Diagnostic Troubleshooting Repair

Series R®
70-125 Ton Air-Cooled and Water-Cooled Rotary Liquid Chillers

Model

RTAA 70-125 Ton
RTWA 70-125 Ton
RTUA 70-125 Ton

August 2005 **RLC-SVD03A-EN**

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NOTICE: Warnings and Cautions appear at appropriate sections throughout this literature. Read these carefully.

⚠ **WARNING:** Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.

⚠ **CAUTION:** Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury. It may also be used to alert against unsafe practices.

CAUTION: Indicates a situation that may result in equipment or property-damage only accidents.

Important - Read This First!

This manual is intended for experienced service personnel familiar with the proper use of electrical diagnostic instruments and all personal safety procedures when working on live electrical circuits.

This Manual is <u>not</u> intended for individuals who have not been properly trained in handling live electrical circuits.

Environmental Concerns!

Scientific research has shown that certain man-made chemicals can affect the earth's naturally occurring stratospheric ozone layer when released to the atmosphere. In particular, several of the identified chemicals that may affect the ozone layer are refrigerants that contain Chlorine, Fluorine and Carbon (CFCs) and those containing Hydrogen, Chlorine, Fluorine and Carbon (HCFCs). Not all refrigerants containing these compounds have the same potential impact to the environment. Trane advocates the responsible handling of all refrigerants—including industry replacements for CFCs such as and HCFCs and HFCs.

Responsible Refrigerant Practices!

Trane believes that responsible refrigerant practices are important to the environment, our customers, and the air conditioning industry. All technicians who handle refrigerants must be certified. The Federal Clean Air Act (Section 608) sets forth the requirements for handling, reclaiming, recovering and recycling of certain refrigerants and the equipment that is used in these service procedures. In addition, some states or municipalities may have additional requirements that must also be adhered to for responsible management of refrigerants. Know the applicable laws and follow them.

⚠ WARNING
Contains Refrigerant!

System contains oil and refrigerant under high pressure. Recover refrigerant to relieve pressure before opening the system. See unit nameplate for refrigerant type. Do not use non-approved refrigerants, refrigerant substitutes, or refrigerant additives.

Failure to follow proper procedures or the use of non-approved refrigerants, refrigerant substitutes, or refrigerant additives could result in death or serious injury or equipment damage.

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General Information

The Unit Control Modules (UCMs) described in this troubleshooting guide provide a microprocessor based refrigeration control system, intended for use with Trane 70-125 ton helical rotor chillers. Six types of modules are used, and throughout this publication will be referred to by their abbreviations or their Line Wiring Drawing Designations, see Table 1.

Table 1 Unit Control Module Designations

Line Drawing Designation	Controller Name Chiller Module	Abbrev. CPM
1U2	Options Module	CSR
1U3	Expansion Valve Module	EXV
1U4 & 1U5	Compressor Module	MCSP A & B
1U6	Clear Language Display	CLD
1U7	Interprocessor Communications Bridge (Remote Display Buffer)	IPCB

Service Philosophy

With the exception of the fuses, no other parts on or within the modules are serviceable. The intent of the troubleshooting is to determine which module is potentially at fault and then to confirm a module problem. This is done either through voltage or resistance measurements at the suspected input or output terminals or by checking related wiring and external control devices (connectors, sensors, transformers, contactors etc.) in a process of elimination. Once a problem has been traced to a module, the module can be easily replaced using only basic tools. In general, all dip switch settings of the replaced modules should be copied onto the replacement module's dip switches before applying control power. CPM replacement is more involved as there are numerous configuration and set-up items that must be programmed at the Clear Language Display in order to insure proper unit operation.

It is helpful to include with the return of a module, a brief explanation of the problem, sales office, job name, and a contact person for possible follow-up. The note can be slipped into the module enclosure. Early and timely processing of Field Returns allows for real measurements of our product quality and reliability, providing valuable information for product improvement and possible design changes.

General Information

System Description

The CPM is the master module and coordinates operation of the entire system. One is used per chiller. The MCSP is a compressor protection module with one being used for each of the compressors in the chiller. The EXV is the expansion valve controller module which controls two Electronic Expansion Valves. There is one valve on each of the two refrigeration circuits.

The CLD is a two line, 40 character alphanumeric interface to the system. It allows the operator to read operating and diagnostic information, as well as change control parameters. The Interprocessor Communications Bridge (IPCB) provides an extension of the IPC link to the Remote Clear Language Display, while protecting the integrity of the IPC communications link between the local modules.

The CSR is an optional communications module which allows for communications between the chiller and a remote building automation system (i.e. Tracer, Tracer Summit, Generic BAS).

All modules in the system communicate with each other over a serial interprocessor communications bus (IPC) consisting of a twisted wire pair "daisy chain" link and RS485 type signal levels and drive capability. Multiple modules of the same type (i.e. MCSPs) in an operating system are differentiated by address dip switches.

All the modules operate from 115VAC, 50 or 60Hz power and each have their own internal step-down transformer and power supply. Each is individually fused with a replaceable fuse. The modules also are designed to segregate their high and low voltage terminals by placing the high voltage on the right side of the module and the low voltage on the left. When stacked, segregation is maintained.

In addition to the modules, there are a number of "system level" components that are closely associated with the modules. These components were specifically designed and/or characterized for operation with the modules. For this reason, the exact Trane part must be used in replacement.

System Level Components

Description

The following is a list of all the components that may be found connected to the various modules.

Transformer, Under/Over voltage

Current Transformer - Compressor

Evap EntlLvg Water Temp Sensor Pair

Sat Evap/Cprsr Suc Rfgt Temp. Sensor Pair

Sat Cond RfgtIOil Temp Sensor Pair

Outdoor Air Temperature Sensor

Zone Temp Sensor

Connector (UCM mating connectors)

Connector Keying Plug

Electronic Expansion Valve

General Information

High Pressure Cutout Switch

Low Pressure Cutout Switch

Variable Speed Fan Drive

Motor Temperature Thermostats

Slide Valve Load/Unload Solenoids

Step Load Solenoid Valve

Chiller Module (CPM) IU1
The CPM module performs machine (chiller) level control and protection functions. Only one CPM is present in the chiller control system. The CPM acts as the master controller to the other modules, running top level machine control algorithms, initiating and controlling all inter-module communication over the IPC, and providing parameters and operational requests (i.e. loading and unloading, starting and stopping) to the other modules in the system via the IPC. The CPM also contains nonvolatile memory, which allows it to remember configuration and set-up values, setpoints, historical diagnostics etc. for an indefinite period of time following a power loss. Direct hard wired I/O associated with the CPM includes low voltage analog inputs, low voltage binary inputs, 115 VAC binary inputs and 115 VAC (rated) relay outputs. See Chiller Module (CPM) (1U1) on page 46 for further details.

Compressor Module (MCSP) 1U4 and 1U5
The MCSP module employs the input and output circuits associated with a particular compressor and refrigeration circuit. Two MCSP modules are used in the UCM system, one for each compressor. Included are low voltage analog and digital circuits, 115 VAC input, and 115 VAC output switching devices. The output switching devices associated with the compressor motor controlling function are contained in this module. The outputs of this module control one compressor motor stop/start contactor, one compressor motor transition contactor, one oil heater, three solenoid valves (compressor load, compressor unload, step loader), and up to four fan motor contactors or groups of contactors. Refer to the chiller's line wiring diagrams for details. Dip switches are provided for redundant programming of the compressor current overload gains, and for unique IPC address identification during operation. Inputs to this module include motor temperature thermostats, thermisters, and safety switches. See Compressor Module (MCSP) (1U4 AND 1U5) on page 72 for details.

Expansion Valve Module (EXV) 1U3
The EXV module provides power and control to the stepper motor driving the electronic expansion valves of the chiller. Each module handles two valves, one in each refrigeration circuit.

Input to the EXV Module is provided by four temperature sensors (two per refrigeration circuit). The sensors are located in the respective refrigeration circuits of the chiller and sense Saturated Evaporator and Suction temperatures and calculate the superheat temperatures. High level operational commands as well as superheat setpoints are received by the EXV Module over the IPC from the CPM module to modulate the EXV's.

General Information

Real time data for temperatures, diagnostics and control algorithms etc. are made available to the CPM and the other modules for display and for input to higher level functions. See Electronic Expansion Valve Module (EXV) (1U3) on page 58 for details.

Options Module (CSR) 1U2
The CSR module is an optional part of the system and employs communications circuits for interface to Trane Building Automation Systems, done through 1C17. The CSR also provides inputs for hard wired external setpoints and reset functions. Included are low voltage analog and digital input circuits. See Options Module (CSR) (1U2) on page 50 for details.

Clear Language Display (CLD) 1U6
The CLD Module provides an operator interface to the system, through a two line, 40 character alphanumeric display. Three reports may be displayed and various operating parameters may be adjusted by depressing a minimal number of keys on the CLD. Also, chiller Start/Stop functions may be performed at this keypad. See Clear Language Display (CLD) 1U6 Keypad Overview on page 42 for details.

Interprocessor Communication Bridge (IPCB) 1U7
The IPCB module allows connection of a Remote Clear Language Display module to the UCM, for distances of up to 1500 feet. The Remote Clear Language Display communicates with the UCM, utilizing the same IPC protocol, and provides most of the same functions as the local CLD. The IPCB then serves to protect the UCM's IPC if wires to the Remote CLD become shorted or broken. See Section 2 and on page 75 for details.

Interprocessor Communications

The respective modules communicate with each other via an InterProcessor Communication link (IPC). The IPC allows the modules to work in a coordinated manner with the CPM directing overall chiller operation while each module handles specific subfunctions. This IPC link is integral and necessary to the operation of the Unit Controls and should not be confused with the Optional ICS (Integrated Comfort System) communication.

In the IPC communication protocol scheme, the CPM acts as the initiator and the arbitrator of all module communication. The CPM essentially requests all the possible "packets" of information from each module in turn, (including itself), in a predefined serial sequence. The other modules act as "responders" only and cannot initiate communication. Modules which are not currently responding to a specific request, can listen to the data and thus, indirectly, they communicate with each other. It is helpful to remember when troubleshooting that a module must be able to hear a request for its information from the CPM, or it will not talk.

The link is non-isolated, which means that a good common ground between all the modules is necessary for trouble-free operation (provided by the module enclosures' mounting using star washers). Also, the link requires consistent polarity on all of the module interconnections. Connections between modules are made at the factory, using unshielded #18 gauge twisted pair cable terminated into a 4-position MTA type connector (orange color code). This connector is plugged onto the 4 pin IPC connection jack designated as J1, located in the upper left corner of the PC board edge on all of the modules. The 4 pins actually represent 2 pairs of communications terminals (J1-1 (+) internally connected to J1-3, and J1-2 (-) internally connected to J1-4) to allow for easy daisy chaining of the bus.

IPC Diagnostics

The modules, in order to work together to control the chiller, must constantly receive information from each other over the IPC. Failure of certain modules to communicate or degradation of the communication link, could potentially result in chiller misoperation. To prevent this situation, each module monitors how often it is receiving information from designated other modules. If a module fails to receive certain other module's transmitted data over a 15 second time period it will:

1. On its own, take specific action to safely shut-down (or to default) its controlled loads.
2. Report a diagnostic to the CPM (over the IPC link).

The CPM (if it properly receives such) will then report and display the diagnostic on the Clear Language Display accordingly. The diagnostic will:

- identify which module is reporting the communication problem and
- identify which module was to have sent the missing information.

The CPM itself will then send out further commands to the other modules to shutdown or take default actions as the particular case may warrant.

All IPC diagnostics are displayed in the Clear Language Display's diagnostics section. For example, "Chiller Mod indicating Options Mod Comm Failure" indicates that the CPM Module has detected a loss of IPC communication

Interprocessor Communication

from the Options Module. When some problem exists with the IPC link or a module fails, it is not uncommon for more than one of these IPC diagnostics to be displayed. Note that only those diagnostics that are indicated to be active currently exist. All other historic diagnostics should be disregarded for the purpose of the following troubleshooting discussion. See RTAA-IOM-4 for a complete listing of diagnostics.

Troubleshooting Modules Using IPC Diagnostics

⚠ WARNING
Live Electrical Components!

During installation, testing, servicing and troubleshooting of this product, it may be necessary to work with live electrical components. Have a qualified licensed electrician or other individual who has been properly trained in handling live electrical components perform these tasks. Failure to follow all electrical safety precautions when exposed to live electrical components could result in death or serious injury.

Communication problems can result from any of the following:

1. Improperly set IPC address dip switches
2. Opens or shorts in the twisted pair IPC wiring or connectors
3. Loss of power to a module
4. Internal module failure
5. Improper connections on terminal J2
6. High levels of EMI (Electro-Magnetic Interference)
7. Module specific function selected without the Options Module.

These are discussed in more detail in the following paragraphs.

1. Improperly set IPC address dip switches:

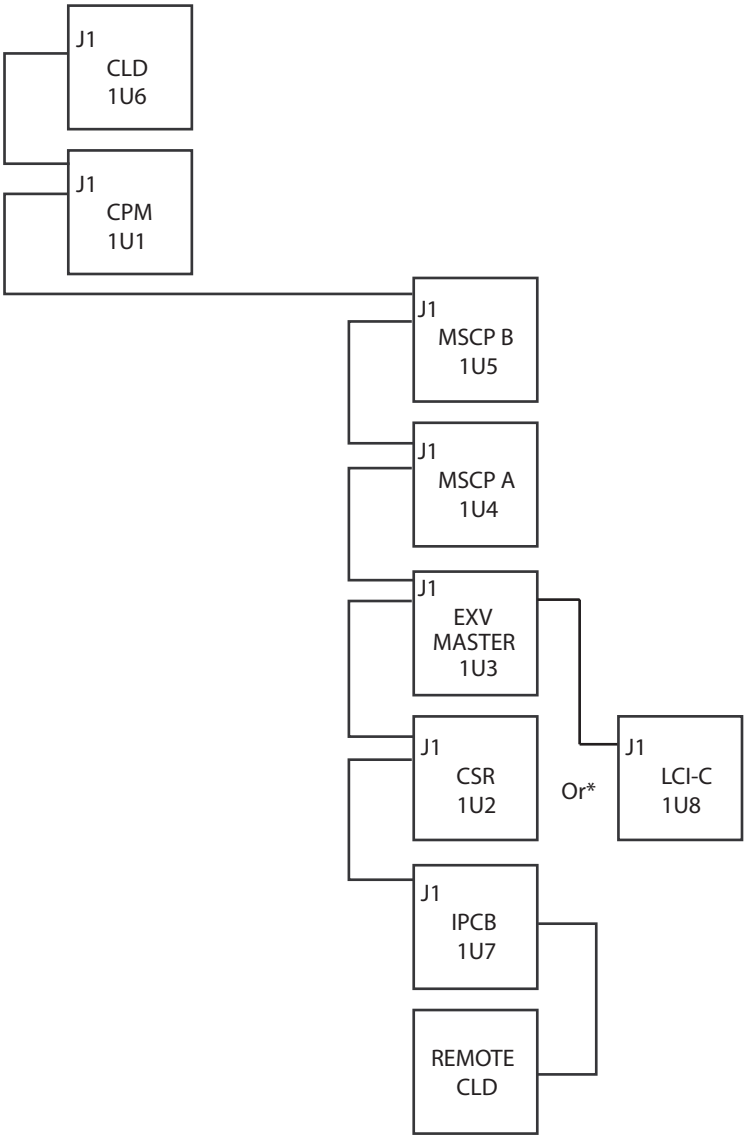
   This could result in more than one module trying to talk at the same time, or cause the mis-addressed module to not talk at all. Only the MCSP and the EXV modules have IPC address dip switches, found in the upper left hand portion of the Module labeled as SW-1. The proper dip switch set-ups are shown in Table 2.

2. Opens or shorts in the twisted pair IPC wiring or connectors:

   One or more modules may be affected by an open or a short in the IPC wiring, depending on the location of the fault in the daisy chain. The diagram below shows the daisy chain order and is helpful in diagnosis of an open link.

Extreme care should be used in making any dip switch changes or when replacing MCSP modules. “Swapping” of addresses on the MCSPs cannot be detected by the communication diagnostics discussed above and serious chiller misoperation will result.

Interprocessor Communication



*1U2 and 1U8 are mutually exclusive options
The Remote CLD is not available if the 1U8 option is installed

Figure 1 IPC Link Order For 70-125 Ton RTAA

Table 2 IPC Address Dip Switch (SW1) Settings for MCSP an EXV Modules

MODULE	DESIG.	CONTROLLING	DIP SWITCH SETTING	
			SW1-1	SW1-2
MCSP "A"	1U4	COMPRESSOR A	OFF	OFF
MCSP "B"	1U5	COMPRESSOR B	OFF	ON
EXV	1U3	CKTS. 1 & 2	OFF	OFF

3. Loss of power to a module:

   Generally a power loss to a particular module will only affect communications with that module. The module can usually be identified by analysis of the IPC diagnostics. (When the display is blank, check power at the CLD). Loss of power can most directly be diagnosed by measuring the AC voltage at the top of the fuse with respect to the neutral of the power connection (pins 4 or 5) on the terminal just below the fuse:

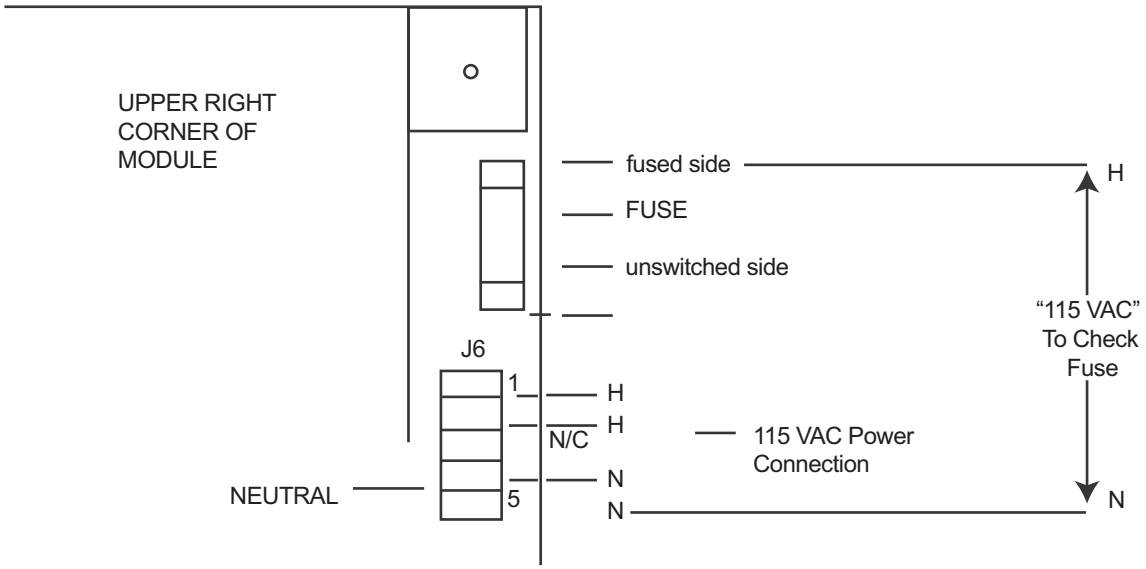


Figure 2 Module Fuse and Power Connection, Except CLD

4. Internal module failure:

   Internal module failures usually result only in communication loss to the failed module, but could, in some cases, affect all the modules because the failed module may "lock up" the IPC bus and prevent all communications. The former can be identified by analyzing all of the active IPC diagnostics. The latter can be identified in a process of elimination, whereby each module, in turn, is taken out of the IPC link and a jumper installed in its place. See Figure 3. The CPM can then be reset and the new IPC diagnostics that result can be analyzed.

Interprocessor Communication

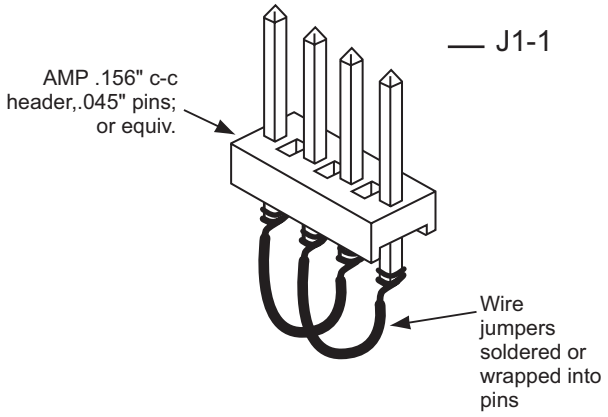


Figure 3 IPC Jumper For Bypassing Modules (to be inserted into MTA connector in place of module)

5. Improper connections to terminal J2:

   Jack J2, present on all modules except CLD, should have no connections. This input is for manufacturing test purposes only and any connections, shorts, etc. will potentially cause the module to not respond, respond to the wrong address, or (in the case of the CPM) fail to initiate any communications and thus fail the entire IPC.

6. High levels of Electro-Magnetic Interference:

   The modules and the IPC have been qualified under severe EMI (both radiated and conducted) and the system was determined to be immune to all but extremely high noise levels. Always be sure to close and latch the control panel cabinet doors as the panel enclosure provides significant shielding and is integral in the overall noise immunity of the control system.

7. Module specific function selected without the Options Module:

   If any of the functions on the Options Module are selected but the Options Module is not present, the UCM will look for this module and generate an error. The Options Module functions include Chilled Water Reset, Ice Machine Control, External Chilled Water Setpoint, External Current Limit Setpoint, and Tracer/Summit Communications.

Troubleshooting Procedure

1. Place the CPM in "Stop". Record the active IPC diagnostics as shown in the Diagnostics Report of the CLD. The communication failure diagnostics and their meanings are shown in IPC Diagnostics of the RTAA-IOM-4 manual.
2. Determine which modules are not talking. These modules must be affected by one of the previously stated problems. If there is a group of modules not talking, suspect a wiring problem early in the daisy chain link. If only one module is not talking, suspect a loss of power or blown fuse.

Interprocessor Communication

3. Determine which modules are still talking. Wiring up to these is likely to be OK.
4. Try disconnecting the link or jumping out modules in the link at various places (use Figure 1). Reset the diagnostics and note which diagnostics reappear.

Here are some examples of IPC diagnostics:

Diagnostics present:

Chiller Mod Indicating EXV Mod Communications

Cprsr A Indicating EXV Mod Communications

Cprsr B Indicating EXV Mod Communications

The CPM and both MCSP modules are detecting a loss of communications with the EXV. Suspect power to the EXV or its fuse or a wiring problem downstream of the MCSP A and B modules.

Diagnostics present:

Chiller Mod Indicating Options Mod Communications

Chiller Mod Indicating EXV Mod Communications

Chiller Mod Indicating Cprsr A Communications

Chiller Mod Indicating Cprsr B Communications

The CPM is reporting that it cannot talk to any of the other modules. Suspect a shorted IPC bus or a module locking up the bus. The CPM could also be bad and not be sending recognizable tokens. Discriminating between these possibilities is done by disconnecting the link or jumping out modules in the link at various places. Refer to Item 4 in Troubleshooting Modules (Troubleshooting Modules Using IPC Diagnostics on page 9) for the procedure and the IPC Jumper for bypassing the Modules.

Diagnostics present:

Chiller Mod Indicating Cprsr B Communications

EXV Mod Indicating Cprsr B Communications

The CPM and EXV have both detected a communication loss with MCSP B. Suspect the address switch on MCSP B or a power/fuse problem.

Diagnostics present:

Chiller Mod Indicating Cprsr A Communications

Chiller Mod Indicating Cprsr B Communications

EXV Mod Indicating Cprsr A Communications

EXV Mod Indicating Cprsr B Communications

The CPM and EXV have both detected a communication loss with MCSP A and MCSP B. Suspect that the address switches on both modules are set to the same address. Wiring is probably OK since the EXV can talk to the CPM.

Diagnostics present:

Chiller Mod Indicating Cprsr B Communications

Chiller Mod Indicating Cprsr A Communications

Chiller Mod Indicating EXV Mod Communications

Interprocessor Communication

The CPM has detected loss of communications with MCSP A, MCSP B, and EXV. Suspect an open early in the IPC link between the CPM and MCSP B.

There are a large number of possible combinations of diagnostics. One must deduce what is causing the problem using all available information.

If the CLD Comm link to the CPM is broken, the message is:

No Communication, Data Not Valid

Temperature Sensor Checkout

With the exception of the thermostats located in the motor windings of the screw compressors, all the temperature sensors used on the UCMs are negative temperature coefficient (NTC) thermistors. The thermistors employed all have a base resistance of 10 Kohms at 77F (25C) and display a decreasing resistance with an increasing temperature. The UCMs "read" the temperature by measuring the voltage developed across the thermistors in a voltage divider arrangement with a fixed internal resistance. The value of this "pull-up" resistor is different depending on the temperature range where the most accuracy is desired. The voltage source for this measurement is a closely regulated 5.0 VDC supply.

An open or shorted sensor will cause the UCM to indicate the appropriate diagnostic. In most cases, an open or short will cause a CMR or MMR diagnostic that will result in a machine or circuit shutdown. Open or shorts on less critical Outdoor Air or Zone Temperature sensors will result in an Informational Warning Diagnostics and the use of default values for that parameter.

Temperature Sensor Checkout Procedure

⚠ WARNING
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1. Measure the temperature at the sensor using an accurate thermometer. Record the temperature reading observed.
2. With the sensor leads connected to the UCM and the UCM powered, measure the DC voltage across the sensor leads at the terminal or probe the back of the MTA plug.

NOTE: Always use a digital volt-ohmmeter with 10 megohm or greater input impedance to avoid "loading down" the voltage divider. Failure to do so will result in erroneously high temperature calculations.

3. Locate the appropriate sensor table. Table 3: Evaporator Water and Refrigerant Temperature Sensors, Table 4: Saturated Condenser Refrigerant and Entering Oil Temperature Sensors. Then compare the temperature in the table corresponding to the voltage reading recorded in Step 2 with the actual temperature observed in Step 1. If the actual temperature measured falls within the allowable tolerance range, both the sensor and the UCM's temperature input circuits are operating properly. However, if the actual temperature is outside the allowable sensor tolerance range, proceed to Step 4.

Temperature Sensor Checkout

4. Again measure the temperature at the sensor with an accurate thermometer; record the temperature reading observed.
5. Remove the sensor leads from the terminal strip or unplug the respective MTA. Measure the resistance of the sensor directly or probe the MTA with a digital volt-ohmmeter. Record the resistance observed.
6. Next, with the sensor still disconnected from the module, check the resistance from each of the sensor leads to the control panel chassis. Both readings should be more than 1 Megohm. If not, the sensor or the wiring to the sensor is either shorted or leaking to chassis ground and must be repaired.
7. Select the appropriate sensor table and locate the resistance value recorded in Step 5. Verify that the temperature corresponding to this resistance value matches (i.e. within the tolerance range specified for that sensor) the temperature measured in Step 4.
8. If the sensor temperature is out of range, the problem is either with the sensor, wiring, or the MTA connector (if applicable). If an MTA connector is used and the thermistor reads open, first try cutting off the MTA, stripping a small amount of insulation from the sensor wire's end and repeating the measurement directly to the leads. Once the fault has been isolated in this manner, install a new sensor, connector or both. When replacing a sensor, it is easiest to cut the sensor wire near the MTA end and splice on a new sensor using wire nuts.
9. A decade box can be substituted for the sensor and any sensor table value used to relate resistance to temperature. By removing the MTA plug and applying the resistance to the proper pin terminals, the temperature, as sensed by the UCM, can be confirmed. Using the CLD menu displays, scroll to the display of the temperature of interest.

NOTE: All displayed temperatures are slew rate limited and only accurate within a specified normal range. It is therefore important to be certain that the temperature readings are stable and that adequate time, up to 1 minute, is allowed after step changes in resistance inputs are made.

10. In all instances where module replacement is indicated, first perform the power supply/fuse check according to the information in the section "Module Power and Miscellaneous I/O" starting on page 41.

Temperature Sensor Checkout

Table 3 Sensor Conversion Data: Outdoor Air (6RT3), Entering and Leaving Evap Water Temp Matched Pairs (6RT7, 6RT8), and Saturated Evap and Comp Suction Refrigeration Temp (6RT9, 3B1RT5; 6RT10, 4B1RT6)

Actual Temp. (F)	Actual Resistance (Ohms)	Thermistor Voltage (Volts DC)	Actual Temp. (F)	Actual Resistance (Ohms)	Thermistor Voltage (Volts DC)	Actual Temp. (F)	Actual Resistance (Ohms)	Thermistor Voltage (Volts DC)
-20.0	170040.3	4.448	30.0	34838.9	3.120	80.0	9297.5	1.533
-19.0	164313.4	4.434	31.0	33833.3	3.086	81.0	9075.9	1.509
-18.0	158796.5	4.414	32.0	32861.4	3.047	82.0	8860.2	1.484
-17.0	153482.9	4.395	33.0	31935.3	3.018	83.0	8650.4	1.460
-16.0	148365.0	4.380	34.0	31038.7	2.983	84.0	8446.2	1.436
-15.0	143432.2	4.360	35.0	30170.5	2.949	85.0	8247.5	1.411
-14.0	138679.6	4.341	36.0	29329.5	2.910	86.0	8054.1	1.387
-13.0	134098.6	4.321	37.0	28515.0	2.876	87.0	7865.8	1.362
-12.0	129684.9	4.302	38.0	27725.9	2.842	88.0	7682.5	1.343
-11.0	125428.5	4.282	39.0	26961.4	2.808	89.0	7504.2	1.318
-10.0	121326.1	4.263	40.0	26220.8	2.773	90.0	7330.5	1.294
-9.0	117369.6	4.238	41.0	25503.0	2.739	91.0	7161.4	1.274
-8.0	113554.9	4.219	42.0	24807.5	2.705	92.0	6996.7	1.250
-7.0	109876.5	4.194	43.0	24133.3	2.671	93.0	6836.3	1.230
-6.0	106328.1	4.175	44.0	23479.7	2.637	94.0	6680.1	1.211
-5.0	102904.9	4.150	45.0	22846.1	2.603	95.0	6528.0	1.187
-4.0	99602.3	4.126	46.0	22231.9	2.568	96.0	6379.8	1.167
-3.0	96416.1	4.106	47.0	21636.2	2.534	97.0	6235.5	1.147
-2.0	93341.6	4.082	48.0	21058.7	2.505	98.0	6094.8	1.128
-1.0	90374.2	4.058	49.0	20498.4	2.471	99.0	5957.8	1.108
0.0	87510.3	4.033	50.0	19955.0	2.437	100.0	5824.3	1.089
1.0	84745.9	4.004	51.0	19427.9	2.402	101.0	5694.2	1.069
2.0	82077.1	3.979	52.0	18916.5	2.368	102.0	5567.4	1.050
3.0	79500.5	3.955	53.0	18420.3	2.334	103.0	5443.8	1.030
4.0	77012.3	3.926	54.0	17938.8	2.305	104.0	5323.3	1.016
5.0	74609.7	3.901	55.0	17471.6	2.271	105.0	5205.9	0.996
6.0	72288.8	3.872	56.0	17018.0	2.236	106.0	5091.5	0.977
7.0	70047.4	3.848	57.0	16577.8	2.207	107.0	4979.9	0.962
8.0	67881.9	3.818	58.0	16150.5	2.173	108.0	4871.1	0.942
9.0	65790.2	3.789	59.0	15735.7	2.144	109.0	4765.0	0.928
10.0	63768.7	3.760	60.0	15332.9	2.109	110.0	4661.5	0.913
11.0	61815.3	3.730	61.0	14941.7	2.080	111.0	4560.6	0.894
12.0	59927.8	3.701	62.0	14561.9	2.046	112.0	4462.2	0.879
13.0	58103.1	3.672	63.0	14193.0	2.017	113.0	4366.3	0.864
14.0	56339.6	3.643	64.0	13834.6	1.987	114.0	4272.6	0.850
15.0	54634.7	3.608	65.0	13486.5	1.958	115.0	4181.3	0.835
16.0	52986.4	3.579	66.0	13148.3	1.924	116.0	4092.2	0.820
17.0	51392.6	3.550	67.0	12819.8	1.895	117.0	4005.3	0.806
18.0	49851.6	3.516	68.0	12500.5	1.865	118.0	3920.5	0.791
19.0	48360.9	3.486	69.0	12190.2	1.836	119.0	3837.7	0.776
20.0	46919.2	3.452	70.0	11888.7	1.807	120.0	3756.9	0.762
21.0	45524.6	3.418	71.0	11595.6	1.777	121.0	3678.1	0.747
22.0	44175.6	3.389	72.0	11310.7	1.753	122.0	3601.1	0.732
23.0	42870.3	3.354	73.0	11033.7	1.724	123.0	3526.5	0.723
24.0	41607.6	3.320	74.0	10764.4	1.694	124.0	3453.6	0.708
25.0	40385.3	3.286	75.0	10502.6	1.670	125.0	3382.4	0.698
26.0	39202.7	3.257	76.0	10248.0	1.641	126.0	3313.0	0.684
27.0	38057.9	3.223	77.0	10000.4	1.616	127.0	3245.1	0.674
28.0	36950.0	3.188	78.0	9759.6	1.587	128.0	3178.9	0.659
29.0	35877.4	3.154	79.0	9525.4	1.563	129.0	3114.2	0.649
						130.0	3051.0	0.635

1. *Overall accuracy for any of the sensors is at least + 2 F over the range shown. Accuracy of matched sensors is + 1 F over specific ranges.*
2. *As you compare a thermistor resistance (or input voltage) reading with the "actual" temperature indicated by the thermometer, be sure to consider the precision and location of the thermometer when you decide whether or not the thermistor is out of specified accuracy.*
3. *The thermistor resistances given do not account for the self-heating effects that are present when connected to the UCM. A connected "operating" thermistor will read a slightly lower (less than 1%) resistance.*

Temperature Sensor Checkout

Table 4 Sensor Conversion Data: Saturated Condenser and Entering Oil Temperature Matched Pairs (6RT12, 3B1RT1; 6RT13, 4B1RT2)

Actual Temp. (F)	Actual Resistance (Ohms)	Thermistor Voltage (Volts DC)	Actual Temp. (F)	Actual Resistance (Ohms)	Thermistor Voltage (Volts DC)	Actual Temp. (F)	Actual Resistance (Ohms)	Thermistor Voltage (Volts DC)
0.0	87510.3	4.651	50.0	19955.0	3.765	100.0	5824.3	2.356
1.0	84745.9	4.641	51.0	19427.9	3.740	101.0	5694.2	2.327
2.0	82072.1	4.630	52.0	18916.5	3.715	102.0	5567.4	2.300
3.0	79500.1	4.619	53.0	18420.3	3.689	103.0	5443.8	2.272
4.0	77012.3	4.608	54.0	17938.8	3.664	104.0	5323.3	2.244
5.0	74609.7	4.596	55.0	17471.6	3.638	105.0	5205.9	2.217
6.0	72288.8	4.584	56.0	17018.0	3.611	106.0	5091.5	2.189
7.0	70047.4	4.572	57.0	16577.8	3.585	107.0	4979.9	2.162
8.0	67881.9	4.560	58.0	16150.5	3.558	108.0	4871.1	2.135
9.0	65790.2	4.547	59.0	15735.7	3.531	109.0	4765.0	2.108
10.0	63768.7	4.534	60.0	15332.9	3.504	110.0	4661.5	2.082
11.0	61815.3	4.521	61.0	14941.7	3.477	111.0	4560.6	2.055
12.0	59927.8	4.507	62.0	14561.9	3.450	112.0	4462.2	2.029
13.0	58103.1	4.494	63.0	14193.0	3.422	113.0	4366.3	2.003
14.0	56339.6	4.479	64.0	13834.6	3.394	114.0	4272.6	1.977
15.0	54634.7	4.465	65.0	13486.5	3.366	115.0	4181.3	1.951
16.0	52986.4	4.450	66.0	13148.3	3.338	116.0	4092.2	1.926
17.0	51392.6	4.435	67.0	12819.8	3.310	117.0	4005.3	1.901
18.0	49851.6	4.420	68.0	12500.5	3.282	118.0	3920.5	1.876
19.0	48360.9	4.404	69.0	12190.2	3.253	119.0	3837.7	1.851
20.0	46919.2	4.388	70.0	11888.7	3.225	120.0	3756.9	1.826
21.0	45524.6	4.372	71.0	11595.6	3.196	121.0	3678.1	1.802
22.0	44175.6	4.355	72.0	11310.7	3.167	122.0	3601.1	1.777
23.0	42870.3	4.338	73.0	11033.7	3.139	123.0	3526.5	1.754
24.0	41607.6	4.321	74.0	10764.4	3.110	124.0	3453.6	1.730
25.0	40385.3	4.303	75.0	10502.6	3.081	125.0	3382.4	1.707
26.0	39202.7	4.285	76.0	10248.0	3.051	126.0	3313.0	1.684
27.0	38057.9	4.266	77.0	10000.0	3.022	127.0	3245.1	1.661
28.0	36950.0	4.248	78.0	9759.6	2.993	128.0	3178.9	1.638
29.0	35877.4	4.229	79.0	9525.4	2.964	129.0	3114.2	1.615
30.0	34838.9	4.209	80.0	9297.5	2.935	130.0	3051.0	1.593
31.0	33833.3	4.190	81.0	9075.9	2.905	131.0	2989.2	1.571
32.0	32861.4	4.170	82.0	8860.2	2.876	132.0	2928.9	1.549
33.0	31935.3	4.150	83.0	8650.4	2.847	133.0	2870.0	1.528
34.0	31038.7	4.130	84.0	8446.2	2.817	134.0	2812.4	1.506
35.0	30170.5	4.109	85.0	8247.5	2.788	135.0	2756.2	1.485
36.0	29329.5	4.088	86.0	8054.1	2.759	136.0	2701.2	1.464
37.0	28515.0	4.067	87.0	7865.8	2.730	137.0	2647.5	1.444
38.0	27725.9	4.045	88.0	7682.5	2.700	138.0	2595.0	1.423
39.0	26961.4	4.024	89.0	7504.2	2.671	139.0	2543.7	1.403
40.0	26220.8	4.002	90.0	7330.5	2.642	140.0	2493.6	1.383
41.0	25503.0	3.979	91.0	7161.4	2.613	141.0	2444.6	1.364
42.0	24807.5	3.957	92.0	6996.7	2.584	142.0	2396.7	1.344
43.0	24133.3	3.934	93.0	6836.3	2.555	143.0	2349.9	1.325
44.0	23479.7	3.910	94.0	6680.1	2.526	144.0	2304.1	1.306
45.0	22846.1	3.887	95.0	6528.0	2.498	145.0	2259.2	1.287
46.0	22231.9	3.863	96.0	6379.8	2.469	146.0	2216.0	1.269
47.0	21636.2	3.839	97.0	6235.5	2.440	147.0	2172.8	1.250
48.0	21058.7	3.815	98.0	6094.8	2.412	148.0	2131.6	1.232
49.0	20498.4	3.790	99.0	5957.8	2.384	149.0	2090.4	1.215
						150.0	2051.2	1.197

1. *Overall accuracy for the sensor is at least + 2 F over the range shown.*
2. *As you compare a thermistor resistance (or input voltage) reading with the "actual" temperature indicated by the thermometer, be sure to consider the location and precision of the thermometer when you decide whether or not the thermistor is out of specified accuracy.*
3. *The thermistor resistances given do not account for the self-heating effects that are present when connected to the UCM. A connected "operating" thermistor will read a slightly lower (less than 1%) resistance.*

Compressor Operation

This feature is called the Auto Lead/Lag and can be found in the Service Settings Group, under the "Balanced CPRSR Starts and Hours" menu. When this function is disabled, the UCM always starts compressor "A" first. When this function is enabled, the following occurs:

The UCM equalizes operating starts and hours. This will cause the compressor with the least amount of starts to be started first. When a compressor starts, it is always started unloaded.

When a compressor is stopped, it shuts down in an unloaded state, unless taken out by a manual reset diagnostic.

When the first compressor is brought on line, it attempts to meet the load by staging on the step load solenoid and by pulsing the male slide valve load solenoid. If one compressor cannot meet the load demand, the second compressor is brought on line. It also attempts to meet the load demand by staging on its step load solenoid and by pulsing its male slide valve solenoid. When both compressors are running and both of their step load solenoids are energized, the male load and unload solenoids on both compressors are pulsed, thus modulating their respective slide valves to balance the load. The UCM attempts to distribute the load evenly between the two compressors. When the load drops off, the compressor with the most hours will always be the first to unload and turn off. The anti-recycle timer is approximately 5 minutes from start to start. The minimum time between compressor shutdown and restart is approximately 10 seconds, but only if the compressor has been running over 5 minutes or longer prior to shutting down on temperature. Otherwise, it is the remaining portion of the 5 minutes.

Restart Inhibit Timer

If compressor operation is interrupted by an extended (not momentary) loss of power or a manual reset, there will be a two minute delay between the power up or manual reset and the start of a compressor, assuming there is a call for cooling. The timer is factory set at 2 minutes but can be field adjusted from 30 seconds to two minutes in the Service Settings Group.

Compressor Start/Stop

To start a compressor after either a "normal' shutdown, a Diagnostic reset, or power-on-reset, the following sequence will occur:

1. On a call for a compressor, the Restart Inhibit Timer will time out, if any time remains.
2. The EXV is positioned to the initial closed start position. At the same time, the unload solenoid is energized and the load solenoid is de-energized. Timing is determined by the time required to position the EXV
3. After the EXV is positioned:

- the compressor is turned on
- the compressor heater is de-energized
- the saturated evaporator ref. temp. cutout ignore time is set, based on the saturated condenser temperature. Prior to start, the condenser temperature approximates the ambient temperature.
- the fan control algorithm is executed

To stop a compressor due to either the Stop button on the CLD or an External/Remote "STOP", the sequence shall be as follows:

1. The unload solenoid is energized for 20 seconds and the load solenoid is de-energized. The compressor continues to run for the remaining 20 seconds. This is defined as the RUN:UNLOAD mode.
2. The compressor and the fans are turned off. The crankcase heater is energized.
3. The unload solenoid remains energized for 60 minutes after the compressor stops. The load solenoid is de-energized.
4. The EXV is closed. Closing begins at maximum speed when the compressor is turned off. (Max. speed is 25 steps per second, full stroke is 757 steps.
5. After 60 minutes, the unload solenoid de-energizes.

The RUN:UNLOAD mode is also used to stop a compressor due to normal LWT control, Low Ambient Run Inhibit, or Freeze Avoidance.

A compressor stop due to any diagnostic will skip step 1 above and go directly to step 2.

Variable Speed Inverter/Condenser Fan Control

When Fan Control and Variable Speed Fan (VSF) are set to Enable in the Machine Configuration Menu, the UCM will control both the variable speed fan and the remaining constant speed fans per the VSF Control Algorithm. If VSF Control is disabled for a given circuit but Fan Control is enabled for the machine, the circuit will perform normal constant speed fan control. The VSF is enabled and operational, the control attempts to provide a 70 ± 5 psid between the Condenser Pressure and the Evaporator Pressure (as derived from the temperature sensor measurements).

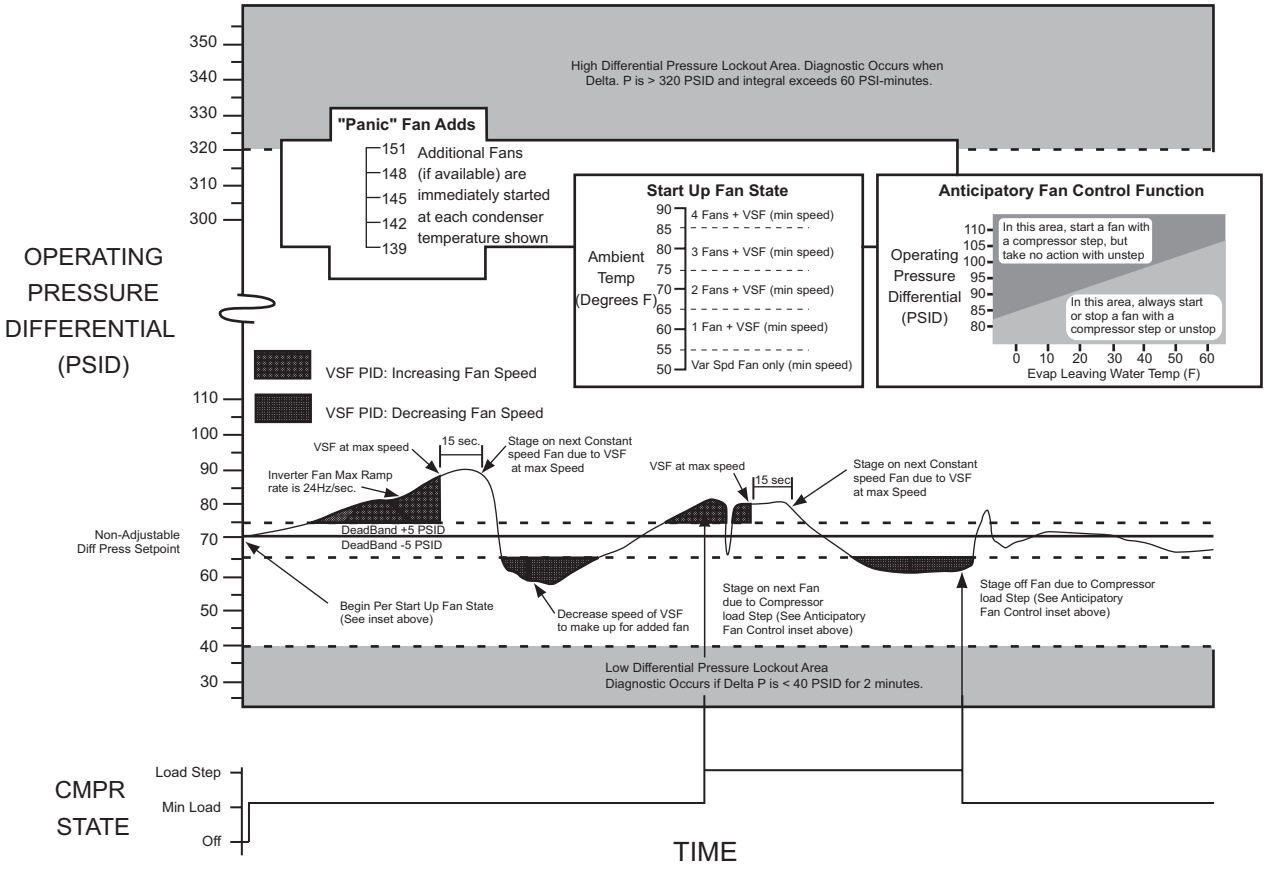


Figure 4 Variable Speed Fan (VSF) and Fan Staging Control

The VSF Inverter is commanded to a given speed by the UCM, using a PWM (Pulse Width Modulated) signal (10V, 15mA, 10 Hz Fundamental) with a duty cycle proportional to the desired voltage and frequency from the Inverter. The UCM also controls power to the Inverter through a contactor. The Inverter Contactor for the respective circuit is energized approximately 20 seconds prior to compressor start on that circuit. The VSF Control algorithm runs on a 5-second interval and is limited to a commanded rate of change of no greater than 40% of full speed per interval. The same algorithm that controls the

Variable Speed Inverter/ Condenser Fan Control

speed will also cause constant speed fans to stage On and Off when the inverter is commanded to full speed and minimum speed respectively. The stage On (or Off) of a constant speed fan will occur if the inverter speed command is at max (or min.) for three consecutive intervals (15 seconds).

Outdoor Air Temperature and Fan Control

Outdoor air temperature is used to provide a reasonable startup state. Using this temperature, the algorithm automatically determines the number of constant speed fans to turn on immediately at compressor start. The outdoor air temperature sensor is also used to anticipate new states during normal running to minimize pressure upsets. This anticipation is based on the staging and unstaging of compressor steps at given leaving water temperatures. In this way, precise airflow can be maintained, allowing for stable differential pressures under part load and low ambient conditions.

VSF Inverter Fault

A fault signal will be sent to the UCM from the Inverter when it has gone through a self-shutdown or if the output frequency of the Inverter is being limited to less than 50% of the signal speed commanded by the UCM. Upon receipt of the fault signal, the UCM shall attempt to reset the fault by sending a 0 PWM command to the Inverter for a total of five seconds. The fault signal will again be checked and repeated if still in fault. If four faults are detected within one minute of each other, the power to the Inverter will be cycled off for 30 seconds (through contactor control) and then re-powered. If the fault still remains or occurs again within one minute, an IFW diagnostic occurs. The UCM will remove power from the Inverter and attempt to run the remaining constant-speed fans using normal constant-speed Fan Control Algorithm. See page 80 for step-by-step troubleshooting procedure.

Current Transformer

Each compressor motor has all three of its line currents monitored by torroid (doughnut) current transformers. While the MCSP utilizes all three of the signals, it only displays the maximum phase at any given time. These currents are normalized with respect to the Rated Load Amps of the respective compressor and thus are expressed in terms of % (percent) RLA. The currents are "normalized" thru the proper selection of the Current Transformer, the setting of the Compressor Current Overload dip switch (SW2) on the MCSPs, and the redundant programming of the decimal equivalent of these settings in the Service Settings Group of the CLD. (The term "Compressor Current Overload setting" is actually a misnomer. Instead the setting should be thought of as an internal software gain that normalizes the currents to a % RLA for a given CT and compressor rating. The true nominal steady state overload setting is fixed at 132%). Refer to Tables 5 thru 9 for setup details.

The current transformers provide the input for six basic functions of the MCSP:

1. Motor overload protection using a programmed "% RLA versus time to trip" characteristic. Refer to Table 6 for details. The steady state "must trip" value is 140% RLA and the "must hold" value is 125% RLA. The MCSP will trip out the compressor. The appropriate diagnostic descriptions are then displayed in the CLD diagnostic section.
2. Verifying contactor drop-out. If currents corresponding to less than 12 ±7% RLA are not detected on all three of the monitored compressor phases within approximately 5 seconds after an attempted contactor drop-out, the compressor will continue to be commanded Off, the Unload solenoid will be pulsed, the EXV will be opened to its fullest position, and the fans will continue to be controlled. This condition will exist until the diagnostic is manually reset.
3. Loss of Phase Current. If the detection of any or all of the three motor phase currents falls below 12 ±7% RLA for 2 ±1 seconds while the branch circuit should be "energized", the MCSP will trip out the compressor. The Phase Loss diagnostic, or the Power Loss diagnostic, will be displayed. Failure of a contactor to pull in will cause the Phase Loss diagnostic. However when reduced voltage starting is employed, it may take an additional 3 seconds to detect a phase loss at startup, as phase loss protection is not active during the 3 second transition time.
4. Phase Rotation. Screw compressors cannot be allowed to run in reverse direction. To protect the compressors, the phase rotation is detected by the current transformers immediately at start up. If improper phasing is detected, within 1 second of startup, the MCSP will trip out the compressor. The Phase Rotation diagnostics will be displayed. This function is not sensitive to the current transformer's polarity.
5. Phase Unbalance. The MCSP will shut down the compressor if a phase current unbalance is detected by the current transformers while the compressor is running. A 15% unbalance, if protection is enabled, will cause the MCSP to trip out the compressor. The Phase Unbalance diagnostics

Current Transformer

will be displayed. If this protection is disabled, a 30% phase unbalance will still be in effect with the diagnostic code Severe Phase Imbalance being displayed.

6. Current Limit. The MCSP will begin to unload its compressor as the %RLA exceeds 120%. Further, the CPM will cause the compressors to automatically unload when the Chiller Current Limit Setpoint is reached. The Current Limit Setpoint is set in the Service Setting Group. Individual compressor phase currents are averaged and added together to compare to the Chiller Current Limit which is in terms of % Total of all of the Compressor RLNs.

NOTE: The current transformers are NOT polarity or directionally sensitive.

CT and MCSP Compressor Current Input Checkout Procedure

⚠ WARNING
Live Electrical Components!

During installation, testing, servicing and troubleshooting of this product, it may be necessary to work with live electrical components. Have a qualified licensed electrician or other individual who has been properly trained in handling live electrical components perform these tasks. Failure to follow all electrical safety precautions when exposed to live electrical components could result in death or serious injury.

1. Check incoming 3-phase power for voltage within 10% of nominal per Chiller nameplate.
2. Interrogate the CPM for all of the presently active diagnostic codes or the historic diagnostic codes in the Diagnostics Menu. Narrow the problem down to a particular compressor or contactor as noted above. Write down all of the diagnostic codes stored in the diagnostic registers.

   If there is any question as to which compressor or current transformer is causing a problem, or simply to verify and "witness" the problem, an attempt should be made to restart the chiller after clearing diagnostics. The diagnostics can be cleared by entering the Diagnostics Menu and stepping to the CLEAR DIAGNOSTICS display.

   It is possible to "force" certain compressors to be the first or next compressor to stage on, using the "Compressor Test" feature in the Service Tests Menu. The Leaving Water Temperature must, however, be above the Chilled Water Setpoint by more than the "differential to start" setting, in order to stage on the first compressor.

   At startup, verify the appropriate contactor(s) pull-in. The "Compressors On" menu item in the Chiller Report Group will indicate which compressor started approximately five seconds after the contactor pulls in. Note the diagnostic(s) that results, then place the Chiller into the "Stop" mode by depressing the Stop button on the CLD.

Current Transformer

⚠ WARNING
Hazardous Voltage w/Capacitors!

Disconnect all electric power, including remote disconnects before servicing. Follow proper lockout/tagout procedures to ensure the power cannot be inadvertently energized. For variable frequency drives or other energy storing components provided by Trane or others, refer to the appropriate manufacturer's literature for allowable waiting periods for discharge of capacitors. Verify with an appropriate voltmeter that all capacitors have discharged. Failure to disconnect power and discharge capacitors before servicing could result in death or serious injury.

Note: For additional information regarding the safe discharge of capacitors, see PROD-SVB06A-EN or PROD-SVB06A-FR

3. For the next portion of the procedure, pull the unit's disconnect and interrupt all high voltage power to the control panel. Locate the torroid (doughnut) current transformers encircling the compressor power wiring and branching to the compressor contactors of the suspect compressor in the control panel. Refer to the Component Location Drawing in the panel to identify the particular current transformer(s) of interest. Locate the part number/UL tag on the transformer leads and note the Trane part number which identifies the transformers. Note: all compressors of a given tonnage should have the same transformer extension number. Verify the proper current transformer using Table 5 in this section. Also check the setting of the dip switch (SW2) on each of the MCSP modules and verify these against Table 5 for each compressor. (Switch position SW2-1 is the Most Significant Bit). The decimal equivalent of this setting should also be verified in the Service Setting Group under the "CURRENT OVRLD SETTINGS" display. If the programmed value does not agree with the dip switch setting for each of the MCSP's, an informational diagnostic will result. The compressors will be allowed to run, but default settings (the most sensitive possible) will be used for the internal software compressor current gains.
4. Utilizing the Schematic Wiring Diagram, locate the termination of the transformer's wiring into the MTA plug at the appropriate MCSP module at pin header J5. Pull off the appropriate MTA connector from the pin header on the MCSP.

Current Transformers can be damaged and high voltages can result due to running the compressors without a suitable burden load for the CTs. This load is provided by the MCSP input. Take care to properly reconnect the CT's MTA prior to attempted start of the compressors.

5. Using a digital volt-ohmmeter, measure the resistance of the transformer(s) by probing the appropriate pair(s) of receptacles within the MTA. The receptacle pairs of the MTA are most easily measured by using meter leads with pointed probes and contacting the exposed metal of the connector through either the top or the side of the MTA. (It may be nec-

Current Transformer

essary to remove a cap over the top of the connector to gain access to the connector conductors.)

6. Refer to Table 7 which lists the normal resistance range for each extension of current transformer. Check the measured resistance against the value listed per transformer extension. If the resistance is within tolerance, the transformer and MTA can be considered good. Go on to step 8.
7. If the resistance reading above is out of tolerance, the problem is either with the transformer, its wiring, or the MTA connector. First double check the schematic to be sure you are working the proper lead pair. Then cut the leads to the particular transformer near the MTA connector and repeat the resistance measurement by stripping insulation from the wire's end. Once the fault has been isolated in this manner, reconnect leads or install a new transformer or connector.

   More than one current transformer is terminated to a single MTA. When replacing, take care to note the proper positions of the respective transformer wire terminations on the MTA for the re-termination. The current transformers are NOT polarity or directionally sensitive. The transformer lead wiring is #22 AWG, UL 1015 600V and the proper MTA connector (red color code) must be used to ensure a reliable connection. If the fault can be isolated to the current transformer or its wiring apart from the connector, the connector can be reused by cutting off the bad transformer and splicing in a new transformer using wire nuts.
8. If the transformer/connector resistance proves accurate, recheck the resistance with the connector held at different angles and with a light lead pull (less than 5 lb.) to test for an intermittent condition.
9. To perform the following test, you will need to use a digital voltmeter with a diode test function,. With the transformer MTA disconnected and the power off to the MCSP, perform a diode test across the corresponding pair of current transformer input pins on the MCSP (header J5). The meter should read from 1.0 to 1.5 volts for each current transformer input. Repeat using the opposite polarity. The same reading should result. Extreme errors suggest a defective MCSP module. If the diode voltage drops prove accurate, reconnect the transformers to the MCSP and repower the unit.
10. With the CT's reconnected to the MCSP, attempt a restart of the chiller. As the given compressor is started, and the inrush locked rotor transient has passed, (locked rotor transient should last less than one second) simultaneously monitor the actual compressor phase current(s) (using a clamp-on type ammeter) and the voltage developed at the respective current transformer's termination at the MCSP (using a digital volt-meter on a 0-20 VAC scale). Refer to Table 8 for the compressor phase current to output voltage relationship for each extension current transformer. Using Table 8, look up to current that corresponds to the output voltage read by the voltmeter and compare to ammeter reading. Assuming relatively accurate meters, the values should agree to within 5%.
11. If the measured current and the output voltage from the CT agree within the tolerance specified, the CT is good. If diagnostics, overload trips, or other problems potentially involving current sensing continue to occur

Current Transformer

with all phase currents to the compressors verified to be within their normal range, then the problem is either with the CT selection, MCSP Compressor Overload Dip Switch Setting, or the MCSP's current input, analog to digital (A/D), or dip switch input circuitry. Since the first two items were verified in Step 2 using Table 5, that leaves only the MCSP circuitry as an issue. It is advisable to replace the MCSP module at this point. However if verification of the MCSP Current sensing operation is desired, go to step 12 below.

12. There are two ways that the MCSP's current sensing can be checked. Both methods use the CLD display of the %RLA from each MCSP (Compressor Report) for indication of the sensed current. The first is straightforward equation and assumes that the proper Compressor Overload dip switch setting and current transformer have been selected:

$$\%RLA = \frac{\text{Measured Compr. amps of max. phase}}{\text{Nameplate Compressor RLA}}$$

To check the displayed % RLA as a function of the output voltage from the current transformers (as connected at the MCSP), Tables 8 and 9 are utilized. In Table 8 look up (or interpolate) the "% of CT rating" corresponding to the maximum of the three CT Input Voltages (VAC rms) as read at the MCSP. (The table is necessary because the voltage developed at the MCSP is not linear with the CT's secondary current). Next, check the Compressor Current Overload setting of switch SW2 on the MCSP and find the corresponding "SOFTWARE GAIN" in Table 9. The % RLA displayed by the CPM should be:

%RLA = % CT Rating X SOFTWARE GAIN

The preceding equations should only be applied during steady state current draws (after transition). Inrush transient currents and associated CT output voltages can be expected to be from 3 to 6 times the steady state values, and the displayed value only reads up to 255% RLA. The accuracy of the displayed value should be within ± 5% of that predicted using the Input voltage. However, the end to end accuracy of the displayed value compared to the actual %RLA max. phase current is ± 3.3% over the range of 50 to 150% of CT rating.

13. If no phase currents are measured with the amprobe on any or all of the legs to a given compressor immediately following the attempted staging of that compressor by the MCSP, the problem lies either with the contactor, motor circuit or the MCSP relay outputs. Refer to MCSP Checkout Procedure in Compressor Module (MCSP) (1U4 AND 1U5) on page 72.

Current Transformer

Table 5 Compressor Overload DIP Switch Settings

Compressor Tons	Volts/Hz	RLA	Primary Turns Through Current Transformer	Current Transformer Extension*	Overload Setting Dip Sw/Decimal 12345**
35	200/60	115	1	-02	01011/11
	230/60	100	1	-01	11111/31
	346/50	58	1	-10	01100/12
	380/60	61	1	-10	10000/16
	400/50	50	1	-10	00000/0
	460/60	50	1	-10	00000/0
	575/60	40	1	-01	01111/15
40	200/60	142	1	-02	11011/27
	230/60	124	1	-02	10001/17
	346/50	72	1	-01	00111/7
	380/60	75	1	-01	01010/10
	400/50	62	1	-10	10001/17
	460/60	62	1	-10	10001/17
	575/60	50	1	-01	11111/31
50	200/60	192	1	-03	11100/28
	230/60	167	1	-03	10010/18
	346/50	96	1	-01	11100/28
	380/60	101	1	-02	00001/1
	400/50	84	1	-01	10011/19
	460/60	84	1	-01	10011/19
	575/60	67	1	-02	10111/23
60	200/60	233	1	-04	10011/19
	230/60	203	1	-04	01000/8
	346/50	117	1	-02	01101/13
	380/60	123	1	-02	10001/17
	400/50	101	1	-02	00001/1
	460/60	101	1	-02	00001/1
	575/60	81	1	-03	10000/16

**The current transformer base part number is X13580253. The numbers in this column are suffixes of the base part number.*

***On the DIP switch, 1=ON, O=OFF. The decimal value should be set in the compressor overload setting menu of the UCM. If the DIP switch value does not match the decimal value entered into the UCM, the related compressor(s) will continue to run, but a diagnostic will be initiated, both settings will be ignored, and the UCM will use the lowest possible trip setting value.*

Current Transformer

Table 6 Trip Times Vs. % Current

MOTOR CURRENT (% RATED RLA)	MINIMUM	TRIP TIME (SEC) NOMINAL	MAXIMUM
127.7 or below	No trip	No Trip	No Trip
132.0	27.2	No Trip	No Trip
132.1	27.2	30.08	No Trip
140.0 (must trip pt.)	22.8	25.28	28.09
150.0	18.8	20.48	22.89
160.0	16.0	17.28	19.29
170.0	14.0	15.28	16.89
180.0	12.4	13.28	14.89
190.0	11.2	12.08	13.29
200.0	10.4	10.88	12.09
210.0	9.6	10.08	10.89
220.0	8.8	9.28	10.09
230.0	8.0	8.48	9.69
240.0	7.6	8.08	8.89
250.0	7.2	7.68	8.49
260.0	6.8	6.88	7.69
270.0	6.4	6.88	7.29
280.0	6.0	6.48	6.89
290.0	5.6	6.08	6.89
300.0	4.0	5.68	6.49
300.1	4.0	4.08	6.49
310.2 or above	4.0	4.08	4.49

Table 7 Current Transformers Ratings and Resistance

EXT*	RATING USABLE	RANGE	RESISTANCE OHMS + 10%
01	100A	66.67 -100A	23.5
02	150A	100 - 150A	35.0
03	200A	134 - 200A	46.0
04	275A	184 -275A	67.0
05	400A	267 - 400A	68.0
09	50A	33.37 - 50A	11.5
10	75A	50 - 75A	17.0

**The current transformer base part number is X13580253. The numbers in this column are suffixes of the base part number.*

Current Transformer

Table 8 Compressor Phase Current vs. AC Input Voltage at MCSP

ACTUAL COMPRESSOR PHASE AMPS THRU CT							TERMINAL VOLTAGE (V RMS)	% OF CT RATING
EXT -01	EXT -02	EXT -03	EXT -04	EXT -05	EXT -09	EXT -10		
0	0	0	0	0	0	0	0.00	0
5	8	10	14	20	2.5	3.75	1.19	5
10	15	20	28	40	5	7.5	1.37	10
15	23	30	41	60	7.5	11.25	1.53	15
20	30	40	55	80	10	15	1.67	20
25	38	50	69	100	12.5	18.75	1.81	25
30	45	60	83	120	15	22.5	1.95	30
35	53	70	96	140	17.5	26.25	2.09	35
40	60	80	110	160	20	30	2.23	40
45	68	90	124	180	22.5	33.75	2.36	45
50	75	100	138	200	25	37.5	2.50	50
55	83	110	151	220	27.5	41.25	2.63	55
60	90	120	165	240	30	45	2.77	60
65	98	130	179	260	32.5	48.75	2.90	65
70	105	140	193	280	35	52.5	3.03	70
75	113	150	206	300	37.5	56.25	3.17	75
80	120	160	220	320	40	60	3.30	80
85	128	170	234	340	42.5	63.75	3.43	85
90	135	180	248	360	45	67.5	3.57	90
95	143	190	261	380	47.5	71.25	3.70	95
100	150	200	275	400	50	75	3.83	100
105	158	210	289	420	52.5	78.75	3.96	105
110	165	220	303	440	55	82.5	4.10	110
115	173	230	316	460	57.5	86.25	4.23	115
120	180	240	330	480	60	90	4.36	120
125	188	250	344	500	62.5	93.75	4.49	125
130	195	260	358	520	65	97.75	4.62	130
135	203	270	371	540	67.5	101.25	4.75	135
140	210	280	385	560	70	105	4.88	140
145	218	290	399	580	72.5	108.75	5.02	145
150	225	300	413	600	75	112.5	5.15	150
160	240	320	440	640	80	120	5.41	160
170	255	340	468	680	85	127.5	5.67	170
180	270	360	495	720	90	135	5.94	180
190	285	380	523	760	95	142.5	6.20	190
200	300	400	550	800	100	150	6.46	200
210	315	420	578	840	105	157.5	6.72	210
220	330	440	605	880	110	165	6.99	220
230	345	460	632	920	115	172.5	7.25	230
240	360	480	660	960	120	180	7.51	240
250	375	500	687	1000	125	187.5	7.77	250
260	390	520	715	1040	130	195	8.03	260
270	405	540	742	1080	135	202.5	8.29	270
280	420	560	770	1120	140	210	8.56	280
290	435	580	797	1160	145	217.5	8.82	290
300	450	600	825	1200	150	225	9.08	300

Current Transformer

Table 9 Overload Dip Switch Setting vs. Internal Software Gain

CPRSR RATED RLA AS A % OF CT RATING	OVERLOAD DP SWITCH SETTING	DECIMAL SETTING	SOFTWARE GAIN
66	00000	00	1.500000
67	00001	01	1.483870
68	00010	02	1.467743
69	00011	03	1.451613
70	00100	04	1.435483
71	00110	06	1.403226
72	00111	07	1.387097
73	01000	08	1.370969
74	01001	09	1.354839
75	01010	10	1.338709
76	01011	11	1.322580
77	01100	12	1.306452
78	01101	13	1.290323
79	01111	15	1.258065
80	01111	15	1.258065
81	10000	16	1.241936
82	10001	17	1.225806
83	10010	18	1.209678
84	10011	19	1.193549
85	10100	20	1.177419
86	10101	21	1.161291
87	10110	22	1.145162
88	10110	22	1.145162
89	10111	23	1.129032
90	11000	24	1.112903
91	11001	25	1.096775
92	11001	25	1.096775
93	11010	26	1.080645
94	11011	27	1.064516
95	11100	28	1.048387
96	11100	28	1.048387
97	11101	29	1.032258
98	11110	30	1.016128
99	11110	30	1.016128
100	11111	31	1.000000

Under-Over Voltage Transformer

The hardware required for the Under/Over voltage sensing function of the UCM is standard on the 70-125 Ton RTAA chiller. This feature must be Enabled in the Service Settings Menu for it to be active. A custom designed transformer whose primary is connected across the Line Voltage phases A to B, provides a stepped down and isolated AC voltage to the CPM at input J4. This secondary voltage is directly proportional to the line voltage applied to the primary. The Chiller Report on the CLD can directly display the % Line Voltage and, when so enabled, can cause automatically reset MAR diagnostics for High and Low Line condition. The % Line Voltage is internally calculated by dividing the selected nominal voltage rating (only certain discrete values are selectable in the Service Settings Group) by the actual line voltage as read and processed by the CPM. With the Under-Over Voltage Protection Function enabled, an Over Voltage diagnostic will occur if the calculated % Line Voltage equals or exceeds 114%, or an Under Voltage diagnostic will occur if it equals or falls below 87% for 15 continuous seconds. Reset differential is set at 3%.

Under-Over Voltage Transformer Checkout

⚠ WARNING
Live Electrical Components!

During installation, testing, servicing and troubleshooting of this product, it may be necessary to work with live electrical components. Have a qualified licensed electrician or other individual who has been properly trained in handling live electrical components perform these tasks. Failure to follow all electrical safety precautions when exposed to live electrical components could result in death or serious injury.

1. Locate the Under-Over Voltage Transformer [1T2] in the panel by referring to the Component Location Drawing. Carefully measure the primary voltage across the Transformer (Line Voltage Phase A to B) and note the value in Vac rms.
2. Next disconnect the transformers secondary from J4 on the CPM. Using voltmeter probes, measure and note the unloaded secondary voltage (Vac rms). (low voltage class 2 less than 32 Vac).
3. The ratio of the primary or line voltage to the open circuity secondary voltage should be 20 to 1. If the unloaded turns ratio is not within ±2% of this value, replace the transformer.
4. Reconnect the secondary back to J4 and remeasure the loaded (connected) secondary voltage. The new loaded ratio should be approximately 20.2 to 1. If not within ±2% of this ratio the transformer's secondary should be disconnected from the CPM and a 1 Kohm resistor connected across the secondary. Measuring the voltage across the 1 Kohm resistor should give us a voltage ratio of 20.17. Ratios more than ±2% in error suggest a bad transformer. If the 1 Kohm loaded ratio is within tolerance, but the CPM connected ratio is out of tolerance suspect a bad CPM. Before

Under-Over Voltage Transformer

replacing the CPM, double check the Under-Over Voltage Function's Nominal Line Voltage Setup in the Service Settings Group.

5. If the Under-Over Voltage Protection function continues to misoperate, and all of the above measured ratios are within tolerance, and all CLD Under Over Voltage setups have been verified, replace the CPM. It is a good idea, before replacing the CPM, however, to copy down all of setup data. This data will be very helpful in making the necessary setup on the replacement CPM.

Compressor Capacity

The 35 to 60 ton helical rotary screw compressors are loaded and unloaded by means of an internal slide valve and a female unloader valve. In simple terms, these valves can regulate the amount of "bite" of the compressor rotors as they turn at relatively constant speeds.

The slide valve is moved by a hydraulic cylinder and piston internal to the compressor (the hydraulic fluid is oil from the refrigerant system). The movement of the cylinder is controlled by the load and unload solenoid valves, which either add oil at compressor discharge pressures, or withdraw oil to suction pressures.

The female unloader valve is moved to either the On or Off position by using internal suction and discharge gas pressure. The movement of this valve is controlled by the female unloader valve solenoid. These solenoid valves are electrically controlled by the MCSP module to handle compressor startup and shutdown, maintain chilled water temperature setpoints and limit current, condenser pressures, and evaporator temperatures etc.

Although the solenoids are an "on - off" device, effective modulation and high resolution of the slide valve (under steady state conditions) is possible by pulsing on and off the solenoid valves and varying the displaced volume of the cylinder/piston. When a given compressor is operating, the MCSP will energize (apply 115 VAC) either the load or the unload solenoid, if necessary, for a period of between 40 and 400 milliseconds, once every 10 seconds to control water temperature or limit conditions.

The female unloader valve solenoid receives a constant signal from the UCM as the first step in compressor loading and the last step in compressor unloading. Just prior to and just after a compressor start, and just before a compressor stop, the MCSP will continuously energize the unload solenoid for 20 to 30 seconds to assure unloaded starts. After a compressor stop, the unload solenoid valve will remain energized for approximately one hour to prevent slide valve movement due to changing cylinder/compressor pressures.

The first procedure below will allow the checkout of the MCSP load and unload outputs. The next procedure will allow the checkout of the Load and Unload Solenoid valves located on the compressor as well as the operation of the Slide Valve modulating unloader. Lastly, the female unloader valve and solenoid will be discussed.

Compressor Capacity

Checkout Procedure for MCSP Load/Unload Outputs

⚠ WARNING
Live Electrical Components!

During installation, testing, servicing and troubleshooting of this product, it may be necessary to work with live electrical components. Have a qualified licensed electrician or other individual who has been properly trained in handling live electrical components perform these tasks. Failure to follow all electrical safety precautions when exposed to live electrical components could result in death or serious injury.

The MCSP controls the Load and Unload Solenoid valves on the respective compressor with 115 V triacs (solid state relays). Unlike mechanical relays however, a triac has a rather high leakage current when off, comparatively speaking. While this leakage is not nearly enough to actuate a solenoid valve, it may, under no load conditions (as would be experienced when a solenoid coil failed open), look like it was stuck "on" when using a voltmeter to test it. Thus it is important to verify that the solenoid coil is continuous and providing a normal load or to connect a known good load, such as a low wattage 115 Volt lamp, to the terminals when testing the outputs. Refer to the Chiller Control Wiring diagrams and Component Location Drawings for the following procedure.

With the particular compressor running, the triacs may be checked (under load as explained above) by measuring the voltage from terminals E7 or E8 to 115 neutral. The triacs operate in the high side and switch 115 Vac power from J7-1 to either E7 (load solenoid) or E8 (unload solenoid) to move the slide valve in the appropriate direction. Except during compressor starts and stops, in normal operation, the solenoid valves can only be energized for a period of between 40 and 400 milliseconds once every 10 seconds. Often, if the chilled water setpoint is being met under steady state conditions, they may not energize at all. To assure loading and unloading is occurring it may be necessary to make slight adjustments to the chilled water setpoints to force action. As the pulsed on-time is potentially short it may be difficult to see, especially if using a meter movement type voltmeter. (Use of a low wattage 115 Vac test lamp may be of some help for a visual indication of output triac operation.)

When a triac is off, about 0 Vac should be measured on its terminal with the solenoid load connected. When it is on, the voltage should be close to 115 Vac (the drop across the triac is about 1-2 volts).

The best time to check the unload solenoid is immediately after a power-up reset of the MCSP. For the first 30 seconds after applying power the unload solenoid should be on continuously. The next best time to check it is after the compressor starts. For the first 30 seconds after a start the unload solenoid should be on continuously.

Checking the load solenoid is more difficult. 30 seconds after a start, the compressor will usually start loading, until water temperatures are satisfied. Remember however, that under certain limit conditions, the MCSP may

Compressor Capacity

prevent a compressor from loading even if the chilled water setpoint is not satisfied. Refer to the RTAA-IOM-4 for discussion on condenser, evaporator, and current limiting functions and setpoints. Refer to the Mode display under the Chiller Report on the CLD for an indication of the current running mode.

Checkout Procedure for the Slide Valve and Load/ Unload Solenoids

Make sure unit is off and there is no power in the control panel before beginning this procedure.

Setup

1. Identify the MCSP Module associated with the compressor to be tested (1U4 or 1U5). Disconnect the stake-on terminals for the Load and Unload Solenoid Valves at the MCSP UCM (E7 and E8 respectively) but take care to identify the wires so as to prevent crosswiring when reconnecting.

⚠ WARNING
Hazardous Voltage w/Capacitors!

Disconnect all electric power, including remote disconnects before servicing. Follow proper lockout/tagout procedures to ensure the power cannot be inadvertently energized. For variable frequency drives or other energy storing components provided by Trane or others, refer to the appropriate manufacturer's literature for allowable waiting periods for discharge of capacitors. Verify with an appropriate voltmeter that all capacitors have discharged. Failure to disconnect power and discharge capacitors before servicing could result in death or serious injury.

Note: For additional information regarding the safe discharge of capacitors, see PROD-SVB06A-EN or PROD-SVB06A-FR

2. Install a toggle switch between Control Power HOT (1TB3-8 or 9) and the Load and Unload Solenoid Valve leads (previously connected to E7 and E8). Initially make sure that the Load toggle switch is open and the Unload toggle switch is closed.
3. Install a pressure gauge with a refrigerant hose (hose should be long enough to read the gauge from the control panel) to the slide valve piston/cylinder cavity Schrader valve located near the load/unload solenoids.
4. Reapply power to the unit and place the chiller in the "Stop" mode. Using the CLD, select and enable the "Compressor Test" (in the Service Tests Menu) for the compressor that is to be run. Additionally, to prevent the opposite refrigeration circuit from running, if desired, the circuit can be locked out through the CIRCUIT LOCKOUT display in the Service Tests Menu for the appropriate circuit. Next place the Chiller into the "Auto" mode and provide all necessary interlocks and a load (or adjust chilled water setpoint) to start the chiller. The selected compressor will be the first to stage on (after the restart inhibit timer has expired).

Compressor Capacity

NOTE: Enabling the "Compressor Test" only affects which compressor will be cycled on next and is not an override mode. The chiller will continue to operate normally (not withstanding circuit lockout) and will stage compressors on and off, as well as attempt to modulate running compressors to maintain chilled water setpoint. Be aware that during manual control of the load/unload solenoids, as explained in item 6, below, other compressors may stage and/or attempt to modulate and thus will affect the leaving chilled water temperature. However, all diagnostics are still active. No specific action, other than reconnecting the solenoid valves to their respective outputs on the MCSP, is required to return the Chiller to normal operation.

5. Allow the compressor to start and monitor compressor currents either in the Compressor Report display (maximum phase % RLA) or with a clamp-on type ammeter.

Load

1. Once the compressor has started, allow the Unload Solenoid Valve to remain energized for approximately 30 seconds, then open the Unload toggle switch to de-energize the valve. Verify that at least one condenser fan is on before continuing with the checkout, as low differential refrigerant pressures will preclude proper Slide Valve operation. Record the cylinder cavity pressure and the compressor currents.
2. Manually close and open the Load toggle switch, to energize the Load Solenoid, in 4 or 5 short "pulses". Each load pulse should be approximately one second in duration, with approximately 10 seconds between pulses.

NOTE: Loading the compressor faster than this rate could cause control instability and possible diagnostics. Leave the toggle switch open, i.e., valve de-energized.

3. If the %RLA or the current and pressure increases,' then the Load Solenoid and Slide Valve are operating properly.
4. If the %RLA or current does not increase, read the pressure at the cylinder cavity; Pressure increases, to approximately condenser pressure (condenser pressure read via the CLD) without an increase in % RLA (unless already fully loaded), indicate the Slide Valve is bound.
5. If cylinder cavity pressure does not increase, check the coil of the Load Solenoid.
6. If the coil checks out, then one of two problems exist. Either the Load Solenoid Valve is malfunctioning or the Unload Valve is stuck open.

NOTE: Refer to the flow chart shown in Figure 5.

Compressor Capacity

1. Install toggle switches across load and unload solenoid
2. Install Pressure Gage on slide valve piston/cylinder cavity Schrader valve.
3. Start Unit.

Load:

4. Manually load compressor in short increments.

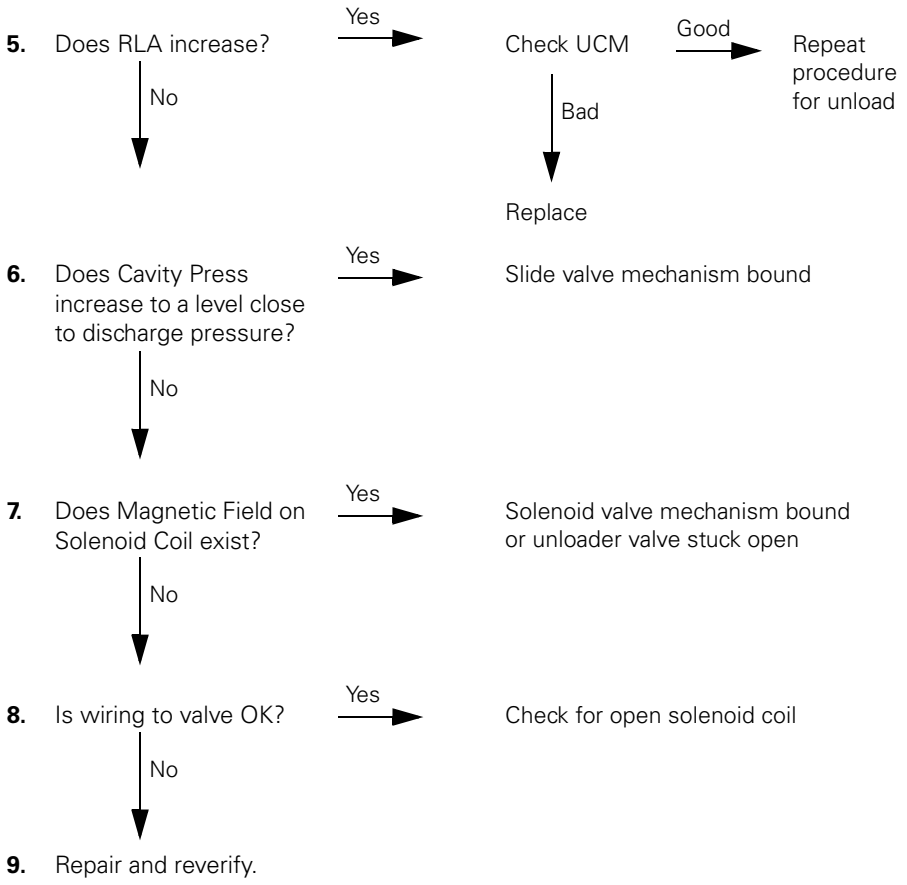


Figure 5 Manual Slide Valve Diagnostic Flow Chart - Load

Unload

NOTE: The following assumes that the compressor's slide valve is already at some loaded position and %RLA is higher than the minimum noted in step 1.

1. Manually close the Unload toggle switch to continuously energize the Unload Solenoid Valve.
2. If the %RLA decreases, then the Unload Valve and Slide Valve are operating properly.
3. If the %RLA does not decrease, observe the cylinder cavity pressure reading.
4. If cylinder cavity pressure reading decreases to approximately the suction

Compressor Capacity

pressure, then the Slide Valve is bound.

5. If cylinder cavity pressure does not decrease or is at suction pressure before the Unload toggle switch was closed, the problem lies with either the solenoid coil or valve.
6. Check coil
7. If coil checks out, change the valve.

NOTE: Refer to the Flow Chart in Figure 6.

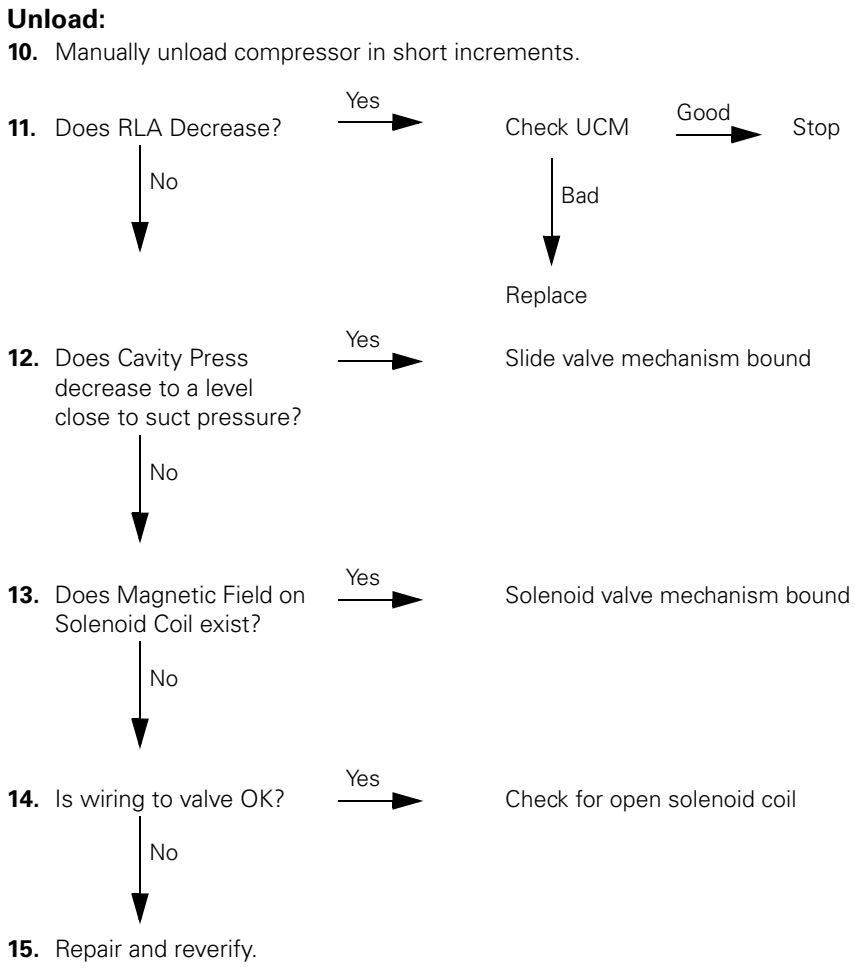


Figure 6 Manual Slide Valve Diagnostic Flow Chart

Checkout Procedure for MCSP Step Load Output

The MCSP controls the step load solenoid valve on the respective compressor with a 115 VAC dry contact output relay. This differs from the Load/Unload solenoid output, which is from a triac (solid state relay). Refer to the Chiller Control Wiring diagrams and the Component Layout Drawings for the following procedure.

Compressor Capacity

⚠ WARNING
Live Electrical Components!

During installation, testing, servicing and troubleshooting of this product, it may be necessary to work with live electrical components. Have a qualified licensed electrician or other individual who has been properly trained in handling live electrical components perform these tasks. Failure to follow all electrical safety precautions when exposed to live electrical components could result in death or serious injury.

With a particular compressor running, the relay may be checked (under load, as explained above) by measuring the voltage from terminal J7-9 to the 115 VAC neutral. The relay operates in the high side and switches power from J7-8 to J7-9, to move the step load valve to the loaded position. When the CPM decides to load the compressor, the step load solenoid is energized continuously. To assure that loading and unloading is occurring, it may be necessary to make slight adjustments to the chilled water setpoints to force action.

Checkout Procedure for Step Load Solenoid Valve and Piston

Prior to a compressor start, connect a pressure gauge to the Schrader port near the step load solenoid valve. This port is connected to the back side of the step load piston and, therefore, will allow direct measurement of the pressure that actuates the step load valve. Observe the pressure gauge during a compressor start, either from a manual compressor test or a normal call for cooling. Initially, the pressure should drop to the suction pressure and, when the MCSP calls for compressor loading, the solenoid will actuate and supply discharge pressure to the piston. If, after verifying that 115 VAC has been applied to the step load solenoid, the pressure does not increase to discharge pressure, the step load solenoid coil and/or valve must be replaced. Also, when the solenoid valve is energized and the piston pressure is near discharge pressure, the percent RLA of the compressor, as seen in the Compressor Report, should increase. If the percent RLA does not increase, the step load valve is stuck and should be repaired.

Module Power and Miscellaneous I/O

This section will detail the normal voltage levels present on each of the modules inputs and outputs under various conditions or states. Typical operation of the I/O will be discussed in terms of chiller operation. This should help the serviceman determine when and how they should function. Certain inputs have been presented in greater detail in earlier sections and these are referenced where applicable.

Power Supply

All of the modules are powered from 115 VAC 50/60hz Control Power except the CLD and the IPCB, which are powered by 24 VAC. This power is provided by either a control power transformer or is customer supplied. With the exception of the CLD, LCI-C and the IPCB modules, the other modules have incoming power connected to the upper-most terminal on the right hand side of the module, just below the fuse. The terminal is arranged with two hot pins (1 and 2), a keying pin (3), and two neutral pins (4 and 5), for ease of "daisy chaining" power from one module to another. Incoming power can be verified by measuring the voltage between the fuse bottom (hot side) and the connector's neutral (pins 4 or 5). The voltage should read between 97.8 to 132.2 volts AC rms. Refer to Figure 7. (The ±15% voltage criteria is most important for the EXV module's operation, as the Electronic Expansion Valve's available torque is directly related to this value).

The fuses can be checked by looking for the supply voltage at the top of the fuse (fused side) with respect to the connector neutral.

If some modules have power and some do not, the "daisy chain" wiring or power connections should be suspected. Refer to the Unit Wiring diagrams for the specifics on the power wiring.

Generally a power loss to a particular module will first be noticed as a communications loss with that module. The module can be identified by analysis of the IPC diagnostics as displayed by the CPM. Refer to Section 2 Interprocessor Communication for more information about Communication (IPC) diagnostics. If the CLD's display is blank, 24 VAC power should be checked at the CLD.

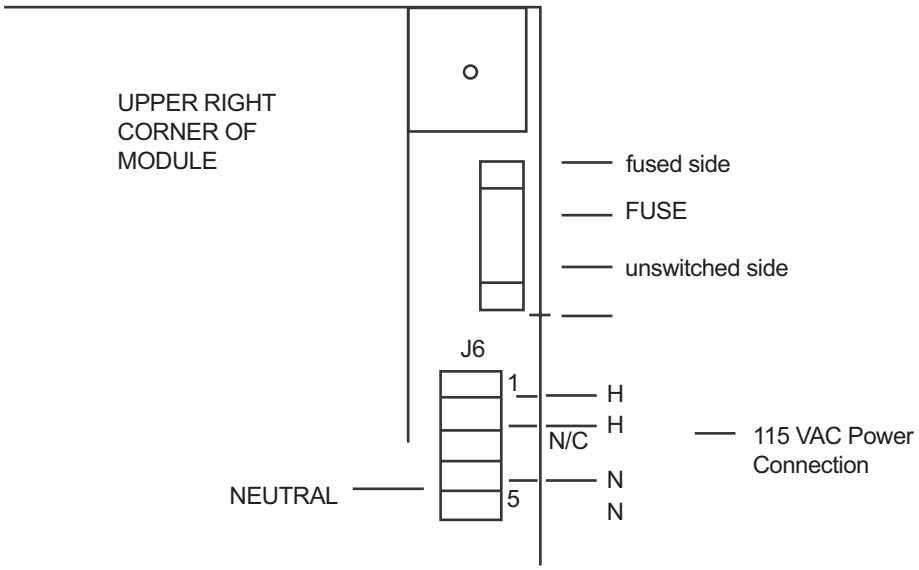


Figure 7 AC Power Connection To Modules

Clear Language Display (CLD) 1U6 Keypad Overview

Local operator interface with the system is accomplished using the 16 keys on the front of the Clear Language Display panel. The readout screen is a two line, 40 character liquid crystal display with a backlight. The backlight allows the operator to read the display in low-light conditions. The depression of any key will activate the backlight. The backlight will stay activated for 10 minutes after the last key is pressed. At 10 F or below the backlight will stay activated continuously.

The keys are grouped on the keyboard by the following functions (refer to Figure 8):

- Select Report Group
- Select Settings Group
- Selection Keys
- Stop & Auto Keys

Figure 8 Operator Interface Adaptive Control

Select Report Group

This group of four keys allows the operator to select and view the following reports:

- Custom Report
- Chiller Report
- Refrigerant Report
- Compressor Report

The Custom Report is the only report of the four that is defined by the operator. Any display under the other three reports can be added to the Custom Report by pressing the plus (+) key while the desired read-out is on the display. A maximum of 20 entries can be contained under the Custom Report. Items can be deleted from the Custom Report by pressing the minus (-) key when the desired read-out is on the display. The operator must be in the Custom Report menu to delete the desired item.

The Chiller Report, Refrigerant Report and Compressor Report are informational reports that give current status. Each report and its contents are discussed in detail on the following pages.

Module Power and Miscellaneous I/O

When any of the four report keys are pressed, the first readout on the display will be the header. The header identifies the title of the report and summarizes the items in the report.

The Next key and Previous key allow the operator to scroll up and down through the display items listed under the report menus. When the last item of a report is displayed and the Next key is pressed, the display will wrap around to the header of the report. When the first item of a report is displayed and the Previous key is pressed, the display will wrap around to the last item.

Select Settings Group
The first three keys on the second row - Operator Settings, Service Settings and Service Tests - allow the operator to adjust various setpoints and perform various tests. Certain items in these groups are password protected. Refer to the Password section for additional information.

When a setpoint key is pressed, a header will be displayed. The setpoint headers identify the available items and setpoint functions.

The Next and Previous keys function in the same manner as that described in Selected Report Group, above.

Setpoint values are incremented by pressing the Plus key and decremented by pressing the Minus key. Once a setpoint is changed, the Enter key must be pressed to save the new setpoint. If the Cancel key is pressed, the setpoint value on the display will be ignored and the original setpoint will remain.

Passwords
Passwords are needed to enter into the Service Setup Menu and the Machine Configuration Menu. Both of these menus are accessed through the Service Settings key. If access into these menus is necessary, follow the list of steps below:

1. Press Service Settings
2. Press Next until the readout in the display is:

   Password Required For Further Access "Please enter Password"
3. To enter into the Service Setup Menu, press: + + - - + + Enter
4. To enter into the Machine Configuration Menu, press: + - + - + - Enter

Refer to RTAA or RTWA IOM for the list of items found in the Service Setup Menu and Machine Configuration Menu.

Select Report Group and Select Settings Group Flowcharts
Refer to RTAA or RTWA IOM for the display readouts found under each menu. The first block of the flowchart is the header which is shown on the display after the menu key is pressed. For example:

Press Chiller Report and the readout on the display will be

CHILLER RPRT:STATUS, WTR TEMPS & SETPTS
"PRESS (NEXT) (PREVIOUS) TO CONTINUE"

Module Power and Miscellaneous I/O

Press Next to move down through the Chiller Report. As shown in the figures, the flowchart explains the conditions that the UCM looks at to determine which readout is to be displayed next. For example:

Press Chiller Report to display the header

Press Next to display

MODE: [OPERATING MODE]

REQUESTED SETPOINT SOURCE: [SETPT SOURCE]

Press Next to display

COMPRESSOR ON

CIRCUITS LOCKED OUT

Press Next to display

ACTIVE ICE TERMINATION SETPOINT

or

ACTIVE CHILLED WATER SETPOINT

The UCM will determine which screen will be displayed after looking at the current Operating Mode. If the Operating Mode is "Ice Making" or "Ice Making Complete", ACTIVE ICE TERMINATION SETPOINT will be displayed. Otherwise, ACTIVE CHILLED WATER SETPOINT will be shown.

The flowcharts also list the setpoint ranges, default options and a brief description of the item, when necessary. This information is shown in the lefthand column of the page, adjacent to the appropriate display.

Auto/Stop Keys

The chiller will go through a "STOPPING" mode when the Stop key is pressed, if a compressor is running. This key has a red background color surrounding it, to distinguish it from the others.

If the chiller is in the Stop mode, pressing the Auto key will cause the UCM to go into the Auto/Local or Auto/Remote mode, depending on the Setpoint Source setting. The Auto key has a green back-ground color.

When either the Auto or Stop key is pressed, Chiller Operating Mode (Chiller Report Menu) will be shown on the display.

Power Up

When power is first applied to the control panel, the Clear Language Display goes through a self-test. For approximately five seconds, the readout on the display will be

SELF TEST IN PROGRESS

During the self-test, the backlight will not be energized. When the tests are successfully complete, the readout on the display will be

6200 xxxx-xx [TYPE] configuration

Updating Unit Data, Please Wait

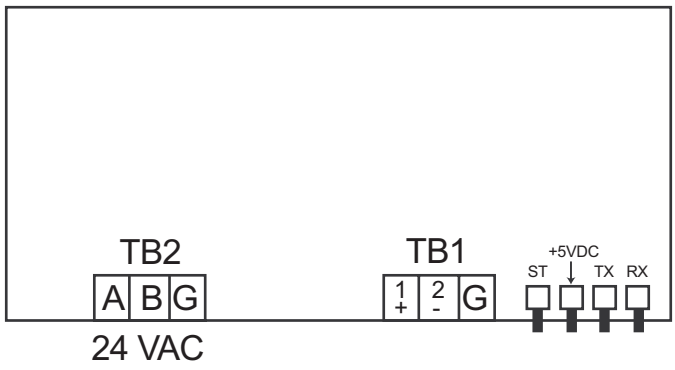
Module Power and Miscellaneous I/O

When updating is successfully completed, the system will default to the first display after the Chiller Report header:

MODE: OPERATING MODE]

REQUESTED SETPOINT SOURCE: [SETPT SOURCE]

and the backlight will be activated.



TB1-1,2	IPC Communications	19.2K Baud serial data 5 V signal level Refer to Interprocessor Communication (IPC)
TB2-1,2	24 VAC Power	18-30 VAC, neither side grounded

Figure 9 CLD Module (1U6)

LEDs

There are four LEDs located to the right of TB1 of the CLD module. See Figure 9. The ST LED should be on continuously. If it blinks, it indicates the processor is repeatedly being reset. The +5 VDC LED should also be on continuously. It will go out if power drops below normal operating voltage. The TX LED should blink every second or two, as the CLD transmits on the IPC. The RX LED should blink continuously, indicating that other modules are communicating.

Chiller Module (CPM) (1U1)

⚠ WARNING
Live Electrical Components!

During installation, testing, servicing and troubleshooting of this product, it may be necessary to work with live electrical components. Have a qualified licensed electrician or other individual who has been properly trained in handling live electrical components perform these tasks. Failure to follow all electrical safety precautions when exposed to live electrical components could result in death or serious injury.

Module Power and Miscellaneous I/O

Test Points

There are two test points associated with the CPM module. They are easily read with a DC voltmeter by probing the PC board solder pads found in the upper left hand corner of the module. The positive meter lead should be connected to the pad while referencing the negative meter lead to the board edge ground plane.

NOTE: Don't use the aluminum module enclosure as a reference as it has an anodized surface with insulating properties.

The DC voltages shall be within the tolerance specified below. If not replace the module.

TP1: + 5 volts DC ± 5%

TP2: +12 volts DC ± 5%

Module Power and Miscellaneous I/O

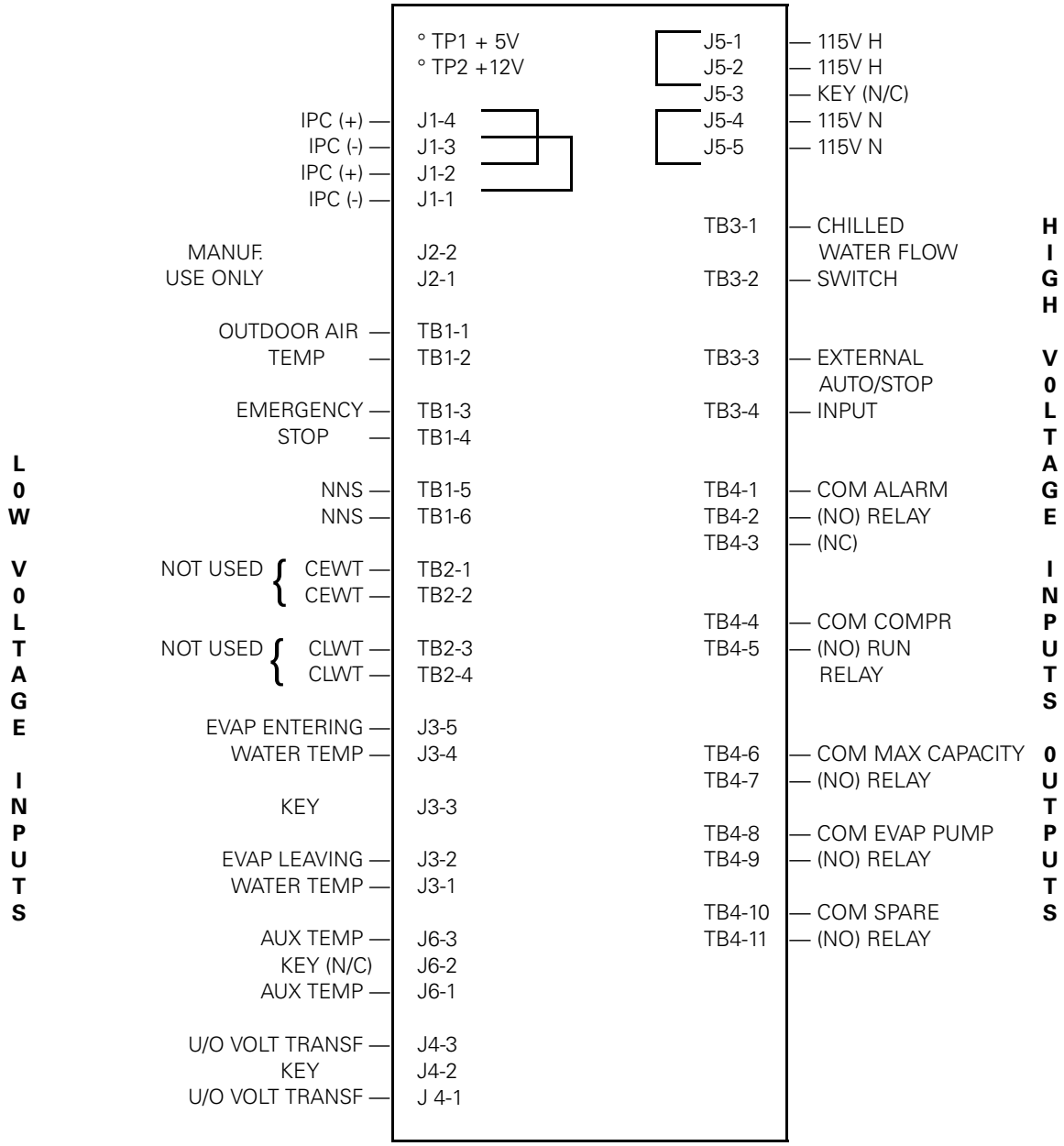


Figure 10 CPM (Chiller) Module (1U1)

I/O terminals

For the checkout of the I/O, refer to the block diagram of the module in Figure 10 and the Chiller Wiring Diagrams for both high and low voltage circuits. All voltages are measured differentially between terminal pairs specified unless otherwise indicated. The first terminal in the pair is the positive (or hot) terminal. Voltages given are nominals and may vary by ±5%. Unregulated Voltages (unreg) or 115 VAC voltages may vary by ±15%.

Module Power and Miscellaneous I/O

Table 16 CPM (Chiller) Nominal Terminal Input and Output (1U1)

Terminal Designation	Description of Circuit	Normal Terminal Voltages for Various Conditions
J1-4 to 3 to CLD J1-2 to 1 to 1U5	IPC Communications	19.2 kbaud serial data, 5 volt signal level. Refer to Interprocessor Communication (IPC)
J2-2, 1	Manufacturing Address Use Only	+5 VDC No connection intended.
TB1-1, 2	Outdoor Air Temperature	Refer to Temperature Sensor Checkout
TB1-3, 4	Emergency Stop	open: 20.6 VDC unreg: Stopped closed: 0 VDC: Normal Must be jumpered if this feature is not used.
TB1-5, 6	NNS (Not Used)	open: 20.6 Vdc unreg: Normal closed: 0 VDC: Setback
TB2-1, 2	ECWT (Not Used)	N/A
TB2-3, 4	LCWT (Not Used)	N/A
J3-5, 4	Entering Evaporator Water Temperature	Refer to Temperature Sensor Checkout
J3-2, 1	Leaving Evaporator Water Temperature	Refer to Temperature Sensor Checkout
J4-3, 1	Under/Over Voltage Transformer Input	Refer to Under/Over Voltage Transformer Checkout Procedure
J5-1 or 2 to J5-4 or 5	Input Power	115 VAC, Power Supply on page 41.
J6-3, 1	Auxiliary Temp. Input	Refer to Temperature Sensor Checkout
TB3-2, 1	Chilled Water Flow Switch Input	open: 115VAC: No Flow closed: < 5VAC: Flow (Software imposes a 6 second delay to respond to opening or closing.
TB3-3,4	Chilled Water Demand Switch and External Auto Stop	open: 115VAC: Stop closed: < 5VAC: Auto
TB4-1, 2	Chiller Alarm or Alarm Ckt 1 (N.O. Contact)	Dry SPDT Contact closes on Alarm, intended for 115 VAC customer control circuit.
TB4-1, 3	Chiller Alarm or Alarm Ckt 1 (N.O. Contact)	Dry SPDT Contact opens on Alarm, intended for 115 VAC customer control circuit.
TB4-4, 5	Unit Running, Alarm Ckt 2, or Ckt 1 Running (N.O. Contact)	Dry SPDT Contact closes on Unit Running, Alarm Ckt 2 or Ckt 1 Running, intended for 115 VAC customer control circuit.
TB4-6, 7	Maximum Capacity or Ckt 2 Running (N.O. Contact)	Dry SPDT Contact closes on Maximum Capacity or Ckt 2 Running, intended for 115 VAC customer control circuit.
TB4-8, 9	Chilled Water Pump Starter (N.O. Contact)	Dry SPST Contact closes when Chilled Water Demand Switch is closed, opens after time delay specified in UCM 115 VAC customer control circuit.
TB4-10, 11	Spare Relay} (N.O.) Contact	Dry SPST contact. 115 VAC customer control circuit.

Module Power and Miscellaneous I/O

Options Module (CSR) (1U2)

⚠ WARNING
Live Electrical Components!

During installation, testing, servicing and troubleshooting of this product, it may be necessary to work with live electrical components. Have a qualified licensed electrician or other individual who has been properly trained in handling live electrical components perform these tasks. Failure to follow all electrical safety precautions when exposed to live electrical components could result in death or serious injury.

Test Points
There are three test points associated with the CSR module. They are easily read with a DC voltmeter by probing the PC board solder pads found in the upper left hand corner of the module. The positive meter lead should be connected to the pad, while referencing the negative meter lead to the board edge ground plane.

Note: don't use the aluminum module enclosure as a reference as it has an anodized surface with insulating properties. The DC voltages shall be within the tolerance specified below. If not replace the module.

TP1: + 5 volts DC ±5%

TP2: + 6 volts DC ±5%

TP3: +12 volts DC ±25%

Switch SW-1
Switch SW1 is used to configure the External Chilled Water Setpoint input and the External Current Limit Setpoint input for either a 2-10VDC, or a 4-20ma signal. With the respective switch closed (on), a shunt resistor is switched into the input circuit to provide a fixed low value input impedance (499 ohms) for current loop operation. With the switch off, the input impedance is differentially 40Kohms.

External Setpoint Inputs (4-20ma/2-10VDC)
The chiller setpoint source should always be set to LOCAL when using any external inputs, except a Tracer. When using a Tracer, always set the chiller setpoint source to the Tracer mode. The setpoint source can be found in the Operator Settings Menu.

These inputs accept either an isolated 4-20mA or 2-10VDC signal from an external controller or programming resistor connected to an internal +5V source. The switches SW1-1 and SW1-2 are used to select either the voltage or current option for External Chilled Water Setpoint and External Current Setpoint respectively. See Test Points, above. Alternately, either input may be used with a resistor or potentiometer.

NOTE: Note: For proper operation, the 4-20mA/2-10VDC inputs are required to be used with a current or voltage source that:

1. Is isolated (floats) with respect to ground, or

Module Power and Miscellaneous I/O

2. Has its negative terminal tied to chassis ground.

If the intended source does not meet the above requirement, an isolation module must be used

The 4-20mA/2-10VDC inputs may be tested in the following ways:

1. Enable External Chilled Water Setpoint and/or External Current Limit Setpoint in the Operator Settings Menu. Advance display to Active Chilled Water Setpoint or Active Current Limit Setpoint to observe the respective setpoint in the Chiller Report.
2. With all wiring in place, apply an external voltage or current to the External Chilled Water Setpoint inputs (TB1-4 & 5) or the External Current Limit Setpoint (TB1-7 & 8). The voltage measured at the terminals and the resulting setpoint, as read on the CLD, should agree with the Table 17 for Chilled Water Setpoint inputs and Table 18 for Current Limit Setpoints inputs. Be sure to wait long enough when reading the display as the values are slew rate limited.
3. Disconnect all wiring to these inputs. The setpoints should slew back to the chiller's Front Panel settings.
4. Disconnect all wiring and install fixed resistors of values near those shown in the following tables across TB1-3,5 or TBI-6,8. The resulting setpoints should agree with the table values.

Table 17 Input Values vs. External Chilled Water Setpoint

INPUTS Resist (ohms)	Current (ma)	Voltage (Vdc)	Resulting Chilled Water Setpt (F)±4F
94433	4.0	2.0	0.0
68609	5.2	2.6	5.0
52946	6.5	3.2	10.0
42434	7.7	3.9	15.0
34889	8.9	4.5	20.0
29212	10.2	5.1	25.0
24785	11.4	5.7	30.0
21236	12.6	6.3	35.0
18327	13.8	6.9	40.0
15900	15.1	7.6	45.0
13844	16.3	8.2	50.0
12080	17.5	8.8	55.0
10549	18.8	9.4	60.0

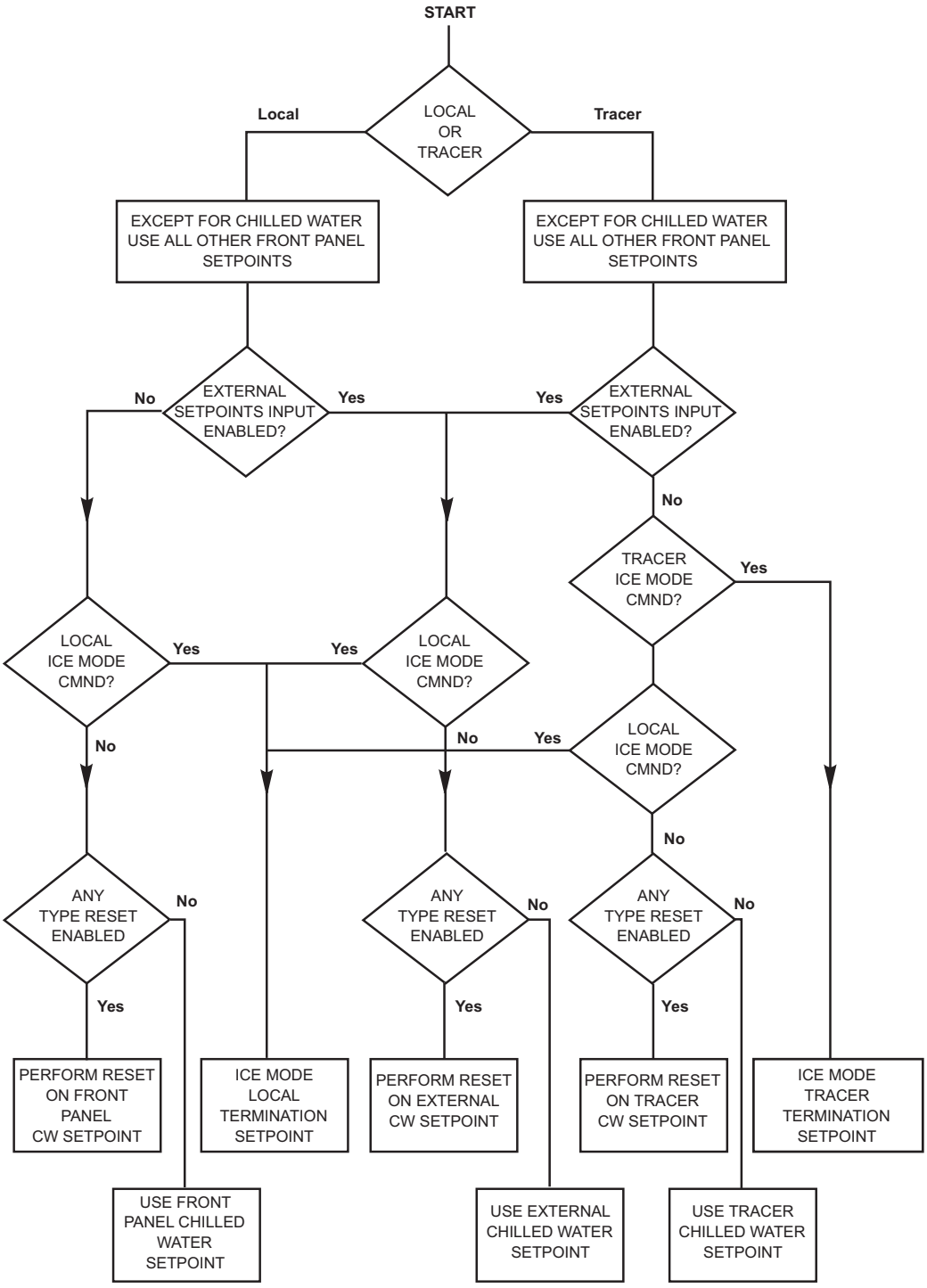
Module Power and Miscellaneous I/O

Table 18 Input Values vs. External Current Limit Setpoint

Resist (ohms)	INPUTS Current (ma)	Voltage (Vdc)	Resulting Current Limit Setpt (%RLA)±5%
49000	4.0	2.0	40
29000	6.0	3.0	50
19000	8.0	4.0	60
13000	10.0	5.0	70
9000	12.0	6.0	80
6143	14.0	7.0	90
4010	16.0	8.0	100
2333	18.0	9.0	110
1000	20.0	10.0	120

Setpoint Priority

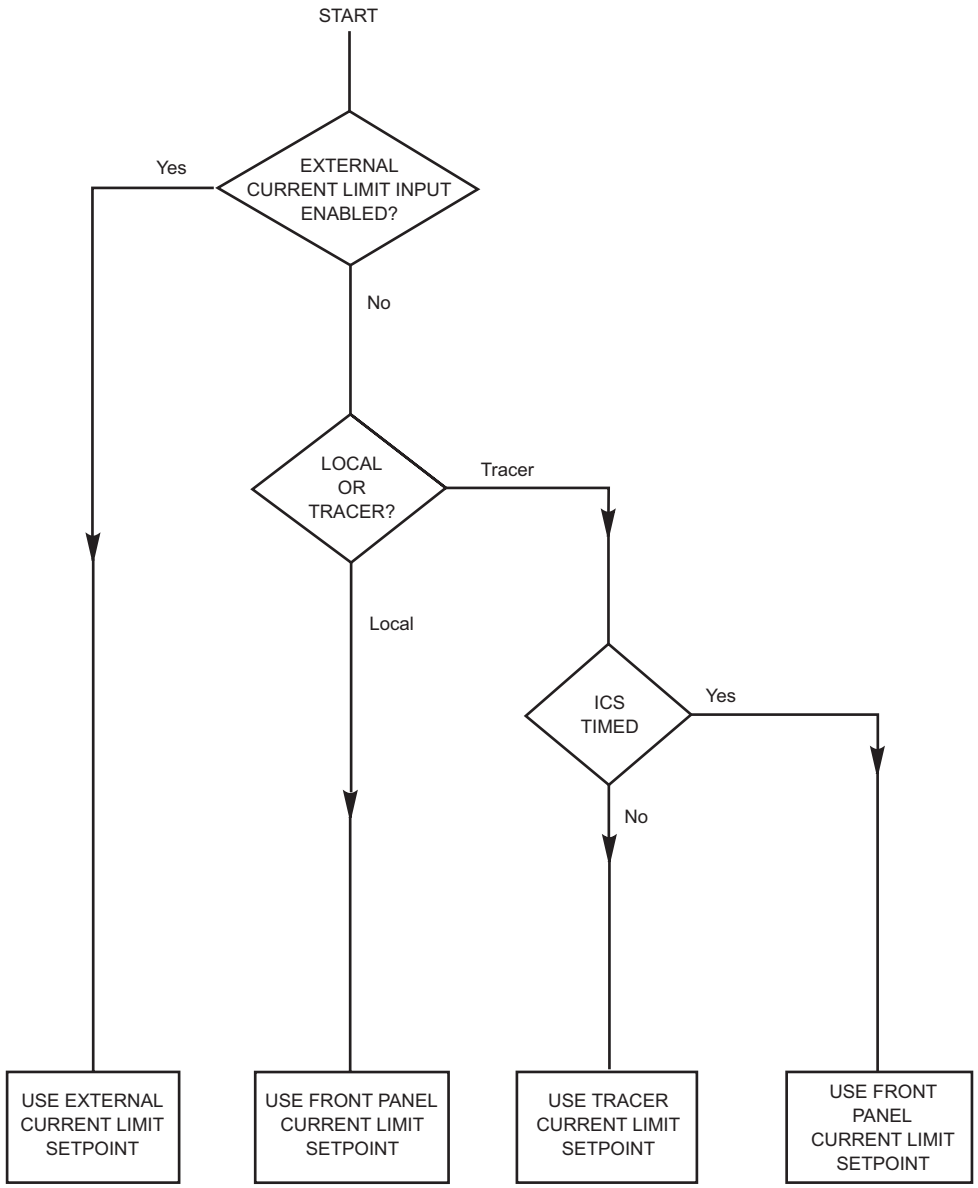
There are many ways in which the Chilled Water and Current Limit setpoints can be adjusted or reset when the Options Module is present in the Chiller control system. The following flow charts show how these methods are prioritized and arbitrated under normal operating conditions. When abnormal conditions are present, such as loss of Tracer communications or out of range values on external setpoint inputs, the system will default to other methods.



"TRACER" implies Trane Integrated Comfort System remote device (ICS) using the digital communication link.

"EXTERNAL" implies generic building automation system or process controller interface using a 4-20ma loop or a 2-10 VDC analog signal.

Figure 11 Chilled Water Setpoint Arbitration



"TRACER" implies Trane Integrated Comfort System remote device (ICS) using the digital communication link.

"EXTERNAL" implies generic building automation system or process controller interface using a 420ma loop or a 2-10 VDC analog signal.

Figure 12 Current Limit Setpoint Arbitration

Module Power and Miscellaneous I/O

ICS Communications
ICS (Tracer) communication is handled the same as on previous products using the Trane proprietary Comm3 standard 1200 baud isolated serial communication link. The following are some things to check when experiencing loss of ICS communications:

1. If ICS control is desired, check that "Tracer" has been selected in Setpoint Source of the Operator Settings Menu. In any case, the Tracer should be able to communicate to the chiller for monitoring purposes, regardless of the Setpoint Source selection. Refer to Figure 11 for a description of the normal operation of setpoint and setpoint reset arbitration.
2. Check for the proper ICS address in the Service Settings Menu and compare to the address programmed at the ICS device.
3. Check for proper termination of the twisted pair communication link wiring to terminals TB2-1 and TB2-2 (or TB2-3 and TB2-4)
4. Check for a diagnostic at the display indicating loss of IPC communications with the Options module. This could indicate IPC bus problems or a dead Options module. (See Options Module (CSR) (1U2) on page 50). The Options module needs to receive 4 good packets of data from the CPM before it will talk on the ICS link.
5. Check power to the Options module and the condition of the fuse. (See Power Supply on page 41)
6. Check the Test Point voltages on the module. (See Test Points on page 47).

NOTE: The red LED on the module blinks each time a proper message or query is received from the Remote ICS device.

I/O Terminals
For the checkout of the I/O refer to the block diagram of the module on the following page and the Chiller Wiring Diagrams for low and high voltage circuits. All voltages are measured differentially between terminal pairs specified unless otherwise indicated. The first terminal in the pair is the positive (or hot) terminal. Voltages given are nominals and may vary by ±5%. Unregulated Voltages (unreg) may vary by ±25% and 115 VAC voltages may vary by ±15%.

Module Power and Miscellaneous I/O

Table 19 CSR Normal Terminal Voltages for Options Module 1U2

Terminal Designation	Description of Circuit	Normal Terminal Voltages for Various Conditions
J1-4 to 3 or J1-2 to 1	IPC Communications	19.2 kbaud serial data, 5 volt signal level. Refer to Interprocessor Communication Link (IPC).
J2-2, 1	Manufacturing Address Use Only	+5 VDC No connection intended.
TB1-3	+5V Source for use with Resistor programming of CW setpoint	+5VDC open circuit with respect to chassis ground.
TB1-3, 5	Ext. Chilled Water Setpoint (Resistive option)	Refer to External Setpoint Inputs (4-20ma/2-10VDC) on page 50.
TB1-4, 5	Ext. Chilled Water Setpoint (Current or Voltage option)	Refer to External Setpoint Inputs (4-20ma/2-10VDC) on page 50.
TB1-6	+5V Source for use with Resistor programming of CL setpoint	+5VDC open circuit.
TB1-6, 8	Ext. Current Limit Setpoint (Resistive option)	Refer to External Setpoint Inputs (4-20ma/2-10VDC) on page 50.
TB1-7, 8	Ext. Current Limit Setpoint (Current or Voltage option)	Refer to External Setpoint Inputs (4-20ma/2-10VDC) on page 50.
TB1-9, 10	Unused	
TB2A-1,2 or TB2B-3,4	Serial Comm.Input	Refer to Section 2, ICS Communications.
J6-1 or 2 to J6-4 or 5	Input Power	115 VAC, Refer to Power Supply on page 41.
Dip Switch SW1-1	External Chilled Water Setpoint Dip Switch	Off for 2-10 VDC input. On for 4-20 mA input.
Dip Switch SW1-2	External Current Limit Setpoint Dip Switch	Off for 2-10 VDC input. On for 4-20 mA input.

Module Power and Miscellaneous I/O

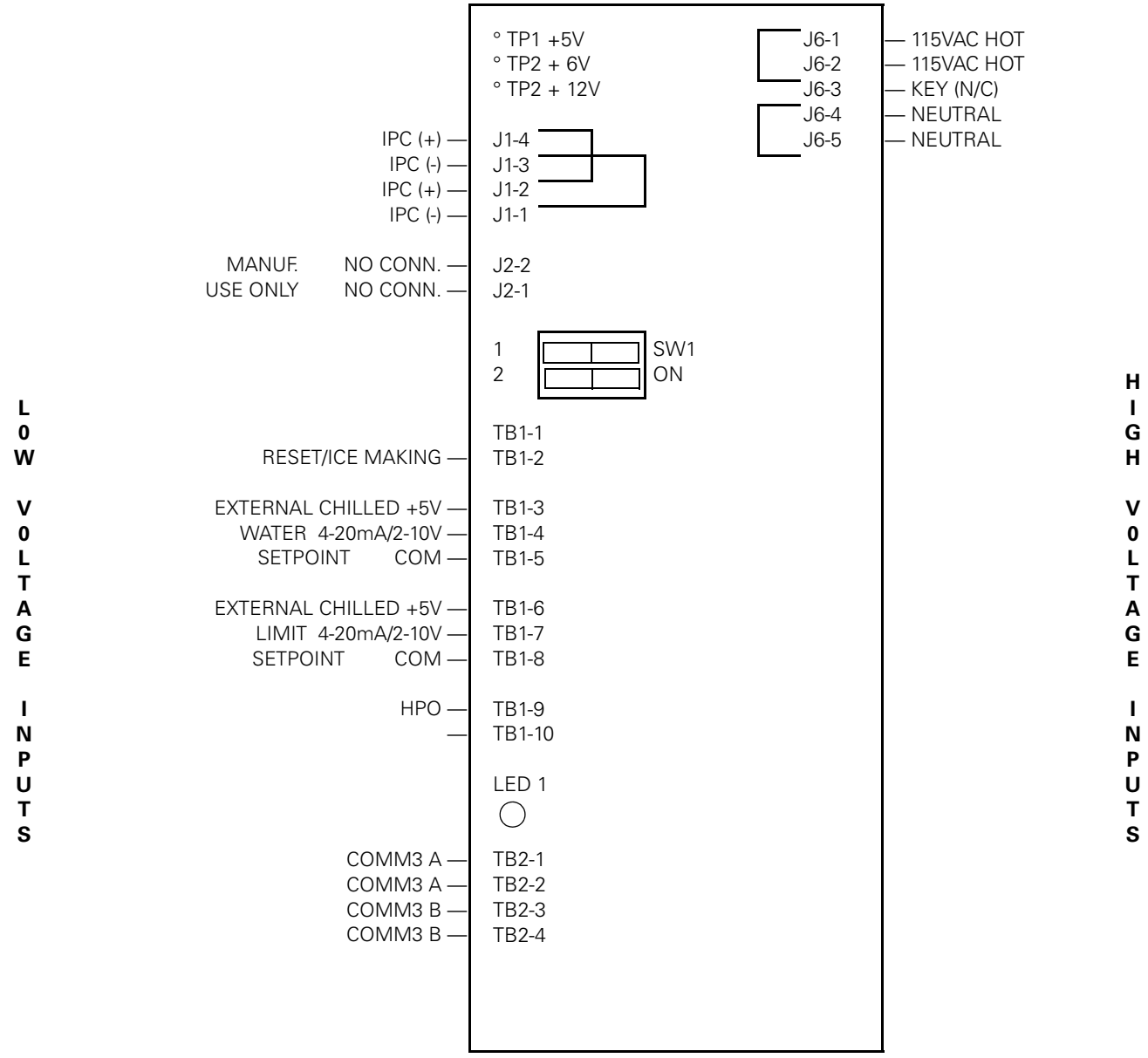


Figure 13 CSR (Options) Module (IU2)

Module Power and Miscellaneous I/O

Electronic Expansion Valve Module (EXV) (1U3)

⚠ WARNING
Live Electrical Components!

During installation, testing, servicing and troubleshooting of this product, it may be necessary to work with live electrical components. Have a qualified licensed electrician or other individual who has been properly trained in handling live electrical components perform these tasks. Failure to follow all electrical safety precautions when exposed to live electrical components could result in death or serious injury.

Valve Operation

The electronic expansion valve is an electronic flow device that replaces the thermostatically controlled expansion valve and liquid line solenoid. A sectional view of the valve is shown in Figure 16 and Figure 17.

The control method uses two sensors that measure the temperature difference between the inlet and outlet evaporator refrigerant temperature. This enables the system to control the temperature difference and maintain superheat.

The SEO-70 and SEO-100 valves were used on units until November 1, 2003. All units built after that date will have a SEHI-100 valve installed.

The module for the SEHI is different because the new valve uses a two coil instead of three. The locations of the keying pins are different on the module.

Design Sequence Information, digit 10-11 of the unit model number.

RTWA/UA A0 - E0	SEO Valve
RTWA/UA F0 and later	SEHI Valve
RTAA A0 - P0	SEO Valve
RTAA Q0 and later	SEHI Valve

NOTE: For units with remote evaporator use 16 AWG wire.

SEO-70 and SEO-100 Valve

The valve is a stepper-motor type, direct acting valve. It uses a three-phase motor (not to be confused with3-phase AC), with each phase having 40 ohms of resistance.

The supply voltage (24 VDC) is switched on and off to each phase, to step the valve open or closed. Each step is 0.0003" of stroke, with a full stroke of 757 steps.

The motor's rotary motion is translated into linear movement through a lead screw and drive coupling arrangement. A clockwise rotation of the motor shaft creates a downward movement of the drive coupling. This presses the pushrod and piston against the return spring, opening the valve. A counter-clockwise rotation of the motor shaft retracts the drive coupling. The return spring moves the piston and pushrod in the closing direction.

A "FLAG" stop is located at either end of the threaded portion of the motor shaft. The stops interfere with the milled flag on the drive coupling, restricting rotation of the motor shaft and producing a clicking sound when the valve is driven fully OPEN or CLOSED.

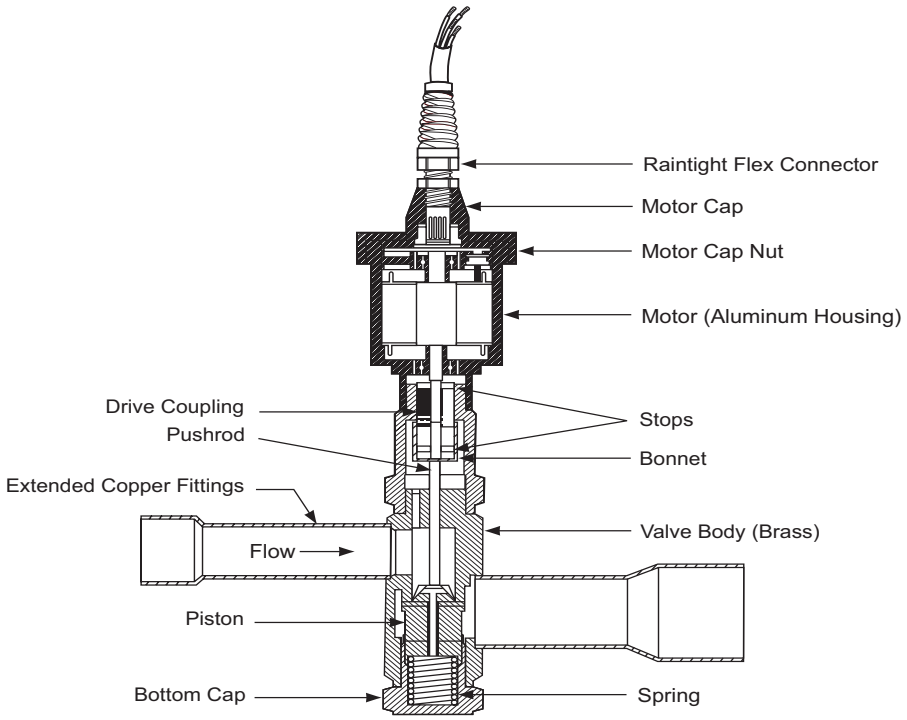


Figure 14 SEO 70, 100 Electronic Expansion Valve Cut Away View

SEHI-100 Valve

The valve is a stepper-motor type, direct acting valve. It uses a two-phase motor, with each phase having 75 ohms of resistance.

The supply voltage (12 VDC) is switched on and off to each phase, to step the valve open or closed. Each step is 0.00007" of stroke, with a full stroke of 6376 steps.

The step motor used in the SEHI valve is a permanent magnet rotor type. Each step creates a 3.6° rotation of the rotor. This rotation is increased in torque and reduced in speed by a 12.25:1 gear train. Final rotation is converted to linear motion by the use of a lead screw and threaded drive coupling. Forward motion of the motor extends the drive coupling and pin, which moves the valve to the closed position. Backward rotation of the motor retracts the drive coupling and pin modulating the valve in the opening direction. Full forward or backward travel, while the valve is assembled, is limited by the valve seat in the closed position or an upper stop in the open direction. A slight clicking sound may be heard at either of these two positions and does no harm to the valve or drive mechanism.

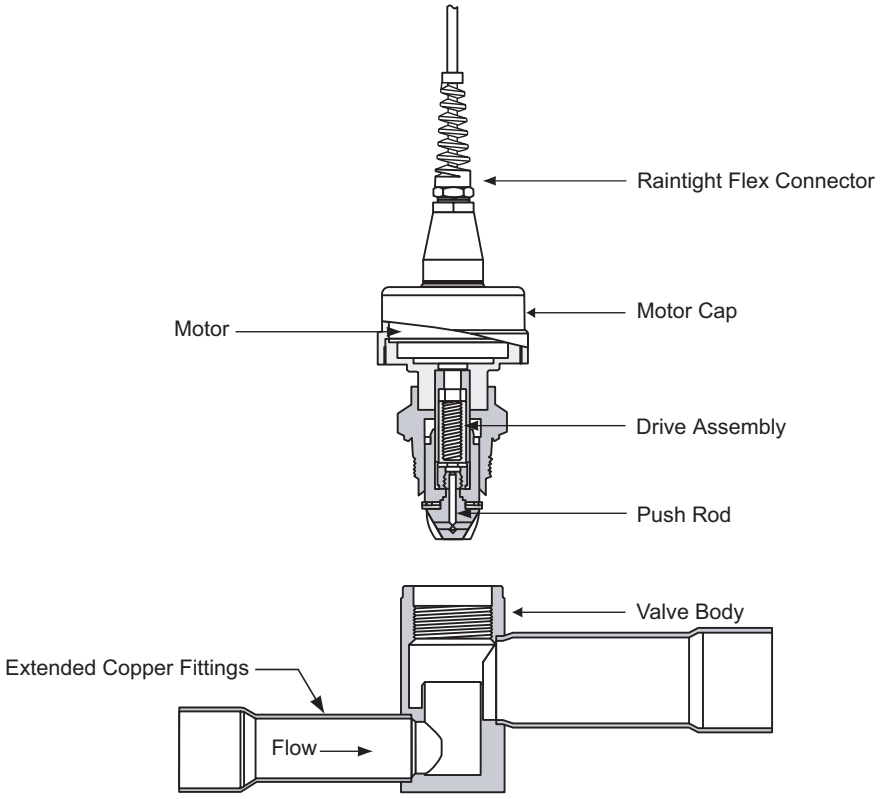


Figure 15 SHEI Valve

Electronic Expansion Valve Location

The valve should be installed with the motor in a vertical position, or no greater than 45° from vertical, as shown in Figure 16. This will prevent oil logging and the possibility of contamination reaching the motor cavity. The valve should also be installed as close to the evaporator as possible.

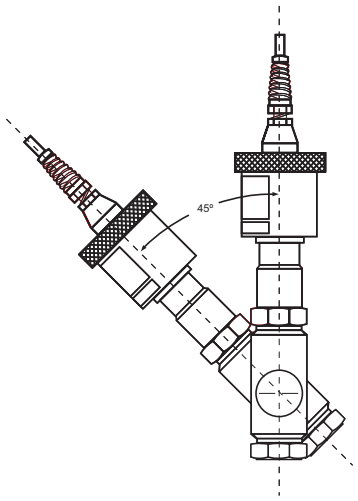


Figure 16 Electronic Expansion Valve Location

Test Points
There is only one test point associated with the EXV module. It is easily read with a DC voltmeter by probing the PC board solder pad found in the upper left hand corner of the module. The positive meter lead should be connected to the pad while referencing the negative meter lead to the board edge ground plane.

NOTE: Don't use the aluminum module enclosure as a reference as it has an anodized surface with insulating properties. The DC voltage shall be within the tolerance specified below. If not replace the module.

TP1: +5 volts DC ±5%

EXV Test
The EXV module has a built in test which is designed to allow the service technician to confirm a problem with the EXV control system and to identify which of the components of the system (the Valve/Stepper Motor assembly, the EXV Module, or the interconnecting wiring) is at fault. The directions to perform this test are given below:

EXV Test Procedure

1. Place the Chiller in the "STOP" mode using the Stop Button on the CLD.
2. Determine which refrigeration circuit is associated with the EXV valve you want to test. Advance to the EXV TEST display in the Service Tests Menu.
3. Press the ⚠ or ▽ keys to change the displayed "d" to an "E", which will enable or initiate the preprogrammed procedure. Display will automatically return the item to disabled when the test is completed.

Electrical Integrity Test

4. Initially the UCM will perform an Electrical Integrity test on the valve's stepper motor phases and associated wiring. If a failure is detected, it will report a diagnostic indicating "EXV Elect. Drive CKT" at this time. This

diagnostic suggests that there is a problem with the valve or the valve wiring. To confirm this, it is necessary to continue the procedure. The Electrical Integrity test will be completed in about 2 seconds. Regardless of whether or not a diagnostic occurs, the UCM will proceed with the stroke timing portion of the test.

Stroke Timing Test

5. At this time the UCM will drive the valve closed. Thus the total closing time will be 25 seconds. Due to mechanical characteristics of the valve, it will make a clicking sound when it reaches its end stops (either full open or full closed). In most cases, the valve will already be closed when this test is initiated, so a normally operating valve will exhibit the clicking for approximately 25 seconds.

NOTE: The loudness of the clicking varies from one valve to another and ambient noise can muffle the clicking sound. Therefore, it may be necessary to use a tool to aid in the hearing of the clicking (such as a screwdriver held between the EXV and the ear.)

6. Following the 25 seconds of closing, the valve will immediately be stepped open for the same period of time (25 seconds). As soon as the valve begins its opening movement the clicking should stop. while it moves through its stroke. The service technician would then note the time between when the clicking stopped until the time it restarts. This would give an indication of the opening stroke time.

NOTE: If the valve and switching circuitry is operating properly, the silent valve movement should last for approximately 15 seconds.

End of stroke clicking should then be heard for 10 seconds.

7. The module will then reverse direction and the valve will be stepped closed again for a full 25 seconds. Since the valve should have started from the full open position, the time to stroke closed should be noted and it should be approximately the same as the opening time above. If both opening and closing stroke times are correct to within ±5 seconds of the time specified, no further testing is required. If any valve fails this test, the service technician should perform the EXV Valve Winding Resistance Check, steps 8 thru 10 below.

SEO EXV Valve Winding Resistance Check

1. Disconnect the appropriate EXV valve from the pin header of the EXV module.
2. With a digital ohm-meter, check the resistance of the valve windings and associated leads/connector by measuring the resistance of pin pairs at the connector plug. Pin pairs are #5 and #3, #5 and #2, and #5 and #1 for Circuit 1. Pin numbers are indicated by corresponding position # on the board or by the raised numbers of the connector block. The resistances should all be 40 ohms ±4 ohms at 75F winding temperature. (At a valve winding temp of 148F the resistance would be no more than 54 ohms; at a valve winding temp of 32F the resistance would be no less than 33 ohms).

3. Check the resistance from each of the three phase pins (J4-3, J4-2, and J4-1) to the board edge GND, with the connector unplugged. This resistance should be between 100K and 200K ohms.

If the valve/wiring/connector combination fails the above tests, suspect the connector or the wiring first. At the valve for circuit #1; wire color black corresponds to pin #5, red to pin #3, white to #2 and green to #1. For circuit #2: black to pin #6, red to pin #4, white to #2, and green to pin #1. Refer to Table 20 and use the pass-fail results above to determine the prescribed action.

SEHI EXV Valve Winding Resistance Check

1. Disconnect the appropriate EXV valve from the pin header of the EXV module.
2. With a digital ohm-meter, check the resistance of the valve windings and associated leads/connector by measuring the resistance of pin pairs at the connector plug. Pin pairs are #5 and #4, #2 and #1 for Circuit 1 and #6 and #5, and #2 and # 1 for Circuit 2. Pin numbers are indicated by corresponding position # on the board or by the raised numbers of the connector block. The resistances should all be 75 ohms ±10 ohms.
3. Check the resistance from each lead to the board edge GND, with the connector unplugged. This resistance should be greater than 1 meg ohms.

If the valve/wiring/connector combination fails the above tests, suspect the connector or the wiring first. At the valve for circuit #1; wire color black corresponds to pin #1, red to pin #5, white to #2 and green to #4. For circuit #2: black to pin #1, red to pin #6, white to #2, and green to pin #5. Refer to Table 20 and use the pass-fail results above to determine the prescribed action.

Table 20 Test Results Logic Table

ELECT. INTEGRITY TEST*	STROKE TIMING	RESISTANCE	PRESCRIBED ACTION
PASS	PASS	NOT REQ.	VALVE/BOARD ARE WORKING PROPERLY - NO ACTION REQ.
PASS	FAIL	PASS	VALVE IS MECHANICALLY STUCK - REPLACE/REPAIR VALVE
PASS	FAIL	FAIL	HIGHLY UNLIKELY CONDITION RETEST-REPLACE MODULE
FAIL	PASS	PASS	HIGHLY UNLIKELY CONDITION RETEST-NO ACTION REQ.
FAIL	FAIL	PASS	CHECK CONNECTION AT MODULE RETEST-REPLACE MODULE
FAIL	FAIL	FAIL	SUSPECT WIRING, PLUG OR VALVE-REPLACE/REPAIR SAME

**.INDICATION OF PASS OR FAIL OF THIS TEST IS DISPLAYED AT THE CLD IN THE DIAGNOSTICS MENU.*

Solder Techniques for Installation

It is not necessary to disassemble the valve when soldering to the connecting lines. Most commonly used types of solder (eg. Sil-Fos, Easy-Flow, PhosCopper or equivalent) are satisfactory. Regardless of the solder

used, it is important to direct the flame away from the valve body. See Figure 17. A wet cloth should be wrapped around the body during soldering to provide extra protection. This will help prevent overheating and damage to the synthetic seals and subsequent degradation in valve performance. Valves are shipped in the full-open position, to allow for the flow of inert gas while soldering.

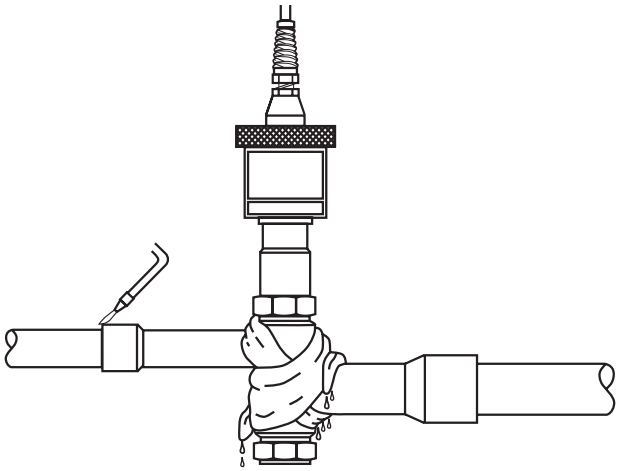


Figure 17 Electronic Expansion Valve Soldering

SEO Electronic Expansion Valve Servicing
The procedures listed below are to. be followed for proper disassembly, inspection, cleaning and reassembly to the valve. The valve does not need to be removed from the refrigerant piping before servicing.

1. Before disassembly of the valve, be sure the refrigerant pressure in the system has been reduced to a safe level (0 psig) on both sides of valve. See RTAA-SB-10 for preferred refrigerant handling in this area.

⚠ WARNING
Hazardous Voltage w/Capacitors!

Disconnect all electric power, including remote disconnects before servicing. Follow proper lockout/tagout procedures to ensure the power cannot be inadvertently energized. For variable frequency drives or other energy storing components provided by Trane or others, refer to the appropriate manufacturer's literature for allowable waiting periods for discharge of capacitors. Verify with an appropriate voltmeter that all capacitors have discharged. Failure to disconnect power and discharge capacitors before servicing could result in death or serious injury.

Note: For additional information regarding the safe discharge of capacitors, see PROD-SVB06A-EN or PROD-SVB06A-FR

2. Disconnect all the line voltage to the power supply of this unit.
3. Refer to the exploded view in Figure 18 while performing the remaining instructions.

⚠ CAUTION
Prevent Injury!

Refer to Figure 18. The pushrod is under spring pressure and will be accelerated out of the top or bottom of the valve body assembly if the activator assembly or bottom cap is removed. When unscrewing either the activator assembly or bottom cap, make sure these assemblies are kept in line with the valve body and moved away from the valve body very slowly in the vertical direction, until you feel the pressure is relieved from the pushrod. At this time hold the pushrod with one hand and then move the activator or bottom cap away from the valve body. * Do not try to remove either the activator assembly or bottom cap under any system pressure. System pressure must be at 0 psig on both sides of the valve before attempting any disassembly of this valve. Failure to slowly relieve spring pressure may result in minor to moderate injury.

4. Remove the actuator assembly from the valve body using large hex nut to turn.
5. Remove pushrod and check for excessive wear or scratches. The pushrod must move freely in the valve body.
6. Remove the bottom cap, spring and piston. Inspect these parts for foreign matter and physical damage.
7. Clean all parts with a suitable solvent and blow dry with clean compressed air.
8. To reassemble, carefully install the piston, spring and bottom cap. Be sure that the piston nose guides are on the inside diameter of the port.

The seating surface may be damaged if the piston is improperly installed.

9. Check that the sealing surfaces are free of foreign material or nicks that may prevent a leak-tight joint. Tighten the bottom cap approximately 1/8 turn past hand tight to seal the knife edge joint.
10. Place the pushrod in the valve body. Press the pushrod down to open the valve and insure proper piston installation. Approximately 8 ft.-lbs. are required to open the valve. If the valve cannot be opened, repeat steps 9 and 10.

    Clean with a suitable solvent, blow dry with clean compressed air and replace the pushrod in the valve body.
11. Before replacing the actuator assembly, be sure that all sealing surfaces are free of foreign material or nicks that may prevent a leak-tight joint. Carefully install the pushrod bonnet and thread the actuator assembly on

to the valve body until the sealing surfaces make contact. Tighten the actuator approximately 1/8 turn to seal the knife edge joint.

12. The motor cap quad-ring may be replaced by removing the ferrule motor cap nut.

Be sure that the motor cap does not rotate with the motor cap nut. The wires internal to the motor can be damaged.

13. When reassembling, be sure that the internal wires do not get crimped between the motor cap and motor housing
14. Pressurize the system and check for leaks.

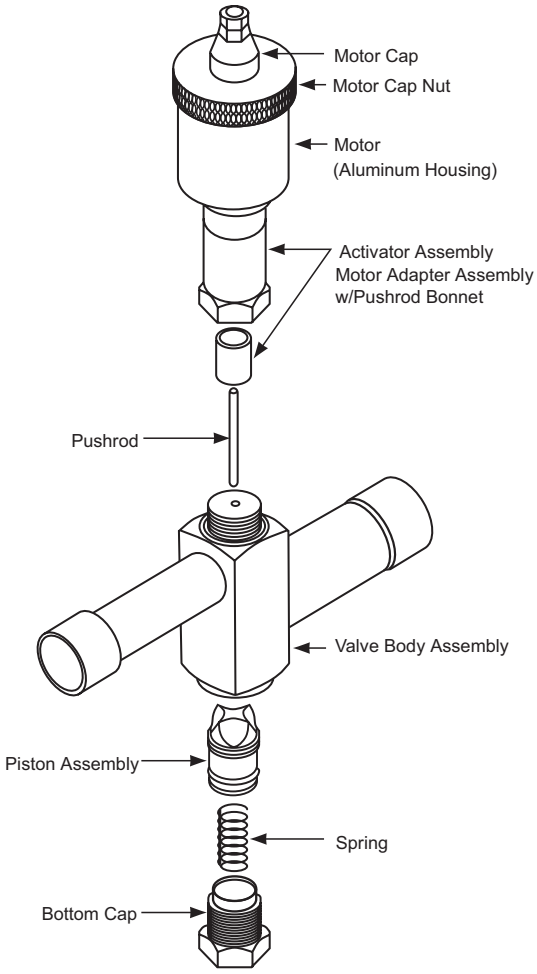


Figure 18 SEO Electronic Expansion Valve Exploded View

Module Power and Miscellaneous I/O

SEHI Electronic Expansion Valve Servicing
The procedures listed below are to. be followed for proper disassembly, inspection, cleaning and reassembly to the valve. The valve does not need to be removed from the refrigerant piping before servicing. If the motor is found to be defective the entire motor assembly must be replaced.

1. Before disassembly of the valve, be sure the refrigerant pressure in the system has been reduced to a safe level (0 psig) on both sides of valve. See RTAA-SB-10 for preferred refrigerant handling in this area.

⚠ WARNING
Hazardous Voltage w/Capacitors!

Disconnect all electric power, including remote disconnects before servicing. Follow proper lockout/tagout procedures to ensure the power cannot be inadvertently energized. For variable frequency drives or other energy storing components provided by Trane or others, refer to the appropriate manufacturer's literature for allowable waiting periods for discharge of capacitors. Verify with an appropriate voltmeter that all capacitors have discharged. Failure to disconnect power and discharge capacitors before servicing could result in death or serious injury.

Note: For additional information regarding the safe discharge of capacitors, see PROD-SVB06A-EN or PROD-SVB06A-FR

2. Disconnect all the line voltage to the power supply of this unit.
3. Refer to the exploded view in Figure 19 while performing the remaining instructions.
4. Unplug valve.
5. Using the appropriate wrenches or a vice to properly support the valve body, remove the motor assembly from the valve body by loosening the lock nut. To prevent permanent damage to the motor, DO NOT attempt to disassemble the motor housing.

NOTE: Regardless of whether the valve is in the system or in a vise, care must be taken to prevent distorting the valve parts when tightening.

6. Verify that the new motor assembly is in the "OPEN" position.
7. Lightly oil the threads and knife-edge on the new motor adapter. Carefully seat the adapter on the valve body.
8. Engage and tighten the lock nut. One eighth turn more than hand tight is sufficient to achieve a leak proof seal.
9. Pressurize the system and check for leaks.

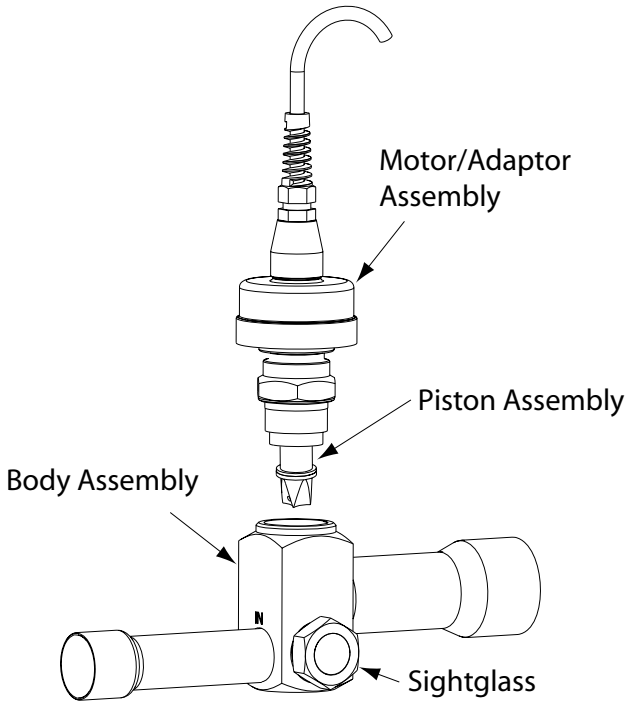


Figure 19 SEHI Electronic Expansion Valve Exploded View

Module Power and Miscellaneous I/O

SEO Valve Module

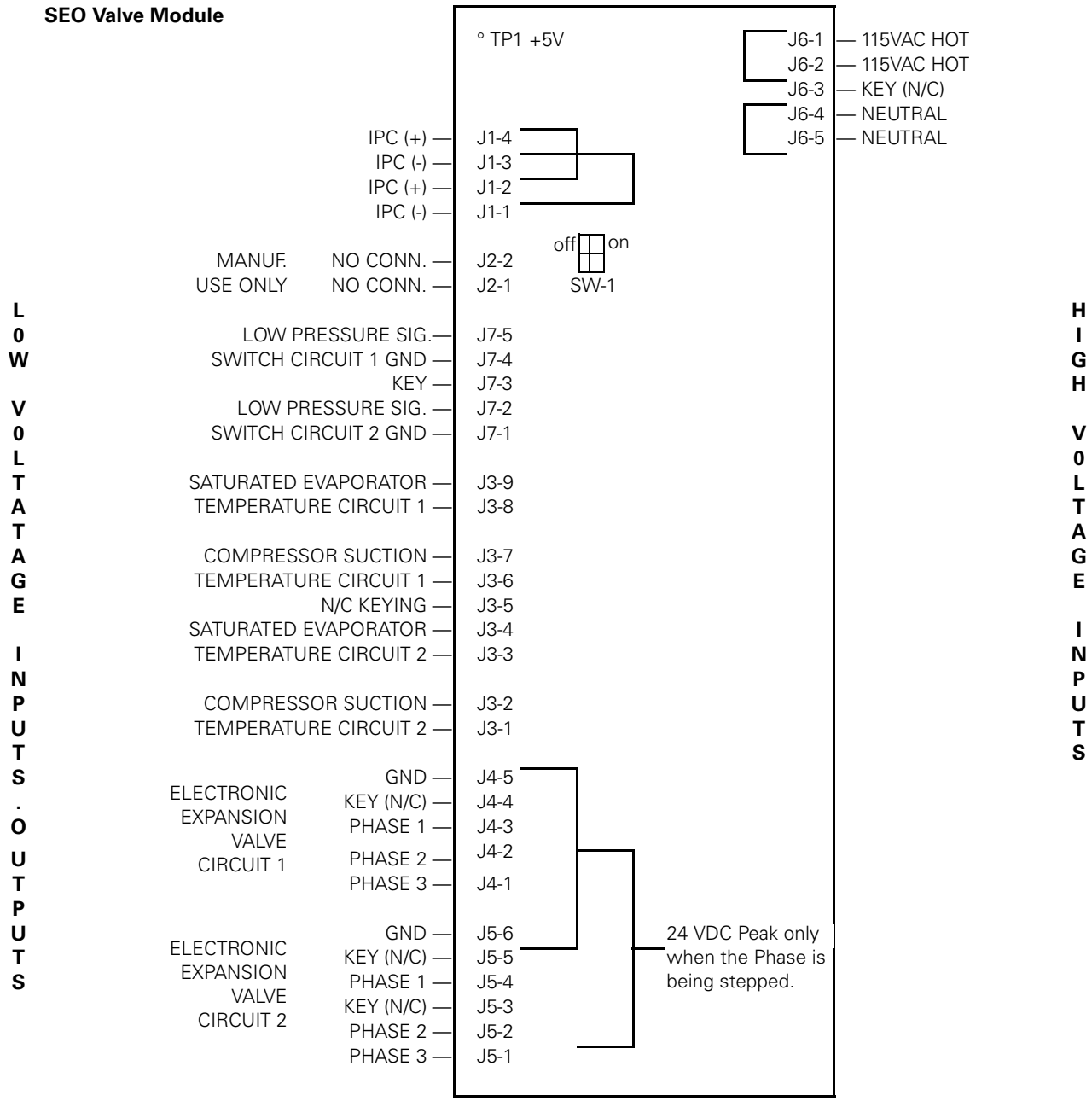


Figure 20 SEO Electronic Expansion Valve Module (1U3)

Module Power and Miscellaneous I/O

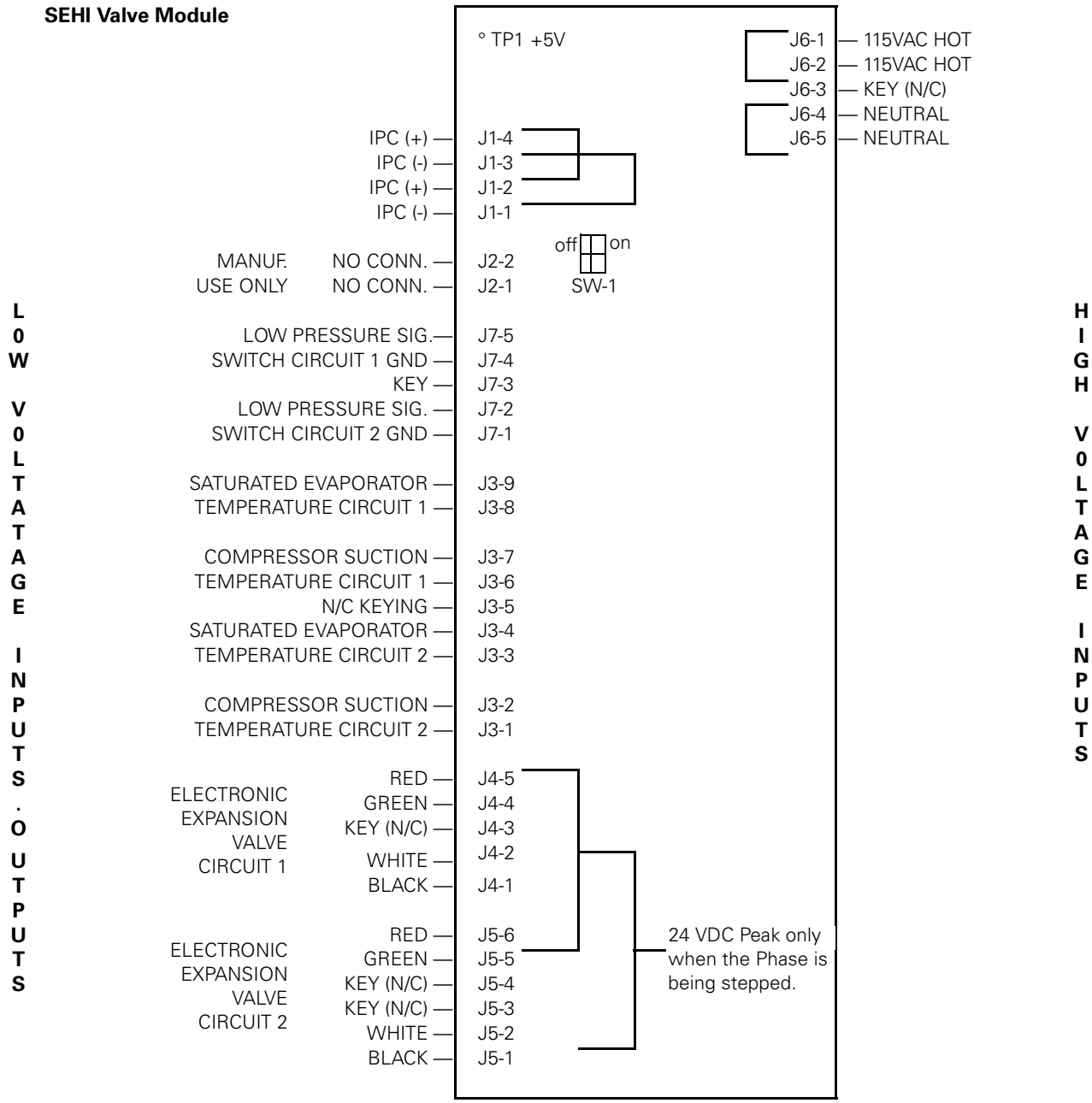


Figure 21 SEHI Electronic Expansion Valve Module (1U3)

I/0 terminals

For the checkout of the I/O, refer to the block diagram of the EXV module in Table 21 and the Chiller Wiring Diagrams for both high and low voltage circuits. All voltages are measured differently between terminal pairs

specified, unless otherwise indicated. The first terminal in the pair is the positive (or hot) terminal. Voltages given are nominals and may vary by ±5%. Unregulated Voltages (unreg) or 115 VAC voltages may vary by ±15%.

Table 21 EXV Module Normal Terminal Voltages

Terminal Designation	Description of Circuit	Normal Terminal Voltages for Various Conditions.
J1-4 to 3 or J1-2 to 1	IPC Communications	19.2 kbaud serial data, 5 volt signal level. Refer to Interprocessor Communication Link (IPC).
J2-2, 1	Manufacturing Address Use Only	+5 VDC No connection intended.
J3-9, 8	Saturated Evap. Rfrg. Temp. CKT 1	Refer to Temperature Sensor Checkout.
J3-7, 6	Compressor Suct. Rfrg. Temp. CKT 2	Refer to Temperature Sensor Checkout.
J3-4, 3	Saturated Evap. Rfrg. Temp. CKT 2	Refer to Temperature Sensor Checkout.
J3-2, 1	Compressor Suct. Rfrg. Temp. CKT2	Refer to Temperature Sensor Checkout.
J4-5[1]	EXV CKT1 GND	OVDC GND.
J4-3[1]	EXV CKT1 Phase 1	Between 0 and 1 VDC when the phase is not being stepped. When the valve is being stepped, this signal is actually a 24.2±17% VDC peak square wave with a period of 60 msec and a 1/3 duty cycle low (On) and 2/3 duty cycle high (Off). An averaging DC voltmeter can be used to measure this voltage. The meter will show fluctuations but the average should be approximately 8 volts.
J4-2[1]	EXV CKT1 Phase 2	
J4-1[1]	EXV CKT1 Phase 3	
J5-6[1]	EXV CKT2 GND	OVDC GND.
J5-4[1]	EXV CKT2 Phase 1	Same a CKT 1.
J5-2[1]	EXV CKT2 Phase 2	Same as above.
J5-1[1]	EXV CKT2 Phase 3	Same as above.
J4-1, 2, 4,5[2]	EXV CKT 1	10-12 VDC
J4-1, 2, 5, 6[2]	EXV CKT 2	10-12 VDC
J6-1 or 2 to J6-4 or 5	Input Power	115 VAC, Refer to Power Supply on page 41.
J7-5, 4	Low Pressure Switch, Circuit 1	Open = 12 VDC, Low Pressure Cutout Closed = 0 VDC, Normal
J7-2, 1	Low Pressure Switch, Circuit 2	Open = 12 VDC, Low Pressure Cutout Closed = 0 VDC, Normal

Note: On a power up or a front panel reset, the valve will always be driven closed for approximately 1000 steps. During this time, approximately 40 seconds, an alternating audible clicking sound can be observed on the valves

[1]*SEO Valve*

[2]*SEHI Valve*

Module Power and Miscellaneous I/O

Compressor Module (MCSP) (1U4 AND 1U5)

⚠ WARNING
Live Electrical Components!

During installation, testing, servicing and troubleshooting of this product, it may be necessary to work with live electrical components. Have a qualified licensed electrician or other individual who has been properly trained in handling live electrical components perform these tasks. Failure to follow all electrical safety precautions when exposed to live electrical components could result in death or serious injury.

Test Points
There are two test points associated with the MCSP module. They are easily read with a DC voltmeter by probing the PC board solder pads found in the upper left hand corner of the module. The positive meter lead should be connected to the pad while referencing the negative meter lead to the board edge ground plane.

NOTE: Don't use the aluminum module enclosure as a reference as it has an anodized surface with insulating properties.

The DC voltage shall be within the tolerance specified below. If not replace the module.

TP1: +5 volts DC ±5%

TP2: +12 volts DC ±5%

IPC Address Switch SW1
Refer to Troubleshooting Modules Using IPC Diagnostics on page 9.

Current Gain (or Overload) Dip Switch SW2
The Compressor phase current inputs on the individual MCSP modules are "normalized" thru the proper setting on this switch. The term "Compressor Current Overload setting" is actually a misnomer. Instead the setting should be thought of as an internal software gain that normalizes the currents to a % RLA for a given CT and compressor rating. The true nominal steady state overload setting is fixed at 132%.

The setting of the dip switch SW2 on each of the MCSP modules should match those of Table 18 for each compressor. Switch position SW2-1 is the Most Significant Bit. The decimal equivalent of this setting should also be verified in the Service Settings Menu, in the CLD display. If the programmed value does not agree with the dip switch setting for each of the MCSP's, an informational diagnostic will result. The compressors will be allowed to run, but default settings (the most sensitive possible) will be used for the internal software compressor current gains. Refer to Section 7 Current Transformer and Current Input Checkout for more details.

Module Power and Miscellaneous I/O

Binary Inputs
The binary inputs shown in Table 22 all use the same basic circuit. A pullup resistor to the 12V power supply is connected to the higher numbered input pin. The lower numbered pin is connected to ground. The voltage between the two pins is sensed by the microprocessor To check the input, measure the voltage between the two associated pins. With the external switch open, approximately 12 Vdc should be measured. With the switch closed, 0 Vdc should be measured.

Temperature Inputs
These inputs use Trane's standard thermistor,. an NTC device giving 10,000 ohms at 25 C (75 F). Refer to Temperature Sensor Checkout, Table 4, for a table of temperature vs., resistance vs. voltage.

Three measurements can be made:

1. With the probe connected, the voltage across the input terminals may be measured. The voltage should agree with the table values in the Temperature Sensor Checkout Procedure on page 15.
2. The probe may be disconnected from the module and its resistance measured. It should agree with the table values.
3. With the probe disconnected, the terminal voltage may be measured with a high impedance voltmeter. It should be between 4.975 and 5.025 Vdc. If the meter loads the input, a slightly lower voltage may be expected.

Refer to Temperature Sensor Checkout for more details.

Current Inputs
The following tests may be used to check a current input circuit:

1. With the compressor off, the AC voltage across the terminals with the current transformer connected should read 0 V The corresponding current as read on the CPM display should read 0.
2. With the compressor on, the AC voltage across the terminals should agree with the data of Table 8. The %RLA read on the CPM display will depend on the setting of the gain switch. If the gain switch is set to 11111, the percent CT rating values should agree with the display. For any other switch setting, the gain factor as found in Table 9 must be taken into account using one of the following procedures:

- Start with the displayed %RLA. Multiply by .67 and divide by the gain where the gain is found in Table 16. The result is the percent CT rating. Use this and the Table 8 to find the corresponding terminal voltage.
- Start with an actual current measurement (such as from a clamp-on ammeter). Determine which CTs are being used and use the Table 8 to find the corresponding terminal voltage and percent CT rating. Multiply the percent CT rating by the gain and divide by.67 to find the %RLA that should be displayed.

NOTE: If the MCSP gain switch and CPM gain setting do not agree, a diagnostic will be generated and the MCSP will continue operating using a default gain setting of 00000 (max gain). This will result in the MCSP thinking

Module Power and Miscellaneous I/O

the currents are higher than actual and will show up as an error in the %RLA displayed by the CPM. The compressor will operate safely but may unload due to the current limit function.

Refer to Current Transformers and Current Inputs for more details on operation and troubleshooting.

Isolated Binary Input: Winding Temperature
This input may be checked by disconnecting all wiring from the terminals and measuring the open circuit voltage. It should read between 10 and 15 Vac. A "Winding Temp. - Cprsr A or B" diagnostic should appear on the CPM's display depending on which compressor module it is. A jumper may then be placed across the input to short it out. After clearing diagnostics, the diagnostic should no longer be present. It a diagnostic continues to occur, the module needs replacement.

Relay Outputs
Compressor and Fan Control relays may be checked by measuring the voltage drop across the contacts. 115 Vac should be seen when the relay is off. 0 Vac should be seen when the relay is on. Before condemning a module for bad relays, make sure to check all diagnostics, power to the module, communications, and the state of the high pressure cutout. Refer to the units' schematic wiring diagram for the control circuitry.

Triac Outputs
The Load/Unload triacs may be checked by measuring the voltage from terminals E7 or E8 to 115 V neutral, with a load connected. The triacs operate in the high side and switch 115 Vac power from J7-1 to either E7 or E8 to turn on the appropriate slide valve solenoid.

When a triac is off, about 0 Vac should be measured on its terminal with the solenoid load connected. When it is on, the voltage should be close to 115 Vac (the drop across the triac is about 1-2 volts). Except during a start or stop, the triacs normally pulse on for short durations (as low as 40mS) once every 10 seconds. If chiller load is satisfied the triacs may not pulse. Because of this, it may be difficult to see the pulses on a meter. A low wattage 115 Vac test lamp may be of help.

The best time to check the unload solenoid is immediately after a power-up reset. For the first 30 seconds after applying power, the unload solenoid should be on continuously. The next best time to check it is after the compressor starts. For the first 30 seconds after a start, the unload solenoid should be on continuously.

Checking the load solenoid is more difficult. Shortly after a start, the compressor will usually start loading. If, however, water temperature is dropping rapidly enough, it will stay unloaded. It may take a while to begin seeing load pulses.

Refer to on page 36, for a more detailed procedure on how to accomplish the load / unload solenoid and slide valve check on the MCSP and associated compressor.

Module Power and Miscellaneous I/O

I/O Terminals

For the checkout of the I/O, refer to the block diagram of the MCSP module in Figure 22 and the Chiller Wiring Diagrams for both high and low voltage circuits. All voltages are measured differentially between terminal pairs specified unless otherwise indicated. The first terminal in the pair is the positive (or hot) terminal. Voltages given are nominals and may vary by ±5%. Unregulated Voltages (unreg) or 115 VAC voltages may vary by ±15%.

Table 22 Compressor Module Normal Terminal Voltages (1 U4 and 1 U5)

Terminal Designation	Description of Circuit	Normal Terminal Voltages for Various Conditions
J1-4 to 3 or J1-2 to 1	IPC Communications	19.2 kbaud serial data, 5 volt signal level. Refer to Interprocessor Communication Interface.
J2-2, 1	Manufacturing Address Use Only	+5 VDC No connection intended.
J3-7, 6	External Circuit Lockout	Open = 12 VDC: ckt lockout Closed 0 VDC: normal (ckt. lockout' only if feature is enabled in Service Settings) Must be jumpered if this feature is not used.
J3-4, 3	Transition Complete	Open = 12 VDC: pre-transition Closed = 0 VDC: transition complete (only used with reduced voltage starters)
J3-2, 1	Not Used	Must be jumpered.
J4-5, 4	Saturated Condenser Refrigerant Temp	Refer to Temperature Sensor Checkout.
J4-3, 1	Entering Oil Temperature	Refer to Temperature Sensor Checkout.
J5-7, 6	Phase A Current Transformer Input	Input for 100-400:0.1 Ratio CT using digital VOM in diode test mode open circuit input should read between 1.0 to 1.5 Volts. Refer to Current Transformer Checkout.
J5-5, 4	Phase B Current Transformer Input	Same as above.
J5-2, 1	Phase C Current Transformer Input	Same as above.
J6-1 or 2 to J6-4 or 5	Input Power	115 VAC, Refer to Power Supply in Module. Power and Miscellaneous I/O.
E3, E4	Compressor Motor Winding Temp Thermostat.	Internally powered Isolated input. Open = 16 Vac: high temp Closed = 0 Vac: Ok temp
E5 to	High Pressure	Externally powered isolation transformer input,
J6-4 or 5	Cutout Input	2 VA, 115 Vac 115 volts input: normal 0 volts: trip
E5, J7-3	Compressor Contactor Output	Normally open contact, closes for compressor start Uses same power input as High Pressure Cutout input above.
J7-1, E6	Crankcase Heater Output	Normally closed contact, powers crankcase heater when compressor is off.
J7-5,6	Transition Command Output	Normally open contact, closes to initiate Wye to Delta Starter transition if configured for Reduced Voltage start.

Module Power and Miscellaneous I/O

Table 22 Compressor Module Normal Terminal Voltages (1 U4 and 1 U5)

Terminal Designation	Description of Circuit	Normal Terminal Voltages for Various Conditions
J7-8,9	Step Load Solenoid	Normally open contact, closes to energize the Step Load Solenoid Valve.
J7-1, E7	Slide Valve Open (Load Solenoid) Output	Triac Output, Refer to Checkout Procedure for MCSP Load/Unload Outputs.
J7-1, E8	Slide Valve Close (Unload Solenoid) Output	Triac Output, Refer to Checkout Procedure for MCSP Load/Unload Outputs.
J8-1, 3	Fan Relay 1 Output	Normally open contact for Variable Speed Fan contactor control.
J8-1, 4	Fan Relay 2 Output	Normally open contact for fan contactor(s) control.
J8-1, 5	Fan Relay 3 Output	Same as above.
J8-1, 6	Fan Relay 4 Output	Same as above.
J9-6, 5	Variable Frequency Fan Output PWM	10 Volt Peak, 10 Hz fundamental. Its average value can be read with a DC voltmeter. Refer to Section 11 Variable Speed Fan System Trouble-shooting.
J9-4, 3	Variable Frequency Fan Fault Signal	Fault: 11 V (connector plugged on) No Fault: 0 VDC (connector plugged on) Refer to Section 11 Variable Speed Fan System Troubleshooting.
J9-2, 1	Not Used	N/A

Module Power and Miscellaneous I/O

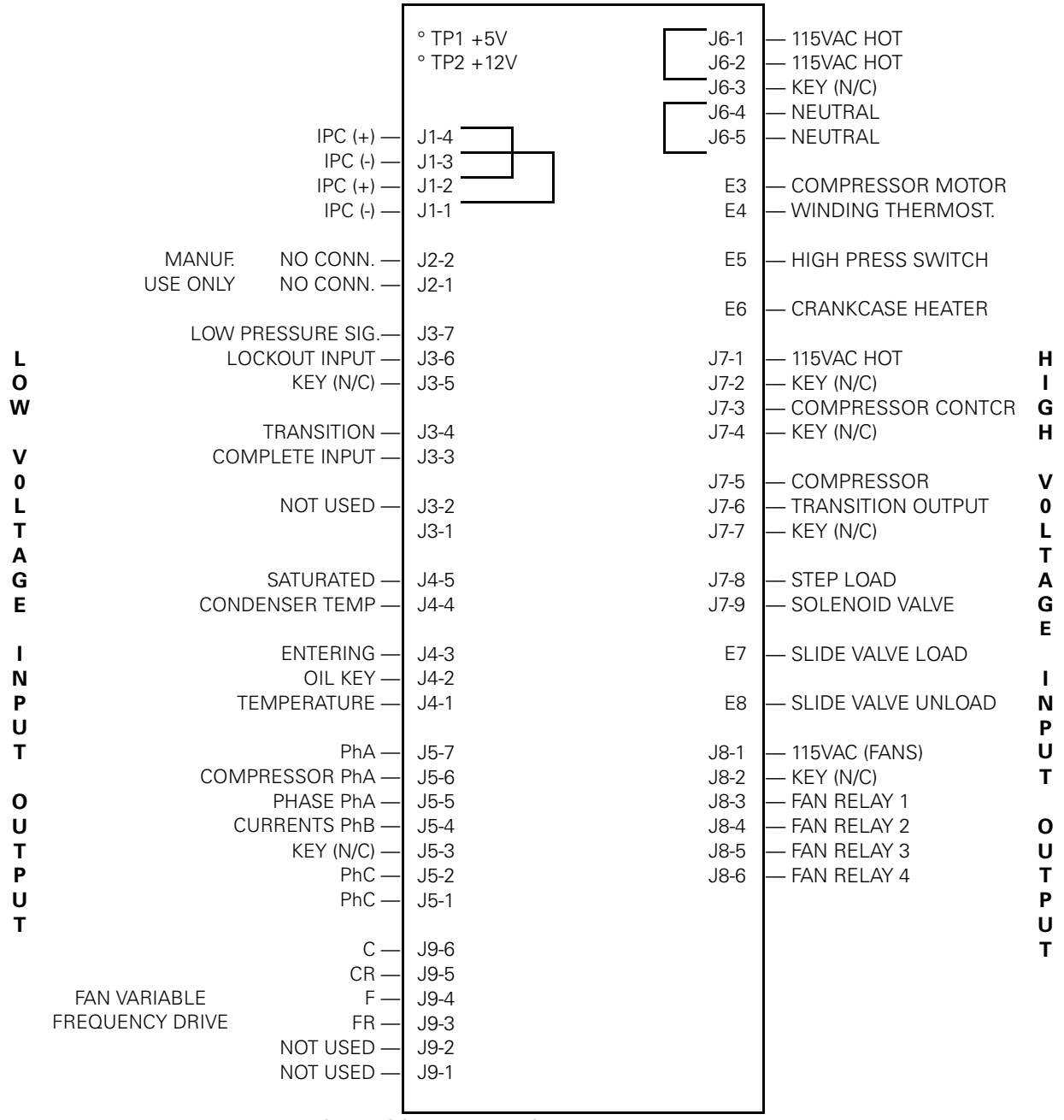


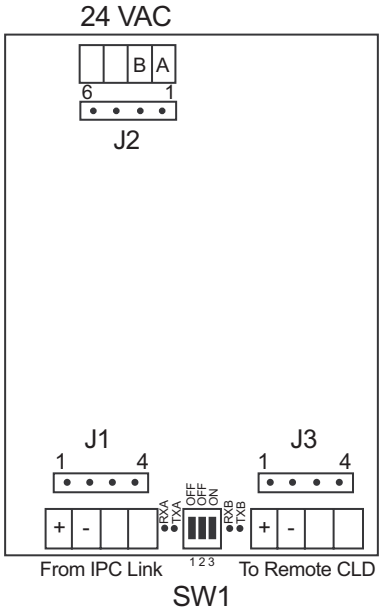
Figure 22 Compressor Module (MCSP) (1U4 and 1U5)

Module Power and Miscellaneous I/O

Interprocessor Communication Bridge Module (IPCB) (1U7)

The IPCB provides an extension of the IPC link to the Remote Clear Language Display. See Figure 23 It prevents "crashes" of the IPC and UCM if the link to the RCLD is shorted or misapplied. The IPCB receives and retransmits data to and from local to remote links. Therefore the data is available on either link.

SW1 should be set per the label on the IPCB. LEDs RXA, TXA, RXB and TXB should be constantly blinking, synchronously, in normal operation.



IPCB Nominal Terminal Voltages

J1-1,2 or J1-3,4	Local IPC	19.2K Baud, 5 V signal level
J2-1,2 or J2-3,4	Power	18-30 VAC, neither side grounded
J3-1,2 or J3-3,4	Remote IPC	19.2K Baud, 5 V signal level

Figure 23 IPCB Nominal Terminal Voltages

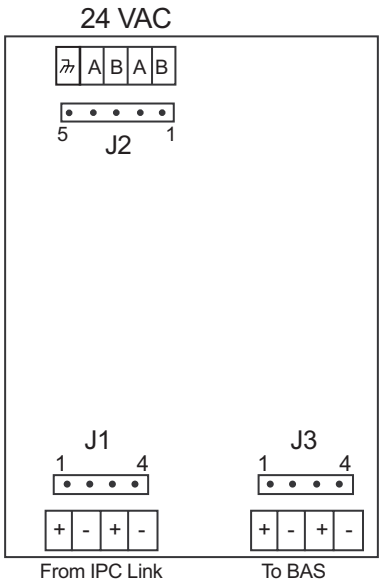
LonTalk® Communications Interface - Chillers Module (LCI-C) (1U8)

The Tracer LCI-C interface acts as a translator between Trane's IPC (Inter-Processor Communication) and Echelon's LonTalk® communications protocol (ANSI/EIA/CEA 709.1). This allows the chiller to communicate with building automation systems which also communicate using the LonTalk® protocol.

The LonTalk® communications protocol also allows for peer to peer communications between controllers so they can share information. Communicated setpoints have priority over locally wired inputs to the controller unless the controller is set to the "Local" control mode.

The LCI-C module provides connectivity to Trane's Rover® service tool for proper configuration of the LCI-C module.

Note: LonTalk® communication links are not polarity sensitive.



LCI-C Nominal Terminal Voltages

J1-1,2 or J1-3,4	Local IPC	19.2K Baud, 5 V signal level
J2-1,2 or J2-3,4	Power	18-30 VAC, neither side grounded
J3-1,2 or J3-3,4	BAS	19.2K Baud, 5 V signal level

Figure 24 LCI-C Nominal Terminal Voltages

Variable Speed Fan System

The purpose of this troubleshooting guide is to help technicians determine if the variable speed fan inverter, the compressor module, the variable speed fan inverter contactor, the fan motor or the interconnecting wiring is faulty.

⚠ WARNING
Hazardous Voltage w/Capacitors!

Disconnect all electric power, including remote disconnects before servicing. Follow proper lockout/tagout procedures to ensure the power cannot be inadvertently energized. For variable frequency drives or other energy storing components provided by Trane or others, refer to the appropriate manufacturer's literature for allowable waiting periods for discharge of capacitors. Verify with an appropriate voltmeter that all capacitors have discharged. Failure to disconnect power and discharge capacitors before servicing could result in death or serious injury.

Note: For additional information regarding the safe discharge of capacitors, see PROD-SVB06A-EN or PROD-SVB06A-FR

In this troubleshooting procedure, the components will be referred to by the descriptions below:

Description	Circuit 1	Circuit 2
Compressor Module	1U4	1U5
Variable Speed Fan Motor	3B2	4B2
Variable Speed Fan Inverter	6U9	6U10
Variable Speed Fan Inverter Contactor	1K9	1K13
Variable Speed Fan Inverter Fuses	1F18 - 1F20	1F21 - 1F23

Inverter Diagnostics

The Inverter has two LED's for diagnostic purposes. They are:

Power On LED: This green LED is illuminated any time that more than 50 VDC is present on the DC Bus Capacitors. Typically when power is removed from the TRANE AC INVERTER this LED will remain illuminated for up to 60 seconds while the DC Bus Capacitor Voltage discharges. This LED also indicates that the 5 VDC Supply Voltage on the TRANE AC INVERTER control board is present.

Alarm LED: When this red LED is illuminated constantly, it indicates that the motor is overloaded and the drive is about to fault on a motor overload. When the Alarm LED is flashing, it indicates the drive is faulted. By counting the number of times the Alarm LED flashes, the cause of the fault can be determined. The following table lists the possible fault conditions for the TRANE AC INVERTERS and the number of times the Alarm LED will flash:

Fault Condition	Number of Alarm LED flashes
Bus Overcurrent Fault	1

Variable Speed Fan System

Bus Overvoltage Fault	2
Motor Overload Fault	3
Low Bus Voltage Fault	4
PWM Generator Fault	5
Logic Fault	6
Stalled Motor Fault	7

Fault Descriptions

Bus Overcurrent Fault: DC Bus Current exceeds the drive rated peak current.

Bus Overvoltage Fault: DC Bus Voltage exceeds 400 VDC on 200/230 VAC input units or exceeds 800 VDC on 400/460 VAC input units.

Motor Overlad Fault: The drive operated in current limit (110 % of rated current) for a period of 60 consecutive seconds. If the motor current reduces to less than 110 % and the motor reaches commanded speed the overload timer will begin to count down.

Low Bus Voltage Fault: DC Bus Voltage is less than 200 VDC on a 200/230 VAC input unit or is less than 400 VDC on a 400/460 VAC input unit. If the motor is already running, this fault will not occur. Instead, the motor speed will be reduced to a speed that the proper voltage can be applied to the motor.

PWM Generator Fault: The drive failed to switch a PWM output properly.

Logic Fault: The Microcontroller in the drive executed an illegal instruction.

Stalled Motor Fault: Motor failed to accelerate to ½ the motor speed setpoint in 30 seconds.

Automatic Restart: If the drive should fault, the drive will automatically attempt one restart after a delay of 5 seconds. If the drive faults a second time, the drive will not attempt to restart and the fault must be cleared before the drive will run again.

Fault Clearing:

Drive Faults may be cleared by one of the following methods:

Removing and reapplying power to the controller.

Setting the speed control input duty cycle to less than 7% for 1 second.

Variable Speed Fan System

Troubleshooting Procedure

⚠ WARNING
Live Electrical Components!

During installation, testing, servicing and troubleshooting of this product, it may be necessary to work with live electrical components. Have a qualified licensed electrician or other individual who has been properly trained in handling live electrical components perform these tasks. Failure to follow all electrical safety precautions when exposed to live electrical components could result in death or serious injury.

1. Go into the "Machine Configuration Menu" by performing the following keystrokes: Service Settings, Previous, +, -, +, -, +, -, Enter. Check this menu to be sure that "Fan Control" and "Variable Speed Fan" are Enabled for both circuits. The "Fan Control" menu item was replaced with "Unit Type" on units built after September 1, 1994 (SN U94HXXXXX and later). Set "Unit Type" to RTA or RTU, which-ever applies. Be sure that "Variable Speed Fan" is Enabled for both circuits.
2. Verify that all inverter power and control signal wiring is correct for the affected circuit, using Figure 11-1 and Trane wiring diagram 2307-3328. The wiring diagram is found in the Unit Wiring Section of RTAA-IOM-4 or on the inside of the unit control panel door.
3. Attempt to start the compressor on the affected circuit. Twenty-five or thirty seconds prior to compressor start, the variable speed fan inverter contactor is energized. Be sure that this is heard. If not heard, attach an AC voltmeter from pin J8-3 to ground on the compressor module. Reset the control and look for a 115 volts reading on the voltmeter at pin J8-3, 25 to 30 seconds prior to compressor start. If this voltage is read but the contactor does not pull in, check for an open circuit in the contactor coil or an open circuit in the interconnecting wiring to the contactor.
4. Check the fan motor by completely bypassing the inverter. Disconnect power from the unit and remove the three-phase power wiring from the inverter. Connect it to the three-phase power wiring of the fan motor, using splice wires with 1/4 inch male quick connects on both ends. Re-apply power to the unit and reset the circuit being tested. Twenty-five or thirty seconds before the compressor starts, the contactor that would normally apply power to the inverter should pull in and the fan should run. If the fan does not run, check the line fuses and contactor contacts.
5. Disconnect power from the unit and reconnect the inverter module. At the same time, check for damaged wiring or loose quick connects on the inverter.
6. Re-apply power to the chiller and check the compressor module power supply, by reading the DC voltage levels from TP1 to the circuit board edge ground and from TP2 to the circuit board edge ground. TP1 and TP2 are found on the upper lefthand side of the compressor module. The voltage at TP1 should be +5 ± .25 VDC. The voltage at TP2 should be +12 ±

.6 VDC. If there is no voltage at either of these two test points, check the incoming 115 VAC between pins J6-1 (hot) and J6-5 (neutral) and check fuse F1, mounted on the upper right-hand corner of the circuit board. If the fuse is OK and the voltage between J6-1 and J6-5 is 115 VDC, but the TP1 and TP2 voltages are out of range, replace the compressor module.

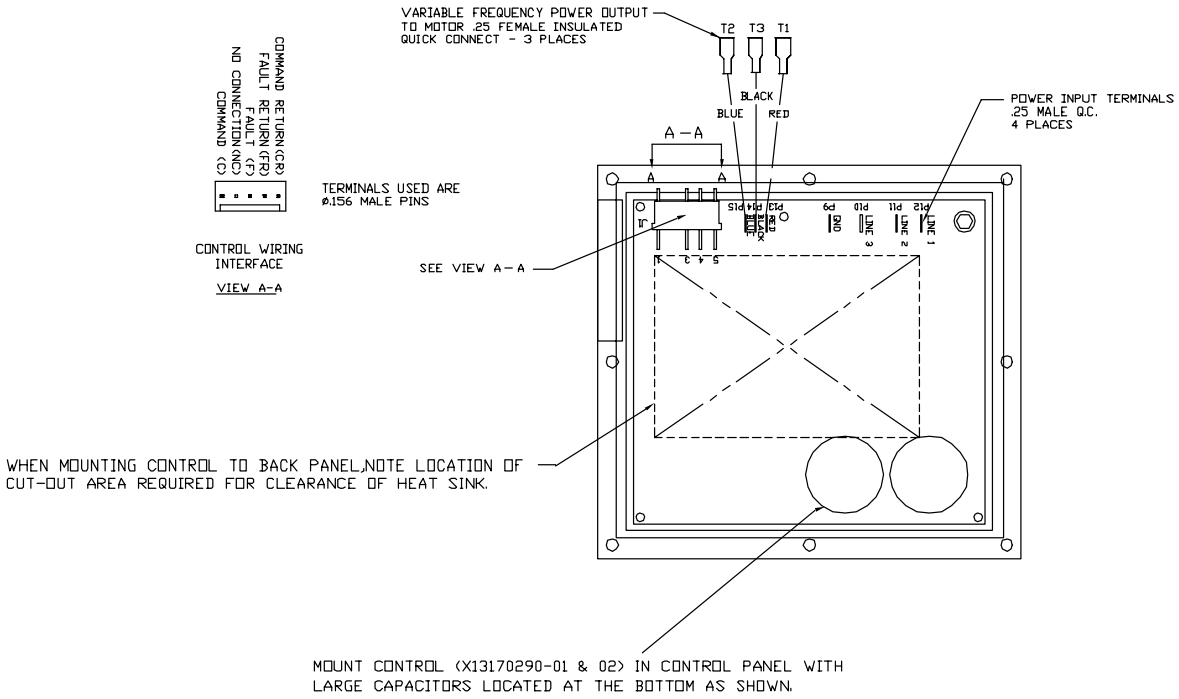


Figure 25 Variable Speed Fan Inverter

7. Remove connector P9 or P10 (whichever applies) from the inverter and place a jumper wire between terminals F and FR on the female connector. See Figure 11-1 for the location of these wires. This will prevent the control from reporting a fault diagnostic. Restart the unit and carefully measure the DC voltage between wires C (+) and CR (-) on the same female connector. The voltage should be 2 to 10 VDC when the compressor on the affected circuit is running. At compressor start, this voltage will start at approximately 2 VDC and gradually ramp up to about 10 VDC. This voltage level is directly proportional to fan speed. At 5 VDC, the fan should be running at 50% of full speed and at 7 VDC the fan should be running at 70% of full speed.

NOTE: The output from the compressor module is a pulse width modulated signal, 10 volt peak and 10 Hz. fundamental. It's average value can be read with a DC voltmeter.

8. Remove the jumper wire and reconnect connector P9 or P10. While the inverter is still powered, measure the DC voltage between pins J9-4 (+) and J9-3 (-) on the compressor module. The connector must be plugged

on at both ends while measuring this voltage. If the reading is between 11.5 and 12.5 VDC, two problems may exist:

- The inverter indicates that it has a fault by opening a semiconductor switch within the inverter. The inverter will send a fault signal to the UCM when:
  - It has gone through a self-shutdown. One cause of this could be high line voltage. A 10% high line voltage could cause a diagnostic trip.
  - The output frequency of the inverter is being internally limited to a less than 50% of the signal speed commanded by the UCM. Excessive fan motor current, high temperature or internal inverter failures could cause this to occur.
- There is an open circuit in the fault signal wiring, somewhere between the inverter and the compressor module.

If the reading is 2 VDC or less between pins J9-4 and J9-3, an inverter fault diagnostic for the affected circuit should not be displayed. But if the variable speed fan in still not working, check these two interconnecting wires from the compressor module to the inverter, to be sure they are not shorted. The inverter cannot send the compressor module a fault signal if these two wires are shorted together.

9. If all settings and voltages through Step 8 are acceptable and the fan does not operate, replace the variable speed fan inverter.

Other Service Features

Service Pumpdown

The UCM provides for a "onetime" Service Pumpdown mode, in which a service-technician can direct a particular compressor to start and run for one minute, to accomplish pumpdown of the low side of the refrigeration system (evaporator and EXV).

To aid in accomplishing this pumpdown, certain noncritical diagnostics will be ignored or disabled during this mode. Critical diagnostics such as those associated with motor protection, high pressure, and chilled water flow, will still be' enforced and may prevent or terminate the sequence.

Service Pumpdown Procedure

1. Place the Chiller in the Stop Mode using the Stop Button on the CLD and allow the Chiller, if currently running, to go through its shutdown sequence.
2. Manually close the liquid line shutoff valve on the circuit to be pumped down.
3. Use the CPM's Operator Interface to begin the mode specifically for the compressor/circuit you wish to pumpdown by selecting and "Enabling" it in the Service Tests Group. The CLD will then be displaying an Operating Code for Service.
4. The UCM shall then begin the start sequence (without restart inhibit) and turn on the selected compressor once the EXV has opened to its pre-position. The compressor shall run for a period of 1 minute at its minimum load and the condenser fans will stage under normal fan control. The UCM will automatically shut off the compressor and condenser fans, close the EXV, and return the chiller to the normal stop mode once the 1 minute timer has expired. The pumpdown sequence cannot be repeated again without a UCM power down reset.

NOTE: The unload solenoid is always kept energized for approximately 1 hour after any compressor shutdown and the oil sump heater is continuously energized.

5. Manually close the discharge line shutoff valve and the oil line shutoff valve.
6. Remove all power to the chiller and service as required.

Other Service Features

⚠ WARNING
Hazardous Voltage w/Capacitors!

Disconnect all electric power, including remote disconnects before servicing. Follow proper lockout/tagout procedures to ensure the power cannot be inadvertently energized. For variable frequency drives or other energy storing components provided by Trane or others, refer to the appropriate manufacturer's literature for allowable waiting periods for discharge of capacitors. Verify with an appropriate voltmeter that all capacitors have discharged. Failure to disconnect power and discharge capacitors before servicing could result in death or serious injury.

Note: For additional information regarding the safe discharge of capacitors, see PROD-SVB06A-EN or PROD-SVB06A-FR

NOTE: If it is necessary to service the circuit/ compressor while allowing the opposite circuit to start and run, first temporarily disconnect all power to the chiller and then disconnect all control power connections to the compressor and associated controls, by pulling off all the control power voltage connectors on the right hand side of the associated MCSP module. Control power to the associated contactor should also be disconnected, as should the power lead(s) to the high pressure switch at the control power terminal block. Repower the chiller, and lockout the circuit you are servicing by entering the Service Tests Menu and enabling CIRCUIT LOCKOUT for the desired circuit. Placing the chiller switch into the Auto mode will then allow the opposite circuit to run.

7. Return all valves to their normal position. temporarily remove all power and reconnect all wiring when servicing is completed.
8. Reset the chiller to clear diagnostics (and diagnostic history if desired) to resume normal operation.

COMPRESSOR TEST

The UCM provides for a Compressor Test feature which is designed to allow a service-technician to direct a particular compressor to be the next compressor to stage on, run and modulate. This allows the temporary override of the lead/lag sequencing currently in effect and relieves the technician from forcing staging of compressors thru load or setpoint changes. It is important to note that invoking this feature does not put the chiller into any kind of override "mode" and no action is required to return to "normal operation". The chiller will continue to run normally and the current lead/lag sequence will again be in effect, once the selected compressor has started. This feature is used in the Slide Valve Checkout Procedure detailed in Slide Valve Checkout Procedure.

Invoking Compressor Test

1. With the Chiller in the Auto Mode, regardless of whether or not other compressors are currently running, use the CLD to enter the Service Tests Menu and enable the COMPRESSOR TEST for the appropriate compressor. The selected compressor will automatically stage on, once the anti-recycle or restart inhibit timer is satisfied and the EXV is preposi-

Other Service Features

tioned (if not already controlling). Most often the stage-on will be accompanied by a controlled stage-off of an already running compressor. Since normal operation is in effect, a constant load or setpoint change may be required to keep the compressor from staging off later.

Circuit Lockout

The UCM provides for a circuit lockout feature which prevents the compressor(s) of the selected refrigeration circuit(s) from starting or- running. If currently running, the compressor(s) and circuit will go through a controlled shutdown. This lockout can be initiated with either an external hardware interlock on either MCSP of a given circuit or can be invoked through the CLD.

Invoking Circuit Lockout

To invoke circuit lockout manually, simply enter the Service Tests Menu and move to the CIRCUIT LOCKOUT display, and "enable" the circuit lockout for the appropriate circuit. Circuit Lockout can then be verified in the Chiller Report under "Circuits Locked Out". The circuit will remain locked out until manually "disabled" at the same place in the menu.

To use an external hardwired interlock to accomplish lockout, refer to the IOM or system wiring diagrams for the field installed interlock connections. The external interlock feature must also be "enabled" in the Service Settings Menu. (Open = normal, and closed = locked out).

Circuit Diagnostic Reset

The UCM provides for a Circuit Diagnostic Reset feature which unlike the Chiller Reset, does not require a complete chiller shutdown to clear CMR diagnostics. By using this feature it is possible to service and restart a circuit that has been latched out on a circuit diagnostic while allowing the alternate circuit to remain on-line making chilled water.

Invoking Circuit Diagnostic Reset

Using the CLD, enter the Diagnostic Menu, and "enable" circuit reset on the appropriate circuit. This will clear all latching diagnostics for that circuit (but will not remove them from the historical list. Clearing the History list can be accomplished when compressors are running, by entering the Diagnostic Menu and scrolling to the CLEAR DIAGNOSTIC HISTORY display). Press Enter to clear the historical diagnostics.

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