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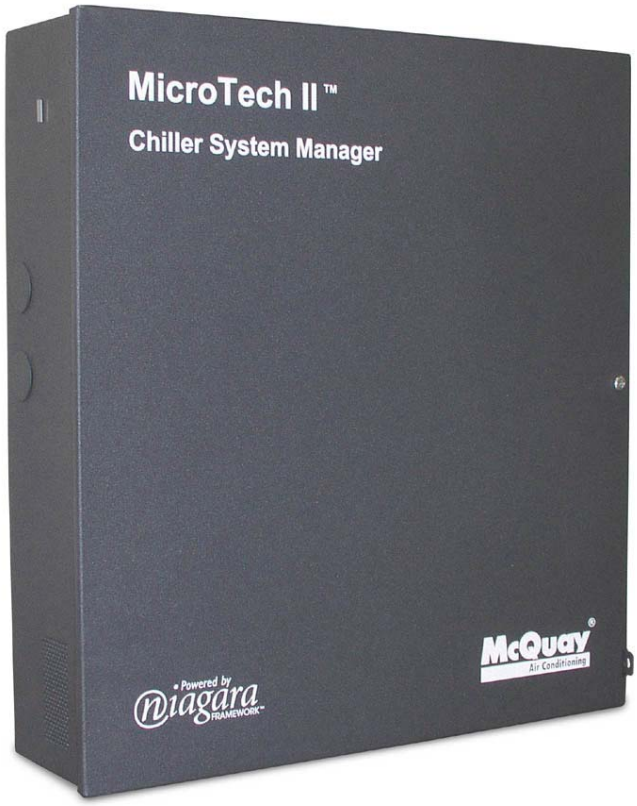
MicroTech II®
Chiller System Manager (CSM) Operation Manual

For
MicroTech II Chillers
Hardwired Chillers



McQuay®
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Table of Contents

Figures 4
Tables 5
Limited Warranty 6
Notice 6
Reference Documents 7
Revision History 7
CSM Software ID 7
Chiller Unit Controller Software Compatibility 8
Introduction 9
Getting Started 11
Connecting to the CSM 11
PC Requirements 11
Connecting Your PC to the CSM 11
Changing the CSM's IP Address and Date/Time 13
Connecting to the CSM's User Interface 16
Connecting to the CSM's User Interface Remotely Using a Modem 18
Using the CSM's User Interface 18
Password Protection 20
Configuring User Accounts 20
User Account Categories 21
Connecting Chillers and Remote I/O to the CSM 22
Commissioning LONWORKS Devices (Chillers or Remote I/O) 22
Commissioning a Chiller to a CSM Chiller Number 23
Commissioning a Remote I/O Module to a CSM Remote I/O Letter 24
Setting up the CSM's Chiller Data 25
Communication Loss Control at the Chiller 26
Setting Up the CSM's I/O 27
Chiller Unit Controller Settings 30
Configuring the Chiller System Manager 32
System Control 32
CSM Control Mode 32
Rapid Restart 33
Low Ambient Lockout 33
Chiller Sequencing Control 34
Sequence Order 34
Sequencing Logic 36
Special Sequencing Logic 40
Designating a Standby Chiller 42
Sequencing Chillers with Series-Piped Evaporators 42
Stage-Up Inhibiting 44
Load Limiting Control 45
Demand Limiting 45
Load Balancing 47
Soft Loading 48
Chilled Water Temperature Control 49
Temperature Control 50
Setpoint Reset 52
Cooling Tower Control 56
Tower Staging Logic 59
Tower Bypass Valve Control 65
Chilled Water Flow Control 67
Pump Logic: Single Pump 72
Pump Logic: Lead/Standby (Auto Lead, Pump 1 Lead, Pump 2 Lead) 72
Pump Logic: Sequenced Constant-Speed Pumps 74
Pump Logic: Multiple Variable-Speed Pumps 77
Pump Speed Control 79

Loop Bypass Valve Control 80
Scheduling 80
Weekly Scheduling 82
Holiday Scheduling 83
Special-Event Scheduling 84
Timed Override 85
External Time Clock 86
Modbus Scheduling 86
BACnet Scheduling 86
Optimal Start 86
BAS Communication 90
BACnet Settings 90
Modbus Settings 91
Alarm Notification 91
Physical alarm outputs 92
E-mail alarm notifications 93
BACnet alarm notifications 95
Saving Your CSM Database Configuration 95
Saving the Database on the CSM 95
Saving the CSM's Configured Database Externally 95
Operator's Guide 97
Chiller System Status 97
CSM Operating State 98
Stage-Up Status 101
Stage-Down Status 101
System Capacity 102
Temperatures 102
Monitoring Chiller Status 103
Status (Chiller Run Mode) 104
Alarm 105
Clear Alarm 105
Chiller Run Time (Op Hours) 105
Comp # 106
Chiller Data 106
Load Limiting Status 106
Chilled Water Distribution System Status 107
Cooling Tower Status 107
Override of the Chiller System Manager's Control 107
Local Override of a Chiller 107
Free Cooling BAS Network Override 108
Alarm Monitoring and Control 108
Acknowledging Alarms on the CSM 108
Clearing CSM Alarms 109
Clearing Chiller Alarms 109
CSM Alarms and Their Effect on System Control 109
Fault Alarms 111
Problem Alarms 112
Warning Alarms 116
Troubleshooting 118
Using Status LEDs 118
Lon Port 119
Ethernet Port 119
Serial Ports 119
Heartbeat 119
Troubleshooting the PC's Connection to the CSM 119
Checking the IP Address and Subnet Mask of Your Computer 120
Determining the CSM's IP Address and Subnet Mask 120
Pinging the CSM from Your Computer 123

Checking Internet Explorer Settings 124
Appendix A: Hardwired Chiller Control 126
Setting up the CSM's Additional Chiller Data for a Hardwired Chiller 126
Chiller % RLA from a Hardwired Chiller 127
Hardwired Chiller - Load Limiting Control 128
Hardwired Chiller - Chilled Water Temperature Control 128
Hardwired Chiller Unit Controller Settings 129
Hardwired Chiller Sequence of Operation 130
Unavailable and Available Hardwired Chillers 130
Chiller Startup 130
Chiller Shutdown 131
Hardwired Chiller Alarms 131
Chiller Fault Alarms 131
Chiller Problem Alarms 132
CSM Alarms Available for Hardwired Chillers 132
Chiller Data 133
Hardwired Chiller - Communication Loss Control at the Chiller 133
Index 134

Figures

Figure 1. Key to Software Identification 7
Figure 2. System Architecture 9
Figure 3. Enter Network Password 14
Figure 4. Niagara Web Administration 15
Figure 5. CSM's User Interface Main Screen (**http://<IP Address>)** 17
Figure 6. Example of a Configuration screen (Main > Configuration > System Control). 19
Figure 7. User Admin Screen (Main > Configuration > BAS Config > USER ADMIN-button) 20
Figure 8. Device Addressing (Main > Configuration > Device Addressing) 22
Figure 9. Service Pin Location on the MicroTech II Chiller LONWORKS Communication Module 24
Figure 10. Chiller Sequence Order Table (Main > Configuration > Chiller Seq) 34
Figure 11. Typical Primary-Only System 38
Figure 12. Typical Primary-Secondary System 39
Figure 13. Chiller System with Evaporators Piped in the Series/Parallel Configuration 43
Figure 14. Screw Chiller Demand Limiting 46
Figure 15. External Signal Demand Limiting Function 47
Figure 16. Soft Load Limit Function 48
Figure 17. CSM Leaving Evaporator Water Temperature Setpoint Flow Chart 51
Figure 18. Typical System with Isolated Chillers 52
Figure 19. Return Water or Outdoor Air Reset (English) 53
Figure 20. Return Water or Outdoor Air Reset (SI) 54
Figure 21. External Reset (English) 55
Figure 22. External Reset (SI) 55
Figure 23. Typical Condenser Water Loop 59
Figure 24. Tower Stage Table (Main>Configuration>Clg Tower Control>Tower Stage Table) 60
Figure 25. Tower Staging Only 62
Figure 26. Tower Staging With Low-Limit Controlled Bypass Valve 63
Figure 27. Tower Staging With Intrastage Controlled Bypass Valve 63
Figure 28. Initial Tower Bypass Valve Position (English) 66
Figure 29. Initial Tower Bypass Valve Position (SI) 66
Figure 30. Configuration 1: Constant-Speed Single Pump 69
Figure 31. Configuration 2: Constant-Speed Lead/Standby Pump Set 70
Figure 32. Configuration 3: Constant-Speed Sequenced Pumps 70
Figure 33. Configuration 4: Variable-Speed Single Pump 70
Figure 34. Configuration 5: Variable-Speed Lead/Standby Pump Set 71
Figure 35. Configuration 6: Multiple Variable-Speed Pumps 71

Figure 36. Configuration 7: Primary-Only System 71
Figure 37. Example of Pump Sequence Order Table (Main > Configuration > Load Flow Control) .75
Figure 38. Menu of Schedules (Main > Configuration > Sched > Schedule Icon) 82
Figure 39. Weekly Schedule (Main > Configuration > Sched > Schedule Icon > Weekly)....83
Figure 40. Calendar (Main > Configuration > Sched > Schedule Icon > Calendar) 84
Figure 41. Special Event Schedule (Main>Configuration>Sched>Schedule Icon>Special Events) 85
Figure 42. Optimal Start Time Line 88
Figure 43. System Status (Main > System Status) 98
Figure 44. Chilled Water Temperature Sensor Locations 102
Figure 45. Condenser Water Temperature Sensor Locations 103
Figure 46. Chiller Status (Main > System Status > Chiller Status) 104
Figure 47. Acknowledging Alarms (Main > View Alarms) 108
Figure 48. Main Board Layout 118
Figure 49. Performing the “ipconfig” Command at the DOS Prompt 120
Figure 50. IP address read from a HyperTerminal boot sequence 122
Figure 51. Performing the “ping” Command at the DOS Prompt 124
Figure 52. Important Microsoft Internet Explorer Options 125
Figure 53. External Demand Limiting Function Signal 128
Figure 54. Hardwired Chiller Leaving Water Temperature Setpoint Reset (English)....129
Figure 55. Hardwired Chiller Leaving Water Temperature Setpoint Reset (SI) 129

Tables

Table 1. Chiller Unit Controller Program Code Software Compatibility....8
Table 2. Default Passwords....21
Table 3. User Admin (Main > Configuration > BAS Config > USER ADMIN-button)....21
Table 4. Device Addressing (Main > Configuration > Device Addressing) 23
Table 5. Chiller Setup (Main > Configuration > Chiller Setup)....25
Table 6. I/O Config (Main > Configuration > I/O Config) 27
Table 7. Chiller Unit Controller Setup Variables....31
Table 8. System Control (Main > Configuration > System Control) 32
Table 9. Chiller Seq - Chiller Sequencing Order (Main > Configuration > Chiller Seq)....34
Table 10. Chiller Seq - Chiller Sequencing Logic (Main > Configuration > Chiller Seq)....36
Table 11. Example of a Typical Sequence Order with Series-Piped Chillers 43
Table 12. Load Limiting (Main > Configuration > Load Limiting)....45
Table 13. Chilled Water Supply Temp (Main > Configuration > Chilled Water Supply Temp) 49
Table 14. Clg Tower Control (Main > Configuration > Clg Tower Control) 56
Table 15. Actual Cooling Tower Staging....60
Table 16. Load Flow Control (Main > Configuration > Load Flow Control)....67
Table 17. Sched (Main > Configuration > Sched) 81
Table 18. Optimal Start (Main > Configuration > Optimal Start)....87
Table 19. Optimal Start Time Increments (in Minutes) 88
Table 20. BAS Config - BACnet (Main > Configuration > BAS Config) 90
Table 21. BAS Config - Modbus (Main > Configuration > BAS Config) 91
Table 22. Configuring Physical Alarm Outputs (Main > Configuration > Alarms)....92
Table 23. Configuring E-Mail Alarm Notification (Main > Configuration > Alarms)....92
Table 24. Configuring BACnet Alarm Notification (Main > Configuration > Alarms)....94
Table 25. CSM Alarms 109
Table 26. DB-9 to RJ-45 Null Modem Adapter Pin Assignments 122
Table 27. Hardwired Chiller Config (Main > Configuration > Chiller Setup)....126
Table 28. Chiller Unit Controller Setup Variables....130
Table 29. CSM Alarms Available for Hardwired Chillers....132

Limited Warranty

Consult your local McQuay Representative for warranty details. Refer to Form 933-430285Y. To find your local McQuay Representative, go to www.mcquay.com.

Notice

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Reference Documents

Company	Number	Title
McQuay International	IM781	MicroTech II Chiller System Manager Installation Manual
McQuay International	IM783	MicroTech II Remote I/O Panel Installation Manual
McQuay International	IM735	MicroTech II Chiller Unit Controller LONWORKS® Communication Module
McQuay International	ED15062	MicroTech II Chiller Controller Protocol Information, BACnet MS/TP and LONWORKS Networks
McQuay International	ED15100	MicroTech II Chiller Controller Protocol Information, BACnet IP or BACnet Ethernet Networks
McQuay International	ED15075	MicroTech II Chiller System Manager Protocol Information, BACnet® Networks
McQuay International	ED15077	MicroTech II Chiller System Manager Protocol Information, Modbus® Networks
Tridium, Inc	-	Net Connect Guide
Tridium, Inc	-	Using the Admin Tool
McQuay International	OM CentrifMicro II	MicroTech II Unit Controller for Centrifugal Chillers and Templifiers Operating Manual
McQuay International	IOMM WPV	MicroTech II Centrifugal Chiller Installation, Operation, and Maintenance Manual
McQuay International	IOMM WSCWDC-2	MicroTech II Chiller Unit Controller Installation, Operation, and Maintenance Manual
McQuay International	OM AGS-1	MicroTech II Controller for AGS Chillers Operating Manual
McQuay International	OM AGS-2	MicroTech II Air-Cooled Screw Chiller Operating Manual
McQuay International	IMM AGS-1	MicroTech II Air-Cooled Screw Chiller Installation and Maintenance Manual
McQuay International	IOMM AGZ-4	MicroTech II Air-Cooled Scroll Chiller Installation, Operation, and Maintenance Manual
McQuay International	IOMM WGZ-1	MicroTech II Water-Cooled Scroll Chiller Installation Manual

All documents are available at www.mcquay.com.

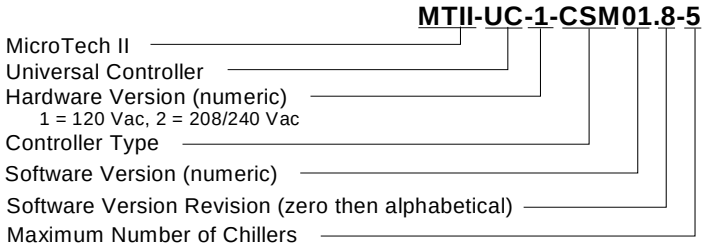
Revision History

OM 780-0	January 30, 2004	First release.
OM 780-1	April 6, 2004	Minor changes prior to Chinese translation.
OM 780-1	October, 2004	Remove common supply control.
OM 780-1	November, 2004	Add hardwired chiller appendix.
OM 780-2	November, 2005	Updated the Hardware Selection field in Table 4. Added Evaporator Flow Sensor, Condenser Flow Sensor and Solid State Starter fields to Table 5. Modified CSM Stop-to-Start Timer description in the Hardwired Chiller Sequence of Operation section.
OM 780-3	October, 2006	Added ED 15100 to Reference Documents table & modified Table 16, pump control options

CSM Software ID

MicroTech II® CSM software is factory installed and tested in each panel prior to shipment. The software is identified by a program code (also referred to as the "Ident"), that is printed on a small label above the controller.

Figure 1. Key to Software Identification



The program code is also encoded in the controller's memory and is available for display on the CSM Configuration Screens.

Chiller Unit Controller Software Compatibility

At the time of this writing, the program code for CSM Software is MTII-UC-x-CSM01.8-x. This CSM software is compatible with MicroTech II chillers unit controller software versions listed in Table 1 below:

Table 1. Chiller Unit Controller Program Code Software Compatibility

Chiller Controller	Code Identification	Availability Date
Centrifugal, Dual and/or Single	WCFU3UU03**H**	11-4-2003
Air Cooled Frame Four Screw	AGSU30101F	To Be Determined
Air Cooled 3200 Screw	AGSD	To Be Determined
Water Cooled 3200 Screw	WGSD30101D	5-11-2004
Air Cooled Global Scroll Single Circuit	AGZS	To Be Determined
Air Cooled Global Scroll Dual Circuit	AGZDU0102**C**	2-23-2004
Air Cooled Global Scroll Single Circuit	AGZSUO102A	4-8-2004
Water Cooled Global Scroll Dual Circuit	WGZDU0102**C**	3-11-2004
Water Cooled Frictionless	WMCU3UU01A	To Be Determined

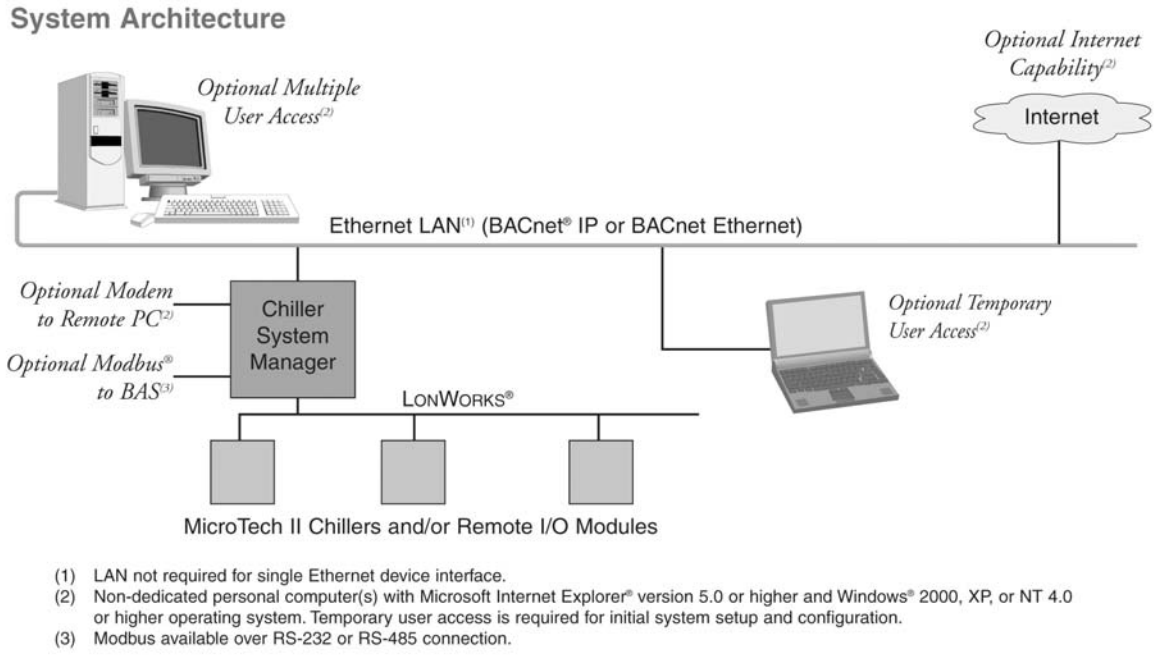
Introduction

This manual provides information about the MicroTech II Chiller System Manager (CSM) for McQuay MicroTech II chillers. It specifically describes the CSM's features, sequences of operation, and configurable options. It also includes information on how to use the user interface to monitor a running system and configure the CSM.

For information on CSM components, field wiring options and requirements, network wiring, and service procedures, refer to IM 781, MicroTech II Chiller System Manager Installation Manual. For specific information about the MicroTech II chiller unit controllers, refer to the appropriate MicroTech II unit controller installation or operation manual (see the Reference Documents section of this document).

The CSM is capable of communicating with a connected building automation system (BAS) using BACnet® (IP or Ethernet protocol as standard) or Modbus® (RTU or ASCII available as an option.) For additional information, see the BACnet or Modbus Protocol Information documents ED 15075 and ED 15077 respectively.

Figure 2. System Architecture



(1) LAN not required for single Ethernet device interface.
(2) Non-dedicated personal computer(s) with Microsoft Internet Explorer® version 5.0 or higher and Windows® 2000, XP, or NT 4.0 or higher operating system. Temporary user access is required for initial system setup and configuration.
(3) Modbus available over RS-232 or RS-485 connection.

⚠ WARNING

Electric shock hazard.

Can cause personal injury or equipment damage.

This equipment must be properly grounded to the MicroTech II control panel. Trained personnel with experience must perform connections and service with the equipment being controlled.

CAUTION
This equipment can cause interference to radio communications if not installed and used properly. It has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC rules. Operating this equipment in a residential area is likely to cause interference which the user will be required to correct at his or her own expense. **McQuay International disclaims any liability resulting from any interference or for the correction thereof.**





Getting Started

The MicroTech II Chiller System Manager (CSM) is a self-contained device that is capable of monitoring and controlling up to six (or 12 if properly licensed) McQuay MicroTech II chillers via network communications. It can also monitor and control a variety of system equipment such as cooling tower fans, bypass valves, and cooling load pumps. All operator interactions with the CSM are achieved using the Internet Explorer browser on a PC connected to the CSM through an Ethernet Local Area Network (LAN), the Internet or a modem.

The web pages an operator uses to configure and monitor the CSM are defined as the CSM's user interface. In addition to chiller system data, the CSM's user interface can show a summary of important data for each chiller. To modify information in a chiller controller, you must use the keypad/display at that chiller.

The "Getting Started" sections describe how to connect to the CSM's user interface to use it after you have a LAN connection.

Connecting to the CSM

The CSM's user interface is used to configure the CSM and view the status of the chiller plant. The CSM serves up web pages to your personal computer (PC) through an Ethernet connection. The following instructions show how to connect your PC to the CSM. When the CSM is connected through the building LAN, multiple users can gain access to the user interface at the same time.

PC Requirements

Operating System

To access the CSM, a PC with Microsoft Windows NT™ 4.0 with Service Pack 4 or higher, Windows 2000 or Windows XP is required.

Software/Hardware Required on your PC

Microsoft Internet Explorer™ The CSM user interface works from your PC with Microsoft Internet Explorer browser version 5.0 or later only (not AOL, Netscape, etc). The CSM requires a Java-enabled Web browser – the typical default configuration for most browsers. For Internet Explorer, the following parameters have proven to be most essential (version 5.5 parameters show):

From the Internet Explorer's menu bar: **Tools>Internet Options>Advanced**

- "HTTP 1.1 Settings": Use HTTP 1.1
- "Microsoft VM": JIT compiler for virtual machine enabled.

Note: Windows XP does not come with the Microsoft VM (Java™ Virtual Machine). If your PC does not have this software you can obtain it by contacting the McQuay Controls Support Group (1-866-4McQuay). The Sun® VM has displayed a problem with changing the time on the CSM using the CSM's Webadmin tool.

Adobe Acrobat Reader™ 5.0 is needed to view the help documentation.

Admin Tool is required if you would need to load new CSM software, install a new license, configure a modem or save the configured CSM database externally. The Admin Tool is available from McQuay at www.mcquay.com, go to Product Information > Controls > Software and download the Admin Tool zip file.

Display: Video card and monitor capable of displaying 1024x768-pixel resolution.

Network Support: Ethernet adapter (10/100 megabit with RJ45 connector)

Connecting Your PC to the CSM

This section discusses the requirements for interfacing your computer to the CSM. If you can't access the CSM's user interface after going through these instructions, see the "Troubleshooting the PC's Connection to the CSM" section of this document.

Required Tools

You need the following tools to configure the CSM for network operation:

- PC with Ethernet card and TCP/IP protocol.
- Internet Explorer browser.
- Ethernet Cable. Either an Ethernet crossover cable for direct connection or a standard Ethernet cable for connecting through a hub. The maximum length of an Ethernet cable is 328 feet (100 meters) without the risk of signal loss. Using hubs or switches can extend length.

Note: These instructions assume that you have a PC with Internet Explorer installed. Internet Explorer can be downloaded at www.microsoft.com if not already installed.

Once the CSM has powered up, you must first access the CSM at its original IP address using your PC at a compatible IP address. The CSM controller is pre-configured with an IP address in the range 192.168.1.14x, where "x" represents the last digit of the CSM's serial number. The default subnet mask is 255.255.255.0. The IP address is also listed on the packing slip that accompanies the unit.

Make sure the PC that you use to access the CSM during installation is assigned an IP address in the range: 192.168.1.1 to 192.168.1.254, with a subnet mask of 255.255.255.0. The IP address of the PC must be unique (not be the same as the IP address of the CSM, or any other device on a LAN).

Making Network Properties on your PC compatible with the CSM

The procedure for changing the network settings varies depending on the operating system in your computer.

Network Setting for Microsoft Windows® 95 and 98

► **To change the network setting in Microsoft Windows 95 and 98 computer**

1. Open the Control Panel on your computer.
   a. Open the Network Applet.
   b. Select the TCP/IP-Ethernet card combination on the computer.
   c. Select the Properties button.
   d. Select the IP Address tab.
   e. Note the IP address and Subnet mask if they have values or that Obtain IP address automatically is selected.
   f. Select Specify an IP address.
   g. Change the Subnet mask to 255.255.255.0.
   h. Change the IP address to 192.168.1.X (where X is unique on the subnet and not the same number as the CSM's IP Address).
   i. Click the OK button.
2. Reboot your computer to change the Subnet Mask and IP address.

► **To restore the network setting in Microsoft Windows 95 and 98 computer**

1. Open the Control Panel on your computer.
   a. Open the Network Applet.
   b. Select the TCP/IP-Ethernet card combination on the computer
   c. Select the Properties button.
   d. Select the IP Address tab.
   e. Restore the settings noted as previously noted.
   f. Click the OK button.
2. Reboot your computer to restore the original Subnet Mask and IP address.

Network Setting for Microsoft Windows NT

► **To change the network settings in a Microsoft Windows NT computer**

1. Open the Control Panel on your computer.
   a. Open the Network Applet.
   b. Select the Protocols tab.
   c. Select the TCP/IP-Ethernet card combination on the computer.

d. Select the Properties button.
e. Select the appropriate adapter.
f. Note the IP address and Subnet mask if they have values or that Obtain IP address automatically is selected.
g. Select Specify an IP address.
h. Change the Subnet mask to 255.255.255.0.
i. Change the IP address to 192.168.1.X (where X is unique on the subnet and not the same as the CSM's IP Address).
j. Click on the Apply button.

▶ **To restore the network settings in a Microsoft Windows NT computer**

1. Open the Control Panel on your computer.
   a. Open the Network Applet.
   b. Select the Protocols tab.
   c. Select the TCP/IP-Ethernet card combination on the computer.
   d. Select the Properties button.
   e. Select the appropriate adapter.
   f. Restore the settings as previously noted.
   g. Click the Apply button.

Network Setting for Microsoft Windows 2000

▶ **To change the network settings in a Microsoft Windows 2000 computer**

1. Select My Network Places on the desktop and right click.
2. Open Properties.
3. Select Local Area Connections and right click.
4. Open Properties.
5. Select TCP/IP.
6. Click on Properties button.
7. Note settings for future reference.
8. Select Use the following IP address.
9. Change the Subnet mask to 255.255.255.0.
10. Change the IP address to the IP address to 192.168.1.X (where X is unique on the subnet and not the same as the CSM's IP Address).
11. Click OK

▶ **To restore the network settings in a Microsoft Windows 2000 computer**

1. Select My Network Places on the desktop and right click.
2. Open Properties.
3. Select Local Area Connections and right click.
4. Open Properties.
5. Select TCP/IP.
6. Restore the network settings as previously noted.
7. Click OK.

Changing the CSM's IP Address and Date/Time

Now that you have changed the network settings on your PC to be compatible with the IP address of the CSM, you can connect to the CSM with the Internet Explorer browser to assign it a unique IP address and other network settings. This is a requirement if the CSM is to be used on a LAN so that its network settings will be compatible with the existing LAN. Connection to the existing LAN provides multiple user access for the user's PC and also allows user access through high speed Internet connections at remote locations. A document titled "Net Connect Guide" is available at www.mcquay.com to assist you in making remote connections to the CSM. Close interaction with your building's IT department is required for successful operation, obtain IP addressing and firewall security support from your IT department.

► **To change the IP address of the CSM, follow this procedure**

1. Attach one end of a standard Category-5 Ethernet unshielded twisted par (UTP) patch cable to the Ethernet port on the CSM.
2. Attach the other end of the patch cable to an Ethernet Hub.

Note: If you do not have access to a hub, use an Ethernet crossover cable to connect the CSM directly to the network connection on your PC.

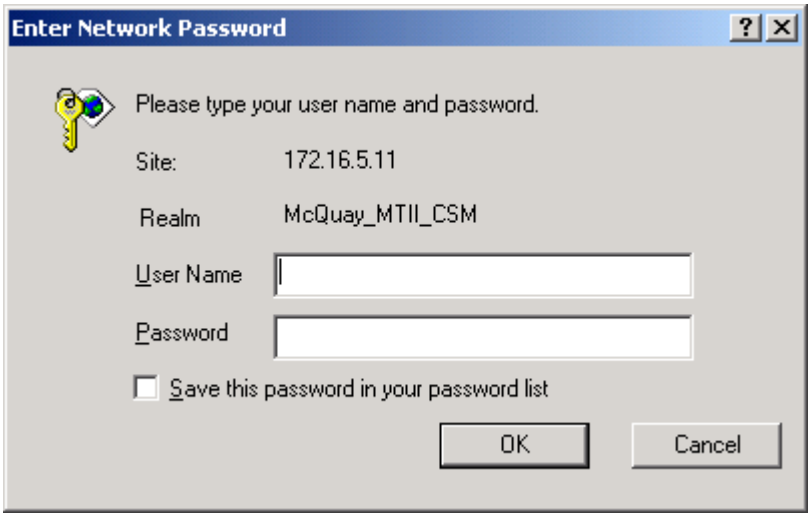
---

3. Power up the CSM.
4. From your PC, start Internet Explorer.
5. In the address bar on the top of your Internet Explorer page, type:

http://<IP Address>:3011/rel/nre/webadmin/webadmin.html

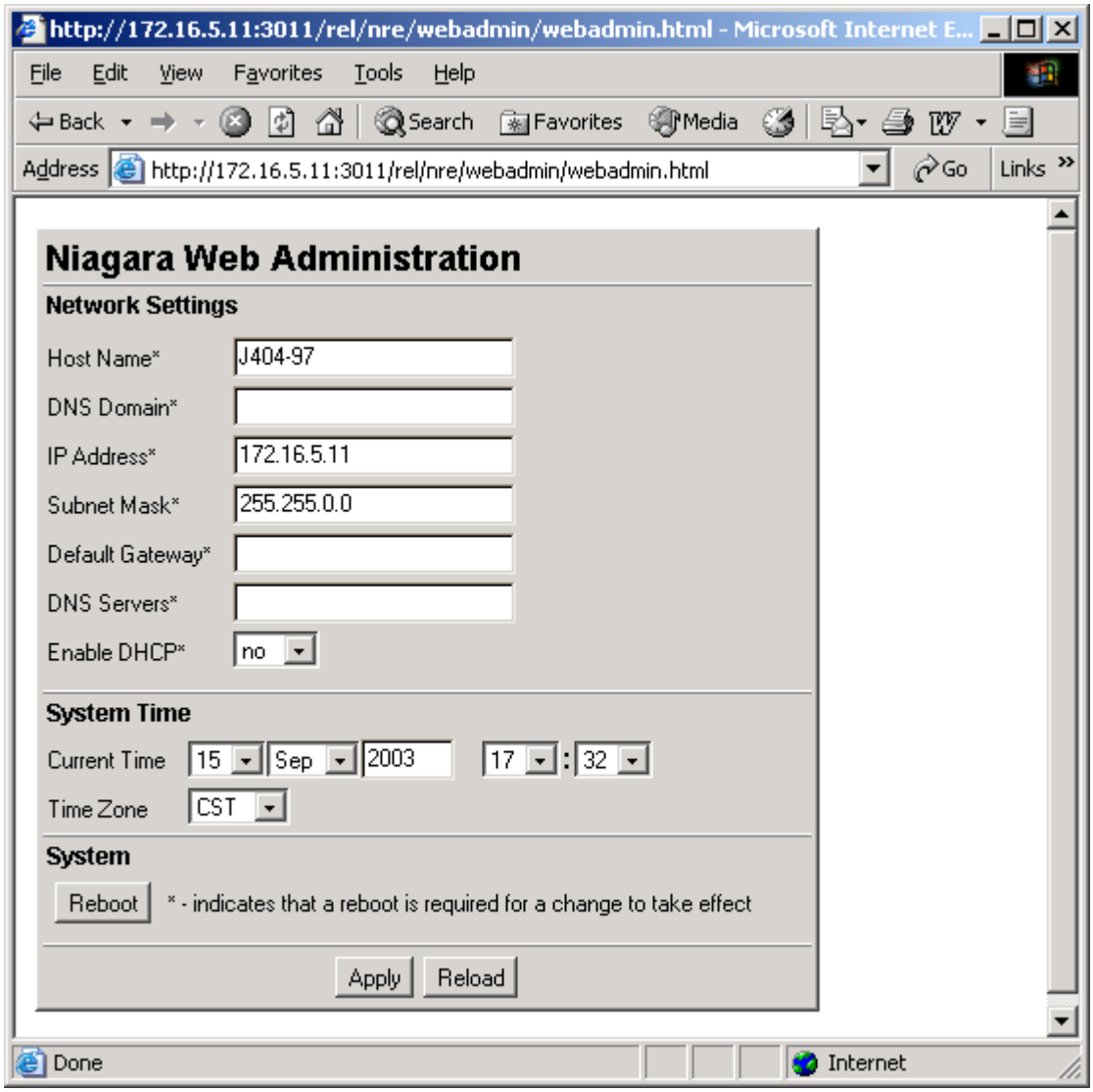
Where <IP Address> is the IP Address of the CSM (e.g. 192.168.1.141). An "Enter Network Password" dialog box will appear.

Figure 3. Enter Network Password



6. Log on to the CSM with the default user name and password, as it appears on the packing list. Typical defaults are User Name = **McQuay** and Password = **Password**. Click **OK**. The Niagara Web Administration dialog box will appear.

Figure 4. Niagara Web Administration



7. Set the CSM's Date, Time and Time Zone.

8. Assign the CSM a unique IP address and other network settings to be used for communications. Consult with local IT personnel to obtain an IP address and Subnet Mask for integration into the existing building network. Be sure to write the IP Address down in a safe place to remember the assigned address. A description of the network settings is given below:

- **Host Name** – The name you want to use for this host
- **DNS Domain** – The TCP/IP Domain Name System (DNS) domain this CSM belongs to, if used
- **IP Address** – The unique Internet Protocol (IP) address for this host
- **Subnet Mask** – The IP subnet mask used by this host
- **Default Gateway** – The IP address for the device that forwards packets to other networks or subnets
- **DNS Servers** – The IP address for one or more DNS servers, each of which can automate associations between host names and IP addresses. If you specify a DNS server, you must provide a domain name for this host in the DNS Domain field. Otherwise, the NNS function will not work.
- **Enable DHCP –** Makes the CSM request an IP address from a DHCP Server. If you use DHCP, reserve a static address within DHCP for the CSM (as opposed to within the entire static pool) so that you will always know the IP Address of the CSM.

CAUTION
After changing network settings, be sure to record the changes and save them in a safe location. We recommend also writing it on the label provided on the inside front cover of the CSM panel, in order to avoid a lengthy recovery procedure if the network settings are lost.

Connecting to the CSM's User Interface

To use the CSM's user interface to configure and monitor the chiller system use the following procedure. If the CSM was placed on a LAN (see the previous section, Changing the CSM's IP Address and Date/Time) and your computer has access to the same LAN, you may skip to step 4.

► **To connect to the CSM's user interface follow this procedure**

1. Attach one end of a standard Category-5 Ethernet unshielded twisted par (UTP) patch cable to the Ethernet port on the CSM (see Figure 48 for port location).
2. Attach the other end of the patch cable to an Ethernet Hub.

Note: If you do not have access to a hub, use an Ethernet crossover cable to connect the CSM directly to the network connection on your PC.

3. Power up the CSM
4. From your PC, start Internet Explorer.
5. In the address bar on the top of your Internet Explorer page, type:

http://<IP Address>

Where <IP Address> is the IP Address of the CSM (e.g. 192.168.1.141). An "Enter Network Password" dialog box will appear (see Figure 3).

6. Log on to the CSM with your user name and password, as it appears on the packing list. Typical defaults are User Name = **McQuay** and Password = **Password**. Click **OK**. The CSM's User Interface Main Screen will appear.

*Figure 5. CSM's User Interface Main Screen (**http://<IP Address>**).*



The *Main* Screen of the CSM's User Interface has three tabs to navigate to the different CSM web pages (called screens throughout the rest of this document). These screens are grouped in the three categories of Configuration, System Status, and View Alarms. There is also a Help tab, which will bring you to an online version of this document.

Configuration Category

Screens in the configuration category contain variables that define how the CSM operates. Entering a new value and pressing the SAVE CHANGES button on the bottom of the screen can change most of the fields on these screens. The screens in the Configuration category are static and do not refresh automatically. Moving off the screen and coming back will refresh any data that may have changed.

System Status Category

Screens in the system status category contain information about the current operation of the chiller system. They also include important information about the current operating conditions in each chiller. The majority of these fields provides status information only and cannot be changed with the keypad. The screens in System Status category are dynamic, meaning that values on these pages are updated as soon as they change in the chiller system.

View Alarm Screen

This screen contains a listing of all the unacknowledged alarms that have occurred in the chiller system. Included with the alarm message are the time the alarm occurred and a description of the alarm. This screen is used to provide alarm information and for the user to acknowledge that an alarm has been viewed.

Connecting to the CSM's User Interface Remotely Using a Modem

The CSM's user interface can also be accessed remotely by direct dialing the CSM through an optional modem. A requirement for a remote modem connection is that you do not have direct connection to the CSM through the Ethernet port (multiple connections will result in routing and address conflicts). For information on installing and configuring a modem to the CSM see IM781. If the CSM has a modem with an analog phone line connection, the following procedure describes how to connect to the CSM.

► **To connect to the CSM's user interface remotely through a modem, follow this procedure:**

1. Install and configure a modem to the dial-in host computer you will be using to direct dial the CSM. The host computer must have a Windows NT 4.0, Windows 2000 or Windows XP operation system. Additional information on setting up a dial-in host computer and modem is available in the "Net Connect Guide" available at www.mcquay.com
2. Attach the dial-in host's modem to an analog phone line
3. Set the IP address of the dial-in host computer to the IP address listed as the value of the remoteAddr parameter in the CSM's ras.properties file (default = 192.168.1.111). To configure the CSM to allow connection from a dial-in-host computer with a different remoteAddr, see IM781 for instructions on editing the CSM's ras.properties file.
4. Using the Dial-Up Networking features of the remote computer enter the phone number of the phone line connected to the CSM's modem
5. If the Dial-Up Networking asks for the User Name and Password of the dial-up device, enter your CSM user name and password
6. Dial the CSM
7. When you have made the direct dial connection between your dial-in host and the CSM open Internet Explorer on your PC
5. In the address bar on the top of your Internet Explorer page, type **http://<IP Address>**

Where <IP Address> is the IP Address listed in the localAddr property of the CSM's ras.properities file (default = 192.168.1.110).

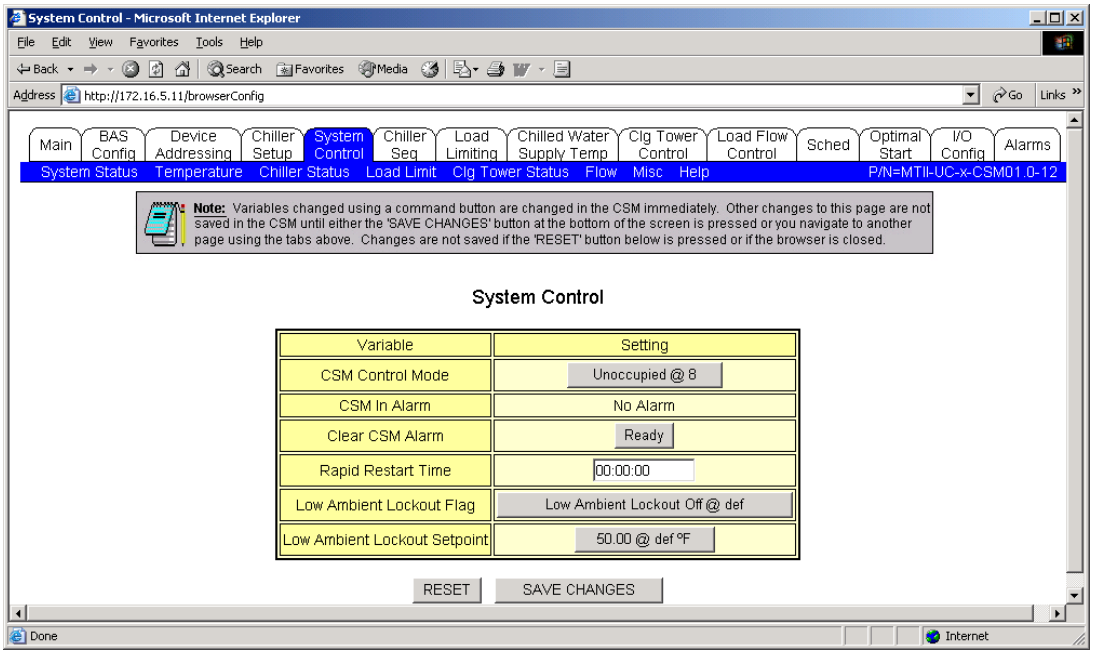
6. An "Enter Network Password" dialog box will appear (see Figure 3). Log on to the CSM with the your user name and password. Click **OK**. The CSM's User Interface *Main* Screen will appear.

Using the CSM's User Interface

Navigating Between Screens

Navigating from screen to screen on the user interface is accomplished by using your mouse to click on the tab with the name of the screen you wish to move to. The *Main* screen allows you to click to any of the three screen categories (System Status, Configuration, and View Alarms). Once you enter the System Status or Configuration category of screens, additional tabs allow you to navigate to other screens. For example, clicking on the Configuration tab on the *Main* screen brings up the following screen:

Figure 6. Example of a Configuration screen (Main > Configuration > System Control).



Notice that when you are viewing a Configuration screen, the white tabs across the top allow you to navigate to any of the other Configuration screens. Also, the blue bar just below the white tabs contain white-letter tabs, which allow you to navigate to any of the System Status screens. These tab layouts are reversed when you are viewing one of the System Status screens.

Changing Values on the User Interface's Configuration Screens

Variable settings on the configuration screens come in two types, commandable inputs and property inputs. Commandable inputs are displayed as gray boxes (see the gray box that reads Unoccupied@8 to the right of the CSM Control Mode in Figure 6). Clicking on the gray box of a commandable input brings up a Command Window. With this Command Window you are able to enter a new value for the variable you wish to change. Clicking OK on the Command Window after changing the value immediately enters the new value into the CSM (you don't have to press SAVE CHANGES when editing a commandable input).

Commandable variables on the user interface are variables that can also be changed through a building automation system (BAS) connection (if one exists). The term "commandable" refers to the command priority assigned to the method of input. When the user interface changes a value it "commands" that variable to the new value at a command priority of 8 (priority 8 is defined to be Manual and the user interface is a manual input). When a BACnet BAS changes a value, it can "command" that variable to a new value at any command priority (1 through 16). The CSM has been programmed to receive Modbus commands at priority 10. When the CSM's application programming commands a value it is typically at priority 16. The optimal start feature commands the CSM at priority 13, etc.

When multiple methods are trying to change the same variable, the input with the lowest priority number takes "command" of that variable. You can view which priority is currently commanding the variable by observing the priority number after the value of a commandable input. For example, in Figure 6 the CSM Control Mode value is "Unoccupied" and the priority is "16". If the priority reads "@def", it means that nothing has commanded that variable and it has resorted to its default value. To allow a BAS input to command a variable, that variable must be commanded to AUTO at the user interface. Commanding to AUTO will relinquish previous commands at priority 8 (from the user interface) and allow BACnet or Modbus device inputs at priorities higher than 8 to take effect.

The second type of variable setting on a configuration screen is the property input. Property inputs are displayed as white boxes (see the white box that reads 00:00:00 to the right of the Rapid Restart Time in Figure 6). Entering a new value for the variable in this white box changes the value on the screen only. After changing a property input on the screen you must press the SAVE CHANGES button on the bottom of the screen or navigate to another page using the tabs on top of this page for the change to be entered into the CSM. If the change is not entered into the CSM before closing the web browser, this change will not take effect in the CSM. The gray note on top of each Configuration page reminds you of this requirement. The RESET button on the bottom of the page can be used to reset all unsaved changed property inputs back to their original values.

For security concerns, access to the user interface is broken down into different categories. Some of these categories (e.g. Operator - Read/Write) allow the user to make changes to the Configuration screens. Other categories (e.g. User – Read Only) are not allowed to make changes to the Configuration screens. When you are logged into the user interface within a read-only category, the commandable variables do not display as gray, and the property inputs do not display as white. For more information on security and read-only access, see the "Password Protection" section.

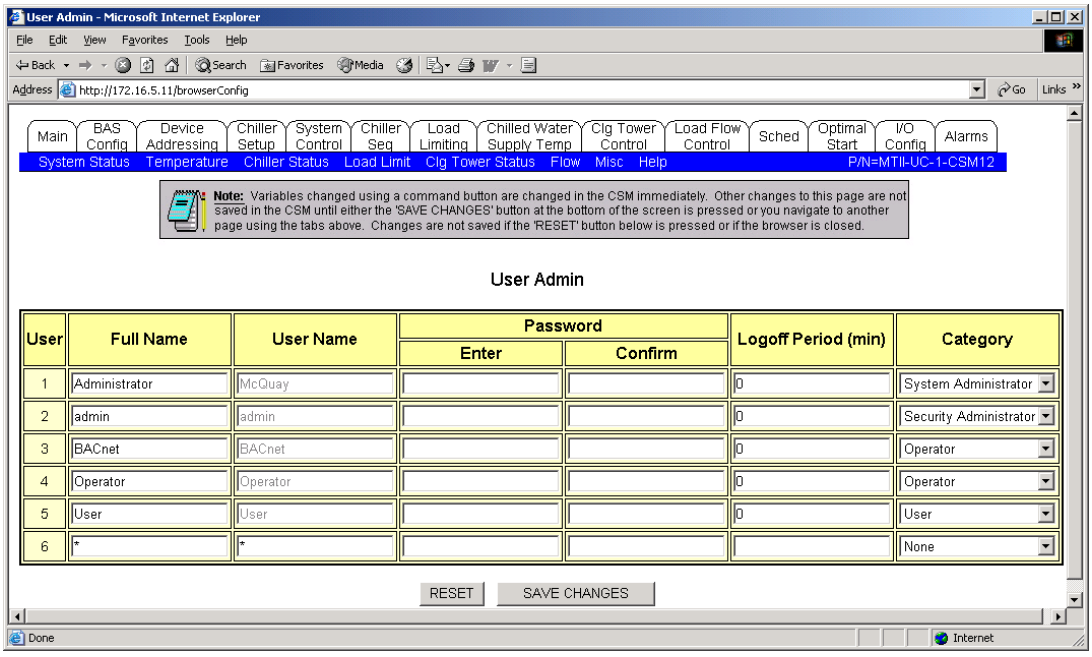
Password Protection

The CSM's user interface includes password protection to restrict access to unwanted users and guard against the entry of inadvertent or unauthorized changes. When you attempt to access the CSM through Internet Explorer, you are prompted for a user name and password (see Figure 3). Different levels of access can be assigned to different users. User accounts can be created and edited using the *User Admin* screen.

Configuring User Accounts

The *User Admin* screen allows the System Administrator or Security Administrator to set-up, alter, and view user access to the CSM. Only a user with System Administrator or Security Administrator privileges can access the *User Admin* screen. To get to the *User Admin* screen on the user interface, click on the Configuration tab, when the *System Control* screen is displayed click on the BAS Config tab. On the bottom of the *BAS Config* screen is a button labeled USER ADMIN, press this button to display the *User Admin* screen.

Figure 7. User Admin Screen (Main > Configuration > BAS Config > USER ADMIN-button)



Selected user account categories have been defined for you. They can be assigned to users at different levels of authorization. A maximum number of 255 users can be defined at one time. Table 2 lists the user accounts that have been set in the CSM during manufacturing.

Table 2. Default Passwords

User Name	Password	Category	Description
McQuay	Password	System Administrator	This allows full read/write capability plus full administration privileges needed to change passwords.
BACnet	BACnet	BACnet	Do not change this user account or a BACnet BAS will not be able to communicate with the CSM
User	User	User	This level allows read-only and no administration privileges.
Operator	Operator	Operator	This level allows read/write capability and no administration privileges

The configurable inputs to the *User Admin* screen are described in Table 3 below.

Table 3. User Admin (Main > Configuration > BAS Config > USER ADMIN-button)

Name	Description
Full Name	A descriptive field that describes the person or persons that will be given this particular User Name and Password. The characters must be alphanumeric or underscores and must start with an alpha character
User Name	User name used to log onto the CSM's user interface.
Enter Password	The password used to log onto the CSM's user interface.
Confirm Password	Re-enter the password that was entered in the Enter Password column. This makes sure you didn't make any typing mistakes.
Category	In this column you will select the type of privileges you want this user to have. Range = None, System Administrator, Security Administrator, User, Operator, Remove User. Default = None

After adding or editing a user account, you must press the SAVE CHANGES button on the bottom of the User Admin page for the changes to take effect.

User Account Categories

The following categories of user accounts have been set up for you to select from when creating new users. Each category provides a different level of security.

- *None* – No User Name or Password has been defined
- *System Administrator* – This allows full read/write capability plus full administrative privileges, including changing user names and passwords of all users. Note: there can only be one System Administrator password.
- *Security Administrator* – This allows the same capability as the System Administrator except this user cannot change the user name or password for the System Administrator
- *User* – This allows read-only capability and no administrative privileges
- *Operator* – This allows read/write capability and no administrative privileges
- *Remove User* – Selecting this and pressing the SAVE CHANGES button removes the corresponding user from the list of all users.

CAUTION

If you edit or create a new System Administrator password, be sure to record your changes and store them in a place you (and your colleagues) can find them again. If you forget or lose the name or password, you must ship the unit back for recovery.

Connecting Chillers and Remote I/O to the CSM

This section explains the setup variables in the CSM that must be set to integrate the CSM and its associated chillers into a working network. It also explains the setup variables that are related to the CSM's analog inputs and outputs. Once set in accordance with the job requirements and characteristics, most of these variables should never need to be changed.

After a working CSM-to-Chiller network has been established, further setup is likely necessary to adapt the CSM and chiller controllers to your particular application's requirements. For complete information on how to do this, see the "Configuring the Chiller System Manager" portion of this manual. Until this configuration is complete, *the chiller system should remain disabled* (see "CSM Control Mode" section in the "Configuring the Chiller System Manager" portion of this manual for information on how to manually disable the chiller system).

Commissioning LONWORKS Devices (Chillers or Remote I/O)

The CSM uses a LONWORKS field bus to communicate to chillers and remote input/output modules. The CSM performs the duties of the LONWORKS network management device on this network. To add, remove, or replace a LONWORKS device (chiller or remote I/O module) into the CSM's control network, go to the *Device Addressing* screen.

Figure 8. Device Addressing (Main > Configuration > Device Addressing)

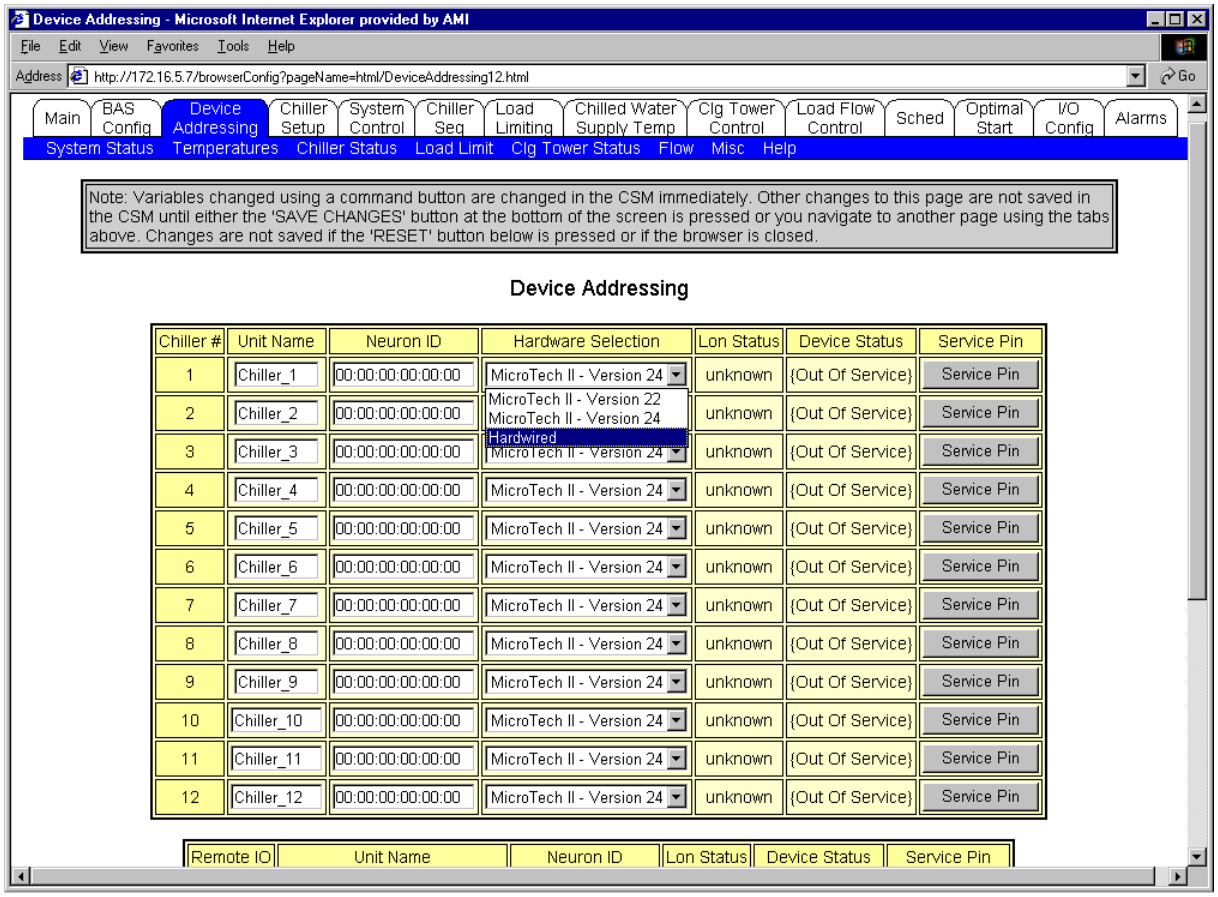


Table 4 describes the variables displayed in Figure 8 that are used to manage the devices on the CSM's LONWORKS network.

Table 4. Device Addressing (Main > Configuration > Device Addressing)

Name	Description
Unit Name	The Unit Name input may be used to input a unique identity for the chillers on a job. Since chillers are referred to as their chiller number throughout this document, it may be convenient to leave the Unit Names at their default values
Neuron ID	The Neuron ID is a LONWORKS communication networking term to describe the network address of the "Neuron" chip on the LONWORKS device. The Neuron ID is used by the CSM to assign a physical chiller as "Chiller 1", "Chiller 2", etc. The CSM is the network administrator in this LONWORKS network of chillers and remote I/O devices.
Hardware Selection	The Hardware Selection needs to be set to the type of chiller you are connecting to. If you are connecting to a Hardwired chiller, select Hardwired. If you are connecting to a MicroTech II chiller you have 2 options. If your chiller has a LONWORKS Communication Modulewith chchla22 XIF file loaded, then select MicroTech II – Version 22. If your chiller has a LONWORKS Communication Module with chchla24 XIF file loaded, then select MicroTech II – Version 24. If you are unsure, look at the lot number on the LONWORKS Communication Module. A lot number less than 301807 shipped from the factory with the chchla22 profile. All others shipped from the factory with the chcla24 profile.
Lon Status	This read only status field indicates the LONWORKS node state of the LONWORKS Device (e.g. chiller). The Lon Status of a device that has not been commissioned will be "unknown". The Lon Status of a properly commissioned device will be "config_online".
Device Status	This read only status field indicates the "status flags" of the LONWORKS Device (e.g. chiller). The Device Status of a device that has not been commissioned will be "outOfService". The Device Status of a properly operating device will be "OK". The Device Status of a commissioned device that is currently not communicating will be "Down".
Service Pin	This button is used to prompt a Service Pin input from a LONWORKS Device. After clicking on the SERVICE PIN button, you will be given five minutes to push the service pin on the LONWORKS device (e.g. chiller) you wish to commission to this Unit Name (e.g. Chiller 1).

Commissioning a Chiller to a CSM Chiller Number

The chiller number that a chiller is assigned too should be determined based on job site terminology. Typically, there will be a chiller on the job which is considered to be "chiller number 1" and a chiller considered to be "chiller number 2", etc. Chiller assignment to the CSM should follow this job-site terminology.

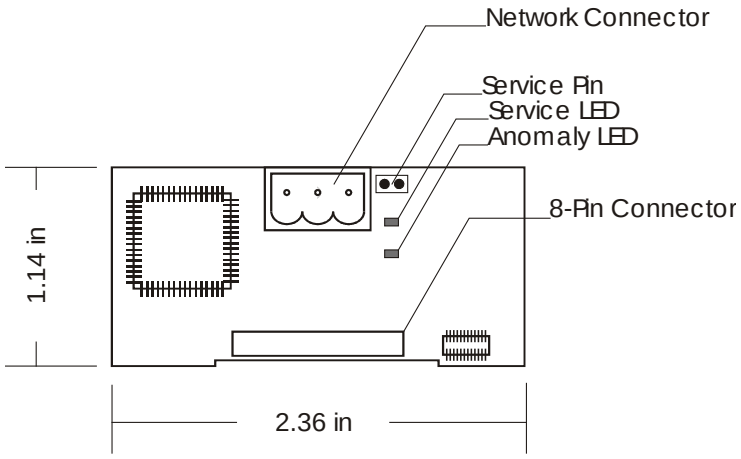
To commission a chiller the Neuron ID of the chiller's LONWORKS communication module must be entered into the CSM's *Device Addressing* screen at the desired location. The Neuron ID is automatically passed from the chiller to the CSM when the CSM is prompted for the chiller's Service Pin and the chiller's service pin is pressed (it could also be written in).

► **To commission chillers to the CSM follow this procedure**

3. Install the chiller's LONWORKS communication module per IM 735.
4. Wire the chiller to the CSM's LONWORKS communication network per IM 781.
5. At the CSM's user interface's *Device Addressing* screen, click on the SERVICE PIN button of the Chiller # you wish to assign this chiller too. A Service Pin Timer window will pop up with a 5-minute count down timer.
6. Before the 5-minute timer expires, go to the chiller and press the service pin on the chiller's LONWORKS communication module. The act of pressing the service pin on the LONWORKS communication module consists of shorting the two metal pins together with a small metal object (see Figure 9). A green LED just behind the service pin will light to indicate that you have successfully pressed the service pin. This will send the Neuron ID through the network to the CSM.
7. Verify that the Neuron ID of the desired chiller has automatically been entered into the correct Neuron ID location of the *Device Addressing* screen.
8. Press "SAVE CHANGES" on the *Device Addressing* screen.

The above procedure performs the LONWORKS network administration tasks of commissioning and binding a LONWORKS device.

Figure 9. Service Pin Location on the MicroTech II Chiller LONWORKS Communication Module



De-commissioning a Chiller or Remote I/O Module from the CSM

To remove a chiller from the CSM, replace the existing Neuron ID address numbers with zeros and press the SAVE CHANGES button on the *Device Addressing* screen. Disconnect any unused chillers (and remote I/O modules, if applicable) from the LONWORKS network. This is done by unplugging the LONWORKS network connector from the chiller or remote I/O's LONWORKS Communication Module. The CSM's LONWORKS network is dedicated only to those chillers and remote I/O modules it is using for control. Failure to remove unused chillers and/or remote I/O modules connected to the LONWORKS network may result in communication failures. The Device Status property of that chiller should change to "outOfService". If the Device Status property reads "outOfService, down" causing the Comm Loss between CSM and Chiller X alarm to occur, save your changes and reboot the CSM. To save changes, press the SAVE DATABASE button on the *BAS Config* screen. To reboot the CSM disconnect power until all LED's go off.

Replacing a LONWORKS Communication Module on a Chiller

If the LONWORKS communication module on a chiller needs to be replaced and the previous module had already been commissioned to the CSM:

► **To replace a commissioned chiller follow this procedure**

1. Remove the existing Neuron ID from the CSM Chiller Number (see "De-Commissioning a Chiller or Remote I/O Module from the CSM" above). Be sure to press the SAVE CHANGES button after zeroing the Neuron ID.
2. Commission the new LONWORKS device to the CSM (see "Commissioning a Chiller to a CSM Chiller Number" above)

Commissioning a Remote I/O Module to a CSM Remote I/O Letter

The CSM uses remote I/O modules to add additional, expandable input/output capabilities. All remote I/O modules are optional and only used based on your system requirements. Remote A, B, and C are only required if the CSM is controlling cooling load pumps (secondary pumps), each module can control up to two pumps. Remote D is only required if the CSM is controlling a chilled water loop bypass valve. Remotes E, F, G, and H are only required if the CSM is directly controlling cooling tower operation (vs. the chillers controlling the cooling tower), with the quantity of cooling tower remotes depending on the tower output requirements.

The Neuron ID is automatically passed from the Remote I/O module to the CSM when the CSM is prompted for the remote I/O modules Service Pin and the module's service pin is pressed. Unlike the chiller, there isn't a separate LONWORKS communication module on remote I/O modules; the LONWORKS hardware is built into the remote I/O module.

► **To commission remote I/O modules to the CSM follow this procedure**

1. Wire the module to the CSM's LONWORKS communication network per IM 781.
2. At the CSM's user interface's *Device Addressing* screen, click on the SERVICE PIN button of the remote I/O letter you wish to assign this module to. A Service Pin Timer window will pop up with a 5-minute count down timer.

3. Before the 5-minute timer expires, go to the remote I/O module and press the clear service pin button on the lower left-hand side of the module (directly below the LONMARK logo). The amber LED just below the service pin will light to indicate that you have successfully pressed the service pin. This will send the module's Neuron ID through the network to the CSM.
4. Verify that the Neuron ID of the desired remote I/O module has automatically been entered into the correct Neuron ID location of the *Device Addressing* screen
5. Press "SAVE CHANGES" on the *Device Addressing* screen

This procedure performs the LONWORKS network administration tasks of commissioning and binding a LONWORKS device.

To remove or replace a Remote I/O module from the CSM's LONWORKS network, follow the same procedures listed previously for a chiller.

Setting up the CSM's Chiller Data

The CSM requires you to enter certain details of the connected chillers to perform proper chiller sequencing and control. The inputs are located on the *Chiller Setup* screen and described in Table 5.

Table 5. Chiller Setup (Main > Configuration > Chiller Setup)

Name	Description
Type	The Type variables tell the CSM what types of chillers are connected to it. The chiller type can be Centrifugal, Dual Centrifugal, Screw (air-cooled), Screw (water-cooled), Scroll (air-cooled), Scroll (water-cooled), or Frictionless. Default = "N/A."
Number of Compressors	The Number of Compressors variables tells the CSM how many *compressors* exist on a McQuay centrifugal chiller (1 or 2 representing single or dual centrifugal). For McQuay screw or scroll chillers, this variable tells the CSM how many *circuits* exist on the chiller. The CSM calculates chiller availability based on the percentage of compressors (or circuits) on an individual chiller that is available to run. Examples: Centrifugal Chiller = 1, Dual Centrifugal Chiller = 2, Three Circuit Screw = 3. Default = 1
Tonnage	The Tons variables tell the CSM the nominal capacity of the chillers connected to it. The CSM determines when to disable the Next-OFF chiller based on the capacity which would be lost by disabling it and the spare capacity of the remaining enabled chillers.
Flow Rate	The Flow Rate variables tell the CSM the flow rate through the evaporator of each chiller. If the Chiller Sequence Control Type = Decoupled, the CSM determines when to it can disable the Next-OFF chiller by comparing the primary water flow that will be lost to the decoupler line flow rate (from supply to return). If a chiller's evaporator is series-piped with another chiller, this Flow Rate variable must be the same for both chillers.
This Chiller is Series-Piped With Chiller #	This input tells the CSM which (if any) chiller number has it's evaporator piped in series (see Figure 13) with this chiller. If this chiller number is <u>not</u> series-piped with another chiller, leave this value = 0. If this chiller is series-piped, enter the chiller number of the other chiller making up the pair. Special logic will be used when staging series piped chillers. Both chillers forming the series-piped pair must have this variable set. For example, if chiller 1 is series-piped with chiller 5, the "This Chiller Is Series-Piped With Chiller #" variable in Chiller # 1's row must = 5 and the "This Chiller Is Series-Piped With Chiller #" variable in Chiller # 5's row must = 1. Default = 0
Receive Heartbeat	This input defines the length of time (in seconds) the chiller waits without receiving a command from the CSM before determining that communications have been lost. An input of 250 seconds or more is recommended for the Receive Heartbeat if the Comm Loss Control at the Chiller feature will be used. This allows for a minimum of two missed communications between the CSM and chiller. Range = 0 seconds and any number of seconds greater than 200. Default = 0 seconds (Comm loss features disabled)
Comm Loss/Power Up State	This input tells the chiller unit controller's LONWORKS communication module what state to be in if communications is lost with the CSM. If the Receive Heartbeat value = 0 (default) the chiller will ignore the value of this input and continue to run with its last received chiller enable setpoint from the CSM. Range = Disable, Enable. Default = Disable
Comm Loss – Cool Setpoint	This input tells the chiller unit controller's LONWORKS communication module what cooling setpoint to use if communications are lost with the CSM. If the Receive Heartbeat value = 0 (default) the chiller will ignore the value of this input and continue to run with its last received cooling setpoint from the CSM. Default = 44.0°F (6.6°C)
Comm Loss – Defaults	This read-only value of Comm Loss Defaults indicates how the chiller will respond when communications are lost with the CSM. This value should always read "Off". Unreliable Comm Loss Power Up State and Comm Loss Cool Setpoints may result if it does not read "Off"
Run Time Reset	The Run Time Reset variables tell the CSM what the current chiller runtime value is for an existing chiller. The CSM uses chiller runtime when determining which chiller is to be the next chiller it will enable when multiple chillers in a row have the same sequence number.
Solid State Starter	The Solid State Starter variables tell the CSM if the chiller has a solid state starter. If Yes is selected, the solid state starter variables will be displayed on the Misc page. This variable applies only to MicroTech II chillers. Default = No .
Evaporator Flow Sensor	The Evaporator Flow Sensor variables tell the CSM if the chiller has an evaporator flow sensor. If Yes is selected, the evaporator flow rate will be displayed on the Misc page. This variable applies only to MicroTech II chillers. Default = No .
Condenser Flow	The Condenser Flow Sensor variables tell the CSM if the chiller has a condenser flow sensor. If Yes is selected, the condenser flow

Sensor	rate will be displayed on the Misc page. This variable applies only to MicroTech II chillers. Default = No .

Communication Loss Control at the Chiller

If the communication between the chiller and the CSM that is commanding the chiller is lost, the chiller's LONWORKS communication module provides configuration properties which may be used to set the commandable variables to default values. The variables you use to define communication loss and set the default values are Receive Heartbeat, Comm Loss/Power Up State and Comm Loss Cool Setpoint.

Receive Heartbeat

The Receive Heartbeat variables tell the chiller unit controller's LONWORKS communication module how long to wait without receiving a communication from the CSM before determining that communications have been lost. The CSM has a Maximum Send Time of 100 seconds, which means that it will update its commands to each chiller at least once every 100 seconds. The chiller's LONWORKS communication module has a timer, which resets every time it receives an update from the CSM. If this time ever reaches a value greater than the Receive Heartbeat, the LONWORKS communication module determines that network communication has been lost and resorts to its Comm Loss states for Chiller Enable, Cool Setpoint, and Capacity Limit. The values for Chiller Enable and Cool Setpoint are discussed below. The Comm Loss State for Capacity Limit is always 100%.

A value of "0" (default) for Receive Heartbeat means that the Comm Loss features of the chiller's LONWORKS communication module are disabled. This means that the chiller will use the last commands it received from the CSM until communications have been restored and the CSM sends it a different command. For example: if the chiller was enabled when communications was lost, it will stay enabled.

If you will be using the communications loss feature at the chiller, set the Receive Heartbeat value to a number greater than 200 seconds. This will allow multiple communication attempts before the chiller switches to its Comm Loss settings. Since the CSM's maximum commanded property update time is 100 seconds, setting the chiller's Receive Heartbeat to 200 seconds would allow for a minimum of 2 communication tries before communication has been determined to be lost. Normally higher Receive Heartbeat times in the range of 300 seconds are acceptable.

Comm Loss/Power Up State

The Comm Loss/Power Up State variables tell the chiller unit controller's LONWORKS communication module what state to be in if communication is lost with the CSM. See the Receive Heartbeat section above for definition of loss of communications. If this value is set to DISABLE, the chiller will be disabled whenever communication is lost between it and the CSM. If this value is set to ENABLE, the chiller will be enabled whenever communication is lost between it and the CSM.

A sometimes-confusing effect of setting the Comm Loss/Power Up State to Enable is that this feature will put that chiller into the Enabled State whenever the chiller is powered up. As soon as a newly powered chiller unit controller begins communicating with the CSM, the CSM will disable the chiller. This may take up to the 100-second maximum commanded property update time. This power up control is necessary since the chiller cannot prove communications with the CSM until it has power.

If you want to start or stop any chiller that has lost communications, you can enable or disable it locally.

If the Receive Heartbeat value = 0 (default), the chiller will ignore the value of this Comm Loss/Power Up State input and continue to run with its last received chiller enable setpoint from the CSM. This will be the desired configuration on many chiller system applications.

Comm Loss - Cool Setpoint

The Comm Loss - Cool Setpoint variables tell the chiller unit controller's LONWORKS communication module what cooling setpoint to use if communications is lost with the CSM. See the Receive Heartbeat section above for definition of loss of communications.

If the Receive Heartbeat value = 0 (default) the chiller will ignore the value of this Comm Loss Cool Setpoint input and continue to run with its last received cooling setpoint from the CSM.

Example #1: You want a chiller to be enabled with a Cool Setpoint of 50 if communication is ever lost between that chiller and the CSM:

- Set that chiller's Receive Heartbeat to 250 seconds

- Set the Comm Loss/Power Up State to Enable
- Set the Comm Loss Cool Setpoint to 50.

If the chiller's LONWORKS communication module does not receive an updated command on its Chiller Enable input within 250 seconds, it determines that it has lost communication with the CSM. The chiller's LONWORKS communication module will then enable the chiller (if it is not already enabled).

Example #2: You want a chiller to always shut down when the CSM is no longer supervising it:

- Set that chiller's Receive Heartbeat to 250 seconds
- Set the Comm Loss/Power Up State to Disable

Note: For Comm Loss Control at the Chiller to operate properly the Comm Loss Defaults value on the *Chiller Setup* screen must read Off, this value is read-only.

Setting Up the CSM's I/O

The CSM requires you to enter certain details of the connected inputs and outputs to perform proper system control. The variables are located on the *I/O Config* screen and described in Table 6.

Table 6. I/O Config (Main > Configuration > I/O Config)

Name	Description
Return Chilled Water Sensor Present Flag	This input tells the CSM if this optional sensor has been wired to the CSM. When the Flag = No, the sensor cannot change to (or from) alarm. Default = No
Entering Condenser Water Sensor Present Flag	This input tells the CSM if this optional sensor has been wired to the CSM. When the Flag = No, the sensor cannot change to (or from) alarm. Default = No
Leaving Condenser Water Sensor Present Flag	This input tells the CSM if this optional sensor has been wired to the CSM. When the Flag = No, the sensor cannot change to (or from) alarm. Default = No
Decoupler Line Water Sensor Present Flag	This input tells the CSM if this optional sensor has been wired to the CSM. When the Flag = No, the sensor cannot change to (or from) alarm. Default = No
Outdoor Air Temperature Source	This input tells the CSM where the outside air temperature value will be input from. Range = None, Local (onboard I/O), BACnet, Modbus, or Chiller X. Default = None
Supply Chilled Water Sensor Offset Return Chilled Water Sensor Offset Entering Cond Water Sensor Offset Leaving Cond Water Sensor Offset Decoupler Line Water Sensor Offset Local Outdoor Air Temp Sensor Offset	Value added to the internally calculated value for the temperature input before it passes to the application software. Allows for wiring or sensor-to-system compensation. Range = Can be positive or negative as needed. Default = 0
Flow Meter Present Flag	This input tells the CSM if a flow meter has been wired to the CSM. When the Flag = No, the sensor cannot change to (or from) alarm. Default = No
Flow Meter Location	This input tells the CSM where the flow meter (if used) is located in the system. Range = Decoupler Line, Common Supply Line. Default = Decoupler Line
Flow Meter Low Calibration Rate	Use this variable to enter the flow rate when the transducer signal is one of the following: a) 4 mA for 4–20 mA transducers or b) 2 Vdc for 2–10 Vdc transducers. Range = 0 – 5120 gpm (0.0 – 322.5 L/s). Default = 0
Flow Meter High Calibration Rate	Use this variable to enter the flow rate when the transducer signal is one of the following: a) 20 mA for 4–20 mA transducers or b) 10 Vdc for 2–10 Vdc transducers. Default = 1000 gpm (63.0 L/s)
Flow Meter Offset	Value added to the internally calculated value for the flow rate input before it passes to the application software. Allows for wiring or sensor-to-system compensation. Range = Can be positive or negative as needed. Default = 0
Loop Differential Pressure Sensor Present Flag	This input tells the CSM if a differential pressure sensor has been wired to the CSM. When the Flag = No, the sensor cannot change to (or from) alarm. Default = No
Loop DP Sensor Low Calibration Pressure	Use this variable to enter the differential pressure when the transducer signal is one of the following: a) 4 mA for 4–20 mA transducers or b) 2 Vdc for 2–10 Vdc transducers. Range = 0 – 150 psi (0 – 1035 kPa).

	Default = 0
Loop DP Sensor High Calibration Pressure	Use this variable to enter the differential pressure when the transducer signal is one of the following: a) 20 mA for 4–20 mA transducers or b) 10 Vdc for 2–10 Vdc transducers. Range = 0 – 150 psi (0 – 1035 kPa). Default = 30 psi (207 kPa)
Loop DP Sensor Offset	Value added to the internally calculated value for the loop differential pressure input before it passes to the application software. Allows for wiring or sensor-to-system compensation. Range = Can be positive or negative as needed. Default = 0
Spare Sensor Type	This input tells the CSM what the spare sensor input is used for. It also activates the spare sensor alarm, which is required for safe operation of the chiller system, when a spare sensor is used. Range = None, Second Loop Diff Pressure Sensor, Special. Default = None
Spare Sensor Low Calibration Rate	Use this variable to enter the value when the transducer signal is one of the following: a) 4 mA for 4–20 mA transducers or b) 2 Vdc for 2–10 Vdc transducers. Range = no limits. Default = 0
Spare Sensor High Calibration Rate	Use this variable to enter the value when the transducer signal is one of the following: a) 20 mA for 4–20 mA transducers or b) 10 Vdc for 2–10 Vdc transducers. Default = 30
Spare Sensor Offset	Value added to the internally calculated value for spare sensor input before it passes to the application software. Allows for wiring or sensor-to-system compensation. Range = Can be positive or negative as needed. Default = 0
Relative Humidity Source	This input tells the CSM where the relative humidity value will be come from. When the source = None, the sensor cannot change to (or from) alarm. Range = None, Local (onboard I/O), BACnet, Modbus. Default = None
Relative Humidity Offset	Value added to the internally calculated value for the relative humidity input before it passes to the application software. Allows for wiring or sensor-to-system compensation. Range = Can be positive or negative as needed. Default = 0
Pump VFD AO Zero (Remote A-AO1) Pump VFD AO Zero (Remote A-AO2) Pump VFD AO Zero (Remote B-AO1) Pump VFD AO Zero (Remote B-AO2) Pump VFD AO Zero (Remote C-AO1) Pump VFD AO Zero (Remote C-AO2) Loop Bypass Valve AO Zero (Remote D- AO1) Tower Bypass Valve AO Zero (Remote E-AO1) Tower VFD AO Zero (Remote E-AO2) Tower VFD AO Zero (Remote F-AO1) Tower VFD AO Zero (Remote F-AO2) Tower VFD AO Zero (Remote G-AO1) Tower VFD AO Zero (Remote G-AO2) Tower VFD AO Zero (Remote H-AO1) Tower VFD AO Zero (Remote H-AO2)	If the chiller system has cooling load pumps with variable frequency drives (VFD), a cooling tower bypass valve, a cooling tower fans with VFD control, or a cooling load bypass valve, the low value of the device's input signal range must be entered into the CSM. Use these input variables to match the controlled device. Set the variable to "AO 0 to 10Vdc" for an actuator or VFD input range of 0–10 Vdc Set the variable to "AO 2 to 10Vdc" for an actuator or VFD input range of 2–10 Vdc Range = AO 0 to 10Vdc, AO 2 to 10Vdc. Default = AO 0 to 10Vdc
Remote A Analog Input #1 Type Remote A Analog Input #2 Type Remote A Analog Input #3 Type Remote A Analog Input #4 Type Remote B Analog Input #1 Type Remote B Analog Input #2 Type Remote B Analog Input #3 Type Remote B Analog Input #4 Type Remote C Analog Input #1 Type Remote C Analog Input #2 Type Remote C Analog Input #3 Type Remote C Analog Input #4 Type	If the CSM is controlling the cooling tower and the tower fans have VFD control. A VFD speed feedback signal can be displayed at the CSM's user interface. The low value of the device's output signal range must be entered into the CSM. Use these input variables to match the controlled device. Cooling tower VFD feedback signal analog inputs exist on Remotes E, F, G and H Set the variable to "AI 0 to 10Vdc" for a VFD feedback signal of 0–10 Vdc. Set the variable to "AI 2 to 10Vdc" for a VFD feedback signal of 2–10 Vdc or 4 –20 mA (with 500-ohm resistor added across the AI). Range = Slow DI, AI 0 to 10Vdc, AI 2 to 10Vdc, AI NTC 20K. Default = AI 0 to 10Vdc

Remote D Analog Input #1 Type Remote D Analog Input #2 Type Remote D Analog Input #3 Type Remote D Analog Input #4 Type Remote E Analog Input #1 Type Remote E Analog Input #2 Type Remote E Analog Input #3 Type Remote E Analog Input #4 Type Remote F Analog Input #1 Type Remote F Analog Input #2 Type Remote F Analog Input #3 Type Remote F Analog Input #4 Type Remote G Analog Input #1 Type Remote G Analog Input #2 Type Remote G Analog Input #3 Type Remote G Analog Input #4 Type Remote H Analog Input #1 Type Remote H Analog Input #2 Type Remote H Analog Input #3 Type Remote H Analog Input #4 Type	
Units	This property input is used to change between English to SI units within the CSM. You must be logged in as the System Administrator to change this value. When Fahrenheit is selected, the following English units are used; degrees Fahrenheit pounds per square inch, and gallons per minute (US). When Celsius is selected, the following SI units are used; degrees Celsius, kiloPascals, and Liters per second. Each time this variable is changed, the CSM converts all inputs (hard-wired sensors and user-defined variables) from the old set of units to the newly selected units. Range = Celsius, Fahrenheit. Default = Fahrenheit
Service Testing	
Load Pump 1 (Remote A-Relay 1) Load Pump 2 (Remote A-Relay 2) Load Pump 3 (Remote B-Relay 1) Load Pump 4 (Remote B-Relay 2) Load Pump 5 (Remote C-Relay 1) Load Pump 6 (Remote C-Relay 2)	These commandable inputs are used to manually test the chilled water loop pumps. Commanding the output to Pump Manually On will force the digital output to close so that you may verify pump control wiring. When a pump output is set manually, it will be indicated on the display by the value@8 (priority 8 indicates Manual or user interface control). The variables must be commanded to "Auto" after manual service testing is complete so that the CSM application software is allowed to set the output state.
Cooling Tower Outputs 1-16 (Remotes E,F,G,H-Relays 1,2,3,4)	This commandable input can be used to manually test the cooling tower relays. Commanding a certain output to Manual On will force the relay on a Remote I/O module to close so that you may verify fan control wiring. When a tower output is set manually, it will be indicated on the display by the value@8 (priority 8 indicates Manual or User Interface control). This variable must be commanded to "Auto after manual service testing is complete so that the CSM application software is allowed to set the output state.
Load Pump VFD Speed (Remote A, B, and C-AO 1&2) Loop Bypass Valve (Remote A-AO 1) Cooling Tower VFD Speed (Remote E-AO 2, F-AO 1&2, G-AO 1&2, H-AO 1&2) Cooling Tower Bypass Valve (Remote E-AO 1)	These commandable inputs are used to manually test the associated devices controlled by the CSM's analog outputs. Commanding the analog output to a desired percentage will force the analog output to the corresponding voltage so that you may verify control wiring. When an output is set manually, it will be indicated on the display by the value@8 (priority 8 indicates Manual or User Interface control). The variables must be commanded to "Auto" after manual service testing is complete so that the CSM application software is allowed to set the output value.

CAUTION

Any sensor wired to the CSM must have its Flag set to "Yes" so that the alarm functionality of that sensor is enabled. The CSM takes action when its sensor inputs are in alarm condition to maintain proper control of the system. See the Alarm Monitoring and Control section of this document for descriptions of action taken to compensate for alarm conditions.

Flow Meter Input Calibration

If the chiller system has a flow meter, the flow meter must be calibrated. Enter the actual water flow rate that corresponds to an output signal of 4 mA (or 2 Vdc) from the flow meter transducer into the Flow Meter Low Calibration Rate variable. Enter the actual water flow rate that corresponds to an output signal of 20 mA (or 10 Vdc) from the flow meter transducer into the Flow Meter High Calibration Rate variable.

There is also an offset provided which may be used to compensate for wiring or sensor-to-system error.

Loop Differential Pressure Sensor Input Calibration

If the chiller system has a differential pressure sensor installed across the supply and return chilled water lines, the pressure sensor must be calibrated. Enter the actual pressure differential that corresponds to an output signal of 4 mA (or 2 Vdc) from the pressure transducer into the Loop DP Sensor Low Calibration Pressure variable. Enter the actual pressure differential that corresponds to an output signal of 20 mA (or 10 Vdc) from the pressure transducer into the Loop DP Sensor High Calibration Pressure variable.

There is also an offset provided which may be used to compensate for wiring or sensor-to-system error.

Some systems require more than one loop differential pressure sensor to properly control the flow to the cooling loads. If a second sensor is required on your system it may be wired to the spare input (AI-9) and calibrated by entering the low and high transducer signal into the Spare Low Calibration Value and Spare High Calibration Values respectively. Also, set the Spare Sensor Type variable to "Second Loop Diff Pressure Sensor". The CSM will then use the sensor with the largest deviation from setpoint as the control pressure.

Temperature Sensor Calibration

There is also an offset provided which may be used to compensate for wiring or sensor-to-system error.

Service Testing

The service testing inputs allow a technician to test the CSM's analog and digital outputs, the field wiring to them, and the auxiliary equipment they control. For example, if the Analog Output for Cooling Tower Bypass Valve is set to "100%," the cooling tower bypass valve should fully open to the tower.

Always remember to command the Service Testing outputs to **Auto** after you are finished so that the CSM application can control the outputs value.

CAUTION

It is important to set the CSM's Control Mode (*System Control* screen) to **Manual Unoccupied** to turn the chiller system off before changing any of the service testing values. Damage to the chiller system components may occur if these devices are overridden while the system is operating.

Chiller Unit Controller Settings

When a chiller is to be controlled by the CSM, the chiller unit controller must be configured to allow LONWORKS network commands. Some of the features that exist on the chiller unit controller for stand-alone operation must also be disabled so that they do not interfere with the CSM's control features. For information on making changes to the MicroTech II chiller unit controllers, refer to the proper chiller Operation Manual (see the Reference Documents section of this document).

The following unit setup variables must be set in all chiller unit controllers associated with a CSM. These variables, which are summarized in Table 7, must be set to the values shown in italic. You can find them at the chiller controller's keypad/display.

Table 7. Chiller Unit Controller Setup Variables

Chiller Controller Variable	Value	Description
Protocol	*Lon*	The CSM communicates with MTII chillers through the chiller's LONWORKS communication module
Source	*Network*	The chiller must allow the LONWORKS network control
Mode	*Cool (not Ice or Cool/Ice)*	The CSM does not support the Heat, Ice or Cool/Ice modes
Start Delta	*1°F (0.6°C)*	Reduce the temp difference required for starting in this multiple chiller system
Max Pull Down	*2°F (1.1°C)*	
Soft Load	*Off*	Soft Load control is supplied through the CSM
Evap Pump Recirculate Timer (MTII Centrifugal Chillers)	*0.5 min (this is the default)*	A compressor must transition from Off to Starting within 3 minutes after being enabled or the CSM will consider it off-line

CAUTION

During the network commissioning process, set the chiller unit controller's SOURCE variable to "Switches" to disable the chiller. *If the network is being commissioned before a particular chiller has been commissioned, that chiller's SOURCE must be set to "Switches" to prevent it from starting.*

Configuring the Chiller System Manager

This section describes how the various CSM control processes can be configured to manage chiller system operation. Each sub-section describes one of the screens under the Configuration tab on the CSM's user interface. The adjustable variables that affect these control processes are tabled near the beginning of each applicable sub-section. Greater detail is provided below the tables for some of the more complicated control processes. Before changing any control variables, you should read and understand the applicable text.

System Control

Configuration variables that control the operation of the entire CSM are listed on the *System Control* screen. The *System Control* screen can be seen in Figure 6. To view the current status of the system, go to the *System Status* screen of the user interface. To configure the system, go to the *System Control* screen to change the values described in Table 8.

Table 8. System Control (Main > Configuration > System Control)

Name	Description
CSM Control Mode	This is the manual command input with the highest priority when scheduling the CSM. To allow other methods to schedule the CSM, this value must be commanded to Automatic. Range = Manually Occupied, Manually Unoccupied, Automatic. Default = Manually Unoccupied
CSM In Alarm	Display of the highest priority CSM Alarm that is currently active. For a list of CSM alarms and the effect they have on the system see the Alarm Monitoring and Control section of this document. Note that chiller alarms are available on the *Chiller Status* screen and logged on the *Misc* screen.
Clear CSM Alarm	Press this button to clear current CSM Alarms. The highest priority CSM Alarm is displayed on the *System Status* screen (alarms can also be cleared from the *System Status* screen). If the condition that caused the alarm has been resolved the CSM alarm (displayed above) will be cleared.
Rapid Restart Time	This input defines the time period that must expire after CSM shutdown before rapid restart will no longer be in effect. Range = 0 to 60 hours. Default = 00:00:00 (rapid restart disabled)
Low Ambient Lockout Flag	Turns Low Ambient Lockout On or Off. Range = On, Off, Auto. Default = Off
Low Ambient Lockout Setpoint	This input sets the low outside-air-temperature limit below which all mechanical cooling will be disabled. Range = 15 – 99.5°F (-9.5 – 37.5°C). Default = 50°F (10°C)

CSM Control Mode

This is the manual input for CSM occupancy control. This manual command input has the highest priority when scheduling the CSM. While configuring the CSM this value should be commanded to Manual Unoccupied so that chillers will not be enabled while configuration is in process. This input must be commanded to Automatic for any of the scheduling methods to command the CSM to Occupied.

Manual Unoccupied (OFF)

A Manual Unoccupied command places the CSM into the Off: Manual state. After the Manual Unoccupied command is issued, this variable reads Unoccupied @ 8, where priority "8" indicates a manual input from the user interface. As a result, the CSM disables all of its associated chillers that are controlled by the CSM, placing them into the Off: CSM chiller state. Auxiliary equipment such as cooling load pumps and cooling tower fans also shut down.

⚠ WARNING

Electric shock and moving machinery hazard. Can cause severe personal injury or death.

When the CSM or a chiller controller is in the Off state, power is not removed from the chiller controller or components. Lock and tag out all power sources before servicing line voltage equipment on a chiller.

Automatic

To allow other methods to schedule the CSM, this variable must be commanded to Automatic. After the Automatic command is issued, this variable will read Occupied or Unoccupied @ various priority (see Scheduling on page 80 for each scheduling method's priority). This means that the CSM's occupancy is now determined according to its internal scheduling, timed override, external time clock, network scheduling, or optimal start features.

Manual Occupied (ON)

A Manual Occupied command places the CSM into the On: Manual state. After the Manual Occupied command is issued, this variable reads Occupied @ 8, where priority "8" indicates a manual input from the user interface. When the CSM is in the On: Manual state, it acts as though it were in the Automatic mode with a permanently occupied schedule. This means that the CSM enables and disables chillers according to its low ambient lockout and sequencing control features and also controls auxiliary equipment such as cooling load pumps and cooling tower fans.

Rapid Restart

The rapid restart feature allows you to specify how the CSM will perform after a temporary loss of power.

Power-Loss Period Is Shorter than Rapid Restart Time

If the power-loss period is less than the Rapid Restart Time setting, the CSM returns to normal operation without changing the current chiller stage. Any chillers that are enabled when the CSM comes back on-line continue to be enabled.

Power-Loss Period Is Longer than Rapid Restart Time

If the power-loss period is greater than the Rapid Restart Time setting, the CSM acts as though it has just entered the Occupied mode when its power is restored:

- Any operational chillers are DISABLED by the CSM when communication is re-established.
- The CSM's chiller stage-up sequencing starts from the beginning.

If the Rapid Restart Time is set to 00:00:00 (zero seconds), the function is disabled which means it reacts as described for "Power-Loss Period Is Longer than Rapid Restart Time".

Note: The CSM has a battery backup that keeps the controller functioning normally for a time after power is lost while a software backup takes place. Until the backup is completed, the CSM continues to operate the chiller system normally on battery power. The Rapid Restart feature does not function unless the backup has been completed and the CSM shuts down. **The CSM will not detect power failures of less than two seconds**. Power failures of over two seconds are detected by the CSM and result in the CSM performing a power-down sequence and then a rapid restart when power returns.

If the CSM loses power and shuts down, but the chillers remain on, the chillers operate on the last commands received from the CSM unless the chiller's Comm Loss configuration variables have been set. Configuration variables allow the operator to define the Chiller's operating state (Chiller Enable, Cooling Setpoint) if communication is lost. See "Setting up the CSM's Chiller Data" for information on setting the Comm Loss configuration variables. For more on what happens when the CSM loses communications with its chillers, see the "Alarm Monitoring and Control" section of this manual.

Low Ambient Lockout

The CSM's low ambient lockout feature can disable the entire chiller system whenever the outdoor air temperature is less than the Low Ambient Lockout Setpoint. If this occurs, the operating state changes to Off: Ambient. As a result, the CSM disables all of its associated chillers and shuts down all auxiliary system equipment. This occurs regardless of the CSM Control Mode setting.

When the outdoor air temperature rises to equal the Low Ambient Lockout Setpoint plus its differential, which is fixed at 2°F (1.1°C), the CSM enables normal chiller system operation again.

For the low ambient lockout feature to function, the Outdoor Air Temperature Source variable (*I/O Config* screen) must be set to provide a valid OAT input and this input must not be in an alarm condition.

Note: If communications are lost with a BAS that is supplying the outdoor air temperature to the CSM, it retains and uses the last temperature it received until communications are restored.

Chiller Sequencing Control

As the cooling load varies, the CSM enables and disables chillers so that the current cooling capacity is matched to the current cooling load. This action is commonly called chiller *sequencing*. The two fundamental elements of any sequencing control strategy are the *sequence order*, the order in which chillers are enabled and disabled, and the *sequencing logic*, the rules by which chillers are enabled and disabled to match the cooling capacity to the load.

To view the current status of chiller sequencing, go to the *System Status* screen. To configure chiller sequencing, go to the *Chiller Seq* screen to change the values described in Table 9 and Table 10.

Sequencing and Staging

In the CSM, a *chiller stage* is defined as a set of chillers. As the CSM sequences chillers on and off, it "stages up" and "stages down." If the sequence order is set properly, each successive stage has more capacity than the preceding stage. Additional capacity could be in the form of one added chiller (typical), or a chiller swap (in which the replacement chiller has more capacity than the one that is stopped). Thus the words "sequencing" and "staging" essentially mean the same thing.

Sequence Order

Figure 10. Chiller Sequence Order Table (Main > Configuration > Chiller Seq)

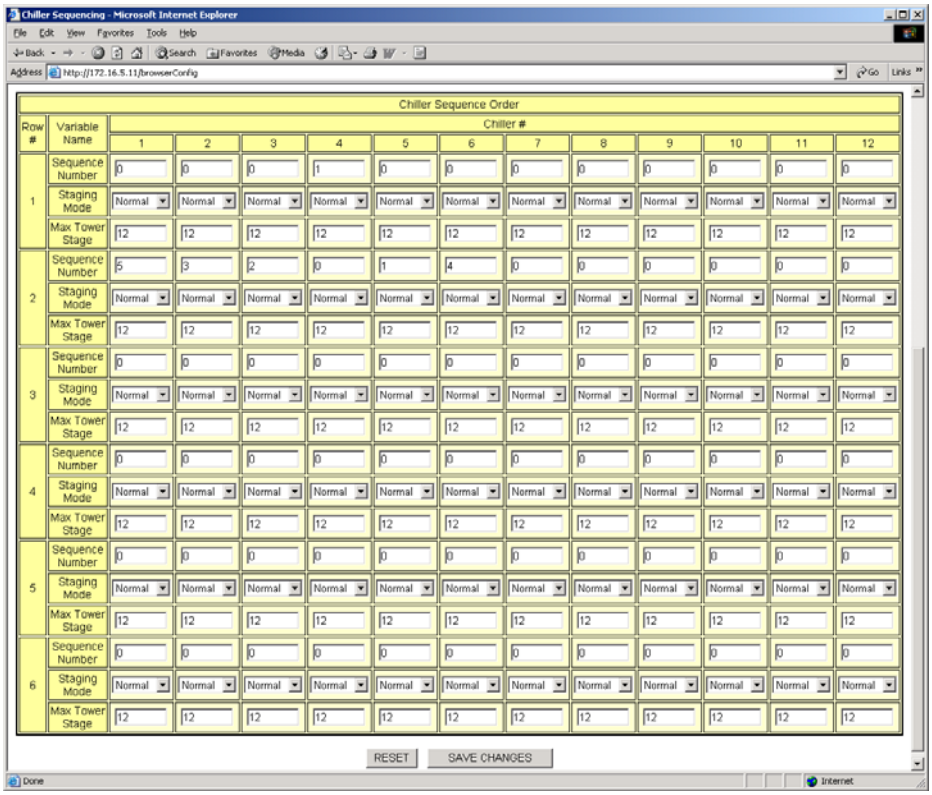


Table 9. Chiller Seq - Chiller Sequencing Order (Main > Configuration > Chiller Seq)

Name	Description
Sequence Number	This input sets the order of chiller staging within a row. All chillers with the *same* Sequence Number form a group of chillers from which the CSM automatically sequences based on run time. If all chillers have *unique* Sequence Numbers a fixed sequencing order results. A chiller with Sequence Number = 0 is considered not in the row and will remain disabled. Chiller sequence numbering starts over at 1 each time you switch to a higher row. Range = 0 – Number Of Chillers. Default = 0 (for all chillers in all rows)
Staging Mode	This input assigns the chiller to be sequenced normally or as a standby chiller. Each standby chiller must have a Sequence Number greater than or equal to all non-standby chillers for which it is in standby. If a chiller is designated as Standby, the CSM

	does not allow it to operate unless at least one other chiller is off-line. Range = Normal, Standby. Default = Normal (for all chillers in all rows)
Max Tower Stage	This input is used to restrict cooling tower staging. The CSM restricts the tower staging to the Max Tower Stage value of the highest sequence running chiller. Within a row, each chiller with the same Sequence Number must have the same Max Tower Stage value. For more information see "Linking Tower Capacity to Chiller Capacity". Range = 1-12. Default = 12 (for all chillers in all rows)

Understanding the Sequence Order Table

Figure 10 is an example of a sequence order table for a typical chiller system. Each column represents a chiller and each row represents a different set of rules. Most sequences will be possible by using only one row in the table. Multiple rows will allow special cases such as chiller DISABLE on stage-up, or chiller ENABLE on stage-down. The operator uses the Sequence Number and the placement of a chiller in a row to assign the chiller sequence order. Any chillers in row-1 with Sequence Number=1 are lead; any chillers in row-1 with Sequence Number=2 are next in the sequence order, etc. If there are no chillers in row-1 with Sequence Number 2, then the chillers in row-2 with the lowest Sequence Number will be next in the sequence order, etc. The operator can set the chiller sequence order to work automatically or fixed by how he or she assigns the Sequence Number variable to each chiller in the sequence order table.

Consider the Chiller Sequence Order Table shown in Figure 10. Notice that this system has six chillers and two rows. Assume that Chiller #4 is much smaller than the other chillers. By comparing rows, the operator can see that this system's sequence order, which occurs as the CSM stages-up, is as follows:

1. Chiller #4
2. Chiller #5 *(Chiller #4 also goes off because it has a sequence # = 0 in row # 2)*
3. Chiller #3
4. Chiller #2
5. Chiller #6
6. Chiller #1

Chiller #4, which has much less capacity than any other chiller, is used only when the cooling load is extremely light. This is an example of a Fixed Sequence Order.

The result of setting up the Chiller Sequence Order Table is that the CSM determines the Next-ON and Next-OFF chillers. The Next-ON chiller will be enabled when system conditions call for more capacity. The Next-OFF chiller will be disabled when system conditions allow for a reduction in capacity. The system conditions required for enabling or disabling chillers is discussed in the Sequencing Logic section.

You can set the chiller sequence order manually or let the CSM set the order automatically. You select the method by the way you assign Sequence Numbers within a row. There are two options: fixed and automatic. A combination of these two methods can also be used within a row.

Fixed Sequence Order With-in a Row

With fixed sequence order option, you manually enter the sequence order into the Chiller Sequence Order Table. Start by assigning Sequence Number 1 to the chiller you want to be enabled first. Assign the chiller you want to be enabled second Sequence Number 2. Continue entering higher Sequence Numbers to chillers until all chillers you want to enable have a number. With fixed sequence order each chiller in a row will have a unique Sequence Number.

Automatic Sequence Order With-in a Row

With automatic sequence order, the CSM choose the NEXT_ON chiller based on each chiller's run time. Chillers that have less run time are enabled before chillers that have more run time. To use automatic sequence orders, place all the chillers you want to enable based on runtime in the same row, and assign them the same Sequence Number. Using Figure 10 for an example, if chillers 2, 3, 5, and 6 all had Sequence Number = 1. The CSM would sequence these 4 chillers based on run time.

Run time is totaled within the CSM whenever a chiller is running (meaning that at least one compressor is on). At the user interface, you can find each chiller's run time on the *Chiller Status* screen. A chiller's run time value can be reset from the user interface on the *Chiller Setup* screen.

Designating a First-On Chiller When Using Automatic Sequencing

You can designate one chiller that is always lead regardless of its run time. The first-on chiller is placed in Row 1 and assigned Sequence Number 1. All additional chillers can also be placed in Row 1 and all given Sequence Number 2. These additional chillers will be enabled based on lowest run time. For this setup the first-on chiller will stay on at stage 2 and higher.

You can also specify that the first-on chiller goes off at stage 2 and higher. This is accomplished by putting the first-on chiller as the only chiller in Row 1 and assigning it Sequence Number 1. All additional chillers are placed in Row 2 and all given Sequence Number 1. Leave the Sequence Number of the first-on chiller in Row 2 at "0". When the CSM stages up to Row 2 and sees that the Sequence Number of a running chiller equals "0", it will disable the first-on chiller.

Designating a Last-On Chiller When Using Automatic Sequencing

You can designate one chiller that always must lag regardless of its run time. The last-on chiller is always given the highest Sequence Number in the highest Row. If a stage-down occurs while the CSM is at the highest stage, the last-on chiller is always the first chiller to be turned off.

Assigning Chillers to Rows

Chiller sequence numbering starts over from 1 in each row. For any unused row, leave all the sequence numbers at zero.

As previously stated, most sequencing applications can be performed using only one row. If multiple rows are used, **each higher row must contain more chiller capacity (tons) than the previous row.** The CSM moves to a higher row when:

- all the available chillers in the current row are enabled
- all the enabled chillers in the current row are at full load
- the current row capacity is less than the maximum row capacity of a higher row
- the chiller stage delay time is exceeded
- the chilled water supply temp minus the system setpoint is greater than the chiller stage-up differential

The CSM calculates maximum row capacity by multiplying the Chiller Availability (*Misc* screen) by the chiller's Tonnage (*Chiller Setup* screen) of every chiller assigned to a row and adding all these values together. Max Row Capacities are displayed on the *System Status* screen.

Be aware that when the CSM moves from a higher row to a lower row, all available chillers in the new lower row will immediately be enabled. This is because the lower row has less capacity than the higher row and all the available capacity of the lower row will be required for a smooth stage-down transition. Enabling multiple chillers simultaneously is normally not recommended based on building power concerns. If you are assigning chillers to multiple rows, it is good practice to only have one chiller in a lower row that does not exist (Sequence Number = 0) in the next higher row.

Sequencing Logic

The CSM's chiller sequencing logic determines when chillers must be enabled or disabled to increase or decrease capacity. The term "stage-up" means to increase capacity by enabling one chiller, and the term "stage-down" means to decrease capacity by disabling one chiller. Do not confuse *compressor* staging with *chiller* staging, the chiller unit controller handles all compressor staging.

Two types of sequencing logic are available: Standard and Decoupled. You can select the type suitable for your system with the Chiller Sequencing Control Type variable.

Table 10. Chiller Seq - Chiller Sequencing Logic (Main > Configuration > Chiller Seq)

Name	Description
Chiller Sequencing Control Type	This input controls whether the CSM sequences chillers with Standard (primary-only) or Decoupled (decoupler line exists creating a primary-secondary system) logic. Range = Standard, Decoupled. Default = Standard
Inhibit Stage-Up After Time	This input sets the time of day after which no additional chillers will be enabled. Range = any time of day. Default = 11:59 PM
BAS Stage-Up Inhibit Override	BAS Stage-Up Inhibit is input from a BAS to the CSM. This input can be used to override the BAS Stage-Up Inhibit function. For example, if a BAS sets the CSM to inhibit chillers from staging up and then loses communications, this variable can be used to set the BAS Stage-Up to NORMAL to override the BAS. After overriding, it must be set back to AUTO (which shows "Normal @ def") for the BAS to again inhibit stage-ups. Range = Normal, Inhibit Stage-Up. Default = Normal
Chiller Stage-	This value sets the chilled water supply temperature error required for the CSM to stage-up. If the Chilled Water Supply Temp –

Up Differential	System Setpoint > Chiller Stage-Up Differential, the Next-ON chiller may be enabled. Range = 0 – 9.5°F (0 – 5.2°C). Default = +1.0°F (+0.5°C)
Spare Capacity Factor	This input sets the spare capacity multiplier required for the CSM to stage-down, which is used to reduce short cycling. If the Active Capacity for the Next-OFF chiller < Spare Capacity Factor * (Sum of the Spare Capacity of all other running chillers), the Next-OFF chiller may be disabled. Lowering this value reduces the possibility of short cycling and increases the possibility of having more chillers running than is required to meet the load. Range = 0.50-0.95. Default = 0.90
Chiller Stage Delay Time	This input sets the time that must expire after one stage-up/down event occurs before the next stage-up/down may occur. Range = 3 to 60 minutes. Default = 5 minutes
Decoupler Stage-Up Temperature Differential	This value sets the decoupler line water temperature error required for the CSM to stage-up due to lack of primary chilled water flow. If the Chiller Sequence Control Type = "Decoupled" and the Decoupler Temp > (Chilled Water Supply Temp + Decoupler Stage-Up Temperature Difference, the Next-ON chiller may be enabled. Range = 0.0 – 9.5°F (0.0 – 5.2°C). Default = +2.0°F (+1.1°C)
Decoupler Stage-Down Flow Rate Factor	This input sets the spare primary flow multiplier required for the CSM to stage-down. If the Chiller Sequencing Control Type = "Decoupled" and the Decoupler Line Flow Rate > (Decoupler Stage-Down Flow Rate Factor * (the Next-OFF Chiller's Flow Rate through its evaporator)), the Next-OFF chiller may be disabled. Raising this value reduces the possibility of short cycling and increases the possibility of having more chillers running than is required to meet the load. Range = 0.75 – 1.50. Default = 1.10
Wait For Evaporator Flow Timer	This input tells the CSM how long to wait after a chiller has been enabled for flow to be proven by that chiller's evaporator flow switch. Also, the CSM waits for this timer to expire before checking for Off-Line chillers, this allows for the starting delays of certain chillers (e.g. centrifugal) to exist without being recognized by the CSM as an Off-Line chiller at startup. Range = 160 seconds – Chiller Stage Delay Time. Wait For Evaporator Timer Default = 2 minutes 55 seconds.
Max Chiller Stop-To-Start Cycle Timer	This input tells the CSM the longest Stop-To-Start Cycle Timer Setpoint in any of the controlled chillers. After a chiller shuts down normally it is unavailable to run until its Stop-To-Start Cycle Timer expires. The CSM will not enable a standby chiller if a normal chiller is unavailable due to its cycle timer. If something happens to the chiller while the cycle timer is active to make it unavailable after the cycle timer expires, this variable will detect that condition and allow a standby chiller to be enabled. Range = 3 – 40 minutes. Default = 20 minutes.

Start-Up Control

When the chiller system starts, the CSM's operating state changes from Off to Recirculate. If there is a cooling load pump, the CSM proves that chilled water flow in the cooling load loop exists before leaving Recirculate and going to the On State.

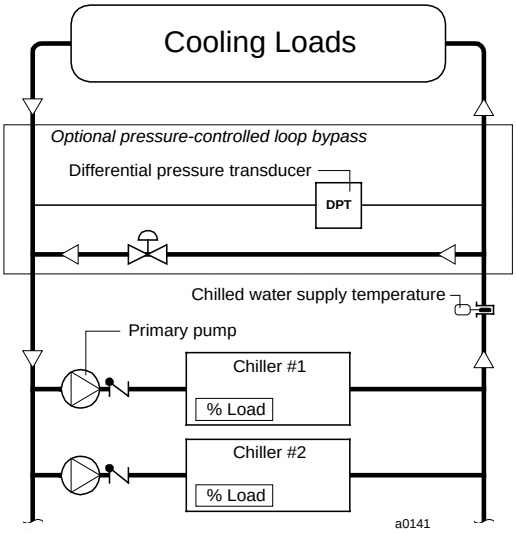
Upon entering the On State, the CSM enables the first chiller. Once the first chiller is enabled, its controller starts the primary chilled water pump, checks for evaporator water flow, and checks for a cooling load. The chiller starts if there is flow and the leaving evaporator water temperature is greater than the Active Setpoint by more than the chiller's Start Delta variable.

After the first chiller starts, its controller increases cooling capacity as required, but only within the constraints of an active Max Pull Down rate control (chiller unit controller function) and soft loading control (CSM function). Any active max pull down rate or soft loading control can limit the chiller's capacity and thus may delay chiller staging.

Standard Sequencing Logic

Standard sequencing logic is intended for constant flow primary-only chiller systems. A typical primary-only system is shown in Figure 11. The distinguishing characteristic is that the primary pumps distribute water to the cooling loads. The primary pump and evaporator piping arrangements are *not* distinguishing characteristics. Dedicated primary pumps and parallel evaporators are shown in Figure 11, but common primary pump and series evaporators are also possible.

Figure 11. Typical Primary-Only System



Standard sequencing logic uses each chiller's load and the chilled water supply temperature to stage the chillers. The values of the sequencing variables discussed below can be viewed on the *System Status* screen.

Stage-Up Control: The CSM stages-up when additional cooling capacity is required. This occurs when the following three conditions are satisfied:

1. All running chillers are at full load (Chiller's at Full Load status may be viewed on the *System Status* screen).
2. The chilled water supply temperature is greater than the System Setpoint by more than the Chiller Stage-Up Differential.

Conditions 1 and 2 above have been true for a period of time specified by the Chiller Stage Delay Time variable. (Stage delay timer does not start until a chiller is available to start)

Stage-Down Control: The CSM stages down when there is an excess of cooling capacity. This occurs when the following conditions are satisfied:

1. The Active Capacity of the Next-OFF chiller is less than the Spare Capacity Factor multiplied by the Sum of All Spare Capacity of All Other Running Chillers.
2. Condition 1 above has been true for a period of time specified by the Chiller Stage Delay Time variable.

► **To set up Standard sequencing logic**

1. Set the Chiller Sequencing Control Type variable to "Standard."
2. Set the Chiller Stage-Up Differential as required.
3. Set the Spare Capacity Factor variable as required.
4. Set the Chiller Stage Delay Time variable as required.

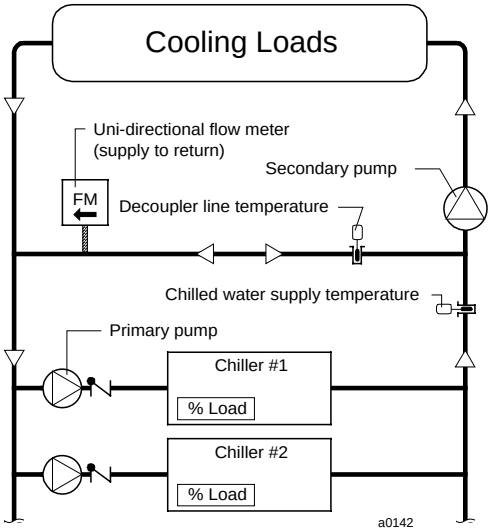
Note: To use Standard sequencing logic, a chilled water supply temperature sensor must be connected to the CSM. For more information, see the "Field Wiring" section of IM 781.

Decoupled Sequencing Logic

Decoupled sequencing logic is intended for use with primary-secondary chiller systems. The Chiller Sequencing Control Type is used to differentiate between primary-only and primary-secondary. A typical primary-secondary system is shown in Figure 12. The distinguishing characteristics of this system are: (1) each chiller (or set of series chillers) has its own primary pump, (2) one or more secondary pumps distribute water to the cooling loads, and (3) the secondary circuit is hydraulically isolated from the primary circuit by a decoupler line. Evaporator piping arrangements are *not* distinguishing characteristics. Parallel evaporators are shown in Figure 12, but series evaporators are also possible.

The purpose of primary-secondary (Decoupled) systems is to maintain relatively constant flow through the chillers while at the same time allowing variable flow to the cooling loads. Because the relationship between a building's total cooling load and its required chilled water flow rate is seldom proportional, situations can occur in which partly loaded chillers cannot provide enough chilled water to the secondary loop. In this instance, water flows from return to supply in the decoupler line. As a result, supply and return water mix, and the chilled water temperature going to the cooling loads rises. The CSM's Decoupled sequencing logic can prevent this from happening.

Figure 12. Typical Primary-Secondary System



Decoupled sequencing logic uses each chiller's load, the chilled water supply temperature, the decoupler line temperature, and the flow rate in the decoupler line (supply to return only) to stage the chillers. A stage-up can occur for either of two reasons: (1) to satisfy the need for additional capacity, *or* (2) to satisfy the need for additional flow. The values of the sequencing variables discussed below can be viewed on the *System Status* screen.

Stage-Up-for-Capacity Control: The CSM stages-up when additional cooling capacity is required. This occurs when the following three conditions are satisfied:

1. All running chillers are at full load (Chiller's at Full Load status may be viewed on the *System Status* screen).
2. The chilled water supply temperature is greater than the System Setpoint by more than the Chiller Stage-Up Differential.
3. Conditions 1 and 2 above have been true for a period of time specified by the Chiller Stage Delay Time variable.

Stage-Up-for-Flow Control: The CSM stages-up when additional primary water flow is required. This occurs when the following two conditions are satisfied:

1. The Decoupler Line Temperature is greater than the Chilled Water Supply Temperature by more than the Decoupler Stage-Up Temperature Differential. (Water is flowing the wrong way through the decoupler line.)
2. Condition 1 above has been true for a period of time specified by the Chiller Stage Delay Time variable.

Stage-Down Control: The CSM stages-down when there is an excess of cooling capacity *and* primary chilled water flow. This occurs when the following conditions are satisfied:

1. The Active Capacity of the Next-OFF chiller is less than the Spare Capacity Factor multiplied by the Sum of All Spare Capacity of All Other Running Chillers.
2. The Decoupler Line Flow Rate is greater than an adjustable percentage of the defined flow rate of the Next-OFF chiller. The chiller flow rates are defined with the Chiller # Flow Rate variables (see *Chiller Setup* screen), and the percentage is defined with the Decoupler Stage-Down Flow Rate Factor.
3. Conditions 1 and 2 above have been true for a period of time specified by the Chiller Stage Delay Time variable.

Condition 2 assures that the chillers that would still be on after a stage-down continue to meet the building's flow requirement. As an example, consider a system in which Chiller #3 is the only chiller that is part of stage 2 and not part of stage 1. Assume that Chiller #3's defined flow rate is 1000 gpm (63.1 L/s) and that the Decoupler Stage-Down Flow Rate Factor is set to 1.10. If the CSM is at stage 2 and the decoupler line flow rate is slightly more than 1100 gpm (69.4 L/s), condition 3 is satisfied. If the stage-down occurs, the flow rate from supply to return in the decoupler line drops from 1100 gpm (69.4 L/s) to 100 gpm (6.3 L/s).

Decoupler Line Flow Rate

The flow meter is used to make sure that the primary water flow through the decoupler line is greater that the primary water flow that will be lost when the Next-OFF chiller is disabled. When the secondary loop's demand for flow exceeds the primary loop flow, the decoupler line temperature sensor will detect flow going backwards through the decoupler line and the CSM will enable another chiller to increase the primary water flow. If the capacity of this newly enabled chiller is not required, the CSM would quickly want to disable this chiller, which turns off the evaporator pump. By knowing the decoupler line flow rate, the CSM will keep the chiller running (so that its evaporator pumps will continue to run) until the secondary loop demand for flow decreases.

Flow Meter in the Decoupler Line

The simplest way to measure the decoupler flow rate is to place a flow meter directly in the decoupler pipe as shown in Figure 12. The CSM reads the decoupler line flow directly and uses it to stage-down. When using this method, set the Flow Meter Location (*I/O Config* screen) to "Decoupler Line".

Flow Meter in the Common Supply Line

Another method of determining the flow rate in the decoupler line is to place a flow meter in the common supply line. The CSM then calculates the decoupler flow rate by subtracting the primary water flow rate from the measured common supply line flow rate (knowing that the difference of these two values must be going through the decoupler). This method is more complicated because the CSM must determine the total primary water flow rate by adding the Chiller # Flow Rate variables (*Chiller Setup* screen) of all chillers with an active flow switch. This requires that the flow through the evaporator of each chiller was set and balanced by an experienced contractor to provide accurate primary flow rate calculation. When using this method, set the Flow Meter Location (*I/O Config* screen) to "Common Supply Line".

► **To set up Decoupled Sequencing Logic**

1. Set the Chiller Sequencing Control Type variable to "Decoupled."
2. Set the following variables as required:
   - Chiller Stage-Up Differential
   - Spare Capacity Factor
   - Chiller Stage Delay Time
3. Set the Decoupler Stage-Up Temperature Differential variable as required.
4. Set the Decoupler Stage-Down Flow Rate Factor variable as required.
5. Set the Flow Meter Location variable (*I/O Config* screen) to indicate the position of the flow meter in the system.
6. Set the Chiller # Flow Rate variables (1 through *x*, where *x* is the number of chillers) as required.

Note: To use Decoupled sequencing logic, a chilled water supply temperature sensor, a decoupler line temperature sensor and a flow meter must be connected to the CSM. For more information, see the "Field Wiring" section of IM 781.

Special Sequencing Logic

The CSM uses special sequencing logic to compensate for an *off-line chiller*. An off-line chiller is defined as a chiller that is part of the current stage, and meets one of the following conditions:

1. The chiller was unavailable at the time the CSM's sequencing logic would have normally enable it
2. The chiller was enabled by the CSM but did not enter the running mode
3. The chiller was enabled by the CSM and then put into Local control (the Control Source on the chiller's unit controller was changed from BAS network)
4. The chiller was enabled by the CSM and then lost communications with the CSM

Chillers That Go Off-line Without Being Enabled

In condition 1 the term *unavailable* means that the CSM cannot start the chiller. If a chiller is unavailable when it would normally be enabled by the CSM, this chiller is skipped and the next available chiller with an equal or higher sequence number will be enabled. This chiller goes off-line when it is skipped. The Chiller Off-line alarm will occur without the chiller ever being enabled.

Enabled Chillers that Go Off-line and Forced Stage-Ups

Conditions 2 through 4 deal with a chiller that has been enabled by the CSM and then goes off-line. An enabled chiller that goes off-line will be compensated for to help maintain system capacity. In this case the CSM will immediately enable the next available chiller. This is called a forced stage-up. Forced stage-ups will occur even if some form of Stage-Up Inhibiting is active. The CSM will also disabled the newly off-line chiller. The Chiller Off-line alarm will occur when the chiller is disabled.

Note: In the case of a running chiller that loses communications a forced stage-up could result in an excess of capacity because the chiller may remain running.

Unavailable and Available Chillers

A chiller is unavailable when the CSM cannot influence its start/stop operation. This can occur for either of two reasons:

1. All compressors (or circuits) on a chiller are unable to run. MicroTech II chiller compressor controllers send the CSM an indicator; AVAILABLE (1) if the CSM can influence it's stop/start operation. The indicator is cleared (0) when the following conditions exist:

   IF Compressor is OFF because of an alarm
   OR
   If Compressor is OFF due to the Pump Down Switch
   OR
   The Unit is OFF because of a Unit alarm
   OR
   The Unit has been disabled at the keypad display
   OR
   The Remote Switch has disabled the Unit
   OR
   The Control Source does not = BAS Network
   OR
   The front panel switch has disabled the Unit
   OR
   The compressor switch has disabled the Compressor
   OR
   An air-cooled unit is below it's outside air temperature setpoint and all compressors are off
   OR
   The Compressor is in the Waiting Low Sump Temperature State
   OR
   The Compressor is in the Anti-recycle State (start-start, stop-start, etc.)
   OR
   The Unit has low source water temperature on a Templifier.

   For example, if a chiller has a Fault alarm, the alarm must be cleared; if a chiller's remote stop switch input is opened, the input must be closed again; if a chiller is set for a local source to enable it, it must be returned to network control.
2. The chiller has lost communications with the CSM.

Conversely, a chiller is *available* when none of the above conditions apply to it.

Chiller Availability can be viewed on the *Misc* screen of the user interface. A value of "0" means the chiller is Unavailable, "1" means the chiller is fully Available, "0.5" means 50% of the chillers compressors (or circuits) are available, etc. Each compressor (or circuit) sends its availability signal to the CSM. If the value for a chiller's availability seems high, check that the chillers Number of Compressors value has been set properly on the *Chiller Setup* screen.

Designating a Standby Chiller

Regardless of whether you're using Automatic or Fixed sequence ordering, you can designate a chiller as a standby chiller with the Staging Mode variable. **Each standby chiller must have a Sequence Number greater than or equal to all non-standby chillers for which it is in standby.**

If you designate a standby chiller, the CSM does not allow it to operate unless at least one other chiller is off-line. It does this by checking for an Unavailable Chiller with a Sequence Number lower (or equal) than the Sequence Number of the standby chiller. Before enabling a standby chiller the CSM also checks to make sure that the Unavailable Chiller was not recently disabled and unavailable due to internal cycle timers. If the chiller was disabled normally, the CSM will wait for the cycle timers to clear on the recently disabled chiller and enable it again (standby chiller stays disabled).

CAUTION
An off-line chiller may be operational if it becomes unavailable as a result of (1) losing communications with the CSM or (2) being locally enabled. In these instances, the standby chiller could start, *making possible a situation in which all chillers are running at the same time*. Also, if the off-line chiller that made it possible for the Standby chiller to be enabled comes back on-line, it will be enabled normally if conditions require further cooling capacity.

The Standby chiller will always be the Next-OFF chiller. This means that at any time after the Standby chiller is enabled, as soon as conditions exist that will allow a stage-down, the Standby chiller will always be the first to be disabled.

NOTE: It may be necessary that a standby chiller absolutely not run when all other chillers are running due to maximum flow capacity in the system piping or another reason. For standby centrifugal chillers only, configure the standby centrifugal chiller to be in row 2 with all other chillers except one. The capacity of row 2 will need to be designated to be **less than** the capacity of row 1. Contact the McQuay Controls Support Group at 866-4MCQUAY(866-462-7829) for comprehensive setup assistance for determining the designated capacity of row 2.

► **To designate a standby chiller**

- Set the Staging Mode of the standby chiller to "Standby".
- Set the Sequence Number of the Standby chiller greater than or equal to the Sequence Number of all chillers you want it to be standby to.

Sequencing Chillers with Series-Piped Evaporators

Chiller systems with chillers piped in a Series/Parallel Configuration require slightly different staging logic. There are situations when both series-piped chillers must be enabled together on a stage-up, and disabled together on a staged-down.

Load balancing will typically be used when the CSM is controlling series-piped centrifugal chillers. Place each pair of series-piped chillers in a unique Load Balancing Group so that those two chiller loads are balanced.

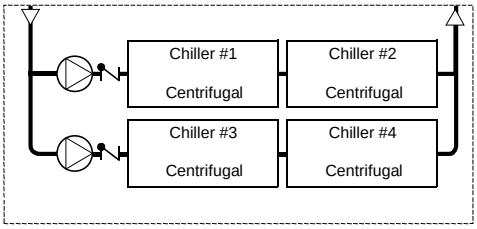
Applications of series-piped chillers almost always consist of centrifugal chillers and the CSM was designed to control series-piped centrifugal chillers. If you have a chiller system consisting of series-piped screw or scroll chillers contact the McQuay Applications Group to see if it is possible to control your application with the CSM.

The operator must inform the CSM that chillers are piped in series for this logic to occur. This is done on the *Chiller Setup* screen by entering the chiller number of the other chiller making up the series-piped pair into the "This Chiller Series Piped With" property of both chillers. Filling in this property also allows the CSM to properly calculate water flow rates when series-piped chillers are present. These flow rates are used to determine the flow through the decoupler line and the primary flow that will be lost when the Next Off chiller is disabled.

Stage-up with Series-Piped Chillers

Consider the chiller system in Figure 13. A typical sequence order would be to enable chiller 1, then 2, then 3, and finally 4. A problem would occur because chiller 4 would not be enabled by the CSM. Chiller 1 is enabled normally. Chiller 2 will be enabled when chiller 1 reaches full load. On primary-secondary systems, chiller 3 would typically get enabled when the load requires more flow than the single primary pump supplying chillers 1 and 2 can deliver. After chiller 3 is enabled, water flow is split between the two sets of series-piped chillers, which also splits the cooling load between the two sets. Chiller 3 would move to a full load condition but chillers 1 and 2 would both move to partially loaded conditions (roughly 50% load each). Since chillers 1 and 2 never reach full load, the CSM would not stage-up to enable chiller 4, even if the system required more cooling capacity.

Figure 13. Chiller System with Evaporators Piped in the Series/Parallel Configuration



When staging-up series-piped chillers, the CSM will automatically enable the second chiller of a series-piped pair 30 seconds after the first was enabled when either of the following conditions already exist in the system.

1. A pair of series-piped chillers are both already enabled
2. Any non-series piped chiller is already enabled

Series-piped chiller pair is already enabled

Condition 1 allows the first and second chillers in Figure 13 to be enabled separately, but once a third chiller is enabled the forth chiller will automatically be enabled 30 seconds later. A typical chiller system would have a sequence order where chillers 1 and 2 are the first and second chillers enabled based on run time, and chillers 3 and 4 would be enabled together when additional flow or additional capacity is required. The table below shows how this typical series-piped system would be configured and the resulting stage-up sequence.

Table 11. Example of a Typical Sequence Order with Series-Piped Chillers

Chiller #	**Sequence Number** (in Row 1 of the Sequence Order Table on the *Chiller Seq* screen)	**This Chiller Series-Piped With Chiller #** (variable on the *Chiller Setup* screen)	**Resulting Sequence Order**
1	1	2	First Chiller On = 1 (or 2 based on lowest runtime of 1 or 2)
2	1	1	Second Chiller On = 2 (or 1 based on runtime of 1 or 2)
3	2	4	Third Chiller On = 3 (or 4 based on lowest runtime of 3 or 4) Forth Chiller is Automatically Enabled 30 seconds after Third Chiller was Enabled
4	2	3	

Non-series chiller is already enabled

Condition 2 allows for the same type of automatic series-piped pair chiller enabling as condition 1 but allows for systems with evaporators piped in a combination of the Series/Parallel Configuration and Parallel Configuration. In this case a single non-series-piped chiller that is already enabled will force both chillers of a series-piped pair to be enabled.

Stage-down with Series-Piped Chillers

Series-pipe chiller pairs will be disabled together unless they are the last two chillers enabled. In the example shown in Table 11, when all four chillers are enabled, the Next OFF chiller will be chiller 4. When system conditions allow a stage-down to occur, both chiller 3 and 4 will be disabled at the same time. Now only chillers 1 and 2 are enabled and the Next OFF chiller will be chiller 2. When system conditions allow a stage-down to occur, only chiller 2 will be disabled.

The CSM adjusts the stage-down conditions when it will be disabling chiller pairs together. The first stage-down condition is:

1. The Active Capacity of the Next-OFF chiller is less than the Spare Capacity Factor multiplied by the Sum of All Spare Capacity of All Other Running Chillers.

If the Next-Off chiller is series-piped with another enabled chiller, the Active Capacity of the Next-Off chiller is re-calculated as the sum of the active capacity of the Next-OFF chiller plus the active capacity of the chiller paired with the Next-OFF chiller in the series-piped configuration. Also, the Sum of All Spare Capacity of All Other Running Chillers is re-calculated as the sum of all running chillers except the Next-OFF chiller and the chiller paired with the Next-OFF chiller in the series-piped configuration.

► **To sequence series-piped chillers**

1. Set the "This Chiller Is Series-Piped With Chiller #" variable of each chiller that has it's evaporator piped in series with another chiller. These variables are on the *Chiller Setup* screen.
2. Set the Flow Rate variable of each chiller in a series-piped pair equal to that of the other chiller making up the pair. These variables are on the *Chiller Setup* screen.
3. On the *Load Limiting* screen, set the Load Balancing Flag to "On" and set the following variables as required:
   - Load Balancing Capacity Difference Limit
   - Load Balancing Start Delay Time
4. Place all chiller numbers into a Load Balancing Group # on the *Load Limiting* screen. Each pair of chillers should have it's own Load Balancing Group # so that only the two chillers creating the series-piped pair are load balanced together.
5. On the *Chiller Seq* screen, set the Sequence Number of all chillers as required. The Sequence Number of series-piped chiller pairs will typically be the same. Make sure that both chillers of a series-piped pair always exist in the same row.
6. When the chiller unit controller of either chiller in a series-piped pair gets enabled, it must enable the primary water flow through the evaporator of both chillers. The flow enable device (pump or valve) must be wired in parallel with both chiller unit controllers so that either chiller can start the evaporator water flow.

Stage-Up Inhibiting

Stage-up inhibiting limits loading by preventing further stage-ups. If stage-up inhibiting is on, the CSM is able to stage-down, but it is not able to stage-up when a normal stage-up would otherwise occur. If stage-up is not inhibited, normal sequencing control occurs. Stage-up inhibiting does *not* prevent a forced stage-up from occurring when an enabled chiller goes off-line.

Stage-up inhibiting does not directly influence the loading of individual chillers, and it cannot actively reduce the system-wide load. It can only prevent more capacity—in the form of additional chillers—from being added to the system. There are two types of stage-up inhibiting:

- Daily Method
- Network Method

The system can use either type or both types at the same time. The Stage-Up Inhibit Source value on the *System Status* screen tells you which (if any) method of Stage-Up Inhibiting is active.

Daily Method

With the Inhibit Stage-Up After Time variable, you can specify a particular time after which no more stage-ups occur. For example, if the chiller system shuts down at 9:00 p.m., the operator may want to prevent more capacity from being added to the system after 8:15 p.m. In this instance, the operator could set the Inhibit Stage-Up After Time to "8:15 PM".

► **To set up daily stage-up inhibiting control**

1. Set the Inhibit Stage-Up After Time as required. Normal stage-ups do not occur after this time.

Network Method

If a BACnet or Modbus BAS is connected to the CSM, the BAS can use a BAS Stage-Up Inhibit inputs to turn stage-up inhibiting on and off. Whenever stage-up inhibit is ON, stage-up inhibiting prevents additional chillers from becoming enabled.

BACnet can control this feature by commanding Binary Output Object instance 51.

Modbus can control this feature by writing to Coil index 00082.

► **To allow network stage-up inhibiting control**

1. Make sure the BAS Stage-Up Inhibit Override variable has been commanded to "Auto".

Note: If communications are lost with a BAS that is supplying the Stage-Up Inhibiting, the CSM retains and uses the last value it received. It can be overridden at the user interface by commanding the BAS Stage-Up Inhibit Override variable to "Normal" on the *Chiller Seq* screen.

Load Limiting Control

The CSM can perform three types of load limiting to the connected chillers:

1. Demand Limiting
2. Load Balancing
3. Soft Loading

To view the current status of the load limiting control go to the *Load Limit* screen. To configure the load limiting operation go to the *Load Limiting* screen to change the values described in Table 12.

Table 12. Load Limiting (Main > Configuration > Load Limiting)

Name	Description
Demand Limiting Type	This input controls what kind of demand-limiting input (if any) will be used. Range = None, External, BACnet, Modbus. Default = None.
Load Balancing Flag	This input turns load balancing on or off. You can also set this input to AUTO, which allows a BAS to gain control. Range = Load Balancing On, Load Balancing Off. Default = Off
Load Balancing Capacity Difference Limit	This input sets a % Rate Load Amps (%RLA) range which chillers may operate in when they are part of a Load Balancing Group. It is added to the lowest %RLA of any chiller in a Load Balancing Group to create the capacity limit (Load Balancing Load Limit Group X) which is sent to every chiller in the group. Range = 5 – 26%. Default = 8%
Load Balancing Start Delay Time	This input sets the amount of time the CSM waits after a chiller start before it includes the new chiller in the load balancing group calculations. This keeps the already running chillers from being unloaded while the new chiller ramps up. Range = 2 – 20 minutes. Default = 5 minutes.
Soft Load Flag	This input turns soft loading on or off. You can also set this input to AUTO, which allows a BAS to gain control. Range = Soft Load On, Soft Load Off. Default = Off
Initial Soft Load Amps	This input is used as a lower limit of the mathematical function used to ramp the Soft Load capacity limit up to 100% over the Soft Load Ramp Time. Range = 40 – 100%. Default = 40%
Soft Load Ramp Time	This input is used as the time it takes the mathematical function to ramp the Soft Load capacity limit from the Initial Soft Load Amps to 100%. Range = 1 – 60 minutes. Default = 5 minutes
Chiller X Load Balancing Group #	This input assigns this chiller to one of six Load Balancing Groups. All chillers with the same Group # will have their loads balanced. If all chillers in the plant are placed in Load Balancing Group 1, all of the chiller loads are balanced together. Placing a chiller into Load Balancing Group 0 means that chiller will not be load balanced with any other chillers. Range = 0 – 6. Default = 1 for all chillers

Demand Limiting

The CSM can provide demand-limiting control for all chillers in the system. If you choose to use demand-limiting control, it affects the entire system. For example a demand limit of 80% will limit the electrical demand to 80% of the system when all chillers are running. To place a demand limit on the system's current electrical usage, both the demand limit and stage-up inhibit features would have to be enabled simultaneously.

How Demand Limiting Works

Demand limiting control requires a capacity limit value, which must come from an outside source. You can choose one of three possible sources with the Demand Limiting Type variable:

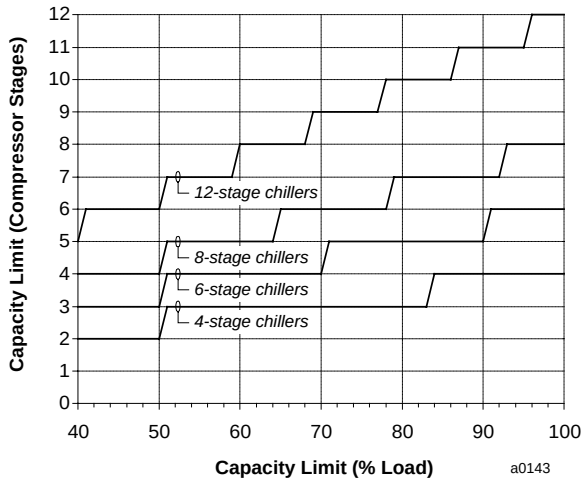
- External (analog signal)
- BACnet
- Modbus

After receiving the capacity limit from the selected source, the CSM generates the System Demand Limiting Load Limit (*Load Limit* screen). If the value of this variable is less than the capacity limit produced by the soft load or load-balancing functions, the CSM sends it to every chiller in the system.

Screw and Scroll Chillers

Since screw and scroll chillers control their capacity in stages, the System Demand Limiting Load Limit cannot be used directly as it is in centrifugal chillers. Instead, each screw or scroll chiller's unit controller converts the percent-load capacity limit into a maximum-stage capacity limit. The step functions that screw chiller unit controllers use to do this are shown in Figure 14.

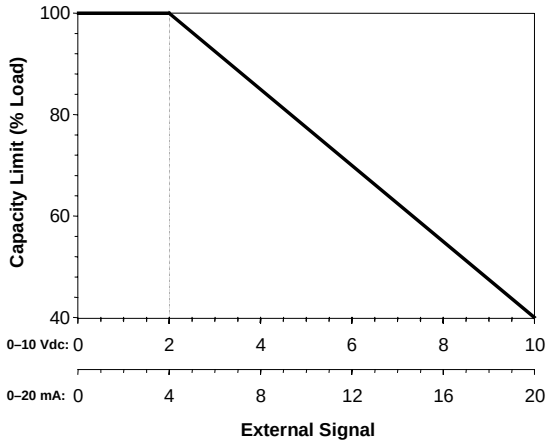
Figure 14. Screw Chiller Demand Limiting



Demand Limiting from an External Signal

If the Demand Limiting Type variable is set to "External," the CSM uses an external voltage or current signal as the source of the System Demand Limiting Load Limit. An analog signal (0–10 Vdc, or 0–20 mA) must be connected to UI-11 on the CSM's onboard I/O panel. For more information, see the Field Wiring section of IM 781. The capacity limit is calculated according to the function shown in Figure 15.

Figure 15. External Signal Demand Limiting Function



Demand Limiting via Network Signal

If the Demand Limiting Type variable is set to "BACnet" or "Modbus", the CSM accepts a capacity limit value sent by a BAS. The value from the BAS becomes the System Demand Limiting Load Limit; however, the CSM limits the value to a range of 40% to 100%. For example, if the BAS writes a value of 20%, the System Demand Limiting Load Limit variable is set to 40%.

Note: If communications are lost with a BAS that is supplying the demand limiting value, the CSM retains and uses the last value it received. To override, set the Demand Limiting Type to "None" on the *Load Limiting* screen.

▶ **To set up demand limiting control**

1. Set the Demand Limiting Type variable as required. If you do not want demand limiting control, set it to "None."

Load Balancing

The CSM will provide load-balancing control for all chillers assigned to a Load Balancing Group #. Centrifugal, screw and scroll chiller types should not be balanced together due to the their means of capacity increase. For example a centrifugal chiller which ramps its capacity linearly cannot be properly balanced with a scroll compressor which increases its capacity in large increments (e.g. 25%).

Centrifugal chillers are typically the only chillers that are load balanced. If you intend to load balance screw or scroll chiller types you must increase the Load Balancing Capacity Difference Limit to be greater than the capacity increase increment of the chillers being balanced.

If load balancing flag = YES, the capacity limit of all chillers with the same Load Balancing Group Number will be affected.

When to Use Load Balancing

Load balancing control is optional. Load balancing is often used (but not required) when there is at least one set of series-piped chillers in the system. When load balancing is used for series-piped chillers, both chillers of the series-piped pair are typically balanced together (i.e. chillers 1 and 2 have Load Balancing Group Number = 1, chillers 3 and 4 have Load Balancing Group Number = 2, etc).

If all the chillers are piped in parallel, as long as their leaving evaporator water temperature setpoints are the same, chillers in these systems tend to automatically balance their loads as they control their chilled water temperatures. In fact, load-balancing control can actually override chilled water temperature control. So if load-balancing control is in use, you can expect some variation in the chillers' leaving evaporator water temperatures. This is more likely to occur in a system that has chillers with a wide range of efficiencies. When load balancing is used for parallel-piped chillers, all centrifugal chillers in the system are typically balanced together (i.e. all chillers have a Load Balancing Group Number = 1).

How Load Balancing Works

The CSM continually reads the percent load (% RLA) from each chiller that is running. It then selects the lowest of these percent load values and adds the Load Balancing Capacity Difference Limit variable (default is 8%) to this minimum. The result is the Load Balancing Load Limit Group X (*Load Limit* screen). If this value is less than the demand limiting function and the soft load function has expired, the CSM sends it to every chiller in the group. Each chiller then inhibits loading or unloads as required to keep the load within 5% of this limit.

The Load Balancing Capacity Difference Limit effectively defines a range of acceptable chiller percent load values. This range floats up and down as the minimum percent load value floats.

A chiller that has just started is not included in the calculation to determine the lowest percent load until one of two conditions are met:

1. The Load Balancing Startup Timeout Period has expired
2. The percent load of the startup chiller has reached the Group Load Balancing Load Limit

The CSM can maintain up to 6 separate Load Balancing Groups. If a chiller has a Load Balancing Group # = 0, that chiller will not be balanced with any other chillers.

As an example, consider a system with two older, inefficient chillers and one new, efficient chiller. The new chiller is Chiller #3, the CSM's Load Balancing Capacity Difference Limit variable is set to 8%, and the chilled water setpoints in each chiller controller are the same. When Chiller #3's load is 55% RLA, the load on Chiller #1 and Chiller #2 is prevented from exceeding 64% RLA. (Loading is inhibited at 63% through 67%; unloading occurs at 68% and higher.)

► **To set up load balancing control**

1. Set the Load Balancing Flag to "Yes."
2. Set the Load Balancing Capacity Difference Limit as required.
3. Enter the same Load Balancing Group # to all chillers which you want to be balanced together.

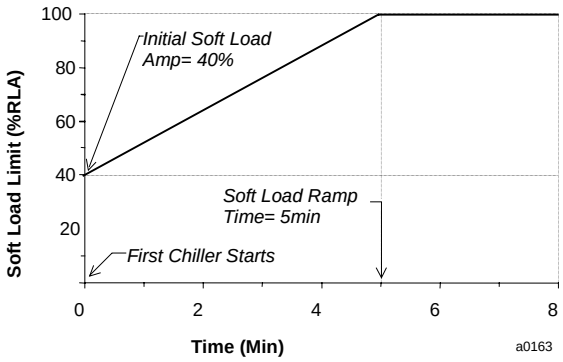
Soft Loading

Soft loading control can be used to prevent the lead chiller's load from rising too fast during chiller system start-up when the return chilled water temperature is high. The CSM provides soft loading by writing a value to the chiller's capacity limit. The value written to this variable ramps up from an initial value when the first chiller starts to run.

How Soft Loading Works

If the Soft Load Flag is set to Yes, the CSM generates the Soft Load Limit function based on the Initial Soft Load Amps variable and the Soft Load Ramp Time variable.

Figure 16. Soft Load Limit Function



Whenever a chiller starts running, the CSM checks to see whether any other chillers are already running. If any other chiller is running, it does nothing. If no other chillers are running, and if the value of Soft Load Limit is less than the capacity limits produced by the demand limit function, the CSM sends the Soft Load Limit to every chiller in the system. Immediately after the first chiller enters the run mode, the Soft Load Limit is continually sent out to the chillers every 15 seconds until it reaches 100% or it bumps into another load limiting control (such as demand limit).

When soft loading is used, the first chiller will start normally, but no other chillers will be enabled until the Soft Load Ramp Time has been reached.

Chiller Controller Setup

Chiller unit controllers are capable of providing soft load control. If soft-loading control is desired from the CSM, the soft loading features of the chillers must be turned off.

► **To set up soft loading control**

1. Set the soft loading flag to ON.
2. Set the initial soft loading amps as required.
3. Set the soft load ramp time as required.
4. Disable the soft load feature in all of the chiller unit controllers.

Chilled Water Temperature Control

In a system of multiple chillers, each individual chiller should normally maintain its leaving evaporator water temperature at the same setpoint—even if that setpoint is being reset. The CSM can generate this setpoint (with or without reset) and send it to every chiller in the system via LONWORKS network communications.

Figure 17 shows a flow chart of how leaving evaporator water temperature setpoints are generated and how they flow to the chiller controllers, which ultimately use them to control capacity and thus water temperature. Notice that the link between the CSM and the chiller controllers is the Chiller Setpoint.

The CSM provides system water temperatures (*Temperature* screen) and, for your convenience, local water temperatures at each chiller (*Chiller Status* screen). To configure the chilled water temperature control go to the *Chilled Water Supply Temp* screen to change the values described in Table 13.

In all cases, each individual chiller controller attempts to maintain its leaving evaporator water temperature at its Active Setpoint, which is the "working" leaving evaporator water temperature setpoint. Any capacity overrides that are in effect, such as load balancing or demand limiting, can affect a chiller's ability to control temperature.

When controlling a chiller using the CSM, the source of the Active Setpoint is the CSM so that the same setpoint is used throughout the system.

There are many other chiller controller variables that affect leaving evaporator water temperature and load recycle control; for example, Start-Delta and Max Pull Down rate. For more information, refer to the appropriate MicroTech II chiller unit controller operation manual (see Reference Documents on page 7).

Table 13. Chilled Water Supply Temp (Main > Configuration > Chilled Water Supply Temp)

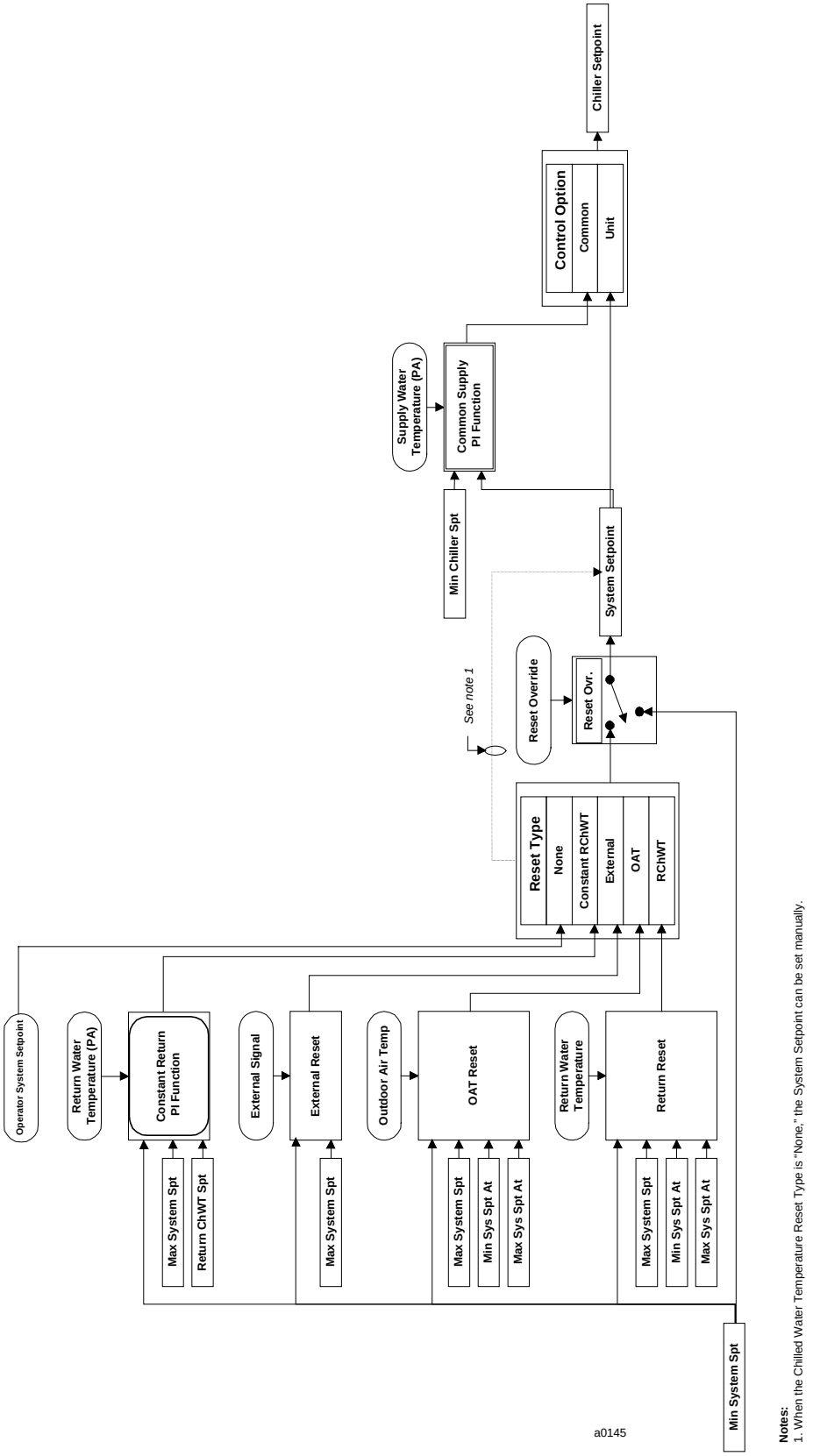
Chilled Water Supply Temperature Control	
Name	**Description**
Operator System Setpoint	This setpoint becomes the System Setpoint if the Reset Type variable = "None". Range = Minimum System Setpoint – to - Maximum System Setpoint. Default = 44.0°F (6.6°C)
Minimum Chiller Setpoint	This input defines the lowest chilled water temperature setpoint that the CSM can send to the chillers. You will not be allowed to set the Operator System Setpoint or Minimum System Setpoint property below this value. Range = 40°F (4.4°C) – to – Minimum System Setpoint (Unless Glycol Flag = yes, then the min = 0°F (-17.8°C)). Default = 40.0°F (4.4°C)
Chilled Water Supply Temperature Reset	
Name	**Description**
Reset Type	This input controls what kind of setpoint reset will be applied to determine the System Setpoint. Range = None, External, OAT, Return Water, Constant Return. Default = None.
Minimum System Setpoint	This value sets the lowest value that you or a reset function can set the System Setpoint. Also, the System Setpoint will be set to this value whenever the Reset Override feature is active. Range = 40.0 – 80.0°F (4.4 – 26.6°C) (Unless Glycol Flag = yes, then the min = 0°F (-17.8°C)). Default = *44.0°F (6.6°C)*
Maximum System Setpoint	This value sets the highest value that you or a reset function can set the System Setpoint. Range = 40.0 – 80.0°F (4.4 – 26.6°C) (Unless Glycol Flag = yes, then the min = 0°F (-17.8°C)). Default = *54.0°F (12.2°C)*
Minimum System Setpoint At	This value is used as a limit of the mathematical function used in OAT and Return Water reset types. Range = 0.0 – 99.5°F (–17.8–37.4°C). Default = *90.0°F (32.2°C)*
Maximum System Setpoint	This value is used as a limit of the mathematical function used in OAT and Return Water reset types. Range = 0.0 – 99.5°F (–17.8–

At	37.4°C). Default = *70.0°F (21.0°C)*
Constant Return Setpoint	This value sets the Constant Return setpoint used in controlling the System Setpoint if Reset Type = "Constant Return". The System Setpoint is modulated to maintain the Chilled Water Return Temperature at this setpoint. Range = 20.0 – 80.0°F (–6.7 – 26.6°C). Default = *54.0°F (12.2°C)*
Constant Return Deadband	This value sets a Deadband around the *Constant Return Setpoint* if Reset Type = "Constant Return". No Constant Return control action is taken when the current Chilled Water Return Temperature is within this Deadband around the Constant Return Setpoint. Range = 0.5 – 9.5°F (0.2 – 5.2°C). Default = 0.5°F (0.2°C)
Constant Return Propband	This value sets the "proportional band" used in the PID control function that modulates the System Setpoint if Reset Type = "Constant Return". In general, increasing this value has a slowing effect and decreasing this value has a speeding effect on the control of the System Setpoint. Range = 1.0 – 60.0°F (0.5 – 33.3°C). Default = ±6.0°F (±3.3°C)
Constant Return Sample Time	This value sets the "sampling period" used in the PID control function that modulates the System Setpoint if Reset Type = "Constant Return". In general, increasing this value has a slowing effect and decreasing this value has a speeding effect on the control of the System Setpoint. Range = 1 – 3600 seconds. Default = 45 seconds
Constant Return Integral Time	This value varies the "integral time" used in the PID control function that modulates the System Setpoint if Reset Type = "Constant Return". In general, increasing this value has a slowing effect and decreasing this value has a speeding effect on the control of the System Setpoint. Range = none. Default = 120 seconds
Glycol Flag	
Name	**Description**
Glycol Flag	This input allows the Minimum Chiller Setpoint, Minimum System Setpoint and Maximum System Setpoint to be set below 40.0°F (4.4°C). Do not set this input to Yes unless the chiller system is protected against freezing or damage will occur. Range = No, Yes. Default = No
Type	This input tells the CSM what type of glycol is used. The glycol type affects the CSM's calculation of Chiller Water Load (Tons) which is displayed on the *System Status* screen if the Flow Meter Location property (I/O Config screen) = Common Supply Line. Range = None, Ethylene Glycol, Propylene Glycol. Default = None
Glycol Percentage	This input tells the CSM the percentage of glycol in the systems water. The glycol percentage affects the CSM's calculation of Chiller Water Load (Tons) which is displayed on the *System Status* screen if the Flow Meter Location property (I/O Config screen) = Common Supply Line. Range = 0-100. Default = 0

Temperature Control

The CSM's ultimate purpose in temperature control is to distribute the *same* leaving evaporator water temperature setpoint to every chiller in the network. This setpoint is the Chiller Setpoint. The CSM can generate the Chiller Setpoint, which is not manually adjustable, in a variety of ways. See Figure 17.

Figure 17. CSM Leaving Evaporator Water Temperature Setpoint Flow Chart



Notes:
1. When the Chilled Water Temperature Reset Type is "None," the System Setpoint can be set manually.

System Setpoint

The Chiller Setpoint is derived from the System Setpoint, which is the CSM's chilled water supply setpoint for the system. You can set the System Setpoint manually using the Operator System Setpoint variable or let the CSM reset it automatically. In either case, the System Setpoint is limited to a range defined by the Minimum System Setpoint and Maximum System Setpoint.

The System Setpoint and Chiller Setpoint can be viewed on the *System Status* screen.

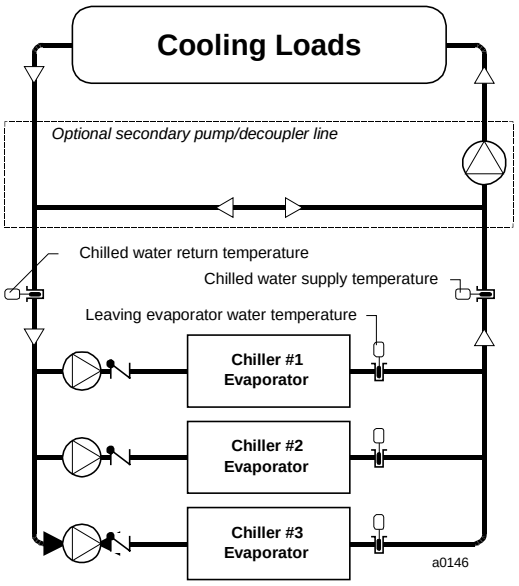
Unit Option

The Unit option simply sets the Chiller Setpoint equal to the System Setpoint.

The Unit option should be used for systems in which the flow through each chiller's evaporator is isolated when not operating. These systems are by far the most common. They include, for example, chillers with dedicated primary pumps or isolation valves (see Figure 18).

When the Unit option is used in systems with isolated chillers, the supply water temperature usually is very close to the System Setpoint even though there is no direct control. (This may not be true if your system is using load balancing.) The Common option can also be used in these systems, but the Unit option is simpler and the effect is usually the same.

Figure 18. Typical System with Isolated Chillers



Low Temperature Operation

The CSM has a software safety built into it that does not allow three chilled water setpoints to be adjusted below 40.0°F (4.4°C): Minimum System Setpoint, Maximum System Setpoint, and Minimum Chiller Setpoint. If your system can withstand low temperature operation with no danger of freezing, you can override the safety by setting the Glycol Flag to "Yes." This allows the above setpoints to be adjusted down to 0.0°F (–17.8°C).

► **To set up chilled water temperature control**
Set the Operator System Setpoint as required.

Setpoint Reset

By automatically varying the leaving evaporator water temperature to suit the building's cooling load, chilled water temperature reset can make some chiller systems more energy efficient. The CSM provides four types of reset, which are described below:

- Return Water

- Outdoor Air
- External *(analog signal)*
- Constant Return *(PI control)*

When a reset strategy is active, it automatically changes the System Setpoint as required. Regardless of the reset method, the Minimum System Setpoint and the Maximum System Setpoint define the range of possible System Setpoint values. The current value of the System Setpoint is determined by the current value of the input variable (e.g. Outdoor Air Temperature).

If you don't want a reset, set Chilled Water Temperature Reset Type to "None" (default). In this case the Operator System Setpoint becomes the System Setpoint.

Reset Override

The CSM provides a digital input (UI-14 of the onboard I/O panel) that you can use to override any setpoint-reset function that you may have configured. You may want to do this, for example, if very cold water is temporarily required for dehumidification.

When the reset override input is closed, the CSM sets the System Setpoint equal to the Minimum System Setpoint. When the input is open, the reset strategy you've selected operates automatically. Reset override can occur even when the Chilled Water Temperature Reset Type is set to "None."

Reset from Return Water or Outdoor Air Temperature

When the return water reset or outdoor air temperature reset method is used, the System Setpoint is determined by the temperature input and the reset function, which is shown in Figure 19 and Figure 20. The following variables define the function:

- Minimum System Setpoint
- Maximum System Setpoint
- Minimum System Setpoint At
- Maximum System Setpoint At

The figures show typical values of these variables. (The values of the "At" variables shown in the figures would be appropriate for Outdoor Air reset.)

Figure 19. Return Water or Outdoor Air Reset (English)

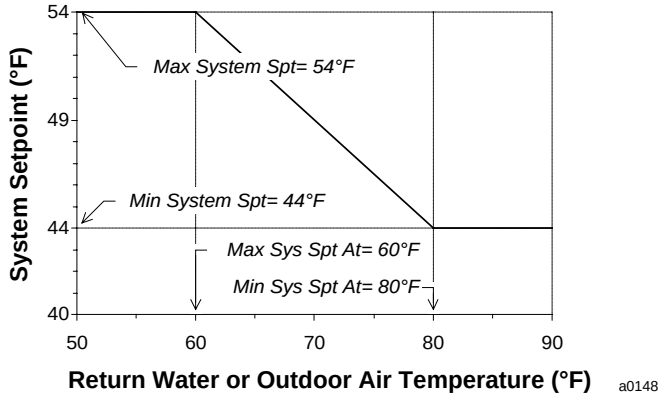
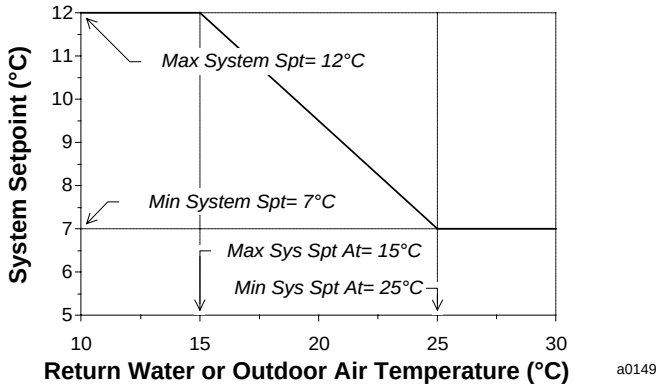


Figure 20. Return Water or Outdoor Air Reset (SI)



For example, if the settings of the Figure 19 and Figure 20 are used, the following occurs when Outdoor Air reset is selected:

Outdoor air temperature	Corresponding System Setpoint
55.0°F (12.5°C)	54.0°F (12.0°C)
70.0°F (20.0°C)	49.0°F (9.5°C)
85.0°F (27.5°C)	44.0°F (7.0°C)

You can monitor the current return water and outdoor air temperatures on the *Temperature* screen.

Note: If communications are lost with a BAS that is supplying the outdoor air temperature to the CSM, the CSM retains and uses the last temperature it received until communications are restored.

► **To set up Return Water or Outdoor Air reset**

1. Set the Chilled Water Temperature Reset Type variable to “Return Water” reset or “OAT”.
2. Set the following variables as required:
   - Minimum System Setpoint
   - Maximum System Setpoint
   - Minimum System Setpoint At
   - Maximum System Setpoint At

The CSM automatically resets the System Setpoint. You can ignore the remaining reset variables.

Note: To use the Outdoor Air reset method; an outdoor air temperature sensor must be connected to the CSM, received from a BAS, or received from a chiller with an OAT sensor. To use the Return Water reset method; a return chilled water temperature sensor must be connected to the CSM. For more information, see the Field Wiring section of IM 781.

Reset from an External Signal

When the external reset method is used, an external analog signal and the reset function determine the System Setpoint. See Figure 21 and Figure 22. The following variables define the function: Minimum System Setpoint and Maximum System Setpoint. The figures show typical values of these variables.

Figure 21. External Reset (English)

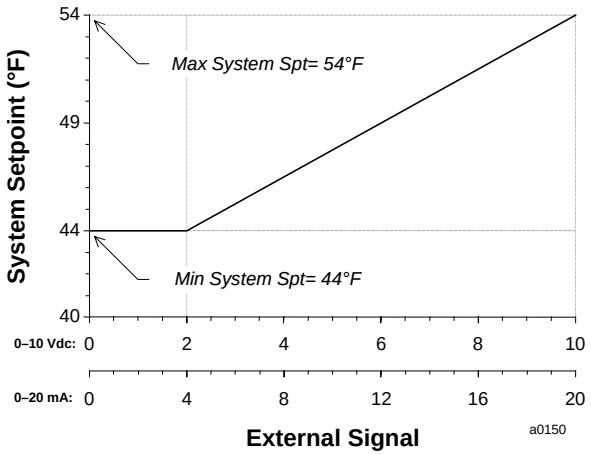
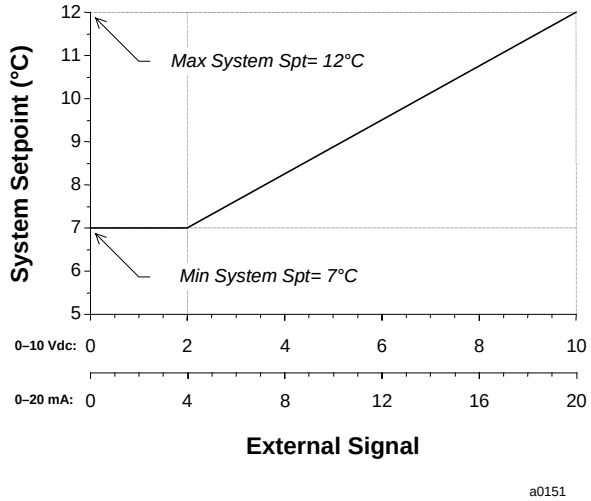


Figure 22. External Reset (SI)



For example, if the settings of Figure 21 and Figure 22 are used, the following occurs when External reset is selected:

External Analog Signal	Corresponding System Setpoint
4 mA	44.0°F (7.0°C)
12 mA	49.0°F (9.5°C)
20 mA	54.0°F (12.0°C)

You can monitor the current value of the External Chilled Water Reset Signal on the *Misc* screen of the user interface. Note that in all cases the displayed value is a *conditioned* value of 0–10 Vdc.

► **To set up External reset**

1. Set the Chilled Water Temperature Reset Type variable to "External."
2. Set the following variables as required:
   - Minimum System Setpoint
   - Maximum System Setpoint

The CSM automatically resets the System Setpoint. You can ignore the remaining reset variables.

Note: To use the External reset method, an external analog signal (0–10 Vdc, or 0–20 mA) must be connected to UI-10 of the CSM's onboard I/O panel, see the Field Wiring section of IM 781.

Constant Return Chilled Water Temperature Control

The constant return reset method uses a proportional-integral (PI) control loop to generate a System Setpoint that keeps the return chilled water temperature at the Constant Return Setpoint. It is different from the other three reset methods because it does not use a mathematical function to reset the System Setpoint.

Constant return temperature control is typically used only in systems that have constant chilled water flow. This is true because return water temperature is a good indicator of cooling load only when the flow is constant. If your system has three-way valves at the loads or a supply-to-return loop bypass valve, it probably has constant flow.

When the return temperature is above the Constant Return Setpoint, the control loop lowers the System Setpoint. When the return temperature is below the Constant Return Setpoint, the control loop raises the System Setpoint. The System Setpoint is limited to a range defined by the Minimum System Setpoint and Maximum System Setpoint.

The PI control loop has four adjustable variables that are dedicated to return chilled water temperature control: (1) Constant Return Deadband, (2) Constant Return Prop Band, (3) Constant Return Sample Time, (4) Constant Return Integral Time. For many applications, the default values for these variables provide good control. The Constant Return Temp PI Function time plot is provided on the *Chilled Water Supply Temp* screen to assist in tuning the PI loop.

▶ **To set up Constant Return reset**

1. Set the Chilled Water Temperature Reset Type variable to "Constant Return".
2. Set the following variables as required:
   - Minimum System Setpoint
   - Maximum System Setpoint
   - Constant Return Setpoint
   - Constant Return Deadband
   - Constant Return Propband
   - Constant Return Sample Time
   - Constant Return Integral Time

The CSM automatically resets the System Setpoint. You can ignore the remaining reset variables.

Note: To use the Constant Return reset method, a return chilled water temperature sensor must be connected to UI-2 of the CSM's onboard I/O panel. For more information, see the Field Wiring section of IM 781.

Cooling Tower Control

The CSM can maintain a common entering or leaving condenser water temperature by controlling up to 12 cooling tower stages, tower fan VFD's and a tower bypass valve. To view the current values of the cooling tower operation go to the *Clg Tower Status* screen. To configure the cooling tower operation, go to the *Clg Tower Control* screen to change the values described in Table 14.

Table 14. Clg Tower Control (Main > Configuration > Clg Tower Control)

Cooling Tower Stages	
Name	**Description**
Tower Control Flag	This input allows CSM's control of the cooling tower to be turned on and off. If this flag = No, the tower outputs will not be enabled by the CSM. Default = No
Control Temperature Source	This input defines whether the CSM will maintain the Entering or Leaving condenser water temperature at the setpoint. If constant approach reset is used, the Control Temperature Source variable must be set to Entering Cond Water (the water temperature leaving the cooling tower). Range = Entering Cond Water, Leaving Cond Water. Default = Entering Cond Water

Number of Tower Stages	This input sets the highest tower stage that the CSM will enable. It is typically set to the highest Stage # row with a Tower Output set to On in the Tower Stage Table. Range = 1 to 12. Default = 6
Tower Stage Differential	The cooling tower will not be staged down until the Control Temperature is less that the current Stage Setpoint minus this Tower Stage Differential. Range = 0 – 9.5°F (0 – 5.2°C). Default = 3°F (1.7°C)
Tower Stage-Up Delay Time	After a tower stage-up occurs, the next stage-up cannot occur until after this period of time expires. Range = 1 to 60 minutes. Default = 2 minutes
Tower Stage-Down Delay Time	After a tower stage-down occurs, the next stage-down cannot occur until after this period of time expires. Range = 1 to 60 minutes. Default = 5 minutes
Stage 1 to 12 Setpoints	Enter the temperature setpoints (up to 12) which correspond to the Stage # in the Tower Stage Table. When the control temperature is higher than the setpoint the CSM will stage-up to enable more cooling tower capacity. These inputs also define the differentials that will be maintained between each stage if the Stage 1 Setpoint is being reset. Range = 40-99.5°F (4.4 to 37.4°C). Defaults; Stage 1 Setpoint =74°F (23.3°C), 2=76°F (24.4°C), 3 through 12=78°F (25.5°C)
Tower VFD Control Flag	This input allows CSM's control of the cooling tower VFD to be turned on and off. If this flag = No, the CSM's tower VFD analog outputs will not modulate to maintain the control temperature. Default = No
Tower VFD Deadband	This input sets a Deadband around the *Stage 1 Setpoint* if tower VFD control is used. No tower VFD control action is taken when the current Control Temperature is within this Deadband around the Stage 1 Setpoint. Range = 0.5 – 10°F (0.2 – 5.6°C). Default = 1.5°F (0.8°C)
Tower VFD Propband	This value sets the "proportional band" used in the PID control function that modulates the tower VFD speed. In general, increasing this value has a slowing effect and decreasing this value has a speeding effect on the control of the VFD speed. Range = 1 – 60°F (0.5 – 33.3°C). Default = ±30°F (±16.7°C)
Tower VFD Sample Time	This value sets the "sampling period" used in the PID control function that modulates the tower VFD speed. In general, increasing this value has a slowing effect and decreasing this value has a speeding effect on the control of the VFD speed. Range = 1 – 3600 seconds. Default = 15 seconds
Tower VFD Integral Time	This value varies the "integral time" used in the PID control function that modulates the tower VFD speed. In general, increasing this value has a slowing effect and decreasing this value has a speeding effect on the control of the VFD speed. Range = none. Default = 120 seconds
Tower VFD PI Function Graph	A graph of the tower Control Temperature vs. Time is shown at the bottom of the page when the Tower VFD Control Flag = Yes to assist in tuning the Tower VFD PI loop.
Tower VFD Minimum Speed	This input sets the minimum percentage from the CSM's tower VFD analog output. Range = 25 – 99 %. Default = 45%
Fan Speed of the First Non-VFD Fan	When VFD's are used on some (but not all) cooling tower fans and the non-VFD fans have multi-speed control, set this input to the lowest multiple fan speed. Then place all VFD controlled fans in Stage 1, and place the lowest fan speed in Stage 2. Stage 2 will only be enabled after the VFD controlled fans reach the Fan Speed of the First Non-VFD Fan. Range = 33 – 100 %. Default = 100%
Constant Approach Reset Flag	This input allows Stage 1 Setpoint reset based on the outside air wet-bulb temperature to be turned on and off. If this flag = Yes, the CSM's cooling tower stage setpoints will change to maintain a constant temperature differential between the common entering condenser water and the ambient wet-bulb. Relative humidity and outside air temp sensors are required. Default = Off
Constant Approach Temperature Differential	This input sets the constant temperature differential that will be added to the wet-bulb temperature to reset the CSM's cooling tower Stage 1 Setpoint (if Constant Approach Reset Flag = Yes). Note that all of the other Stage Setpoints (2 through 12) are also reset to maintain their original user defined differentials from the Stage 1 Setpoint. Range = 5-25 °F (2.8 - 13.9°C). Default = 7°F (3.9°C)
Constant Approach Reset – Minimum Setpoint	This input sets the minimum value for the cooling towers Stage 1 Setpoint when using Constant Approach Reset. Resetting the condenser entering water too low during cold weather could cause chiller operating problems. Range = 40 – 99.5°F (4.4 – 37.5°C). Default = 74°F (23.3°C)

Cooling Tower Bypass Valve

Name	**Description**
Tower Valve Control Option	This input tells the CSM if there is a cooling tower bypass valve. If there is a valve, you further define what setpoint the valve will use. Range = None, Valve Setpoint, Stage Setpoint. Default = None
Tower Valve Setpoint	This input is the user defined cooling tower valve setpoint. If the Tower Valve Control Option = Valve Setpoint, the valve will be modulated to maintain the Control Temperature at this setpoint. Range = 40 – 99.5°F (4.5 – 37.5°C). Default = 70°F (21.1°C)
Tower Valve Control Range Min	This input defines the lowest valve position the CSM will send to the tower bypass valve. Range = 0 – 100%. Default = 0%
Tower Valve Control Range Max	This input defines the highest valve position the CSM will send to the tower bypass valve. Range = 0 – 100%. Default = 100%
Min Tower Valve Position Setpoint	This value is used as a stage-down condition for interstage control when the Tower Valve Control Option = Stage Setpoint. Range = Tower Valve Control Range Min – 100%. Default = 20%

Max Tower Valve Position Setpoint	This value is used as a stage-up condition for interstage and low limit control when a tower valve is used (the CSM will not increase the tower stage until the valve position is greater than this setpoint). Range = 0% - Tower Valve Control Range Max. Default = 80%
Tower Valve Type	Defines whether the tower bypass valve is normally open or normally closed to the tower. Range = NC to Tower, NO to Tower. Default = NO to Tower
Tower Valve Deadband	This value sets a Deadband around the *Tower Valve Setpoint* if a tower valve is used. No tower valve control action is taken when the current Control Temperature is within this Deadband around the Tower Valve Setpoint. Range = 0 – 9.5°F (0 – 5.2°C). Default = 2°F (1.1°C)
Tower Valve Propband	This value sets the "proportional band" used in the PID control function that modulates the tower valve position. In general, increasing this value has a slowing effect and decreasing this value has a speeding effect on the control of the valve position. Range = 1 – 60°F (0.5 – 33.3°C). Default = ±7.5°F (±4.1°C)
Tower Valve Sample Time	This value sets the "sampling period" used in the PID control function that modulates the tower valve position. In general, increasing this value has a slowing effect and decreasing this value has a speeding effect on the control of the valve position. Range = 1 – 3600 seconds. Default = 15 seconds
Tower Valve Integral Time	This value varies the "integral time" used in the PID control function that modulates the tower valve position. In general, increasing this value has a slowing effect and decreasing this value has a speeding effect on the control of the valve position. Range = none. Default = 120 seconds
Tower Valve PI Function Graph	A graph of the tower Control Temperature vs. Time is shown at the bottom of the page when the Tower Valve Control Option is not equal to "None", to assist in tuning the Tower VFD PI loop.
Min Tower Valve Start Up Position	Used to define the initial tower valve position (before any chillers enter the Running mode). See the *Start-Up Valve Position Control* section of this document. Range = Tower Valve Control Range Min – to - 100%. Default = 0%.
Max Tower Valve Start Up Position	Used to define the initial tower valve position (before any chillers enter the Running mode). See the *Start-Up Valve Position Control* section of this document. Range = 0% - Tower Valve Control Range Max. Default = 100%.
Min Tower Valve Start Up Position @ (OAT)	Used to define the initial tower valve position (before any chillers enter the Running mode). See the *Start-Up Valve Position Control* section of this document. Range = 0-120 °F (-17.8 – 48.8°C). Default = 60°F (15.5°C)
Max Tower Valve Start Up Position @ (OAT)	Used to define the initial tower valve position (before any chillers enter the Running mode). See the *Start-Up Valve Position Control* section of this document. Range = 0-120 °F (-17.8 – 48.8°C). Default = 90°F (32.2°C)
Tower Stage Table	Pressing this button takes you to the Cooling Tower Sequence Order Table.
Cooling Tower Output Sequence Order Table	
Name	**Description**
Stage 1, Output 1 Stage 1, Output 2 Stage x, Output y	This table is used to assign tower outputs to cooling tower stages. Setting a tower output to ON in a stage #'s row will close the associated relay whenever that particular tower stage is reached.

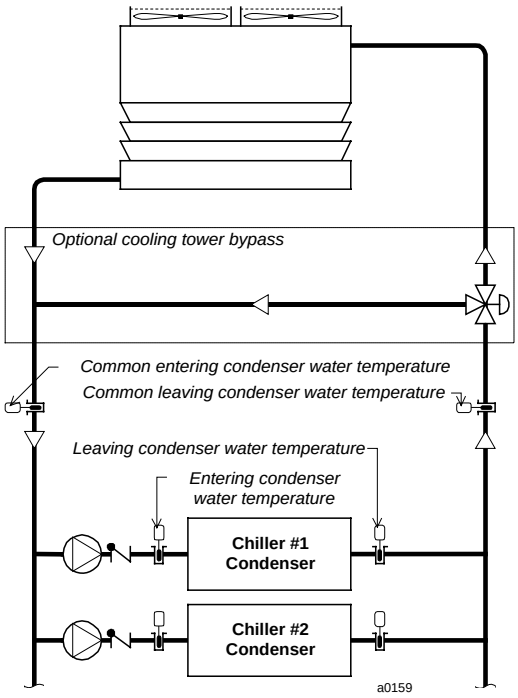
The CSM can control a cooling tower system that has up to 12 stages of heat rejection. It can also control a tower bypass valve, but this is not required.

A typical condenser water loop is shown in the Figure 23. Notice that the condenser pumps at the chillers pump water through the system. The CSM does not directly control the operation of these pumps; the chiller controllers do.

When to Use the CSM's Cooling Tower Control

MicroTech II water-cooled chiller unit controllers and the CSM both have cooling tower control capability. If the cooling tower system is piped so that it is common to all chillers, you should use the CSM for cooling tower control. This type of configuration is shown in Figure 23. If each chiller has a dedicated cooling tower, you should use the chiller controllers for cooling tower control.

Figure 23. Typical Condenser Water Loop



Tower Staging Logic

Cooling tower staging logic depends on whether or not there is a bypass valve in the system, and if there is, it further depends on how the valve is controlled. There are three possible applications, which are described below:

1. Tower staging only
2. Tower staging with low-limit controlled bypass valve
3. Tower staging with intrastage controlled bypass valve

In all of these applications, the CSM controls up to 16 digital outputs, which can be arranged in up to 12 stages. The number of outputs does not need to match the number of stages. A separate temperature setpoint is provided for each cooling tower stage. You can change each of the 12 tower stage setpoints.

Control Temperature

The CSM controls the tower stages and the tower bypass valve (if any) to maintain a desired condenser water temperature. This temperature is called the *Control Temperature*, and it can be either the common entering condenser water temperature or the common leaving condenser water temperature. You can specify which one it is with the Control Temperature Source variable.

Tower Stage 1 Setpoint Reset

The Stage 1 Setpoint may be reset, in which case all the other setpoints will be adjusted along with stage 1 based on their original offset from stage 1. Reset is possible in two ways:

- Set by the BAS
- Continually Reset by the CSM to maintain a constant approach temperature differential between the condenser water supply temperature and the wet bulb temperature

► **To set up Constant Approach Reset of the cooling tower's Stage 1 Setpoint**

1. Set the Constant Approach Flag = ON
2. Set the Constant Approach Temperature Differential as required
3. Set the Constant Approach Reset – Minimum Setpoint

4. When constant approach reset is used, the Control Temperature Source variable must be set to “Entering Cond Water”

Note: An OAT sensor and Relative Humidity Sensor must be installed and not in an alarm condition.

Tower Stage Table

A *tower stage* is defined as a set of tower outputs. An output might be used to start a fan, set the speed of a two-speed fan or enable a VFD. In any case, as the stage number increases, the proper outputs should be specified so that the heat rejection capacity increases. Outputs in the current stage are closed; any other tower outputs are opened.

An example of the tower stage table is shown in Figure 24. Assume that this system has three two-speed fans that are controlled in six stages. Each fan is assigned two outputs: an odd output for high speed, and an even output for low speed. Fan #1 has outputs 1 and 2; Fan #2 has outputs 3 and 4; and Fan #3 has outputs 5 and 6. Actual staging operation is shown in Table 15.

Figure 24. Tower Stage Table (Main>Configuration>Clg Tower Control>Tower Stage Table)

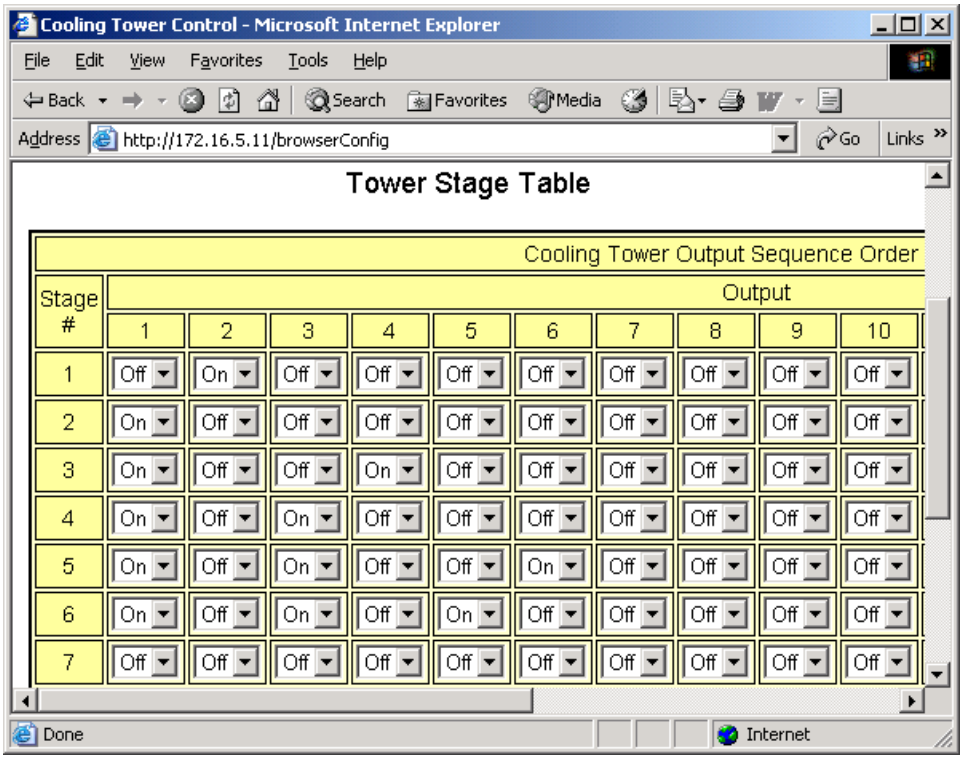


Table 15. Actual Cooling Tower Staging

Tower Stage	Result
Stage 1	Fan #1 low speed
Stage 2	Fan #1 high speed
Stage 3	Fan #1 high speed, Fan #2 low speed
Stage 4	Fan #1 high speed, Fan #2 high speed
Stage 5	Fan #1 high speed, Fan #2 high speed, Fan #3 low speed
Stage 6	Fan #1 high speed, Fan #2 high speed, Fan #3 high speed

Tower Staging with VFD’s

VFD’s and the Tower Stage Table

If the CSM will be modulating tower fans with VFD’s, set the Tower VFD Control Flag = Yes and fill in the Tower Stage Table using the following rules:

1. Place all fans controlled by VFDs in Stage 1. This provides the highest efficiency by maximizing the tower heat exchange surface area used (reference ASHRAE Handbook - HVAC Applications).
2. Place all fans not controlled by VFDs in the Tower Stage Table as desired. If multi-speed fans are used, best performance is typically achieved by staging all fans on at low speed first, then staging up to higher speeds.

The CSM will control all VFDs at the same speed to maintain the Control Temperature. Stage 2 will not be energized until the stage 2 setpoint is reached **AND** the tower VFD speed output is greater than the operator input of *Fan Speed of First Non-VFD Fan* variable.

PI Control Process for Tower VFD's

The CSM can control Tower VFD speed to maintain the Control Temperature at the Tower Stage 1 Setpoint. The VFDs are activated just like a non-VFD fan using tower outputs 1-16. The CSM uses a proportional-integral (PI) control loop to generate one analog speed signal, which it sends to the VFD's via analog outputs on the Remote I/O Modules. The Tower VFD Speed variable *(Clg Tower Status* screen) shows the current value of this output signal. The same signal is always sent to all tower VFD outputs.

When the Control Temperature is above the tower Stage 1 Setpoint, the control loop increases the VFD speed. When the Control Temperature is below the setpoint, the control loop decreases the VFD speed. The range is from the Tower VFD Min Speed input to 100%.

The PI control loop has four adjustable variables that are dedicated to tower VFD control: (1) Tower VFD Deadband, (2) Tower VFD Prop Band, (3) Tower VFD Sample Time, (4) Tower VFD Integral Time. The Tower VFD PI Function time plot is provided on the *Clg Tower Control* screen to assist in tuning the PI loop.

Interstage Timers

The CSM uses a stage-up timer and a stage-down timer to coordinate staging. After any tower stage change, both timers reset and start counting down. The stage-up timer is set equal to the Tower Stage-Up Delay Time variable (default is 2 minutes), and the stage-down timer is set equal to the Tower Stage-Down Delay Time variable (default is 5 minutes).

A stage-up cannot occur while the stage-up timer is counting down. A stage-down cannot occur while the stage-down timer is counting down (unless a chiller stage-down forces the tower to stage-down, see "Linking Tower Capacity to Chiller Capacity" below).

When the system starts up, the stage-up timer likely has expired, and thus stages up immediately if all other stage-up conditions are satisfied.

Linking Tower Capacity to Chiller Capacity

You can link the available heat rejection capacity of the cooling tower to the amount of online cooling capacity with the Max Tower Stage variables (*Chiller Sequencing* screen). These variables allow you to define a separate maximum tower stage for each chiller staging sequence number. The CSM prevents a tower stage-up when the current tower stage is equal to the max tower stage variable for the current chiller sequence. If a chiller stage-down results in a max tower stage variable that is lower than the current tower stage, a forced tower stage-down occurs immediately—regardless of the Control Temperature or whether the stage-down timer has expired. If a forced stage-down occurs, the interstage timers reset as they would with any other stage change. The current Max Tower Stage value is displayed on the *Clg Tower Status* screen.

Note: Within a row, each chiller with the same Sequence Number must have the same Max Tower Stage.

As an example, consider a system that has six cooling tower stages. The highest Sequence Number with a running chiller is Sequence Number 4, and the Max Tower Stage variables of all chillers in the current row with Sequence Number = 4 are set to 5. If the current tower stage = 5, the CSM does not allow the tower to stage up any further. If a chiller stage-down suddenly occurs and the highest Sequence Number with a running chiller changes to Sequence Number 3, the CSM forces the tower to stage down to the Max Tower Stage value of the chillers with Sequence Number = 3. The current max tower stage is displayed on the *Clg Tower Status* screen.

Tower Staging Only

If the Tower Valve Control Option variable is "None" (no tower bypass valve), the tower stages are controlled as described below.

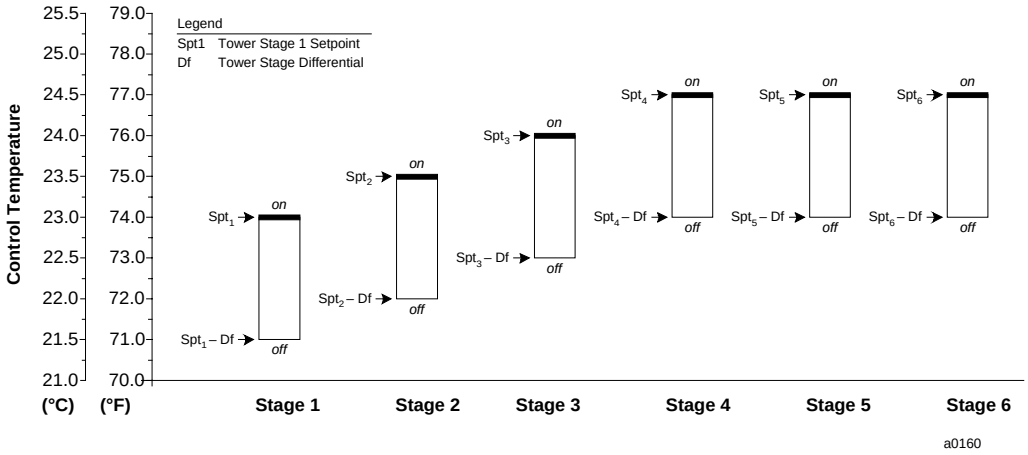
Stage-Up Control: The CSM stages up when the Control Temperature is too high. This occurs whenever the following three conditions are satisfied:

1. The stage-up timer has expired. (See “Interstage Timers” above.)
2. The Control Temperature is greater than the Tower Stage *x* Setpoint, where *x* is the next higher tower stage (1 through 12).
3. The current tower stage is less than the Max Tower Stage setting of the highest active sequence.

Stage-Down Control: The CSM stages down when the Control Temperature is too low. This occurs whenever the following two conditions are satisfied:

1. The stage-down timer has expired. (See “Interstage Timers” above.)
2. The Control Temperature is less than or equal to the Tower Stage *x* Setpoint minus the Tower Stage Differential, where *x* is the current tower stage (1 through 12).

Figure 25. Tower Staging Only



Tower Staging with Low-Limit Controlled Bypass Valve

If the Tower Valve Control Option variable is “Valve Setpoint,” the tower stages are controlled as described below.

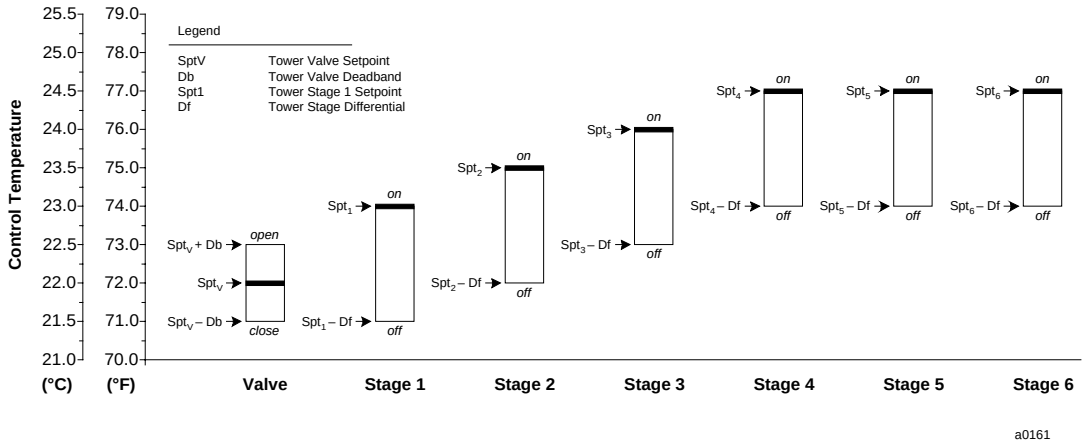
Stage-Up Control: The CSM stages up when the Control Temperature is too high. This occurs whenever the following four conditions are satisfied:

1. The stage-up timer has expired. (See “Interstage Timers” above.)
2. The Control Temperature is greater than the Tower Stage *x* Setpoint, where *x* is the next higher tower stage (1 through 12).
3. The current tower stage is less than the Max Tower Stage setting of the chillers in the highest active sequence.
4. The bypass valve position is greater than the Maximum Tower Valve Position Setpoint. (This ensures that the valve is sufficiently open to the tower.)

Stage-Down Control: The CSM stages down when the Control Temperature is too low. This occurs whenever the following two conditions are satisfied:

1. The stage-down timer has expired. (See “Interstage Timers” above.)
2. The Control Temperature is less than or equal to the Tower Stage *x* Setpoint minus the Tower Stage Differential, where *x* is the current tower stage (1 through 12).

Figure 26. Tower Staging With Low-Limit Controlled Bypass Valve



Tower Staging with Intrastage Controlled Bypass Valve

If the Tower Valve Control Option variable is "Stage Setpoint," the tower stages are controlled as described below.

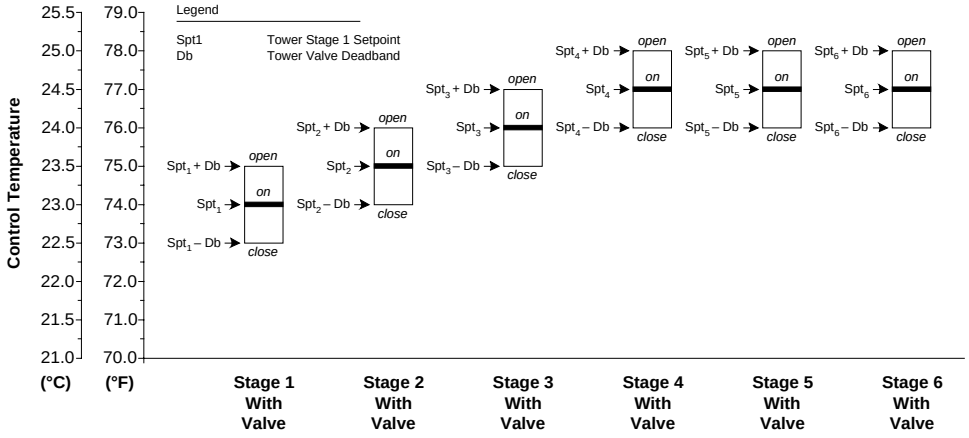
Stage-Up Control: The CSM stages up when the Control Temperature is too high. This occurs whenever the following four conditions are satisfied:

1. The stage-up timer has expired. (See "Interstage Timers" above.)
2. The Control Temperature is greater than the Tower Stage *x* Setpoint, where *x* is the next higher tower stage (1 through 12).
3. The current tower stage is less than the Max Tower Stage setting of the chillers in the highest active sequence.
4. The bypass valve position is greater than the Maximum Tower Valve Position Setpoint. (This ensures that the valve is sufficiently open to the tower.)

Stage-Down Control: The CSM stages down when the valve is bypassing more heat than the stage to be turned off can reject. This occurs whenever the following two conditions are satisfied:

1. The stage-down timer has expired. (See "Interstage Timers" above.)
2. The bypass valve position is less than the Minimum Tower Valve Position Setpoint. (This setting must be determined by trial and error.)

Figure 27. Tower Staging With Intrastage Controlled Bypass Valve



Examples of Applications

Examples of the three tower staging control applications are shown in the three previous figures. All three applications have six stages, and all stage setpoints are the same.

The tower-only application (Figure 25) is straightforward. The first four stages have successively higher setpoints, which effectively resets the Control Temperature as the load increases. The last two stages have the same setpoint as stage 4. Because of this, the interstage time variables must be set long enough to prevent cycling.

The tower with low-limit controlled bypass valve (Figure 26) is similar to the tower-only application. The valve modulates open when the Control Temperature is greater than the Tower Valve Setpoint by more than half the Tower Valve Deadband, and it modulates closed when the Control Temperature is less than the Tower Valve Setpoint by more than half the Tower Valve Deadband. When the Control Temperature is within the range defined by the Tower Valve Deadband, the valve holds its position. The first stage cannot start until the valve is sufficiently open.

The tower with an intrastage controlled bypass valve (Figure 27) is a combination of the two applications. The valve modulates open when the Control Temperature is greater than the *current stage's* setpoint by more than half the Tower Valve Deadband, and it modulates closed when the Control Temperature is less than the current stage's setpoint by more than half the Tower Valve Deadband. When the Control Temperature is within the range defined by the Tower Valve Deadband, the valve holds its position. The "off" point for each stage is not shown in the figure because it does not depend on the Control Temperature; instead, it depends on the bypass valve position. The valve cannot reach the stage-down position unless it is closing, and it cannot close unless the Control Temperature is below the Tower Valve Deadband range.

The settings of the variable used in the examples are as follows:

Variable	Setting
Tower Stage 1 Setpoint	74.0°F (23.0°C)
Tower Stage 2 Setpoint	75.0°F (23.5°C)
Tower Stage 3 Setpoint	76.0°F (24.0°C)
Tower Stage 4 Setpoint	77.0°F (24.5°C)
Tower Stage 5 Setpoint	77.0°F (24.5°C)
Tower Stage 6 Setpoint	77.0°F (24.5°C)
Tower Stage Differential	3.0°F (1.5°C)
Tower Valve Setpoint	72.0°F (22.0°C)
Tower Valve Deadband	2.0°F (1.1°C)

► **To set up cooling tower staging logic**

1. Set the Tower Control Flag to "Yes."
2. Commission Remote I/O Modules E, F, G, and/or H on the *Device Addressing* screen as required based on the number of tower outputs required.
3. Set the Control Temperature Source variable to one of the following:
   - "Entering Cond Water" (entering condenser water temperature control)
   - "Leaving Cond Water" (leaving condenser water temperature control)
3. Set the Number of Tower Stages variable to the number of stages you assign in the stage table.
4. Set up the stage table by setting the Stage *x* ∗ Output *y* variables (1 through *x*, where *x* is the number of stages specified in step 3).
5. Set the Tower Valve Control Option variable to one of the following:
   - "None," if there is no tower bypass valve
   - "Valve Setpoint," if there is a tower bypass valve and it is used to provide low-limit temperature control
   - "Stage Setpoint," if there is a tower bypass valve and it is used to provide intrastage temperature control

   If you are using a tower bypass valve, see "Tower Bypass Valve Control" below for additional setup information.
6. Set the tower Stage *x* Setpoint variables as required (1 through *x*, where *x* is the number of stages specified in step 3).
7. Set the following staging variables as required:
   - Tower Stage Differential (not needed for intrastage)
   - Tower Stage-Up Delay Time

- Tower Stage-Down Delay Time

7. If you are using VFD controlled fans, set the following valve variables as required:
   - Tower VFD Control Flag
   - Tower VFD Deadband, Prop Band, Sample Time, Integral Time
   - Set the Tower VFD AO Zero variables on the *I/O Config* screen to match the VFD's analog input.
   - Fan Speed of First Non-VFD Fan
8. If you are using a bypass valve in a low-limit control application, set the following valve variables as required:
   - Tower Valve Setpoint
   - Tower Valve Deadband
   - Max Tower Valve Position Setpoint
9. If you are using a bypass valve in a intrastage control application, set the following valve variables as required:
   - Tower Valve Deadband
   - Min Tower Valve Position Setpoint
   - Max Tower Valve Position Setpoint

Tower Bypass Valve Control

The CSM can control the position of a cooling tower bypass valve to maintain the Control Temperature at the Tower Valve Setpoint (low-limit control) or the individual stage setpoints (intrastage control). Except for the setpoint used, the CSM's tower bypass valve control method is the same in either case.

A cooling tower bypass valve can be either type: normally open (NO) to the tower or normally closed (NC). The operator can specify which type it is with the Tower Valve Type variable.

NC Tower Valve: If the valve type is normally closed, the CSM increases the voltage or current signal to the valve as it opens the valve to the tower. When there is no control signal, the valve should be closed to the tower (full bypass).

NO Tower Valve: If the valve type is normally open, the CSM decreases the voltage or current signal to the valve as it opens the valve to the tower. When there is no control signal, the valve should be open to the tower (no bypass). This is a reverse active valve and the signal to the analog output will be inverted from the Cooling Tower Bypass Valve Position shown on the *Clg Tower Status* screen.

The CSM uses a proportional-integral (PI) control loop to generate an analog valve position signal, which it sends to the valve via an analog output (AO 1 on Remote E). The Cooling Tower Bypass Valve Position (% Open to Tower) variable (*Clg Tower Status* screen) shows the current value of this signal.

PI Control Process for Tower Valve Position

When the Control Temperature is above the Tower Valve Setpoint, the control loop increases the valve position, which opens the valve to the tower. When the Control Temperature is below the setpoint, the control loop decreases the valve position, which closes the valve to the tower and increases the bypass flow. The position can modulate from Tower Valve Control Range Min input (Default = 0% NC low signal; NO high signal) to Tower Valve Control Range Max input (Default = 100% NC high signal; NO low signal).

The PI control loop has four adjustable variables that are dedicated to tower bypass valve control: (1) Tower Valve Deadband, (2) Tower Valve Prop Band, (3) Tower Valve Sample Time, (4) Tower Valve Integral Time. The Tower Valve PI Function time plot is provided on the *Clg Tower Control* screen to assist in tuning the PI loop.

Start-Up Valve Position Control

When the chiller system is starting up, the CSM positions the bypass valve to anticipate the heat rejection needed. This action occurs whenever (1) at least one chiller has been Enabled and (2) no chillers are in the Running chiller state. The initial valve position is based on the outdoor air temperature and a reset function, which is shown in Figure 28 and Figure 29. The following variables define the function:

- Minimum Tower Valve Start-Up Position
- Maximum Tower Valve Start-Up Position
- Minimum Tower Valve Start-Up Position At (OAT)
- Maximum Tower Valve Start-Up Position At (OAT)

For example, if the settings of the figures are used, the following occurs:

Outdoor air Temperature	Initial Valve Position
55.0°F (12.5°C)	20% open to tower
75.0°F (22.5°C)	60% open to tower
90.0°F (30.0°C)	100% open to tower

When at least one chiller enters the Running chiller state, the CSM begins modulating the bypass valve to maintain the Control Temperature, starting from the initial position. The valve is fully closed to the tower (Tower Valve Control Range Min – Default = 0%) when all of the chillers are in the Off chiller state.

The initial valve position does not need to be based on the outdoor air temperature. If the minimum and maximum position variables are set to the same value, the initial valve position always is set to that value regardless of the outdoor air temperature. By doing this, you can use the initial valve position function even if you do not have an outdoor air temperature source.

Note: If communications are lost with a BAS that is supplying the outdoor air temperature, the CSM retains and uses the last temperature it received until communications are restored.

Figure 28. Initial Tower Bypass Valve Position (English)

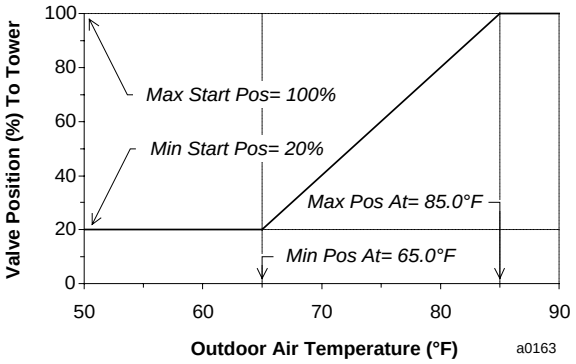
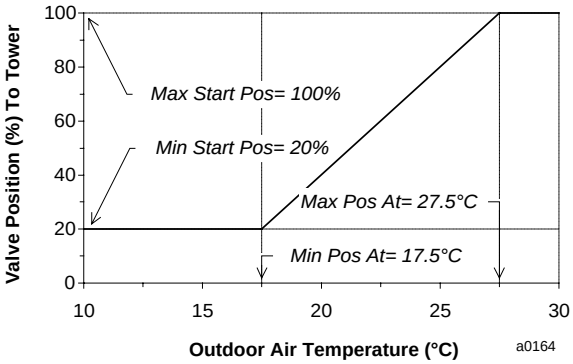


Figure 29. Initial Tower Bypass Valve Position (SI)



► **To set up cooling tower bypass valve control**

1. Set up the cooling tower staging logic as described above in the "Tower Staging Logic" sub-section.
2. Commission Remote I/O Module E on the *Device Addressing* screen and set the Tower Bypass Valve AO Zero variables on the *I/O Config* screen.
3. Set the following variables as required:
   - Tower Valve Deadband

- Tower Valve Propband
- Tower Valve Sample Time
- Tower Valve Integral Time
- Minimum Tower Valve Start-Up Position
- Maximum Tower Valve Start-Up Position
- Minimum Tower Valve Start-Up Position At (OAT)
- Maximum Tower Valve Start-Up Position At (OAT)

Chilled Water Flow Control

The CSM can maintain a constant differential pressure across the cooling loads by controlling a loop bypass valve, variable speed cooling load pump(s), or a set of constant speed cooling load pumps. For applications that require a "lead/standby" arrangement of two pumps, the CSM can automatically alternate the lead pump to equalize run time. To view the current values of the load flow operation, go to the *Flow* screen. To configure the chilled water flow control operation, go to the *Load Flow Control* screen to change the values described in Table 16.

Table 16. Load Flow Control (Main > Configuration > Load Flow Control)

Load Flow Control	
Name	**Description**
Pump Control Option	If the CSM will be controlling cooling load pumping, set this value to meet the pump configuration. Range = None, One Pump, Auto Lead, Pump 1 Lead, Pump 2 Lead, Sequencing, Multiple VFD Pumps. Default = None
Pump Status Check Delay Time	Used to determine a pumps alarm status. Any time the CSM has enabled a pump it monitors that pumps status switch. If the status switch of an enabled pump is open, the CSM waits until this Pump Status Check Delay time expires before setting the pump in alarm. Range = 1 to 60 seconds. Default = 30 seconds
Lead/Standby Pump Resequence Day/Time	If the Pump Control Option is Auto Lead, this will force the running pump at the defined time to be the pump with the lowest accumulated run time. If the control option is Pump 1, this will force Pump 1 (CSM in occupied mode) to be the running pump at the defined time. If the control option is Pump 2, this will force Pump 2 (CSM in occupied mode) to be the running pump at the defined time.[1] Default = N/A
Resequence Lead/Standby Pumps NOW	If the Pump Control Option is Auto Lead, this button will force the running pump to be the pump with the lowest accumulated run time. If the control option is Pump 1, this button will force Pump 1 to be the running pump. If the control option is Pump 2, this button will force pump 2 to be the running pump.[1] Default = N/A
Pump 1 Runtime Reset Pump 2 Runtime Reset Pump 3 Runtime Reset Pump 4 Runtime Reset Pump 5 Runtime Reset Pump 6 Runtime Reset	The Pump Runtime Reset variables can be used to tell the CSM what the pump runtime value is for an existing pump. Also, if an old pump is replace by a new pump, the runtime can be reset to zero. The CSM uses pump runtime to determine a "lead" pump when Pump Control Option = Auto Lead. It also uses pump runtime to determine the next pump to enable when Pump Control Option = Multiple VFD Pumps
Chilled Water Loop Modulation Control Option	If the CSM will be controlling the differential pressure across the load, set this value to meet the system configuration. Range = None, Chilled Water Loop Bypass Valve, Pump VFD. Default = None
Loop Differential Pressure Setpoint	This input is the user defined differential pressure across the load setpoint. If the Chilled Water Loop Modulation Control Option = Chilled Water Loop Bypass Valve or Pump VFD, the output will be modulated to maintain the differential pressure at this setpoint. If the Pump Control Option = Sequencing, pump stages will be increased to supply this differential pressure. Range = 2 - 99 psi (13 – 683 kPa). Default = 10 psi (69 kPa)
Loop Differential Pressure Deadband	This value sets a Deadband around the *Loop Differential Pressure Setpoint*. No control action is taken when the current Differential Pressure is within this Deadband around the Loop Differential Pressure Setpoint. Range = 0 – 9 psi (0 – 62 kPa). Default = 2 psi (13 kPa)
Loop Differential Pressure	This value sets the "proportional band" used in the PID control function that modulates the loop differential pressure. In general, increasing this value has a slowing effect and decreasing this value has a speeding effect on the control of the valve

Propband	position or VFD speed. Range = 1 – 99 psi (6 – 683 kPa). Default = ±10 psi (±69 kPa)
Loop Differential Pressure Sample Time	This value sets the "sampling period" used in the PID control function that modulates the loop differential pressure. In general, increasing this value has a slowing effect and decreasing this value has a speeding effect on the control of the valve position or VFD speed. When using a pump VFD, a typical sample time to start tuning the system is one second. When using a loop bypass valve a typical sample time to start tuning the system is 15 seconds. Range = 1 – 60 seconds. Default = 1 second
Loop Differential Pressure Integral Time	This value varies the "integral time" used in the PID control function that modulates the loop differential pressure. In general, increasing this value has a slowing effect and decreasing this value has a speeding effect on the control of the valve position or VFD speed. Range = 1 - 240 seconds. Default = 120 seconds
Loop Differential Pressure PI Function Graph	A graph of the Differential Pressure vs. Time is shown at the bottom of the page when the Chilled Water Loop Modulation Control Option = Chilled Water Loop Bypass Valve or Pump VFD to assist in tuning the PI loop.
Minimum Loop Bypass Valve Position	If the Pump Control Option = Sequencing and the Chilled Water Loop Modulation Control Option = Chilled Water Loop Bypass Valve, the bypass valve must be less than this Minimum Loop Bypass Valve Position for a pump stage-up to occur. Range = 0 to 100 %. Default = 20%
Maximum Loop Bypass Valve Position	If the Pump Control Option = Sequencing and the Chilled Water Loop Modulation Control Option = Chilled Water Loop Bypass Valve, the bypass valve must be less than this Maximum Loop Bypass Valve Position for a pump stage-down to occur. Range = 0 to 100 %. Default = 90%

Multiple VFD Controlled Pumps (if Pump Control Option = Multiple VFD Pumps, the following inputs are valid)

Name	Description
Number of VFD Controlled Pumps	This input defines the maximum number of VFD controlled pumps that the CSM will enable in order to satisfy the cooling load's demand for flow. Range = 2 to 6 pumps. Default = 2 pumps.
1st Pump Stage-Up % 2nd Pump Stage-Up % 3rd Pump Stage-Up % 4th Pump Stage-Up % 5th Pump Stage-Up %	If the Pump Control Option = Multiple VFD Pumps, stage-up from 1 pump enabled to 2 pumps enabled will not occur until the Cooling Load Pump VFD Speed has been above the 1st Pump Stage-Up % for a continuous period of time greater than the 1st Pump Stage-Up Delay Time. Stage-up from 2 pumps enabled to 3 pumps enabled cannot occur until the Cooling Load Pump VFD Speed has been above the 2nd Pump Stage-Up % for a continuous period of time greater than the 2nd Pump Stage-Up Delay Time, etc. Range = 0 to 100%. Default = 95%
1st Pump Stage-Up Delay Time 2nd Pump Stage-Up Delay Time 3rd Pump Stage-Up Delay Time 4th Pump Stage-Up Delay Time 5th Pump Stage-Up Delay Time	If the Pump Control Option = Multiple VFD Pumps, stage-up from 1 pump enabled to 2 pumps enabled cannot occur until the Cooling Load Pump VFD Speed has been above the 1st Pump Stage-Up % for a continuous period of time greater than the 1st Pump Stage-Up Delay Time. Stage-up from 2 pumps enabled to 3 pumps enabled cannot occur until the Cooling Load Pump VFD Speed has been above the 2nd Pump Stage-Up % for a continuous period of time greater than the 2nd Pump Stage-Up Delay Time, etc. Range = 1 to 60 minutes. Default = 2 minutes
2nd Pump Stage-Down % 3rd Pump Stage-Down % 4th Pump Stage-Down % 5th Pump Stage-Down % 6th Pump Stage-Down %	If the Pump Control Option = Multiple VFD Pumps, stage-down from 2 pumps enabled to 1 pump enabled cannot occur until the Cooling Load Pump VFD Speed has been below the 2nd Pump Stage-Down % for a continuous period of time greater than the 2nd Pump Stage-Down Delay Time. Stage-down from 3 pumps enabled to 2 pumps enabled cannot occur until the Cooling Load Pump VFD Speed has been below the 3rd Pump Stage-Down % for a continuous period of time greater than the 3rd Pump Stage-Down Delay Time, etc. Range = 0 to 100 %. Default = 47.5%, 63%, 71%, 76%, 79% respectively
2nd Pump Stage-Down Delay Time 3rd Pump Stage-Down Delay Time 4th Pump Stage-Down Delay Time 5th Pump Stage-Down Delay Time 6th Pump Stage-Down Delay Time	If the Pump Control Option = Multiple VFD Pumps, stage-down from 2 pumps enabled to 1 pump enabled cannot occur until the Cooling Load Pump VFD Speed has been below the 2nd Pump Stage-Down % for a continuous period of time greater than the 2nd Pump Stage-Down Delay Time. Stage-down from 3 pumps enabled to 2 pumps enabled cannot occur until the Cooling Load Pump VFD Speed has been below the 3rd Pump Stage-Down % for a continuous period of time greater than the 3rd Pump Stage-Down Delay Time, etc. Range = 1 to 60 minutes. Default = 5 minutes

Sequencing Constant Flow Pumps (if Pump Control Option = Sequencing, the following inputs are valid)	
Name	**Description**
Number of Sequenced Pump Stages	If the Pump Control Option = Sequencing, this input defines the highest stage that the CSM will stage-up to in its Pump Sequence Order table. Range = 1 to 9 stages. Default = 6 stages
Pump Stage Differential	If the Pump Control Option = Sequencing, the CSM will not stage-down until the differential pressure is greater than or equal to the Differential Pressure Setpoint plus this Pump Stage Differential. Range = 0 to 9 psi (0 to 62 kPa). Default = 2 psi (13 kPa)
Pump Stage-Up Delay Time	If the Pump Control Option = Sequencing, the next stage-up cannot occur until after this period of time expires. Range = 1 to 60 minutes. Default = 2 minutes
Pump Stage-Down Delay Time	If the Pump Control Option = Sequencing, the next stage-down cannot occur until after this period of time expires. Range = 1 to 60 minutes. Default = 5 minutes
Stage 1, Pump 1 Stage 1, Pump 2 Stage x, Pump y	These input values are used to set the pump order if the Pump Control Option = Sequencing. See the "Pump Logic: Sequenced Pumps" section later in this document for further information.

[1]The standby pump takes over if the lead pump fails, causing the CSM to lose sequence. To properly reset the CSM after the pump has been fixed, clear the error on the failed pump and then switch the CSM from occupied to unoccupied to initialize the pump sequence (refer to Changing Values on the User Interface's Configuration Screens on p.19).

The CSM can control a variety of chilled water distribution system equipment in several combinations. There are seven basic configurations:

1. Constant-speed secondary pump, with optional pressure-controlled loop bypass valve
2. Constant-speed lead/standby secondary pump set, with optional pressure-controlled loop bypass valve
3. Constant-speed sequenced pumps (two to six), with optional pressure-controlled loop bypass valve
4. Variable-speed cooling load pump
5. Variable-speed lead/standby cooling load pump set
6. Multiple Variable-speed pumps (two to six)
7. Optional pressure-controlled loop bypass valve (primary-only system)

Typical, schematic representations of these configurations are shown in Configurations 1 through 6. Configurations 1 through 5 are primary-secondary (Decoupled) systems. Configuration 6 is a primary-only system.

The following sub-sections are organized according to the types of equipment that you may have in your system. You only need to read the ones that apply to your application. For example, if your system is like configuration 4, you should look at "Pump Logic: Single Pump" and "Pump Speed Control." Or if your system is like configuration 3 with the optional bypass valve, you should look at "Pump Logic: Sequenced Pumps" and "Loop Bypass Valve Control."

Figure 30. Configuration 1: Constant-Speed Single Pump

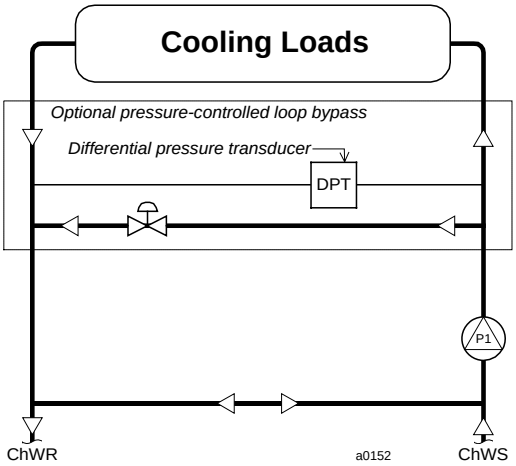


Figure 31. Configuration 2: Constant-Speed Lead/Standby Pump Set

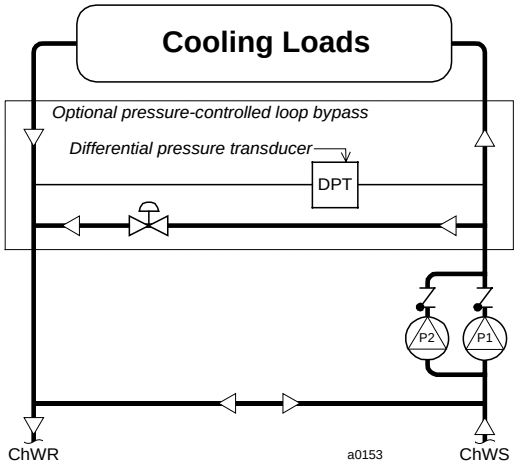


Figure 32. Configuration 3: Constant-Speed Sequenced Pumps

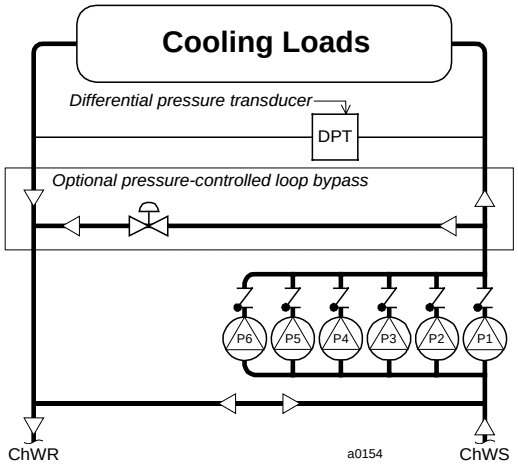


Figure 33. Configuration 4: Variable-Speed Single Pump

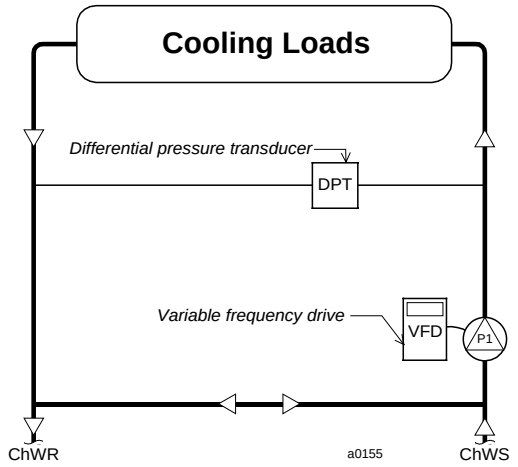


Figure 34. Configuration 5: Variable-Speed Lead/Standby Pump Set

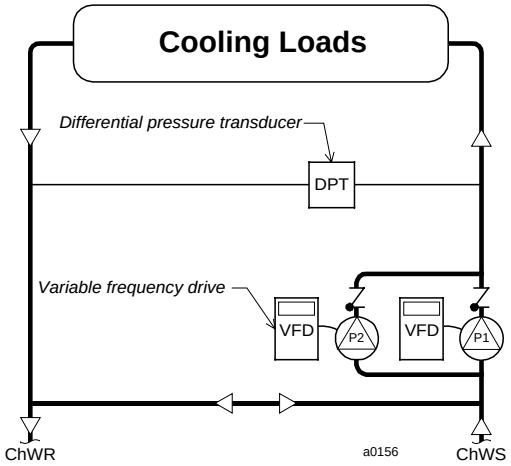


Figure 35. Configuration 6: Multiple Variable-Speed Pumps

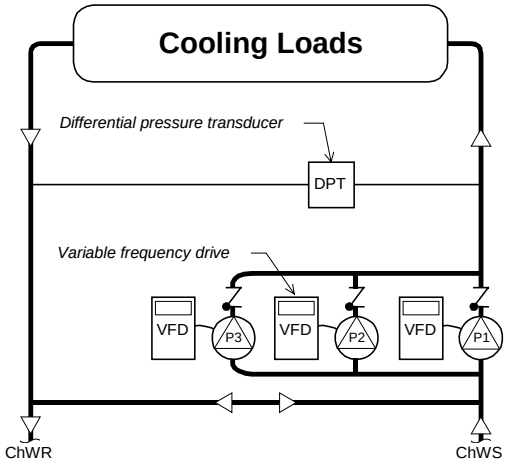
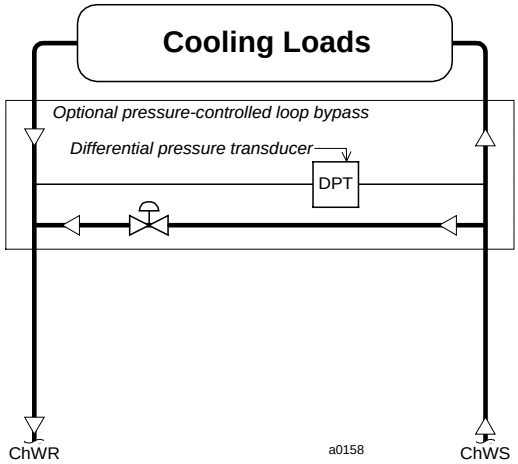


Figure 36. Configuration 7: Primary-Only System



Pump Logic: Single Pump

Configurations 1 and 4 use the CSM's single-pump cooling load pump logic. Single-pump logic simply starts the pump when the system starts and stops it when the system stops. Note that the pump is identified as Cooling Load Pump #1 on the *Flow* screen.

Pump Failure

After the CSM enables the pump, it continually checks the Cooling Load Pump #1 Status to verify that it is operating (true-switch closed). If the CSM finds that the pump is not operating (Status = false-switch open), it immediately starts a timer which is set equal to the Pump Status Check Delay Time variable (default is 30 seconds). If the status returns before the timer expires, the timer resets and stops, and the system continues to operate normally. If the timer expires before the status returns:

- The No Chilled Water Flow alarm occurs and the system shuts down.
- The Cooling Load Pump #1 Fail manual reset alarm occurs. The pump will not run again until the operator clears the CSM alarms.
- The pump 1 output is de-energized.

► **To set up single-pump logic**

1. Set the Pump Control Option variable to "Single Pump."
2. Set the Chilled Water Loop Modulation Control Option variable to one of the following:
   - "None," if there is no variable frequency drive or loop bypass valve.
   - "Chilled Water Loop Bypass Valve," if there is a loop bypass valve (see "Loop Bypass Valve Control" below).
   - "Pump VFD," if there is a variable frequency drive (see "Pump Speed Control" below).
3. Set the Pump Status Check Delay Time variable as required.

Note: To use single-pump cooling load pump control, connect a pump status device with dry contacts to the CSM. If pump status is not available, a jumper can be installed, *but this defeats the CSM's pump-failure alarm control.* This alarm control can fail-safe the system by shutting it down if the pump fails. *Using a jumper for pump status is not recommended.*

Pump Logic: Lead/Standby (Auto Lead, Pump 1 Lead, Pump 2 Lead)

Configurations 2 and 5 use the CSM's lead/standby pump logic. Lead/standby logic can be applied to a set of two pumps, which are identified as Cooling Load Pump #1 and Cooling Load Pump #2 on the *Flow* screen. It allows only one pump to operate at any one time. If the running pump fails, the other pump starts.

The "lead" pump is the pump that starts when the system starts. It can be either Pump #1 or Pump #2. You can designate the lead pump manually or let the CSM do it automatically, according to run time. Lead/standby logic provides three control options: Auto Lead, Pump 1 Lead, and Pump 2 Lead.

Automatic Lead Designation

When the Auto Lead option is selected, the CSM designates the lead pump as required to equalize each pump's run time. The pump with less run time is lead, and the pump with more run time is standby. You can view each pump's run time on the *Flow* screen.

Manual Lead Designation

When the Pump 1 Lead option is selected, the CSM designates Pump #1 as lead. When the Pump 2 Lead option is selected, the CSM designates Pump #2 as lead. Once you manually designate the lead pump in this way, that pump remains lead until you change it.

Implementing a new "Lead" pump

If the pump that is designated "lead" changes—whether manually or automatically—while the system is operating, the CSM does not stop one pump and start the other. A new lead pump is *implemented* only under certain conditions.

Natural Lead Pump Implementation

Natural lead pump implementation automatically occurs whenever the CSM is in any Off operating state. For a typical chiller system that is shut down daily, a new lead pump is implemented within 24 hours (at most). If your chiller system seldom or never shuts down, you should consider using forced lead pump implementation.

Forced Lead Pump Implementation

With the Resequence Lead/Standby Pumps NOW button you can manually force the lead pump to change. With the Lead/Standby Pump Resequence Day/Time input, you can force a new lead pump at a scheduled time on a scheduled day. You can choose any day of the week, every day, or holidays. The following selections are possible:

- Daily, any time
- Sunday, any time
- Monday, any time
- Tuesday, any time
- Wednesday, any time
- Thursday, any time
- Friday, any time
- Saturday, any time
- Holidays, any time

If you set the Lead/Standby Pump Resequence Day/Time variable's day setting to "Holiday," the forced lead pump implementation occurs when a scheduled holiday occurs. In this way you can customize the lead pump changeover schedule to make it, for example, biweekly, monthly, or quarterly. You can disable the scheduled lead pump changeover feature by setting the Lead/Standby Pump Resequence Day/Time variable to "N/A" (default).

When you press the "Now" button or when the current day and time match the Lead/Standby Pump Resequence Day/Time variable's setting, the following occurs if the CSM is in the Recirculate or On state:

1. The designated lead pump is started.
2. The standby pump stops.

Pump Failure

After the CSM enables the lead pump, it continually checks the Cooling Load Pump #1 (or #2) Status to verify that it is operating. If the CSM finds that the pump is not operating (switch open), it immediately starts a timer, which is set equal to the Pump Status Check Delay Time variable (default is 30 seconds). If the status returns before the timer expires, the timer resets and stops, and the system continues to operate normally. If the timer expires before the status returns:

- The standby pump is enabled
- The Cooling Load Pump #1 Fail manual reset alarm occurs. The pump will not run again until the operator clears the CSM alarms
- The lead pump's output is de-energized

When the CSM starts the standby pump, it checks the pump's status in the same manner described above. If the standby pump starts successfully, it becomes the new lead pump and the failed pump becomes the new standby pump. If the standby pump does not start, the No Chilled Water Flow alarm occurs and the system shuts down.

► **To set up lead/standby pump logic**

1. Set the Pump Control Option variable to "Auto Lead," "Pump 1 Lead," or "Pump 2 Lead"
2. Set the Chilled Water Loop Modulation Control Option variable to one of the following:
   - "None," if there is no variable frequency drive or loop bypass valve
   - "Chilled Water Loop Bypass Valve," if there is a loop bypass valve (see "Loop Bypass Valve Control" below)
   - "Pump VFD," if there is a variable frequency drive (see "Pump Speed Control" below)
3. Set the following variables as required:
   - Pump Status Check Delay Time
   - Lead/Standby Pump Resequence Day/Time

Note: To use lead/standby pump logic, a pump status device with dry contacts must be connected to the CSM for each pump.

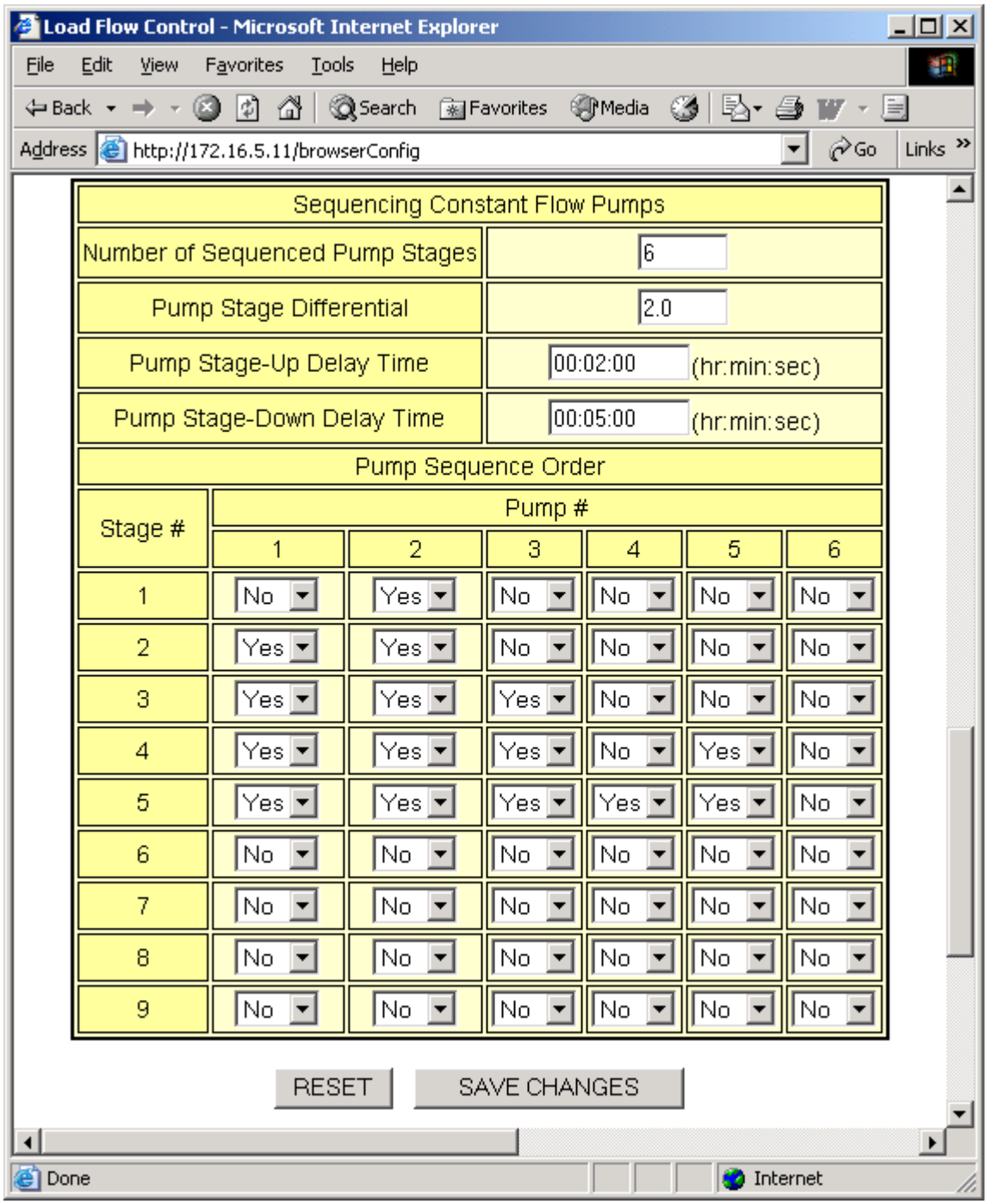
Pump Logic: Sequenced Constant-Speed Pumps

Configuration 3 uses the CSM's sequencing pump logic. Sequencing logic can be applied to a group of two to six pumps, which are identified as Cooling Load Pump #1 through Cooling Load Pump #6 on the *Flow* screen. It operates one or more pumps as required to maintain the differential pressure across the loop at the Loop Differential Pressure Setpoint. For applications that require exact differential pressure control, the CSM can modulate a loop bypass valve as it sequences the pumps.

Sequencing and Staging

A *pump stage* is defined as a set of pumps. As the CSM turns pumps on and off, it "stages up" and "stages down." Pumps in the current stage are started; other pumps are stopped.

Figure 37. Example of Pump Sequence Order Table (Main > Configuration > Load Flow Control)



An example of the pump sequence order table is shown in Figure 37. Notice that this system has five pumps and five stages. By comparing rows, you can see that this sequence order is as follows:

1. Pump #2
2. Pump #1
3. Pump #3
4. Pump #5
5. Pump #4

The current pump stage can be viewed on the *Flow* screen.

Interstage Timers

The CSM uses a stage-up timer and a stage-down timer to coordinate staging. After any pump stage change *or chiller stage change,* both timers reset and start counting down. The stage-up timer is set equal to the Pump Stage-Up Delay Time variable (default is 2 minutes), and the stage-down timer is set equal to the Pump Stage-Down Delay Time variable (default is 5 minutes). A pump stage change (up or down) cannot occur while the applicable timer is counting down. The timers are reset after a chiller is enabled or disabled so that the system has a chance to stabilize after a primary pump starts or stops.

Sequencing Logic, Without Loop Bypass Valve

Pump stage 1 is turned on when the chilled water system is turned on, and it is turned off when the system is turned off. If the Chilled Water Loop Modulation Control Option variable is "None" (no loop bypass valve), the other stages are controlled as described below.

Stage-Up Control: The CSM stages up when the differential pressure across the cooling loads is too low. This occurs whenever the following two conditions are satisfied:

1. The stage-up timer has expired. (See "Interstage Timers" above.)
2. The differential pressure is less than the Loop Differential Pressure Setpoint.

Stage-Down Control: The CSM stages down when the differential pressure across the cooling loads is too high. This occurs whenever the following two conditions are satisfied:

1. The stage-down timer has expired. (See "Interstage Timers" above.)
2. The differential pressure is greater than or equal to the sum of the Loop Differential Pressure Setpoint and the Pump Stage Differential.

Sequencing Logic, With Loop Bypass Valve

Pump stage 1 is turned on when the CSM has been set to On (Occupied) or the Recirculate Mode has been turned on, and it is turned off when the CSM is set to Off (Unoccupied) or the Recirculate Mode has been turned off. If the Chilled Water Loop Modulation Control Option variable is "Chilled Water Bypass Valve," the other stages are controlled as described below.

Stage-Up Control: The CSM stages up when the differential pressure across the cooling loads is too low. This occurs whenever the following four conditions are satisfied:

1. The stage-up timer has expired. (See "Interstage Timers" above.)
2. The differential pressure is less than the Loop Differential Pressure Setpoint.
3. The bypass valve position is less than the Minimum Loop Bypass Valve Position setting.
4. Condition 3 above has been true longer than the Pump Stage-Up Delay Time setting. (The stage-up timer continuously resets whenever condition 3 is *not* true.)

Stage-Down Control: The CSM stages down when the valve is bypassing more water than the stage to be turned off is supplying. This occurs whenever the following three conditions are satisfied:

1. The stage-down timer has expired. (See "Interstage Timers" above.)
2. The valve position is greater than the Maximum Loop Bypass Valve Position setting. (This setting must be determined by trial and error.)
3. Condition 2 above has been true longer than the Pump Stage-Down Delay Time setting. (The stage-down timer continuously resets whenever condition 2 is *not* true.)

Pump Failure

After the CSM enables any pump, it continually checks the pump's status to verify that it is operating. If the CSM finds that a pump is not operating (switch open), it immediately starts a timer, which is set equal to the Pump Status Check Delay Time variable (default is 30 seconds). If the status returns before the timer expires, the timer resets and stops, and the system continues to operate normally. If the timer expires before the status returns:

- A forced stage-up occurs.
- The Cooling Load Pump #X Fail alarms occurs.

If a pump fails, the CSM does not de-energize that pump's output when the timer expires—the output will be energized whenever it is part of the current stage. So if the problem goes away, the pump restarts immediately and the Cooling Load Pump #X Fail alarm will automatically be reset.

If the current pump stage is the highest stage and all pumps have failed, the No Chilled Water Flow alarm occurs and the system shuts down. As a result, all pump outputs are de-energized. The Number of Sequenced Pump Stages variable specifies the highest stage.

► **To set up sequencing constant-speed pump logic**

1. Set the Pump Control Option variable to "Sequencing."
2. Set the Number of Sequenced Pump Stages variable to the number of stages in the stage table.

   In a typical system, this number equals the number of pumps.
3. Commission Remote I/O Module A on the *Device Addressing* screen. If more than two pumps are to be controlled commission Remote I/O Modules B, if more than four pumps are to be controlled commission Remote I/O Module C.
4. Set up the stage table by setting the Stage *X*, Pump *Y* variables (1 through *x*, where *x* is the number of stages specified in step 2).
5. Set the Chilled Water Loop Modulation Control Option variable to one of the following:
   - "None," if there is no loop bypass valve
   - "Chilled Water Loop Bypass Valve," if there is a loop bypass valve (see "Loop Bypass Valve Control" below)
6. Set the following variables as required:
   - Pump Status Check Delay Time
   - Loop Differential Pressure Setpoint
   - Pump Stage-Up Delay Time
   - Pump Stage-Down Delay Time
7. If you're not using a bypass valve, set the Pump Stage Differential as required.
8. If you are using a bypass valve, set the following variables as required:
   - Minimum Loop Bypass Valve Position
   - Maximum Loop Bypass Valve Position

Note: To use sequencing pump logic, a differential pressure transducer must be installed and connected to the CSM. In addition, a pump status device with dry contacts should be connected to the CSM for each pump. If pump status is not available, jumpers can be installed, *but this defeats the CSM's pump-failure alarm control.* As described above, this alarm control can fail-safe the system by shutting it down if all pumps fail. *Using jumpers for pump status is not recommended.* For more information, see the Field Wiring section of IM 781.

Pump Logic: Multiple Variable-Speed Pumps

Configuration 6 uses the CSM's multiple variable-speed pump logic to control VFDs on pumps that have identical capacities and performance. This control can be applied to a group of two to six pumps, which are identified as Cooling Load Pump #1 through Cooling Load Pump #6 on the *Flow* screen. It operates one or more pumps as required to maintain the differential pressure across the loop at the Loop Differential Pressure Setpoint. This logic is different than Lead/Standby control of pumps with VFDs because it will run more than one pump at a time.

Sequencing and Staging

The *sequencing* order of multiple VFD pumps is based on pump runtime. The pump with the lowest runtime will be the 1st pump enabled, the pump with the next lowest runtime will be the 2nd pump enabled, etc. Pump runtime is defined and calculated by the CSM to be the amount of time the CSM has enabled the pump. Each pump's runtime can be reset by the operator at the *Load Flow Control* screen for any number of reasons including:

- Reset to match the known runtime of an existing pump
- Reset to an artificially large number to force a problem pump to be the last to be enabled

A *pump stage* is defined as the number of running pumps. When the CSM turns the next pump on, it "stages up". When the CSM turns a pump off, it "stages down". The Current Pump Stage is displayed on the *Flow* screen. The current Cooling Load Pump Speed (also on the *Flow* screen) and interstage timers determine when a pump is staged up or staged down.

Interstage Timers

The CSM uses the Stage-Up Delay Time and Stage-Down Delay Time variables for transition between stages. Different stage-up and stage-down delay times may be entered for each pump stage if desired. These stage timers start counting down after the Cooling Load Pump Speed crosses the current Stage-Up/Down % setpoint. Pump stage changes (up or down) will occur when the timer reaches zero. These timers are reset (set back to their full value) for three reasons;

- The Cooling Load Pump slips back across the current Stage-Up/Down % setpoint.
- A chiller stage change.
- The timer reached zero and the CSM performed the pump stage change.

When reset occurs on either timer, both timers reset and start counting down. The timers are reset after a chiller is enabled or disabled so that the system has a chance to stabilize after a chiller's flow valve opens or closes.

Sequencing Logic

The first cooling load pump (the pump with the lowest runtime) is turned on when the CSM has been set to On (Occupied) or the Recirculate Mode has been turned on. All cooling load pumps are turned off when the CSM is set to Off (Unoccupied) and the Recirculate Mode has been turned off.

Stage-Up Control: The CSM enables the next pump when the differential pressure across the cooling load is too low. This stage-up occurs whenever the following two conditions are satisfied:

1. The pump speed control PI loop has commanded the Cooling Load VFD Speed higher than the current pump's Stage-Up % setpoint.
2. Condition 1 above has been true for period of time longer than the current pump stage's Stage-Up Delay Time (with no chiller stage change).

Any time multiple VFD controlled pumps are running the CSM will always send the same signal to all VFDs so that all pumps operate at the same speed. When a new pump is enabled, its VFD will have the same speed setting as the previously running pumps. Initially the pump will run but not have enough speed to overcome the pressure differential created by the other operating pumps, as the pump accelerates it will generate enough pressure to produce flow. The acceleration rate of the VFDs must be set fast enough so that the newly enabled pump begins to generate flow in a reasonable amount of time to prevent overheating of the pump. The resulting acceleration time (time from zero to maximum frequency) of the VFD must be less that the Pump Status Check Delay Time variable to avoid nuisance Cooling Load Pump #X Fail alarms

As the new pump's flow is added to the system, the pumps will create more flow than required by the cooling loads, which will increase the loop differential pressure above the setpoint. The pump control PI loop will notice the increased loop differential pressure and decrease the speed of the pumps.

Stage-Down Control: The CSM stages down when the differential pressure across the cooling loads is too high. This occurs whenever the following two conditions are satisfied:

1. The pump speed control PI loop has commanded the Cooling Load VFD Speed lower than the current pump's Stage-Down % setpoint.
2. Condition 1 above has been true for period of time longer than the current pump stage's Stage-Down Delay Time (with no chiller stage change).

Pump Failure

After the CSM enables any pump, it continually checks each pump's status to verify that it is operating. If the CSM finds that a pump is not operating (switch open), it immediately starts a timer, which is set equal to the Pump Status Check Delay Time variable (default is 30 seconds). If the status returns before the timer expires, the timer resets and stops, and the system continues to operate normally. Be sure that the acceleration time of the pump's VFD is less than the Pump Status Check Delay Time or the pump may not generate enough flow to satisfy the flow proving device before the timer expires. If the timer expires before the status returns:

- The pump with the next lowest runtime is enabled.
- The Cooling Load Pump #X Fail manual reset alarm occurs. The pump will not run again until the operator clears the CSM alarms.
- The failed pump's output is de-energized.

If all pumps have failed, the No Chilled Water Flow alarm occurs and the system shuts down. As a result, all pump outputs are de-energized.

► **To set up multiple variable-speed pump logic**

1. Set the Pump Control Option variable to "Multiple VFD Pumps."
2. Set the Number of VFD Controlled Pumps variable to the number of pumps to be controlled.
3. Commission Remote I/O Module A on the *Device Addressing* screen. If more than two pumps are to be controlled commission Remote I/O Modules B, if more than four pumps are to be controlled commission Remote I/O Module C.
4. Set the following variables as required for each pump stage up to the Number of VFD Controlled Pumps variable:
   - Stage-Up %
   - Stage-Up Delay Time
   - Stage-Down %
   - Stage-Down Delay Time
5. Set the Chilled Water Loop Modulation Control Option variable to "Pump VFD"(see "Pump Speed Control" below).
6. Set the Pump Status Check Delay Time as required.
7. Set the Loop Differential Pressure Setpoint as required.
8. Set the following variables as required to tune the Pump Speed Control PI Loop:
   - Loop Differential Pressure Deadband
   - Loop Differential Pressure Propband
   - Loop Differential Pressure Sample Time
   - Loop Differential Pressure Integral Time

Note: To use multiple VFD pump logic, a differential pressure transducer must be installed and connected to the CSM. In addition, a pump status device with dry contacts should be connected to the associated Remote I/O Module for each pump. The VFD fault output should also be wired in series with the pump status device. As described above, this alarm control can fail-safe the system by shutting it down if all pumps fail. For more information, see the Field Wiring section of IM 781.

Pump Speed Control

The CSM can control pump speed to maintain the differential pressure at the Loop Differential Pressure Setpoint. A VFD must control the pumps. The CSM uses a proportional-integral (PI) control loop to generate an analog pump speed signal, which it sends to the VFDs via 0-10 Vdc analog outputs (AO 1 and AO 2 on Remote A, B, and C). The Cooling Load Pump VFD Speed variable (*Flow* screen) shows the current value of this signal. The same signal is always sent to both analog outputs.

PI Control Process

When the pressure is above the Loop Differential Pressure Setpoint, the control loop reduces pump speed. When the pressure is below the Loop Differential Pressure Setpoint, the control loop increases pump speed. The speed can modulate between 0% and 100%.

The PI control loop has four adjustable variables that are used for pump speed control: (1) Loop Differential Pressure Deadband, (2) Loop Differential Pressure Propband, (3) Loop Differential Pressure Sample Time, (4) Loop Differential Pressure Integral Time. The Loop Differential Pressure PI Function time plot is provided on the *Load Flow Control* screen to assist in tuning the PI loop.

► **To set up pump speed control**

1. Set the Chilled Water Loop Modulation Control Option variable to "Pump VFD."
2. Commission Remote I/O Module A, B, and/or C on the *Device Addressing* screen. Set the Pump VFD AO Zero variables for all analog outputs used on the *I/O Config* screen to match the analog input of the pump's VFD.
3. Set the following variables as required:
   - Loop Differential Pressure Setpoint
   - Loop Differential Pressure Deadband
   - Loop Differential Pressure Propband
   - Loop Differential Sample Time
   - Loop Differential Integral Time

Loop Bypass Valve Control

The CSM can control the position of a loop bypass valve to maintain the differential pressure at the Loop Differential Pressure Setpoint. This type of control is typically used in primary-only systems, but it can also be effectively used in primary-secondary systems. In either case, the loop bypass valve control method is the same. A loop bypass valve must be a normally closed (NC) valve (a closed valve prevents flow from bypassing the cooling loads). When the CSM opens the valve it increases the voltage signal.

Configuration 7 (Figure 36) shows a typical primary-only system. If there is no bypass valve, the Pump Control Option variable and the Chilled Water Loop Modulation Control Option variable should both be set to "None."

In a primary-secondary system, loop bypass valve control can be used with any pump logic (single-pump, lead/standby, sequencing constant speed pumps or sequencing variable speed pumps) when exact pressure control is required; however, it cannot be used in the same application with pump speed control. Typical primary-secondary systems that use a bypass valve are shown in Configurations 1, 2 and 3.

The CSM uses a proportional-integral (PI) control loop to generate an analog valve position signal, which it sends to the valve via an analog output (AO 1 on Remote D). The Differential Pressure Bypass Valve Position variable (*Flow* screen) shows the current value of this signal.

PI Control Process

When the pressure is above the Loop Differential Pressure Setpoint, the control loop increases the valve position, which opens the valve and increases the bypass flow from supply to return. When the pressure is below the Loop Differential Pressure Setpoint, the control loop decreases the valve position, which closes the valve and reduces the bypass flow. The position can modulate between 0% (low signal) and 100% (high signal).

The PI control loop has four adjustable variables that are used for pump speed control: (1) Loop Differential Pressure Deadband, (2) Loop Differential Pressure Propband, (3) Loop Differential Pressure Sample Time, (4) Loop Differential Pressure Integral Time. The Loop Differential Pressure PI Function time plot is provided on the *Load Flow Control* screen to assist in tuning the PI loop.

► **To set up loop bypass valve control**

1. Set the Chilled Water Loop Modulation Control Option variable to "Chilled Water Loop Bypass Valve."
2. For primary-only applications, set the Pump Control Option variable to "None."
3. Commission Remote I/O Module D on the *Device Addressing* screen. Set the Loop Bypass Valve AO Zero variable on the *I/O Config* screen.
4. Set the following variables as required:
   - Loop Differential Pressure Setpoint
   - Loop Differential Pressure Deadband
   - Loop Differential Pressure Propband
   - Loop Differential Sample Time
   - Loop Differential Integral Time

Scheduling

The CSM's control mode can be scheduled for occupied operation with any of nine methods (listed highest too lowest in priority):

1. CSM internal weekly scheduling (priority = 16)
2. CSM internal holiday scheduling (priority = 16)
3. CSM internal special-event scheduling (priority = 16)
4. CSM internal timed override (priority = 16)
5. Optimal Start (priority = 13)
6. External time clock (priority = 11)
7. Modbus BAS scheduling (priority = 10)

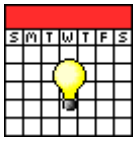
8. BACnet BAS scheduling (priority = 9)
9. Manual (priority = 8). Note: the Manual CSM Control Mode must be set to AUTOMATIC for any of the other scheduling methods to take command.

To view the current value of the CSM Control Mode and the priority at which it has been set, go to the *System Control* screen. To view the overall effect scheduling has on the CSM Operating State, go to the *System Status* screen. To configure the scheduling features, go to the *Sched* screen to edit the variables described in Table 17.

This section describes how to use the CSM's internal scheduling features and variables that must be set to use the BAS scheduling method or an external time clock. For additional information on how to use the BAS scheduling function, refer to the ED 15075 for BACnet and ED 15077 for Modbus. For information on how to connect an external time clock to UI-13 of the CSM's onboard I/O panel, refer to the Field Wiring section of IM 781.

The CSM's optimal start feature works in conjunction with the internal weekly, holiday, and special-event scheduling methods. When optimal start is enabled, the CSM can start the chiller system early to ensure that the loop temperature is cold when the normal scheduled start time occurs. To configure the optimal start feature go to the *Optimal Start* screen to change the values described in Table 18.

Table 17. Sched (Main > Configuration > Sched)

Name	Description
Override Time	This input allows you to manually set a timer that overrides the Off: Unoccupied state for the length of time specified. After it is set the Override Time variable shows the time remaining in the override period but will only be updated if you re-enter the *Sched* screen. You can reset it (up or down) at any time. If nothing else is enabling the CSM (for example, an occupied schedule), the operating state returns to Off: Unoccupied when the timer expires. During a timed override period, the CSM's operating state is On: Schedule. Range = 0 – 60 hour. Default = 0.00 minutes.
BAS Network Schedule Flag	This input allows you to restrict the ability of a BACnet or Modbus BAS to schedule the CSM into the occupied mode. Range = BAS Can Schedule, No BAS Scheduling Allowed. Default = BAS can Schedule
	This schedule icon indicates the current occupancy status of the CSM's internal schedule. Clicking on this icon also brings up the Schedule Editor. The Schedule Editor appears as a separate Web page, which means that your original user interface screen is still active in the background. Range = Gray Bulb (unoccupied), Yellow Bulb (occupied). Default = Gray Bulb

Scheduling Method Interaction

When *any* of the above scheduling functions is calling for occupied operation, the CSM (chiller system) operates—if the CSM Control Mode is set to Automatic on the *System Control* screen. Conversely, it goes into its unoccupied state only when *all* of the above scheduling methods are calling for unoccupied operation. Therefore, any unused schedules should be set for continuous unoccupied operation. An unassigned BAS schedule or a disconnected external time clock is equivalent to an unoccupied setting for those functions.

To allow all these scheduling methods to work with each other they are each assigned a priority. If multiple scheduling methods are setting the chiller system to occupied, the method with the lowest priority has command. When any of these scheduling methods is not commanding the chiller system to occupied at a priority number, it is set to auto (not unoccupied) so that higher priority methods can gain command. If none of the methods is commanding the chiller system to occupied, the system will be unoccupied at priority 16 (the highest priority).

There are 4 scheduling methods that schedule at priority 16. Within priority 16, these methods have the following order or importance: Timed Override, Special-event, Holiday, and Weekly. For example, if both the Special-event and Weekly schedules were forcing the chiller system occupied, the system would actually be occupied due to the Special-event schedule.

Setting Time and Date

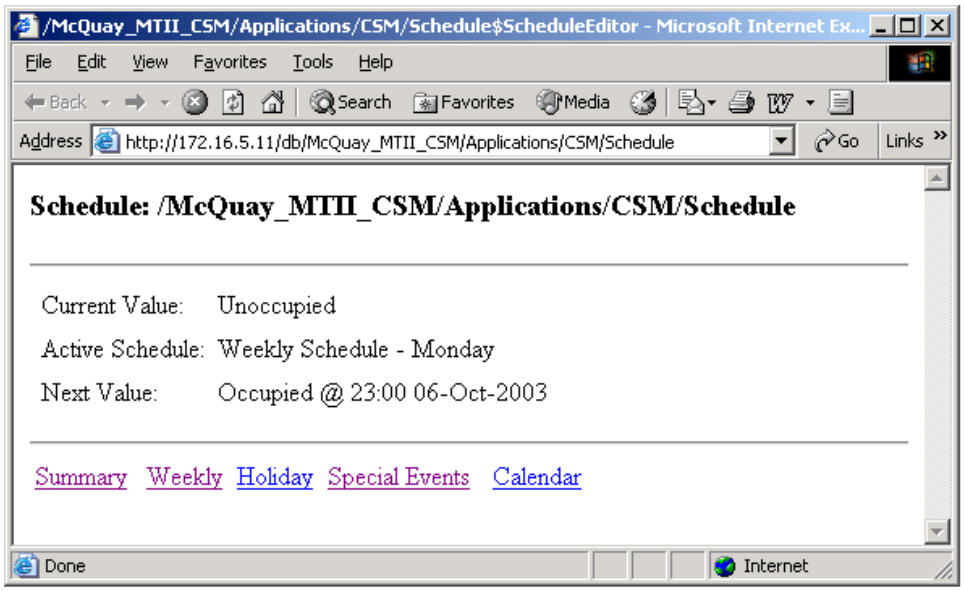
The CSM uses the time and date to execute its internal scheduling functions. Refer to the "Changing the CSM's IP Address and Date/Time" instructions in the "Getting Started" section of this document to set the CSM's date and time. Once set, the battery-backed internal clock keeps the current time regardless of whether power is supplied to the panel. If the battery wears out or is replaced for any reason, the time and date must be reset.

The Internal Schedule Editor

Clicking on the Schedule Icon on the *Sched* screen brings up the schedule editor. From the schedule editor you can select the Weekly, Holiday, Special-event, and Calendar schedules.

If you want the CSM to have complete authority over chiller system scheduling, set the BAS Network Schedule Flag to "No BAS Scheduling Allowed" and do not connect a clock to the external start/stop input.

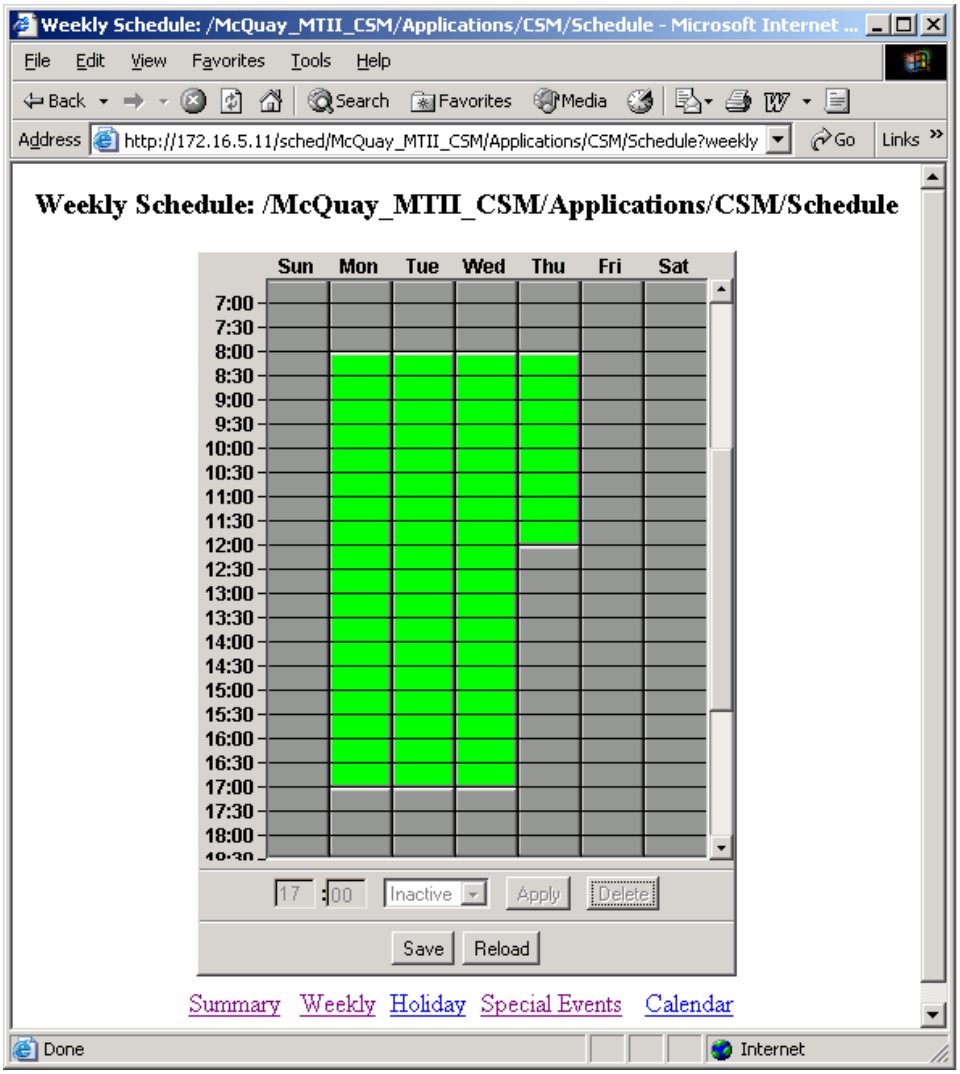
Figure 38. Menu of Schedules (Main > Configuration > Sched > Schedule Icon)



Weekly Scheduling

With the CSM's internal weekly scheduling function, you can set start and stop times for each day of the week. This is a repeating 7-day schedule.

Figure 39. Weekly Schedule (Main > Configuration > Sched > Schedule Icon > Weekly)



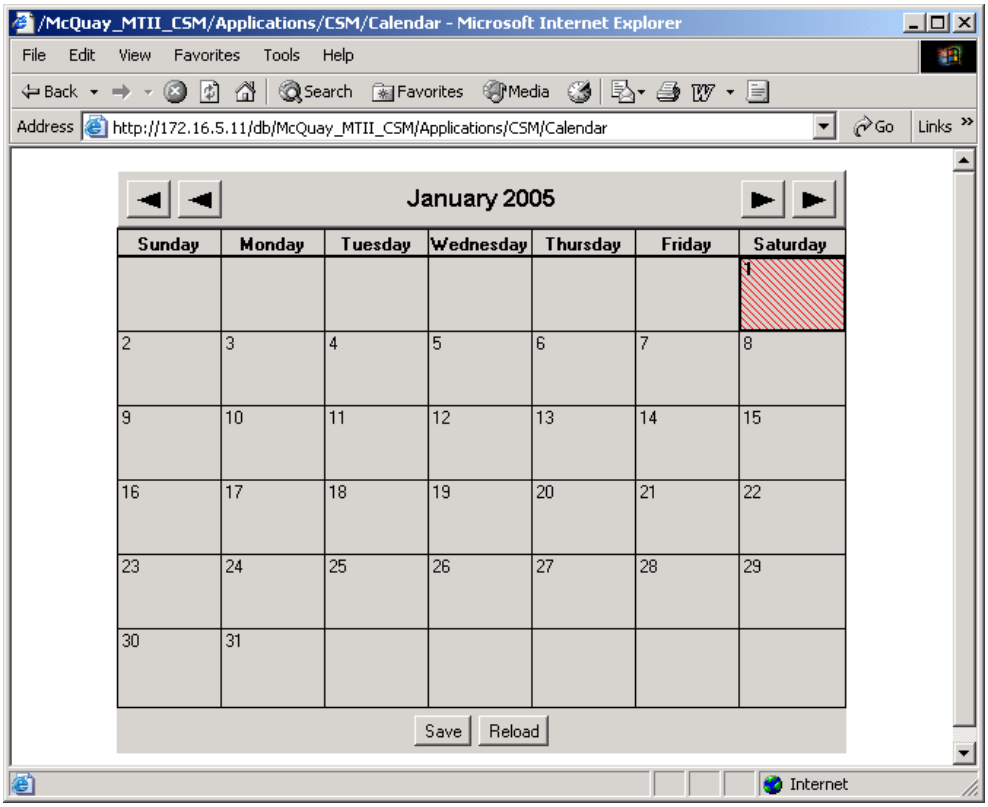
Enter start and stop times by clicking in the row and column where you want an event to occur. Highlighting a stop or start time and clicking on the Delete button will remove that entry. Multiple events can be entered for any and all days. When a weekly schedule is active, the CSM's system status is "On: Schedule."

To keep the chiller system off for the entire day, set the schedule fields to gray for all hours of the day (this is the default). To set the chiller system to occupied, set the schedule fields to green for the occupied hours. The schedule fields can be set to 15-minute increments. When you have finished making changes to the weekly schedule, click the Save button to enter your new schedule.

Holiday Scheduling

You can schedule holiday operating hours for any day designated in the calendar as a holiday by using the CSM's holiday scheduling feature. Whenever a holiday date occurs in the calendar, the controller uses the Holiday Schedule's start and stop times. The Holiday Schedule is accessed and edited just like the Weekly Schedule. The CSM uses a graphical calendar that is shown in Figure 40.

Figure 40. Calendar (Main > Configuration > Sched > Schedule Icon > Calendar)



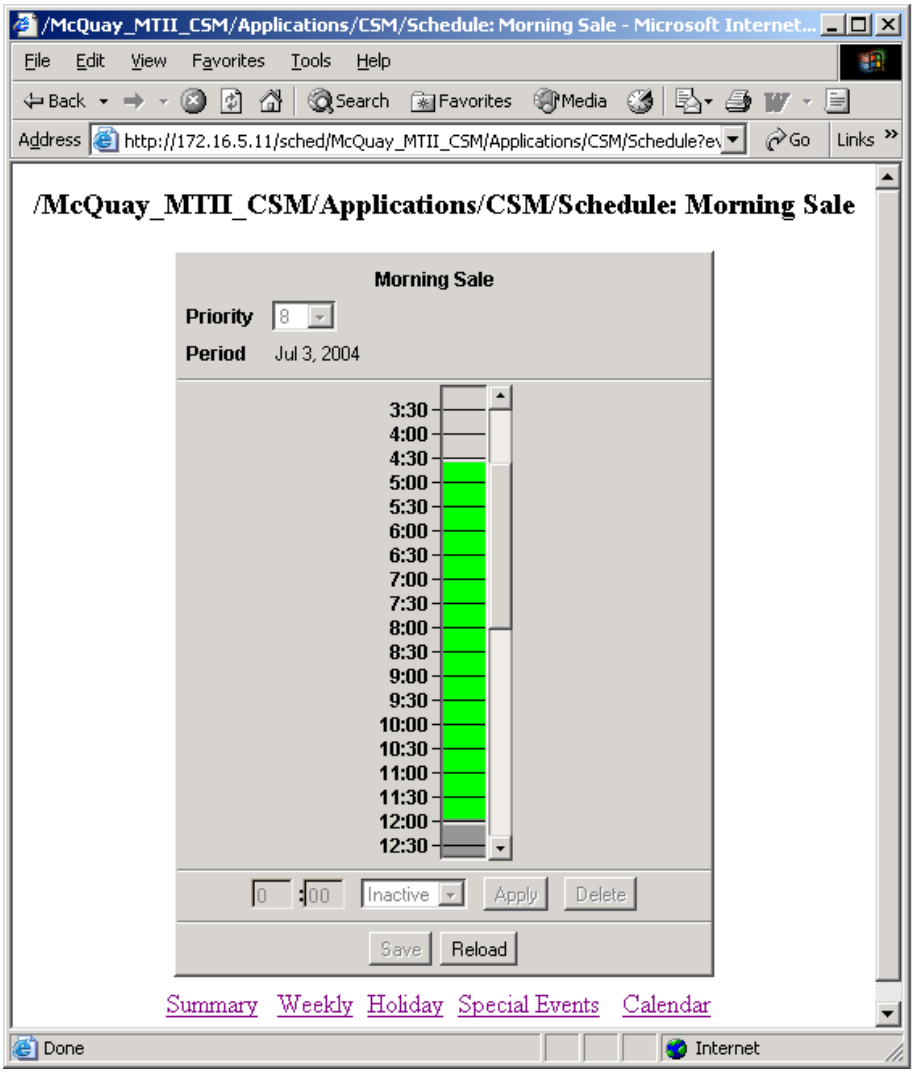
Any date box that is shaded red is a holiday date. To designate a date as a holiday, right click on the date box, select NEW, select DATE, enter the date that you want to be a holiday, and click OK. Holiday dates can also be entered in this same way as a DATE RANGE or as a recurring WEEK AND DAY each year. When you have finished making changes to the weekly schedule, click the Save button to enter your new schedule. When a Holiday Schedule is active, the CSM's system status is "On: Schedule."

Note: In addition to allowing holiday operating hours, the CSM's holiday calendar feature can be used to specify certain days on which the pump (lead/standby) order is forced to change. If you specify a holiday date to force a sequence order change and you're using the internal weekly scheduling function, be sure to set the Holiday Schedule's start and stop times as required for chiller system operation on that day. For more information, see Chilled Water Flow Control on page 67.

Special-Event Scheduling

With the CSM's internal special-event scheduling function, you can schedule multiple special periods of occupied operation that is outside (or around) the normal weekly and holiday schedules.

Figure 41. Special Event Schedule (Main>Configuration>Sched>Schedule Icon>Special Events)



As shown in Figure 41, the special-event schedule has four adjustable fields: description, priority, period and start/stop times. Start/stop times are edited as described in the weekly schedule section above. When you have finished making changes to the special-events schedule, click the Save button to enter your changes. When a Special-event is active, the CSM's system status is "On: Schedule."

For example: the schedule shown above starts the chiller system at 4:30 a.m. on July 3, and shuts down 7.5 hours later. Assume that your building is a department store and on Saturday July 3rd there is a sale that requires the chiller system to start up at 4:30 a.m. and shut down at 12:00 p.m. on the same day. The normal start and stop times are 6:00 a.m. and 11:00 p.m. for Saturday. Although you can change the normal Saturday schedules for the sale (and then change them back before the next Saturday), it is much easier to enter a one-event schedule.

To remove a special-event, go to Main > Configuration > Sched > Schedule Icon > Special Events, check the special-event which you want to remove, and click DELETE.

Timed Override

With the Override Time variable, you can manually set a timer that set the CSM to occupied for the length of time specified. Override Time can be set for any amount of time up to 60 hours. After it is set, the Override Time variable shows the time remaining in the override period whenever you re-enter the *Sched* screen. You can reset it (up or down) at any time. When the Override Time variable is counting down, the CSM's system status is "On: Schedule."

External Time Clock

If desired, an external clock can be used to schedule chiller system operation. The clock must be connected to the CSM's external start/stop input (UI-13 of the CSM's onboard I/O panel). If the switch or relay contact connected to it is closed, the CSM is occupied. If nothing else is enabling the CSM (for example, an occupied schedule), the operating state returns to Off: Unoccupied when the switch or relay opens. If you don't want the CSM's internal schedule to influence scheduling (likely), remove the occupied periods from the CSM's internal weekly, holiday and special-event schedules.

An external clock does not actually schedule the CSM; it works by overriding the Off: Unoccupied state. Therefore, when the external clock is in the occupied mode, the CSM's system status is "On: Input" instead of "On: Schedule." The effect is the same—except that the CSM's optimal start feature cannot work with an external clock.

Note: The external start/stop contact can be wired to a manual switch, external time clock, or both (wired in parallel).

Modbus Scheduling

If the CSM is integrated into a Modbus network, a Modbus master may schedule the CSM by writing to Coil Index 00081. Writing a "1" to this variable sets the CSM to occupied. Writing a "0" to this variable sets this input to AUTO which allows internal schedules or external time clock scheduling to command the CSM to occupied. If you don't want the CSM's internal schedule to influence scheduling (likely), remove the occupied periods from the CSM's internal weekly, holiday and special-event schedules. When the Modbus scheduling coil is set to Occupied, the CSM's system status is "On: Modbus Network". The CSM's optimal start feature cannot work with Modbus scheduling.

See the Configuring the CSM for BAS Communication section of this document for information on setting up the CSM to communicate on a Modbus network.

BACnet Scheduling

If the CSM is integrated into a BACnet network, a BACnet device may schedule the CSM by writing to Binary Output instance 50. Writing a "1" to this variable sets the CSM to occupied. Writing a "0" to this variable sets this input to AUTO which allows internal schedules or external time clock scheduling to command the CSM to occupied. If you don't want the CSM's internal schedule to influence scheduling (likely), remove the occupied periods from the CSM's internal weekly, holiday and special-event schedules. This BACnet binary output can be written to at any BACnet priority in accordance with the BACnet standard, but the CSM's internal logic will always display priority 9 as a BACnet priority. When the BACnet scheduling binary output is set to Occupied, the CSM's system status is "On: BACnet Network". The CSM's optimal start feature cannot work with BACnet scheduling using this binary output method.

Alternatively, a BACnet device may edit the CSM's internal schedules directly. The CSM's schedule is presented to a BACnet network as Schedule Object instance 1. The CSM's calendar is presented to a BACnet network as Calendar Object instance 1. If you are using BACnet to edit the CSM's internal schedules, the CSM's system status is "On: Schedule" when in the occupied mode. Scheduling in this way allows the CSM's optimal start feature to work with BACnet scheduling.

See the Configuring the CSM for BAS Communication section of this document for information on setting up the CSM to communicate on a BACnet network.

Optimal Start

The optimal start feature works with the internal scheduling functions (not with External Start/Stop or BAS scheduling via BACnet or Modbus inputs) to start the chiller system early during periods of high cooling load. The goal of optimal start is to drop the chilled water supply temperature to the System Setpoint just as the normal occupied period begins. Optimal start uses an algorithm that adapts to the characteristics of the chiller system. If Optimal Start is enabled the following events occur:

1. The cooling load pumps are started and operated just long enough to get a representative return chilled water temperature.
2. The return chilled water and outdoor air temperatures are sampled. Based on these temperatures, an estimate is made of the amount of time required to pull the chilled water supply temperature down to the System Setpoint.
3. An optimal start time is calculated by subtracting the estimate from the scheduled start time.

4. The system starts and operates. When the chilled water supply temperature reaches the System Setpoint, the time that it took is compared with the estimate—if you want to adapt the time.

Note: Optimal start control can be used only with systems in which the CSM is controlling the cooling load pump(s).

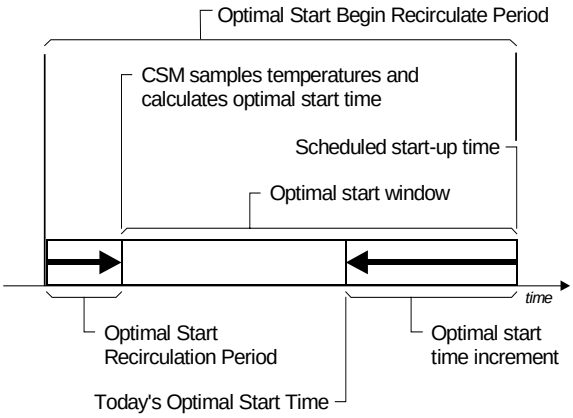
Table 18. Optimal Start (Main > Configuration > Optimal Start)

Name	Description
Optimal Start Flag	Turns Optimal Start On or Off. Range = OS Enabled, OS Disabled, Auto. Default = OS Disabled
Optimal Start Begin Recirculate Period	This input sets the amount of time before the next scheduled Occupied period that the CSM will start the cooling load pump(s) to sample the water temp. Range = 30 min to 5 hrs. Default = 1 hr
Optimal Start Recirculation Period	This input sets the amount of time the cooling load pump(s) will run before the chilled water return temperature sample is taken. Range = 1 to 59 minutes. Default = 10 minutes
Run Time Per Degree CWRT User Defined	This input allows you to input the desired factor that will be multiplied by (chilled water return temp – system setpoint). This calculation is then used to determine the optimal start time increment. Range = 0 to 10 minutes/degree. Default = 0.5 minutes/degree
Run Time Per Degree OAT User Defined	This input allows you to input the desired factor that will be multiplied by (outside air temp – system setpoint). This calculation is then used to determine the optimal start time increment. Range = 0 to 10 minutes/degree. Range = 0 to 10 minutes/degree. Default = 0.5 minutes/degree
Auto Update CWRT Flag	Turns on the feature that resets the Run Time Per Degree CWRT variable to provide optimal start adaptation. Range = No, Yes. Default = No
Auto Update Outside Air Temp Flag	Turns on the feature that resets the Run Time Per Degree OAT variable to provide optimal start adaptation. Range = No, Yes. Default = No
Auto Update Inhibit Minutes	This input prevents adaptation when the optimal start time increment is less than this value. This is necessary because the auto update calculation is skewed at short lead times due to chiller startup times, soft load limiting, etc. Range =1 to 20 minutes. Default = 10 minutes
Update Ratio	This input defines the ratio (x:1) of old Run Time Per Degree values to observed Run Time Per Degree values for calculating the new Current Run Time Per Degree values. A value of 1 will average the old with the observed to create the new. A value of 10 will add 1/10th of the difference between the old and the observed to the old to create the new. Range = 1 to 10. Default = 1
Reset Updated Parameters	If the auto update feature is being used, commanding this button to reset the runtime parameters will force the Current Run Time Per Degree CWRT (or OAT) values back to the Run Time per Degree CWRT (or OAT) User Defined values.
Current Run Time Per Degree CWRT	Display of the updated Run Time Per Degree Chilled Water Return Temperature value that will be used to calculate the optimal start time increment the next time Optimal Start runs.
Current Run Time Per Degree OAT	Displays the updated Run Time Per Degree Outside Air Temperature value that will be used to calculate the optimal start time increment the next time Optimal Start runs.
Optimal Start Function Message	This message displays information on the Optimal Start feature while the feature is operating. To update this message, leave the *Optimal Start* screen and then re-enter the screen.
Optimal Start Time	This value shows the last calculated optimal start time or the upcoming optimal start time if optimal start is currently running.

How Optimal Start Works

Optimal chiller system start-up can occur only during a window prior to occupancy that is defined by the scheduled start-up time for the day, the Optimal Start Begin Recirculate Period variable, and the Optimal Start Recirculation Period variable. See Figure 42.

Figure 42. Optimal Start Time Line



When the Scheduled Start-Up Time minus the Optimal Start Begin Recirculate Period occurs, the CSM enters the Recirculate operating state and starts the cooling load pump(s). The Optimal Start Recirculation Period variable defines the length of time the CSM remains in the Recirculate State. At the end of the recirculation period, the CSM samples the chilled water return temp (CWRT) and outside air temp (OAT).

The *exact time* at which the CSM enables the chiller system is determined by calculating the optimal start time increment. The time increment is calculated using the following equation:

OptimalStartTimeInc = (OAT–System Setpt)*RunTimePerDegreeOAT + (CWRT–System Setpt)*RunTimePerDegreeCWRT

The optimal start time increment is limited to a maximum of 240 minutes.

When the Scheduled Start-Up Time minus the Optimal Start Time Increment occurs, the CSM enters the On operating state and starts the chillers and cooling load pump(s). Optimal Start keeps the CSM ON until the Scheduled Start-Up Time. If the supply temperature reaches the System Setpoint before the scheduled start-up time, the system continues to operate; it does *not* shut down and then start up again.

A table of optimal start time increments in Table 19 shows some temp/time combinations for the default values (0.5 Min/degree) of Run Time Per Degree OAT and Run Time Per Degree CWR. This table was calculated assuming a System Setpoint of 45 °F. For any combination of CWRT and OAT, a particular time increment is used. Notice that as the return water or OAT increases, the optimal start time increment increases.

Table 19. Optimal Start Time Increments (in Minutes)

	Chilled Water Return Temperature (CWRT)				
Outdoor Air Temperature (OAT)	**50°F(10°C)**	**60°F(15°C)**	**70°F(21°C)**	**80°F(26°C)**	**90°F(32°C)**
50°F (10°C)	5	10	15	20	25
60°F (15°C)	10	15	20	25	30
70°F (21°C)	15	20	25	30	35
80°F (26°C)	20	25	30	35	40
90°F (32°C)	25	30	35	40	45
100°F (38°C)	30	35	40	45	50

Note: Calculations in this table used the default optimal start settings and a System Setpoint = 45°F (7.2°C)

For example, if the return water temperature is 83°F (28°C) and the OAT is 87°F (31°C), the optimal start time increment would be 40 minutes;

Optimal Start Time Increment = (87 – 45) * 0.5 + (83 – 45) * 0.5 = 40 minutes

If the OAT were 106°F (41°C) instead of 87°F (31°C), the optimal start time increment would be 49.5 minutes

Optimal Start Time Increment = (106 – 45) * 0.5 + (83 – 45) * 0.5 = 49.5 minutes

The CSM subtracts the Optimal Start Time Increment from the scheduled start time to get the Optimal Start Time. If the calculated optimal start time is after the current time, the CSM returns to the Off: Unoccupied state, stops the cooling load pump(s), and waits. If the calculated optimal start time is before the current time, the CSM immediately enters the On: Schedule state and starts the system.

Note: If the return water or OAT sensor fails, the optimal start algorithm assumes that the unreliable temperature is very high. As a result, the increment used will likely be higher, and thus the CSM starts the chiller system earlier than it would otherwise.

Note: If communications are lost with a BAS that is supplying the OAT, the CSM retains the last temperature it received and uses it until communications are restored.

Adaptation

You can manually adjust the Run Time Per Degree OAT and Run Time Per Degree CWRT values to effect the Optimal Start Time. You can also set the Auto Update Float- OAT and/or Auto Update Flag-CWRT to yes and the CSM will automatically update the Run Time Per Degree variables respectively.

When auto update is used, each time the optimal start process is used the CSM keeps track of how long it takes the chilled water supply temperature to reach the System Setpoint after start-up. When the supply temperature falls to the setpoint, the CSM compares this observed amount of time with the last optimal start time increment that it used. The CSM replaces the old Run Time Per Degree OAT and Run Time Per Degree CWRT values with new adjusted values. The new Run Time Per Degree values are calculated so that the next optimal start time increment will approach the observed time. The Update Ratio defines the ratio (x:1) of desired change from last Run Time Per Degree value to observed Run Time Per Degree (e.g. an Update Ratio of 1 will average the last value with the observed value to create the next value). Over a period of time, adaptations reduce the overshoot or undershoot.

If auto update is active, the CSM continues to use and change the current values. If, while using adaptation, the operator wants to reset the updated Run Time Per Degree OAT/CWRT values back to the user-defined values, press the “Reset Updated Parameters” button.

Typical Operating Sequence

Following is an example of how the optimal start feature works. Assume that the following is true:

1. The Optimal Start default values for Run Time Per Degree OAT and Run Time Per Degree CWRT (default = 0.5 Min/degree) are used (producing the values shown in Table 19).
2. The supply and return chilled water temperature is 80.0°F (26.7°C).
3. The outdoor air temperature is 90.0°F (32.2°C).
4. The System Setpoint is 45.0°F (7.2°C).
5. The Optimal Start Begin Recirculate Period is 1:00 hour.
6. The Optimal Start Recirculation Period is 10 minutes.
7. The scheduled start time is 7:00 a.m.

At 6:00 a.m., the CSM starts the cooling load pump as it enters the Recirculate operating state. At 6:10 a.m., it reads the CWRT and OAT. The optimal start time increment is calculated to be 40 minutes. The Optimal Start Time variable changes to “6:20”. The CSM stops the pump, and returns to the Off: Unoccupied state. The chiller system is enabled at 6:20 a.m., or 40 minutes early.

The chilled water supply temperature ideally falls to the System Setpoint of 45.0°F (7.2°C) right at 7:00 a.m. Following are two scenarios that illustrate how the optimal start feature adapts if this doesn’t happen.

Scenario 1: The chilled water supply temperature only falls to 50°F (10°C) by the scheduled start-up time (7:00 a.m.). When this occurs, the CSM updates the Run Time Per Degree OAT and Run Time Per Degree CWRT values from 0.5 Min/degree to 0.59 Min/degree.

Scenario 2: The chilled water supply temperature falls to the System Setpoint at 6:37 a.m. or 17 minutes after start-up. When this occurs, the CSM updates the Run Time Per Degree OAT and Run Time Per Degree CWRT values from 0.5 Min/degree to 0.37 Min/degree.

► **To set up optimal start control**

1. Command the Optimal Start Flag to "OS Enabled"
2. If you want the CSM to automatically adapt to your Optimal Start characteristics set the Auto Update Flag CWRT Flag and/or Auto Update OAT Flag to "Yes."
3. Set the Optimal Start Begin Recirculate Period to the desired time period before the scheduled start time which optimal start-up will run the cooling load pump(s) for a temperature sample.

   A typical setting would be about one hour before the normal scheduled start time
4. Set the Optimal Start Recirculation Period to the amount time you want the cooling load pump(s) to run before the CSM takes a temperature reading at the return chilled water sensor.

   The CSM requires an accurate return water temperature to estimate the load and thus the optimal start-up time.

Note: The CSM's optimal start feature works only with systems that have at least one cooling load pump. To use the optimal start feature, chilled water supply and return temperature sensors must be connected to the CSM. In addition, an outdoor air temperature sensor must be connected to the CSM.

BAS Communication

The CSM may be configured for integration into either a BACnet or Modbus BAS.

BACnet Settings

The CSM may be integrated into either a BACnet/IP or BACnet over Ethernet BAS. In either case, connection to the BACnet network is done through the CSM's Ethernet port. See ED 15075 for more information on the BACnet protocol data points. Configuration properties for both are described below. To configure the CSM for BACnet communication, go to the *BAS Config* screen to change the values described in Table 20. To configure the CSM for Modbus communication, go to the *BAS Config* screen to change the values described in Table 21.

Table 20. BAS Config - BACnet (Main > Configuration > BAS Config)

Name	Description
BACnet Device Instance Number	BACnet device instance number of the CSM. This must be unique to the BACnet network Range = 0– 4194304. Default = -1
BACnet IP Configuration – Enable (BAS only)	Setting this value to Yes enables the CSM's Ethernet port for BACnet/IP communications. If there is no BACnet/IP BAS, this variable should be set to No. Range = No, Yes. Default = No
BACnet IP Configuration – Network Number	The Network Number must be unique for each BACnet network segment. All BACnet/IP devices on all BACnet/IP segments must have the same BACnet/IP Network Number. Range = 0 to 65534. Default = 1001
BACnet/IP Subnet Mask	A subnet mask is a 32-bit number, written in dotted decimal form. Only BACnet/IP devices that are on the same subnet can communicate with each other without a router. Default = 255.255.0.0
BACnet/IP UDP Port	The UDP (User Datagram Protocol) port number is used by the client or server device for sending or receiving messages. Taken together with a network address (IP address), a port number identifies both a device and also a "channel" within that device where network communication will take place. Note that the UDP Port string entered from the user interface requires the "0x" prefix on the hexadecimal value. Default = 0xBAC0 (47808 in decimal)
BACnet/IP Device Type	If BACnet/IP broadcast messaging through IP routers is required, there are two possible configurations. Another BACnet/IP device on the same subnet as the CSM can be the BBMD (set this value = none). The CSM can function as the BBMD on it's subnet (set this value = BBMD and input another BBMD's address into the Remote BBMD Address field). Do not set the CSM up as a BBMD if another BBMD already exists on the same subnet or communication problems will result. Range = none, BBMD. Default = none
Remote BBMD Address	If the BACnet/IP Device Type variable = BBMD, you need to enter the known address of another BBMD on your BACnet/IP network here. Entry format requires all hexadecimal with colons; xx:xx:xx:yy:yy where xx:xx:xx:xx is the IP address and yy:yy is the UDP port of the remote BBMD device. Use Windows® Calculator to convert IP octets from decimal to hex. The CSM must be shut down for 3 minutes (or until all LED's go off) and restarted for this change to take effect. The CSM will automatically fill in its Broadcast Distribution Table from the remote BBMD after startup. Default = null
BACnet Ethernet Configuration –	Setting this value to Yes enables the CSM's Ethernet port for BACnet over Ethernet communications. If there is no BACnet over Ethernet BAS, this variable should be set to No. Range = No, Yes. Default = No

Enable (BAS only)	
BACnet Ethernet Configuration – Network Number	The CSM's network number defines the network connection to a BACnet router. Range = 0 to 65534. Default = 10

Modbus Settings

If the CSM was purchased with a Modbus License, the CSM may be integrated into a Modbus BAS. The CSM has been programmed to operate as a Modbus slave device and may be integrated into a serial Modbus RTU or ASCII network using either an RS-485 or RS-232 port connection. The Modbus RTU or ASCII protocol is used for all messaging to a single Modbus master device. Configuration properties for Modbus networks are described below. See ED 15077 for more information on the Modbus protocol data points.

Table 21. BAS Config - Modbus (Main > Configuration > BAS Config)

Name	Description
Modbus Device Address	Must be unique from any other Modbus device on the network. Range = 1 to 247. Default = 1
Enable (BAS only)	Setting this value to Yes enables the CSM's Modbus Slave service and allows it to field requests. Range = No, Yes. Default = No
Data Mode	The CSM can be set to either the RTU or ASCII Modbus protocol. This setting must match the protocol used by the master device. RTU is more common. Range = RTU, ASCII. Default = RTU
Float Byte Order	This input defines the byte-order in which float values are assembled by the CSM. Range = order_3_2_1_0, order_1_0_3_2. Default = order_3_2_1_0
Long Byte Order	This input defines the byte-order in which long values are assembled by the CSM. Range = order_3_2_1_0, order_1_0_3_2. Default = order_3_2_1_0
Preset Multiple Registers	This input specifies if the CSM supports Modbus function code 16. Range = No, Yes. Default = No
Force Multiple Coils	This input specifies if the CSM supports Modbus function code 15. Range = No, Yes. Default = No
Comm Port	This input must match the physical Communication Port on the CSM (see Figure 48) that will be used for the Modbus network connection. Comm1 is used for RS-232 networks. Comm3 is used for RS-485 networks. Note that the RS-485 variable must be set to Yes if this Comm Port variable = Comm3. Range = Comm1, Comm3. Default = Comm3
Baud Rate	This input must match the baud rate of the Modbus serial network. Range = 1200, 2400, 4800, 9600, 19200, 32400. Default = 9600
Data Bits	This input must match the communication setup of the Modbus serial network. Range = dataBits_5, dataBits_6, dataBits_7, dataBits_8. Default = dataBits_8
Stop Bits	This input must match the communication setup of the Modbus serial network. Range = stopBits_1, stopBits_1_5, stopBits_2. Default = stopBits_1
Parity	This input must match the communication setup of the Modbus serial network. Range = even, mark, odd, none, space. Default = none
Flow Control	This input must match the communication setup of the Modbus serial network. Range = none, RtsCtsOnInput, RtsCtsOnOutput, XonXoffOnInput, XonXoffOnOutput. Default = none
RS-485 Mode	This input must be set to Yes if the Comm Port setting is Comm3 (for RS-485 networks). It must be set to No if the Comm Port Setting is set to Comm1 (see Figure 48 for Comm port locations). Range = No, Yes. Default = Yes

Alarm Notification

The CSM provides multiple methods of notifying an operator that an alarm has occurred. These methods include physical digital outputs, e-mail alarm notifications, and BACnet intrinsic reporting. To configure the CSM for alarm notification go to the *Alarms* screen to change the values described in Table 22.

Table 22. Configuring Physical Alarm Outputs (Main > Configuration > Alarms)

Name	Description
Horn on Comm Loss Flag	If this input = "Horn", the alarm horn relay (DO-2 on the CSM's onboard I/O panel) will close whenever a Comm Loss alarm is present. Range = No Horn, Horn. Default = No Horn
Horn on Fault Alarm Flag	If this input = "Horn", the alarm horn relay (DO-2 on the CSM's onboard I/O panel) will close whenever a Fault alarm is present. Range = No Horn, Horn. Default = No Horn
Horn on Problem Alarm Flag	If this input = "Horn", the alarm horn relay (DO-2 on the CSM's onboard I/O panel) will close whenever a Problem alarm is present. Range = No Horn, Horn. Default = No Horn
Horn on Warning Alarm Flag	If this input = "Horn", the alarm horn relay (DO-2 on the CSM's onboard I/O panel) will close whenever a Warning alarm is present. Range = No Horn, Horn. Default = No Horn
Alarm Output Normal State	If this input = "Open", the alarm output relay (DO-3 on the CSM's onboard I/O panel) will be open when the CSM does not have any alarms. Range = Open, Closed. Default = Open
Alarm Output Comm Loss State	The alarm output relay (DO-3 on the CSM's onboard I/O panel) will go to the state defined by this input whenever a Comm Loss alarm is present. Range = Open, Closed, Slow, Fast. Default = Open
Alarm Output Fault State	The alarm output relay (DO-3 on the CSM's onboard I/O panel) will go to the state defined by this input whenever a Fault alarm is present. Range = Open, Closed, Slow, Fast. Default = Open
Alarm Output Problem State	The alarm output relay (DO-3 on the CSM's onboard I/O panel) will go to the state defined by this input whenever a Problem alarm is present. Range = Open, Closed, Slow, Fast. Default = Open
Alarm Output Warning State	The alarm output relay (DO-3 on the CSM's onboard I/O panel) will go to the state defined by this input whenever a Warning alarm is present. Range = Open, Closed, Slow, Fast. Default = Open

Physical alarm outputs

The CSM has three physical digital outputs on the onboard I/O board that can indicate an alarm by closing a contact connected to an external device; the Alarm LED Output, the Alarm Horn Output, and the Alarm Output. An LED can be wired to the Alarm LED output (DO-1 of the CSM's onboard I/O) which closes when any alarm occurs. A horn can be wired to the Alarm Horn that can be set to indicate different alarm types in different ways. The Alarm Output can be wired to a receiving device and also set to indicate different alarm types in different ways.

Table 23. Configuring E-Mail Alarm Notification (Main > Configuration > Alarms)

Name	Description
E-mail Alarm Flag	When this input is set to Disable, the CSM does not route alarms to the listed E-mail recipients. Range = Disable, Enable Default = Disable
SMTP Host	This input specifies the SMTP host the CSM will use to send E-mail alarms. Contact you IT department for the proper host name or address. The CSM must be restarted after changing the SMTP host name. Range = any valid host name or address of SMTP server. Default = 172.16.1.56 (note: this default will need to be changed to the Host address or name of the SMTP server on your LAN)
From Address	This input specifies the "from" address used in sent e-mail alarms. An e-mail account on the SMTP server is typically required using this same address. Often, an e-mail account named "ChillerSystemManager" is created and used. Range = valid e-mail address. Default = ChillerSystemManager@nowhere.com
SMTP Server User Name	Username associated with the e-mail account used on the SMTP server. May be left blank unless the SMTP server requires authentication on a send operation.
SMTP Server Password	Password for the user named by the SMTP Server User Name property. May be left blank unless the SMTP server requires authentication on a send operation.

Fault-1-E-Mail Address:To Fault-1-E-Mail Address: CC Fault-2-E-Mail Address:To Fault-2-E-Mail Address: CC Fault-3-E-Mail Address:To Fault-3-E-Mail Address: CC Problem-1-E-Mail Address:To Problem-1-E-Mail Address: CC Problem-2-E-Mail Address:To Problem-2-E-Mail Address: CC Problem-3-E-Mail Address:To Problem-3-E-Mail Address: CC Warning-1-E-Mail Address:To Warning-1-E-Mail Address: CC Warning-2-E-Mail Address:To Warning-2-E-Mail Address: CC Warning-3-E-Mail Address:To Warning-3-E-Mail Address: CC	These inputs specify the e-mail addresses to which the alarms are sent. A primary (To) address is required; other addresses are optional. If multiple addresses are used in an entry, use a semicolon (;) between addresses, e.g.: hsmith@aol.com;bjones@msn.com. Range = valid e-mail address including domain The e-mail addresses are offered in the Fault/Problem/Warning categories so that less important alarms (e.g. warnings) do not have to be sent to all e-mail recipients. Each category is offered three times so that alarms can be sent to designated recipients at certain time/date combinations and other recipients at different time/date combinations. See the Time Range and Valid Days entries that follow. For example alarms can be e-mailed to on-staff maintenance people during the normal workweek and off-site service personnel on nights and weekends. Default = nobody@nowhere.com
Fault 1 – Time Range Fault 2 – Time Range Fault 3 – Time Range Problem 1 – Time Range Problem 2 – Time Range Problem 3 – Time Range Warning 1 –Time Range Warning 2 –Time Range Warning 3 –Time Range	Defines the time period in which routed alarms can be sent as e-mails (on valid days of the week), using a start time and end time. If you select “Exclusive”, alarms are sent only outside of the defined period. Range 12:00 AM to 12:00 AM. Default = 12:00 AM to 12:00 AM, Inclusive
Fault 1 - Valid Days Fault 2 - Valid Days Fault 3 - Valid Days Problem 1 – Valid Days Problem 2 – Valid Days Problem 3 – Valid Days Warning 1 – Valid Days Warning 2 - Valid Days Warning 3 - Valid Days	Defines the days of the week in which routed alarms can be sent as e-mails. Can be set in any combination. Range = Sun, Mon, Tues, Wed, Thurs, Fri, Sat. Default = All days

E-mail alarm notifications

The CSM can export alarms via e-mail. Multiple e-mail recipients can be grouped into any of the **To:** or **CC:** inputs. To provide e-mail alarm notification, the CSM must be configured into a SMTP server on the building LAN with an e-mail address so that the CSM can send e-mail to anyone, anywhere with a valid e-mail address. Work closely with the building LAN administrator if e-mail is to be supplied.

Each group of e-mail Recipients can be configured to receive any or all of the three alarm categories (Fault, Problem, and Warning) at different times throughout the day or week. This feature is provided so that less important alarms (e.g. warnings) do not have to be sent to all recipients at all times/dates. The e-mail alarm recipient’s portion of the *Alarms* screen is laid out in a Fault1/Fault2/Fault3, Problem1/Problem2/Problem3, and Warning1/Warning2/Warning3 format to allow for this flexibility.

Example:

To have e-mail addresses John.Smith@aol.com and Jane.Doe@msn.com receive all three CSM alarm categories (Faults, Problems, Warnings) at all hours, every day of the week, the operator would configure the following;

a) Set Fault 1 E-mail Address To: = John.Smith@aol.com;Jane.Doe@msn.com

b) Set Problem 1 E-mail Address To: = John.Smith@aol.com;Jane.Doe@msn.com

c) Set Warning 1 E-mail Address To: = John.Smith@aol.com;Jane.Doe@msn.com

d) Leave all three Time Range and all three Valid Days inputs at their defaults

Table 24. Configuring BACnet Alarm Notification (Main > Configuration > Alarms)

Name	Description
BACnet Alarm Recipient 1 BACnet Alarm Recipient 2 BACnet Alarm Recipient 3	Up to three different BACnet devices can be sent alarm notifications from the CSM. Use these inputs to enter the Device Instance number of the target BACnet device. The combination of entering the target BACnet device here and then selecting one of these BACnet Alarm Recipients as the BACnet Recipient (see next table entry) of a Fault/Problem/Warning alarm type will result in the CSM sending alarm notifications to the BACnet device. Range = any valid BACnet Device Instance. Default = -1, -1, and –1 (respectively)
Fault 1 – BACnet Recipient Fault 2 – BACnet Recipient Fault 3 – BACnet Recipient Problem 1 – BACnet Recipient Problem 2 – BACnet Recipient Problem 3 – BACnet Recipient Warning 1 – BACnet Recipient Warning 2 – BACnet Recipient Warning 3 – BACnet Recipient	Defines the first of three possible target BACnet device to receive CSM Fault alarms. Range = none, Recipient 1, Recipient 2, Recipient 3. Default = Recipient 1 Defines the second of three possible target BACnet device to receive CSM Fault alarms. Range = none, Recipient 1, Recipient 2, Recipient 3. Default = Recipient 2 Defines the third of three possible target BACnet device to receive CSM Fault alarms. Range = none, Recipient 1, Recipient 2, Recipient 3. Default = Recipient 3 Defines the first of three possible target BACnet device to receive CSM Problem alarms. Range = none, Recipient 1, Recipient 2, Recipient 3. Default = Recipient 1 Defines the second of three possible target BACnet device to receive CSM Problem alarms. Range = none, Recipient 1, Recipient 2, Recipient 3. Default = Recipient 2 Defines the third of three possible target BACnet device to receive CSM Problem alarms. Range = none, Recipient 1, Recipient 2, Recipient 3. Default = Recipient 3 Defines the first of three possible target BACnet device to receive CSM Warning alarms. Range = none, Recipient 1, Recipient 2, Recipient 3. Default = Recipient 1 Defines the second of three possible target BACnet device to receive CSM Warning alarms. Range = none, Recipient 1, Recipient 2, Recipient 3. Default = Recipient 2 Defines the third of three possible target BACnet device to receive CSM Warning alarms. Range = none, Recipient 1, Recipient 2, Recipient 3. Default = Recipient 3
Fault 1 - Process ID Fault 2 - Process ID Fault 3 - Process ID Problem 1 - Process ID Problem 2 - Process ID Problem 3 - Process ID Warning 1 - Process ID Warning 2 - Process ID Warning 3 - Process ID	The handle of a process within the recipient device that is to receive the alarm. Use of this property is a local mater in the BACnet device receiving the alarm. Range = integer. Default = 0
Fault 1 – Time Range Fault 2 – Time Range Fault 3 – Time Range Problem 1 - Time Range Problem 2 - Time Range Problem 3 - Time Range Warning 1 –Time Range Warning 2 –Time Range Warning 3 –Time Range	Defines the time period in which routed alarms can be sent as BACnet notifications (on valid days of the week), using a start time and end time. If you select “Exclusive”, alarms are sent only outside of the defined period. Range 12:00 AM to 12:00 AM. Default = 12:00 AM to 12:00 AM, Inclusive

Fault 1 - Valid Days Fault 2 - Valid Days Fault 3 - Valid Days Problem 1 – Valid Days Problem 2 - Valid Days Problem 3 - Valid Days Warning 1 - Valid Days Warning 2 - Valid Days Warning 3 - Valid Days	Defines the days of the week in which routed alarms can be sent as BACnet notifications. Can be set in any combination. Range = Sun, Mon, Tues, Wed, Thurs, Fri, Sat. Default = All days

BACnet alarm notifications

The CSM can export alarms via BACnet. A total of three BACnet Recipients can be entered at the CSM's user interface.

Each BACnet Recipient can be configured to receive any or all of the three alarm categories (Fault, Problem, and Warning) at different times throughout the day or week. This feature is provided so that less important alarms (e.g. warnings) do not have to be sent to all recipients at all times/dates. Similar to e-mail, the BACnet alarm recipient portion of the *Alarms* screen is laid out in a Fault1/Fault2/Fault3, Problem1/Problem2/Problem3, Warning1/Warning2/Warning3 format to allow for this flexibility.

Examples:

1) To have a BACnet Workstation with Device Instance = 23 receive all three CSM alarm categories (Faults, Problems, Warnings) at all hours, every day of the week, the operator would configure the following;
   a) Set BACnet Alarm Recipient 1 = 23
   b) Set Fault 1 BACnet Recipient = Recipient 1
   c) Set Problem 1 BACnet Recipient = Recipient 1
   d) Set Warning 1 BACnet Recipient = Recipient 1
2) To have a remote BACnet device with Device Instance = 5 receive CSM Fault alarms (alarms that shut the CSM down) before 8:00 AM and after 5:00 PM, the operator would configure the following;
   a) Set BACnet Alarm Recipient 2 = 5
   b) Set Fault 2 BACnet Recipient = Recipient 2
   c) Set Fault 2 Time Range = 8:00 AM to 5:00 PM – Exclusive

Saving Your CSM Database Configuration

Saving the Database on the CSM

Save the current database after making any changes. To do so, navigate to the *BAS Config* screen of the CSM's user interface and press the Save Database button. If the database is not saved, all changes you have made to the configuration screens will be lost if the CSM looses power and the battery is bad.

Also, keep a written copy of the *User Admin* screen and any other screens you would want to duplicate if the CSM's configuration was lost. Either printing the page from Internet Explorer or taking screen captures and saving them in an electronic file can do this.

Saving the CSM's Configured Database Externally

The configured database can also be saved in an XML file format and saved on a CD. The Admin Tool is required in order to save the CSM database in XML format. This would be useful if the CSM's main controller needed replacing and the existing database could not be recovered. When the new hardware was installed on the job this saved database could be loaded to the new CSM. This would configure the new CSM exactly like the old CSM.

About the Admin Tool

To save an XML file of your CSM database the Admin Tool is required. The Admin Tool is used to perform certain functions on the CSM. The Admin Tool comes with a document titled "Using the Admin Tool". This document refers to multiple Tridium hardware platforms. The CSM is developed on the JACE 4 platform, so disregard references to the JACE 5, JACE NT and Web Supervisor.

The Admin Tool is available at www.mcquay.com, go to Product Information > Controls > Software. Download the AdminTool.zip file to the hard drive of a Windows NT, Windows 2000 or Windows XP computer. Unzip this file and run the enclosed executable file. This will place an Admin.exe file on your computer under the C:\niagara\McQuayAdminTool\R2.301.503\nre\bin directory that you will use to start the Admin Tool. With your computer connected to the CSM's Ethernet port directly or on the LAN, run the Admin.exe file. When the Admin Tool is running select File, then select Open and the Connect to Host dialog box will appear. In this dialog box enter the IP address of the CSM and press Ok. The Login dialog box will now appear, you must enter the system administrator User Name and Password. You are now connected to the CSM with the Admin Tool.

Also included in this zip file you will find a document titled *Using the Admin Tool*. For instructions to save your CSM database configuration externally go to Procedure 10-*Export a Station Database* in the Advanced Admin Tool Tasks portion of the Admin Tool Tasks section of the document. Be sure to select XML format in step 4. This will save a file named *config.xml* on your computer under C:\niagara\McQuayAdminTool \R2.301.503\stations\McQuay_MTII_CSM. Keep this file in a safe place to be used if you want to reconfigure a replacement CSM.

If you ever need to install this saved database configuration, go to the Admin Tool Tasks > Advanced Admin Tool Tasks > Procedure 11 Import a Station Database. This procedure loads your save *config.xml* file into a CSM.

Operator's Guide

This section provides information on the day-to-day operation of the CSM. Each sub-section describes one of the screens under the System Status tab on the *Main* screen of the CSM's user interface. The final sub-section, Alarm Monitoring and Control, describes the information under the View Alarms tab of the *Main* screen.

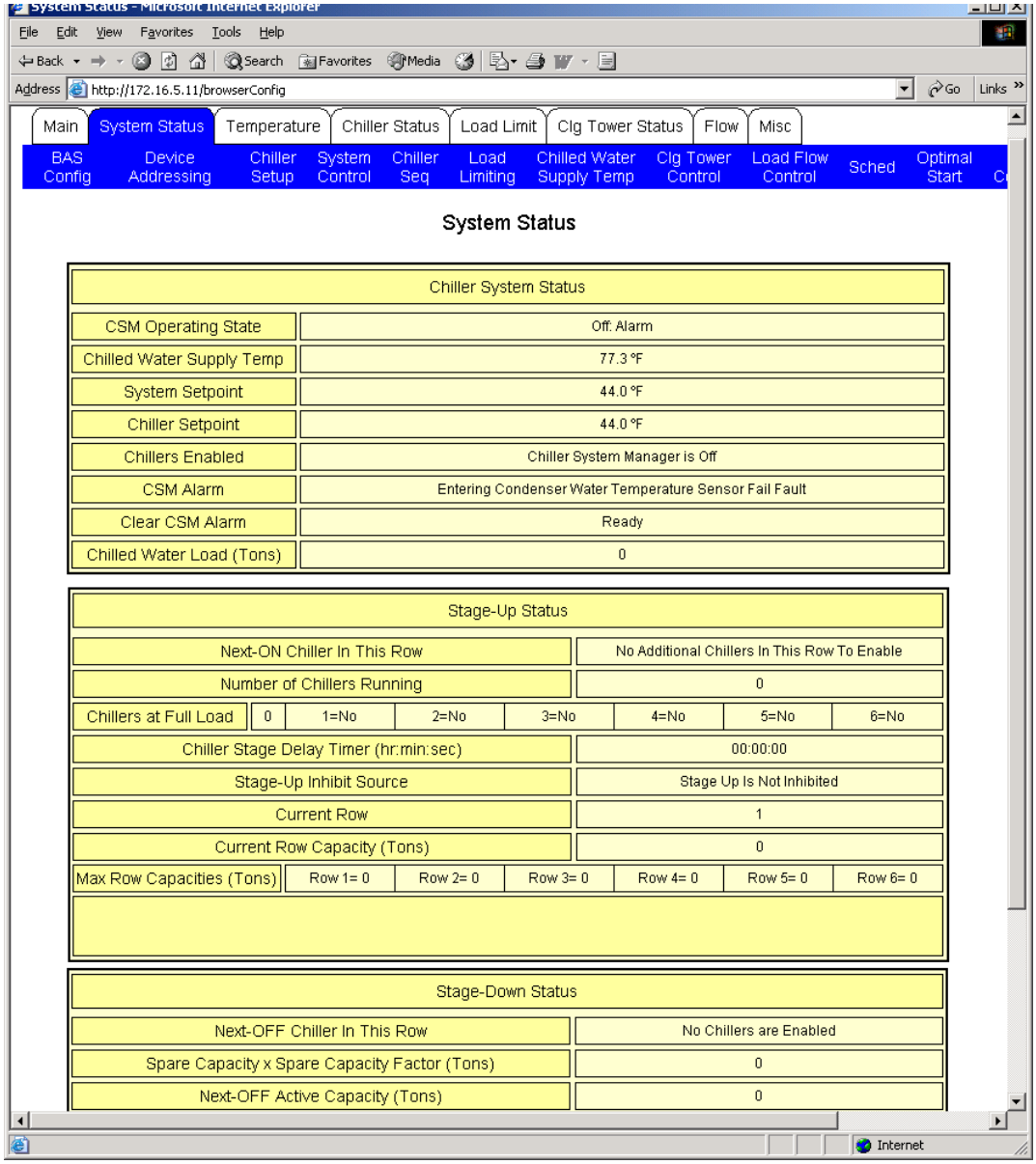
The information on the System Status screens update automatically whenever a change of value occurs in one of the displayed variables. Some of the displayed variables also change colors if the "status" of that variable changes. The status colors are described below:

- Status = OK – Normal
- Status = Alarm – Red
- Status = Out of Service – Light Blue
- Status = Overridden – Magenta
- Status = Down (not communicating) = Yellow

Chiller System Status

The CSM provides information that you can use to determine the overall status of the chiller system. At the user interface, you can find this information on the *System Status* screen. The System Status screen is broken down into three tables. The first table displays information describing the entire system status. The second table displays information pertaining to the stage-up status of the system. The last table displays information pertaining to the stage-down status of the system.

Figure 43. System Status (Main > System Status)



This section summarizes the most important chiller system information; you can get details about each chiller by using its keypad/display or the *Chiller Status* screen.

CSM Operating State

The CSM Operating State variable tells you what state the chiller system is currently in. The chiller system includes everything under the CSM's supervision; for example, chillers, cooling towers, and cooling load pumps. Four operating states are possible: Off, Recirculate, On, and Free Cooling.

Off (Unoccupied)

When the operating state is Off, all chillers, cooling tower fans, and cooling load pumps are disabled. The Off State has five sub-states:

1. Off: Alarm
2. Off: Manual
3. Off: Ambient
4. Off: BACnet Network

5. Off: Unoccupied

The sub-state name tells you why the CSM is in the Off State.

Off: Alarm Sub-state: The Off: Alarm state indicates that a CSM Fault alarm exists. In this state, the CSM cannot start for any reason. To get the CSM out of Off: Alarm, you must clear any Fault alarms that exist. The Off: Alarm state overrides any On state.

Off: Manual Sub-state: The Off: Manual state indicates that the CSM's Control Mode input (*System Control* screen) is set to Manual Unoccupied. In this state, the CSM cannot start for any reason. To get the CSM out of Off: Manual, you must set the CSM Control Mode to "Automatic" or "Manual Occupied." The Off: Manual state overrides any On state.

Off: Ambient Sub-state: The Off: Ambient state indicates that the CSM's low ambient lockout feature is enabled and the outdoor air temperature is below the Low Ambient Lockout Setpoint (see the *System Control* screen). In this state, the CSM cannot start for any reason. Before the CSM can leave Off: Ambient, the outdoor air temperature must rise above the setpoint by a differential of 2°F (1.1°C). Or you could also disable the feature by setting the Low Ambient Lockout Flag to "Off." The Off: Ambient state overrides any On state.

Off: BACnet Network Sub-state: The Off: BACnet Network state indicates that the CSM's Control Mode is set to "Automatic" and the CSM has received an Off command from a BACnet device. The Off: BACnet Network state overrides the On: Schedule, On: Optimal Start, On: Input, On: Modbus Network and On: BACnet Network states. BACnet is unique from all other scheduling methods because it can command the CSM to Off (all other scheduling methods command the CSM to On or AUTO). BACnet can also command to AUTO (instead of Off) to allow lower priority scheduling methods to be used.

Off: Unoccupied Sub-state: The Off: Unoccupied state indicates that the CSM is ready to operate whenever it receives an On command. Off: Unoccupied is different from the other Off states in that it is not caused by any one stop condition; for example, a "Manual Off" (from the CSM Control Mode variable). Instead, it is caused by the *absence* of an On condition. If the CSM Control Mode is "Automatic", any of the following On conditions will override the Off: Unoccupied state and start the system:

- An occupied weekly, holiday or special event schedule
- An Override Time setting other than zero
- A pre-occupancy optimal start condition
- A closed external start/stop input
- A network schedule input from BACnet or Modbus

Conversely, Off: Unoccupied can occur only when the CSM's Control Mode is "Automatic" and none of the above conditions exist.

Recirculate

In systems that have at least one cooling load pump, the Recirculate state is used (1) to verify cooling load water flow during the transition between Off and On and (2) to obtain an accurate cooling load loop water temperature reading before optimal start operation. During Recirculate, the cooling load pump system operates normally. The chillers and cooling tower systems are disabled.

On (Occupied)

When the operating state is On, the CSM supervises chiller system operation, deciding which chillers and auxiliary equipment should operate based on the chiller sequence order and the cooling load. The On State has six sub-states:

1. On: Manual
2. On: BACnet Network
3. On: Modbus Network
4. On: Input
5. Optimal Start
6. On: Schedule

The sub-state name tells you why the CSM is in the On State.

On: Manual Sub-state: The On: Manual state indicates that the CSM has started because the CSM Control Mode has been set to "Manual Occupied" and low ambient lockout is not in effect. The On: Manual state overrides the Off: Unoccupied, Off: BACnet Network, and Off: Manual states. On: Manual commands the CSM's Control Mode @ priority 8.

On: BACnet Network Sub-state: The On: BACnet Network state indicates that the CSM has started because the CSM Control Mode has been set to "Automatic", low ambient lockout is not in effect, and BACnet device has set the CSM's Binary Output instance 50. The On: BACnet Network state overrides the Off: Unoccupied and Off: BACnet Network states. On: BACnet Network commands the CSM's Control Mode @ priority 9.

On: Modbus Network Sub-state: The On: Modbus Network state indicates that the CSM has started because the CSM Control Mode has been set to "Automatic", low ambient lockout is not in effect, and Modbus master device has set the CSM's Coil index 00081. The On: Modbus Network state overrides the Off: Unoccupied. On: Modbus Network commands the CSM's Control Mode @ priority 10.

On: Input Sub-state: The On: Input state indicates that the CSM has started because the CSM Control Mode has been set to "Automatic", low ambient lockout is not in effect, and the external start/stop input is closed. The On: Input state overrides the Off: Unoccupied state. On: Input commands the CSM's Control Mode @ priority 11. At the user interface, the external start/stop switch status is shown on the *Misc* screen ("Auto" is open; "Occupied" is closed).

On: Optimal Start Sub-state: The On: Modbus Network state indicates that the CSM has started because the CSM Control Mode has been set to "Automatic", low ambient lockout is not in effect, and the optimal start feature has enabled the system prior to a scheduled start time. The On: Optimal Start state overrides the Off: Unoccupied. On: Optimal Start commands the CSM's Control Mode @ priority 13.

On: Schedule Sub-state: The On: Schedule state indicates that the CSM has started because the CSM Control Mode has been set to "Automatic", low ambient lockout is not in effect, and at least one of the following start conditions exists:

- An occupied weekly, holiday or special-event schedule
- An Override Time (*Sched* screen) setting greater than zero

The On: Schedule state overrides the Off: Unoccupied state. On: Schedule commands the CSM's Control Mode @ priority 16.

Free Cooling

If a BAS is used to put the CSM in the Free Cooling state:

1. The chillers are disabled.
2. The cooling tower system is enabled and operates normally.
3. Cooling tower stages are not restricted.
4. The CSM's chilled water flow control is enabled and operates normally.

This alone is not enough to create free cooling. The Free Cooling State is provided so that a BAS can implement a *custom* free cooling strategy in conjunction with the CSM's *standard* chiller system control strategies. Unless it has special software, *the CSM is not capable of coordinating an entire free cooling strategy by itself.*

Unlike the other operating states, Free Cooling can only occur as a result of a network command the CSM receives from a BAS network. In addition to sending the Free Cooling network command, the BAS would typically perform many other tasks as part of a free cooling strategy. For example, it might send different cooling tower setpoints to the CSM, open two-position bypass valves via digital outputs, and override chiller pumps via digital outputs.

Note: McQuay International's chiller applications group must approve all free cooling strategies. Contact your McQuay representative for information.

Loss of BAS Communications while in the Free Cooling State

If the BAS loses communications with the CSM, it retains and uses the last network command it received. If the BAS has the CSM in the Free Cooling state when it losses communication, the CSM will operate similar to the Manual Unoccupied mode until communications are restored. The CSM's user interface provides a BAS Free Cooling Input variable on the *Misc* screen to monitor the status of the BAS input and to manually override the BAS input if communications are lost and cannot be restored.

CAUTION

If a BAS is coordinating a free cooling strategy in which it changes cooling tower setpoints as it changes the network command, the CSM should be set up to be Unoccupied during any period when free cooling is possible. If this is not done, *chillers could start and operate with extremely low condenser water temperatures.*

Stage-Up Status

Whenever the common Chilled Water Supply Temperature is higher than the System Setpoint by more than the Chiller Stage-Up Differential, the CSM controls the chilled water capacity by sequencing its chillers. As the CSM sequences chillers on and off, it "stages-up" and "stages-down." If the sequence order is set properly, each successive stage has more capacity than the preceding stage. Additional capacity could be in the form of one added chiller (typical), or a chiller swap (in which the replacement chiller has more capacity than the one that is stopped). To allow you to monitor the stage-up operation the following variables are provided on the *System Status* screen:

- Next-ON Chiller
- Number of Chillers Running
- Chillers at Full Load
- Chiller Stage Delay Timer
- Stage-Up Inhibit Source
- Current Row
- Current Row Capacity (Tons)
- Max Row Capacities (Tons)
- And for Decoupled Systems (Chiller Sequence Control Type = Decoupled, *Chiller Seq* screen)
    - Decoupler Line Temp
    - Chilled Water Supply Temp + Decoupler Stage Up Differential

Whenever stage-up is not inhibited, the **next-on chiller** will be enabled when the **number of chillers running** equals the **chillers at full load**. Decoupled systems will also stage-up if the **decoupler line temp** is greater than (**chilled water supply temp** plus **the decoupler stage-up differential)**. All stage-ups require that the **chiller stage delay time** has expired since the last stage-up or stage-down. See the "Sequencing Logic" section of this document for more detail on stage-up.

If multiple rows are used, the CSM will move to a higher row when:

- All the available chillers in the current row are enabled (Next-ON Chiller In This Row variable will read "No Additional Chillers In This Row To Enable")
- All the enabled chillers in the current row are at full load
- The Current Row Capacity is less than the Maximum Row Capacity of a higher row
- The chiller stage delay time is exceeded

The CSM calculates maximum row capacity by multiplying the Chiller Availability (*Misc* screen) by the chiller's Tonnage (an operator input on the *Chiller Setup* screen) of every chiller assigned to a row and adding all these values together.

Stage-Down Status

To allow you to monitor the stage-down operation the following variables are provided on the *System Status* screen:

- Next-OFF Chiller
- Spare Capacity x Spare Capacity Factor
- Next-OFF Active Capacity
- Chiller Stage Delay Timer (see Stage-Up Status)
- And for Decoupled Systems (Chiller Sequence Control Type = Decoupled, *Chiller Seq* screen)
    - Decoupler Line Flow Rate
    - Next-OFF Chiller's Flow x Decoupler Stage Down Flow Rate Factor

The **next-off chiller** will be disabled when the **next-off active capacity** is less than (**spare capacity** multiplied by **spare capacity factor)**. Decoupled systems have the additional stage-down requirement that the **decoupler line flow rate** is greater than (**next-off chiller's flow** multiplied by **decoupler stage down flow rate factor)**. All stage-downs require that the **chiller stage delay time** has expired since the last stage-up or stage-down. See Sequencing Logic section on page 78.

System Capacity

System capacity is available in two possible forms. The first indication of system capacity is available for all system configurations and gives a *nominal* system capacity. The second indication of system capacity is available for system configurations with a flow meter in the common supply line and a common return water sensor.

Nominal System Capacity

The nominal system capacity is displayed as Current Row Capacity (Tons) in the stage-up section of the *System Status* screen. This is a nominal capacity because it displays the sum total of the capacity of each chiller multiplied by each chiller's current percent rated load amps (%RLA). The chiller's nominal capacity is entered by the operator and represents the full load capacity of a chiller at one operating condition. The %RLA is a general indication of the percent of full load that a chiller is currently running. The current row capacity value is displayed to allow you to monitor the stage-up status of the system, but it also gives you a rough estimate of the cooling load.

Measured System Capacity

The CSM can display a calculated value of the system capacity if the system has the following sensors:

- An optional flow meter located in the common supply line
- An optional common return water temperature sensor
- The required common supply water temperature sensor

The Flow Meter Present Flag and Return Water Sensor Present Flag must be set to true, and the Flow Meter Location variable must be set to Common Supply Line (all on the *I/O Config* screen). The Chilled Water Load (Tons) variable will then be displayed under the Clear CSM Alarm button on the *System Status* screen. This value is only available on systems with a flow meter measuring the flow through the common supply line.

Temperatures

The CSM provides both system temperatures (*Temperature* screen) and, for your convenience, local water temperatures at each chiller (*Chiller Status* screen). Figure 44 and Figure 45 show the locations of these temperature sensors.

Figure 44. Chilled Water Temperature Sensor Locations

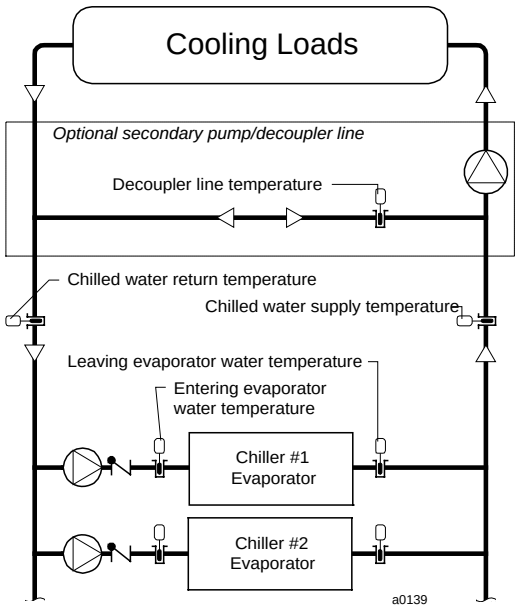
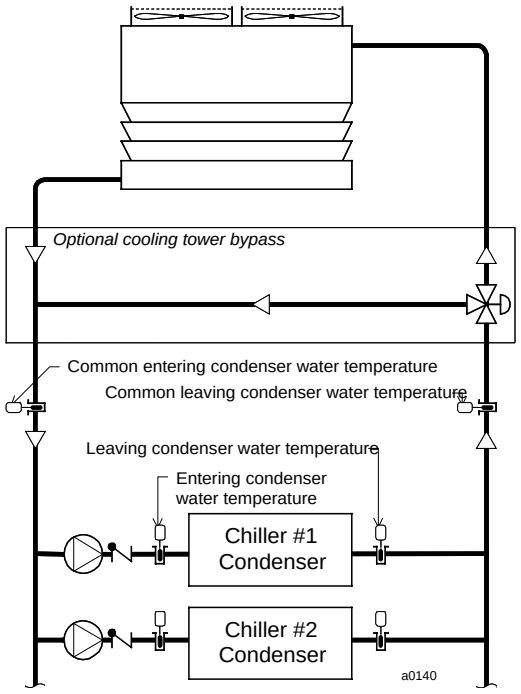


Figure 45. Condenser Water Temperature Sensor Locations

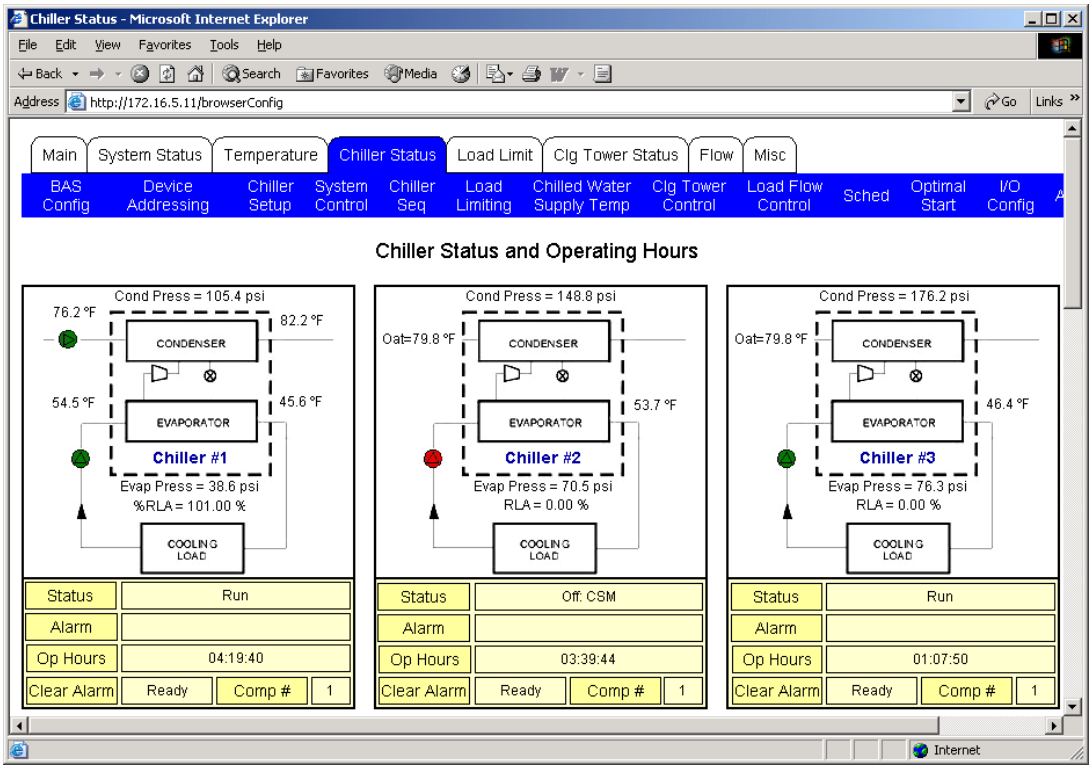


Note: All chillers provide a leaving evaporator water temperature to the CSM. The availability of the other three chiller water temperatures is dependent on chiller type.

Monitoring Chiller Status

The status and operating conditions of each chiller is displayed on the *Chiller Status* screen. An information box appears for every chiller that has been commissioned and is currently communicating with the CSM.

Figure 46. Chiller Status (Main > System Status > Chiller Status)



Status (Chiller Run Mode)

The chiller status tells you what general state a chiller is currently in. The following chiller status states are possible:

- Off
- Start
- Run
- PreShutdown
- Comm Loss

Chiller status at the CSM corresponds to one or more operating states (or other conditions) at a chiller. For information on specific chiller operating states, refer to the appropriate chiller operation manual (see Reference Documents on page 7.

Off

When the chiller status is Off, the chiller is disabled. The Off chiller status has two sub-states:

1. Off: Local
2. Off: CSM

The sub-state name tells you why the chiller status is Off.

Off: Local Sub-state: The Off: Local chiller status occurs if the chiller is communicating with the CSM but is unavailable (see the “Unavailable and Available Chillers” section in the “Chiller Sequencing Control” portion of this document). It indicates that something at the chiller has it disabled and thus the CSM is not able to start it. The cause might be, for example, a Fault alarm, or an open remote start/stop switch.

Off: CSM Sub-state: The Off: CSM chiller status indicates that the chiller is available, but the CSM has it disabled. This is the normal chiller status of a chiller that is not part of the current stage. If the chiller status of a chiller that is part of the current stage is Off: CSM, it is likely that the CSM tried to start that chiller but was unable to. In this instance, the CSM keeps the chiller off and—in most cases—performs a stage-up.

Start

The Starting chiller status indicates that a chiller is going through its start-up sequence after being enabled either locally or by the CSM.

Run

The Running chiller status indicates that a chiller is operational with at least one compressor on.

PreShutdown

The PreShutdown chiller status indicates that a chiller is going through its shutdown sequence after being disabled either locally or by the CSM.

Comm Loss

The Comm Loss chiller status indicates that the CSM has lost communications with a chiller. The CSM generates a Comm Loss alarm whenever this happens. See Alarm Monitoring and Control on page 108 for more information about what happens when a Comm Loss alarm occurs.

WAR NING
A chiller that is running when it loses communications does not automatically stop. Equipment damage, severe personal injury, or death can result.

Alarm

Each chillers alarm status is displayed on the CSM's user interface for your convenience. If a chiller has more than one current alarm, the alarm text will switch every 10 seconds so that all alarms are displayed. A log of each chiller's alarms is also available on the *Misc* screen. Alarms are also displayed at the chiller unit controller.

Clear Alarm

MicroTech II centrifugal chiller alarms can be cleared from the CSM by commanding the Clear Alarms variable. To clear chiller alarms right-click your mouse on the "Ready" box and then select the "Clear Alarm" command of the dialog box that appears. Before the chiller alarms can be cleared again, you must first set the clear alarm variable back to "Ready". If the chiller still remains in the alarm condition after clearing, the alarm will re-occur.

Alarm Clearing through the CSM cannot clear all alarms in the Chiller's Fault category (alarms that shut down the chiller). They would have to be cleared at the chiller unit controller. The alarms that cannot be cleared at the CSM (but can be cleared at the chiller) are:

1) Low Evaporator Pressure
2) High Condenser Pressure (by pressure sensor)
3) High Condenser Pressure (by pressure switch)
4) Low Oil Pressure
5) Freeze Protection
6) High Motor Temperature

Chiller Run Time (Op Hours)

The CSM tracks the run time of each chiller, which is measured in hours: minutes: seconds. For example, the run time for chiller 1 in Figure 46 is 4 hours: 19 minutes: 40 seconds. Run time is accumulated whenever at least one compressor is running (Status = Run). The CSM uses this run-time data to set the sequence order when multiple chillers in the same row have the same Sequence Number *(Chiller Seq* screen).

Comp

On dual centrifugal chillers, refrigerant pressure and saturated refrigerant temperature data is displayed one compressor at a time. This is also the case for multiple circuit screw and scroll chillers. The Comp # variable tells you which compressor (or circuit) is currently being displayed on the CSM. To change compressors (or circuits) right-click your mouse on the box displaying the current number and then select the "Set" command of the dialog box that appears. Changing the displayed Comp # for any chiller changes the Comp # variable for all chillers.

Chiller Data

%RLA (Chiller Load)

For any given chiller, the *chiller load* is the percent of available capacity currently being used. The way the chiller load is calculated depends on the type of chiller. See below.

Load Calculation: Centrifugal Chillers

The chiller load for centrifugal chillers is the percent of rated load amps (%RLA).

Load Calculation: Screw and Scroll Chillers

The chiller load for screw and scroll chillers is the percent of total compressor stages that are active. As an example, consider a two-circuit, four-stage scroll chiller. If the chiller is operating at stage 3, the chiller load is 75%.

Flow

The chiller's evaporator water flow status is displayed for each chiller using a circle with a triangle inside pointing in the direction of flow. This status represents a signal sent from the chiller to the CSM indicating that the chiller has proven evaporator flow. A green circle indicates evaporator flow has been proven and a red circle indicates no flow.

For water-cooled chillers the condenser water flow status is also displayed similar to the evaporator (see Chiller # 1 in Figure 46).

Evaporator Water Temperatures

The leaving evaporator water temperature is displayed for all chillers. The entering evaporator water temperature is also displayed for water-cooled centrifugal chillers (see Chiller # 1 in Figure 46).

Condenser Temperatures

The entering condenser water temperature is displayed for all water-cooled chillers. Leaving condenser water temperature is displayed on all water-cooled centrifugal chillers (see Chiller # 1 in Figure 46).

The outside air temperature is displayed for all air-cooled chillers (see Chiller # 3 in Figure 46).

Refrigerant Pressures

The evaporator and condenser refrigerant pressures are displayed for all chillers. On dual centrifugal or multiple circuit screw/scroll chillers, these pressures represent the compressor (or circuit) selected by the Comp # variable.

Saturated Refrigerant Temperatures

The saturated evaporator refrigerant temperature and the saturated condenser refrigerant temperature are tabled on the *Misc* screen for all chillers. On dual centrifugal or multiple circuit screw/scroll chillers, these temperatures represent the compressor (or circuit) selected by the Comp # variable.

Load Limiting Status

The CSM can perform three types of load limiting:

1. Demand Limiting
2. Soft Load
3. Load Balancing

For more information, see Load Limiting Control on page 45. The effects of these load-limiting functions are shown on the *Load Limit* screen.

Load limiting prevent the affected chillers from exceeding a certain percentage of their capacity. When no percent-of-capacity load limit is in effect, the load limit sent to each chiller is 100%. When any one is in effect, the load limit is less than 100%. Each chiller receives the minimum of the three percent-of-capacity load limit values that apply to it (see below). The Chiller #X Load Limit values show the load limit the CSM is currently sending to the individual chillers.

A centrifugal chiller uses a load limit value it receives from the CSM in the same manner as a load limit value it might generate internally:

1. Loading is inhibited when the load (%RLA) is equal to the load limit or 1% to 4% above the load limit.
2. Unloading occurs when the load is 5% or more above the load limit.

Reciprocating or screw chillers convert the load limit value it receives from the CSM into a maximum stage value.

Demand Limiting: When the CSM receives a demand-limiting signal, it sends it to *all* chillers associated with it. The System Demand Limiting Load Limit variable shows the current value. If an external voltage or current is being used, the External Demand Limiting Signal variable (*Misc* screen) shows the *conditioned* value of the input. (The CSM conditions all analog inputs to 0–10 Vdc signals.)

Soft Load: When soft loading is enabled, it applies to the first chiller that the CSM enables. The Soft Load Limit variable is displayed as it ramps up from its Initial Soft Load %RLA to 100%.

Load Balancing: When load balancing is enabled, it applies to all chillers that have been assigned a Load Balancing Group #. Typically, when load balancing is used all chillers will be placed in Load Balancing Group 1 so that they are all balanced together. The effect that load balancing is having on the system is displayed as the Load Balancing Load Limit Group X variables displayed on the *Load Limit* screen for the six possible load balancing groups.

Chilled Water Distribution System Status

The CSM can maintain a constant differential pressure across the cooling loads by controlling a loop bypass valve, variable speed cooling load pump(s), or a set of sequenced pumps. For applications that require a “lead/standby” arrangement of two cooling load pumps, the CSM can automatically alternate the lead pump to equalize run time. To view the chilled water distribution system status, go to the *Flow* screen. For more information, see Chilled Water Flow Control on page 67.

Cooling Tower Status

The CSM can maintain a common entering or leaving condenser water temperature by controlling up to 12 cooling tower stages and a tower bypass valve. To view the cooling tower status, go to the *Clg Tower Status* screen. For more information, see Cooling Tower Control on page 56.

Override of the Chiller System Manager’s Control

Local Override of a Chiller

CSM control can be overridden if you want to enable or disable a chiller locally (at the chiller unit controller); however, *this should be done only if it is absolutely necessary*. If you set a chiller to local control the Chiller Off-line alarm occurs. If you locally disable a chiller while it is enabled by the CSM, the CSM forces a stage-up, allowing the Next-ON chiller to start immediately.

When you wish to take local control of a chiller that is running and is communicating with the CSM, the CSM will know that the chiller is running and will not stage-up until all running chillers are fully loaded. This action helps avoid having too much system capacity in the event of a chiller(s) running in local control, and allows the CSM to continue to control other system components and attempt to maintain system setpoints.

There are several ways to locally enable or disable a chiller, see your chiller’s operation manual for details. When you locally disable a chiller it cannot run for any reason. When you locally enable a chiller it runs—if the CSM is the only thing disabling it. (For example, if there is a Fault alarm in a chiller, the chiller cannot start if you try to enable it locally.)

Free Cooling BAS Network Override

The CSM's operating state can be overridden by a network command received from a BAS to provide a custom free cooling strategy. The CSM provides the BAS with a Free Cooling data point (see ED 15075-BACnet and ED 15076-Modbus) to allow the BAS to override the normal operation of the CSM in specific instances.

Alarm Monitoring and Control

The CSM monitors the chiller system equipment for specific alarm conditions that may occur. If the CSM detects an alarm condition, it indicates the CSM Alarm on the *System Status* screen, logs the alarm for acknowledgement in the *View Alarms* screen, identifies the alarm, and executes appropriate control actions that fail-safe the equipment.

⚠ CAUTION

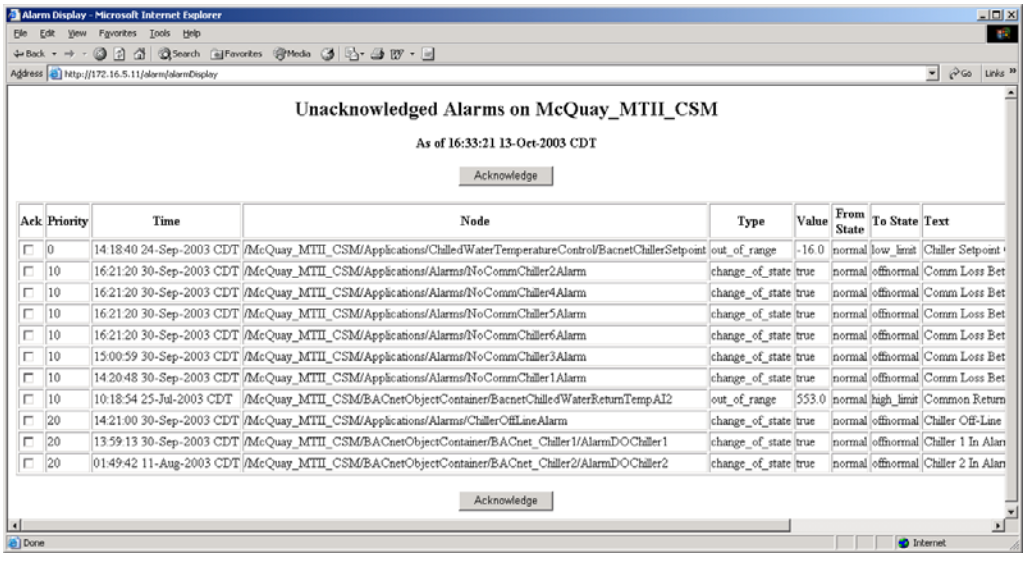
System damage hazard. Alarms associated with optional sensors must be enabled when the optional sensor is installed. Each time a sensor is installed the "sensor present flag" on the *I/O Config* screen must be set to YES to initiate that sensors alarm features. If this flag is not set the fail-safe features of the Chiller System Manager will not execute when that sensor fails.

The CSM also indicates the existence of chiller alarms, and it tells the operator which chiller or chillers have them. The CSM's user interface tells the operator the specific current chiller alarms on the *Chiller Status* screen. The CSM also logs the last 10 chiller alarms for each chiller and displays them on the *Misc* screen (to view a log, left click on a Chiller Alarm Log and a web page will appear displaying the alarms).

Acknowledging Alarms on the CSM

Each CSM alarm will be logged for viewing at the user interface at the *View Alarms* web page. Alarms will remain on this screen until an operator acknowledges viewing each alarm. Important information on the *View Alarms* screen includes a TIME stamp of when the alarm occurred and a TEXT description of what alarm occurred.

Figure 47. Acknowledging Alarms (Main > View Alarms)



To acknowledge viewing an alarm, click on the box to the left of the alarm you wish to acknowledge, then click on the Acknowledge button on the top or bottom of the web page. After acknowledging alarms, refresh the Unacknowledged Alarms web page to see that they are no longer on the list (to refresh on Internet Explorer go to View > Refresh).

Clearing CSM Alarms

Before an alarm can be cleared, the alarm conditions that caused it must be returned to normal. When the alarm conditions are gone, an alarm may be cleared either automatically or manually. Table 25 shows how CSM alarms are cleared in the Reset column.

An auto-reset alarm immediately clears when the alarm conditions that caused it return to normal.

To clear a manual-reset alarm, the operator must press the CLEAR CSM ALARM button on the *System Control* screen of the user interface. If the condition that caused the alarm still exists, the alarm will occur again.

Alarms that are associated with optional sensors connected to the CSM are inhibited from entering the alarm condition until the Sensor Present Flag for that particular sensor has been set to YES on the *I/O Config* screen. If a sensor present flag is accidentally set to YES when a properly operating sensor is not connected, an unwanted alarm condition will be created. To make this unwanted alarm go away, a valid value must be assigned to the sensor that is in the alarm condition.

► To clear unwanted temperature sensor alarms

1. Set the Sensor Present Flag of the sensor that is in alarm to YES.
2. Wire approximately 10,000 ohms across the input of the sensor that is in alarm.
3. If the alarm is an automatically cleared alarm it will go away, if it is a manually reset alarm press the Clear CSM Alarm button.
4. Set the Sensor Present Flag of the unused sensor to NO.

► To clear unwanted Decoupler Flow Meter, Loop DP, Relative Humidity or Spare sensor alarms

1. Set the Sensor Present Flag of the sensor that is in alarm to YES. Or in the case of the spare sensor alarm set the Spare Sensor Type equal to something other than None.
2. Increase the "Offset" variable (*I/O Config* screen) until the value of the sensor comes into range, which will stop the alarm condition. Setting the offset to one-half the value of that sensors High Cal Rate will normally clear the alarm.
3. These are all automatically cleared alarms and will go away.
4. Set the Sensor Present Flag of the unused sensor to NO. Or in the case of the spare sensor, set the Spare Sensor Type equal to None.

Clearing Chiller Alarms

Each chiller's alarms may be cleared at the chiller unit controller. MicroTech II centrifugal chiller alarms can also be cleared through the CSM. To clear chiller alarms from the CSM see Clear Alarm on page 105.

CSM Alarms and Their Effect on System Control

CSM alarms are broken down into the three alarm types of Fault, Problem and Warning alarms. The Fault alarm type consists of alarms that shut down the CSM. The Problem alarm type consists of alarms that affect the control of the system, but do not shut the system down. The Warning alarm type consist of alarms that do not affect the control of the system and are for the operator's information only.

Table 25. CSM Alarms

Alarm Type	Alarm Priority	Alarm Message	Indication	Reset
Fault	0	Leaving Condenser Water Temp Sensor Fail	Common leaving condenser water temperature sensor failed while it was the cooling tower Control Temperature source	Manual
		Entering Condenser Water Temp Sensor Fail	Common entering condenser water temperature sensor failed while it was the cooling tower Control Temperature source	Manual
		No Chilled Water Flow	All cooling load pumps failed, resulting in a loss of chilled water flow to the loads	Manual
Problem	10	Comm Loss Between CSM and Chiller 12	Communications lost between CSM and Chiller #12	Auto
		Comm Loss Between CSM and Chiller 11	Communications lost between CSM and Chiller #11	Auto

Alarm Type	Alarm Priority	Alarm Message	Indication	Reset
		Comm Loss Between CSM and Chiller 10	Communications lost between CSM and Chiller #10	Auto
		Comm Loss Between CSM and Chiller 9	Communications lost between CSM and Chiller #9	Auto
		Comm Loss Between CSM and Chiller 8	Communications lost between CSM and Chiller #8	Auto
		Comm Loss Between CSM and Chiller 7	Communications lost between CSM and Chiller #7	Auto
		Comm Loss Between CSM and Chiller 6	Communications lost between CSM and Chiller #6	Auto
		Comm Loss Between CSM and Chiller 5	Communications lost between CSM and Chiller #5	Auto
		Comm Loss Between CSM and Chiller 4	Communications lost between CSM and Chiller #4	Auto
		Comm Loss Between CSM and Chiller 3	Communications lost between CSM and Chiller #3	Auto
		Comm Loss Between CSM and Chiller 2	Communications lost between CSM and Chiller #2	Auto
		Comm Loss Between CSM and Chiller 1	Communications lost between CSM and Chiller #1	Auto
		Comm Loss Between CSM and Remote Module A	Communications lost between CSM and Remote I/O Module A (cooling load pump control)	Auto
		Comm Loss Between CSM and Remote Module B	Communications lost between CSM and Remote I/O Module B (cooling load pump control)	Auto
		Comm Loss Between CSM and Remote Module C	Communications lost between CSM and Remote I/O Module C (cooling load pump control)	Auto
		Comm Loss Between CSM and Remote Module D	Communications lost between CSM and Remote I/O Module D (loop bypass valve control)	Auto
		Comm Loss Between CSM and Remote Module E	Communications lost between CSM and Remote I/O Module E (cooling tower control)	Auto
		Comm Loss Between CSM and Remote Module F	Communications lost between CSM and Remote I/O Module F (cooling tower control)	Auto
		Comm Loss Between CSM and Remote Module G	Communications lost between CSM and Remote I/O Module F (cooling tower control)	Auto
		Comm Loss Between CSM and Remote Module H	Communications lost between CSM and Remote I/O Module H (cooling tower control)	Auto
		Decoupler Flow Meter Fail	The flow rate sensor used to determine decoupler line flow has failed. Excess primary water flow will be eliminated as a stage-down precondition	Auto
		Cooling Load Pump #6 Fail	Cooling Load Pump #6 status not proven after output was energized	Manual
		Cooling Load Pump #5 Fail	Cooling Load Pump #5 status not proven after output was energized	Manual
		Cooling Load Pump #4 Fail	Cooling Load Pump #4 status not proven after output was energized	Manual
		Cooling Load Pump #3 Fail	Cooling Load Pump #3 status not proven after output was energized	Manual
		Cooling Load Pump #2 Fail	Cooling Load Pump #2 status not proven after output was energized	Manual
		Cooling Load Pump #1 Fail	Cooling Load Pump #1 status not proven after output was energized	Manual
		Outside Air Temp Sensor Fail	Outdoor air temperature sensor failed	Auto
		Decoupler Temp Sensor Fail	Decoupler temperature sensor failed. The requirement of additional primary water flow will not cause a stage-up.	Auto

Alarm Type	Alarm Priority	Alarm Message	Indication	Reset
		Common Return Chilled Water Temp Sensor Fail	Common return chilled water temperature sensor failed	Auto
		Common Supply Chilled Water Temp Sensor Fail	Common supply chilled water temperature sensor failed	Auto
		Chilled Water Loop Differential Pressure Sensor Fail	Chilled water loop differential pressure sensor failed	Auto
		Relative Humidity Sensor Fail	Relative Humidity sensor failed	Auto
		Chiller Availability Greater Than One	The Chiller Availability of one of the connected chillers is being calculated to be higher than possible	Auto
		Spare Sensor Fail	The sensor connected to the spare input has failed	Auto
		No Evaporator Flow After Enabling Chiller X	After a chiller is enabled, the evaporator flow switch must prove flow before the Wait For Evaporator Flow Timer property expires	Manual
Warning	100	Cooling Tower Alarm X	Cooling towers partially or totally failed. See the value column of the *Alarm View* screen to determine which cooling tower output is in alarm	Auto
		Leaving Condenser Water Temp Sensor Warning	Common leaving condenser water temperature sensor failed while it was not the cooling tower Control Temperature source	Auto
		Entering Condenser Water Temp Sensor Warning	Common entering condenser water temperature sensor failed while it was not the cooling tower Control Temperature source	Auto
		Chiller Off-line	At least one chiller that is part of the current sequence is unavailable to the CSM	Auto
		Chiller X In Alarm	At least one alarm in chiller X is active. X could be any chiller commissioned to the CSM. For a description of the current active alarms on a particular chiller, see it's "Alarm" line on the *Chiller Status* screen or that chillers alarm log on the *Misc* screen	
		Stage-Up Inhibiting has Restricted the Enabling of a Chiller	System conditions have occurred which would normally have caused a stage-up but the stage-up did not occur because some form of Stage-Up Inhibiting is active.	Auto

Note: Alarms that are associated with optional sensors connected to the CSM will not occur if the Sensor Present Flag has not been set to YES on the *I/O Config* screen. If the alarm does not occur, the action taken by the CSM during that alarm condition does not take place. This will produce unwanted reaction from the chiller system. Make sure to set the Sensor Present Flags after installing optional sensors.

Fault Alarms

Leaving Condenser Water Temperature Sensor Fail

If the common leaving condenser water temperature sensor fails while Control Temperature Source = Leaving Cond Water and the cooling tower is enabled, the Leaving Condenser Water Temperature Sensor Fail alarm occurs as a Fault. The system immediately shuts down and remains shut down until the alarm is manually cleared at the user interface. If the Leaving Condenser Water Sensor Present Flag = No (I/O Config screen), the alarm is inhibited from changing.

Entering Condenser Water Temperature Sensor Fail

If the common entering condenser water temperature sensor fails while Control Temperature Source = Entering Cond Water and the cooling tower is enabled, the Entering Condenser Water Temperature Sensor Fail alarm occurs as a Fault. The system immediately shuts down and remains shut down until the alarm is manually cleared at the user interface. If the Entering Condenser Water Sensor Present Flag = No (*I/O Config* screen), the alarm is inhibited from changing.

No Chilled Water Flow

If the Pump Control Option is not equal to "None (*Load Flow Control* screen), the no chilled water flow alarm occurs whenever all cooling load pumps have failed. A pump is considered "failed" if its digital input is open while its digital output is closed for any continuous period of time equal to the Pump Status Check Delay Time variable (*Load Flow Control* screen). If the No Chilled Water Flow alarm occurs, the system immediately shuts down and remains shut down until the alarm is manually cleared at the user interface.

Problem Alarms

Comm Loss Between CSM and Chiller X (x could be any commissioned chiller #)

When the communications between the CSM and a chiller on the CSM's LONWORKS network is lost; two types of Comm Loss control take place; 1) Comm Loss control at the CSM, and 2) Comm Loss control at the chiller.

Comm Loss control at the CSM

If the CSM loses communications with a chiller the comm loss between CSM and chiller X alarm occurs, where *x* is the number of the affected chiller. When communications are restored, the alarm automatically clears.

If the affected chiller would normally be enabled at this point of the chiller sequencing logic, the Chiller Off-line alarm will occur (see "Warning Alarms" below).

Comm Loss Control at the Chiller

The CSM continually updates all commanded properties at the chiller every 100 seconds (max). The commanded properties are Chiller Enable, Cool Setpoint and Chiller Capacity Limit. If communication is lost between the CSM and chiller these points will no longer be updated and the chiller will operate in the last enable/disable, cool setpoint and capacity limit commands it received from the CSM. For example: if the chiller was enabled when communications were lost it will stay enabled until communications are restored. This is an acceptable control strategy on many chiller systems.

The operator can program the chiller's Comm Loss states for Chiller Enable and Cool Setpoint. The Comm Loss default for Chiller Capacity Limit is 100 % and is not changeable through the CSM. To change the Comm Loss conditions of Chiller Enable or Cool Setpoint, see Communication Loss Control at the Chiller on page 26.

Comm Loss Between CSM and Remote Module X (x could be any commissioned remote I/O module)

When the communications between the CSM and a commissioned remote I/O module on the CSM's LONWORKS network is lost control of the devices connected to that module is lost.

- When communications is lost with Remote Module A, B, or C control of the cooling load pumps will be lost. This will typically cause the No Chilled Water Flow fault alarm to occur and shut down the system. If the module is operating properly except for loss of communication with the CSM, the following conditions will be locally set after communications has been lost for 200 seconds.

  The pump output relays will be turned off.

  The pump VFD speed output signals will be set to 0% speed.
- When communications is lost with any of the Remote Modules E through H, cooling tower control will be reduced or lost. If the module is operating properly except for loss of communication with the CSM, the following conditions will be locally set after communications has been lost for 200 seconds.

  The tower output relays on all non-communicating modules will be turned off.

  The tower VFD speed output signal on all non-communicating modules will be set to 0% speed.

  If Remote Module B looses communication the tower bypass valve will hold current position.
- When communications is lost with Remote Module D, control of the loop bypass valve will be lost. If Module F is operating properly except for the loss of communications with the CSM, the loop bypass valve position will be locally set to 100% (full bypass) after communications has been lost for 200 seconds.

When communication is re-established, the alarm automatically clears.

Decoupler Flow Meter Fail

If the conditioned analog signal from the flow rate sensor used to determine flow through the decoupler line falls below 1 Vdc (or the current signal from the flow meter falls below 2 mA), the decoupler flow meter fail alarm occurs. As a result, the system continues to operate, but the decoupled sequencing logic is modified to eliminate excess primary water flow as a stage-down precondition. Thus stage-down control is based on the Active Capacity of the Next-OFF chiller and time only. This may affect the system in the following way:

- When the secondary loop demand for flow exceeds the primary loop flow, the decoupler line temperature sensor will detect flow going backwards through the decoupler line and the CSM will enable another chiller to increase the primary water flow. If the capacity of this newly enabled chiller is not required the CSM may quickly disable this chiller, which turns off the evaporator pump. This again allows flow to travel backwards in the decoupler line raising the supply water temperature.
- The flow meter is used to make sure that the primary water flow through the decoupler line is greater that the primary water flow that will be lost when the Next-OFF chiller is disabled. If this flow sensor fails, one of the chiller evaporator pumps may short-cycle. A properly operating flow meter will keep this chiller running (so that its evaporator pumps will run) until the secondary loop demand for flow decreases.

When the alarm condition is gone, the alarm automatically clears.

If a flow meter is not connected to the CSM, leave the Flow Meter Present Flag = No (*I/O Config* screen) so that the alarm is inhibited from changing.

Cooling Load Pump #X Fail (x could be pump 1, 2, 3, 4, 5, or 6)

If the CSM enables pump *x* and pump *x* fails, the cooling load pump #*x* fail alarm occurs, where *x* is the pump number. If there are two or more cooling load pumps the CSM attempts to start another pump, and the system continues to operate. A pump is considered "failed" if its status digital input is open while its digital output is closed for any continuous period of time equal to the Pump Status Check Delay Time variable (*Load Flow Control* screen). The alarm must be manually cleared at the user interface. If the Pump Control Option = "Sequencing" and a pump that failed returns to operation, the alarm will clear automatically.

Outdoor Air Temperature Sensor Fail

If an outdoor air temperature sensor is connected to the CSM and it fails, the outdoor air temp sensor fail alarm occurs. As a result, the system continues to operate, but the following features are affected:

- Low ambient lockout

  The low ambient lockout feature acts as though the OAT is extremely high (120 F). Therefore, low ambient lockout never occurs.
- Optimal start

  The optimal start feature acts as though the OAT is extremely high (100°F, 38°C) which likely results in an earlier start-up time.
- Chilled water reset based on OAT

  The Outdoor Air reset function acts as though the OAT is extremely high. Therefore, it sets the System Setpoint equal to the Minimum System Setpoint.
- Cooling tower Stage 1 Setpoint Reset based on Constant Approach to Wet Bulb

  The constant approach reset function is disabled and the Operator Defined (or BAS reset input) Stage 1 Setpoint are used.
- Cooling tower bypass valve initial position

  The initial bypass valve position function acts as though the OAT is extremely high. Therefore, it sets the initial valve position equal to the Maximum Tower Valve Start-Up Position variable.

When the alarm condition is gone, the alarm automatically clears.

If an OAT value is not supplied to the CSM, the operator should disable this alarm by setting the Outdoor Air Temp Source = None (*I/O Config* screen).

Decoupler Temperature Sensor Fail

If the temperature sensor in the decoupler line reads out of range (-10 to 135°F, -23.3 to 57.2°C), the decoupler temperature sensor fail alarm occurs. As a result, the system continues to operate, but the decoupled sequencing logic is modified to allow stage-ups only when additional capacity is required, not when additional primary water flow is required. The decoupler line temperature is used to check the need for additional primary water flow. When the alarm condition is gone, the alarm automatically clears.

If a decoupler line temperature sensor is not connected to the CSM, leave the Decoupler Sensor Present Flag = "No" (*I/O Config* screen) so that the alarm is inhibited from changing.

Return Chilled Water Temperature Sensor Fail

If the temperature sensor in the return chilled water line reads out of range (-10 to 135°F, -23.3 to 57.2°C), the return chilled water temperature sensor fail alarm occurs. As a result, the system continues to operate. The following features are affected:

- Optimal start

  The optimal start feature acts as though the return water temperature is extremely high. Therefore, it uses 90°F (32°C), which likely results in an earlier start-up time.
- Chilled water reset based on return water temperature

  The Return Water reset function acts as though the return water temperature is extremely high. Therefore, it sets the System Setpoint equal to the Minimum System Setpoint.
- Chilled water reset for constant return water temperature

  The Constant Return reset function acts as though the return water temperature is extremely high. Therefore, it sets the System Setpoint to the Minimum System Setpoint.

When the alarm condition is gone, the alarm automatically clears.

If a return chilled water temperature sensor is not connected to the CSM, leave the Return Chilled Water Sensor Present Flag = "No" (*I/O Config* screen) so that the alarm is inhibited from changing.

Supply Chilled Water Temperature Sensor Fail

If the temperature sensor in the supply chilled water line reads out of range (-10 to 135°F, -23.3 to 57.2°C), the supply chilled water temperature sensor fail alarm occurs. As a result, the system continues to operate. The following features are affected:

- Standard chiller sequencing

  Standard sequencing logic acts as though the supply water temperature is extremely high. Therefore, stage-up control is based on chiller full load status and the chiller stage delay time only.
- Decoupled chiller sequencing

  Decoupled sequencing logic acts as though the supply water temperature is extremely high. Therefore, stage-up control is based on chiller full-load status and the chiller stage delay time only. A stage-up does not occur if additional primary water flow is required.
- Common chilled water temp control option

  The Common chilled water temp control option acts as though the supply water temperature is extremely high. Therefore, it quickly reduces the Chiller Setpoint to the Minimum Chiller Setpoint.
- Optimal start

  The optimal start feature disables its adaptation process. Thus, an optimal start can still occur, but the time increment used is not updated.

When the alarm condition is gone, the alarm automatically clears. This sensor is required for all CSM applications and there is no means to disable the alarm.

Loop Differential Pressure Sensor Fail

If the conditioned analog signal from the loop differential pressure sensor falls below 1 Vdc, the loop differential pressure sensor fail alarm occurs. As a result, the system continues to operate, but the following features are affected:

- Sequencing pump logic

Sequencing pump logic acts as though the loop differential pressure is extremely high (1035). Therefore, stage-down control is based on time only, and thus the pump set quickly stages down to stage 1.

- Variable speed pump control

  The variable speed pump control process acts as though the loop differential pressure is extremely high (1035). Therefore, it quickly reduces the pump speed to 0%.

- Chilled water loop bypass valve control

  The loop bypass valve control process acts as though the loop differential pressure is extremely high (1035). Therefore, it quickly increases the valve position to 100% (full bypass).

If the Spare Sensor Type = Second Loop Diff Pressure Sensor and two loop differential pressure sensors are used for modulation control of the pressure across the cooling loads, the sensor with the greatest deviation from setpoint is used as the controlled variable. When the spare sensor input is used for the second loop differential pressure input and the first loop differential pressure sensor is in alarm, the second sensor is used exclusively as the controlled variable and all above features are not affected. If both sensors are in alarm all above features are affected as stated.

When the alarm condition is gone, the alarm automatically clears

If a loop differential pressure sensor is not connected to the CSM, leave the Loop Differential Pressure Sensor Present Flag = "No" (*I/O Config* screen) so that the alarm is inhibited from changing.

Relative Humidity Sensor Fail

If the conditioned analog signal from the relative humidity sensor falls below 1 Vdc (< 2 mA) or above 10 Vdc (> 20 mA), the Relative Humidity Sensor Fail alarm occurs. As a result, the system continues to operate, but the following features are affected:

- Cooling tower Stage 1 Setpoint Reset based on Constant Approach to Wet Bulb

  The constant approach reset function is disabled and the Operator Defined (or BAS reset input) Stage 1 Setpoint are used.

- Dew Point, Wet Bulb and Enthalpy display values are invalid

When the alarm condition is gone, the alarm automatically clears.

If a Relative Humidity sensor is not connected to the CSM, leave the Relative Humidity Sensor Present Flag = No (*I/O Config* screen) so that the alarm is inhibited from changing.

Spare Sensor Fail

If the conditioned analog signal from the spare sensor falls below 1 Vdc (< 2 mA), the Spare Sensor Fail alarm occurs. As a result, the system continues to operate, but the following features are affected:

- If the Spare Sensor Type = Second Loop Diff Pressure Sensor

  When two loop differential pressure sensors are used for modulation control of the pressure across the cooling loads, the sensor with the greatest deviation from setpoint is used as the controlled variable. When the spare sensor input is used for the second loop differential pressure input and this input is in alarm, the first loop differential pressure sensor is used exclusively as the controlled variable.

If both sensors fail, all features listed in the Loop Differential Pressure Sensor Fail alarm are affected.

When the alarm condition is gone, the alarm automatically clears.

If a Spare sensor is not connected to the CSM, leave the Spare Sensor Type = None (*I/O Config* screen) so that the alarm is inhibited from changing.

Chiller Availability Greater Than One

The maximum possible value for any chiller's availability (*Misc* screen) is "1", which means the chiller is capable of providing 100% of its cooling capacity. The Chiller Availability Greater Than One alarm occurs if the CSM calculates the chiller availability to be greater than one for any chiller. Since chiller availability is calculated by dividing a signal from each compressor on a chiller by the chiller's Number of Compressors variable, a value greater than one typically means the Number of Compressors variable has been entered incorrectly for a chiller. Go to the *Chiller Setup* screen and check the Number of Compressors variable matches the physical chiller's number of compressors.

If any chiller availability value is greater than zero, the CSM will overestimate that chiller's cooling capacity and sequencing logic will be affected.

No Evaporator Flow After Enabling Chiller X

Some chillers have a "Waiting For Flow" status condition where the compressors will not run because evaporator flow does not exist. Since chillers may remain in this state indefinitely if flow is never provided, the CSM must recognize this condition and enable different chillers to meet load requirements.

After enabling a chiller, the CSM monitors that chillers evaporator flow switch to verify that the evaporator pump operating properly. After enabling, if flow is not proven by the time the "Wait For Evaporator Flow Timer" expires, the No Evaporator Flow After Enabling Chiller X alarm will occur. The chiller will be disabled and the Next-ON chiller will be immediately enabled. This alarm sets the chiller unavailable (*Misc* screen) which means the chiller will not be enabled again until this alarm in manually cleared at the CSM user interface. For an indication of which chiller caused this alarm to occur, the number in the Value column for this alarm in the *View Alarm* (see Figure 48) indicates the chiller number which didn't receive evaporator flow on startup.

Warning Alarms

Cooling Tower Fail X (x could be cooling tower output 1 through 16)

If a cooling tower output has been enabled and a contact connected to the cooling tower alarm input with the same number is closed for the delay time of 30 seconds, the cooling tower fail X alarm occurs. When the contact connected to the alarm input is opened again or the tower output is disabled for the delay time of 30 seconds, the alarm automatically clears. See the Cooling Tower Output in Alarm value on the *Clg Tower Status* screen to determine X (which cooling tower output is in alarm).

System operation is not affected by this alarm and wiring a contact to the tower alarm inputs is optional. This alarm is provided so that an external alarm-logic circuit for cooling tower equipment can be field wired.

Leaving Condenser Water Temperature Sensor Fail Warning

If the common leaving condenser water temperature sensor fails while it is not the selected Control Temperature source for the cooling tower, the leaving condenser water temp sensor fail warning alarm occurs as a Warning. System operation is not affected by this alarm. When the alarm condition is gone, the alarm automatically clears.

If you don't have a common leaving condenser water temperature sensor connected to the CSM, leave the Leaving Condenser Water Sensor Present Flag = "No" (*I/O Config* screen) so that the alarm is inhibited from changing.

Entering Condenser Water Temperature Sensor Fail Warning

If the common entering condenser water temperature sensor fails while it is not the selected Control Temperature source for the cooling tower, the entering condenser water temp sensor fail warning alarm occurs as a Warning. System operation is not affected by this alarm. When the alarm condition is gone, the alarm automatically clears.

If you don't have a common entering condenser water temperature sensor connected to the CSM, leave the Entering Condenser Water Sensor Present Flag = "No" (*I/O Config* screen) so that the alarm is inhibited from changing.

Chiller Off-line

The chiller off-line alarm occurs whenever at least one chiller is part of the current sequence but unavailable. This alarm does not affect system operation, but it is an indication that total system capacity will be decreased. When no off-line chillers exist, the alarm automatically clears.

Chiller X In Alarm (x could be any commissioned chiller number)

The chiller X in alarm occurs whenever a connected chiller has at least one active alarm. When all chiller alarms are cleared, the alarm automatically clears. For a text description of the current active alarms on a particular chiller:

1. See the "Alarm" line of that chiller on the *Chiller Status* screen.
2. See that chillers alarm log on the *Misc* screen.
3. Or go directly to the chiller's unit controller.

Stage-Up Inhibiting has Restricted the Enabling of a Chiller

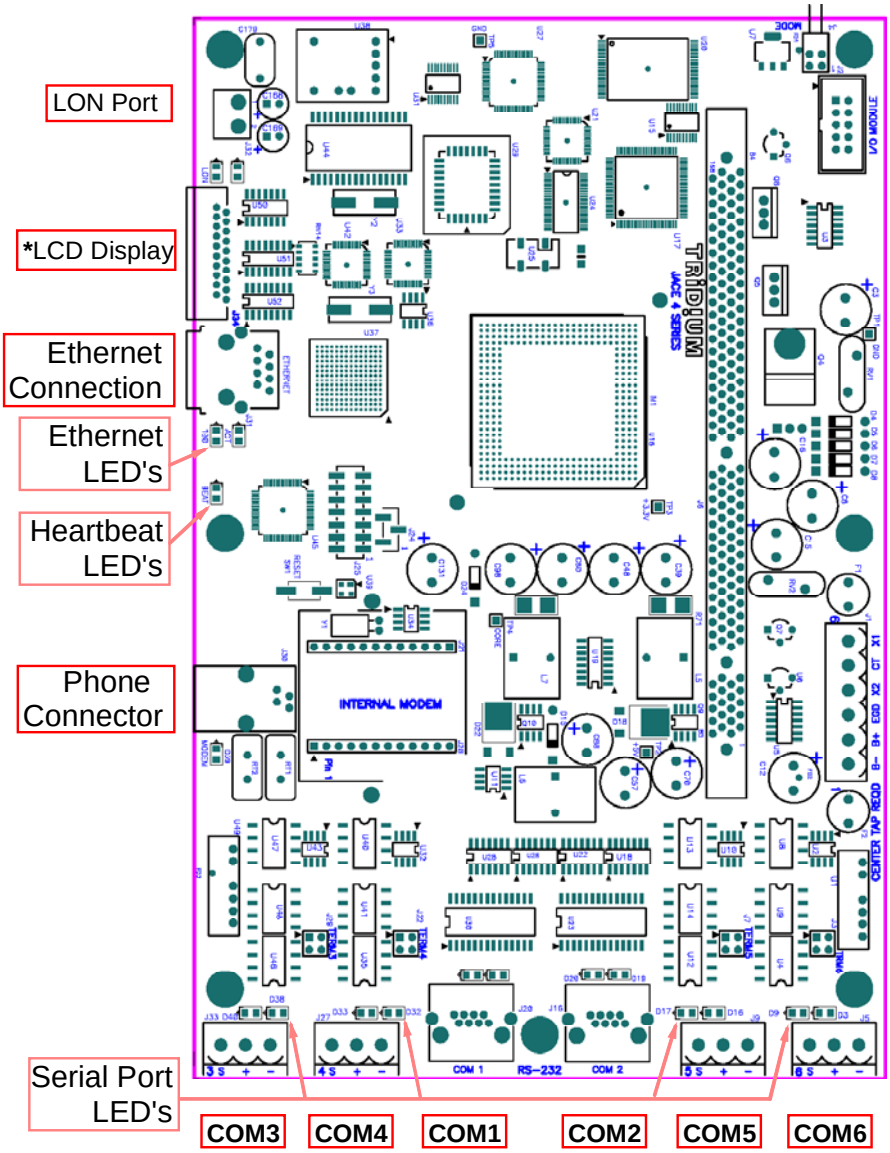
If some form of stage-up inhibiting is active while the conditions in the system would normally cause a stage-up to occur, this alarm occurs as a warning. The restriction of capacity this creates is normally expected and desired when using stage-up inhibiting, the associated loss of primary flow in primary-secondary systems my cause unforeseen problems including water flowing backwards through the decoupler line. When all forms of stage-up inhibiting are removed, the alarm automatically clears.

Using Status LEDs

The CSM controller includes a series of LEDs that can be used to determine the status of a variety of normal operating parameters for the unit. They are located on the main circuit board (see Figure 48). From the top of the board to the bottom, these include the following:

- Lon Port
- Ethernet Port
- Heartbeat
- Serial Port

Figure 48. Main Board Layout



Lon Port

There are two LEDs associated with the Lon port, located below the port. One LED is yellow and the other LED is green. The yellow LED means the CSM is sending out a LONWORKS message. The green LED means some other LONWORKS device on the network is sending a message.

Ethernet Port

There are two green LEDs associated with the Ethernet port, located below the port. The LED marked "100" indicates whether the CSM is operating at 10 MBPS (Ethernet) or 100 MBPS (Fast Ethernet). It the 00 LED is on, the network connection is operating at 100 MBPS. Otherwise, the port is operating at 10 MBPS.

The LED marked "ACT" indicates activity on the port as follows:

- Off – No Ethernet link is made
- On – Ethernet link is present, but no activity on the LAN
- Blinking – Ethernet link is present with data activity on the LAN

Serial Ports

The status LEDs for the serial ports are located above the RS-232 and RS-485 ports. They are marked COM1 through COM6 and correspond to the software configuration of the COM ports. The CSM software has been set to use the following COM ports:

- COM1 – Modbus using RS-232
- COM2 - Optional external modem
- COM3 – Modbus using RS-485

The yellow transmit LED indicates that the CSM is sending data out the serial port over a communications line to a connected device. The green receive LED indicates that the CSM is receiving data from a connected device.

Pulse detectors that provide a fixed on time when data is detected on the port drive these LED's. If these LED's are on constantly, this indicates a problem with the communications channel, such as a shorted wire or reversed wiring.

Heartbeat

The Heartbeat LED is located below the Ethernet Port LED's, and is red. Under normal operation, this LED should blink about once per second. The blink pattern will differ as station activity increases, but any pulse rate from once per second to 10 blinks per minute usually indicates normal activity. If the heartbeat LED stays on constantly or does not light, contact the McQuay Controls Support Group at 886-4McQuay (866-462-9829).

Troubleshooting the PC's Connection to the CSM

This section discusses what you can do if you are having difficulty connecting your computer to the CSM over an Ethernet connection. Always verify that the Ethernet wiring is connected properly. Remember that standard patch cables are used when connecting through a hub and crossover cables are used to connect directly from computer to CSM.

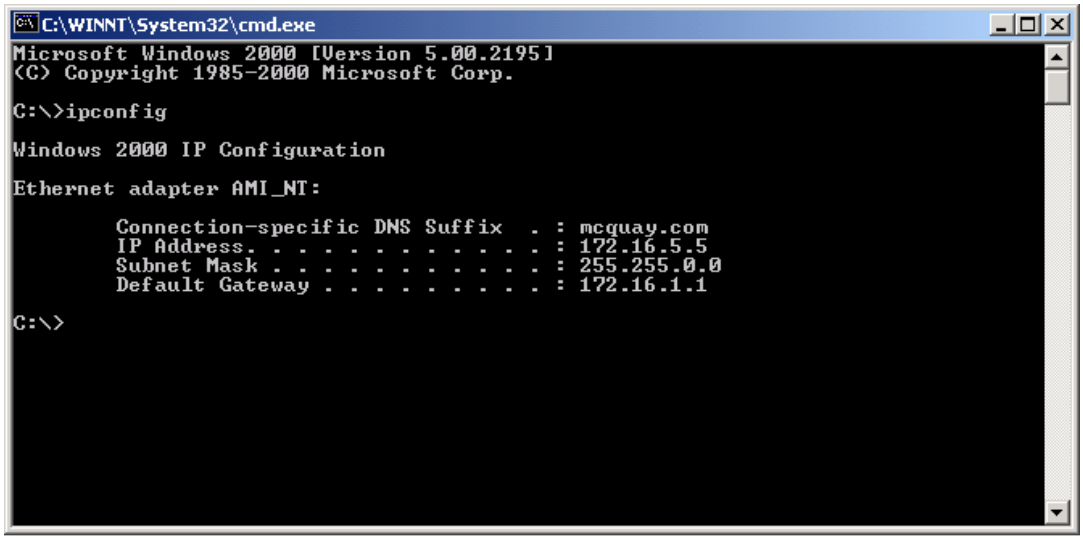
One of the most common configuration issues is that the computer's IP address and subnet mask are not compatible (because they are not on the same network) with the CSM's IP address and subnet mask. The subnet masks should be exactly the same on both devices. The IP addresses cannot be the same on both devices but must be close enough to each other to be on the same subnet (make the last octet of the PC's IP address one number higher or lower than the CSM's). To compare the IP addresses and subnet masks, you need to know how to find these network configuration values on each device. The next two sections of this troubleshooting guide describe how to determine these values.

The most efficient way to prove that the wiring and network configuration of the devices are working is to have your computer *ping* the CSM. An Ethernet network utility can eliminate many higher level sources of communication problems. If you can't ping the CSM, do not try any other forms of Ethernet communications (i.e. the user interface web screens) with the CSM. If you call the McQuay Controls Support Group for support connecting to the CSM, the first thing they may ask you is if you can "ping" the controller. For instructions on pinging, see the Pinging the CSM from Your Computer on page 123.

Checking the IP Address and Subnet Mask of Your Computer

The *ipconfig* command is a command-line utility available on Windows NT 4.0 and Windows 2000 operating systems. Open the DOS prompt and type “ipconfig” or “ipconfig/all” to determine the current IP Address and Subnet Mask of the computer you are trying to connect to the CSM.

Figure 49. Performing the “ipconfig” Command at the DOS Prompt



If you determine that you need to change the IP address of your computer, follow the instructions in the Connecting Your PC to the CSM on page 11.

Determining the CSM’s IP Address and Subnet Mask

If you are unsure of the network settings on a CSM, first attempt to connect at the default IP address. The CSM controller is pre-configured with an IP address in the range 192.168.1.14x and default subnet mask of 255.255.255.0, where x is the last digit of the CSM’s serial number. The IP address is also listed on the packing slip that accompanies the unit. The previous installer may have left the CSM at the default settings for convenience.

If the previous installer has gone through the process to change the IP address and subnet mask, he or she was instructed to write down the new IP address for future use. You should investigate all possibilities for finding the network setting before starting the lengthy procedure for determining the IP address from the CSM.

If you are still unsure of the IP address, you can use the HyperTerminal program on your computer to read it from the CSM through a serial connection to COM1 on the CSM.

CAUTION
Exercise caution when using HyperTerminal on the CSM. You must log on to the CSM with administrative privileges, which means you can change many settings. Modifications you make could have unexpected consequences, including making the CSM inoperable.

► Use the following procedure to directly connect to a CSM using HyperTerminal:

1. Attach an Ethernet patch cable (straight through, not crossover) with standard male RJ-45 (8-wire) connectors to the RJ-45 connector on COM1 of the CSM.

2. Connect the other end of the cable to a RJ-45 to DB-9 null modem adapter. This adapter can be purchased at www.cdw.com (Part #533740). Assemble this adapter must be pinned out per Table 26.
3. Connect the DB-9 adapter to a serial port (generally COM1 or COM2) of a Windows NT 4.0, 2000 or XP computer. The two devices are now physically connected.
4. Open HyperTerminal as follows:
   - On Windows NT – Click Start then choose Programs > Accessories > HyperTerminal > HyperTerminal
   - On Windows 2000 – Click Start then choose Programs > Accessories > Communications > HyperTerminal
5. In the **Connection Description** dialog box, type a name for this session. For example: "Direct Connect to CSM"
6. Click **OK**
7. In the **Connect to** dialog box, choose either COM1 or COM2, depending on which serial port the null modem cable or adapter is attached to on your PC. This makes the remaining options on the dialog box unavailable.
8. Click **OK**
9. On the **Comm Properties** dialog box, choose the following settings:
   - Bits per Second: 9600
   - Data Bits: 8
   - Parity None
   - Stop Bits: 1
   - Flow Control Hardware

   If the CSM has been configured in the past to communicate with a Modbus BAS using RS-232, the COM1 properties in the CSM may have been reconfigured. Contact the Modbus BAS personnel to determine current CSM COM1 properties.
10. Click **OK**. The HyperTerminal session is now set up.
11. Open the CSM's cover.
12. Find the 4-pin connector on the Main Board. The connector is at the top of the board and is marked "MODE" (see Figure 48).
13. Connect a jumper to the outer most (furthest distance from the green board) two pins of the connector.
14. With HyperTerminal open on the Windows PC, unplug the 6-position power connector on the CSM, then plug it back in to restart the CSM. Remember that the CSM has a battery backup and disconnecting the 6-position power connector is required, not just shutting down power external to the CSM.
15. When the CSM stops displaying new messages on the HyperTerminal screen, press **ENTER** to reach the command prompt. You see a prompt similar to the following: ->
16. Using the scroll bars on the HyperTerminal window, scroll up until the section that begins with the line **Press any key to stop auto-boot….** (See Figure 50).

    The IP address of the CSM is listed on the line that begins **inet on ethernet (e) :** The IP address is listed (in dotted decimal), followed by a colon, and then the subnet mask (in hexadecimal).
17. After making note of the IP address, press the Disconnect button on the HyperTerminal tool bar.
18. Close HyperTerminal by choosing File > Exit.
19. Remove the jumper from the CSM's MODE connector.
20. Reboot the CSM by removing the power connector, waiting for all lights to extinguish, and plugging the power connector back in.

Figure 50. IP address read from a HyperTerminal boot sequence

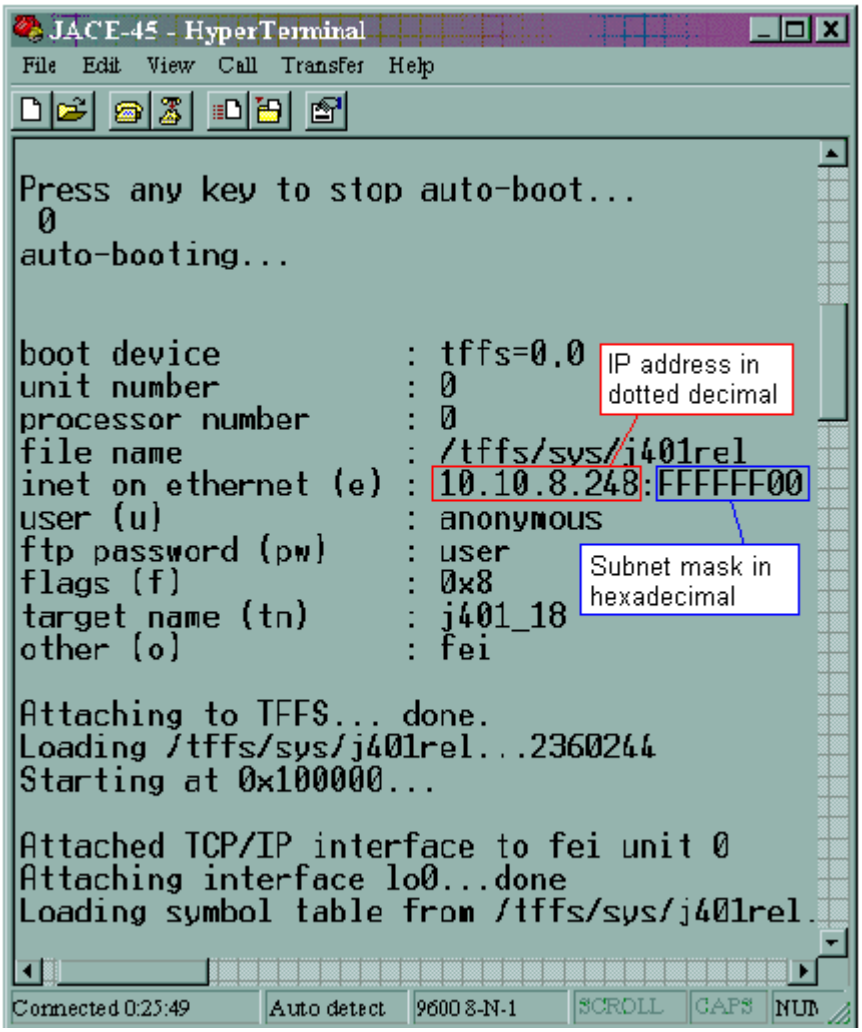
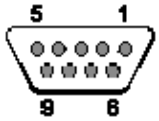
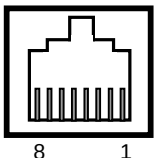


Table 26. DB-9 to RJ-45 Null Modem Adapter Pin Assignments

DB-9 Female Pin	Signal		RJ-45 Female Pin
6	DTR	Data terminal ready	1
8	RTS	Request to send	2
2	TXD	Transmit data	3
5	GND	Signal ground	4
1	DCD	Data carrier detect	5
3	RXD	Receive data	6
7	CTS	Clear to send	7
4	DSR	Data set ready	8

DB-9 Female Pin Reference	RJ-45 Female Pin Reference
 (view when looking at the pins from the front, see numbers on adapter)	

Pinging the CSM from Your Computer

Packet Internet grouper (ping) is a utility that checks the availability and response time of a network host. It uses the Internet control message protocol (ICMP).

The *ping* utility is typically used to determine whether one host can reach another host. For example, if your PC was having difficulty connecting to the CSM, you could ping the IP address (or name) of the CSM to see if it responds. If the CSM does not respond, there could be a problem with the CSM's configuration (IP address not what you think it is), or the Ethernet connection (cable, Ethernet card, hub).

The typical use of the ping command is to type the following at the DOS prompt:

ping <ipaddress>

Or

ping <hostname>

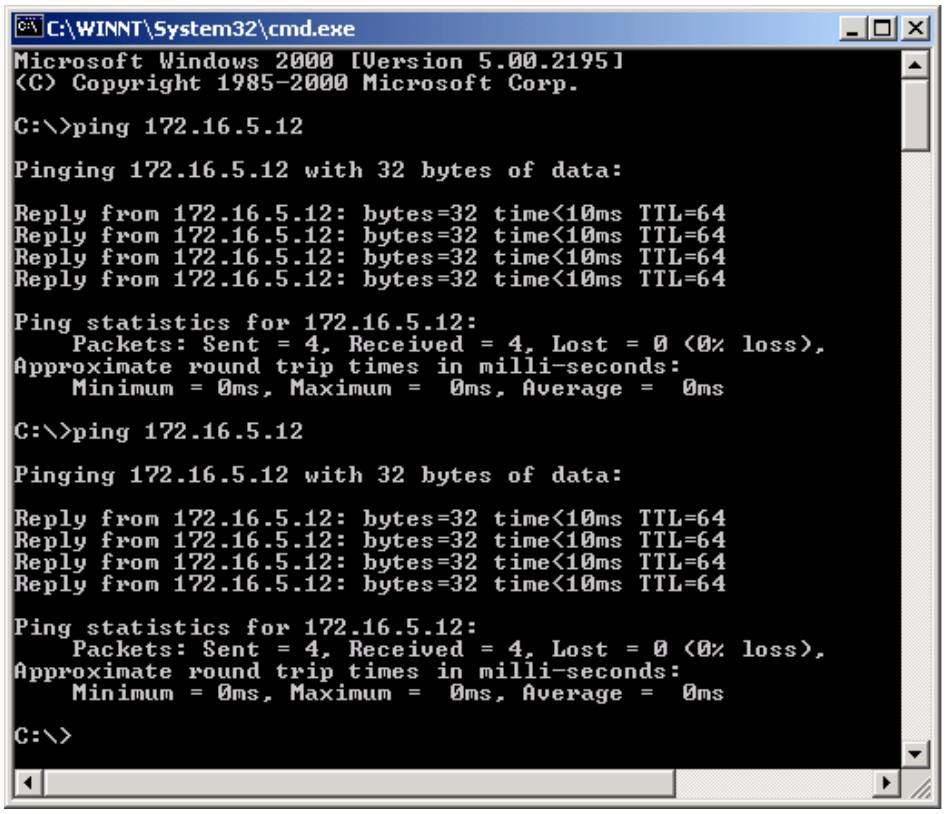
Where

<ipaddress> is the IP address of the CSM in the dotted decimal format (e.g. 172.16.5.12)

<hostname> is the name of the CSM

Figure 51 shows two examples of the ping command. In the first example, the CSM responded in less than 10 milliseconds showing good connectivity. The second example shows that there is no response when trying to "ping" a CSM with power turned off.

Figure 51. Performing the "ping" Command at the DOS Prompt

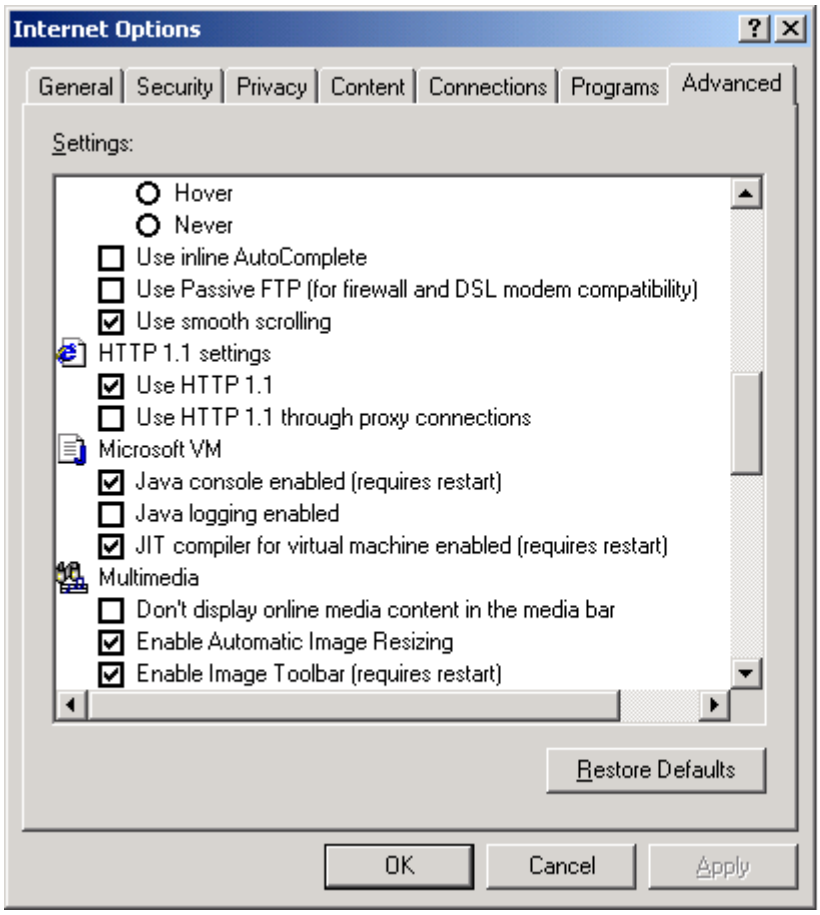


Checking Internet Explorer Settings

If you can ping the CSM from your computer but cannot bring up the CSM's user interface on your web browser, verify the following:

- The CSM user interface works from your PC with Microsoft Internet Explorer browser version 5.0 or later only (not AOL or Netscape). The CSM requires a Java-enabled Web browser – the typical default configuration for most browsers.
- Verify the following settings of your Internet Explorer browser. Open Internet Explorer's, go to **Tools** on the top menu bar, select **Internet Options,** click on the **Advanced** tab, make sure the following selections are checked (see Figure 52);
  - "HTTP 1.1 Settings": Use HTTP 1.1
  - "Microsoft VM": JIT compiler for virtual machine enabled.
- Disable Internet Explorer's use of a proxy server. The PC you are using to access the CSM may be configured to use a proxy server if it sometimes resides on a LAN. If you have changed the IP address of the PC to be on the same subnet as the CSM, you have taken your computer off the subnet it normally resides on and the PC cannot access the proxy server. This will cause Internet Explorer to return a "This Page Cannot Be Displayed" error. To disable Internet Explorers use of a proxy server, go to **Tools** on the top menu bar, select **Internet Options**, click on the **Connections** tab, click on the **LAN Settings** button, make sure the "Use a proxy server for your LAN" box is not checked.
- If the above settings are correct and you still cannot access the CSM, set the IP address of your computer to be one number away from the IP address of the CSM. For example, if the IP address of the CSM = 192.168.1.143, make the IP address of your computer 192.168.1.142.

Figure 52. Important Microsoft Internet Explorer Options



Appendix A: Hardwired Chiller Control

This appendix provides information about using the CSM to control chillers via hardwired binary and analog inputs and outputs. This option should be used when a serial communication option is not available since control, monitoring, and alarm indication is reduced. Hardwired chillers have control features wired to a remote I/O module mounted near the chiller's unit controller. The hardwired chiller's remote I/O module communicates with the CSM via a LONWORKS network. The CSM controls the chiller using the following outputs on the remote I/O module:

1. Remote Auto/Stop (Relay Output)
2. Evaporator pump enable – if the chiller is not controlling its own pumps (Relay Output)
3. Condenser pump enable – if the chiller is water cooled and not controlling its own pumps (Relay Output)
4. Chiller leaving water temperature setpoint reset (Analog Output)
5. Capacity limit (Analog Output)

The CSM will receive the following information through the remote I/O module's inputs:

1. Proof of evaporator water flow (Digital Input)
2. Proof of condenser water flow - on water cooled chillers (Digital Input)
3. Chiller alarm output (Digital Input)
4. Second chiller alarm output – if the chiller has multiple compressors, the chiller provides two alarm outputs (Digital Input)
5. Compressor percent rated load amps - % RLA (Analog Input)
6. Optional chiller evaporator leaving water temperature (Analog Input)
7. Optional chiller condenser leaving water temperature (Analog Input)

Hardwired chillers are controlled by the CSM the same as a MicroTech II chiller with some exceptions. These differences include limited chiller data, limited alarm information, and the limited Comm Loss control features.

Setting up the CSM's Additional Chiller Data for a Hardwired Chiller

In addition to the Chiller Data that must be entered for all chillers on the *Chiller Setup* screen, the CSM also requires you to enter certain additional details about a hardwired chiller. The variables are located on the *Chiller Setup* screen and described in Table 27.

Table 27. Hardwired Chiller Config (Main > Configuration > Chiller Setup)

Name	Description
Stop-to-Start Timer	This input tells the CSM how long to wait after this chiller is disabled before it can be made available to enable again. Enter the same time period as the stop-to-start timer setting in the associated chiller unit controller. Default = 00:05:00 (5 minutes).
Full Load % RLA Level	This input tells the CSM when to consider the chiller to be at full load. When the % RLA of the chiller is greater than this value, the CSM may begin the stage-up control process. Range = 1 to 99%. Default = 90%.
Running % RLA Level	This input defines the minimum measured % RLA from a hardwired chiller required to have that chiller considered in the Running state. Below this level the chiller compressors are considered Off and the chiller is not producing chilled water. Range = 5 to 50%. Default = 20%.
% RLA Input Type	This input tells the CSM how % RLA will be sent from the chiller to the remote I/O modules analog input. Range = % RLA from chiller (4-20 mA), % RLA from chiller (0-10 Vdc), Amps from 4-20 mA output current transducer (CT). Default = % RLA from chiller (0-10 Vdc).
Voltage Signal At 100 % RLA	Only use this value if % RLA Input Type is set to "% RLA from chiller (4-20 mA)" or "% RLA from chiller (0-10 Vdc)". This input tells the CSM what the voltage on the analog input (AI 1) will be to represent 100% RLA. For example, a McQuay MicroTech Series 200 Centrifugal chiller outputs a 0-10 Vdc range which represents a % RLA range from 0% to 125%, this means that when the compressor is running at 100% RLA it will output 8 Vdc. Range = from 4 to 10 Vdc. Default = 8.
Nameplate RLA	If % RLA is sent from the chiller unit controller this property is not used. This input tells the CSM the

(not used if chiller supplies % RLA)	associated chiller's Nameplate Rated Load Amps. This value is used to calculate % RLA by measuring the amps used by the chiller. Default = 150 Amps.
Current Transducer High Signal Amps (not used if chiller supplies % RLA)	If % RLA is sent from the chiller unit controller this property is not used. This input tells the CSM the amps associated with the high range of the current transducer's (CT) output signal (20 mA). For example, if a current transducer with a range of 0-200 Amps is mounted on the chiller and wired directly to the remote I/O module's AI, the value of this property must be set to 200 (also, set % RLA Input Type = Amps from 4-20 mA output CT. This value is used to calculate % RLA by measuring the amps used by the chiller. Default = 200 Amps.
% RLA Offset	If % RLA is sent from the chiller unit controller this property is not used. Value added to the internally calculated value of % RLA. Allows for wiring or sensor-to-system compensation. Range = Can be positive or negative as needed. Default = 0.
Alarm Switch State	This property defines which chiller alarm contact position is used to indicate alarm. If a contact opening from the chiller indicates an Alarm, set this property to "Open". If a contact closure from the chiller indicates an alarm, set this property to "Close". Default = "Open".
Fault Alarm Proving Time	This property defines how long a chiller's alarm contact must be in the alarm state (open or closed based on the Alarm Switch State property) before the CSM recognizes a chiller fault. This is required for the CSM to differentiate between a fault alarm (steadily switched contacts) and a problem alarm (flashing contacts). Range = 2 to 60 seconds. Default = 16 seconds.
Number Of Chiller Alarm Outputs	This property tells the CSM if the chiller will be providing one or two alarm signals. If a multiple compressor chiller has two separate alarm indicators, wire the second contacts to DI 4 on the remote I/O module. The CSM will then calculate the chiller's availability based on alarm information from both signals. If a chiller has two alarm outputs, when one output indicates fault alarm, the chiller will be considered to have 50% of its capacity unavailable, if both outputs indicate fault alarm, the chiller will be considered unavailable. Range 1 or 2 outputs. Default = 1 output. For example; a MicroTech Series 200 Centrifugal chiller has two alarm outputs. Note: If the property is set = 2, this chiller's Number Of Compressors property must be set = 2.
Receive Heartbeat	This input defines the length of time (in seconds) the hardwired chiller's remote I/O module waits without receiving a command from the CSM before determining that communications have been lost. If this value = 0 and communication loss occurs, an enabled chiller will remain enabled at it current setpoints until communications are restored. If this value is set to be greater than 200, an enabled chiller will be disabled if communication loss occurs. Range = 0 seconds and any number of seconds greater than 200. Default = 0 seconds (Comm loss features disabled, chiller will remain in existing state if communications is lost).
Leaving Evaporator Water Temp Offset Leaving Condenser Water Temperature Offset	This value is added to the measured temperature values for calibration purposes allowing for wiring or sensor-to-system compensation. Range = Can be positive or negative as needed. Default = 0.

Chiller % RLA from a Hardwired Chiller

The CSM displays the chiller's % RLA and uses it on a hardwired chiller when deciding when to perform a stage-up or a stage-down. Stage-up is possible when this chiller has been operating at a % RLA higher than the Full Load % RLA for a period of time greater than the Chiller Stage Delay Time.

Stage-down is possible when the spare capacity of all the running chillers (excluding the next-off chiller) is greater than the capacity that will be lost when the next-off chiller is disabled before a stage-down will occur.

The CSM also uses % RLA on a hardwired chiller to determine when that chiller is in the "running" state. When the % RLA is higher than the Running % RLA, the chiller is considered to be running. This is an important distinction because if a chiller is enabled but not running, it will be considered an offline chiller.

If the chiller to be hardwired provides an analog output, which represents % RLA, the output is wired directly to the hardwired chillers remote I/O module. If this is the case, set the % RLA Input Type property to "% RLA from chiller (4-20 mA)" or "% RLA from chiller (0-10 Vdc)" and set the RLA Signal At 100% based on your particular chiller.

If the chiller to be hardwired does not provide an analog output which represents % RLA, a current transducer (CT) must be added to the chiller to provide a measurement of running amps. If this is the case, set the % RLA Input Type property to "Amps from 4-20 mA output CT". Set the Nameplate RLA and Current Transducer High Signal Amps based on your particular chiller and selected current transformer.

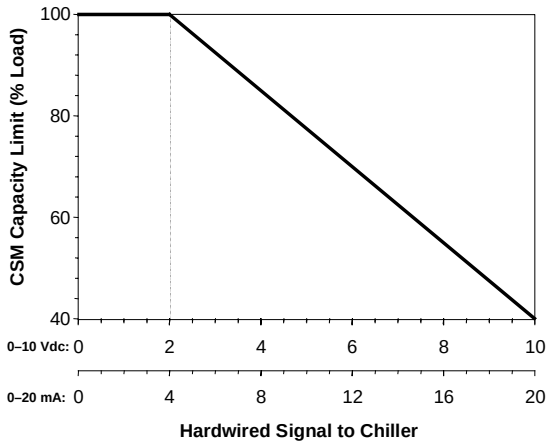
See IM 781 for details on wiring and hardware requirements for % RLA on hardwired chillers.

Hardwired Chiller - Load Limiting Control

The CSM can limit the loading of each chiller in the system from 100% to 40% by sending it a capacity limit. The CSM generates the load limit for each chiller based on a demand limiting, soft load, or load-balancing function (see the Load Limiting Control section for details). The capacity limit is sent to a hardwired chiller via analog output (AO 2) on that chiller's hardwire remote I/O module.

The output signal from the CSM to the chiller is shown in Figure 53.

Figure 53. External Demand Limiting Function Signal



The chiller must be configured to have a demand limiting range corresponding to the CSM's signal. Its maximum amps (at 2 Vdc or 4 mA) must be set to allow full chiller capacity and its minimum amps (at 10 Vdc or 20 mA) must be set to approximately 40% of full load. The chiller must also be configured to enable demand limiting from a 2-10 Vdc (or 4-20 mA) source.

Hardwired Chiller - Chilled Water Temperature Control

In a system of multiple hardwired chillers, each individual chiller maintains its leaving evaporator water temperature based on the individual chiller setpoint. Each chiller's setpoint should be set to the same value. The CSM generates a system reset based on a number of different functions (see Chilled Water Temperature Control on page 49.) The CSM's system reset is sent to a hardwired chiller via an analog output (AO 1) on that chiller's hardwire remote I/O module. The output signal from the CSM to the chiller is shown in Figure 54 and Figure 55.

Figure 54. Hardwired Chiller Leaving Water Temperature Setpoint Reset (English)

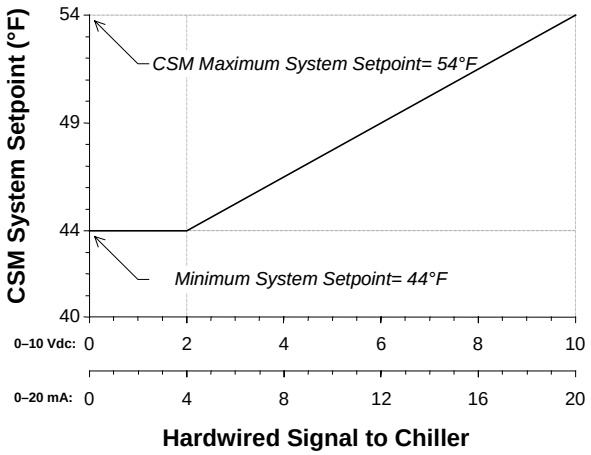
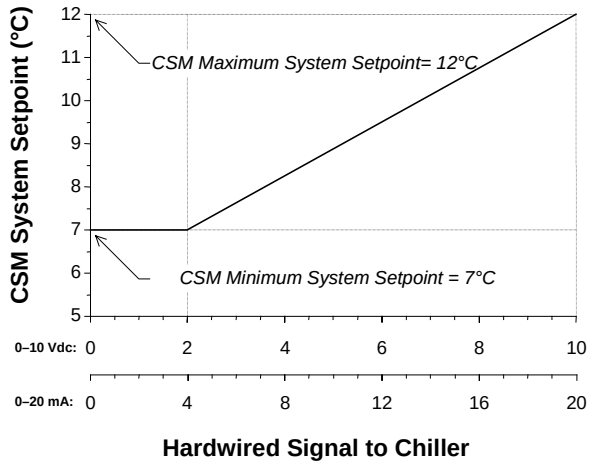


Figure 55. Hardwired Chiller Leaving Water Temperature Setpoint Reset (SI)



The chiller must be configured to have the same reset range as the CSM. Its low range (at 2 Vdc or 4 mA) must equal the Minimum System Setpoint property of the CSM and its high range (at 10 Vdc or 20 mA) must equal the Maximum System Setpoint property of the CSM. The chiller must also be configured to enable external chilled water temperature setpoint reset from a 2-10 Vdc or 4-20 mA source.

Hardwired Chiller Unit Controller Settings

When a chiller is to be controlled by the CSM, the chiller unit controller must be configured to allow the remote I/O module to control it and send communications to the CSM via a LONWORKS network. Some of the features that exist on the chiller unit controller for stand-alone operation must also be disabled so that they do not interfere with the CSM's control features. For information on making changes to the hardwired chiller unit controllers, refer to the proper chiller Operation Manual (see the Reference Documents on page 7).

The following unit setup variables must be set in all chiller unit controllers associated with a CSM. These variables (see Table 28) must be set to the values shown in italic. You can typically find them through the chiller controller's keypad/display.

Table 28. Chiller Unit Controller Setup Variables

Chiller Controller Variable	Value	Description
Source	*Local*	The outputs from the remote I/O module must be able to control the chiller.
Mode	*Cool (not Ice or Cool/Ice)*	The CSM does not support the Heat, Ice or Cool/Ice modes.
Start Delta	*1°F (0.6°C)*	Reduce the temp difference required for starting in this multiple chiller system.
Soft Load	*Off*	Soft Load control is supplied through the CSM.
Chilled Water Reset	*On (set to external signal)*	Allow chiller to accept chilled water setpoint reset from an hardwired source.
External Chilled Water Setpoint Reset Minimum	*User Defined (must match CSM setting)*	This is the chilled water setpoint when the CSM sends the chiller 2 Vdc (4 mA) or less on its AI. This value must be set equal to the CSM's Minimum System Setpoint property on the *Chilled Water Supply Temp* screen.
External Chilled Water Setpoint Reset Maximum *(must match CSM setting)*	*User Defined (must match CSM setting)*	This is the chilled water setpoint when the CSM sends the chiller 10 Vdc (20 mA) on its AI. This value must be set equal to the CSM's Maximum System Setpoint property on the *Chilled Water Supply Temp* screen.
Demand Limit	*On (set to external signal)*	Allow chiller to accept demand limiting from an hardwired source.
External Demand Limit Minimum Amps	*40% RLA*	This is the demand limit when the CSM sends the chiller 10 Vdc (20 mA) on its AI.
External Demand Limit Maximum Amps	*100% RLA*	This is the demand limit when the CSM sends the chiller 2 Vdc (4 mA) or less on its AI.
Evaporator Pump Recirculate Timer	*0.5 min*	A compressor must transition from Off to Starting within the Wait For Flow time period after being enabled or the CSM will consider it off-line.

Hardwired Chiller Sequence of Operation

Unavailable and Available Hardwired Chillers

A chiller is unavailable when the CSM cannot influence its start/stop operation. This can occur for either of two reasons:

1. All compressors (or circuits) on a chiller are unable to run. A hardwired chiller is unavailable if either of the following conditions exist:
   - All hardwired alarm digital inputs are indicating a fault alarm.
   - The chiller was recently disabled and the chiller's timers (Start-to-Start and/or Stop-to-Start) prevents the chiller from starting. On MicroTech II chillers, the CSM receives a "chiller enable" signal from the chiller telling the CSM the chiller is ready to run. No such signal is available to the CSM on hardwired chillers. The CSM's Stop-to-Start Timer (see Table 27) is used by the CSM to keep track of chiller availability on hardwired chillers. The CSM's Stop-to-Start Timer and the CSM's stage timer must be set so the combined time is greater than the time a hardwired chiller is unavailable due to its internal time delays. For example, if a hardwired chiller has a Start-to-Start time of 20 minutes and a Stop-to-Start of 10 minutes, the combined time of the CSM's Stop-to-Start plus the CSM's stage time must be greater than 20 minutes. This prevents the CSM from trying to start the hardwired chiller while it is disabled on internal timers.
2. The chiller's hardwired remote I/O module has lost communications with the CSM.

Chiller Startup

If the hardwired chiller is available it can be enabled normally. After the CSM commands a hardwired chiller to be enabled, the following control takes place at the chiller's remote I/O module:

1. Relay Output 1 is closed to enable the chiller through its Remote Start/Stop input.
   a. The chiller will be enabled, but will not allow its compressors to run until its unit controller has proven evaporator flow (it will be in a Waiting for Flow State).
   b. The Proof of Evaporator Flow device to the chiller should be the same device that proves flow to the CSM (at DI 1). It is mandatory and must not be bypassed.
2. Relay Output 2 is closed to enable evaporator flow.

a. If the evaporator flow switch (wired to DI 1) remains open for a time period greater than the "Waiting For Flow Timer" property, the COMP STOP – Evaporator Water Flow Loss alarm occurs and the chiller is disabled until the alarm has been cleared from the CSM user interface.
b. If the evaporator flow switch re-opens for longer than three seconds after flow has been initially proven, the COMP STOP – Evaporator Water Flow Loss alarm occurs. The chiller is disabled and marked as unavailable until the alarm has been cleared from the CSM user interface.
c. If the chiller will be controlling its own evaporator pump, Relay Output 2 is not used but DI 1 is always required to prove evaporator flow.

3. After the compressor begins to run (defined as chiller % RLA > Running % RLA Level), Relay Output 4 is closed to enable condenser flow.
   a. If the condenser flow switch (DI 2) is open for longer than 15 seconds after flow has been enabled, the COMP STOP – Condenser Water Flow Loss alarm occurs. The chiller is disabled and marked as unavailable until the alarm has been cleared from the CSM user interface.
   b. If the chiller will be controlling its own condenser pump, or the chiller is air-cooled, a jumper must be placed across DI 2. Also, Relay Output 4 is not used.
4. After the chiller has been enabled, if the compressor does not begin running (defined as chiller % RLA > Running % RLA Level) within the time period defined by the Wait For Flow Time (*Chiller Seq* screen) property, this chiller will be disabled and considered Off-Line. Also, the CHILLER STOP – No Start alarm occurs. The chiller is disabled and marked as unavailable until the alarm has been cleared from the CSM user interface.

Chiller Shutdown

After the CSM commands a hardwired chiller to be disabled, the following control takes place at the chiller's remote I/O module:

1. Relay Outputs 1, 2, and 3 are opened to disable the chiller and pumps.
2. On a normal shutdown the chiller is marked as unavailable until the "Stop-to-Start Timer" property in the CSM for this hardwired chiller has expired.
3. On a fault alarm shutdown the chiller is marked as unavailable until the fault alarm is cleared.

Hardwired Chiller Alarms

A hardwired chiller's remote I/O module has two digital inputs (DI) available for connection to the dry contacts of the chiller unit controller's alarm output signal. All chillers will typically have one alarm output signal. Chillers with multiple compressors (i.e. the McQuay MicroTech™ 200 series dual compressor centrifugal chiller) may have two alarm output signals. If a chiller has two alarm outputs the Number Of Chiller Alarm Outputs (see Table 27) property must be set to 2. Chillers with two alarm outputs will be considered 50% available if one of the two alarm outputs indicate a fault alarm.

Note: If two chiller alarm outputs are wired from the chiller to the remote I/O module, the Number Of Compressors property on the *Chiller Setup* screen must be set to 2. If it is set to 1, there will be an error in the chiller availability calculated by the CSM. Even if the Chiller has more than 2 compressors/circuits, the CSM will only associate it with 2 (representing 50% of the total capacity).

Chiller Fault Alarms

Fault alarms are defined as alarms that shut down the compressor (no available cooling capacity). If the chiller's alarm output relay is switched (steady), this indicates to the CSM that the chiller has a Fault alarm. The chiller can indicate a Fault alarm by either switching a contact closed or by switching a contact open. To tell the CSM which contact position indicates a Fault alarm condition, set the Alarm Switch State (see Table 27). It is best to set the alarm signal up to indicate a Fault alarm using a normally open contact in the open position (Alarm Switch State = Open). This provides a Fault indication to the CSM when the chiller does not have power (the CSM will then know that this chiller is unavailable).

Fault (Check Unit for Details)

If the chiller's alarm output relay is switched (steady), the "Fault (Check Unit for Details)" alarm will occur. Upon receipt of this generic alarm, the CSM sets the chiller unavailable and disables it (if enabled). The chiller will not be enabled again by the CSM until the chiller's alarm output relay changes to a non-fault state. This alarm is automatically cleared at the CSM when the alarm no longer exists at the chiller.

COMP STOP - Evaporator Water Flow Loss

If the evaporator flow switch re-opens for a period of three seconds anytime after the chiller is running, the COMPRESSOR STOP – Evaporator Water Flow Loss alarm occurs. This is a Fault alarm and the chiller is immediately disabled and remains disabled until the alarm is manually cleared at the CSM user interface. Note that this alarm cannot be cleared at the chiller. The chiller may also have a similar alarm that may require clearing.

COMP STOP - Condenser Water Flow Loss

If the condenser flow switch is open for any period greater than fifteen seconds after the evaporator flow has been proven, the COMPRESSOR STOP – Condenser Water Flow Loss alarm occurs. This is a fault alarm and the chiller is immediately disabled and remains disabled until the alarm is manually cleared at the CSM user interface (note that this alarm cannot be cleared at the chiller).

If this is an air-cooled chiller, place a jumper across DI 2 to disable this alarm.

Chiller Problem Alarms

Problem alarms are defined as alarms that affect the operation of the chiller but do not shut it down (cooling capacity still available). A flashing (open/closed) alarm output contact from the chiller indicates to the CSM that the chiller has a Problem alarm. The CSM reads the status of the alarm signal input approximately every two seconds, which means that the frequency of the flashing relay must read both open and closed at least once within the period of time defined by the Fault Alarm Proving Time (see Table 27). A chiller's alarm contact must be steadily switched for a period of time greater than the Fault Alarm Proving Time for the CSM to consider the alarm a Fault.

Problem (Check Unit for Details)

If the chiller's alarm output relay is flashing (alternately opened and closed), the "Problem (Check Unit for Details)" alarm will occur. The CSM takes no action upon receipt of this alarm, but the alarm is displayed and logged to alert the operator of a chiller generic alarm. This alarm is automatically cleared at the CSM when the alarm no longer exists at the chiller.

CSM Alarms Available for Hardwired Chillers

CSM alarms are broken down into the three types: Fault, Problem and Warning alarms. The Fault alarm type consists of alarms that shut down the CSM. The Problem alarm type consists of alarms that affect the control of the system, but do not shut the system down. The Warning alarm type consists of alarms that do not affect the control of the system and are for the operator's information only. Chiller alarms displayed by the CSM from a hardwired chiller are limited to the following alarms. Additional alarm information may be available at the chiller unit controller.

Table 29. CSM Alarms Available for Hardwired Chillers

Alarm Type	Alarm Priority	Alarm Message	Indication	Reset
Fault	0	No Chilled Water Flow	All cooling load pumps failed, resulting in a loss of chilled water flow to the loads	Manual
Problem	10	Comm Loss Between CSM and Chiller X	Communications lost between CSM and Chiller X	Auto
		No Evaporator Flow After Enabling Chiller X	After a chiller is enabled, the evaporator flow switch must prove flow before the Wait For Evaporator Flow Timer property expires	Manual
Warning	100	Cooling Tower Alarm X	Cooling towers partially or totally failed. See the value column of the *Alarm View* screen to determine which cooling tower output is in alarm	Auto
		Chiller Off-line	At least one chiller that is part of the current sequence is unavailable to the CSM	Auto

Alarm Type	Alarm Priority	Alarm Message	Indication	Reset
		Chiller X In Alarm	At least one alarm in chiller X is active. X could be any chiller commissioned to the CSM. For a description of the current active alarms on a particular chiller, see it's "Alarm" line on the *Chiller Status* screen or that chillers alarm log on the *Misc* screen	

Chiller Data

Hardwired chillers have less information available at the CSM user interface or offered to a BAS than MicroTech II chillers communicating with the CSM on the dedicated LONWORKS network. Chiller alarm descriptions are also limited (see Table 29). The following list represents data points available on the CSM user interface from a chiller connected to the CSM via hardwiring:

Analog Data

Actual Chiller Capacity (% RLA)

Chiller Evaporator Leaving Water Temperature (optional)

Chiller Condenser Leaving Water Temperature (optional)

Chiller Capacity Limit

Active Chiller Setpoint

Digital Data

Chiller Run Mode

Chiller Run Enabled/Disabled

Chiller Evaporator Flow Status

Chiller Condenser Flow Status

Chiller Limited

Alarm Digital Output

Note: Two temperature sensors can be installed to show the leaving evaporator water temperature and the leaving condenser water temperature (on water-cooled units) of each hardwired chiller. These temperatures are optional because they are not used by the CSM logic (or by the chiller) for any control purposes. If one or both of these sensors are installed they will be displayed on the Chiller Status screen and can be passed by the CSM to an optional BACnet or Modbus building automation system for display and/or monitoring purposes.

Hardwired Chiller - Communication Loss Control at the Chiller

If a hardwired chiller loses communication with the CSM, the chiller can be set up to maintain last setpoints or to shut down.

If a hardwired chiller's Receive Heartbeat property is set to zero (default), the state of a hardwired chiller's Enable Command and Cool Setpoint will remain at their current settings if communications are lost between the CSM and the hardwired chillers remote I/O module. For example, if the chiller is enabled with a cool setpoint of 44 °F at the time communications are lost, it will remain enabled at 44 °F until communications is restored.

If a hardwired chiller's Receive Heartbeat property is set to a value greater than 200 seconds, the hardwired chiller will be disabled if communications are lost between the CSM and the hardwired chiller's remote I/O module.

The ability to enable a chiller in the event of communication loss is not available on hardwired chillers. This feature is available on MicroTech II LONWORKS communicating chillers but not on hardwired chillers.

Index

A

Admin Tool, 7, 11, 96
alarm notification, 91
AUTO, 19
Automatic Sequence Order, 35

B

BACnet, 7, 19, 21, 27, 28, 45, 81, 86, 90, 91, 94, 95, 98, 99, 100, 108
BAS Network Schedule Flag, 81
BAS Stage-Up Inhibit Override, 36
battery backup, 33, 121

C

Calibration, 30
chiller alarms, 105
chiller load, 106
chiller offline alarm, 117
chiller runtime, 25
Chiller Sequencing Control Type, 36
Chiller Stage Delay Time, 37
Chiller Stage-Up Differential, 36
chiller status, 104
Chiller Unit Controller Setup, 31, 130
chiller X in alarm, 117
Chillers at Full Load, 101
Clear CSM Alarm, 32
Comm Loss, 25, 26, 33, 92, 104, 105, 110, 111, 127, 132
Comm Loss – Cool Setpoint, 25
comm loss between CSM and chiller X alarm, 112
Comm Loss Defaults, 27
Comm Loss/Power Up State, 25, 26
commandable input, 19, 29
commission, 23, 24
Comp #, 106
condenser water flow status, 106
condenser water temperature, 106
Constant Approach, 57, 59, 114, 115
Constant Return, 50
constant return reset, 56
Control Temperature Source, 56
cooling load pump *x* fail alarm, 113
cooling tower, 24, 29, 35, 56, 59, 61, 64, 66, 100, 107, 111, 112, 132
cooling tower alarm X, 116
cooling tower bypass valve, 65
cooling tower status, 107
CSM Control Mode, 32, 99
CSM Operating State, 98

D

decoupler flow meter fail alarm, 113
Decoupler Stage-Down Flow Rate Factor, 37
Decoupler Stage-Up Temperature Differential, 37
decoupler temperature sensor fail alarm, 114
demand-limiting, 45, 107, 128

E

entering condenser water temp sensor warning alarm, 117
entering condenser water temperature sensor fail, 112
Ethernet, 11, 12, 13, 14, 16, 18, 90, 119, 123
Ethernet Port, 118
evaporator water flow status, 106
evaporator water temperature, 106
external reset, 54

F

firewall, 13
Fixed Sequence Order, 35
Free Cooling, 100

G

Glycol Flag, 50

I

Inhibit Stage-Up After Time, 36
IP address, 12, 13, 15, 90, 119, 120, 121, 122, 123
ipconfig, 120

L

LAN, 11, 13, 93, 119
leaving condenser water temp sensor warning alarm, 116
leaving condenser water temperature sensor fail, 112, 132
license, 11
load balancing, 45, 47, 107
Load Balancing Group, 45
load limiting, 45, 48, 87, 107
Lon Port, 118
loop bypass valve, 80
loop differential pressure sensor fail alarm, 115
Loop Differential Pressure Setpoint, 67
low ambient lockout, 33, 99, 100, 114

M

Max Chiller Stop-To-Start Cycle Timer, 37
Max Pull Down, 31, 37
Max Tower Stage, 35
Maximum Send Time, 26
Maximum System Setpoint, 49
Minimum Chiller Setpoint, 49
Minimum System Setpoint, 49
Modbus, 7, 19, 27, 28, 45, 46, 47, 81, 86, 90, 91, 92, 99, 100, 108, 119, 121
Mode, 31, 130
modem, 11, 119, 121

N

Neuron ID, 23, 24
Next-OFF Active Capacity, 101
Next-OFF Chiller, 101
Next-ON Chiller, 101
no chilled water flow alarm, 112
Number of Chillers Running, 101

O

Off, 98
On, 99
Operator System Setpoint, 49
Optimal Start, 87
outdoor air temp sensor fail alarm, 113
Outdoor Air Temp Source, 33, 114
outdoor air temperature reset, 53
Override Time, 81

P

Password, 14, 16, 18, 20, 21, 92
ping, 119, 123
primary-only, 37
primary-secondary, 39, 42, 69, 80, 117
priority, 19, 29, 32, 33, 80, 81, 85, 86, 99, 100
property input, 20, 29
Protocol, 31
Pump Control Option, 67
Pump Resequence, 67
Pump Runtime Reset, 67
Pump Stage Differential, 69
Pump Status Check Delay Time, 67

R

Rapid Restart Time, 32
Receive Heartbeat, 25, 26
Recirculate, 37, 73, 87, 89, 90, 98, 99
refrigerant pressures, 106
Remote I/O, 7, 22, 24, 29, 61
reset override, 53
Reset Type, 49
return chilled water temperature sensor fail alarm, 114
return water reset, 53
run time, 34, 35, 36, 67, 72, 106, 107

S

Saturated Refrigerant Temperatures, 106
schedule editor, 82
secondary pumps, 24
Security Administrator, 20, 21
Sequence Number, 34
Serial Port, 118
series-piped, 25, 42, 43, 44
Service Pin, 23, 24
Setpoint Reset, 52, 59, 114, 115
Soft Load, 31, 130
soft loading, 48, 107
Source, 31, 130
Spare Capacity, 101
Spare Capacity Factor, 37
Stage-Down Control, 38, 39, 76, 78
Stage-Up Control, 38, 76, 78
Stage-Up Inhibit, 44, 101
Staging Mode, 34
standby chiller, 34, 42
Start Delta, 31, 37, 130
Start-Up Control, 37
subnet mask, 12, 15, 90, 119, 120, 121
supply chilled water temperature sensor fail alarm, 114
System Administrator, 20, 21, 29

T

Tower Stage Differential, 57
Tower Stage Table, 60
Tower Stage-Down Delay Time, 57, 61
Tower Stage-Up Delay Time, 57, 61
Tower Staging, 61
Tower Valve Control, 57
Tower Valve Setpoint, 57
Tower Valve Start-Up, 65
Tower VFD Control, 57, 60

U

Unavailable, 41, 42
Units, 29
user name, 14, 16, 18, 20, 21

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