

**MicroTech<sup>®</sup>  
Chiller Plant Controller**



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### CAUTION

**Connections and service to this panel must only be performed by personnel knowledgeable in the operation of the equipment being controlled. Ignorance or carelessness can cause personal injury or equipment damage.**

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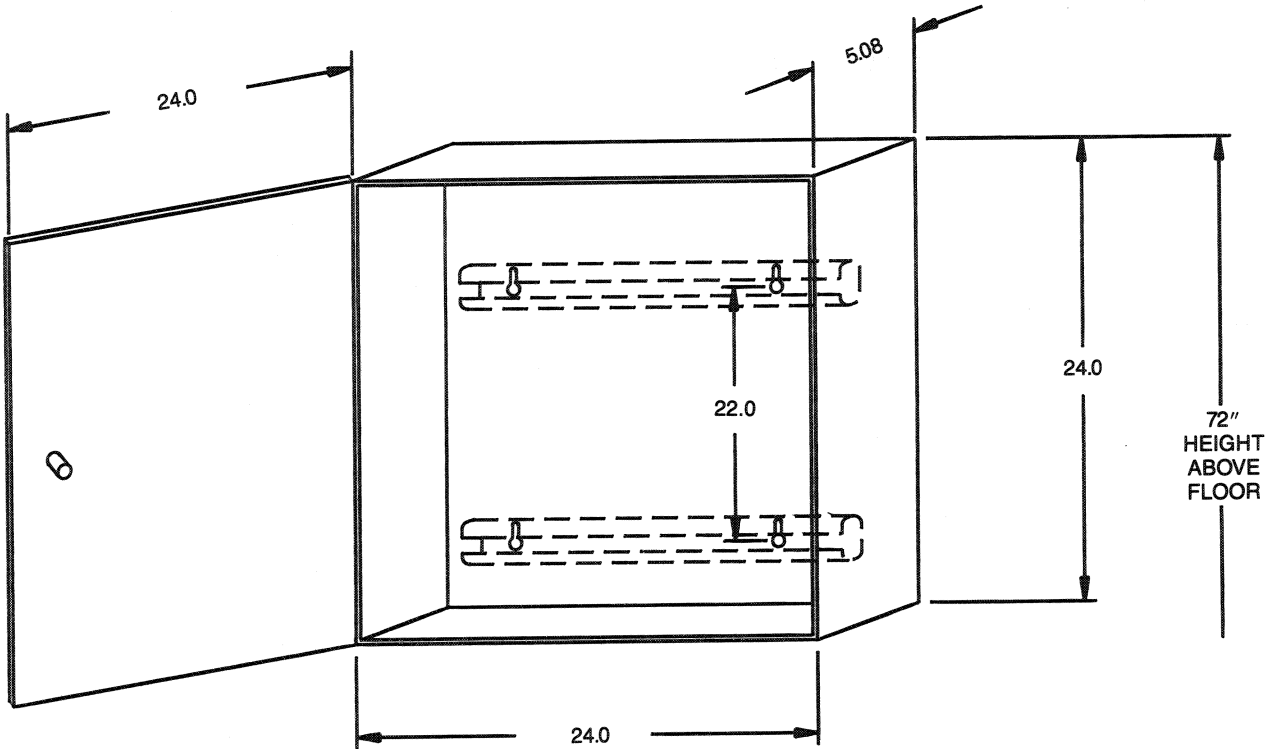
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# INTRODUCTION

The following pages provide information on the features, installation, operation and problem analysis of the McQuay microprocessor control for centrifugal chiller plants. Some discrepancy may exist between display statements,

or time intervals on certain units, and published data. The differences are minor and exist because of SnyderGeneral's avowed intention to continually improve its products.

Figure 1. Chiller Plant Controller (CPC) Exterior



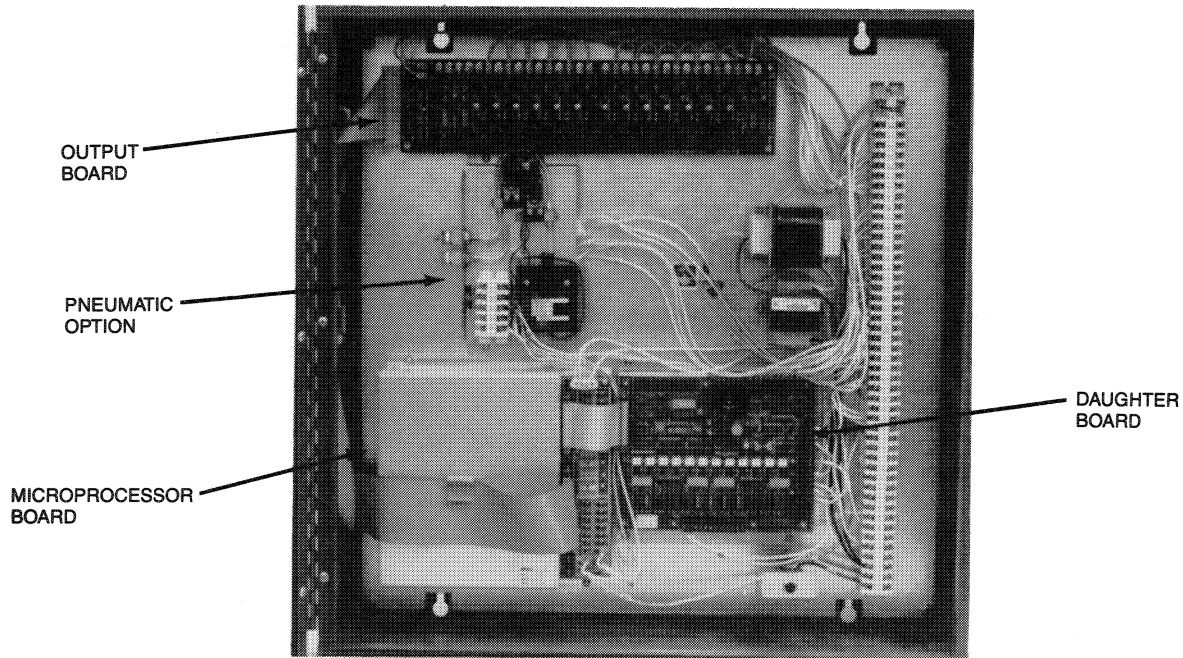
## GENERAL DESCRIPTION OF CHILLER PLANT CONTROLLER SYSTEM

The MicroTech Chiller Plant Controller is a microprocessor based control panel designed to provide sophisticated chiller plant control for McQuay MicroTech based centrifugal chillers.

A summary of the primary control features offered by the Chiller Plant Controller (CPC) is as follows:

- Programmable lead-lag sequencing in any order for up to 6 MicroTech centrifugal chiller compressors.
- Automatic sequencing of compressors to meet changing chiller plant loads.
- Automatic balancing of compressor loading to maximize compressor efficiencies.
- Programmable 7-day battery backed timeclock for time of day scheduling of chiller plant operation with 21 programmable holidays.
- Control of secondary pumping system with automatic sequencing of lag pump should lead pump fail to establish flow.
- Cooling tower bypass valve control for maintaining proper condenser water loop temperatures. Control for electric bypass valve is provided as standard with an option for pneumatic bypass valve control.
- Cooling tower control for up to 9 stages of heat rejection.

**Figure 2. Chiller Plant Controller (CPC) Interior**



The Chiller Plant Controller consists of three main components: the Model 180 Microprocessor Board, the Daughter Board, and the Output Board. A description of each component and its function is as follows:

### THE MODEL 180 MICROPROCESSOR

The MicroTech Model 180 microprocessor board contains software logic for the CPC panel. All software is stored in non-volatile memory and will remain intact without power being supplied to the panel indefinitely.

The Model 180 also has two communication ports. One port is for communications to the MicroTech chillers and the other is reserved for communications to the CPC operators personal computer. The communications trunk between the CPC panel and all MicroTech chillers is shielded, twisted pair, RS-485 at

9600 baud. The communications between the CPC panel and the personal computer is shielded, twisted pair, RS-232 at 9600 baud.

The Model 180 microprocessor contains a real-time battery backed clock. Should a power failure occur, the CPC panel will continue to maintain the correct time and date regardless of the duration of the power failure.

The Model 180 microprocessor controls up to 16 digital outputs via the output board.

### DAUGHTER BOARD

The daughter board's primary function is to perform input conditioning for all analog and digital inputs to the Model 180 microprocessor. The maximum number of inputs to the daughter board are 14 analog and 12 digital inputs.

All analog input connections are factory wired from the field

connection terminals to TS3 and TS4 on the daughter board. See the Chiller Plant Controller field wiring schematic for field terminal designations.

The analog inputs on the standard Chiller Plant Controller are as follows:

Sensor Type	Description	Daughter Board Terminals
1. Thermistor	Evap. Supply Water T.	TS3- 1 & 2
2. Thermistor	Evap. Return Water T.	TS3- 3 & 4
3. Thermistor	Cond. Supply Water T.	TS3- 5 & 6
4. Thermistor	Cond. Return Water T.	TS3- 7 & 8
5. Thermistor	Outdoor Air T.	TS3- 9 & 10
6. Potentiometer	Tower Valve Position	TS4- 7 & 8
7. 4-20 madc Signal	Chiller Water Reset	TS4- 9 & 10
8. 4-20 madc Signal	Remote Demand Limit	TS4- 11 & 12

**NOTE:** CPC panels with the Pneumatic Option substitute a pressure transducer for the Tower Valve Position as follows:

Sensor Type	Description	Daughter Board Terminals
1. Pressure Transducer	Tower Valve Position	TS4- 7 & 8

The digital inputs to the microprocessor are received by sensing the presence of 24 VAC at each of the digital input contacts on TS1. A listing of digital inputs are as follows:

Description	Daughter Board Terminals
1. Secondary Pumping System Water Flow Switch	TS1-1
2. Remote Start/Stop	TS1-2

The presence of 24 VAC at each digital input is indicated by individual red LED's on the daughter board. For example, if the remote start/stop switch is closed, completing the electrical circuit, LED #2 would be illuminated.

In addition to input conditioning, the daughter board also contains power supply circuitry and watchdog connections which are all made on TS2.

### POWER SUPPLY TRANSFORMER

A 24 volt center tap transformer (UL Class II) is provided to power the Chiller Plant Controller. This transformer is protected by an internal, non-replaceable fusible link.

### OUTPUT BOARD

The output board contains 24 VAC output circuits from the microprocessor. Each output consists of an optically isolated, solid-state relay with a maximum rating of 1.5 amps and is normally open. Status of each output is visually indicated by a LED on the output board.

A listing of standard outputs is as follows:

Description
1. Tower Bypass Valve Open
2. Tower Bypass Valve Closed
3. Secondary Water Pump P1
4. Secondary Water Pump P2
5. Stage 1 Tower Fan On/Off
6. Stage 2 Tower Fan On/Off
7. Stage 3 Tower Fan On/Off
8. Stage 4 Tower Fan On/Off
9. Stage 5 Tower Fan On/Off
10. Stage 6 Tower Fan On/Off
11. Stage 7 Tower Fan On/Off
12. Stage 8 Tower Fan On/Off
13. Stage 9 Tower Fan On/Off
14. Master Condenser Pump
15. Alarm Output
16. Microprocessor OK Indicator

## INSTALLATION INSTRUCTIONS

The CPC panel is typically mounted in the mechanical equipment room with the MicroTech centrifugal chillers and close to the electrical control panels for auxiliary control devices such as towers, pumps, flow switches to minimize wiring distances.

The panel should be mounted indoors on a wall or supporting angle iron with 24" clearance for the door swing.

The CPC panel should be mounted in a location which is free from moisture and excessive dust.

The ambient environmental temperature and humidity

specifications on the panel are:

Operating: 32°F to 115°F (0 to 95% RH, non-condensing)  
Storage: -20°F to 158°F (0 to 95% RH, non-condensing)

When mounting the panel, use mounting keyholes provided. If it is necessary to drill other holes, we recommend temporarily removing the back plane of the CPC panel to protect all electrical devices from metal filings and electrostatic discharge.

## FIELD WIRING INSTRUCTIONS

Interconnecting wiring to the CPC panel consists of:

- Analog Input Signals
- Digital Input Signals
- Digital Output Signals
- Network Communications to the MicroTech Chillers
- Communications from the CPC Panel to the personal computer
- Telephone line for Remote Modem Access
- Power Wiring — 115 VAC

Please refer to the following McQuay wiring diagrams when using this section of the manual.

- #499533D-02 (For standard CPC panels)
- #651257D-01 (For pneumatic CPC panels)

### ANALOG INPUT SIGNALS TO CPC PANEL

#### THERMISTORS

All analog signals to the CPC panel require twisted, shielded pair wire (Beldon #8760 or equal). The thermistors are negative temperature coefficient type and have identical resistive characteristics to those used on the MicroTech chillers. The sensors must be installed as per the "Installation Data Instructions" (Form #553458Y-00) provided with the sensor kit.

#### DEMAND LIMIT & CHILLED WATER RESET SIGNAL

The demand limit and chilled water reset signals are 4 to 20 maDC signals. The resistive load used to condition the milliamp signals is a 250 ohm resistor.

#### COOLING TOWER BYPASS VALVE POSITION SIGNAL

If an electric actuator is used for tower bypass valve positioning, a 300 to 5000 ohm feedback potentiometer should be wired as shown on field wiring diagram (#478172D-01). **The electric valve actuator should be mounted so that the valve is normally closed to the cooling towers.** The microprocessor receives a voltage signal from the potentiometer and converts the signal into a position reading using a linear equation. The "Hi" and "Lo" calibration constants of the linear equation are input as setpoints under the commissioning procedure.

#### DIGITAL INPUTS TO CPC PANEL

Digital contacts for the secondary chilled water flow switch and the remote start/stop switch must be dry contacts suitable for 24 VAC control signal from the CPC panel. If these points are not used, a jumper must be installed across terminals 40 and 42 and terminals 41 and 43.

**NOTE: Do not connect 115 VAC control power into these or any other connecting circuits.**

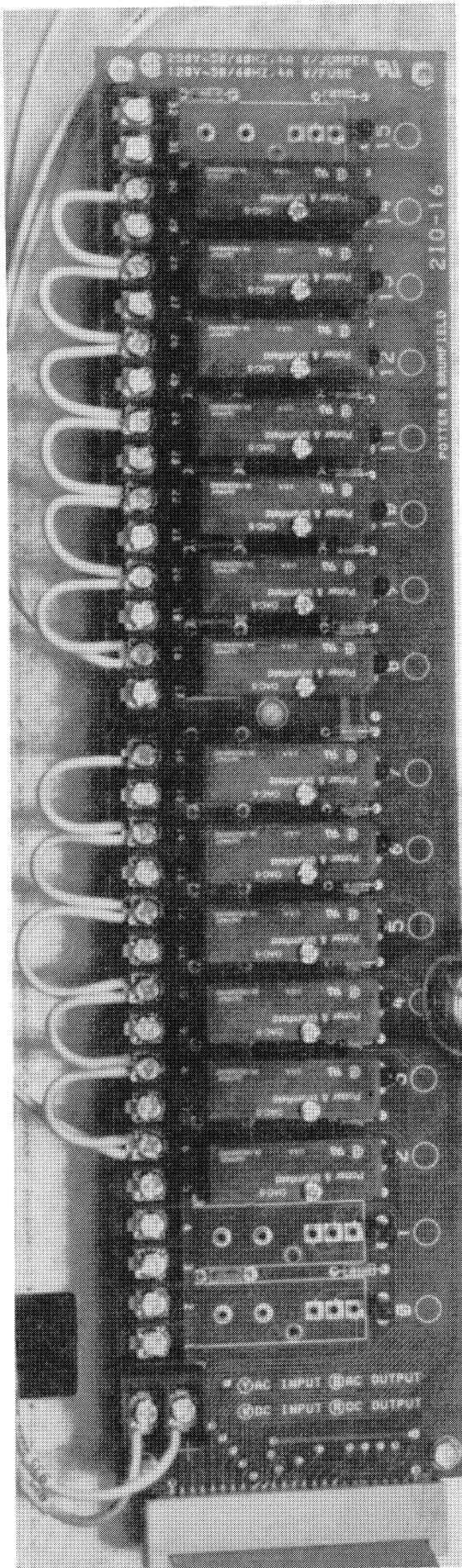
**Table 1. Input Sensor Information**

INPUT SENSOR DESCRIPTION	SENSOR REF. NO.	INPUT TYPE	TERMINAL STRIP LOC.
Common Evaporator Supply	0 0	Thermistor	81/82
Common Evaporator Return	0 1	Thermistor	83/84
Common Condenser Supply	0 2	Thermistor	85/86
Common Condenser Return	0 3	Thermistor	87/88
Outside Air Temperature	0 4	Thermistor	89/90
Chilled Water Reset	1 1	4-20 maDC	83/84
Demand Limit	1 2	4-20 maDC	95/96
Secondary ChW Flow Switch	0 1	Dry Contact	40/42
Remote Start/Stop Switch	0 2	Dry Contact	41/43
Tower Bypass Valve Position	1 3	0-5 VDC	97/98/99

**Table 2. MicroTech Thermistors Resistance vs. Specified Temperature**

°F	Ohms	°F	Ohms	°F	Ohms	°F	Ohms
15	16,104	71	3,477	127	973	183	333
16	15,627	72	3,392	128	953	184	327
17	15,166	73	3,309	129	933	185	321
18	14,720	74	3,228	130	914	186	316
19	14,288	75	3,150	131	895	187	310
20	13,871	76	3,074	132	877	188	305
21	13,467	77	3,000	133	859	189	299
22	13,076	78	2,927	134	842	190	294
23	12,698	79	2,857	135	825	191	289
24	12,333	80	2,789	136	809	192	284
25	11,979	81	2,723	137	792	193	280
26	11,636	82	2,658	138	777	194	275
27	11,304	83	2,595	139	761	195	270
28	10,983	84	2,534	140	746	196	266
29	10,672	85	2,474	141	731	197	261
30	10,371	86	2,416	142	717	198	257
31	10,079	87	2,360	143	703	199	252
32	9,797	88	2,305	144	689	200	248
33	9,523	89	2,251	145	676	201	244
34	9,258	90	2,199	146	662	202	240
35	9,002	91	2,149	147	649	203	236
36	8,753	92	2,099	148	637	204	232
37	8,512	93	2,051	149	625	205	228
38	8,278	94	2,004	150	613	206	225
39	8,052	95	1,959	151	601	207	221
40	7,832	96	1,914	152	589	208	217
41	7,619	97	1,871	153	578	209	214
42	7,413	98	1,829	154	567	210	210
43	7,213	99	1,788	155	556	211	207
44	7,019	100	1,747	156	546	212	204
45	6,831	101	1,708	157	535	213	200
46	6,648	102	1,670	158	525	214	197
47	6,471	103	1,633	159	516	215	194
48	6,299	104	1,597	160	506	216	191
49	6,133	105	1,562	161	496	217	188
50	5,971	106	1,528	162	487	218	185
51	5,814	107	1,494	163	478	219	182
52	5,662	108	1,461	164	469	220	179
53	5,514	109	1,430	165	461	221	176
54	5,371	110	1,398	166	452	222	173
55	5,231	111	1,368	167	444	223	171
56	5,096	112	1,339	168	436	224	168
57	4,965	113	1,310	169	428	225	165
58	4,838	114	1,282	170	420	226	163
59	4,714	115	1,254	171	413	227	160
60	4,594	116	1,228	172	405	228	158
61	4,477	117	1,201	173	398	229	155
62	4,363	118	1,176	174	391	230	153
63	4,253	119	1,151	175	384	231	151
64	4,146	120	1,127	176	377	232	148
65	4,042	121	1,103	177	370	233	146
66	3,941	122	1,080	178	364	234	144
67	3,843	123	1,058	179	357	235	142
68	3,748	124	1,036	180	351	236	139
69	3,655	125	1,014	181	345	237	137
70	3,565	126	993	182	339	238	135

Figure 3. Solid-state Relay Board



## OUTPUTS

All outputs signals from the CPC panel are 24 VAC. The output device is a normally open solid-state relay with an onboard, replaceable 5 amp fuse. The status of all outputs are shown by individual red LED's for ease of determining output status.

Each output has a 5 amp fuse mounted on the output board. The fuses appear to be soldered on the board, but are actually replaceable. With the power off, use a needle nose pliers to alternately lift each lead of the fuse a small amount until free from the output board. Replacement fuses are simply slipped into place.

It is highly recommended that an audible alarm be wired to the Alarm Output of the CPC panel so that the operator is alerted to any alarm condition as soon as possible. This alarm output is **de-energized** upon detecting any safety shutdown of a unit controller or alarm condition within the CPC panel.

## NETWORK COMMUNICATIONS TO MICROTECH CHILLERS

Communications from the CPC panel to chiller unit control panels requires a shielded, twisted pair wire (Belden #8760 or equal), daisy chained in a parallel fashion from the CPC panel (port B) to each of the connected MicroTech chiller (port B) display processors. The network communications adheres to the standards of RS-485 and the rate of communications is 9600 baud. The CPC panel is shipped with 6 communications cable assemblies for connection to the display processors on the MicroTech unit controller. The cable assemblies consist of a 6-position female plug with 24 inches of shielded twisted pair wire.

Special care must be taken to insure correct polarity and isolation of circuits in the communications network. When performing the communications wiring take the following precautions:

- The CPC panel and all MicroTech unit control panels should **NOT BE POWERED**. The communications ports will be permanently damaged if any stray voltage in excess of 14 VAC or VDC is applied. To prevent this, remove power from all panels.
- As a further precaution, **DO NOT PLUG THE 6-POSITION COMMUNICATIONS PLUGS INTO ANY OF THE MICROTECH PANELS** until the pre-check portion of the installation. The CPC panel is shipped from the factory with the communications plugs removed from their sockets.

## COMMUNICATIONS FROM CPC TO PERSONAL COMPUTER

A personal computer is **REQUIRED** for all Chiller Plant Controller applications. The personal computer specifications are:

1. IBM PC or 100% true compatible computer including:
  - a. 5¼" or 3½" Floppy Diskette Drive. Utilized for loading the MicroTech monitor program into the hard disk of the computer for operating the MicroTech Chiller Plant Control Panel. Also provides capability of archiving historical data and system backup.
  - b. 640 KB RAM (Random Access Memory). The computer must have 640 KB in order to run the MicroTech Monitor Program. Any memory resident programs that run in the background must be disabled to run the monitor program.
  - c. Asynchronous Serial Communications Adapter. A direct communications interface connection between the PC and the MicroTech Network Controller. Connection to be 25 pin male or 9 pin male with a 9 to 25 conversion cable.

- d. Enhanced Graphics Adapter. For high resolution graphics and data display.
  - e. Parallel Printer Adapter. For hard-copy custom reports of all accumulated data.
  - f. Hard Disk Drive (20 Megabyte minimum). A mass data storage area for the operator interface and custom report software.
  - g. 101 Enhanced Keyboard. Required for more advanced functions of the operator interface and custom report software.
  - h. The computer shall include a DOS 3.0 or greater and manual along with other manuals provided with the computer.
  - i. The computer shall have an internal timeclock that is battery backed to maintain system time and date.
  - j. The computer shall come with the screen saver option, to extend the life of the display monitor.
2. Multisync or Compatible Enhanced Color Monitor. For use with the enhanced graphics adapter for high resolution data display.
  3. Printer, 192 CPC (characters per second) Dot Matrix Type. Must have the ability of supporting IBM extended character graphics.
  4. Printer Cable, 6 Ft. Parallel. For communications connection between the PC and the printer.

The computer is used for changing setpoints, monitoring data, trend logging, diagnostics, and remotely clearing faults within the chiller system. The computer is normally a dedicated personal computer; however, the operator may choose to exit the monitor program from time to time to perform other functions such as word processing or data manipulation us-

ing a spreadsheet program. It should be noted, however, that for maximum convenience and functionality, the computer should be considered a dedicated computer for the MicroTech system.

The communications from the CPC panel to the personal computer is shielded, twisted pair wire (Belden #8760 or equal). The communications adheres to the industry standards of RS-232C and the rate of communications of 9600 baud. A 25 pin communications plug with six feet of twisted pair wire is shipped with the CPC panel for connection to the serial port of an IBM compatible personal computer. If the personal computer has 9 pin serial port, a 9 pin to 25 pin converter is required and is to be supplied by others.

The recommended maximum distance from the personal computer to the CPC panel is 100 feet. If the required distance is in excess of 100 feet, an optional RS-232 extension kit is required (contact McQuay).

### TELEPHONE LINE FOR REMOTE MODEM ACCESS

A voice quality, direct dial telephone line is REQUIRED for remote access and monitoring of the CPC panel installation. The telephone line should be connected to the modem which may be factory installed in one of the MicroTech Unit Controller panels. The phone line should be terminated with a standard RJ-11 modular phone plug.

### FIELD WIRING INSTRUCTIONS FOR 115 VAC POWER

A 15 amp, fused source of 115 VAC power is required for powering the CPC panel. The panel must be grounded as shown on CPC Wiring Drawing 499533D-03

## OPTIONAL PNEUMATIC CONNECTIONS

The pneumatic version of the CPC panel requires a source of 20 psig (20 micron filtration) and is connected to the pneumatic output barb connection "PS."

The pneumatic output signal is typically a 3 to 15 psi signal. The output signal is adjustable via the software to match pneumatic valves with different spring ranges. **The pneumatic valve actuator should be mounted so that the valve is normally closed to the cooling towers.** Interconnecting pneumatic tubing is run from the output barb connection "PO" to the tower bypass pneumatic valve.

Figure 4. Pneumatic Outputs

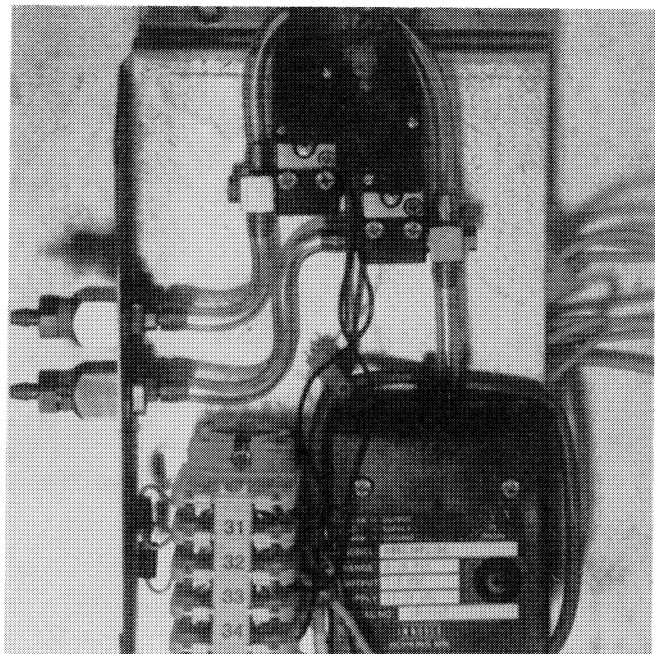
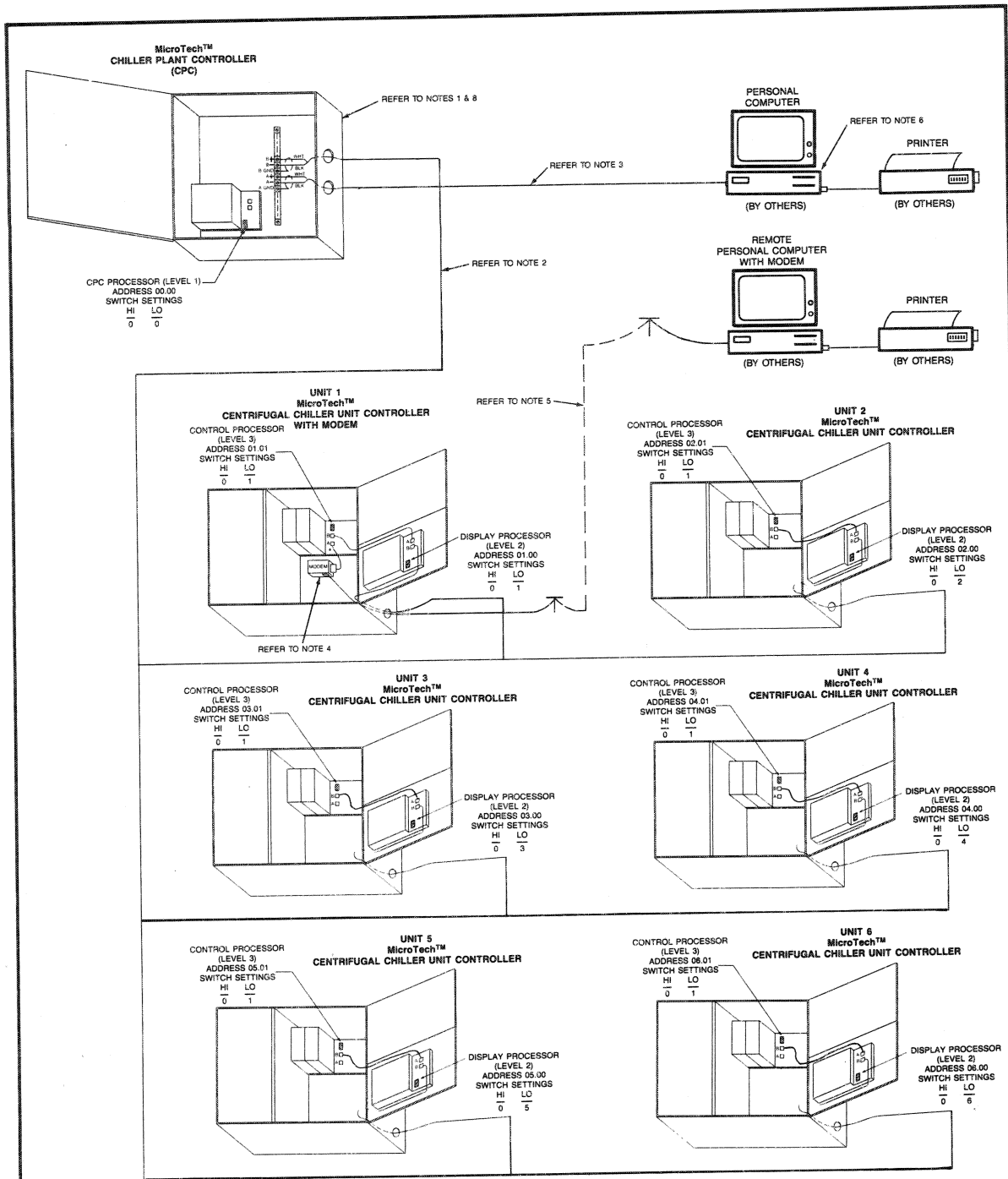


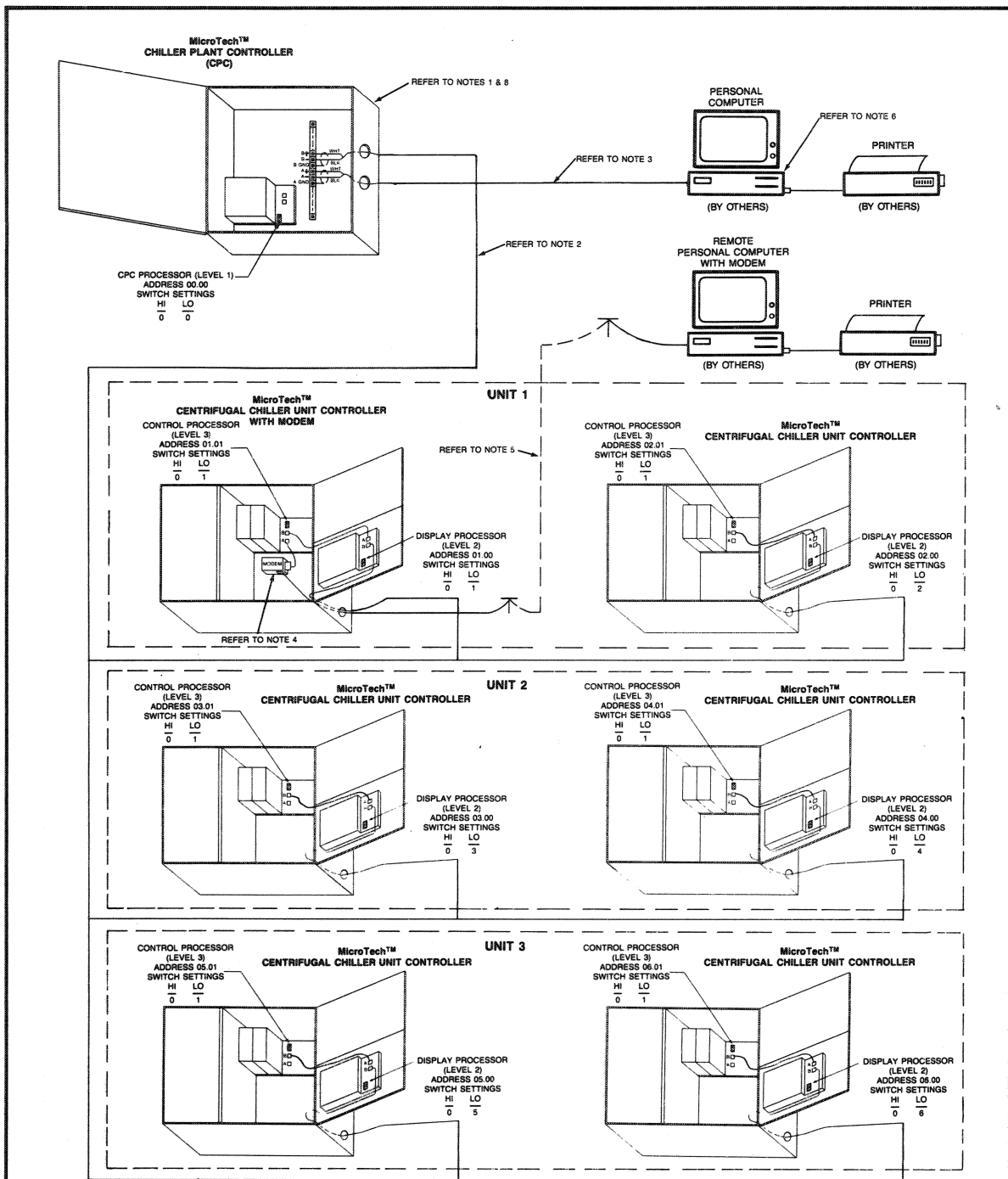
Figure 5. Network Overview — Single Compressor Units



**NOTES:**

- Supply 115VAC, 60 Hz power, to the Chiller Plant Controller, with a dedicated 115 VAC, 15 amp circuit breaker.
- Communication cable between each controller is to be a shielded twisted pair with drain wire, 300V, 60C, 20 AWG stranded, polyethylene insulated, PVC outer jacket, Belden 8762 or equivalent. Maximum cable length between Chiller Plant Controller and farthest Level 3 Controller is 5,000 feet. Six (6) cables, approximately 2 feet long, for unit display connections are supplied with CPC. Crimp type butt splices or solder connections are required; do not use wire nuts.
- Communication cable for the personal computer is to be Belden 8762 or equivalent, maximum length 50 feet. A cable 6 feet long, with 25 pin RS-232 connector, is supplied with the CPC. Personal computer with a 9 pin RS-232 port requires a 9 pin to 25 pin adapter supplied by others.
- For communication with a remote personal computer and MicroTech Monitor Software, a modem is to be factory installed in one of the Centrifugal Chillers.
- A dedicated telephone line, terminated with standard RJ-11 modular plug is required for modem communication.
- MicroTech Monitor Software and personal computer are required when a CPC panel is used; all system setpoints are entered via computer interface.
- All wiring must comply with N.E.C. and local electrical code. In some cases, plenum cable Belden 88760 may be used in place of 8762.
- Refer to certified drawings for input/output terminations for Chiller Plant Controller.

**Figure 6. Network Overview — Dual Compressor Units**



**NOTES:**

- Supply 115VAC, 60 Hz power, to the Centrifugal Chiller Communication Link, with a dedicated 115 VAC, 15 amp circuit breaker.
- Disconnect Lead/Lag Load Balance Panel terminals 3, 4, and 5 on each dual compressor unit when using a CPC Panel. Communication cable between each controller is to be a shielded twisted pair with drain wire, 300V, 60C, 20 AWG stranded, polyethylene insulated, PVC outer jacket, Beldon 8762 or equivalent. Maximum cable length between CCCL and farthest Level 2 Controller is 5,000 feet. Six (6) cables, approximately 2 feet long, for unit display connections are supplied with CCCL. Crimp type butt splices or solder connections are required; do not use wire nuts.
- Communication cable for the personal computer is to be Beldon 8762 or equivalent, maximum length 50 feet. A cable 6 feet long, with 25 pin RS-232 connector, is supplied with the CPC. Personal computer with a 9 pin RS-232 port requires a 9 pin to 25 pin adapter supplied by others.
- For communication with a remote personal computer and MicroTech Monitor Software, a modem is to be factory installed in one of the Centrifugal Chillers.
- A dedicated telephone line, terminated with standard RJ-11 modular plug is required for modem communication.
- MicroTech Monitor Software and personal computer are required when a CPC panel is used; all system setpoints are entered via computer interface.
- All wiring must comply with N.E.C. and local electrical code. In some cases, plenum cable Beldon 88760 may be used in place of 8762.
- Refer to certified drawings for input/output terminations for Chiller Plant Controller.

# CPC SYSTEM PRE-START

## PRE-START

Prior to CPC panel startup, all individual MicroTech Chiller Unit Controllers should be checked, tested, and started in accordance with McQuay installation and startup procedures (see appropriate IM manuals for chillers and MicroTech panel).

## CHECKING FOR PROPER VOLTAGES ON DAUGHTER BOARD

As a precautionary measure, the terminal strips on the daughter board (TS1, TS2, TS3, TS4) have been disconnected at the factory to prevent any stray voltages from damaging the electronics. Before plugging the terminal strips into the appropriate header, apply power to the panel and check the voltage levels at the following terminal strip connections. All measurements should be referenced to the CPC panel ground connector.

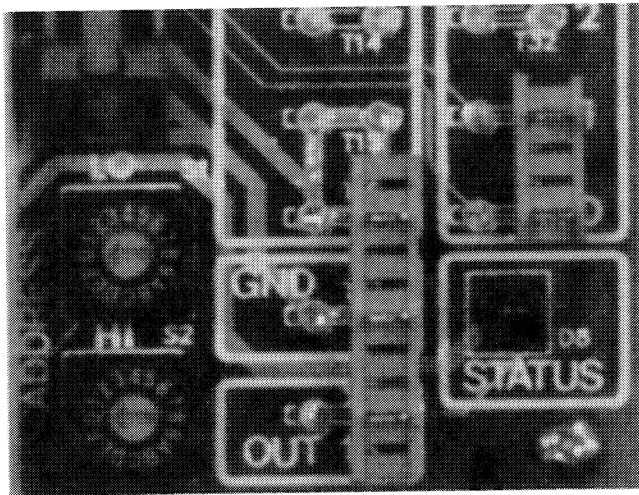
- TS1-2, 3 ..... Should be 26 VAC or less
- TS2-2, 3 ..... Must be 12 VAC 1.2V
- TS3-1 Thru 10 ..... Should be less than 5 VAC or 5 VDC
- TS4-1 Thru 12 ..... Should be less than 5 VAC or 5 VDC

After confirmation of correct levels, remove power from L1 and L2 and plug in the above terminal strips. Note the terminal strips have a polarizing pin (close to terminal #1) which correctly locates the terminal strip in relation to the daughter board.

## SETTING THE ADDRESS SWITCHES

The hexadecimal address switches of the CPC panel EnGinn and the unit controller EnGinns should be set in accordance with Table 3.

Figure 7. Hex Switch & Status LED



## POWERING THE CPC PANEL & ALL UNIT CONTROL PANELS

With the network communications cables STILL NOT PLUGGED INTO any controllers, power up the CPC panel and all unit control panels. The individual chiller unit control panels should all have the front panel "STOP/AUTO" switch in the "STOP" position.

The CPC panel's Status LED located in the bottom right-hand corner of the display board should begin to blink on and off at 1 second intervals to indicate power to the panel and "OK" status. Similarly, the "Microprocessor Status" LED on the front panel of the unit control panels should also be blinking on and off at 1 second intervals to indicate "OK" status.

## CONNECTING COMMUNICATIONS CABLES

Now that power is applied to the panels we can check to make sure that no stray voltages are present on the communication lines prior to plugging them in. With a voltmeter, check to make sure that there is no voltage present on any of the communication lines. To do this, connect the voltmeter black (ground) lead to an accessible ground (typically chassis sheetmetal) and alternately read the AC and DC voltage at the White (B+), the Black (B-), and Shield (G) to confirm that no voltage in excess of 3 VAC or VDC are present. Verify the communications plug wire numbers against Figure 8.

**YOU CAN NOW PLUG THE COMMUNICATIONS PLUG INTO PORT B OF THE CPC PANEL MODEL 180 BOARD.** Port B of the CPC panel Model 180 is the communications trunk master port. This master port presents a small voltage on the communications trunk. The proper voltages are as follows:

Terminal	Acceptable Voltage Readings
White Wire (B+)	3.0 VDC ± 0.2 VDC
Black Wire (B-)	2.0 VDC ± 0.3 VDC
Shield (G)	0.0 VDC ± 0.2 VDC

Next, move to the first unit control panel and confirm the above voltages are present at the communications plug to the display board. If they are correct, PLUG THE COMMUNICATIONS LINE INTO PORT B OF THE DISPLAY ENGINN and proceed to the next unit control panel until all unit controllers are connected.

If you do not read the above voltages, it is most likely the result of improper wiring such as crossed wires, shorts, open circuits or excessively long wire runs.

The network communications wiring is now complete and you can proceed to check the PC to CPC panel communications wiring.

If you have not set up and checked the personal computer, you should do so now. Turn on the PC and connect the communications cable to the serial port of the computer. Then go to the other end of the communication cable and with reference to chassis ground, check that there is no voltage in excess of 14 VAC or VDC present at wires #939, 940 and 941. Next, plug in the communications cable into Port A of the Model 180 microprocessor and check for the presence of the following voltages:

Table 3.

HEX. SWITCH	CPC SWITCH	DUAL COMPRESSOR UNIT #1				DUAL COMPRESSOR UNIT #2				DUAL COMPRESSOR UNIT #3			
		#1 COMPRESSOR		#2 COMPRESSOR		#3 COMPRESSOR		#4 COMPRESSOR		#5 COMPRESSOR		#6 COMPRESSOR	
		Control EnGinn	Display EnGinn	Control EnGinn	Display EnGinn	Control EnGinn	Display EnGinn	Control EnGinn	Display EnGinn	Control EnGinn	Display EnGinn	Control EnGinn	Display EnGinn
LO	0	1	1	1	2	1	3	1	4	1	5	1	6
HI	0	0	0	0	0	0	0	0	0	0	0	0	0

Terminal	Acceptable Voltage Readings
White Wire (A+)	0.2 VDC $\pm$ 1.0 VDC
Black Wire (A-)	-11.0 VDC $\pm$ 2.0 VDC
Shield (G)	0.0 VDC $\pm$ 0.2 VDC

If you do not read the above voltages, it is most likely the result of improper wiring such as crossed wires, shorts, open circuits, etc.

### ESTABLISHING COMMUNICATIONS BETWEEN PC & CPC PANEL

The next step is to install the MicroTech Monitor Program onto the hard disk of the personal computer and establish communications. Please see the appropriate section of the Monitor Program User's Manual.

The monitor program should connect at 9600 baud and you should be presented with the "Main Menu" of the monitor program. If this does not happen, recheck all wiring, the serial port and the manufacturer's default settings.

### OPTIONAL DOWNLOADING OF CUSTOM OR UPGRADED SOFTWARE

Each CPC panel is shipped from the factory with the current up-to-date software. The version of the software loaded by the factory into the CPC can be determined by viewing the "Software Version Label" located at the bottom right-hand corner of the Model 180 board. A sample label is shown in Figure 9.

The software "version" is the 4th and 5th digit of the Software Version Number. In Figure 9, the version is "08" and the revision to the software is "E." Revisions are in alphabetical order.

Figure 9. Software Version ID

MCQUAY	02-09-89	← Factory Ship Date
P/N 492636B-03		← Part No. for Model 180
S/N 977757		← McQuay General Order No.
VER. CPC08E		← Software Version No.

The CPC panel and all MicroTech panels in the system must have the same software version number for proper operation. It will be necessary to verify this before system startup.

Since many CPC panel installations require custom or slightly modified software, it will be necessary for the commissioning McQuay representative to update the software within the CPC panel. Specific instructions are contained in the CPC software release form accompanying each CPC panel.

### COMMISSIONING CPC PANEL

With the proper software now loaded into the CPC panel, invoke the CPC panel monitoring program from the personal computer. The monitoring program is typically invoked with a batch file called "RUN.BAT", so please type: **RUN [enter]**

The monitor program will require several seconds to load itself into the personal computer and will present the Main Menu when completely loaded. From the Main Menu, select CPC Screen 0-8 which is the Chiller Plant Controller Commissioning Screen as shown in Figure 10.

**NOTE:** All values shown in Figures 10 through 16 are typical only. See paragraphs following for individual function explanation.

Figure 8. Communication Cable Detail

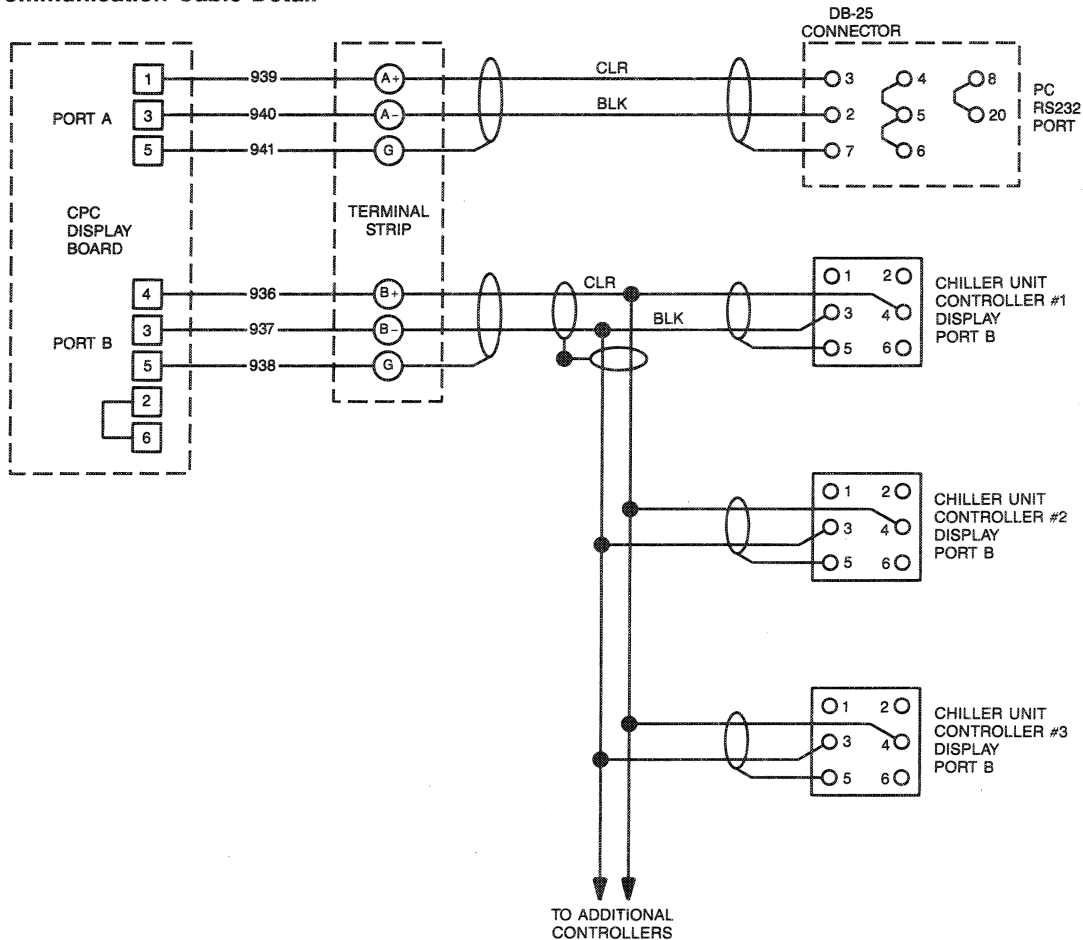


Figure 10. Screen 0-8: Chiller Plant Screen

<p>COMMISSIONING SETPOINTS: These values should be set once at the time of startup and not changed again. Should changing values become necessary, please refer to the User's Manual for help.</p>		
<p>Compressors: 4 Compressor Stages: 4 Cooling Tower Stages: 4</p> <p>PNEUMATIC ACTUATOR Hi Calibrate 15.1 PSID Lo Calibrate 2.9 PSID Currently -.4 PSID</p> <p>ELECTRIC ACTUATOR Hi Calibrate 3.61 VDC Lo Calibrate 1.49 VDC Currently .94 VDC</p>	<p>RESETS Chilled Water: OFF Demand Limit: OFF</p> <p>BYPASS VALVE Wait Time: 10 Sec Dead Zone: 1.0°F Max Step: 5 Sec Step Zone: 9.0°F Min. Step: 2 Sec</p> <p>UNLOAD ALL COMP'S DURING STARTUP On</p>	<p>CHECKSUMS Downloaded: 236 EOS Calculated: 236 Reset CPC: No</p> <p>MANUAL MODE Auto Staging</p>

As noted on the top of the commissioning screen, all values on this screen are typically set only once at the time of startup and should not require changing. Using the [F1] "Change Values" key, change the default settings for the CPC panel to match the job specific requirements. An explanation of each commissioning setpoint is as follows:

**Compressors:** Enter the number of MicroTech centrifugal compressors connected via communications to the CPC panel.

**Compressor Stages:** Enter the number of compressor stages. Compressor staging is usually identical to the number of compressors except when the compressor sequencing requires some compressors to be staged off while others are turned on as chiller plant load is increased. For more information on chiller stages, see Screen 0-4.

**Cooling Tower Stages:** Enter the number of cooling tower stages which are wired to the CPC panel. The maximum number of cooling tower stages is 9.

**Pneumatic Actuator:** If you are using a pneumatic actuator, you must inform the CPC panel of the proper spring range of the pneumatic valve. The "Hi Calibrate" value is the pressure at which the pneumatic valve is completely open, allowing all condenser flow to the cooling towers. The "Lo Calibrate" is the pressure at which the pneumatic valve will be completely closed and all condenser water flow is bypassing the towers. The "Currently" is the pressure which the CPC panel is sensing currently from the pressure transducer.

**Electric Actuator:** If you are using an electric actuator, you must inform the CPC panel of the proper voltages from the feedback potentiometer which represent completely open and completely closed positions. To determine the proper voltages, drive the electric actuator (refer to electric valve manufacturers wiring schematic) until the valve is completely closed such that all flow is bypassing the cooling towers. Next, read the "Currently" voltage from the commissioning screen. The "Currently" voltage should read between 0 and 1 VDC. Set the "Lo Calibrate" to agree with the "Currently" voltage. Similarly, drive the electric actuator so the valve is completely open to the cooling towers and read the "Currently" voltage. The "Currently" voltage should read between 4 and 5 VDC. Set the "Hi Calibrate" to agree with the "Currently" voltage.

**Resets:** The CPC panel is capable of receiving 4 to 20 mADC signals for chilled water reset and demand limiting and communicating the reset signals to all connected MicroTech Unit

Control panels. To activate the resets, change the setpoint to "On" for the proper reset. Note that you must also change the "Reset Options" setpoint on the Screens 1-6, 2-6, 3-6, etc., for all chillers to the proper setpoint. Thus, for chilled water reset only, the proper setpoint is "ChW"; for amp limiting, the setpoint is "Amp"; and for both chilled water reset and amp limiting, the setpoint is "ChW & Amp". See MicroTech IM Bulletin 403 for more information.

**Bypass Valve:** The bypass valve uses a control algorithm called "Step-and-Wait" for control of the bypass valve. This algorithm is similar to PI (Proportional & Integral) control but is much more intuitive and avoids the difficult "tuning" process normally required by PI algorithms to determine the correct control constants. See Figure 16 for more information on Step-and-Wait.

**Unload All Compressors During Startup:** This setpoint informs the CPC panel to insure that all compressors are fully unloaded before attempting to bring on any additional compressors. By unloading all compressors, the refrigerant head which the starting compressor will see is greating reduced, which is beneficial for most compressors. This option should be "On" for most applications and MUST BE "ON" FOR ANY JOB WHICH HAS DUAL COMPRESSOR UNITS.

**Checksums:** All MicroTech controllers use an "EnGinn Operating System" checksum procedure to insure that the application code is intact and has not changed. This checksum is recalculated each time the controller is restarted by re-powering the controller or by performing a reset via communications. The "Compressors Setpoint" is included in this checksum to agree with the EOS calculated checksum. The procedure is as follows:

With the number of compressors set to the desired setpoint, use the [F1] change values key to change the "Reset CPC" value from "No" to "Yes" and type [F1] to resume monitoring.

Observe that the EOS calculated checksum will change in a few seconds. Now use the [F1] key to change the "Downloaded" checksum to agree with the new "EOS" calculated checksum. If the two checksums do not match, the controller will not execute the application software and all outputs will be in an off or fail-safe condition.

Next, you should proceed to the compressor staging screen, Screen 0-4, as shown in Figure 11.

Figure 11. Screen 0-4: Chiller Plant Controller — Staging Setup

8:32:24 pm 12/12/88

STAGE	COMP 1	COMP 2	COMP 3	COMP 4	COMP 5	COMP 6	TOTAL CAPAC.	STAGE UP % RLA	STAGE DOWN % RLA	DELAY TIME	MAX TOWER
1	████	---	---	---	---	---	230	95	---	5	1
2	████	████	---	---	---	---	470	95	60	5	2
3	████	████	████	---	---	---	710	95	60	5	4
4	████	████	████	████	---	---	940	---	60	5	4
5	---	---	---	---	---	---	---	---	---	---	---
6	---	---	---	---	---	---	---	---	---	---	---
7	---	---	---	---	---	---	---	---	---	---	---
8	---	---	---	---	---	---	---	---	---	---	---
9	---	---	---	---	---	---	---	---	---	---	---
10	---	---	---	---	---	---	---	---	---	---	---
11	---	---	---	---	---	---	---	---	---	---	---
12	---	---	---	---	---	---	---	---	---	---	---
CAPC.	240	230	240	230							

The "Chiller Plant Controller — Staging Setup" screen is used to select the order and sequencing of compressors. For example, Figure 11 shows a total of four compressors which will be sequenced in the order of 1, 2, 3, and 4 as the CPC capacity staging requirements increase from 1 through 4, respectively.

To change the order of compressor staging, use the [F1] change values key. For each stage of increasing chiller plant capacity, determine which compressors should be on. Moving the cursor horizontally for each CPC capacity stage, you can "toggle" the appropriate compressors to be on or off using the "+" or "-" key to make the "ON" symbol "████" appear or disappear.

Next, move the cursor to the bottom of Screen 0-4 and input the correct capacity of each compressor in tons. For example, in Figure 11 the capacity is 240, 230, 240, 230, respectively, for compressors 1 through 4.

The CPC panel calculates the average percent RLA of all compressors running and uses this information to determine if the CPC plant capacity should be increased or decreased. The control logic is as follows for determining if CPC plant capacity should be increased:

If the average % RLA of all compressors running is greater than the "Stage Up % RLA" setpoint of the current CPC plant capacity stage and this condition has been true for at least the time shown in the "Delay Time" setpoint column, then the CPC plant capacity stage will be incremented by one.

The reverse of the above logic is also used to determine if CPC plant capacity should be decreased:

If the average RLA of all compressors running is less than the "Stage Down % RLA" setpoint of the current CPC plant capacity stage and this condition has been true for at least the time shown in the "Delay Time" setpoint column, the the CPC plant capacity stage will be decremented by one.

The typical values for "Stage Up % RLA" is 95% and can be used for all CPC capacity stages.

The typical value for "Stage Down % RLA" is 60% and can be used for all CPC capacity stages. Special caution should be used in setting the "Stage Down % RLA" since the "Stage Down % RLA" must be greater than the % RLA which the compressors draw when fully loaded. Observe the average % RLA of all compressors running at their minimum load and verify it is indeed less than the "Stage Down % RLA" setpoint.

The "Max Tower" setpoint in the last column of Screen 0-4 allows the operator to limit the number of tower stages to a maximum value. This is important since in many chiller plants, the chiller stages are equally matched with tower stages. For example, you would never want four stages of tower control when only one out of four chillers is currently running. Determine the appropriate "Max Tower" setpoint for your application. It may be necessary to consult with the design engineer who selected the cooling tower.

Next, you should proceed to the Tower Staging Screen 0-5 as shown in Figure 12.

Figure 12. Screen 0-5: CPC — Tower Staging Setup

8:34:04 pm 12/12/88

COOLING TOWER STAGE	TOWER STAGE OUTPUTS								ON/OFF	
	1	2	3	4	5	6	7	8		9
1	████	---	---	---	---	---	---	---	---	---
2	████	████	---	---	---	---	---	---	---	---
3	████	████	████	---	---	---	---	---	---	---
4	████	████	████	████	---	---	---	---	---	---
5	---	---	---	---	---	---	---	---	---	---
6	---	---	---	---	---	---	---	---	---	---
7	---	---	---	---	---	---	---	---	---	---
8	---	---	---	---	---	---	---	---	---	---
9	---	---	---	---	---	---	---	---	---	---

The "Tower Staging" screen allows the operator to select which CPC panel outputs should be turned on for each stage of tower capacity. Figure 12 shows a very typical situation where there are four stages of tower capacity which have been wired to staging outputs 1 through 4, respectively. Similar to the compressor staging Screen 0-4, a "█" symbol indicates that the 24 VAC output should be "on". The absence of the symbol "—" indicates that the 24 VAC output will be off.

Note that if you are using two-speed motors or pony motor drives in the cooling tower, additional "hard wired" delay timers must be provided by others to provide time delay between speed changes. Refer to the cooling tower manufacturer's data or the consulting engineer.

Next, you should proceed to Operations Screen 0-2 as shown in Figure 13.

Figure 13. Screen 0-2: Chiller Plant Controller — Control

12:45:29 pm 4/05/89

STATUS	SETPOINTS	SERVICE
CPC OPERATING MODE System On, Stage: 1	CHILLER Load Bal Limit: 100% RLA	MANUAL MODE Auto Staging
TEMPERATURE Evap Supply: 42.6°F Evap Return: 56.0°F Cond Supply: 84.6°F Cond Return: 76.6°F Outdoor Air: 78.0°F	COOLING TOWER Mod'l Valve Spt: 68.6°F Stage Up Spt: 77.0°F Stage Down Spt: 72.0°F Stage Up Timer: 4 Min Stage Dn Timer: 4 Min	ALARM STATUS Reset Alarm(s): No None
COOLING TOWER Bypass Valve: 100% Open Tower Stage: 3 Stage Up Time: 0 Min Stage Dn Time: 0 Min	Project Ahead: 2 Min Project Ent Cond: 76.6°F	SECONDARY ChW PUMPS #1 Op Hours: 0 #2 Op Hours: 0 Lead Pump: Auto
SECONDARY ChW PUMPS Pump #1: On Lead Pump #2: Off Lag	SECONDARY ChW PUMPS Startup Setpoint: 44.0°F Startup Delta T: 3.0°F Recir Time Delay: 60 Sec	EMS Contact: Open ChW Reset: 0% Demand Limit: 0%

Using the [F1] "Change Values" key, change the default setpoints for the CPC panel to match the job specific requirements. An explanation of each Operations setpoint is as follows:

#### COOLING TOWER:

**Mod'l Valve Spt:** This is the control setpoint for the entering condensing water temperature (condenser return) which the CPC panel will attempt to maintain via the modulating tower bypass valve. The typical value for this setpoint is 68°F. Do not set below 62°F. If you are not using the bypass valve control feature, ignore this data.

**Stage Up Setpoint:** If the entering condenser water temperature increases above this setpoint and the Stage Up Timer has been satisfied, the CPC will increment the number of tower stages which are active.

**Stage Down Setpoint:** If the entering condenser water temperature decreases below this setpoint and the Stage Down Timer has been satisfied, the CPC will decrement the number of tower stages which are active.

**Stage Up Timer:** This is a timer which controls the rate at which additional tower stages can be added. It is a minimum inter-stage timer. The timer is displayed under the Status section.

**Stage Down Timer:** This is a timer which controls the rate at which tower stages can be decreased. It is a minimum inter-stage timer. The timer is displayed under the Status section.

**Project Ahead:** The CPC panel anticipates changes in the entering condenser water temperature by recording the rate of change of the entering condenser water temperature over the last 30 seconds. By projecting out a variable time, one can add an anticipation factor to the control of entering condenser water temperature. This timer defines how many minutes of anticipation should be used by the control of entering condenser water temperature. The recommended value is between 2 and 4 minutes. A larger anticipation timer will

cause faster response in tower staging. A smaller anticipation timer will cause a slower response in tower staging.

**Projecting Entering Condenser Water Temp:** This is the calculated entering condenser water temperature which the CPC panel has calculated by recording the current rate of change of the water temperature and using the project ahead time value as defined above.

#### SECONDARY ChW SETPOINTS:

**Startup Setpoint & Startup Delta:** Upon startup, and after the "Recir Time Delay", the CPC panel samples the common leaving evaporator water temperature. If the temperature is greater than the startup temperature plus the startup delta, the CPC panel will bring on the first stage of compressor control. The startup setpoint should agree with the design leaving chilled water temperature of the chiller plant. Typical values are from 42°F to 45°F. Each MicroTech Unit Controller should also have the correct design leaving water temperature setpoint.

**Recirc Time Delay:** This is the time delay the CPC panel waits upon startup before sampling the common leaving chilled water temperature.

#### SERVICE SETPOINTS:

**Manual Mode:** This is a setpoint which the operator can "manually" override the current operating mode of the CPC panel. The setpoint should always be in "Auto Staging" unless the operator wishes to manually override.

Possible manual override modes include:

- Manual Recirc
- Manual Stage 1 (Compressor Stage 1)
- Manual Stage 2 (Compressor Stage 2)
- Manual Stage 3 (Compressor Stage 3)
- Manual Stage 4 (Compressor Stage 4)
- Manual Stage 5 (Compressor Stage 5)
- Manual Stage 6 (Compressor Stage 6)

- Manual Stage 7 (Compressor Stage 7)
- Manual Stage 8 (Compressor Stage 8)
- Manual Stage 9 (Compressor Stage 9)
- Manual Stage 10 (Compressor Stage 10)
- Manual Stage 11 (Compressor Stage 11)
- Manual Stage 12 (Compressor Stage 12)
- Manual Off (All Compressors Off)
- Auto Staging

The CPC panel is shipped from the factory in a "Manual Off" mode.

**ALARM STATUS:**

**ChW Pump 1:** This flashing red alarm will appear when the CPC panel fails to detect flow through the secondary chilled

water pump flow switch within 15 seconds of turning on the #1 secondary chilled water pump. To reset the alarm, use the [F1] change values key.

**ChW Pump 2:** This flashing red alarm will appear when the CPC panel fails to detect flow through the secondary chilled water pump flow switch within 15 seconds of turning on the #2 secondary chilled water pump. To reset the alarm, use the [F1] change values key.

**Comm Fail:** This flashing red alarm will appear when the CPC panel fails to maintain communications with one of the unit control panels. The alarm is automatically cleared when communications is re-established.

Next, you should proceed to the Time Schedule Screen 0-6 as shown in Figure 14.

**Figure 14. Screen 0-6: Chiller Plant Controller — Timeclock**

8:35:33 pm 12/12/88

DAILY SCHEDULE	START		STOP	
	HR	MIN	HR	MIN
MONDAY	6	0	18	0
TUESDAY	6	0	16	30
WEDNESDAY	6	0	18	0
THURSDAY	6	0	18	0
FRIDAY	6	0	18	0
SATURDAY	6	0	18	0
SUNDAY	6	0	18	0

OPTIMIZED START TABLE: On						
4:00 ChW Temperature						
OAT	40	50	60	70	80	90
50	0	0	0	0	0	0
60	0	10	15	20	25	30
70	0	15	20	25	30	35
80	0	20	25	30	35	40
90	0	25	30	35	40	45
100	0	30	35	40	45	50

Recirc at 4:00 For 10 Min  
Optimum Start Time: 5:40

INTERNAL TIMECLOCK		
Mon	21:33:35	12/12/88

The time schedule screen allows the operator to set up a 7-day, one start and stop per day schedule for the chiller plant. This schedule overrides the timeclock contained within each of the chiller unit control panels.

Each chiller control panel should have the "Start Mode" changed to "Remote" on Screens 1-6, 2-6, 3-6, etc., and a mechanical jumper installed between terminals 9 and 64 in the MicroTech unit control panel. This is necessary since the CPC panel does not actually command a chiller to turn on; it only inhibits the chiller from turning on. Thus, if the start mode is remote, and the mechanical jumper is installed, the

panel will automatically start as soon as the CPC removes the inhibit command.

Optimum Start/Stop is a selectable option from this screen. Optimum Start allows the CPC panel to save energy by turning on the chiller plant based on the time required to cool the chilled water loop to the design setpoint at the time of building occupancy. Refer to the "Control Theory" section of this manual for more information on this option.

Next, you should proceed to the Holiday Schedule Screen 0-7 as shown in Figure 15.

**Figure 15: Screen 0-7: Chiller Plant Controller — Holidays**

8:37:27 pm 12/12/88

SCHEDULED HOLIDAYS								
HOLIDAY	MON	DAY	HOLIDAY	MON	DAY	HOLIDAY	MON	DAY
1. New Year's	1	1	8. Special	0	0	15. Special	0	0
2. July 4th	7	4	9. Special	0	0	16. Special	0	0
3. Christmas	12	25	10. Special	0	0	17. Special	0	0
4. Special	12	24	11. Special	0	0	18. Special	0	0
5. Special	11	24	12. Special	0	0	19. Special	0	0
6. Special	11	25	13. Special	0	0	20. Special	0	0
7. Special	0	0	14. Special	0	0	21. Special	0	0

The above holiday schedule screen allows the operator to program up to 21 holidays into the CPC panel. The CPC panel will not allow chiller plant operation on holidays. Note that you cannot change the holiday descriptions. The monitor program

checks to see if the date is close to one of the standard holiday dates and puts the appropriate label on the screen. If the date does not match one of the standard dates, it applies the label "Special" to the date.

# START UP OF THE CPC PANEL

You are now ready to allow the CPC panel to begin operation of the chiller plant. The mode of the CPC panel on Screen 0-2 should be "Off-Manual."

All MicroTech unit control panels should be powered and ready for operation. Check that the unit control panels are set up as follows:

1. The panels are in "Remote" mode and a jumper has been installed between 9 and 64 on each of the control panels.
2. The Soft Loading option for all unit control panels except the Stage 1 compressor has been turned off by setting the ramp up time to 0 minutes.
3. The chilled water setpoints for all chillers have been set to the same value.
4. The maximum amp limit for all machines is set to 100%.

All evaporator pumps, condenser pumps, and cooling tower stages should be checked and ready to be energized.

The next step is to change the CPC operating mode on Screen 0-2 from "Manual-Off" to "Manual Recirculate." The secondary chilled water pumps should energize and the CPC

panel should detect flow through the secondary chiller water flow switch.

Next, change the CPC operating mode from "Manual-Recirculate" to "Manual-Stage 1." The CPC panel will now bring on the first stage of chiller plant control.

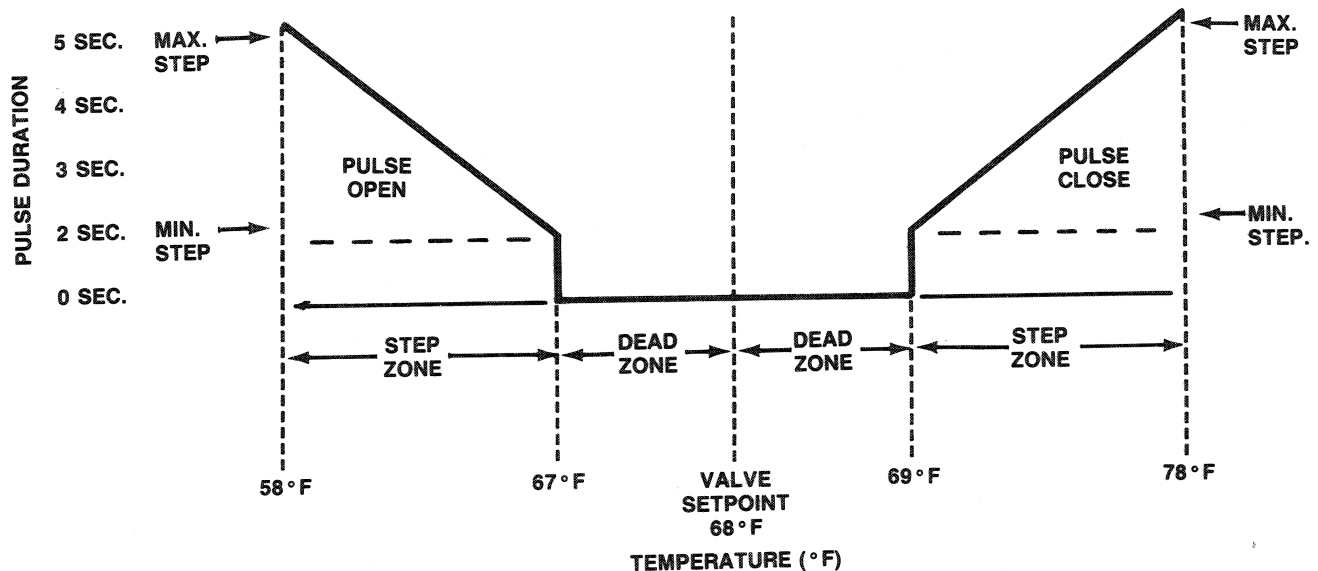
This process of incrementing the manual control mode should be repeated for all stages of chiller plant capacity control. This may or may not be possible depending upon the cooling load. When bringing on additional chillers, check that compressors are being controlled to the CPC "Load Balance Limit" as shown at the top of the "Setpoints" column on Screen 0-2.

Next, you should turn all compressors off by changing the CPC panel operating mode to "Manual-Off." You are now ready to check automatic operation of the chiller plant. With all compressors off, change the CPC manual mode to "Auto Staging" and check all stages of compressor operation.

This completes the installation and operation instructions for the McQuay MicroTech Chiller Plan Controller (CPC). Should you need further assistance, please contact your local McQuay service representative.

## CONTROL THEORY

Figure 16. Step-and-Wait



For this example, consider the tower bypass valve step-and-wait default setpoints:

Valve Spt:	68°F
Wait Time:	10 Seconds
Dead Zone:	1°F
Max Step:	5 Seconds
Step Zone:	9°F
Min Step:	2 Seconds

Every 10 seconds (the "Wait Time") the CPC panel compares the actual entering condenser water temperature with the condenser water temperature setpoint.

When the entering condenser water temperature is at setpoint (68°F) plus or minus the dead zone (1°F), the valve will

neither be pulsed open nor closed and will thus maintain its present position.

When the entering condenser water temperature is below 67°F or above 69°F, the valve will be pulsed open (in the case of the temperature being above setpoint) or closed (in the case of the temperature being below setpoint) at a rate proportional to the difference between the current entering condenser water temperature and the setpoint. With a 2°F difference between entering condenser water temperature and the setpoint (i.e., just outside the dead zone), the pulse duration is 2 seconds (the "Min Step"). At a difference of 9°F between entering condenser water temperature and the setpoint, the pulse duration is 5 seconds (the "Max Step").

When the differential between entering condenser water

temperature and the setpoint is greater than 9°F, the valve actuation will be continuous.

Optimum start allows the CPC panel to save energy by only turning on the chiller plant at the proper time so that the chilled water loop temperature reaches the design setpoint at the time of building occupancy. Energy savings result from optimum start since the chillers are not turned on before absolutely necessary. It is recommended that the operator use the soft load feature on the LEAD COMPRESSOR which will effectively limit the number of compressors used to pull down the chiller loop and prevent peak electrical demand. The optimum start logic is best explained by the following example:

At a programmable time (default 4:00 a.m., adjustable from 12:00 a.m. to 8:00 a.m.) the Chiller Plant Controller starts the secondary water pump to establish flow. After circulating water for 10 minutes (adjustable from 0 to 30 minutes), the Chiller Plant Controller samples the secondary return water temperature. Based upon this sampled water temperature, the controller determines the time required to pull down the loop temperature to the desired "secondary chilled water setpoint plus 1°F" by entering the matrix at right.

For example, if the secondary return water temperature is 70°F and the outdoor air temperature at 4:00 a.m. is 80°F, the

optimum time to start the chiller is 30 minutes before the time the operator wishes to reach chilled water setpoint. Thus if the day is Monday and Monday's time schedule is programmed to start occupancy at 8:00 a.m., the Chiller Plant Controller should begin operation at 7:30 a.m.

After starting at 7:30 a.m., the Chiller Plant Controller will log the actual time required to pull down the loop and reach setpoint. The CPC averages the actual time with the initial value from the matrix, and places the result back into the table. For example, if the actual time to reach chilled water setpoint turned out to be 40 minutes, the controller would place 35 minutes back into the table.

	Secondary Return Water Temp at 4:00 a.m.					
O.A. Temp.	40	50	60	70	80	90
50	0	5	10	15	20	25
60	0	10	15	20	25	30
70	0	15	20	25	30	35
80	0	20	25	30	35	40
90	0	25	30	35	40	45
100	0	30	35	40	45	50

## TEST PROCEDURE — TROUBLE ANALYSIS

All of the following procedures assume that power is applied to the CPC control panel and the circuit breaker is on. Some of the following procedures require the removal or replacement of fuses, connectors, terminals or jumpers. Always shut off the power before making the required changes. Refer to the CPC schematic #499533D-02 while performing these procedures.

1. The first thing to check when you suspect a CPC panel malfunction is the microprocessor status LED on the lower right corner of the display EnGinn. The LED will be blinking if the display board is functioning and the software is intact. If the status LED is on (not blinking) or off, locate terminal strip TS-2 on the daughter board and with a voltmeter check for approximately 24 VAC across terminals 2 and 3. If 24 VAC is not present and circuit breaker CB-1 is closed, replace transformer T1.
2. If the correct voltage is measured at this point, move the meter leads to terminals 5 and 13 on TS-2 and check for 15 VDC. If the voltage across these points is correct, replace the display EnGinn.
3. If the meter reads near 0 volts, check fuse F1 on the daughter board. If the fuse is blown, replace it with a fuse of the same size and rating and re-apply power to the panel. If the panel appears to power up correctly and the status LED is blinking, recheck the voltage reading at terminals 2 and 3 and 5 and 13 and check the panel carefully for correct operation.
4. If the replacement fuse blows, remove wires 930 and 931 from TS-2 terminals 5 and 13, replace fuse F-1 and re-apply power to the panel. If the new fuse blows again, replace the daughter board. If the fuse does not blow and you measure 15 VDC across terminals 5 and 13, replace the display EnGinn.
5. The output board used in the CPC panel contains solid-state relays to switch external loads. Please read the solid-state relay testing procedure in this manual before troubleshooting the output board.  
The field wiring to the external equipment must be checked against the job drawings before assuming that a problem exists on the relay board.
6. If one or several of the relays appear to be inoperative, check the fuse associated with the suspected relay(s). Replace the fuse if necessary and check the CPC panel for correct operation. If the fuses are good, visually inspect the ribbon cable which ties the relay board to the display EnGinn. Check for cracks or abrasions in the insulation which could indicate a damaged cable. The plugs should be seated tightly in the receptacle at each end and held in place by the plug retainers. Carefully unplug the cable at each end and check the socket for bent or missing pins. A short between adjacent conductors in the ribbon cable can cause a relay to be permanently on. If this is suspected, substitute a new ribbon cable.
7. If all of the relays are inoperative, verify that 24 VAC is present on all even numbered terminals (except #32) on the relay board when referenced to chassis ground. If no voltage is present, replace transformer T2. If the correct voltage is present on these terminals, check for 5 VDC on the input control power terminals. If 5 VDC is not present on these terminals, move the meter leads to TS-2, terminals 6 and 15 on the daughter board, and check for 5 VDC. If the correct voltage is not present on these terminals, check fuse F1 on the daughter board. If the fuse is not blown, replace the daughter board.
8. Communications problems between the CPC and the MicroTech panels can be somewhat difficult to troubleshoot. The best method is to isolate the fault to one of the panels or one particular section of cable. Before proceeding to Item 9, **check the address switch settings on each panel against the job documentation and check the password used to sign onto the system.**
9. To test a suspected cable, disconnect the shielded cable between the panels and use an ohmmeter to check carefully for opens, shorts and intermittent connections. Check the cable wiring against the drawing to verify pin-out and polarity. If the cables are correctly wired and all the pins are firmly seated in the plugs, connect the CPC panel to the PC and establish communications. If this step is successful, connect the lead MicroTech panel to the CPC and establish communication with it. Continue adding one panel at a time until the system fails. The problem should

now be isolated to the last panel connected to the system and the appropriate troubleshooting procedures can be implemented to correct the problem.

If the CPC will not talk to the lead MicroTech panel, substitute another MicroTech panel as the lead. If the CPC will not talk to the PC, check the PC configuration table in the CPC monitor User's Manual. If the CPC still will not talk, replace the CPC display Enginn.

**Table 4. Control Fuses**

LOCATION	QTY.	TYPE	AMP RATING
Output Relays	16	Little Fuse #275005	5.0
Daughter Board	1	Little Fuse #229015	1.5
Transformers T1 & T2	1 Ea.	Non-Replaceable Fusible Link	2.5

## SOLID-STATE RELAY SWITCHES

### RECOMMENDED TESTING PROCEDURE

Solid-state relay switches may be depicted as shown in the McQuay schematic wiring diagram: de-energized, with contacts open. The contacts will not "open," however, in the sense that conventional electrical-mechanical relays open their contacts.

When energized, the relay "contacts" lower their resistance and pass current freely. De-energized, they create a barrier to current flow, but permit voltage to exist at downstream terminals under certain conditions.

If, for example, a voltmeter is used to test logic output relay

#14, with power applied to L1 and L2 terminals, and the 3 amp circuit breaker "closed," the voltmeter will display 115 volts AC when connected to terminal 30 on the relay and L2. Similarly, if the relay is de-energized and the SW1 switch or oil pump auxiliary contacts open, a voltmeter connected between terminal 29 on the relay and L2 will also display 115 volts.

On the other hand, if a test light or a relay coil such as the oil pump contact coil (OP), chilled water (ChWR) or condenser water (CWR) pump relay coils are permanently connected to the downstream relay terminal and to ground, a voltmeter connected between the solid-state relay's downstream terminal and ground will not display any voltage. The absence of a voltage reading in this case is due to the fact that the voltage is being bled off to ground by the connected load.

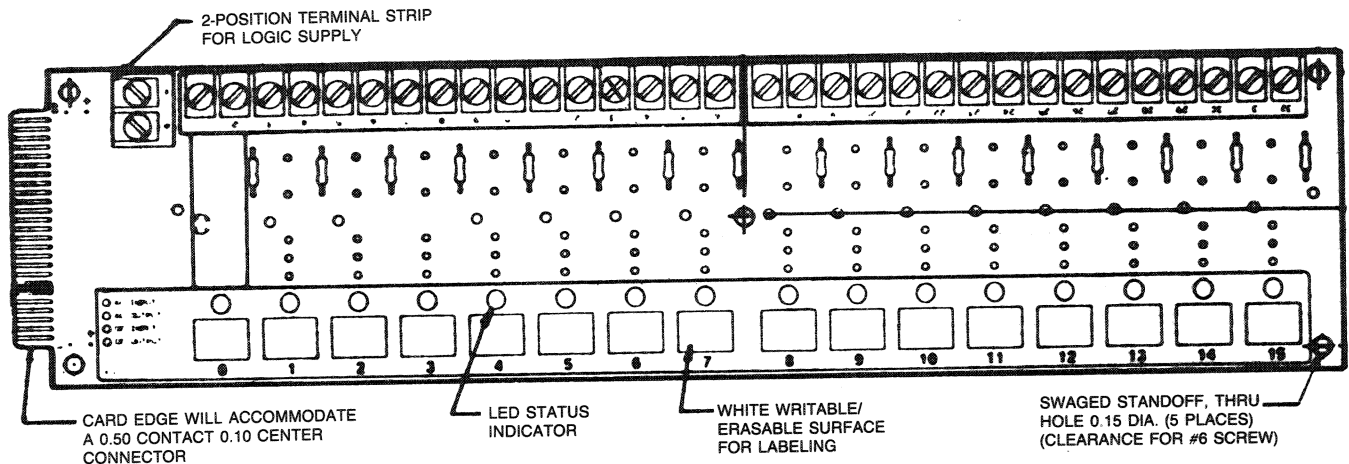
A thorough understanding of this departure from the characteristics of conventional relays is required to permit prompt and accurate service analysis.

Each solid-state output relay used in the CPC panel is equipped with its individual 3 amp fuse. Fuses resemble tiny resistors, and are located directly above the relay they serve on the relay base. Fuses are pressed into place, and can be removed by lifting them out with needle nose pliers.

Note the location of the fuse in the wiring circuit. Consider its location and the characteristics of the solid-state relay when electrically testing the circuit for a fault.

The LED present in the solid-state relay base responds to the relay's optically isolated "coil" circuit. If the LED does not glow, the relay probably is not being energized. Relays require the existence of 5 VDC to initiate closure. When the relay is energized, the LED should glow.

**Figure 19. Solid-state Relay Board**



# TERMS & DEFINITIONS

- Actuator . . . . . Electric or pneumatic operator used to position a damper or valve. It also contains a feedback device to indicate percent open.
- ASCII . . . . . (American Standard Code for Information Interchange). Method with which all alphanumeric characters are assigned a unique number between 1 and 127.
- Baud . . . . . Normally ranges from 300 to 9600 and indicates the speed of computer communication. The higher the baud, the faster the data transfer. The baud rate is changeable for each communications port.
- Checksum . . . . . The operating system of the microprocessor, upon power up or a reset, sweeps through the application program memory space and adds the values of all memory locations together. The resultant number is referred to as the checksum and is used to insure that the application program space has not been corrupted.
- CPU . . . . . (Central Processing Unit). The main component of a computer system. It interprets and executes program instructions, contains computational circuits, and input/output ports. Each MicroTech has its own CPU which allows it to operate independently.
- Download . . . . . The process of sending information from a PC or terminal to a MicroTech controller. Can be either individual setpoints or an entire new logic program.
- EEPROM . . . . . (Electrically Erasable Programmable Read-Only Memory). Enables the MicroTech controller to retain its memory even during power outages, yet allows changing of values from a remote location.
- EnGinn . . . . . A copyrighted trademark of EnergyLine Systems L.P. of Hayward, California. EnGinn is a generic term for the EnergyLine microprocessor controller.
- EOS . . . . . EnGinn Operating System. The EOS supports the use of the sensor inputs, outputs, terminal and network communications as well as control applications software.
- Hexadecimal . . . . . Refers to the base 16 number system in which the basic digits are represented by 0 thru 9 and A thru F.

<u>Decimal</u>	<u>Hexadecimal</u>
0 Thru 9	0 Thru 9
10	A
11	B
12	C
13	D
14	E
15	F
16	10

Computers operate in Base 2, but since that quickly becomes complicated and it does not convert easily to decimal, hexadecimal is commonly used for computer applications.

- Input . . . . . The MicroTech controller allows up to 16 inputs from sensors that return a voltage of 0 to 5 volts. Each reading is converted to a number between 0 and 255.  
Examples: temperature sensor, pressure transducer, potentiometer, etc.
- Logic Cartridge . . . . . The controller component which contains the microprocessor, operating system, applications program, and setpoint memory.
- Modem . . . . . Device that allows communication with a controller network over a telephone line. Two modems are required, one at the terminal end of the phone line and one wired to a controller in the network.
- Output . . . . . The MicroTech controller allows up to 16 outputs capable of turning a device on or off.
- Parity Check . . . . . A check of whether the total number of 1's in a data byte is even or odd. Used in data transmission to insure error-free communication, data bytes are converted to either even or odd parity before transmission by setting their eighth bit.
- Port . . . . . A communications channel on a controller for talking either to other controllers, a PC, or terminal. Each unit has two ports for various network connections. Each port must be pre-set for specific communications purposes.
- Power Cartridge . . . . . The controller component which contains the power conditioning hardware as well as the input and output circuitry.
- Pressure Transducer . . . . . Device used to convert a reading of static pressure into a voltage for input into the MicroTech controller.
- RAM . . . . . (Random Access Memory). Computer memory that will NOT hold its contents through a power outage. The MicroTech controller also contains some RAM for storage of temporary variables such as sensor readings. RAM memory values may be changed an infinite number of times without any problem, whereas EEPROM's may only be overwritten approximately 10,000 times before they begin to fail.

- RS232C ..... A hardware configuration standard used for communications between computers and computer equipment. Many personal computers are equipped with RS232C connections and this is required for linking a PC with the controller network.
- RS422/485 ..... A hardware configuration standard that is very common for linking of computer equipment into networks because of its resistance to transmission errors at high baud rates. It involves the use of a twisted pair of wires to connect components and requires one controller to coordinate the communications between all the other units.
- Setpoint ..... A desired value for some measured quantity. The MicroTech controller operates to maintain comfort based upon the values of specific setpoints. Example: leaving chilled water setpoints, discharge air temperature, room temperature, minimum and maximum CFM.
- Terminal ..... Normally refers to an IBM compatible personal computer but could be any computer equipment capable of RS232C communications and ASCII protocol.
- Temperature Sensor ..... The temperature of a monitored point is measured as output from a thermistor which the controller reads as a number between 0 and 255. This value is used to calculate the actual temperature in degrees Fahrenheit.
- Timing Constants ..... Refers to adjustable time values that the controller uses to manage its inputs and outputs. The time between room temperature readings or the amount of time to turn on an actuator are two examples. They may range from a tenth of a second to 62 hours or they may also indicate "always" or "never."
- UART ..... (Universal Asynchronous Receiver-Transmitter). Typically, a single computer chip that converts serial data transmissions into parallel information. The fact that the MicroTech controller contains two UART's means that it can transmit and receive at different baud rates. It also maintains automatic parity error checking and speeds the entire communications process.

**SCHEM. 499533D-03 REV. 0**

**MI CROTECH  
CPC - CHILLER PLANT CONTROLLER**

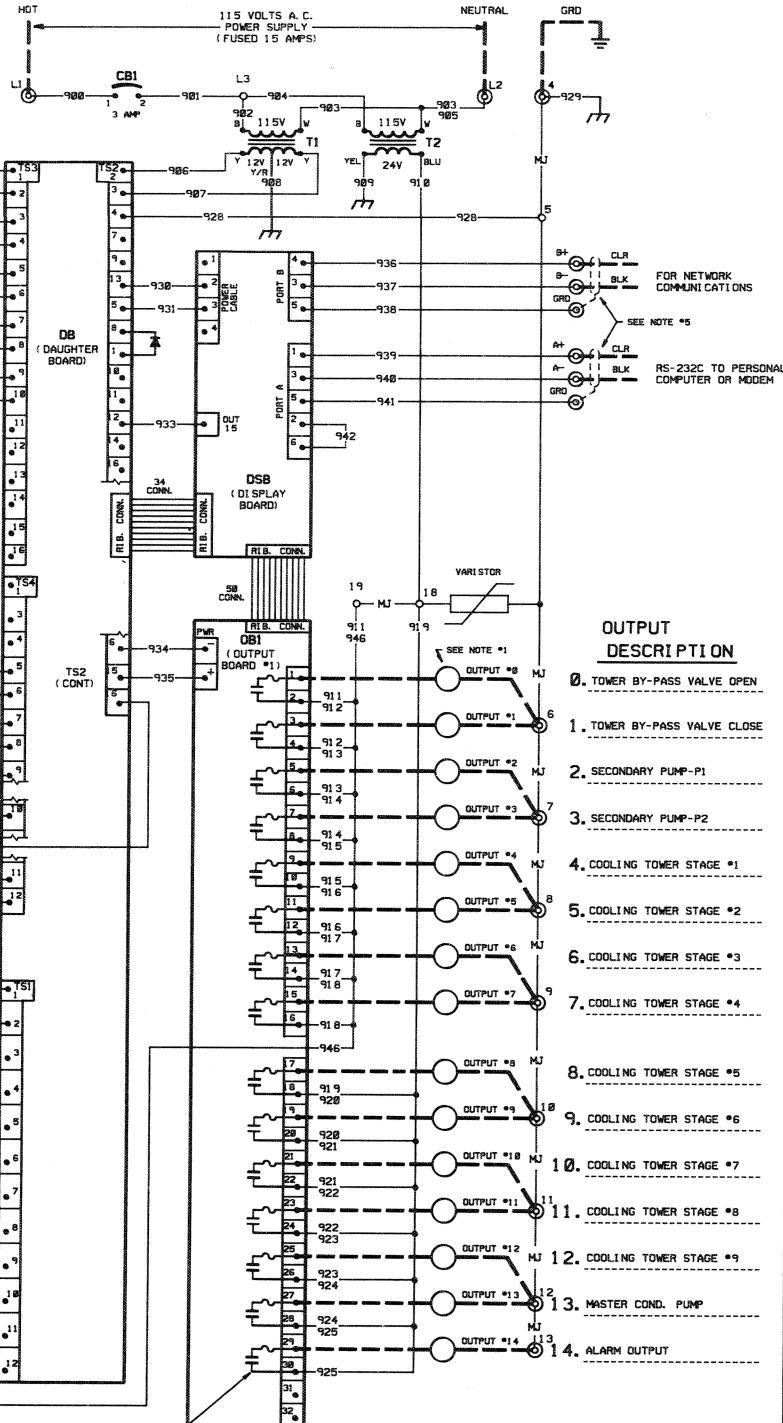
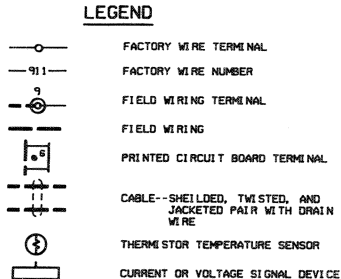
**ANALOG INPUT DESCRIPTION**

- 0. COMMON EVAP SUPPLY
- 1. COMMON EVAP RETURN
- 2. COMMON COND. SUPPLY
- 3. COMMON COND. RETURN
- 4. OUTSIDE AIR

- 10. CHILLED WATER RESET
- 11. DEMAND LIMIT
- 12. TOWER BY-PASS VALVE POSITION

**DIGITAL INPUT DESCRIPTION**

- 1. SECONDARY FLOW SWITCH
- 2. REMOTE START/STOP



**OUTPUT DESCRIPTION**

- 0. TOWER BY-PASS VALVE OPEN
- 1. TOWER BY-PASS VALVE CLOSE
- 2. SECONDARY PUMP-P1
- 3. SECONDARY PUMP-P2
- 4. COOLING TOWER STAGE #1
- 5. COOLING TOWER STAGE #2
- 6. COOLING TOWER STAGE #3
- 7. COOLING TOWER STAGE #4
- 8. COOLING TOWER STAGE #5
- 9. COOLING TOWER STAGE #6
- 10. COOLING TOWER STAGE #7
- 11. COOLING TOWER STAGE #8
- 12. COOLING TOWER STAGE #9
- 13. MASTER COND. PUMP
- 14. ALARM OUTPUT

**LEGEND**

**NOTES:**

1. TOTAL VA OF ALL CONNECTED OUTPUT LOADS NOT TO EXCEED VA RATING OF TRANSFORMER (75 VA FROM FACTORY) AND NO INDIVIDUAL OUTPUT SHALL EXCEED 48 VA.
2. THE LOAD OF EACH DIGITAL INPUT IS 0.48 VA.
3. EXTERNAL DIGITAL CONTACTS SHALL BE SUITABLE FOR SWITCHING 24 VOLTS A.C. AND LOW CURRENT (APPROXIMATELY 16MA).
4. BLANK INPUT OR OUTPUT DESCRIPTION SPACES INDICATES THAT THE INPUT/OUTPUT IS NOT CURRENTLY SUPPORTED IN SOFTWARE AND HARDWARE. CONTACT MCGRAW HILL IF ADDITIONAL I/O SUPPORT IS DESIRED.
5. USE TWO-CONDUCTOR, SHIELDED, TWISTED, AND JACKETED PAIR WITH DRAIN WIRE.
6. EACH OUTPUT CONSISTS OF A NORMALLY OPEN SOLID STATE RELAY AND A REPLACABLE 5 AMP FUSE.

**SCHEM. 651257D-02 REV. 0**

**MICROTECH  
CPC-CHILLER PLANT CONTROLLER  
WITH PNEUMATIC OUTPUT**

**ANALOG INPUT  
DESCRIPTION**

- 0. COMMON EVAP SUPPLY
- 1. COMMON EVAP RETURN
- 2. COMMON COND. SUPPLY
- 3. COMMON COND. RETURN
- 4. OUTSIDE AIR
- 10.
- 11. CHILLED WATER RESET
- 12. DEMAND LIMIT
- 13. TOWER BY-PASS VALVE POSITION

**DIGITAL INPUT  
DESCRIPTION**

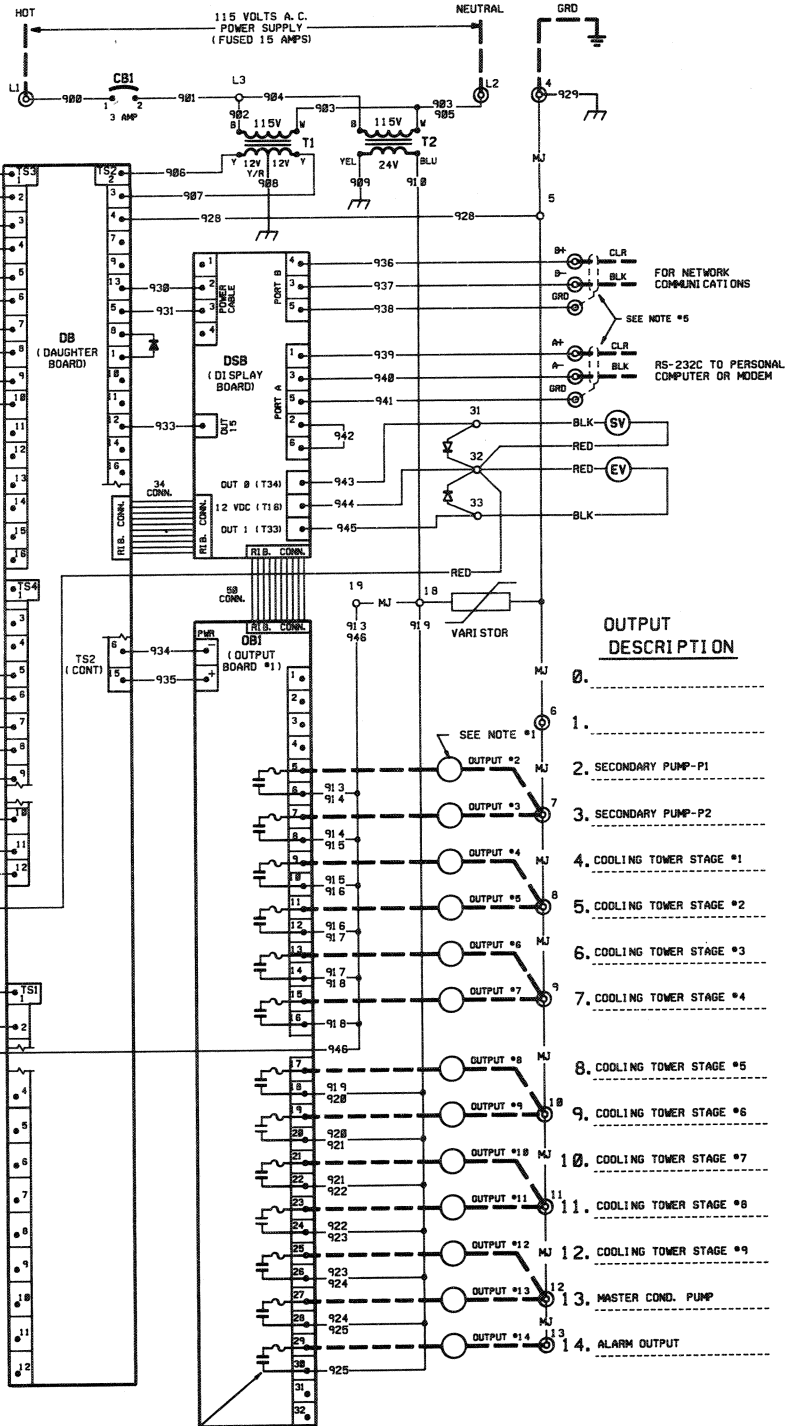
- 1. SECONDARY FLOW SWITCH
- 2. REMOTE START/STOP

**LEGEND**

- FACTORY WIRE TERMINAL
- FACTORY WIRE NUMBER
- FIELD WIRING TERMINAL
- FIELD WIRING
- PRINTED CIRCUIT BOARD TERMINAL
- CABLE--SHEILED, TWISTED, AND JACKETED PAIR WITH DRAIN WIRE
- THERMISTOR TEMPERATURE SENSOR
- CURRENT OR VOLTAGE SIGNAL DEVICE
- UNIDENTIFIED TERMINAL

**NOTES:**

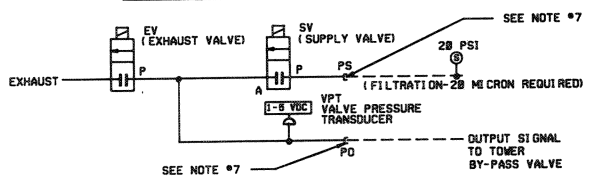
1. TOTAL VA OF ALL CONNECTED OUTPUT LOADS NOT TO EXCEED VA RATING OF TRANSFORMER (75 VA FROM FACTORY) AND NO INDIVIDUAL OUTPUT SHALL EXCEED 48 VA.
2. THE LOAD OF EACH DIGITAL INPUT IS 0.48 VA.
3. EXTERNAL DIGITAL CONTACTS SHALL BE SUITABLE FOR SWITCHING 24 VOLTS A.C. AND LOW CURRENT (APPROXIMATELY 100MA).
4. BLANK INPUT OR OUTPUT DESCRIPTION SPACES INDICATES THAT THIS INPUT/OUTPUT IS NOT CURRENTLY SUPPORTED IN SOFTWARE AND HARDWARE. CONTACT MEDWAY IF ADDITIONAL I/O SUPPORT IS DESIRED.
5. USE TWO-CONDUCTOR, SHIELDED, TWISTED, AND JACKETED PAIR WITH DRAIN WIRE
6. EACH OUTPUT CONSISTS OF A NORMALLY OPEN SOLID STATE RELAY AND A REPLACABLE 5 AMP FUSE.
7. PNEUMATIC CONNECTIONS ARE .125 NPTF OR .125 I. D. POLYURETHANE TUBE.



**OUTPUT  
DESCRIPTION**


- 0.
- 1.
- 2. SECONDARY PUMP-P1
- 3. SECONDARY PUMP-P2
- 4. COOLING TOWER STAGE #1
- 5. COOLING TOWER STAGE #2
- 6. COOLING TOWER STAGE #3
- 7. COOLING TOWER STAGE #4
- 8. COOLING TOWER STAGE #5
- 9. COOLING TOWER STAGE #6
- 10. COOLING TOWER STAGE #7
- 11. COOLING TOWER STAGE #8
- 12. COOLING TOWER STAGE #9
- 13. MASTER COND. PUMP
- 14. ALARM OUTPUT

**PNEUMATIC SCHEMATIC**





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