Plant Manager Controller
Manual Rev. 1.0

Following MCS Software is required:
MGR 10.02-A MCS-8 software
PC-Connect V4.0-B software
PC-Config V3.00l software
(or more current releases)

The MCS Commitment

Our commitment is to provide practical solutions for the industries needs and to be both a leader and partner in the effective use of microprocessor controls.

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(Website contains product descriptions, manuals, software releases, troubleshooting aids, etc)

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Date	Author	Description of Changes
03-01-06	RCT	Initial manual, Following are the earliest releases required: MGR 10.02-A, MCS8 software; PC-Connect V4.0-B; PC-Config V3.00I The above software supports the features described in this manual.

1. Table of Contents

2. Introduction

2.1. Introduction to MCS-8 MGR 10 Software Family

The Plant Manager software is designed to control loops 1 thru 4 in the same manner as the Loop Controller. All loops have the capability of generating messages that are transmitted to MCS-8 controllers on the MCS 485 network if they are setup to perform this function. The information transmitted will contain: run enable, maximum steps that can be turned on and if variable capacity (screw) the maximum demand capacity percentage. Class 55 type of message is used to transmit this information. When the first stage of cooling is turned on the run enable will be set to run. Setpoint numbers 101, 105, 109 and 113 for the four loops will control the number of steps. The MCS-8 controllers on the network must be configured to accept this message and take the appropriate action.

This software requires that the Plant Manager have a control temperature that is locate to record the temperature that has been affected by all of the controllers on the network. Based upon this control temperature the system will vary the demand capacity and the number of cooling steps that are required to maintain the target temperature. This information will be communicated to all MCS-8 controllers that are on the network. The individual MCS-8 controllers will function independently in controlling their compressors based upon temperatures, pressures, amps etc. They will receive a run enable indicator and be limited by the Plant Manager in the number steps that can be turned on and if variable capacity the maximum demand capacity.

The software has been built to be generic and handle many configurations of loop controllers and different control strategies for the MCS-8 network. The type of loop, water with pumps or air with fans, is selected. The states have been modified to reflect the type of system.

The user is provided with the exact status of what the system is doing by displaying meaningful control state names. This together with history status of all the inputs and outputs plus alarm information, provided in simple English, provides excellent user/machine interface.

2.2. Common support items of the MGR 10 Software Family:

Loops up to 4,
Pumps per Loop up to 8,
One Variable Speed for Pumps per Loop
Stages of Heating per Loop up to 16,
One Variable Speed for Heating Stage per Loop
Stages of Cooling per Loop up to 16,
One Variable Speed for Cooling Stage per Loop
Relay Outputs up to 48,
Analog Outputs up to 6,
Sensor Inputs up to 48,
Setpoints up to 120,
Alarms up to 60

2.3. About MCS-8 Hardware Support by MGR 10 Software Family

The following MCS boards can be connected to via the MCS-I/O network:

- MCS-8 (8 RO - 8 SI - 1 AO with the appropriate MGR 10 software and a GAL 6.0 chip),
- MCS-I/O (8 RO - 8 SI - 1 AO with IO 7.00-C with a GAL 5.0 chip),
- MCS-RO8 (8 RO),
- MCS-SI8 (8 SI),
- MCS-SI16. (16 SI).

This provides flexibility in configuring the individual systems to obtain the desired number of points in the most economical way.

2.4. About this Manual

The purpose of this manual is to document MCS's MGR 10 software for the MCS-8.

This manual documents how the MGR 10 software functions. Since this is a large manual, it is structured in logical sections for ease of reference. The Table of Contents will guide you through the sections but you are urged to read the entire manual. This will provide an understanding of the capabilities of the MCS-8 and hopefully introduce other ways that you may benefit from the existing control strategies. Quick Reference sheets and MCS Specification sheets are provided in the appendixes. The Plant Manger PC-Config Manual reviews the steps to build the configuration file for this software.

This manual was created using Microsoft Office, Word 97. A printed copy may be ordered, please refer to our Price Book. Or a copy of this manual maybe down loaded from our web site: www.mcscontrols.com.

An approved OEM of MCS may make copies and / or change any section of this manual to develop custom documentation for a site where an MCS-8 controller is installed. In this way, MCS supports the documentation requirements of individual customer sites.

2.5. About the MCS-8

The MCS-8 is a rugged microprocessor based controller that is designed for the hostile environment of the HVAC/R industry. It is designed to provide primary control, no mechanical controls; interface with building management systems; communicate both locally and remotely. The MCS-8 provides flexibility with setpoints and control options that can be selected prior to commissioning a system or when the unit is live and functioning. Displays, alarms and other interfaces are accomplished in a clear and simple language that informs the user as to the status of the controller.

The MCS-8 is designed to safeguard the system that is being controlled, eliminate the need for manual intervention and to provide a simple but meaningful man-machine-interface.

2.6. About PC Support Software for MCS-8

- **PC-Config (V3.00I or later)** program provides the configuration file: points list, setpoints, options, etc., for all versions of software. This program is user friendly with English questions and drop down menus. It is written in the Microsoft Visual Basic programming language. A manual created under Microsoft Office, Word 97, for Windows 95 is available on our web site; www.mcscontrols.com, this is in a PDF format, on diskette or CD-ROM.

- **PC-Conn (V4.0-B or later)** program provides both local and remote communications to the MCS-8 independent of the type of software. Through this program the status of the controller can be viewed and with proper authorization changes can be made to the system. Configuration files can be transmitted to or received from an MCS-8 unit. The MCS-8 automatically performs history logging; this program will graph selected items. This program is written in the Microsoft Visual C++ programming language. A general manual created under Microsoft Office, Word 97, for Windows 95 is available on our web site ; www.mcscontrols.com, this is in a PDF format; on diskette or CD-ROM.

Both of these programs run under Windows 3.1 or greater and they make use of the Microsoft Windows Help function to assist the user.

2.7. MCS 485 Network connected to the Plant Manger

The Plant Manager is in control of all of the MCS-8 chillers that are connected to it. **The Plant Manager must have a network address of zero.** The number and addresses of MCS-8 chillers are specified when the configuration of the Plant Manager is built.

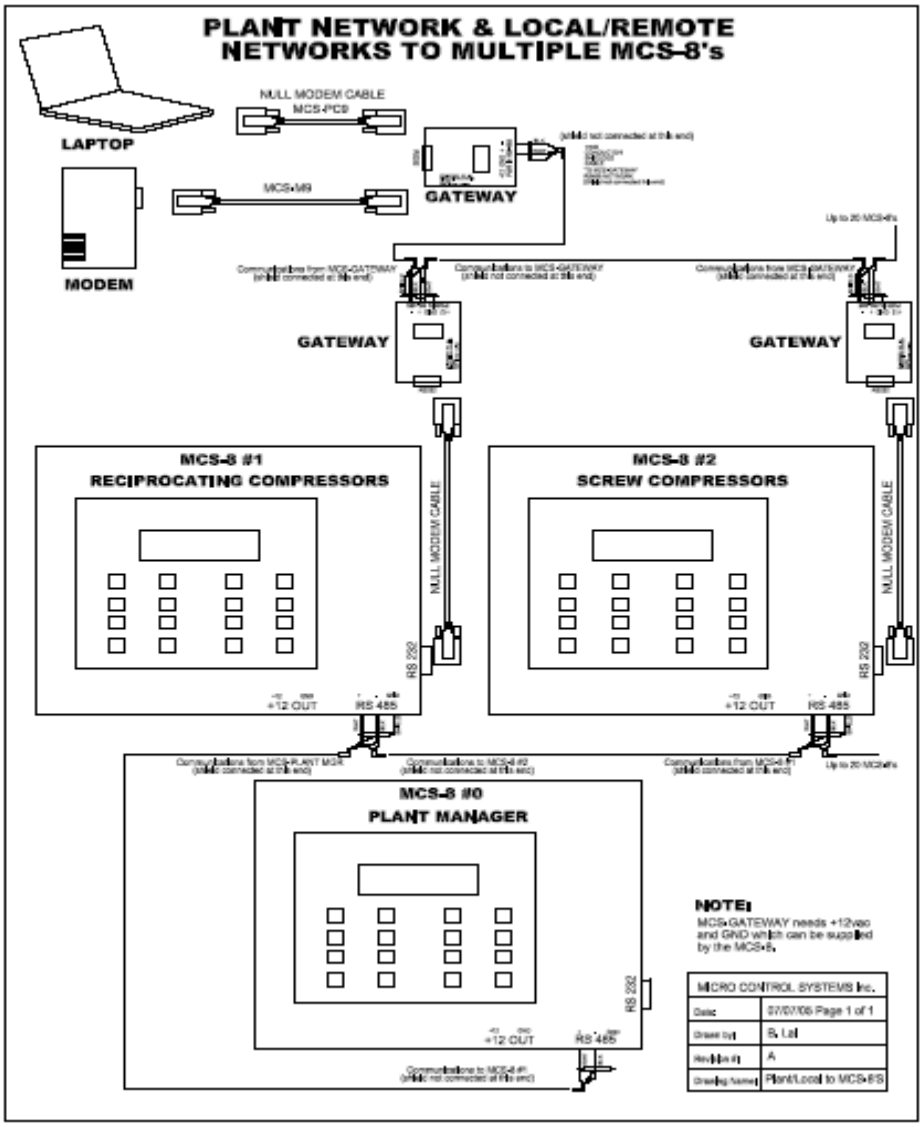
All MCS-8 controllers, including the Plant Manager will support PC-Connect being connected via the RS232 port. If all MCS-8's are to be accessed by PC-Connect then a secondary network must be established.

3. Requirements for PC Software

To install and run the program we suggest the following system requirements:

- Windows 95 or later operating system
- Pentium 166 MHz
- 2 Gigabyte hard disk with at least 25 Megabytes free
- Super VGA display capable of displaying 256 colors
- 32MB of RAM
- 33.6k baud modem

4. Plant Manger Network



5. MCS-8 MGR 10 Sequence of Operation

5.1. General Information

The MGR 10 MCS-8 unit control has been designed to provide easy to understand user interface via the on board key pad and LCD display or via the PC-CONN program running on a Window based PC. The status; control state of the unit, of the pumps and stages of cooling or heating; is displayed. The control states are defined in defined in this manual.

Setpoints can be changed in a live unit with the proper authorization. This provides the user with flexibility to change parameters during the commissioning or during the running of a live unit. The setpoints are defined in defined in this manual.

The system will support up to four loops and control each loop independently.
Each loop will have its own:

- Pumps or fans can be selected and the loop states name will be changed to match the selection,
- Run/stop switch, run override (occupancy) indicator,
- Individual schedule options can be selected,
- Up to eight pumps with one variable speed with its control sensor,
- Up to sixteen stages of cooling with one variable speed,
- Up to sixteen stages of heating with one variable speed,
- Either cooling and/or heating stages can be selected,
- Each pump will have its own set of sensors to indicate a pump failure.

5.2. Chiller Control Options

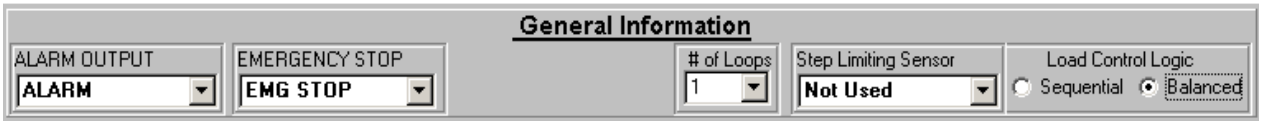
There are two basic options:

1. **Balanced Loading**, all chillers will be stepped equally. If one step of cooling is needed, then all chillers will be enabled to load to a maximum of one step.
2. **Sequential Loading,** the first chiller will be loaded to its maximum before the next chiller is allowed to run. The pumps can be indicated as **primary** or **common**.

   Primary pumps are directly connected with a chiller. The first pump is associated with the first chiller. The chiller will not be run unless its pump is on. If the pump fails, the chiller will be turned off.

   Common pump{s} are not connected to any chiller stage. Once a pump or set of pumps are on the first chiller will be allowed to run. If a pump fails another pump if available will be turned on.

5.3. Sequence of Operation – **Balanced** Loading



The control of the pumps will be handled separately from the cooling stages. Before a cooling stage can be turned on a pump must be running and providing flow.

All chillers will be allowed to run when the control algorithm calls for cooling. Each chiller will be allowed to have one-step or stage of cooling on. If additional cooling is required, each chiller will be allowed another step to be turned on. This option supports both fixed and variable compressor types.

If less cooling is required, each chiller will have the number of steps reduced by one.

All chillers will have the same number of steps that are allowed on-they are loaded and unloaded balanced.

5.4. Sequence of Operation – **Sequential** Loading

Sequential loading requires that the first chiller to be allowed to run will be loaded to its maximum before the next chiller is allowed to run. It then will be loaded to its maximum before the next chiller is allowed to run and so on. Unloading, less cooling capacity is required, will function in the same manner: A chiller will be completely unloaded and the RUN/STOP indicator will be STOP before the next chiller begins to unload.

This option supports both fixed and variable compressor types. Addition information is supplied in the Relay Output Screen:

Relay Output Information Screen (New)

#	Name	0 - Fixed Comp else Max Chg to Slide %	Number of Steps in Chiller Package	Capacity Load Limit	Capacity UnLoad Limit (Slide Start)
M-1	CHWP-1	0	0	0	0
M-2	CHWP-2	0	0	0	0
M-3	SPAREM-3	0	0	0	0
M-4	VALVE 1	0	0	0	0
M-5	VALV 2	0	0	0	0
M-6	CH-1	8	2	98	45
M-7	CH-2	10	2	90	40
M-8	ALARM	0	0	0	0

In the above example Relays M-6 and M-7 present two cooling steps (chiller packages) that will be controlled by the Plant Manger. Both have two variable step compressors. CH-1 (M-6) will start the slide at 45% and load until it reaches 98%. If more capacity is required, the second compressor will be allowed to run and the slide % will be started at 49% (98 / 2 = 49). Both compressors will be enabled to load to 98%. If additional cooling is required, the second cooling point, CH-2, will be allowed to run. Its first compressor's slide will be set to 40% and load until it reaches 90%. If more capacity is required, the second compressor will be allowed to run and the slide % will be started at 45 (90/ 2 = 45). Both compressors will be enabled to load to 90%.

The slide adjustment is based on the difference between the cooling target for the loop and the control temperature. For example if the target temperature is 45.0F and the control temperature is 47.5F the slide adjustment would be 2.5%. The maximum slide adjustment for CH-1 is 8% and for CH-2 it is 10%. This information is provided as samples only.

The two cooling stages are specified in the Loop Grid for loop #1:

Loop Information				
Max # of Cooling Stages On:	# of Cooling Stages	1st Cool Stage RO	Cool Variable Speed AO	Cool Variable Speed Fault
2	2	CH-1	Not Used	Not Used
0	0	Not Used	Not Used	Not Used
0	0	Not Used	Not Used	Not Used
0	0	Not Used	Not Used	Not Used

The pump control can be either **primary** or **common**. This option defines the association of pumps and the cooling (chiller) stages.

1. PRIMARY PUMP CONTROL:

Loop Information				
Pump Function:	System a Loop with Pumps?	# of Pumps/ Fans	Max # of Pumps/ Fans On	Rotate Pumps/ Fans
PRIMARY ...	YES ...	6	4	NO ...

When this option is specified, a pump is directly associated with a chiller step. If there are 3 pumps there must be 3 chiller steps.

When cooling is required, the first pump will be started, after the pump as been on for the time specified in setpoint #10, PmpOnOffDely; the first chiller stage will be started, the RUN/STOP indicator will be RUN.

As more cooling capacity is required, this chiller will be loaded to its maximum capacity. When this is reached, the next pump will be turned on and the sequence with its chiller will begin. This will continue as more cooling capacity is needed until the maximum number of pumps that is allowed on has been reached.

If less cooling capacity is required, this chiller will be unloaded to its minimum capacity. When this is reached, the chiller stage will be turned off, the RUN/STOP indicator will be STOP. The associated pump will be turned off after the delay specified in setpoint #10, PmpOnOffDely. This sequence will continue with the next chiller step as less cooling capacity is needed.

The system will increase or decrease the cooling stages until the control temperature is with the Control Target Zone. Once the control temperature has been satisfied the system will be in a HOLD state.

If either the pump or the chiller stage fails, both the pump and chiller stage will be locked off. If pump rotation option has been selected then both the pumps and the chiller stages are rotated. Rotation occurs when all pumps are off and the system calls for cooling.

2. COMMON PUMP CONTROL:

Loop Information				
Pump Function:	System a Loop with Pumps?	# of Pumps/ Fans	Max # of Pumps/ Fans On	Rotate Pumps/ Fans
COMMON ...	YES ...	6	4	NO ...

When this option is specified, the pump control functions independent from the chiller control. The pumps are common to all chiller stages. It does not matter which pumps are on as long as the number of pumps required on is satisfied.

The number of pumps that are required for each chiller is specified and when a chiller stage is needed on, that many pumps must be turned.

Pumps RO Required ON per Common Pump
2

For example if 2 pumps are needed per chiller stage then if 2 chillers are on 4 pumps are required. If a pump fails and there are other pumps available then one will be turned on to replace the pump that has failed. There will be no change to the number of chiller stages that are on. However, if the number of pumps cannot support the number of chiller stages then a chiller stage must be turned off.

Normally there will be a chiller valve that is associated with a chiller. This valve must first be opened and an acknowledgment that it is in fact open before additional pumps and then the chiller stage can be turned on. If a valve acknowledge input has not been received within the time specified in setpoint #115, Cvalve FAIL the system will lock off that chiller and proceed to the next if one exists. If there is not a valve acknowledge input then the system will wait the time specified in setpoint #115, Cvalve FAIL before continuing.

Once the valve has been successfully opened, the necessary number of pumps will be turned on. The system will delay for the time specified in setpoint ##10, PmpOnOffDely and the chiller stage will be turned on, the RUN/STOP command will be RUN. That chiller will then be staged to its maximum capacity. If more cooling capacity is required and another chiller stage exists, the procedure for starting a chiller stage will be repeated.

This option also allows standby cooling stages:

		Loop Information
Max # of Cooling Stages On:	# of Cooling Stages	1st Cool Stage RO
1	2	CHILLER1

In the above example this loop has 2 cooling stages but only 1 can be on at any one time. This is the same concept as in used in specifying the number of pumps. If the cooling stage that is on fails, the system will attempt to bring on the second cooling stage.

5.5. Sequence of Operation – **Sequential** Loading with Primary pumps Example

System configuration is as follows:

- 1 loop,
- 2 pumps with maximum of 2 on,
- 2 chiller stages with a maximum of 2 on,
- Chillers are screw compressors,
- Control target 44 degrees,
- Actual 46 degrees

The following are the Relay Outputs Inputs for this example:

Relay Output Information Screen (New)

#	Name	0 - Fixed Comp else Max Chg to Slide %	Number of Steps in Chiller Package	Capacity Load Limit	Capacity UnLoad Limit (Slide Start)
M-1	CHWP-1	0	0	0	0
M-2	CHWP-2	0	0	0	0
M-3	SPAREM-3	0	0	0	0
M-4	SPAREM-4	0	0	0	0
M-5	SPAREM-5	0	0	0	0
M-6	CH-1	8	2	98	45
M-7	CH-2	10	2	90	40
M-8	ALARM	0	0	0	0

The pump RO CHWP-1 is tied to chiller stage CH-1. This chiller has 2 steps with the maximum load limit of 98% and a minimum of 45%.

The pump RO CHWP-2 is tied to chiller stage CH-2. This chiller has 2 steps with the maximum load limit of 90% and a minimum of 40%.

The following are the Sensor Inputs for this example:

Sensor Input Information Scre

#	Name (1 to 8 char)	Display Type	Offset	Manual Value or NC/NO (select to change)	Display Text (select to change)	Setpoint Index
M-1	RUN/STOP	DIGITAL	Not Used	Open=OFF	Run, Stop	Not Used
M-2	CHWR	MCST100	0	66	Not Used	Not Used
M-3	CHWS	MCST100	0	55	Not Used	Not Used
M-4	FLOW 1	DIGITAL	Not Used	Open=OFF	Yes, No	Not Used
M-5	FLOW 2	DIGITAL	Not Used	Open=OFF	Yes, No	Not Used
M-6	AH Oride	DIGITAL	Not Used	Open=OFF	Yes, No	Not Used
M-7	SPAREM-7	SPARE	0	0	Not Used	Not Used
M-8	AMBIENT	MCST100	0	77	Not Used	Not Used

Sensor M-3, CHWS is the control temperature. Sensor M-4, FLOW1 when on indicates that flow exists for pump1 and FLOW2 when on indicates that flow exists for pump2.

The control temperature is at 47.6F and pump 2 is the lead:
The system has turned on the lead pump and the chiller state is COOL LOADING. The chiller stage will not be added until the pump has been on for the time specified in setpoint #10, PmpOnOffDely.

Note the information provided under the CHILLER(S) STATUS:
Both stages are off and run enable is set to STOP. Stage 1 has 2 steps available but none are allowed on and its maximum capacity is 98.0%.

	STATE	TIME	DELAY	WANTED /ACTUAL	ROC/CAP%
UNIT STATUS	UNIT-NORMAL RUN	00:53:22	Mode	Sequential	PriPumps
#1 CHILLERS	LOOP NORMAL	00:53:32			
PUMP(s) STATUS	PUMPS LOADING	00:00:03	117	1 / 1	No AO
CHWP-1	Stage 1 OFF				
CHWP-2	Stage 2<-ON				
CHILLER(s) STATUS	COOL-LOADING	00:00:03	116	0 / 0	0.0
CH-1	Stage 1 OFF			2 / 0	98.0/45.0
CH-2	Stage 2 OFF			2 / 0	90.0/40.0

The Stage 2 is now allowed to run. The capacity allowed will start at 40.0% and be increased by 2.6% (difference between target and actual temperature) as long as the control temperature is at 46.7F.

	STATE	TIME	DELAY	WANTED /ACTUAL	ROC/CAP%
UNIT STATUS	UNIT-NORMAL RUN	00:59:19	Mode	Sequential	PriPumps
#1 CHILLERS	LOOP NORMAL	00:59:29			
PUMP(s) STATUS	PUMPS LOADING	00:06:00	2	1 / 1	No AO
CHWP-1	Stage 1 OFF				
CHWP-2	Stage 2<-ON				
CHILLER(s) STATUS	COOL-LOADING	00:06:00	1	1 / 1	0.0
CH-1	Stage 1 OFF			2 / 0	98.0/45.0
CH-2	Stage 2 ON			2 / 1	90.0/45.2

When the capacity reaches 90.0% the second step will be enabled and the capacity will be reduced to 45.0%. This is calculated by the number of steps on (1) times the maximum capacity (90.0) divided by the number of steps on plus 1 (2). 90.0 x 1 = 90 / 2 = 45.0%. If the stage had 3 steps and 2 steps had reached the maximum capacity then when the 3rd steps is added the capacity would be 60.0% (90.0 x 2 = 180 / 3 = 60.0).

The second step of Stage 2 is now allowed to run. Now the capacity has been reduced to 45.0%.

	STATE	TIME	DELAY	WANTED /ACTUAL	ROC/CAP%
UNIT STATUS	UNIT-NORMAL RUN	01:15:53	Mode	Sequential	PriPumps
#1 CHILLERS	LOOP NORMAL	01:16:03			
PUMP(s) STATUS	PUMPS LOADING	00:22:34	9	1 / 1	No AO
CHWP-1	Stage 1 OFF				
CHWP-2	Stage 2<-ON				
CHILLER(s) STATUS	COOL-LOADING	00:22:34	8	1 / 1	0.0
CH-1	Stage 1 OFF			2 / 0	98.0/45.0
CH-2	Stage 2 ON			2 / 2	90.0/45.0

When all steps have been enabled and the maximum capacity has been obtained, the next cooling stage will be enabled. Note Stage 2 has steps available and maximum capacity allowed. Now the next stage is allowed to run. This stage will be stage will be staged up in the same manner.

	STATE	TIME	DELAY	WANTED /ACTUAL	ROC/CAP%
UNIT STATUS	UNIT-NORMAL RUN	01:19:16	Mode	Sequential	PriPumps
#1 CHILLERS	LOOP NORMAL	01:19:26			
PUMP(s) STATUS	MAX PUMPS ON	00:00:18	3	2 / 2	No AO
CHWP-1	Stage 1 ON				
CHWP-2	Stage 2<-ON				
CHILLER(s) STATUS	COOL-LOADING	00:00:18	2	2 / 2	0.0
CH-1	Stage 1 ON			2 / 1	98.0/45.0
CH-2	Stage 2 ON			2 / 2	90.0/90.0

The system will react to the control temperature by adding additional capacity, reducing capacity or hold at its present capacity. The CHILLER(S) STATUS state will reflect this condition.

The last stage that is being loaded will be unloaded if less capacity is needed.
Rotation if specified will not occur until all stages have been turned off.

The following condition shows a loss of flow for pump 2.

RELAY OUTPUTS		VALUE	MANUAL STATUS
M-1	CHWP-1	ON	AUTO
M-2	CHWP-2	OFF	LOCKOFF
M-3	SPAREM-3	OFF	AUTO
M-4	SPAREM-4	OFF	AUTO
M-5	SPAREM-5	OFF	AUTO
M-6	CH-1	ON	AUTO
M-7	CH-2	OFF	LOCKOFF
M-8	ALARM	ON	AUTO

SENSOR INPUTS		VALUE
M-1	RUN/STOP	RUN
M-2	CHWR	66.0F
M-3	CHWS	46.0F
M-4	FLOW 1	YES
M-5	FLOW 2	NO
M-6	AH Oride	NO
M-7	SPAREM-7	
M-8	AMBIENT	77.0F

	STATE	TIME	DELAY	WANTED /ACTUAL	ROC/CAP%
UNIT STATUS	UNIT-NORMAL RUN	00:05:38	Mode	Sequential	PriPumps
#1 CHILLERS	LOOP NORMAL	00:05:48			
PUMP(s) STATUS	PUMPS LOADING	00:01:53	2	2 / 1	No AO
CHWP-1	Stage 1<-ON				
CHWP-2	Stage 2 FAILED				
CHILLER(s) STATUS	COOL-ROC HOLDG	00:00:02	7	2 / 1	-9.0
CH-1	Stage 1 ON			2 / 2	98.0/98.0
CH-2	Stage 2 FAILED			2 / 0	90.0/0.0

The RO's for pump 2 and chiller stage 2 have been locked off. The status for pump 2 and chiller stage 2 indicate failed. The system will attempt to restart from this condition based upon the information in the no flow setpoint.

5.6. Sequence of Operation – **Sequential** Loading with Common pumps Example

System configuration is as follows:

- 1 loop,
- 6 pumps with maximum of 4 on,
- 3 chiller stages with a maximum of 2 on,
- Chillers are reciprocating compressors,
- Chiller valve & acknowledge input,
- Control target 44 degrees,
- Actual 46 degrees

The following are the Relay Outputs and Sensor Inputs for this example:

RELAY OUTPUTS	
M-1	PMP A1
M-2	PMP A2
M-3	PMP B1
M-4	PMP B2
M-5	PMP C1
M-6	PMP C2
M-7	SPAREM-7
M-8	SPAREM-8
1-1	CHILLER1
1-2	CHILLER2
1-3	CHILLER3
1-4	CHLVALV1
1-5	CHLVALV2
1-6	CHLVALV3
1-7	SPARE1-7
1-8	ALARM

SENSOR INPUTS	
M-1	RUN/STOP
M-2	RETURN
M-3	SUPPLY
M-4	PPA1 AMP
M-5	PPA2 AMP
M-6	PPB1 AMP
M-7	PPB2 AMP
M-8	PPC1 AMP
1-1	PPC2 AMP
1-2	SPARE1-2
1-3	EMG STOP
1-4	SPARE1-4
1-5	CH1 MODE
1-6	CH2 MODE
1-7	CH3 MODE
1-8	SPARE1-8
2-1	VALVE 1
2-2	VALVE 2
2-3	VALVE 3

System has determined that the control temperature is above the control target zone. Cooling is required. Two pumps (PMP A1 & PMP A2) are wanted on, they are not on at this point. The chiller valve (CHLVALV1) has been turned on and chiller stage 1 is wanted on. The system is waiting for the valve acknowledgment (SI 2-1, VALV1).

	STATE	TIME	DELAY	WANTED /ACTUAL	ROC/CAP%
PUMP(s) STATUS	PUMPS LOADING	00:00:11	10	2 / 2	No AO
PMP A1	Stage 1<-Wantd ON				
PMP A2	Stage 2 Wantd ON				
PMP B1	Stage 3 OFF				
PMP B2	Stage 4 OFF				
PMP C1	Stage 5 OFF				
PMP C2	Stage 6 OFF				
CHILLER(s) STATUS	COOL-HOLDING	00:00:11	9	1 / 1	0.0 / 0.0
CHILLER1	Stage 1 Wantd ON				
CHILLER2	Stage 2 OFF				
CHILLER3	Stage 3 OFF				

Once the valve acknowledgment (SI 2-1, VALV1) is on, pumps (PMP A1 & PMP A 2) will be turned on. The chiller point (RO 1-1, CHILLER1) will be turned on after a delay specified in setpoint #10. This is to allow time for flow to be developed.

Once chiller point (RO 1-1, CHILLER1) is on, The system will then send the RUN/STOP command RUN to the MCS-8 and then begin to allow this chiller to load. With each pass of the delay another step will be enabled until the maximum has been reached.

	STATE	TIME	DELAY	WANTED /ACTUAL	ROC/CAP%
PUMP(s) STATUS	PUMPS LOADING	00:00:05	1	2 / 2	No AO
PMP A1	Stage 1<-ON				
PMP A2	Stage 2 ON				
PMP B1	Stage 3 OFF				
PMP B2	Stage 4 OFF				
PMP C1	Stage 5 OFF				
PMP C2	Stage 6 OFF				
CHILLER(s) STATUS	COOL-HOLDING	00:00:42	0	1 / 1	0.0 / 0.0
CHILLER1	Stage 1 ON				
CHILLER2	Stage 2 OFF				
CHILLER3	Stage 3 OFF				

Once this chiller has reached it maximum allowed capacity, the system will repeat the steps to bring on the second chiller.

	STATE	TIME	DELAY	WANTED /ACTUAL	ROC/CAP%
PUMP(s) STATUS	MAX PUMPS ON	00:00:11	9	4 / 4	No AO
PMP A1	Stage 1<-ON				
PMP A2	Stage 2 ON				
PMP B1	Stage 3 Wantd ON				
PMP B2	Stage 4 Wantd ON				
PMP C1	Stage 5 OFF				
PMP C2	Stage 6 OFF				
CHILLER(s) STATUS	COOL-HOLDING	00:02:02	8	2 / 2	0.0 / 0.0
CHILLER1	Stage 1 ON				
CHILLER2	Stage 2 Wantd ON				
CHILLER3	Stage 3 OFF				

	STATE	TIME	DELAY	WANTED /ACTUAL	ROC/CAP%
PUMP(s) STATUS	MAX PUMPS ON	00:00:08	10	4 / 4	No AO
PMP A1	Stage 1<-ON				
PMP A2	Stage 2 ON				
PMP B1	Stage 3 ON				
PMP B2	Stage 4 ON				
PMP C1	Stage 5 OFF				
PMP C2	Stage 6 OFF				
CHILLER(s) STATUS	COOL-HOLDING	00:02:34	9	2 / 2	0.0 / 0.0
CHILLER1	Stage 1 ON				
CHILLER2	Stage 2 ON				
CHILLER3	Stage 3 OFF				

At this point the maximum capacity has been reached. Four pumps and two chillers are on. If one of the pumps fails then it will be locked off and the next available pump (PMP C1) will be turned on. There will be no change to the chiller stages. If CHILLER1 or CHILLER2 fail then the CHILLER3 will be allowed to run.

5.7. Schedule Options

The loop control logic has been designed to provide maximum flexibility in the scheduling of each individual loop. The following options are available:

1. DoW SCH/ON, this option will first check the day of week schedule for the loop as specified in the PC-Config program. If this option is set to:

- ON ALL DAY, the schedule will be true for that day;
- OFF ALL DAY, the schedule will be false for that day;
- DoW SCH/ON, the associate setpoints for this loop (setpoints 15, 37, 59, 81 or 103 for beginning of the first schedule and setpoints 16, 38, 60, or 82 for the duration of the first schedule and setpoints 17, 39, 61 or 83 for beginning of the second schedule and setpoints 18, 40, 62, 84 or 105 for the duration of the second schedule) will be tested to determine if the schedule is true or not. Note a schedule can extend into the next day.

2. PEAK/OFF, this option will look only at the Peak Hour Flags that have been set in the PC-Config program. If the time is one of the peak hours the schedule will be false and the Loop State will be LOOP STOP PEAK. If the current time is with in ten minutes of the first peak hour, the schedule will be false and the Loop State will be LOOP PRE PEAK. If the current time is with in the first ten minutes following the last peak hour, the schedule will be false and the Loop State will be LOOP POST PEAK.

3. ALWAYS ON, this option will always set the schedule to true.
NOTE: The schedules cannot be changed from the MCS-8 keypad by selecting OPERATING SCHEDs option within the PROGRAM OPTION key or from the PC-Connect program by clicking on the SCHED button. The DoW SCH/ON option's setpoints can be changed, other type of schedule options require a change to the PC-Config file.

5.8. Loop Pump Control Options

There are two methods of controlling the pumps on a loop:

1. **R/S ONLY**, This option allows all available pumps to be turned on, one per delay cycle, when the RUN/STOP switch is ON.

2. **R/S & TMP**, This option allows all available pumps to be turned on, one per delay cycle, when the RUN/STOP switch is ON and the temperature of the control sensor is greater than the cool target for that loop. The pumps will be turned off based upon the temperature control zone.

5.9. Ambient Control Options

There are four options (options 1, 2 & 3 require an ambient temperature sensor):

1. **LOW/LOOP OFF**, when this option is selected and the ambient temperature drops below the value in setpoint #2, all pumps and stages that are on will be turned off and the loop state will be LOOP STOP AMB. The purpose of this option is to stop the flow thus preventing freezing. The ambient temperature must then rise above this setpoint plus 5.0 degrees before the system will leave this state.

2. **LOW/RUN PUMPS**, when this option is selected and the ambient temperature drops below the value in setpoint #2 and the pumps are not on, all pumps will be turned on and the loop state will be LOOP AMB/PUMPS. The purpose of this option is to ensure flow thus preventing freezing. The ambient temperature must then raise above this setpoint plus 5.0 degrees before the system will leave this state.

3. **LOW/LOOP ON**, when this option is selected and the ambient temperature is **greater** than the value in setpoint #2, all pumps and stages that are on will be turned off and the loop state will be LOOP STOP AMB. When the ambient temperature is **less** than the value in setpoint #2 the loop

will enter a normal run mode. The loop will remain in this state until the ambient temperature rises above this setpoint plus 5.0 degrees before the system will return to LOOP STOP AMB. The purpose of this option is to enable a loop to run when the ambient temperature is low, for example to option free cooling.

4. **NONE**, when this option is selected no action is taken based upon ambient temperature.

If either **LOW/LOOP OFF** or **LOW/RUN PUMPS** states occur and setpoint #2 is an ALARM type the alarm relay if one exists will be turned on and the loop state will be set accord ling. Executing a lock out reset can turn off this relay.

5.10. Ice Making Options (this option is NOT available)

A loop can either provide cooling stages or ice making stages, not both. There are thee options if the loop is to make ice. If one of these options is selected, the loop can make ice once a normal scheduled on cycle. If an override switch is indicated and is active (ON) then the loop will be enabled to make ice during the override period. Once the loop begins to make ice, all ice making steps will be turned on, one per delay cycle.

1. **ICE/TEMP**, this option indicates that the loop is to make ice and is to be controlled only on temperature. This will be the sensor that is indicated as the control sensor for the pumps and cooling stages. When the control temperature is above the value in setpoint #4 plus the cooling target for that loop (setpoint #17, 39, 61, 83 or 105), the stage state will be changed to MAKING ICE, a message indicating this action will be generated and the first ice making stage will be turned on. All stages will be turned on one per delay cycle. The stage will remain in this state until the control temperature is less than setpoint #17 minus #19 (for loop 1, each loop has its own temperature target), at this point all steps of ice making will be turned off. When viewing the system with PC-Connect, the status line of the stage for that loop will indicate MAKING ICE/TEMP.

2. **ICE/LEVEL**, this option indicates that the loop is to make ice and is to be controlled only on level of the ice. This will be the sensor that is indicated as the ice level indicator. When the ice level sensor is less than the value in setpoint #6, the stage state will be changed to MAKING ICE, a message indicating this action will be generated and the first ice making stage will be turned on. All stages will be turned on one per delay cycle. The stage will remain in this state until ice level is greater than setpoint #5, at this point all steps of ice making will be turned off. When viewing the system with PC-Connect, the status line of the stage for that loop will indicate MAKING ICE/LEVEL.

3. **ICE/BOTH**, this option indicates that the loop is to make ice and is to be controlled both on temperature and on the level of the ice. Both the temperature and ice level conditions must be meet before ice making will begin. If either the temperature or ice level indicates that the ice making should stop, all steps of ice making will be turned off. When viewing the system with PC-Connect, the status line of the stage for that loop will indicate MAKING ICE/TP&LV.

5.11. Loop Control

The loop's RUN/STOP switch must indicate RUN before the system will attempt to start the loop. When the switch is set to STOP the Loop State will be LOOP STOP SW. If the switch is in the RUN position, the loop's schedule will be checked. If the schedule is false, the Loop State will be LOOP STOP SCH, LOOP STOP PEAK, LOOP PRE PEAK or LOOP POST PEAK, depending on the schedule option selected for that loop. If the schedule is true, the Loop State will be LOOP NORMAL and system will begin to control the pumps, heating and cooling/ice making stages on the loop.

When the loop state is in any of the stopped states, the loop's override indicator will be tested. If on the loop state will be LOOP OVER RIDE and control of all functions of that loop will be executed. If the loop has been selected to make ice, one cycle of ice making will be allowed.

The ambient temperature and ambient control option will be checked regardless of the loop state. Appropriate action will be taken based upon the ambient temperature option selected.

The loop controls functions consist of pump or fan control and controlling the steps of heating and cooling/ice making. The various options will determine how these elements are controlled.

Before any steps of heating or cooling/ice making can be turned on, the pumps must be on for the time contained in setpoint #10. This is to ensure proper flow through the loop.

5.12. Pump or Fan Control

There can be a maximum of eight pumps or fans per loop. If a pump or fan fault sensor is provided, there must be one for each pump or fan in the loop. This sensor can be a digital input and it if on or an analog input and if its value is less than its corresponding setpoint #31, 53, 75 or 97, that individual pump or fan will be locked off and its state changed to FAULT. This action will **NOT** change the pump or fan state of the loop but it will reduce he number of pumps or fans on by one.

Two methods of controlling the pumps or fans in a loop are available.

If R/S ONLY was selected in the PC-Config program for this loop, then when the loop is running a pump or fan will be turned on. If there are multiple pumps or fans, additional pumps or fans will be turned on until the maximum pumps or fans allowed on, is reached.

If R/S &TMP CTL was selected in the PC-Config program for this loop, then when the loop is running a pump or fan will be turned on only if a pump or fan needed to support the heating or cooling/ice making stages.

If the control mode is BALANCED, pumps or fans will not be turned off until all stages of heating and cooling/ice making are off and the stage state timer is greater than the value in setpoint #10, PmpOnOffDely.

If variable speed control has been specified, when the first pump or fan is turned on the system will vary the speed of the associated Analog Output based upon the target zone that has been established and the step points that control the minimum, maximum and speed adjustment.

5.13. Heating Temperature Target Adjustment

The heating target for a loop can be adjusted based upon the ambient temperature. For each degree that the ambient temperature is below set point #2 the target for each individual loop will be increased by the value entered in the “Loop Heat Target Increase” column for that loop.

5.14. MGR 10 Temperature Control Zone Control for Heating and Cooling

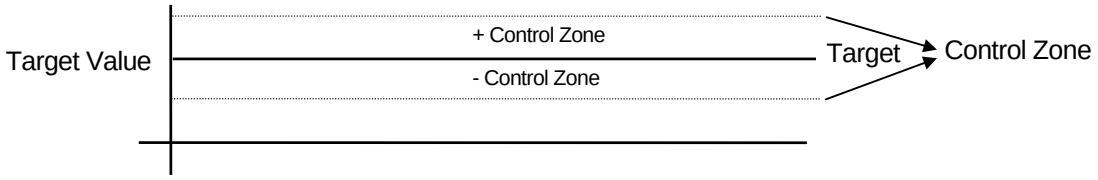
This control strategy is based upon developing a control zone and then to step the steps of heating or cooling or vary the speed of a pump or fan to maintain the control sensor reading within this zone. A unique control zone will be developed for a variable speed or fan, cooling or heating for each loop. To accomplish this the system will constantly monitor the control value, its rate of change and position in relationship to the control zone.

5.14.1. Target

The control target for each loop is specified for cooling, setpoint 18, 40, 62, 84 or 106; and for heating, setpoints 19, 41, 63 or 85.

5.14.2. Control Zone

The control zone is developed by adding and subtracting the value in setpoint 20, 42, 64, 86 or 108, to both cooling and heating targets.



Once the control zone has been established, the system will attempt to keep the control sensor reading with in this range.

5.14.3. Controlling Sensor

This is the sensor that has been specified in the PC-Config program as providing the control value reading. Each loop can have a unique control sensor. If the loop has pump or fan variable speed a unique sensor will be specified to control the speed of the pump or fan.

5.14.4. The Rate Of Change Of The Control Input

The rate of change is how fast the control value is changing over a period of time. If the control value is increasing the rate will be positive, if decreasing the rate will be a negative value. How fast the input is changing, its direction and where the current input reading is in relationship to the control zone will determine what action the system will take.

5.14.5. Step Delay

The system will not attempt to take action until the Step Delay reaches zero. Setpoint 21, 43, 65 or contains the initial value for the staging of heating or cooling. All step delays are decrement each second.

5.15. Heating Cooling Stage Control

The heating and cooling stages have the same temperature control sensor. Cooling or heating stages will be changed based upon this control temperature and it relationship to the control zone and its rate of change.

5.16. Variable Speed Control

If variable speed has been indicated for either or both the cooling/ice making or heating stages, the system will vary the speed of the associated Analog Output based upon the target zone that has been established and the step points that control the minimum, maximum and speed adjustment. An addition stage will not be added unless the maximum value has been reached, setpoint #24, 46, 68 or 90 when an additional stage is added, the Analog Output value will be set to its minimum speed, setpoint #23, 45, 67 or 89.

5.17. Unit is in Cooling

The loop is in a run mode and the loop water or air temperature indicates that cooling is required. The action of the system is display in the Staging Status section of the Control Status.

5.17.1. Temperature is above the Control Zone

If the temperature is dropping, rate of change, is greater than the value in setpoint #22, 44, 66 or 88 StageROC LP x. The system will hold, COOL-HOLDING, the temperature is moving toward the target at a sufficient speed.

If not, then the system will add one stage of cooling, COOL LOADING.

5.17.2. Temperature is above the Target but with in the Control Zone

If the temperature is with in 2.0 degrees of the target, the system will hold, COOL-TMP HOLDG.

If not and the temperature is not dropping, then the system will add stages of cooling, COOL LOADING. Else the system will hold, COOL-ROC HOLDG.

5.17.3. Temperature is below the Target but with in the Control Zone

If the temperature rate of change is ½ of the maximum positive, setpoint #22, 44, 66 or 88, StageROC LP x, the system will reduce the number of stages of cooling by one, COOL-ROC UNLDG.

Else the system will hold, COOL HOLDING.

5.17.4. Temperature is below the Control Zone

If the temperature is increasing, rate of change, is greater than the value in setpoint #22, 44, 66 or 88, StageROC LP x. The system will hold, COOL-ROC HOLDG, the temperature is moving toward the target at a sufficient speed.

If not, then the system will reduce stages of cooling, COOL-ROC UNLDG.

5.18. Unit is in Heating

The loop is in a run mode and the loop water or air temperature must be heated. The action of the system is display in the Staging Status section of the Control Status.

5.18.1. Temperature is above the Control Zone

If the temperature is dropping, rate of change is greater than the value in setpoint #22, 44, 66 or 88 StageROC LP x. The system will hold, HEAT-ROC HOLDG, the temperature is moving toward the target at a sufficient speed.

If not, then the system will reduce the number stages of heating, HEAT-UNLOADING.

5.18.2. Temperature is above the Target but with in the Control Zone

If the temperature is dropping, rate of change is greater than the value in setpoint point #22, 44, 66 or 88, StageROC LP x. The system will reduce the number of stages of heating by one, HEAT-ROC UNLDG, the temperature is moving away from the target.

If not, the system will hold, HEAT HOLDING.

5.18.3. Temperature is below the Target but with in the Control Zone

If the temperature is with in 2.0 degrees of the target, the system will hold, HEAT-TMP HOLDG.

Else, if the temperature rate of change has not increased, the system will turn on a stage of heating, HEAT LOADING. The temperature is not moving toward the target.

Else the system will hold, HEAT-ROC HOLDG.

5.18.4. Temperature is below the Control Zone

If the temperature is increasing, rate of change, is greater than the value in setpoint #22, 44, 66 or 88, StageROC LP x. The system will hold, HEAT-ROC HOLDG, the temperature is moving toward the target at a sufficient speed.

If not, then the system will add stages of heating, HEAT-LOADING.

5.19. Unit is Making Ice (not available)

The loop is in a run mode and the loop indicates that ice is to be made. The action of the system is display in the Staging Status section of the Control Status. One step will be turned on per delay cycle until all available steps are on.

When the unit begins making ice based upon the control criteria, the state will indicate making ice and an alarm "MAKING ICE #n" will be generated. The n will indicate the loop number. When the system stops making ice and an alarm "STOP MAKING #n" will be generated and the state will be ALL STAGES OFF.

6. MGR 10 Control States

We should consider the MCS-8 controller as a state computer, that is, decisions are made based upon setpoints, timers and sensor inputs, the controller moves from one state to another. The controller will change states to ensure the proper functioning of the chiller package.

As we review the various states, we must remember that a Loop Control package consists of a number of different parts or functions: the basic unit and the individual loops with pumps or fans and stages of cooling/ice making and heating. To control these functions the states will be divided into four sections:

- **Unit Control States**
- **Loop Control States**
- **Pump or Fan Control States**
- **Stage Control States (either heating or cooling/ice making)**

All control information is displayed on the 2x16 LCD. Press the SERVICE DIAGNOSTICS key until the option is the CONTROL STATUS, then press the ENTER key. The INCREASE and DECREASE keys can be used to scroll through the various state screens. Or it can be accessed via the PC-Connect program under status screen by clicking on the CONTROL STATUS button.

6.1. Control Status Display (from the MCS-8 keypad)

The following will be displayed:

A. The CURRENT STATE OF THE UNIT.
The 1st display shows the current status of the unit and how long we have been in this state. This information is only display when the control status is initially entered.

Line 1) `UNIT-NORMAL RUN`
Line 2) `TIMER=00:21:10`

By pressing the + key you will get information on the status of the first loop. This screen on line one shows the number of the loop and its state; line two contains the time in that state.

Line 1) `1 LOOP NORMAL`
Line 2) `TIMER=00:21:10`

By pressing the + key you will get information on the status of the pumps or fans on the first loop. This screen on line one shows the number of the loop and its pump or fan state, line two contains the time in that state.

(The following reflect a system, which does not have pumps)

Line 1) `1 MAX FANS ON`
Line 2) `TIMER=00:19:40`

By pressing the + key you will get information on the number of pumps or fans that are wanted on and the number that are actually on the first loop.

Line 1) `1 FANS WANTED=1`
Line 2) `ACTUAL PUMPS=1`

By pressing the + key you will get information on the accumulator. (Starts with the value in the setpoint 'PumpStepDely, #5' and decrements down as a function of the difference between the target and the current value of the controlling sensor. The second line provides the Rate Of Change of the controlling sensor.

Line 1) `1 FAN DELAY= 30`
Line 2) `RATE OF CHG+ 0.0`

By pressing the + key you will get information on the stages for this loop.

Line 1) `1 HEAT-LOADING`
Line 2) `TIMER=00:27:25`

By pressing the + key you will get information on the number of stages that are wanted on and the number that are actually on the first loop.

Line 1) `1 STAGE WANTED=1`
Line 2) `  ACTUAL STAGE=1`

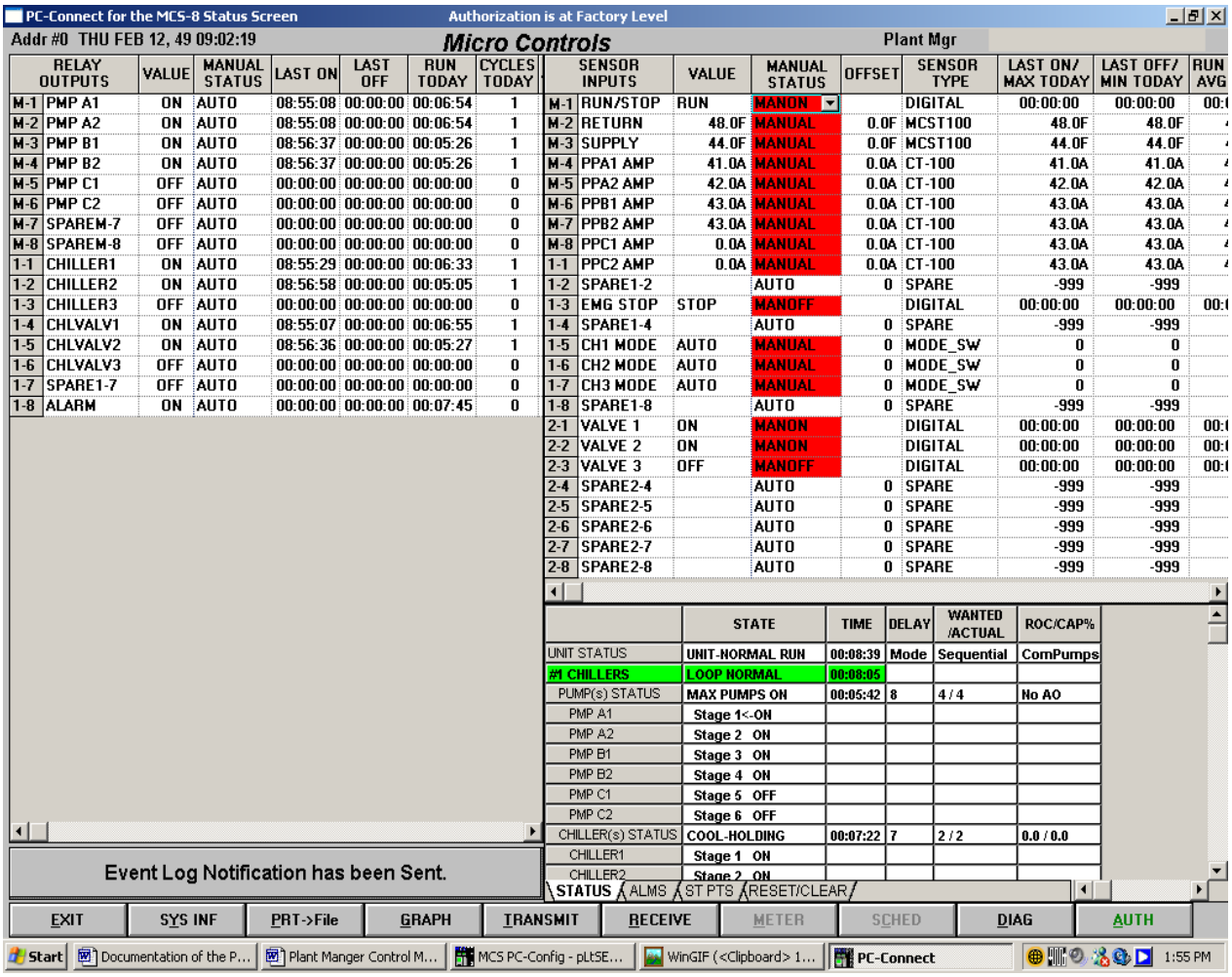
By pressing the + key you will get information on the accumulator. (Starts with the value in the setpoint 'StageDelyLPx, #56 - 60' and decrements down as a function of the difference between the target and the current value of the controlling sensor. The second line provides the Rate Of Change of the controlling sensor.

Line 1) `1 STAGE DELAY= 14`
Line 2) `RATE OF CHG+ 0.0`

By pressing the + key the all the information for the next loop will be repeated. None line one of each display contains the number of the loop. The information displayed can be accessed by moving forward, pressing the + key or moving backwards, pressing the - key. Note the unit status screen is not included in this loop.

6.2. Control Status Display (from the PC-Connect program)

The status of the unit can be viewed from the PC-Connect program by accessing the CONTROL STATUS key under status screen. The following is an test example that has 6 pumps with a maximum of 4 being on, 3 chiller stages with a maximum of 2 being on each chiller has a chiller valve (CHLVALVx) and an acknowledgment sensor input (VALVE x):



Use your arrow keys to access all information (Active loops will be displayed)

	STATE	TIME	DELAY	WANTED /ACTUAL	ROC/CAP%
UNIT STATUS	UNIT-NORMAL RUN	00:18:24	Mode	Sequential	ComPumps
#1 CHILLERS	LOOP NORMAL	00:17:50			

The number of the loop and its name will be displayed in the row that is high lighted. The loop state and the time in that state will also be displayed on that row.

The following rows will contain the status of the pumps/fans that are on that loop with the lead pump being indicated with <- symbol. If the pump/fan is to be modulated, the cell in CHANGE column will contain AO followed by the delay timer value.

PUMP(s) STATUS	MAX PUMPS ON	00:09:54	9	4 / 4	No AO
PMP A1	Stage 1<-ON				
PMP A2	Stage 2 ON				
PMP B1	Stage 3 ON				
PMP B2	Stage 4 ON				
PMP C1	Stage 5 OFF				
PMP C2	Stage 6 OFF				

The status of the heating or cooling that has been setup for the loop will follow the pump information.

CHILLER(s) STATUS	COOL-HOLDING	00:11:34	8	2 / 2	0.0 / 0.0
CHILLER1	Stage 1 ON				
CHILLER2	Stage 2 ON				
CHILLER3	Stage 3 OFF				

This information will be repeated for each active loop.

Information displayed in the status grid contains one line for the unit plus three lines for each loop. Only the number of loops that is specified for this system will be display. A number on the loop status line identifies each loop.

UNIT STATUS line:

- **UNIT STATE** – State of unit
- **TIME** – time in that state, if the state is UNIT IN POWER UP time will decrement to zero

Line one of a loop (only active loops will be displayed):

- **LOOP NUMBER with the loop name & "LOOP STATUS"** - This identities the beginning of a loop
- **STATE** – loop state.
- **TIME** – time in that state.
- **INDIVIDUAL PUMP or FAN STATE** – There can be a maximum of four pumps or fans per loop. The pump or fan number and its state are shown. This state cannot be accessed by the MCS-8 keypad.

Line two of a loop (only active loops will be displayed) will begin the pump status:

- **"PUMP or FAN STATUS"** - This identities that this line contains information on the staging of the pumps or fans on this loop. It is NOT the status of the individual pumps or fans on this loop.
- **STATE** – pump or fan staging state.
- **TIME** – time in that state.
- **DELAY** – Delay between decisions on pump or fan staging. This counter that will be set to the setpoint value contained in PumpStepDely, #5 and counted down to zero.
- **WANTED** – Number of pumps or fans that the system wants on. If a pump or fan is in the ANTI-CYCLE state, the system will wait until it moves to the OFF state; however if the pump or fan is in the FAILED state, the system will attempt to move to the next pump or fan if available.
- **ACTUAL** – Number of pumps or fans that the system has turned on.
- **CHANGE** – If there is AO (variable speed) pump or fan associated with this loop, this cell will contain AO and its delay counter. This is the delay between decisions on adjusting the pump or fan speed. This counter that will be set to the setpoint value contained in PumpVSDelay, (#13, 35, 57 or 79) and counted down to zero. If there is no AO, this cell will contain "No AO".

Line three through the number of pumps on the loop (only active loops will be displayed) will contain the pump status:

- **"PUMP #x"** – the number of the pump (1 through 8) will be indicated followed by its status: ON, OFF, FAILED etc. Only the number of pumps specified for that loop will be displayed.

Next line of a loop (only active loops will be displayed):

- **"HEATING or COOLING STATUS/ice making"** - This identities that this line contains information on the stages of heating or cooling/ice making steps.
- **STATE** –stage state of the heating or cooling/ice making.
- **TIME** – time in that state.
- **DELAY** – Delay between decisions on staging. This counter that will be set to the setpoint value contained in StageDelyLPx, #21, 33, 55 or 77 (each loop has its own setpoint) and counted down to zero.
- **WANTED** – Number of stages that the system wants on. Before a stage can be wanted on, a pump or fan must be on for the time specified in setpoint PmpOnOffDely, #10.
- **ACTUAL** – Number of stages that the system has turned on.
- **CHANGE** – This is the rate of change for the control sensor for this loop.

7. MGR 10 Control State Definitions

7.1. Unit Control States

UNIT IN POWER UP

This state is entered when the MCS-8 is powered up or the system has been reset. The system will remain in this state for 60 seconds; this is no longer a setpoint. In this state all points (RO's) are turned off. This is a time delay to insure the micro has stable power before turning any points on.

UNIT IN LOCKOUT

This state is entered whenever emergency stop switch is on. Lockouts can be reset without authorization from the keypad or PC-Connect program; however if the lockout condition has not been corrected, the system will again be forced into the LOCKOUT state. In this state, all RO's except ALARM RO turned OFF & placed in the 'LOCKOUT' state.

UNIT IN I/O LOST

This state will be entered whenever the MCS-8 loses communications with any of the I/O boards that are connected via the MCS I/O network. When this state is entered the system will generate an MCS I/O alarm, which identifies which I/O is off-line, and a lost IO shutdown alarm. The lockout-reset key must be depressed to reset the system, after the lost I/O has been corrected. In this state, all RO's except ALARM RO are turned OFF.

UNIT NORMAL RUN

This state is entered when the emergency stop switch is off, in the stop position, communications to all I/O boards has been established and the system is not in power up. When the chiller is in this state, the individual loops will be checked to determine if they should be running.

7.2. Loop Control States

These states indicate the status of the individual loops.

LOOP STOP SW

This state is entered when the run/stop switch, if used, is in the stop (off) position. The loop will not leave this state unless the run/stop switch is turned on (run), the loop override switch is on or the ambient temperature test is active and the temperature is above the setpoint AMB OFF TEMP, #2.

LOOP STOP SCH

This state is entered when the run/stop switch, if used, is in the run (on) position and the schedule option for the loop is DoW SCH/ON and both of the two schedules for this loop are false. The loop state will remain in this state unless one of the two schedules for this loop becomes true, the loop override switch is on or the ambient temperature test is active and the temperature is above the setpoint AMB OFF TEMP, #2.

LOOP STOP PEAK

This state is entered when the run/stop switch, if used, is in the run (on) position and the schedule option for the loop is PEAK/OFF and hour is a peak hour. The loop state will remain in this state until the hour is no longer a peak off hour, the loop override switch is on or the ambient temperature test is active and the temperature is above the setpoint AMB OFF TEMP, #2. All pumps and steps of staging are off in this state.

LOOP POST PEAK

This state is entered when the run/stop switch, if used, is in the run (on) position and the schedule option for the loop is PEAK/OFF and time is within the first ten minutes of the first non peak hour. The loop state will remain in this state until the minutes exceed this value, the loop override switch is on or the ambient temperature test is active and the temperature is above the setpoint AMB OFF TEMP, #2. All pumps and steps of staging are off in this state.

LOOP PRE PEAK

This state is entered when the run/stop switch, if used, is in the run (on) position and the schedule option for the loop is PEAK/OFF and next hour is a peak hour and the current minute is within ten minutes of the top of the hour. The loop state will remain in this state until the next hour is reached, the loop override switch is on or the ambient temperature test is active and the temperature is above the setpoint AMB OFF TEMP, #2. All pumps and steps of staging are off in this state.

LOOP NORMAL

This state is entered when the run/stop switch, if used, is in the run (on) position and schedule for this loop is true. The loop state will remain in this state unless a schedule for this loop become false or the run/stop switch, if used, is in the stop (off) position. In this state, the system determines what pumps or fans and stages of cooling/ice making or heating or ice making should be on.

LOOP OVERRIDE

This state is entered when the loop is stopped state and the loop override switch is turned on. The loop state will remain in this state until the override switch is off plus the time specified setpoint #1. This state is the same as the LOOP NORMAL state.

LOOP STOP AMB

This state is entered when the loop is in a stopped state due to:
1) the ambient temperature option of turn off all pumps/fans and cooling/heating stages if the temperature is below the setpoint AMB OFF TEMP, #2. The purpose of this state is to prevent freezing. The loop will remain in this state until the ambient temperature raises 5 degrees above the setpoint AMB OFF TEMP, #2. or
2) the ambient temperature option of turn on all pumps/fans and cooling/heating stages if the temperature is above the setpoint AMB OFF TEMP, #2. Once the loop is out of this state, it will remain in a normal run until the ambient temperature raises 5 degrees above the setpoint AMB OFF TEMP, #2, then it will return to the LOOP STOP AMB state.

LOOP AMB/PUMPS

This state is entered when the loop is in a stopped state due to and the ambient temperature option of turn on the loop pumps if when the temperature is below the setpoint AMB OFF TEMP, #2. In this state only the loop pumps or fans will be turned on. The purpose of this state is to circulate the liquid to prevent freezing. The loop will remain in this state until the ambient temperature raises 5 degrees above the setpoint AMB OFF TEMP, #2.

7.3. Pump or Fan Control States

These states indicate the status of the pumps or fans that are on a loop. These are not the state of the individual pumps or fans. If the option of loop with water and pumps is selected then the states will indicate pumps else fans will be indicated.

ALL PUMPS OFF or ALL FANS OFF

All pumps or fans on the loop are off.

PUMPS LOADING or FANS LOADING

The loop needs another pump or fan on. The wanted on count is greater than the actually on count.

MAX PUMPS ON or MAX FANS ON

All available pumps or fans are on.

PMPS UNLOADING or FANS UNLOADING

The loop needs another pump or fan off. The wanted on count is less than the actually on count. The system will turn off a pump or a fan and reduce the number of actually on by one. The pumps or fans will not be turned off until after all stages of heating and cooling/ice making have been turned off and the stage state timer is greater than setpoint PumpOnOffepDely, #10. This is to insure that proper flow is maintained.

7.4. Individual Pump or Fan Control States (only viewed from PC-Connect)

These states can only be viewed from PC-Connect. They indicate the status of the individual pumps or fans that are on a loop. There can be a maximum of four pumps or fans per loop.

FAILED

This pump or fan has failed, its corresponding fault sensor has indicated a fault and the relay output for this pump or fan has been LOCKED OFF. Manual intervention is required by executing a lockout reset either form the MCS-8 keypad or PC-Connect.

ANTI-CY

This pump or fan has been turned off and it will remain in this state for the time specified in setpoint 4, PUMP ANTICYC. The relay output for this pump or fan has been turned OFF. It cannot be turned on until it has been move to the OFF state.

OFF

This pump or fan has been turned off and has been move from PUMP ANTICYC to the OFF state. It can now be turned on if the loop needs this pump or fan. The relay output for this pump or fan is OFF.

ON

This pump or fan has been turned on. The relay output for this pump or fan is ON and it is running normally.

7.5. Stage Control States

These states indicate the status of the stages of heating or cooling/ice making or ice making that are on the loop.

ALL STAGES OFF

All of the stages of heat heating or cooling/ice making are on the loop are off. The loop does not need any stages to be on.

These states are active when the loop is in a cooling mode.

COOL- HOLDING

The control temperature is above the cooling target but within the zone and the temperature is falling at a rate of change greater than one half the setpoint StageROC LPx, #22, 44, 64 or 86. No change to the number of stages of cooling is required.

COOL-ROC HOLDG

The control temperature is above the cooling target zone but the temperature is falling at a rate of change greater than setpoint StageROC LPx, #22, 44, 64 or 86. No change to the number of stages of cooling is required.

COOL-TMP HOLDG

The control temperature is within the cooling target zone. No change to the number of stages of cooling is required.

COOL-UNLOAD

The control temperature is below the cooling target zone and the temperature is falling at a rate of change greater than setpoint StageROC LPx, #22, 44, 64 or 86. The number of stages of cooling wanted will be reduced by one.

COOL-ROC UNLDG

The control temperature is below the cooling target but within the control zone and the temperature is falling at a rate of change greater than setpoint StageROC LPx, #22, 44, 64, 86 or 108. The number of stages of cooling wanted will be reduced by one.

COOL-LOADING

The control temperature is above the cooling target zone and the temperature is not falling at a rate of change greater than setpoint StageROC LPx, ##22, 44, 64, 86 or 108 **or** the control temperature is above the cooling target but within the control zone and the temperature is not moving toward the cooling target. The number of stages of cooling wanted will be increased by one.

These states are active when the loop is in a heating mode.

HEAT- HOLDING

The control temperature is below the heating target but within the zone and the temperature is relativity stable. No change to the number of stages of heating is required.

HEAT -ROC HOLDG

The control temperature is below the heating target but within in the heating zone and the temperature is increasing **or** the control temperature is below the heating target zone and the temperature is increasing at a rate of change greater than setpoint StageROC LPx, #22, 44, 64, 86 or 108 **or** the control temperature is above the heating target but within in the heating zone and the temperature is decreasing. No change to the number of stages of heating is required.

HEAT -TMP HOLDG

The control temperature is below the heating target but within the zone and the temperature is not decreasing and the control temperature is within two degrees of the heating target. No change to the number of stages of heating is required.

HEAT -UNLOAD

The control temperature is above the heating target zone and the temperature is not falling. The number of stages of heating wanted will be reduced by one.

HEAT -ROC UNLDG

The control temperature is above the heating target but within the control zone and the temperature is increasing at a rate of change greater than one half of the setpoint StageROC LPx, #22, 44, 64, 86 or 108. The number of stages of heating wanted will be reduced by one.

HEAT -LOADING

The control temperature is below the heating target zone and the temperature is not increasing at a rate of change greater than setpoint StageROC LPx, #22, 44, 64, 86 or 108or the control temperature is below the heating target but within the control zone and the temperature is not within 2 degrees of the heating target and the control temperature is not increasing. The number of stages of heating wanted will be increased by one.

MAKING ICE

The ice making option has been selected for this loop and the ice making stage(s) are on. Refer to this option for more details. The system will allow only one ice making sequence per scheduled on. When an ice making sequence begins and ends, a message indicating this action will be generated.

8. Setpoint Definitions

8.1. Setpoint elements that can be viewed:

1) Number - the number is from 1 to 120, maximum number of setpoints that are supported. Only active setpoints will be displayed.
2) Name - the setpoint's name consists of up to 12 alphanumeric characters. The name is displayed following the number on the first line of the LCD display. The name of the setpoint can be changed to make it meaningful to the given application. **HOWEVER** the function of the setpoint will remain the same.
3) Value - this is the value or target of a setpoint. This value is displayed on the second line of the LCD display. With the proper authorization this value can be changed within limits that have been established by the PC-Config program.
4) Time - this is the time that the setpoint must be true before it will trip. E.g. a high discharge safety must have its value exceeded for this length of time before it will trip. This time is always in seconds and it is not displayed on the LCD and can only be seen via the PC-Connect program, it can be changed in both the PC-Connect and the PC-Config program.
5) Type - the type indicates the action that will be taken.

A list of setpoints and all their elements can be obtained from the PC-Config program.

8.2. Setpoint Types:

There are three different types of setpoints. The type determines the action that the system will take.

8.2.1. SETPOINT

This type of setpoint's value contains a target or provides information for some type of action. The time element in this type is not used. Examples are the setpoints defined in sections 12.1 through 12.7.

8.2.2. LOCKOUT

This type of setpoints value contains a safety level and the time that the safety must be violated before the safety will trip. Once a safety has tripped the system will take the appropriate action, shutting down the entire package or an individual circuit (compressor) depending on the purpose of the safety. The system will then wait the safety down time contained in that setpoint before trying to return the system to normal. If successful, the system will continue to operate. If a second trip occurs on the same setpoint with in the lock out delay time that is contained in that setpoint the system will move to a LOCKOUT state. **IF THE LOCKOUT DELAY TIME IS SET TO ZERO THE LOCKOUT WILL OCCUR ON THE FIRST TRIP.** This will require manual intervention to reset the system. With each safety trip, the system will generate an alarm; refer to Alarms and Safeties section of this manual.

The safety down time and the lock out delay time are unique for each setpoint. They cannot be viewed in a live unit. They are set in the PC-Config program.

8.2.3. ALARM

This type is similar to the LOCKOUT setpoint except it will never cause a lock out. The system will continue to try to return to normal operation after waiting the safety down time. An ALARM setpoint type will never require manual intervention to reset the system.

9. Setpoints for MGR 10 Algorithm

9.1. Control Setpoints #1-10 (apply to all loops)

1	OVERIDE TIME	This is the time expressed in minutes that the loop override will be in effect. If the over ride indicator is a momentary type switch, then the loop will be placed in an over ride state for this period of time. . If the over ride indicator is a switch that remains on, the loop will be placed in an over ride state as long as the indicator is on and once off, it will remain in that state for the time contained in this setpoint.
2	AMB OFF TEMP	If the loop points to an ambient temperature sensor; three options are available: 1) LOW/LOOP OFF; if the loop is on and the ambient temperature drops below this value, all heating or cooling/ice making stages will be turned off and followed by the pumps or fans being turned off. This is to prevent the loop from freezing. Loop state will be LOOP OFF AMB. 2) LOW/RUN PUMP; if the loop is off and the ambient temperature drops below this value, the pumps in the loop will be turned on. This is to prevent the loop from freezing. Loop state will be LOOP AMB/PUMPS. 3) NONE; no special action will be taken based upon ambient temperature.
3	PUMP ANTICYC	Delay, expressed in seconds, for each pump or fan when it is turned off before it can be restarted. The individual pump or fan state will be ANTI-CY. Once this time is pasted, the individual pump or fan state will be OFF and the pump or fan is ready to be started if needed.
4	ICETempHIGH	This setpoint must be active if any of the loops have the ICE MAKING option with control on Temperature. The cool control temperature sensor must be greater than the value of this setpoint plus the value of set point 18, 40, 62, 84 or 106, ChilCOOL TRG, before the loop will turn on any stages of ice making. Once on, the stages will remain on until the temperature drops below the ChilCOOL TRG minus the ChilCTL Zone setpoint values for that loop. Note only one ice making cycle per schedule on will be allowed.
5	ICELevelFULL	This setpoint must be active if any of the loops have the ICE MAKING option with control on Level. When the ice level sensor is greater than the value of this setpoint the loop will turn off all stages of ice making. Stages will remain off until the ice level sensor is less than the value of setpoint #6 ICELevelLOW. Note only one ice making cycle per schedule on will be allowed.
6	ICELevelLOW	This setpoint is the indicator that the ice level is low. See setpoint #5.
7	Lo AMP FAULT	This value is a percentage of the FLA amps. All loops will use this value to determine if a low amp condition is encountered.
8	Hi AMP FAULT	This value is a percentage of the FLA amps. All loops will use this value to determine if a high amp condition is encountered.
9	ROC INTERVAL	Time span, expressed in seconds, that is used in calculated the slope of the control temperature sensor. Usually set to 60 seconds.

10	PmpOnOffDely	Delay, expressed in seconds, that the pump or fan state timer must exceed once a pump or fan has been turned on before the first stage of heating or cooling/ice making can be turned on. When all stages of either heating or cooling/ice making have been turned off, the stage state timer must exceed this value before any pumps or fans can be turned off. The purpose of this delay is to ensure that there is flow before turning on stages of heating or cooling/ice making and also to ensure that there is flow after turning off stages of heating or cooling/ice making.

9.2. Control Setpoints #11- 120 (loop setpoints)

(These setpoints apply to the individual loops, there are 22 unique setpoints per loop, and these will be repeated for the other loops. Since each loop can be named it is suggested that the setpoints names relate to the loop name. For example, a loop with the name of BLDG LP1 may have the name of each setpoint start with BLD. A sample of the configuration file for Edgewood School is contained in the appendix)

9.3. Control Setpoints #11- 32 for loop 1

These setpoints will be repeated for the other loops:

LOOP 2 Setpoints #33-54
LOOP 3 Setpoints #55-76
LOOP 4 Setpoints #77-98

Use the column headers to determine the loop.

9.4. Control Setpoints #11- 16 (only required for pump or fan variable speed)

#4	#3	#2	#1	NAME	DESCRIPTION
77	55	33	11	PumpVS TRG1	Control target for variable speed pump or fan.
78	56	34	12	PumpVS Zone1	This value is added to and subtracted from the control target to create the control target zone.
79	57	35	13	PumpVSDelay1	Delay, expressed in seconds, between calculating the desired pump or fan speed. This value is only displayed in the MISC GRID of the STATUS screen on PC-Connect.
80	58	36	14	PumpVS Min1	This is the minimum speed of the variable speed for the pump or fan. When a pump or fan is started, it speed is set to this value. Before a pump or fan is turned off, its speed must be reduced to this value.
81	59	37	15	PumpVS Max1	This is the maximum speed of the variable speed for the pump or fan.
82	60	38	16	PumpVS Adj1	This is the maximum adjustment, either increase or decrease, that can be made to the speed of the variable speed for the pump or fan.

9.5. Control Setpoint #17 (only required for pump with an amp sensor)

#4	#3	#2	#1	NAME	DESCRIPTION

83	61	39	17	PumpFLA Amps	The value of this setpoint contains the Full Load Amp drawn for all pumps or fans that are on the associated loop. All pumps or fans on a loop will use the same FLA setpoint. Setpoint #7, Lo AMP FAULT and set point #8, Hi AMP FAULT will be used to test for low and high amp draw when a pump or fan is on.

9.6. Control Setpoints #18-22 (control for heating-cooling stages)

#4	#3	#2	#1	NAME	DESCRIPTION
84	62	40	18	COOL TRG LP1	Control target for cooling temperature on this loop.
85	63	41	19	HEAT TRG LP1	Control target for heating temperature on this loop.
86	64	42	20	StageZoneLP1	This value is added to and subtracted from the cooling control target to create the control target zone for cooling. This value is also added to and subtracted from the heating control target to create the control target zone for heating.
87	65	43	21	StageDelyLP1	Delay, expressed in seconds, between interrogating the status of the pumps and the cooling and heating stages.
88	66	44	22	StageROC LP1	This is the maximum slope of the control temperature for both the cooling and heating stages. This slope is used to for both positive (temperature increasing) and negative (temperature decreasing) slopes. This is used to determine if the temperature is moving away from the target too rapidity, require reduction in number of stages, or is moving toward the target at a sufficient rate, hold the number of stages constant.

9.7. Control Setpoints #23- 25 (control for heating-cooling VFD)

#4	#3	#2	#1	NAME	DESCRIPTION
89	67	45	23	StageVS Min1	This is the minimum speed of the variable speed for both the cooling and heating variable speed. When a stage of either cooling or heating is started, the speed is set to this value. **Only required if variable speed, Analog Output, has been specified for this loop.**
90	68	46	24	StageVS Max1	This is the maximum speed of the variable speed for both the cooling and heating variable speed. The variable speed is increased to this value before the next stage of either cooling or heating can be started. **Only required if variable speed, Analog Output, has been specified for this loop.**

91	69	47	25	StageVS Adj1	This is the maximum adjustment, either increase or decrease, that can be made to the speed of the variable speed for either the cooling and heating stages. **Only required if variable speed, Analog Output, has been specified for this loop.**

9.8. Control Setpoints #26- 29 (schedules, two per loop, used with DoW SCH/ON option)

#4	#3	#2	#1	NAME	DESCRIPTION
92	70	48	26	Sch1 On LP1	Starting time for the first schedule for this loop. The schedule is expressed in military time. For example: start at 6:45AM would be entered as 0645: start a 2:00PM would be entered as 1400. **This schedule will not be tested, always true, if this setpoint is inactive.**
93	71	49	27	Sch1 Dur LP1	Duration of the first schedule for this loop is expressed in minutes. If a schedule is to be true for 5 hours, then 300 will be entered. Note the schedule can cross mid-night. For example if a schedule is true from 7:00AM until 5AM of the next day: Sch1 On LP1 is 0700 and Sch1 Dur LP1 is 1320. The duration is for 22 hours or 1320 minutes.
94	72	50	28	Sch2 On LP1	Starting time for the second schedule for this loop. The schedule is expressed in military time. For example: start at 10:05AM would be entered as 1005: start a 10:10PM would be entered as 2210. **This schedule will not be tested, always true, if this setpoint is inactive.**
95	73	51	29	Sch2 Dur LP1	Duration of the second schedule for this loop is expressed in minutes. If a schedule is to be true for 3 hours and 15 minutes, then 195 will be entered. Note the schedule can cross mid-night. For example if a schedule is true from 11:00PM until 6:15AM of the next day: Sch2 On LP1 is 2300 and Sch2 Dur LP1 is 435. The duration is for 7 hours and 15 minutes or 435 minutes.

9.9. Control Setpoints #30- 32 (loop testing)

#4	#3	#2	#1	NAME	DESCRIPTION

96	74	52	30	HiTankTmpLP1	If the tank temperature exceeds this value for the time specified in this setpoint, the alarm relay output will be turned on and an error message indicating this condition will be generated. If this condition occurs there will be no change to the loop status or state. **This setpoint will only be tested if the loop contains a tank temperature sensor and this setpoint is active.**
97	75	53	31	No Flow LP1	If the pump or fan has a fault sensor, normally indicating flow, and it drops below this value, or if pump or fan fault sensor is a digital input and it is on, for the time contained in the safety time of this setpoint a pump or fan failure has occurred. The pump or fan will be locked off and the individual pump or fan state will indicate failed, the number of pumps or fans on will be reduced by one and if there are more available pumps or fans in the loop, one will be started. Note, the pump or fan state will not be changed. **This setpoint will only be tested if the loop contains pumps or fans with a flow sensor.**
98	76	54	32	TankLow LP1	If the tank level indicator is on, indicates a low level for a time that exceeds time specified in this setpoint safety time, the alarm relay output will be turned on and an error message indicating this condition will be generated. . If this condition occurs there will be no change to the loop status or state. **This setpoint will only be tested if the loop contains a tank level sensor.**

9.10. Control Setpoints #33- 54 for loop 2

For definition of setpoint #33…. #54 refer to column header #2

9.11. Control Setpoints #55- 76 for loop 3

For definition of setpoint #55…. #76 refer to column header #3

9.12. Control Setpoints #77- 98 for loop 4

For definition of setpoint #77…. #98 refer to column header #4

9.13. Control Setpoints #99- 120 for Plant Manager

99	LP1Start MCS	This is the network address of the first MCS-8 controller that will be controlled by loop 1.

100	LP1 # MCS	This is the number of MCS-8 controller that will be controlled by loop 1. If there are no MCS-8s for this loop this value must be set to zero. If not zero: A class 55 message will be created and sent to the number of controllers indicated starting with network address contained in setpoint #99.
101	LP1Steps Max	If this setpoint is active: The value of this setpoint will be passed to the MCS-8s via the class 55 message. If this setpoint is inactive: The maximum number of steps that the MCS-8s may turn on will be based upon Plant Manager's calculation.
102	LP1 Var Comp	If the MCS-8 has variable capacity this value must be set to zero. The Plant Manager will dynamically built the maximum capacity that the MCS-8s are allowed to reach.
103 106	Loop2	Setpoints #99- #102 are repeated for loop 2
107 110	Loop3	Setpoints #99- #102 are repeated for loop 3
111 114	Loop4	Setpoints #99- #102 are repeated for loop 4
115 118	Spare	Not used at this time
119	TimeToWait	Load Delay Seconds. This set point defines the number of seconds before reacting to an increase in the specified load limit. If this setpoint is inactive, the system will default to 120 seconds. Note, the system will react to a decrease in the specified load whenever it occurs.
120	Demand Limit	If demand limiting is used, time expressed in seconds before reacting to changes in the demand limiting sensor value.

10. AUTHORIZATION FUNCTION

The authorization code is a special four-character code that enables access in to the MCS-8 system. The code must be numeric with values between 1 and 8 if it is to be entered from the Keypad/Display. If the system is being accessed via PC-Connect program, the code may consist of any valid alpha/numeric characters. Each system can have up to 15 different authorization codes. This provides the capability of issuing different codes to different people if desired. There are four levels of authorization, which provide different capabilities with in the system. The authorization code and the associated level cannot be displayed or viewed in an MCS-8 system. These are established when building the configuration file in the PC-Config program. The authorization codes must be protected and remain confidential, if they are compromised unauthorized personnel can gain access to the system.

From the Keypad/Display the following changes can be made based upon the authorization level:

FUNCTION	VIEW	SERVICE	SUPERVI-SORY	FACTORY
SENSOR OFFSETS	NO	YES	YES	YES
SENSOR DIAGOSTICS	NO	YES	YES	YES
CLEAR ALARM HISTORY	NO	NO	NO	YES
CLEAR POINT INFORMATION	NO	NO	NO	YES
DATE & TIME SET	YES	YES	YES	YES
DAY OF WEEK SET	YES	YES	YES	YES
CHANGE NO FLOW LOCKOUT OR SHUT DOWN	NO	NO	NO	YES
CHANGE ROTATE YES OR NO	NO	NO	NO	YES
CHANGE MANUAL/AUTO SETTINGS	NO	NO	YES	YES
CHANGE SETPOINT VALUES*	NO	YES	YES	YES
CHANGE OPERATING SCHEDULES	NO	YES	YES	YES
CHANGE HOLIDAY DATES	NO	YES	YES	YES
LOCK OUT RESET	YES	YES	YES	YES

*Note - before a setpoint can be changed the setpoint must be able to be viewed.

11. MCS-8 Alarms and Safeties

11.1. Introduction

There are three types of alarms that are generated by the MCS-8 control logic:

- Information only alarms,
- MCS-8 system alarms and
- Chiller setpoint safety alarms.

All of the alarms have the same format. The alarm is identified and it is date time stamped. Alarms can be viewed from the MCS-8 by pressing the ALARM STATUS (4) key or from the PC-Connect program.

11.2. Information only alarms

11.2.1. System generated alarms

The following alarms are generated to provide information; they will not cause a change in the control algorithm such as a lock out condition or a relay output being forced off.

- POWER FAILED
- POWER RETURNED
- COMPUTER RESET
- LCD FAILURE
- HW DATE INVALID
- HW TIME INVALID
- SW DATE INVALID
- SW TIME INVALID
- RAM INTEGRITY
- WATCHDOG RESET

11.2.2. Alarms as a result of individual action

The following alarms indicate that an individual took action:

- ALARMS CLEARED
- STPT CHANGED
- RO MANUAL
- AO MANUAL
- SI MANUAL
- POINT INFO CLEAR
- CLOCK SET
- CFG DOWNLOADED

11.2.3. Alarms generated by the control algorithm

The following alarms indicate that the control algorithm took action:

- ROTATED LEAD
- DAYLIGHT SAVINGS

11.3. MCS-8 system alarms

11.3.1. Alarms are generated by the MCS-8 control algorithm:

11.3.1.1.Configuration problem alarms

These alarms indicate a problem with the configuration file that has been loaded into the system. The system is not operational, a configuration must be transmitted to the unit form PC-Connect or the config chip must be replaced with a valid one.

- INVALID CONFIG. (Check sums are incorrect)
- INVALID CFG VER (version number of the configurator is invalid)
- INVALID CFG TYPE (the type does not agree with software, chiller software with a home unit configuration)

11.3.1.2.MCS local network problem alarms

These alarms indicate problems with the MCS local network, the system can be accessed but the system is in a lock out state, LOST I/O.

- MCS-I/O 1 LOST
- MCS-I/O 2 LOST
- MCS-I/O 3 LOST
- LOST IO SHUTDOWN

11.3.1.3.Key sensors problem alarms

This alarm indicate a problem with a key sensor, it is either shorted or open. The alarm will contain ALARM followed by the 8-character name of the sensor.

The following sensors related to the entire system are tested:

- Leaving liquid, if failed: lock out the chiller system
- Returning liquid, if failed: alarm only no lock out
- Ambient temperature, if failed: alarm only no lock out

The following circuit sensors are tested. If they fail that circuit only is locked out.

- Suction pressure and temperature
- Discharge pressure and temperature
- Oil pressure and temperature
- Motor temperature (if it is an analog input device)

11.3.1.4.EMERGENCY STOP alarm

This alarm indicates that the emergency stop switch has been turned on. The system can be accessed but the entire system is in a lock out state.

- EMERGENCY STOP

11.4. Setpoint safety alarms

11.4.1. Introduction

The MGR 10 algorithm incorporates a number of safety checks to ensure that the various components that make up the control package are not damaged. These types of safeties are based upon setpoints. When a safety trips for the first time, the pump or fan will be set to “SAFETY TRIPPED” state. The pump or fan will remain in “SAFETY TRIPPED” state for ten minutes and then move to the “PMP OFF” state where the pump or fan will be allowed to run if required. If the same safety trips occurs again within two hours of the first trip, the compressor will be set to “FAILED state, which requires a manual reset to restart

the pump or fan. In this matter the MGR 10 attempts to take corrective action to protect the compressors but avoid nuisance trips.

The time in the safety state and the time between safeties are specified in the individual setpoints. This enables the times to be unique for each lock out setpoint.

For a safety to be interrogated, both the associated sensor input and the lockout setpoint must be active. If a safety trips, the alarm name will consist of the setpoint name plus additional identification such as point number or circuit number if applicable.

The system exercises “smart” safety testing in the following manner:

The time in the safety state and the time between safeties are specified in the individual setpoints. This enables the times to be unique for each lock out setpoint.

11.4.2. Lost of Flow

When a pumps or fans are on, the flow for that loop will be check every second. Each pump or fan on the loop will have an associated fault indicator input. This input can be either a digital indicating a fault if it is on or an analog indicating the pressure. If multiple pumps or fans on a circuit, each pump or fan will be checked.

If the flow indicator is a digital input, if it is on for longer than the time specified in setpoint # 111 – 115, No Flow LPx, an alarm will be generated and that individual pump or fan on the loop will be placed in a safety state.

If the flow indicator is an analog input, if it is value is less than the value in setpoint # 111 – 115, No Flow LPx, for longer than the time specified, an alarm will be generated and that individual pump or fan on the loop will be placed in a safety state.

If a pump or fan is turned off, and there is another available pump or fan, that pump or fan will be started.

11.4.3. Tank Low Level

If a loop contains a tank low-level sensor, then if this sensor indicates a low level, it is on for longer than the time specified in setpoint # 116 – 120, TankLow LPx; the system will generate low-level alarm for that loop. This is an informational message only. The status of the loop will not be changed.

11.4.4. Tank High Temperature

If setpoint #30, 52, 74, 96or 118, HiTankTmpLPx, is active and the tank temperature is greater than this value for longer than the time; the system will generate high tank temperature alarm for that loop. This is an informational message only. The status of the loop will not be changed.

12. MCS Control States Quick Reference – MGR 10 .00 Software

Control States tell the user the system's status; this information is critical.

UNIT CONTROL STATES

STATE	DESCRIPTION
UNIT IN POWER UP	System Reset or Power Returned.
UNIT IN LOCKOUT	Emergency Stop SI is ON (STOP) Unit will not run.
UNIT IN I/O LOST	Lost communications with an I/O board of some type.
UNIT IN NORMAL RUN	Unit is normal-loops will run.

LOOP CONTROL STATES

STATE	DESCRIPTION
LOOP STOP SW	Loop is stopped, RUN/STOP indicator being off (STOP).
LOOP STOP SCH	Loop is stopped, schedule being false, RUN/STOP indicator is on (RUN).
LOOP STOP PEAK	Loop is stopped. RUN/STOP is on / peak off and peak hour.
LOOP POST PEAK	Loop is stopped / peak off and in hour after peak hour.
LOOP PRE PEAK	Loop is stopped / peak off, next hour is a peak hour.
LOOP NORMAL	Loop is running normal. RUN/STOP is on the schedule is true,
LOOP OVERRIDE	Loop was stopped but OVERRIDE is on, running.
LOOP LOW AMB	Loop was stopped ambient temp is too low, run pumps only.
LOOP STOP AMB	Loop was running ambient temp is too low -stop the loop.

PUMP/FAN CONTROL STATES

STATE	DESCRIPTION
ALL PUMPS OFF or ALL FANS OFF	All pumps/fans in the loop are off.
PUMPS LOADING OR FANS LOADING	Pumps/fans wanted is greater than pumps on, trying to turn on another pump.
MAX PUMPS ON or MAX FANS ON	All pumps/fans in the loop that are allowed on are on.
PMPS UNLOADING or FANS UNLOADING	Pumps/fans wanted less than pumps/fans on, trying to turn off a pump/fan.

INDIVIDUAL PUMP/FAN STATES

STATE	DESCRIPTION
FAILED	Pump or fan has failed. Its relay output is locked off.
ANTI-CY	Pump or fan turned off, must wait until it can be turned back on.
OFF	Pump or fan turned off; ready to be turned on when the loop needs it.
ON	Pump or fan is on.

HEATING/COOLING STATES

STATE	DESCRIPTION
ALL STAGES OFF	No stages of heating or cooling are on.
COOL- HOLDING	In cooling mode and with in the control target zone. No change.
COOL- ROC HOLDG	In cooling mode and control temperature ROC is moving toward target zone.
COOL- TMP HOLDG	In cooling mode and control temperature is with in target zone. No change.
COOL- TMP HOLDG	In cooling mode and control temperature is with in target zone. No change.
COOL- UNLOAD	In cooling mode and the control temperature is too low. Turn off one stage
COOL- ROC UNLDG	In cooling mode and control temp is with in target zone but it is moving away too fast. Add one stage.
COOL-LOADING	In cooling mode. Control temp is too high or not moving toward target.
COOL-LOADING	In cooling mode. Control temp is too high or not moving toward target.
HEAT- HOLDING	In heating mode and with in the control target zone. No change.
HEAT- ROC HOLDG	In heating mode and control temperature ROC is moving toward target zone.
HEAT- TMP HOLDG	In heating mode and control temperature is with in target zone. No change.
HEAT- UNLOAD	In heating mode and the control temperature is too high. Turn off one stage
HEAT- ROC UNLDG	In heating mode and control temp is with in target zone but it is moving away too fast. Add one stage.
HEAT-LOADING	In heating mode and control temperature is too low or not moving toward target. Add one stage.

	MAKING ICE	The loop is making ice.

13. OEM Factory Checkout Procedure

13.1. Visual Check

- 120 VAC power wiring
- Jumper settings
  - Sensor input
  - Address
  - MCS communication termination
  - EEPROM write protection
- Sensor Wiring
- MCS-IO Communication Wiring
- LCD Connector (dot to mark on the board)
- Keypad Connector (dot to mark on the board)
- Chips
  - Master software and chip
  - I/O software
- RO Wiring

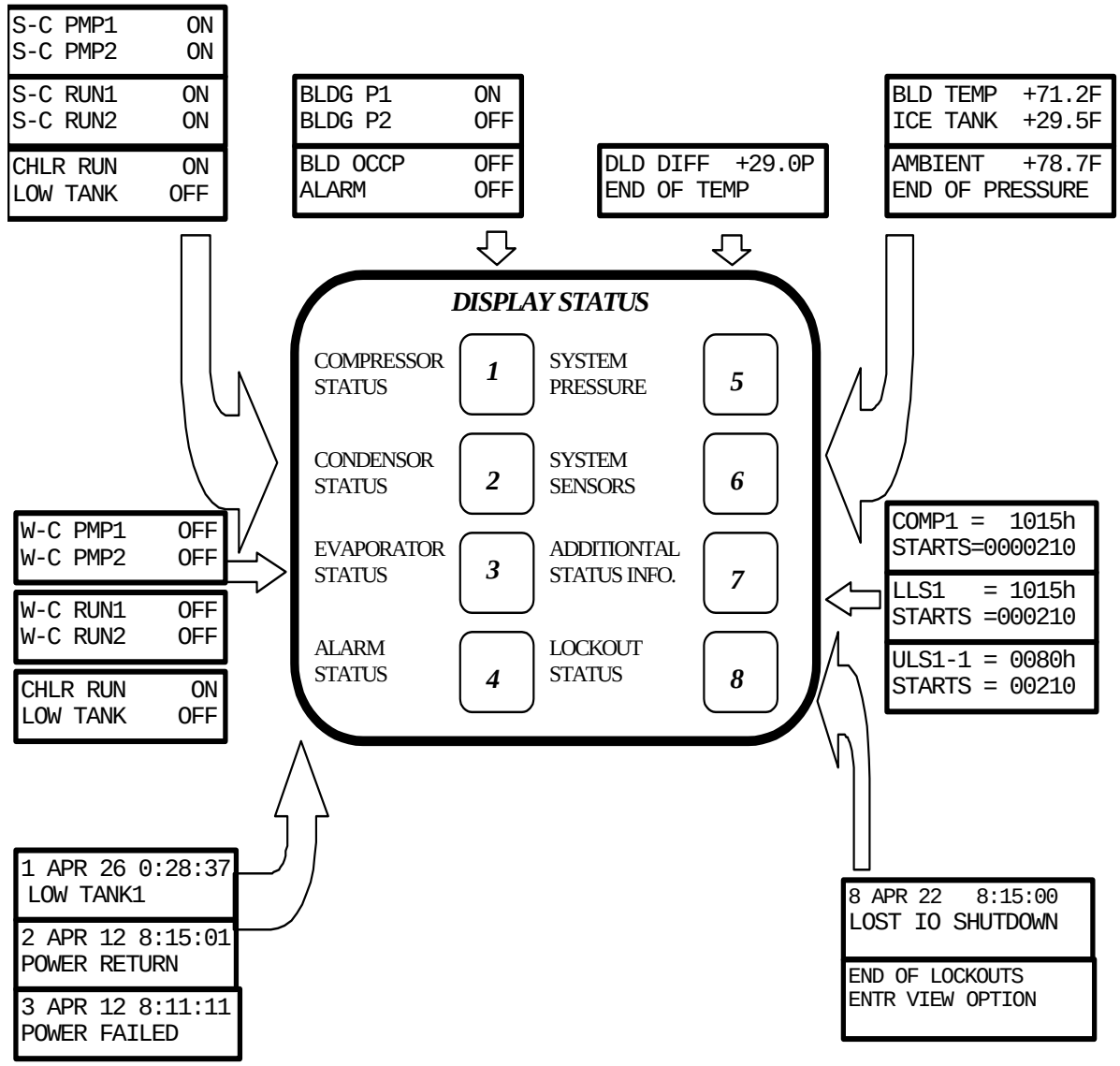
Ensure that the EMG stop is on (closed position) or run/stop input off so that the unit will not run after power applied to micro.

13.2. Mcs Power On (Compressor Power off)

- MCS System on
- LCD on and valid display - “MCS Initialization” then default screen
- Communications light blinking if I/O units
- Get AUTHORIZED
- Check board version number: SERVICE DIAGNOSTICS/UNIT INFORMATION/HARDWARE VERSION/ENTER (if change is required)
- Check sensor readings
- Manually bump (on then off) each point (take care your in control)

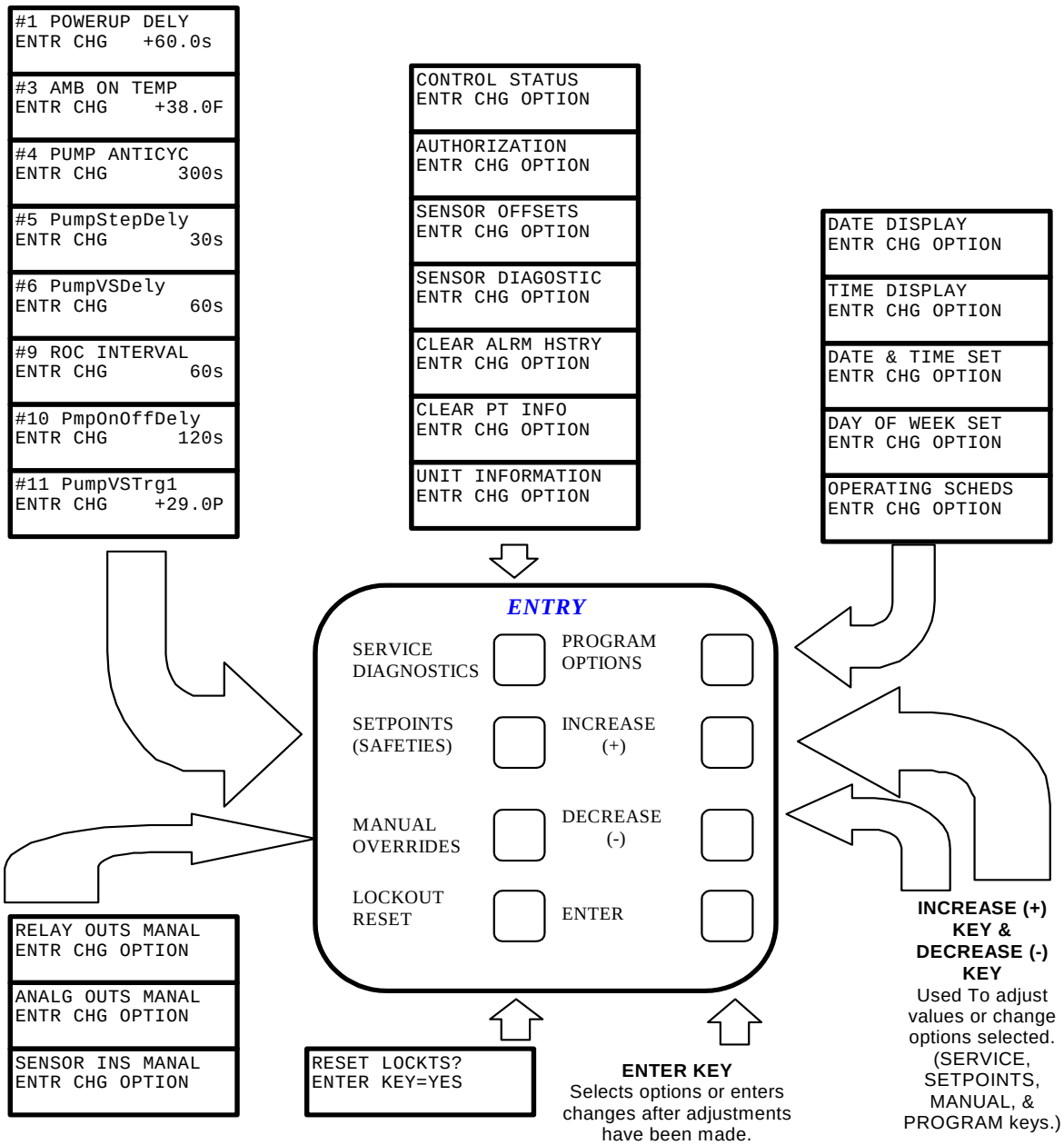
14. The Micro Control Center Keypad Display Quick Reference- *STATUS KEYS*

- No authorization is required in the DISPLAY STATUS section for viewing information.
- Pressing a key selects the 1st two lines of data. Repressing the same key selects the next two lines, etc.
- The ALARM STATUS displays all alarms and lockouts while LOCKOUT STATUS displays only active lockouts.
- The "+" and "-" keys may be used with alarm & lockout status to allow scrolling.
- The items displayed when COMPRESSOR STATUS, CONDENSOR STATUS, EVAPATOR STATUS, SYSTEM PRESSURE OR SYSTEM TEMPERATURE are setup when the configuration file is built.
- LOCKOUT STATUS for lockouts caused by either suction discharge oil or amps, the actual value at the time of the lockout of the associated sensor is displayed.



15. The Micro Control Center Keypad Display Quick Reference- *ENTRY KEYS*

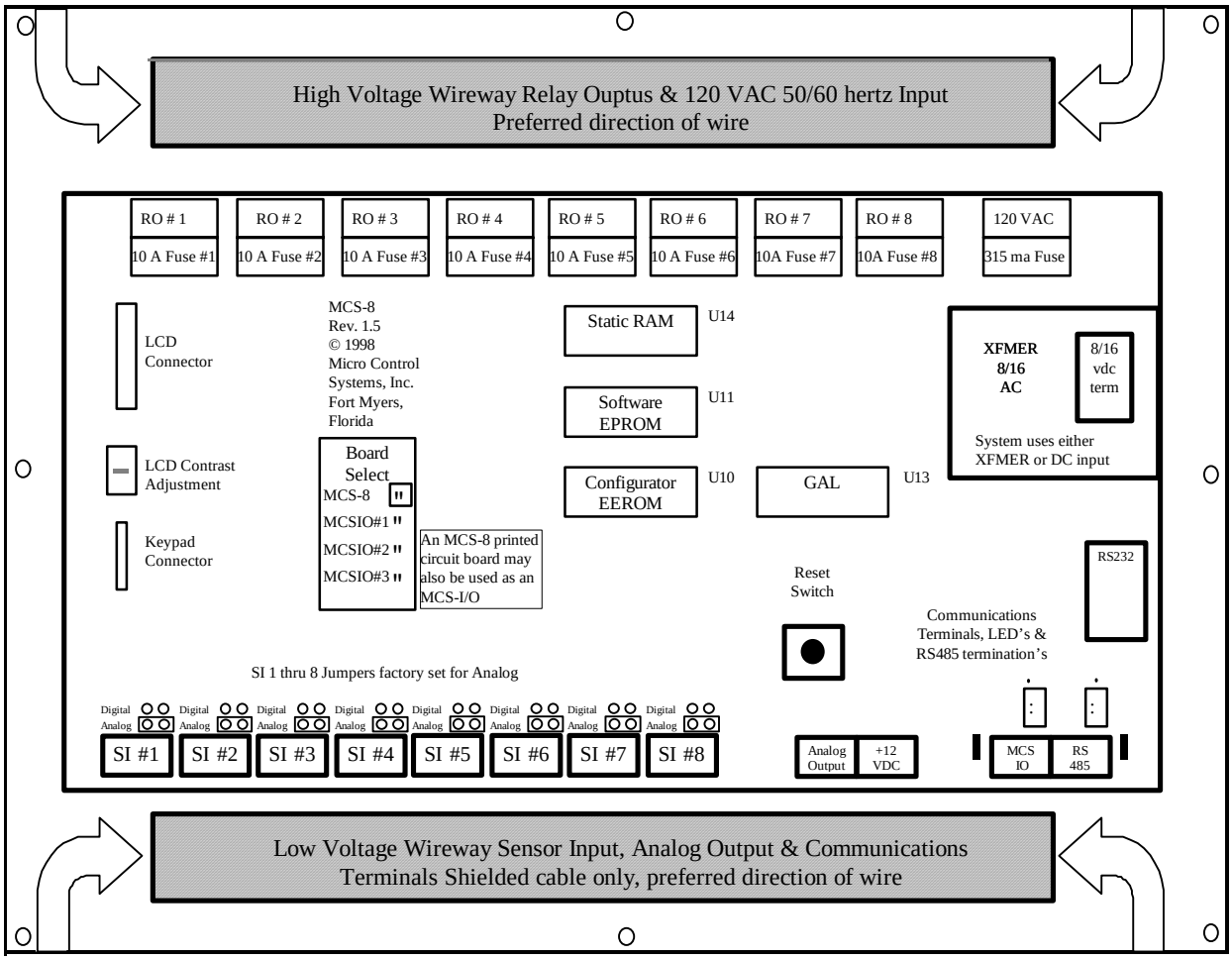
- The ENTRY keys (SERVICE, SETPOINT, MANUAL and PROGRAM) provide menu items, some of which when selected will present sub menus.
- When making value changes the INCREASE (+) & DECREASE (-) keys may be held for continuous updating.
- Different items will appear depending on the package configuration and options selected.
- Units may be English or Metric.
- The clock is factory set at EST or EDST based on time of year.
- Enter authorization code at the authorization function within the SERVICE DIAGNOSTIC key menu.



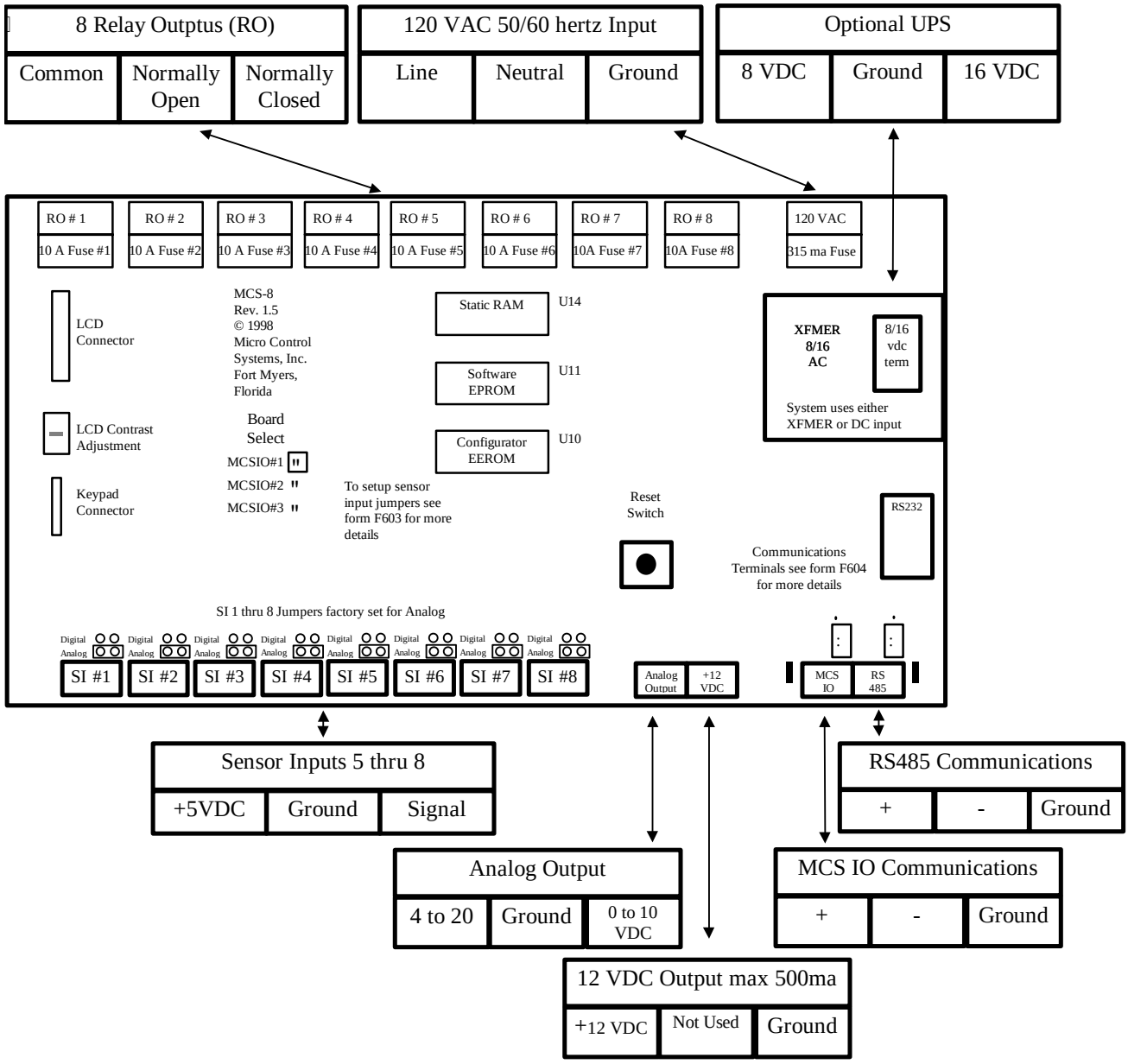
16. The Micro Control Center MCS-8 & I/O Quick Reference Sheet

Wiring Guide Notes

- Relay Outputs (RO) 120 VAC 10 amps.
- SI 1-4 factory set for 4 wire differential inputs. (0 to 100 milla volts dc)
- SI 5-8 factory set for MCS-T100 temperature inputs. (0 to 5 volts dc)
- All analog inputs must have shield tied to GND.
- MCS-8 factory set address to MCS-8.
- MCS-I/O factory set address to MCSIO address 1.
- Detail of MCS-8 and I/O items next page.



17. Details of MCS-8 & I/O Key Items

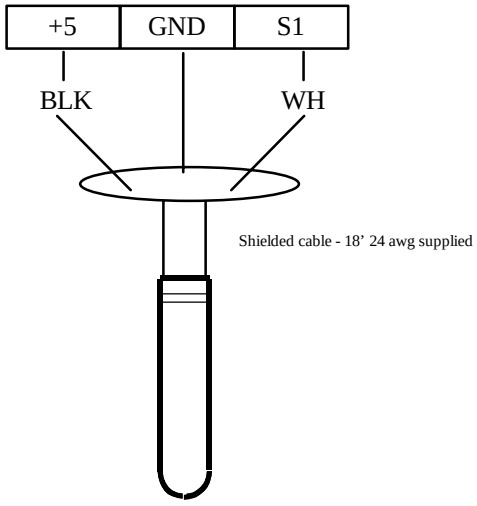


18. The MCS Sensors Quick Reference Sheet– Temp./Humd. Sensors

MCS-T100 (SI #1 through 8, REV 1.5 & higher)

1. Connects to 1 of MCS Sensor Inputs 1through 8
2. Shielded cable GND drain must be connected to SI 'GND'
3. Temp MCS-8 SI (inputs 1-8) jumper setting is 'ANALOG'

MCS Sensor Input Terminal Strips

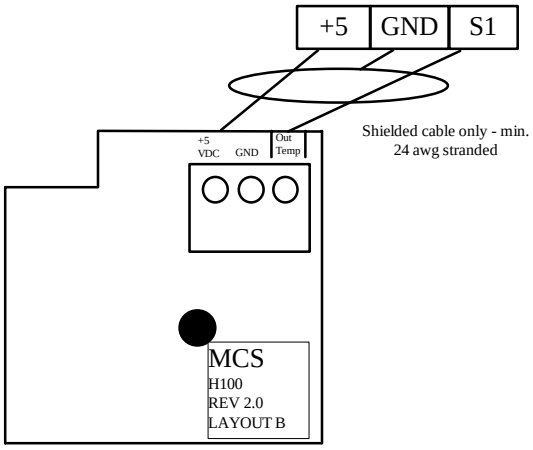


MCS-T100

MCS-ZONE (SI #1 through 8, REV 1.5 & higher)

1. Connects to 1 of MCS Sensor Inputs 1 through 8
2. Shielded cable GND drain must be connected to SI 'GND'
3. Temp MCS-8 SI (inputs 1-8) jumper setting is 'ANALOG'

MCS Sensor Input Terminal Strips
SENSOR (x)

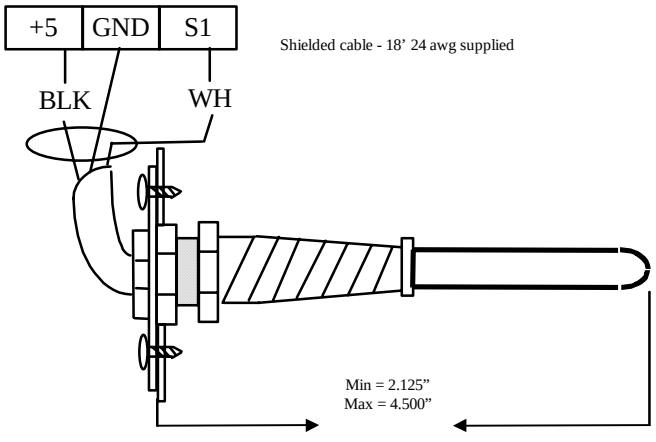


MCS-ZONE

MCS-SAIR (SI #1 through 8, REV 1.5 & higher)

1. Connects to 1 of MCS Sensor Inputs 1through 8
2. Shielded cable GND drain must be connected to SI 'GND'
3. Temperature MCS-8 SI (input 1-8) jumpers setting to Analog'
4. Minimum extension inside duct 2.25"
5. Normal extension, as shown, 4.00".

MCS Sensor Input Terminal Strips

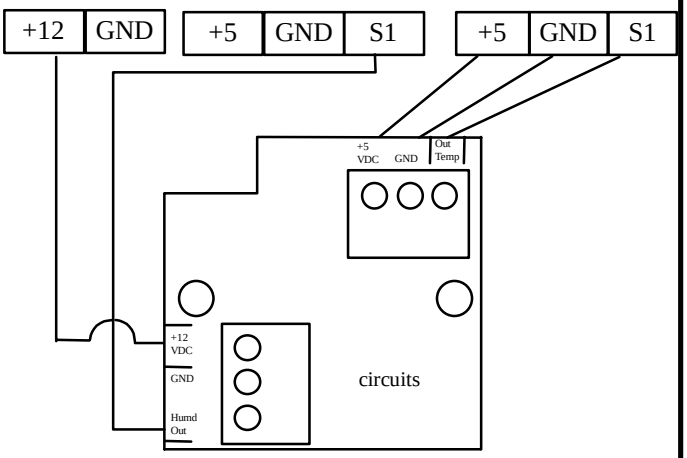


MCS-SAIR

MCS-HUMD (SI #1 through 8, REV 1.5 & higher)

1. Connects to 2 of MCS Sensor Inputs 1 through 8
2. Humidity MCS-8 SI (input 1-8) jumper setting is ANALOG'
3. +5 vdc & GND are common (only one connection required)
4. Temp. MCS-8 SI (input 1-8) jumper setting is 'ANALOG'
5. Shielded cable GND drain must be connected to SI 'GND'

MCS Sensor Input Terminal Strips
+12 OUT SENSOR (x1) SENSOR(x2)



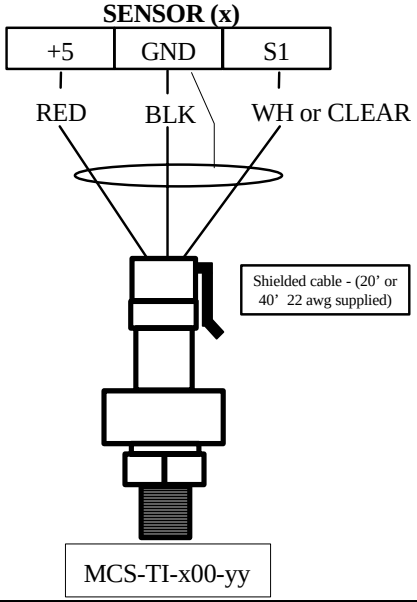
MCS-H100

19. The MCS Sensors Quick Reference Sheet - Pressure Sensor & Digital inputs

MCS-TI-500-xx (SI #1 thru 8, REV 1.5 & higher)

1. MCS-TI-500-xx pressure transducer (3 wire 0-5 vdc)
2. Wiring for 3 wire to SI# 1 through 8
3. Jumper settings for SI# 1 through 8 is 'ANALOG'
4. Pressure range 0 - 500 psi

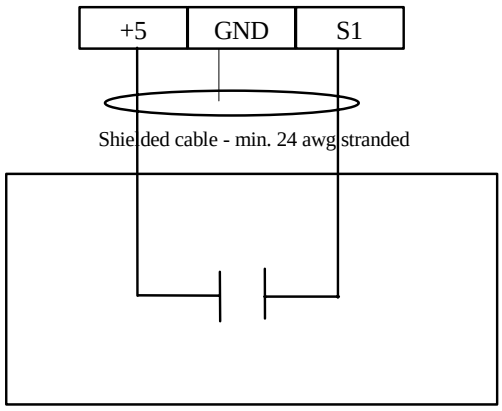
MCS Sensor Input Terminal Strips
SENSOR (x)



Dry Contact's (SI#1 through 8, REV 1.5 & higher)

1. Digital inputs for use on sensor inputs (SI 1-8)
2. Dry Contact MCS-8 SI (input 1-8) jumper setting is 'DIGITAL'
3. Verify with sensor diagnostic under service on keypad
4. Shielded cable GND drain must be connected to SI "GND"

MCS Sensor Input Terminal Strips
Sensor (x)

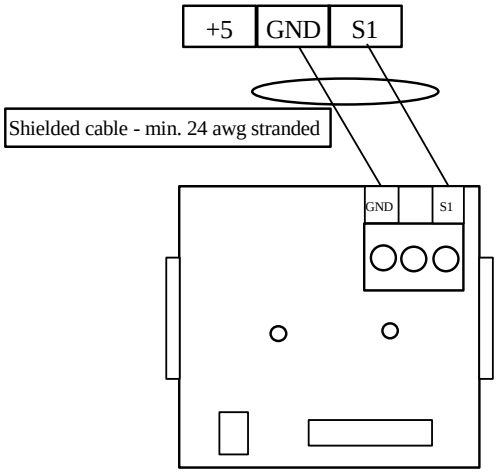


MCS DRY CONTACT DI (SI 1-8)

MCS-CT-xxx (SI #1 through 8, REV 1.5 & higher)

1. Connects to 1 of MCS sensor inputs 1 through 8
2. The current transformer may be 100:5 or 250:5
3. The size of the CT (xxx) must be larger than FLA
4. AMPS jumper setting is 'ANALOG'
5. For wiring only remove terminal block. DO NOT REMOVE PRINTED CIRCUIT BOARD.

MCS Sensor Input Terminal Strip Sensor (x)



MCS-CT-xxx

20. The MCS Trouble Shooting Quick Reference Sheet

(Complete trouble shooting write up is available on web site *www.mcscontrols.com*)

PROBLEM	POTENTIAL SOLUTION
No Sensor + 5 vdc	• Indicates a possible shorted input sensor • Remove all sensor + 5 vdc wires. • Wait about 30 to 60 seconds. If + 5 vdc returns, replace one sensor wire at a time until the + 5 vdc is lost again. This will be the shorted sensor.
A sensor input reads -99.9	This indicates an open sensor input signal or 5 VDC problem. • Check sensor wiring for missing wire or poor connection. • Check sensor for bad sensor. • Check + 5 vdc on sensor input to ground. If less than 5 VDC is on the sensor 5 VDC terminal block, the problem is with probably a shorted sensor. (A poly fuse protects the board) - Remove all sensor input terminals. - Wait about 1 min. or until 5 VDC restored at sensor input. - Connect terminals 1 at time until short reappears & fix bad sensor.
A sensor input reads +999.9	This indicates a shorted sensor input signal. • Check sensor wiring for +5VDC shorted to signal etc. • Check sensor for bad sensor.
A pressure sensor is reading more than 1 psi off (The temperature & humidity sensors do not require calibration.)	This indicates the transducer sensor input needs to be calibrated via the offset capability in the software. (Transducers by design need to be calibrated based on construction and altitude.) • You need to have a valid Auth code to change sensor offsets • You must use the Windows based software package 'PConn' • See PConn Interactive section for instructions. ('Change SI Status, Manual Value and / or offset.)
Invalid reading on one sensor input.	This indicates an input problem with 1 sensor. • Verify jumper settings correct for that SI.
'MCS CONTROLLER INITIALIZATION' on LCD display.	Indicates Micro in constant reset. • Check incoming power > 105 VAC or 22 VAC
Top row of LCD display all bars & 2nd row blank.	Indicates software chip problem possible. • Possible U11 software version incorrect or chip bad. • Possible U13 GAL chip incorrect or chip bad. • Possible bad connection or cable between LCD and MCS8
LCD blank.	Indicates bad connection. • Connector J2 on MCS not on or offset on connector. • Resistor adjustment VR1 out of adjustment.
Lost I/O	Indicates communications problem. • Verify RS485 LED blinking. • Verify termination jumper J6 only on at MCS-8 & last I/O. • Verify MCS-8 & I/O address's set correctly. • Verify wiring from MCS-8 to each I/O correct. • Check fuses/120 VAC on I/O units
Changes to MCS not being made from the unit's keypad.	This indicates inability to write to chip U10. • Verify 'EEP WRITE ENABLE' jumper W6 is on. • Not authorized
PConn – cannot make changes	This indicates you are not at a proper authorization level. Follow steps below for proper authorization

PROBLEM	POTENTIAL SOLUTION
	• From either the SYSTEM INFO or STATUS screen, under PConn, click on the 'AUTH' button on the lower right of your LCD display. • Follow prompts and enter a valid 4-digit authorization number. • The authorization level is displayed at the top of the display and is reflected via the color of the AUTH button. 1. RED = view only 2. YELLOW = service level 3. BLUE = Supervisor level 4. Green = Factory level
Invalid authorization	This indicates an invalid auth number. Follow steps below for proper authorization • Press SERVICE DIAGNOSTICS key until the authorization option appears • Press the ENTER key • From the "Display Status" press keys corresponding to your authorization number. • Press ENTER
SI from AMPS board 10 A low.	This indicates a problem with this SI only. • Jumper setting on this SI in wrong position. • Incorrect sensor type used.
INVALID CONFIG VER	Indicates layout of CFG wrong. • CFG layout for different version than software chip U11.
INVALID CONFIG TYPE	Indicates U10 CFG incompatible with U11 software. • Example U10 CFG for home while U11 for chiller.
INVALID CONFIG	Indicates Checksum invalid • Reload CFG
Sensor input believed invalid (Under Sensor Diagnostic Sub Menu)	• Verify Berg jumpers using Quick Reference Sheets • Check board version number • Check wiring of sensor
Communications to MCS-485-GATEWAY from PC-Connect not working.	• Verify red LED on the gate way is blinking. This indicates that the PC-Connect program is talking to the gateway. • Verify that the two wire shielded cable is properly wired from the RS-485 connector to the gateway. • Verify red LED (Located just to he left of the RS-485 connector on the MCS-8 board is blinking. This indicates that the MCS-8 is responding to the gateway. • If both of these LED are blinking, check the address of the MCS-8 and any other MCS-8s that are on the network. Each must have a unique address. This address can be changed from the MCS-8. Proper authorization is required. Enter the UNIT INFORMATION screen by depressing the SERVICE DIAGNOSTIC key and scrolling to this item. Depress the ENTER key and scroll to the NETWORK ADDRESS screen. Change address if needed. • Verify + 12 vdc to MCS-485-GATEWAY
INVALID CONFIG	Indicates Checksum invalid • Either set to factory defaults on reset settings.

--- NOTE ---

ALL SENSOR INPUTS SHOULD BE SHIELDED CABLE WITH SHIELD TIED TO GROUND ON MCS-8 SENSOR INPUT GROUND TERMINAL