



Open-loop Validation - Review

Chiller Plant Sequences

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Lawrence Berkeley National Laboratory

Agenda

- Get familiarized with the chiller plant sequences in CDL
 - Package vs 1711 structure
- Dive into each validation package
 - OBC team to demo open-loop validation tests
 - Discuss output and models
 - Discuss questions related to 1711
 - Get familiar with the info sections
 - models fully reflecting the 1711 specification
 - models to generalize the controller

The following slides are added as an intro to the demo content that will be presented in the meetings.

Updated for May 22: Equipment rotation, Sec. 5.1.2

leaLag in Buildings.Controls.OBC.ASHRAE.PrimarySystem.ChillerPlant.Generic.EquipmentRotation.Validation.ControllerTwo

General Advanced Add modifiers Attributes

Component

Name leaLag
Comment Lead/lag rotation

Model

Path Buildings.Controls.OBC.ASHRAE.PrimarySystem.ChillerPlant.Generic.EquipmentRotation.ControllerTwo
Comment Lead/lag or lead/standby equipment rotation controller for two devices or two groups of devices

Icon

Parameters

lag true true = lead/lag; false = lead/standby
continuous false Continuous lead device operation
minLim false Utilize minimum runtime period for a current lead device before rotation may occur
minLeaRuntime 12 h Minimum cumulative runtime period for a current lead device before rotation may occur

Scheduler

simTimSta true Measure rotation time from the simulation start
weelnt true Rotation is scheduled in: true = weekly intervals; false = daily intervals
rotationPeriod 336 h Rotation time period measured from simulation start
houOfDay 2 Rotation hour of the day: 0 = midnight; 23 = 11pm
weeCou 1 Number of weeks
weekday 1 Rotation weekday, 1 = Monday, 7 = Sunday
dayCou 1 Number of days

Calendar

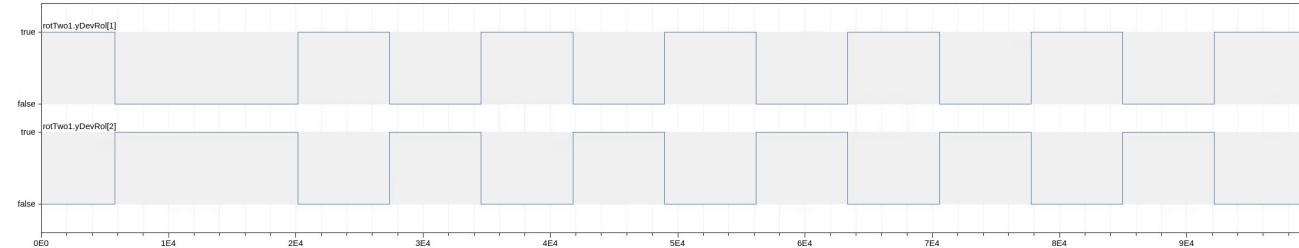
offset 0 s Offset that is added to 'time', may be used for computing time in a different time zone
zerTim Building Enumeration for choosing how reference time (time = 0) should be defined
yearRef 2019 Year when time = 0, used if zerTim=Custom

Info Cancel OK

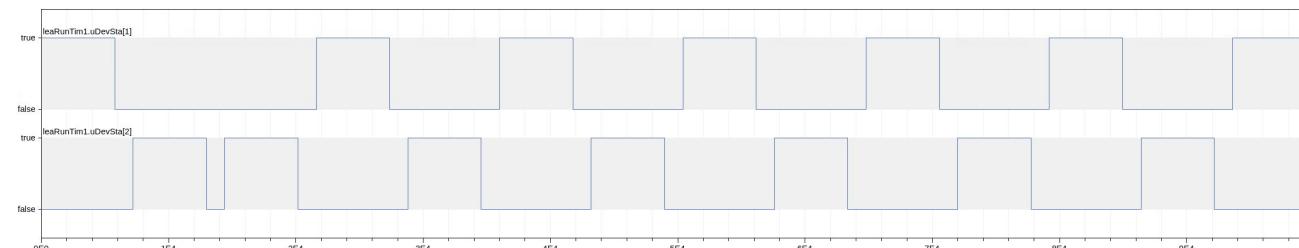
Currently implemented for two devices and groups of devices.

When `continuous` is true the default setting is to rotate at `rotationPeriod` after the start of the simulation/operation

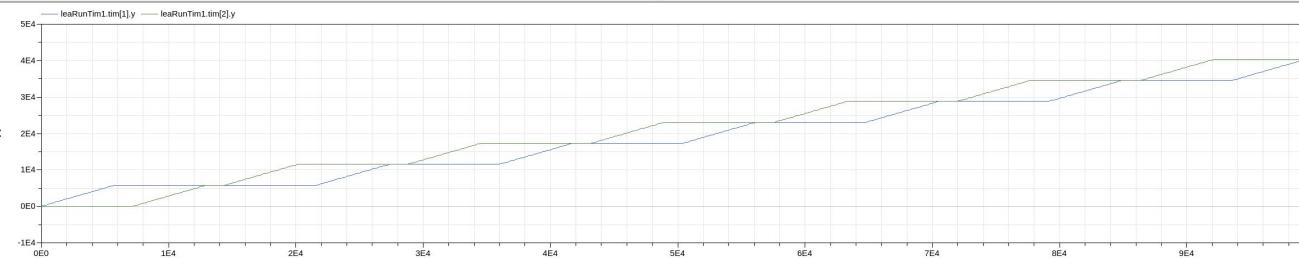
Updated for May 22: Equipment rotation - lead/standby case, default settings



$yDevRole[i]$ - device i role,
true is lead, false is lag



$yDevStat[i]$ - device i status



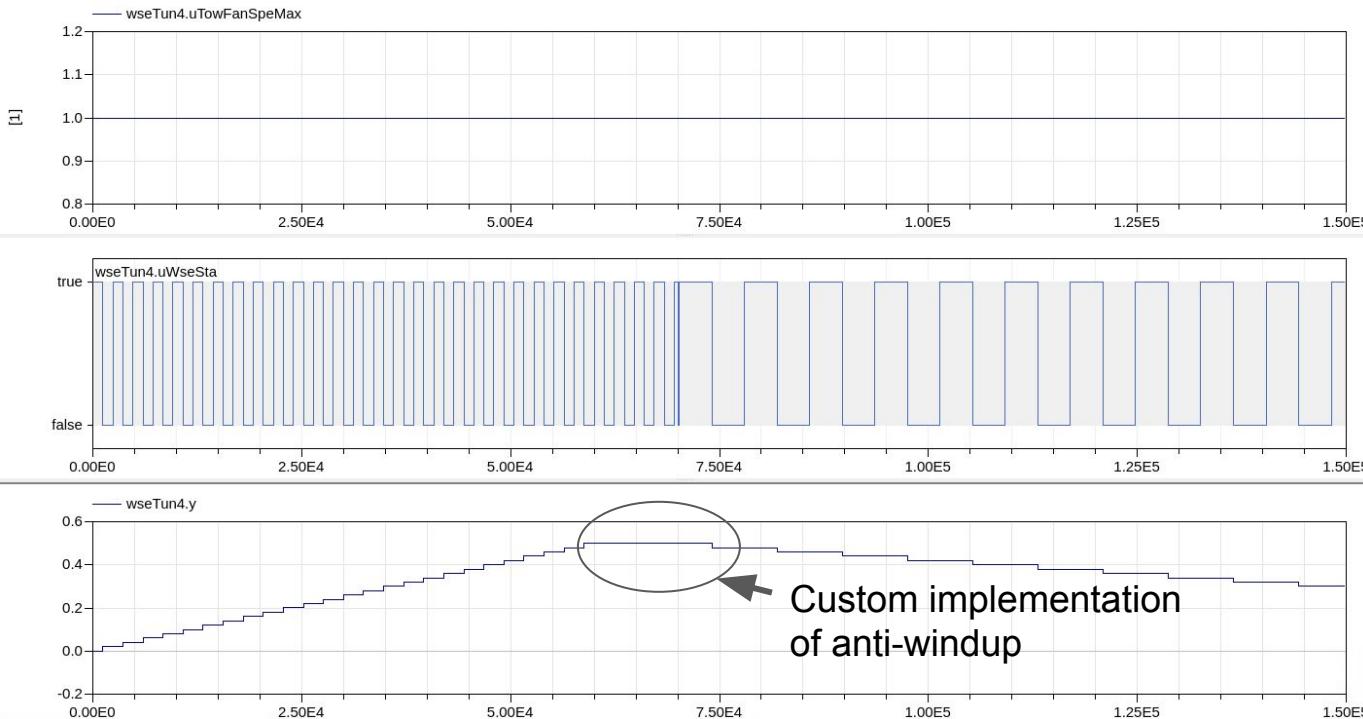
Runtime counters for each
device/group of devices

Waterside economizer - Tuning parameter simulation

Section 5.2.3.3 March draft

Type	Name	Description
input BooleanInput	uWseSta	WSE enable disable status
input RealInput	uTowFanSpeMax	Maximum cooling tower fan speed signal [1]
output RealOutput	y	Tuning parameter for the waterside economizer outlet temperature prediction

wseTun4 - instance name of the tuning parameter model

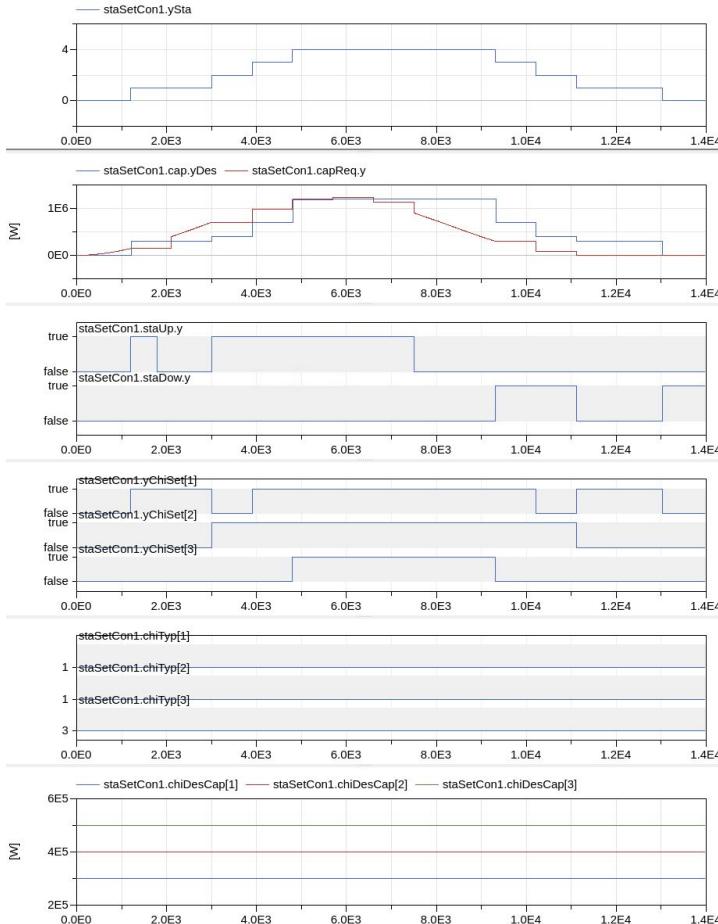


WSE status controller calls for a maximum tower fan speed input (5.2.2.3) - is that the fan speed output of the tower controller (asking based on the reference to the tower sequences)?

Yes, answered May 15

Chiller staging setpoints

Sections from 5.2.4.1 +
OBC generalization



staSetCon1 - an instance of the staging setpoint controller
ySta - chiller stage setpoint to send to staging processes

cap.yDes - design capacity of a given stage
capReq.y - capacity requirement based on load

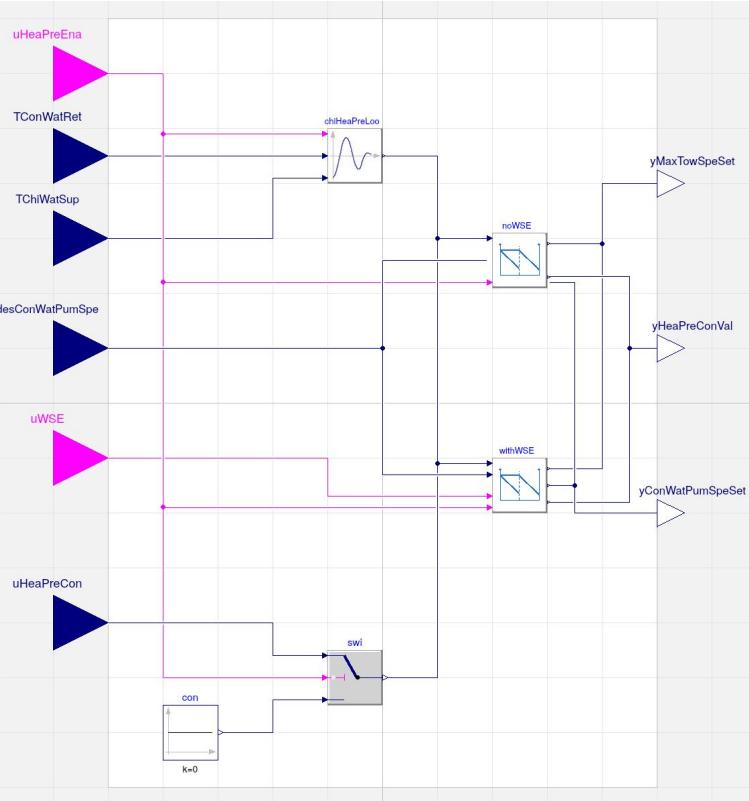
cap.yDes - design capacity of a given stage
capReq.y - capacity requirement based on load

cap.yChiSet[i] - Chiller i enabling status (status setpoint as opposed to proven on status)

cap.chiTyp[i] - Chiller i type

cap.chiDesCap[i] - Chiller i design capacity

Head pressure control (Sec. 5.2.10)



Parameters

Type	Name	Default	Description
Real	minTowSpe	0.1	Minimum cooling tower fan speed
Real	minConWatPumSpe	0.1	Minimum condenser water pump speed
Real	minHeaPreValPos	0.1	Minimum head pressure control valve position
Plant			
Boolean	hasHeaPreConSig	false	Flag indicating if there is head pressure control signal from chiller controller
Boolean	hasWSE	true	Flag indicating if the plant has waterside economizer
Boolean	fixSpePum	true	Flag indicating if the plant has fixed speed condenser water pumps
Loop signal			
TemperatureDifference	minChiLif	10	Minimum allowable lift at minimum load for chiller [K]
PID controller			
SimpleController	controllerType	Buildings.Controls.OBC.CDL.T...	Type of controller
Real	k	1	Gain of controller
Time	Ti	0.5	Time constant of integrator block [s]

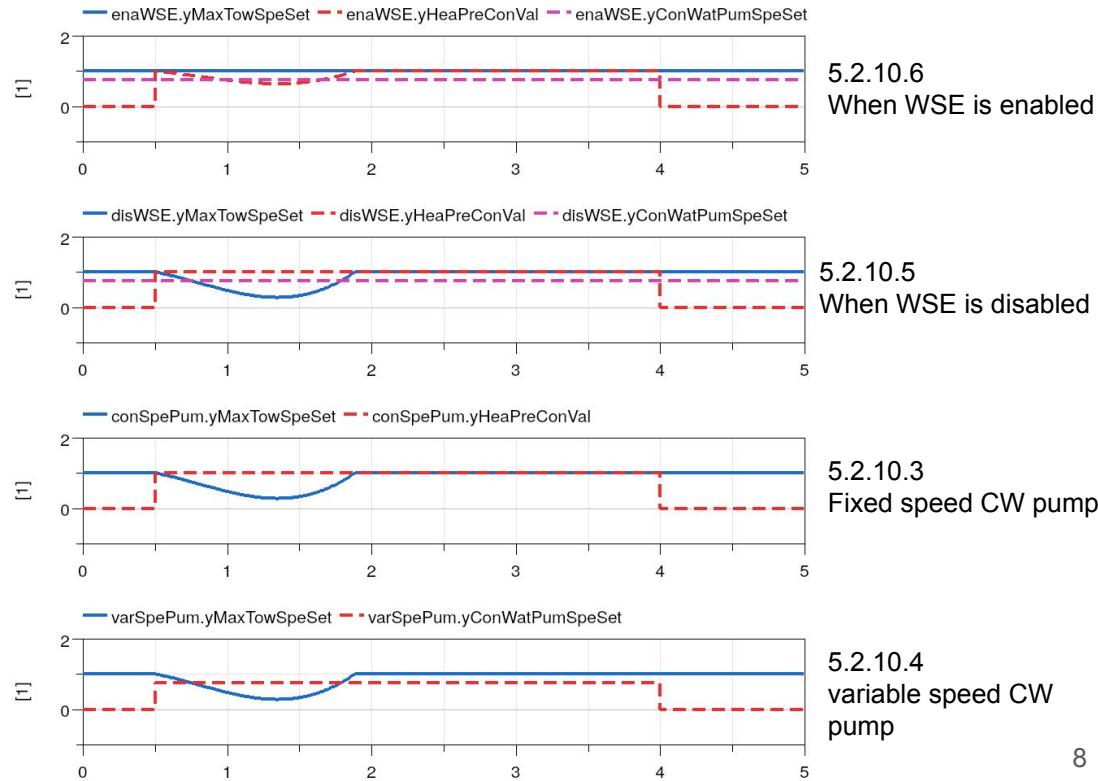
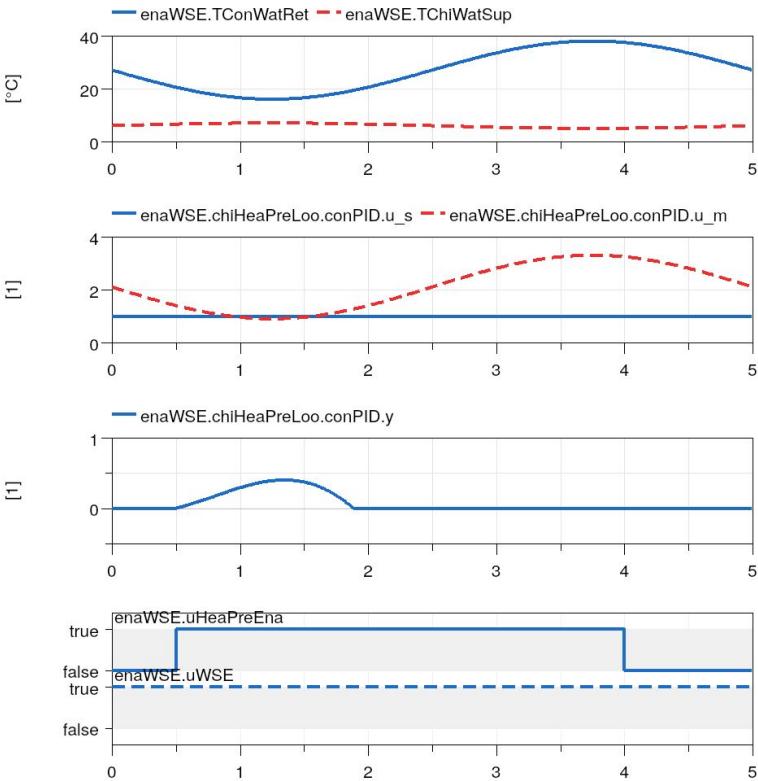
Connectors

Type	Name	Description
input BooleanInput	<i>uHeaPreEna</i>	Status of head pressure control: true = ON, false = OFF
input RealInput	<i>TConWatRet</i>	Measured condenser water return temperature [K]
input RealInput	<i>TChiWatSup</i>	Measured chilled water supply temperature [K]
input RealInput	<i>desConWatPumSpe</i>	Design condenser water pump speed for current stage [1]
input BooleanInput	<i>uWSE</i>	Status of water side economizer: true = ON, false = OFF
input RealInput	<i>uHeaPreCon</i>	Chiller head pressure control loop signal from chiller controller [1]
output RealOutput	<i>yMaxTowSpeSet</i>	Maximum cooling tower speed setpoint [1]
output RealOutput	<i>yHeaPreConVal</i>	Head pressure control valve position [1]
output RealOutput	<i>yConWatPumSpeSet</i>	Condenser water pump speed setpoint [1]

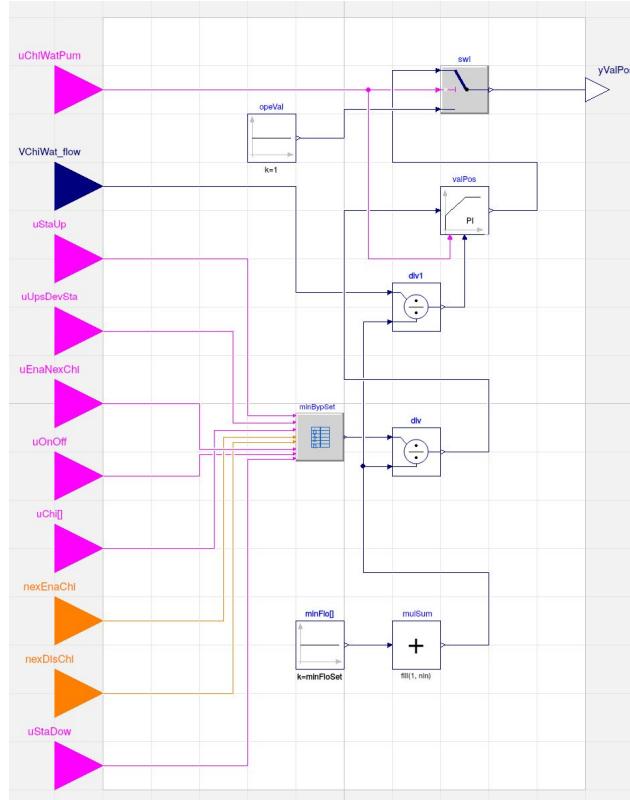
"if a head pressure control signal is not available from the chiller controller, a reverse acting PID loop shall maintain the temperature differential between the chiller's condenser water return temperature and chilled water supply temperature at LIFTminX"

--- Does it mean when the LIFT becoming smaller, the loop output should be larger?

Head pressure control (Sec. 5.2.10)



Minimum flow bypass control (Sec. 5.2.8)



Parameters

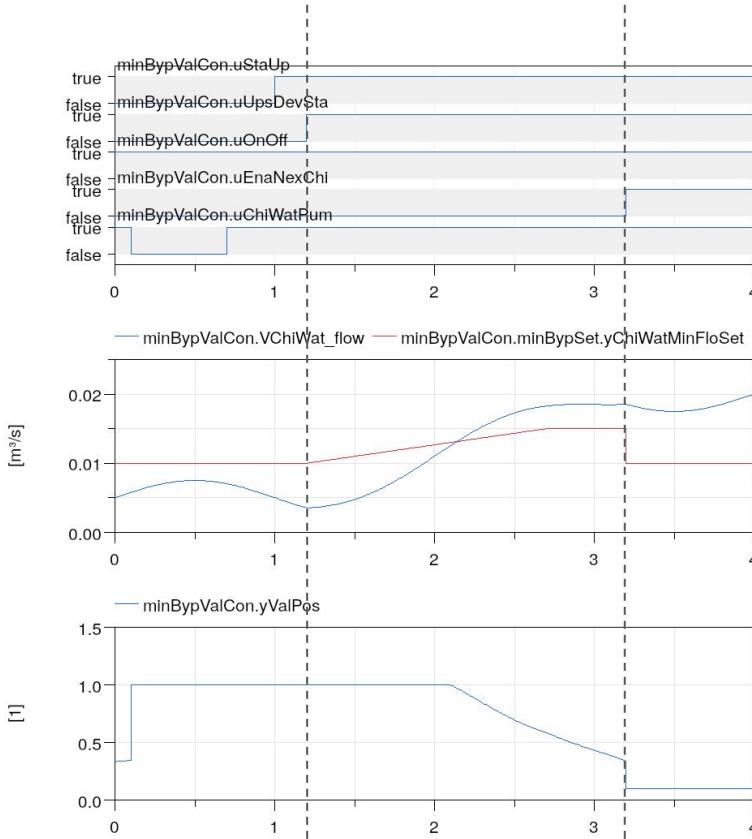
Type	Name	Default	Description
Integer	nChi		Total number of chillers
Boolean	isParallelChiller		Flag: true means that the plant has parallel chillers
Time	byPasSetTim		Time constant for resetting minimum bypass flow [s]
VolumeFlowRate	minFloSet[nChi]		Minimum chilled water flow through each chiller [m ³ /s]
VolumeFlowRate	maxFloSet[nChi]		Maximum chilled water flow through each chiller [m ³ /s]
Controller			
SimpleController	controllerType	Buildings.Controls.OBC.CDL.T...	Type of controller
Real	k	1	Gain of controller
Time	Ti	0.5	Time constant of integrator block [s]
Time	Td	0	Time constant of derivative block [s]
Real	yMax	1	Upper limit of output
Real	yMin	0.1	Lower limit of output

Connectors

Type	Name	Description
input BooleanInput	uChiWatPum	Maximum status feedback of all the chilled water pumps: true means at least one pump is proven on
input RealInput	VChiWat_flow	Measured chilled water flow rate through chillers [m ³ /s]
input BooleanInput	uStaUp	Stage up logical signal
input BooleanInput	uUpsDevSta	During chiller stage changing process, resetting status of device before reset minimum flow setpoint
input BooleanInput	uEnaNexChi	Status to indicate that it starts to enable another chiller. This input is used when the stage change needs chiller on/off
input BooleanInput	uOnOff	Indicate if the stage change requires one chiller to be enabled while another is disabled
input BooleanInput	uChi[nChi]	Chiller status: true=ON
input IntegerInput	nexEnaChi	Index of next chiller to be enabled
input IntegerInput	nexDisChi	Index of next chiller to be disabled
input BooleanInput	uStaDow	Stage down logical signal
output RealOutput	yValPos	Chilled water minimum flow bypass valve position [1]

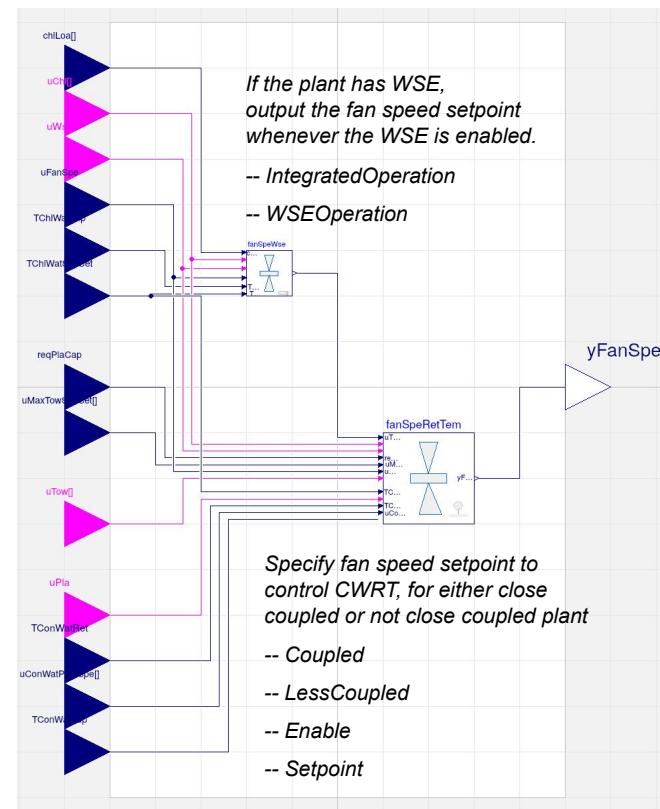
*Should the minimum flow setpoint be reset slowly?
If yes, how slowly should it be?*

Minimum flow bypass control (Sec. 5.2.8)



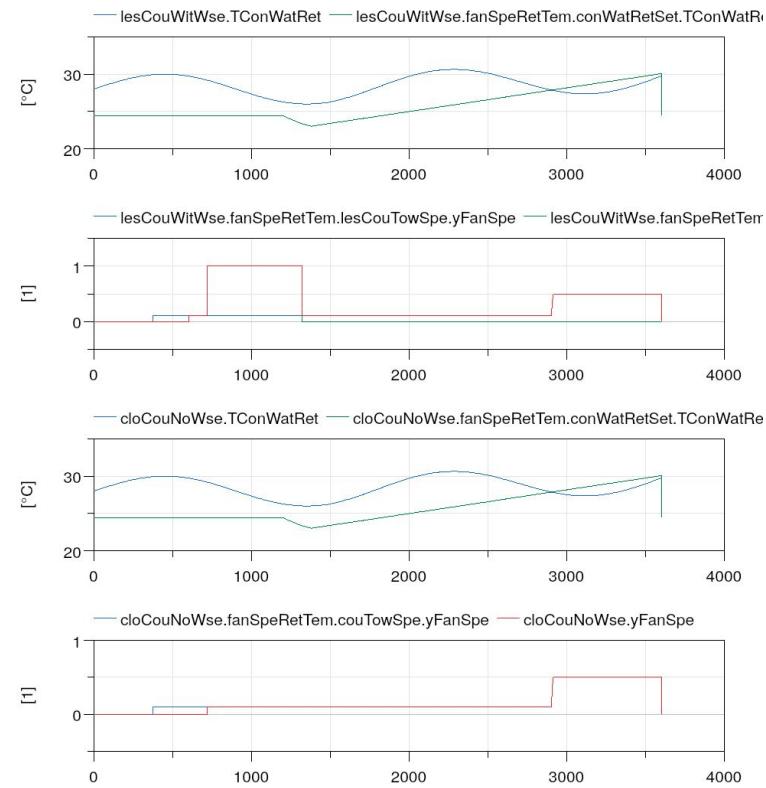
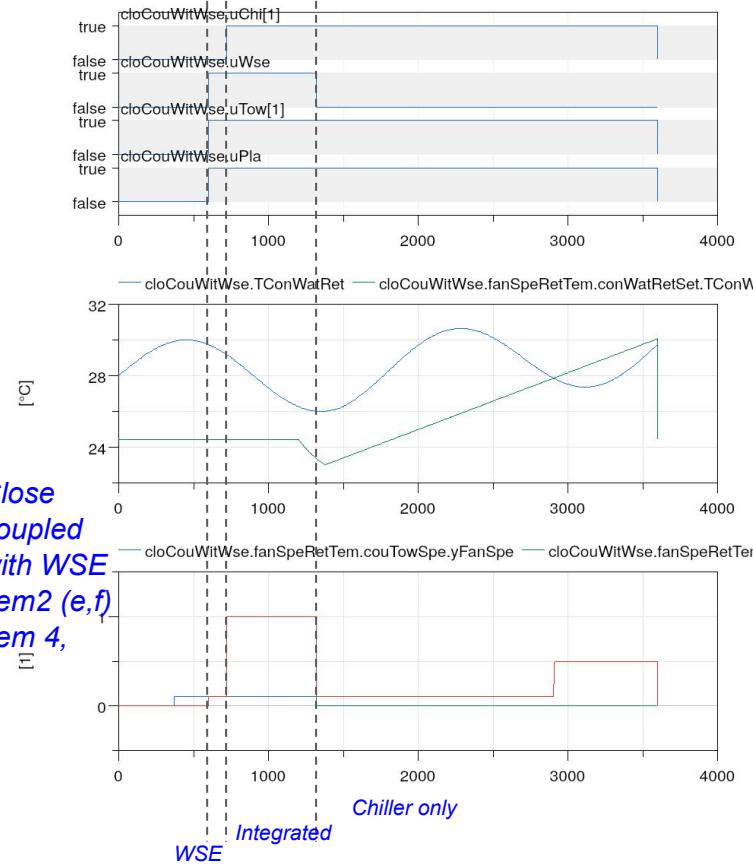
- total 3 chillers (have the same miniflow setpoints 0.005 m³/s), 2 chillers are running initially.
- stage up: enable a larger chiller, disable a small chiller ($uOnOff = \text{true}$)
- in the stage up process ($uStaUp = \text{true}$)
- after the upstream steps are finished ($uUpsDevSta = \text{true}$)
- slowly changing minimum flow setpoints from the one for 2 initial chillers (total 0.01 m³/s), to the one for 2 initial chillers + 1 to be enabled chiller (total 0.015 m³/s).
- when it is time to actually enabling the next chiller, change the setpoint to the one for 1 initial chiller and the enabled chiller (total 0.01 m³/s)

Tower control: fan speed (Sec. 5.2.12.2)

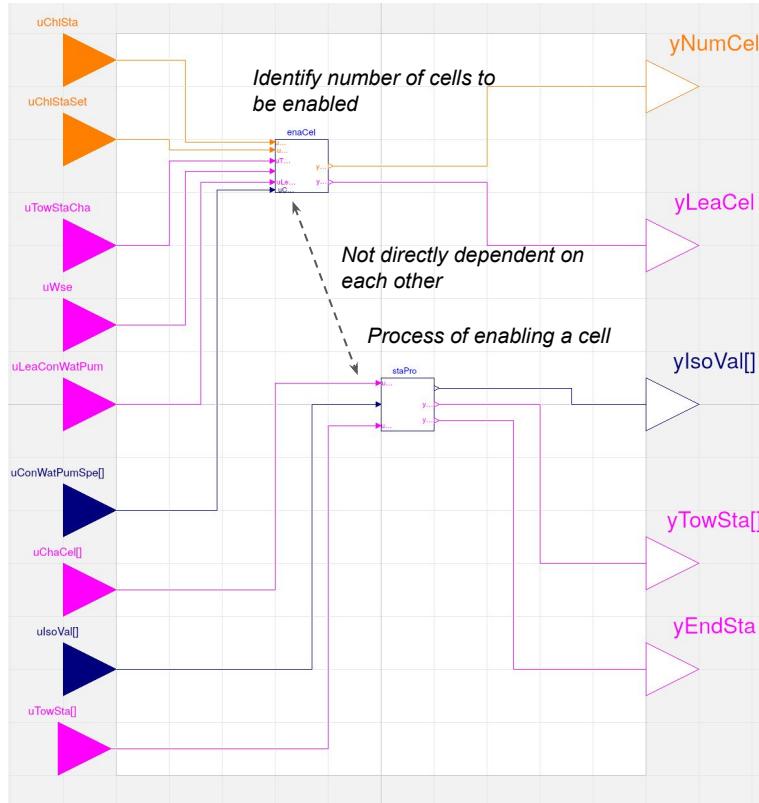


Parameters			
Type	Name	Default	Description
Integer	nChi	2	Total number of chillers
Integer	nTowCel	4	Total number of cooling tower cells
Integer	nConWatPum	2	Total number of condenser water pumps
Boolean	closeCoupledPlant	true	Flag to indicate if the plant is close coupled
Boolean	have_WSE	true	Flag to indicate if the plant has waterside economizer
Real	desCap	1e6	Plant design capacity [W]
Real	fanSpeMin	0.1	Minimum tower fan speed
Real	fanSpeMax	1	Maximum tower fan speed
WSE Enabled			
Integrated			
Real	chiMinCap[nChi]	[1e4,1e4]	Minimum cycling load below which chiller will begin cycling [W]
SimpleController	intOpeCon	Buildings.Controls.OBC.CDL.T...	Type of controller
Real	kIntOpe	1	Gain of controller
Real	TiIntOpe	0.5	Time constant of integrator block [s]
Real	TdIntOpe	0.1	Time constant of derivative block [s]
WSE-only			
SimpleController	chiWatCon	Buildings.Controls.OBC.CDL.T...	Type of controller
Real	kWSE	1	Gain of controller
Real	TIWSE	0.5	Time constant of integrator block [s]
Real	TDWSE	0.1	Time constant of derivative block [s]
Return temperature control			
Setpoint			
TemperatureDifference	LIFT_min[nChi]	[12.12]	Minimum LIFT of each chiller [K]
Real	TConWatSup_nominal[nChi]	[293.15,293.15]	Design condenser water supply temperature (condenser entering) of each chiller [K]
Real	TConWatRet_nominal[nChi]	[303.15,303.15]	Design condenser water return temperature (condenser leaving) of each chiller [K]
Real	TChiWatSupMin[nChi]	[278.15,278.15]	Lowest chilled water supply temperature of each chiller [K]
Coupled plant			
SimpleController	couPlaCon	Buildings.Controls.OBC.CDL.T...	Type of controller
Real	kCoupPla	1	Gain of controller
Real	TiCoupPla	0.5	Time constant of integrator block [s]
Real	TdCoupPla	0.1	Time constant of derivative block [s]
Real	yCoupPlaMax	1	Upper limit of output
Real	yCoupPlaMin	0	Lower limit of output
Less coupled plant			
Real	samplePeriod	30	Period of sampling condenser water supply and return temperature difference
SimpleController	supWatCon	Buildings.Controls.OBC.CDL.T...	Type of controller
Real	kSupCon	1	Gain of controller
Real	TiSupCon	0.5	Time constant of integrator block [s]
Real	TdSupCon	0.1	Time constant of derivative block [s]
Real	ySupConMax	1	Upper limit of output
Real	ySupConMin	0	Lower limit of output
Advanced			
Real	speChe	0.005	Lower threshold value to check fan or pump speed
Return temperature control: Enable tower			
Real	cheMinFanSpe	300	Threshold time for checking duration when tower fan equals to the minimum tower fan speed [s]
Real	cheMaxTowSpe	300	Threshold time for checking duration when any enabled chiller maximum cooling speed equals to the minimum tower fan speed [s]
Real	cheTowOff	60	Threshold time for checking duration when there is no enabled tower fan [s]
Return temperature control: Setpoint			
Real	iniPlaTim	600	Time to hold return temperature to initial setpoint after plant being enabled [s]
Real	ramTim	180	Time to ramp return water temperature from initial value to setpoint [s]

Tower control: fan speed (Sec. 5.2.12.2)



Tower control: staging (Sec. 5.2.12.1)



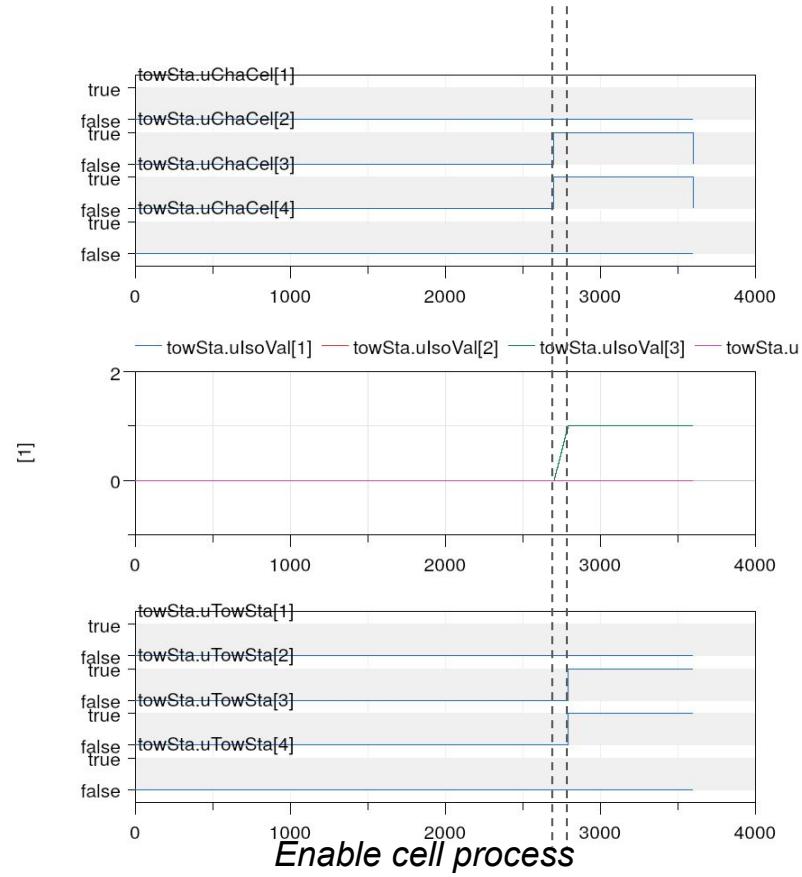
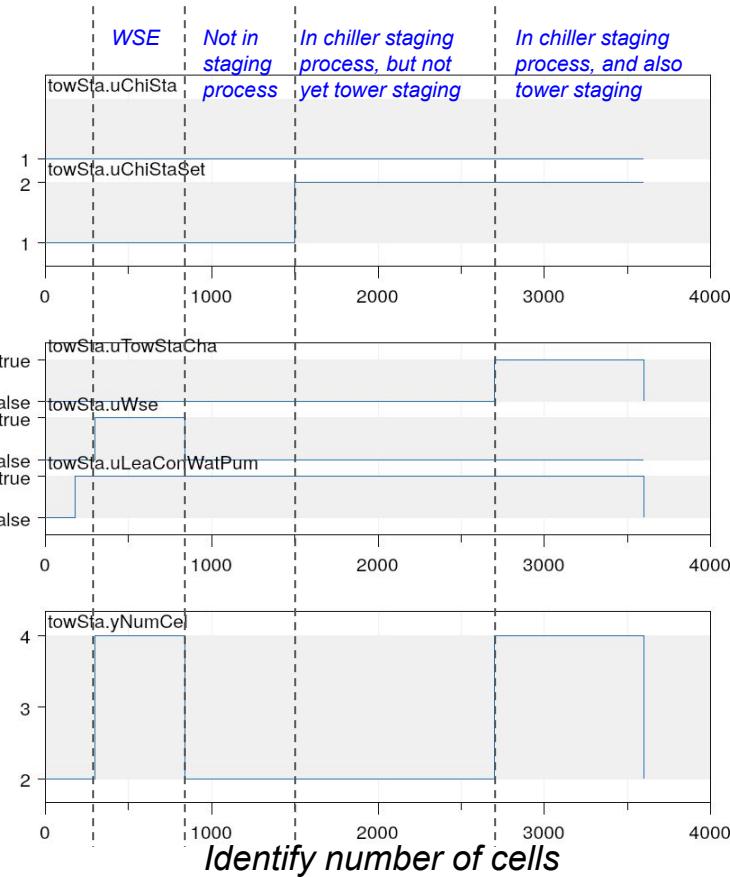
Parameters

Type	Name	Default	Description
Boolean	have_WSE	true	Flag to indicate if the plant has waterside economizer
Integer	nTowCel	4	Total number of cooling tower cells
Integer	nConWatPum	2	Total number of condenser water pumps
Integer	totChiSta	6	Total number of plant stages, stage zero should be counted as one stage
Real	staVec[totChiSta]	{0,0.5,1,1.5,2,2.5}	Plant stage vector with size of total number of stages, element value like x.5 means chiller stage x plus WSE
Real	towCelOnSel[totChiSta]	{0,2,2,4,4,4}	Design number of tower fan cells that should be ON, according to current chiller stage and WSE status
Real	chaTowCellsofTim	90	Nominal time needed for open isolation valve of the tower cells
Advanced			
Real	speChe	0.01	Lower threshold value to check if condenser water pump is proven on

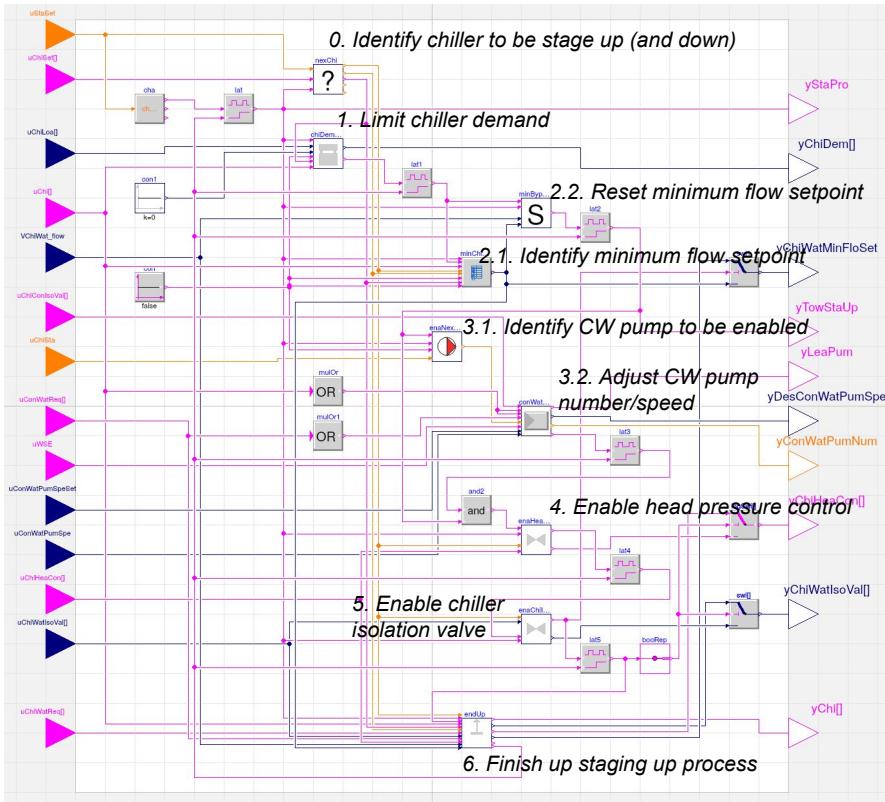
Connectors

Type	Name	Description
Input IntegerInput	uChiSta	Current chiller stage
Input IntegerInput	uChiStaSet	Current chiller stage setpoint
Input BooleanInput	uTowStaCha	Cooling tower stage change command from plant staging process
Input BooleanInput	uWse	Water side economizer status: true = ON, false = OFF
Input BooleanInput	uLeaConWatPum	Enabling status of lead condenser water pump
Input RealInput	uConWatPumSpe[nConWatPum]	Current condenser water pump speed [1]
Input BooleanInput	uChaCel[nTowCel]	Vector of boolean flags to show if a cell should change its status: true = the cell should change status (be enabled or disabled)
Input RealInput	ulsoVal[nTowCel]	Vector of tower cells isolation valve position
Input BooleanInput	uTowSta[nTowCel]	Vector of tower cells proven on status: true=proven on
Output IntegerOutput	yNumCel	Total number of enabled cells
Output BooleanOutput	yLeaCel	Lead tower cell status
Output RealOutput	ylsoVal[nTowCel]	Vector of tower cells isolation valve position [1]
Output BooleanOutput	yTowSta[nTowCel]	Vector of tower cells status setpoint
Output BooleanOutput	vEndSta	Rising edge to indicate the staging process is done

Tower control: staging (Sec. 5.2.12.1)



Chiller staging up (Sec. 5.2.4.16)

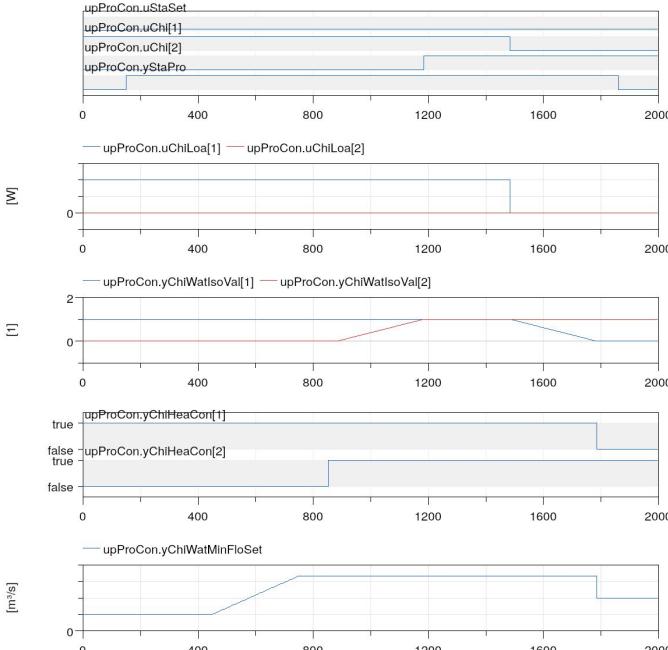
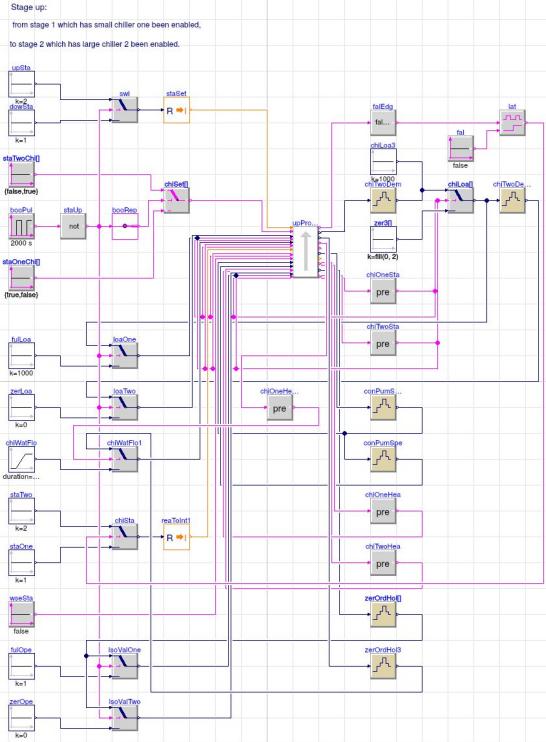


Parameters

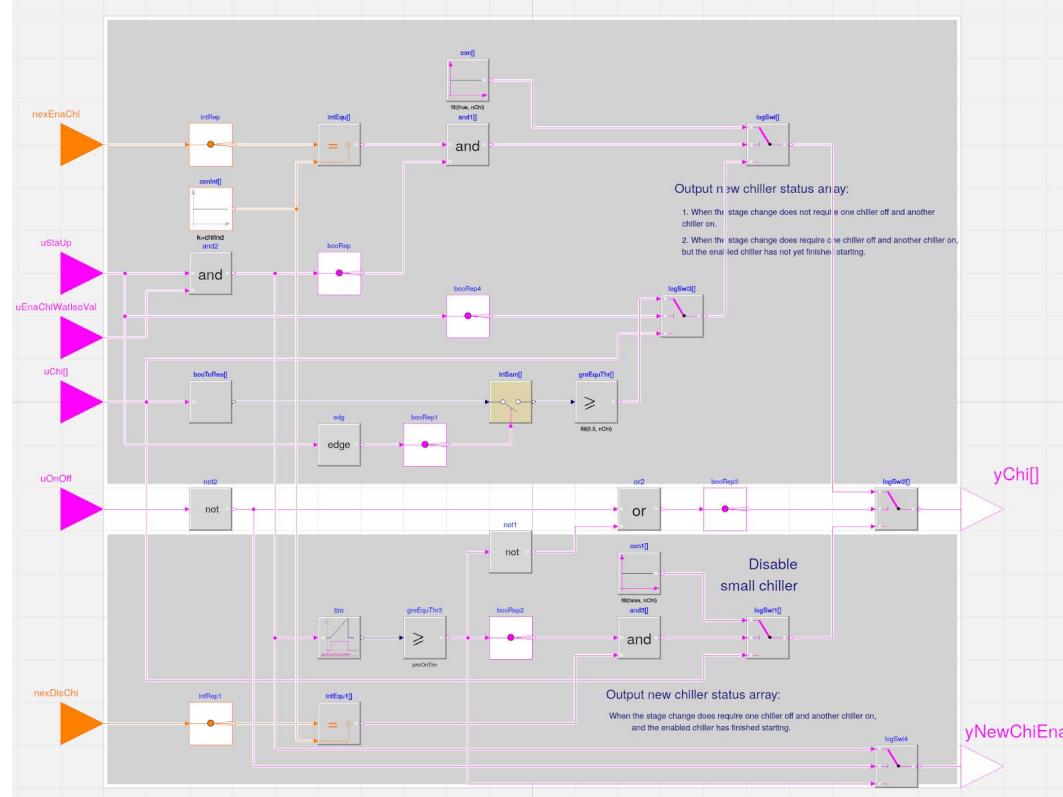
Type	Name	Default	Description
Integer	nChi	2	Total number of chillers in the plant
Integer	totSta	6	Total number of stages, including the stages with a WSE, if applicable
Boolean	haveWSE	true	Flag: true = have waterside economizer
Boolean	havePonyChiller	false	Flag: true = have pony chiller
Boolean	isParallelChiller	true	Flag: true = the plant has parallel chillers
Boolean	isHeadered	true	Flag: true = headered condenser water pumps
Limit chiller demand			
Real	chiDemRedFac	0.75	Demand reducing factor of current operating chillers
Time	holChiDemTim	300	Maximum time to wait for the actual demand less than percentage of current load [s]
Reset CHW minimum flow setpoint			
Time	byPasSetTim	300	Time to reset minimum by-pass flow [s]
VolumeFlowRate	minFloSet[nChi]	[0.0089, 0.0089]	Minimum chilled water flow through each chiller [m ³ /s]
VolumeFlowRate	maxFloSet[nChi]	[0.025, 0.025]	Maximum chilled water flow through each chiller [m ³ /s]
Reset bypass			
Time	aftByPasSetTim	60	Time to allow loop to stabilize after resetting minimum chilled water flow setpoint [s]
Enable condenser water pump			
Real	staVec[totSta]	[0, 0.5, 1, 1.5, 2, 2.5]	Chiller stage vector, element value like x.5 means chiller stage x plus WSE
Real	desConWatPumSpe[totSta]	[0, 0.5, 0.75, 0.6, 0.75, 0.9]	Design condenser water pump speed setpoints, the size should be double of total stage numbers
Real	desConWatPumNum[totSta]	[0, 1, 1.2, 2, 2]	Design number of condenser water pumps that should be ON, the size should be double of total stage numbers
Enable head pressure control			
Time	thrTimEnb	10	Threshold time to enable head pressure control after condenser water pump being reset [s]
Time	waTim	30	Waiting time after enabling next head pressure control [s]
Enable CHW isolation valve			
Time	chaChiWatIsoTim	300	Time to slowly change isolation valve, should be determined in the field [s]
Enable next chiller			
Time	proOnTim	300	Threshold time to check if newly enabled chiller being operated by more than 5 minutes [s]
Advanced			
Enable condenser water pump			
Real	relSpeDif	0.05	Relative error to the setpoint for checking if it has achieved speed setpoint
Reset bypass			
Real	relFloDif	0.05	Relative error to the setpoint for checking if it has achieved flow rate setpoint

- Is it possible that “enable a larger chiller and disable a smaller chiller” happens other than staging-up from 1 to 2?

Chiller staging up (Sec. 5.2.4.16)



Chiller staging up: enable chiller



Parameters

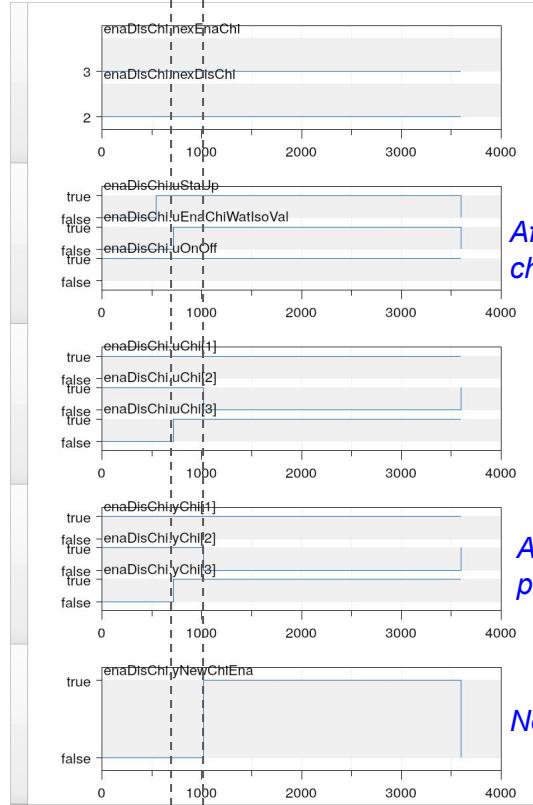
Type	Name	Default	Description
Integer	nChi	Total number of chillers	
Time	proOnTim	300	Enabled chiller operation time to indicate if it is proven on [s]

Connectors

Type	Name	Description
input IntegerInput	nexEnaChi	Index of next enabling chiller
input BooleanInput	uStaUp	Indicate if there is stage-up command
input BooleanInput	uEnaChiWattIsoVal	Status of chilled water isolation valve control: true=enabled valve is fully open
input BooleanInput	uChi[nChi]	Chiller status: true=ON
input BooleanInput	uOnOff	Indicate if the stage require one chiller to be enabled while another is disabled
input IntegerInput	nexDisChi	Next disabling chiller when there is any stage up that need one chiller on and another off
output BooleanOutput	yChi[nChi]	Chiller enabling status
output BooleanOutput	yNewChiEna	Newly enabled chiller has been proven on by more than 5 minutes

Chiller staging up: enable chiller

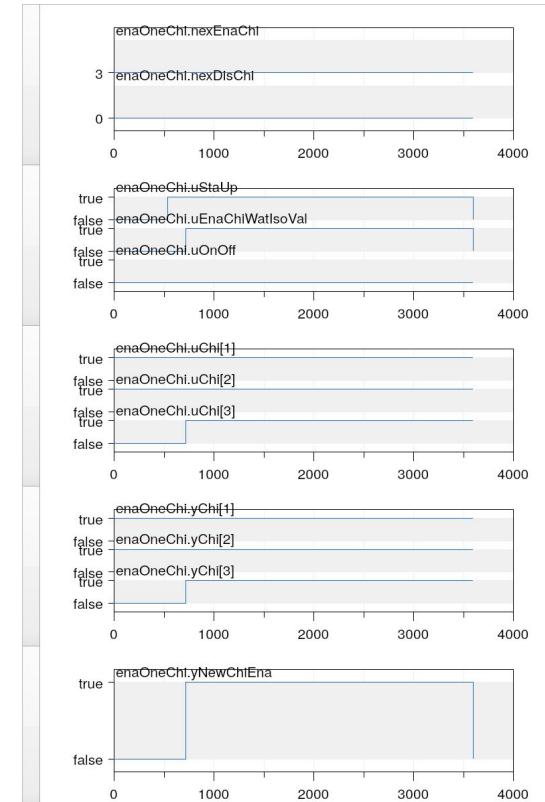
Enable large chiller (3), disable small chiller (2)



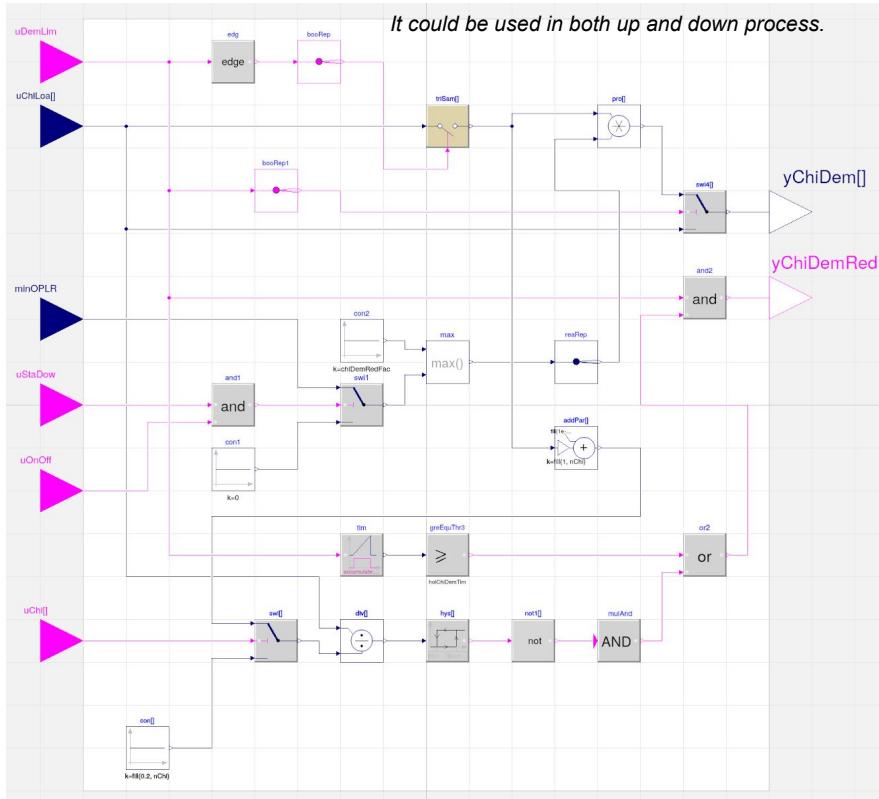
After enabling chiller (3) has been proven on, disable chiller 2

Newly enabled chiller is proven on

Enable a chiller



Chiller staging: reduce demand



Parameters

Type	Name	Default	Description
Integer	nChi		Total number of chillers in the plant
Real	chiDemRedFac	0.75	Demand reducing factor of current operating chillers
Time	hotChiDemTim	300	Maximum time to wait for the actual demand less than percentage of current load [s]

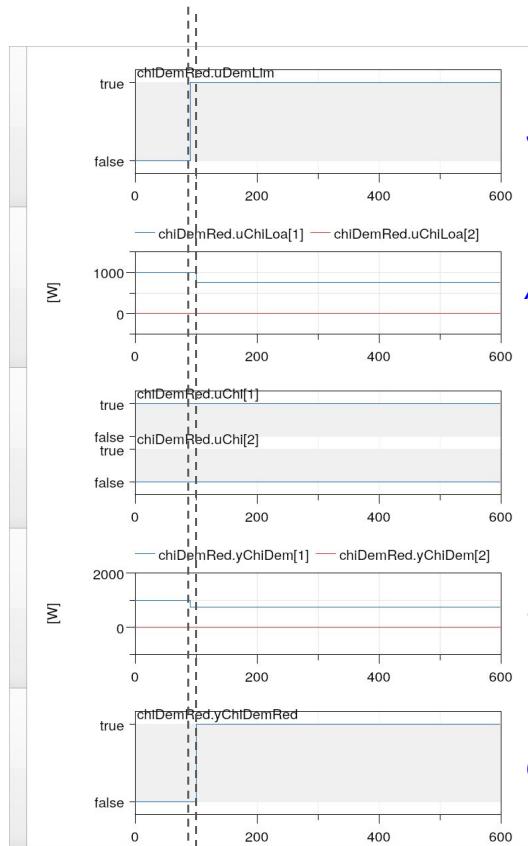
Connectors

Type	Name	Description
input BooleanInput	uDemLim	Demand limit: true=limit chiller demand
input RealInput	uChiLoa[nChi]	Current chiller load [W]
input RealInput	minOPLR	Current stage minimum cycling operative partial load ratio [1]
input BooleanInput	uStaDow	Stage down status: true=stage-down
input BooleanInput	uOnOff	Indicate if the stage require one chiller to be enabled while another is disabled
input BooleanInput	uChi[nChi]	Chiller status: true=ON
output RealOutput	yChiDem[nChi]	Chiller demand setpoint [W]
output BooleanOutput	yChiDemRed	Indicate if the chiller demand reduction process has finished

- What does the “chiller load” mean? Is it a reading data from chiller itself?
- How is the “chiller demand” signal being sent to the chiller?
- Does the minimum OPLR input (*minOPLR*) refer to each chiller individually or to a stage, or something else?

Chiller staging: reduce demand

Enable one more chiller



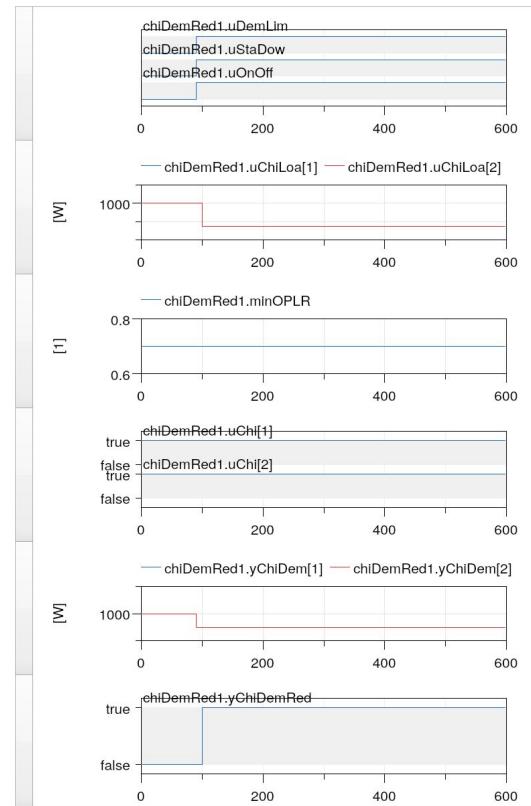
Should limit the demand

Actual chiller load

“Demand setpoint”

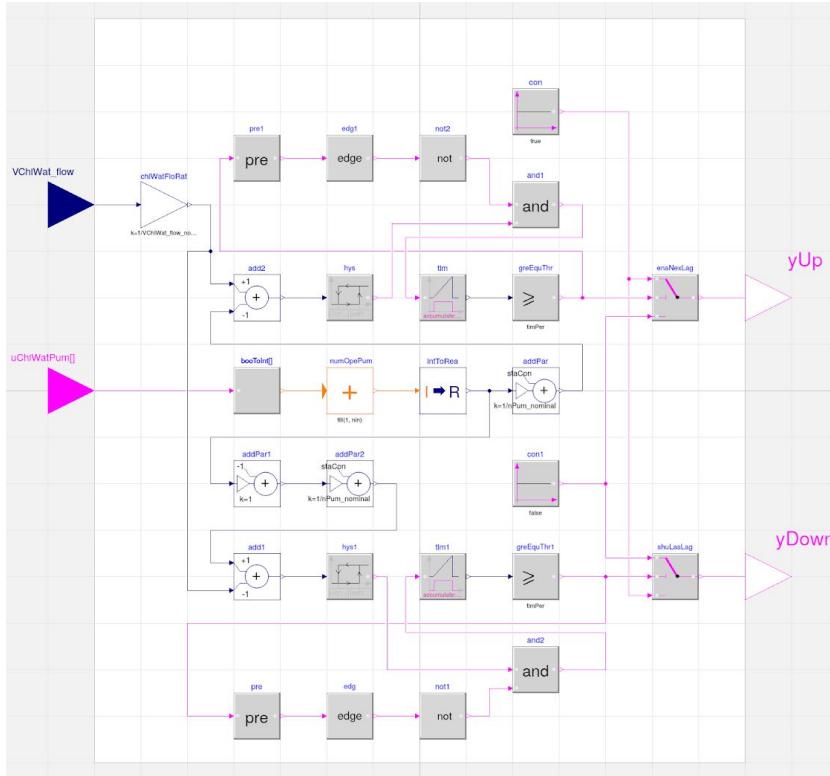
Chiller demand has been limited.

Down: enable 1 and disable another



Chilled water pump: enable/disable lag pump

Section 5.2.6.6: enable/disable lag pumps for primary-only plants using dP



Parameters

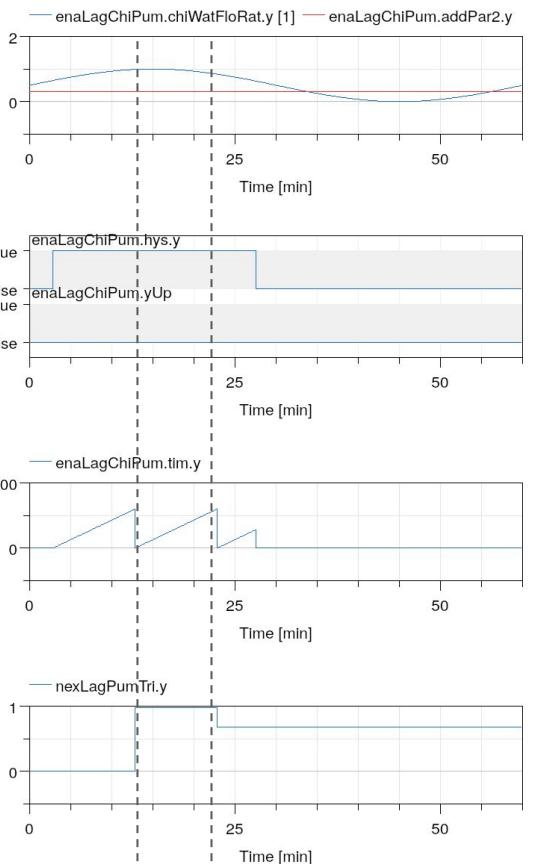
Type	Name	Default	Description
Integer	nPum	2	Total number of pumps
Time	timPer	600	Delay time period for enabling and disabling lag pumps [s]
Nominal conditions			
Integer	nPum_nominal	nPum	Total number of pumps that operate at design conditions
VolumeFlowRate	VChiWat_flow_nominal	0.5	Total plant design chilled water flow rate [m ³ /s]
Advanced			
Real	staCon	-0.03	Constant used in the staging equation
Real	relFloHys	0.01	Constant value used in hysteresis for checking relative flow rate

Connectors

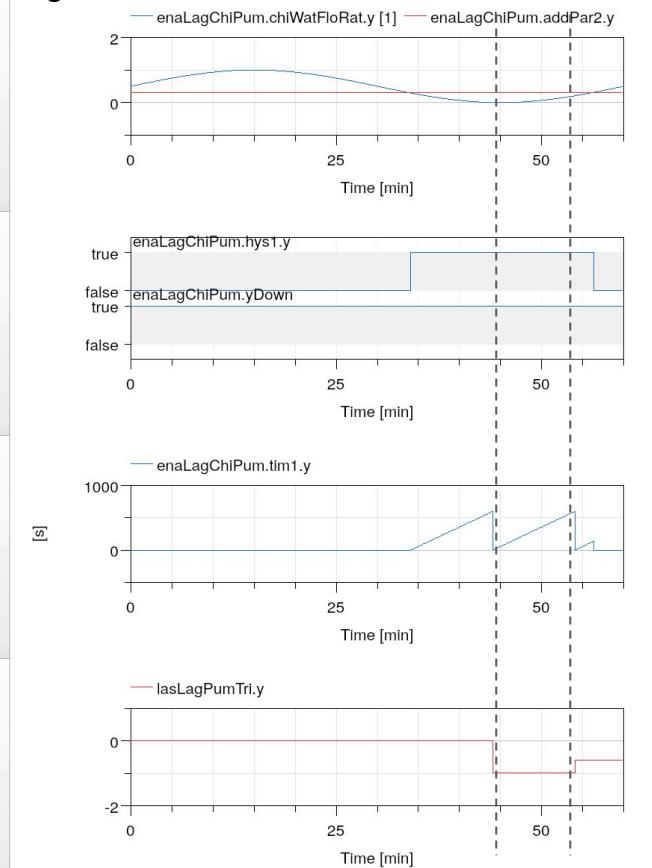
Type	Name	Description
input RealInput	VChiWat_flow	Chilled water flow [m ³ /s]
input BooleanInput	uChiWatPum[nPum]	Chilled water pump status
output BooleanOutput	yUp	Next lag pump status, a rising edge indicates that next lag pump should be enabled
output BooleanOutput	yDown	Last lag pump status, a falling edge indicates that last lag pump should be disabled

Chilled water pump: enable/disable lag pump

Section 5.2.6.6: enable/disable lag pumps for primary-only plants using dP



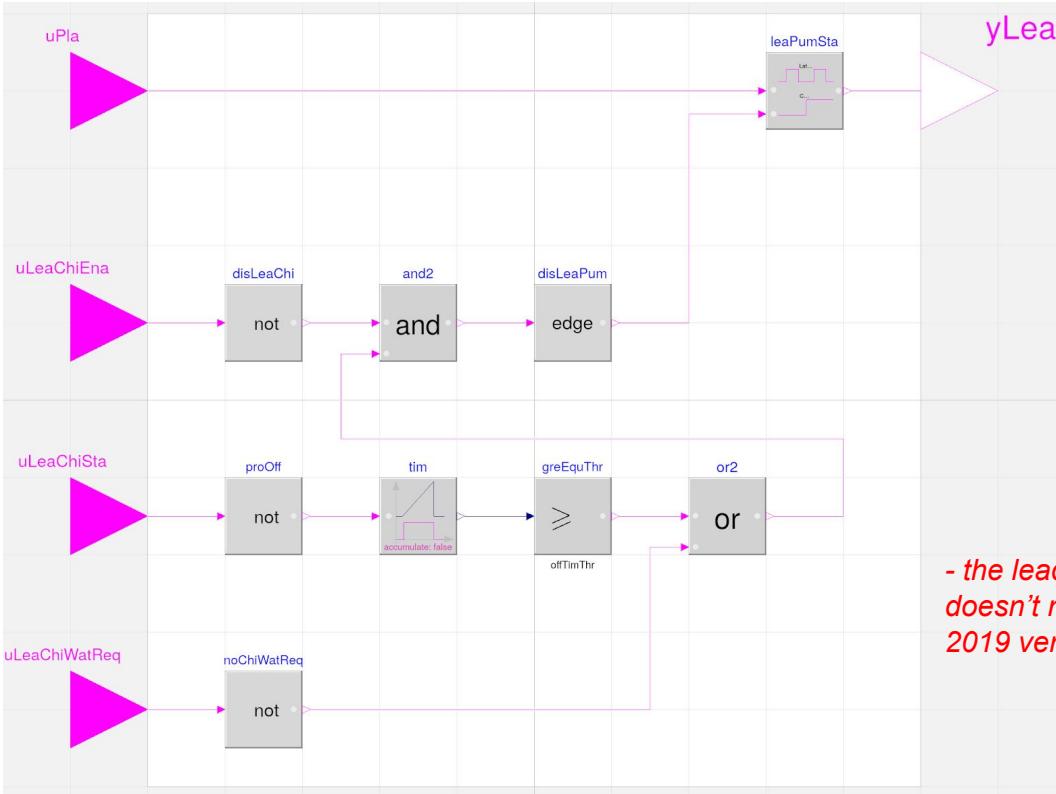
Enable next pump



disable last pump

Chilled water pump: enable lead pump - dedicated

Section 5.2.6.5: enable lead pump for primary-only plants with dedicated pump



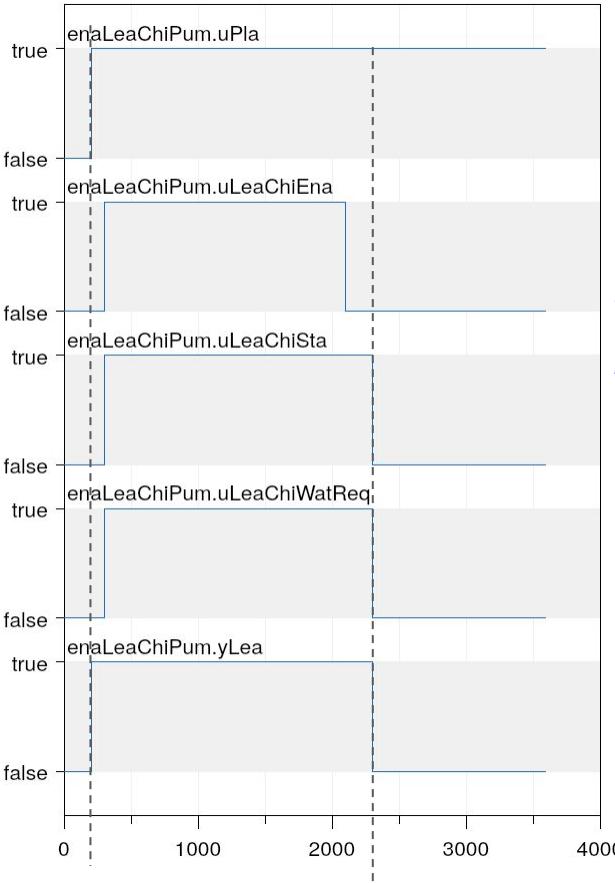
Connectors

Type	Name	Description
input BooleanInput	<code>uPla</code>	True: plant is enabled
input BooleanInput	<code>uLeaChiEna</code>	True: lead chiller is enabled
input BooleanInput	<code>uLeaChiSta</code>	True: lead chiller is proven on
input BooleanInput	<code>uLeaChiWatReq</code>	True: lead chiller is requesting chilled water
output BooleanOutput	<code>yLea</code>	Lead pump status

- the lead pump could be enabled as long as the plant is enabled, so it doesn't matter if the lead chiller is enabled? (this was updated from July 2019 version to current version)

Chilled water pump: enable lead pump - dedicated

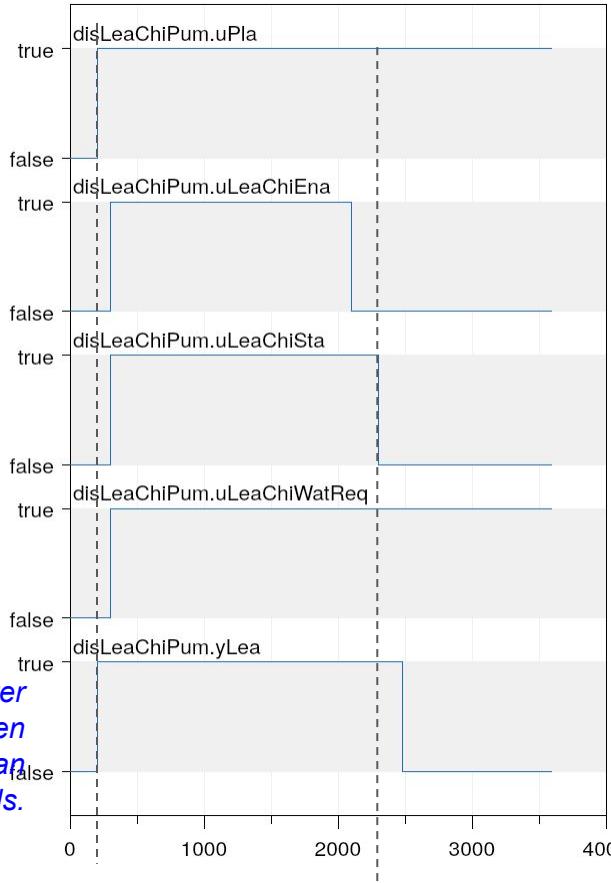
Section 5.2.6.5: enable lead pump for primary-only plants with dedicated pump



Enable lead pump when plant is enabled

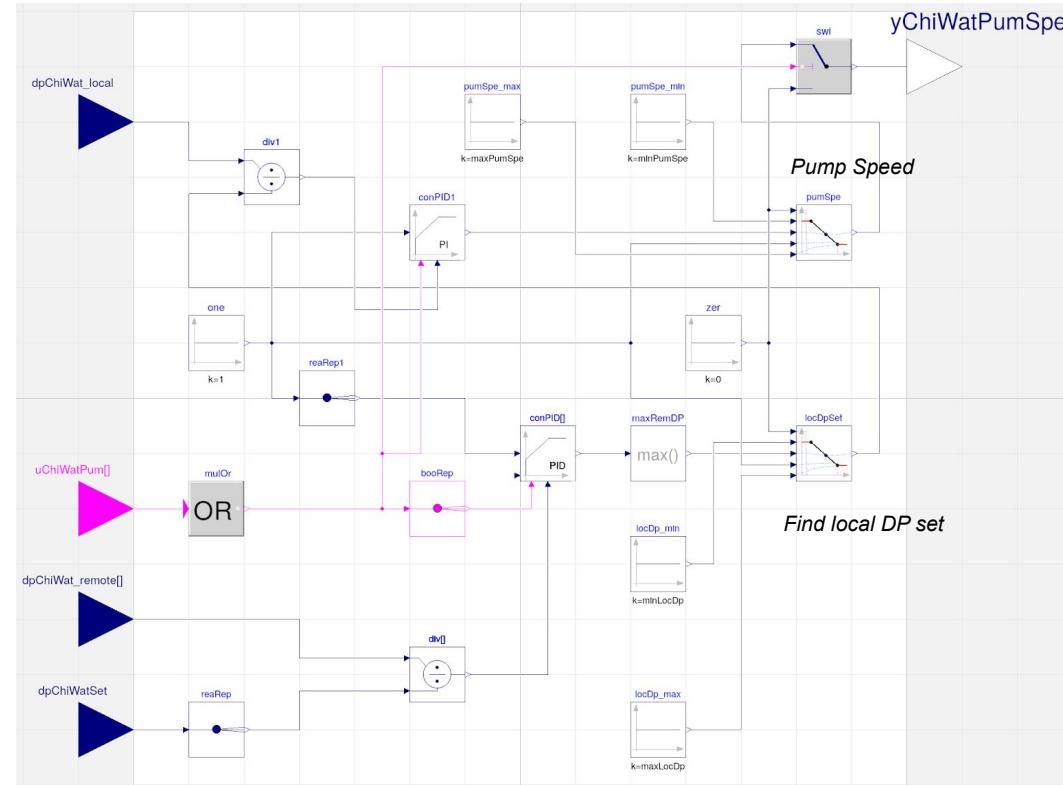
Disable lead pump when the lead chiller does not require chilled water

Disable lead pump after the lead chiller has been proven off by more than 180 seconds.



Chilled water pump: pump speed without hardwired remote sensor

(Section 5.2.6.9-11)



Parameters

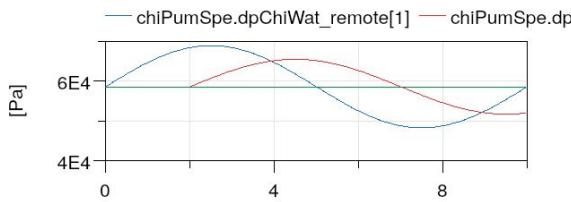
Type	Name	Default	Description
Integer	nSen	2	Total number of remote differential pressure sensors
Integer	nPum	2	Total number of chilled water pumps
PressureDifference	minLocDp	5*6894.75	Minimum chilled water loop local differential pressure setpoint [Pa]
PressureDifference	maxLocDp	15*6894.75	Maximum chilled water loop local differential pressure setpoint [Pa]
Real	minPumSpe	0.1	Minimum pump speed
Real	maxPumSpe	1	Maximum pump speed
Speed controller	SimpleController	Buildings.Controls.OBC.CDL.T...	Type of controller
Real	k	1	Gain of controller
Real	Ti	0.5	Time constant of integrator block [s]
Real	Td	0.1	Time constant of derivative block [s]

Connectors

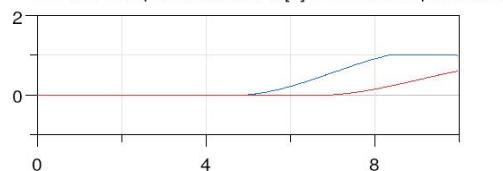
Type	Name	Description
input RealInput	dpChiWat_local	Chilled water differential static pressure from local sensor [Pa]
input BooleanInput	uChiWatPum[nPum]	Chilled water pump status
input RealInput	dpChiWat_remote[nSen]	Chilled water differential static pressure from remote sensor [Pa]
input RealInput	dpChiWatSet	Chilled water differential static pressure setpoint [Pa]
output RealOutput	yChiWatPumSpe	Chilled water pump speed [1]

Chilled water pump: pump speed without hardwired remote sensor

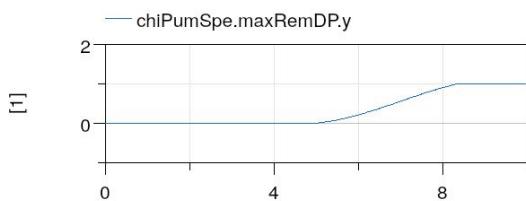
(Section 5.2.6.9-11)



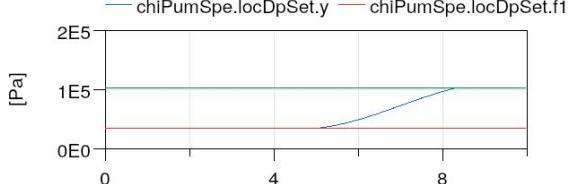
00. Measured remote dP and local dP



01. PID1 outputs

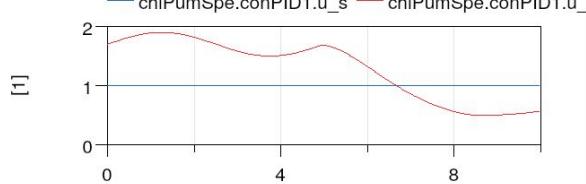
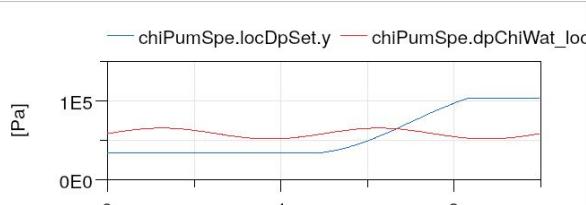


02. Maximum output

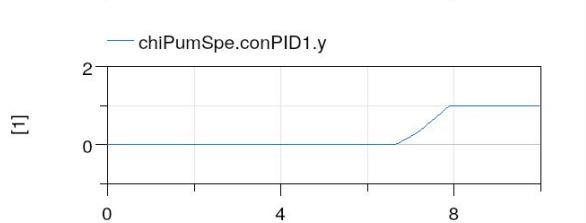


03. Map to local setpoint

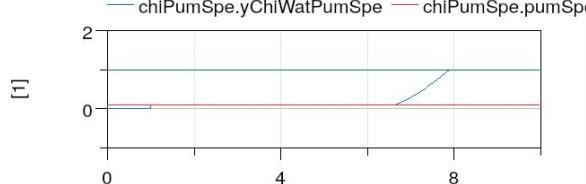
04. Local dP measurement



05. PID2 output



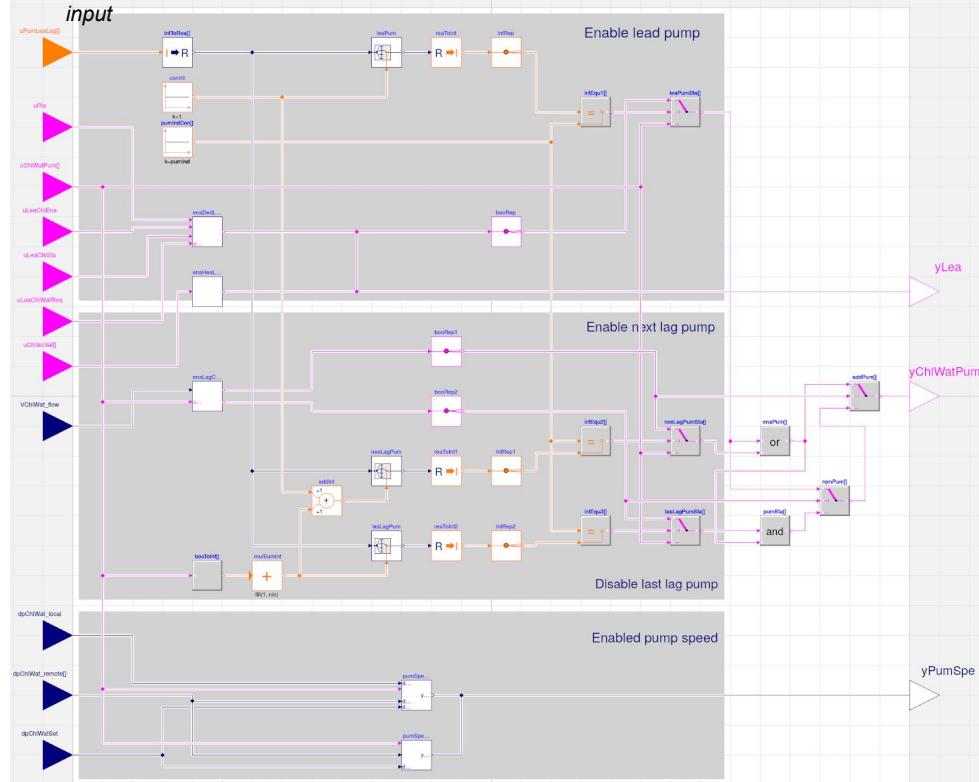
06. Map to pump speed



Chilled water pump: top level controller

(Section 5.2.6.1-11)

Need the array of lead/lag order as an input



Parameters

Type	Name	Default	Description
Boolean	isHeadered	true	Flag of headered chilled water pumps design: true=headered, false=dedicated
Boolean	have_LocalSensor	false	Flag of local DP sensor: true=local DP sensor hardwired to controller
Integer	nPum	2	Total number of chilled water pumps
Integer	nChi	2	Total number of chillers
Integer	nSen	2	Total number of remote differential pressure sensors
Real	minPumSpe	0.1	Minimum pump speed
Real	maxPumSpe	1	Maximum pump speed
Nominal conditions			
Integer	nPum_nominal	nPum	Total number of pumps that operate at design conditions
VolumeFlowRate	VChiWat_flow_nominal	0.5	Total plant design chilled water flow rate [m ³ /s]
PressureDifference	maxLocDp	15*6894.75	Maximum chilled water loop local differential pressure setpoint [Pa]
Speed controller			
SimpleController	controllerType	Buildings.Controls.OBC.CDL.T...	Type of controller
Real	k	1	Gain of controller
Real	Ti	0.5	Time constant of integrator block [s]
Real	Td	0.1	Time constant of derivative block [s]

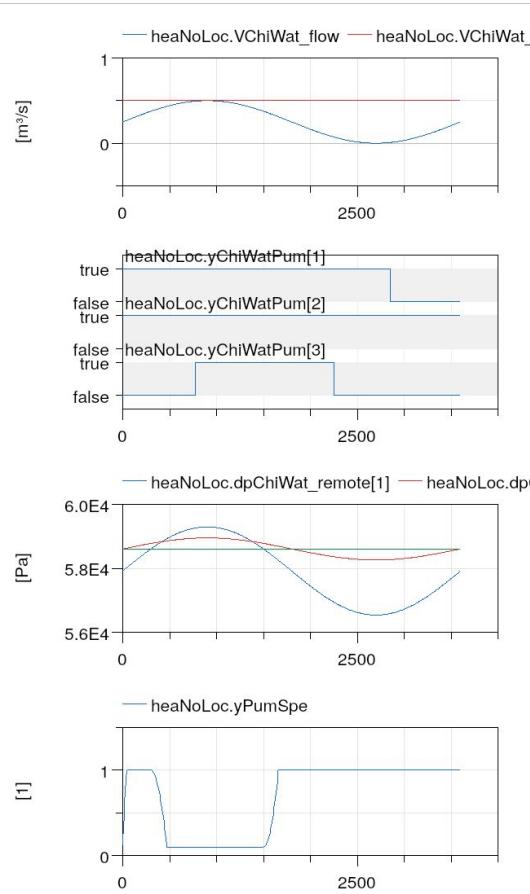
Connectors

Type	Name	Description
input IntegerInput	$uPumLeaLag[nPum]$	Chilled water pump lead-lag order
input BooleanInput	$uPia$	True: plant is enabled
input BooleanInput	$uChiWatPum[nPum]$	Chilled water pumps operating status
input BooleanInput	$uLeaChiEnr$	Lead chiller enabling status
input BooleanInput	$uLeaChiSts$	Lead chiller status
input BooleanInput	$uLeaChiWatReq$	Status indicating if lead chiller is requesting chilled water
input BooleanInput	$uChisoVal[nChi]$	Chilled water isolation valve status
input RealInput	$VChiWat_flow$	Chilled water flow [m ³ /s]
input RealInput	$dpChiWat_local$	Chilled water differential static pressure from local sensor [Pa]
input RealInput	$dpChiWat_remote[nSen]$	Chilled water differential static pressure from remote sensor [Pa]
input RealInput	$dpChiWat_Set$	Chilled water differential static pressure setpoint [Pa]
output BooleanOutput	$yLea$	Lead pump status
output BooleanOutput	$yChiWatPum[nPum]$	Chilled water pump status
output RealOutput	$yPumSpe$	Enabled chilled water pump speed

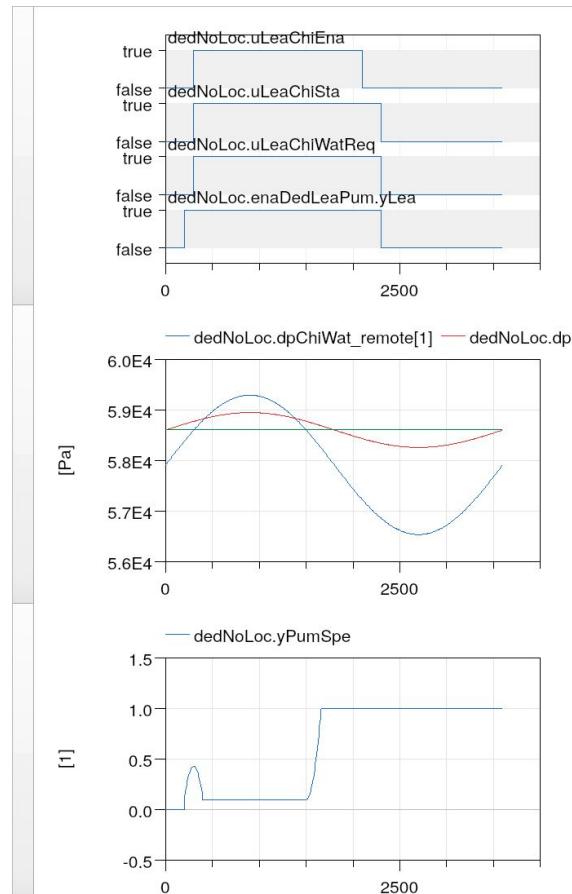
- how to stage dedicated pumps? Just according the chiller staging sequence or should also consider WSE status?

Chilled water pump: top level controller

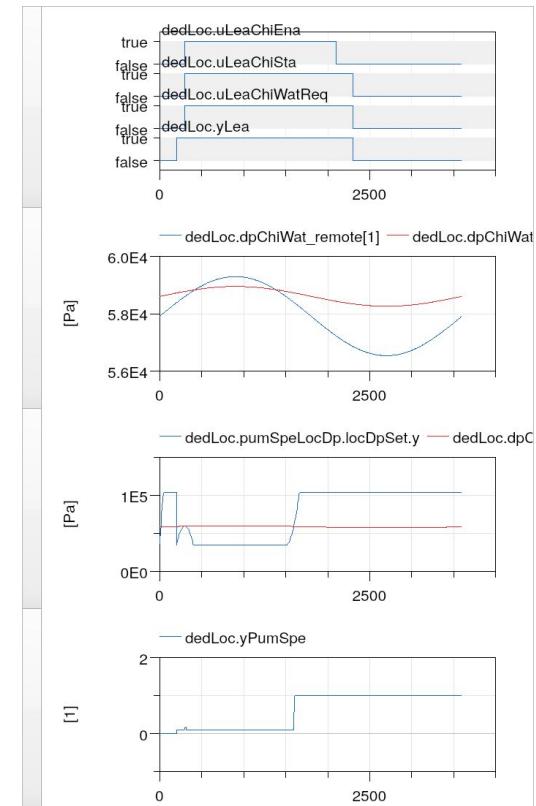
Headed, no local sensor



Dedicated , no local sensor

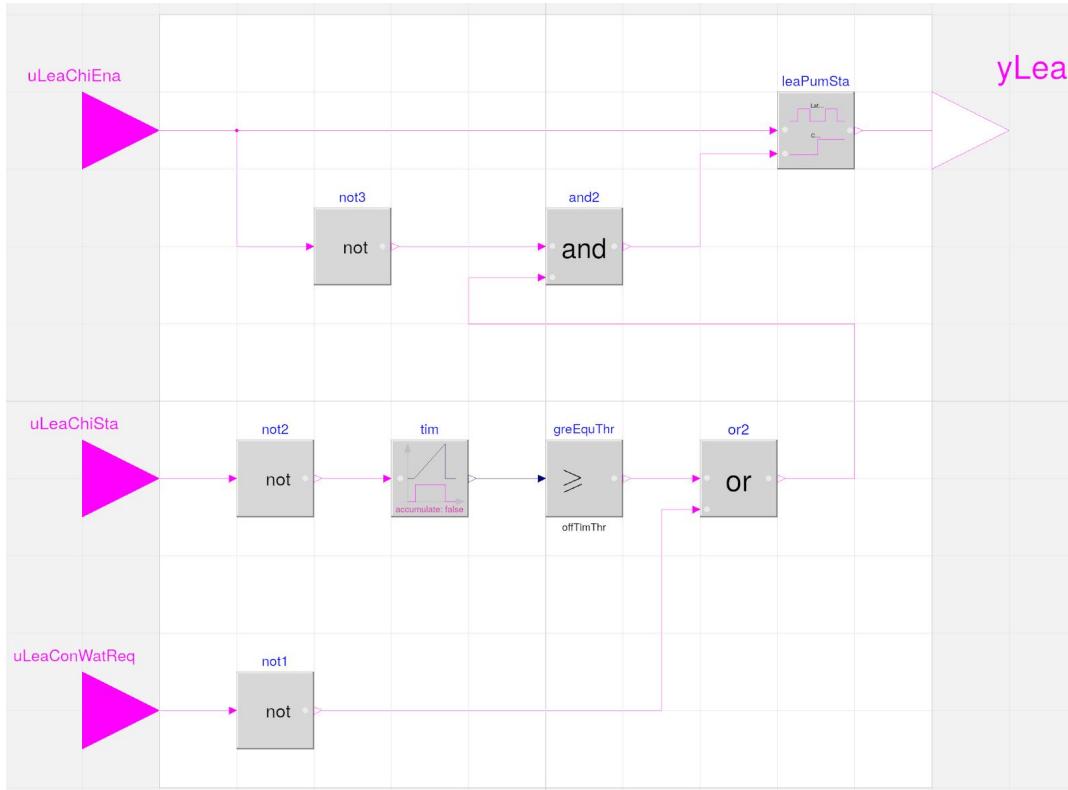


Dedicated , has local sensor



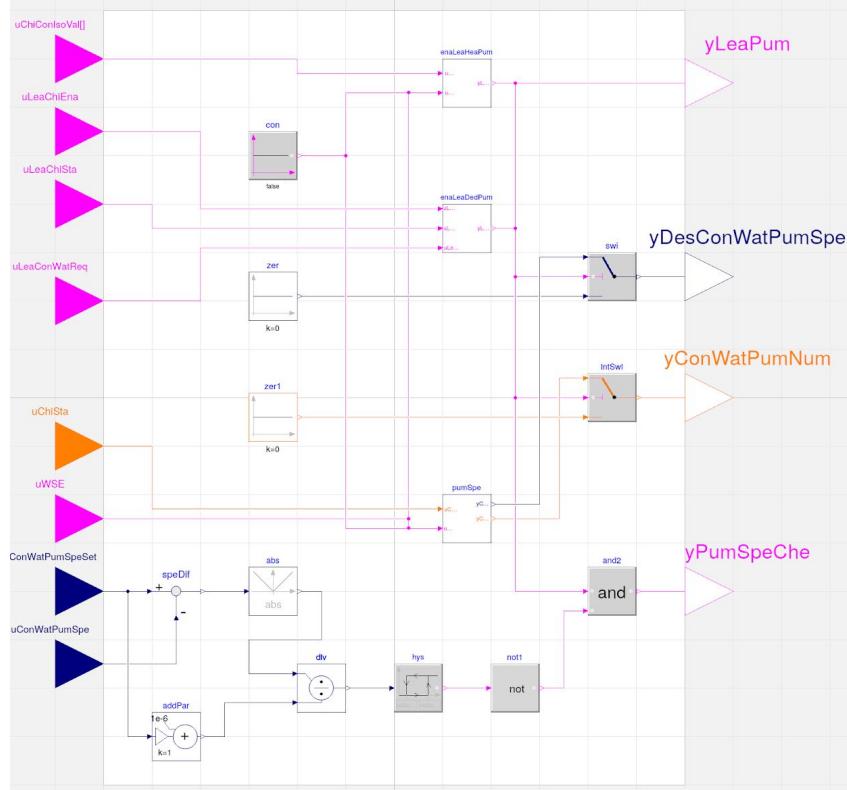
Condenser water pump: enable lead pump, dedicated

(Section 5.2.9.4)



- It's very similar as enabling lead chilled water pump, except, it should be enabled when the lead chiller is enabled, not when plant is enabled?

Condenser water pump: top level controller



Parameters

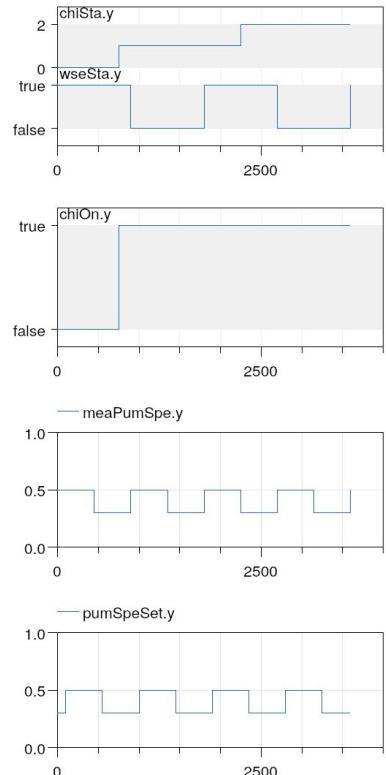
Type	Name	Default	Description
Boolean	isHeadered	true	Flag of headered condenser water pumps design: true=headered, false=dedicated
Boolean	have_WSE	true	Flag of waterside economizer: true=have WSE, false=no WSE
Integer	nChi	2	Total number of chiller
Stage design speed			
Integer	totSta	6	Total number of stages, including the stages with a WSE, if applicable
Real	staVec[totSta]	{0.0, 0.5, 1.5, 2.2, 2.5}	Chiller stage vector, element value like x.5 means chiller stage x plus WSE
Real	desConWatPumSpe[totSta]	{0.0, 0.5, 0.75, 0.6, 0.75, 0.9}	Design condenser water pump speed setpoints, the size should be double of total stage numbers
Real	desConWatPumNum[totSta]	{0.1, 1.2, 2.2, 2}	Design number of condenser water pumps that should be ON, the size should be double of total stage numbers
Advanced			
Real	relSpeDif	0.05	Relative error to the setpoint for checking if it has achieved speed setpoint

Connectors

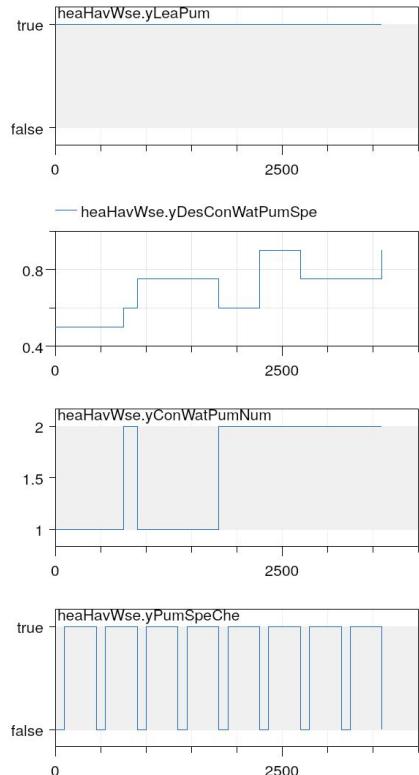
Type	Name	Description
input BooleanInput	<i>uChiConIsoVal[nChi]</i>	Chiller condenser water isolation valve status
input BooleanInput	<i>uLeaChiEna</i>	Lead chiller enabling status: true=lead chiller is enabled
input BooleanInput	<i>uLeaChiSta</i>	Lead chiller status: true=lead chiller proven on
input BooleanInput	<i>uLeaConWatReq</i>	Status indicating if chiller is requesting condenser water
input IntegerInput	<i>uChiSta</i>	Current chiller stage that does not include WSE
input BooleanInput	<i>uWSE</i>	Water side economizer status: true = ON, false = OFF
input RealInput	<i>uConWatPumSpeSet</i>	Condenser water pump speed setpoint [1]
input RealInput	<i>uConWatPumSpe</i>	Current condenser water pump speed [1]
output BooleanOutput	<i>yLeaPum</i>	Lead pump status
output RealOutput	<i>yDesConWatPumSpe</i>	Condenser water pump design speed at current stage
output IntegerOutput	<i>yConWatPumNum</i>	Number of operating condenser water pumps
output BooleanOutput	<i>yPumSpeChe</i>	Flag to indicate if pump speed achieve setpoint

Condenser water pump: top level controller

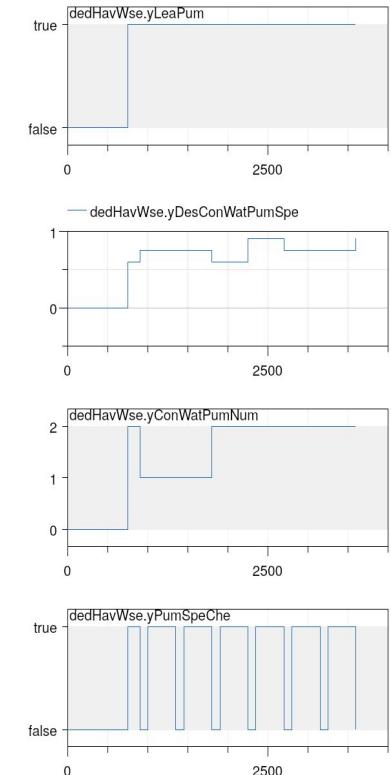
Inputs



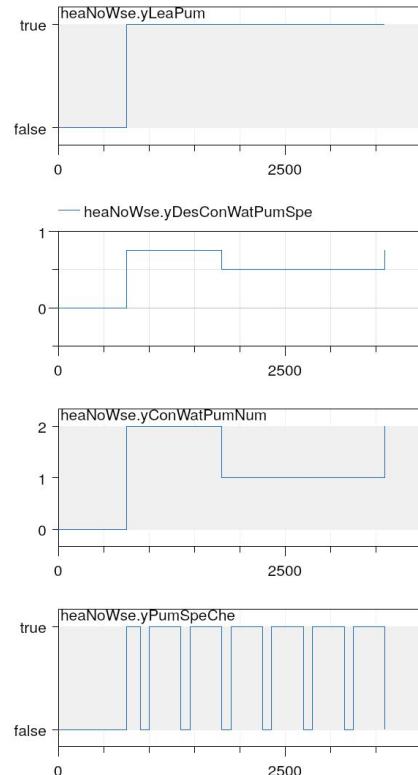
Headed, has WSE



Dedicated, has WSE



headed, no WSE



Top level controller

towCon.yFanSpe[] (array value)-> **inserted multiMax**-> staSetCon.uTowFanSpeMax (scalar value)