McQuay
Air Conditioning

INSTALLATION AND OPERATION DATA

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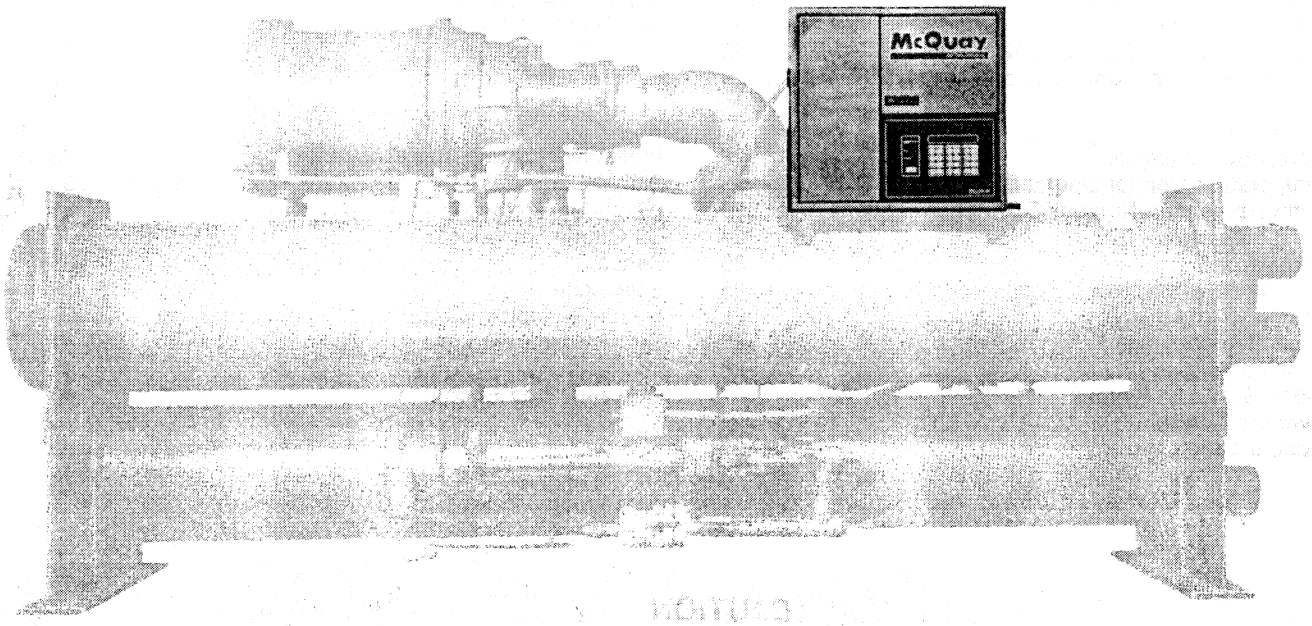
MICROTECH®
UNIT CONTROLLER



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CAUTION

Connections and service to this panel must only be provided 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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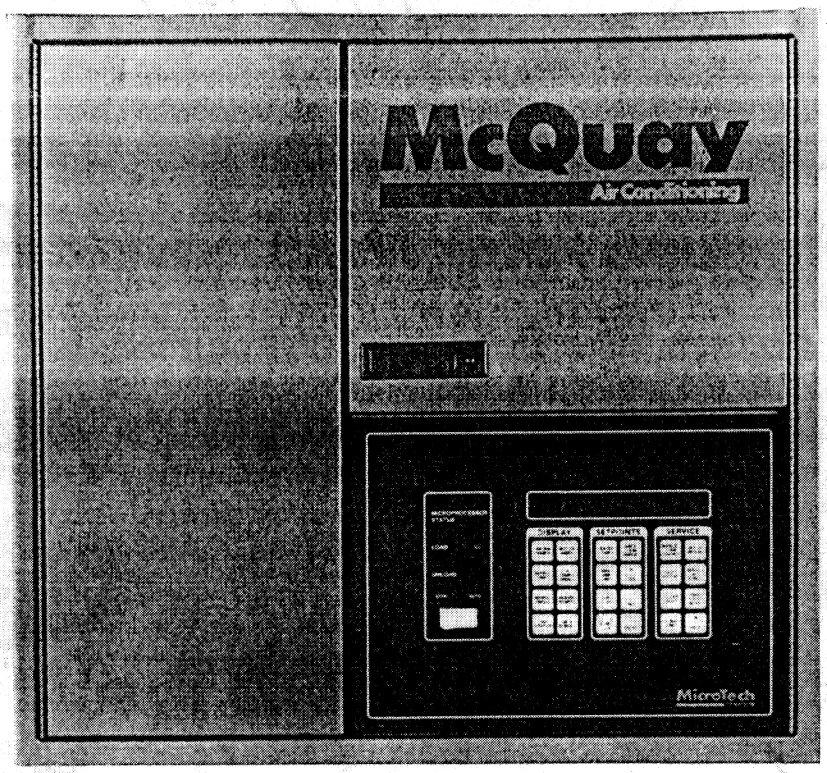
INTRODUCTION

The following pages provide information on the features, installation, operation and problem analysis of the McQuay Microprocessor control for Centrifugal chillers.

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. MicroTech Control Panel



GENERAL DESCRIPTION

The MicroTech Unit Controller is a microprocessor based control panel designed to initiate the step-by-step start functions of its host centrifugal compressor unit, monitor and regulate the compressor's capacity, protect it, and sequence the compressor shutdown on temperature demand or in response to a pre-set time.

Visual display of the entire sequence of functions is provided in plain English on a 20 character vacuum fluorescent display.

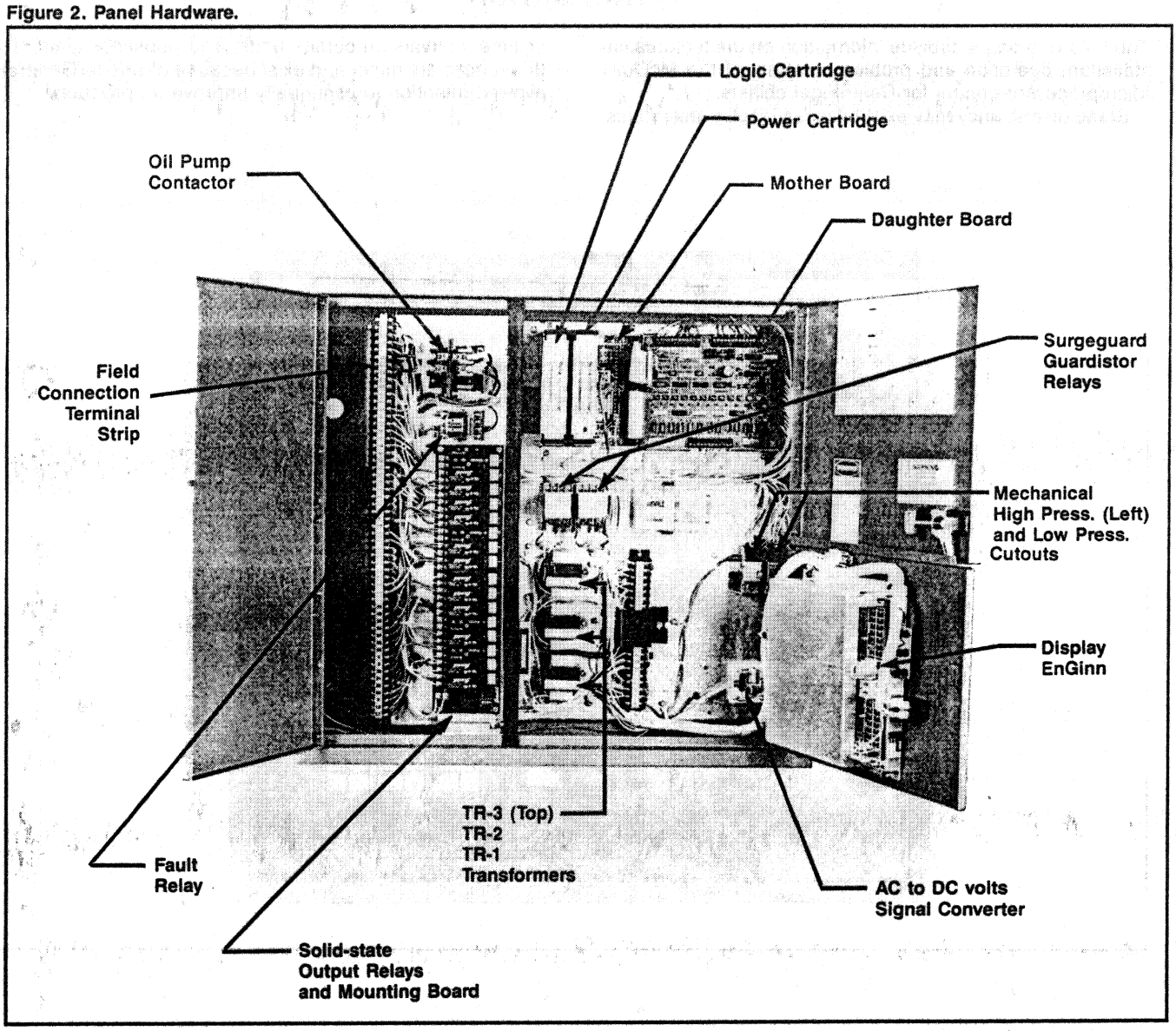
Communication ports permit control and/or status inquiry through a telephone modem, or over a limited distance, through a twisted pair, to an IBM PC compatible computer using MicroTech software.

In the event the compressors' operation is interrupted by the action of a safety trip, the cause of the trip condition is displayed. To further assist the operator or service personnel, the cause of the preceeding eight trip conditions is also recorded in the non-volatile memory.

Information about the units' fault history, setpoints or operating display values may be obtained by pressing any of 24 touch sensitive membrane key switches.

To protect the system from unauthorized or accidental setpoint changes, the MicroTech panel also includes operator password protection.

Figure 2. Panel Hardware.



The control panel contains the following components:

- 16 lighted and fused optically isolated output contact terminals for pre-assigned logic control functions.

  See the Control Legend or the wiring schematic for specific terminal identification.
- 14 analog and 12 digital information inputs. The monitored data includes water and refrigerant temperatures, motor amperage, oil pressure and oil temperature.
- Digital contact closures prove the existence or operation of ancillary functions required for the safe operation of the controlled chiller.

(For a complete list of inputs, see the table provided or the wiring schematic).

- Microprocessor Control EnGinn parts consisting of durable aluminum encased logic and power cartridges securely clamped to the controlling mother board.
- A daughter board to collect and condition digital and analog input signals, and deliver the needed voltage levels to the microprocessor.
- An aluminum encased 20 character microprocessor display EnGinn.
- A printed circuit AC to DC signal converter. (Optional).
- Three 115 volt to 24 and 12 volt control power transformers.
- Compressor Surgegard and motor Guardistor protective relays and capacitors.
- Mechanical/Electrical low pressure (MLP) and high pressure (MHP) refrigerant protective controls.
- A Safety Fault Relay (FT).
- Oil pump contactor with auxiliary interlocks.
- Communication ports.
- An internal 115 volt, 3 amp manual reset circuit breaker.
- An electrically grounded, touch sensitive keyboard mounted on the cover panel.
- A cover panel mounted "Stop-Auto" switch.
- Cover panel mounted indicating lights for indicating the status of the microprocessor control and compressor loading or unloading.

VACUUM FLUORESCENT DISPLAY

The display type used was carefully selected for its clarity and long life. The system is equipped however to automatically shut off the display if keypads have not been pressed within the preceeding ten minutes.

RESET CONTROL OPTIONS

The MicroTech panel is programmed to accept:

No Reset	Reset = None
Entering Chilled Water	Reset = ENT
Leaving Chilled Water	Reset = ChW
Electrical Demand	Reset = AMP
Electrical Demand & ENT	Reset = AMP ENT
Electrical Demand & ChW	Reset = AMP CHW

If entering chilled water is elected as a reset option, no additional control is required. The MicroTech panel will attempt to control a fixed return water temperature. To do so, as the building load is reduced, return water temperature will decrease. The microprocessor, however, will check return water temperature every 2 to 60 minutes (operator adjustable) and elevate the leaving chilled water temperature to regain the original return water (entering water) temperature.

Since the "Start" and "Stop" temperatures are temperature differences from the leaving chilled water setpoint temperature, the actual "start" and "stop" temperatures also reset as the leaving chilled water temperature is reset.

As building load is increased, the return water temperature would increase, causing the microprocessor to lower leaving chilled temperature, thereby returning the return chilled water temperature to its original value.

The other four (4) reset options require an external 4 to 20 mA signal, input to the field connection terminals 69, 70, and 71. The 4 to 20 milliamp transmitter will itself be controlled by a demand limiter for motor current limit, or for chilled water elevation based upon an EMS control.

If the installation consists of multiple chillers, or a single dual compressor chiller, with a lead-lag load balance (L/LLB) control, the remote reset transmitters are connected to the lead-lag control panel, not to the individual MicroTech panels. The control signal is then sent to the individual chiller through the L/LLB. See the Field connection wiring diagram for the L/LLB accessory panel.

Figure 3. Keypad and Display.

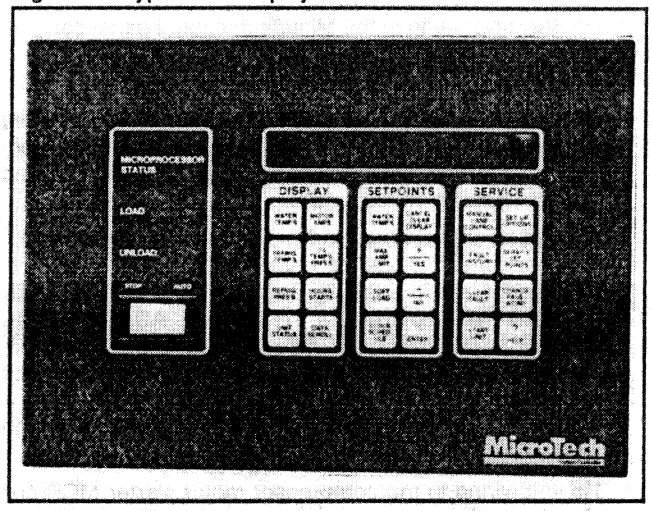


Figure 4. Max. Chilled Water Reset

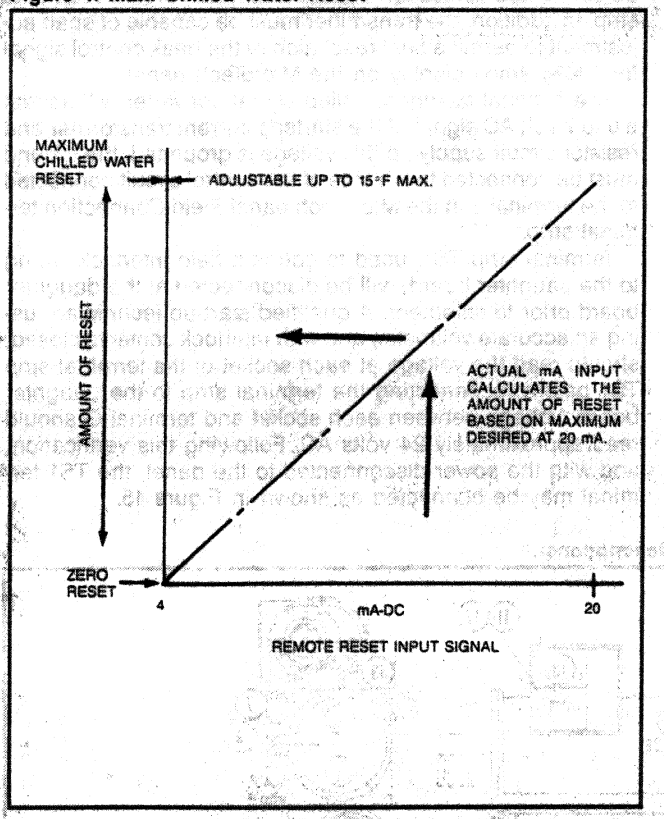
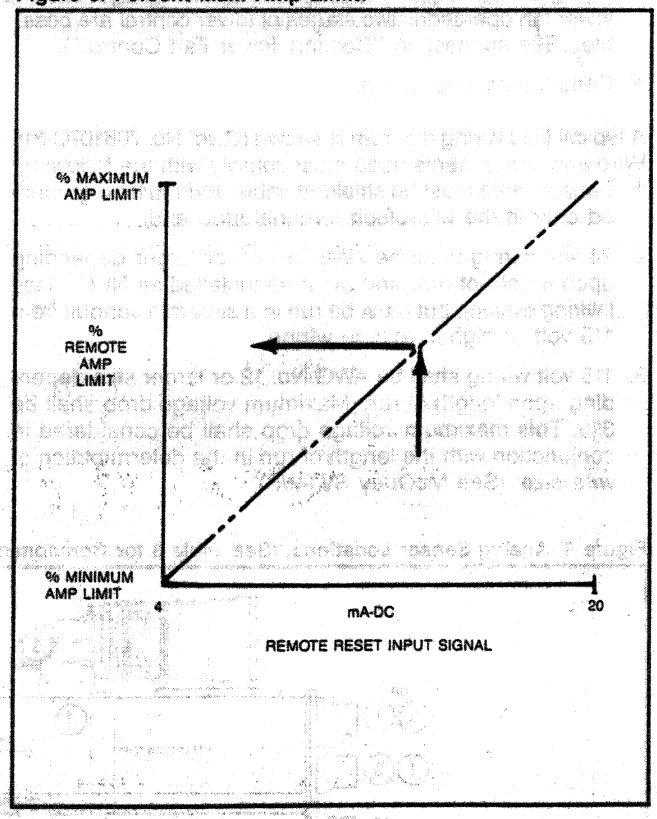


Figure 5. Percent Max. Amp Limit.



INSTALLATION

FACTORY MOUNTED & WIRED

MicroTech panels are completely factory assembled tested and mounted on centrifugal chillers. Sensors are located as shown in Figure 6 and are pre-wired with shielded cable to their appropriate termination. Field wiring connections need only be made to the terminal strip located on the left side of the control panel.

The following provides general wiring information of interest for service, and for those installations where the control panel will be retrofit to an existing installation.

INTERCONNECTING WIRING

Interconnecting wiring to the MicroTech control panel consists of:

- Sensor wiring to the analog input terminals.
- 24 volt wiring to the compressor motor starter (field installed if a remote starter is used), and to chilled water and condenser water flow switches and interlocks, alarm relay and external cycling or reset control.

  CAUTION: Digital contacts for pump interlocks, flow switches, or remote start-stop control must be dry contacts suitable for use in a factory powered 24 VAC control circuit. **DO NOT CONNECT 115 VOLT AC CONTROL POWER INTO THESE INTERLOCK CIRCUITS.**

  Further, care must be exercised in routing these interlock lines. They must not be sufficiently long to produce a voltage drop, and they must not be run in conduit with high voltage lines.
- 115 volt wiring to the compressor motor starter MCR coil circuits, to the control power source, and to condenser water pump and chilled water pump relay coils. 115 volt wiring is also required if relays are used to stage cooling tower fan operation. Two stages of tower control are possible. (See subsection "Cooling Tower Fan Control").
- Communications wiring.

A typical field wiring diagram is shown (Dwg. No. 706107C-01). Wire and components used must comply with the following:

1. Sensor wires must be shielded cable and must be grounded only at the MicroTech terminal strip end.
2. 24 volt wiring must be AWG No. 18 or larger depending upon length of run, and must be installed as NEC Class I wiring system, but must be run in a separate conduit from 115 volt or higher voltage wiring.
3. 115 volt wiring shall be AWG No. 12 or larger size depending upon length of run. Maximum voltage drop shall be 3%. This maximum voltage drop shall be considered in conjunction with the length of run in the determination of wire size. (See McQuay SVT-WS).
4. Transmitter wires providing a reset signal based upon chiller water temperature or motor current should be run in a separate conduit.
5. Communications wiring shall be standard insulated telephone wire, for telephone modem communication. In all other cases, use shielded twisted pair similar to Belden #8760. For complex communication and control systems see the wiring recommendations in other appropriate publications.
6. A Hayes or compatible modem with its own 115 volt power supply is required if phone communication will be used. Baud rate required is 1200. Communications interface shall be RS232. If direct, hardwired communication will be used, a dedicated, shielded twisted wire pair may be extended to not more than 5000 feet. Where hardwired communications of over 100 feet will be required, an RS422/485 communications interface is recommended.
7. Miscellaneous chilled water pump, condenser water pump, cooling tower fan motor control relays and an alarm relay are normally field supplied. These relays require either 115 volt or 24 volt coil, and are limited to a 25 VA maximum power consumption, per coil. (See Table 8 and the schematic wiring diagram).
8. A 0 to 7 volt AC, to 0 to 4 volt DC signal converter, or 4 to 20 mA, DC load signal is required at the customer furnished starter; or a separate factory mounted signal converter will be supplied if required.

If the customer will furnish a 0 to 20 milliamp signal to field connection terminals numbered 1 and 2 in lieu of a 0 to 5 volt AC signal, then a 249 ohm resistor, ±1%, ¼ watt must be connected across terminals 9 and 10 on the TS4 terminal strip. In addition, the transmitter must be capable of span adjustment to permit a final resolution of the peak control signal for 100% amps display on the MicroTech panel.

The optional factory supplied signal converter will accept a 0 to 7 volt AC signal. If the starter's current transformer and resistor circuit supplying this voltage is grounded, the ground must be connected to the side of the control circuit connected to the terminal 2 in the MicroTech panel Field Connection terminal strip.

Terminal strip TS1, used to connect field interlock wiring to the daughter board, will be disconnected at the daughter board prior to shipment. A qualified start-up technician, using an accurate voltmeter, and with interlock contacts closed, should read the voltage at each socket of the terminal strip TS1 before reconnecting the terminal strip to the daughter board. Voltage between each socket and terminal G should read approximately 24 volts AC. Following this verification, and with the power disconnected to the panel, the TS1 terminal may be connected as shown in Figure 15.

Figure 6. Analog Sensor Locations. (See Table 3 for Component Descriptions).

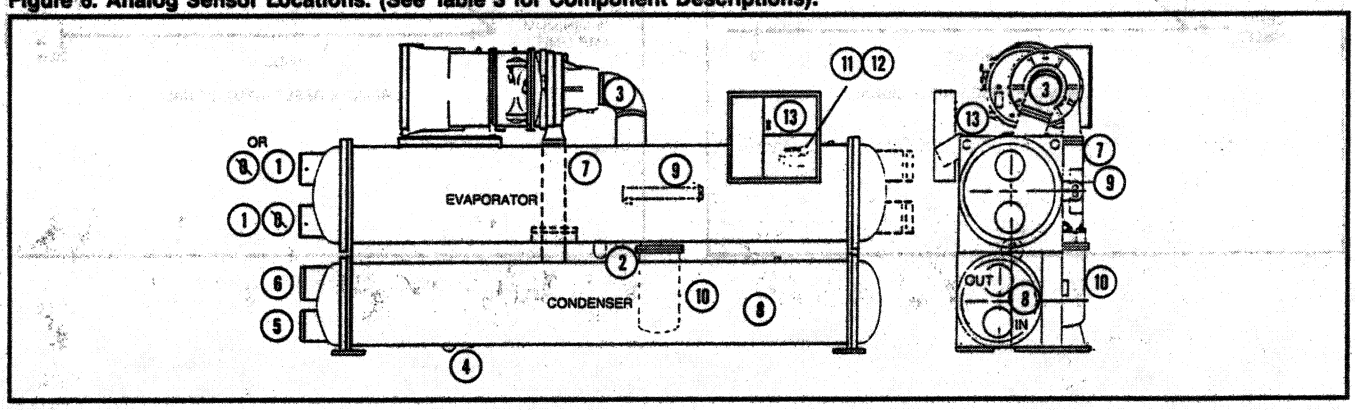
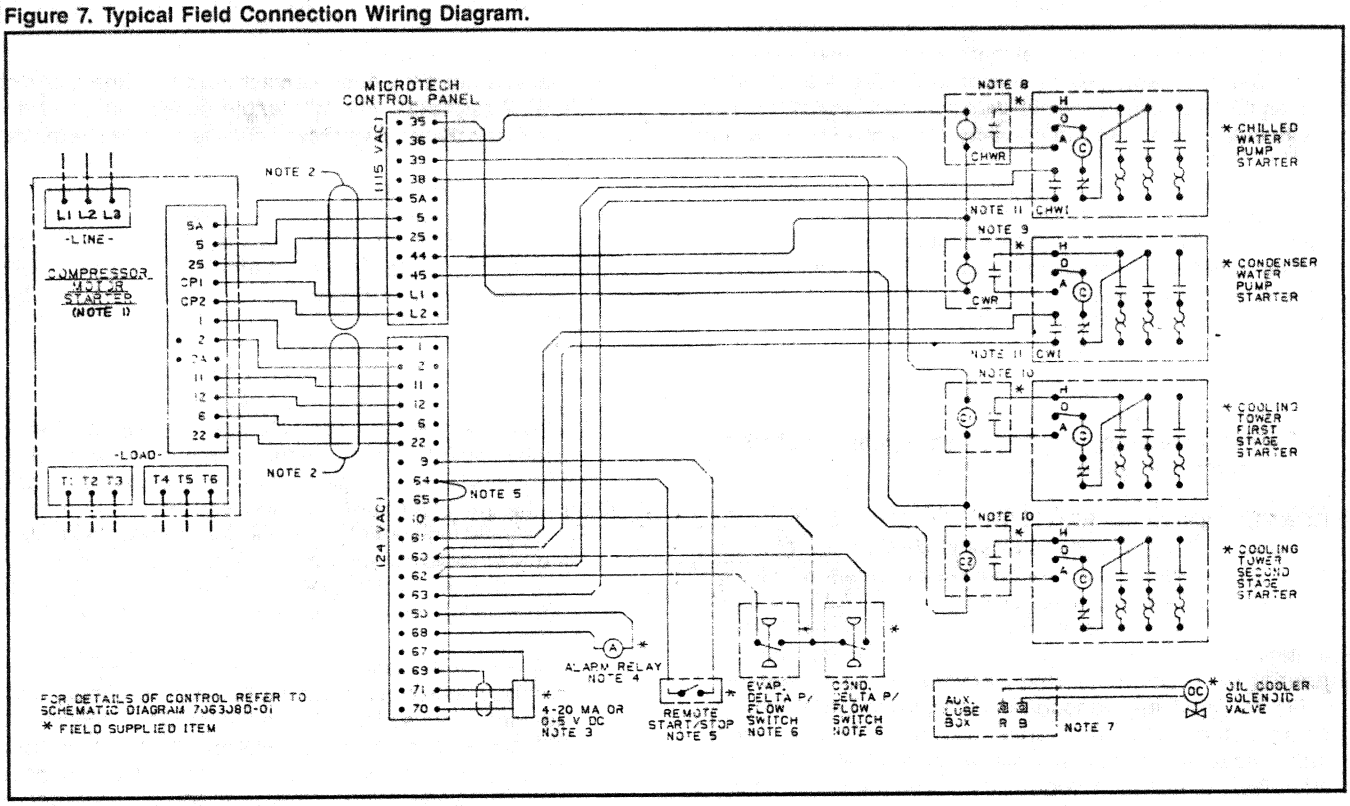


Figure 7. Typical Field Connection Wiring Diagram.



Wiring Notes

1. Compressor motor starters are either factory mounted and wired or shipped separate for field mounting and wiring. If provided by others, starters must comply with McQuay specification 359A999 or 7515A69. All line and load side power conductors must be copper.
2. If starters are free standing then field wiring between the starter and the control panel is required. Minimum wire size for 115V AC is 12 GA. for a maximum length of 50 feet. If greater than 50 feet refer to McQuay for recommended wire size. Wire size for 24V AC is 18 GA. All wiring to be installed as NEC Class I wiring system. All 24V AC wiring must be run in separate conduit from 115V AC wiring.
3. Optional reset of chilled water temperature or reset of motor current limit can be accomplished by wiring 4-20 MA DC as shown. If customer supplied transmitter does not have a power supply, then a 17V DC unregulated power supply can be obtained at terminal #67 of the control panel. It is recommended that transmitter wires be run separately from the 115V AC wiring.
4. An optional customer supplied 24V AC, 25 VA maximum rated alarm relay can be wired as shown. The circuit will be de-energized if any safety shutdown occurs.
5. Remote ON/OFF control of units for multiple unit applications can be accomplished by installing a set of dry contacts between terminals 9 and 64. If an additional point of ON/OFF control is required, remove jumper J6 from terminals 64 and 65 and install the additional set of dry contacts.
6. Evaporator and condenser water pressure differential or paddle type flow switches are required and must be wired as shown. If field supplied pressure differential switches are used then these must be installed across the vessel and not the pump.
7. Oil cooler solenoid valve (ASCO) model –8210B27 is required on some models. If not factory installed, refer to the installation manual and wire as shown.
8. An optional customer supplied 115V AC maximum coil rated chilled water pump relay (CHWR) may be wired as shown. This option will cycle the chilled water pump in response to building load.
9. The condenser water pump must cycle with the unit. A customer supplied 115V AC, 25VA maximum coil rated condenser water pump relay (CWR) is to be wired as shown.
10. Optional customer supplied 115V AC, 25 VA maximum coil rated cooling tower fan relays (C1, C2) may be wired as shown. This option will cycle the cooling tower fans in order to maintain unit head pressure.
11. Auxilliary 24V AC rated contacts in both the chilled water and condenser water pump starters must be wired as shown. ALL WIRING to be NEC Class 1.

STARTER TYPE

McQuay Centrifugal chillers are primarily designed for use with Star-Delta and auto-transformer starters requiring a transition between starting stages.

They can also be used with across-the-line starters where no transition takes place. In this event (i.e., there is no transition in the starter), it is necessary that a normally open auxillary contact on the starter be wired between control panel terminals numbered 11 and 12.

STARTER OVERLOAD RELAY CONTACTS

The MicroTech control panel is designed to accept an overload trip action from a conventional thermal or magnetic overload; or from a solid state device similar to the McQuay IQ-1000.

If an IQ-1000 or similar solid-state overload is used, the normally closed overload trip contacts are wired in series with the MCR (Main Contactor Relay) coils.

An additional set of trip relay contacts on the solid state overload are wired between the MicroTech control panel terminals 6 and 22. These terminals should be the type that are closed whenever control power is applied to the overload device, and open when:

1. Power to the device is interruped ***or***
2. An overload trip occurs

When this overload relay trips, the control panel display will indicate a "Starter Fault".

IQ-1000 contacts to be wired in series with MicroTech terminals number 6 and 22 are terminal numbers 15 and 16.

CONVENTIONAL OVERLOADS

In the event the overloads used with the MicroTech panel are conventional thermal, or magnetic, their normally closed contacts should be wired in series with the MCR coil(s). Since there is no second, parallel, set of contacts to be wired across terminals numbered 6 and 22 on the MicroTech panel, ***a jumper must be connected between these terminals.***

Operation of the overload trip is displayed under this condition by the message "Starter Transition". This display occurs because the auxillary starter contact wired between MicroTech terminals number 11 and 12 will open, with an overload signaling the shutdown.

MULTIPLE STARTER RESISTORS (Use of Terminals 2 and 2A)

Many installed starters are equipped with two resistors in the current transformer's circuit. These are identified as resistor A and resistor B. The second resistor, resistor B was required for the McQuay resistance type load balance. With MicroTech's lead-lag, load balance accessory control, the B resistor is not required and can be deleted from the circuit simply by adding a jumper between terminals 2 and 2A.

CHILLED WATER PUMP CONTROL

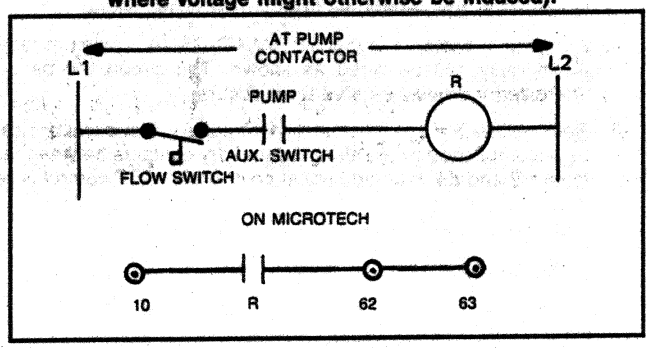
The MicroTech control panel has been designed to permit the chiller control panel to initiate the starting and stopping of the chilled water pump in response to a call for the chiller's operation.

This feature may or may not be used, at the option of the system designer.

If it is not used, that is, if the system is designed such that the chilled water pump is started by a remote time clock, or separate manual pushbutton station,

1. A chilled water relay need not be installed between control panel terminals number 36 and 44 an shown in wiring diagrams numbered 706308D.
2. Interlock connections such as a flow switch, or water differential pressure switch , and pump starter interlock connections must be wired between control panel terminals numbered 10, 62 and 63.
3. If the chilled water pump's "On" and "Off" operation will be the primary control signal to start and stop the chiller, the following hardware and control sequence are recommended to protect the chiller from damage and eliminate any possibility of nuisance safety trips. (See Figure 9).
   a. Install a chilled water flow switch or differential pressure switch and a chilled water pump starter interlock in the protective circuit provided (between terminals 10, 62 and 63).
      Follow the guidelines recommended in paragraph 4 concerning wiring for the flow switch and interlock circuit.
   b. Install a normally open contact from the time clock or EMCS to the 24 volt AC remote switch circuit of the MicroTech panel. Wire these contacts between terminals 9 and 64 on the MicroTech field terminal strip.
      Be sure to program the set-up options key for "Remote" control as described under the keypad functions.
   c. The time clock control must be another normally closed set of contacts. These are required to start the chilled water pump by closing a contact in the circuit to the pump contactor coil (PC), and to close a circuit to an instant on (IOT) or a solid-state timer (SSTD) as shown. See the applicable proposed wiring diagram.
   d. These devices work in the following manner:
      When the time clock or EMS control calls for the air conditioning system to operate, it will complete the electrical circuit to the chilled water pump contactor, and to the chiller's remote starting switch.
      The chilled water pump will start immediately, closing flow switches and interlocks in the chiller's protective circuit. Concurrently, closure of the remote (MicroTech) contact circuit will begin the normal chiller starting sequence.
      As the time clock, or EMS is satisfied, it will open its normally open contacts, and will close the normally closed contacts in series with the IOT or SSTD coil circuit. IOT, or SSTD contacts in parallel with the normally open TC contact in the pump contactor coil circuit will close instantly, keeping the pump energized for 3 to 4 seconds (the minimum time delay recommended) after the MicroTech's remote control circuit has been opened.
      In this manner, the chiller will cycle through a normal controlled shutdown without tripping on chilled water pump safety controls.
      At the same time, water flow switches are operable as protective controls should the need arise.
4. Interlock wiring must NOT be connected to a separate voltage source outside of the MicroTech panel. Internally, one side of the connection (terminal No. 10) is connected to +24 volts AC. Further, if the wiring will be of a very long run, creating excessive voltage drop or will run in conduit with other, high voltage wiring causing induced current flow, a separate relay and contact circuit may be required. (See Figure 8).

Figure 8. Alternate Interlock Wiring. (For long runs for systems where voltage might otherwise be induced).

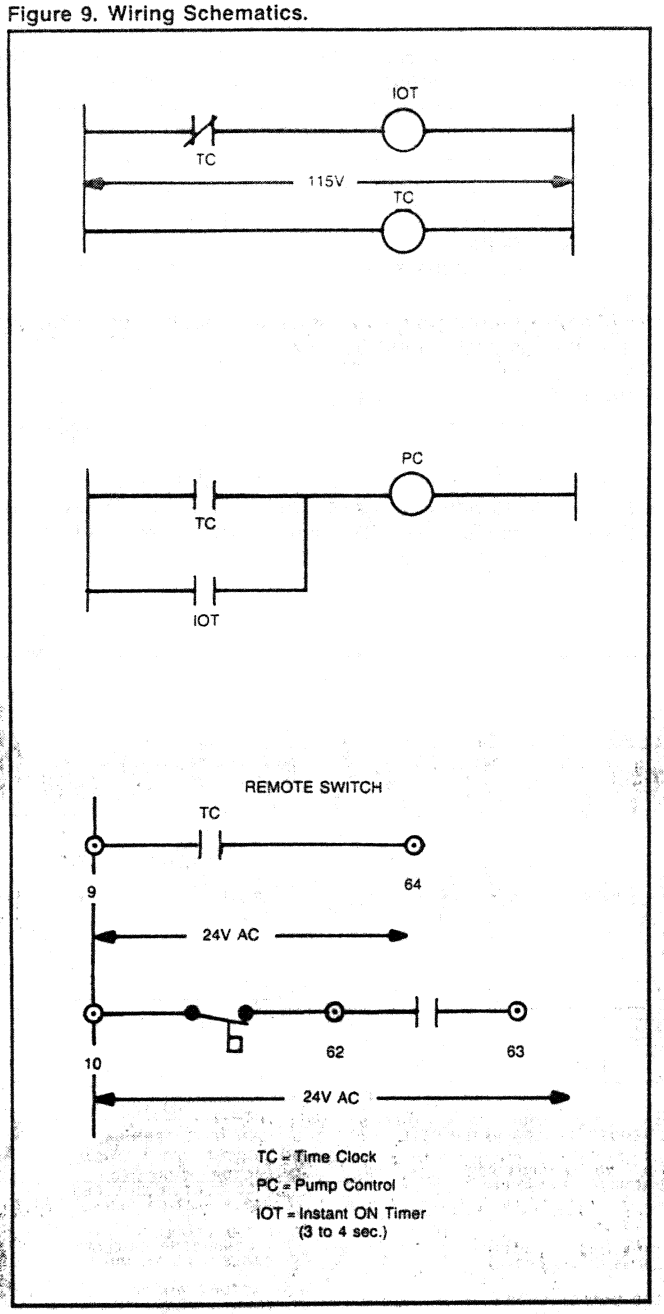


If the MicroTech panel ***will be used to start and stop the chilled*** water pump, the system designer should be aware that the pump will routinely cycle off only with an interruption in the switch, time clock, or protection, circuit. The pump will not cycle off when the controlling chilled water thermostat is satisfied.

If this action is not desirable because the controlled pump is the principal system pump, the alarm relay circuit may be used with a normally closed contact to provide a parallel contact in the pump's control circuit.

Should this latter wiring be considered provision must be made to open this circuit during scheduled downtimes.

Figure 9. Wiring Schematics.



ALARM RELAY

(See Table 1 for Relay Coil Characteristics)

Provision exists on the MicroTech control panel to activate an alarm circuit whenever a fault occurs.

The 24 volt alarm relay (field supplied) is normally energized whenever 120 volt control power is applied to control panel terminals number L1 and L2 and the 3 amp circuit breaker is closed.

If a fault occurs, preventing the chiller from operating, and the fault is recorded by the MicroTech control, the alarm relay circuit will open, de-energizing the relay.

Normally closed relay contacts should be used in a separate circuit to annunciate the fault.

NOTE: If an alarm relay is used, we suggest that the annunciation circuit include a service 'interruption' switch to prevent unnecessarily triggering an alarm during normal service operations.

Table 1. Customer Furnished A.C. Operating Relays.

RELAY	SYMBOL	COIL* VOLTAGE	CONTACTS	STATUS
Chilled Water Pump Relay	CHWR	115	N.O.	Optional
Condenser Water Pump Relay	CHR	115	N.O.	Required
Cooling Tower Fan Relay	C1	115	N.O.	Optional
Cooling Tower Fan Relay	C2	115	N.O.	Optional
Alarm Relay	A	24	N.C.	Optional

* No single coil with a rating of more than 25 VA may be connected. Maximum total VA rating of field supplied coils shall not exceed 125 VA.

COOLING TOWER FAN CONTROL

The MicroTech panel includes software capability to start and stop two stages of cooling tower fans in response to differential refrigerant pressure.

The system offered provides a form of head pressure control. If it will be used, the installer must provide one or two 115 volt coil relays to be wired as shown in the field wiring diagram. See Table 1 for relay characteristics.

The field supplied relay(s) will be energized as required by the operating compressor's refrigerant pressure differential through the factory mounted solid-state relays. These latter relays will energize and de-energize based upon the settings programmed for them under the set-up options keypad.

Contacts from the installer furnished relays will be imposed in the starting circuit for the tower fan(s) contactor coil.

The MicroTech design is such that one or both of the tower fan control relays may be omitted, and tower fan control furnished in another manner.

The installer should also note that tower fan cycling by itself may not be adequate to prevent lower than desirable refrigerant condensing pressure. If the building load, tower and fan size or arrangement, and ambient wet bulb temperature combine to require adjustments in water flow in the condenser water system, the engineer or installer should provide that piping and control.

Table 2. Tower Fan Control.

STAGE	"ON" PSID		"OFF" PSID	
	RANGE	FACTORY SETPOINT	RANGE	FACTORY SETPOINT
#1	45 to 55	50	35 to 45	40
#2	50 to 60	55	40 to 50	45

LEAD-LAG/LOAD BALANCE (LLLB)

The lead-lag/load balance (LLLB) control is a special purpose computer. It is designed to interact with two separate MicroTech unit panels for maximum control efficiency. Through a simple twisted pair wiring connection between the wall, or unit mounted, controller, and two MicroTech unit panels, the computer designates the lead chiller, directs the lag machine to start and stop in response to pre-determined operating conditions, and causes the machines to operate at approximately equal percent of RLA when both units are operating.

Since the LLLB controller has no display or keypad, the primary start/stop protective control functions remains with each individual MicroTech unit panel. For this reason, each MicroTech unit panel must be programmed entirely; and at equal values of temperature, reset and clock scheduling. The single difference between the two MicroTech unit control panels should be the hex switch settings of the Display EnGinn. Set all hex switches according to the values shown in Table 11.

Whether or not the clock schedule will be used to control daily or weekly operating hours, the clock schedule *MUST* be activiated on each chiller if the lead-lag/load balance accessory is expected to work. The clock schedule is activiated by pressing the "Clock Schedule" keypad 10 times, then setting the display "S1 First Day = Sun" (or Mon. etc). This setting must *NOT* read "=OFF". With the clock schedule activiated, it will be desirable to check the holiday settings to be sure the units will run on all of the days intended. If no holiday shut-off dates are wanted, set the holiday month and date at "0", "0". For more information see the keypad section covering the "Clock Schedule".

Dual compressor units shipped from the factory have the clock schedule S1 First Day=Sun.

For more detailed information on the LLLB control panel, see IM 425.

WIRING

The contractor will mount the LLLB control panel within sight of the chillers in a reasonably accessible location. A source of 115 volt AC control power must be connected to terminals L1 and L2 inside the LLLB box. Wiring must be sized to carry not less than 5 amps. Shielded twisted pair wiring of 22 AWG minimum should be connected between the remote controller and communications port B of the Display EnGinn on each MicroTech panel.

See the appropriate field connection wiring diagram for specific details.

On dual compressor PFH units, the panel may be factory mounted and the wiring complete.

REMOTE RESET CONTROL

In the event remote reset of chilled water and/or electrical demand will be provided, the customer furnished 4 to 20 mA transmitter(s) and wiring must be connected to the LLLB box, and not to individual MicroTech unit panels. The "Set-up Options" key for each MicroTech panel must, however, reflect the reset options(s) chosen.

Figure 10. Lead-Lag Wiring Diagram.

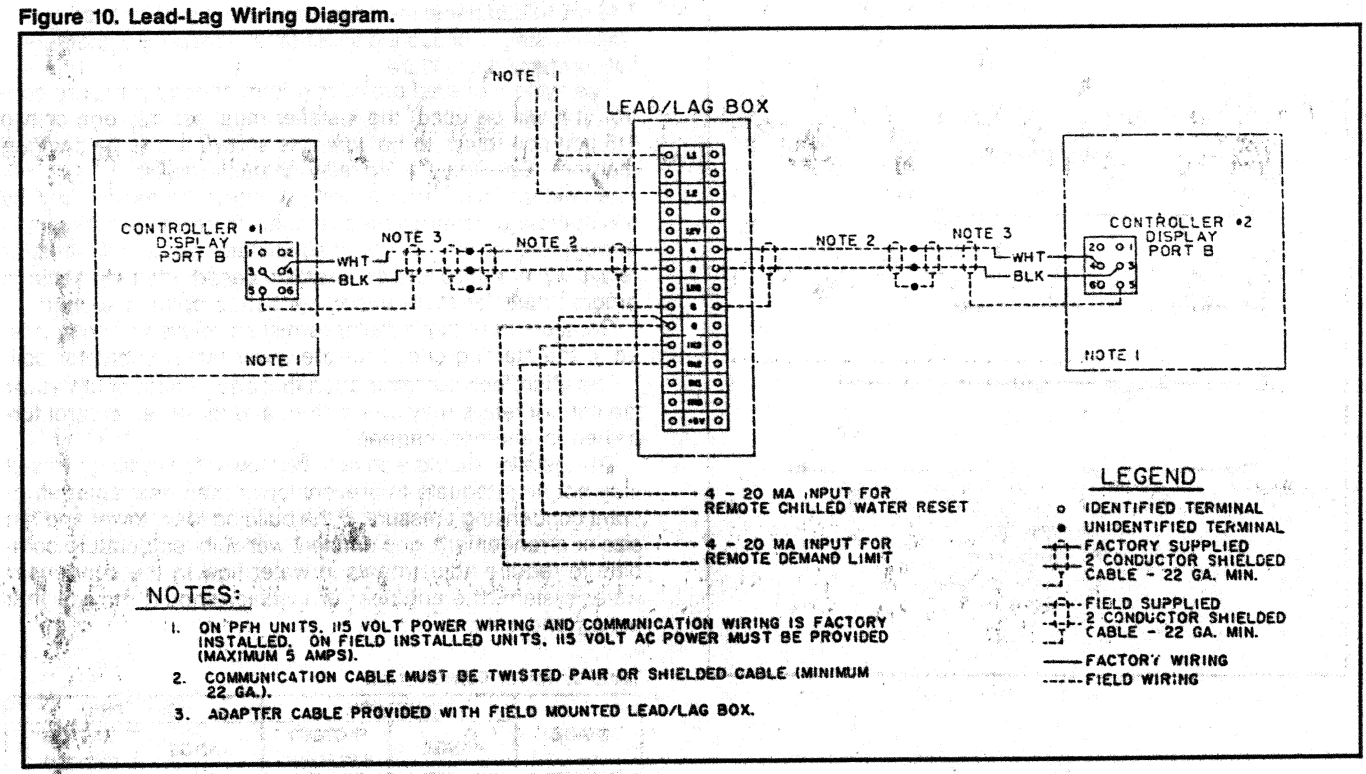


Figure 11. Analog Sensor Locations

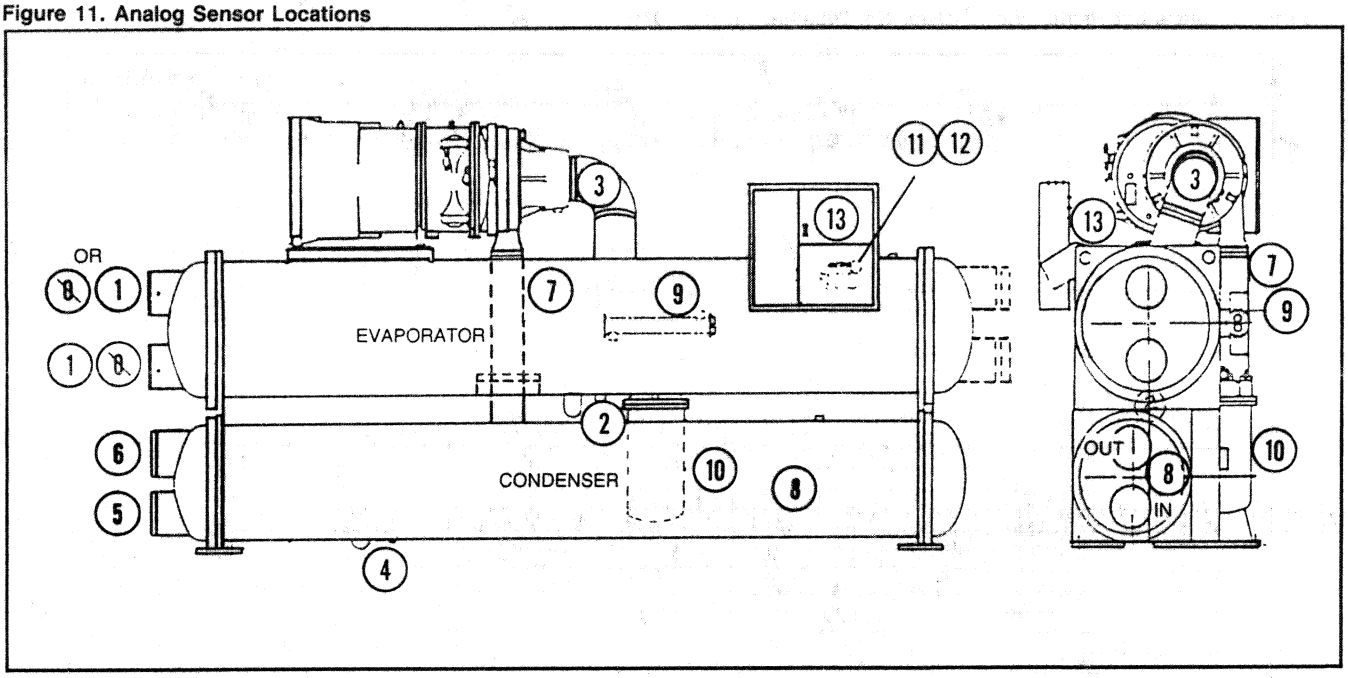


Table 3. Control Devices

SENSOR DESCRIPTION	SENSOR REF. NO.	TYPE INPUT	TERMINAL STRIP LOCATION	COMPONENT LOCATION
Evap. LV Water Temp.	00	Analog	TS3-01/02	LV chilled water nozzle on the evaporator.
Evap. Ent. Water Temp.	01	Analog	TS3-03/04	Entering chilled water nozzle on the evaporator.
Evap. Satur. Refr. Temp.	02	Analog	TS3-05/06	Strapped to the shell or in a well at the bottom of the evaporator.
Compr. Refr. Suction Temp.	03	Analog	TS3-07/08	Strapped to, or in a well in the suction inlet to the compressor.
Cond. Liquid Line Temp.	04	Analog	TS3-09/10	Strapped to the refr. liquid line at the condenser outlet.
Cond. Ent. Water Temp.	05	Analog	TS3-11/12	At the condenser water inlet nozzle.
Cond. LV Water Temp.	06	Analog	TS3-13/14	At the condenser water outlet nozzle.
Refr. Disch. Temp.	07	Analog	TS3-15/16	Strapped to the compressor discharge line.
Cond. Saturated Refr. Temp.	08	Analog	TS4-01/02	Strapped to the shell or in a well in the side of the condenser.
Oil Feed Temp.	09	Analog	TS4-03/04	On the oil line leaving the oil cooler & entering the compressor.
Oil Sump Temp.	10	Analog	TS4-05/06	Strapped to, or in a well in the oil pump below the oil level.
Reset-Evap. LV Temp. or Mtr. Amps	11	Transducer	TS4-07/08	4—20 mA signal from remote, customer supplied source.
Mtr. Current-Capacity Signal	12	DC Volt Signal	TS4-09/10	From a 5 volt AC to 4 V DC signal converter in the unit control panel.
Oil Gauge Pressure	13	Transducer	TS4-11/12	From a pressure to electric signal transducer located on the back of the MicroTech control panel.

Table 4.

OPERATING CONTROL DESCRIPTION	SYMBOL	TYPE INPUT	TERMINAL STRIP LOCATION	COMPONENT LOCATION	SWITCH POSITION
Manual Stop-Auto Switch	SW1	Digital	TS1-06(A)	Mounted in the front MicroTech cover panel.	Must be closed to start & run.
Remote (Optional) Start-Stop Switch	SW2	Digital	TS1-11(B)	Remote (Optional) switch, may be located anywhere.	Closed to start & run.

Table 5.

PERMISSIVE INTERLOCK CONTROLS	SYMBOL	TYPE INPUT	TERMINAL STRIP LOCATION	COMPONENT LOCATION	SWITCH POSITION
Cond. Water Interlock Contacts	CWI	Digital	TS1-08(B)	Cond. water pump starter interlock.	Closed to start & run.
Cond. Water Flow Switch	CW	Digital	TS1-08(B)	Differential or flow switch in the cond. water piping.	Closed to start & run.
Ch. W Interlock contacts	CHWI	Digital	TS1-09(B)	Chilled water pump starter interlock	Closed to start & run.
Ch. Water Flow Switch	CHW	Digital	TS1-09(B)	Differential or flow switch in the chilled water piping.	Closed to start & run.
Starter Transition Interlock	2mA	Digital	TS1-10(B)	A mechanical interlock on the main compr. starter.	Closes on start—Closed to run.
Vane Close Switch	VC	Digital	TS1-12(B)	Switch is mounted in the compr. lube box.	Must be closed to start, can be open during run.

Figure 12. Typical Schematic Wiring (Dwg. No. 706308D-01, Rev. OM)

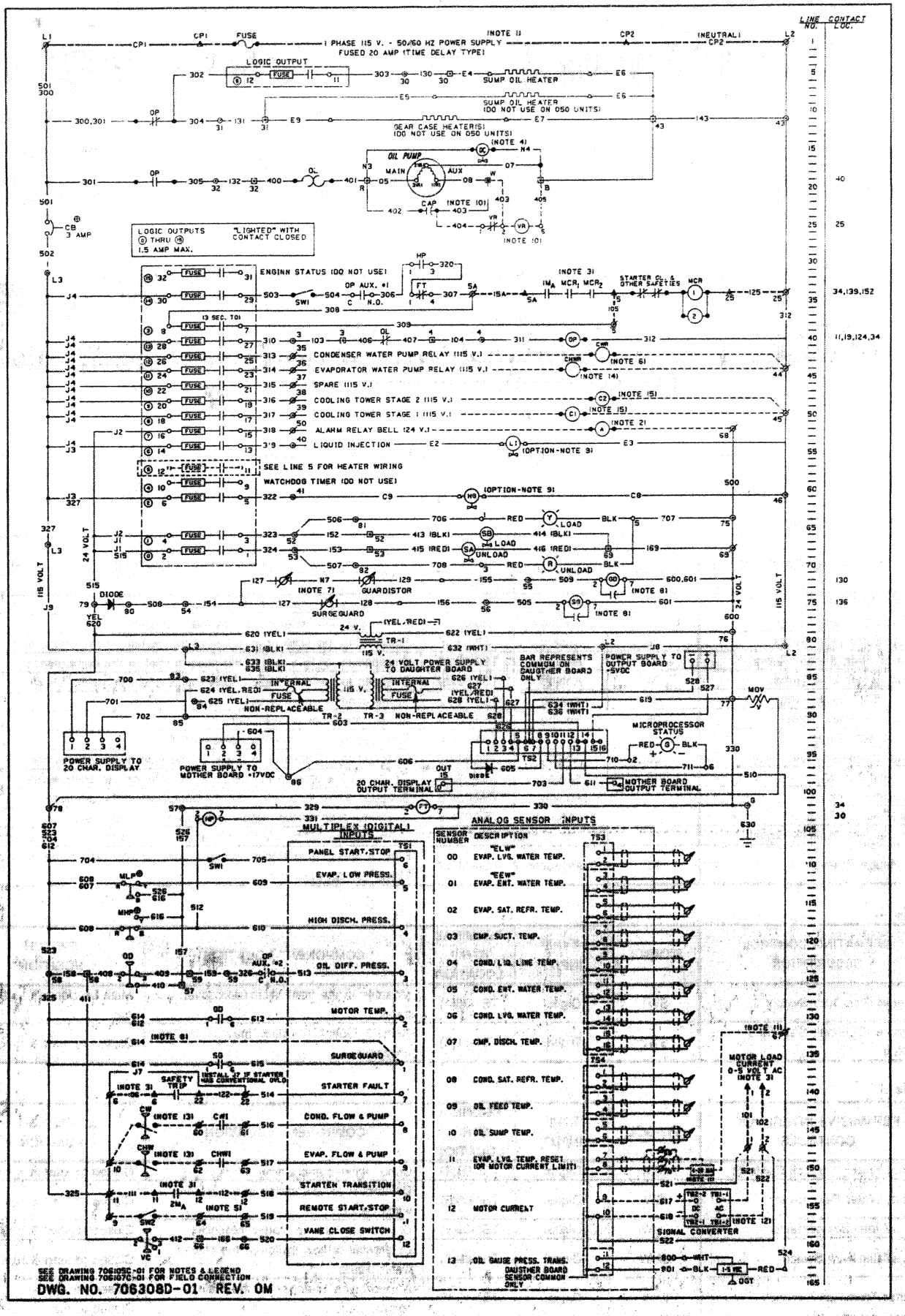


Figure 13. Legend—Symbols and Wiring Schematic Notes (Dwg. No. 706105C-01)

LEGEND

A . . . . . ALARM, RELAY COIL
CAP . . . . . CAPACITOR
CB . . . . . CIRCUIT BREAKER
CHW . . . . . EVAPORATOR FLOW SWITCH
CHWI . . . . . EVAPORATOR WATER INTERLOCKS
CHWR . . . . . EVAPORATOR WATER RELAY
CW . . . . . CONDENSER FLOW SWITCH
CWI . . . . . CONDENSER WATER INTERLOCKS
CWR . . . . . COND. PUMP CYCLING RELAY
C1 . . . . . COOLING TOWER FAN RELAY (STAGE 1)
C2 . . . . . COOLING TOWER FAN RELAY (STAGE 1)
G . . . . . LIGHT (GREEN). MICRO STATUS
FT . . . . . FAULT RELAY
GD . . . . . GUARDISTOR RELAY
HG . . . . . HOT GAS SOLENOID
HP . . . . . HIGH PRESSURE RELAY
LI . . . . . LIQUID INJECTION SOLENOID
MHP . . . . . MECHANICAL HIGH PRESSURE SWITCH
MLP . . . . . MECHANICAL LOW PRESSURE SWITCH
M_A . . . . . CONTACTOR AUXILIARY
MCR . . . . . MTR. CONTR. RELAY (STARTER)
OC . . . . . OIL COOLER SOLENOID
OD . . . . . OIL PRESS. DIFFERENTIAL SW.
OL . . . . . OVERLOAD
OP . . . . . OIL PUMP CONTACTOR
OGT . . . . . OIL GAUGE PRESSURE TRANSDUCER
PT . . . . . PNEUMATIC PRESSURE TRANSDUCER
R . . . . . LIGHT (RED). UNLOAD
SA.SB . . . . . VANE CONTROL SOLENOIDS
SG . . . . . SURGEGUARD RELAY
SW1 . . . . . PANEL START/STOP SWITCH
SW2 . . . . . REMOTE START/STOP SWITCH
TR-1. TR-2. TR.3 . . . . . TRANSFORMER (24 VAC CT)
TS1. TS2. TS3. TS4. . . . . DAUGHTERBOARD CONN.
TO . . . . . TIMED OPEN CONTACTS
VC . . . . . VANE CLOSE SWITCH
VR . . . . . VOLTAGE RELAY
Y . . . . . LIGHT (YELLOW). LOAD

TERMINAL SYMBOLS

- CONTROL BOX TERM. FACTORY WIRING
- CONTROL BOX FIELD CONN. TERM.
- LUBE BOX TERMINAL
- STARTER TERMINAL
- LEAD/LAG TERMINAL
- UNIDENTIFIED TERMINALS
- IDENTIFIED TERMINALS
- AUTOMATIC RESET
- MANUAL RESET
- THERMISTOR
- FACTORY WIRING
- FIELD WIRING
- STARTER WIRING
- OPTIONAL WIRING
- CABLE—TWISTED. SHIELDED AND JACKETED PAIR

NOTES:

1. A separate 115 V ± 10% 60 HZ, 115 V +5% −10% 50 HZ single phase power supply is required. Fuse size requirement is 20 amp fusetron on L1 only. L2 is a grounded neutral.
2. A customer furnished 24 volt alarm relay coil may be connected between terminals 50 and 68 of the control panel. The alarm coil will de-energize when safety shut down occurs. Maximum rating of the alarm relay coil is 25 VA.
3. The compressor motor starters may be free standing or factory mounted. If factory mounted, all the control wiring between the starter and the control panel is factory wired.
4. Oil cooler solenoid is a factory installed option on some models. If field supplied it must be wired to terminals B and R located in the lube control box.
5. Remote ON/OFF control of units for multiple unit applications can be accomplished by installing a set of dry contacts between terminals 9 and 64. If an additional point or ON/OFF control is required, remove jumper J6 from terminal 64 and 65 and install the additional set of dry contacts.
6. Condenser water pump must cycle with the compressor by connecting a 115V relay coil (CWR) with a maximum rating of 25 VA between terminals 35 and 44.
7. Three or four thermistors may be used depending on motor size and type.
8. Surgeguard relay is not used on units employing a CE050 compressor. On these units lead 614 is routed directly from guardistor relay terminal 1 to TS1-1.
9. Liquid injection solenoid (L1) and hot gas solenoid (HG) are found only on units supplied with these options.
10. Voltage relay (VR) is used on units employing a CE050 compressor. On the remaining units VR leads 404 and 405 are deleted and lead 403 is routed from terminal W to the capacitor.
11. A customer supplied 4-20 MA signal can be supplied for chilled water temperature reset or motor current limit reset. If the customer supplied signal requires a power supply, then a 17 VDC unregulated power supply is available at terminal 67.
12. A signal converter is supplied on units where the starter is not furnished with a 0—5 VDC or 4—20 MA DC load signal. If signal is available then signal converter leads 617 and 618 are deleted and lead 521 is routed from terminal 1 to TS4—9 and lead 522 is routed from terminal 2 to TS4—10.
13. Water flow protection for both the evaporator and condenser must be provided. This protection shall consist of a flow switch or differential pressure switch wired between terminals 10 and 62 for the evaporator, and 10 and 60 for the condenser. In addition each pump starter shall have a set of auxillary contacts wired to the following terminals (Evap.-Terminals 62 and 63: Condenser-Terminals 80 and 81).
14. A customer furnished 115 V evaporator water pump relay (CHWR) may be connected between terminals 36 and 44. This relay will energize anytime the control requires the evaporator water pump to be energized. The maximum rating of this coil is 25 VA.
15. Condenser water temperature control can be obtained by connecting two customer furnished staging relays between terminals 39 and 45 for the first stage and 38 and 45 for the second stage. The maximum rating of these coils is 25 VA.

Table 6. Field Connection Terminal Strip

TERMINAL NO.	VOLTS	FIELD WIRING	CONNECTION FROM	CONNECTION TO
71	+1, to +5 VDC	Y*	4-20 mA Source	TS4-7**
70	G	Y*	4-20mA Source	TS4-8**
69	G	Y*	Shield Cable (Above)	GRD
68	G	Y*	Alarm Relay Coil	GRD
67	17 VDC	Y*	TS2-14	4-20 mA Source & OGT
66	24 VAC	N	Lube Box (V.C. sw)	TS1-12
65	24 VAC	Y*	Terminal No. 64	TS1-11
64	24 VAC	Y*	Remote SW2	Terminal No. 65
63	24 VAC	Y	CHWI Interlock	TS1 No. 9
62	24 VAC	Y	CHW Flow Switch	CHWI Interlock
61	24 VAC	Y	CWI Interlock	TS1-8
60	24 VAC	YC	CW Flow Switch	CWI Interlock
59	24 VAC	N	Lube Box (O.D. sw)	Com-Term OP Aux. Contact
58	24 VAC	N	Term 78	Lube Box (O.D. & VC Sw)
57	24 VAC	N	MHP & MLP & Lube Box (O.D. Sw)	Fault Relay Coil
56	24 VDC	N	Surgeguard Sensor	Surgeguard Relay Coil
55	24 VDC	N	Guardistor Sensor	Guardistor Relay Coil
54	24 VDC	N	Terminal 80	SG & GD Sensors
53	24 VAC	N	Output Relay #0	SA Unload Solenoid & Light
52	24 VAC	N	Output Relay #1	SB Load Solenoid & Light
51	Not Used	—	———	———
50	24 VAC	Y*	Output Relay #7	Alarm Bell Relay Coil
22	24 VAC	Y	Starter Fault Safety Trip	TS1-7
12	24 VAC	Y	Starter 2 MA Aux.	TS1-10
11	24 VAC	Y	Terminal 58	Starter 2 MA Aux.
10	24 VAC	Y	Terminal 58	CW & CHW Flow Sw.
9	24 VAC	Y*	Terminal 58	Remote Switch Sw. 2
6	24 VAC	Y	Terminal 58	Starter Fault Safety Trip
2A	N/A	—	———	———
2	0-7 VAC	Y	CT in Starter	TS4-10
1	0-7 VAC	Y	CT in Starter	TS4-9
47	Spare	———	———	———
46	Neutral	N	Hot Gas Solenoid	115 Neutral
45	Neutral	Y*	Cooling Tower Fan Starter Coils	115 Neutral
44	Neutral	Y	CWR & CHWR Coils	115 Neutral
43	Neutral	N	Lube Box (OP & Htrs.)	115 Neutral
25	Neutral	Y	Starter MCR Coils	115 Neutral
L2	Neutral	Y	Power Source	Neutral Side of Coils
41	115	N	Output Relay #2	Hot Gas Solenoid
40	115	N	Output Relay #6	Lig. Injection Solenoid
39	115	Y*	Output Relay #8	Cooling Tower Fan Relay
38	115	Y*	Output Relay #9	Cooling Tower Fan Relay
37	115	Spare	———	———
36	115	Y	Output Relay #11	CHWR Coil
35	115	Y	Output Relay #12	CWR Coil
4	115	N	Lube Box (OL Sw)	Oil Pump Contactor Coil
3	115	N	Output Relay #13	Lube Box (OL Sw)
32	115	N	Oil Pump Contactor	Lube Box (OL Htr.)
31	115	N	Oil Pump NC Contact	Lube Box (Sump Htr.)
30	115	N	Output Relay #5	Lube Box (Sump Htr.)
5A	115	Y	Starting Circuit	Output Relay #3 & MCR Interlock Circuit
5	115	Y	Output Relay #3	Starter MCR Terminals
L3	115	N	3 Amp Circuit Breaker	115 Volt Power Circuits
L1	115	Y	Control Power Source	OP-Htrs. & Circuit Breaker

NOTES:

Red Leads are 115 volt power
Yellow Leads are 24 volt power
White Leads are neutral ground

* Asterisk after Y in the Field Wiring column indicates that the device is an option. If the option is elected, Field Wiring is required.

Field Wiring Required: Y = Yes; N = No

** Terminals 70 to 71 include a 250 ohm resistor wired to produce a one to five volt control signal.

Figure 14. Open Panel.

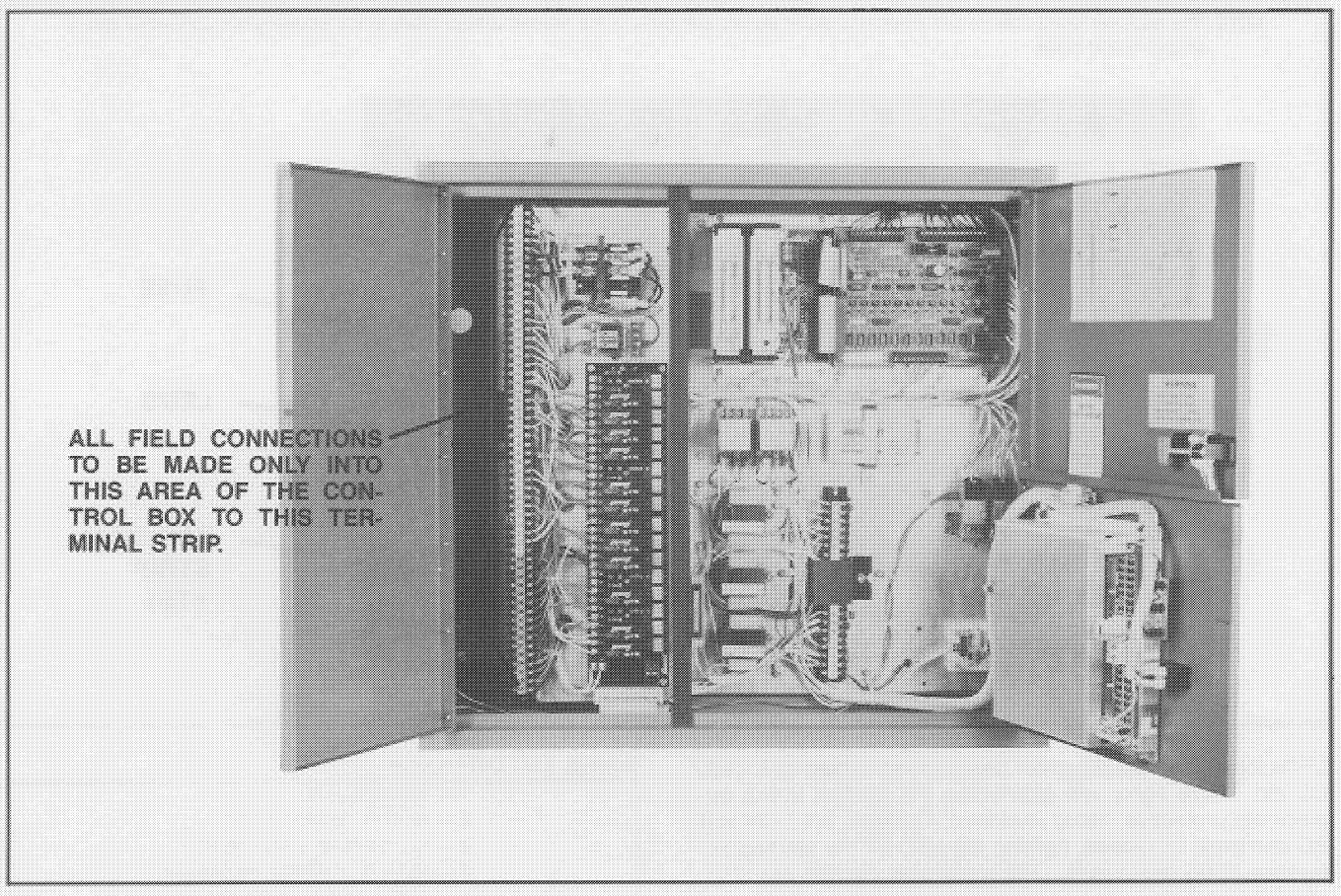


Table 7. Output Relay Switches

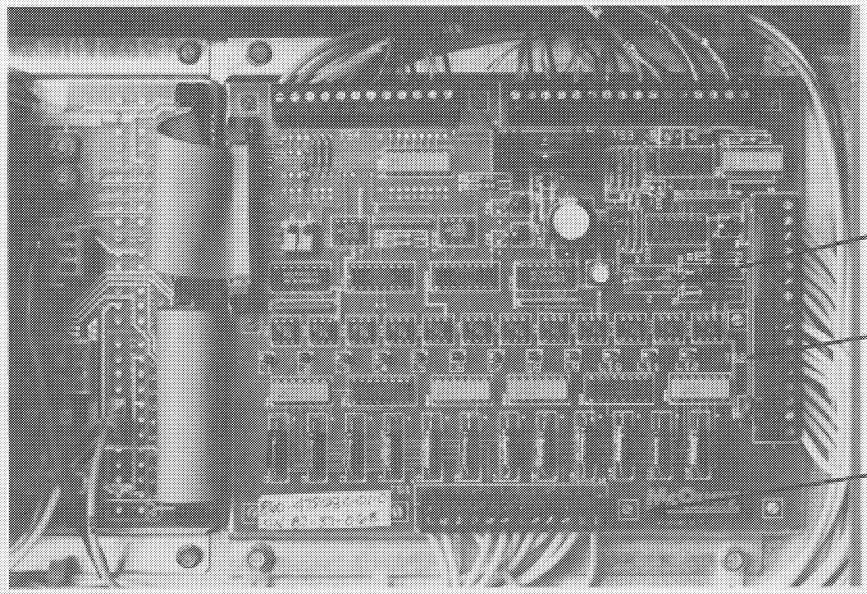
OUTPUT DESCRIPTION	DEVICE OPERATED	RELAY NUMBER	SWITCH CONTACT TERMINAL NOS.	TERMINAL VOLTAGE **
Compressor Unloading Solenoid	SA Solenoid & Light	0	2—1	24
Compressor Loading Solenoid	SB Solenoid & Light	1	4—3	24
Hot Gas Bypass Control	HGBP Solenoid	2	6—5	115
Starter Interlock Bypass Timer	MCR Coils	3	8—7	*
Watchdog Timer	Microprocessor Protection	4	10—9	—
Oil Heater Control	Sump Oil Heater	5	12—11	115
Liquid Injection Control	Liquid Injection Solenoid	6	14—13	115
Alarm Signal	Alarm Relay	7	16—15	24
Cooling Tower Fan Control	Cycles #1 Tower Fan	8	18—17	115
Cooling Tower Fan Control	Cycles #2 Tower Fan	9	20—19	115
115 Volt Spare	————————————	10	22—21	115
Evaporator Water Pump Control	Energizes Evaporator Water Pump Relay	11	24—23	115
Condenser Water Pump Control	Energizes CW Pump Relay	12	26—25	115
Oil Pump Starter Control	Energizes Oil Pump Starter	13	28—27	115
MCR Coil Control	Energizes the Circuit to Start the Comp.	14	30—29	115
EnGinn Status Relay	————————————	15	32—31	—

* Relay Switch No. 3 will have 115 volts or zero volts on both terminals depending upon whether or not the circuit through relay No. 14 is completed to control panel terminal No. 5A.

** **USE CAUTION.** Ground side terminals may carry 115 volt (or 24 volts) to ground even when the relay is de-energized. See "Recommended Testing Procedure" for Solid-state Relay Switches.

Figure 15. Daughter Board

NOTE: The daughter board collects and conditions digital signals and delivers the needed voltage levels to the adjoining microprocessor thru a plug-in ribbon cable.



LEDs located on the daughter board are identified as L1, L2, L3, etc. These lights will glow when the contact in the appropriate protective circuit is closed. Contacts are +24 volt AC and must be closed, lighting the LED for the starting sequence to be completed. LED numbered circuits are identified in Table 8.

Table 8. LED Description

1 — SURGEGUARD
2 — MOTOR TEMPERATURE
3 — OIL DIFFERENTIAL SWITCH
4 — HIGH DISCHARGE PRESSURE
5 — EVAPORATOR LOW PRESSURE
6 — PANEL START/STOP
7 — STARTER FAULT
8 — CONDENSER FLOW & PUMP
9 — EVAPORATOR FLOW & PUMP
10 — STARTER TRANSITION
11 — REMOTE START/STOP
12 — VANE CLOSE SWITCH

Table 9. Daughter Board Terminal Connections.

TERMINAL NO.	VOLTS (To GRD)	CONNECTION FROM	CONNECTION TO
TS2-1	GRD	TS2-8	Daughter Board
TS2-2	12 VAC	TRANS-3	Daughter Board
TS2-2	12 VAC	TRANS-3	Daughter Board
TS2-4	GRD	TRANS-3	TS2-5 & 6 & 7 & 8
TS2-5	GRD	TRANS-2 & TS2-4	Daughter Board
TS2-6	GRD	TS2-5 & 4	Neu at Output Board Power Supply
TS2-7	GRD	TS2-6 & 5 & 4	Field Connection Terminal 77
TS2-8	GRD	TS2-7 & 6 & 5 & 4	TS2-1 & To Daughter Board
TS2-9	+5 VDC	Daughter Board	Microprocessor Status Light
TS2-10	0 to 2.9 VDC	Daughter Board	Microprocessor Status Light
TS2-11	0 to +5 VDC*	Display EnGinn Output Terminal	Daughter Board
TS2-12	0 to +5	Mother Board Output Terminal	Daughter Board
TS2-13	+17 VDC	Daughter Board	Mother Board Power Supply (#2)
TS2-14	+17 VDC	TS2-13	Field Conn. Terminal 67 & OGT
TS2-15**	+5 VDC	Daughter Board	Power to Output Board Power Supply
TS2-16**	+5 VDC	TS2-5	(No Connection)

NOTES:

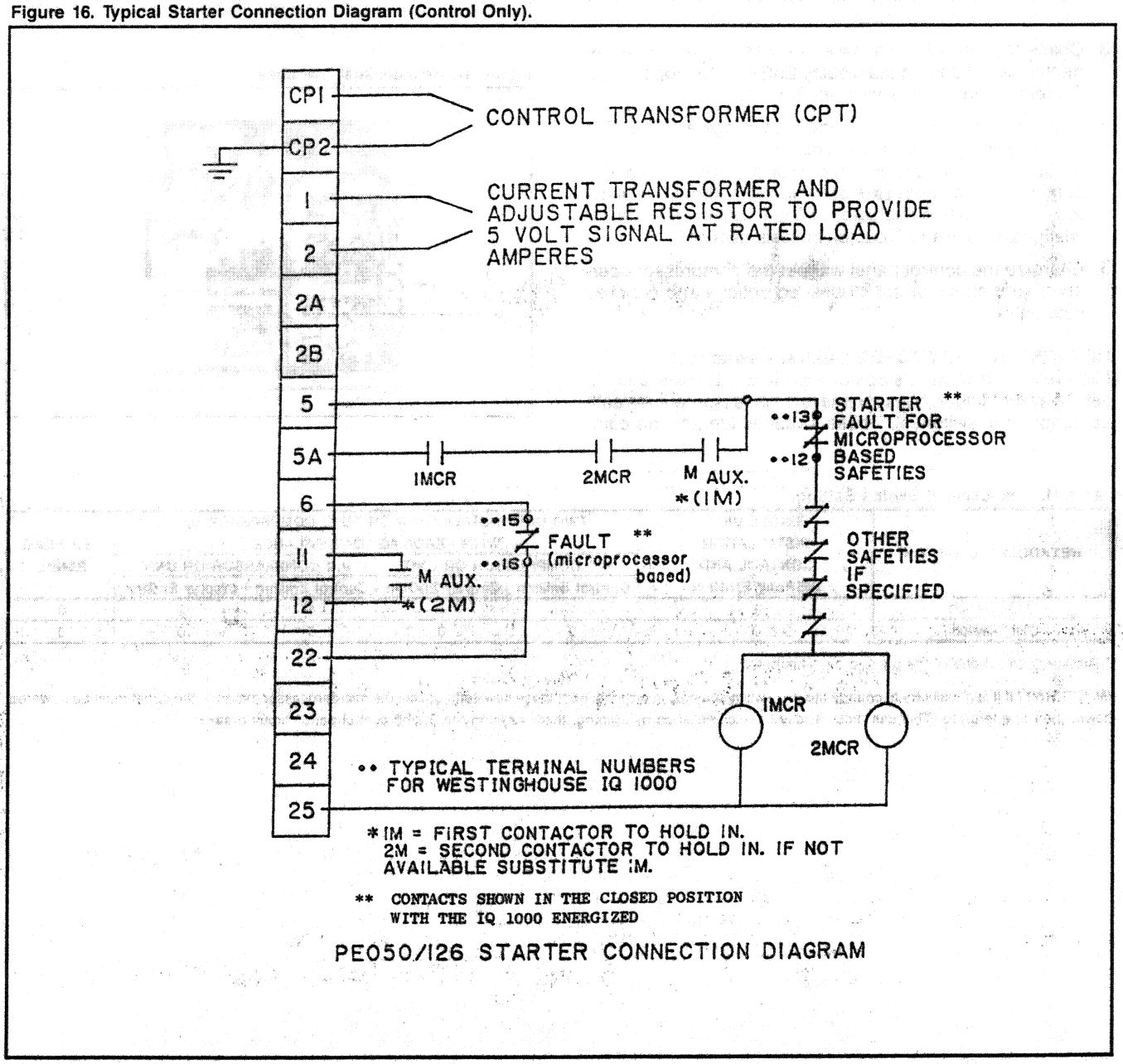
1. No field wiring required.
2. See Sensor and Control Connection Table for connections to terminal boards TS1, TS3, and TS4.
3. * Pulsed volts to power status LED's. Zero volts LED "on"; 5 volts LED "off".
4. ** Under control of the "Watchdog" circuit.
5. 12 volt AC and unregulated 17 VDC voltages are approximate. Actual values may be slightly more or less.
6. See the Control Devices Table for wiring to daughter board terminal strips TS1, TS3 and TS4.

Table 10. Lube Box Terminals

TERMINAL NO.	VOLTS	CONNECTION FROM	CONNECTION TO
69	GRD	Load & Unload Sol. Coils	Ground
66	24	Vane Close SW	Field Terminal 66
59	24	O.D. Switch	Field Terminal 59
58	24	Field Terminal 58	O.D. Switch
57	24	O.D. Switch	Field Terminal 57
53	24	Field Terminal 53	SA Unload Sol. Coil
52	24	Field Terminal 52	SB Load Sol. Coil
4	115	Oil Pump Overload	Field Terminal 4
3	115	Field Terminal 3	Oil Pump Overload
32	115	Field Terminal 32	OP Overload Heater
31	115	Field Terminal 31	Oil Pump Heater
30	115	Field Terminal 30	Oil Sump Heater
43	115/Neutral	Oil Pump & Heater	Field Terminal 43-L2
B	115/Neutral	Oil Pump & Coils	Lube Box Terminal 43
R	115	OP Overload Heater	Oil Pump Motor
W	115/Neutral	Capacitor	Oil Pump Motor

NOTE: No field connections required to this terminal block.

Figure 16. Typical Starter Connection Diagram (Control Only).



INITIAL START-UP CHECKS

The following checks of the control system are recommended before power is applied to the compressor.

1. Check that flow switches, interlocks, or jumpers (if required) are properly connected to MicroTech terminals 6 to 22, 10 to 61, 10 to 63, 11 to 12, and 58 to 66.
   Closure of these contacts during or prior to the start-up sequence is required to complete steps in the logic control path. SEE CAUTION AND TERMINAL STRIP TESTING DESCRIBED ON PAGE 6.
   Proof of closure of these contacts and others required to be closed is given by the glow of appropriate LEDs on the daughter board. (See Table 8).
2. If a remote start-stop control (SW2) will be used, the control option must be activated in the logic panel (see Table 17) and wiring must be connected across terminals 9 to 64.

Conversely, if the logic control panel has been set to call for the remote start-stop option, then a connection must be made across terminals 9 to 64. If remote start-stop is not intended, then the programmable software must be left on "Local". Use the service or operator password, if required.

3. Check that hexadecimal switches (see Figure 17) on the mother board and on the display EnGinn are properly set. Correct settings are shown in Table 11.
4. Check that the LED on the power cartridge and the LED on the display EnGinn are blinking.
   If one is blinking and one is out, or if one or both are lit continuously, or if both are out when they should be blinking, the condition indicates a fault which must be investigated. See the Trouble Analysis section.
5. Energize the control panel without the compressor operating, and check or set all desired options and required setpoints.

HEXADECIMAL SWITCHES (Address switches)

MicroTech control panels do not include any DIP switches to set. They do include hexadecimal switches (sometimes called simply hex switches). These switches identify the communications address by which one microprocessor provides and/or retrieves information to or from another.

There are two hex switches on the Control EnGinn, and two on the door-mounted Display EnGinn. When a Lead/Lag Load Balance panel is supplied, either with a dual compressor chiller, or with two single compressor chillers, there are two more hex switches mounted on the Mother board in this panel.

These switches are approximately ½" square, with an arrow shaped screwdriver slot in the center face. Around the perimeter of the adjusting screw, the face of the square block contains the numbers 0 thru 9 and the letters A through F.

Next to or above each switch, on the mounting panel, lettering will identify the switch as "Hi" or "Lo". Do not assume the 'high' or 'low' from their physical position.

Switches should be factory set. If there are two units being connected through a lead/lag MicroTech panel, the switch settings may not be correct. In any case verify that the arrow in each hex switch points to the number listed in the table.

IMPORTANT! If it is necessary to change the hex switch settings, in order to input those new settings into the microprocessor memory, the panel must be powered down, then re-energized. This can most readily be accomplished by tripping, than resetting the 3 amp control panel circuit breaker.

Figure 17. Hexadecimal Switches

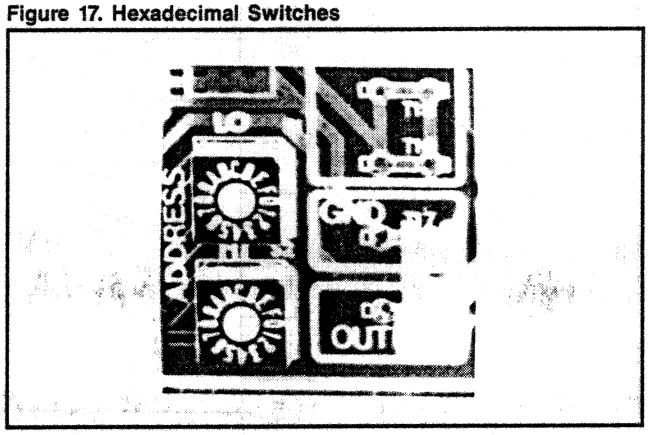


Table 11. Hexadecimal Switch Settings

HEXADECIMAL SWITCH	SINGLE UNIT INSTALLATION CONTROL AND DISPLAY ENGINN	TWO UNIT INSTALLATION OR DUAL COMPRESSOR UNIT WITH LEAD/LAG LOAD BALANCE				LEAD/LAG PANEL
		# 1 COMPRESSOR OR UNIT		# 2 COMPRESSOR OR UNIT		
		Control EnGinn	Display EnGinn	Control EnGinn	Display EnGinn	
"LO" Switch	1	1	1	1	2	0
"HI" Switch	0	0	0	0	0	0

* Arbitrarily select one of the units to be "Number 2".

IMPORTANT! If it is necessary to change the hex switch settings, in order to input those new settings into the microprocessor memory, the panel must be powered down, then re-energized. This can most readily be accomplished by tripping, than resetting the 3 amp control panel circuit breaker.

MECHANICAL PROTECTIVE SWITCH SETTINGS

See Table 12 for the recommended settings for the Mechanical High Pressure (MHP), Mechanical Low Pressure (MLP), and Oil Differential Pressure (OD) protective controls.

Table 12. Setpoint Settings.

SWITCH	SETPOINTS-PSIG (Except O.D. PSID)			
	R-12		R-500	
	OPEN	CLOSE	OPEN	CLOSE
OD (PSID)	50	60	50	60
MLP (PSIG)	25	28	32	35
MHP (PSIG)	150	140	176	166

DRY RUNNING THE CONTROL PANEL

On initial start-up of a new system, it's desirable to dry run the starter and control panel to check operation of both operating and protective controls.

This is usually accomplished with the compressor motor terminal leads disconnected at the starter, or at the motor (*and taped*).

The absence of a motor amperage during the starting sequence on MicroTech panels bearing the software version .07 and later will result in a controlled shutdown and safety trip. This condition can be avoided by disconnecting either one of the two D.C. voltage leads at the signal converter, or at terminal number 9 or 10 on the TS-4 terminal strip as the starter is energized. This action impresses a false amperage reading on the display Microprocessor which can be read on the 20 character display if the motor amps keypad is pressed.

If, after energizing the panel, a flow switch, overload or other safety is opened to prove the integrity of the control, the opened DC circuit must be reclosed if only momentarily to decay the impressed amperage before a repetition of the starting operation can be attemped.

Reconnect the disconnected lead before leaving the site.

Figure 18. AC to DC Volts Signal Converter

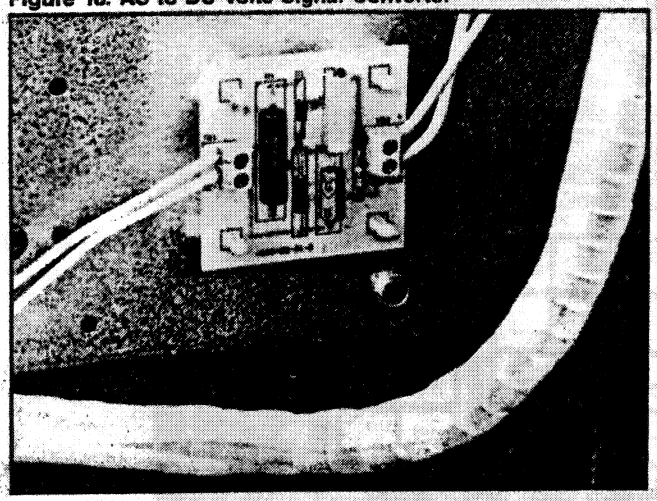
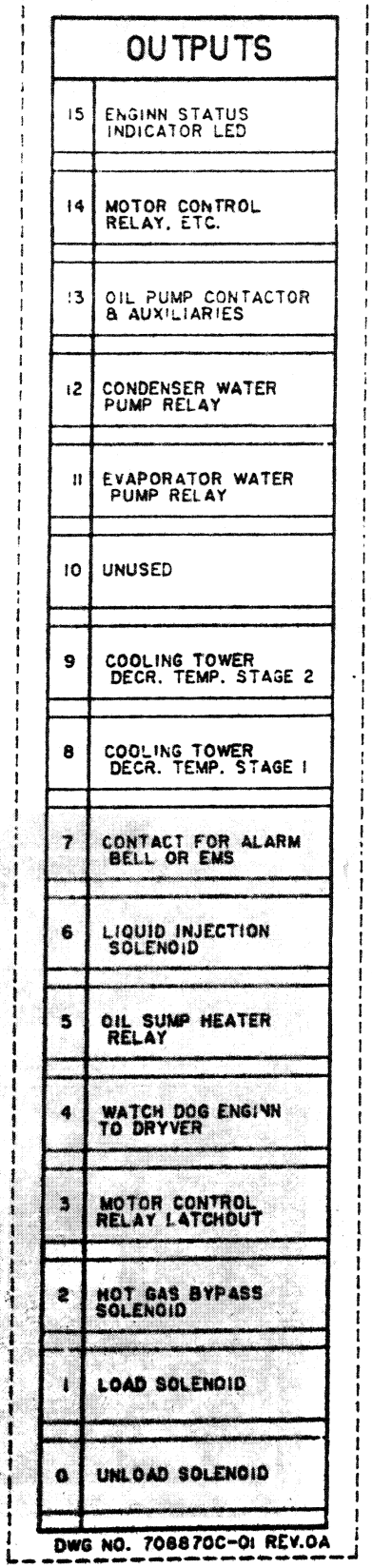


Figure 19. Solid-state Relay Position



STARTING THE CENTRIFUGAL COMPRESSOR

Prior to starting the compressor, all procedural steps normally associated with starting a newly installed machine must be followed. For detailed recommendations, see McQuay SM001 and IM 392 covering general start-up and the IQ-1000 solid-state overload.

The proper direction of compressor motor rotation is vital, and may be determined:

1. By means of a phase sequence test device.
2. By "bumping" the motor momentarily while visually observing the direction of the motor rotation.

With a MicroTech control panel, a machine may be "bumped" *only after all other start-up steps are completed,* by starting the machine with a 115 volt control lead and pushbutton switch connected between terminals 25 at the starter and 25 at the MicroTech control panel. The normal interconnecting lead must be disconnected at either end and the end taped temporarily.

The pushbutton switch should be a thumb-held button, pressed and held to complete the circuit, suitable for 115 volts, 50 VA. It should be connected to 115 volt wiring long enough to reach comfortably between the control panel connection and a point at the compressor motor end cover where the start-up technician can interrupt motor power instantly as the motor begins to turn.

The sequence of timed functions such as "evaporator pump on", "waiting for load", and "oil pump" pre-lube provide adequate time for the technician to get into place at the motor end cover sight glass. The direction of the motor rotation can now be determined within a few electrical cycles after the MCR coils close energizing the compressor. The technician should then immediately release the "bump" switch, opening the circuit to the MCR relays and stopping the compressor.

Following completion of this last verification step (direction of motor rotation), shut off the control circuit power at its source, disconnect the "bump" switch wiring and reconnect conventional control wiring.

Prior to re-connecting control power and energizing the compressor power circuit, it is often possible and desirable to set the current transformer circuits' variable reisistor following a quick calculation. Using the compressor RLA, and the current transformer's primary to secondary ratio, calculate the resistance in ohms required to produce 5 volts AC.

1. $\text{RLA} \times \frac{\text{Transf. Sec. Ratio}}{\text{Transf. Primary Ratio}} \times (1.0, .50, \text{ or } .58)^{*} = \text{C.T. output amps.}$

* If the current transformer is in the main line use 1.0; use 0.58 if the CT is in a phase leg (Star-Delta starters); use .50 if dual conductors are used on across the line, or auto-transformer starters and only one lead out of six is passed through the CT.

2. Calculate the required ohms from the CT output amps as follows:

$$\frac{5 \text{ Volts}}{\text{C.T. output amps}} = \text{Resistance in ohms}$$

Since the MicroTech panel will accept between 5.0 and 7.0 volts AC, recalculate step 2) using 7 volts

Figure 20. Keypad.

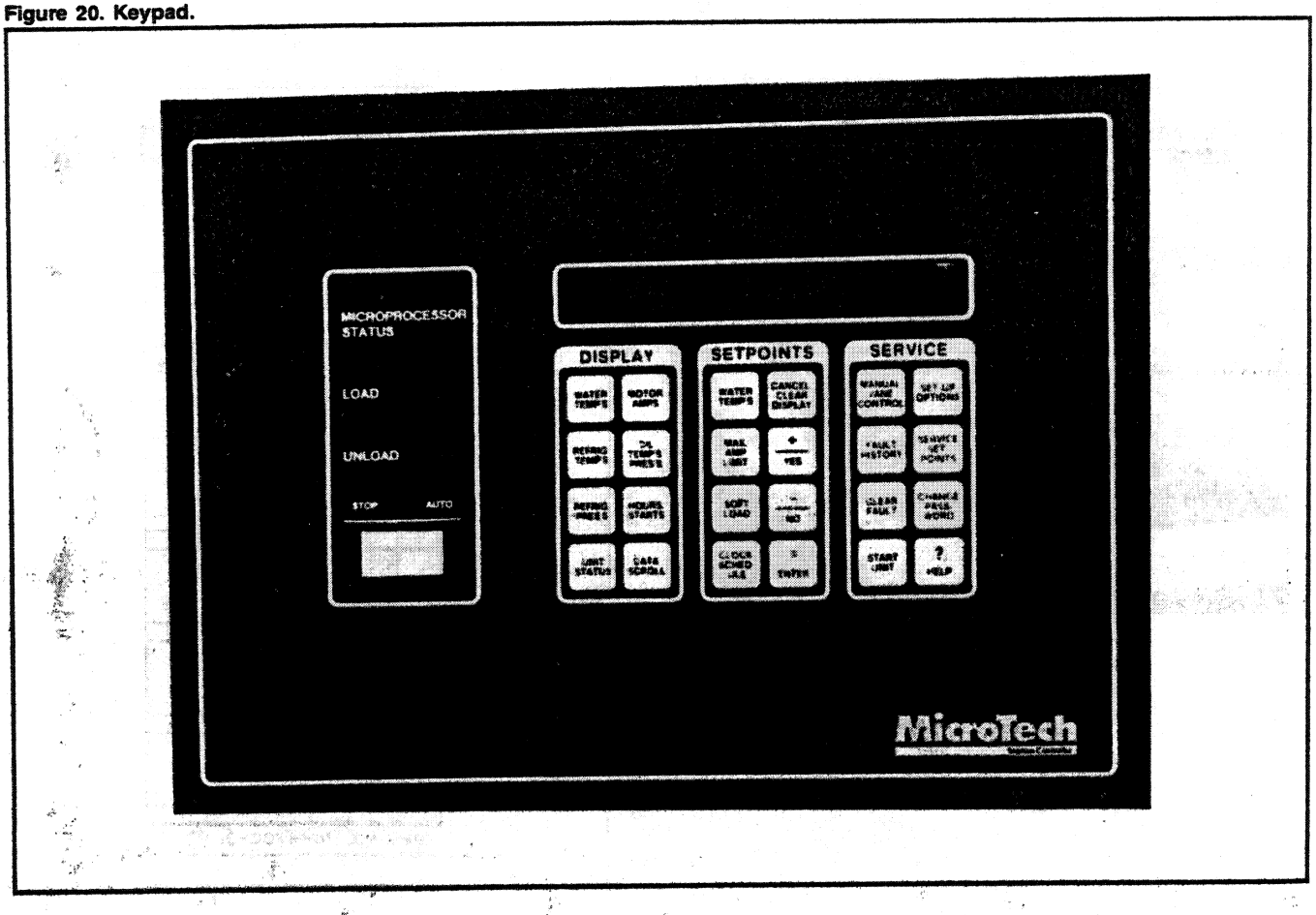


Figure 21. IQ-1000.

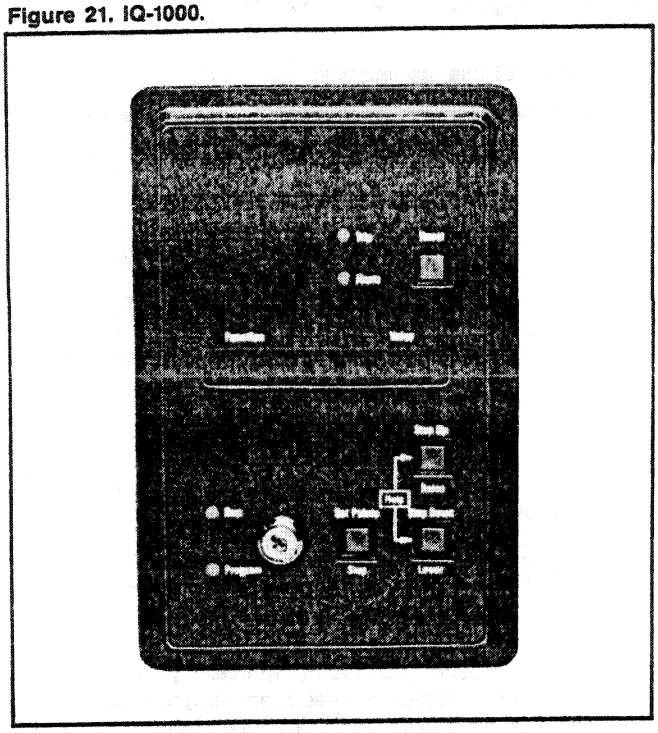


Figure 22. IQ-Data Plus.

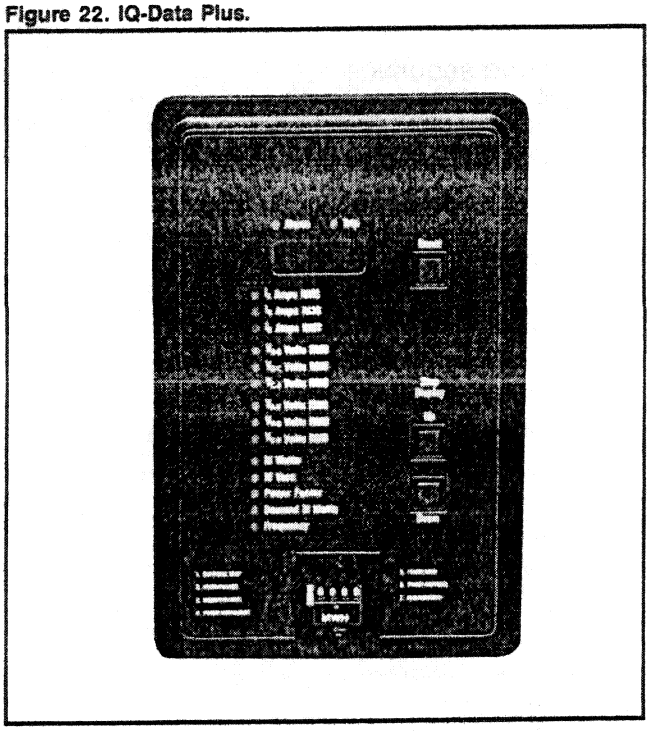
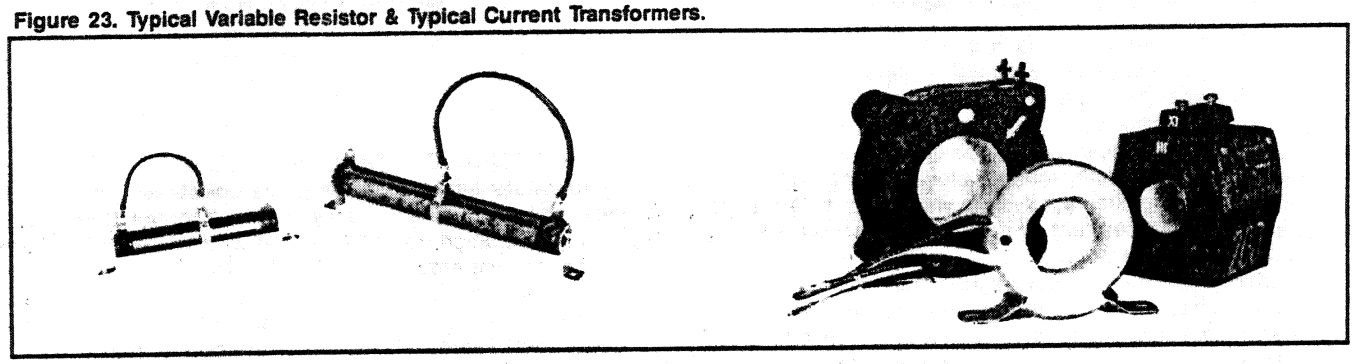


Figure 23. Typical Variable Resistor & Typical Current Transformers.



NOTE: If the unit has 2 resistors in parallel providing the AC voltage signal, see Catalog SM001 for calculation of the principal resistance.

Using an ohmmeter, set the variable resistor for a resistance between the two values calculated.

Reconnect any loose leads and connect both lines and control power.

1. Close all interlocks and switches to energize the compressor motor.
2. Connect an amprobe around the line or phase leads to the motor at the motor starter.
3. Note the compressor motor rated load amps (or required phase amps to equal motor rated load amps).
4. Press the "manual vane control" switch on the control panel keypad. If the display requests a password input, comply with the operator or service password. If the display begins blinking "[+] load, [–] unload" the unit will be in a hold position.
5. Press the display section "motor amps" keypad once to display "motor percent RLA=XX%". The message will be blinking indicating a continuance of the manual vane control mode.
   DO NOT watch the MicroTech display for this step. Bring the amps drawn by the compressor motor up to Rated Load Amps, (nameplate RLA).
7. Stop loading the compressor at the design RLA. NOTE; when neither the "+/Yes" nor "–/No" keypad is being pressed the compressor vanes will be in a hold position if the display is blinking.
8. If for some reason, a further "lock" on the RLA hold position is desired the needle valves in the SA-SB solenoid ports may be closed.
9. If the 5 to 7 volt AC signals' resistance was not calculated as stated previously, with the compressor drawing rated load amps, carefully and cautiously adjust the starter's variable resistor to obtain a 5 to 6 volt AC signal between terminals 1 and 2 (or 2A) on the MicroTech's field connection terminal strip. (See SM001).
10. With the line ammeter showing Rated Load Amps, and 5 to 7 volts AC present at terminals 1 and 2 (or 2A) as noted above, use a small screwdriver at the trim pot of the signal converter board in the MicroTech panel to dial in a display reading of 100% amps. When this reading is obtained, the signal converter will be delivering +4 volts DC to the Microprocessor daughter board TS4 terminal No. 9.

    If the display reads 100% amps at actual compressor RLA as read on the line connected ammeter, no further adjustment is necessary.

OPERATING SEQUENCE

The following describes the unit's normal operating sequence provided the time delay requirements are met and no safety control has tripped or holiday schedule set to keep the unit off. Place the control panel "Stop-Auto" switch in the "Auto" position.

In this position the switch is engaged and the unit may be started provided:

1. The chilled water sensor is calling for cooling.
2. No time delay is restraining operation.
3. A remote start-stop switch (See SW2 in the control wiring), is not open preventing unit operation.
4. No safety switch has been tripped and not reset.

Press the "Start Unit" key switch. The following messages appear in the display screen, in sequence, indicating action which has taken place.

FUNCTION	COUNTDOWN TIME
Will start in XX minutes*	
Evaporator pump on	20 (seconds)
Waiting for load	(Variable) (seconds)
Oil pump is on (Variable)	30 or 60 (seconds)
Condenser pump is on (Adjustable)	05 (seconds)
MCR is on	XX (seconds)
Unit is running okay	

* Programmed safety time delayed start is based on a factory set 40 minute start-to-start but not less than 3 minutes between stop-to-start.

The statement displayed "Waiting for load" in the above sequence, and the countdown period in seconds assigned to it, assumes that the water temperature sensed by the chilled water temperature sensor may not represent the entire chilled water system temperature if the chilled water pump has been shut off. This delay interval provides time for the chilled water pump to circulate system water and impart a valid system water temperature to the chilled water sensor.

In the starting sequence:

1. A call for cooling will energize the control through the logic output circuit to the evaporator water pump relay coil.
   If the circuit to this solid-state relay is completed the LED at the solid-state relay supplying that control power will glow.
2. If the evaporator water pump relay's operation results in operation of the chilled water pump, then closure of proof of flow contacts and interlocks will permit the next step. Proof of flow will also light LED number 9 on the daughter board.
3. An oil temperature sensor (#10) must indicate an oil temperature at least 40°F above the saturated refrigerant evaporator temperature (#2 sensor).
4. If steps 2 and 3 are satisfied, the oil pump contactor is energized through the logic output circuit. The oil pump motor is started.
   Simultaneously with the starting of the oil pump motor, the 115 volt circuit supplying power to the oil pump heaters is opened de-energizing them.
5. With the oil pump operating, a minimum oil pressure of 60 PSIG above evaporator pressure is required to complete the sequence for the next step.
6. Following proof of adequate oil pressure and the passage of a 60 second prelube time, the condenser water pump relay is energized, through the logic output circuit. Again proof of the logic instruction to this circuit is evidenced by the glow of this solid-state relay's LED. If the CWR relay is energized and this action results in closure of the flow switch and interlock between terminals 10 and 61, LED number 8 on the daughter board will glow, confirming completion of this starting step.
7. Within 5 seconds of energizing the condenser water pump, if the compressors' vane closed switch shows the vanes to be in a closed (compressor unloaded) position, the logic output circuit (14) is completed through closed mechanical contacts to control panel terminal 5A, back through the solid-state latch-in circuit, and through to the main starter operating coils, (MCR1, and MCR2).
   The latch-in circuit is a normally open contact solid-state relay. Upon the application of a logic signal, the relay closes its contacts instantly. They remain closed for 3 seconds, then open. The operating contacts are in parallel with normally open MCR coil contacts. These close and serve to prove the operation of the compressor motor starter coils. Closure of interlocks, and the transition relay also serve to confirm normal and complete starter operation.
8. Throughout this entire process, conventional protective controls remain active to interrupt the starting sequence in the event of a fault.
9. An incomplete sequence is recorded as a fault and trip. If the fault occurs because of the failure of the logic output circuit to *complete a sequence*, the solid-state relay's LED may be lit, but the LED on the daughter board for that circuit will not be lit. **NOTE:** a blown fuse in the solid-state relay circuit (see Figure 29), or an open in the operating circuit beyond the solid-state relay will not prevent the solid-state relay's LED from being lighted. See section on Trouble Analysis.

TEMPERATURE CONTROL OPERATION

Temperature sensors are negative co-efficient thermistors selected for extended accuracy and close control. During compressor operation from 10% to 100% capacity chilled water operating temperature will be held to within ±0.5°F.

The operator shall input the design leaving chilled water temperature by first pressing the water temperature keypad under the "Setpoints" section of the control panel.

The setpoint value listed in the program will then be displayed in the window above the keypad.

If the value displayed is the desired temperature, no further action is required. The "Cancel, Clear Display" keypad should be pressed to clear the screen.

If the value displayed is not the desired setpoint temperature, the value may be changed by:

1. Press the "+/Yes" or "−/No" keypad. The display will read "Enter Password" if a password has not already been entered. **NOTE:** All setpoint and service changes require use of a password.
2. Enter the required password. The operator password may be entered by pressing the "?/HELP" keypad four (4) times in succession.
3. The display will then read, "Operator Password Okay".
4. Re-press the water temperature setpoints keypad to display the leaving chilled water temperature. To raise the value displayed, press the "+/Yes" keypad. To lower the value displayed, press the "−/No" keypad.
5. When the revised, desired, setpoint is displayed, it must be entered into the program by pressing the "=/Enter" keypad.

Other Operator controlled setpoints are changed in the same manner. The cycling "on-off" thermostat function is programmed into the MicroTech software. An operating unit will shut off when the leaving chilled water temperature is pulled down, (at 10% compressor capacity) to 2°F below the leaving chill-

ed water setpoint. The thermostat will reclose, initiating a compressor start when the chilled water temperature rises to 2°F above the setpoint.

These values are adjustable as described in the keypad section of this manual.

SOFTWARE VERSION NUMBER CODE INFORMATION

The Logic Cartridge on the mother board, the Display EnGinn on the back of the keypad door, and the logic cartridge mounted inside the lead-lag/load balance panel (where used) all contain the software information required to control and protect the chiller.

For varied reasons, there are different software versions.

On any single compressor chiller, the software version on the Logic Cartridge and the Display EnGinn must be the same.

On any dual compressor chiller, the software on both MicroTech panels Logic Cartridges and Display Enginns, and the Lead-Lag/Load Balance Logic Cartridge must all be the same.

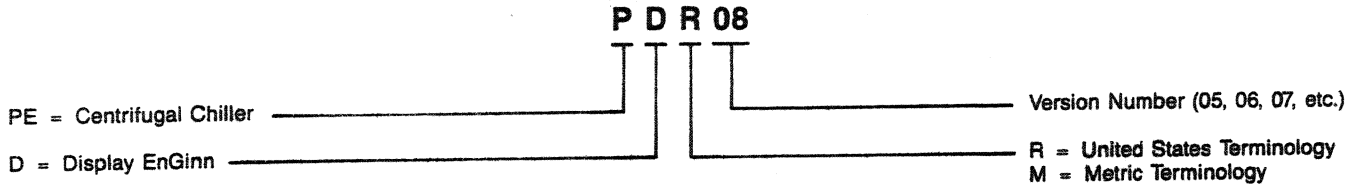
On any two chillers on the same installation using a separate Lead-Lag/Load Balance control, the software programs on all programmable components must all be the same version.

In addition, whenever inquiries are being made, or programmable components replaced, the Version number must be furnished to McQuay.

Version number codes for the three (3) basic components, and their location on the components are shown below.

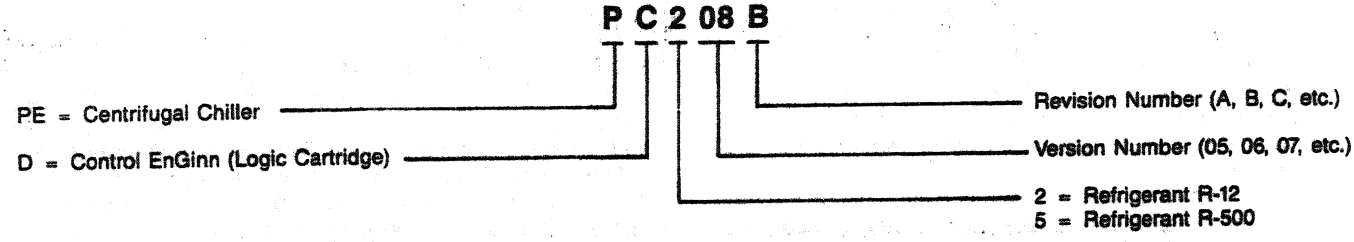
DISPLAY ENGINN CODE

(Software Version Number Code is found on the label attached to the upper right-hand side of the Display EnGinn.)



LOGIC CARTRIDGE CODE (CONTROL ENGINN)

(Software Version Number is found on the label attached to the upper spine of the Logic Cartridge.)



LOGIC CARTRIDGE CODE (LEAD-LAG/LOAD BALANCE)

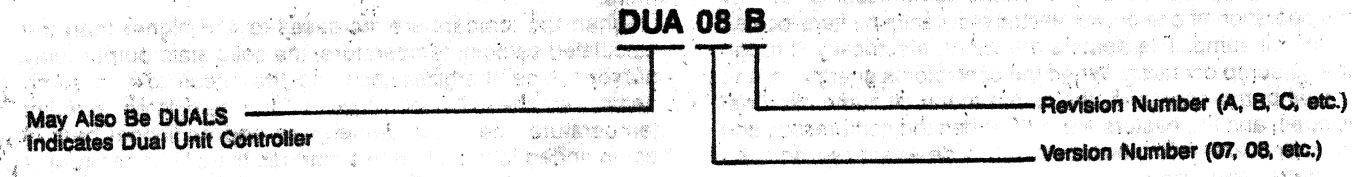
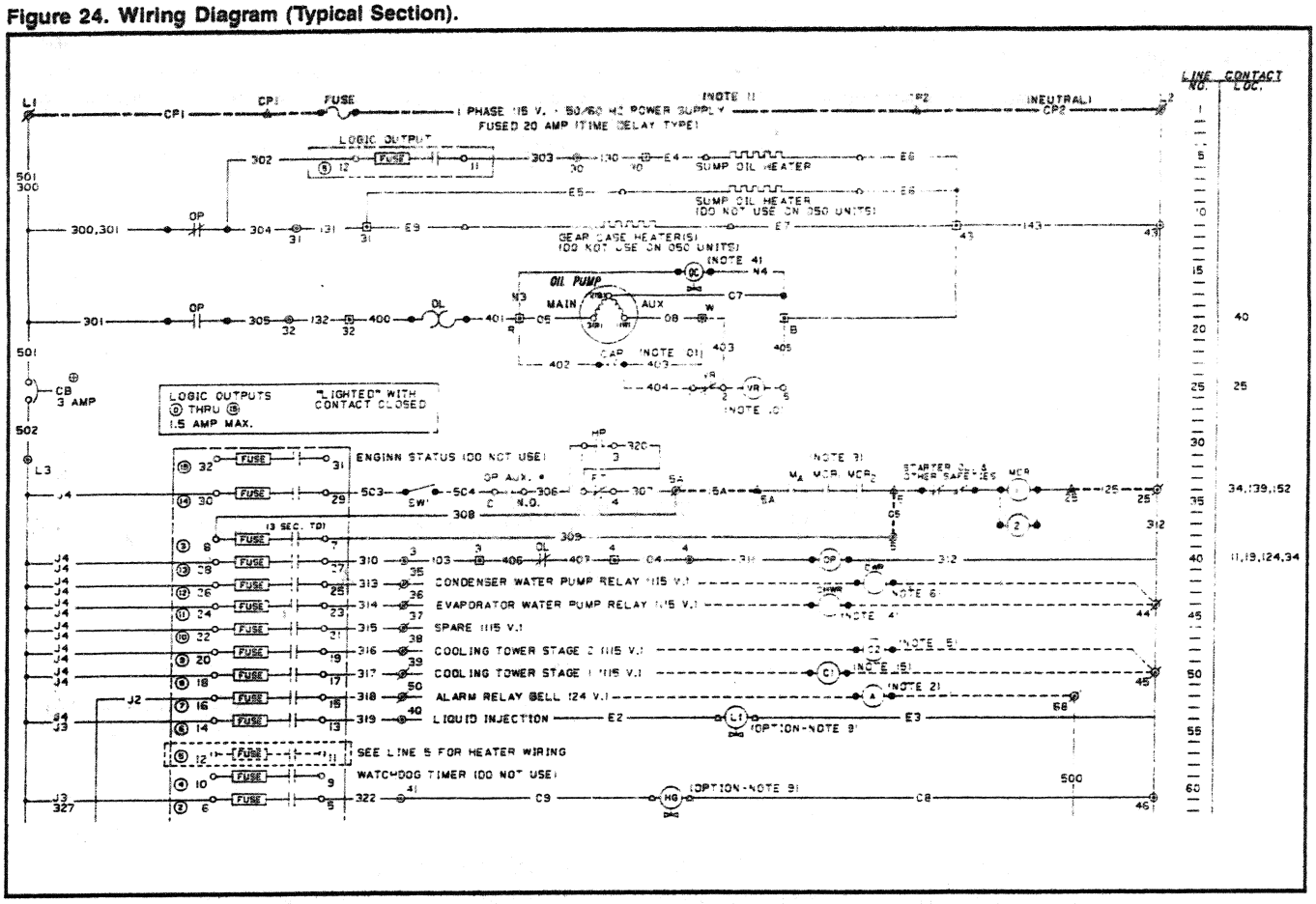


Figure 24. Wiring Diagram (Typical Section).



OIL TEMPERATURE

To maintain a separation of refrigerant and oil in the refrigerant atmosphere, the oil must be heated to a temperature approximately 40°F to 50°F above saturated refrigerant (Evap.) temperature.

During normal compressor operation, saturated refrigerant evaporating temperature is less than leaving chilled water temperature, and sufficient heat is added to the oil by the friction of shaft journals rotating in the bearings. With the compressor "off", the saturated refrigerant temperature rises, approaching ambient, and the oil must be heated to maintain the required temperature difference.

Heat is applied to the oil when the compressor is "off" by the operation of one or two electric resistance heaters located in the oil sump. The heaters are wired, electrically, through the oil pump contactor. When the contactor is energized, and the oil pump operating, the circuit to the oil sump heater(s) is open, and the heaters are "off". When the compressor, and oil pump are "off", the contactor is de-energized and the heater(s) energized.

To protect the compressor from operating with refrigerant laden oil being delivered to the bearings, the MicroTech software includes a protective control located under the Service Setpoints key. Press number 5 of that key will show, "Low Oil Delta = XXX". The setting may be Service adjusted between 40°F and 60°F, and is factory set for 50°F.

If the oil temperature is not equal to, or above the Low Oil Delta setpoint plus the saturated refrigerant (Evap.) temperature, the unit will not start, but will display the statement "Waiting Low Sump T".

If the chiller is running and the oil temperature in the sump falls below a temperature equal to the saturated refrigerant (Evap.) temperature plus the Low Oil Delta setpoint, the chiller will cycle "off", and one press of the "Fault History" key will produce the display "Now = Low Sump Temp".

The two sensors that produce the actual calculated temperature difference are the oil sump sensor (Number 10) and the Evap. Saturated Refr. Temp. sensor (Number 02).

The Low Oil Delta setpoint also serves a second function. It's temperature setpoint plus 10°F, plus the saturated refrigerant (Evap.) temperature is displayed as the "Calc Oil SPT" temperature. This is the oil temperature that the computer software will attempt to maintain when the chiller is "off".

As described above, electric heat is applied to the oil when the compressor is "off". That heat increases the oil temperature to the calculated oil setpoint temperature and more.

When the temperature increases to 4°F higher than the calculated setpoint temperature, the solid-state output relay number 5 de-energizes, opening the circuit to one sump heater. As the oil cools down to the calculated setpoint temperature, the relay re-energizes and additional heat is again added to the oil. In this manner, the oil temperature is maintained within a 4°F to 5°F temperature of the calculated setpoint during compressor "off" cycles.

An additional oil temperature protective control prevents overheated oil from being delivered to compressor bearings. This protection is a "High Oil Feed" temperature, and its value is determined by measurement through the "Oil Feed Temp" sensor, (number 09).

If the oil temperature at the oil feed sensor exceeds the setpoint temperature when the chiller is running, or "off", a fault condition will occur.

Based upon all of the above, it will be desirable to set the control setpoints while considering both compressor operating and "off" conditions to prevent overlapping temperatures and nuisance tripping.

THE KEYPAD

The keypad consists of 24 touch sensitive membrane key switches that provide a total of over 160 separate statements regarding the operation, setpoints, and service history of the controlled chiller.

To provide the abundance of information from so few keypads, many of the keys must be pressed more than once. When pressed, *Display section keys*, for example, display a single statement. The next press of the same key displays the next statement in that scroll. Subsequent keystrokes of that same key will complete the presentation of the functions assigned to that key, and will begin again if the key is re-pressed following completion of the series.

As an example, if the "Water Temps" keypad is pressed;

once: the statement appears "LEAVING EVAP = XX.X°F"
twice: the statement appears "ENTERING EVAP = XX.X°F"
three: the statement appears "ENTERING COND = XX.X°F"
four: the statement appears "LEAVING COND = XX.X°F"
five: repeats No. 1 "ENTERING EVAP = XX.X°F"
etc.

For simplicity a table is provided listing the number of keystrokes required for each key to display it's allocated information, and the information statement. The keys do not scroll backward. If review of a preceding statement is desired, the Cancel, Clear Display keypad, or any other, may be pressed, then the original keypad re-pressed. The lead, or first-press statement will appear. It's also possible to scroll on through with sequential keystrokes, to complete the cycle and begin again.

Under the Display section, two keypads operate just slightly different from the rest. Pressing "Unit Status" once will produce any one of eighteen (18) different statements. Those statements depend on the present mode of the unit and are tabulated below:

First press — "Unit Status" — Statements.

OFF Mode (See Operational Status)
Off: Waiting for system load
Off: Due to Fault

Start-up Sequence
Will start in XX minutes
Waiting: Low Sump Temp.
Evap. Pump is On XX (seconds)
Waiting for Load XX (seconds)
Oil Pump is On XX (seconds)
Cond. Pump is On XX (seconds)
MCR is On XX (seconds)
Unit is running ok

Shutdown Sequence
Stop Unloading XX sec.
MCR OFF Post Lube

Operational Status
Waiting, High Amps
OFF, Load Recycle
OFF, Time Schedule
OFF, Remote Signal
OFF, Manual Switch
OFF, Ready to Start

Pressing the "Unit Status" keypad a second, third, fourth, etc., through eight strokes will reveal whether or not any or all of seven (7) options have been activated. See the Table of Keystrokes Displays for information of the options available. See the description under the Service, "Set Up Options" keypad for information on how to activate options.

The second different keypad under the Display section is the **"Data Scroll"** key. Following a single press of this key, a complete list of all of the functional values available in the Display section and other data will be displayed, each for an interval of four (4) seconds. This scroll will begin with "Unit is Running OK", and end following 52 intermediate statements with a repetition of the same "Unit is Running OK". The intermediate statements are tabulated in a form to permit service personnel to record the data. These statements include temperatures, pressures, amps, options, setpoints, operating hours, and faults (if any).

The Setpoints Section does **not** contain protective settings, but does contain the leaving Chilled Water Setpoint Temperature, Reset Options, % of Amp Limits, Soft Load, Time and Holiday Schedules, and the means to change those changeable values impressed in the Microprocessor memory. See the keypad Table for a listing of the information displayed with each Setpoints key press.

The following paragraphs describe specific functions and their operation.

To change a Setpoint (or input an option)

1. Press the setpoint or setup option keypad.
2. With the setpoint or option statement displayed, press the "+/Yes" or "−/No" key.
3. The display will than read "Enter Password", if it has not previously been entered and remains active.
4. Enter the operator or service password, as required. See Table 2.

The Operator Password is 4 consecutive keystrokes of "?/Help".

5. The display will read "Operator (or Service) Password OK".
6. Repress the keypad representing the function to be changed.
7. With the statement or value displayed, press "Yes" or "No"; "+" or "−" to activate or de-activate an option; increase or decrease a numerical value. For large changes in numerical values, hold down the "+/Yes" or "−/No" key until the desired value is reached.
8. The statement or numerical value will be blinking indicating that a change in setpoint has been requested.
9. To input the new value into the Microprocessor memory, press "=/Enter". The display will stop blinking.
10. If after reconsideration, the new statement of value is not wanted, do not press "=/Enter", but instead press "Cancel, Clear display". The original value will remain in the microprocessor memory.

PASSWORD INFORMATION

Once a password has been entered, it remains active for an interval of ten minutes from the time of its use. For example if a password is entered and used eleven minutes previously, it will have disappeared from the system. If, on the other hand, it was used nine (9) minutes ago, another setpoint may be changed without again re-entering the password. In addition, following this latest setpoint change, the password interval is extended for another ten minutes.

To withdraw the "password OK" status press "Cancel, clear display". Doing so will cause the password approval to expire in one minute.

"WATER TEMPS" KEYPAD (Setpoints)

Actual water temperature is displayed by pressing the "Water Temps" keypad under the Display section.

To display the leaving chilled water setpoint temperature, press the "Water Temps" keypad under the Setpoints section just once. LVG EVAP SPT=XX.XF will be displayed. This is the temperature setting to which the compressor vanes will respond; opening and closing, loading and unloading to maintain the operating temperature at the setpoint temperature.

This is the temperature also that is used as a base against which the compressor will start and stop. See the descriptions for the "Start-up Temperature Difference" and "Shutdown Temperature Difference". These latter statements are displayed by pressing the "Set-up Options" keypad.

Pressing the "Water Temps" (Setpoints) keypad a second time will display the statement "Reset LVG SPT=ZZZ".

The three Z's indicate letter options which in this case would be "N/A" for not active, CHW for chilled water, and ENT for return water temperature reset.

See the section marked Reset Control for a description of reset opportunities with MicroTech.

Keep in mind that these statements and others under this Setpoints section are statements only. To input these values or statements, press the "Set-up Options" keypad under the Service section, and follow the instructions given in the following section, "Set-up Option". A third press of the "Water Temps" (Setpoints) key will display the statement "RMT Reset SIG=N/A" or ". . . =XX.X". The three X's indicate that the displayed value will be numbers that represent the milliamp (mA) value impressed.

If the option to reset based on "CHW" is elected, a 4 to 20 mA signal is required. The signal is input at terminals 69, 70 and 71 on the Field Connection terminal strip (single unit installation) or at the Lead/Lag Load Balance control box on two-unit installations.

If the option to reset based on "ENT" is elected, no remote Reset signal is required.

"Max Amp Limit" keypad also provides multiple statements with each of 3 separate strokes of the keypad. The first keystroke and statement "Max Amp Lim=XX% indicates the maximum % of Rated Load Amps that the chiller will be permitted to draw. The setting cannot be increased above 100%, nor lowered below 30%. This control provides a manual limit of power consumption which may be used in mild weather to save energy.

Automatic reset of amps is possible also by activating the AMP reset option ("Set-up Options" key) and inputting a 4 to 20 mA signal. If this has been done the second press of the "Max Amp Lim" keypad will display this information. A third press will display the currently impressed remote mA signal.

SOFT LOAD KEYPAD

Each centrifugal compressor must have its mechancial vane closed switch in the "closed" (10% capacity) position to permit completion of a unit start. Following start-up, it may be desirable to limit the loading of the compressor for energy conservation.

"Soft Load" provides that additional control. When pressed consecutively the "Soft Load" keypad produces the following three statements.

First, "Soft Load Limit=N/A" (or XX%). If activated, this limit is the maximum percent of RLA at which the compressor will be allowed to operate based upon the setting of the MAX AMP LIMIT key. This value may be set anywhere between 30% and 100%.

Second, "Beginning Amp Limit=XX%". This value is also a percentage of rated load amps (RLA). It represents the compressor ampere percentage at which the soft loading will begin its' time controlled increase up to the maximum percentage of step one. This value can also range between 30% and 100%; but must be a lower setting than the setting displayed in the first keypress, (above).

Third, "Ramp up time=XX min.". This value is expressed in minutes and defines the time period over which the compressor can load from the "Beginning Amp Limit (percent)" to the upper "Maximum Amp Limit (percent)" or "Soft Load Limit (percent)".

The time is adjustable from zero to 120 minutes.

If the Soft Load feature will be activated, press the Soft Load Keypad three (3) times to display the statement "Ramp Up Time=XX min.". If the value displayed is "0" minutes, the first keypress of the Soft Load Key will have displayed the reading "Soft Load Limit=N/A".

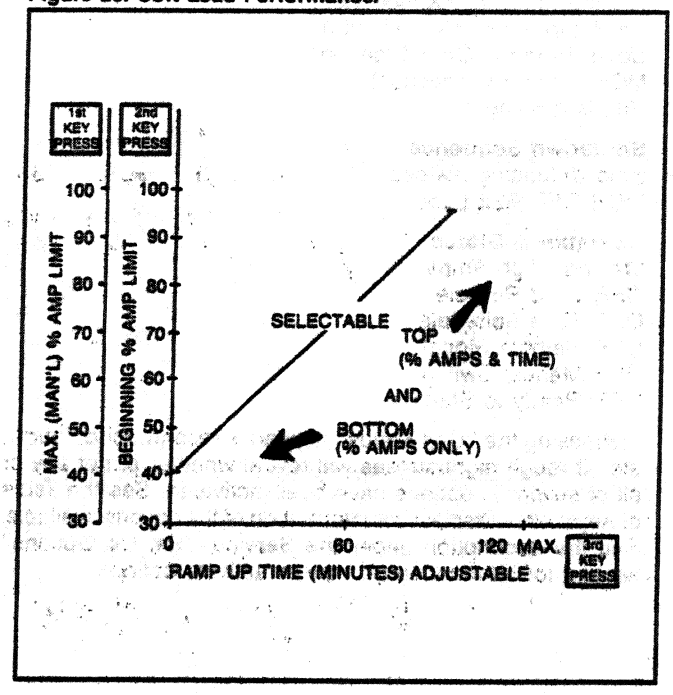
Insert the desired ramp up time into the program memory by following the procedure described under the section "To Change a Setpoint". Simply by inputting a time frame greater than zero in the "Ramp Up Time" function, the Soft Load Limit becomes activated. Returning to the first keypress of this keypad will then display the percentage that will represent the maximum load that the unit capacity will operate at following completion of the time period.

If this percentage should be changed, return to the first press of the **Max Amp Limit** keypad, and increase or decrease the allowable percent.

Return to the **Soft Load Limit** keypad. The first press of this keypad will display the % RLA input under the **Max Amp Limit** key. The second press of the **Soft Load Limit** keypad will, as described above, show the **"Beginning Amp Limit=XX%"**. This later percentage value can be increased or decreased within the 30 to 100% range by pressing the "+/Yes" or "−/No" keypads following insertion of the password.

Note that the % amps consumed by a centrifugal compressor are not directly proportional to the % capacity of the compressor. The 30% amps figure in less than the amps normally drawn by a compressor operating at 10% of capacity. The 30% amps 'number' is, therefore, representative of the minimum compressor capacity. Actual amps drawn at 10% capacity will vary based on compressor motor power factor and efficiency characteristics, and by chilled water and condenser water operating temperatures.

Figure 25. Soft Load Performance.



CLOCK SCHEDULE KEYPAD

This keypad requires a total of 49 keystrokes to sequence entirely through the loop. See the keystrokes sequence table for individual keystrokes information. In summary, the Clock Schedule keypad provides:

- Current date and time
- Weekly and daily on-off time schedules
- 14 holiday "off"schedules
- An over-ride function to counter a programmed "off" period
- And a Master "off" function to over-ride the daily, weekly, and holiday schedules entirely.

Most of these function are self-explanatory. All can be visualized in their place on the printed Clock Schedule table. A brief explanation of some of these steps follow.

When shipped, each unit has the date and time set but the clock control program de-activated.

De-activation of the daily and weekly clock control schedule is accomplished by setting the S1 display (the 10th press of the "Clock Schedule" keypad) equal to "Off".

If the operator wishes to activate the automatic control schedule, including holidays, S1 must be changed to Sunday, Monday, etc., or whichever day is to be considered the first day of controlled operation. Subsequent keypresses will set the time of start-up and shutdown.

Reference to the Clock Schedule Table will show that a second weekly control schedule may also be incorporated.

NOTE: On dual compressor units, it may be desirable to set the clock schedules for each of the control panels at the same values. At the very least, clock schedules on dual compressor units must be turned "On". This is accomplished by setting "S1 First Day=Sun.

OVER-RIDE CONTROL

In the event the clock schedule time and holidays have been pre-set, and it becomes desirable to turn the chiller "on" on a scheduled "off" day, it is not necessary to re-enter the program and alter the entire schedule.

Simply press the Clock Schedule keypad twice. "Over-ride (Hours)=X.X" will appear on the display. With the password entered, press the "+/Yes" key. Numerical values for the desired number of operating hours will be shown in the display. Press enter to insert the time into the control memory, and if water temperature, control power, and interlocks permit, the unit will start.

Assuming that the chiller will not satisfy the water temperature, or experience a fault condition, the unit will sequence through a controlled shutdown following passage of the alloted hours.

"+/Yes", "-/No", "=/Enter"

These keys are used to input desired options, raise or lower setpoints and protective settings, and enter the chosen value or statement into the Microprocessor memory.

See the earlier paragraph headed "To Change A Setpoint".

MANUAL VANE CONTROL

For service purposes, it's sometimes necessary to put an operating compressor into a manually controlled capacity mode.

A password must be entered, and the "Manual Vane Control" key pressed. This display will immediately begin blinking "[+] Load, [-] Unload". This flashing statement indicates that the unit is in manual control and is in a holding position.

In this position other keys such as "Water Temp", "Unit Status", "Motor Amps", etc. may be pressed. They will display the operating value, but in each case, the entire statement will be flashing, indicating that the unit is under manual capacity control. If, for example "Motor Amps=XX" is flashing, pressing the "+/Yes" keypad will load the machine and the increase will be reflected by an increase in the amp value displayed, provided higher amperage is permissable.

Similarily, if unloading is desired, pressing the "-/No" keypad will display a reduction in amps confirming that the compressor has unloaded.

Remember, if the entire displayed message is flashing, the unit is in Manual control. To return the control to automatic, press the "Cancel, clear display" keypad.

If the chiller control is accidentally left under manual control, the display *and* manual operation will automatically cancel itself after 10 minutes of no keystrokes.

"FAULT HISTORY", "CLEAR FAULT"

If a unit trips due to a fault, the first press of the "Fault History" keypad will display the cause. Pressing the keypad eight more times will display the previous eight faults, thereby providing a pattern for service analysis.

Following correction of the actual (current) fault, the "Clear Fault" keypad must be pressed to permit restarting the unit. Possible safety faults are listed below. (Words in parenthesis are not displayed).

Some versions of software may also include "High Motor Current" or "Low Motor Current".

In all cases the general reason for the outage will be self-explanatory.

NO TRANSITION (Starter)
LOW SUMP TEMP (Oil)
HIGH FEED TEMP (Oil)
LOW EVAP PRESS (Refrig)
HIGH DISCHARGE PRESS (Refrig)
HIGH DISCHARGE TEMP
SURGE (Compressor)
HIGH SUCTION TEMP (Refrig)
HIGH MOTOR TEMP (Guardistor)
STARTER FAULT (Overload)
LOW CHARGE SW (MLP)
NO EVAP FLOW (Water)
NO COND FLOW (Water)
LOW OIL PRESS (OP)
HIGH PRESS SW (MHP)
LVG EVAP WTR SEN
ENT EVAP WTR SEN
EVAPORATOR SEN (Refrig)
SUCTION SENSOR (Refrig)
LIQUID LINE SEN (Refrig)
ENT CND WTR SEN
LVG CND WTR SEN
DISCHARGE SEN (Refrig)
CONDENSER SEN (Refrig)
OIL FEED SENSOR
OIL SUMP SENSOR
OIL PRESS SEN
VANES OPEN

"SET-UP OPTIONS"

This keypad will produce seventeen or eighteen separate displayed functions (depending on the software version) with each separate press of the keypad. Each is listed in the keypad table with the individual options or ranges shown.

The first of these are **Reset Options.** There are six (6) options associated with this function. They are:

1. None
2. AMP
3. CHW
4. ENT
5. AMP ENT
6. AMP CHW

If one of these options is to be selected, the statement "Reset Options = "ZZZ" in this example represents any one of the 6 options listed. To change the displayed statement, press "+/Yes", or "−/No" keypad. With the desired option displayed, press "=/Enter" to establish the option in the Microprocesor memory. If reset options are chosen, their inclusion in the program will be displayed by successive keypresses of the Setpoints section keys,—"Water Temps" and/or "Max Amp Limit".

For a detailed explanation of the available "Reset" feature, see the subsection "Reset Options".

Tower Staging will control cooling tower fan operation; but only if the control relays required are field installed, and wired to initiate the operation of one or more tower fans.

Enable Lag, Disable Lag, and **Delay Timer** "Set-up Options" are control values that are required only if the unit is one of two compressors (PF unit), or two units connected in a "Lead, Lag, Load Balance" configuration.

For a detailed explanation of these three functions, see the section marked **"Lead, Lag, & Load Balance".**

TIME CONTROL FUNCTIONS (Not Clock Schedule)

Statements such as "Waiting High Amps" or "Waiting —Low Sump T" are time dependent, but they can not be modified by an adjustment of the time interval.

To assist the operator, the following provides a summary of timed functions, whether or not they are adjustable, their location, and time frame.

A brief description of each listed function follows:

Start-to-Start / Stop-to-Start—These two timers limit the frequency of motor starting to assure longer motor life. Centrifugal compressors unload to 10% and continue to operate until the water temperature is overcooled by a few degrees. The combination of compressor capacity reduction and temperature control are intended to minimize the need for too frequent starting. If more frequent starting seems to be required to prevent wide temperature fluctuations, the application or equipment and system control should be examined.

Oil Pump is On / Post Lube (Oil Pump)—These two time functions provide bearing lubrication through time controlled operation of the oil pump both before and after compressor operation. The time periods alloted are satisfactory for all sizes of McQuay Centrifugal compressors.

Condenser Pump Timer—This timer determines the length of time the condenser pump will operate before the main compressor motor control relays (MCR) are energized. Some extended time may be required; but only if a delay is required to refill the system, average condenser water temperature, or prove closure of system flow controls. A long condenser pump time interval, without the compressor operating is not desirable. Five to ten seconds is adequate.

An exception to the short time interval exists where one condenser pump serves two or more machines. In this case, the pump might be running for a very long period of time with the second or third chiller inoperative.

Table 13. Time Controlled Functions.

FUNCTION	CONTROL	KEYPAD	RANGE & FRAME
"Will Start in XX Minutes"			
Start-to-Start Time	Adjustable	Start-Up Option	20 min. to 60 min.
Stop-to Start Time	Adjustable	Start-Up Option	3 min. to 20 min.
Oil Pump is On	Non-Adjustable	None (Software)	30 sec.
Post Lube (Oil Pump)	Non-Adjustable	None (Software)	30 sec.
Condenser Pump TMR	Adjustable	Start-Up Option	5 sec. to 240 sec.
Entering Evaporator Timer	Adjustable	Start-Up Option	2 min. to 60 min.
Delay Timer	Adjustable	Start-Up Option	1 min. to 10 min.
Load Delay (Waiting for Load)	Adjustable	Start-Up Option	15 sec. to 240 sec.
MCR is on	Non-Adjustable	None (Software)	30 sec.
Override (Hrs.)	Adjustable	Clock Schedule	0 to 51 hours
Soft Load (Ramp Up Time)	Adjustable	Soft Load	0 to 120 min.
Step and Wait	Non-Adjustable	None (Software)	Seconds

Ent Evap. Timer—This timer is an integral part of the "Entering" chilled water temperature reset feature. As the building load changes, entering, or return, chilled water temperature increases or decreases. At fixed time intervals, the software compares return water temperature and leaving chilled water temperature. If the time interval is too short, over-adjustment and hunting, may result; if it's too long, system inefficiency may exist. The actual setting should be adjusted to suit the job system characteristics.

Delay Timer—The "Delay Timer" applies only to dual unit or dual compressor installations. The second, or lag compressor will not be started unless the lead compressor's operating amps exceeds the Enable % RLA for the preset "Delay Timer" interval. Conversely, the lag compressor or chiller will not shut off unless the lead compressors operating amps is less than the "Disable % RLA for the preset "Delay Timer" interval.

In this manner, unnecessary cycling "on" and "off" of the lag machine is avoided.

Load Delay (Waiting for Load)—Where energy efficiency dictates that a chilled water pump be shut off when its chiller is inoperative, water temperature within the piping system may vary widely depending upon the ambient temperature conditions. The "Load Delay" timer permits the chilled water pump to circulate and mix chilled water in the piping system before the chiller is actually started. By so doing, the temperature imparted to the chiller's water sensors more closely resembles the total building water temperature. The Load Delay time interval should be set shorter or longer as the mass of water in the building's system is comparatively little or great.

MCR is On (or Stop, Unloading)—The time interval associated with the MCR operation is intended to establish reasonable delay for closure of the starter transition contacts. "Stop, Unloading" provides a time period to permit the oil pump to close the compressor vanes.

Override (HRS)—This feature permits overriding the established clock schedule to operate a unit on an "off" day, without changing the entire schedule. The desired number of operating hours are entered into the program and the regular schedule will be overridden for that number of hours.

Soft Load (Ramp Up Time)—The soft load ramp up time establishes a period that may be as long as two hours to permit a controlled increase in chiller capacity. During that controlled time interval, it's possible that the sizeable cooling load developed only by a weekend shutdown may be reduced to a manageable partial load at less than maximum electrical demand.

Step and Wait—Within a range of plus or minus two tenths (0.2°F) of a degree Fahrenheit of the chilled water setpoint, the compressor capacity control system will "hold", neither loading nor unloading the compressor. As the leaving chilled water temperature drifts above or below the setpoint within a range from two tenths (0.2) to two (2.0) degrees F, the compressor will pulse control to the unload or load solenoids, respectively, to return the water temperature to setpoint. Should the drift away from setpoint be more than two (2.0) degrees F, as it might be following an overnight shutdown, loading is continuous.

OPERATION OF THE LEAD-LAG/LOAD BALANCE PANEL

GENERAL

The LLLB controller is provided with an internal 3 amp circuit breaker switch, or a cover panel mounted "on"—"off" switch. When power is applied, and the switch closed, an LED status light in the front cover panel will blink.

LED's will blink also on the cover panel to confirm the operational status of controller number 1's microprocessor, and that of controller number 2. Another LED will indicate which compressor or unit is the "Lead".

Lead-Lag — A three-position switch on the front cover panel is marked

- Controller (Number) 1 Lead
- Auto Lead, (and)
- Controller (Number) 2 Lead

If the switch is positioned to either Controller 1 or Controller 2, that unit will be the lead unit, and the other, the lag.

If the switch is positioned for Auto Lead, the computer will read the operating hours of the two machines and select the one with the least operating hours to be the lead. A change from one lead unit to the other will only occur when both units are off, or both are operating. In this manner the units are protected against a sudden switch in the lead unit selection as the hours of the operating machine overtake the operating hours of the other (off) machine.

Lag Start-Stop — The lead machine increases its capacity to satisfy an increasing cooling load. When this compressor's maximum capacity is approached, at a pre-set value input under the "Set-up Options" key, the signal is communicated to the lag machine to start and run. The operating signal is "Enable Lag" and it is set based on the percent of the Lead units operating amps. The Enable Lag cannot be set for less than 80%, nor more than 100%. A normal recommended setpoint is 95%. Further, the lag machine will not start immediately when the % amps reaches the setpoint. A "Delay Timer" setpoint requires that the % amps consumed equal or exceed the setpoint % amps for the period of time programmed.

In this manner, unnecessary cycling is avoided.

A third setpoint, "Disable Lag = XX%," also requires setting. This too is a % of the lead compressor's operating amps. The value may be set anywhere between 35% to 60%. A recommended value is 40%. Here too the "Delay Timer" setpoint will require that the lead compressor's operating amps be equal or less than the setpoint value for the programmed "Delay " time.

Because either compressor can be the "Lead" unit, the three values must be set the same in each MicroTech chiller panel.

AUTOMATIC STARTUP

If the lead compressor has shutdown and is inoperative because of a fault, the LLLB controller will automatically start the other machine. No operator changeover is required.

LOAD BALANCE

When both units, or compressors, are operating, the controller unloads the compressor drawing the greatest % of amps until the % of amps drawn by both are within 5% of each other.

At any given load, as the one compressor is unloaded, the second is loaded to achieve the balance and satisfy the setpoint water temperature.

NOTE: Clock schedule and hex switches must be set in accordance with earlier instructions.

Table 14. KEY: DISPLAY SECTION

Key	Key Press Sequence	Display
Water Temp's	1	LEAVING EVAP = XX
	2	ENTERING EVAP = XX
	3	ENTERING COND = XX
	4	LEAVING COND = XX
Refrig Temp's	1	EVAPORATOR = XX
	2	SUCTION LINE = XX
	3	SUPERHEAT = XX
	4	DISCHARGE = XX
	5	CONDENSER = XX
	6	LIQUID LINE = XX
	7	LIQ. SUBCOOL = XX
	8	COND. APPROACH = XX
Refrig Pres's	1	EVAP PRESSURE = XXZ
	2	COND PRESSURE = XXZ
	3	LIFT PRESSURE = XXZ
Unit Status	1	
	2 thru 8	(See keypad text, page 25)

Key	Key Press Sequence	Display
Motor Amps	1	MOTOR % RLA = XX
	2	MOTOR AMPS = XXX
Oil Temp's Pres's	1	OIL FEED TEMP = XXX
	2	OIL SUMP TEMP = XXX
	3	OIL GAGE PRES = XXZ
	4	OIL DIF PRES = XXZ
Hours Starts	1	OPERATION HRS. = XXX
	2	# OF STARTS = XX
	3	START HRS. AGO = XX
Data Scroll	1	
	2 thru 52	(See keypad text, page 25)

Table 15. KEY: SETPOINTS SECTION

Key	Key Press Sequence	Display
Water Temp's	1	LVG EVAP SPT = XXX
	2	RESET LVG SPT = ZZZ
	3	RMT RESET SIG = XXX
Max Amp Limit	1	MAX AMP LIM = XXX
	2	REMOT AMP LIM = XXX
	3	REMOT AMP SIG = XXX
Soft Load	1	SOFT LOAD AMP = XXX
	2	BEG. AMP LIM = XXX
	3	RAMP UP TIME = XXX
Clock Schedule	1	
	2 thru 49	(See keypad text and separate schedule, pages 27 and 32)

Key	Key Press Sequence	Display
Cancel, Clear Display	1	(Turns OFF display) (Cancels Password)
+ Yes	1	(Increases setpoint values or changes statements)
- No	1	(Decreases setpoint values or changes statements)
= Enter	1	(Enters new setpoint values into the software memory)

Table 16. KEY:

SERVICE SECTION

Key	Key Press Sequence	Display
Manual Vane Control	1	[+] LOAD, [−] UNLOAD (See text, page 27)
Fault History	1 2 3 thru 9	NOW = ZZZ − ZZZ LAST = ZZZ − ZZZ (See keypad text, page 27)
Clear Fault	1	CLEARING THIS FAULT
Start Unit	1	(Starts the unit as the "Local" start mode switch)
Set-Up Options	1 2 thru 18	(See keypad text and separate schedule, page 28 and below)
Service Set-points	1 2 thru 13	(See keypad text and separate schedule, pages 25 and 33)
Change Pass-word	1	(McQuay Service phone number)
? Help	1	(McQuay Service phone number)

KEY: Set-up Options

Table 17.

KEY PRESS SEQUENCE	PASS-WORD REQ'D	DISPLAY	OPTIONS (or range)
1	P	RESET OPTIONS = ZZZ	NONE, ENT, CHW, AMP, AMPENT, AMPCHW
2	P	MAX. CHW RESET = XX.X	N/A, 0°F minimum to 15°F maximum
3	P	ENT EVAP. SPT = XX.X	N/A, 21°F minimum to 70°F maximum.
4	P	ENT EVAP TIMER = XXZ	N/A, 2 minute to 60 minute maximum
5	P	START MODE = ZZZ	Local, Remote
6	P	START UP D—T = XX.X	1°F minimum to 10°F maximum
7	P	SHUTDOWN D—T = XX.X	3°F minimum to 10°F maximum
8	P	START-START = XXZ	20 minutes to 60 minute maximum
9	P	STOP TO START = XXZ	3 minutes to 20 minutes maximum
10	P	LOAD DELAY = XXZ	15 seconds to 240 seconds maximum
11	P	COND PUMP TMR = XXZ	5 seconds to 240 seconds maximum
12	P	TWR STG 1 ON = XXZ	45 PSID to 55 PSID maximum
13	P	TWR STG 1 OFF = XXZ	35 PSID to 45 PSID maximum
14	P	TWR STG 2 ON = XXZ	50 PSID to 60 PSID maximum
15	P	TWR STG 2 OFF = XXZ	40 PSID to 50 PSID maximum
16	P	ENABLE LAG = XX%	80% to 100% maximum
17	P	DISABLE LAG = XX%	35% to 60% maximum
18	P	DELAY TIMER = XXZ	1 minute to 10 minute maximum

P means a Password is required. TMR means Timer

TWR STG means "Tower Stage" and refers to the cooling tower fans. If the fan control circuit includes one or two fan cycling control relay(s), the relay(s) may be energized and de-energized by "Set-up Options". Keypress 12 and 13, and 14 and 15 through the solid-state output relay circuit.

KEY: [Clock Sched-ule]

Table 18.

KEY PRESS SEQUENCE	PASS-WORD REQ'D	DISPLAY	OPTIONS
1		Current Time = XX:XX (Hrs):(Min)	
2	P	Override (Hrs.) = X.X	
3	P	Hour Now, 0—23 = XX	
4	P	Minutes, 0—59 = XX	
5	P	Seconds, 0—59 = XX	
6	P	Day Of Week = ZZZ	
7	P	Month, 1—12 = XX	
8	P	Date, 1—31 = XX	
9	P	Year, 0—99 = XX	
10	P	S1 First Day = ZZZ	OFF , Sunday, Monday, Tuesday, etc.
11	P	S1 Last Day = ZZZ	Fri, Sat, etc.
12	P	S1 Start Hour = XX	0—23 Hours
13	P	S1 Start Min. = XX	0—59 Minutes
14	P	S1 Stop Hour = XX	0—23 Hours
15	P	S1 Stop Min. = XX	0—59 Minutes
16	P	S2 First Day = ZZZ	Off, Sunday, Monday, Tuesday, etc.
17	P	S2 Last Day = ZZZ	Fri., Sat., etc.
18	P	S2 Start Hour = XX	0—23 Hours
19	P	S2 Start Min. = XX	0—59 Minutes
20	P	S2 Stop Hour = XX	0—23 Hours
21	P	S2 Stop Min. = XX	0—59 Minutes
22	P	#1 Holiday Month = 1	0 or 1 (Disable, or New Years Day)
23	P	#1 Holiday Date = 1	0 or 1 (Disable, or New Years Date)
24	P	#2 Holiday Month = 1	0 or 1 (Disable, or Martin Luther King Jr. Day)
25	P	#2 Holiday Date = 19	0 or 19 (Disable, or Martin Luther King Jr. Date)
26	P	#3 Holiday Month = 2	0 or 2 (Disable, or Presidents Day)
27	P	#3 Holiday Date = 16	0 or 16 (Disable, or Presidents Date)
28 thru 49	P	#4 thru #14 Holiday Months & Date	See Table 19 for Holiday programmed

Table 19. Holiday's Scheduled

#1	New Year's Day	1/1	#8	Columbus Day	10/12
#2	Martin Luther King Jr. Day	1/19	#9	Veterans Day	11/11
#3	Presidents Day	2/16	#10	Thanksgiving Day	11/26
#4	Easter	3/19	#11	Day after Thanksgiving	11/27
#5	Memorial Day	5/25	#12	Christmas	12/25
#6	July 4th	7/4	#13	Special	0/0
#7	Labor Day	9/7	#14	Special	0/0

NOTES:

P = Password is required to change values
X = Indicates numerical values
ZZZ = Indicates alphabetical display
OFF = Principle disabling function to negate all time schedule control

SPECIAL NOTE:

If the system involves two compressors on one unit, or two or more units, using a Lead/Lag-Load Balance control module, the clock schedule setpoint "S1-First Day" (10th press of the keypad), must *NOT* be "OFF". "S1-First Day" must be set for any day of the week.

KEY: **Service Set-Points**

Table 20.

KEY PRESS SEQUENCE	PASS-WORD REQ'D	DISPLAY	RANGE	DEFAULT SETTING	TRIP CONDITION ***
1	SP	LAST START = XXZ	0 to 255 min.	———	
2	SP	100% RLA = XXZ	5 to 1275 amp max. (5 amp increm.)	———	
3	SP	LOW MTR CURR = XX%	5% to 15%	10%	—
4	SP	HOT GAS SPT = XX%	0% to 80%	40%	#
5*	SP	LOW OIL DELTA = XXX	40°F to 60°F	50°	—
6	**	CALC OIL SPT = XXX	**	103°F	—
7	SP	HIGH OIL FEED = XXX	130°F to 150°F	140°F	+
8	SP	LOW EVAP PRES = XXZ	10 PSI to 50 PSI	31 PSI	—
9	SP	LP OVERRIDE = XZ	1 PSID to 6 PSID	3 PSID	—
10	SP	HI DISCHARGE = XXX	100°F to 235°F	190°F	+
11	SP	HIGH SUCT RUN = XXX	30°F to 150°F	95°F	+
12	SP	HIGH SUCT OFF = XXX	100°F to 200°F	125°F	+
13	SP	HI COND PRES = XXZ	100 PSI to 160 PSI	140 PSI	+

NOTES:

SP means Service Password LP means Low Pressure SPT means Setpoint

Default Setting is the factory input setting. Default pressure values are R12: for R500, use pressures equal to the saturated temperatures of the R12 pressures.

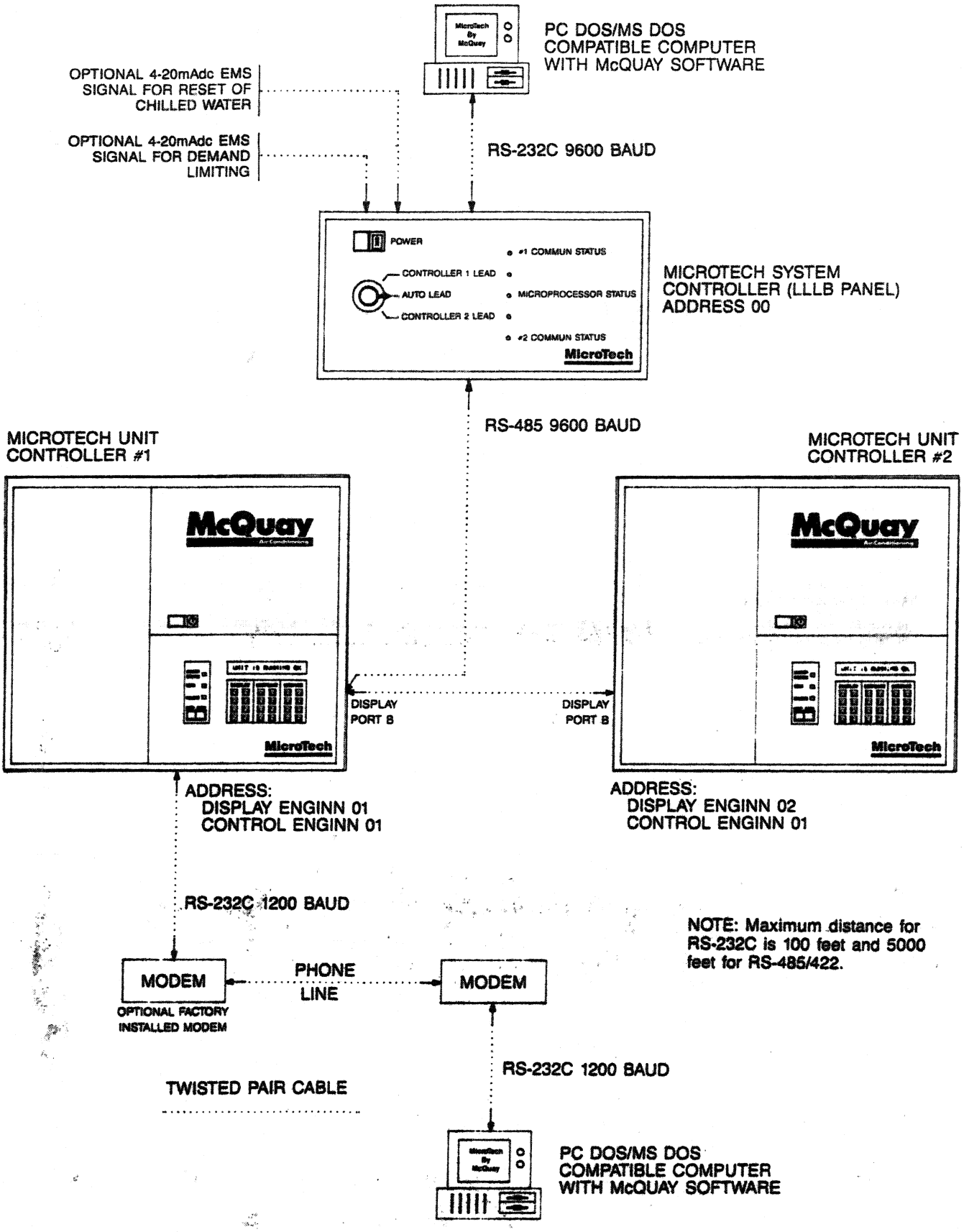
* Press 5—"Low Oil Delta" is the temperature difference required above saturated refrigerant suction temperature to permit the chiller to start. If the difference between actual oil temperature, and saturated refrigerant temperature is less than the input setting, the unit will not start.

** This valve is automatically set equal to the sum of 10°F plus the Low Oil Delta Temp. (Press 5), plus the saturated refrigerant (Evap.) temperature.

*** Trip conditions are displayed by a minus or plus sign, indicating that the control will trip as the %, temperature, or pressure goes below (–), or goes above (+) the control setting.

\# The Hot Gas Bypass setpoint does not define a safety trip device, but an operating control. If used, the Hot Gas Bypass solenoid will be energized at and below the percent RLA setpoint.

Figure 26. Typical Communications Interconnections.



PROTECTIVE CONTROL TIME CONSTRAINTS

Operation of the mechanical low pressure switch (MLP), high pressure switch (MHP), and oil pressure differential switch (OD) serve to instantly shutdown an operating machine if values in the open range of those shown in Table 12 occur. Operation of motor overloads, and other safeties wired in series with the MCR coils, and Surgeguard and Guardistor relay operation also all result in instantaneous trip.

To prevent nuisance tripping from fluttering flow switches, or delayed interlock closure, devices connected to terminals 7, 8, 9, 10, 11, and 12 on TS1 terminal strip have a built in time lag of 1.7 to 3.1 seconds prior to operation of a shutdown. Obviously, if a motor overload trip occurs, the protection is instantaneous, because the contacts are in the main MCR coil circuits. The readout display is delayed because of the location of the logic in the time delay circuit.

SIGNAL CONVERTER

The McQuay furnished signal converter accepts a zero to 5, 6, or 7 volt AC signal and converts it to a zero to 4 volt DC signal.

If the converter should fail and pass AC volts to the MicroTech terminal strip, TS4, the unit will trip off, and the display will signal a "Mtr Current Fault".

If the signal converter fails "Open", the display will read "Waiting High Amps".

WATCHDOG PROTECTION

The MicroTech panel includes two microprocessors, in the Display EnGinn mounted on the keypad door, the other in the logic cartridge mounted on the mother board.

Each of these two components has a blinking LED that blinks independently of one another.

A third light marked "Microprocessor Status" on the keypad door blinks in union with the control EnGinn LED silently proclaiming normal or troublesome operation to passersby.

The two microprocessor circuits are connected through the daughter board to a protective circuit that keeps watch over the operation of both.

In the event a malfunction occurs in either of the two microprocessors, the watchdog circuit instantly removes +5VDC power to the output board, thereby de-energizing all outputs. This action immediately shuts down the chiller.

If the control EnGinn microprocessor fails, indicated by the control EnGinn LED being constantly "on" or "off" but not blinking, the chiller can not be run until the cause of the failure is corrected.

In the event the problem is caused by the display EnGinn microprocessor, indicated by the display EnGinn LED being constantly "on" or "off" but not blinking, the control panel may be de-energized, the watchdog circuit de-activated, and the unit allowed to operate temporarily if necessary without the display EnGinn operative.

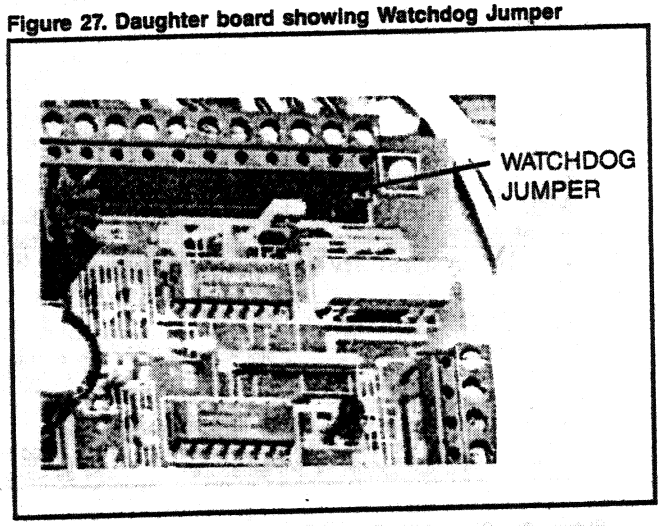
To turn a chiller back on with a bad display EnGinn microprocessor,

1. Trip the 3 amp circuit breaker, or otherwise de-energize the control power to the panel.
2. Remove the watchdog jumper from the daughter board (See Figure 27).
3. Disconnect the communications lead linking the two microprocessors together. Unplug the lead at the Port A connection on the inside of the door.
4. Re-apply the power to the control panel.
5. After power has been re-applied, the unit will start if it had been programmed for remote control; but not without further control refinement if the unit control was on "Local".

   With the keypad and display initially programmed for "Local" control, and the display EnGinn inactive because of a malfunction, the keypad cannot be operated to start the chiller. The display panel must be replaced immediately, or a portable computer with IBM capability and MicroTech software connected at the communications Port A on the control EnGinn.

   Another option exists if the unit is equipped with a telephone modem. The unit may be called over phone company lines and instructions phoned via an IBM compatible and MicroTech software.
6. Because the avenues available to return a chiller to operating status are more cumbersome if the keypad and display are programmed for "Local" control, we recommend that the unit be programmed for "Remote" and a jumper or toggle switch wired across Field Connection terminal strip terminals number 9 to 64 (or 65), if a conventional remote switch is not planned.

Figure 27. Daughter board showing Watchdog Jumper



DAUGHTER BOARD GROUND WIRE DIODE

Daughter board terminal strip TS2 should have a diode, connected across terminals 1 and 8. This diode is standard on MicroTech panels manufactured on or after April 1, 1989, serial number 5UDXXXX. Panels manufactured before April, 1989, will not have this diode and it must be added during a routine visit to the job.

This modification consists of installing a standard Surgegard diode, part number 350A034H04, across terminals 1 and 8 on terminal strip TS2. To install the diode, remove jumper wire 605 from terminals 1 and 8. Connect the cathode (banded) end of the diode to terminal 8 and the other end to terminal 1.

This modification will help prevent many potential daughter board failures and prolong the useful life of the board.

OIL GAUGE TRANSDUCER (OGT)

The oil gauge transducer is a zero to 300 PSI input, 1 to 5 volt DC output LVDT type transducer. The device is powered by a 17 VDC unregulated power supply from the daughter board and produces a linear 1 to 5 volt DC as output as the pressure is increased from zero to 300 volts.

The transducer senses gross oil pressure (saturated suction plus oil pressure). Actual, or net oil pressure is the gross oil pressure minus the saturated refrigerant suction pressure as calculated from the refrigerant saturated suction temperature.

At 150 PSI gross oil pressure, the transducer should deliver +3 VDC to the TS4 terminal number 11 on the daughter board.

If the DC voltage varies appreciably from the linear curve as depicted in Figure 21, the transducer may be bad and require replacement.

If the DC voltage equals 4.9 to 5.0 volts, the unit will shutdown, and the display will read "Off: Oil Gauge Sensor".

Since the DC voltage output from the transducer is a function of oil pressure into the device, check the oil pressure with service gauges before condemning the transducer.

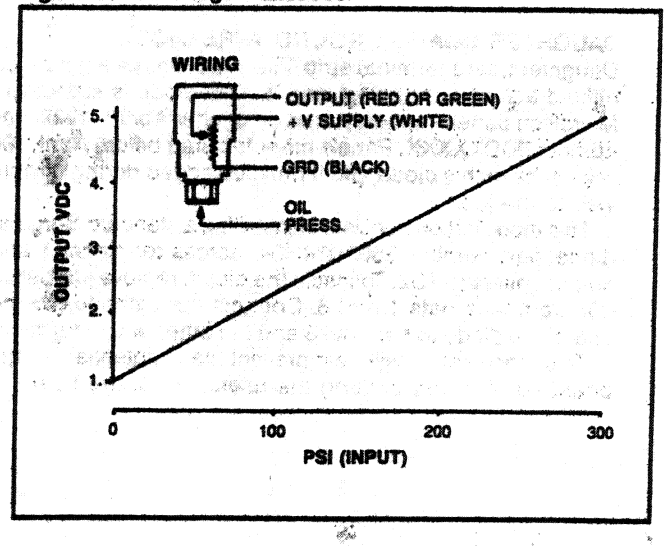
Bear in mind also that during pre-lube, with a high standby refrigerant pressure, gross oil pressure will be much higher than may normally be expected with the chiller running.

If pressures permit, adjust the oil pressure relief valve to lower actual oil pressure, and the resultant DC voltage signal.

Table 21. 0—300 PSIG

ACCURACY (% Full Scale @ 25°C) • Repeatability: ±0.3% max., ±0.1% typical • Linearity: ±0.3%, ±0.3% typical • Hysteresis: ±1.0% max., ±0.5% typical
MAXIMUM POWER RATING: 0.125 watts
RESPONSE TIME: less than 15 milliseconds
OPERATING TEMP. RANGE: -40 to +125°C
TEMPERATURE SENSITIVITY OVER ABOVE OPERATING RANGE: ±0.1%/°C maximum
TOTAL RESISTANCE: 1 K-ohms
OUTPUT SIGNAL AMPLITUDE: spans available to 80% of supply voltage
ACCELERATION EFFECTS • Acceleration-induced error under worst case conditions (in longitudial axis with gas medium): ±0.1%/g @ 60 Hz • Contact lift under conditions defined above: none detectable

Figure 28. Oil Gauge Transducer



SENSORS

With the exception of sensors numbered 11, 12, and 13 the omission or the failure of analog sensors connected to the daughter board terminals TS3 and TS4 will be discerned by the microprocessor as a fault. The unit will shut down and the faulty sensor will be identified in the MicroTech display.

This presumes that the fault exceeds pre-programmed limits in the software. For example, if any of the eleven (11) temperature sensors short, or open, their electrical resistance will instantly trigger a service shutdown.

If on the other hand, one of the sensors becomes erratic, or erroneous in reflection of a temperature value, this aberation will only be apparent following analysis of the chiller's operating data. In the event a temperature sensor is suspect, the electrical resistance at known temperatures may be checked in comparison to the "Resistance vs. Temperature" table included.

Sensors 11, 12, and 13 also will produce an equipment shutdown and identifying display if these sensors fail. Unlike the thermistors, however, each of these decay to zero when the chiller is off; and sensor number 11 (the Reset signal) may remain at zero while the chiller is running without trigging a fault indication.

Sensors numbered 12 and 13 must signal more than zero while the unit is running, and less than a pre-determined maximum to prevent a fault statement and a trip.

Table 22. 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

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 are not 'open', however, in the sense that conventional electrical-mechanical relays open their contacts.

When energized, the relay 'contacts' lower their resistance and pass currrent 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 number 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 auxillary 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 MicroTech control 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 doesn't glow, the relay probably is not being energized. Relays require the existance of 5 VDC to initiate closure. When the relay is energized, the LED should glow.

Figure 29. Solid-state Relay Board.

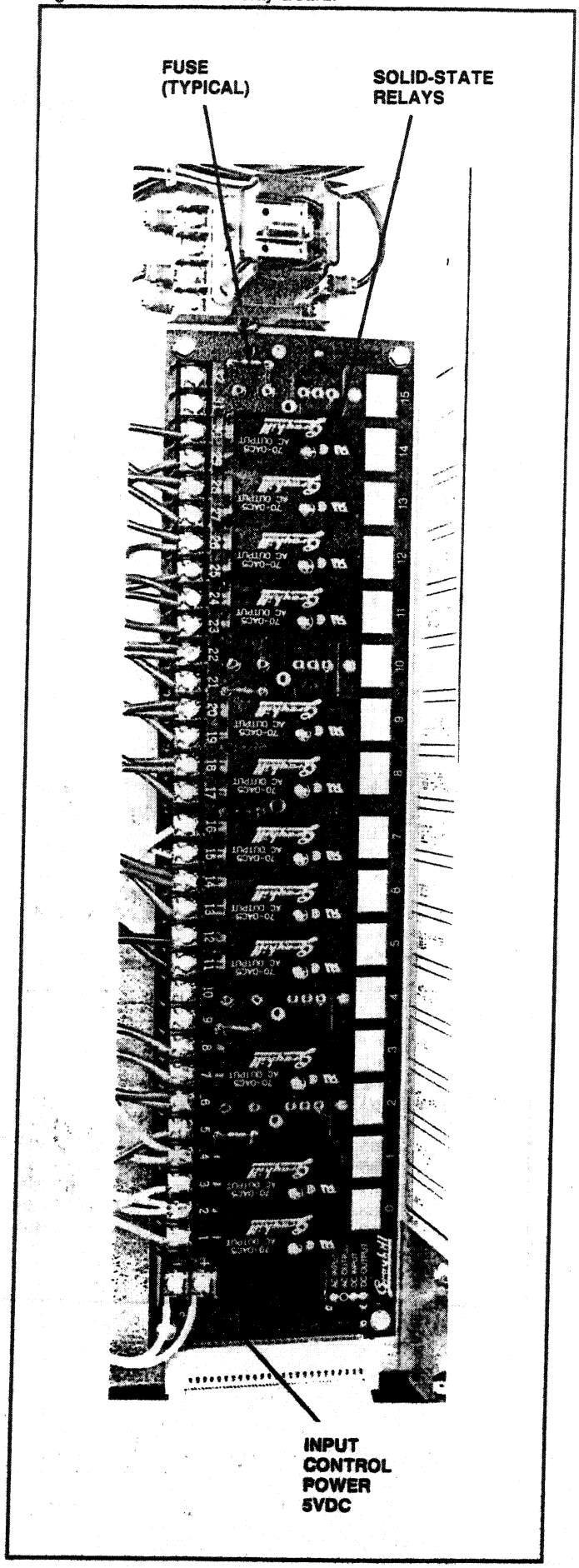


Table 23. Trouble Symptom Chart

MICRO-PROCESSOR STATUS LED	CONTROL ENGINN** LED	DISPLAY ENGINN LED	DISPLAY SCREEN	OUTPUT* RELAY LED(S)	DAUGHTER BOARD LED(S)	POSSIBLE CAUSE	TEST PROCEDURE
OUT	OUT	BLINKING	NONSENSE	OUT	SOME ON UNIT OFF	POWER CARTRIDGE	(1)
						LOGIC CARTRIDGE	(2)
						MOTHER BOARD	(1 & 2)
						DAUGHTER BOARD FUSE BLOWN	(4)
						TRANS 3 FUSIBLE LINK BLOWN	(5)
OUT	BLINKING	OUT	BLANK	OUT	SOME ON SOME OFF	TRANS 2 FUSIBLE LINK BLOWN	(3)
						DISPLAY ENGINN BAD	(9)
OUT	BLINKING	BLINKING	NORMAL	ON	ON	MICROPROCESSOR LED BAD	(8)
OUT	ON CONSTANT BUT DIM	BLINKING	NONSENSE	OUT	SOME ON UNIT OFF	LOGIC CARTRIDGE	(2)
BLINKING	BLINKING	BLINKING	TRIP STATEMENT	ON	TRIP STMT DISAGREES W/LED IND. LED IS DIM	DAUGHTER BOARD DEFECTIVE	(6)
BLINKING	BLINKING	BLINKING	NONSENSE	ON	ON UNIT RUNS	HEX SWITCH SETTING	(7)
BLINKING	BLINKING	BLINKING	"MCR OFF" WAITING LOW AMPS	ON	ON UNIT OFF	MCR CIRCUIT (SOLID STATE RELAYS #14 & 3) FUSES, RELAYS OR OTHER SAFTIES OPEN	(10)
BLINKING	BLINKING	BLINKING	"HIGH MOTOR AMPS"	ON	SOME ON SOME OFF OIL PUMP RUNNING UNIT OFF	VOLTAGE INPUT TO TS4, TERMINALS 7 & 8	(12)
						OPEN CIRCUIT AT TS4 TERMINALS 9 & 10	(11)
BLINKING	BLINKING	BLINKING	"OIL GAUGE SENSOR"	ON	SOME ON SOME OFF UNIT OFF	SUPPLY VOLTAGE TO OGT ABNORMAL	(13)
						OIL PRESS. TOO HIGH	(13)
						OGT DEFECTIVE	(13)
						SENSOR TO DAUGHTER BOARD (TS4) WIRING SHORTED	(15)
BLINKING	BLINKING	BLINKING	"WAITING FOR LOAD"	ON	SOME ON SOME OFF UNIT OFF	IF WATER TEMP. IND. LOAD EXISTS, CHECK RESET STMT. AND CLOCK SCHEDULE	(14)

* Output relay LED's light when the relay coil circuit is instructed to energize, if there is a source of 0 and +5 VDC at the - and + terminals at the bottom of the terminal strip.

** The Control EnGinn consists of a Logic Cartridge, a Power Cartridge and a mother board.

Table 24. Control Fuses.

LOCATION	QUANTITY	TYPE	AMP RATING
Output Relays	16	Little Fuse # 275005	5.0
Daughter Board	1	Little Fuse # 229015	1.5
Transformers TR2 & TR3	1 ea.	Non-Replaceable Fusible Link	2.5

TEST PROCEDURE — TROUBLE ANALYSIS

Numbers below coincide with numbers shown in the right hand column of the Trouble Symptom Chart.

System or chiller operating problems are not described. Check the MicroTech display and fault history, or see the IM for the unit involved for chiller problems.

All of the following assumes that power is applied to the MicroTech Station panel and the circuit breaker is on.

Where the following procedures describe the removal and replacement of fuses, connectors, terminals or jumpers, ***always shut off the power to the panel before making the disconnect or replacement.***

1. If the control EnGinn LED is out, or if the LED is on but does not blink, check for the presence of 17 VDC entering the control EnGinn, and for 5 VDC leaving. Voltage readings should be measured by connecting the power lead of the voltmeter to the appropriate solder plug on the mother board, and the common meter lead to the ground screw in the control back panel.
   Solder plugs to be tested are approximately 1 inch in from the right hand edge of the mother board, and in the approximate vertical center.
   One solder plug is to the left of the words "12 VAC". This plug should read, 17 VDC. Directly above this plug is another marked "5 VDC". A test at this plug should show 5 VDC.
   If the lower plug test delivers a reading of 17 VDC, and the upper test plug shows less than 5 VDC, the problem is either in the power cartridge or the mother board. Substitute a new power cartridge for testing before replacing the mother board.

2. If the test above confirms the presence of 17 VDC entering the Control EnGinn, and 5 VDC leaving, the problem will probably be either a faulty logic cartridge, or a bad mother board. Substitute a new logic cartridge before replacing the mother board.

3. To test for a blown fusible link in the #2 transformer, with the circuit breaker tripped off (white sleeve showing), disconnect the red striped yellow lead from the terminal number 85. Re-apply power, and check for 12 volts AC between the exposed end of the red striped yellow lead, and terminal number 83 or 84.
   If no voltage is indicated, verify that the meter is functioning or that the transformer is otherwise delivering power by reading between terminals 83 and 84. (Read 24 VAC).
   Replace a defective transformer.

4. To test the daughter board fuse, read 17 volts DC between the left side terminal clip at the fuse outlet and the back panel ground. If no voltage is present, move the power test lead of the meter to the right side fuse clip.
   If 12 volts DC is present at one end of the fuse, and 0 to 1.9 volts at the other, the fuse is bad. Replace it.
   If no voltage is present to ground on either side of the fuse, or very low voltage exists on both sides, check the transformer #3 fusible link (See #5, below).
   If the transformer fusible link is okay and no voltage or very low voltage exists on both ends of the fuse, the fuse is okay, but the daughter board may be bad. If so, replace it.

5. To test the transformer #3 fusible link, interrupt the power to the panel and lift the TS2 terminal strip off the daughter board pins. Re-apply power to the panel, and measure for voltage between TS2 terminals #2 and #4, or #3 and #4. Voltage should read 12 VAC If it does not, replace the transformer.

6. The daughter board contains 12 LED's to visually depict closure of the multiplexed digital inputs. Figure 30, page 42, lists these safety devices and the LED number associated with each.
   If a daughter board LED is lit, yet the display statement shows that contact to be open, it's possible that the daughter board itself may be bad. To check the daughter board, using a DC voltmeter, read the voltage across the daughter board capacitors (mounted below LED's). If the LED is lit, voltage should approximate 30 VDC. If the LED is out, voltage should be zero.
   If widely different values are present, before condemning the daughter board, check to be sure a diode, part number 350A034H04, has been installed between terminals 1 and 8 on terminal strip TS2. If not, add this diode following the instructions on page 35 ("Daughter Board Ground Wire Diode"). Then retest the voltage at the capacitor. If the voltage is still not correct, check the diode and replace it or the daughter board.

7. Hex switch settings must be correct for the combination of equipment connected. See the text and Table 11 in the main body of this IM.

8. The microprocessor LED located on the keypad cover is replaceable. See Replacement parts data for the correct part number.

9. To check a suspected bad display EnGinn, interrupt power to the panel then disconnect the power plug from the top right hand side of the display EnGinn. Re-apply power to the panel. Read the voltage at the plug.
   At the plug pins 3 to 2, read 12 VAC.
   At the plug pins 3 to 1, read 12 VAC.
   At the plug pins 1 to 2, read 24 VAC.
   If readings are not as described, replace transformer #2.
   If readings are as described, interrupt power to the panel and reconnect the power plug to test for 5 volts DC to ground. Re-apply power to the panel. A test voltage connection may be made at the 5 volt DC solder plug on the right side of the display EnGinn directly above the communications cable port.
   If 5 volts DC is not available, replace the Display EnGinn.
   If a replacement is not immediately available, it's possible that the chiller may be operated with a minor control modification. See the text describing the watchdog circuit.

10. Control panels with software versions number 07 and later (see software identification information) require a minimum amps consumption, following the 30 second "MCR is on" starting sequence. The minimum amps draw will be between 5% and 15% of compressor Rated Load Amps (RLA) and if unchanged from the factory setpoint, will be 10% of RLA.
    If something in the MCR circuit, not included in the Multiplex digital inputs (daughter board LED) circuits, prevents the MCR coils from energizing, the display may assume the MCR coils were energized, but because of the low current measured, scheduled an orderly shutdown.
    If this circumstance occurs, inspect those devices or connections not overseen separately. These include the fuses in the number 14 and number 3 output relay circuits, the relays themselves, the MCR coils and interconnecting 115 VAC control wiring.
    To test the solid-state relay fuses, with the LED "off", disconnect the lead at the odd numbered relay terminal. Using a voltmeter read AC voltage from the odd numbered terminal to ground. Voltage read should be the same as the reading from the even numbered terminal to ground.
    If no voltage is read from the odd numbered terminal to ground *when voltage is applied to the even numbered terminal*, and the one lead is disconnected as noted

above, the fuse is probably bad. Remove the fuse and test with an ohmmeter.

NOTE: The solid-state relay number 3 is in series with the relay number 14. In order to make the test described above for relay 3, close the keypad panel switch SW1, and temporarily jumper the Oil Pump contactor's normally open auxillary contact (terminals C to NO). Relay 14's odd numbered terminal should be connected to lead 503, but lead 309 should be disconnected at the odd numbered terminal of Relay 3.

If the above described circuit also includes a set of normally open (N.O.) high pressure (HP) relay contacts, temporarily jumper these contacts to complete this test.

Conclude the test described above.

11. If the compressor motor has been shut down by operation of the controlling thermostat, or by opening either the remote, or local switch, and high amperage remains impressed at Analog sensor terminals number 9 and 10, the oil pump control will interpret the high amps as indicating that the compressor motor is still running. The oil pump will continue to run. The circumstances will also prevent the compressor from restarting until the problem is resolved.

    This condition will occur if the signal converter DC circuit fails "open" while the unit was operating.

    Check the signal converter-to-analog terminal strip wiring and circuitry.

    If the signal converter fails in such a manner as to pass AC volts to the microprocessor the unit will shut down and the display will signal a motor current fault.

12. If AC volts is accidently introduced into terminals number 70 and 71, this condition also will cause microprocessor to see "High Amps" and the operating results will be similar to those described in paragraph 11.

13. See the text and Figure 28 concerning the Oil Gauge Transducer operation.

14. "Waiting for Load" will not normally indicate a hardware fault. It could, however, be caused by an inadvertent control setting. If operating conditions seem to warrant chiller operation, but the machine has not started, review the control set-up options with particular emphasis on reset.

15. Wiring from the sensors to the daughter board terminal strip is composed of stranded, 18 AWG and 22 AWG wire. Tiny strands may project beyond the terminal to accidentally touch adjacent ground circuits.

    No special instruction is required to check wiring integrity.

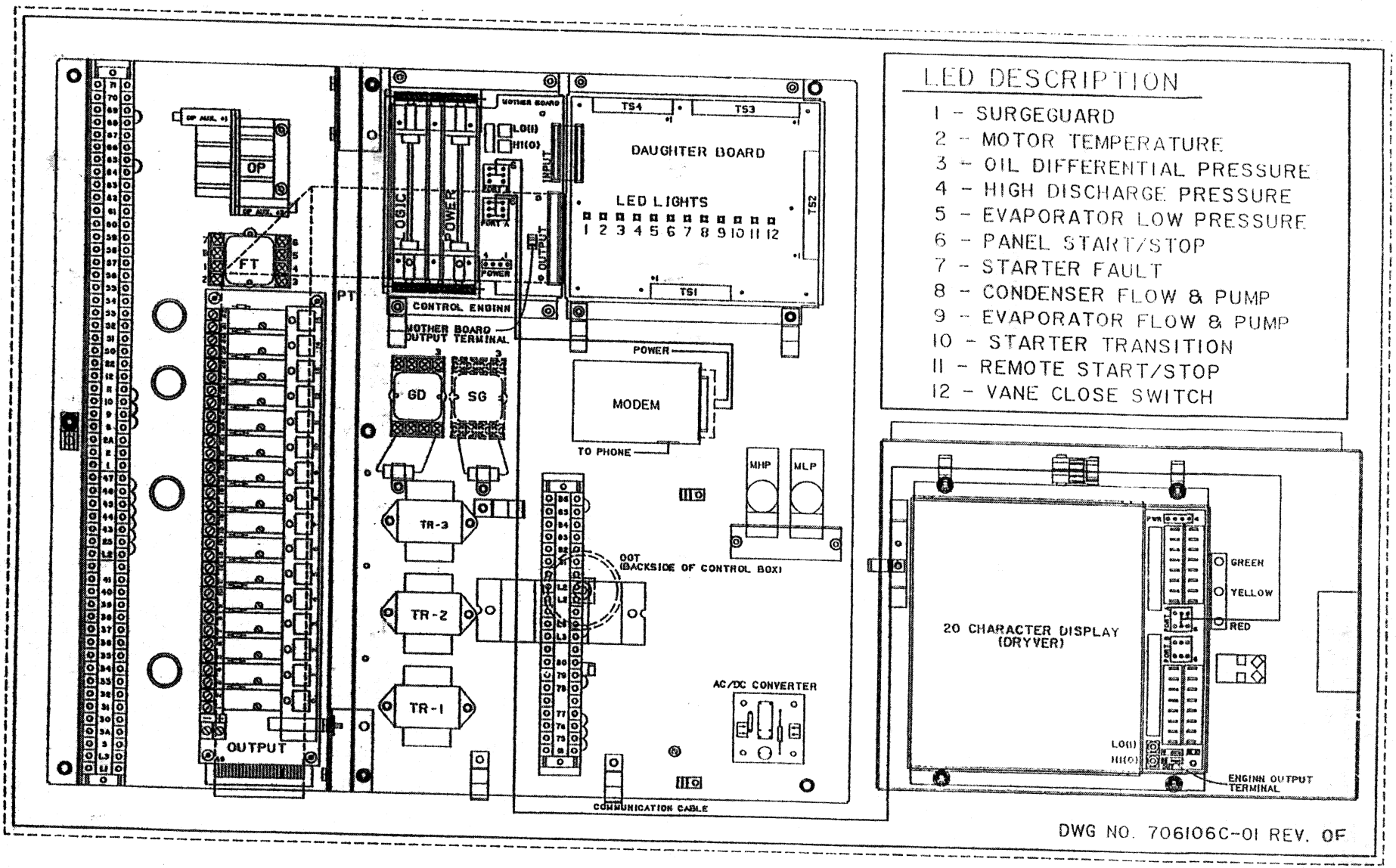


Figure 30. MicroTech Panel Layout.

OPERATING LOG RECORD

Chiller Model No._____

Serial No._____

Refrigerant_____

Compressor R.L.A._____**(Each compressor)**

Leaving Chilled Water_____ **F. (C.)**

Entering Condenser Water_____ **F. (C.)**

Evap. PD_____**Ft. H2O: Cond. PD**_____**Ft. H2O:**

OPERATING CONDITION	DATE						OPERATING CONDITION	DATE					
	TIME							TIME					
Unit is Running OK							Low Pressure Unloading						
Leaving Evap. (Temp.)							Max. Amp Limit						
Entering Evap. (Temp.)							Remote Amp Limit						
Entering Cond. (Temp.)							Manual Amp Limit						
Leaving Cond. (Temp.)							Unit Running OK						
Evaporator (Refrig. Temp.)							Leaving Evap SPT.						
Suction Line (Refrig. Temp.)							Reset Leaving SPT.						
Superheat (Refrig. Temp.)							Remote Reset SIG.						
Discharge (Refrig. Line Temp.)							Max. Amp Limit						
Condenser (Refrig. Temp.)							Remote Amp Limit						
Liquid Line (Refrig. Temp.)							Remote Amp Signal						
Liquid Subcool (Refrig. Temp.)							Soft Load Limit						
Cond. Approach (Temp.)							Beginning Amp Limit						
Evap. Pressure (PSIG)							Ramp Up Time						
Cond. Pressure (PSIG)							Now Fault						
Lift Pressure (PSIG)							Last Fault						
Motor % RLA							2nd Last Fault						
Motor Amps							3rd Last Fault						
Oil Feed Temp.							4th Last Fault						
Oil Sump Temp.							5th Last Fault						
Oil Gage Pressure							6th Last Fault						
Oil Differential Pressure							7th Last Fault						
Operating Hours							8th Last Fault						
Number of Starts													
Start Hours Ago							Evap. Water PD (PSIG)						
Unit Running OK							Cond. Water PD (PSIG)						

Start Up Delta Temp._____**: Shut Down Delta Temp.**_____**:**

(Dual unit(s) only: Enable Lag_____**%: Disable Lag**_____**%: Delay Timer**_____**minutes)**

Figure 32. Operating Log Record.