dead band temperature difference for the specified heating element. The thermostat will enable the heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb and continue to heat the fluid until it reaches the set point temperature.					

	Where Tset = previous parameter; Tdb = this parameter					
25	Maximum heating rate of element 2	Power	kJ/hr	real	[0.0;+Inf]	16200
	The maximum heating rate of the heating element. If the specified heating element is to not to be used for the simulation, set the maximum power to 0.					
26	Overall loss coefficient for gas flue	Overall Loss Coefficient	kJ/hr.K	real	[0.0;+Inf]	0.0
	The overall loss coefficient of the gas flue when the tank is not being heated. If this tank is not being heated by gas, simply set this parameter to 0.0 and the next parameter (flue temperature) to any reasonable value.					
27	Flue temperature	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the gas flue when the tank is not being heated. This parameter is used tto calculate the losses from the storage to the flue when the tank is not being heated. If the tank is not heated witth gas, simply set this parameter to any reasonable value and set the previous parameter (flue loss coefficient) to 0.					
28	Fraction of critical timestep	Dimensionless	-	integer	[1;1000]	6
	To minimize numerical errors, the TYPE 60 tank model uses its own internal time step. This has the advantage of results being unaffected by the size of the TRNSYS time step. The model internally computes the critical Euler time step. The user then chooses the fraction of the critical time step that will be used. Increasing this parameter will increase the accuracy of the model, but decrease the simulation speed. A value of 6 represents an excellent compromise between accuracy and speed for most simulations.					
29	Gas heater?	Dimensionless	-	integer	[0;+Inf]	1
	This parameter indicates to the general storage tank model whether the tank is heated with electric elements, with a gas flue, or with a combination of gas and electric. 0 = Both heater are electric 1 = Auxiliary heater #2 is gas (setting the maximum heating rate of the first heating element to zero or non-zero dictates whether the tank also has an electric element).					
30	Number of internal heat exchangers	Dimensionless	-	integer	[0;3]	1
	The number of internal heat exchangers that are contained within the storage tank. For each internal heat exchanger, the user must specify 12 parameters that describe the heat exchanger.					
31	Node heights supplied	Dimensionless	-	integer	[1;1]	1
	This parameter indicates to the general storage taank model that the user will be supplying the height of all the nodes in the storage tank. The number of nodes is controlled by the number of derivatives supplied. Do not change this parameter.					
32	Additional loss coeff's supplied	Dimensionless	-	integer	[1;1]	1
	This parameter indicates to the general storagee tank model that the user will be specifying the value of the incremental loss coefficients for each node in the storage tank. The number of nodes is controlled by the number of supplied derivatives. Do not change this parameter.					
33	HX Fluid Indicator	Dimensionless	-	integer	[1;3]	1
	The fluid contained in the first internal heat exchanger: 1=Water ; 2=Propylene Glycol ; 3=Ethylene Glycol These fluids are contained in the internal heat exchanger and are not mixed with the storage fluid.					
34	Fraction of glycol	Dimensionless	-	real	[0.0;1.0]	0.75
	The fraction of glycol contained in the internal heat exchanger fluid by volume. If the previous parameter is set to 1 (water), this parameter is ignored. If the previous parameter is set to propylene glycol (2), this parameter may range from 0 to 1. If the previous parameter indicates ethylene glycol (3), this parameter may range from 0.55 to 0.85.					
35	Heat exchanger inside diameter	Length	m	real	[0.0;+Inf]	0.01
	The inside diameter of the pipe comprising the internal heat exchanger.					
36	Heat exchanger outside diameter	Length	m	real	[0.0;+Inf]	0.012
	The outside diameter of the pipe comprising the internal heat exchanger.					
37	Heat exchanger fin diameter	Length	m	real	[0.0;+Inf]	0.012
	The diameter of the fins on the outside pipe surface of the internal heat exchanger. If there are no fins (a					

	smooth tube), set this parameter equal to the previous parameter (heat exchanger outside diameter).					
38	Total surface area of heat exchanger	Area	m^2	real	[0.0;+Inf]	1.0
	The total outside surface area of the internal heat exchanger.					
39	Fins per meter for heat exchanger	Dimensionless	-	integer	[0;+Inf]	100
	The number of fins per unit length (meter) on the outside surface of the internal heat exchanger pipe. This parameter is ignored for smooth tubes.					
40	Heat exchanger length	Length	m	real	[0.0;+Inf]	2.0
	The total length of internal heat exchanger pipe immersed within the storage tank fluid.					
41	Heat exchanger wall conductivity	Thermal Conductivity	kJ/hr.m.K	real	[0.0;+Inf]	1.40
	The conductivity of the heat exchanger wall including any applicable contact resistance. Contact resistance would be present with a double wall heat exchanger where the heat exchaanger is a tube within a tube design.					
42	Heat exchanger material conductivity	Thermal Conductivity	kJ/hr.m.K	real	[0.0;+Inf]	1.40
	The thermal conductivity of the material which comprises the internal heat exchanger.					
43	Height of heat exchanger inlet	Length	m	real	[0.0;+Inf]	0.00
	The height above the bottom of the storage tank of the inlet of the internal heat exchanger.					
44	Height of heat exchanger outlet	Length	m	real	[0.0;+Inf]	1.25
	The height of the outlet of the internal heat exchanger from the tank above the bottom of the storage tank.					
45	Height of node	Length	m	real	[0.0;+Inf]	0.25
	The height of the specified node. The number of nodes is controlled by the number of derivatives supplied to the model.					
46	Additional loss coefficient for node	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[-Inf;+Inf]	0.00
	The additional loss coefficient for the specified node. The total loss coefficient for each node will be the average loss coefficient (specified much earlier) plus this incremental loss coefficient. Incremental loss coefficients are typically used when one section of the tank is more heavily insulated than other sections or to account for thermal shorts due to pipes and fittings.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
33-44	Number of internal heat exchangers		1	50
45-46		How many temperature levels (nodes) should be used in the tank?	1	50

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Flow rate at inlet 1	Flow Rate	kg/hr	real	[-2;+Inf]	0.0
	The flow rate entering the storage tank at the first inlet.					
2	Flow rate at outlet 1	Flow Rate	kg/hr	real	[-2;+Inf]	0.0
	The flow rate of fluid exiting the storage tank from the first outlet. One of the outlet flow rates MUST be specified as a constant value of -2 to indicate that the outlet flow rate will be determined from a mass balance on the constant volume storage tank.					
3	Not used (flow inlet 2)	Dimensionless	-	integer	[-1;-1]	-1
	This input should be set to a constant value of -1 to indicate to the general storage tank model that the tank has only 1 inlet.					
4	Flow rate at outlet 2	Flow Rate	kg/hr	real	[-2;+Inf]	-2

	The flow rate of fluid exiting ths storage tank from the second outlet. One of the outlet flow rates MUST be set to a constant value of -2 to indicate that the outlet flow rate will be determined from a mass balance on the constant volume storage tank.					
5	Temperature at inlet 1	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the fluid entering the storage tank at the first inlet.					
6	Not used (temp inlet 2)	Temperature	C	real	[-Inf;+Inf]	20.0
	This input is not used in this mode of the storage tank model.					
7	Environment temperature	Temperature	C	real	[-Inf;+Inf]	22.0
	The temperature of the environment in which the storage tank is located.					
8	Control signal for element 1	Dimensionless	-	real	[0.0;1.0]	1.0
	The control signal for the specified auxiliary heating element. The available power for the heating element will be this input multiplied by the maximum power for the element. If an auxiliary heater is not desired for the simulation, set this input to a constant of 0.0 or set the maximum power for the element to 0.0					
9	Control signal for element 2	Dimensionless	-	real	[0.0;1.0]	1.0
	The control signal for the specified auxiliary heating element. The available power for the heating element will be this input multiplied by the maximum power for the element. If an auxiliary heater is not desired for the simulation, set this input to a constant of 0.0 or set the maximum power for the element to 0.0					
10	Flow rate for heat exchanger	Flow Rate	kg/hr	real	[0.0;+Inf]	0.0
	The flow rate through the specified internal heat exchanger.					
11	Inlet temperature for heat exchanger	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature at the inlet of the specified internal heat exchanger.					
12	Nusselt constant for heat exchanger	Dimensionless	-	real	[0.0;+Inf]	0.50
	The natural convection coefficient between the storage fluid and the internal heat exchanger wall is modeled with an equation of the form: h = Nu * k / do ; Nu = C * Ra^n (See mathematical reference for details) Typical value for C is about 0.5 and n is usually 0.25.					
13	Nusselt exponent for heat exchanger	Dimensionless	-	real	[-Inf;+Inf]	0.25
	The natural convection coefficient between the storage fluid and the internal heat exchanger wall is modeled with an equation of the form: h = Nu * k / do ; Nu = C * Ra^n (See mathematical reference for details) Typical value for C is about 0.5 and n is usually 0.25.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
10-13	Number of internal heat exchangers		1	50

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Flowrate at inlet 1	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	The flow rate of fluid into the storage tank at inlet 1.					
2	Flowrate at outlet 1	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	The flow rate of fluid exiting the storage tank through outlet 1.					
3	Not used (inlet 2 flow)	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	This output should not be used in this mode of the storage tank model.					
4	Flowrate at outlet 2	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	The flowrate of fluid exiting the storage tank through outlet 2.					
5	Temperature of outlet flow 1	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid exiting the storage tank through outlet 1.					
6	Temperature of outlet flow 2	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid exiting the storage tank through outlet 2.					

7	Thermal losses	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate of thermal energy loss to the environment. Includes the vented energy if a boiling condition is reached.					
8	Energy supplied by inlet 1	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is added to the storage tank by the entrance of the fluid through inlet 1.					
9	Energy removed by outlet 1	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is removed from the storage tank by the exiting of fluid through outlet 1.					
10	Not used (energy inlet 2)	Power	kJ/hr	real	[-Inf;+Inf]	0
	This output should not be used in this mode of the storage tank model.					
11	Energy removed by outlet 2	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is removed from the storage tank by the exiting of fluid through outlet 2.					
12	Auxiliary heating rate	Power	kJ/hr	real	[-Inf;+Inf]	0
	The average rate at which power was added to the tank by BOTH auxiliary heaters.					
13	Element 1 power	Power	kJ/hr	real	[-Inf;+Inf]	0
	The average power supplied to the storage tank over the timestep by the first heating element specified in the parameter list.					
14	Element 2 power	Power	kJ/hr	real	[-Inf;+Inf]	0
	The average power over the timestep supplied to the tank by the second auxiliary heater specified in the parameter list.					
15	Losses to gas flue	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is removed from the storage tank through losses to the gas flue (while the tank is not being charged by the gas flue).					
16	Internal energy change	Energy	kJ	real	[-Inf;+Inf]	0
	The change in internal energy of the tank from the beginning of the simulation.					
17	Average tank temperature	Temperature	C	real	[-Inf;+Inf]	0
	The average temperature of the fluid in the storage tank over the timestep.					
18	Static pressure difference - inlet 1	Pressure	kPa	real	[-Inf;+Inf]	0
	The static pressure difference between the top of the tank and the first inlet port.					
19	Static pressure difference - outlet 1	Pressure	kPa	real	[-Inf;+Inf]	0
	The static pressure difference between the top of the tank and the first outlet port.					
20	Not used (presure inlet 2)	Pressure	kPa	real	[-Inf;+Inf]	0
	This output should not be used in this mode of the storage tnk model.					
21	Static pressure difference - outlet 2	Pressure	kPa	real	[-Inf;+Inf]	0
	The static pressure difference between the top of the tank and the second outlet port.					
22	Energy input from heat exchanger	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is added to the storage tank from the specified internal heat exchanger.					
23	Temperature of fluid exiting heat exchanger	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid exiting the specified internal heat exchanger.					
24	Tank temperature at outlet of heat exchanger	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the storage tank at the outlet of the specified internal heat exchanger.					
25	LMTD of heat exchanger	Temperature	C	real	[-Inf;+Inf]	0
	The average log mean temperature difference of the specified internal heat exchanger over the timestep.					
26	UA of heat exchanger	Overall Loss Coefficient	kJ/hr.K	real	[0.0;+Inf]	0
	The average overall heat transfer coefficient of the specified internal heat exchanger over the timestep.					
27	Tank temperature - top	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid at the top of the storage tank.					

28	Tank temperature - bottom	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid at the bottom of the storage tank.					
29	Temperature of node 1+	Temperature	C	real	[-Inf;+Inf]	0
	Temperature of node 1+ The temperature of the specified node.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
22-26	Number of internal heat exchangers		1	50
29-29		Besides the top and bottom nodes, how many other nodes are there?	1	13

DERIVATIVES

	Name	Dimension	Unit	Type	Range	Default
1	Initial temperature of node	Temperature	C	real	[-Inf;+Inf]	0
	The initial temperature of the specified node.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
1-1		How many temperature levels (nodes) should be used in the tank?	1	50

4.12.1.19. Vertical Cylinder - Non-Uniform Losses and Heights - 2 Inlets, 1 Outlet

Icon		TRNSYS Model	Type 60
Proforma	Thermal Storage\Detailed Fluid Storage Tank\Vertical Cylinder\Non-Uniform Losses and Heights\2 Inlets, 1 Outlet\Type60g.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	User-specified inlet positions	Dimensionless	-	integer	[1;2]	2
	The auxiliary storage tank may operate in one of two modes in determining the inlet positions of the flow streams. In this mode (2), the user must specify the locations (nodes) of the entering flow streams. Do not change this parameter.					
2	Tank volume	Volumetric Flow Rate	m^3	real	[0.0;+Inf]	0.35
	The actual volume of the storage tank (not the nominal value).					
3	Tank height	Length	m	real	[0.0;+Inf]	1.25
	The height of the storage tank. If the tank is a horizontal cylinder, this parameter should be set to the diameter of the storage tank.					
4	Tank perimeter	Length	m	integer	[-1;-1]	-1
	By setting this parameter to -1, the user is specifying that the tank is cylindrical with a vertical orientation (standing up). Do not change this parameter.					
5	Height of flow inlet 1	Length	m	real	[0.0;+Inf]	1.25
	The height of the first inlet above the bottom of the tank. Make sure that this value is between 0 and the total height of the tank.					
6	Height of flow outlet 1	Length	m	real	[0.0;+Inf]	0.0
	The height of the first outlet from the storage tank above the bottom of the tank. Make sure that this value is between 0 and the total height of the tank.					
7	Height of flow inlet 2	Length	m	real	[0.0;+Inf]	0.0
	The height of the second inlet to the staorage tank above the bottom of the tank. Make sure that this value is between 0 and the total height of the storage tank.					
8	Not Used (outlet 2)	Dimensionless	-	integer	[-1;-1]	-1
	This parameter should be set to a value of -1 to indicate to the general storage tank model that there is only one outlet from the tank.					
9	Fluid specific heat	Specific Heat	kJ/kg.K	real	[0.0;+Inf]	4.190
	The specific heat of the fluid contained in the storage tank.					
10	Fluid density	Density	kg/m^3	real	[0.0;+Inf]	1000.0
	The density of the fluid contained in the storage tank.					
11	Tank loss coefficient	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[0.0;+Inf]	3.0
	The average tank loss coefficient per unit area. Different loss coefficients for each node can be modeled by use of the incremental loss coefficient parameters.					
12	Fluid thermal conductivity	Thermal Conductivity	kJ/hr.m.K	real	[0.0;+Inf]	1.40
	The thermal conductivity of the fluid contained in the storage tank.					
13	Destratification conductivity	Thermal Conductivity	kJ/hr.m.K	real	[0.0;+Inf]	0.0
	To model de-stratification due to mixing at node interfaces and conduction along the tank wall, the user may enter this additional conductivity parameter. The additional conductivity term is added to the conductivity of the tank fluid and is applied to all nodes. For rough calculations, one may calculate this parameter as the thermal conductivity of the tank wall times the cross sectional area of the tank wall divided by the cross sectional area					

	of the fluid in the storage tank.					
14	Boiling temperature	Temperature	C	real	[-Inf;+Inf]	100.0
	The boiling point temperature of the fluid contained in the storage tank.					
15	Auxiliary heater mode	Dimensionless	-	integer	[1;2]	1
	The auxiliary heater may be operated in one of two modes: 1 = Master/Slave Relation: The lower heating element is only enabled when the upper heating element is satisified. In this mode, only one heater may be on at any instant of time. This is a common design in residential electric hot water tanks. 2 = Both Enabled: In this mode, both heaters may be on simultaneously. This allows for significantly quicker heating of the water, but at a much higher electrical demand.					
16	Height of 1st aux. heater	Length	m	real	[0.0;+Inf]	1.0
	The height of the first auxiliary heater element above the bottom of the storage tank. If there are no auxiliary heaters, set this parameter and the thermostat height parameter to any value between 0 anf the total tank height. Then simply set either the maximum heating rate or the control signal for this heating element to a constant value of 0.					
17	Height of 1st thermostat	Length	m	real	[0.0;+Inf]	1.25
	The height of the thermostat for the first heating element above the bottom of the storage tank. If there are no heating elements, simply set this parameter to any value between 0 and the total tank height. Then set either the maximum heating rate or the control signal for this heating element to a constant value of 0.					
18	Set point temperature for element 1	Temperature	C	real	[-Inf;+Inf]	55.0
	The set point temperature for the specified heating element. The thermostat will enable the heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb and continue to heat the fluid until it reaches the set point temperature. Tset = this parameter; Tdb = next parameter					
19	Deadband for heating element 1	Temp. Difference	deltaC	real	[-Inf;+Inf]	5.0
	The dead band temperature difference for the specified heating element. The thermostat will enable the heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb and continue to heat the fluid until it reaches the set point temperature. Where Tset = previous parameter; Tdb = this parameter					
20	Maximum heating rate of element 1	Power	kJ/hr	real	[0.0;+Inf]	16200.0
	The maximum heating rate of the heating element. If the specified heating element is to not to be used for the simulation, set the maximum power to 0.					
21	Height of heating element 2	Length	m	real	[0.0;+Inf]	1
	Height of heating element 2 above tank bottom					
22	Height of thermostat 2	Length	m	real	[0.0;+Inf]	1
	Height of thermostat 2 above the tank bottom					
23	Set point temperature for element 2	Temperature	C	real	[-Inf;+Inf]	55.0
	The set point temperature for the specified heating element. The thermostat will enable the heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb and continue to heat the fluid until it reaches the set point temperature. Tset = this parameter; Tdb = next parameter					
24	Deadband for heating element 2	Temp. Difference	deltaC	real	[0.0;+Inf]	5.0
	The dead band temperature difference for the specified heating element. The thermostat will enable the heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb and continue to heat the fluid until it reaches the set point temperature.					

	Where Tset = previous parameter; Tdb = this parameter					
25	Maximum heating rate of element 2	Power	kJ/hr	real	[0.0;+Inf]	16200
	The maximum heating rate of the heating element. If the specified heating element is to not to be used for the simulation, set the maximum power to 0.					
26	Overall loss coefficient for gas flue	Overall Loss Coefficient	kJ/hr.K	real	[0.0;+Inf]	0.0
	The overall loss coefficient of the gas flue when the tank is not being heated. If this tank is not being heated by gas, simply set this parameter to 0.0 and the next parameter (flue temperature) to any reasonable value.					
27	Flue temperature	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the gas flue when the tank is not being heated. This parameter is used tto calculate the losses from the storage to the flue when the tank is not being heated. If the tank is not heated witth gas, simply set this parameter to any reasonable value and set the previous parameter (flue loss coefficient) to 0.					
28	Fraction of critical timestep	Dimensionless	-	integer	[1;1000]	6
	To minimize numerical errors, the TYPE 60 tank model uses its own internal time step. This has the advantage of results being unaffected by the size of the TRNSYS time step. The model internally computes the critical Euler time step. The user then chooses the fraction of the critical time step that will be used. Increasing this parameter will increase the accuracy of the model, but decrease the simulation speed. A value of 6 represents an excellent compromise between accuracy and speed for most simulations.					
29	Gas heater?	Dimensionless	-	integer	[0;+Inf]	1
	This parameter indicates to the general storage tank model whether the tank is heated with electric elements, with a gas flue, or with a combination of gas and electric. 0 = Both heater are electric 1 = Auxiliary heater #2 is gas (setting the maximum heating rate of the first heating element to zero or non-zero dictates whether the tank also has an electric element).					
30	Number of internal heat exchangers	Dimensionless	-	integer	[0;3]	1
	The number of internal heat exchangers that are contained within the storage tank. For each internal heat exchanger, the user must specify 12 parameters that describe the heat exchanger.					
31	Node heights supplied	Dimensionless	-	integer	[1;1]	1
	This parameter indicates to the general storage taank model that the user will be supplying the height of all the nodes in the storage tank. The number of nodes is controlled by the number of derivatives supplied. Do not change this parameter.					
32	Additional loss coeff's supplied	Dimensionless	-	integer	[1;1]	1
	This parameter indicates to the general storagee tank model that the user will be specifying the value of the incremental loss coefficients for each node in the storage tank. The number of nodes is controlled by the number of supplied derivatives. Do not change this parameter.					
33	HX Fluid Indicator	Dimensionless	-	integer	[1;3]	1
	The fluid contained in the first internal heat exchanger: 1=Water ; 2=Propylene Glycol ; 3=Ethylene Glycol These fluids are contained in the internal heat exchanger and are not mixed with the storage fluid.					
34	Fraction of glycol	Dimensionless	-	real	[0.0;1.0]	0.75
	The fraction of glycol contained in the internal heat exchanger fluid by volume. If the previous parameter is set to 1 (water), this parameter is ignored. If the previous parameter is set to propylene glycol (2), this parameter may range from 0 to 1. If the previous parameter indicates ethylene glycol (3), this parameter may range from 0.55 to 0.85.					
35	Heat exchanger inside diameter	Length	m	real	[0.0;+Inf]	0.01
	The inside diameter of the pipe comprising the internal heat exchanger.					
36	Heat exchanger outside diameter	Length	m	real	[0.0;+Inf]	0.012
	The outside diameter of the pipe comprising the internal heat exchanger.					
37	Heat exchanger fin diameter	Length	m	real	[0.0;+Inf]	0.012
	The diameter of the fins on the outside pipe surface of the internal heat exchanger. If there are no fins (a					

	smooth tube), set this parameter equal to the previous parameter (heat exchanger outside diameter).					
38	Total surface area of heat exchanger	Area	m^2	real	[0.0;+Inf]	1.0
	The total outside surface area of the internal heat exchanger.					
39	Fins per meter for heat exchanger	Dimensionless	-	integer	[0;+Inf]	100
	The number of fins per unit length (meter) on the outside surface of the internal heat exchanger pipe. This parameter is ignored for smooth tubes.					
40	Heat exchanger length	Length	m	real	[0.0;+Inf]	2.0
	The total length of internal heat exchanger pipe immersed within the storage tank fluid.					
41	Heat exchanger wall conductivity	Thermal Conductivity	kJ/hr.m.K	real	[0.0;+Inf]	1.40
	The conductivity of the heat exchanger wall including any applicable contact resistance. Contact resistance would be present with a double wall heat exchanger where the heat exchaanger is a tube within a tube design.					
42	Heat exchanger material conductivity	Thermal Conductivity	kJ/hr.m.K	real	[0.0;+Inf]	1.40
	The thermal conductivity of the material which comprises the internal heat exchanger.					
43	Height of heat exchanger inlet	Length	m	real	[0.0;+Inf]	0.00
	The height above the bottom of the storage tank of the inlet of the internal heat exchanger.					
44	Height of heat exchanger outlet	Length	m	real	[0.0;+Inf]	1.25
	The height of the outlet of the internal heat exchanger from the tank above the bottom of the storage tank.					
45	Height of node	Length	m	real	[0.0;+Inf]	0.25
	The height of the specified node. The number of nodes is controlled by the number of derivatives supplied to the model.					
46	Additional loss coefficient for node	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[-Inf;+Inf]	0.00
	The additional loss coefficient for the specified node. The total loss coefficient for each node will be the average loss coefficient (specified much earlier) plus this incremental loss coefficient. Incremental loss coefficients are typically used when one section of the tank is more heavily insulated than other sections or to account for thermal shorts due to pipes and fittings.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
33-44	Number of internal heat exchangers		1	50
45-46		How many temperature levels (nodes) should be used in the tank?	1	50

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Flow rate at inlet 1	Flow Rate	kg/hr	real	[-2;+Inf]	0.0
	The flow rate entering the storage tank at the first inlet.					
2	Flow rate at outlet 1	Flow Rate	kg/hr	real	[-2;+Inf]	-2
	The flow rate of fluid exiting the storage tank from the first outlet. One of the outlet flow rates MUST be specified as a constant value of -2 to indicate that the outlet flow rate will be determined from a mass balance on the constant volume storage tank.					
3	Flow rate at inlet 2	Flow Rate	kg/hr	real	[-2;+Inf]	0.0
	The flow rate of fluid entering the storage tank at the second inlet.					
4	Not used (outlet 2)	Dimensionless	-	integer	[-1;-1]	-1
	This input must be set to a constant value of -1 to inform the general storage tank model that there is only one					

	outlet from the tank.					
5	Temperature at inlet 1	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the fluid entering the storage tank at the first inlet.					
6	Temperature at inlet 2	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the fluid entering the storage tank at the second inlet.					
7	Environment temperature	Temperature	C	real	[-Inf;+Inf]	22.0
	The temperature of the environment in which the storage tank is located.					
8	Control signal for element 1	Dimensionless	-	real	[0.0;1.0]	1.0
	The control signal for the specified auxiliary heating element. The available power for the heating element will be this input multiplied by the maximum power for the element. If an auxiliary heater is not desired for the simulation, set this input to a constant of 0.0 or set the maximum power for the element to 0.0					
9	Control signal for element 2	Dimensionless	-	real	[0.0;1.0]	1.0
	The control signal for the specified auxiliary heating element. The available power for the heating element will be this input multiplied by the maximum power for the element. If an auxiliary heater is not desired for the simulation, set this input to a constant of 0.0 or set the maximum power for the element to 0.0					
10	Flow rate for heat exchanger	Flow Rate	kg/hr	real	[0.0;+Inf]	0.0
	The flow rate through the specified internal heat exchanger.					
11	Inlet temperature for heat exchanger	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature at the inlet of the specified internal heat exchanger.					
12	Nusselt constant for heat exchanger	Dimensionless	-	real	[0.0;+Inf]	0.50
	The natural convection coefficient between the storage fluid and the internal heat exchanger wall is modeled with an equation of the form: h = Nu * k / do ; Nu = C * Ra^n (See mathematical reference for details) Typical value for C is about 0.5 and n is usually 0.25.					
13	Nusselt exponent for heat exchanger	Dimensionless	-	real	[-Inf;+Inf]	0.25
	The natural convection coefficient between the storage fluid and the internal heat exchanger wall is modeled with an equation of the form: h = Nu * k / do ; Nu = C * Ra^n (See mathematical reference for details) Typical value for C is about 0.5 and n is usually 0.25.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
10-13	Number of internal heat exchangers		1	50

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Flowrate at inlet 1	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	The flow rate of fluid into the storage tank at inlet 1.					
2	Flowrate at outlet 1	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	The flow rate of fluid exiting the storage tank through outlet 1.					
3	Flowrate at inlet 2	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	The flow rate of fluid entering the storage tank through inlet 2.					
4	Not used in this mode	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	This output is not available in this mode.					
5	Temperature of outlet flow 1	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid exiting the storage tank through outlet 1.					
6	Not used (temp at outlet 2)	Temperature	C	real	[-Inf;+Inf]	0
	This output should not be used in this mode of the storage tank.					
7	Thermal losses	Power	kJ/hr	real	[-Inf;+Inf]	0

	The rate of thermal energy loss to the environment. Includes the vented energy if a boiling condition is reached.					
8	Energy supplied by inlet 1	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is added to the storage tank by the entrance of the fluid through inlet 1.					
9	Energy removed by outlet 1	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is removed from the storage tank by the exiting of fluid through outlet 1.					
10	Energy supllied by inlet 2	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is added to the storage tank by the entrance of the fluid through inlet 2.					
11	Not used (energy outlet 2)	Power	kJ/hr	real	[-Inf;+Inf]	0
	This output should not be used in this mode of the storage tank model.					
12	Auxiliary heating rate	Power	kJ/hr	real	[-Inf;+Inf]	0
	The average rate at which power was added to the tank by BOTH auxiliary heaters.					
13	Element 1 power	Power	kJ/hr	real	[-Inf;+Inf]	0
	The average power supplied to the storage tank over the timestep by the first heating element specified in the parameter list.					
14	Element 2 power	Power	kJ/hr	real	[-Inf;+Inf]	0
	The average power over the timestep supplied to the tank by the second auxiliary heater specified in the parameter list.					
15	Losses to gas flue	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is removed from the storage tank through losses to the gas flue (while the tank is not being charged by the gas flue).					
16	Internal energy change	Energy	kJ	real	[-Inf;+Inf]	0
	The change in internal energy of the tank from the beginning of the simulation.					
17	Average tank temperature	Temperature	C	real	[-Inf;+Inf]	0
	The average temperature of the fluid in the storage tank over the timestep.					
18	Static pressure difference - inlet 1	Pressure	kPa	real	[-Inf;+Inf]	0
	The static pressure difference between the top of the tank and the first inlet port.					
19	Static pressure difference - outlet 1	Pressure	kPa	real	[-Inf;+Inf]	0
	The static pressure difference between the top of the tank and the first outlet port.					
20	Static pressure difference - inlet 2	Pressure	kPa	real	[-Inf;+Inf]	0
	The static pressure difference between the top of the tank and the second inlet port.					
21	Not used (pressure outlet 2)	Pressure	kPa	real	[-Inf;+Inf]	0
	This output should not be used in this mode of the storage tank model.					
22	Energy input from heat exchanger	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is added to the storage tank from the specified internal heat exchanger.					
23	Temperature of fluid exiting heat exchanger	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid exiting the specified internal heat exchanger.					
24	Tank temperature at outlet of heat exchanger	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the storage tank at the outlet of the specified internal heat exchanger.					
25	LMTD of heat exchanger	Temperature	C	real	[-Inf;+Inf]	0
	The average log mean temperature difference of the specified internal heat exchanger over the timestep.					
26	UA of heat exchanger	Overall Loss Coefficient	kJ/hr.K	real	[0.0;+Inf]	0
	The average overall heat transfer coefficient of the specified internal heat exchanger over the timestep.					
27	Tank temperature - top	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid at the top of the storage tank.					
28	Tank temperature - bottom	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid at the bottom of the storage tank.					

29	Temperature of node 1+	Temperature	C	real	[-Inf;+Inf]	0
	Temperature of node 1+ The temperature of the specified node.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
22-26	Number of internal heat exchangers		1	50
29-29		Besides the top and bottom nodes, how many other nodes are there?	1	13

DERIVATIVES

	Name	Dimension	Unit	Type	Range	Default
1	Initial temperature of node	Temperature	C	real	[-Inf;+Inf]	0
	The initial temperature of the specified node.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
1-1		How many temperature levels (nodes) should be used in the tank?	1	50

4.12.1.20. Vertical Cylinder - Non-Uniform Losses and Heights - 2 Inlets, 2 Outlets

Icon		TRNSYS Model	Type 60
Proforma	Thermal Storage\Detailed Fluid Storage Tank\Vertical Cylinder\Non-Uniform Losses and Heights\2 Inlets, 2 Outlets\Type60f.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	User-specified inlet positions	Dimensionless	-	integer	[1;2]	2
	The auxiliary storage tank may operate in one of two modes in determining the inlet positions of the flow streams. In this mode (2), the user must specify the locations (nodes) of the entering flow streams. Do not change this parameter.					
2	Tank volume	Volumetric Flow Rate	m^3	real	[0.0;+Inf]	0.35
	The actual volume of the storage tank (not the nominal value).					
3	Tank height	Length	m	real	[0.0;+Inf]	1.25
	The height of the storage tank. If the tank is a horizontal cylinder, this parameter should be set to the diameter of the storage tank.					
4	Tank perimeter	Length	m	integer	[-1;-1]	-1
	By setting this parameter to -1, the user is specifying that the tank is cylindrical with a vertical orientation (standing up). Do not change this parameter.					
5	Height of flow inlet 1	Length	m	real	[0.0;+Inf]	1.25
	The height of the first inlet above the bottom of the tank. Make sure that this value is between 0 and the total height of the tank.					
6	Height of flow outlet 1	Length	m	real	[0.0;+Inf]	0.0
	The height of the first outlet from the storage tank above the bottom of the tank. Make sure that this value is between 0 and the total height of the tank.					
7	Height of flow inlet 2	Length	m	real	[0.0;+Inf]	0.0
	The height of the second inlet to the staorage tank above the bottom of the tank. Make sure that this value is between 0 and the total height of the storage tank.					
8	Height of flow outlet 2	Length	m	real	[0.0;+Inf]	1.25
	The height of the 2nd outlet from the storage tank above the bottom of the tank. Make sure that this value is between 0 and the total height of the storage tank.					
9	Fluid specific heat	Specific Heat	kJ/kg.K	real	[0.0;+Inf]	4.190
	The specific heat of the fluid contained in the storage tank.					
10	Fluid density	Density	kg/m^3	real	[0.0;+Inf]	1000.0
	The density of the fluid contained in the storage tank.					
11	Tank loss coefficient	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[0.0;+Inf]	3.0
	The average tank loss coefficient per unit area. Different loss coefficients for each node can be modeled by use of the incremental loss coefficient parameters.					
12	Fluid thermal conductivity	Thermal Conductivity	kJ/hr.m.K	real	[0.0;+Inf]	1.40
	The thermal conductivity of the fluid contained in the storage tank.					
13	Destratification conductivity	Thermal Conductivity	kJ/hr.m.K	real	[0.0;+Inf]	0.0
	To model de-stratification due to mixing at node interfaces and conduction along the tank wall, the user may enter this additional conductivity parameter. The additional conductivity term is added to the conductivity of the tank fluid and is applied to all nodes. For rough calculations, one may calculate this parameter as the thermal conductivity of the tank wall times the cross sectional area of the tank wall divided by the cross sectional area					

	of the fluid in the storage tank.					
14	Boiling temperature	Temperature	C	real	[-Inf;+Inf]	100.0
	The boiling point temperature of the fluid contained in the storage tank.					
15	Auxiliary heater mode	Dimensionless	-	integer	[1;2]	1
	The auxiliary heater may be operated in one of two modes: 1 = Master/Slave Relation: The lower heating element is only enabled when the upper heating element is satisified. In this mode, only one heater may be on at any instant of time. This is a common design in residential electric hot water tanks. 2 = Both Enabled: In this mode, both heaters may be on simultaneously. This allows for significantly quicker heating of the water, but at a much higher electrical demand.					
16	Height of 1st aux. heater	Length	m	real	[0.0;+Inf]	1.0
	The height of the first auxiliary heater element above the bottom of the storage tank. If there are no auxiliary heaters, set this parameter and the thermostat height parameter to any value between 0 anf the total tank height. Then simply set either the maximum heating rate or the control signal for this heating element to a constant value of 0.					
17	Height of 1st thermostat	Length	m	real	[0.0;+Inf]	1.25
	The height of the thermostat for the first heating element above the bottom of the storage tank. If there are no heating elements, simply set this parameter to any value between 0 and the total tank height. Then set either the maximum heating rate or the control signal for this heating element to a constant value of 0.					
18	Set point temperature for element 1	Temperature	C	real	[-Inf;+Inf]	55.0
	The set point temperature for the specified heating element. The thermostat will enable the heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb and continue to heat the fluid until it reaches the set point temperature. Tset = this parameter; Tdb = next parameter					
19	Deadband for heating element 1	Temp. Difference	deltaC	real	[-Inf;+Inf]	5.0
	The dead band temperature difference for the specified heating element. The thermostat will enable the heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb and continue to heat the fluid until it reaches the set point temperature. Where Tset = previous parameter; Tdb = this parameter					
20	Maximum heating rate of element 1	Power	kJ/hr	real	[0.0;+Inf]	16200.0
	The maximum heating rate of the heating element. If the specified heating element is to not to be used for the simulation, set the maximum power to 0.					
21	Height of heating element 2	Length	m	real	[0.0;+Inf]	1
	Height of heating element 2 above tank bottom					
22	Height of thermostat 2	Length	m	real	[0.0;+Inf]	1
	Height of thermostat 2 above tank bottom					
23	Set point temperature for element 2	Temperature	C	real	[-Inf;+Inf]	55.0
	The set point temperature for the specified heating element. The thermostat will enable the heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb and continue to heat the fluid until it reaches the set point temperature. Tset = this parameter; Tdb = next parameter					
24	Deadband for heating element 2	Temp. Difference	deltaC	real	[0.0;+Inf]	5.0
	The dead band temperature difference for the specified heating element. The thermostat will enable the heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb and continue to heat the fluid until it reaches the set point temperature.					

	Where Tset = previous parameter; Tdb = this parameter					
25	Maximum heating rate of element 2	Power	kJ/hr	real	[0.0;+Inf]	16200
	The maximum heating rate of the heating element. If the specified heating element is to not to be used for the simulation, set the maximum power to 0.					
26	Overall loss coefficient for gas flue	Overall Loss Coefficient	kJ/hr.K	real	[0.0;+Inf]	0.0
	The overall loss coefficient of the gas flue when the tank is not being heated. If this tank is not being heated by gas, simply set this parameter to 0.0 and the next parameter (flue temperature) to any reasonable value.					
27	Flue temperature	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the gas flue when the tank is not being heated. This parameter is used tto calculate the losses from the storage to the flue when the tank is not being heated. If the tank is not heated witth gas, simply set this parameter to any reasonable value and set the previous parameter (flue loss coefficient) to 0.					
28	Fraction of critical timestep	Dimensionless	-	integer	[1;1000]	6
	To minimize numerical errors, the TYPE 60 tank model uses its own internal time step. This has the advantage of results being unaffected by the size of the TRNSYS time step. The model internally computes the critical Euler time step. The user then chooses the fraction of the critical time step that will be used. Increasing this parameter will increase the accuracy of the model, but decrease the simulation speed. A value of 6 represents an excellent compromise between accuracy and speed for most simulations.					
29	Gas heater?	Dimensionless	-	integer	[0;+Inf]	1
	This parameter indicates to the general storage tank model whether the tank is heated with electric elements, with a gas flue, or with a combination of gas and electric. 0 = Both heater are electric 1 = Auxiliary heater #2 is gas (setting the maximum heating rate of the first heating element to zero or non-zero dictates whether the tank also has an electric element).					
30	Number of internal heat exchangers	Dimensionless	-	integer	[0;3]	1
	The number of internal heat exchangers that are contained within the storage tank. For each internal heat exchanger, the user must specify 12 parameters that describe the heat exchanger.					
31	Node heights supplied	Dimensionless	-	integer	[1;1]	1
	This parameter indicates to the general storage taank model that the user will be supplying the height of all the nodes in the storage tank. The number of nodes is controlled by the number of derivatives supplied. Do not change this parameter.					
32	Additional loss coeff's supplied	Dimensionless	-	integer	[1;1]	1
	This parameter indicates to the general storagee tank model that the user will be specifying the value of the incremental loss coefficients for each node in the storage tank. The number of nodes is controlled by the number of supplied derivatives. Do not change this parameter.					
33	HX Fluid Indicator	Dimensionless	-	integer	[1;3]	1
	The fluid contained in the first internal heat exchanger: 1=Water ; 2=Propylene Glycol ; 3=Ethylene Glycol These fluids are contained in the internal heat exchanger and are not mixed with the storage fluid.					
34	Fraction of glycol	Dimensionless	-	real	[0.0;1.0]	0.75
	The fraction of glycol contained in the internal heat exchanger fluid by volume. If the previous parameter is set to 1 (water), this parameter is ignored. If the previous parameter is set to propylene glycol (2), this parameter may range from 0 to 1. If the previous parameter indicates ethylene glycol (3), this parameter may range from 0.55 to 0.85.					
35	Heat exchanger inside diameter	Length	m	real	[0.0;+Inf]	0.01
	The inside diameter of the pipe comprising the internal heat exchanger.					
36	Heat exchanger outside diameter	Length	m	real	[0.0;+Inf]	0.012
	The outside diameter of the pipe comprising the internal heat exchanger.					
37	Heat exchanger fin diameter	Length	m	real	[0.0;+Inf]	0.012
	The diameter of the fins on the outside pipe surface of the internal heat exchanger. If there are no fins (a					

	smooth tube), set this parameter equal to the previous parameter (heat exchanger outside diameter).					
38	Total surface area of heat exchanger	Area	m^2	real	[0.0;+Inf]	1.0
	The total outside surface area of the internal heat exchanger.					
39	Fins per meter for heat exchanger	Dimensionless	-	integer	[0;+Inf]	100
	The number of fins per unit length (meter) on the outside surface of the internal heat exchanger pipe. This parameter is ignored for smooth tubes.					
40	Heat exchanger length	Length	m	real	[0.0;+Inf]	2.0
	The total length of internal heat exchanger pipe immersed within the storage tank fluid.					
41	Heat exchanger wall conductivity	Thermal Conductivity	kJ/hr.m.K	real	[0.0;+Inf]	1.40
	The conductivity of the heat exchanger wall including any applicable contact resistance. Contact resistance would be present with a double wall heat exchanger where the heat exchaanger is a tube within a tube design.					
42	Heat exchanger material conductivity	Thermal Conductivity	kJ/hr.m.K	real	[0.0;+Inf]	1.40
	The thermal conductivity of the material which comprises the internal heat exchanger.					
43	Height of heat exchanger inlet	Length	m	real	[0.0;+Inf]	0.00
	The height above the bottom of the storage tank of the inlet of the internal heat exchanger.					
44	Height of heat exchanger outlet	Length	m	real	[0.0;+Inf]	1.25
	The height of the outlet of the internal heat exchanger from the tank above the bottom of the storage tank.					
45	Height of node	Length	m	real	[0.0;+Inf]	0.25
	The height of the specified node. The number of nodes is controlled by the number of derivatives supplied to the model.					
46	Additional loss coefficient for node	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[-Inf;+Inf]	0.00
	The additional loss coefficient for the specified node. The total loss coefficient for each node will be the average loss coefficient (specified much earlier) plus this incremental loss coefficient. Incremental loss coefficients are typically used when one section of the tank is more heavily insulated than other sections or to account for thermal shorts due to pipes and fittings.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
33-44	Number of internal heat exchangers		1	50
45-46		How many temperature levels (nodes) should be used in the tank?	1	50

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Flow rate at inlet 1	Flow Rate	kg/hr	real	[-Inf;+Inf]	0.0
	The flow rate entering the storage tank at the first inlet.					
2	Flow rate at outlet 1	Flow Rate	kg/hr	real	[-2;+Inf]	0.0
	The flow rate of fluid exiting the storage tank from the first outlet. One of the outlet flow rates MUST be specified as a constant value of -2 to indicate that the outlet flow rate will be determined from a mass balance on the constant volume storage tank.					
3	Flow rate at inlet 2	Flow Rate	kg/hr	real	[-Inf;+Inf]	0.0
	The flow rate of fluid entering the storage tank at the second inlet.					
4	Flow rate at outlet 2	Flow Rate	kg/hr	real	[-2;+Inf]	-2
	The flow rate of fluid exiting ths storage tank from the second outlet. One of the outlet flow rates MUST be set					

	to a constant value of -2 to indicate that the outlet flow rate will be determined from a mass balance on the constant volume storage tank.					
5	Temperature at inlet 1	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the fluid entering the storage tank at the first inlet.					
6	Temperature at inlet 2	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the fluid entering the storage tank at the second inlet.					
7	Environment temperature	Temperature	C	real	[-Inf;+Inf]	22.0
	The temperature of the environment in which the storage tank is located.					
8	Control signal for element 1	Dimensionless	-	real	[0.0;1.0]	1.0
	The control signal for the specified auxiliary heating element. The available power for the heating element will be this input multiplied by the maximum power for the element. If an auxiliary heater is not desired for the simulation, set this input to a constant of 0.0 or set the maximum power for the element to 0.0					
9	Control signal for element 2	Dimensionless	-	real	[0.0;1.0]	1.0
	The control signal for the specified auxiliary heating element. The available power for the heating element will be this input multiplied by the maximum power for the element. If an auxiliary heater is not desired for the simulation, set this input to a constant of 0.0 or set the maximum power for the element to 0.0					
10	Flow rate for heat exchanger	Flow Rate	kg/hr	real	[0.0;+Inf]	0.0
	The flow rate through the specified internal heat exchanger.					
11	Inlet temperature for heat exchanger	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature at the inlet of the specified internal heat exchanger.					
12	Nusselt constant for heat exchanger	Dimensionless	-	real	[0.0;+Inf]	0.50
	The natural convection coefficient between the storage fluid and the internal heat exchanger wall is modeled with an equation of the form: h = Nu * k / do ; Nu = C * Ra^n (See mathematical reference for details) Typical value for C is about 0.5 and n is usually 0.25.					
13	Nusselt exponent for heat exchanger	Dimensionless	-	real	[-Inf;+Inf]	0.25
	The natural convection coefficient between the storage fluid and the internal heat exchanger wall is modeled with an equation of the form: h = Nu * k / do ; Nu = C * Ra^n (See mathematical reference for details) Typical value for C is about 0.5 and n is usually 0.25.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
10-13	Number of internal heat exchangers		1	50

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Flowrate at inlet 1	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	The flow rate of fluid into the storage tank at inlet 1.					
2	Flowrate at outlet 1	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	The flow rate of fluid exiting the storage tank through outlet 1.					
3	Flowrate at inlet 2	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	The flow rate of fluid entering the storage tank through inlet 2.					
4	Flowrate at outlet 2	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	The flowrate of fluid exiting the storage tank through outlet 2.					
5	Temperature of outlet flow 1	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid exiting the storage tank through outlet 1.					
6	Temperature of outlet flow 2	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid exiting the storage tank through outlet 2.					
7	Thermal losses	Power	kJ/hr	real	[-Inf;+Inf]	0

	The rate of thermal energy loss to the environment. Includes the vented energy if a boiling condition is reached.					
8	Energy supplied by inlet 1	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is added to the storage tank by the entrance of the fluid through inlet 1.					
9	Energy removed by outlet 1	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is removed from the storage tank by the exiting of fluid through outlet 1.					
10	Energy supllied by inlet 2	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is added to the storage tank by the entrance of the fluid through inlet 2.					
11	Energy removed by outlet 2	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is removed from the storage tank by the exiting of fluid through outlet 2.					
12	Auxiliary heating rate	Power	kJ/hr	real	[-Inf;+Inf]	0
	The average rate at which power was added to the tank by BOTH auxiliary heaters.					
13	Element 1 power	Power	kJ/hr	real	[-Inf;+Inf]	0
	The average power supplied to the storage tank over the timestep by the first heating element specified in the parameter list.					
14	Element 2 power	Power	kJ/hr	real	[-Inf;+Inf]	0
	The average power over the timestep supplied to the tank by the second auxiliary heater specified in the parameter list.					
15	Losses to gas flue	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is removed from the storage tank through losses to the gas flue (while the tank is not being charged by the gas flue).					
16	Internal energy change	Energy	kJ	real	[-Inf;+Inf]	0
	The change in internal energy of the tank from the beginning of the simulation.					
17	Average tank temperature	Temperature	C	real	[-Inf;+Inf]	0
	The average temperature of the fluid in the storage tank over the timestep.					
18	Static pressure difference - inlet 1	Pressure	kPa	real	[-Inf;+Inf]	0
	The static pressure difference between the top of the tank and the first inlet port.					
19	Static pressure difference - outlet 1	Pressure	kPa	real	[-Inf;+Inf]	0
	The static pressure difference between the top of the tank and the first outlet port.					
20	Static pressure difference - inlet 2	Pressure	kPa	real	[-Inf;+Inf]	0
	The static pressure difference between the top of the tank and the second inlet port.					
21	Static pressure difference - outlet 2	Pressure	kPa	real	[-Inf;+Inf]	0
	The static pressure difference between the top of the tank and the second outlet port.					
22	Energy input from heat exchanger	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is added to the storage tank from the specified internal heat exchanger.					
23	Temperature of fluid exiting heat exchanger	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid exiting the specified internal heat exchanger.					
24	Tank temperature at outlet of heat exchanger	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the storage tank at the outlet of the specified internal heat exchanger.					
25	LMTD of heat exchanger	Temperature	C	real	[-Inf;+Inf]	0
	The average log mean temperature difference of the specified internal heat exchanger over the timestep.					
26	UA of heat exchanger	Overall Loss Coefficient	kJ/hr.K	real	[0.0;+Inf]	0
	The average overall heat transfer coefficient of the specified internal heat exchanger over the timestep.					
27	Tank temperature - top	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid at the top of the storage tank.					
28	Tank temperature - bottom	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid at the bottom of the storage tank.					

29	Temperature of node 1+	Temperature	C	real	[-Inf;+Inf]	0
	Temperature of node 1+ The temperature of the specified node.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
22-26	Number of internal heat exchangers		1	50
29-29		Besides the top and bottom nodes, how many other nodes are there?	1	13

DERIVATIVES

	Name	Dimension	Unit	Type	Range	Default
1	Initial temperature of node	Temperature	C	real	[-Inf;+Inf]	0
	The initial temperature of the specified node.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
1-1		How many temperature levels (nodes) should be used in the tank?	1	50

4.12.1.21. Vertical Cylinder - Uniform Losses and Node Heights - 1 Inlet, 1 Outlet

Icon		**TRNSYS Model**	Type 60
Proforma	Thermal Storage\Detailed Fluid Storage Tank\Vertical Cylinder\Uniform Losses and Node Heights\1 Inlet, 1 Outlet\Type60d.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	User-specified inlet positions	Dimensionless	-	integer	[1;2]	2
	The auxiliary storage tank may operate in one of two modes in determining the inlet positions of the flow streams. In this mode (2), the user must specify the locations (nodes) of the entering flow streams. Do not change this parameter.					
2	Tank volume	Volumetric Flow Rate	m^3	real	[0.0;+Inf]	0.35
	The actual volume of the storage tank (not the nominal value).					
3	Tank height	Length	m	real	[0.0;+Inf]	1.25
	The height of the storage tank. If the tank is a horizontal cylinder, this parameter should be set to the diameter of the storage tank.					
4	Tank perimeter	Length	m	integer	[-1;-1]	-1
	By setting this parameter to -1, the user is specifying that the tank is cylindrical with a vertical orientation (standing up). Do not change this parameter.					
5	Height of flow inlet 1	Length	m	real	[0.0;+Inf]	1.25
	The height of the first inlet above the bottom of the tank. Make sure that this value is between 0 and the total height of the tank.					
6	Height of flow outlet 1	Length	m	real	[0.0;+Inf]	0.0
	The height of the first outlet from the storage tank above the bottom of the tank. Make sure that this value is between 0 and the total height of the tank.					
7	Not used (inlet 2)	Dimensionless	-	integer	[-1;-1]	-1
	This parameter must be set to -1 to indicate to the general storage tank model that there is only one inlet to this tank.					
8	Not used (outlet 2)	Dimensionless	-	integer	[-1;-1]	-1
	This parameter should be set to a value of -1 to indicate to the general storage tank model that there is only one outlet from this tank.					
9	Fluid specific heat	Specific Heat	kJ/kg.K	real	[0.0;+Inf]	4.190
	The specific heat of the fluid contained in the storage tank.					
10	Fluid density	Density	kg/m^3	real	[0.0;+Inf]	1000.0
	The density of the fluid contained in the storage tank.					
11	Tank loss coefficient	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[0.0;+Inf]	3.0
	The average tank loss coefficient per unit area. Different loss coefficients for each node can be modeled by use of the incremental loss coefficient parameters.					
12	Fluid thermal conductivity	Thermal Conductivity	kJ/hr.m.K	real	[0.0;+Inf]	1.40
	The thermal conductivity of the fluid contained in the storage tank.					
13	Destratification conductivity	Thermal Conductivity	kJ/hr.m.K	real	[0.0;+Inf]	0.0
	To model de-stratification due to mixing at node interfaces and conduction along the tank wall, the user may enter this additional conductivity parameter. The additional conductivity term is added to the conductivity of the tank fluid and is applied to all nodes. For rough calculations, one may calculate this parameter as the thermal conductivity of the tank wall times the cross sectional area of the tank wall divided by the cross sectional area					

	of the fluid in the storage tank.					
14	Boiling temperature	Temperature	C	real	[-Inf;+Inf]	100.0
	The boiling point temperature of the fluid contained in the storage tank.					
15	Auxiliary heater mode	Dimensionless	-	integer	[1;2]	1
	The auxiliary heater may be operated in one of two modes: 1 = Master/Slave Relation: The lower heating element is only enabled when the upper heating element is satisified. In this mode, only one heater may be on at any instant of time. This is a common design in residential electric hot water tanks. 2 = Both Enabled: In this mode, both heaters may be on simultaneously. This allows for significantly quicker heating of the water, but at a much higher electrical demand.					
16	Height of 1st aux. heater	Length	m	real	[0.0;+Inf]	1.0
	The height of the first auxiliary heater element above the bottom of the storage tank. If there are no auxiliary heaters, set this parameter and the thermostat height parameter to any value between 0 anf the total tank height. Then simply set either the maximum heating rate or the control signal for this heating element to a constant value of 0.					
17	Height of 1st thermostat	Length	m	real	[0.0;+Inf]	1.25
	The height of the thermostat for the first heating element above the bottom of the storage tank. If there are no heating elements, simply set this parameter to any value between 0 and the total tank height. Then set either the maximum heating rate or the control signal for this heating element to a constant value of 0.					
18	Set point temperature for element 1	Temperature	C	real	[-Inf;+Inf]	55.0
	The set point temperature for the specified heating element. The thermostat will enable the heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb and continue to heat the fluid until it reaches the set point temperature. Tset = this parameter; Tdb = next parameter					
19	Deadband for heating element 1	Temp. Difference	deltaC	real	[-Inf;+Inf]	5.0
	The dead band temperature difference for the specified heating element. The thermostat will enable the heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb and continue to heat the fluid until it reaches the set point temperature. Where Tset = previous parameter; Tdb = this parameter					
20	Maximum heating rate of element 1	Power	kJ/hr	real	[0.0;+Inf]	16200.0
	The maximum heating rate of the heating element. If the specified heating element is to not to be used for the simulation, set the maximum power to 0.					
21	Height of heating element 2	Length	m	real	[0.0;+Inf]	1
	Height of 2nd aux. heater above the tank bottom					
22	Height of thermostat 2	Length	m	real	[0.0;+Inf]	1
	Height of 2nd thermostat above the tank bottom					
23	Set point temperature for element 2	Temperature	C	real	[-Inf;+Inf]	55.0
	The set point temperature for the specified heating element. The thermostat will enable the heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb and continue to heat the fluid until it reaches the set point temperature. Tset = this parameter; Tdb = next parameter					
24	Deadband for heating element 2	Temp. Difference	deltaC	real	[0.0;+Inf]	5.0
	The dead band temperature difference for the specified heating element. The thermostat will enable the heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb and continue to heat the fluid until it reaches the set point temperature.					

	Where Tset = previous parameter; Tdb = this parameter					
25	Maximum heating rate of element 2	Power	kJ/hr	real	[0.0;+Inf]	16200
	The maximum heating rate of the heating element. If the specified heating element is to not to be used for the simulation, set the maximum power to 0.					
26	Overall loss coefficient for gas flue	Overall Loss Coefficient	kJ/hr.K	real	[0.0;+Inf]	0.0
	The overall loss coefficient of the gas flue when the tank is not being heated. If this tank is not being heated by gas, simply set this parameter to 0.0 and the next parameter (flue temperature) to any reasonable value.					
27	Flue temperature	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the gas flue when the tank is not being heated. This parameter is used tto calculate the losses from the storage to the flue when the tank is not being heated. If the tank is not heated witth gas, simply set this parameter to any reasonable value and set the previous parameter (flue loss coefficient) to 0.					
28	Fraction of critical timestep	Dimensionless	-	integer	[1;1000]	6
	To minimize numerical errors, the TYPE 60 tank model uses its own internal time step. This has the advantage of results being unaffected by the size of the TRNSYS time step. The model internally computes the critical Euler time step. The user then chooses the fraction of the critical time step that will be used. Increasing this parameter will increase the accuracy of the model, but decrease the simulation speed. A value of 6 represents an excellent compromise between accuracy and speed for most simulations.					
29	Gas heater?	Dimensionless	-	integer	[0;+Inf]	1
	This parameter indicates to the general storage tank model whether the tank is heated with electric elements, with a gas flue, or with a combination of gas and electric. 0 = Both heater are electric 1 = Auxiliary heater #2 is gas (setting the maximum heating rate of the first heating element to zero or non-zero dictates whether the tank also has an electric element).					
30	Number of internal heat exchangers	Dimensionless	-	integer	[0;3]	1
	The number of internal heat exchangers that are contained within the storage tank. For each internal heat exchanger, the user must specify 12 parameters that describe the heat exchanger.					
31	Equal sized nodes	Dimensionless	-	integer	[0;0]	0
	This parameter indicates to the general storage tank model that all the temperature nodes should have the identical size . The number of nodes is controlled by the number of derivatives supplied. Do not change this parameter.					
32	Uniform tank losses	Dimensionless	-	integer	[0;0]	0
	This parameter indicates to the general storage tank model that the user will not be specifying the value of the incremental loss coefficients for each node in the storage tank (uniform losses from the tank is the results). The number of nodes is controlled by the number of supplied derivatives. Do not change this parameter.					
33	HX Fluid Indicator	Dimensionless	-	integer	[1;3]	1
	The fluid contained in the first internal heat exchanger: 1=Water ; 2=Propylene Glycol ; 3=Ethylene Glycol These fluids are contained in the internal heat exchanger and are not mixed with the storage fluid.					
34	Fraction of glycol	Dimensionless	-	real	[0.0;1.0]	0.75
	The fraction of glycol contained in the internal heat exchanger fluid by volume. If the previous parameter is set to 1 (water), this parameter is ignored. If the previous parameter is set to propylene glycol (2), this parameter may range from 0 to 1. If the previous parameter indicates ethylene glycol (3), this parameter may range from 0.55 to 0.85.					
35	Heat exchanger inside diameter	Length	m	real	[0.0;+Inf]	0.01
	The inside diameter of the pipe comprising the internal heat exchanger.					
36	Heat exchanger outside diameter	Length	m	real	[0.0;+Inf]	0.012
	The outside diameter of the pipe comprising the internal heat exchanger.					
37	Heat exchanger fin diameter	Length	m	real	[0.0;+Inf]	0.012
	The diameter of the fins on the outside pipe surface of the internal heat exchanger. If there are no fins (a					

	smooth tube), set this parameter equal to the previous parameter (heat exchanger outside diameter).					
38	Total surface area of heat exchanger	Area	m^2	real	[0.0;+Inf]	1.0
	The total outside surface area of the internal heat exchanger.					
39	Fins per meter for heat exchanger	Dimensionless	-	integer	[0;+Inf]	100
	The number of fins per unit length (meter) on the outside surface of the internal heat exchanger pipe. This parameter is ignored for smooth tubes.					
40	Heat exchanger length	Length	m	real	[0.0;+Inf]	2.0
	The total length of internal heat exchanger pipe immersed within the storage tank fluid.					
41	Heat exchanger wall conductivity	Thermal Conductivity	kJ/hr.m.K	real	[0.0;+Inf]	1.40
	The conductivity of the heat exchanger wall including any applicable contact resistance. Contact resistance would be present with a double wall heat exchanger where the heat exchaanger is a tube within a tube design.					
42	Heat exchanger material conductivity	Thermal Conductivity	kJ/hr.m.K	real	[0.0;+Inf]	1.40
	The thermal conductivity of the material which comprises the internal heat exchanger.					
43	Height of heat exchanger inlet	Length	m	real	[0.0;+Inf]	0.00
	The height above the bottom of the storage tank of the inlet of the internal heat exchanger.					
44	Height of heat exchanger outlet	Length	m	real	[0.0;+Inf]	1.25
	The height of the outlet of the internal heat exchanger from the tank above the bottom of the storage tank.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
33-44	Number of internal heat exchangers		1	50

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Flow rate at inlet 1	Flow Rate	kg/hr	real	[-2;+Inf]	0.0
	The flow rate entering the storage tank at the first inlet.					
2	Flow rate at outlet 1	Flow Rate	kg/hr	real	[-2;+Inf]	-2
	The flow rate of fluid exiting the storage tank from the first outlet. One of the outlet flow rates MUST be specified as a constant value of -2 to indicate that the outlet flow rate will be determined from a mass balance on the constant volume storage tank.					
3	Not used (flow inlet 2)	Dimensionless	-	integer	[-1;-1]	-1
	This input should be set to a constant value of -1 to indicate to the general storage tank model that the tank has only 1 inlet.					
4	Not used (flow outlet 2)	Dimensionless	-	integer	[-1;-1]	-1
	This input should be set to a constant value of -1 to indicate to the general storage tank moel that there is only one outlet from this tank.					
5	Temperature at inlet 1	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the fluid entering the storage tank at the first inlet.					
6	Not used (temp inlet 2)	Temperature	C	real	[-Inf;+Inf]	20.0
	This input is not used in this mode of the storage tank model.					
7	Environment temperature	Temperature	C	real	[-Inf;+Inf]	22.0
	The temperature of the environment in which the storage tank is located.					
8	Control signal for element 1	Dimensionless	-	real	[0.0;1.0]	1.0
	The control signal for the specified auxiliary heating element. The available power for the heating element will be this input multiplied by the maximum power for the element. If an auxiliary heater is not desired for the simulation, set this input to a constant of 0.0 or set the maximum power for the element to 0.0					

9	Control signal for element 2	Dimensionless	-	real	[0.0;1.0]	1.0
	The control signal for the specified auxiliary heating element. The available power for the heating element will be this input multiplied by the maximum power for the element. If an auxiliary heater is not desired for the simulation, set this input to a constant of 0.0 or set the maximum power for the element to 0.0					
10	Flow rate for heat exchanger	Flow Rate	kg/hr	real	[0.0;+Inf]	0.0
	The flow rate through the specified internal heat exchanger.					
11	Inlet temperature for heat exchanger	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature at the inlet of the specified internal heat exchanger.					
12	Nusselt constant for heat exchanger	Dimensionless	-	real	[0.0;+Inf]	0.50
	The natural convection coefficient between the storage fluid and the internal heat exchanger wall is modeled with an equation of the form: h = Nu * k / do ; Nu = C * Ra^n (See mathematical reference for details) Typical value for C is about 0.5 and n is usually 0.25.					
13	Nusselt exponent for heat exchanger	Dimensionless	-	real	[-Inf;+Inf]	0.25
	The natural convection coefficient between the storage fluid and the internal heat exchanger wall is modeled with an equation of the form: h = Nu * k / do ; Nu = C * Ra^n (See mathematical reference for details) Typical value for C is about 0.5 and n is usually 0.25.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
10-13	Number of internal heat exchangers		1	50

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Flowrate at inlet 1	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	The flow rate of fluid into the storage tank at inlet 1.					
2	Flowrate at outlet 1	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	The flow rate of fluid exiting the storage tank through outlet 1.					
3	Not used (inlet 2 flow)	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	This output should not be used in this mode of the storage tank model.					
4	Not used (outlet 2 flow)	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	This output should not be used in this model of the storage tank model.					
5	Temperature of outlet flow 1	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid exiting the storage tank through outlet 1.					
6	Not used (temp flow 2)	Temperature	C	real	[-Inf;+Inf]	0
	This output should not be used in this model of the storage tank model.					
7	Thermal losses	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate of thermal energy loss to the environment. Includes the vented energy if a boiling condition is reached.					
8	Energy supplied by inlet 1	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is added to the storage tank by the entrance of the fluid through inlet 1.					
9	Energy removed by outlet 1	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is removed from the storage tank by the exiting of fluid through outlet 1.					
10	Not used (energy inlet 2)	Power	kJ/hr	real	[-Inf;+Inf]	0
	This output should not be used in this mode of the storage tank model.					
11	Not used (energy outlet 2)	Power	kJ/hr	real	[-Inf;+Inf]	0
	This output should not be used in this mode of the storage tank model.					
12	Auxiliary heating rate	Power	kJ/hr	real	[-Inf;+Inf]	0

	The average rate at which power was added to the tank by BOTH auxiliary heaters.					
13	Element 1 power	Power	kJ/hr	real	[-Inf;+Inf]	0
	The average power supplied to the storage tank over the timestep by the first heating element specified in the parameter list.					
14	Element 2 power	Power	kJ/hr	real	[-Inf;+Inf]	0
	The average power over the timestep supplied to the tank by the second auxiliary heater specified in the parameter list.					
15	Losses to gas flue	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is removed from the storage tank through losses to the gas flue (while the tank is not being charged by the gas flue).					
16	Internal energy change	Energy	kJ	real	[-Inf;+Inf]	0
	The change in internal energy of the tank from the beginning of the simulation.					
17	Average tank temperature	Temperature	C	real	[-Inf;+Inf]	0
	The average temperature of the fluid in the storage tank over the timestep.					
18	Static pressure difference - inlet 1	Pressure	kPa	real	[-Inf;+Inf]	0
	The static pressure difference between the top of the tank and the first inlet port.					
19	Static pressure difference - outlet 1	Pressure	kPa	real	[-Inf;+Inf]	0
	The static pressure difference between the top of the tank and the first outlet port.					
20	Not used (pressure inlet 2)	Pressure	kPa	real	[-Inf;+Inf]	0
	This output should not be used in this mode of the storage tnk model.					
21	Not used (pressure outlet 2)	Pressure	kPa	real	[-Inf;+Inf]	0
	This output should not be used in this mode of the storage tank model.					
22	Energy input from heat exchanger	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is added to the storage tank from the specified internal heat exchanger.					
23	Temperature of fluid exiting heat exchanger	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid exiting the specified internal heat exchanger.					
24	Tank temperature at outlet of heat exchanger	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the storage tank at the outlet of the specified internal heat exchanger.					
25	LMTD of heat exchanger	Temperature	C	real	[-Inf;+Inf]	0
	The average log mean temperature difference of the specified internal heat exchanger over the timestep.					
26	UA of heat exchanger	Overall Loss Coefficient	kJ/hr.K	real	[0.0;+Inf]	0
	The average overall heat transfer coefficient of the specified internal heat exchanger over the timestep.					
27	Tank temperature - top	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid at the top of the storage tank.					
28	Tank temperature - bottom	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid at the bottom of the storage tank.					
29	Temperature of node 1+	Temperature	C	real	[-Inf;+Inf]	0
	Temperature of node 1+ The temperature of the specified node.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
22-26	Number of internal heat exchangers		1	50
29-29		Besides the top and bottom nodes, how many other nodes are there?	1	13

DERIVATIVES

	Name	Dimension	Unit	Type	Range	Default
1	Initial temperature of node	Temperature	C	real	[-Inf;+Inf]	0
	The initial temperature of the specified node.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
1-1		How many temperature levels (nodes) should be used in the tank?	1	50

4.12.1.22. Vertical Cylinder - Uniform Losses and Node Heights - 1 Inlet, 2 Outlets

Icon		TRNSYS Model	Type 60
Proforma	Thermal Storage\Detailed Fluid Storage Tank\Vertical Cylinder\Uniform Losses and Node Heights\1 Inlet, 2 Outlets\Type60a.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	User-specified inlet positions	Dimensionless	-	integer	[1;2]	2
	The auxiliary storage tank may operate in one of two modes in determining the inlet positions of the flow streams. In this mode (2), the user must specify the locations (nodes) of the entering flow streams. Do not change this parameter.					
2	Tank volume	Volumetric Flow Rate	m^3	real	[0.0;+Inf]	0.35
	The actual volume of the storage tank (not the nominal value).					
3	Tank height	Length	m	real	[0.0;+Inf]	1.25
	The height of the storage tank. If the tank is a horizontal cylinder, this parameter should be set to the diameter of the storage tank.					
4	Tank perimeter	Length	m	integer	[-1;-1]	-1
	By setting this parameter to -1, the user is specifying that the tank is cylindrical with a vertical orientation (standing up). Do not change this parameter.					
5	Height of flow inlet 1	Length	m	real	[0.0;+Inf]	1.25
	The height of the first inlet above the bottom of the tank. Make sure that this value is between 0 and the total height of the tank.					
6	Height of flow outlet 1	Length	m	real	[0.0;+Inf]	0.0
	The height of the first outlet from the storage tank above the bottom of the tank. Make sure that this value is between 0 and the total height of the tank.					
7	Not used (inlet 2)	Dimensionless	-	integer	[-1;-1]	-1
	This parameter must be set to -1 to indicate to the general storage tank model that there is only one inlet to this tank.					
8	Height of flow outlet 2	Length	m	real	[0.0;+Inf]	1.25
	The height of the 2nd outlet from the storage tank above the bottom of the tank. Make sure that this value is between 0 and the total height of the storage tank.					
9	Fluid specific heat	Specific Heat	kJ/kg.K	real	[0.0;+Inf]	4.190
	The specific heat of the fluid contained in the storage tank.					
10	Fluid density	Density	kg/m^3	real	[0.0;+Inf]	1000.0
	The density of the fluid contained in the storage tank.					
11	Tank loss coefficient	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[0.0;+Inf]	3.0
	The average tank loss coefficient per unit area. Different loss coefficients for each node can be modeled by use of the incremental loss coefficient parameters.					
12	Fluid thermal conductivity	Thermal Conductivity	kJ/hr.m.K	real	[0.0;+Inf]	1.40
	The thermal conductivity of the fluid contained in the storage tank.					
13	Destratification conductivity	Thermal Conductivity	kJ/hr.m.K	real	[0.0;+Inf]	0.0
	To model de-stratification due to mixing at node interfaces and conduction along the tank wall, the user may enter this additional conductivity parameter. The additional conductivity term is added to the conductivity of the tank fluid and is applied to all nodes. For rough calculations, one may calculate this parameter as the thermal conductivity of the tank wall times the cross sectional area of the tank wall divided by the cross sectional area					

	of the fluid in the storage tank.					
14	Boiling temperature	Temperature	C	real	[-Inf;+Inf]	100.0
	The boiling point temperature of the fluid contained in the storage tank.					
15	Auxiliary heater mode	Dimensionless	-	integer	[1;2]	1
	The auxiliary heater may be operated in one of two modes: 1 = Master/Slave Relation: The lower heating element is only enabled when the upper heating element is satisified. In this mode, only one heater may be on at any instant of time. This is a common design in residential electric hot water tanks. 2 = Both Enabled: In this mode, both heaters may be on simultaneously. This allows for significantly quicker heating of the water, but at a much higher electrical demand.					
16	Height of 1st aux. heater	Length	m	real	[0.0;+Inf]	1.0
	The height of the first auxiliary heater element above the bottom of the storage tank. If there are no auxiliary heaters, set this parameter and the thermostat height parameter to any value between 0 anf the total tank height. Then simply set either the maximum heating rate or the control signal for this heating element to a constant value of 0.					
17	Height of 1st thermostat	Length	m	real	[0.0;+Inf]	1.25
	The height of the thermostat for the first heating element above the bottom of the storage tank. If there are no heating elements, simply set this parameter to any value between 0 and the total tank height. Then set either the maximum heating rate or the control signal for this heating element to a constant value of 0.					
18	Set point temperature for element 1	Temperature	C	real	[-Inf;+Inf]	55.0
	The set point temperature for the specified heating element. The thermostat will enable the heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb and continue to heat the fluid until it reaches the set point temperature. Tset = this parameter; Tdb = next parameter					
19	Deadband for heating element 1	Temp. Difference	deltaC	real	[-Inf;+Inf]	5.0
	The dead band temperature difference for the specified heating element. The thermostat will enable the heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb and continue to heat the fluid until it reaches the set point temperature. Where Tset = previous parameter; Tdb = this parameter					
20	Maximum heating rate of element 1	Power	kJ/hr	real	[0.0;+Inf]	16200.0
	The maximum heating rate of the heating element. If the specified heating element is to not to be used for the simulation, set the maximum power to 0.					
21	Height of 2nd aux. heater	Length	m	real	[0.0;+Inf]	1
	Height of second aux heater above the tank bottom					
22	Height of thermostat 2	Length	m	real	[0.0;+Inf]	1
	Height of the second thermostat above the tank bottom					
23	Set point temperature for element 2	Temperature	C	real	[-Inf;+Inf]	55.0
	The set point temperature for the specified heating element. The thermostat will enable the heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb and continue to heat the fluid until it reaches the set point temperature. Tset = this parameter; Tdb = next parameter					
24	Deadband for heating element 2	Temp. Difference	deltaC	real	[0.0;+Inf]	5.0
	The dead band temperature difference for the specified heating element. The thermostat will enable the heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb and continue to heat the fluid until it reaches the set point temperature.					

	Where Tset = previous parameter; Tdb = this parameter					
25	Maximum heating rate of element 2	Power	kJ/hr	real	[0.0;+Inf]	16200
	The maximum heating rate of the heating element. If the specified heating element is to not to be used for the simulation, set the maximum power to 0.					
26	Overall loss coefficient for gas flue	Overall Loss Coefficient	kJ/hr.K	real	[0.0;+Inf]	0.0
	The overall loss coefficient of the gas flue when the tank is not being heated. If this tank is not being heated by gas, simply set this parameter to 0.0 and the next parameter (flue temperature) to any reasonable value.					
27	Flue temperature	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the gas flue when the tank is not being heated. This parameter is used tto calculate the losses from the storage to the flue when the tank is not being heated. If the tank is not heated witth gas, simply set this parameter to any reasonable value and set the previous parameter (flue loss coefficient) to 0.					
28	Fraction of critical timestep	Dimensionless	-	integer	[1;1000]	6
	To minimize numerical errors, the TYPE 60 tank model uses its own internal time step. This has the advantage of results being unaffected by the size of the TRNSYS time step. The model internally computes the critical Euler time step. The user then chooses the fraction of the critical time step that will be used. Increasing this parameter will increase the accuracy of the model, but decrease the simulation speed. A value of 6 represents an excellent compromise between accuracy and speed for most simulations.					
29	Gas heater?	Dimensionless	-	integer	[0;+Inf]	1
	This parameter indicates to the general storage tank model whether the tank is heated with electric elements, with a gas flue, or with a combination of gas and electric. 0 = Both heater are electric 1 = Auxiliary heater #2 is gas (setting the maximum heating rate of the first heating element to zero or non-zero dictates whether the tank also has an electric element).					
30	Number of internal heat exchangers	Dimensionless	-	integer	[0;3]	1
	The number of internal heat exchangers that are contained within the storage tank. For each internal heat exchanger, the user must specify 12 parameters that describe the heat exchanger.					
31	Equal node sizes	Dimensionless	-	integer	[0;0]	0
	This parameter indicates to the general storage tank model that the tank should be divided into nodes of equal size. The number of nodes is controlled by the number of derivatives supplied. Do not change this parameter.					
32	Uniform tank losses	Dimensionless	-	integer	[0;0]	0
	This parameter indicates to the general storage tank model that each node in the storagetank should have an identical loss coefficient. The number of nodes is controlled by the number of supplied derivatives. Do not change this parameter.					
33	HX Fluid Indicator	Dimensionless	-	integer	[1;3]	1
	The fluid contained in the first internal heat exchanger: 1=Water ; 2=Propylene Glycol ; 3=Ethylene Glycol These fluids are contained in the internal heat exchanger and are not mixed with the storage fluid.					
34	Fraction of glycol	Dimensionless	-	real	[0.0;1.0]	0.75
	The fraction of glycol contained in the internal heat exchanger fluid by volume. If the previous parameter is set to 1 (water), this parameter is ignored. If the previous parameter is set to propylene glycol (2), this parameter may range from 0 to 1. If the previous parameter indicates ethylene glycol (3), this parameter may range from 0.55 to 0.85.					
35	Heat exchanger inside diameter	Length	m	real	[0.0;+Inf]	0.01
	The inside diameter of the pipe comprising the internal heat exchanger.					
36	Heat exchanger outside diameter	Length	m	real	[0.0;+Inf]	0.012
	The outside diameter of the pipe comprising the internal heat exchanger.					
37	Heat exchanger fin diameter	Length	m	real	[0.0;+Inf]	0.012
	The diameter of the fins on the outside pipe surface of the internal heat exchanger. If there are no fins (a smooth tube), set this parameter equal to the previous parameter (heat exchanger outside diameter).					

38	Total surface area of heat exchanger	Area	m^2	real	[0.0;+Inf]	1.0
	The total outside surface area of the internal heat exchanger.					
39	Fins per meter for heat exchanger	Dimensionless	-	integer	[0;+Inf]	100
	The number of fins per unit length (meter) on the outside surface of the internal heat exchanger pipe. This parameter is ignored for smooth tubes.					
40	Heat exchanger length	Length	m	real	[0.0;+Inf]	2.0
	The total length of internal heat exchanger pipe immersed within the storage tank fluid.					
41	Heat exchanger wall conductivity	Thermal Conductivity	kJ/hr.m.K	real	[0.0;+Inf]	1.40
	The conductivity of the heat exchanger wall including any applicable contact resistance. Contact resistance would be present with a double wall heat exchanger where the heat exchaanger is a tube within a tube design.					
42	Heat exchanger material conductivity	Thermal Conductivity	kJ/hr.m.K	real	[0.0;+Inf]	1.40
	The thermal conductivity of the material which comprises the internal heat exchanger.					
43	Height of heat exchanger inlet	Length	m	real	[0.0;+Inf]	0.00
	The height above the bottom of the storage tank of the inlet of the internal heat exchanger.					
44	Height of heat exchanger outlet	Length	m	real	[0.0;+Inf]	1.25
	The height of the outlet of the internal heat exchanger from the tank above the bottom of the storage tank.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
33-44	Number of internal heat exchangers		1	50

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Flow rate at inlet 1	Flow Rate	kg/hr	real	[-2;+Inf]	0.0
	The flow rate entering the storage tank at the first inlet.					
2	Flow rate at outlet 1	Flow Rate	kg/hr	real	[-2;+Inf]	0.0
	The flow rate of fluid exiting the storage tank from the first outlet. One of the outlet flow rates MUST be specified as a constant value of -2 to indicate that the outlet flow rate will be determined from a mass balance on the constant volume storage tank.					
3	Not used (flow inlet 2)	Dimensionless	-	integer	[-1;-1]	-1
	This input should be set to a constant value of -1 to indicate to the general storage tank model that the tank has only 1 inlet.					
4	Flow rate at outlet 2	Flow Rate	kg/hr	real	[-2;+Inf]	-2
	The flow rate of fluid exiting ths storage tank from the second outlet. One of the outlet flow rates MUST be set to a constant value of -2 to indicate that the outlet flow rate will be determined from a mass balance on the constant volume storage tank.					
5	Temperature at inlet 1	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the fluid entering the storage tank at the first inlet.					
6	Not used (temp inlet 2)	Temperature	C	real	[-Inf;+Inf]	20.0
	This input is not used in this mode of the storage tank model.					
7	Environment temperature	Temperature	C	real	[-Inf;+Inf]	22.0
	The temperature of the environment in which the storage tank is located.					
8	Control signal for element 1	Dimensionless	-	real	[0.0;1.0]	1.0
	The control signal for the specified auxiliary heating element. The available power for the heating element will be this input multiplied by the maximum power for the element. If an auxiliary heater is not desired for the simulation, set this input to a constant of 0.0 or set the maximum power for the element to 0.0					

9	Control signal for element 2	Dimensionless	-	real	[0.0;1.0]	1.0
	The control signal for the specified auxiliary heating element. The available power for the heating element will be this input multiplied by the maximum power for the element. If an auxiliary heater is not desired for the simulation, set this input to a constant of 0.0 or set the maximum power for the element to 0.0					
10	Flow rate for heat exchanger	Flow Rate	kg/hr	real	[0.0;+Inf]	0.0
	The flow rate through the specified internal heat exchanger.					
11	Inlet temperature for heat exchanger	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature at the inlet of the specified internal heat exchanger.					
12	Nusselt constant for heat exchanger	Dimensionless	-	real	[0.0;+Inf]	0.50
	The natural convection coefficient between the storage fluid and the internal heat exchanger wall is modeled with an equation of the form: h = Nu * k / do ; Nu = C * Ra^n (See mathematical reference for details) Typical value for C is about 0.5 and n is usually 0.25.					
13	Nusselt exponent for heat exchanger	Dimensionless	-	real	[-Inf;+Inf]	0.25
	The natural convection coefficient between the storage fluid and the internal heat exchanger wall is modeled with an equation of the form: h = Nu * k / do ; Nu = C * Ra^n (See mathematical reference for details) Typical value for C is about 0.5 and n is usually 0.25.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
10-13	Number of internal heat exchangers		1	50

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Flowrate at inlet 1	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	The flow rate of fluid into the storage tank at inlet 1.					
2	Flowrate at outlet 1	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	The flow rate of fluid exiting the storage tank through outlet 1.					
3	Not used (inlet 2 flow)	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	This output should not be used in this mode of the storage tank model.					
4	Flowrate at outlet 2	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	The flowrate of fluid exiting the storage tank through outlet 2.					
5	Temperature of outlet flow 1	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid exiting the storage tank through outlet 1.					
6	Temperature of outlet flow 2	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid exiting the storage tank through outlet 2.					
7	Thermal losses	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate of thermal energy loss to the environment. Includes the vented energy if a boiling condition is reached.					
8	Energy supplied by inlet 1	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is added to the storage tank by the entrance of the fluid through inlet 1.					
9	Energy removed by outlet 1	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is removed from the storage tank by the exiting of fluid through outlet 1.					
10	Not used (energy inlet 2)	Power	kJ/hr	real	[-Inf;+Inf]	0
	This output should not be used in this mode of the storage tank model.					
11	Energy removed by outlet 2	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is removed from the storage tank by the exiting of fluid through outlet 2.					
12	Auxiliary heating rate	Power	kJ/hr	real	[-Inf;+Inf]	0

	The average rate at which power was added to the tank by BOTH auxiliary heaters.					
13	Element 1 power	Power	kJ/hr	real	[-Inf;+Inf]	0
	The average power supplied to the storage tank over the timestep by the first heating element specified in the parameter list.					
14	Element 2 power	Power	kJ/hr	real	[-Inf;+Inf]	0
	The average power over the timestep supplied to the tank by the second auxiliary heater specified in the parameter list.					
15	Losses to gas flue	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is removed from the storage tank through losses to the gas flue (while the tank is not being charged by the gas flue).					
16	Internal energy change	Energy	kJ	real	[-Inf;+Inf]	0
	The change in internal energy of the tank from the beginning of the simulation.					
17	Average tank temperature	Temperature	C	real	[-Inf;+Inf]	0
	The average temperature of the fluid in the storage tank over the timestep.					
18	Static pressure difference - inlet 1	Pressure	kPa	real	[-Inf;+Inf]	0
	The static pressure difference between the top of the tank and the first inlet port.					
19	Static pressure difference - outlet 1	Pressure	kPa	real	[-Inf;+Inf]	0
	The static pressure difference between the top of the tank and the first outlet port.					
20	Not used (presure inlet 2)	Pressure	kPa	real	[-Inf;+Inf]	0
	This output should not be used in this mode of the storage tnk model.					
21	Static pressure difference - outlet 2	Pressure	kPa	real	[-Inf;+Inf]	0
	The static pressure difference between the top of the tank and the second outlet port.					
22	Energy input from heat exchanger	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is added to the storage tank from the specified internal heat exchanger.					
23	Temperature of fluid exiting heat exchanger	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid exiting the specified internal heat exchanger.					
24	Tank temperature at outlet of heat exchanger	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the storage tank at the outlet of the specified internal heat exchanger.					
25	LMTD of heat exchanger	Temperature	C	real	[-Inf;+Inf]	0
	The average log mean temperature difference of the specified internal heat exchanger over the timestep.					
26	UA of heat exchanger	Overall Loss Coefficient	kJ/hr.K	real	[0.0;+Inf]	0
	The average overall heat transfer coefficient of the specified internal heat exchanger over the timestep.					
27	Tank temperature - top	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid at the top of the storage tank.					
28	Tank temperature - bottom	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid at the bottom of the storage tank.					
29	Temperature of node 1+	Temperature	C	real	[-Inf;+Inf]	0
	Temperature of node 1+ The temperature of the specified node.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
22-26	Number of internal heat exchangers		1	50
29-29		Besides the top and bottom nodes, how many other nodes are there?	1	13

DERIVATIVES

	Name	Dimension	Unit	Type	Range	Default
1	Initial temperature of node	Temperature	C	real	[-Inf;+Inf]	0
	The initial temperature of the specified node.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
1-1		How many temperature levels (nodes) should be used in the tank?	1	50

4.12.1.23. Vertical Cylinder - Uniform Losses and Node Heights - 2 Inlets, 1 Outlet

Icon		**TRNSYS Model**	Type 60
Proforma	Thermal Storage\Detailed Fluid Storage Tank\Vertical Cylinder\Uniform Losses and Node Heights\2 Inlets, 1 Outlet\Type60b.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	User-specified inlet positions	Dimensionless	-	integer	[1;2]	2
	The auxiliary storage tank may operate in one of two modes in determining the inlet positions of the flow streams. In this mode (2), the user must specify the locations (nodes) of the entering flow streams. Do not change this parameter.					
2	Tank volume	Volumetric Flow Rate	m^3	real	[0.0;+Inf]	0.35
	The actual volume of the storage tank (not the nominal value).					
3	Tank height	Length	m	real	[0.0;+Inf]	1.25
	The height of the storage tank. If the tank is a horizontal cylinder, this parameter should be set to the diameter of the storage tank.					
4	Tank perimeter	Length	m	integer	[-1;-1]	-1
	By setting this parameter to -1, the user is specifying that the tank is cylindrical with a vertical orientation (standing up). Do not change this parameter.					
5	Height of flow inlet 1	Length	m	real	[0.0;+Inf]	1.25
	The height of the first inlet above the bottom of the tank. Make sure that this value is between 0 and the total height of the tank.					
6	Height of flow outlet 1	Length	m	real	[0.0;+Inf]	0.0
	The height of the first outlet from the storage tank above the bottom of the tank. Make sure that this value is between 0 and the total height of the tank.					
7	Height of flow inlet 2	Length	m	real	[0.0;+Inf]	0.0
	The height of the second inlet to the staorage tank above the bottom of the tank. Make sure that this value is between 0 and the total height of the storage tank.					
8	Not Used (outlet 2)	Dimensionless	-	integer	[-1;-1]	-1
	This parameter should be set to a value of -1 to indicate to the general storage tank model that there is only one outlet from the tank.					
9	Fluid specific heat	Specific Heat	kJ/kg.K	real	[0.0;+Inf]	4.190
	The specific heat of the fluid contained in the storage tank.					
10	Fluid density	Density	kg/m^3	real	[0.0;+Inf]	1000.0
	The density of the fluid contained in the storage tank.					
11	Tank loss coefficient	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[0.0;+Inf]	3.0
	The average tank loss coefficient per unit area. Different loss coefficients for each node can be modeled by use of the incremental loss coefficient parameters.					
12	Fluid thermal conductivity	Thermal Conductivity	kJ/hr.m.K	real	[0.0;+Inf]	1.40
	The thermal conductivity of the fluid contained in the storage tank.					
13	Destratification conductivity	Thermal Conductivity	kJ/hr.m.K	real	[0.0;+Inf]	0.0
	To model de-stratification due to mixing at node interfaces and conduction along the tank wall, the user may enter this additional conductivity parameter. The additional conductivity term is added to the conductivity of the tank fluid and is applied to all nodes. For rough calculations, one may calculate this parameter as the thermal conductivity of the tank wall times the cross sectional area of the tank wall divided by the cross sectional area					

	of the fluid in the storage tank.					
14	Boiling temperature	Temperature	C	real	[-Inf;+Inf]	100.0
	The boiling point temperature of the fluid contained in the storage tank.					
15	Auxiliary heater mode	Dimensionless	-	integer	[1;2]	1
	The auxiliary heater may be operated in one of two modes: 1 = Master/Slave Relation: The lower heating element is only enabled when the upper heating element is satisified. In this mode, only one heater may be on at any instant of time. This is a common design in residential electric hot water tanks. 2 = Both Enabled: In this mode, both heaters may be on simultaneously. This allows for significantly quicker heating of the water, but at a much higher electrical demand.					
16	Height of 1st aux. heater	Length	m	real	[0.0;+Inf]	1.0
	The height of the first auxiliary heater element above the bottom of the storage tank. If there are no auxiliary heaters, set this parameter and the thermostat height parameter to any value between 0 anf the total tank height. Then simply set either the maximum heating rate or the control signal for this heating element to a constant value of 0.					
17	Height of 1st thermostat	Length	m	real	[0.0;+Inf]	1.25
	The height of the thermostat for the first heating element above the bottom of the storage tank. If there are no heating elements, simply set this parameter to any value between 0 and the total tank height. Then set either the maximum heating rate or the control signal for this heating element to a constant value of 0.					
18	Set point temperature for element 1	Temperature	C	real	[-Inf;+Inf]	55.0
	The set point temperature for the specified heating element. The thermostat will enable the heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb and continue to heat the fluid until it reaches the set point temperature. Tset = this parameter; Tdb = next parameter					
19	Deadband for heating element 1	Temp. Difference	deltaC	real	[-Inf;+Inf]	5.0
	The dead band temperature difference for the specified heating element. The thermostat will enable the heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb and continue to heat the fluid until it reaches the set point temperature. Where Tset = previous parameter; Tdb = this parameter					
20	Maximum heating rate of element 1	Power	kJ/hr	real	[0.0;+Inf]	16200.0
	The maximum heating rate of the heating element. If the specified heating element is to not to be used for the simulation, set the maximum power to 0.					
21	Height of 2nd aux heater	Length	m	real	[0.0;+Inf]	1
	Height of 2nd aux. heting element above the tank bottom					
22	Height of thermostat 2	Length	m	real	[0.0;+Inf]	1
	Height of second thermostat above tank bottom					
23	Set point temperature for element 2	Temperature	C	real	[-Inf;+Inf]	55.0
	The set point temperature for the specified heating element. The thermostat will enable the heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb and continue to heat the fluid until it reaches the set point temperature. Tset = this parameter; Tdb = next parameter					
24	Deadband for heating element 2	Temp. Difference	deltaC	real	[0.0;+Inf]	5.0
	The dead band temperature difference for the specified heating element. The thermostat will enable the heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb and continue to heat the fluid until it reaches the set point temperature.					

	Where Tset = previous parameter; Tdb = this parameter					
25	Maximum heating rate of element 2	Power	kJ/hr	real	[0.0;+Inf]	16200
	The maximum heating rate of the heating element. If the specified heating element is to not to be used for the simulation, set the maximum power to 0.					
26	Overall loss coefficient for gas flue	Overall Loss Coefficient	kJ/hr.K	real	[0.0;+Inf]	0.0
	The overall loss coefficient of the gas flue when the tank is not being heated. If this tank is not being heated by gas, simply set this parameter to 0.0 and the next parameter (flue temperature) to any reasonable value.					
27	Flue temperature	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the gas flue when the tank is not being heated. This parameter is used tto calculate the losses from the storage to the flue when the tank is not being heated. If the tank is not heated witth gas, simply set this parameter to any reasonable value and set the previous parameter (flue loss coefficient) to 0.					
28	Fraction of critical timestep	Dimensionless	-	integer	[1;1000]	6
	To minimize numerical errors, the TYPE 60 tank model uses its own internal time step. This has the advantage of results being unaffected by the size of the TRNSYS time step. The model internally computes the critical Euler time step. The user then chooses the fraction of the critical time step that will be used. Increasing this parameter will increase the accuracy of the model, but decrease the simulation speed. A value of 6 represents an excellent compromise between accuracy and speed for most simulations.					
29	Gas heater?	Dimensionless	-	integer	[0;+Inf]	1
	This parameter indicates to the general storage tank model whether the tank is heated with electric elements, with a gas flue, or with a combination of gas and electric. 0 = Both heater are electric 1 = Auxiliary heater #2 is gas (setting the maximum heating rate of the first heating element to zero or non-zero dictates whether the tank also has an electric element).					
30	Number of internal heat exchangers	Dimensionless	-	integer	[0;3]	1
	The number of internal heat exchangers that are contained within the storage tank. For each internal heat exchanger, the user must specify 12 parameters that describe the heat exchanger.					
31	Equal node sizes	Dimensionless	-	integer	[0;0]	0
	This parameter indicates to the general storage tank model that the tank should be divided into nodes of equal size. The number of nodes is controlled by the number of derivatives supplied. Do not change this parameter.					
32	Uniform tank losses	Dimensionless	-	integer	[0;0]	0
	This parameter indicates to the general storage tank model that the tank should have uniform loss coefficients for each node. The number of nodes is controlled by the number of supplied derivatives. Do not change this parameter.					
33	HX Fluid Indicator	Dimensionless	-	integer	[1;3]	1
	The fluid contained in the first internal heat exchanger: 1=Water ; 2=Propylene Glycol ; 3=Ethylene Glycol These fluids are contained in the internal heat exchanger and are not mixed with the storage fluid.					
34	Fraction of glycol	Dimensionless	-	real	[0.0;1.0]	0.75
	The fraction of glycol contained in the internal heat exchanger fluid by volume. If the previous parameter is set to 1 (water), this parameter is ignored. If the previous parameter is set to propylene glycol (2), this parameter may range from 0 to 1. If the previous parameter indicates ethylene glycol (3), this parameter may range from 0.55 to 0.85.					
35	Heat exchanger inside diameter	Length	m	real	[0.0;+Inf]	0.01
	The inside diameter of the pipe comprising the internal heat exchanger.					
36	Heat exchanger outside diameter	Length	m	real	[0.0;+Inf]	0.012
	The outside diameter of the pipe comprising the internal heat exchanger.					
37	Heat exchanger fin diameter	Length	m	real	[0.0;+Inf]	0.012
	The diameter of the fins on the outside pipe surface of the internal heat exchanger. If there are no fins (a smooth tube), set this parameter equal to the previous parameter (heat exchanger outside diameter).					

38	Total surface area of heat exchanger	Area	m^2	real	[0.0;+Inf]	1.0
	The total outside surface area of the internal heat exchanger.					
39	Fins per meter for heat exchanger	Dimensionless	-	integer	[0;+Inf]	100
	The number of fins per unit length (meter) on the outside surface of the internal heat exchanger pipe. This parameter is ignored for smooth tubes.					
40	Heat exchanger length	Length	m	real	[0.0;+Inf]	2.0
	The total length of internal heat exchanger pipe immersed within the storage tank fluid.					
41	Heat exchanger wall conductivity	Thermal Conductivity	kJ/hr.m.K	real	[0.0;+Inf]	1.40
	The conductivity of the heat exchanger wall including any applicable contact resistance. Contact resistance would be present with a double wall heat exchanger where the heat exchaanger is a tube within a tube design.					
42	Heat exchanger material conductivity	Thermal Conductivity	kJ/hr.m.K	real	[0.0;+Inf]	1.40
	The thermal conductivity of the material which comprises the internal heat exchanger.					
43	Height of heat exchanger inlet	Length	m	real	[0.0;+Inf]	0.00
	The height above the bottom of the storage tank of the inlet of the internal heat exchanger.					
44	Height of heat exchanger outlet	Length	m	real	[0.0;+Inf]	1.25
	The height of the outlet of the internal heat exchanger from the tank above the bottom of the storage tank.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
33-44	Number of internal heat exchangers		1	50

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Flow rate at inlet 1	Flow Rate	kg/hr	real	[-2;+Inf]	0.0
	The flow rate entering the storage tank at the first inlet.					
2	Flow rate at outlet 1	Flow Rate	kg/hr	real	[-2;+Inf]	-2
	The flow rate of fluid exiting the storage tank from the first outlet. One of the outlet flow rates MUST be specified as a constant value of -2 to indicate that the outlet flow rate will be determined from a mass balance on the constant volume storage tank.					
3	Flow rate at inlet 2	Flow Rate	kg/hr	real	[-2;+Inf]	0.0
	The flow rate of fluid entering the storage tank at the second inlet.					
4	Not used (outlet 2)	Dimensionless	-	integer	[-1;-1]	-1
	This input must be set to a constant value of -1 to inform the general storage tank model that there is only one outlet from the tank.					
5	Temperature at inlet 1	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the fluid entering the storage tank at the first inlet.					
6	Temperature at inlet 2	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the fluid entering the storage tank at the second inlet.					
7	Environment temperature	Temperature	C	real	[-Inf;+Inf]	22.0
	The temperature of the environment in which the storage tank is located.					
8	Control signal for element 1	Dimensionless	-	real	[0.0;1.0]	1.0
	The control signal for the specified auxiliary heating element. The available power for the heating element will be this input multiplied by the maximum power for the element. If an auxiliary heater is not desired for the simulation, set this input to a constant of 0.0 or set the maximum power for the element to 0.0					
9	Control signal for element 2	Dimensionless	-	real	[0.0;1.0]	1.0
	The control signal for the specified auxiliary heating element. The available power for the heating element will					

	be this input multiplied by the maximum power for the element. If an auxiliary heater is not desired for the simulation, set this input to a constant of 0.0 or set the maximum power for the element to 0.0					
10	Flow rate for heat exchanger	Flow Rate	kg/hr	real	[0.0;+Inf]	0.0
	The flow rate through the specified internal heat exchanger.					
11	Inlet temperature for heat exchanger	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature at the inlet of the specified internal heat exchanger.					
12	Nusselt constant for heat exchanger	Dimensionless	-	real	[0.0;+Inf]	0.50
	The natural convection coefficient between the storage fluid and the internal heat exchanger wall is modeled with an equation of the form: h = Nu * k / do ; Nu = C * Ra^n (See mathematical reference for details) Typical value for C is about 0.5 and n is usually 0.25.					
13	Nusselt exponent for heat exchanger	Dimensionless	-	real	[-Inf;+Inf]	0.25
	The natural convection coefficient between the storage fluid and the internal heat exchanger wall is modeled with an equation of the form: h = Nu * k / do ; Nu = C * Ra^n (See mathematical reference for details) Typical value for C is about 0.5 and n is usually 0.25.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
10-13	Number of internal heat exchangers		1	50

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Flowrate at inlet 1	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	The flow rate of fluid into the storage tank at inlet 1.					
2	Flowrate at outlet 1	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	The flow rate of fluid exiting the storage tank through outlet 1.					
3	Flowrate at inlet 2	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	The flow rate of fluid entering the storage tank through inlet 2.					
4	Not used in this mode	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	This output is not available in this mode.					
5	Temperature of outlet flow 1	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid exiting the storage tank through outlet 1.					
6	Not used (temp at outlet 2)	Temperature	C	real	[-Inf;+Inf]	0
	This output should not be used in this mode of the storage tank.					
7	Thermal losses	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate of thermal energy loss to the environment. Includes the vented energy if a boiling condition is reached.					
8	Energy supplied by inlet 1	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is added to the storage tank by the entrance of the fluid through inlet 1.					
9	Energy removed by outlet 1	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is removed from the storage tank by the exiting of fluid through outlet 1.					
10	Energy supllied by inlet 2	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is added to the storage tank by the entrance of the fluid through inlet 2.					
11	Not used (energy outlet 2)	Power	kJ/hr	real	[-Inf;+Inf]	0
	This output should not be used in this mode of the storage tank model.					
12	Auxiliary heating rate	Power	kJ/hr	real	[-Inf;+Inf]	0
	The average rate at which power was added to the tank by BOTH auxiliary heaters.					
13	Element 1 power	Power	kJ/hr	real	[-Inf;+Inf]	0

	The average power supplied to the storage tank over the timestep by the first heating element specified in the parameter list.					
14	Element 2 power	Power	kJ/hr	real	[-Inf;+Inf]	0
	The average power over the timestep supplied to the tank by the second auxiliary heater specified in the parameter list.					
15	Losses to gas flue	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is removed from the storage tank through losses to the gas flue (while the tank is not being charged by the gas flue).					
16	Internal energy change	Energy	kJ	real	[-Inf;+Inf]	0
	The change in internal energy of the tank from the beginning of the simulation.					
17	Average tank temperature	Temperature	C	real	[-Inf;+Inf]	0
	The average temperature of the fluid in the storage tank over the timestep.					
18	Static pressure difference - inlet 1	Pressure	kPa	real	[-Inf;+Inf]	0
	The static pressure difference between the top of the tank and the first inlet port.					
19	Static pressure difference - outlet 1	Pressure	kPa	real	[-Inf;+Inf]	0
	The static pressure difference between the top of the tank and the first outlet port.					
20	Static pressure difference - inlet 2	Pressure	kPa	real	[-Inf;+Inf]	0
	The static pressure difference between the top of the tank and the second inlet port.					
21	Not used (pressure outlet 2)	Pressure	kPa	real	[-Inf;+Inf]	0
	This output should not be used in this mode of the storage tank model.					
22	Energy input from heat exchanger	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is added to the storage tank from the specified internal heat exchanger.					
23	Temperature of fluid exiting heat exchanger	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid exiting the specified internal heat exchanger.					
24	Tank temperature at outlet of heat exchanger	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the storage tank at the outlet of the specified internal heat exchanger.					
25	LMTD of heat exchanger	Temperature	C	real	[-Inf;+Inf]	0
	The average log mean temperature difference of the specified internal heat exchanger over the timestep.					
26	UA of heat exchanger	Overall Loss Coefficient	kJ/hr.K	real	[0.0;+Inf]	0
	The average overall heat transfer coefficient of the specified internal heat exchanger over the timestep.					
27	Tank temperature - top	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid at the top of the storage tank.					
28	Tank temperature - bottom	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid at the bottom of the storage tank.					
29	Temperature of node 1+	Temperature	C	real	[-Inf;+Inf]	0
	Temperature of node 1+ The temperature of the specified node.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
22-26	Number of internal heat exchangers		1	50
29-29		Besides the top and bottom nodes, how many other nodes are there?	1	13

DERIVATIVES

	Name	Dimension	Unit	Type	Range	Default

1	Initial temperature of node	Temperature	C	real	[-Inf;+Inf]	0
	The initial temperature of the specified node.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
1-1		How many temperature levels (nodes) should be used in the tank?	1	50

4.12.1.24. Vertical Cylinder - Uniform Losses and Node Heights - 2 Inlets, 2 Outlets

Icon		TRNSYS Model	Type 60
Proforma	Thermal Storage\Detailed Fluid Storage Tank\Vertical Cylinder\Uniform Losses and Node Heights\2 Inlets, 2 Outlets\Type60c.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	User-specified inlet positions	Dimensionless	-	integer	[1;2]	2
	The auxiliary storage tank may operate in one of two modes in determining the inlet positions of the flow streams. In this mode (2), the user must specify the locations (nodes) of the entering flow streams. Do not change this parameter.					
2	Tank volume	Volumetric Flow Rate	m^3	real	[0.0;+Inf]	0.35
	The actual volume of the storage tank (not the nominal value).					
3	Tank height	Length	m	real	[0.0;+Inf]	1.25
	The height of the storage tank. If the tank is a horizontal cylinder, this parameter should be set to the diameter of the storage tank.					
4	Tank perimeter	Length	m	integer	[-1;-1]	-1
	By setting this parameter to -1, the user is specifying that the tank is cylindrical with a vertical orientation (standing up). Do not change this parameter.					
5	Height of flow inlet 1	Length	m	real	[0.0;+Inf]	1.25
	The height of the first inlet above the bottom of the tank. Make sure that this value is between 0 and the total height of the tank.					
6	Height of flow outlet 1	Length	m	real	[0.0;+Inf]	0.0
	The height of the first outlet from the storage tank above the bottom of the tank. Make sure that this value is between 0 and the total height of the tank.					
7	Height of flow inlet 2	Length	m	real	[0.0;+Inf]	0.0
	The height of the second inlet to the staorage tank above the bottom of the tank. Make sure that this value is between 0 and the total height of the storage tank.					
8	Height of flow outlet 2	Length	m	real	[0.0;+Inf]	1.25
	The height of the 2nd outlet from the storage tank above the bottom of the tank. Make sure that this value is between 0 and the total height of the storage tank.					
9	Fluid specific heat	Specific Heat	kJ/kg.K	real	[0.0;+Inf]	4.190
	The specific heat of the fluid contained in the storage tank.					
10	Fluid density	Density	kg/m^3	real	[0.0;+Inf]	1000.0
	The density of the fluid contained in the storage tank.					
11	Tank loss coefficient	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[0.0;+Inf]	3.0
	The average tank loss coefficient per unit area. Different loss coefficients for each node can be modeled by use of the incremental loss coefficient parameters.					
12	Fluid thermal conductivity	Thermal Conductivity	kJ/hr.m.K	real	[0.0;+Inf]	1.40
	The thermal conductivity of the fluid contained in the storage tank.					
13	Destratification conductivity	Thermal Conductivity	kJ/hr.m.K	real	[0.0;+Inf]	0.0
	To model de-stratification due to mixing at node interfaces and conduction along the tank wall, the user may enter this additional conductivity parameter. The additional conductivity term is added to the conductivity of the tank fluid and is applied to all nodes. For rough calculations, one may calculate this parameter as the thermal conductivity of the tank wall times the cross sectional area of the tank wall divided by the cross sectional area					

	of the fluid in the storage tank.					
14	Boiling temperature	Temperature	C	real	[-Inf;+Inf]	100.0
	The boiling point temperature of the fluid contained in the storage tank.					
15	Auxiliary heater mode	Dimensionless	-	integer	[1;2]	1
	The auxiliary heater may be operated in one of two modes: 1 = Master/Slave Relation: The lower heating element is only enabled when the upper heating element is satisified. In this mode, only one heater may be on at any instant of time. This is a common design in residential electric hot water tanks. 2 = Both Enabled: In this mode, both heaters may be on simultaneously. This allows for significantly quicker heating of the water, but at a much higher electrical demand.					
16	Height of 1st aux. heater	Length	m	real	[0.0;+Inf]	1.0
	The height of the first auxiliary heater element above the bottom of the storage tank. If there are no auxiliary heaters, set this parameter and the thermostat height parameter to any value between 0 anf the total tank height. Then simply set either the maximum heating rate or the control signal for this heating element to a constant value of 0.					
17	Height of 1st thermostat	Length	m	real	[0.0;+Inf]	1.25
	The height of the thermostat for the first heating element above the bottom of the storage tank. If there are no heating elements, simply set this parameter to any value between 0 and the total tank height. Then set either the maximum heating rate or the control signal for this heating element to a constant value of 0.					
18	Set point temperature for element 1	Temperature	C	real	[-Inf;+Inf]	55.0
	The set point temperature for the specified heating element. The thermostat will enable the heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb and continue to heat the fluid until it reaches the set point temperature. Tset = this parameter; Tdb = next parameter					
19	Deadband for heating element 1	Temp. Difference	deltaC	real	[-Inf;+Inf]	5.0
	The dead band temperature difference for the specified heating element. The thermostat will enable the heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb and continue to heat the fluid until it reaches the set point temperature. Where Tset = previous parameter; Tdb = this parameter					
20	Maximum heating rate of element 1	Power	kJ/hr	real	[0.0;+Inf]	16200.0
	The maximum heating rate of the heating element. If the specified heating element is to not to be used for the simulation, set the maximum power to 0.					
21	Height of heating element 2	Length	m	real	[0.0;15]	1
	The node containing the specified auxiliary heating element. Make sure that the specified node for the heater is between 1 and the total number of nodes specified. Node 1 is the topmost node in the tank.					
22	Height of thermostat 2	Length	m	real	[0.0;15]	1
	The node containing the thermostat for the specified auxiliary heater. The thermostat is typically either located in the same node as the heating element or in a node located above the element. Node 1 is the topmost node in the tank.					
23	Set point temperature for element 2	Temperature	C	real	[-Inf;+Inf]	55.0
	The set point temperature for the specified heating element. The thermostat will enable the heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb and continue to heat the fluid until it reaches the set point temperature. Tset = this parameter; Tdb = next parameter					
24	Deadband for heating element 2	Temp. Difference	deltaC	real	[0.0;+Inf]	5.0
	The dead band temperature difference for the specified heating element. The thermostat will enable the					

	heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb and continue to heat the fluid until it reaches the set point temperature. Where Tset = previous parameter; Tdb = this parameter					
25	Maximum heating rate of element 2	Power	kJ/hr	real	[0.0;+Inf]	16200
	The maximum heating rate of the heating element. If the specified heating element is to not to be used for the simulation, set the maximum power to 0.					
26	Overall loss coefficient for gas flue	Overall Loss Coefficient	kJ/hr.K	real	[0.0;+Inf]	0.0
	The overall loss coefficient of the gas flue when the tank is not being heated. If this tank is not being heated by gas, simply set this parameter to 0.0 and the next parameter (flue temperature) to any reasonable value.					
27	Flue temperature	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the gas flue when the tank is not being heated. This parameter is used tto calculate the losses from the storage to the flue when the tank is not being heated. If the tank is not heated witth gas, simply set this parameter to any reasonable value and set the previous parameter (flue loss coefficient) to 0.					
28	Fraction of critical timestep	Dimensionless	-	integer	[1;1000]	6
	To minimize numerical errors, the TYPE 60 tank model uses its own internal time step. This has the advantage of results being unaffected by the size of the TRNSYS time step. The model internally computes the critical Euler time step. The user then chooses the fraction of the critical time step that will be used. Increasing this parameter will increase the accuracy of the model, but decrease the simulation speed. A value of 6 represents an excellent compromise between accuracy and speed for most simulations.					
29	Gas heater?	Dimensionless	-	integer	[0;+Inf]	1
	This parameter indicates to the general storage tank model whether the tank is heated with electric elements, with a gas flue, or with a combination of gas and electric. 0 = Both heater are electric 1 = Auxiliary heater #2 is gas (setting the maximum heating rate of the first heating element to zero or non-zero dictates whether the tank also has an electric element).					
30	Number of internal heat exchangers	Dimensionless	-	integer	[0;3]	1
	The number of internal heat exchangers that are contained within the storage tank. For each internal heat exchanger, the user must specify 12 parameters that describe the heat exchanger.					
31	Equal sized nodes	Dimensionless	-	integer	[0;0]	0
	This parameter indicates to the general storage taank model that the tank should be divided into nodes of the same size. The number of nodes is controlled by the number of derivatives supplied. Do not change this parameter.					
32	Uniform tank losses	Dimensionless	-	integer	[0;0]	0
	This parameter indicates to the general storagee tank model that the tank will have uniform loss coefficients for each node. The number of nodes is controlled by the number of supplied derivatives. Do not change this parameter.					
33	HX Fluid Indicator	Dimensionless	-	integer	[1;3]	1
	The fluid contained in the first internal heat exchanger: 1=Water ; 2=Propylene Glycol ; 3=Ethylene Glycol These fluids are contained in the internal heat exchanger and are not mixed with the storage fluid.					
34	Fraction of glycol	Dimensionless	-	real	[0.0;1.0]	0.75
	The fraction of glycol contained in the internal heat exchanger fluid by volume. If the previous parameter is set to 1 (water), this parameter is ignored. If the previous parameter is set to propylene glycol (2), this parameter may range from 0 to 1. If the previous parameter indicates ethylene glycol (3), this parameter may range from 0.55 to 0.85.					
35	Heat exchanger inside diameter	Length	m	real	[0.0;+Inf]	0.01
	The inside diameter of the pipe comprising the internal heat exchanger.					
36	Heat exchanger outside diameter	Length	m	real	[0.0;+Inf]	0.012
	The outside diameter of the pipe comprising the internal heat exchanger.					

37	Heat exchanger fin diameter	Length	m	real	[0.0;+Inf]	0.012
	The diameter of the fins on the outside pipe surface of the internal heat exchanger. If there are no fins (a smooth tube), set this parameter equal to the previous parameter (heat exchanger outside diameter).					
38	Total surface area of heat exchanger	Area	m^2	real	[0.0;+Inf]	1.0
	The total outside surface area of the internal heat exchanger.					
39	Fins per meter for heat exchanger	Dimensionless	-	integer	[0;+Inf]	100
	The number of fins per unit length (meter) on the outside surface of the internal heat exchanger pipe. This parameter is ignored for smooth tubes.					
40	Heat exchanger length	Length	m	real	[0.0;+Inf]	2.0
	The total length of internal heat exchanger pipe immersed within the storage tank fluid.					
41	Heat exchanger wall conductivity	Thermal Conductivity	kJ/hr.m.K	real	[0.0;+Inf]	1.40
	The conductivity of the heat exchanger wall including any applicable contact resistance. Contact resistance would be present with a double wall heat exchanger where the heat exchaanger is a tube within a tube design.					
42	Heat exchanger material conductivity	Thermal Conductivity	kJ/hr.m.K	real	[0.0;+Inf]	1.40
	The thermal conductivity of the material which comprises the internal heat exchanger.					
43	Height of heat exchanger inlet	Length	m	real	[0.0;+Inf]	0.00
	The height above the bottom of the storage tank of the inlet of the internal heat exchanger.					
44	Height of heat exchanger outlet	Length	m	real	[0.0;+Inf]	1.25
	The height of the outlet of the internal heat exchanger from the tank above the bottom of the storage tank.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
33-44	Number of internal heat exchangers		1	50

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Flow rate at inlet 1	Flow Rate	kg/hr	real	[-Inf;+Inf]	0.0
	The flow rate entering the storage tank at the first inlet.					
2	Flow rate at outlet 1	Flow Rate	kg/hr	real	[-2;+Inf]	0.0
	The flow rate of fluid exiting the storage tank from the first outlet. One of the outlet flow rates MUST be specified as a constant value of -2 to indicate that the outlet flow rate will be determined from a mass balance on the constant volume storage tank.					
3	Flow rate at inlet 2	Flow Rate	kg/hr	real	[-Inf;+Inf]	0.0
	The flow rate of fluid entering the storage tank at the second inlet.					
4	Flow rate at outlet 2	Flow Rate	kg/hr	real	[-2;+Inf]	-2
	The flow rate of fluid exiting ths storage tank from the second outlet. One of the outlet flow rates MUST be set to a constant value of -2 to indicate that the outlet flow rate will be determined from a mass balance on the constant volume storage tank.					
5	Temperature at inlet 1	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the fluid entering the storage tank at the first inlet.					
6	Temperature at inlet 2	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the fluid entering the storage tank at the second inlet.					
7	Environment temperature	Temperature	C	real	[-Inf;+Inf]	22.0
	The temperature of the environment in which the storage tank is located.					
8	Control signal for element 1	Dimensionless	-	real	[0.0;1.0]	1.0
	The control signal for the specified auxiliary heating element. The available power for the heating element will					

	be this input multiplied by the maximum power for the element. If an auxiliary heater is not desired for the simulation, set this input to a constant of 0.0 or set the maximum power for the element to 0.0					
9	Control signal for element 2	Dimensionless	-	real	[0.0;1.0]	1.0
	The control signal for the specified auxiliary heating element. The available power for the heating element will be this input multiplied by the maximum power for the element. If an auxiliary heater is not desired for the simulation, set this input to a constant of 0.0 or set the maximum power for the element to 0.0					
10	Flow rate for heat exchanger	Flow Rate	kg/hr	real	[0.0;+Inf]	0.0
	The flow rate through the specified internal heat exchanger.					
11	Inlet temperature for heat exchanger	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature at the inlet of the specified internal heat exchanger.					
12	Nusselt constant for heat exchanger	Dimensionless	-	real	[0.0;+Inf]	0.50
	The natural convection coefficient between the storage fluid and the internal heat exchanger wall is modeled with an equation of the form: h = Nu * k / do ; Nu = C * Ra^n (See mathematical reference for details) Typical value for C is about 0.5 and n is usually 0.25.					
13	Nusselt exponent for heat exchanger	Dimensionless	-	real	[-Inf;+Inf]	0.25
	The natural convection coefficient between the storage fluid and the internal heat exchanger wall is modeled with an equation of the form: h = Nu * k / do ; Nu = C * Ra^n (See mathematical reference for details) Typical value for C is about 0.5 and n is usually 0.25.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
10-13	Number of internal heat exchangers		1	50

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Flowrate at inlet 1	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	The flow rate of fluid into the storage tank at inlet 1.					
2	Flowrate at outlet 1	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	The flow rate of fluid exiting the storage tank through outlet 1.					
3	Flowrate at inlet 2	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	The flow rate of fluid entering the storage tank through inlet 2.					
4	Flowrate at outlet 2	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	The flowrate of fluid exiting the storage tank through outlet 2.					
5	Temperature of outlet flow 1	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid exiting the storage tank through outlet 1.					
6	Temperature of outlet flow 2	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid exiting the storage tank through outlet 2.					
7	Thermal losses	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate of thermal energy loss to the environment. Includes the vented energy if a boiling condition is reached.					
8	Energy supplied by inlet 1	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is added to the storage tank by the entrance of the fluid through inlet 1.					
9	Energy removed by outlet 1	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is removed from the storage tank by the exiting of fluid through outlet 1.					
10	Energy supllied by inlet 2	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is added to the storage tank by the entrance of the fluid through inlet 2.					
11	Energy removed by outlet 2	Power	kJ/hr	real	[-Inf;+Inf]	0

	The rate at which energy is removed from the storage tank by the exiting of fluid through outlet 2.					
12	Auxiliary heating rate	Power	kJ/hr	real	[-Inf;+Inf]	0
	The average rate at which power was added to the tank by BOTH auxiliary heaters.					
13	Element 1 power	Power	kJ/hr	real	[-Inf;+Inf]	0
	The average power supplied to the storage tank over the timestep by the first heating element specified in the parameter list.					
14	Element 2 power	Power	kJ/hr	real	[-Inf;+Inf]	0
	The average power over the timestep supplied to the tank by the second auxiliary heater specified in the parameter list.					
15	Losses to gas flue	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is removed from the storage tank through losses to the gas flue (while the tank is not being charged by the gas flue).					
16	Internal energy change	Energy	kJ	real	[-Inf;+Inf]	0
	The change in internal energy of the tank from the beginning of the simulation.					
17	Average tank temperature	Temperature	C	real	[-Inf;+Inf]	0
	The average temperature of the fluid in the storage tank over the timestep.					
18	Static pressure difference - inlet 1	Pressure	kPa	real	[-Inf;+Inf]	0
	The static pressure difference between the top of the tank and the first inlet port.					
19	Static pressure difference - outlet 1	Pressure	kPa	real	[-Inf;+Inf]	0
	The static pressure difference between the top of the tank and the first outlet port.					
20	Static pressure difference - inlet 2	Pressure	kPa	real	[-Inf;+Inf]	0
	The static pressure difference between the top of the tank and the second inlet port.					
21	Static pressure difference - outlet 2	Pressure	kPa	real	[-Inf;+Inf]	0
	The static pressure difference between the top of the tank and the second outlet port.					
22	Energy input from heat exchanger	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is added to the storage tank from the specified internal heat exchanger.					
23	Temperature of fluid exiting heat exchanger	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid exiting the specified internal heat exchanger.					
24	Tank temperature at outlet of heat exchanger	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the storage tank at the outlet of the specified internal heat exchanger.					
25	LMTD of heat exchanger	Temperature	C	real	[-Inf;+Inf]	0
	The average log mean temperature difference of the specified internal heat exchanger over the timestep.					
26	UA of heat exchanger	Overall Loss Coefficient	kJ/hr.K	real	[0.0;+Inf]	0
	The average overall heat transfer coefficient of the specified internal heat exchanger over the timestep.					
27	Tank temperature - top	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid at the top of the storage tank.					
28	Tank temperature - bottom	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid at the bottom of the storage tank.					
29	Temperature of node 1+	Temperature	C	real	[-Inf;+Inf]	0
	Temperature of node 1+ The temperature of the specified node.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
22-26	Number of internal heat exchangers		1	50
29-29		Besides the top and bottom nodes, how many other	1	13

		nodes are there?		

DERIVATIVES

	Name	Dimension	Unit	Type	Range	Default
1	Initial temperature of node	Temperature	C	real	[-Inf;+Inf]	0
	The initial temperature of the specified node.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
1-1		How many temperature levels (nodes) should be used in the tank?	1	50

4.12.1.25. Vertical Cylinder - Uniform Losses and Node Heights - 2 Inlets, 2 Outlets

Icon		TRNSYS Model	Type 60
Proforma	Thermal Storage\Detailed Fluid Storage Tank\Vertical Cylinder\Uniform Losses and Node Heights\2 Inlets, 2 Outlets\Type60cNoHeat.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	User-specified inlet positions	Dimensionless	-	integer	[1;2]	2
	The auxiliary storage tank may operate in one of two modes in determining the inlet positions of the flow streams. In this mode (2), the user must specify the locations (nodes) of the entering flow streams. Do not change this parameter.					
2	Tank volume	Volumetric Flow Rate	m^3	real	[0.0;+Inf]	0.35
	The actual volume of the storage tank (not the nominal value).					
3	Tank height	Length	m	real	[0.0;+Inf]	1.25
	The height of the storage tank. If the tank is a horizontal cylinder, this parameter should be set to the diameter of the storage tank.					
4	Tank perimeter	Length	m	integer	[-1;-1]	-1
	By setting this parameter to -1, the user is specifying that the tank is cylindrical with a vertical orientation (standing up). Do not change this parameter.					
5	Height of flow inlet 1	Length	m	real	[0.0;+Inf]	1.25
	The height of the first inlet above the bottom of the tank. Make sure that this value is between 0 and the total height of the tank.					
6	Height of flow outlet 1	Length	m	real	[0.0;+Inf]	0.0
	The height of the first outlet from the storage tank above the bottom of the tank. Make sure that this value is between 0 and the total height of the tank.					
7	Height of flow inlet 2	Length	m	real	[0.0;+Inf]	0.0
	The height of the second inlet to the staorage tank above the bottom of the tank. Make sure that this value is between 0 and the total height of the storage tank.					
8	Height of flow outlet 2	Length	m	real	[0.0;+Inf]	1.25
	The height of the 2nd outlet from the storage tank above the bottom of the tank. Make sure that this value is between 0 and the total height of the storage tank.					
9	Fluid specific heat	Specific Heat	kJ/kg.K	real	[0.0;+Inf]	4.190
	The specific heat of the fluid contained in the storage tank.					
10	Fluid density	Density	kg/m^3	real	[0.0;+Inf]	1000.0
	The density of the fluid contained in the storage tank.					
11	Tank loss coefficient	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[0.0;+Inf]	3.0
	The average tank loss coefficient per unit area. Different loss coefficients for each node can be modeled by use of the incremental loss coefficient parameters.					
12	Fluid thermal conductivity	Thermal Conductivity	kJ/hr.m.K	real	[0.0;+Inf]	1.40
	The thermal conductivity of the fluid contained in the storage tank.					
13	Destratification conductivity	Thermal Conductivity	kJ/hr.m.K	real	[0.0;+Inf]	0.0
	To model de-stratification due to mixing at node interfaces and conduction along the tank wall, the user may enter this additional conductivity parameter. The additional conductivity term is added to the conductivity of the tank fluid and is applied to all nodes. For rough calculations, one may calculate this parameter as the thermal conductivity of the tank wall times the cross sectional area of the tank wall divided by the cross sectional area					

	of the fluid in the storage tank.					
14	Boiling temperature	Temperature	C	real	[-Inf;+Inf]	100.0
	The boiling point temperature of the fluid contained in the storage tank.					
15	Auxiliary heater mode	Dimensionless	-	integer	[1;2]	1
	The auxiliary heater may be operated in one of two modes: 1 = Master/Slave Relation: The lower heating element is only enabled when the upper heating element is satisified. In this mode, only one heater may be on at any instant of time. This is a common design in residential electric hot water tanks. 2 = Both Enabled: In this mode, both heaters may be on simultaneously. This allows for significantly quicker heating of the water, but at a much higher electrical demand.					
16	Height of 1st aux. heater	Length	m	real	[0.0;+Inf]	1.0
	The height of the first auxiliary heater element above the bottom of the storage tank. If there are no auxiliary heaters, set this parameter and the thermostat height parameter to any value between 0 anf the total tank height. Then simply set either the maximum heating rate or the control signal for this heating element to a constant value of 0.					
17	Height of 1st thermostat	Length	m	real	[0.0;+Inf]	1.25
	The height of the thermostat for the first heating element above the bottom of the storage tank. If there are no heating elements, simply set this parameter to any value between 0 and the total tank height. Then set either the maximum heating rate or the control signal for this heating element to a constant value of 0.					
18	Set point temperature for element 1	Temperature	C	real	[-Inf;+Inf]	55.0
	The set point temperature for the specified heating element. The thermostat will enable the heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb and continue to heat the fluid until it reaches the set point temperature. Tset = this parameter; Tdb = next parameter					
19	Deadband for heating element 1	Temp. Difference	deltaC	real	[-Inf;+Inf]	5.0
	The dead band temperature difference for the specified heating element. The thermostat will enable the heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb and continue to heat the fluid until it reaches the set point temperature. Where Tset = previous parameter; Tdb = this parameter					
20	Maximum heating rate of element 1	Power	kJ/hr	real	[0.0;+Inf]	16200.0
	The maximum heating rate of the heating element. If the specified heating element is to not to be used for the simulation, set the maximum power to 0.					
21	Height of 2nd aux. heater	Length	m	real	[0.0;+Inf]	1
	Height of the second heating element above the bottom of the tank					
22	Height of 2nd thermostat	Length	m	real	[0.0;+Inf]	1
	Height of 2nd thermostat above the bottom of the tank					
23	Set point temperature for element 2	Temperature	C	real	[-Inf;+Inf]	55.0
	The set point temperature for the specified heating element. The thermostat will enable the heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb and continue to heat the fluid until it reaches the set point temperature. Tset = this parameter; Tdb = next parameter					
24	Deadband for heating element 2	Temp. Difference	deltaC	real	[0.0;+Inf]	5.0
	The dead band temperature difference for the specified heating element. The thermostat will enable the heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb and continue to heat the fluid until it reaches the set point temperature.					

	Where Tset = previous parameter; Tdb = this parameter					
25	Maximum heating rate of element 2	Power	kJ/hr	real	[0.0;+Inf]	16200
	The maximum heating rate of the heating element. If the specified heating element is to not to be used for the simulation, set the maximum power to 0.					
26	Overall loss coefficient for gas flue	Overall Loss Coefficient	kJ/hr.K	real	[0.0;+Inf]	0.0
	The overall loss coefficient of the gas flue when the tank is not being heated. If this tank is not being heated by gas, simply set this parameter to 0.0 and the next parameter (flue temperature) to any reasonable value.					
27	Flue temperature	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the gas flue when the tank is not being heated. This parameter is used tto calculate the losses from the storage to the flue when the tank is not being heated. If the tank is not heated witth gas, simply set this parameter to any reasonable value and set the previous parameter (flue loss coefficient) to 0.					
28	Fraction of critical timestep	Dimensionless	-	integer	[1;1000]	6
	To minimize numerical errors, the TYPE 60 tank model uses its own internal time step. This has the advantage of results being unaffected by the size of the TRNSYS time step. The model internally computes the critical Euler time step. The user then chooses the fraction of the critical time step that will be used. Increasing this parameter will increase the accuracy of the model, but decrease the simulation speed. A value of 6 represents an excellent compromise between accuracy and speed for most simulations.					
29	Gas heater?	Dimensionless	-	integer	[0;+Inf]	1
	This parameter indicates to the general storage tank model whether the tank is heated with electric elements, with a gas flue, or with a combination of gas and electric. 0 = Both heater are electric 1 = Auxiliary heater #2 is gas (setting the maximum heating rate of the first heating element to zero or non-zero dictates whether the tankalso has an electric element).					
30	Number of internal heat exchangers	Dimensionless	-	integer	[0;0]	1
	The number of internal heat exchangers that are contained within the storage tank. No heat exchanger in this case Do not change this parameter					
31	Equal sized nodes	Dimensionless	-	integer	[0;0]	0
	This parameter indicates to the general storage taank model that the tank should be divided into nodes of the same size. The number of nodes is controlled by the number of derivatives supplied. Do not change this parameter.					
32	Uniform tank losses	Dimensionless	-	integer	[0;0]	0
	This parameter indicates to the general storagee tank model that the tank will have uniform loss coefficients for each node. The number of nodes is controlled by the number of supplied derivatives. Do not change this parameter.					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Flow rate at inlet 1	Flow Rate	kg/hr	real	[-Inf;+Inf]	0.0
	The flow rate entering the storage tank at the first inlet.					
2	Flow rate at outlet 1	Flow Rate	kg/hr	real	[-2;+Inf]	0.0
	The flow rate of fluid exiting the storage tank from the first outlet. One of the outlet flow rates MUST be specified as a constant value of -2 to indicate that the outlet flow rate will be determined from a mass balance on the constant volume storage tank.					
3	Flow rate at inlet 2	Flow Rate	kg/hr	real	[-Inf;+Inf]	0.0
	The flow rate of fluid entering the storage tank at the second inlet.					
4	Flow rate at outlet 2	Flow Rate	kg/hr	real	[-2;+Inf]	-2
	The flow rate of fluid exiting ths storage tank from the second outlet. One of the outlet flow rates MUST be set to a constant value of -2 to indicate that the outlet flow rate will be determined from a mass balance on the constant volume storage tank.					

5	Temperature at inlet 1	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the fluid entering the storage tank at the first inlet.					
6	Temperature at inlet 2	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the fluid entering the storage tank at the second inlet.					
7	Environment temperature	Temperature	C	real	[-Inf;+Inf]	22.0
	The temperature of the environment in which the storage tank is located.					
8	Control signal for element 1	Dimensionless	-	real	[0.0;1.0]	1.0
	The control signal for the specified auxiliary heating element. The available power for the heating element will be this input multiplied by the maximum power for the element. If an auxiliary heater is not desired for the simulation, set this input to a constant of 0.0 or set the maximum power for the element to 0.0					
9	Control signal for element 2	Dimensionless	-	real	[0.0;1.0]	1.0
	The control signal for the specified auxiliary heating element. The available power for the heating element will be this input multiplied by the maximum power for the element. If an auxiliary heater is not desired for the simulation, set this input to a constant of 0.0 or set the maximum power for the element to 0.0					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Flowrate at inlet 1	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	The flow rate of fluid into the storage tank at inlet 1.					
2	Flowrate at outlet 1	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	The flow rate of fluid exiting the storage tank through outlet 1.					
3	Flowrate at inlet 2	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	The flow rate of fluid entering the storage tank through inlet 2.					
4	Flowrate at outlet 2	Flow Rate	kg/hr	real	[0.0;+Inf]	0
	The flowrate of fluid exiting the storage tank through outlet 2.					
5	Temperature of outlet flow 1	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid exiting the storage tank through outlet 1.					
6	Temperature of outlet flow 2	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid exiting the storage tank through outlet 2.					
7	Thermal losses	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate of thermal energy loss to the environment. Includes the vented energy if a boiling condition is reached.					
8	Energy supplied by inlet 1	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is added to the storage tank by the entrance of the fluid through inlet 1.					
9	Energy removed by outlet 1	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is removed from the storage tank by the exiting of fluid through outlet 1.					
10	Energy supllied by inlet 2	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is added to the storage tank by the entrance of the fluid through inlet 2.					
11	Energy removed by outlet 2	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is removed from the storage tank by the exiting of fluid through outlet 2.					
12	Auxiliary heating rate	Power	kJ/hr	real	[-Inf;+Inf]	0
	The average rate at which power was added to the tank by BOTH auxiliary heaters.					
13	Element 1 power	Power	kJ/hr	real	[-Inf;+Inf]	0
	The average power supplied to the storage tank over the timestep by the first heating element specified in the parameter list.					
14	Element 2 power	Power	kJ/hr	real	[-Inf;+Inf]	0
	The average power over the timestep supplied to the tank by the second auxiliary heater specified in the parameter list.					

15	Losses to gas flue	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is removed from the storage tank through losses to the gas flue (while the tank is not being charged by the gas flue).					
16	Internal energy change	Energy	kJ	real	[-Inf;+Inf]	0
	The change in internal energy of the tank from the beginning of the simulation.					
17	Average tank temperature	Temperature	C	real	[-Inf;+Inf]	0
	The average temperature of the fluid in the storage tank over the timestep.					
18	Static pressure difference - inlet 1	Pressure	kPa	real	[-Inf;+Inf]	0
	The static pressure difference between the top of the tank and the first inlet port.					
19	Static pressure difference - outlet 1	Pressure	kPa	real	[-Inf;+Inf]	0
	The static pressure difference between the top of the tank and the first outlet port.					
20	Static pressure difference - inlet 2	Pressure	kPa	real	[-Inf;+Inf]	0
	The static pressure difference between the top of the tank and the second inlet port.					
21	Static pressure difference - outlet 2	Pressure	kPa	real	[-Inf;+Inf]	0
	The static pressure difference between the top of the tank and the second outlet port.					
22	Tank temperature - top	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid at the top of the storage tank.					
23	Tank temperature - bottom	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid at the bottom of the storage tank.					
24	Temperature of node 1+	Temperature	C	real	[-Inf;+Inf]	0
	Temperature of node 1+ The temperature of the specified node.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
24-24		Besides the top and bottom nodes, how many other nodes are there?	1	13

DERIVATIVES

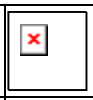
	Name	Dimension	Unit	Type	Range	Default
1	Initial temperature of node	Temperature	C	real	[-Inf;+Inf]	0
	The initial temperature of the specified node.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
1-1		How many temperature levels (nodes) should be used in the tank?	1	50

4.12.2. Plug-Flow Tank

4.12.2.1. Plug-Flow Tank

Icon		TRNSYS Model	Type 38
Proforma	Thermal Storage\Plug-Flow Tank\Type38.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Inlet position mode	Dimensionless	-	integer	[1;2]	1
	The auxiliary storage tank may operate in one of two modes in determining the inlet positions of the flow streams. Mode 1 indicates that the heat source flow enters the tank in a fixed location and the flow mixes with adjacent segments if the temperature is within 1/2 degree. In Mode 2, the tank has variable inlet positions and new segments are inserted at the levels which produce no temperature inversions. This allows for a maximum degree of stratification.					
2	Tank volume	Volumetric Flow Rate	m^3	real	[0.0;+Inf]	0.35
	The actual volume of the storage tank (not the nominal value).					
3	Tank height	Length	m	real	[0.0;+Inf]	1.2
	The height of the storage tank.					
4	Height of collector return	Length	m	real	[0.0;+Inf]	1.0
	The vertical distance between the bottom of the storage tank and the inlet of the hot-side flow stream.					
5	Fluid specific heat	Specific Heat	kJ/kg.K	real	[0.0;+Inf]	4.190
	The specific heat of the fluid contained in the storage tank.					
6	Fluid density	Density	kg/m^3	real	[0.0;+Inf]	1000.0
	The density of the fluid contained in the storage tank.					
7	Thermal conductivity	Thermal Conductivity	kJ/hr.m.K	real	[0.0;+Inf]	1.5
	The effective thermal conductivity of the fluid and the walls of the thermal storage tank (0 = no conduction).					
8	Tank configuration	Dimensionless	-	integer	[1;2]	1
	The configuration of the thermal storage tank: 1 ---> Vertical cylinder ; 2 ---> Horizontal cylinder					
9	Overall Loss Coefficient	Overall Loss Coefficient	kJ/hr.K	real	[0.0;+Inf]	5.0
	The overall loss coefficient (UA) for the storage tank.					
10	Insulation ratio	Dimensionless	-	real	[0.0;+Inf]	1.0
	The ratio of the thickness of the top insulation to the side insulation for vertical tanks, or the ratio of the insulation thickness of the top insulation to the bottom insulation of a horizontal cylindrical tank (set this ratio to 1 if the tank has a concentric insulation jacket).					
11	Initial temperature	Temperature	C	real	[-Inf;+Inf]	30.0
	The initial temperature of the preheat portion of the thermal storage tank.					
12	Maximum heating rate	Power	kJ/hr	real	[0.0;+Inf]	16200
	The maximum rate at which energy can be added to the thermal storage tank from the auxiliary heating element. If there is no element present in the tank, set this parameter to 0.					
13	Auxiliary height	Length	m	real	[0.0;+Inf]	0.5
	The height of the auxiliary heater element above the bottom of the storage tank.					
14	Thermostat height	Length	m	real	[0.0;+Inf]	0.75
	The height of the thermostat for the auxiliary heater above the bottom of the storage tank.					

15	Set point temperature	Temperature	C	real	[-Inf;+Inf]	55.0
	The set point temperature for the auxiliary heating element. The thermostat will enable the heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb and continue to heat the fluid until it reaches the set point temperature. Tset = this parameter; Tdb = temperature deadband					
16	Temperature deadband	Temp. Difference	deltaC	real	[0.0;+Inf]	5.0
	The dead band temperature difference for the auxiliary heating element. The thermostat will enable the heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb and continue to heat the fluid until it reaches the set point temperature. (See manual for further information on equation)					
17	Flue loss coefficient	Overall Loss Coefficient	kJ/hr.K	real	[0.0;+Inf]	0.0
	The overall loss coefficient (UA) for heat loss to the flue when the auxiliary heater is off. This parameter is used to model gas heated storage tanks and should be set to zero if there is no flue.					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Hot-side temperature	Temperature	C	real	[-Inf;+Inf]	45.0
	The temperature of the fluid flowing into the tank from the heat source.					
2	Hot-side flowrate	Flow Rate	kg/hr	real	[0.0;+Inf]	100.0
	The flowrate of fluid into the storage tank from the heat source. An equal flowrate of fluid leaves the bottom of the storage tank for return to the heat source.					
3	Cold-side temperature	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the replacement fluid flowing into the bottom of the storage tank.					
4	Cold-side flowrate	Flow Rate	kg/hr	real	[0.0;+Inf]	100.0
	The flowrate of replacement fluid flowing into the bottom of the storage tank. An equal amount of fluid is assumed to flow from the top of the tank to meet the load.					
5	Environment temperature	Temperature	C	real	[-Inf;+Inf]	22.0
	The temperature of the environment in which the storage tank is located.					
6	Control signal	Dimensionless	-	real	[0.0;1.0]	0.0
	The control signal for the auxiliary heating element. The available power for the heating element will be this input multiplied by the maximum power for the element. If an auxiliary heater is not desired for the simulation, set this input to a constant of 0.0 or set the maximum power for the element to 0.0					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Temperature to heat source	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid flowing from the bottom of the storage tank and returning to the heat source (the bottom node temperature).					
2	Flowrate to heat source	Flow Rate	kg/hr	real	[-Inf;+Inf]	0
	The flow rate of fluid exiting the bottom of the storage tank to return to the heat source.					
3	Temperature to load	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid flowing from the top of the storage tank to the load (the temperature of the top node).					
4	Flowrate to load	Flow Rate	kg/hr	real	[-Inf;+Inf]	0
	The flow rate of fluid exiting the tank at the top to meet the load.					
5	Thermal losses	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate of thermal energy loss to the environment.					
6	Energy rate to load	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is removed from the tank to supply the load. The energy rate to the load is calculated					

	by: Qload = mdot,load * Cp * (Ttop - Treplace) (See manual for further information on equation)					
7	Internal energy change	Energy	kJ	real	[-Inf;+Inf]	0
	The internal energy change of the tank relative to its initial condition. This output should not be integrated as it is an energy quantity and not an energy rate.					
8	Auxiliary heating rate	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy was added to the thermal storage tank by the auxiliary heater.					
9	Energy rate from heat source	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate of energy transfer from the heat source to the storage tank. The rate is calculated from: Qin = mdot,source * Cp * (Thot - Ttosource) (See manual for further information on equation)					
10	Average tank temperature	Temperature	C	real	[-Inf;+Inf]	0
	The average temperature of the fluid in the storage tank over the timestep.					

4.12.3. Rock Bed Storage

4.12.3.1. Rock Bed Storage

Icon		TRNSYS Model	Type 10
Proforma	Thermal Storage\Rock Bed Storage\Type10.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Specific heat of air	Specific Heat	kJ/kg.K	real	[0.0;+Inf]	1.0035
	The specific heat of the fluid flowing through the rock bed (typically air).					
2	Length of rock bed	Length	m	real	[0.0;+Inf]	1.5
	The length of the rock bed in the direction of the flow.					
3	Cross-sectional area	Area	m^2	real	[0.0;+Inf]	2.25
	The cross-sectional area of the rock bed (inside dimensions).					
4	Perimeter	Length	m	real	[0.0;+Inf]	6.0
	The perimeter of the rock bed (inside dimension).					
5	Specific heat of rock	Specific Heat	kJ/kg.K	real	[0.0;+Inf]	0.8
	The specific heat of the rock contained in the rock bed.					
6	Apparent rock bed density	Density	kg/m^3	real	[0.0;+Inf]	1800
	The apparent density of the rock bed including voids.					
7	Loss coefficient	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[0.0;+Inf]	3.0
	The loss coefficient from the rock bed to the surroundings.					
8	Effective thermal conductivity	Thermal Conductivity	kJ/hr.m.K	real	[0.0;+Inf]	10.0
	The effective thermal conductivity of the rock bed in the axial direction (including voids).					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Temperature into top	Temperature	C	real	[-Inf;+Inf]	25.0
	The temperature of the air entering the rock bed from the top and flowing down.					
2	Flowrate into top	Flow Rate	kg/hr	real	[0.0;+Inf]	0.1
	The flowrate of air entering the rock bed from the top and flowing down. *Note - the flowrate of air entering the bed from the top (this input) and the flowrate of air entering the bed from the bottom (input 4) cannot be greater than zero simultaneously.					
3	Temperature into bottom	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the air entering the tank from the bottom and flowing upwards.					
4	Flowrate into bottom	Flow Rate	kg/s	real	[0.0;+Inf]	0.0
	The flowrate of air entering the rock bed from the bottom and flowing upwards. *Note - the flowrate entering the bottom (this input) and the flow entering from the top of the tank (Input 2) cannot be greater than zero simultaneously.					
5	Environment temperature	Temperature	C	real	[-Inf;+Inf]	10.0
	The temperature of the surroundings to which the rock bed is exposed. This input is used to calculate the thermal losses from the rock bed.					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Bottom node temperature	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the air/rock in the bottom segment of the tank.					
2	Flowrate out of bottom	Flow Rate	kg/hr	real	[-Inf;+Inf]	0
	The flowrate of air entering the top of the rock bed and leaving at the bottom of the rock bed.					
3	Top node temperature	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the air/rock in the top segment of the rock bed.					
4	Flowrate out of top	Flow Rate	kg/hr	real	[-Inf;+Inf]	0
	The flowrate of air entering the bottom of the rock bed and exiting the top of the rock bed.					
5	Internal energy change	Energy	kJ	real	[-Inf;+Inf]	0
	The change in internal energy since the simulation began. This output should not be integrated.					
6	Rate of energy supply	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate of energy supplied by the rock bed to the load stream (the air entering from the bottom and leaving the top). The supply rate is: Qsupply = mdot,b * Cpair * (T1 - Tinb) (See manual for further information on equation)					
7	Environment losses	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate of energy lost to the surroundings from the rock bed.					
8	Average temperature	Temperature	C	real	[-Inf;+Inf]	0
	The average temperature of the rock bed.					

DERIVATIVES

	Name	Dimension	Unit	Type	Range	Default
1	Initial temperature of segment	Temperature	C	real	[-Inf;+Inf]	0
	The initial temperature of the specified segment of the rock bed. segment 1 = top of rock bed ; segment N = bottom of rock bed For most cases, a value of N = 5 is recommended					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
1-1		How many segments should the rock bed be divided into?	1	40

4.12.4. Stratified Storage Tank

4.12.4.1. Fixed Inlets - Non-uniform Losses

Icon		TRNSYS Model	Type 4
Proforma	Thermal Storage\Stratified Storage Tank\Fixed Inlets\Non-uniform Losses\Type4b.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Fixed inlet positions	Dimensionless	-	integer	[1;1]	1
	The auxiliary storage tank may operate in one of three modes in determining the inlet positions of the flow streams. Mode 1 indicates that the heat source flow enters the tank in the node located just below the top auxiliary heating element. The cold source flow enters at the bottom of the tank. Do not change this parameter.					
2	Tank volume	Volumetric Flow Rate	m^3	real	[0.0;+Inf]	0.35
	The actual volume of the storage tank (not the nominal value).					
3	Fluid specific heat	Specific Heat	kJ/kg.K	real	[0.0;+Inf]	4.190
	The specific heat of the fluid contained in the storage tank.					
4	Fluid density	Density	kg/m^3	real	[0.0;+Inf]	1000.0
	The density of the fluid contained in the storage tank.					
5	Tank loss coefficient (-)	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[-Inf;0.0]	-3.0
	The average tank loss coefficient per unit area. In this mode, the average tank loss coefficient should be entered as a negative number indicating to the general model that incremental U-values will be added to the average loss coefficient for each node.					
6	Height of node	Length	m	real	[0.0;+Inf]	0.05
	The height of the storage tank node in question. The total tank height will be determined by summing the heights of the nodes.					
7	Auxiliary heater mode	Dimensionless	-	integer	[1;2]	1
	The auxiliary heater may be operated in one of two modes: 1 = Master/Slave Relation: The lower heating element is only enabled when the upper heating element is satisified. In this mode, only one heater may be on at any instant of time. This is a common design in residential electric hot water tanks. 2 = Both Enabled: In this mode, both heaters may be on simultaneously. This allows for significantly quicker heating of the water, but at a much higher electrical demand.					
8	Node containing heating element 1	Dimensionless	-	integer	[1;100]	1
	The node containing the specified auxiliary heating element. Make sure that the specified node for the heater is between 1 and the total number of nodes specified. Node 1 is the topmost node in the tank.					
9	Node containing thermostat 1	Dimensionless	-	integer	[1;100]	1
	The node containing the thermostat for the specified auxiliary heater. The thermostat is typically either located in the same node as the heating element or in a node located above the element. Node 1 is the topmost node in the tank.					
10	Set point temperature for element 1	Temperature	C	real	[-Inf;+Inf]	55.0
	The set point temperature for the specified heating element. The thermostat will enable the heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb and continue to heat the fluid until it reaches the set point temperature.					

	Tset = this parameter; Tdb = next parameter					
11	Deadband for heating element 1	Temp. Difference	deltaC	real	[-Inf;+Inf]	5.0
	The dead band temperature difference for the specified heating element. The thermostat will enable the heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb and continue to heat the fluid until it reaches the set point temperature. Where Tset = previous parameter; Tdb = this parameter					
12	Maximum heating rate of element 1	Power	kJ/hr	real	[0.0;+Inf]	16200.0
	The maximum heating rate of the heating element. If the specified heating element is to not to be used for the simulation, set the maximum power to 0.					
13	Node containing heating element 2	Dimensionless	-	integer	[1;100]	1
	The node containing the specified auxiliary heating element. Make sure that the specified node for the heater is between 1 and the total number of nodes specified. Node 1 is the topmost node in the tank.					
14	Node containing thermostat 2	Dimensionless	-	integer	[1;100]	1
	The node containing the thermostat for the specified auxiliary heater. The thermostat is typically either located in the same node as the heating element or in a node located above the element. Node 1 is the topmost node in the tank.					
15	Set point temperature for element 2	Temperature	C	real	[-Inf;+Inf]	55.0
	The set point temperature for the specified heating element. The thermostat will enable the heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb and continue to heat the fluid until it reaches the set point temperature. Tset = this parameter; Tdb = next parameter					
16	Deadband for heating element 2	Temp. Difference	deltaC	real	[0.0;+Inf]	5.0
	The dead band temperature difference for the specified heating element. The thermostat will enable the heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb and continue to heat the fluid until it reaches the set point temperature. Where Tset = previous parameter; Tdb = this parameter					
17	Maximum heating rate of element 2	Power	kJ/hr	real	[0.0;+Inf]	16200
	The maximum heating rate of the heating element. If the specified heating element is to not to be used for the simulation, set the maximum power to 0.					
18	Not used (Flue UA)	Overall Loss Coefficient	W/K	real	[0.0;0.0]	0.0
	This parameter is not used in this mode of the storage tank.					
19	Not used (Tflue)	Temperature	C	real	[-Inf;+Inf]	20.0
	This parameter is not used in this mode of the storage tank.					
20	Boiling point	Temperature	C	real	[-Inf;+Inf]	100.0
	The boiling point temperature of the fluid in the storage tank. If the tank temperature reaches the boiling temperature, venting of steam is assumed to occur to keep the fluid at the boiling temperature. The venting is assumed to occur with negligible loss of mass.					
21	Incremental loss coefficient for node	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[-Inf;+Inf]	0
	The incremental loss coefficient for each node is used to specify nodes with differing loss coefficients from the average loss coefficient. The loss coefficient for the node will be: Absolute Value(Parameter 5) + This Parameter Users can specify a positive or negative incremental loss coefficient for each node, but the calculated loss coefficient has to be greater than zero.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
6-6		How many temperature levels (nodes) should be used in the tank?	1	100
21-21		How many temperature levels (nodes) should be used in the tank?	1	100

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Hot-side temperature	Temperature	C	real	[-Inf;+Inf]	45.0
	The temperature of the fluid flowing into the tank from the heat source. The inlet location for this hot-side fluid is one element below the upper auxiliary heating element.					
2	Hot-side flowrate	Flow Rate	kg/hr	real	[0.0;+Inf]	100.0
	The flowrate of fluid into the storage tank from the heat source. The hot-side fluid enters the tank below the upper heating element. An equal flowrate of fluid leaves the bottom of the storage tank for return to the heat source.					
3	Cold-side temperature	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the replacement fluid flowing into the bottom of the storage tank.					
4	Cold-side flowrate	Flow Rate	kg/hr	real	[0.0;+Inf]	100.0
	The flowrate of replacement fluid flowing into the bottom of the storage tank. An equal amount of fluid is assumed to flow from the top of the tank to meet a load.					
5	Environment temperature	Temperature	C	real	[-Inf;+Inf]	22.0
	The temperature of the environment in which the storage tank is located.					
6	Control signal for element	Dimensionless	-	real	[0.0;1.0]	0.0
	The control signal for the specified auxiliary heating element. The available power for the heating element will be this input multiplied by the maximum power for the element. If an auxiliary heater is not desired for the simulation, set this input to a constant of 0.0 or set the maximum power for the element to 0.0					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
6-6		How many heating elements to be modeled in this tank?	2	2

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Temperature to heat source	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid flowing from the bottom of the storage tank and returning to the heat source (the bottom node temperature).					
2	Flowrate to heat source	Flow Rate	kg/hr	real	[-Inf;+Inf]	0
	The flow rate of fluid entering the storage tank below the upper heating element and exiting at the bottom of the storage tank to return to the heat source.					
3	Temperature to load	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid flowing from the top of the storage tank to the load (the temperature of the top node).					
4	Flowrate to load	Flow Rate	kg/hr	real	[-Inf;+Inf]	0
	The flowrate of fluid entering the tank at the bottom and leaving the tank at the top to meet the load.					
5	Thermal losses	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate of thermal energy loss to the environment. Includes the vented energy if a boiling condition is reached.					
6	Energy rate to load	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is removed from the tank to supply the load. The energy rate to the load is calculated					

	by: Qload = mdot,load * Cp * (Ttop - Treplace) (See manual for further information on equation)					
7	Internal energy change	Energy	kJ	real	[-Inf;+Inf]	0
	The internal energy change of the tank relative to its initial condition. This output should not be integrated as it is an energy quantity and not an energy rate.					
8	Auxiliary heating rate	Power	kJ/hr	real	[-Inf;+Inf]	0
	The average rate at which power was added to the tank by BOTH auxiliary heaters.					
9	Element 1 power	Power	kJ/hr	real	[-Inf;+Inf]	0
	The average power supplied to the storage tank over the timestep by the first heating element specified in the parameter list.					
10	Element 2 power	Power	kJ/hr	real	[-Inf;+Inf]	0
	The average power over the timestep supplied to the tank by the second auxiliary heater specified in the parameter list.					
11	Energy rate from heat source	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate of energy transfer from the heat source to the storage tank. The rate is calculated from: Qin = mdot,source * Cp * (Thot - Ttosource) (See manual for further information on equation)					
12	Average tank temperature	Temperature	C	real	[-Inf;+Inf]	0
	The average temperature of the fluid in the storage tank over the timestep.					
13	Temperature of node 1+	Temperature	C	real	[-Inf;+Inf]	0
	Temperature of node 1+ The temperature of the specified node.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
13-13		Besides the top and bottom nodes, how many other nodes are there?	1	98

DERIVATIVES

	Name	Dimension	Unit	Type	Range	Default
1	Initial temperature of node	Temperature	C	real	[-Inf;+Inf]	0
	The initial temperature of the specified node.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
1-1		How many temperature levels (nodes) should be used in the tank?	1	100

4.12.4.2. Fixed Inlets - Uniform Losses

Icon		TRNSYS Model	Type 4
Proforma	Thermal Storage\Stratified Storage Tank\Fixed Inlets\Uniform Losses\Type4a.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Fixed inlet positions	Dimensionless	-	integer	[1;1]	1
	The auxiliary storage tank may operate in one of three modes in determining the inlet positions of the flow streams. Mode 1 indicates that the heat source flow enters the tank in the node located just below the top auxiliary heating element. The cold source flow enters at the bottom of the tank. Do not change this parameter.					
2	Tank volume	Volumetric Flow Rate	m^3	real	[0.0;+Inf]	0.35
	The actual volume of the storage tank (not the nominal value).					
3	Fluid specific heat	Specific Heat	kJ/kg.K	real	[0.0;+Inf]	4.190
	The specific heat of the fluid contained in the storage tank.					
4	Fluid density	Density	kg/m^3	real	[0.0;+Inf]	1000.0
	The density of the fluid contained in the storage tank.					
5	Tank loss coefficient	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[0.0;+Inf]	3.0
	The average tank loss coefficient per unit area.					
6	Height of node	Length	m	real	[0.0;+Inf]	0.05
	The height of the storage tank node in question. The total tank height will be determined by summing the heights of the nodes.					
7	Auxiliary heater mode	Dimensionless	-	integer	[1;2]	1
	The auxiliary heater may be operated in one of two modes: 1 = Master/Slave Relation: The lower heating element is only enabled when the upper heating element is satisified. In this mode, only one heater may be on at any instant of time. This is a common design in residential electric hot water tanks. 2 = Both Enabled: In this mode, both heaters may be on simultaneously. This allows for significantly quicker heating of the water, but at a much higher electrical demand.					
8	Node containing heating element 1	Dimensionless	-	integer	[1;100]	1
	The node containing the specified auxiliary heating element. Make sure that the specified node for the heater is between 1 and the total number of nodes specified. Node 1 is the topmost node in the tank.					
9	Node containing thermostat 1	Dimensionless	-	integer	[1;100]	1
	The node containing the thermostat for the specified auxiliary heater. The thermostat is typically either located in the same node as the heating element or in a node located above the element. Node 1 is the topmost node in the tank.					
10	Set point temperature for element 1	Temperature	C	real	[-Inf;+Inf]	55.0
	The set point temperature for the specified heating element. The thermostat will enable the heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb and continue to heat the fluid until it reaches the set point temperature. Tset = this parameter; Tdb = next parameter					
11	Deadband for heating element 1	Temp. Difference	deltaC	real	[-Inf;+Inf]	5.0
	The dead band temperature difference for the specified heating element. The thermostat will enable the heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb					

	and continue to heat the fluid until it reaches the set point temperature. Where Tset = previous parameter; Tdb = this parameter					
12	Maximum heating rate of element 1	Power	kJ/hr	real	[0.0;+Inf]	16200.0
	The maximum heating rate of the heating element. If the specified heating element is to not to be used for the simulation, set the maximum power to 0.					
13	Node containing heating element 2	Dimensionless	-	integer	[1;100]	1
	The node containing the specified auxiliary heating element. Make sure that the specified node for the heater is between 1 and the total number of nodes specified. Node 1 is the topmost node in the tank.					
14	Node containing thermostat 2	Dimensionless	-	integer	[1;100]	1
	The node containing the thermostat for the specified auxiliary heater. The thermostat is typically either located in the same node as the heating element or in a node located above the element. Node 1 is the topmost node in the tank.					
15	Set point temperature for element 2	Temperature	C	real	[-Inf;+Inf]	55.0
	The set point temperature for the specified heating element. The thermostat will enable the heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb and continue to heat the fluid until it reaches the set point temperature. Tset = this parameter; Tdb = next parameter					
16	Deadband for heating element 2	Temp. Difference	deltaC	real	[0.0;+Inf]	5.0
	The dead band temperature difference for the specified heating element. The thermostat will enable the heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb and continue to heat the fluid until it reaches the set point temperature. Where Tset = previous parameter; Tdb = this parameter					
17	Maximum heating rate of element 2	Power	kJ/hr	real	[0.0;+Inf]	16200
	The maximum heating rate of the heating element. If the specified heating element is to not to be used for the simulation, set the maximum power to 0.					
18	Not used (Flue UA)	Overall Loss Coefficient	W/K	real	[0.0;0.0]	0.0
	This parameter is not used in this mode of the storage tank.					
19	Not used (Tflue)	Temperature	C	real	[-Inf;+Inf]	20.0
	This parameter is not used in this mode of the storage tank.					
20	Boiling point	Temperature	C	real	[-Inf;+Inf]	100.0
	The boiling point temperature of the fluid in the storage tank. If the tank temperature reaches the boiling temperature, venting of steam is assumed to occur to keep the fluid at the boiling temperature. The venting is assumed to occur with negligible loss of mass.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
6-6		How many temperature levels (nodes) should be used in the tank?	1	100

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Hot-side temperature	Temperature	C	real	[-Inf;+Inf]	45.0
	The temperature of the fluid flowing into the tank from the heat source. The inlet location for this hot-side fluid is one element below the upper auxiliary heating element.					
2	Hot-side flowrate	Flow Rate	kg/hr	real	[0.0;+Inf]	100.0

	The flowrate of fluid into the storage tank from the heat source. The hot-side fluid enters the tank below the upper heating element. An equal flowrate of fluid leaves the bottom of the storage tank for return to the heat source.					
3	Cold-side temperature	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the replacement fluid flowing into the bottom of the storage tank.					
4	Cold-side flowrate	Flow Rate	kg/hr	real	[0.0;+Inf]	100.0
	The flowrate of replacement fluid flowing into the bottom of the storage tank. An equal amount of fluid is assumed to flow from the top of the tank to meet a load.					
5	Environment temperature	Temperature	C	real	[-Inf;+Inf]	22.0
	The temperature of the environment in which the storage tank is located.					
6	Control signal for element	Dimensionless	-	real	[0.0;1.0]	0.0
	The control signal for the specified auxiliary heating element. The available power for the heating element will be this input multiplied by the maximum power for the element. If an auxiliary heater is not desired for the simulation, set this input to a constant of 0.0 or set the maximum power for the element to 0.0					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
6-6		How many heating elements to be modeled in this tank?	2	2

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Temperature to heat source	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid flowing from the bottom of the storage tank and returning to the heat source (the temperature of the bottom node).					
2	Flowrate to heat source	Flow Rate	kg/hr	real	[-Inf;+Inf]	0
	The flow rate of fluid entering the storage tank below the upper heating element and exiting at the bottom of the storage tank to return to the heat source.					
3	Temperature to load	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid flowing from the top of the storage tank to the load (the temperature of the top node).					
4	Flowrate to load	Flow Rate	kg/hr	real	[-Inf;+Inf]	0
	The flowrate of fluid entering the tank at the bottom and leaving the tank at the top to meet the load.					
5	Thermal losses	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate of thermal energy loss to the environment. Includes the vented energy if a boiling condition is reached.					
6	Energy rate to load	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is removed from the tank to supply the load. The energy rate to the load is calculated by: Qload = mdot,load * Cp * (Ttop - Treplace) (See manual for further information on equation)					
7	Internal energy change	Energy	kJ	real	[-Inf;+Inf]	0
	The internal energy change of the tank relative to its initial condition. This output should not be integrated as it is an energy quantity and not an energy rate.					
8	Auxiliary heating rate	Power	kJ/hr	real	[-Inf;+Inf]	0
	The average rate at which power was added to the tank by BOTH auxiliary heaters.					
9	Element 1 power	Power	kJ/hr	real	[-Inf;+Inf]	0
	The average power supplied to the storage tank over the timestep by the first heating element specified in the parameter list.					
10	Element 2 power	Power	kJ/hr	real	[-Inf;+Inf]	0
	The average power over the timestep supplied to the tank by the second auxiliary heater specified in the parameter list.					

11	Energy rate from heat source	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate of energy transfer from the heat source to the storage tank. The rate is calculated from: Qin = mdot,source * Cp * (Thot - Ttosource) (See manual for further information on equation)					
12	Average tank temperature	Temperature	C	real	[-Inf;+Inf]	0
	The average temperature of the fluid in the storage tank over the timestep.					
13	Temperature of node 1+	Temperature	C	real	[-Inf;+Inf]	0
	Temperature of node 1+ The temperature of the specified node.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
13-13		Besides the top and bottom nodes, how many other nodes are there?	1	98

DERIVATIVES

	Name	Dimension	Unit	Type	Range	Default
1	Initial temperature of node	Temperature	C	real	[-Inf;+Inf]	0
	The initial temperature of the specified node.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
1-1		How many temperature levels (nodes) should be used in the tank?	1	100

4.12.4.3. User-Designated Inlets - Non-uniform Losses

Icon		TRNSYS Model	Type 4
Proforma	Thermal Storage\Stratified Storage Tank\User-Designated Inlets\Non-uniform Losses\Type4f.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	User-specified inlet positions	Dimensionless	-	integer	[3;3]	3
	The auxiliary storage tank may operate in one of three modes in determining the inlet positions of the flow streams. Mode 3 indicates that the heat source flow enters the tank in the node specified by the user. The cold source flow also enters the tank at a user-specified location. Do not change this parameter.					
2	Tank volume	Volumetric Flow Rate	m^3	real	[0.0;+Inf]	0.35
	The actual volume of the storage tank (not the nominal value).					
3	Fluid specific heat	Specific Heat	kJ/kg.K	real	[0.0;+Inf]	4.190
	The specific heat of the fluid contained in the storage tank.					
4	Fluid density	Density	kg/m^3	real	[0.0;+Inf]	1000.0
	The density of the fluid contained in the storage tank.					
5	Tank loss coefficient (-)	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[-Inf;0.0]	-3.0
	The average tank loss coefficient per unit area. In this mode, the average tank loss coefficient should be entered as a negative number indicating to the general model that incremental U-values will be added to the average loss coefficient for each node.					
6	Height of node	Length	m	real	[0.0;+Inf]	0.05
	The height of the storage tank node in question. The total tank height will be determined by summing the heights of the nodes.					
7	Auxiliary heater mode	Dimensionless	-	integer	[1;2]	1
	The auxiliary heater may be operated in one of two modes: 1 = Master/Slave Relation: The lower heating element is only enabled when the upper heating element is satisified. In this mode, only one heater may be on at any instant of time. This is a common design in residential electric hot water tanks. 2 = Both Enabled: In this mode, both heaters may be on simultaneously. This allows for significantly quicker heating of the water, but at a much higher electrical demand.					
8	Node containing heating element 1	Dimensionless	-	integer	[1;100]	1
	The node containing the specified auxiliary heating element. Make sure that the specified node for the heater is between 1 and the total number of nodes specified. Node 1 is the topmost node in the tank.					
9	Node containing thermostat 1	Dimensionless	-	integer	[1;100]	1
	The node containing the thermostat for the specified auxiliary heater. The thermostat is typically either located in the same node as the heating element or in a node located above the element. Node 1 is the topmost node in the tank.					
10	Set point temperature for element 1	Temperature	C	real	[-Inf;+Inf]	55.0
	The set point temperature for the specified heating element. The thermostat will enable the heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb and continue to heat the fluid until it reaches the set point temperature. Tset = this parameter; Tdb = next parameter					
11	Deadband for heating element 1	Temp. Difference	deltaC	real	[-Inf;+Inf]	5.0
	The dead band temperature difference for the specified heating element. The thermostat will enable the					

	heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb and continue to heat the fluid until it reaches the set point temperature. Where Tset = previous parameter; Tdb = this parameter					
12	Maximum heating rate of element 1	Power	kJ/hr	real	[0.0;+Inf]	16200.0
	The maximum heating rate of the heating element. If the specified heating element is to not to be used for the simulation, set the maximum power to 0.					
13	Node containing heating element 2	Dimensionless	-	integer	[1;100]	1
	The node containing the specified auxiliary heating element. Make sure that the specified node for the heater is between 1 and the total number of nodes specified. Node 1 is the topmost node in the tank.					
14	Node containing thermostat 2	Dimensionless	-	integer	[1;100]	1
	The node containing the thermostat for the specified auxiliary heater. The thermostat is typically either located in the same node as the heating element or in a node located above the element. Node 1 is the topmost node in the tank.					
15	Set point temperature for element 2	Temperature	C	real	[-Inf;+Inf]	55.0
	The set point temperature for the specified heating element. The thermostat will enable the heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb and continue to heat the fluid until it reaches the set point temperature. Tset = this parameter; Tdb = next parameter					
16	Deadband for heating element 2	Temp. Difference	deltaC	real	[0.0;+Inf]	5.0
	The dead band temperature difference for the specified heating element. The thermostat will enable the heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb and continue to heat the fluid until it reaches the set point temperature. Where Tset = previous parameter; Tdb = this parameter					
17	Maximum heating rate of element 2	Power	kJ/hr	real	[0.0;+Inf]	16200
	The maximum heating rate of the heating element. If the specified heating element is to not to be used for the simulation, set the maximum power to 0.					
18	Not used (Flue UA)	Overall Loss Coefficient	W/K	real	[0.0;0.0]	0.0
	This parameter is not used in this mode of the storage tank.					
19	Not used (Tflue)	Temperature	C	real	[-Inf;+Inf]	20.0
	This parameter is not used in this mode of the storage tank.					
20	Boiling point	Temperature	C	real	[-Inf;+Inf]	100.0
	The boiling point temperature of the fluid in the storage tank. If the tank temperature reaches the boiling temperature, venting of steam is assumed to occur to keep the fluid at the boiling temperature. The venting is assumed to occur with negligible loss of mass.					
21	Entering node for hot-source flow	Dimensionless	-	integer	[1;100]	1
	The node that contains the hot-source inlet flow (Node 1 = top). Make sure that the specified node falls between node 1 and the total number of nodes specified.					
22	Entering node for cold-side fluid	Dimensionless	-	integer	[1;100]	5
	The node which contains the cold-side flow entrance (Node 1 = top). Make sure that the inlet location for this flow is between 1 and the total number of nodes specified.					
23	Incremental loss coefficient for node	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[-Inf;+Inf]	0
	The incremental loss coefficient for each node is used to specify nodes with differing loss coefficients from the average loss coefficient. The loss coefficient for the node will be:					

	Absolute Value(Parameter 5) + This Parameter Users can specify a positive or negative incremental loss coefficient for each node, but the calculated loss coefficient has to be greater than zero.

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
6-6		How many temperature levels (nodes) should be used in the tank?	1	15
23-23		How many temperature levels (nodes) should be used in the tank?	1	15

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Hot-side temperature	Temperature	C	real	[-Inf;+Inf]	45.0
	The temperature of the fluid flowing into the tank from the heat source. The inlet location for this hot-side fluid is specified in the parameter list.					
2	Hot-side flowrate	Flow Rate	kg/hr	real	[0.0;+Inf]	100.0
	The flowrate of fluid into the storage tank from the heat source. The hot-side fluid enters the tank in the node specified in the parameter list. An equal flowrate of fluid leaves the bottom of the storage tank for return to the heat source.					
3	Cold-side temperature	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the replacement fluid flowing into tank at the node specified in the parameter list.					
4	Cold-side flowrate	Flow Rate	kg/hr	real	[0.0;+Inf]	100.0
	The flowrate of replacement fluid flowing into the storage tank at the location specified in the parameter list. An equal amount of fluid is assumed to flow from the top of the tank to meet the load.					
5	Environment temperature	Temperature	C	real	[-Inf;+Inf]	22.0
	The temperature of the environment in which the storage tank is located.					
6	Control signal for element	Dimensionless	-	real	[0.0;1.0]	0.0
	The control signal for the specified auxiliary heating element. The available power for the heating element will be this input multiplied by the maximum power for the element. If an auxiliary heater is not desired for the simulation, set this input to a constant of 0.0 or set the maximum power for the element to 0.0					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
6-6		How many heating elements to be modeled in this tank?	2	2

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Temperature to heat source	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid flowing from the bottom of the storage tank and returning to the heat source (the bottom node temperature).					
2	Flowrate to heat source	Flow Rate	kg/hr	real	[-Inf;+Inf]	0
	The flow rate of hot-side fluid entering the storage tank in the location specified in the parameter list and exiting at the bottom of the storage tank to return to the heat source.					
3	Temperature to load	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid flowing from the top of the storage tank to the load (the top node temperature).					
4	Flowrate to load	Flow Rate	kg/hr	real	[-Inf;+Inf]	0
	The flowrate of cold-side fluid entering the tank at the location specified in the parameter list and leaving the tank at the top to meet the load.					
5	Thermal losses	Power	kJ/hr	real	[-Inf;+Inf]	0

	The rate of thermal energy loss to the environment. Includes the vented energy if a boiling condition is reached.					
6	Energy rate to load	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is removed from the tank to supply the load. The energy rate to the load is calculated by: Qload = mdot,load * Cp * (Ttop - Treplace) (See manual for further information on equation)					
7	Internal energy change	Energy	kJ	real	[-Inf;+Inf]	0
	The internal energy change of the tank relative to its initial condition. This output should not be integrated as it is an energy quantity and not an energy rate.					
8	Auxiliary heating rate	Power	kJ/hr	real	[-Inf;+Inf]	0
	The average rate at which power was added to the tank by BOTH auxiliary heaters.					
9	Element 1 power	Power	kJ/hr	real	[-Inf;+Inf]	0
	The average power supplied to the storage tank over the timestep by the first heating element specified in the parameter list.					
10	Element 2 power	Power	kJ/hr	real	[-Inf;+Inf]	0
	The average power over the timestep supplied to the tank by the second auxiliary heater specified in the parameter list.					
11	Energy rate from heat source	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate of energy transfer from the heat source to the storage tank. The rate is calculated from: Qin = mdot,source * Cp * (Thot - Ttosource) (See manual for further information on equation)					
12	Average tank temperature	Temperature	C	real	[-Inf;+Inf]	0
	The average temperature of the fluid in the storage tank over the timestep.					
13	Temperature of node 1+	Temperature	C	real	[-Inf;+Inf]	0
	Temperature of node 1+ The temperature of the specified node.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
13-13		Besides the top and bottom nodes, how many other nodes are there?	1	98

DERIVATIVES

	Name	Dimension	Unit	Type	Range	Default
1	Initial temperature of node	Temperature	C	real	[-Inf;+Inf]	0
	The initial temperature of the specified node.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
1-1		How many temperature levels (nodes) should be used in the tank?	1	100

4.12.4.4. User-Designated Inlets - Uniform Losses

Icon		TRNSYS Model	Type 4
Proforma	Thermal Storage\Stratified Storage Tank\User-Designated Inlets\Uniform Losses\Type4e.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	User-specified inlet positions	Dimensionless	-	integer	[3;3]	3
	The auxiliary storage tank may operate in one of three modes in determining the inlet positions of the flow streams. Mode 3 indicates that the heat source flow enters the tank in the node specified by the user. The cold source flow also enters the tank at a user-specified location. Do not change this parameter.					
2	Tank volume	Volumetric Flow Rate	m^3	real	[0.0;+Inf]	0.35
	The actual volume of the storage tank (not the nominal value).					
3	Fluid specific heat	Specific Heat	kJ/kg.K	real	[0.0;+Inf]	4.190
	The specific heat of the fluid contained in the storage tank.					
4	Fluid density	Density	kg/m^3	real	[0.0;+Inf]	1000.0
	The density of the fluid contained in the storage tank.					
5	Tank loss coefficient (-)	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[0.0;+Inf]	3.0
	The average tank loss coefficient per unit area.					
6	Height of node	Length	m	real	[0.0;+Inf]	0.05
	The height of the storage tank node in question. The total tank height will be determined by summing the heights of the nodes.					
7	Auxiliary heater mode	Dimensionless	-	integer	[1;2]	1
	The auxiliary heater may be operated in one of two modes: 1 = Master/Slave Relation: The lower heating element is only enabled when the upper heating element is satisified. In this mode, only one heater may be on at any instant of time. This is a common design in residential electric hot water tanks. 2 = Both Enabled: In this mode, both heaters may be on simultaneously. This allows for significantly quicker heating of the water, but at a much higher electrical demand.					
8	Node containing heating element 1	Dimensionless	-	integer	[1;100]	1
	The node containing the specified auxiliary heating element. Make sure that the specified node for the heater is between 1 and the total number of nodes specified. Node 1 is the topmost node in the tank.					
9	Node containing thermostat 1	Dimensionless	-	integer	[1;100]	1
	The node containing the thermostat for the specified auxiliary heater. The thermostat is typically either located in the same node as the heating element or in a node located above the element. Node 1 is the topmost node in the tank.					
10	Set point temperature for element 1	Temperature	C	real	[-Inf;+Inf]	55.0
	The set point temperature for the specified heating element. The thermostat will enable the heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb and continue to heat the fluid until it reaches the set point temperature. Tset = this parameter; Tdb = next parameter					
11	Deadband for heating element 1	Temp. Difference	deltaC	real	[-Inf;+Inf]	5.0
	The dead band temperature difference for the specified heating element. The thermostat will enable the heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb					

	and continue to heat the fluid until it reaches the set point temperature. Where Tset = previous parameter; Tdb = this parameter					
12	Maximum heating rate of element 1	Power	kJ/hr	real	[0.0;+Inf]	16200.0
	The maximum heating rate of the heating element. If the specified heating element is to not to be used for the simulation, set the maximum power to 0.					
13	Node containing heating element 2	Dimensionless	-	integer	[1;100]	1
	The node containing the specified auxiliary heating element. Make sure that the specified node for the heater is between 1 and the total number of nodes specified. Node 1 is the topmost node in the tank.					
14	Node containing thermostat 2	Dimensionless	-	integer	[1;100]	1
	The node containing the thermostat for the specified auxiliary heater. The thermostat is typically either located in the same node as the heating element or in a node located above the element. Node 1 is the topmost node in the tank.					
15	Set point temperature for element 2	Temperature	C	real	[-Inf;+Inf]	55.0
	The set point temperature for the specified heating element. The thermostat will enable the heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb and continue to heat the fluid until it reaches the set point temperature. Tset = this parameter; Tdb = next parameter					
16	Deadband for heating element 2	Temp. Difference	deltaC	real	[0.0;+Inf]	5.0
	The dead band temperature difference for the specified heating element. The thermostat will enable the heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb and continue to heat the fluid until it reaches the set point temperature. Where Tset = previous parameter; Tdb = this parameter					
17	Maximum heating rate of element 2	Power	kJ/hr	real	[0.0;+Inf]	16200
	The maximum heating rate of the heating element. If the specified heating element is to not to be used for the simulation, set the maximum power to 0.					
18	Not used (Flue UA)	Overall Loss Coefficient	W/K	real	[0.0;0.0]	0.0
	This parameter is not used in this mode of the storage tank.					
19	Not used (Tflue)	Temperature	C	real	[-Inf;+Inf]	20.0
	This parameter is not used in this mode of the storage tank.					
20	Boiling point	Temperature	C	real	[-Inf;+Inf]	100.0
	The boiling point temperature of the fluid in the storage tank. If the tank temperature reaches the boiling temperature, venting of steam is assumed to occur to keep the fluid at the boiling temperature. The venting is assumed to occur with negligible loss of mass.					
21	Entering node for hot-source flow	Dimensionless	-	integer	[1;100]	1
	The node that contains the hot-source inlet flow (Node 1 = top). Make sure that the specified node falls between node 1 and the total number of nodes specified.					
22	Entering node for cold-side fluid	Dimensionless	-	integer	[1;100]	5
	The node which contains the cold-side flow entrance (Node 1 = top). Make sure that the inlet location for this flow is between 1 and the total number of nodes specified.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
6-6		How many temperature levels (nodes) should be used in the	1	100

		tank?		

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Hot-side temperature	Temperature	C	real	[-Inf;+Inf]	45.0
	The temperature of the fluid flowing into the tank from the heat source. The inlet location for this hot-side fluid is specified in the parameter list.					
2	Hot-side flowrate	Flow Rate	kg/hr	real	[0.0;+Inf]	100.0
	The flowrate of fluid into the storage tank from the heat source. The hot-side fluid enters the tank in the node specified in the parameter list. An equal flowrate of fluid leaves the bottom of the storage tank for return to the heat source.					
3	Cold-side temperature	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the replacement fluid flowing into tank at the node specified in the parameter list.					
4	Cold-side flowrate	Flow Rate	kg/hr	real	[0.0;+Inf]	100.0
	The flowrate of replacement fluid flowing into the storage tank at the location specified in the parameter list. An equal amount of fluid is assumed to flow from the top of the tank to meet the load.					
5	Environment temperature	Temperature	C	real	[-Inf;+Inf]	22.0
	The temperature of the environment in which the storage tank is located.					
6	Control signal for element	Dimensionless	-	real	[0.0;1.0]	0.0
	The control signal for the specified auxiliary heating element. The available power for the heating element will be this input multiplied by the maximum power for the element. If an auxiliary heater is not desired for the simulation, set this input to a constant of 0.0 or set the maximum power for the element to 0.0					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
6-6		How many heating elements to be modeled in this tank?	2	2

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Temperature to heat source	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid flowing from the bottom of the storage tank and returning to the heat source (the bottom node temperature).					
2	Flowrate to heat source	Flow Rate	kg/hr	real	[-Inf;+Inf]	0
	The flow rate of hot-side fluid entering the storage tank in the location specified in the parameter list and exiting at the bottom of the storage tank to return to the heat source.					
3	Temperature to load	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid flowing from the top of the storage tank to the load (the top node temperature).					
4	Flowrate to load	Flow Rate	kg/hr	real	[-Inf;+Inf]	0
	The flowrate of cold-side fluid entering the tank at the location specified in the parameter list and leaving the tank at the top to meet the load.					
5	Thermal losses	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate of thermal energy loss to the environment. Includes the vented energy if a boiling condition is reached.					
6	Energy rate to load	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is removed from the tank to supply the load. The energy rate to the load is calculated by: Qload = mdot,load * Cp * (Ttop - Treplace) (See manual for further information on equation)					
7	Internal energy change	Energy	kJ	real	[-Inf;+Inf]	0
	The internal energy change of the tank relative to its initial condition. This output should not be integrated as it is an energy quantity and not an energy rate.					

8	Auxiliary heating rate	Power	kJ/hr	real	[-Inf;+Inf]	0
	The average rate at which power was added to the tank by BOTH auxiliary heaters.					
9	Element 1 power	Power	kJ/hr	real	[-Inf;+Inf]	0
	The average power supplied to the storage tank over the timestep by the first heating element specified in the parameter list.					
10	Element 2 power	Power	kJ/hr	real	[-Inf;+Inf]	0
	The average power over the timestep supplied to the tank by the second auxiliary heater specified in the parameter list.					
11	Energy rate from heat source	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate of energy transfer from the heat source to the storage tank. The rate is calculated from: Qin = mdot,source * Cp * (Thot - Ttosource) (See manual for further information on equation)					
12	Average tank temperature	Temperature	C	real	[-Inf;+Inf]	0
	The average temperature of the fluid in the storage tank over the timestep.					
13	Temperature of node 1+	Temperature	C	real	[-Inf;+Inf]	0
	Temperature of node 1+ The temperature of the specified node.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
13-13		Besides the top and bottom nodes, how many other nodes are there?	1	98

DERIVATIVES

	Name	Dimension	Unit	Type	Range	Default
1	Initial temperature of node	Temperature	C	real	[-Inf;+Inf]	0
	The initial temperature of the specified node.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
1-1		How many temperature levels (nodes) should be used in the tank?	1	100

4.12.4.5. Variable Inlets - Non-uniform Losses

Icon		TRNSYS Model	Type 4
Proforma	Thermal Storage\Stratified Storage Tank\Variable Inlets\Non-uniform Losses\Type4d.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Variable inlet positions	Dimensionless	-	integer	[2;2]	2
	The auxiliary storage tank may operate in one of three modes in determining the inlet positions of the flow streams. Mode 2 indicates that both the heat source flow and replacement fluid flow enter the tank in the node closest in temperature to the respective inlet temperatures. With sufficient nodes, this permits a maximum degree of stratification. Do not change this parameter.					
2	Tank volume	Volumetric Flow Rate	m^3	real	[0.0;+Inf]	0.35
	The actual volume of the storage tank (not the nominal value).					
3	Fluid specific heat	Specific Heat	kJ/kg.K	real	[0.0;+Inf]	4.190
	The specific heat of the fluid contained in the storage tank.					
4	Fluid density	Density	kg/m^3	real	[0.0;+Inf]	1000.0
	The density of the fluid contained in the storage tank.					
5	Tank loss coefficient (-)	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[-Inf;0.0]	-3.0
	The average tank loss coefficient per unit area. In this mode, the average tank loss coefficient should be entered as a negative number indicating to the general model that incremental U-values will be added to the average loss coefficient for each node.					
6	Height of node	Length	m	real	[0.0;+Inf]	0.05
	The height of the storage tank node in question. The total tank height will be determined by summing the heights of the nodes.					
7	Auxiliary heater mode	Dimensionless	-	integer	[1;2]	1
	The auxiliary heater may be operated in one of two modes: 1 = Master/Slave Relation: The lower heating element is only enabled when the upper heating element is satisified. In this mode, only one heater may be on at any instant of time. This is a common design in residential electric hot water tanks. 2 = Both Enabled: In this mode, both heaters may be on simultaneously. This allows for significantly quicker heating of the water, but at a much higher electrical demand.					
8	Node containing heating element	Dimensionless	-	integer	[1;100]	1
	The node containing the specified auxiliary heating element. Make sure that the specified node for the heater is between 1 and the total number of nodes specified. Node 1 is the topmost node in the tank.					
9	Node containing thermostat	Dimensionless	-	integer	[1;100]	1
	The node containing the thermostat for the specified auxiliary heater. The thermostat is typically either located in the same node as the heating element or in a node located above the element. Node 1 is the topmost node in the tank.					
10	Set point temperature for element	Temperature	C	real	[-Inf;+Inf]	55.0
	The set point temperature for the specified heating element. The thermostat will enable the heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb and continue to heat the fluid until it reaches the set point temperature. Tset = this parameter; Tdb = next parameter					
11	Deadband for heating element	Temp. Difference	deltaC	real	[-Inf;+Inf]	5.0
	The dead band temperature difference for the specified heating element. The thermostat will enable the					

	heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb and continue to heat the fluid until it reaches the set point temperature. Where Tset = previous parameter; Tdb = this parameter					
12	Maximum heating rate of element	Power	kJ/hr	real	[0.0;+Inf]	16200.0
	The maximum heating rate of the heating element. If the specified heating element is to not to be used for the simulation, set the maximum power to 0.					
13	Not used (Flue UA)	Overall Loss Coefficient	W/K	real	[0.0;0.0]	0.0
	This parameter is not used in this mode of the storage tank.					
14	Not used (Tflue)	Temperature	C	real	[-Inf;+Inf]	20.0
	This parameter is not used in this mode of the storage tank.					
15	Boiling point	Temperature	C	real	[-Inf;+Inf]	100.0
	The boiling point temperature of the fluid in the storage tank. If the tank temperature reaches the boiling temperature, venting of steam is assumed to occur to keep the fluid at the boiling temperature. The venting is assumed to occur with negligible loss of mass.					
16	Incremental loss coefficient for node	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[-Inf;+Inf]	0
	The incremental loss coefficient for each node is used to specify nodes with differing loss coefficients from the average loss coefficient. The loss coefficient for the node will be: Absolute Value(Parameter 5) + This Parameter Users can specify a positive or negative incremental loss coefficient for each node, but the calculated loss coefficient has to be greater than zero.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
6-6		How many temperature levels (nodes) should be used in the tank?	1	100
8-12		How many heating elements to be modeled in this tank?	2	2
16-16		How many temperature levels (nodes) should be used in the tank?	1	100

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Hot-side temperature	Temperature	C	real	[-Inf;+Inf]	45.0
	The temperature of the fluid flowing into the tank from the heat source. The inlet location for this hot-side fluid is the node closest in temperature to the inlet temperature.					
2	Hot-side flowrate	Flow Rate	kg/hr	real	[0.0;+Inf]	100.0
	The flowrate of fluid into the storage tank from the heat source. The hot-side fluid enters the tank in the node closest in temperature to the temperature of the hot-source stream. An equal flowrate of fluid leaves the bottom of the storage tank for return to the heat source.					
3	Cold-side temperature	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the replacement fluid entering the storage tank. The replacement fluid will enter the tank in the node which is closest in temperature to this cold-side temperature.					
4	Cold-side flowrate	Flow Rate	kg/hr	real	[0.0;+Inf]	100.0
	The flowrate of replacement fluid flowing into storage tank. The fluid will enter the storage tank in the node which is closest in temperature to the temperature of the cold-side flow. An equal amount of fluid is assumed to flow from the top of the tank to meet the load.					
5	Environment temperature	Temperature	C	real	[-Inf;+Inf]	22.0
	The temperature of the environment in which the storage tank is located.					
6	Control signal for element	Dimensionless	-	real	[0.0;1.0]	0.0

	The control signal for the specified auxiliary heating element. The available power for the heating element will be this input multiplied by the maximum power for the element. If an auxiliary heater is not desired for the simulation, set this input to a constant of 0.0 or set the maximum power for the element to 0.0

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
6-6		How many heating elements to be modeled in this tank?	2	2

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Temperature to heat source	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid flowing from the bottom of the storage tank and returning to the heat source (the bottom node temperature).					
2	Flowrate to heat source	Flow Rate	kg/hr	real	[-Inf;+Inf]	0
	The flow rate of hot-side fluid entering the storage tank at the node closest in temperature and exiting at the bottom of the storage tank to return to the heat source.					
3	Temperature to load	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid flowing from the top of the storage tank to the load (the temperature of the top node).					
4	Flowrate to load	Flow Rate	kg/hr	real	[-Inf;+Inf]	0
	The flowrate of cold-side fluid entering the tank at the node closest in temperature and leaving the tank at the top to meet the load.					
5	Thermal losses	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate of thermal energy loss to the environment. Includes the vented energy if a boiling condition is reached.					
6	Energy rate to load	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is removed from the tank to supply the load. The energy rate to the load is calculated by: Qload = mdot,load * Cp * (Ttop - Treplace) (See manual for further information on equation)					
7	Internal energy change	Energy	kJ	real	[-Inf;+Inf]	0
	The internal energy change of the tank relative to its initial condition. This output should not be integrated as it is an energy quantity and not an energy rate.					
8	Auxiliary heating rate	Power	kJ/hr	real	[-Inf;+Inf]	0
	The average rate at which power was added to the tank by BOTH auxiliary heaters.					
9	Element 1 power	Power	kJ/hr	real	[-Inf;+Inf]	0
	The average power supplied to the storage tank over the timestep by the first heating element specified in the parameter list.					
10	Element 2 power	Power	kJ/hr	real	[-Inf;+Inf]	0
	The average power over the timestep supplied to the tank by the second auxiliary heater specified in the parameter list.					
11	Energy rate from heat source	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate of energy transfer from the heat source to the storage tank. The rate is calculated from: Qin = mdot,source * Cp * (Thot - Ttosource) (See manual for further information on equation)					
12	Average tank temperature	Temperature	C	real	[-Inf;+Inf]	0
	The average temperature of the fluid in the storage tank over the timestep.					
13	Temperature of node 1+	Temperature	C	real	[-Inf;+Inf]	0
	Temperature of node 1+ The temperature of the specified node.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
13-13		Besides the top and bottom nodes, how many other nodes are there?	1	98

DERIVATIVES

	Name	Dimension	Unit	Type	Range	Default
1	Initial temperature of node	Temperature	C	real	[-Inf;+Inf]	0
	The initial temperature of the specified node.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
1-1		How many temperature levels (nodes) should be used in the tank?	1	100

4.12.4.6. Variable Inlets - Uniform Losses

Icon		TRNSYS Model	Type 4
Proforma	Thermal Storage\Stratified Storage Tank\Variable Inlets\Uniform Losses\Type4c.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Variable inlet positions	Dimensionless	-	integer	[2;2]	2
	The auxiliary storage tank may operate in one of three modes in determining the inlet positions of the flow streams. Mode 2 indicates that the heat source flow and the cold-side flow enter the tank in the nodes closest in temperature to the temperature of the respective flows. With a sufficient number of nodes, this permits a maximum degree of stratification. Do not change this parameter.					
2	Tank volume	Volumetric Flow Rate	m^3	real	[0.0;+Inf]	0.35
	The actual volume of the storage tank (not the nominal value).					
3	Fluid specific heat	Specific Heat	kJ/kg.K	real	[0.0;+Inf]	4.190
	The specific heat of the fluid contained in the storage tank.					
4	Fluid density	Density	kg/m^3	real	[0.0;+Inf]	1000.0
	The density of the fluid contained in the storage tank.					
5	Tank loss coefficient	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[0.0;+Inf]	3.0
	The average tank loss coefficient per unit area.					
6	Height of node	Length	m	real	[0.0;+Inf]	0.05
	The height of the storage tank node in question. The total tank height will be determined by summing the heights of the nodes.					
7	Auxiliary heater mode	Dimensionless	-	integer	[1;2]	1
	The auxiliary heater may be operated in one of two modes: 1 = Master/Slave Relation: The lower heating element is only enabled when the upper heating element is satisified. In this mode, only one heater may be on at any instant of time. This is a common design in residential electric hot water tanks. 2 = Both Enabled: In this mode, both heaters may be on simultaneously. This allows for significantly quicker heating of the water, but at a much higher electrical demand.					
8	Node containing heating element	Dimensionless	-	integer	[1;100]	1
	The node containing the specified auxiliary heating element. Make sure that the specified node for the heater is between 1 and the total number of nodes specified. Node 1 is the topmost node in the tank.					
9	Node containing thermostat	Dimensionless	-	integer	[1;100]	1
	The node containing the thermostat for the specified auxiliary heater. The thermostat is typically either located in the same node as the heating element or in a node located above the element. Node 1 is the topmost node in the tank.					
10	Set point temperature for element	Temperature	C	real	[-Inf;+Inf]	55.0
	The set point temperature for the specified heating element. The thermostat will enable the heating element when the temperature of the fluid in the node containing the thermostat falls below: Tset - Tdb and continue to heat the fluid until it reaches the set point temperature. Tset = this parameter; Tdb = next parameter					
11	Deadband for heating element	Temp. Difference	deltaC	real	[-Inf;+Inf]	5.0
	The dead band temperature difference for the specified heating element. The thermostat will enable the heating element when the temperature of the fluid in the node containing the thermostat falls below:					

	Tset - Tdb and continue to heat the fluid until it reaches the set point temperature. Where Tset = previous parameter; Tdb = this parameter					
12	Maximum heating rate of element	Power	kJ/hr	real	[0.0;+Inf]	16200.0
	The maximum heating rate of the heating element. If the specified heating element is to not to be used for the simulation, set the maximum power to 0.					
13	Not used (Flue UA)	Overall Loss Coefficient	W/K	real	[0.0;0.0]	0.0
	This parameter is not used in this mode of the storage tank.					
14	Not used (Tflue)	Temperature	C	real	[-Inf;+Inf]	20.0
	This parameter is not used in this mode of the storage tank.					
15	Boiling point	Temperature	C	real	[-Inf;+Inf]	100.0
	The boiling point temperature of the fluid in the storage tank. If the tank temperature reaches the boiling temperature, venting of steam is assumed to occur to keep the fluid at the boiling temperature. The venting is assumed to occur with negligible loss of mass.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
6-6		How many temperature levels (nodes) should be used in the tank?	1	100
8-12		How many heating elements to be modeled in this tank?	2	2

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Hot-side temperature	Temperature	C	real	[-Inf;+Inf]	45.0
	The temperature of the fluid flowing into the tank from the heat source. The inlet location for this hot-side fluid is the node closest in temperature to the temperature of the hot-side flow.					
2	Hot-side flowrate	Flow Rate	kg/hr	real	[0.0;+Inf]	100.0
	The flowrate of fluid into the storage tank from the heat source. The hot-side fluid enters the storage tank in the node closest in temperature to the temperature of the hot-side flow. An equal flowrate of fluid leaves the bottom of the storage tank forreturn to the heat source.					
3	Cold-side temperature	Temperature	C	real	[-Inf;+Inf]	20.0
	The temperature of the replacement fluid flowing into the storage tank. The flow will enter the tank in the node which is closest in temperature to the cold-side flow.					
4	Cold-side flowrate	Flow Rate	kg/hr	real	[0.0;+Inf]	100.0
	The flowrate of replacement fluid flowing into the storage tank. The flow will enter the tank in the node which is closest in temperature to this cold-side flow. An equal amount of fluid is assumed to flow from the top of the tank to meet the load.					
5	Environment temperature	Temperature	C	real	[-Inf;+Inf]	22.0
	The temperature of the environment in which the storage tank is located.					
6	Control signal for element	Dimensionless	-	real	[0.0;1.0]	0.0
	The control signal for the specified auxiliary heating element. The available power for the heating element will be this input multiplied by the maximum power for the element. If an auxiliary heater is not desired for the simulation, set this input to a constant of 0.0 or set the maximum power for the element to 0.0					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
6-6		How many heating elements to be modeled in this tank?	2	2

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Temperature to heat source	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid flowing from the bottom of the storage tank and returning to the heat source (the bottom node temperature).					
2	Flowrate to heat source	Flow Rate	kg/hr	real	[-Inf;+Inf]	0
	The flow rate of fluid entering the storage tank in the node closest in temperature and exiting at the bottom of the storage tank to return to the heat source.					
3	Temperature to load	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid flowing from the top of the storage tank to the load (the top node temperature).					
4	Flowrate to load	Flow Rate	kg/hr	real	[-Inf;+Inf]	0
	The flowrate of fluid entering the tank at the node closest in temperature and leaving the tank at the top to meet the load.					
5	Thermal losses	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate of thermal energy loss to the environment. Includes the vented energy if a boiling condition is reached.					
6	Energy rate to load	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is removed from the tank to supply the load. The energy rate to the load is calculated by: Qload = mdot,load * Cp * (Ttop - Treplace) (See manual for further information on equation)					
7	Internal energy change	Energy	kJ	real	[-Inf;+Inf]	0
	The internal energy change of the tank relative to its initial condition. This output should not be integrated as it is an energy quantity and not an energy rate.					
8	Auxiliary heating rate	Power	kJ/hr	real	[-Inf;+Inf]	0
	The average rate at which power was added to the tank by BOTH auxiliary heaters.					
9	Element 1 power	Power	kJ/hr	real	[-Inf;+Inf]	0
	The average power supplied to the storage tank over the timestep by the first heating element specified in the parameter list.					
10	Element 2 power	Power	kJ/hr	real	[-Inf;+Inf]	0
	The average power over the timestep supplied to the tank by the second auxiliary heater specified in the parameter list.					
11	Energy rate from heat source	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate of energy transfer from the heat source to the storage tank. The rate is calculated from: Qin = mdot,source * Cp * (Thot - Ttosource) (See manual for further information on equation)					
12	Average tank temperature	Temperature	C	real	[-Inf;+Inf]	0
	The average temperature of the fluid in the storage tank over the timestep.					
13	Temperature of node 1+	Temperature	C	real	[-Inf;+Inf]	0
	Temperature of node 1+ The temperature of the specified node.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
13-13		Besides the top and bottom nodes, how many other nodes are there?	1	98

DERIVATIVES

	Name	Dimension	Unit	Type	Range	Default
1	Initial temperature of node	Temperature	C	real	[-Inf;+Inf]	0
	The initial temperature of the specified node.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
1-1		How many temperature levels (nodes) should be used in the tank?	1	100

4.12.5. Variable Volume Tank

4.12.5.1. Variable Volume Tank

Icon		**TRNSYS Model**	Type 39
Proforma	Thermal Storage\Variable Volume Tank\Type39.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Tank operation mode	Dimensionless	-	integer	[1;2]	2
	The operation mode of the storage tank when a full condition is reched: 1 ---> Recirculate the fluid if the tank is full 2 ---> Divert the fluid stream if the tank is full					
2	Overall tank volume	Volumetric Flow Rate	m^3	real	[0.0;+Inf]	20.0
	The overall volume of the storage tank.					
3	Minimum fluid volume	Volumetric Flow Rate	m^3	real	[0.0;+Inf]	1.0
	The minimum volume of fluid allowed in the storage tank before the load is modulated to maintain this minimum volume.					
4	Maximum fluid volume	Volumetric Flow Rate	m^3	real	[0.0;+Inf]	18.0
	The maximum volume of fluid allowed in the storage tank before the fluid stream is either recirculated or diverted.					
5	Tank circumference	Length	m	real	[0.0;+Inf]	15.0
	The circumference of the storage tank.					
6	Cross-sectional area	Area	m^2	real	[0.0;+Inf]	4.0
	The cross-sectional area of the variable volume storage tank.					
7	Wetted loss coefficient	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[0.0;+Inf]	6.0
	The loss coefficient of that part of the tank which is in contact with the fluid.					
8	Dry loss coefficient	Heat Transfer Coeff.	kJ/hr.m^2.K	real	[0.0;+Inf]	4.0
	The heat transfer coeficient of that part of the tank which is not in contact with the fluid.					
9	Fluid specific heat	Specific Heat	kJ/kg.K	real	[0.0;+Inf]	4.190
	The specific heat of the fluid contained in the storage tank.					
10	Fluid density	Density	kg/m^3	real	[0.0;+Inf]	1000.0
	The density of the fluid contained in the storage tank.					
11	Initial fluid temperature	Temperature	C	real	[-Inf;+Inf]	22.0
	The temperature of the fluid in the storage tank at the beginning of the simulation.					
12	Initial fluid volume	Volumetric Flow Rate	m^3	real	[0.0;+Inf]	5.0
	The volume of the fluid in the storage tank at the beginning of the simulation.					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Inlet temperature	Temperature	C	real	[-Inf;+Inf]	25.0
	The temperature of the fluid entering the storage tank.					
2	Inlet flow rate	Flow Rate	kg/hr	real	[0.0;+Inf]	100.0
	The flow rate of fluid entering the storage tank.					

3	Flow rate to load	Flow Rate	kg/hr	real	[0.0;+Inf]	75.0
	The flow rate required by the load which is to be met by the storage tank.					
4	Environment temperature	Temperature	C	real	[-Inf;+Inf]	15.0
	The temperature of the environment in which the storage tank is located.					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Fluid temperature	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the fluid contained in the storage tank.					
2	Load flow rate	Flow Rate	kg/hr	real	[-Inf;+Inf]	0
	The flow rate of fluid exiting the storage tank to meet the load. Note - this may be different than the desired load flow rate due to minimum and maximum volume considerations.					
3	Excess flow temperature	Temperature	C	real	[-Inf;+Inf]	0
	The temperature of the recirculated flow stream (mode 1) or the diverted flow stream (mode 2) if a maximum volume condition is reached.					
4	Excess flow rate	Flow Rate	kg/hr	real	[-Inf;+Inf]	0
	The flow rate of fluid that is either recirculated (mode 1) or diverted (mode 2) due to a maximum volume condition being reached.					
5	Fluid volume	Volumetric Flow Rate	m^3	real	[-Inf;+Inf]	0
	The volume of fluid in the storage tank.					
6	Enthalpy difference	Power	kJ/hr	real	[-Inf;+Inf]	0
	The difference in enthalpies of the outgoing and the incoming flow streams.					
7	Environment losses	Power	kJ/hr	real	[-Inf;+Inf]	0
	The rate at which energy is transferred to the environment from the storage tank.					
8	Internal energy change	Energy	kJ	real	[-Inf;+Inf]	0
	The change in internal energy of the tank relative to the beginning of the simulation. This term is an energy quantity and not an energy rate and should not be integrated.					
9	Level indicator	Dimensionless	-	integer	[-Inf;+Inf]	0
	The level indicator for the storage tank: -1 ---> Tank fluid is at minimum level 0 ---> Tank fluid is somewhere between minimum and maximum levels 1 ---> Tank fluid is at maximum level					

4.13. Utility

4.13.1. Calling External Programs

4.13.1.1. COMIS

Icon		**TRNSYS Model**	Type 157
Proforma	Utility\Calling External Programs\COMIS\Type157.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Number of Zones	Dimensionless	-	real	[0;+Inf]	1
2	Number of links w/schedules	Dimensionless	-	real	[0;+Inf]	0
3	CIF Seq. Num. of link with TRNSYS schedule	Dimensionless	-	real	[0;+Inf]	0
	CIF Sequence Number of the link with TRNSYS defined schedule					
4	Number of Source Schedules	Dimensionless	-	real	[0;+Inf]	0
5	Source Schedule	Dimensionless	-	real	[-Inf;+Inf]	0
	Source Schedule Format: Pnr. Znr Pnr: Number of the pollutant for which the TRNSYS defined source schedule is applied. Znr: CIF sequence number of the first zone with TRNSYS defined pollutant source schedule.					
6	Number of Sink Schedules	Dimensionless	-	real	[0;+Inf]	0
7	Sink Schedule	Dimensionless	-	real	[-Inf;+Inf]	0
	Sink Schedule Format: Pnr.Znr Pnr : Number of the pollutant for which the TRNSYS defined sink schedule is applied. Znr : CIF sequence number of the first zone with TRNSYS defined pollutant sink schedule.					
8	Number of Outputs	Dimensionless	-	real	[0;+Inf]	0
9	Output Indices for output	Dimensionless	-	real	[-Inf;+Inf]	0
	Output Indicator Format: OI1.OI2 Pairs Output Indicator Format= OI1:OI2 OI1>0 Fma Coupling flow from zone OI1 to zone OI2 [kg/h] OI1=-1 Inf Infiltration into zone OI2 [ach/hr] OI1=-2 VIn Ventilation supply into zone OI2 [ach/h] OI1=-3 Exf Exfiltration from Zone OI2 [ach/h] OI1=-4 VOut Ventilation exhaust from zone OI2 [ach/h] OI1<-10 C Concentration of pollutant nr. (-OI1-10) in zone OI2 (See manual for examples.)					
10	Logical unit for Comis input file	Dimensionless	-	real	[15;99]	40
11	Logical unit for comis output file	Dimensionless	-	real	[15;99]	41

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
3-3	Number of links w/schedules		1	50
5-5	Number of Source Schedules		1	50
7-7	Number of Sink Schedules		1	50
9-9	Number of Outputs		1	50

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Wind Speed	Velocity	m/s	real	[-Inf;+Inf]	2
2	Wind Direction	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
	Comis requires N=0°, E=90°,… (see User manual http://www-epb.lbl.gov/comis/composite.pdf)					
3	Ambient Temp.	Temperature	C	real	[-Inf;+Inf]	20
4	Absolute Humidity	any	any	real	[0;+Inf]	0.005
5	Abs. Ambient Pressure	Pressure	Pa	real	[-Inf;+Inf]	98800
6	Amb. Conc. Pollutant 1	any	any	real	[0;+Inf]	0
7	Amb. Conc. Pollutant 2	any	any	real	[0;+Inf]	0
8	Amb. Conc. Pollutant 3	any	any	real	[0;+Inf]	0
9	Amb. Conc. Pollutant 4	any	any	real	[0;+Inf]	0
10	Amb. Conc. Pollutant 5	any	any	real	[0;+Inf]	0
11	Air Temp. in Zone	Temperature	C	real	[-Inf;+Inf]	20
12	'Actual Factor' for links with schedules	Dimensionless	-	real	[-Inf;+Inf]	0
	'Actual Factor' for links with schedules [-]					
13	'Actual Factor' for source with schedule*	Dimensionless	-	real	[-Inf;+Inf]	0
	'Actual Factor' for the pollutant sources with schedules [-]					
14	'Actual Factor' for sinks with schedules	Dimensionless	-	real	[-Inf;+Inf]	0
	'Actual Factor' for the pollutant sinks with schedules [-]					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
11-11	Number of Zones		1	50
12-12	Number of links w/schedules		1	50
13-13	Number of Source Schedules		1	50
14-14	Number of Sink Schedules		1	50

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Output (from parameters)	Dimensionless	-	real	[-Inf;+Inf]	0
	Output : according to the corresponding OI1.OI2 pair Format: OI1>0 Fma Coupling flow from zone OI1 to zone OI2 [kg/h] OI1=-1 Inf Infiltration into Zone OI2 [ach/h] OI1=-2 VIn Ventilation supply into zone OI2 [ach/h] OI1=-3 Exf Exfiltration from zone OI2 [ach/h] OI1=-4 VOut Ventilation exhaust from zone OI2 [ach/h] OI1<-10 C Concentration of pollutant nr. (-OI1-10) in zone OI2 (See manual for examples.)					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
1-1	Number of Outputs		1	50

EXTERNAL FILES

Question	File	Associated parameter
Name of comis input file		Logical unit for Comis input file
Name of Comis Output file		Logical unit for comis output file
Source file	.\SourceCode\Types\comv-trn3.for	

4.13.1.2. CONTAM

Icon		TRNSYS Model	Type 97
Proforma	Utility\Calling External Programs\CONTAM\Type97.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	CONTAM building model input file (*.air)	Dimensionless	-	integer	[40;+Inf]	0

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Temperature of zone	Temperature	C	real	[-Inf;+Inf]	0
2	Ambient Temperature	Temperature	C	real	[-Inf;+Inf]	0
3	Barometric Pressure	Pressure	Pa	real	[-Inf;+Inf]	0
4	Wind Speed	Velocity	m/s	real	[-Inf;+Inf]	0
5	Wind Direction	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
	N=0°, E = 90° (see user manual http://www.bfrl.nist.gov/IAQanalysis/CONTAM/)					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
1-1		How many zones are modeled in CONTAM ?	1	100

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Output	any	any	real	[-Inf;+Inf]	0

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
1-1		How many outputs provided by CONTAM ?	1	100

EXTERNAL FILES

Question	File	Associated parameter
CONTAM building model input file (*.air)		CONTAM building model input file (*.air)
Source file	.\SourceCode\Types\Type97.for	

4.13.1.3. EES - Call EES EveryTime

Icon		TRNSYS Model	Type 66
Proforma	Utility\Calling External Programs\EES\Call EES EveryTime\Type66a.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Input mode	Dimensionless	-	integer	[1;1]	0
	This parameter specifies how the EES model will be called. If set to 1, the EES model will be called at every time step and at every iteration. If set to 2, the first input is a control signal. The first input will not be sent to EES. Please refer to parameter 2 for information on the various ways that outputs can be treated in Input mode 2.					
2	not used	Dimensionless	-	real	[1;1]	0
	This parameter is only used in Input mode 2 (parameter 1 set to 2). In Input mode 2, the first input is not sent to EES but is a control signal. When that control signal is set to 0, the EES model will not be called. This parameter determines how outputs will be treated when the EES model is not called. 1: outputs are set to 0 if Input Mode is 2 and the first input is 0 2: outputs are set to predefined (parameter) values if Input Mode is 2 and the first input is 0 3: output values are held from the previous time step if Input Mode is 2 and the first input is 0					
3	Allowable wait	Time	s	real	[0;+Inf]	0
	The allowable amount of time that TRNSYS will allow EES before deciding that EES is non responsive. (Not implemented yet)					
4	Number of ouputs	Dimensionless	-	integer	[0;+Inf]	0
	The number of outputs that EES will be returning					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Input	any	any	real	[-Inf;+Inf]	0

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
1-1		How many INPUTS does the EES model require?	1	50

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Output	any	any	real	[-Inf;+Inf]	0

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
1-1	Number of ouputs		1	50

SPECIAL CARDS

Name	Question	Answer
LABELS 2	2 Labels are required (Do not Edit)	2
	Where is EES located?	
	Where is the EES file to be run located?	

4.13.1.4. EES - First Input is a Control Signal - Hold Last Calculated Values when OFF

Icon		TRNSYS Model	Type 66
Proforma	Utility\Calling External Programs\EES\First Input is a Control Signal\Hold Last Calculated Values when OFF\Type66d.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Input mode	Dimensionless	-	integer	[2;2]	0
	This parameter specifies how the EES model will be called. If set to 1, the EES model will be called at every time step and at every iteration. If set to 2, the first input is a control signal. The first input will not be sent to EES. Please refer to parameter 2 for information on the various ways that outputs can be treated in Input mode 2.					
2	Output mode	Dimensionless	-	integer	[3;3]	0
	This parameter is only used in Input mode 2 (parameter 1 set to 2). In Input mode 2, the first input is not sent to EES but is a control signal. When that control signal is set to 0, the EES model will not be called. This parameter determines how outputs will be treated when the EES model is not called. 1: outputs are set to 0 if Input Mode is 2 and the first input is 0 2: outputs are set to predefined (parameter) values if Input Mode is 2 and the first input is 0 3: output values are held from the previous time step if Input Mode is 2 and the first input is 0					
3	Allowable wait	Time	s	real	[0;+Inf]	0
	The allowable amount of time that TRNSYS will allow EES before deciding that EES is non responsive. (Not implemented yet)					
4	Number of ouputs	Dimensionless	-	integer	[0;+Inf]	0
	The number of outputs that EES will be returning					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Control signal	Dimensionless	-	real	[0;1]	0
	If this input is set to 0, the EES model will not be called at the current time step. The output mode (parameter 2) determines how the outputs normally generated by EES will be treated when the EES model is not called.					
2	Input	any	any	real	[-Inf;+Inf]	0

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
2-2		How many INPUTS does the EES model require?	1	50

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Output	any	any	real	[-Inf;+Inf]	0

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
1-1	Number of ouputs		1	50

SPECIAL CARDS

Name	Question	Answer
LABELS 2	2 Labels are required (Do not Edit)	2

	Where is EES located?	
	Where is the EES file to be run located?	

4.13.1.5. EES - First Input is a Control Signal - Set Outputs to Predefined Values when OFF

Icon		TRNSYS Model	Type 66
Proforma	Utility\Calling External Programs\EES\First Input is a Control Signal\Set Outputs to Predefined Values when OFF\Type66c.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Input mode	Dimensionless	-	integer	[2;2]	0
	This parameter specifies how the EES model will be called. If set to 1, the EES model will be called at every time step and at every iteration. If set to 2, the first input is a control signal. The first input will not be sent to EES. Please refer to parameter 2 for information on the various ways that outputs can be treated in Input mode 2.					
2	Output mode	Dimensionless	-	integer	[2;2]	0
	This parameter is only used in Input mode 2 (parameter 1 set to 2). In Input mode 2, the first input is not sent to EES but is a control signal. When that control signal is set to 0, the EES model will not be called. This parameter determines how outputs will be treated when the EES model is not called. 1: outputs are set to 0 if Input Mode is 2 and the first input is 0 2: outputs are set to predefined (parameter) values if Input Mode is 2 and the first input is 0 3: output values are held from the previous time step if Input Mode is 2 and the first input is 0					
3	Allowable wait	Time	s	real	[0;+Inf]	0
	The allowable amount of time that TRNSYS will allow EES before deciding that EES is non responsive. (Not implemented yet)					
4	Number of ouputs	Dimensionless	-	integer	[0;+Inf]	0
	The number of outputs that EES will be returning					
5	Value when OFF for output	any	any	real	[-Inf;+Inf]	0
	The predefined value of each output when the EES model is not called.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
5-5	Number of ouputs		1	100

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Control signal	Dimensionless	-	real	[0;1]	0
	If this input is set to 0, the EES model will not be called at the current time step. The output mode (parameter 2) determines how the outputs normally generated by EES will be treated when the EES model is not called.					
2	Input	any	any	real	[-Inf;+Inf]	0

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
2-2		How many INPUTS does the EES model require?	1	50

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Output	any	any	real	[-Inf;+Inf]	0

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
1-1	Number of ouputs		1	50

SPECIAL CARDS

Name	Question	Answer
LABELS 2	2 Labels are required (Do not edit)	2
	Where is EES located?	
	Where is the EES file to be run located?	

4.13.1.6. EES - First Input is a Control Signal - Set Outputs to Zero when OFF

Icon		TRNSYS Model	Type 66
Proforma	Utility\Calling External Programs\EES\First Input is a Control Signal\Set Outputs to Zero when OFF\Type66b.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Input mode	Dimensionless	-	integer	[2;2]	0
	This parameter specifies how the EES model will be called. If set to 1, the EES model will be called at every time step and at every iteration. If set to 2, the first input is a control signal. The first input will not be sent to EES. Please refer to parameter 2 for information on the various ways that outputs can be treated in Input mode 2.					
2	Output mode	Dimensionless	-	real	[1;1]	0
	This parameter is only used in Input mode 2 (parameter 1 set to 2). In Input mode 2, the first input is not sent to EES but is a control signal. When that control signal is set to 0, the EES model will not be called. This parameter determines how outputs will be treated when the EES model is not called. 1: outputs are set to 0 if Input Mode is 2 and the first input is 0 2: outputs are set to predefined (parameter) values if Input Mode is 2 and the first input is 0 3: output values are held from the previous time step if Input Mode is 2 and the first input is 0					
3	Allowable wait	Time	s	real	[0;+Inf]	0
	The allowable amount of time that TRNSYS will allow EES before deciding that EES is non responsive. (Not implemented yet)					
4	Number of ouputs	Dimensionless	-	integer	[0;+Inf]	0
	The number of outputs that EES will be returning					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Control signal	Dimensionless	-	real	[0;1]	0
	If this input is set to 0, the EES model will not be called at the current time step. The output mode (parameter 2) determines how the outputs normally generated by EES will be treated when the EES model is not called.					
2	Input	any	any	real	[-Inf;+Inf]	0

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
2-2		How many INPUTS does the EES model require?	1	50

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Output	any	any	real	[-Inf;+Inf]	0

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
1-1	Number of ouputs		1	50

SPECIAL CARDS

Name	Question	Answer
LABELS 2	2 Labels are required (Do not edit)	2

	Where is EES located?	
	Where is the EES file to be run located?	

4.13.1.7. Excel

Icon		TRNSYS Model	Type 62
Proforma	Utility\Calling External Programs\Excel\Type62.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Mode	Dimensionless	-	integer	[0;0]	0
	Not implemented yet					
2	Nb of inputs	Dimensionless	-	integer	[1;10]	0
	Number of inputs. Please define the corresponding names in the excel workbook (Input1 to InputN)					
3	Nb of outputs	Dimensionless	-	integer	[1;10]	0
	Number of outputs. Please define the corresponding names in the excel workbook (Output1 to OutputN)					
4	Show Excel	Dimensionless	-	boolean	[0;1]	0
	Set this parameter to 1 if you want excel to be visible during the simulation. If this parameter is set to 0, excel will run hidden in the background					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	input	any	any	real	[-Inf;+Inf]	0
	Input sent to Excel. The total number of inputs is set by parameter 1					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
1-1	Nb of inputs		1	100

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	output	any	any	real	[-Inf;+Inf]	0
	Output from Excel. The total number of outputs is set by parameter 2					

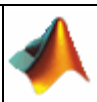
Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
1-1	Nb of outputs		1	100

SPECIAL CARDS

Name	Question	Answer
LABELS	Always 1 (do not edit)	1
	Excel file name	".\Examples\Data Files\Type62-CallingExcel.xls"

4.13.1.8. Matlab

Icon		TRNSYS Model	Type 155
Proforma	Utility\Calling External Programs\Matlab\Type155.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Mode	Dimensionless	-	integer	[0;0]	0
	Not implemented yet					
2	Number of inputs	Dimensionless	-	integer	[1;200]	0
	Number of inputs sent to Matlab					
3	Number of outputs	Dimensionless	-	integer	[1;200]	0
	Number of outputs from Matlab					
4	Calling Mode	Dimensionless	-	integer	[0;10]	0
	This parameter describes the iterative behavior of this component. Currently, the values 0 and 10 are defined. 0: Standard Iterative component (called at each call of each time step) 10: Non-iterative component called at the end of each time step, after integrators and printers - This is suitable for a controller that calculates its outputs for one time step based on the converged ("measured") values of previous time step					
5	Keep Matlab open after simulation	Dimensionless	-	boolean	[0;1]	0
	If this parameter is 1 for at least one unit of Type 155 in the simulation, the Matlab engine will not be closed when TRNSYS exits. This can be useful for further data analysis or debugging purposes. Please note that the Matlab instance launched by TRNSYS will exit by itself after a certain time, so you should save your session and re-open it in another Matlab instance if you want to keep working on the data					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	input	any		real	[-Inf;+Inf]	0
	input sent to Matlab. the total number of inputs is set by parameter 2 (nInputs)					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
1-1	Number of inputs		1	100

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	output	any		real	[-Inf;+Inf]	0
	output from Matlab. The total number of outputs is set by parameter 3					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
1-1	Number of outputs		1	100

SPECIAL CARDS

Name	Question	Answer
LABELS	Set to 1 (do NOT edit)	1
	m-file name (relative or absolute path)	".\Examples\Data Files\Type155_CallingMatlab.m"

4.13.2. Data Readers

4.13.2.1. Generic Data Files - Expert Mode - Free Format

Icon		**TRNSYS Model**	Type 9
Proforma	Utility\Data Readers\Generic Data Files\Expert Mode\Free Format\Type9e.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Mode	Dimensionless	-	integer	[1;6]	2
	This parameter sets the mode of the data reader. The different values (Modes 1 to 6) are explained hereunder: 1: The first line in the data file is the simulation start time. Initial conditions are provided as instantaneous values for ALL variables (including the ones that are given as average values over the time step in the rest of the data file) 2: The first line in the data file is the simulation start time. Initial conditions are provided as instantaneous or averaged values over one timestep according to the options set for each variables 3. The first line in the data file corresponds to the first time step of the simulation. No initial values are provided in the file. 4: The first line in the data file corresponds to time = 0. If the simulation start is not 0, lines are skipped accordingly in the data file. Initial conditions are provided as instantaneous values for ALL variables (including the ones that are given as average values over the time step in the rest of the data file) 5: The first line in the data file corresponds to time = 0. If the simulation start is not 0, lines are skipped accordingly in the data file. Initial conditions are provided as instantaneous or averaged values over one timestep according to the options set for each variables 6. The first line in the data file corresponds to the first timestep in a year. If the simulation does not start at the beginning of the year, lines are skipped in the data file. No initial values are provided in the file					
2	Header Lines to Skip	Dimensionless	-	integer	[0;+Inf]	0
	Number of header lines to skip in the data file (e.g. Variable names, units, or additional information not used by TRNSYS)					
3	No. of values to read	Dimensionless	-	integer	[1;98]	2
	This parameter specifies how many values are to be read from each line of the data file. Note that even if some values are used, the component must read all values up to the last one which is used. E.g. if only the 1st, 2nd and 6th values are desired, this parameter should be equal to 6.					
4	Time interval of data	Time	hr	real	[0.0;+Inf]	1.0
	Time interval used to record the data in the file (e.g. hourly = 1.0, daily = 24.0). The data time interval must be an integer multiplier of the simulation timestep. E.g. if the simulation timestep is 15 minutes, the data time interval could be 15 min, 30 min, 1h, etc.					
5	Interpolate or not	Dimensionless	-	integer	[-1;1]	1
	This parameter indicates whether the values for the nth variable in the data file are to be interpolated (1) or not (-1). Parameter 5 is for the first column, Parameter 9 is for the second column, etc. Radiation values should NOT be interpolated - this is the function of the radiation processor.					
6	Multiplication factor	Dimensionless	-	real	[-Inf;+Inf]	1.0
	Multiplication factor for the nth variable (column). Parameter 6 is for the first column, Parameter 10 is for the second column, etc. Output(n) = Value(n) * multiplication factor + addition factor					
7	Addition factor	Dimensionless	-	real	[-Inf;+Inf]	0
	Addition factor for the nth variable (column). Parameter 7 is for the first column, Parameter 11 is for the second column, etc. Output(n) = Value(n) * multiplication factor + addition factor					

8	Average or instantaneous value	Dimensionless	-	integer	[0;1]	0
	This parameter indicates whether the nth variable (column) is an average value over the data time interval (0) or an instantaneous value (1). Note that printed results from previous TRNSYS simulations are average values over the time step. Parameter 8 is for the first column, Parameter 12 is for the second column, etc.					
9	Logical unit for input file	Dimensionless	-	integer	[30;999]	14
	This parameter sets the Fortran Logical Unit (File reference number) of the output file. It is used internally by TRNSYS to refer to the file. This parameter will automatically be assigned to a unique value by the TRNSYS Studio.					
10	Free format mode	Dimensionless	-	integer	[-1;-1]	-1
	The value -1 for this parameter indicates that the data reader should read data in free format mode. The values should be separated by blanks (spaces, tabs) or commas (","). Do not change ths parameter, use another proforma if you want to read a file according to a specified format statement.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
5-8	No. of values to read		1	98

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Output 1	any	any	real	[-Inf;+Inf]	0
	nth value read from data file (if at least n values are read).					
⋮	⋮	⋮	⋮	⋮	⋮	⋮
10	Output 10	any	any	real	[-Inf;+Inf]	0
	nth value read from data file (if at least n values are read).					
⋮	⋮	⋮	⋮	⋮	⋮	⋮
98	Output 98	any	any	real	[-Inf;+Inf]	0
99	Time of last read	Time	hr	real	[-Inf;+Inf]	0
	The time at which the values were last read from the data file. This output is intended to be hooked up to the radiation processor (Type 16).					
100	Time of next read	Time	hr	real	[-Inf;+Inf]	0
	The time at which the next values will be read from the data file. This output is intended to be hooked up to the radiation processor (Type16).					
101	Value at next timestep of Output	any	any	real	[-Inf;+Inf]	0
	The value at the next timestep of the listed output.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
101-101	No. of values to read		1	98

EXTERNAL FILES

Question	File	Associated parameter
Input file name	"Please Select The Input File For Type 9"	Logical unit for input file
Source file	.\SourceCode\Types\Type9.for	

4.13.2.2. Generic Data Files - Expert Mode - Specified Format

Icon		TRNSYS Model	Type 9
Proforma	Utility\Data Readers\Generic Data Files\Expert Mode\Specified Format\Type9g.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Mode	Dimensionless	-	integer	[1;6]	2
	This parameter sets the mode of the data reader. The different values (Modes 1 to 6) are explained hereunder: 1: The first line in the data file is the simulation start time. Initial conditions are provided as instantaneous values for ALL variables (including the ones that are given as average values over the time step in the rest of the data file) 2: The first line in the data file is the simulation start time. Initial conditions are provided as instantaneous or averaged values over one timestep according to the options set for each variables 3. The first line in the data file corresponds to the first time step of the simulation. No initial values are provided in the file. 4: The first line in the data file corresponds to time = 0. If the simulation start is not 0, lines are skipped accordingly in the data file. Initial conditions are provided as instantaneous values for ALL variables (including the ones that are given as average values over the time step in the rest of the data file) 5: The first line in the data file corresponds to time = 0. If the simulation start is not 0, lines are skipped accordingly in the data file. Initial conditions are provided as instantaneous or averaged values over one timestep according to the options set for each variables 6. The first line in the data file corresponds to the first timestep in a year. If the simulation does not start at the beginning of the year, lines are skipped in the data file. No initial values are provided in the file					
2	Header Lines to Skip	Dimensionless	-	integer	[0;+Inf]	0
	Number of header lines to skip in the data file (e.g. Variable names, units, or additional information not used by TRNSYS)					
3	No. of values to read	Dimensionless	-	integer	[1;98]	2
	This parameter specifies how many values are to be read from each line of the data file. Note that even if some values are used, the component must read all values up to the last one which is used. E.g. if only the 1st, 2nd and 6th values are desired, this parameter should be equal to 6.					
4	Time interval of data	Time	hr	real	[0.0;+Inf]	1.0
	Time interval used to record the data in the file (e.g. hourly = 1.0, daily = 24.0). The data time interval must be an integer multiplier of the simulation timestep. E.g. if the simulation timestep is 15 minutes, the data time interval could be 15 min, 30 min, 1h, etc.					
5	Interpolate or not	Dimensionless	-	integer	[-1;1]	1
	This parameter indicates whether the values for the nth variable in the data file are to be interpolated (1) or not (-1). Parameter 5 is for the first column, Parameter 9 is for the second column, etc. Note that in Formatted read "the nth column" means the nth value read using the specified format. Radiation values should NOT be interpolated - this is the function of the radiation processor.					
6	Multiplication factor	Dimensionless	-	real	[-Inf;+Inf]	1.0
	Multiplication factor for the nth variable (column). Parameter 6 is for the first column, Parameter 10 is for the second column, etc. Output(n) = Value(n) * multiplication factor + addition factor					
7	Addition factor	Dimensionless	-	real	[-Inf;+Inf]	0
	Addition factor for the nth variable (column). Parameter 7 is for the first column, Parameter 11 is for the second column, etc. Output(n) = Value(n) * multiplication factor + addition factor					
8	Average or instantaneous value	Dimensionless	-	integer	[0;1]	0
	This parameter indicates whether the nth variable (column) is an average value over the data time interval (0)					

	or an instantaneous value (1). Note that printed results from previous TRNSYS simulations are average values over the time step. Parameter 8 is for the first column, Parameter 12 is for the second column, etc.					
9	Logical unit for input file	Dimensionless	-	integer	[30;999]	14
	This parameter sets the Fortran Logical Unit (File reference number) of the output file. It is used internally by TRNSYS to refer to the file. This parameter will automatically be assigned to a unique value by the TRNSYS Studio.					
10	Specified format mode	Dimensionless	-	integer	[1;1]	-1
	The value of 1 for this parameter indicates that the data reader should read data in the input file using the format string specified in "Special Cards". Do not change this parameter, use another proforma if you want to read a file in free format mode.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
5-8	No. of values to read		1	98

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Output 1	any	any	real	[-Inf;+Inf]	0
	nth value read from data file (if at least n values are read).					
⋮	⋮	⋮	⋮	⋮	⋮	⋮
98	Output 98	any	any	real	[-Inf;+Inf]	0
99	Time of last read	Time	hr	real	[-Inf;+Inf]	0
	The time at which the values were last read from the data file. This output is intended to be hooked up to the radiation processor (Type 16).					
100	Time of next read	Time	hr	real	[-Inf;+Inf]	0
	The time at which the next values will be read from the data file. This output is intended to be hooked up to the radiation processor (Type16).					
101	Value at next timestep of Output	any	any	real	[-Inf;+Inf]	0
	The value at the next timestep of the listed output.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
101-101	No. of values to read		1	98

SPECIAL CARDS

Name	Question	Answer
FORMAT	Format Statement to read the input file	(1X,F6.2)

EXTERNAL FILES

Question	File	Associated parameter
Input file name	"Please select the input file for Type 9"	Logical unit for input file
Source file	.\SourceCode\Types\Type9.for	

4.13.2.3. Generic Data Files - First Line is Simulation Start - Free Format

Icon		TRNSYS Model	Type 9
Proforma	Utility\Data Readers\Generic Data Files\First Line is Simulation Start\Free Format\Type9a.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Mode	Dimensionless	-	integer	[2;2]	2
	This parameter sets the mode of the data reader to 2: the first line in the data file is the simulation start time. Initial conditions are provided as instantaneous or averaged values over one timestep according to the options set for each variables					
2	Header Lines to Skip	Dimensionless	-	integer	[0;+Inf]	0
	Number of header lines to skip in the data file (e.g. Variable names, units, or additional information not used by TRNSYS)					
3	No. of values to read	Dimensionless	-	integer	[1;98]	2
	This parameter specifies how many values are to be read from each line of the data file. Note that even if some values are used, the component must read all values up to the last one which is used. E.g. if only the 1st, 2nd and 6th values are desired, this parameter should be equal to 6.					
4	Time interval of data	Time	hr	real	[0.0;+Inf]	1.0
	Time interval used to record the data in the file (e.g. hourly = 1.0, daily = 24.0). The data time interval must be an integer multiplier of the simulation timestep. E.g. if the simulation timestep is 15 minutes, the data time interval could be 15 min, 30 min, 1h, etc.					
5	Interpolate or not?	Dimensionless	-	integer	[-1;1]	1
	This parameter indicates whether the values for the nth variable in the data file are to be interpolated (1) or not (-1). Parameter 5 is for the first column, Parameter 9 is for the second column, etc. Radiation values should NOT be interpolated - this is the function of the radiation processor.					
6	Multiplication factor	Dimensionless	-	real	[-Inf;+Inf]	1.0
	Multiplication factor for the nth variable (column). Parameter 6 is for the first column, Parameter 10 is for the second column, etc. Output(n) = Value(n) * multiplication factor + addition factor					
7	Addition factor	Dimensionless	-	real	[-Inf;+Inf]	0
	Addition factor for the nth variable (column). Parameter 7 is for the first column, Parameter 11 is for the second column, etc. Output(n) = Value(n) * multiplication factor + addition factor					
8	Average or instantaneous value	Dimensionless	-	integer	[0;1]	0
	This parameter indicates whether the nth variable (column) is an average value over the data time interval (0) or an instantaneous value (1). Note that printed results from previous TRNSYS simulations are average values over the time step. Parameter 8 is for the first column, Parameter 12 is for the second column, etc.					
9	Logical unit for input file	Dimensionless	-	integer	[30;999]	14
	This parameter sets the Fortran Logical Unit (File reference number) of the output file. It is used internally by TRNSYS to refer to the file. This parameter will automatically be assigned to a unique value by the TRNSYS Studio.					
10	Free format mode	Dimensionless	-	integer	[-1;-1]	-1
	The value -1 for this parameter indicates that the data reader should read data in free format mode. The values should be separated by blanks (spaces, tabs) or commas (","). Do not change ths parameter, use another proforma if you want to read a file according to a specified format statement.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
5-8	No. of values to read		1	98

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Output 1	any	any	real	[-Inf;+Inf]	0
	nth value read from data file (if at least n values are read).					
⋮	⋮	⋮	⋮	⋮	⋮	⋮
98	Output 98	any	any	real	[-Inf;+Inf]	0
99	Time of last read	Time	hr	real	[-Inf;+Inf]	0
	The time at which the values were last read from the data file. This output is intended to be hooked up to the radiation processor (Type 16).					
100	Time of next read	Time	hr	real	[-Inf;+Inf]	0
	The time at which the next values will be read from the data file. This output is intended to be hooked up to the radiation processor (Type16).					
101	Value at next timestep of Output	any	any	real	[-Inf;+Inf]	0
	The value at the next timestep of the listed output.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
101-101	No. of values to read		1	98

EXTERNAL FILES

Question	File	Associated parameter
Input file name	"Please select the input file for Type 9"	Logical unit for input file
Source file	.\SourceCode\Types\Type9.for	

4.13.2.4. Generic Data Files - First Line is Simulation Start - Specified Format

Icon		TRNSYS Model	Type 9
Proforma	Utility\Data Readers\Generic Data Files\First Line is Simulation Start\Specified Format\Type9b.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Mode	Dimensionless	-	integer	[-10;10]	2
	This parameter sets the mode of the data reader to 2: the first line in the data file is the simulation start time. Initial conditions are provided as instantaneous or averaged values over one timestep according to the options set for each variable					
2	Header Lines to Skip	Dimensionless	-	integer	[0;+Inf]	0
	Number of header lines to skip in the data file (e.g. Variable names, units, or additional information not used by TRNSYS)					
3	No. of values to read	Dimensionless	-	integer	[1;98]	2
	This parameter specifies how many values are to be read from each line of the data file. Note that even if some values are used, the component must read all values up to the last one which is used. E.g. if only the 1st, 2nd and 6th values are desired, this parameter should be equal to 6.					
4	Time interval of data	Time	hr	real	[0.0;+Inf]	1.0
	Time interval used to record the data in the file (e.g. hourly = 1.0, daily = 24.0). The data time interval must be an integer multiplier of the simulation timestep. E.g. if the simulation timestep is 15 minutes, the data time interval could be 15 min, 30 min, 1h, etc.					
5	Interpolate or not	Dimensionless	-	integer	[-1;1]	1
	This parameter indicates whether the values for the nth variable in the data file are to be interpolated (1) or not (-1). Parameter 5 is for the first column, Parameter 9 is for the second column, etc. Note that in Formatted read "the nth column" means the nth value read using the specified format. Radiation values should NOT be interpolated - this is the function of the radiation processor.					
6	Multiplication factor	Dimensionless	-	real	[-Inf;+Inf]	1.0
	Multiplication factor for the nth variable (column). Parameter 6 is for the first column, Parameter 10 is for the second column, etc. Output(n) = Value(n) * multiplication factor + addition factor					
7	Addition factor	Dimensionless	-	real	[-Inf;+Inf]	0
	Addition factor for the nth variable (column). Parameter 7 is for the first column, Parameter 11 is for the second column, etc. Output(n) = Value(n) * multiplication factor + addition factor					
8	Average or instantaneous value	Dimensionless	-	integer	[0;1]	0
	This parameter indicates whether the nth variable (column) is an average value over the data time interval (0) or an instantaneous value (1). Note that printed results from previous TRNSYS simulations are average values over the time step. Parameter 8 is for the first column, Parameter 12 is for the second column, etc.					
9	Logical unit for input file	Dimensionless	-	integer	[30;999]	14
	This parameter sets the Fortran Logical Unit (File reference number) of the output file. It is used internally by TRNSYS to refer to the file. This parameter will automatically be assigned to a unique value by the TRNSYS Studio.					
10	Specified format mode	Dimensionless	-	integer	[1;1]	-1
	The value of 1 for this parameter indicates that the data reader should read data in the input file using the format string specified in "Special Cards". Do not change this parameter, use another proforma if you want to read a file in free format mode.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
5-8	No. of values to read		1	98

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Output 1	any	any	real	[-Inf;+Inf]	0
	nth value read from data file (if at least n values are read).					
⋮	⋮	⋮	⋮	⋮	⋮	⋮
98	Output 98	any	any	real	[-Inf;+Inf]	0
99	Time of last read	Time	hr	real	[-Inf;+Inf]	0
	The time at which the values were last read from the data file. This output is intended to be hooked up to the radiation processor (Type 16).					
100	Time of next read	Time	hr	real	[-Inf;+Inf]	0
	The time at which the next values will be read from the data file. This output is intended to be hooked up to the radiation processor (Type16).					
101	Value at next timestep of Output	any	any	real	[-Inf;+Inf]	0
	The value at the next timestep of the listed output.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
101-101	No. of values to read		1	98

SPECIAL CARDS

Name	Question	Answer
FORMAT	Format Statement to read the input file	(1X,F6.2)

EXTERNAL FILES

Question	File	Associated parameter
Input file name	"Please select the input file for Type9"	Logical unit for input file
Source file	.\SourceCode\Types\Type9.for	

4.13.2.5. Generic Data Files - Skip Lines to Start - Free Format

Icon		TRNSYS Model	Type 9
Proforma	Utility\Data Readers\Generic Data Files\Skip Lines to Start\Free Format\Type9c.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Mode	Dimensionless	-	integer	[-10;10]	2
	This parameter sets the mode of the data reader to 5: The first line in the data file corresponds to time = 0. If the simulation start is not 0, lines are skipped accordingly in the data file. Initial conditions are provided as instantaneous or averaged values over one timestep according to the options set for each variables					
2	Header Lines to Skip	Dimensionless	-	integer	[0;+Inf]	0
	Number of header lines to skip in the data file (e.g. Variable names, units, or additional information not used by TRNSYS)					
3	No. of values to read	Dimensionless	-	integer	[1;98]	2
	This parameter specifies how many values are to be read from each line of the data file. Note that even if some values are used, the component must read all values up to the last one which is used. E.g. if only the 1st, 2nd and 6th values are desired, this parameter should be equal to 6.					
4	Time interval of data	Time	hr	real	[0.0;+Inf]	1.0
	Time interval used to record the data in the file (e.g. hourly = 1.0, daily = 24.0). The data time interval must be an integer multiplier of the simulation timestep. E.g. if the simulation timestep is 15 minutes, the data time interval could be 15 min, 30 min, 1h, etc.					
5	Interpolate or not	Dimensionless	-	integer	[-1;1]	1
	This parameter indicates whether the values for the nth variable in the data file are to be interpolated (1) or not (-1). Parameter 5 is for the first column, Parameter 9 is for the second column, etc. Radiation values should NOT be interpolated - this is the function of the radiation processor.					
6	Multiplication factor	Dimensionless	-	real	[-Inf;+Inf]	1.0
	Multiplication factor for the nth variable (column). Parameter 6 is for the first column, Parameter 10 is for the second column, etc. Output(n) = Value(n) * multiplication factor + addition factor					
7	Addition factor	Dimensionless	-	real	[-Inf;+Inf]	0
	Addition factor for the nth variable (column). Parameter 7 is for the first column, Parameter 11 is for the second column, etc. Output(n) = Value(n) * multiplication factor + addition factor					
8	Average or instantaneous value	Dimensionless	-	integer	[0;1]	0
	This parameter indicates whether the nth variable (column) is an average value over the data time interval (0) or an instantaneous value (1). Note that printed results from previous TRNSYS simulations are average values over the time step. Parameter 8 is for the first column, Parameter 12 is for the second column, etc.					
9	Logical unit for input file	Dimensionless	-	integer	[30;999]	14
	This parameter sets the Fortran Logical Unit (File reference number) of the output file. It is used internally by TRNSYS to refer to the file. This parameter will automatically be assigned to a unique value by the TRNSYS Studio.					
10	Free format mode	Dimensionless	-	integer	[-1;-1]	-1
	The value -1 for this parameter indicates that the data reader should read data in free format mode. The values should be separated by blanks (spaces, tabs) or commas (","). Do not change ths parameter, use another proforma if you want to read a file according to a specified format statement.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
5-8	No. of values to read		1	98

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Output 1	any	any	real	[-Inf;+Inf]	0
	nth value read from data file (if at least n values are read).					
⋮	⋮	⋮	⋮	⋮	⋮	⋮
98	Output 98	any	any	real	[-Inf;+Inf]	0
99	Time of last read	Time	hr	real	[-Inf;+Inf]	0
	The time at which the values were last read from the data file. This output is intended to be hooked up to the radiation processor (Type 16).					
100	Time of next read	Time	hr	real	[-Inf;+Inf]	0
	The time at which the next values will be read from the data file. This output is intended to be hooked up to the radiation processor (Type16).					
101	Value at next timestep of Output	any	any	real	[-Inf;+Inf]	0
	The value at the next timestep of the listed output.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
101-101	No. of values to read		1	98

EXTERNAL FILES

Question	File	Associated parameter
Input file name	"Please select the input file for Type 9"	Logical unit for input file
Source file	.\SourceCode\Types\Type9.for	

4.13.2.6. Generic Data Files - Skip Lines to Start - Specified Format

Icon		TRNSYS Model	Type 9
Proforma	Utility\Data Readers\Generic Data Files\Skip Lines to Start\Specified Format\Type9d.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Mode	Dimensionless	-	integer	[5;5]	2
	This parameter sets the mode of the data reader to 5: the first line in the data file corresponds to time = 0. If the simulation start is not 0, lines are skipped accordingly in the data file. Initial conditions are provided as instantaneous or averaged values over one timestep according to the options set for each variable					
2	Header Lines to Skip	Dimensionless	-	integer	[0;+Inf]	0
	Number of header lines to skip in the data file (e.g. Variable names, units, or additional information not used by TRNSYS)					
3	No. of values to read	Dimensionless	-	integer	[1;98]	2
	This parameter specifies how many values are to be read from each line of the data file. Note that even if some values are used, the component must read all values up to the last one which is used. E.g. if only the 1st, 2nd and 6th values are desired, this parameter should be equal to 6.					
4	Time interval of data	Time	hr	real	[0.0;+Inf]	1.0
	Time interval used to record the data in the file (e.g. hourly = 1.0, daily = 24.0). The data time interval must be an integer multiplier of the simulation timestep. E.g. if the simulation timestep is 15 minutes, the data time interval could be 15 min, 30 min, 1h, etc.					
5	Interpolate or not	Dimensionless	-	integer	[-1;1]	1
	This parameter indicates whether the values for the nth variable in the data file are to be interpolated (1) or not (-1). Parameter 5 is for the first column, Parameter 9 is for the second column, etc. Note that in Formatted read "the nth column" means the nth value read using the specified format. Radiation values should NOT be interpolated - this is the function of the radiation processor.					
6	Multiplication factor	Dimensionless	-	real	[-Inf;+Inf]	1.0
	Multiplication factor for the nth variable (column). Parameter 6 is for the first column, Parameter 10 is for the second column, etc. Output(n) = Value(n) * multiplication factor + addition factor					
7	Addition factor	Dimensionless	-	real	[-Inf;+Inf]	0
	Addition factor for the nth variable (column). Parameter 7 is for the first column, Parameter 11 is for the second column, etc. Output(n) = Value(n) * multiplication factor + addition factor					
8	Average or instantaneous value	Dimensionless	-	integer	[0;1]	0
	This parameter indicates whether the nth variable (column) is an average value over the data time interval (0) or an instantaneous value (1). Note that printed results from previous TRNSYS simulations are average values over the time step. Parameter 8 is for the first column, Parameter 12 is for the second column, etc.					
9	Logical unit for input file	Dimensionless	-	integer	[30;999]	14
	This parameter sets the Fortran Logical Unit (File reference number) of the output file. It is used internally by TRNSYS to refer to the file. This parameter will automatically be assigned to a unique value by the TRNSYS Studio.					
10	Specified format mode	Dimensionless	-	integer	[1;1]	-1
	The value of 1 for this parameter indicates that the data reader should read data in the input file using the format string specified in "Special Cards". Do not change this parameter, use another proforma if you want to read a file in free format mode.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
5-8	No. of values to read		1	98

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Output 1	any	any	real	[-Inf;+Inf]	0
	nth value read from data file (if at least n values are read).					
⋮	⋮	⋮	⋮	⋮	⋮	⋮
98	Output 98	any	any	real	[-Inf;+Inf]	0
99	Time of last read	Time	hr	real	[-Inf;+Inf]	0
	The time at which the values were last read from the data file. This output is intended to be hooked up to the radiation processor (Type 16).					
100	Time of next read	Time	hr	real	[-Inf;+Inf]	0
	The time at which the next values will be read from the data file. This output is intended to be hooked up to the radiation processor (Type16).					
101	Value at next timestep of Output	any	any	real	[-Inf;+Inf]	0
	The value at the next timestep of the listed output.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
101-101	No. of values to read		1	98

SPECIAL CARDS

Name	Question	Answer
FORMAT	Format Statement to read the input file	(1X,F6.2)

EXTERNAL FILES

Question	File	Associated parameter
Input file name	"Please select the input file for Type 9"	Logical unit for input file
Source file	.\SourceCode\Types\Type9.for	

4.13.2.7. Standard Weather Files - EnergyPlus - Simulation Start is first line

Icon		TRNSYS Model	Type 89
Proforma	Utility\Data Readers\Standard Weather Files\EnergyPlus\Simulation Start is first line\Type89e.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Mode	Dimensionless	-	integer	[3;3]	-1
	Mode = 2 specifies to the general data reader component that the file to be read is a TRNSYS TMY2 weather file and that the first line in the data file corresponds to the simulation start time. This parameter should not be changed!					
2	Logical unit	Dimensionless	-	integer	[10;30]	13
	The logical unit through which the data reader will read the TMY weather file.					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Month	Dimensionless	-	integer	[-Inf;+Inf]	0
	The month of the year. (Not interpolated for timesteps less than 1 hour)					
2	Hour	Time	hr	real	[0.0;+Inf]	0
	The hour of the year. (Interpolated at timesteps less than 1 hour)					
3	Direct normal radiation	Flux	kJ/hr.m^2	real	[0.0;+Inf]	0
	The direct normal solar radiation integrated over the previous hour. (Not interpolated at timesteps less than 1 hour - use radiation processor to interpolate solar radiation)					
4	Global horizontal radiation	Flux	kJ/hr.m^2	real	[0.0;+Inf]	0
	The global solar radiation on a horizontal surface integrated over the previous hour. (Not interpolated at timesteps less than one hour - use radiation processor to interpolate solar radiation)					
5	Dry bulb temperature	Temperature	C	real	[-Inf;+Inf]	0
	The dry bulb (ambient) temperature. (Interpolated at timestep less than one hour)					
6	Humidity ratio	Dimensionless	-	real	[0.0;0.5]	0
	The absolute humidity ratio of the ambient air. (Interpolated at timesteps of less than one hour)					
7	Wind velocity	Velocity	m/s	real	[0.0;+Inf]	0
	The velocity of the wind. (Interpolated at timesteps of less than one hour)					
8	Wind direction	Direction (Angle)	degrees	real	[0.0;360.0]	0
	The direction from which the wind originates. (Interpolated for timesteps of less than one hour) 0 = North 90 = East 180 = South 270 = West					
9	Dew point temperature	Temperature	C	real	[-Inf;+Inf]	0
	The dew point temperature of the ambient air.					
10	Percent relative humidity	Dimensionless	-	real	[0.0;100.0]	0
	The relative humidity of the ambient air (percentage).					
11	Diffuse radiation on horizontal	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
12	Global horizontal illuminance	Illuminance		real	[-Inf;+Inf]	0
13	Direct normal illuminance	Illuminance		real	[-Inf;+Inf]	0
14	Diffuse illuminance on horizontal	Illuminance		real	[-Inf;+Inf]	0

15	Zenith luminance	Luminance		real	[-Inf;+Inf]	0
16	Total sky cover	any	any	real	[-Inf;+Inf]	0
17	Opaque sky cover	any	any	real	[-Inf;+Inf]	0
18	Atmospheric pressure	Pressure	atm	real	[-Inf;+Inf]	0
19	Horizontal visibility	Length	km	real	[-Inf;+Inf]	0
20	Ceiling height	Length	m	real	[-Inf;+Inf]	0
21	Precipitable water	any	any	real	[-Inf;+Inf]	0
22	Aerosol optical depth	any	any	real	[-Inf;+Inf]	0
23	Snow depth	any	any	real	[-Inf;+Inf]	0
24	Days since last snowfall	Time	day	real	[-Inf;+Inf]	0
25	Extraterrestrial beam radiation	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
26	Infrared radiation on horizontal	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
27	Output 27 not used	dimensionless	-	real	[-Inf;+Inf]	0
⋮	⋮	⋮	⋮	⋮	⋮	⋮
98	Output 98 not used	dimensionless	-	real	[-Inf;+Inf]	0
99	Time of last read	Time	hr	real	[0;+Inf]	0
	The time at which the last values were read from the data file. This output is to be used strictly with the TYPE 16 radiation processor Input 19.					
100	Time of next read	Time	hr	real	[0;+Inf]	0
	Thetime at which the next values will be read from the data file. This output is to be strictly used with the radiation processor Input 20.					
101	Month at next timestep	Dimensionless	-	real	[-Inf;+Inf]	0
	The month of the year at the next timestep.					
102	Hour at next timestep	Time	hr	real	[0;+Inf]	0
	The hour of the year at the next timestep.					
103	Direct normal at next timestep	Flux	kJ/hr.m^2	real	[0;+Inf]	0
	Direct normal solar radiation at the next timestep. Used with the radiation smoothing option in the radiation processor component.					
104	Global horiz. at next timestep	Flux	kJ/hr.m^2	real	[0;+Inf]	0
	Global horizontal surface radiation at the next timestep. Used with the smoothing option in he radiation processor.					
105	Dry bulb at next timestep	Temperature	C	real	[-Inf;+Inf]	0
	The dry bulb (ambient) temperature at the next timestep.					
106	Humidity ratio at next timestep	Dimensionless	-	real	[0.0;0.5]	0
	The absolute humidity ratio at the next timestep.					
107	Wind velocity at next timestep	Velocity	m/s	real	[0.0;+Inf]	0
	The wind velocity at the next timestep.					
108	Wind direction at next timestep	Direction (Angle)	degrees	real	[0.0;360.0]	0
	The wind direction at the next timestep. 0 = North 90 = East 180 = South 270 = West					
109	Dew point at next timestep	Temperature	C	real	[-Inf;+Inf]	0
	The dew point temperature of the ambient air at the next timestep.					
110	Percent relative humidity at next timestep	Dimensionless	-	real	[0.0;1.0]	0

	The percent relative humidity of the ambient air at the next timestep.					
111	Diffuse horizontal radiation at next timestep	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
112	Global illuminance at next timestep	Illuminance		real	[-Inf;+Inf]	0
113	Direct normal illuminance at next timestep	Illuminance		real	[-Inf;+Inf]	0
114	Diffuse illuminance at next timestep	Illuminance		real	[-Inf;+Inf]	0
115	Zenith luminance at next timestep	Luminance		real	[-Inf;+Inf]	0
116	Total sky cover at the next timestep	any	any	real	[-Inf;+Inf]	0
117	Opaque sky cover at next timestep	any	any	real	[-Inf;+Inf]	0
118	Atmospheric pressure at next timestep	Pressure	atm	real	[-Inf;+Inf]	0
119	Horizontal visibility at	Length	km	real	[-Inf;+Inf]	0
120	Ceiling height at next timestep	Length	m	real	[-Inf;+Inf]	0
121	Precipitable water at next timestep	any	any	real	[-Inf;+Inf]	0
122	Aerosol optical depth at next timestep	any	any	real	[-Inf;+Inf]	0
123	Snow depth at next timestep	any	any	real	[-Inf;+Inf]	0
124	Days since last snowfall at next timestep	Time	day	real	[-Inf;+Inf]	0
125	Extraterrestrial beam radiation at next timestep	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
126	Infrared radiation on horiz. at next timestep	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0

EXTERNAL FILES

Question	File	Associated parameter
Which file contains the EnergyPlus weather information?		Logical unit
Source file	.\SourceCode\Types\Type89.for	

4.13.2.8. Standard Weather Files - EnergyPlus - Skip N Lines before starting

Icon		TRNSYS Model	Type 89
Proforma	Utility\Data Readers\Standard Weather Files\EnergyPlus\Skip N Lines before starting\Type89f.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Mode	Dimensionless	-	integer	[-3;-3]	-1
	Mode = 2 specifies to the general data reader component that the file to be read is a TRNSYS TMY2 weather file and that the first line in the data file corresponds to the simulation start time. This parameter should not be changed!					
2	Logical unit	Dimensionless	-	integer	[10;30]	13
	The logical unit through which the data reader will read the TMY weather file.					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Month	Dimensionless	-	integer	[-Inf;+Inf]	0
	The month of the year. (Not interpolated for timesteps less than 1 hour)					
2	Hour	Time	hr	real	[0.0;+Inf]	0
	The hour of the year. (Interpolated at timesteps less than 1 hour)					
3	Direct normal radiation	Flux	kJ/hr.m^2	real	[0.0;+Inf]	0
	The direct normal solar radiation integrated over the previous hour. (Not interpolated at timesteps less than 1 hour - use radiation processor to interpolate solar radiation)					
4	Global horizontal radiation	Flux	kJ/hr.m^2	real	[0.0;+Inf]	0
	The global solar radiation on a horizontal surface integrated over the previous hour. (Not interpolated at timesteps less than one hour - use radiation processor to interpolate solar radiation)					
5	Dry bulb temperature	Temperature	C	real	[-Inf;+Inf]	0
	The dry bulb (ambient) temperature. (Interpolated at timestep less than one hour)					
6	Humidity ratio	Dimensionless	-	real	[0.0;0.5]	0
	The absolute humidity ratio of the ambient air. (Interpolated at timesteps of less than one hour)					
7	Wind velocity	Velocity	m/s	real	[0.0;+Inf]	0
	The velocity of the wind. (Interpolated at timesteps of less than one hour)					
8	Wind direction	Direction (Angle)	degrees	real	[0.0;360.0]	0
	The direction from which the wind originates. (Interpolated for timesteps of less than one hour) 0 = North 90 = East 180 = South 270 = West					
9	Dew point temperature	Temperature	C	real	[-Inf;+Inf]	0
	The dew point temperature of the ambient air.					
10	Percent relative humidity	Dimensionless	-	real	[0.0;100.0]	0
	The relative humidity of the ambient air (percentage).					
11	Diffuse radiation on horizontal	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
12	Global horizontal illuminance	Illuminance		real	[-Inf;+Inf]	0
13	Direct normal illuminance	Illuminance		real	[-Inf;+Inf]	0
14	Diffuse illuminance on horizontal	Illuminance		real	[-Inf;+Inf]	0

15	Zenith luminance	Luminance		real	[-Inf;+Inf]	0
16	Total sky cover	any	any	real	[-Inf;+Inf]	0
17	Opaque sky cover	any	any	real	[-Inf;+Inf]	0
18	Atmospheric pressure	Pressure	atm	real	[-Inf;+Inf]	0
19	Horizontal visibility	Length	km	real	[-Inf;+Inf]	0
20	Ceiling height	Length	m	real	[-Inf;+Inf]	0
21	Precipitable water	any	any	real	[-Inf;+Inf]	0
22	Aerosol optical depth	any	any	real	[-Inf;+Inf]	0
23	Snow depth	any	any	real	[-Inf;+Inf]	0
24	Days since last snowfall	Time	day	real	[-Inf;+Inf]	0
25	Extraterrestrial beam radiation	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
26	Infrared radiation on horizontal	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
27	Output 27 not used	dimensionless	-	real	[-Inf;+Inf]	0
⋮	⋮	⋮	⋮	⋮	⋮	⋮
99	Time of last read	Time	hr	real	[0;+Inf]	0
	The time at which the last values were read from the data file. This output is to be used strictly with the TYPE 16 radiation processor Input 19.					
100	Time of next read	Time	hr	real	[0;+Inf]	0
	Thetime at which the next values will be read from the data file. This output is to be strictly used with the radiation processor Input 20.					
101	Month at next timestep	Dimensionless	-	real	[-Inf;+Inf]	0
	The month of the year at the next timestep.					
102	Hour at next timestep	Time	hr	real	[0;+Inf]	0
	The hour of the year at the next timestep.					
103	Direct normal at next timestep	Flux	kJ/hr.m^2	real	[0;+Inf]	0
	Direct normal solar radiation at the next timestep. Used with the radiation smoothing option in the radiation processor component.					
104	Global horiz. at next timestep	Flux	kJ/hr.m^2	real	[0;+Inf]	0
	Global horizontal surface radiation at the next timestep. Used with the smoothing option in he radiation processor.					
105	Dry bulb at next timestep	Temperature	C	real	[-Inf;+Inf]	0
	The dry bulb (ambient) temperature at the next timestep.					
106	Humidity ratio at next timestep	Dimensionless	-	real	[0.0;0.5]	0
	The absolute humidity ratio at the next timestep.					
107	Wind velocity at next timestep	Velocity	m/s	real	[0.0;+Inf]	0
	The wind velocity at the next timestep.					
108	Wind direction at next timestep	Direction (Angle)	degrees	real	[0.0;360.0]	0
	The wind direction at the next timestep. 0 = North 90 = East 180 = South 270 = West					
109	Dew point at next timestep	Temperature	C	real	[-Inf;+Inf]	0
	The dew point temperature of the ambient air at the next timestep.					
110	Percent relative humidity at next timestep	Dimensionless	-	real	[0.0;1.0]	0
	The percent relative humidity of the ambient air at the next timestep.					

111	Diffuse horizontal radiation at next timestep	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
112	Global illuminance at next timestep	Illuminance	Illuminance	real	[-Inf;+Inf]	0
113	Direct normal illuminance at next timestep	Illuminance		real	[-Inf;+Inf]	0
114	Diffuse illuminance at next timestep	Illuminance		real	[-Inf;+Inf]	0
115	Zenith luminance at next timestep	Luminance		real	[-Inf;+Inf]	0
116	Total sky cover at the next timestep	any	any	real	[-Inf;+Inf]	0
117	Opaque sky cover at next timestep	any	any	real	[-Inf;+Inf]	0
118	Atmospheric pressure at next timestep	Pressure	atm	real	[-Inf;+Inf]	0
119	Horizontal visibility at	Length	km	real	[-Inf;+Inf]	0
120	Ceiling height at next timestep	Length	m	real	[-Inf;+Inf]	0
121	Precipitable water at next timestep	any	any	real	[-Inf;+Inf]	0
122	Aerosol optical depth at next timestep	any	any	real	[-Inf;+Inf]	0
123	Snow depth at next timestep	any	any	real	[-Inf;+Inf]	0
124	Days since last snowfall at next timestep	Time	day	real	[-Inf;+Inf]	0
125	Extraterrestrial beam radiation at next timestep	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
126	Infrared radiation on horiz. at next timestep	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0

EXTERNAL FILES

Question	File	Associated parameter
Which file contains the EnergyPlus weather information?		Logical unit
Source file	.\SourceCode\Types\Type89.for	

4.13.2.9. Standard Weather Files - IWEC - Simulation Start is first line

Icon		TRNSYS Model	Type 89
Proforma	Utility\Data Readers\Standard Weather Files\IWEC\Simulation Start is first line\Type89g.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Mode	Dimensionless	-	integer	[4;4]	-1
	Mode = 2 specifies to the general data reader component that the file to be read is a TRNSYS TMY2 weather file and that the first line in the data file corresponds to the simulation start time. This parameter should not be changed!					
2	Logical unit	Dimensionless	-	integer	[10;30]	13
	The logical unit through which the data reader will read the TMY weather file.					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Month	Dimensionless	-	integer	[-Inf;+Inf]	0
	The month of the year. (Not interpolated for timesteps less than 1 hour)					
2	Hour	Time	hr	real	[0.0;+Inf]	0
	The hour of the year. (Interpolated at timesteps less than 1 hour)					
3	Direct normal radiation	Flux	kJ/hr.m^2	real	[0.0;+Inf]	0
	The direct normal solar radiation integrated over the previous hour. (Not interpolated at timesteps less than 1 hour - use radiation processor to interpolate solar radiation)					
4	Global horizontal radiation	Flux	kJ/hr.m^2	real	[0.0;+Inf]	0
	The global solar radiation on a horizontal surface integrated over the previous hour. (Not interpolated at timesteps less than one hour - use radiation processor to interpolate solar radiation)					
5	Dry bulb temperature	Temperature	C	real	[-Inf;+Inf]	0
	The dry bulb (ambient) temperature. (Interpolated at timestep less than one hour)					
6	Humidity ratio	Dimensionless	-	real	[0.0;0.5]	0
	The absolute humidity ratio of the ambient air. (Interpolated at timesteps of less than one hour)					
7	Wind velocity	Velocity	m/s	real	[0.0;+Inf]	0
	The velocity of the wind. (Interpolated at timesteps of less than one hour)					
8	Wind direction	Direction (Angle)	degrees	real	[0.0;360.0]	0
	The direction from which the wind originates. (Interpolated for timesteps of less than one hour) 0 = North 90 = East 180 = South 270 = West					
9	Dew point temperature	Temperature	C	real	[-Inf;+Inf]	0
	The dew point temperature of the ambient air.					
10	Percent relative humidity	Dimensionless	-	real	[0.0;100.0]	0
	The relative humidity of the ambient air (percentage).					
11	Diffuse radiation on horizontal	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
12	Global horizontal illuminance	Illuminance		real	[-Inf;+Inf]	0
13	Direct normal illuminance	Illuminance		real	[-Inf;+Inf]	0

14	Diffuse illuminance on horizontal	Illuminance		real	[-Inf;+Inf]	0
15	Zenith luminance	Luminance		real	[-Inf;+Inf]	0
16	Total sky cover	dimensionless	-	real	[-Inf;+Inf]	0
17	Opaque sky cover	dimensionless	-	real	[-Inf;+Inf]	0
18	Atmospheric pressure	Pressure	atm	real	[-Inf;+Inf]	0
19	Horizontal visibility	Length	km	real	[-Inf;+Inf]	0
20	Ceiling height	Length	m	real	[-Inf;+Inf]	0
21	Precipitable water	any	any	real	[-Inf;+Inf]	0
22	Aerosol optical depth	any	any	real	[-Inf;+Inf]	0
23	Snow depth	Length	cm	real	[-Inf;+Inf]	0
24	Days since last snowfall	Time	day	real	[-Inf;+Inf]	0
25	Extraterrestrial beam radiation	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
26	Extraterrestrial direct normal radiation	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The direct normal radiation for the location latitude in absence of the atmosphere.					
27	Infrared radiation - not in data file	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
28	Sky condition	dimensionless	-	real	[-Inf;+Inf]	0
	The sky condition is described by four numbers which correspond to ascending layers of the atmosphere. 0 = clear 1 = thin scattered clouds 2. = opaque scattered clouds 3 = thin broken clouds 4 = opaque broken clouds 5 = thin overcast 6 = opaque overcast 7 = obscuration 8 = partial obscuration an output of 0000 indicates that all four layers are clear an output of 1000 indicates that there are thin, scattered clouds low but that above them, it is clear.					
29	Output 29 not used	dimensionless	-	real	[-Inf;+Inf]	0
⋮	⋮	⋮	⋮	⋮	⋮	⋮
98	Output 98 not used	dimensionless	-	real	[-Inf;+Inf]	0
99	Time of last read	Time	hr	real	[0;+Inf]	0
	The time at which the last values were read from the data file. This output is to be used strictly with the TYPE 16 radiation processor Input 19.					
100	Time of next read	Time	hr	real	[0;+Inf]	0
	Thetime at which the next values will be read from the data file. This output is to be strictly used with the radiation processor Input 20.					
101	Month at next timestep	Dimensionless	-	real	[-Inf;+Inf]	0
	The month of the year at the next timestep.					
102	Hour at next timestep	Time	hr	real	[0;+Inf]	0
	The hour of the year at the next timestep.					
103	Direct normal at next timestep	Flux	kJ/hr.m^2	real	[0;+Inf]	0
	Direct normal solar radiation at the next timestep. Used with the radiation smoothing option in the radiation processor component.					
104	Global horiz. at next timestep	Flux	kJ/hr.m^2	real	[0;+Inf]	0
	Global horizontal surface radiation at the next timestep. Used with the smoothing option in he radiation processor.					
105	Dry bulb at next timestep	Temperature	C	real	[-Inf;+Inf]	0

	The dry bulb (ambient) temperature at the next timestep.					
106	Humidity ratio at next timestep	Dimensionless	-	real	[0.0;0.5]	0
	The absolute humidity ratio at the next timestep.					
107	Wind velocity at next timestep	Velocity	m/s	real	[0.0;+Inf]	0
	The wind velocity at the next timestep.					
108	Wind direction at next timestep	Direction (Angle)	degrees	real	[0.0;360.0]	0
	The wind direction at the next timestep. 0 = North 90 = East 180 = South 270 = West					
109	Dew point at next timestep	Temperature	C	real	[-Inf;+Inf]	0
	The dew point temperature of the ambient air at the next timestep.					
110	Percent relative humidity at next timestep	Dimensionless	-	real	[0.0;1.0]	0
	The percent relative humidity of the ambient air at the next timestep.					
111	Diffuse horizontal radiation at next timestep	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
112	Global illuminance at next timestep	Illuminance	Illuminance	real	[-Inf;+Inf]	0
113	Direct normal illuminance at next timestep	Illuminance	Illuminance	real	[-Inf;+Inf]	0
114	Diffuse illuminance at next timestep	Illuminance		real	[-Inf;+Inf]	0
115	Zenith luminance at next timestep	Luminance		real	[-Inf;+Inf]	0
116	Total sky cover at the next timestep	any	any	real	[-Inf;+Inf]	0
117	Opaque sky cover at next timestep	any	any	real	[-Inf;+Inf]	0
118	Atmospheric pressure at next timestep	Pressure	atm	real	[-Inf;+Inf]	0
119	Horizontal visibility at	Length	km	real	[-Inf;+Inf]	0
120	Ceiling height at next timestep	Length	m	real	[-Inf;+Inf]	0
121	Precipitable water at next timestep	any	any	real	[-Inf;+Inf]	0
122	Aerosol optical depth at next timestep	any	any	real	[-Inf;+Inf]	0
123	Snow depth at next timestep	any	any	real	[-Inf;+Inf]	0
124	Days since last snowfall at next timestep	Time	day	real	[-Inf;+Inf]	0
125	Extraterrestrial beam radiation at next timestep	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
126	Infrared radiation on horiz. at next timestep - not available	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
127	Extraterrestrial direct normal at next timestep	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
128	Sky condition at next timestep	Dimensionless	-	real	[-Inf;+Inf]	0

EXTERNAL FILES

Question	File	Associated parameter
Which file contains the IWEC weather information?		Logical unit
Source file	.\SourceCode\Types\Type89.for	

4.13.2.10. Standard Weather Files - IWEC - Skip N Lines before starting

Icon		TRNSYS Model	Type 89
Proforma	Utility\Data Readers\Standard Weather Files\IWEC\Skip N Lines before starting\Type89h.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Mode	Dimensionless	-	integer	[-4;-4]	-1
	Mode = 2 specifies to the general data reader component that the file to be read is a TRNSYS TMY2 weather file and that the first line in the data file corresponds to the simulation start time. This parameter should not be changed!					
2	Logical unit	Dimensionless	-	integer	[10;30]	13
	The logical unit through which the data reader will read the TMY weather file.					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Month	Dimensionless	-	integer	[-Inf;+Inf]	0
	The month of the year. (Not interpolated for timesteps less than 1 hour)					
2	Hour	Time	hr	real	[0.0;+Inf]	0
	The hour of the year. (Interpolated at timesteps less than 1 hour)					
3	Direct normal radiation	Flux	kJ/hr.m^2	real	[0.0;+Inf]	0
	The direct normal solar radiation integrated over the previous hour. (Not interpolated at timesteps less than 1 hour - use radiation processor to interpolate solar radiation)					
4	Global horizontal radiation	Flux	kJ/hr.m^2	real	[0.0;+Inf]	0
	The global solar radiation on a horizontal surface integrated over the previous hour. (Not interpolated at timesteps less than one hour - use radiation processor to interpolate solar radiation)					
5	Dry bulb temperature	Temperature	C	real	[-Inf;+Inf]	0
	The dry bulb (ambient) temperature. (Interpolated at timestep less than one hour)					
6	Humidity ratio	Dimensionless	-	real	[0.0;0.5]	0
	The absolute humidity ratio of the ambient air. (Interpolated at timesteps of less than one hour)					
7	Wind velocity	Velocity	m/s	real	[0.0;+Inf]	0
	The velocity of the wind. (Interpolated at timesteps of less than one hour)					
8	Wind direction	Direction (Angle)	degrees	real	[0.0;360.0]	0
	The direction from which the wind originates. (Interpolated for timesteps of less than one hour) 0 = North 90 = East 180 = South 270 = West					
9	Dew point temperature	Temperature	C	real	[-Inf;+Inf]	0
	The dew point temperature of the ambient air.					
10	Percent relative humidity	Dimensionless	-	real	[0.0;100.0]	0
	The relative humidity of the ambient air (percentage).					
11	Diffuse radiation on horizontal	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
12	Global horizontal illuminanace	Illuminance		real	[-Inf;+Inf]	0
13	Direct normal illuminance	Illuminance		real	[-Inf;+Inf]	0

14	Diffuse illuminance on horizontal	Illuminance		real	[-Inf;+Inf]	0
15	Zenith luminance	Luminance		real	[-Inf;+Inf]	0
16	Total sky cover	dimensionless	-	real	[-Inf;+Inf]	0
17	Opaque sky cover	dimensionless	-	real	[-Inf;+Inf]	0
18	Atmospheric pressure	Pressure	atm	real	[-Inf;+Inf]	0
19	Horizontal visibility	Length	km	real	[-Inf;+Inf]	0
20	Ceiling height	Length	m	real	[-Inf;+Inf]	0
21	Precipitable water	any	any	real	[-Inf;+Inf]	0
22	Aerosol optical depth	any	any	real	[-Inf;+Inf]	0
23	Snow depth	Length	cm	real	[-Inf;+Inf]	0
24	Days since last snowfall	Time	day	real	[-Inf;+Inf]	0
25	Extraterrestrial beam radiation	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
26	Extraterrestrial direct normal radiation	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The direct normal radiation for the location latitude in absence of the atmosphere.					
27	Infrared radiation - not in data file	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
28	Sky condition	dimensionless	-	real	[-Inf;+Inf]	0
	The sky condition is described by four numbers which correspond to ascending layers of the atmosphere. 0 = clear 1 = thin scattered clouds 2. = opaque scattered clouds 3 = thin broken clouds 4 = opaque broken clouds 5 = thin overcast 6 = opaque overcast 7 = obscuration 8 = partial obscuration an output of 0000 indicates that all four layers are clear an output of 1000 indicates that there are thin, scattered clouds low but that above them, it is clear.					
29	Output 29 not used	dimensionless	-	real	[-Inf;+Inf]	0
⋮	⋮	⋮	⋮	⋮	⋮	⋮
98	Output 98 not used	dimensionless	-	real	[-Inf;+Inf]	0
99	Time of last read	Time	hr	real	[0;+Inf]	0
	The time at which the last values were read from the data file. This output is to be used strictly with the TYPE 16 radiation processor Input 19.					
100	Time of next read	Time	hr	real	[0;+Inf]	0
	Thetime at which the next values will be read from the data file. This output is to be strictly used with the radiation processor Input 20.					
101	Month at next timestep	Dimensionless	-	real	[-Inf;+Inf]	0
	The month of the year at the next timestep.					
102	Hour at next timestep	Time	hr	real	[0;+Inf]	0
	The hour of the year at the next timestep.					
103	Direct normal at next timestep	Flux	kJ/hr.m^2	real	[0;+Inf]	0
	Direct normal solar radiation at the next timestep. Used with the radiation smoothing option in the radiation processor component.					
104	Global horiz. at next timestep	Flux	kJ/hr.m^2	real	[0;+Inf]	0
	Global horizontal surface radiation at the next timestep. Used with the smoothing option in he radiation processor.					
105	Dry bulb at next timestep	Temperature	C	real	[-Inf;+Inf]	0

	The dry bulb (ambient) temperature at the next timestep.					
106	Humidity ratio at next timestep	Dimensionless	-	real	[0.0;0.5]	0
	The absolute humidity ratio at the next timestep.					
107	Wind velocity at next timestep	Velocity	m/s	real	[0.0;+Inf]	0
	The wind velocity at the next timestep.					
108	Wind direction at next timestep	Direction (Angle)	degrees	real	[0.0;360.0]	0
	The wind direction at the next timestep. 0 = North 90 = East 180 = South 270 = West					
109	Dew point at next timestep	Temperature	C	real	[-Inf;+Inf]	0
	The dew point temperature of the ambient air at the next timestep.					
110	Percent relative humidity at next timestep	Dimensionless	-	real	[0.0;1.0]	0
	The percent relative humidity of the ambient air at the next timestep.					
111	Diffuse horizontal radiation at next timestep	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
112	Global illuminance at next timestep	Illuminance		real	[-Inf;+Inf]	0
113	Direct normal illuminance at next timestep	Illuminance		real	[-Inf;+Inf]	0
114	Diffuse illuminance at next timestep	Illuminance		real	[-Inf;+Inf]	0
115	Zenith luminance at next timestep	Luminance		real	[-Inf;+Inf]	0
116	Total sky cover at the next timestep	any	any	real	[-Inf;+Inf]	0
117	Opaque sky cover at next timestep	any	any	real	[-Inf;+Inf]	0
118	Atmospheric pressure at next timestep	Pressure	atm	real	[-Inf;+Inf]	0
119	Horizontal visibility at	Length	km	real	[-Inf;+Inf]	0
120	Ceiling height at next timestep	Length	m	real	[-Inf;+Inf]	0
121	Precipitable water at next timestep	any	any	real	[-Inf;+Inf]	0
122	Aerosol optical depth at next timestep	any	any	real	[-Inf;+Inf]	0
123	Snow depth at next timestep	any	any	real	[-Inf;+Inf]	0
124	Days since last snowfall at next timestep	Time	day	real	[-Inf;+Inf]	0
125	Extraterrestrial beam radiation at next timestep	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
126	Infrared radiation on horiz. at next timestep - not available	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
127	Extraterrestrial direct normal at next timestep	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
128	Sky condition at next timestep	dimensionless	-	real	[-Inf;+Inf]	0

EXTERNAL FILES

Question	File	Associated parameter
Which file contains the IWEC weather information?		Logical unit
Source file	.\SourceCode\Types\Type89.for	

4.13.2.11. Standard Weather Files - Standard Tmy - Simulation Start is first line

Icon		TRNSYS Model	Type 89
Proforma	Utility\Data Readers\Standard Weather Files\Standard Tmy\Simulation Start is first line\Type89i.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Mode	Dimensionless	-	integer	[5;5]	-1
	Mode = 2 specifies to the general data reader component that the file to be read is a TRNSYS TMY2 weather file and that the first line in the data file corresponds to the simulation start time. This parameter should not be changed!					
2	Logical unit	Dimensionless	-	integer	[10;999]	13
	The logical unit through which the data reader will read the TMY weather file.					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Month	Dimensionless	-	integer	[-Inf;+Inf]	0
	The month of the year. (Not interpolated for timesteps less than 1 hour)					
2	Hour	Time	hr	real	[0.0;+Inf]	0
	The hour of the year. (Interpolated at timesteps less than 1 hour)					
3	Direct normal radiation	Flux	kJ/hr.m^2	real	[0.0;+Inf]	0
	The direct normal solar radiation integrated over the previous hour. (Not interpolated at timesteps less than 1 hour - use radiation processor to interpolate solar radiation)					
4	Global horizontal radiation	Flux	kJ/hr.m^2	real	[0.0;+Inf]	0
	The global solar radiation on a horizontal surface integrated over the previous hour. (Not interpolated at timesteps less than one hour - use radiation processor to interpolate solar radiation)					
5	Dry bulb temperature	Temperature	C	real	[-Inf;+Inf]	0
	The dry bulb (ambient) temperature. (Interpolated at timestep less than one hour)					
6	Humidity ratio	Dimensionless	-	real	[0.0;0.5]	0
	The absolute humidity ratio of the ambient air. (Interpolated at timesteps of less than one hour)					
7	Wind velocity	Velocity	m/s	real	[0.0;+Inf]	0
	The velocity of the wind. (Interpolated at timesteps of less than one hour)					
8	Wind direction	Direction (Angle)	degrees	real	[0.0;360.0]	0
	The direction from which the wind originates. (Interpolated for timesteps of less than one hour) 0 = North 90 = East 180 = South 270 = West					
9	Dew point temperature	Temperature	C	real	[-Inf;+Inf]	0
	The dew point temperature of the ambient air.					
10	Percent relative humidity	Dimensionless	-	real	[0.0;100.0]	0
	The relative humidity of the ambient air (percentage).					
11	Diffuse radiation on horizontal	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
12	Global horizontal illuminance	Illuminance		real	[-Inf;+Inf]	0
13	Direct normal illuminance	Illuminance		real	[-Inf;+Inf]	0

14	Diffuse illuminance on horizontal	Illuminance		real	[-Inf;+Inf]	0
15	Zenith luminance	Luminance		real	[-Inf;+Inf]	0
16	Total sky cover	any	any	real	[-Inf;+Inf]	0
17	Opaque sky cover	any	any	real	[-Inf;+Inf]	0
18	Atmospheric pressure	Pressure	atm	real	[-Inf;+Inf]	0
19	Horizontal visibility	Length	km	real	[-Inf;+Inf]	0
20	Ceiling height	Length	m	real	[-Inf;+Inf]	0
21	Precipitable water	any	any	real	[-Inf;+Inf]	0
22	Aerosol optical depth	any	any	real	[-Inf;+Inf]	0
23	Snow depth	any	any	real	[-Inf;+Inf]	0
24	Days since last snowfall	Time	day	real	[-Inf;+Inf]	0
25	Extraterrestrial horizontal radiation	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The amount ot solar radiation in absence of the atmosphere incident on a horizontal surface.					
26	Extraterrestrial direct normal radiation	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The amount of solar radiation in absense of the atmosphere incident on a plane perpendicular to beam solar radiation.					
27	Horizontal infrared radiation	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The amount of infrared radiation incident per unit area on a horizontal surface.					
28	Output 28 not used	dimensionless	-	real	[-Inf;+Inf]	0
⋮	⋮	⋮	⋮	⋮	⋮	⋮
98	Output 98 not used	dimensionless	-	real	[-Inf;+Inf]	0
99	Time of last read	Time	hr	real	[0;+Inf]	0
	The time at which the last values were read from the data file. This output is to be used strictly with the TYPE 16 radiation processor Input 19.					
100	Time of next read	Time	hr	real	[0;+Inf]	0
	Thetime at which the next values will be read from the data file. This output is to be strictly used with the radiation processor Input 20.					
101	Month at next timestep	Dimensionless	-	real	[-Inf;+Inf]	0
	The month of the year at the next timestep.					
102	Hour at next timestep	Time	hr	real	[0;+Inf]	0
	The hour of the year at the next timestep.					
103	Direct normal at next timestep	Flux	kJ/hr.m^2	real	[0;+Inf]	0
	Direct normal solar radiation at the next timestep. Used with the radiation smoothing option in the radiation processor component.					
104	Global horiz. at next timestep	Flux	kJ/hr.m^2	real	[0;+Inf]	0
	Global horizontal surface radiation at the next timestep. Used with the smoothing option in he radiation processor.					
105	Dry bulb at next timestep	Temperature	C	real	[-Inf;+Inf]	0
	The dry bulb (ambient) temperature at the next timestep.					
106	Humidity ratio at next timestep	Dimensionless	-	real	[0.0;0.5]	0
	The absolute humidity ratio at the next timestep.					
107	Wind velocity at next timestep	Velocity	m/s	real	[0.0;+Inf]	0
	The wind velocity at the next timestep.					
108	Wind direction at next timestep	Direction (Angle)	degrees	real	[0.0;360.0]	0
	The wind direction at the next timestep. 0 = North 90 = East					

	180 = South 270 = West					
109	Dew point at next timestep	Temperature	C	real	[-Inf;+Inf]	0
	The dew point temperature of the ambient air at the next timestep.					
110	Percent relative humidity at next timestep	Dimensionless	-	real	[0.0;1.0]	0
	The percent relative humidity of the ambient air at the next timestep.					
111	Diffuse horizontal radiation at next timestep	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
112	Global illuminance at next timestep	Illuminance		real	[-Inf;+Inf]	0
113	Direct normal illuminance at next timestep	Illuminance		real	[-Inf;+Inf]	0
114	Diffuse illuminance at next timestep	Illuminance		real	[-Inf;+Inf]	0
115	Zenith luminance at next timestep	Luminance		real	[-Inf;+Inf]	0
116	Total sky cover at the next timestep	any	any	real	[-Inf;+Inf]	0
117	Opaque sky cover at next timestep	any	any	real	[-Inf;+Inf]	0
118	Atmospheric pressure at next timestep	Pressure	atm	real	[-Inf;+Inf]	0
119	Horizontal visibility at	Length	km	real	[-Inf;+Inf]	0
120	Ceiling height at next timestep	Length	m	real	[-Inf;+Inf]	0
121	Precipitable water at next timestep	any	any	real	[-Inf;+Inf]	0
122	Aerosol optical depth at next timestep	any	any	real	[-Inf;+Inf]	0
123	Snow depth at next timestep	any	any	real	[-Inf;+Inf]	0
124	Days since last snowfall at next timestep	Time	day	real	[-Inf;+Inf]	0
125	Extraterrestrial horizontal radiation at next timestep	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The amount ot solar radiation in absence of the atmosphere incident on a horizontal surface at the next timestep					
126	Extraterrestrial direct normal radiation at next timestep	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The amount of solar radiation in absense of the atmosphere incident on a plane perpendicular to beam solar radiation at the next time step.					
127	Horizontal infrared radiation at next timestep	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The amount of infrared radiation incident per unit area on a horizontal surface at the next timestep.					

EXTERNAL FILES

Question	**File**	**Associated parameter**
Which file contains the TMY weather information?		Logical unit
Source file	.\SourceCode\Types\Type89.for	

4.13.2.12. Standard Weather Files - Standard Tmy - Skip N Lines before starting

Icon		**TRNSYS Model**	Type 89
Proforma	Utility\Data Readers\Standard Weather Files\Standard Tmy\Skip N Lines before starting\Type89j.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Mode	Dimensionless	-	integer	[-5;-5]	-1
	Mode = -2 specifies to the general data reader component that the file to be read is a TRNSYS TMY2 weather file and that the program should skip into the data file corresponding to the simulation start time. This parameter should not be changed!					
2	Logical unit	Dimensionless	-	integer	[10;999]	13
	The logical unit through which the data reader will read the TMY weather file.					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Month	Dimensionless	-	integer	[-Inf;+Inf]	0
	The month of the year. (Not interpolated for timesteps less than 1 hour)					
2	Hour	Time	hr	real	[0.0;+Inf]	0
	The hour of the year. (Interpolated at timesteps less than 1 hour)					
3	Direct normal radiation	Flux	kJ/hr.m^2	real	[0.0;+Inf]	0
	The direct normal solar radiation integrated over the previous hour. (Not interpolated at timesteps less than 1 hour - use radiation processor to interpolate solar radiation)					
4	Global horizontal radiation	Flux	kJ/hr.m^2	real	[0.0;+Inf]	0
	The global solar radiation on a horizontal surface integrated over the previous hour. (Not interpolated at timesteps less than one hour - use radiation processor to interpolate solar radiation)					
5	Dry bulb temperature	Temperature	C	real	[-Inf;+Inf]	0
	The dry bulb (ambient) temperature. (Interpolated at timestep less than one hour)					
6	Humidity ratio	Dimensionless	-	real	[0.0;0.5]	0
	The absolute humidity ratio of the ambient air. (Interpolated at timesteps of less than one hour)					
7	Wind velocity	Velocity	m/s	real	[0.0;+Inf]	0
	The velocity of the wind. (Interpolated at timesteps of less than one hour)					
8	Wind direction	Direction (Angle)	degrees	real	[0.0;360.0]	0
	The direction from which the wind originates. (Interpolated for timesteps of less than one hour) 0 = North 90 = East 180 = South 270 = West					
9	Dew point temperature	Temperature	C	real	[-Inf;+Inf]	0
	The dew point temperature of the ambient air.					
10	Percent relative humidity	Dimensionless	-	real	[0.0;100.0]	0
	The relative humidity of the ambient air (percentage).					
11	Diffuse radiation on horizontal	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
12	Global horizontal illuminanace	Illuminance		real	[-Inf;+Inf]	0
13	Direct normal illuminance	Illuminance		real	[-Inf;+Inf]	0

14	Diffuse illuminance on horizontal	Illuminance		real	[-Inf;+Inf]	0
15	Zenith luminance	Luminance		real	[-Inf;+Inf]	0
16	Total sky cover	any	any	real	[-Inf;+Inf]	0
17	Opaque sky cover	any	any	real	[-Inf;+Inf]	0
18	Atmospheric pressure	Pressure	atm	real	[-Inf;+Inf]	0
19	Horizontal visibility	Length	km	real	[-Inf;+Inf]	0
20	Ceiling height	Length	m	real	[-Inf;+Inf]	0
21	Precipitable water	any	any	real	[-Inf;+Inf]	0
22	Aerosol optical depth	any	any	real	[-Inf;+Inf]	0
23	Snow depth	any	any	real	[-Inf;+Inf]	0
24	Days since last snowfall	Time	day	real	[-Inf;+Inf]	0
25	Extraterrestrial horizontal radiation	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The amount ot solar radiation in absence of the atmosphere incident on a horizontal surface.					
26	Extraterrestrial direct normal radiation	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The amount of solar radiation in absense of the atmosphere incident on a plane perpendicular to beam solar radiation.					
27	Horizontal infrared radiation	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The amount of infrared radiation incident per unit area on a horizontal surface.					
28	Output 28 not used	dimensionless	-	real	[-Inf;+Inf]	0
⋮	⋮	⋮	⋮	⋮	⋮	⋮
98	Output 98 not used	dimensionless	-	real	[-Inf;+Inf]	0
99	Time of last read	Time	hr	real	[0;+Inf]	0
	The time at which the last values were read from the data file. This output is to be used strictly with the TYPE 16 radiation processor Input 19.					
100	Time of next read	Time	hr	real	[0;+Inf]	0
	Thetime at which the next values will be read from the data file. This output is to be strictly used with the radiation processor Input 20.					
101	Month at next timestep	Dimensionless	-	real	[-Inf;+Inf]	0
	The month of the year at the next timestep.					
102	Hour at next timestep	Time	hr	real	[0;+Inf]	0
	The hour of the year at the next timestep.					
103	Direct normal at next timestep	Flux	kJ/hr.m^2	real	[0;+Inf]	0
	Direct normal solar radiation at the next timestep. Used with the radiation smoothing option in the radiation processor component.					
104	Global horiz. at next timestep	Flux	kJ/hr.m^2	real	[0;+Inf]	0
	Global horizontal surface radiation at the next timestep. Used with the smoothing option in he radiation processor.					
105	Dry bulb at next timestep	Temperature	C	real	[-Inf;+Inf]	0
	The dry bulb (ambient) temperature at the next timestep.					
106	Humidity ratio at next timestep	Dimensionless	-	real	[0.0;0.5]	0
	The absolute humidity ratio at the next timestep.					
107	Wind velocity at next timestep	Velocity	m/s	real	[0.0;+Inf]	0
	The wind velocity at the next timestep.					
108	Wind direction at next timestep	Direction (Angle)	degrees	real	[0.0;360.0]	0
	The wind direction at the next timestep. 0 = North 90 = East					

	180 = South 270 = West					
109	Dew point at next timestep	Temperature	C	real	[-Inf;+Inf]	0
	The dew point temperature of the ambient air at the next timestep.					
110	Percent relative humidity at next timestep	Dimensionless	-	real	[0.0;1.0]	0
	The percent relative humidity of the ambient air at the next timestep.					
111	Diffuse horizontal radiation at next timestep	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
112	Global illuminance at next timestep	Illuminance		real	[-Inf;+Inf]	0
113	Direct normal illuminance at next timestep	Illuminance		real	[-Inf;+Inf]	0
114	Diffuse illuminance at next timestep	Illuminance		real	[-Inf;+Inf]	0
115	Zenith luminance at next timestep	Luminance		real	[-Inf;+Inf]	0
116	Total sky cover at the next timestep	any	any	real	[-Inf;+Inf]	0
117	Opaque sky cover at next timestep	any	any	real	[-Inf;+Inf]	0
118	Atmospheric pressure at next timestep	Pressure	atm	real	[-Inf;+Inf]	0
119	Horizontal visibility at	Length	km	real	[-Inf;+Inf]	0
120	Ceiling height at next timestep	Length	m	real	[-Inf;+Inf]	0
121	Precipitable water at next timestep	any	any	real	[-Inf;+Inf]	0
122	Aerosol optical depth at next timestep	any	any	real	[-Inf;+Inf]	0
123	Snow depth at next timestep	any	any	real	[-Inf;+Inf]	0
124	Days since last snowfall at next timestep	Time	day	real	[-Inf;+Inf]	0
125	Extraterrestrial horizontal radiation at next timestep	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The amount ot solar radiation in absence of the atmosphere incident on a horizontal surface at the next time step.					
126	Extraterrestrial direct normal radiation at next timestep	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The amount of solar radiation in absense of the atmosphere incident on a plane perpendicular to beam solar radiation at the next time step.					
127	Horizontal infrared radiation at next timestep	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	The amount of infrared radiation incident per unit area on a horizontal surface at the next timestep.					

EXTERNAL FILES

Question	File	Associated parameter
Which file contains the TMY weather information?		Logical unit
Source file	.\SourceCode\Types\Type89.for	

4.13.2.13. Standard Weather Files - Tmy2 - Simulation Start is first line

Icon		TRNSYS Model	Type 89
Proforma	Utility\Data Readers\Standard Weather Files\Tmy2\Simulation Start is first line\Type89b.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Mode	Dimensionless	-	integer	[2;2]	-1
	Mode = 2 specifies to the general data reader component that the file to be read is a TRNSYS TMY2 weather file and that the first line in the data file corresponds to the simulation start time. This parameter should not be changed!					
2	Logical unit	Dimensionless	-	integer	[10;30]	13
	The logical unit through which the data reader will read the TMY weather file.					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Month	Dimensionless	-	integer	[-Inf;+Inf]	0
	The month of the year. (Not interpolated for timesteps less than 1 hour)					
2	Hour	Time	hr	real	[0.0;+Inf]	0
	The hour of the year. (Interpolated at timesteps less than 1 hour)					
3	Direct normal radiation	Flux	kJ/hr.m^2	real	[0.0;+Inf]	0
	The direct normal solar radiation integrated over the previous hour. (Not interpolated at timesteps less than 1 hour - use radiation processor to interpolate solar radiation)					
4	Global horizontal radiation	Flux	kJ/hr.m^2	real	[0.0;+Inf]	0
	The global solar radiation on a horizontal surface integrated over the previous hour. (Not interpolated at timesteps less than one hour - use radiation processor to interpolate solar radiation)					
5	Dry bulb temperature	Temperature	C	real	[-Inf;+Inf]	0
	The dry bulb (ambient) temperature. (Interpolated at timestep less than one hour)					
6	Humidity ratio	Dimensionless	-	real	[0.0;0.5]	0
	The absolute humidity ratio of the ambient air. (Interpolated at timesteps of less than one hour)					
7	Wind velocity	Velocity	m/s	real	[0.0;+Inf]	0
	The velocity of the wind. (Interpolated at timesteps of less than one hour)					
8	Wind direction	Direction (Angle)	degrees	real	[0.0;360.0]	0
	The direction from which the wind originates. (Interpolated for timesteps of less than one hour) 0 = North 90 = East 180 = South 270 = West					
9	Dew point temperature	Temperature	C	real	[-Inf;+Inf]	0
	The dew point temperature of the ambient air.					
10	Percent relative humidity	Dimensionless	-	real	[0.0;100.0]	0
	The relative humidity of the ambient air (percentage).					
11	Diffuse radiation on horizontal	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
12	Global horizontal illuminance	Illuminance	Illuminance	real	[-Inf;+Inf]	0
13	Direct normal illuminance	Illuminance	Illuminance	real	[-Inf;+Inf]	0

14	Diffuse illuminance on horizontal	Illuminance	Illuminance	real	[-Inf;+Inf]	0
15	Zenith luminance	Luminance	Luminance	real	[-Inf;+Inf]	0
16	Total sky cover	any	any	real	[-Inf;+Inf]	0
17	Opaque sky cover	any	any	real	[-Inf;+Inf]	0
18	Atmospheric pressure	Pressure	atm	real	[-Inf;+Inf]	0
19	Horizontal visibility	Length	km	real	[-Inf;+Inf]	0
20	Ceiling height	Length	m	real	[-Inf;+Inf]	0
21	Precipitable water	any	any	real	[-Inf;+Inf]	0
22	Aerosol optical depth	any	any	real	[-Inf;+Inf]	0
23	Snow depth	any	any	real	[-Inf;+Inf]	0
24	Days since last snowfall	Time	day	real	[-Inf;+Inf]	0
25	Output 25 not used	Dimensionless	-	real	[-Inf;+Inf]	0
⋮	⋮	⋮	⋮	⋮	⋮	⋮
98	Output 98 not used	dimensionless	-	real	[-Inf;+Inf]	0
99	Time of last read	Time	hr	real	[0;+Inf]	0
	The time at which the last values were read from the data file. This output is to be used strictly with the TYPE 16 radiation processor Input 19.					
100	Time of next read	Time	hr	real	[0;+Inf]	0
	Thetime at which the next values will be read from the data file. This output is to be strictly used with the radiation processor Input 20.					
101	Month at next timestep	Dimensionless	-	real	[-Inf;+Inf]	0
	The month of the year at the next timestep.					
102	Hour at next timestep	Time	hr	real	[0;+Inf]	0
	The hour of the year at the next timestep.					
103	Direct normal at next timestep	Flux	kJ/hr.m^2	real	[0;+Inf]	0
	Direct normal solar radiation at the next timestep. Used with the radiation smoothing option in the radiation processor component.					
104	Global horiz. at next timestep	Flux	kJ/hr.m^2	real	[0;+Inf]	0
	Global horizontal surface radiation at the next timestep. Used with the smoothing option in he radiation processor.					
105	Dry bulb at next timestep	Temperature	C	real	[-Inf;+Inf]	0
	The dry bulb (ambient) temperature at the next timestep.					
106	Humidity ratio at next timestep	Dimensionless	-	real	[0.0;0.5]	0
	The absolute humidity ratio at the next timestep.					
107	Wind velocity at next timestep	Velocity	m/s	real	[0.0;+Inf]	0
	The wind velocity at the next timestep.					
108	Wind direction at next timestep	Direction (Angle)	degrees	real	[0.0;360.0]	0
	The wind direction at the next timestep. 0 = North 90 = East 180 = South 270 = West					
109	Dew point at next timestep	Temperature	C	real	[-Inf;+Inf]	0
	The dew point temperature of the ambient air at the next timestep.					
110	Percent relative humidity at next timestep	Dimensionless	-	real	[0.0;1.0]	0
	The percent relative humidity of the ambient air at the next timestep.					

111	Diffuse horizontal radiation at next timestep	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
112	Global illuminance at next timestep	Illuminance	Illuminance	real	[-Inf;+Inf]	0
113	Direct normal illuminance at next timestep	Illuminance	Illuminance	real	[-Inf;+Inf]	0
114	Diffuse illuminance at next timestep	Illuminance	Illuminance	real	[-Inf;+Inf]	0
115	Zenith luminance at next timestep	Luminance	Luminance	real	[-Inf;+Inf]	0
116	Total sky cover at the next timestep	any	any	real	[-Inf;+Inf]	0
117	Opaque sky cover at next timestep	any	any	real	[-Inf;+Inf]	0
118	Atmospheric pressure at next timestep	Pressure	atm	real	[-Inf;+Inf]	0
119	Horizontal visibility at	Length	km	real	[-Inf;+Inf]	0
120	Ceiling height at next timestep	Length	m	real	[-Inf;+Inf]	0
121	Precipitable water at next timestep	any	any	real	[-Inf;+Inf]	0
122	Aerosol optical depth at next timestep	any	any	real	[-Inf;+Inf]	0
123	Snow depth at next timestep	any	any	real	[-Inf;+Inf]	0
124	Days since last snowfall at next timestep	Time	day	real	[-Inf;+Inf]	0

EXTERNAL FILES

Question	File	Associated parameter
Which file contains the TMY2 weather information?		Logical unit
Source file	.\SourceCode\Types\Type89.for	

4.13.2.14. Standard Weather Files - Tmy2 - Skip N Lines before starting

Icon		**TRNSYS Model**	Type 89
Proforma	Utility\Data Readers\Standard Weather Files\Tmy2\Skip N Lines before starting\Type89d.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Mode	Dimensionless	-	integer	[-2;-2]	-1
	Mode = -2 specifies to the general data reader component that the file to be read is a TRNSYS TMY2 weather file and that the program should skip into the data file corresponding to the simulation start time. This parameter should not be changed!					
2	Logical unit	Dimensionless	-	integer	[10;30]	13
	The logical unit through which the data reader will read the TMY weather file.					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Month	Dimensionless	-	integer	[-Inf;+Inf]	0
	The month of the year. (Not interpolated for timesteps less than 1 hour)					
2	Hour	Time	hr	real	[0.0;+Inf]	0
	The hour of the year. (Interpolated at timesteps less than 1 hour)					
3	Direct normal radiation	Flux	kJ/hr.m^2	real	[0.0;+Inf]	0
	The direct normal solar radiation integrated over the previous hour. (Not interpolated at timesteps less than 1 hour - use radiation processor to interpolate solar radiation)					
4	Global horizontal radiation	Flux	kJ/hr.m^2	real	[0.0;+Inf]	0
	The global solar radiation on a horizontal surface integrated over the previous hour. (Not interpolated at timesteps less than one hour - use radiation processor to interpolate solar radiation)					
5	Dry bulb temperature	Temperature	C	real	[-Inf;+Inf]	0
	The dry bulb (ambient) temperature. (Interpolated at timestep less than one hour)					
6	Humidity ratio	Dimensionless	-	real	[0.0;0.5]	0
	The absolute humidity ratio of the ambient air. (Interpolated at timesteps of less than one hour)					
7	Wind velocity	Velocity	m/s	real	[0.0;+Inf]	0
	The velocity of the wind. (Interpolated at timesteps of less than one hour)					
8	Wind direction	Direction (Angle)	degrees	real	[0.0;360.0]	0
	The direction from which the wind originates. (Interpolated for timesteps of less than one hour) 0 = North 90 = East 180 = South 270 = West					
9	Dew point temperature	Temperature	C	real	[-Inf;+Inf]	0
	The dew point temperature of the ambient air.					
10	Percent relative humidity	Dimensionless	-	real	[0.0;100.0]	0
	The relative humidity of the ambient air (percentage).					
11	Diffuse radiation on horizontal	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
12	Global horizontal illuminanace	Illuminance	Illuminance	real	[-Inf;+Inf]	0
13	Direct normal illuminance	Illuminance		real	[-Inf;+Inf]	0

14	Diffuse illuminance on horizontal	Illuminance		real	[-Inf;+Inf]	0
15	Zenith luminance	Luminance		real	[-Inf;+Inf]	0
16	Total sky cover	any	any	real	[-Inf;+Inf]	0
17	Opaque sky cover	any	any	real	[-Inf;+Inf]	0
18	Atmospheric pressure	Pressure	atm	real	[-Inf;+Inf]	0
19	Horizontal visibility	Length	km	real	[-Inf;+Inf]	0
20	Ceiling height	Length	m	real	[-Inf;+Inf]	0
21	Precipitable water	any	any	real	[-Inf;+Inf]	0
22	Aerosol optical depth	any	any	real	[-Inf;+Inf]	0
23	Snow depth	any	any	real	[-Inf;+Inf]	0
24	Days since last snowfall	Time	day	real	[-Inf;+Inf]	0
25	Output 25 not used	dimensionless	-	real	[-Inf;+Inf]	0
⋮	⋮	⋮	⋮	⋮	⋮	⋮
98	Output 98 not used	dimensionless	-	real	[-Inf;+Inf]	0
99	Time of last read	Time	hr	real	[0;+Inf]	0
	The time at which the last values were read from the data file. This output is to be used strictly with the TYPE 16 radiation processor Input 19.					
100	Time of next read	Time	hr	real	[0;+Inf]	0
	Thetime at which the next values will be read from the data file. This output is to be strictly used with the radiation processor Input 20.					
101	Month at next timestep	Dimensionless	-	real	[-Inf;+Inf]	0
	The month of the year at the next timestep.					
102	Hour at next timestep	Time	hr	real	[0;+Inf]	0
	The hour of the year at the next timestep.					
103	Direct normal at next timestep	Flux	kJ/hr.m^2	real	[0;+Inf]	0
	Direct normal solar radiation at the next timestep. Used with the radiation smoothing option in the radiation processor component.					
104	Global horiz. at next timestep	Flux	kJ/hr.m^2	real	[0;+Inf]	0
	Global horizontal surface radiation at the next timestep. Used with the smoothing option in he radiation processor.					
105	Dry bulb at next timestep	Temperature	C	real	[-Inf;+Inf]	0
	The dry bulb (ambient) temperature at the next timestep.					
106	Humidity ratio at next timestep	Dimensionless	-	real	[0.0;0.5]	0
	The absolute humidity ratio at the next timestep.					
107	Wind velocity at next timestep	Velocity	m/s	real	[0.0;+Inf]	0
	The wind velocity at the next timestep.					
108	Wind direction at next timestep	Direction (Angle)	degrees	real	[0.0;360.0]	0
	The wind direction at the next timestep. 0 = North 90 = East 180 = South 270 = West					
109	Dew point at next timestep	Temperature	C	real	[-Inf;+Inf]	0
	The dew point temperature of the ambient air at the next timestep.					
110	Percent relative humidity at next timestep	Dimensionless	-	real	[0.0;1.0]	0
	The percent relative humidity of the ambient air at the next timestep.					

111	Diffuse horizontal radiation at next timestep	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
112	Global illuminance at next timestep	Illuminance	Illuminance	real	[-Inf;+Inf]	0
113	Direct normal illuminance at next timestep	Illuminance	Illuminance	real	[-Inf;+Inf]	0
114	Diffuse illuminance at next timestep	Illuminance		real	[-Inf;+Inf]	0
115	Zenith luminance at next timestep	Luminance	Luminance	real	[-Inf;+Inf]	0
116	Total sky cover at the next timestep	any	any	real	[-Inf;+Inf]	0
117	Opaque sky cover at next timestep	any	any	real	[-Inf;+Inf]	0
118	Atmospheric pressure at next timestep	Pressure	atm	real	[-Inf;+Inf]	0
119	Horizontal visibility at	Length	km	real	[-Inf;+Inf]	0
120	Ceiling height at next timestep	Length	m	real	[-Inf;+Inf]	0
121	Precipitable water at next timestep	any	any	real	[-Inf;+Inf]	0
122	Aerosol optical depth at next timestep	any	any	real	[-Inf;+Inf]	0
123	Snow depth at next timestep	any	any	real	[-Inf;+Inf]	0
124	Days since last snowfall at next timestep	Time	day	real	[-Inf;+Inf]	0

EXTERNAL FILES

Question	**File**	**Associated parameter**
Which file contains the TMY2 weather information?		Logical unit
Source file	.\SourceCode\Types\Type89.for	

4.13.2.15. Standard Weather Files - Trnsys Tmy - Simulation Start is first line

Icon		**TRNSYS Model**	Type 89
Proforma	Utility\Data Readers\Standard Weather Files\Trnsys Tmy\Simulation Start is first line\Type89a.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Mode	Dimensionless	-	integer	[1;1]	-1
	Mode = 1 specifies to the general data reader component that the file to be read is a TRNSYS TMY weather file and that the first line in the data file corresponds to the simulation start time. This parameter should not be changed!					
2	Logical unit	Dimensionless	-	integer	[10;30]	13
	The logical unit through which the data reader will read the TMY weather file.					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Month	Dimensionless	-	integer	[-Inf;+Inf]	0
	The month of the year. (Not interpolated for timesteps less than 1 hour)					
2	Hour	Time	hr	real	[0.0;+Inf]	0
	The hour of the year. (Interpolated at timesteps less than 1 hour)					
3	Direct normal radiation	Flux	kJ/hr.m^2	real	[0.0;+Inf]	0
	The direct normal solar radiation integrated over the previous hour. (Not interpolated at timesteps less than 1 hour - use radiation processor to interpolate solar radiation)					
4	Global horizontal radiation	Flux	kJ/hr.m^2	real	[0.0;+Inf]	0
	The global solar radiation on a horizontal surface integrated over the previous hour. (Not interpolated at timesteps less than one hour - use radiation processor to interpolate solar radiation)					
5	Dry bulb temperature	Temperature	C	real	[-Inf;+Inf]	0
	The dry bulb (ambient) temperature. (Interpolated at timestep less than one hour)					
6	Humidity ratio	Dimensionless	-	real	[0.0;0.5]	0
	The absolute humidity ratio of the ambient air. (Interpolated at timesteps of less than one hour)					
7	Wind velocity	Velocity	m/s	real	[0.0;+Inf]	0
	The velocity of the wind. (Interpolated at timesteps of less than one hour)					
8	Wind direction	Direction (Angle)	degrees	real	[0.0;360.0]	0
	The direction from which the wind originates. (Interpolated for timesteps of less than one hour) 0 = North 90 = East 180 = South 270 = West					
9	Dew point temperature	Temperature	C	real	[-Inf;+Inf]	0
	The dew point temperature of the ambient air.					
10	Percent relative humidity	Dimensionless	-	real	[0.0;100.0]	0
	The relative humidity of the ambient air (percentage).					
11	Output 11 not used	dimensionless	-	real	[-Inf;+Inf]	0
⋮	⋮	⋮	⋮	⋮	⋮	⋮
98	Output 98 not used	any	any	real	[-Inf;+Inf]	0

99	Time of last read	Time	hr	real	[0;+Inf]	0
	The time at which the last values were read from the data file. This output is to be used strictly with the TYPE 16 radiation processor Input 19.					
100	Time of next read	Time	hr	real	[0;+Inf]	0
	Thetime at which the next values will be read from the data file. This output is to be strictly used with the radiation processor Input 20.					
101	Month at next timestep	Dimensionless	-	real	[-Inf;+Inf]	0
	The month of the year at the next timestep.					
102	Hour at next timestep	Time	hr	real	[0;+Inf]	0
	The hour of the year at the next timestep.					
103	Direct normal at next timestep	Flux	kJ/hr.m^2	real	[0;+Inf]	0
	Direct normal solar radiation at the next timestep. Used with the radiation smoothing option in the radiation processor component.					
104	Global horiz. at next timestep	Flux	kJ/hr.m^2	real	[0;+Inf]	0
	Global horizontal surface radiation at the next timestep. Used with the smoothing option in he radiation processor.					
105	Dry bulb at next timestep	Temperature	C	real	[-Inf;+Inf]	0
	The dry bulb (ambient) temperature at the next timestep.					
106	Humidity ratio at next timestep	Dimensionless	-	real	[0.0;0.5]	0
	The absolute humidity ratio at the next timestep.					
107	Wind velocity at next timestep	Velocity	m/s	real	[0.0;+Inf]	0
	The wind velocity at the next timestep.					
108	Wind direction at next timestep	Direction (Angle)	degrees	real	[0.0;360.0]	0
	The wind direction at the next timestep. 0 = North 90 = East 180 = South 270 = West					
109	Dew point at next timestep	Temperature	C	real	[-Inf;+Inf]	0
	The dew point temperature of the ambient air at the next timestep.					
110	Percent relative humidity at next timestep	Dimensionless	-	real	[0.0;1.0]	0
	The percent relative humidity of the ambient air at the next timestep.					

EXTERNAL FILES

Question	File	Associated parameter
Which file contains the TRNSYS TMY weather information?		Logical unit
Source file	.\SourceCode\Types\Type89.for	

4.13.2.16. Standard Weather Files - Trnsys Tmy - Skip N Lines before starting

Icon		TRNSYS Model	Type 89
Proforma	Utility\Data Readers\Standard Weather Files\Trnsys Tmy\Skip N Lines before starting\Type89c.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Mode	Dimensionless	-	integer	[-1;-1]	-1
	Mode = -1 specifies to the general data reader component that the file to be read is a TRNSYS TMY weather file and that the program should skip into the data file corresponding to the simulation start time. This parameter should not be changed!					
2	Logical unit	Dimensionless	-	integer	[10;30]	13
	The logical unit through which the data reader will read the TMY weather file.					

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Month	Dimensionless	-	integer	[-Inf;+Inf]	0
	The month of the year. (Not interpolated for timesteps less than 1 hour)					
2	Hour	Time	hr	real	[0.0;+Inf]	0
	The hour of the year. (Interpolated at timesteps less than 1 hour)					
3	Direct normal radiation	Flux	kJ/hr.m^2	real	[0.0;+Inf]	0
	The direct normal solar radiation integrated over the previous hour. (Not interpolated at timesteps less than 1 hour - use radiation processor to interpolate solar radiation)					
4	Global horizontal radiation	Flux	kJ/hr.m^2	real	[0.0;+Inf]	0
	The global solar radiation on a horizontal surface integrated over the previous hour. (Not interpolated at timesteps less than one hour - use radiation processor to interpolate solar radiation)					
5	Dry bulb temperature	Temperature	C	real	[-Inf;+Inf]	0
	The dry bulb (ambient) temperature. (Interpolated at timestep less than one hour)					
6	Humidity ratio	Dimensionless	-	real	[0.0;0.5]	0
	The absolute humidity ratio of the ambient air. (Interpolated at timesteps of less than one hour)					
7	Wind velocity	Velocity	m/s	real	[0.0;+Inf]	0
	The velocity of the wind. (Interpolated at timesteps of less than one hour)					
8	Wind direction	Direction (Angle)	degrees	real	[0.0;360.0]	0
	The direction from which the wind originates. (Interpolated for timesteps of less than one hour) 0 = North 90 = East 180 = South 270 = West					
9	Dew point temperature	Temperature	C	real	[-Inf;+Inf]	0
	The dew point temperature of the ambient air.					
10	Percent relative humidity	Dimensionless	-	real	[0.0;100.0]	0
	The relative humidity of the ambient air (percentage).					
11	Output 11 not used	dimensionless	-	real	[-Inf;+Inf]	0
⋮	⋮	⋮	⋮	⋮	⋮	⋮
98	Output 98 not used	any	any	real	[-Inf;+Inf]	0

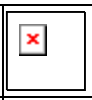
99	Time of last read	Time	hr	real	[0;+Inf]	0
	The time at which the last values were read from the data file. This output is to be used strictly with the TYPE 16 radiation processor Input 19.					
100	Time of next read	Time	hr	real	[0;+Inf]	0
	Thetime at which the next values will be read from the data file. This output is to be strictly used with the radiation processor Input 20.					
101	Month at next timestep	Dimensionless	-	real	[-Inf;+Inf]	0
	The month of the year at the next timestep.					
102	Hour at next timestep	Time	hr	real	[0;+Inf]	0
	The hour of the year at the next timestep.					
103	Direct normal at next timestep	Flux	kJ/hr.m^2	real	[0;+Inf]	0
	Direct normal solar radiation at the next timestep. Used with the radiation smoothing option in the radiation processor component.					
104	Global horiz. at next timestep	Flux	kJ/hr.m^2	real	[0;+Inf]	0
	Global horizontal surface radiation at the next timestep. Used with the smoothing option in he radiation processor.					
105	Dry bulb at next timestep	Temperature	C	real	[-Inf;+Inf]	0
	The dry bulb (ambient) temperature at the next timestep.					
106	Humidity ratio at next timestep	Dimensionless	-	real	[0.0;0.5]	0
	The absolute humidity ratio at the next timestep.					
107	Wind velocity at next timestep	Velocity	m/s	real	[0.0;+Inf]	0
	The wind velocity at the next timestep.					
108	Wind direction at next timestep	Direction (Angle)	degrees	real	[0.0;360.0]	0
	The wind direction at the next timestep. 0 = North 90 = East 180 = South 270 = West					
109	Dew point at next timestep	Temperature	C	real	[-Inf;+Inf]	0
	The dew point temperature of the ambient air at the next timestep.					
110	Percent relative humidity at next timestep	Dimensionless	-	real	[0.0;1.0]	0
	The percent relative humidity of the ambient air at the next timestep.					

EXTERNAL FILES

Question	File	Associated parameter
Which file contains the TRNSYS TMY weather information?		Logical unit
Source file	.\SourceCode\Types\Type89.for	

4.13.3. Forcing Function Sequencers

4.13.3.1. Unique Days and Holidays

Icon		**TRNSYS Model**	Type 41
Proforma	Utility\Forcing Function Sequencers\Unique Days and Holidays\Type41d.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Number of profiles for each day	dimensionless	-	integer	[1;20]	0
2	Input set for day 1	dimensionless	-	integer	[1;1]	0
3	Input set for day 2	dimensionless	-	real	[2;2]	0
4	Input set for day 3	dimensionless	-	integer	[3;3]	0
5	Input set for day 4	dimensionless	-	integer	[4;4]	0
6	Input set for day 5	dimensionless	-	integer	[5;5]	0
7	Input set for day 6	dimensionless	-	integer	[6;6]	0
8	Input set for day 7	dimensionless	-	integer	[7;7]	0
9	Number of nonstandard days	dimensionless	-	integer	[1;365]	0
10	Input set for nonstandard days	dimensionless	-	real	[8;8]	0
11	Day of year for nonstandard day	dimensionless	-	integer	[1;365]	0

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
11-11	Number of nonstandard days		1	100

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	First day input	any	any	real	[-Inf;+Inf]	0
2	Second day input	any	any	real	[-Inf;+Inf]	0
3	Third day input	any	any	real	[-Inf;+Inf]	0
4	Fourth day input	any	any	real	[-Inf;+Inf]	0
5	Fifth day input	any	any	real	[-Inf;+Inf]	0
6	Sixth day input	any	any	real	[-Inf;+Inf]	0
7	Seventh day input	any	any	real	[-Inf;+Inf]	0
8	Nonstandard day input	any	any	real	[-Inf;+Inf]	0

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
1-1	Number of profiles for each day		1	100
2-2	Number of profiles for each day		1	100
3-3	Number of profiles for each day		1	100
4-4	Number of profiles for each day		1	100
5-5	Number of profiles for each day		1	100

6-6	Number of profiles for each day		1	100
7-7	Number of profiles for each day		1	100
8-8	Number of profiles for each day		1	100

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Forcing function output for current day	any	any	real	[-Inf;+Inf]	0

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
1-1	Number of profiles for each day		1	100

4.13.3.2. Unique Days of the Week

Icon		TRNSYS Model	Type 41
Proforma	Utility\Forcing Function Sequencers\Unique Days of the Week\Type41c.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Number of profiles for each day	dimensionless	-	integer	[1;20]	0
2	Input set for day 1	dimensionless	-	integer	[1;1]	0
3	Input set for day 2	dimensionless	-	real	[2;2]	0
4	Input set for day 3	dimensionless	-	integer	[3;3]	0
5	Input set for day 4	dimensionless	-	integer	[4;4]	0
6	Input set for day 5	dimensionless	-	integer	[5;5]	0
7	Input set for day 6	dimensionless	-	integer	[6;6]	0
8	Input set for day 7	dimensionless	-	integer	[7;7]	0

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	First day input	any	any	real	[-Inf;+Inf]	0
2	Second day input	any	any	real	[-Inf;+Inf]	0
3	Third day input	any	any	real	[-Inf;+Inf]	0
4	Fourth day input	any	any	real	[-Inf;+Inf]	0
5	Fifth day input	any	any	real	[-Inf;+Inf]	0
6	Sixth day input	any	any	real	[-Inf;+Inf]	0
7	Seventh day input	any	any	real	[-Inf;+Inf]	0

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
1-1	Number of profiles for each day		1	100
2-2	Number of profiles for each day		1	100
3-3	Number of profiles for each day		1	100
4-4	Number of profiles for each day		1	100
5-5	Number of profiles for each day		1	100
6-6	Number of profiles for each day		1	100
7-7	Number of profiles for each day		1	100

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Forcing function output for current day	any	any	real	[-Inf;+Inf]	0

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
1-1	Number of profiles for each day		1	100

4.13.3.3. Weekdays and Weekends

Icon		TRNSYS Model	Type 41
Proforma	Utility\Forcing Function Sequencers\Weekdays and Weekends\Type41a.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Number of profiles for each day	dimensionless	-	integer	[1;20]	0
2	Input set for day 1	dimensionless	-	integer	[1;2]	0
3	Input set for day 2	dimensionless	-	real	[1;2]	0
4	Input set for day 3	dimensionless	-	integer	[1;2]	0
5	Input set for day 4	dimensionless	-	integer	[1;2]	0
6	Input set for day 5	dimensionless	-	integer	[1;2]	0
7	Input set for day 6	dimensionless	-	integer	[1;2]	0
8	Input set for day 7	dimensionless	-	integer	[1;2]	0

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Weekday input	any	any	real	[-Inf;+Inf]	0
2	Weekend input	any	any	real	[-Inf;+Inf]	0

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
1-1	Number of profiles for each day		1	100
2-2	Number of profiles for each day		1	100

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Forcing function output for current day	any	any	real	[-Inf;+Inf]	0

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
1-1	Number of profiles for each day		1	100

4.13.3.4. Weekdays Weekends and Holidays

Icon		TRNSYS Model	Type 41
Proforma	Utility\Forcing Function Sequencers\Weekdays Weekends and Holidays\Type41b.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Number of profiles for each day	dimensionless	-	integer	[1;20]	0
2	Input set for day 1	dimensionless	-	integer	[1;2]	0
3	Input set for day 2	dimensionless	-	real	[1;2]	0
4	Input set for day 3	dimensionless	-	integer	[1;2]	0
5	Input set for day 4	dimensionless	-	integer	[1;2]	0
6	Input set for day 5	dimensionless	-	integer	[1;2]	0
7	Input set for day 6	dimensionless	-	integer	[1;2]	0
8	Input set for day 7	dimensionless	-	integer	[1;2]	0
9	Number of nonstandard days	dimensionless	-	integer	[1;365]	0
10	Input set for nonstandard day	dimensionless	-	real	[3;3]	0
11	Day of year for nonstandard day	dimensionless	-	integer	[1;365]	0

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
11-11	Number of nonstandard days		1	100

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Weekday input	any	any	real	[-Inf;+Inf]	0
2	Weekend input	any	any	real	[-Inf;+Inf]	0
3	Nonstandard day input	any	any	real	[-Inf;+Inf]	0

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
1-1	Number of profiles for each day		1	100
2-2	Number of profiles for each day		1	100
3-3	Number of profiles for each day		1	100

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Forcing function output for current day	any	any	real	[-Inf;+Inf]	0

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
1-1	Number of profiles for each day		1	100

4.13.4. Forcing Functions

4.13.4.1. General

Icon		TRNSYS Model	Type 14
Proforma	Utility\Forcing Functions\General\Type14h.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Initial value of time	Time	hr	real	[0;+Inf]	0
	The initial value of time for the function. If the cycle is to repeat, this initial value of time must be set to 0.0.					
2	Initial value of function	any	any	real	[-Inf;+Inf]	0.0
	The value of the function at the initial value of time.					
3	Time at point	Time	hr	real	[0;+Inf]	1.0
	The value of time at the specified data point.					
4	Value at point	any	any	real	[-Inf;+Inf]	0
	The value of the function at the specified data point.					

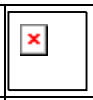
Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
3-4		Besides the initial point, how many points make up the forcing function?	1	100

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Average value of function	any	any	real	[-Inf;+Inf]	0
	The average value of the function over the timestep.					
2	Instantaneous value of function over the timestep	any	any	real	[-Inf;+Inf]	0
	The instantaneous value of the function at the end of the timestep.					

4.13.4.2. Internal Gains

Icon		TRNSYS Model	Type 14
Proforma	Utility\Forcing Functions\Internal Gains\Type14c.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Initial value of time	Time	hr	real	[0.0;+Inf]	0
	The initial value of time for the function. If the cycle is to repeat, this initial value of time must be set to 0.0.					
2	Initial value of gains	Power	kJ/hr	real	[-Inf;+Inf]	0.0
	The internal gains at the initial value of time.					
3	Time at point	Time	hr	real	[0.0;+Inf]	1.0
	The value of time at the specified data point.					
4	Internal gains at point	Power	kJ/hr	real	[-Inf;+Inf]	0.0
	The internal gains at the specified data point.					

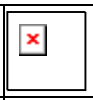
Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
3-4		Besides the initial point, how many points make up the forcing function?	1	50

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Average internal gains	Power	kJ/hr	real	[-Inf;+Inf]	0
	The average value of the internal gain function over the timestep.					
2	Instantaneous internal gains	Flow Rate	kg/hr	real	[-Inf;+Inf]	0
	The instantaneous value of the internal gain function occurring at the end of the timestep.					

4.13.4.3. Lighting

Icon		TRNSYS Model	Type 14
Proforma	Utility\Forcing Functions\Lighting\Type14d.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Initial value of time	Time	hr	real	[0.0;+Inf]	0
	The initial value of time for the function. If the cycle is to repeat, this initial value of time must be set to 0.0.					
2	Initial value of lighting	Power	kJ/hr	real	[-Inf;+Inf]	0.0
	The value of lighting at the initial value of time.					
3	Time at point	Time	hr	real	[0.0;+Inf]	1.0
	The value of time at the specified data point.					
4	Lighting at point	Power	kJ/hr	real	[-Inf;+Inf]	0.0
	The value of lighting at the specified data point.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
3-4		Besides the initial point, how many points make up the forcing function?	1	50

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Average lighting	Power	kJ/hr	real	[-Inf;+Inf]	0
	The average value of the lighting function over the timestep.					
2	Instantaneous lighting	Power	kJ/hr	real	[-Inf;+Inf]	0
	The instantaneous value of the lighting function occurring at the end of the timestep.					

4.13.4.4. Occupancy

Icon		TRNSYS Model	Type 14
Proforma	Utility\Forcing Functions\Occupancy\Type14a.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Initial value of time	Time	hr	real	[0.0;+Inf]	0
	The initial value of time for the function. If the cycle is to repeat, this initial value of time must be set to 0.0.					
2	Initial number of people	Dimensionless	-	integer	[0;+Inf]	0
	The number of people at the initial value of time.					
3	Time at point	Time	hr	real	[0.0;+Inf]	1.0
	The value of time at the specified data point.					
4	Occupancy at point	Dimensionless	-	integer	[0;+Inf]	2
	The number of occupants at the specified data point.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
3-4		Besides the initial point, how many points make up the forcing function?	1	50

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Average number of occupants	Dimensionless	-	real	[-Inf;+Inf]	0
	The average number of occupants over the timestep.					
2	Instantaneous number of occupants	Dimensionless	-	real	[-Inf;+Inf]	0
	The instantaneous value of the occupancy function occurring at the end of the timestep.					

4.13.4.5. Relative Humidity

Icon		TRNSYS Model	Type 14
Proforma	Utility\Forcing Functions\Relative Humidity\Type14f.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Initial value of time	Time	hr	real	[0;+Inf]	0
	The initial value of time for the function. If the cycle is to repeat, this initial value of time must be set to 0.0.					
2	Initial value of relative humidity	Dimensionless	-	real	[0.0;100.0]	5.0
	The value of the relative humidity function at the initial value of time.					
3	Time at point	Time	hr	real	[0;+Inf]	1.0
	The value of time at the specified data point.					
4	Relative humidity at point	Dimensionless	-	real	[0.0;100.0]	50.0
	The value of the relative humidity function at the specified data point.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
3-4		Besides the initial point, how many points make up the forcing function?	1	50

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Average relative humidity	Dimensionless	-	real	[-Inf;+Inf]	0
	The average value of the relative humidity function over the timestep.					
2	Instantaneous relative humidity	Dimensionless	-	real	[-Inf;+Inf]	0
	The instantaneous value of the relative humidity function occurring at the end of the timestep.					

4.13.4.6. Temperature

Icon		TRNSYS Model	Type 14
Proforma	Utility\Forcing Functions\Temperature\Type14e.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Initial value of time	Time	hr	real	[0.0;+Inf]	0
	The initial value of time for the function. If the cycle is to repeat, this initial value of time must be set to 0.0.					
2	Initial temperature	Temperature	C	real	[-Inf;+Inf]	10.0
	The temperature at the initial value of time for the forcing function.					
3	Time at point	Time	hr	real	[0.0;+Inf]	1.0
	The value of time at the specified data point.					
4	Temperature at point	Temperature	C	real	[-Inf;+Inf]	10.0
	The temperature at the specified data point.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
3-4		Besides the initial point, how many points make up the forcing function?	1	50

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Average temperature	Temperature	C	real	[-Inf;+Inf]	0
	The average value of the temperature function over the timestep.					
2	Instantaneous temperature	Temperature	C	real	[-Inf;+Inf]	0
	The instantaneous value of the temperature function occurring at the end of the timestep.					

4.13.4.7. Water Draw

Icon		TRNSYS Model	Type 14
Proforma	Utility\Forcing Functions\Water Draw\Type14b.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Initial value of time	Time	hr	real	[0.0;+Inf]	0
	The initial value of time for the function. If the cycle is to repeat, this initial value of time must be set to 0.0.					
2	Initial value of function	Flow Rate	kg/hr	real	[0.0;+Inf]	0.0
	The water draw at the initial value of time.					
3	Time at point	Time	hr	real	[0.0;+Inf]	1.0
	The value of time at the specified data point.					
4	Water draw at point	Flow Rate	kg/hr	real	[0.0;+Inf]	0.0
	The water draw at the specified data point.					

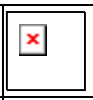
Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
3-4		Besides the initial point, how many points make up the forcing function?	1	50

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Average water draw	Flow Rate	kg/hr	real	[-Inf;+Inf]	0
	The average value of the water draw function over the timestep.					
2	Instantaneous water draw	Flow Rate	kg/hr	real	[-Inf;+Inf]	0
	The instantaneous value of the water draw function occurring at the end of the timestep.					

4.13.4.8. Wind Speed

Icon		TRNSYS Model	Type 14
Proforma	Utility\Forcing Functions\Wind Speed\Type14g.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Initial value of time	Time	hr	real	[0;+Inf]	0
	The initial value of time for the function. If the cycle is to repeat, this initial value of time must be set to 0.0.					
2	Initial value of wind speed	Dimensionless	-	real	[0.0;100.0]	5.0
	The value of the wind speed function at the initial value of time.					
3	Time at point	Time	hr	real	[0;+Inf]	1.0
	The value of time at the specified data point.					
4	Wind speed at point	Dimensionless	-	real	[0.0;100.0]	50.0
	The value of the wind speed function at the specified data point.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
3-4		Besides the initial point, how many points make up the forcing function?	1	50

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Average wind speed	Dimensionless	-	real	[-Inf;+Inf]	0
	The average value of the wind speed function over the timestep.					
2	Instantaneous wind speed	Dimensionless	-	real	[-Inf;+Inf]	0
	The instantaneous value of the wind speed function occurring at the end of the timestep.					

4.13.5. Holiday Calculator

4.13.5.1. American Holidays

Icon		TRNSYS Model	Type 95
Proforma	Utility\Holiday Calculator\American Holidays\Type95a.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Mode	dimensionless	-	integer	[0;0]	0
2	Year	any	any	integer	[-Inf;+Inf]	0
3	Initial simulation start time	Time	hr	real	[0;+Inf]	0
4	Daylight savings time flag	dimensionless	-	integer	[1;2]	0

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Hour of day	Time	hr	integer	[-Inf;+Inf]	0
2	Hour of year	Time	hr	integer	[-Inf;+Inf]	0
3	Day of year	Time	day	integer	[-Inf;+Inf]	0
4	Day of week	Time	day	integer	[-Inf;+Inf]	0
5	Month	any	any	integer	[-Inf;+Inf]	0
6	Date	Time	day	integer	[-Inf;+Inf]	0
7	Year2	any	any	integer	[-Inf;+Inf]	0
8	Weekend Flag	Dimensionless	-	integer	[-Inf;+Inf]	0
9	Holiday flag	dimensionless	-	integer	[-Inf;+Inf]	0

4.13.5.2. American plus user defined holidays

Icon		TRNSYS Model	Type 95
Proforma	Utility\Holiday Calculator\American plus user defined holidays\Type95b.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Mode	dimensionless	-	integer	[1;1]	0
2	Year	any	any	integer	[-Inf;+Inf]	0
3	Initial simulation start time	Time	hr	real	[0;+Inf]	0
4	Daylight savings time flag	dimensionless	-	integer	[1;2]	0
5	Month of holiday	any	any	integer	[1;12]	0
6	Date of holiday	Time	day	integer	[1;31]	0

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
5-6		How many holidays would you like to create?	1	18

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Hour of day	Time	hr	integer	[-Inf;+Inf]	0
2	Hour of year	Time	hr	integer	[-Inf;+Inf]	0
3	Day of year	Time	day	integer	[-Inf;+Inf]	0
4	Day of week	Time	day	integer	[-Inf;+Inf]	0
5	Month	any	any	integer	[-Inf;+Inf]	0
6	Date	Time	day	integer	[-Inf;+Inf]	0
7	Year2	any	any	integer	[-Inf;+Inf]	0
8	Weekend Flag	dimensionless	-	integer	[-Inf;+Inf]	0
9	Holiday flag	dimensionless	-	integer	[-Inf;+Inf]	0

4.13.5.3. User Defined Holidays

Icon		TRNSYS Model	Type 95
Proforma	Utility\Holiday Calculator\User Defined Holidays\Type95c.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Mode	Dimensionless	-	integer	[2;2]	0
2	Year	any	any	integer	[-Inf;+Inf]	0
3	Initial simulation start time	Time	hr	real	[0;+Inf]	0
4	Daylight savings time flag	Dimensionless	-	integer	[1;2]	0
5	Month of holiday	any	any	integer	[1;12]	0
6	Date of holiday	Time	day	integer	[1;31]	0

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
5-6		How many holidays would you like to define?	1	18

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Hour of day	Time	hr	integer	[-Inf;+Inf]	0
2	Hour of year	Time	hr	integer	[-Inf;+Inf]	0
3	Day of year	Time	day	integer	[-Inf;+Inf]	0
4	Day of week	Time	day	integer	[-Inf;+Inf]	0
5	Month	any	any	integer	[-Inf;+Inf]	0
6	Date	Time	day	integer	[-Inf;+Inf]	0
7	Year2	any	any	integer	[-Inf;+Inf]	0
8	Weekend Flag	Dimensionless	-	integer	[-Inf;+Inf]	0
9	Holiday flag	Dimensionless	-	integer	[-Inf;+Inf]	0

4.13.6. Input Value Recall

4.13.6.1. Input Value Recall

Icon		TRNSYS Model	Type 93
Proforma	Utility\Input Value Recall\Type93.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Number of inputs to be stored	Dimensionless	-	integer	[1;10]	0
	NOTE: The maximum value of inputs to be stored is 10. In addition, the product of the number of inputs to store and the number of time steps to store must be less than or equal to 1000					
2	Number of timesteps to be stored	Dimensionless	-	integer	[1;500]	0
	NOTE: The maximum value of time steps to be stored is 500. In addition, the product of the number of inputs to store and the number of time steps to store must be less than or equal to 1000					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Input value	any	any	real	[-Inf;+Inf]	0

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
1-1	Number of inputs to be stored		1	100

OUTPUTS

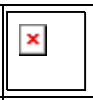
	Name	Dimension	Unit	Type	Range	Default
1	Inp-Step	any	any	real	[-Inf;+Inf]	0
	The outputs are the recalled values of NI inputs for NT time steps, where NI is parameter 1 and NT is parameter 2. InpStep-j-k means "Input j, value at time step (current-k+1) Examples: InpStep-2-1 is the value of Input 2 at current time step InputSequence-10-5 is the value of Input 10 4 time steps before the current one					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
1-1	Number of inputs to be stored		1	100
1-1	Number of timesteps to be stored		1	100

4.13.7. Integrators

4.13.7.1. Periodic Integrator

Icon		TRNSYS Model	Type 55
Proforma	Utility\Integrators\Periodic Integrator\Type55.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Integrate or sum input	Dimensionless	-	integer	[-10;10]	1
	This parameter indicates to the periodic integrator component whether this input should integrated with respect to time or summed over the period of interest. If the input is to be integrated set this parameter equal to the input number. If the input is to be summed instead, set this parameter to the negative of the input number. For example, if the first input is to be summed over the time period and the second input is to be integrated with respect to time, parameter 1 should be set to -1 and parameter 8 should be set to 2.					
2	Relative starting hour for input	Time	hr	real	[-1;+Inf]	1.0
	The relative starting hour of the period for the specified input (referenced to midnight). For example, if the simulation start time is set to 1, and this parameter is set to 8, the periodic summary for this input will begin at 8:00 am, not 9:00 am. Example: The first input is to be investigated between 8 am and 10 am every day with monthly results expected for March and April. Answer: the value of this parameter should be 8					
3	Duration for input	Time	hr	real	[-1.0;+Inf]	1.0
	The length of time for which the specified input is to be evaluated after the relative starting hour is reached. By specifying a value of -1 for this parameter, the summary period will run from the starting hour to the end of the month. Example: The first input is to be investigated between 8 am and 10 am every day with results expected for March and April. Answer: the value of this parameter should be 2					
4	Cycle repeat time for input	Time	hr	real	[-1;+Inf]	24.0
	The number of hours between the start of consecutive summary periods for the specified input. Specifying a value of -1 indicates to the component that the cycles should repeat monthly. Example: The first input is to be evaluated between 8 am and 10 am every day with monthly results expected for March and April. Answer: the value of this parameter should be 24					
5	Reset time for input	Time	hr	real	[-1;+Inf]	-1
	The time interval over which the specified input is to be investigated before the outputs are reset to zero. Specifing a value of -1 for this parameter indicates that the outputs are to be reset at the end of each month. Example: An input is to be investigated between 8 am and 10 am every day with results expected for March and April Answer: the value of this parameter should be -1 (monthly reset)					
6	Absolute starting hour for input	Time	hr	real	[0;+Inf]	0
	The absolute starting hour for the periodic summary. This feature allows the periodic integrator to skip times at which no information is desired for this input. For example, an input is to be investigated only in December of an annual simulation. By setting this parameter to the first hour in December, significant calculation time is saved. Be careful to have the absolute starting time less than the first hour of the year for which this input is to be investigated.					
7	Absolute stopping hour for input	Time	hr	real	[0;+Inf]	8760
	The absolute stopping hour for the specified input. This parameter allows the periodic integrator routine to skip times when no summary information is desired for this input. For example, periodic information is only desired					

	for January of an annual simulation. By setting this parameter to the last hour of January, significant calculation time can be saved. Be sure to set this parameter greater than the last hour for which summary information is desired.

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
1-7		How many inputs are to be investigated with this component?	1	10

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Input	any	any	real	[-Inf;+Inf]	0.
	The input to be evaluated over the period specified by parameters: 1+(i-1)*7 through 7+(i-1)*7. Make sure to integrate a rate and sum a quantity!					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
1-1		How many inputs are to be investigated with this component?	1	10

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Integral of input	any	any	real	[-Inf;+Inf]	0
	The integral of the specified input with respect to time over the period specified by the parameter list.					
2	Count of input	any	any	integer	[-Inf;+Inf]	0
	The number of times the specified input was evaluated over the period specified by the parameter list.					
3	Mean value of input	any	any	real	[-Inf;+Inf]	0
	The average value of the specified input over the time period. Mean = Sum of Input/Count					
4	Standard deviation of input	any	any	real	[-Inf;+Inf]	0
	The sample standard deviation for the specified input over the time period. The lower the standard deviation, the closer the inputs are grouped around the mean. SSD = ((Sum of (Input - Mean)^2)/(Count-1))^0.5					
5	Variance of input	any	any	real	[-Inf;+Inf]	0
	The variance of the specified input over the time period. The lower the variance, the closer the inputs are grouped around the mean. Variance = Sample Standard Deviation ^ 2					
6	Sum of squares of input	any	any	real	[-Inf;+Inf]	0
	The sum of squares of the specified input over the time period. The sum of squares of an input is a measure of how closely the inputs are grouped around the mean. The lower the SSQ, the closer the inputs are grouped around the mean. SSQ = Sum of (Inputs - Mean)^2					
7	Minimum value of input	any	any	real	[-Inf;+Inf]	0
	The minimum value of the specified input occurring in the specified time period.					
8	Time of minimum for input	Time	hr	real	[-Inf;+Inf]	0
	The hour of the year during which the minimum value of the specified input occurred in the time period.					
9	Maximum value of input	any	any	real	[-Inf;+Inf]	0
	The maximum value of the specified input occurring in the time period.					
10	Time of maximum for input	Time	s	real	[-Inf;+Inf]	0

	The hour of the year at which the maximum value of the specified input occurred during the time period.

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
1-10		How many inputs are to be investigated with this component?	1	10

4.13.7.2. Quantity Integrator

Icon		TRNSYS Model	Type 24
Proforma	Utility\Integrators\Quantity Integrator\Type24.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Integration period	Time	hr	real	[-12;+Inf]	8760.0
	The time interval over which the inputs are to be investigated. Theoutputs are reset to zero after each reset time interval. If thereset time is set to a negative value, then units of months are assumed (if the reset time is set to -2, then the reset time will be two months...)					
2	Relative or absolute start time	Dimensionless	-	integer	[0;1]	0
	This parameter controls whether the integration intervals are relative or absolute 0: integrate at time intervals relative to the simulation start time 1: integrate at absolute time intervals For example, if the simulation start time is 0.5, the simulation time step is 0.25 and the integration interval (or reset time) is 1: If this parameter is set to 0, reset will occur at 0.5, 1.5, 2.5, etc. If this parameter is set to 1, reset will occur at 1, 2, 3, etc.					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Input to be integrated	any	any	real	[-Inf;+Inf]	0.0
	Leave the initial value at zero unless you wish to add a constant to the integration results. The constant added will be the initial value.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
1-1		How many inputs should be integrated?	1	100

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Result of integration	any	any	real	[-Inf;+Inf]	0
	The result of the integration of the corresponding input. Output 1will be the result of the integration of Input 1 with respect to time.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
1-1		How many inputs should be integrated?	1	100

4.13.8. Parameter replacement

4.13.8.1. Parameter replacement

Icon		TRNSYS Model	Type 70
Proforma	Utility\Parameter replacement\Type70.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Logical unit number of file containing parameters	any	any	integer	[10;30]	0
2	Number of consecutive parameters to be replaced	any	any	integer	[-Inf;+Inf]	0
3	The unit number in the deck to which the parameters belong	any	any	integer	[-Inf;+Inf]	0

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
2-3		How many units' PARAMETERS are to be replaced?	1	50

EXTERNAL FILES

Question	File	Associated parameter
File containing PARAMETERS to be replaced		Logical unit number of file containing parameters
Source file	.\SourceCode\Types\Type70.for	

4.13.9. Unit Conversion Routine

4.13.9.1. Unit Conversion Routine

Icon		TRNSYS Model	Type 57
Proforma	Utility\Unit Conversion Routine\Type57.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Table Nb. for input	Dimensionless	-	integer	[1;25]	1
	The table number corresponding to the dimension of the specified input. Refer to section 4.1.12 of Volume 1 - TRNSYS Reference Manual for more details. Temperature=1; Length=2; Area=3; Volume=4; Specific Volume=5; Velocity=6; Mass=7; Density=8; Force=9; Pressure=10; Energy=11; Power=12; Specific Energy=13 (h,u); Specific Heat=14; Flowrate=15; Volumetric Flowrate=16; Flux=17; Thermal Conductivity=18; Heat Transfer Coeff.=19; Dynamic Viscosity=20; Kinematic Viscosity=21 Misc.=22					
2	ID number from table for input	Dimensionless	-	integer	[1;10]	1
	The number corresponding to the units of the specified inputs from the table specified in the previous parameter. See table in section 4.1.12 of Volume 1 - TRNSYS Reference manual for more details.					
3	ID number from table for output	Dimensionless	-	integer	[1;10]	2
	The identification number corresponding to the desired output units from the table specified two parameters previous.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
1-3		How many inputs are to have their units converted ?	1	20

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Input	any	any	real	[-Inf;+Inf]	0.0
	The specified input that it to have its units converted according to parameters: 3*(i-1) + 1 3*(i-1) + 2 3*(i-1) + 3 For example, input number 3 will be converted to a new unit system based on parameters 10,11, and 12.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
1-1		How many inputs are to have their units converted ?	1	20

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Output	any	any	real	[-Inf;+Inf]	0
	Output i is equal to input i after the unit conversion process.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max

1-1		How many inputs are to have their units converted ?	1	20

4.13.10. Utility Rate Schedule Processors

4.13.10.1. Utility Rate Schedule Processors

Icon		TRNSYS Model	Type 96
Proforma	Utility\Utility Rate Schedule Processors\Type96.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Logical unit for rate schedule input file	Dimensionless	-	integer	[10;+Inf]	0
2	Logical unit for text output	Dimensionless	-	integer	[10;+Inf]	0
3	Logical unit for spreadsheet output	Dimensionless	-	integer	[10;+Inf]	0
4	Switch to observe off-peak weekend rates	Dimensionless	-	integer	[0;1]	0
5	Switch to observe off-peak holiday rates	dimensionless	-	integer	[0;1]	0
6	Maximum excess power	Power	W	real	[-Inf;+Inf]	0

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Hour of the day	Time	hr	real	[0;24]	0
2	Hour of the year	Time	hr	real	[0;8760]	0
3	Month	any	any	real	[0;12]	0
4	Year	any	any	real	[0;+Inf]	0
5	Building load	Power	W	real	[-Inf;+Inf]	0
6	Flag indicating weekend	Dimensionless	-	integer	[0;1]	0
7	Flag indicating holiday	Dimensionless	-	integer	[0;1]	0
8	Parallel generation	Power	W	real	[-Inf;+Inf]	0

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Useage rate	any	any	real	[-Inf;+Inf]	0
2	Monthly demand rate	any	any	real	[-Inf;+Inf]	0
3	Net load	Power	W	real	[-Inf;+Inf]	0
4	Power purchased from utility	Power	W	real	[-Inf;+Inf]	0
5	Power sold to utility	Power	W	real	[-Inf;+Inf]	0
6	Instantaneous value of power purchased	any	any	real	[-Inf;+Inf]	0
7	Instantaneous value of power sold	any	any	real	[-Inf;+Inf]	0
8	Instantaneous savings from parallel generation	any	any	real	[-Inf;+Inf]	0
9	Instantaneous parallel fraction	dimensionless	-	real	[-Inf;+Inf]	0
10	Total instantaneous losses	Power	W	real	[-Inf;+Inf]	0
11	Instantaneous value of load	any	any	real	[-Inf;+Inf]	0
12	Cumulative utility bill	any	any	real	[-Inf;+Inf]	0
13	Useful parallel generation	Power	W	real	[-Inf;+Inf]	0

EXTERNAL FILES

Question	File	Associated parameter
Where is the utility rate schedule input file located?	.\Examples\Data Files\Type96-UtilityRateScheduler.dat	Logical unit for rate schedule input file
Where should the text based utility bill output file be created?	UtilityBill.txt	Logical unit for text output
Where should the spreadsheet utility bill output file be created?	UtilityBill.dat	Logical unit for spreadsheet output
Source file	.\SourceCode\Types\Type96.for	

4.14. Weather Data Reading and Processing

4.14.1. Standard Format

4.14.1.1. German TRY

Icon		**TRNSYS Model**	Type 109
Proforma	Weather Data Reading and Processing\Standard Format\German TRY\Type109-TRY.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Data Reader Mode	Dimensionless	-	integer	[3;3]	-2
	The mode of the weather data reader 109 : The value 3 means that Type 109 will read a Standard weather file in the German TRY format					
2	Logical unit	Dimensionless	-	integer	[30;999]	0
	This parameter sets the Fortran Logical Unit (File reference number) of the output file. It is used internally by TRNSYS to refer to the file. This parameter will automatically be assigned to a unique value by the TRNSYS Studio					
3	Sky model for diffuse radiation	Dimensionless	-	integer	[1;4]	0
	This parameter selects the sky model used to calculate diffuse radiation on tilted surfaces. 1: Isotropic sky model 2: Hay and Davies model 3: Reindl model 4: Perez model Note: The Perez model is usually considered to be the best available model					
4	Tracking mode	Dimensionless	-	integer	[1;4]	1.0
	This parameter is used to indicate that the surfaces on which the tilted surface radiation is calculated are tracking the sun. 1: Fixed surface 2: Single axis tracking, vertical axis (fixed slope, variable azimuth) 3: Single-axis tracking, axis is in the plane of the surface 4: Two-axis tracking					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Ground reflectance	Dimensionless	-	real	[0.0;1.0]	0.2
	The reflectance of the ground above which the surface is located.Typical values are 0.2 for ground not covered by snow and 0.7 forground covered by snow.					
2	Slope of surface	Direction (Angle)	degrees	real	[0;+Inf]	0.0
	The slope of the surface or tracking axis. The slope is positivewhen tilted in the direction of the azimuth. 0 = Horizontal90 = Vertical facing toward azimuthRefer to the abstract for details on slope specification for trackingsurfaces.					
3	Azimuth of surface	Direction (Angle)	degrees	real	[-360;+360]	0.0
	The solar azimuth angle is the angle between the local meridian andthe projection of the line of sight of the sun onto the horizontalplane.0 = Facing equater90 = Facing west180 = Facing north270 = Facing eastRefer to the					

	abstract for deatils on the azimuth parameter for tracking surfaces.

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
2-3		How many surfaces are to be evaluated by This Type 109?	1	16

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Ambient temperature	Temperature	C	real	[-Inf;+Inf]	0
	ambient temperature					
2	relative humidity	any	any	real	[-Inf;+Inf]	0
	ambient relative humidity					
3	wind velocity	Velocity	m/s	real	[-Inf;+Inf]	0
	wind speed					
4	wind direction	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
	N=0°, E=90°, etc.					
5	Atmospheric pressure	Pressure	Pa	real	[-Inf;+Inf]	0
	Atmospheric pressure					
6	userdefined data 2	any	any	real	[-Inf;+Inf]	0
	Sixth value read from data file (if PAR 2 > 5).					
7	userdefined data 3	any	any	real	[-Inf;+Inf]	0
	Seventh value read from data file (if PAR 2 > 6).					
8	userdefined data 4	any	any	real	[-Inf;+Inf]	0
	Eigth value read from data file (if PAR 2 > 7)					
9	extraterrestrial radiation on horizontal	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	Ninth value read from data file (if PAR 2 > 8).					
10	solar zenith angle	Direction (Angle)	degrees	real	[-360;+360]	0
	Tenth value read from data file (if PAR 2 > 9).					
11	solar azimuth angle	Direction (Angle)	degrees	real	[-360;+360]	0
	Eleventh value read from data file (if PAR 2 > 10).					
12	total radiation on horizontal	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	Twelfth value read from data file (if PAR 2 > 11).					
13	beam radiation on horitonzal	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	Thirteenth value read from data file (if PAR 2 > 12).					
14	sky diffuse radiation on horizontal	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	Fourteenth value read from data file (if PAR 2 > 13).					
15	ground reflected diffuse radiation on horizontal	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	Fifteenth value read from data file (if PAR 2 > 14).					
16	angle of incidence on horizontal surface	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
	Sixteenth value read from data file (if PAR 2 > 15).					
17	slope of horizontal surface	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
	Seventeenth value read from data file (if PAR 2 > 16).					
18	total radiation on tilted surface	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	Eighteenth value read from data file (if PAR 2 = 18).					
19	beam radiation on tilted surface	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
20	sky diffuse radiation on tilted surface	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
21	ground reflected diffuse radiation on tilted surface	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0

22	angle of incidence for tilted surface	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
23	slope of tilted surface	Direction (Angle)	degrees	real	[-Inf;+Inf]	0

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
18-23		How many surfaces are to be evaluated by This Type 109?	1	16

EXTERNAL FILES

Question	File	Associated parameter
Weather data file	.\Examples\Data Files\Type109-German-TRY-Format.try	Logical unit
Source file	.\SourceCode\Types\Type109.f90	

4.14.1.2. German VDI

Icon		TRNSYS Model	Type 109
Proforma	Weather Data Reading and Processing\Standard Format\German VDI\Type109-VDI.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Data Reader Mode	Dimensionless	-	integer	[900;999]	-2
	The mode of the weather data reader 109 : Mode 9xy corresponds to data for the German VDI 2078 standard.					
2	Logical unit	Dimensionless	-	integer	[30;999]	0
	This parameter sets the Fortran Logical Unit (File reference number) of the output file. It is used internally by TRNSYS to refer to the file. This parameter will automatically be assigned to a unique value by the TRNSYS Studio					
3	Sky model for diffuse radiation	Dimensionless	-	integer	[1;4]	0
	This parameter selects the sky model used to calculate diffuse radiation on tilted surfaces. 1: Isotropic sky model 2: Hay and Davies model 3: Reindl model 4: Perez model Note: The Perez model is usually considered to be the best available model					
4	Tracking mode	Dimensionless	-	integer	[1;4]	1.0
	This parameter is used to indicate that the surfaces on which the tilted surface radiation is calculated are tracking the sun. 1: Fixed surface 2: Single axis tracking, vertical axis (fixed slope, variable azimuth) 3: Single-axis tracking, axis is in the plane of the surface 4: Two-axis tracking					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Ground reflectance	Dimensionless	-	real	[0.0;1.0]	0.2
	The reflectance of the ground above which the surface is located.Typical values are 0.2 for ground not covered by snow and 0.7 forground covered by snow.					
2	Slope of surface	Direction (Angle)	degrees	real	[0;+Inf]	0.0
	The slope of the surface or tracking axis. The slope is positivewhen tilted in the direction of the azimuth. 0 = Horizontal90 = Vertical facing toward azimuthRefer to the abstract for details on slope specification for trackingsurfaces.					
3	Azimuth of surface	Direction (Angle)	degrees	real	[-360;+360]	0.0
	The solar azimuth angle is the angle between the local meridian andthe projection of the line of sight of the sun onto the horizontalplane.0 = Facing equater90 = Facing west180 = Facing north270 = Facing eastRefer to the abstract for deatils on the azimuth parameter for tracking surfaces.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
2-3		How many surfaces are to be evaluated by This Type 109?	1	16

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Ambient temperature	Temperature	C	real	[-Inf;+Inf]	0

	ambient temperature					
2	relative humidity	any	any	real	[-Inf;+Inf]	0
	ambient relative humidity					
3	wind velocity	Velocity	m/s	real	[-Inf;+Inf]	0
	wind speed					
4	wind direction	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
	N=0°, E=90°, etc.					
5	Atmospheric pressure	Pressure	Pa	real	[-Inf;+Inf]	0
	Atmospheric pressure					
6	userdefined data 2	any	any	real	[-Inf;+Inf]	0
	Sixth value read from data file (if PAR 2 > 5).					
7	userdefined data 3	any	any	real	[-Inf;+Inf]	0
	Seventh value read from data file (if PAR 2 > 6).					
8	userdefined data 4	any	any	real	[-Inf;+Inf]	0
	Eigth value read from data file (if PAR 2 > 7)					
9	extraterrestrial radiation on horizontal	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	Ninth value read from data file (if PAR 2 > 8).					
10	solar zenith angle	Direction (Angle)	degrees	real	[-360;+360]	0
	Tenth value read from data file (if PAR 2 > 9).					
11	solar azimuth angle	Direction (Angle)	degrees	real	[-360;+360]	0
	Eleventh value read from data file (if PAR 2 > 10).					
12	total radiation on horizontal	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	Twelfth value read from data file (if PAR 2 > 11).					
13	beam radiation on horitonzal	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	Thirteenth value read from data file (if PAR 2 > 12).					
14	sky diffuse radiation on horizontal	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	Fourteenth value read from data file (if PAR 2 > 13).					
15	ground reflected diffuse radiation on horizontal	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	Fifteenth value read from data file (if PAR 2 > 14).					
16	angle of incidence on horizontal surface	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
	Sixteenth value read from data file (if PAR 2 > 15).					
17	slope of horizontal surface	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
	Seventeenth value read from data file (if PAR 2 > 16).					
18	total radiation on tilted surface	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	Eighteenth value read from data file (if PAR 2 = 18).					
19	beam radiation on tilted surface	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
20	sky diffuse radiation on tilted surface	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
21	ground reflected diffuse radiation on tilted surface	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
22	angle of incidence for tilted surface	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
23	slope of tilted surface	Direction (Angle)	degrees	real	[-Inf;+Inf]	0

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
18-23		How many surfaces are to be evaluated by This Type 109?	1	16

EXTERNAL FILES

Question	File	Associated parameter

Weather data file	.\Examples\Data Files\Type109-German-VDI-Data-VDI2078.wet	Logical unit
Source file	.\SourceCode\Types\Type109.f90	

4.14.1.3. Japan

Icon		TRNSYS Model	Type 109
Proforma	Weather Data Reading and Processing\Standard Format\Japan\Type109-AMeDAS.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Data Reader Mode	Dimensionless	-	integer	[1;1]	-2
	The mode of the weather data reader 109 : The value 2 means that Type 109 will read a Standard weather file in a format understood by TRNSYS					
2	Logical unit	Dimensionless	-	integer	[30;999]	0
	This parameter sets the Fortran Logical Unit (File reference number) of the output file. It is used internally by TRNSYS to refer to the file. This parameter will automatically be assigned to a unique value by the TRNSYS Studio					
3	Sky model for diffuse radiation	Dimensionless	-	integer	[1;4]	0
	This parameter selects the sky model used to calculate diffuse radiation on tilted surfaces. 1: Isotropic sky model 2: Hay and Davies model 3: Reindl model 4: Perez model Note: The Perez model is usually considered to be the best available model					
4	Tracking mode	Dimensionless	-	integer	[1;4]	1.0
	This parameter is used to indicate that the surfaces on which the tilted surface radiation is calculated are tracking the sun. 1: Fixed surface 2: Single axis tracking, vertical axis (fixed slope, variable azimuth) 3: Single-axis tracking, axis is in the plane of the surface 4: Two-axis tracking					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Ground reflectance	Dimensionless	-	real	[0.0;1.0]	0.2
	The reflectance of the ground above which the surface is located.Typical values are 0.2 for ground not covered by snow and 0.7 forground covered by snow.					
2	Slope of surface	Direction (Angle)	degrees	real	[0;+Inf]	0.0
	The slope of the surface or tracking axis. The slope is positivewhen tilted in the direction of the azimuth. 0 = Horizontal90 = Vertical facing toward azimuthRefer to the abstract for details on slope specification for trackingsurfaces.					
3	Azimuth of surface	Direction (Angle)	degrees	real	[-360;+360]	0.0
	The solar azimuth angle is the angle between the local meridian andthe projection of the line of sight of the sun onto the horizontalplane.0 = Facing equater90 = Facing west180 = Facing north270 = Facing eastRefer to the abstract for deatils on the azimuth parameter for tracking surfaces.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
2-3		How many surfaces are to be evaluated by This Type 109?	1	16

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Ambient temperature	Temperature	C	real	[-Inf;+Inf]	0

	ambient temperature					
2	Relative humidity	any	any	real	[-Inf;+Inf]	0
	ambient relative humidity					
3	Wind velocity	Velocity	m/s	real	[-Inf;+Inf]	0
	wind speed					
4	Wind direction	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
	N=0°, E=90°, etc.					
5	Atmosphric radiation	Flux	W/m^2	real	[-Inf;+Inf]	0
	Atmospheric pressure					
6	Hourly precipitation	Length	mm	real	[-Inf;+Inf]	0
	Sixth value read from data file (if PAR 2 > 5).					
7	Sunshine duration	Time	hr	real	[-Inf;+Inf]	0
	Seventh value read from data file (if PAR 2 > 6).					
8	Not used	any	any	real	[-Inf;+Inf]	0
	Eigth value read from data file (if PAR 2 > 7)					
9	Extraterrestrial radiation on horizontal	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	Ninth value read from data file (if PAR 2 > 8).					
10	Solar zenith angle	Direction (Angle)	degrees	real	[-360;+360]	0
	Tenth value read from data file (if PAR 2 > 9).					
11	Solar azimuth angle	Direction (Angle)	degrees	real	[-360;+360]	0
	Eleventh value read from data file (if PAR 2 > 10).					
12	Total radiation on horizontal	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	Twelfth value read from data file (if PAR 2 > 11).					
13	Beam radiation on horitonzal	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	Thirteenth value read from data file (if PAR 2 > 12).					
14	Sky diffuse radiation on horizontal	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	Fourteenth value read from data file (if PAR 2 > 13).					
15	Ground reflected diffuse radiation on horizontal	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	Fifteenth value read from data file (if PAR 2 > 14).					
16	Angle of incidence on horizontal surface	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
	Sixteenth value read from data file (if PAR 2 > 15).					
17	Slope of horizontal surface	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
	Seventeenth value read from data file (if PAR 2 > 16).					
18	Total radiation on tilted surface	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	Eighteenth value read from data file (if PAR 2 = 18).					
19	Beam radiation on tilted surface	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
20	Sky diffuse radiation on tilted surface	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
21	Ground reflected diffuse radiation on tilted surface	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
22	Angle of incidence for tilted surface	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
23	Slope of tilted surface	Direction (Angle)	degrees	real	[-Inf;+Inf]	0

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
18-23		How many surfaces are to be evaluated by This Type 109?	1	16

EXTERNAL FILES

Question	File	Associated parameter

Weather data file	.\Examples\Weather Data\Tokyo.109	Logical unit
Source file	.\SourceCode\Types\Type109.f90	

4.14.1.4. TMY2

Icon		TRNSYS Model	Type 109
Proforma	Weather Data Reading and Processing\Standard Format\TMY2\Type109-TMY2.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Data Reader Mode	Dimensionless	-	integer	[2;2]	-2
	The mode of the weather data reader 109 : The value 2 means that Type 109 will read a Standard weather file in the TMY2 format					
2	Logical unit	Dimensionless	-	integer	[30;999]	0
	This parameter sets the Fortran Logical Unit (File reference number) of the output file. It is used internally by TRNSYS to refer to the file. This parameter will automatically be assigned to a unique value by the TRNSYS Studio					
3	Sky model for diffuse radiation	Dimensionless	-	integer	[1;4]	0
	This parameter selects the sky model used to calculate diffuse radiation on tilted surfaces. 1: Isotropic sky model 2: Hay and Davies model 3: Reindl model 4: Perez model Note: The Perez model is usually considered to be the best available model					
4	Tracking mode	Dimensionless	-	integer	[1;4]	1.0
	This parameter is used to indicate that the surfaces on which the tilted surface radiation is calculated are tracking the sun. 1: Fixed surface 2: Single axis tracking, vertical axis (fixed slope, variable azimuth) 3: Single-axis tracking, axis is in the plane of the surface 4: Two-axis tracking					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Ground reflectance	Dimensionless	-	real	[0.0;1.0]	0.2
	The reflectance of the ground above which the surface is located.Typical values are 0.2 for ground not covered by snow and 0.7 forground covered by snow.					
2	Slope of surface	Direction (Angle)	degrees	real	[0;+Inf]	0.0
	The slope of the surface or tracking axis. The slope is positivewhen tilted in the direction of the azimuth. 0 = Horizontal90 = Vertical facing toward azimuthRefer to the abstract for details on slope specification for trackingsurfaces.					
3	Azimuth of surface	Direction (Angle)	degrees	real	[-360;+360]	0.0
	The solar azimuth angle is the angle between the local meridian andthe projection of the line of sight of the sun onto the horizontalplane.0 = Facing equater90 = Facing west180 = Facing north270 = Facing eastRefer to the abstract for deatils on the azimuth parameter for tracking surfaces.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
2-3		How many surfaces are to be evaluated by This Type 109?	1	16

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Ambient temperature	Temperature	C	real	[-Inf;+Inf]	0

	ambient temperature					
2	relative humidity	any	any	real	[-Inf;+Inf]	0
	ambient relative humidity					
3	wind velocity	Velocity	m/s	real	[-Inf;+Inf]	0
	wind speed					
4	wind direction	Direction (Angle)	Degrees	real	[-Inf;+Inf]	0
	N=0°, E=90°, etc.					
5	Atmospheric pressure	Pressure	Pa	real	[-Inf;+Inf]	0
	Atmospheric pressure					
6	userdefined data 2	any	any	real	[-Inf;+Inf]	0
	Sixth value read from data file (if PAR 2 > 5).					
7	userdefined data 3	any	any	real	[-Inf;+Inf]	0
	Seventh value read from data file (if PAR 2 > 6).					
8	userdefined data 4	any	any	real	[-Inf;+Inf]	0
	Eigth value read from data file (if PAR 2 > 7)					
9	extraterrestrial radiation on horizontal	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	Ninth value read from data file (if PAR 2 > 8).					
10	solar zenith angle	Direction (Angle)	degrees	real	[-360;+360]	0
	Tenth value read from data file (if PAR 2 > 9).					
11	solar azimuth angle	Direction (Angle)	degrees	real	[-360;+360]	0
	Eleventh value read from data file (if PAR 2 > 10).					
12	total radiation on horizontal	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	Twelfth value read from data file (if PAR 2 > 11).					
13	beam radiation on horitonzal	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	Thirteenth value read from data file (if PAR 2 > 12).					
14	sky diffuse radiation on horizontal	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	Fourteenth value read from data file (if PAR 2 > 13).					
15	ground reflected diffuse radiation on horizontal	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	Fifteenth value read from data file (if PAR 2 > 14).					
16	angle of incidence on horizontal surface	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
	Sixteenth value read from data file (if PAR 2 > 15).					
17	slope of horizontal surface	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
	Seventeenth value read from data file (if PAR 2 > 16).					
18	total radiation on tilted surface	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	Eighteenth value read from data file (if PAR 2 = 18).					
19	beam radiation on tilted surface	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
20	sky diffuse radiation on tilted surface	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
21	ground reflected diffuse radiation on tilted surface	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
22	angle of incidence for tilted surface	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
23	slope of tilted surface	Direction (Angle)	degrees	real	[-Inf;+Inf]	0

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
18-23		How many surfaces are to be evaluated by This Type 109?	1	16

EXTERNAL FILES

Question	File	Associated parameter

Weather data file	.\Weather\US-TMY2\US-WI-Madison-14837.tm2	Logical unit
Source file	.\SourceCode\Types\Type109.f90	

4.14.2. User Format

4.14.2.1. User Format

Icon		TRNSYS Model	Type 109
Proforma	Weather Data Reading and Processing\User Format\Type109-User.tmf		

PARAMETERS

	Name	Dimension	Unit	Type	Range	Default
1	Data Reader Mode	Dimensionless	-	integer	[1;1]	-2
	The mode of the weather data reader 109 : The value 1 means that Type 109 will read a weather file in Type 109's user format (see manual for details)					
2	Logical unit	Dimensionless	-	integer	[30;999]	0
	This parameter sets the Fortran Logical Unit (File reference number) of the output file. It is used internally by TRNSYS to refer to the file. This parameter will automatically be assigned to a unique value by the TRNSYS Studio					
3	Sky model for diffuse radiation	Dimensionless	-	integer	[1;4]	0
	This parameter selects the sky model used to calculate diffuse radiation on tilted surfaces. 1: Isotropic sky model 2: Hay and Davies model 3: Reindl model 4: Perez model Note: The Perez model is usually considered to be the best available model					
4	Tracking mode	Dimensionless	-	integer	[1;4]	1.0
	This parameter is used to indicate that the surfaces on which the tilted surface radiation is calculated are tracking the sun. 1: Fixed surface 2: Single axis tracking, vertical axis (fixed slope, variable azimuth) 3: Single-axis tracking, axis is in the plane of the surface 4: Two-axis tracking					

INPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Ground reflectance	dimensionless	-	real	[0.0;1.0]	0.2
	The reflectance of the ground above which the surface is located.Typical values are 0.2 for ground not covered by snow and 0.7 forground covered by snow.					
2	Slope of surface	Direction (Angle)	degrees	real	[0;+Inf]	0.0
	The slope of the surface or tracking axis. The slope is positive when tilted in the direction of the azimuth. 0 = Horizontal, 90 = Vertical facing toward azimuth. Refer to the abstract for details on slope specification for tracking surfaces.					
3	Azimuth of surface	Direction (Angle)	degrees	real	[-360;+360]	0.0
	The solar azimuth angle is the angle between the local meridian and the projection of the line of sight of the sun onto the horizontalplane. 0 = Facing equator, 90 = Facing west, 180 = Facing north, 270 = Facing east. Refer to the manual for details on the azimuth parameter for tracking surfaces.					

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max
2-3		How many surfaces are to be evaluated by This Type 109?	1	16

OUTPUTS

	Name	Dimension	Unit	Type	Range	Default
1	Ambient temperature	Temperature	C	real	[-Inf;+Inf]	0
	ambient temperature					
2	relative humidity	any	any	real	[-Inf;+Inf]	0
	ambient relative humidity					
3	wind velocity	Velocity	m/s	real	[-Inf;+Inf]	0
	wind speed					
4	wind direction	Direction(Angle)	degrees	real	[-Inf;+Inf]	0
	The user must make sure that the convention is in accord with the components using this information.					
5	Atmospheric pressure	Pressure	Pa	real	[-Inf;+Inf]	0
	Atmospheric pressure					
6	userdefined data 2	any	any	real	[-Inf;+Inf]	0
	Sixth value read from data file (if PAR 2 > 5).					
7	userdefined data 3	any	any	real	[-Inf;+Inf]	0
	Seventh value read from data file (if PAR 2 > 6).					
8	userdefined data 4	any	any	real	[-Inf;+Inf]	0
	Eigth value read from data file (if PAR 2 > 7)					
9	extraterrestrial radiation on horizontal	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	Ninth value read from data file (if PAR 2 > 8).					
10	solar zenith angle	Direction (Angle)	degrees	real	[-360;+360]	0
	Tenth value read from data file (if PAR 2 > 9).					
11	solar azimuth angle	Direction (Angle)	degrees	real	[-360;+360]	0
	Eleventh value read from data file (if PAR 2 > 10).					
12	total radiation on horizontal	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	Twelfth value read from data file (if PAR 2 > 11).					
13	beam radiation on horitonzal	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	Thirteenth value read from data file (if PAR 2 > 12).					
14	sky diffuse radiation on horizontal	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	Fourteenth value read from data file (if PAR 2 > 13).					
15	ground reflected diffuse radiation on horizontal	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	Fifteenth value read from data file (if PAR 2 > 14).					
16	angle of incidence on horizontal surface	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
	Sixteenth value read from data file (if PAR 2 > 15).					
17	slope of horizontal surface	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
	Seventeenth value read from data file (if PAR 2 > 16).					
18	total radiation on tilted surface	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
	Eighteenth value read from data file (if PAR 2 = 18).					
19	beam radiation on tilted surface	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
20	sky diffuse radiation on tilted surface	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
21	ground reflected diffuse radiation on tilted surface	Flux	kJ/hr.m^2	real	[-Inf;+Inf]	0
22	angle of incidence for tilted surface	Direction (Angle)	degrees	real	[-Inf;+Inf]	0
23	slope of tilted surface	Direction (Angle)	degrees	real	[-Inf;+Inf]	0

Cycles

Variable Indices	Associated parameter	Interactive Question	Min	Max

18-23		How many surfaces are to be evaluated by This Type 109?	1	16

EXTERNAL FILES

Question	File	Associated parameter
Weather data file	.\Examples\Data Files\Type109-UserFormat.109	Logical unit
Source file	.\SourceCode\Types\Type109.f90	