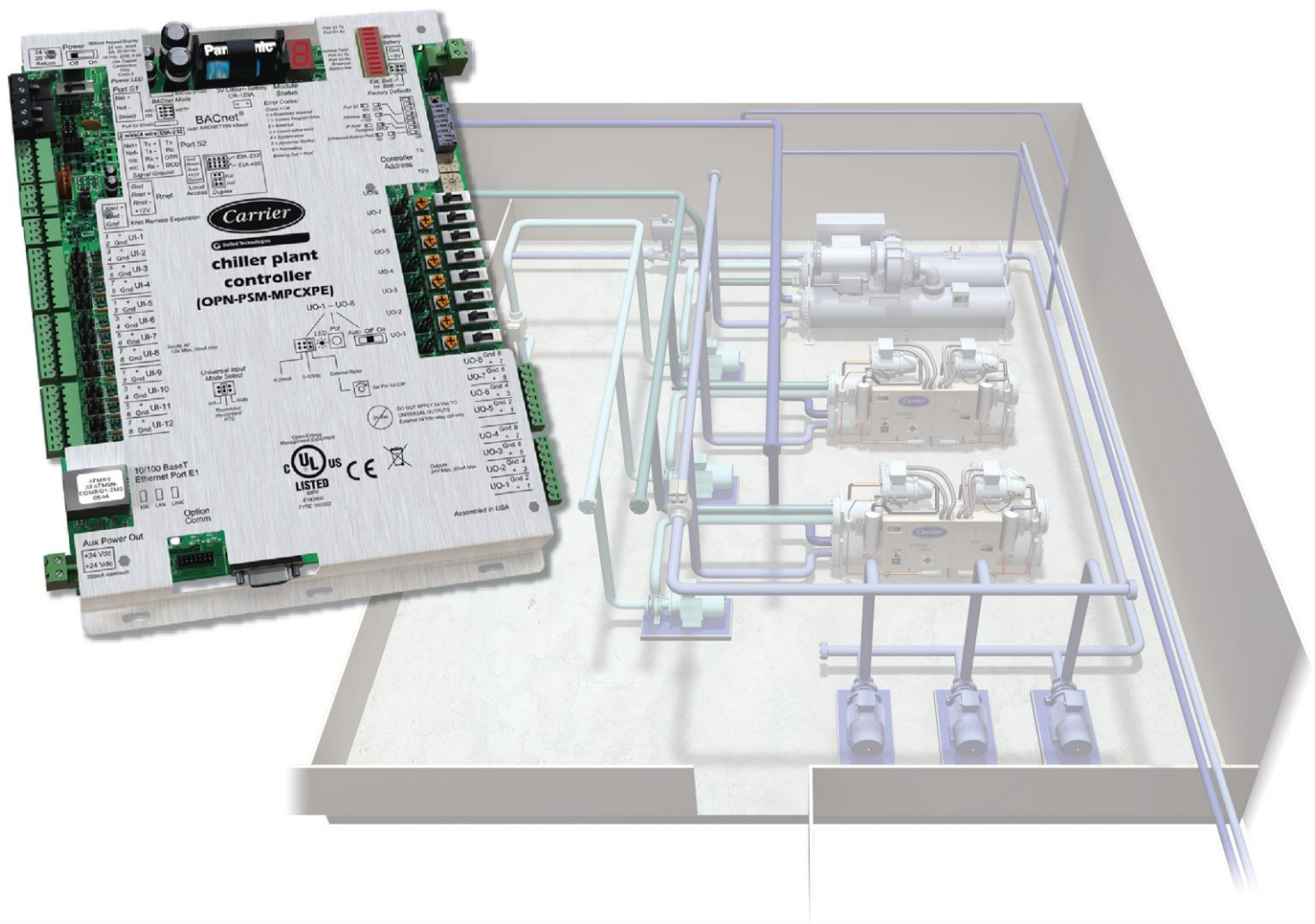


Carrier® ChillerVu™ Application Guide





Verify that you have the most current version of this document from **www.hvacpartners.com** or **www.accounts.lvusystems.com** or your local Carrier office.

Important changes are listed in **Document revision history** at the end of this document.

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Contents

What is the Carrier® ChillerVu™?	1
Application library	2
Supported chiller hardware	3
Graphics	4
SAL library applications	5
Inputs and outputs	5
Special considerations	6
Single loop plants with dedicated pumps	7
Single loop plants with constant flow headered pumps	9
Single loop variable primary flow plants with headered pumps	11
Primary/Secondary chilled water systems	13
Applications with chilled water differential bypass	15
Applications with air-cooled chillers	16
Multiple Cell/Multiple Tower systems with optional bypass	18
Document revision history	20



What is the Carrier® ChillerVu™?

The Carrier® ChillerVu™ provides comprehensive, micro-processor-based, chilled water plant control that utilizes the full power and flexibility of the i-Vu® Control System.



CAUTION You can use the following applications and equipment files with the Carrier® ChillerVu™ controller ONLY.

The Carrier® ChillerVu™

- Starts and stops a chiller plant by using an internal time schedule, remote contact override, network command, outside air temperature, cooling requests, or a time schedule override
- Provides chiller staging, fault logic, and automatically starts and stops chillers
- Provides multiple, user-selectable sequencing options so the correct amount of capacity is online at any given time
- Optional soft start ramp loading, chilled water reset, load feathering (Add/Drop), and demand limiting
- Provides constant or variable primary flow chilled water pump sequencing, including Differential Pressure Control
- Provides constant or variable flow condenser pump sequencing
- Optional chilled water setpoint reset

You can find detailed information on the capabilities of the Carrier® ChillerVu™ hardware in the *Carrier® ChillerVu™ Installation and Start-up Guide* (#11-808-532-01).

See the *Carrier® ChillerVu™ 23XRV Series Counterflow Application Guide* for information on the Series Counter Flow application.

Application library

Create your control program (.equipment file) in EquipmentBuilder by selecting options and control features that match your mechanical system's requirements. The Carrier® ChillerVu™ 1.3 application library provides tailored programs for general purpose chiller plant management, including:

- **Chiller Manager** with the actual chiller staging sequences, available for equal or dissimilar sized chiller applications

NOTES

- A single instance of the Chiller Manager application supports up to 8 machines. Multiple instances of the Chiller Manager application can be linked together for plants with more than 8 machines.
- The Equal/Parallel Chiller Manager application, with optional ACR/RCR staging selected, is not currently expandable beyond 8 machines.
- **Pump Manager** with control sequences for constant or variable flow primary and secondary chilled water pumps and constant or variable flow condenser pumps
- **Tower Manager** with control sequences for multiple towers
- **Open** and **Closed Cooling Tower** programs for tower-specific control points, including condenser water pumps and associated equipment
- **Chiller System - Single** with an application for chillers with dedicated pumps and towers
- **23XRV Series Counterflow** - For details, see the *Carrier® ChillerVu™ Series Counterflow Application Guide*.

NOTE The applications shown in this document and the suggested control programs represent one possible approach to address a given application. You can use additional combinations of library logic and custom programs, depending on the application.

Supported chiller hardware

The Carrier® ChillerVu™ supports the following:

Controller types

- Carrier PIC-based CCN chillers, with or without the UPC Open (part #OPN-UPC, BACnet communication option)
NOTE Pre-configured CCN connectivity is only supported for non-UPC PIC chillers added to the database using CCN auto-discovery. UPC-equipped chillers and CCN PIC chillers, which are not supported in the auto-discovery library, require you to manually configure the network points between the Chiller Manager applications and the chiller integration programs (whether UPC or custom).
- Third-party chillers that support the BACnet protocol, if specific BACnet points are accessible and have the required read/write capability
- Plants with non-communicating chillers, using field-installed controllers and logic

Machine types

- Multi-machine plants with the chillers piped in parallel
- Centrifugal, Screw, Scroll, and Recip chillers
- Carrier 23XRV Screw Chillers in Series Counterflow configuration

Machine sizes - equal or dissimilar

If dissimilar:

- The smallest machine should be no less than 50% of the capacity of the average of all machines in the system
- The largest machine should be no greater than 200% of the capacity of the average of all machines in the system

Mixed plants – While the general purpose Chiller Manager staging sequence can be tuned for plants consisting of mixed machine types, fully optimized staging for this type of plant will be considered for a future release.

Chilled water pumps (primary)

- Lead/Lag
- Lead/Standby
- Headered CV pumps - up to 8
- Headered VSD pumps - up to 8

NOTE You can control plants with more than 8 pumps by linking multiple pump control programs.

Chilled water pumps (secondary)

- Lead/Lag
- Lead/Standby
- Headered VSD secondary pumps - up to 8

NOTE You can control plants with more than 8 pump stages by linking multiple pump control programs.

Condenser water pumps

- Lead/Lag
- Lead/Standby
- Dedicated or Headered pumps - up to 8
- Constant Speed Pumps - up to 8
- VSD pumps - up to 8

NOTE You can control plants with more than 8 pump by linking multiple pump control programs.

Towers

- Open and closed towers with single or 2-speed fans
- VFD-based tower fans
- Single speed, VFD, and lead/standby condenser pumps
- Modulating or 2-position tower bypass valves
- Condenser water isolation valves
- Tower sump controls

NOTE You can control plants with more than 1 tower by installing the Tower Manager program.

Graphics

Graphics are not currently included with the Carrier® ChillerVu™. When planning a project, you must budget the time and labor to create custom graphics.

A library of editable view files that represent various basic plant configurations, including some of those shown in this document, can be downloaded from the Carrier Commercial Controls section of the *HVACpartners website* <http://www.hvacpartners.com/>, <https://accounts.ivusystems.com/>.

SAL library applications

Before preparing a project bid, study the following information to understand the supported plant configurations. You should always carefully review all mechanical drawings, specifications, and be sure to field-verify the job before submitting a project bid.

The following are supported types of air or water-cooled plants:

- *Single loop plants with dedicated pumps* (page 7)
- *Single loop plants with constant flow headered pumps* (page 9)
- *Single loop variable primary flow plants with headered pumps* (page 11)
- *Primary or secondary chilled water systems* (page 13)
- *Applications with chilled water differential bypass* (page 15)
- *Applications with air-cooled chillers* (page 16)
- Single loop plants with coolers in series (series counter flow, 23XRV machines only)
- *Multiple Cell/Multiple Tower systems with optional bypass* (page 18)

Inputs and outputs

The Carrier® ChillerVu™ provides hardware and network-based I/O channels for system sensors and outputs.

Input and output between the Carrier® ChillerVu™ and the chillers is through network points. Depending on the sequence configurations, the application will read/write to some or all of the following chiller points:

- Chiller Start/Stop
- Chiller Status
- Chiller Load
- Chiller KW
- Chiller Leaving Water Temperature
- Chiller Demand Limit
- Chiller Leaving Water Setpoint

NOTE Carefully review the I/O points list generated in EquipmentBuilder to verify that the required hardware and network I/O points for the project are understood and provided.

You may need some or all of the following hardware sensors:

Name	Purpose
CHWST	Common chilled water supply temperature used as a stage up/stage down control input.
CHWRT	Common chilled water temperature sensor used to measure the temperature of the water returning from the plant, used to compute total plant tonnage.
CHWFLOW	Common chilled water flow sensor used to measure the total flow from the plant into the loads and to compute total plant tonnage.
CHWLPD	Chilled water differential sensor used with pressure taps in the common supply and return headers. Also used by the differential pressure algorithm to maintain the CHWLPD setpoint by modulating chilled water differential pressure valves.
RST	Reset sensor may be used with the chilled water reset algorithm, which can also use the outdoor air temperature.
REMCON	External dry contact. When the switch is closed, the plant starts. When the contacts are open, a plant shutdown sequence begins.

Special considerations

The following plant systems are not currently supported in the library. You must make custom programs in Snap and/or modify the mechanical system configuration:

- Water Economizer systems with Plate/Frame Heat Exchangers
- Heat recovery applications
- Thermal storage systems
- Plants with manual isolation valves

NOTE Must be automated to use with a Carrier® ChillerVu™

- Plants that require more than 1 chiller to run during low load conditions for redundancy

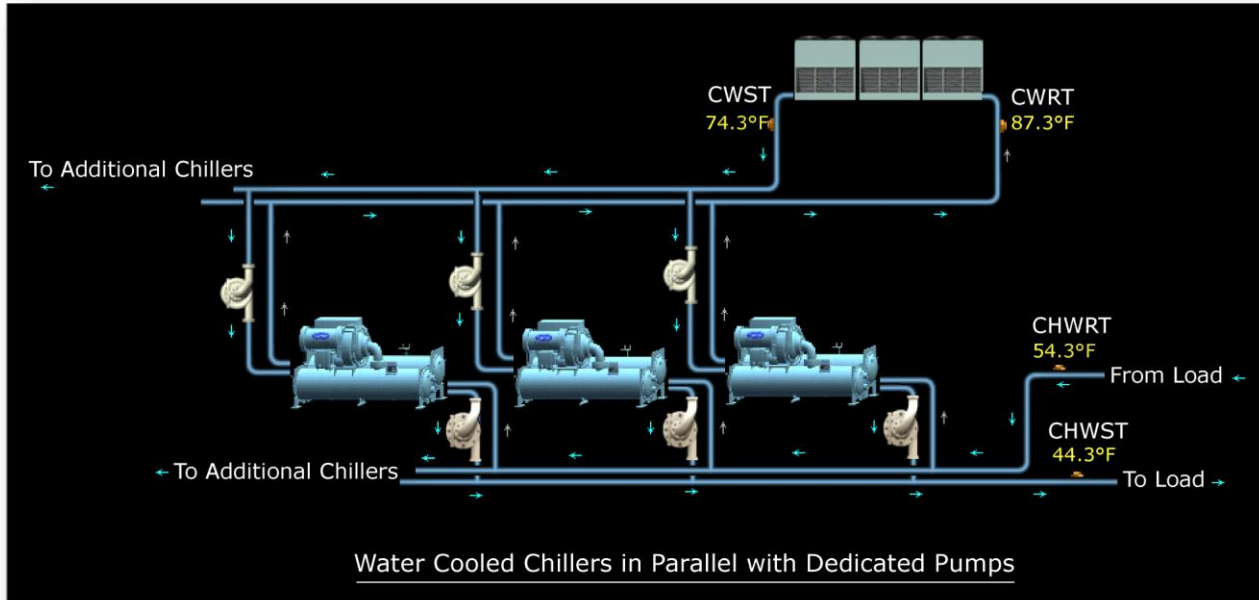
NOTE Chillers that are not required by the current load conditions are always turned off.

- Systems with split chilled water loops

NOTE Required at all times - A common chilled water supply or return sensor that is representative of the entire plant.

- Any chiller system piped in series, except for the 23XRV series counterflow applications

Single loop plants with dedicated pumps



Characteristics

- 2 - 8 chillers
- Chillers may be different capacities
- 1 chilled water pump dedicated to each chiller
- 1 condenser water pump dedicated to each chiller
- No secondary chilled water pumping
- Towers may be dedicated or non-dedicated
- May have 2-way or 3-way control valves on loads

NOTE 2-way valves require a modulating bypass across the chilled water supply and return line. See *Applications with chilled water differential bypass* (page 15).

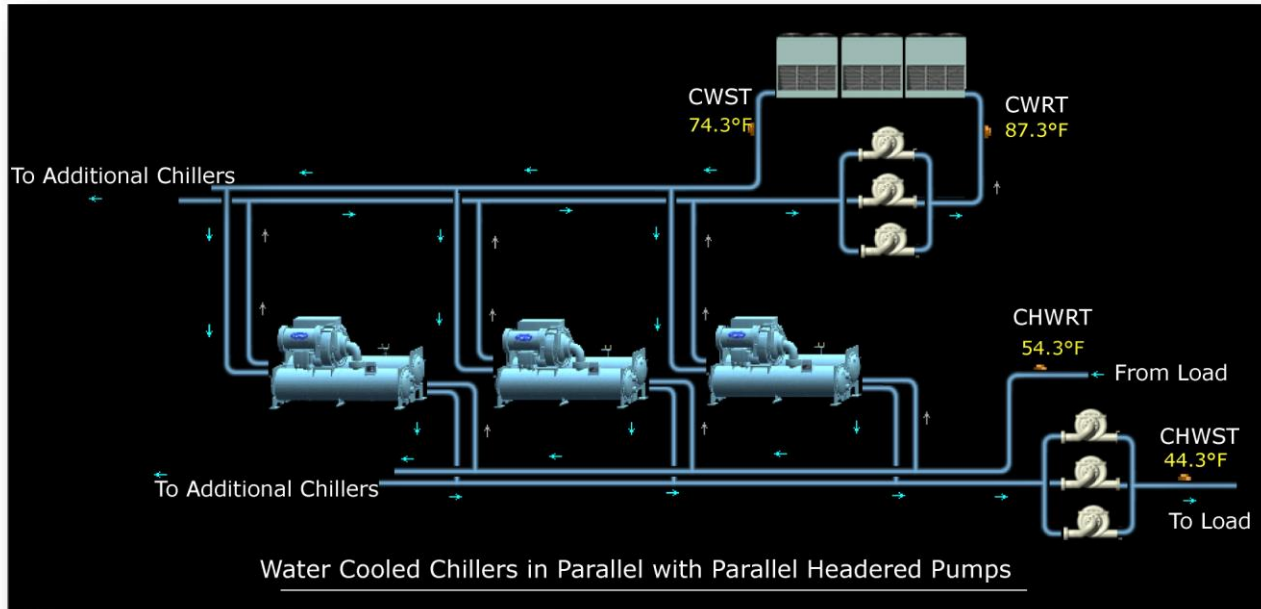
- Automatic Isolation valves (not shown here) are required on chillers to prevent mixing warm return water in the supply header
- Depending on the staging method, it is mandatory that you use either a common Chilled Water Supply Temp Sensor or a common Chilled Water Return Temp Sensor. For applications where load calculations are required, both are mandatory.

Exception The Equal/Parallel Chiller Manager application, with optional ACR/RCR staging selected, does not currently support Chilled Water Return Sensor staging.

- A Condenser Water Supply Temp Sensor is mandatory for tower control. A Condenser Water Return Temp Sensor is optional.
- Flow sensors on the chilled water supply line (not shown here) are mandatory when selecting staging-by-load.

Location	On high sensible heat load applications, such as in an office building or high-rise
Mechanical applications	<ul style="list-style-type: none"> • If loads have 2-way control valves, then you need a bypass to maintain minimum flow through chillers and to keep pressure-drop across loads within a designated control range. • Check valves are recommended to prevent backflow through inactive chillers.
Control applications	<ul style="list-style-type: none"> • CHWST or CHWRT sensors can be used for staging. (Optional ACR/RCR staging must use CHWST.) • CHWST sensor is located in the common supply header, downstream of all chillers. • CHWRT sensor is located in the common return header, upstream of all chillers. • PIC controller starts and stops all pumps. <p>Alternate In cases where the native chiller control lacks outputs for the chilled water and condenser water pumps, you can apply an instance of the Chiller System – Single, Water Cooled Chiller program to each chiller for chilled water and condenser water pump control.</p>
Advantage	Low installed cost
Disadvantages	<ul style="list-style-type: none"> • System is susceptible to low flow if 2-way valves are used at load side
Suggested control programs	<ul style="list-style-type: none"> • Chiller Manager - Select the number of chillers and required staging method. <p>NOTE We recommend ACR/RCR in most applications.</p> <ul style="list-style-type: none"> • Single Chiller – Optional - Create as many instances as needed for the application – can control dedicated constant or variable flow chilled water pumps, constant flow condenser water pumps, and towers • Condenser Pump Manager – Required for dedicated variable flow condenser pump applications. Constant volume condenser pumps can be controlled via the native chiller control or the Single Chiller application. • Tower Manager – For non-dedicated tower systems • Single Tower – one per tower. Select the required mechanical configuration.

Single loop plants with constant flow headered pumps



Characteristics

- 2 - 8 chillers
- Chillers may be different capacities
- Chilled water pumps piped together in a parallel arrangement
- No secondary chilled water pumping
- Condenser water pumps piped together in a parallel arrangement.
- May have 2-way or 3-way control valves on loads.

NOTE 2-way valves require a modulating bypass across the chilled water supply and return line. See *Applications with chilled water differential bypass* (page 15).

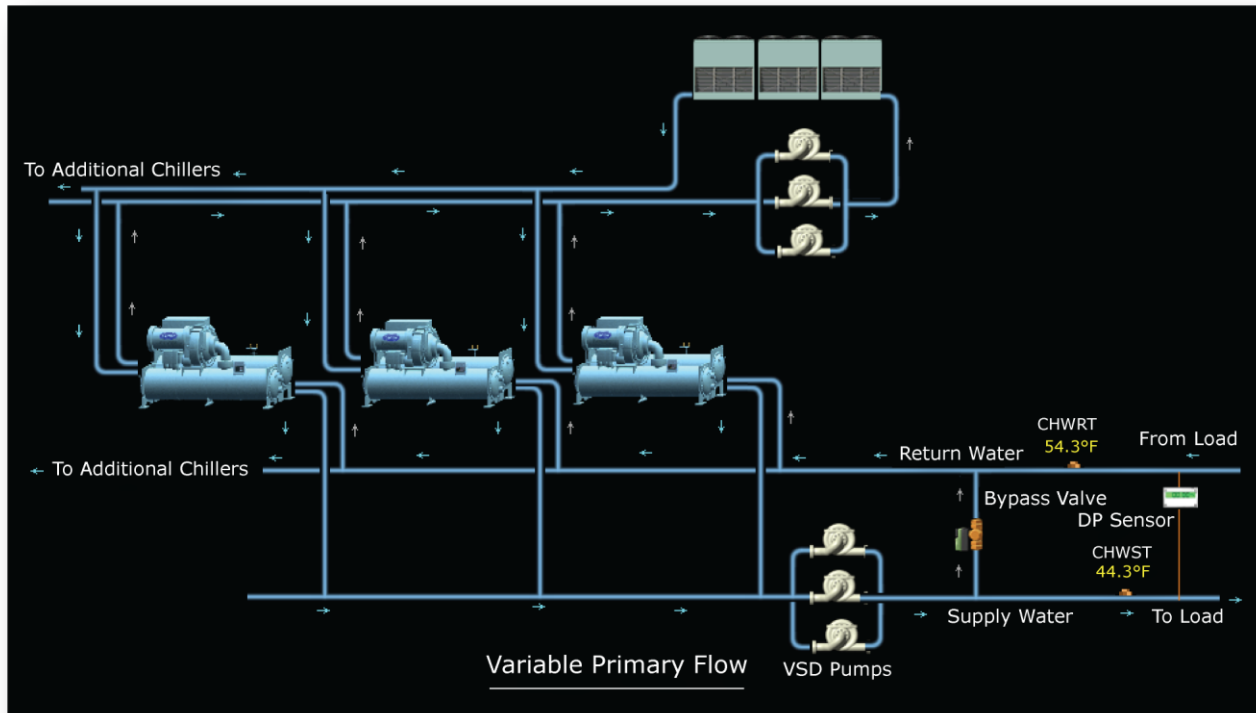
- Automatic Isolation valves (not shown here) are required on chillers to prevent mixing return water in the supply header.
- Depending on your staging method, either a common Chilled Water Supply Temp Sensor or a common Chilled Water Return Temp Sensor is mandatory.

Exception The Equal/Parallel Chiller Manager application, with optional ACR/RCR staging selected, does not currently support Chilled Water Return Sensor staging. For applications where load calculations are required, both are mandatory.

- A Condenser Water Supply Temp Sensor is mandatory for tower control. A Condenser Water Return Temp Sensor is optional.
- Flow sensors on the chilled water supply line (not shown here) are mandatory when you select staging by load.
-

Location	In hotels and industrial applications
Mechanical applications	<ul style="list-style-type: none"> • If loads have 2-way control valves, then you need a bypass to maintain minimum flow through chillers and to keep pressure-drop across loads within a designated control range. • Not recommended for chillers with large variance in capacities due to parallel piping of primary pumps. • If the system has hand-operated isolation valves, they must be automated to open before starting the chiller and to close after stopping the chiller. • Pump can be constant or variable speed.
Control applications	<ul style="list-style-type: none"> • CHWST or CHWRT sensors can be used for staging. Optional ACR/RCR staging must use CHWST. • CHWST sensor is located in the common supply header, downstream of all chillers and downstream of pumps. • You can use the native chiller control pump start/stop point to control the automatic isolation valves or add custom logic.
Suggested control programs	<ul style="list-style-type: none"> • Chiller Manager - select the number of chillers and required staging method. NOTE We recommend ACR/RCR in most applications. • Primary Pump Manager (Constant Flow) - select the number of chilled water pumps • Condenser Pump Manager (Constant Flow) - select the number of condenser water pumps • Tower Manager - select the number of towers • Single Tower - one per tower - Select the required mechanical configuration.

Single loop variable primary flow plants with headered pumps

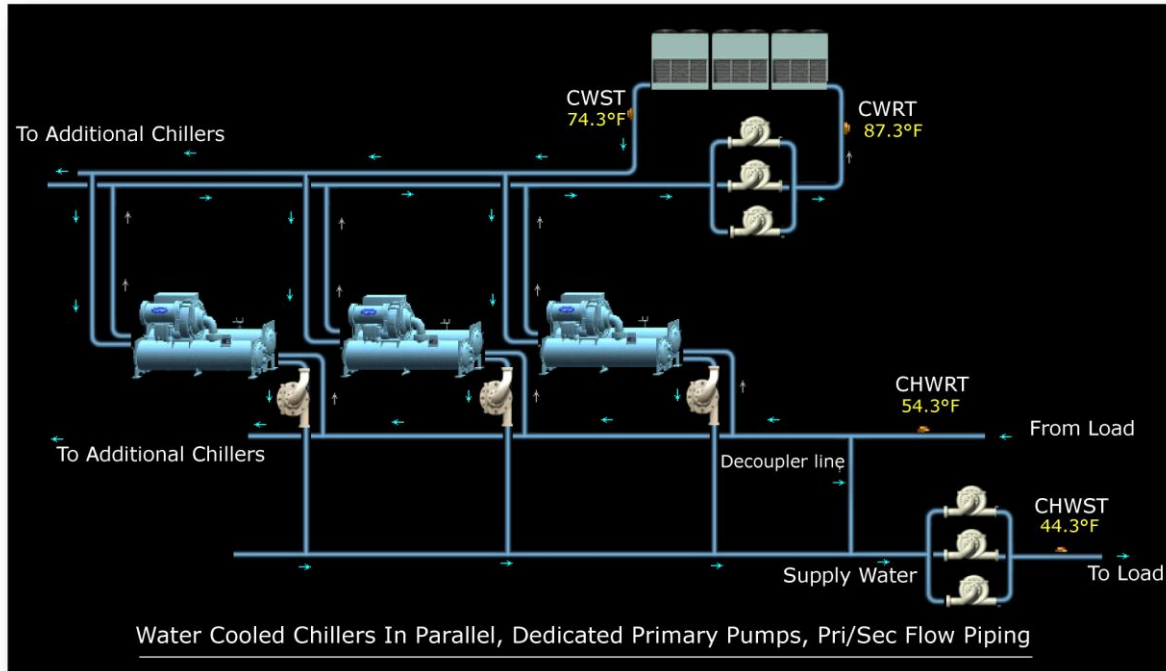


Characteristics

- 2 - 8 chillers
 - Chillers may be different capacities
 - No secondary pumping
 - 2-way valves on loads
 - Automatic Isolation valves (not shown here) are required on chillers to prevent mixing return water in the supply header
 - Depending on your staging method, either a common Chilled Water Supply Temp Sensor or a common Chilled Water Return Temp Sensor is mandatory.
- Exception** The Equal/Parallel Chiller Manager application, with optional ACR/RCR staging selected, does not currently support Chilled Water Return Sensor staging. For applications where load calculations are required, both are mandatory.
- A Condenser Water Supply Temp Sensor is mandatory for tower control. A Condenser Water Return Temp Sensor is optional.
 - Flow sensors on the chilled water supply line (not shown here) are mandatory when you select staging by load.
 -

Location	On high sensible heat load applications, such as, an office building or high rise
Mechanical applications	<ul style="list-style-type: none"> • If loads have 2-way control valves, then you need a bypass to maintain minimum flow through chillers and to keep pressure-drop across loads within a designated control range. • We recommend using check valves to prevent backflow through inactive chillers.
Control applications	<ul style="list-style-type: none"> • CHWST or CHWRT are used for staging (Optional ACR/RCR staging must use CHWST) • CHWST sensor is located in the common supply header, downstream of all chillers • CHWRT sensor is located in the common return header, upstream of all chillers
Advantage	Costs less to install
Disadvantages	None
Suggested control programs	<ul style="list-style-type: none"> • Chiller Manager - select the number of chillers NOTE We recommend ACR/RCR in most applications. • Primary Pump Manager - (Variable Primary Flow) - select the number of pumps • Condenser Pump Manager - select the number of pumps and flow type • Tower Manager - select the number of towers • Single Tower - one per tower - select the tower configuration

Primary/Secondary chilled water systems



Characteristics

- 2 - 8 chillers
- Chillers may be different capacities
- Independently pumped production and distribution loops (primary/ secondary)
- 1 chilled water pump is dedicated to each chiller on the primary loop

Alternate Headered primary chilled water pumps are also supported

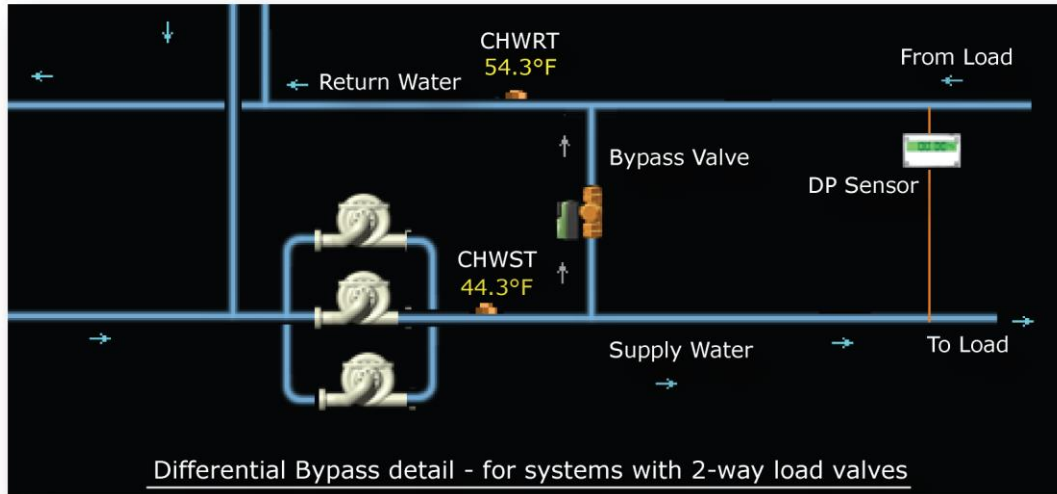
- The secondary loop requires variable-speed pumps
- Assumes 2-way control valves on loads
- A hydraulic decoupling line between the 2 loops allows constant flow in each operating chiller and variable flow in the distribution loop
- Flow can go in both directions in the hydraulic decoupling line
- Depending on your staging method, either a common Chilled Water Supply Temp Sensor, or a common Chilled Water Return Temp Sensor, are mandatory.

Exception The Equal/Parallel Chiller Manager application, with optional ACR/RCR staging selected, does not currently support Chilled Water Return Sensor staging. For applications where load calculations are required, both are mandatory.

- A Condenser Water Supply Temp Sensor is mandatory for tower control. A Condenser Water Return Temp Sensor is optional.
- Flow sensors on the chilled water supply line (not shown here) are mandatory when you select staging by load.

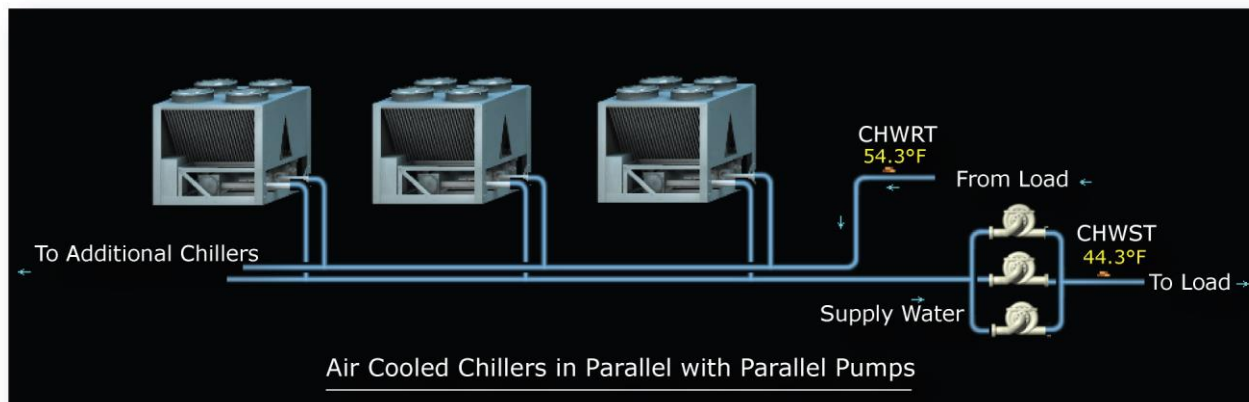
Location	Large central plant-type systems such as hospitals and universities
Mechanical applications	For peak capacity selection, chillers should be selected for their individual lifts and entering and leaving water temperatures.
Control applications	<ul style="list-style-type: none"> • CHWST or CHWRT are used for staging - (Optional ACR/RCR staging must use CHWST sensors.) • Install the CHWST sensor in the common supply header, downstream of the hydraulic decoupling line and upstream of distribution loop pumps. • Install the CHWRT sensor in the common return header, downstream of the hydraulic decoupling line and upstream of the production loop pumps. • The production loop pumps may be dedicated and controlled by the chiller's native control, or headered and controlled, either by the chiller's native control or by an instance of Primary Pump Manager. • The distribution loop pump start/stop sequencing requires an instance of Secondary Pump Manager.
Advantage	<ul style="list-style-type: none"> • Easy to operate • Easier to control chilled water • Good application for the Add/Drop feature
Disadvantages	Higher first cost to install chilled water system
Suggested control programs	<ul style="list-style-type: none"> • Chiller Manager - select the number of chillers and required staging method. NOTE We recommend ACR/RCR in most applications. • Primary Pump Manager for chilled water primary pumps - select the number of pumps • Secondary Pump Manager for chilled water secondary pumps - select the number of pumps • Condenser Pump Manager - select the number of pumps and flow type • Tower Manager - configure for the number of towers • Single Tower - select number of towers and mechanical configuration

Applications with chilled water differential bypass



Characteristics	<ul style="list-style-type: none"> For any system with 2-way control valves on loads The system bypass valve and differential pressure sensor should be as far downstream in the piping as possible to keep a large part of the system pressure drop constant. Bypass valve is controlled to open as pressure across supply-and-return headers increases. It is a normally closed valve. Flow through the bypass is in only 1 direction. Special considerations are required for differential pressure control in tall buildings because of the static effect on lower floors.
Mechanical applications	The bypass line's size should be equal to the flow through the largest chiller.
Control applications	<ul style="list-style-type: none"> Install the CHWST sensor on the chiller side of the bypass divergence point. Install the CHWRT sensor on the chiller side of the bypass convergence point. Install the differential pressure sensor downstream of the plant, prior to the loads.
Suggested control programs	<p>Chilled Water Pumps/Basic Arrangements - Primary-Single, Lead/Standby</p> <p>NOTE The chilled water bypass control is a feature of the Chilled Water Pumps/Basic Arrangements section of the library. Select the Bypass control and set the pump control option to None.</p>

Applications with air-cooled chillers



Characteristics

- 2 - 8 chillers
 - Chillers may be different capacities
 - Chilled water pumps piped together in a parallel arrangement
 - May be variable or constant flow. For variable flow, a bypass line between the supply and return line is required to insure minimum flow through the chillers. See *Single loop variable primary flow plants with headered pump* (page 11) for bypass installation.
 - May have 2-way or 3-way control valves on loads.
- NOTE** 2-way valves require a modulating bypass across the chilled water supply and return line after the chilled water pumps. See *Applications with chilled water differential bypass* (page 15).
- Automatic Isolation valves (not shown here) are required on chillers to prevent mixing return water in the supply header.
 - Depending on your staging method, either a common Chilled Water Supply Temp Sensor or a common Chilled Water Return Temp Sensor are mandatory.
- Exception** The Equal/Parallel Chiller Manager application, with optional ACR/RCR staging selected, does not currently support Chilled Water Return Sensor staging. For applications where load calculations are required, both are mandatory.
- Flow sensors on the chilled water supply line (not shown here) are mandatory when you select staging by load.

Location

In hotels and industrial applications

Mechanical applications

- Not recommended for chillers with large variance in capacities due to parallel piping of primary pumps.
- If the system has hand-operated isolation valves, they must be automated to open before starting the chiller and to close after stopping the chiller.
- Pump can be constant or variable speed.

Control applications

- CHWST or CHWRT are used for staging. (Optional ACR/RCR staging must use CHWST.)
- CHWST sensor is located in the common supply header, downstream of all chillers and downstream of pumps.
- The Chiller PIC pump start/stop point controls the automatic isolation valves.

Alternate In cases where the native chiller control lacks outputs for the chilled water pumps, you can apply an instance of the Chiller System – Single, Air Cooled Chiller program to each chiller for chilled water pump control.

Suggested control programs

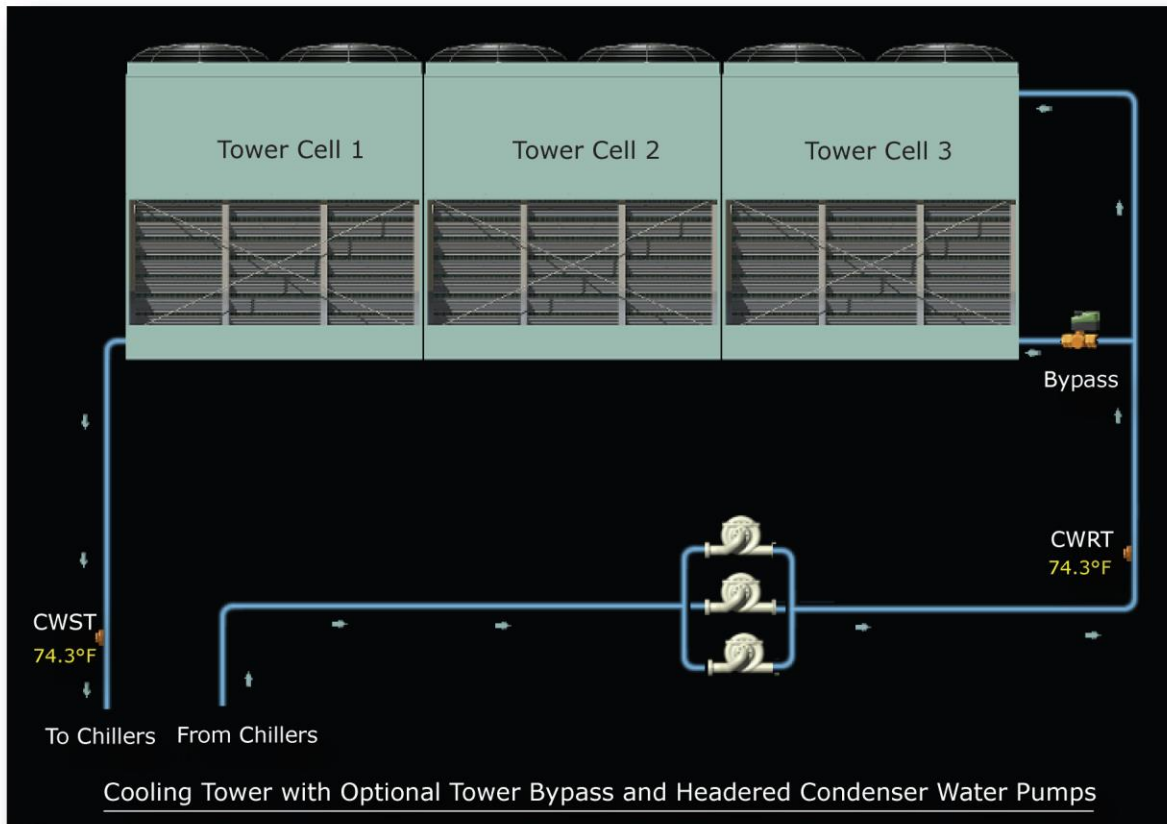
- Chiller Manager - select the number of chillers and staging method.

NOTE We recommend ACR/RCR for most applications.

- Primary Pump Manager - select the number of chilled water pumps

NOTE For variable flow applications, select the Variable Primary Flow Pump Manager.

Multiple Cell/Multiple Tower systems with optional bypass



Characteristics

- Chiller plants that are served by a common cooling tower system
- Flow passes through all tower cells when any chiller runs
- Tower cells may be different sizes
- Modulating 2-way tower bypass valve
- Single-speed, 2-speed, or VFD fans
- 1 condenser water pump is dedicated to each chiller
- **Alternate** Pumps may also be controlled in a non-dedicated arrangement
- Open and closed tower configurations are supported

Mechanical applications

- The bypass line should be sized equal to the flow through the largest chiller.
- The bypass line may be piped into the sump as shown, or directly back to the chillers, although it is recommended by at least 1 major tower manufacturer that bypassing into the sump is preferred.

Control applications

- For constant volume, dedicated condenser pump applications, the pumps may be controlled by either: the native chiller controller, the Open or Closed Single Tower program, or an instance of the Condenser Pump Manager program
- For variable flow Condenser Pump systems, the pumps must be controlled by the Condenser Pump Manager, configured for variable flow
- You can link additional Tower Managers for systems with more than 8 towers.
- The diverting valve is sequenced to maintain a control setpoint approximately 2° F (adjustable) less than the setpoint used by the staging routine.

Suggested control programs

- Tower Manager - select the number of towers or tower cells
 - Single Tower Open or Closed - create the same number of instances of this program as there are towers or tower cells
- NOTE** One single instance of Single Tower must be configured in EquipmentBuilder to control the Tower Bypass valve.
- Condenser Pump Manager (Optional) - specific number of pumps and flow type
-

Document revision history

Important changes to this document are listed below. Minor changes such as typographical or formatting errors are not listed.

Date	Topic	Change description	Code*
9/19/16	Single loop plants with dedicated pumps	Corrected error in Alternate Control Applications.	X-AE-BL-E
	Applications with air-cooled chillers	Corrected error in Alternate Control Applications.	X-AE-BL-E
9/15/16	Applications with chilled water differential bypass	Graphic updated to correct water temp sensor positions	X-AE-BL-E
1/8/16	Inputs and Outputs	CHWRT corrected to temperature sensor from flow sensor.	X-AE-BL-E

* For internal use only



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