Diagnostic Troubleshooting Repair

RTHC

Control Operation, Setup and Troubleshooting for RTHC Units with UCP2 Controls

Order No: **RTHC-SVD01B-EN** Date: August 2002

Pueblo Built Units Only

Introduction

The purpose of this bulletin is to provide control operation and general troubleshooting information on the RTHC Water Chillers with the UCP2 control panel. Additional information on the UCP2 is located in the RTHC-IOM. It is recommended that the service technician be familiar with the UCP2 operation prior to servicing the microprocessor.

NOTICE:

Warnings and Cautions appear at appropriate sections throughout this manual. 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.

Discussion

This bulletin is intended to serve as a supplement to the RTHC-IOM, the installation, operation and maintenance manuel for all RTHC units. Subjects covered in this bulletin are intended to provide more comprehensive information for the RTHC units.

Units Affected

This bulletin pertains to any RTHC unit built in Pueblo.

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Section 1 Overview

1-1. General

The Unit Control Modules (UCMs) described in this troubleshooting guide provide a microprocessor based refrigeration control system, intended for use on the RTHC units. The table below describes the various modules used.

Table 1-1: Unit Control Module Designations

Line Drawing Designator	Controller Name
1U1	UCM Chiller Module
1U2	UCM Starter Module
1U3	UCM Stepper Module
1U4	Clear Language Display
1U5	UCM Options Module (optional)
1U6	TCI-IV Comm 4 (optional- Tracer Summit) or Comm 3 (optional - Tracer interface)
1U7	Printer Interface (optional)
4U1	Adder Subtractor Module for Optional Condenser Water Regulating Valve

1-2. Service Philosophy

The intent of the troubleshooting bulletin 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 in a process of elimination. Once a problem has been traced to a module, the module can easily be 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 voltage. Replacement of the 1U1 is more involved due to the numerous configuration and set-up items that need to be reprogrammed into UCP2.

If a module is requested to be returned, it is helpful to include with the returned module a brief explanation of the problem, the unit serial number, sales office, job name, and a contact person for possible follow-up. The note should be slipped into the module enclosure. Early and timely processing of field returns allows for immediate reaction by our quality assurance department. Return the modules as specified by the local parts department or Technical Service.

1-3. System Description

UCP2 control consists of a modular design partitioned by major functions. All modules communicate with each other through the IPC (interprocessor communication or twisted pair) link. Each microprocessor based control module is described below.

1-3 a. 1U1 - UCM Chiller Module

The Chiller module is the main module, communicating commands to other modules and collecting data/status/diagnostic information from other modules over the IPC link. The Chiller module performs the leaving chilled water temperature and limit control algorithms controlling the load against any operating limits that occur. The 1U1 checks for valid setpoints. The non-volatile memory (NOVRAM) allows UCP2 to retain setpoints through a power loss and is contained in the 1U1 module. Some of the inputs and outputs of the 1U1 are evaporator and condenser water temperature, evaporator and condenser water pump control, status and alarm relays, external auto/stop, and emergency stop.

1-3 b. 1U2 - Starter Module

The Starter module controls the starter while starting, running and stopping the compressor. The Starter module provides interface to, and control of, the Y-Delta and Solid State Starters. The Starter module also provides protection to both the compressor and motor through running overload, phase reversal, phase loss, phase unbalance, starting overload and momentary power loss diagnostics.

1-3 c. 1U3 - Stepper Module

The Stepper module is designed to drive the stepper motor on the electronic expansion valve. It also receives the input from refrigerant temperature sensors and the Liquid Level sensor.

1-3 d. 1U4 - Clear Language Display

The Clear Language Display provides a display of chiller data and access to the operator. This allows for control, setpoint adjustments and chiller set-up information. All information is then stored in non-volatile memory located in the Chiller module.

1-3 e. 1U5 - UCM Options Module

The Options module satisfies control or interface requirements for a number of options. Options support either additions or modifications to the chiller itself. Some of the features supported by the Options module are Ice Making, External Chilled Water Setpoint and External Current Limit Setpoint and Generic BAS interface.

1-3 f. 1U6 - TCI Comm 3 or TCI Comm 4

The TCI Comm 3 is a 1200 Baud isolated communications link to Tracer.

The TCI Comm 4 is a 9600 Baud non-isolated communications link to Tracer Summit.

1-3 g. 1U7 - Printer Interface

The Printer Interface module provides a preformatted chiller log output, as specified by ASHRAE 3, to a serial printer. The Printer Interface can be programmed through UCP2 to print a report from a command, at the time of a diagnostic and/or on a periodic basis.

1-3 h. 4U1 - Adder Subtractor Module for Optional Condenser Water Regulating valve.

This module is an additional controller required to operate the optional water regulating valve. UCP2 does not have the software capabilities to operate a water regulating valve; therefore an additional controller is required to monitor the system pressure and adjust the position of the valve accordingly. The 4U1 is not a part of UCP2. It is an external component to UCP2 and thus there is no interface.

Section 2 Menu Item Description

2-1. General

UCP2 has several added features that are new to the Series R product line. Some of those features are self-explanatory or were already discussed in the RTHC-IOM. Those will not be discussed below. Other items are not self-explanatory, those items are discussed below.

2-2. Restart Inhibit Timer

High motor temperatures are avoided through using an embedded simulation of the motor temperature based on an assumed amount of heat added at start as well as cool down rates (heat dissipation) for both running and stopped modes. This predicted temperature is then utilized in establishing the restart inhibit time so that the motor does not overheat.

The RTHC controls do not accommodate analog motor winding temperature inputs.

The RI Timer shall be set based on a Background Timer (BT) that is incremented by XX minutes (Value equal to the Motor Heating Constant) at every start. UCP2 models the temperature continuously including the effects of the energy or heat dissipated in the motor at startup as well as the cooldown rates for both operating and nonoperating modes. The BT is timed out on a basis of 1 second per second while the chiller is running. When the chiller is not running, the background timer is decremented by 1 second every 5 seconds. The Background Timers current value is immediately stored nonvolatily upon detection of imminent power loss and held until the reapplication of power. Unlike the Restart Inhibit Timer, the Background Timer is not resettable from any menu.

The Background Timer is incremented at compressor start by the “Motor Heating Constant”, and is adjustable at the Human Interface in the Machine Configuration Menu from 0 to 100 Minutes.

Table 2-1: Restart Inhibit Parameters

Parameter	Value
Adjustment range of Motor Heating constant	0-100 minutes
Default of Motor Heating constant	5 minutes.
General RI Timer Equation	RI = BT - 8 Minutes
Minimum RI Timer	30 Seconds
Maximum RI Timer (Adjustable setting)	5 to 20 Minutes
Default Factory Setting of Maximum RI Timer	5 Minutes
IFW Diagnostic Threshold	RI Timer = 15 Minutes

The recommended motor heating time constants are a function of compressor size.

Table 2-2: Motor Heating Constant

Compressor Size	Motor Heating Constant (minutes)
B1/B2	3
C1/C2	4
D1/D2/D3	5
E3	5

The initial value of RI Timer is based on the background timer by the equation RI = BT - 8.0 minutes and is re-calculated immediately on power up, and just after each start (once the BT is incremented by the Motor heating Time constant). Once the initial value is set, the RI Timer continues to timeout during all modes of operation.

The initial RI Timer never is allowed to be less than 30 seconds nor any higher than the Maximum value as set in a Field Startup Menu (adjustable from 5 to 20 minutes). The initial value of the RI Timer shall be clearable to 30 seconds in the Service Settings Menu. If the initial RI Timer ever exceeds 15 minutes, an IFW diagnostic is generated, warning the operator of a system problem that needs attention.

Any other pre-start system timers overlap with the RI Timer so as to anticipate it's timeout and permit start of the compressor at or shortly after RI Timer timeout. Any EXV prepositioning, for example, is run in parallel with the last seconds of the RI Timer.

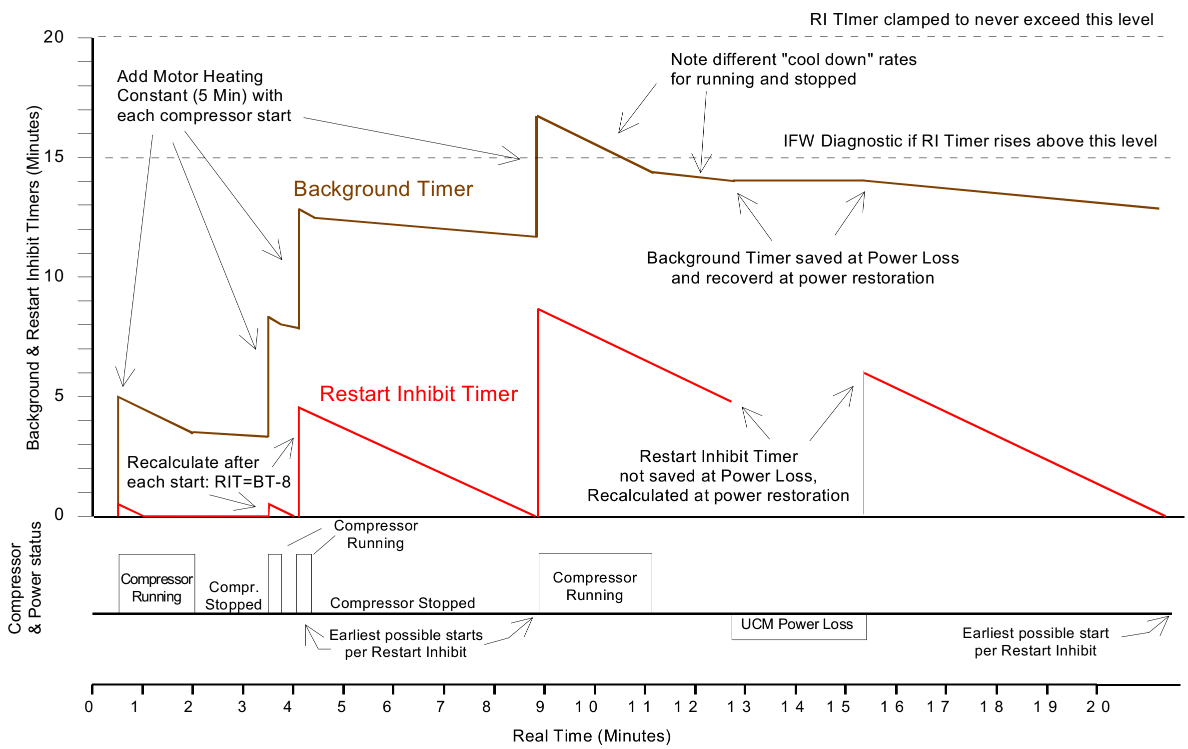

Figure 2-1 Restart Inhibit Timer

When the Restart Inhibit Timer is the overriding criteria holding the chiller off, the UCM will display this as a mode and display the remaining minutes: seconds remaining on the Restart Inhibit Timer.

Unlike other UCP2 applications, for RTHC, the Restart Inhibit Timer is not automatically set at 30 seconds following either a software or hardware reset. It is instead recalculated from the Background Timer's value which was saved nonvolatile with the previous removal or loss of power and recovered upon power restoration. This is necessary due to the lack of any winding temperature sensor to confirm that the motor is not too hot to start again.

Comment: This method would normally permit two starts in rapid succession and a third start 9 minutes after the second (Assuming 1 minute Run Times and a 5 minute motor heating constant). After the third start the motor would be permitted to cool. This method:

- Approximates current practice in the field (e.g. can do three starts in a row and wait after that)
- Models a fixed amount of energy put into the motor and starter each time it starts with increasingly greater cooldown periods after successive starts.
- Usually Permits rapid restart after a Momentary Power Loss, but only if Background Timer was less than 8 min. 30 seconds when power was lost. The Background Timer does not continue to count down while power is lost to UCP2.

Example of this Method using the following settings
Motor Heating Constant = 5 minutes
Max. RI time = 20 Minutes
See Figure 2-1

The restart inhibit timer is used as short cycling protection. This feature in UCP2 uses a different logic than the UCP1 controllers used on the RTHA units. UCP2 uses a background timer (BT) as well as the motor winding temperatures to determine how quickly the compressor can be cycled back on.

2-3. Soft Loading

When soft loading is enabled, it slows the rate of loading at start-up. Soft loading is factory set as disabled.When disabled, the compressor will load up as fast as needed to allow the chiller to reach setpoint. In situations where frequent cycling is an issue, soft loading can be enabled to slow the pull down process.

The items that can be set in UCP2 are:

Located in Service Settings, Field Start-up Group (++--++)

- Soft Load Control (Enable/Disable)
- Soft Load Starting Current Limit (40-100%)
- Soft Load Current Limit Rate of Change (0.5 to 5%/min.)
- Soft Load Leaving Water Temperature Rate of Change (0.5 to 5 F/ min.)

Factory Defaults:

- Soft Load Control (Enable/Disable) = Disable
- Soft Load Starting Current Limit (40-100%) =100%
- Soft Load Current Limit Rate of Change (0.5 to 5%/min.) =5%
- Soft Load Leaving Water Temperature Rate of Change (0.5 to 5 F/ min.) =5

For example, if soft load control is enabled.
Soft load starting current limit is set for 40%.
Soft load current limit rate of change is set for 5%/min.
Soft load leaving water temperature rate of change is set for 5 F/min.

The chiller will start and load normally (i.e.: as fast as needed) until the soft load starting current limit (40%) is reached. At this point, UCP2 will monitor both the current draw and the leaving water temperature ensuring that neither exceed the rate of change set in the menu (5%/ min. and 5 F/min. respectively in this example).

2-4. External Base Loading

Base loading is a control feature used to load the chiller at a constant rate, in an open loop fashion. This feature, working in conjunction with the chiller's limit controls, can force the chiller to a specified operating point by appropriately setting limit set points. The unit can then be held at this operating condition indefinitely, as long as sufficient load exists. Such a feature is typically used to force one or more chillers on a multiple chiller water loop to operate at a specified condition. The base loading control feature can only be enabled or disabled by a higher level building management system. There is no front panel means to start base loading control. Differential to start and stop are still enforced.

2-5. Start to Transition Timing Logic

For ElectroMechanical Staters, the Start-to-Transition timing and logic will be based on the motor current decreasing to below 85% RLA. At this time UCP2 times out 1.5 seconds and then transitions. The exception to this rule is a Fixed Minimum Transition Time of 1.6 seconds; the starter shall never be transitioned at less than 1.6 seconds from start. If at 1.6 seconds the current is less than 85% RLA, UCP2 transitions immediately.

For Solid State Starters, the phase currents cannot be expected to rise above 85 percent RLA prior to 1.6 seconds following the closing of the “Start” contact and remain above 85 percent RLA until the compressor motor has come up to speed. The “Up-to-Speed” contact operation cannot be tied to the motor currents falling below 85% RLA. Therefore, regardless of motor current, the “Up-to-Speed” contact closure input is expected to close before the Maximum Acceleration Timer times out, otherwise an MMR diagnostic occurs.

The Starting Overload is a timing function based on the Maximum Time to Transition permitted for a particular motor; this criteria requires that the motor can withstand a locked rotor condition for a particular starting method for the Maximum Transition Time. Therefore, UCP2 provides field adjustable Maximum Acceleration Timers. If the starter is not transitioned within the Timer Setpoint, there are two possible outcomes based on a Second Setting:

1. The starting sequence is aborted, the starter is de-energized, and a Latching Diagnostic (MMR) is generated.
2. The starter is transitioned (“thrown across the line”) and an Informational Diagnostic (IFW) is generated.

UCP2 also provides a setting to either “Shutdown” or “Transition” the Starter if the Maximum Acceleration Timer Times out.

The items that can be set in UCP2 are:

Located in Service Settings, Machine Configuration Group (+-+-+-)

- Maximum Acceleration Timer #1 (2- 64)
- Maximum Acceleration Timer #2 (191 - 253)
- Acceleration Time Out Action (shutdown, transition)

Factory Settings:

- Maximum Acceleration Timer #1 = 6
- Maximum Acceleration Timer #2 = 249
- Acceleration Time Out Action = Transition

2-6. Leaving Water Temperature Control

Rather than having one setting for the leaving water temperature (LWT) control response, UCP2 has a separate setting for the three parts of the PID (Proportional, Integral, Derivative) algorithm.

The items that can be set in UCP2 are:

Located in Service Settings, Field Start-up Group (++--++)

- LWT Proportional Gain Setpoint (0-100% /F)
- LWT Integral Gain Setpoint (0-1% /F)
- LWT Derivative Gain Setpoint (0-1000%/F)

Factory Settings: The LWT settings are dependent on the unit size. Refer to the RTHC-IOM for the correct settings.

It is strongly recommended that the factory defaults listed in RTHC-IOM be used without adjustment.

2-7. EXV Settings

The Electronic Expansion Valve (EXV) regulates the flow of refrigerant into the evaporator, to match the compressor capacity (mass flow rate). Refer to Figure 2-2 for a diagram of the EXV. This provides increased part load efficiencies. The EXV modulates off of the evaporator liquid level. If the liquid level is below 0.0”, the EXV is commanded to open. If the level is above 0.0”, the EXV is commanded to close.

The item that can be set in UCP2 are:

Located in Service Settings, Machine Configuration Group (+-+-+-)

- EXV Size (01-04)

Factory settings: The EXV size is dependent on unit size. Refer to RTHC-IOM-1C for correct settings.

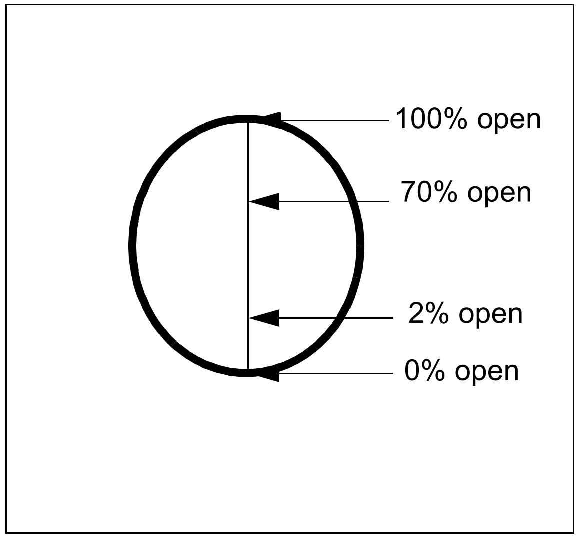

Figure 2-2 Diagram of EXV Steps

2-8. Liquid Level Control

On RTHC units the EXV controls off of the liquid level sensor in the evaporator rather than the discharge superheat. The liquid level sensor is required to provide input necessary for the control of the EXV. As the liquid level in the evaporator exceeds the optimum level the EXV will begin to close. As the liquid level value drops the EXV will begin to open.

The liquid level sensor (see Figure 2-3) only has a readable range from +1.0 to -1.0 therefore, it is mounted at different elevations on the various evaporators to give an optimum level read out on the UCP2 of 0.0 inches on all evaporator sizes.

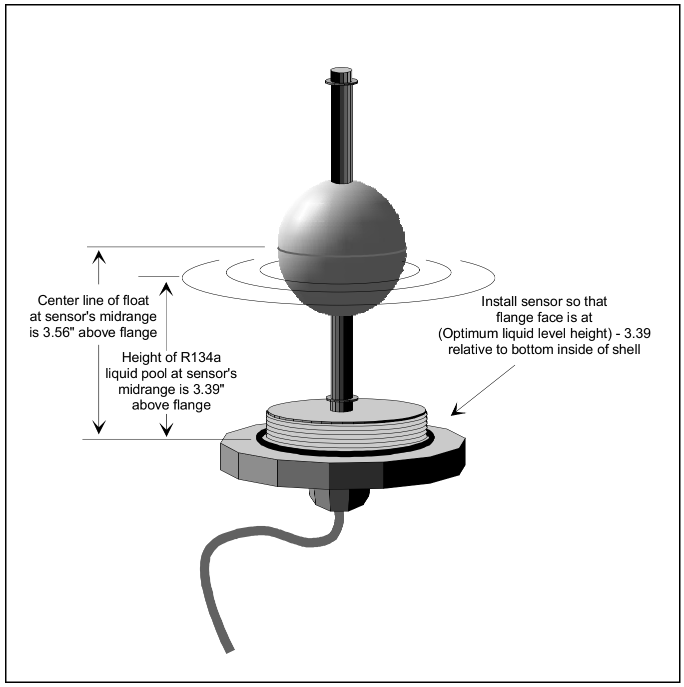

Figure 2-3 Liquid Level Sensor

Section 3 Temperature Sensors

3-1. General

All of the temperature sensors used on UCP2 are negative temperature coefficients (NTC) thermistors and located in thermal wells. The thermistors all have a base resistance of 10 Kohms at 77 F (25C) and display a decreasing resistance with an increasing temperature. UCP2 reads the temperature by measuring the voltage developed across the thermistors in a voltage divider arrangement with a fixed internal resistance. The value of the “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 UCP2 to indicate the appropriate sensor. In most cases, an open or short will cause a MMR diagnostic that will result in a machine shutdown.

3-2. Sensor Checkout Procedure

All temperature sensors on the RTHC units are in thermal wells. Cycle the chiller off prior to testing the sensors.

1. Remove the sensor of concern from the thermal well.
2. Place the sensor, while still connected to the UCP2, in an ice bath.
3. Monitor the UCP2 and record which sensor reading approaches 32 F.
4. With the sensor in an ice bath, the read-out on the front panel display should approach 32 F.
5. If the sensor is wired correctly but does not approach 32 F follow the steps below.
6. Re-install the sensor in the well with a suitable heat transfer paste.

NOTE: Heat transfer paste must be used on all sensors for an accurate reading.

7. Measure the temperature at the sensor with an accurate thermometer.
8. Record the temperature reading observed.
9. With the sensor leads connected to UCP2 and UCP2 powered,

measure the DC voltage across the sensor leads at the terminal or probe the screws on the Phoenix connector.

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

10. Locate the appropriate sensor table and then compare the temperature in the table corresponding to the voltage reading recorded in step 9 with the actual temperature observed in step 8. If the actual measured temperature falls within the allowable tolerance range, both the sensor and the UCP2 input circuits are operating properly. However, if the actual temperature is outside the allowable sensor tolerance range, proceed with step 11.
11. Again measure the temperature at the sensor with an accurate thermometer; record the temperature reading observed.
12. Remove the sensor leads from the terminal strip or unplug the respective Phoenix connector. Measure the resistance of the sensor directly at the sensor leads or probe the Phoenix connector with a digital volt-ohmmeter. Record the resistance observed.
13. 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 should be replaced.
14. Select the appropriate sensor table and locate the resistance value recorded in step 12. Verify that the temperature corresponding to the resistance value matches the temperature measured in step 11. The values should fall within the tolerance ranges noted in the table.
15. If the temperature sensor is out of range, the problem is either the sensor, wiring, or the Phoenix connector. If the Phoenix connector is used and the thermistor reads open, first disconnect the leads from the Phoenix connector. Remove a small amount of insulation on the leads and repeat the measurements directly. Once the fault is isolated, install a new sensor, connector or both.

16. A decade box or resistor can be substituted for the sensor and any sensor table value used to relate the resistance to the temperature. By removing the Phoenix connector plug and applying the resistance to the proper pin terminals, the temperature, as sensed by UCP2, can be confirmed. Use the CLD to confirm that the input of the decade box or resistor matches the resistance tables.

Table 3-1: Entering and Leaving Evaporator Water Temperature Sensors

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)
15	54635	3.42	57	16584	1.99	99	5958	0.9657
16	52987	3.39	58	16151	1.96	100	5825	0.95
17	51393	3.35	59	15736	1.93	101	5694	0.93
18	49852	3.32	60	15333	1.90	102	5567	0.91
19	48361	3.29	61	14942	1.87	103	5444	0.90
20	46920	3.25	62	14562	1.84	104	5324	0.88
21	45525	3.22	63	14193	1.81	105	5206	0.86
22	44176	3.18	64	13835	1.78	106	5092	0.85
23	42871	3.15	65	13487	1.75	107	4980	0.83
24	41608	3.11	66	13149	1.72	108	4871	0.82
25	40386	3.08	67	12820	1.69	109	4765	0.80
26	39203	3.04	68	12501	1.67	110	4662	0.79
27	38058	3.01	69	12190	1.64	111	4561	0.77
28	36951	2.97	70	11889	1.61	112	4462	0.76
29	35877	2.94	71	11596	1.58	113	4366	0.74
30	34839	2.90	72	11311	1.56	114	4273	0.73
31	33834	2.87	73	11034	1.53	115	4182	0.72
32	32862	2.83	74	10765	1.50	116	4092	0.70
33	31936	2.80	75	10503	1.48	117	4005	0.69
34	31039	2.76	76	10248	1.45	118	3921	0.68
35	30171	2.73	77	10001	1.43	119	3838	0.67
36	29330	2.69	78	9760	1.40	120	3757	0.65
37	28515	2.66	79	9526	1.38	121	3678	0.64
38	27726	2.62	80	9298	1.36	122	3602	0.63
39	26962	2.59	81	9076	1.33	123	3527	0.62
40	26221	2.55	82	8860	1.31	124	3454	0.61
41	25503	2.52	83	8650	1.29	125	3383	0.60
42	24808	2.49	84	8446	1.26	126	3313	0.59
43	24134	2.45	85	8248	1.24	127	3245	0.58
44	23480	2.42	86	8054	1.22	128	3179	0.57
45	22846	2.38	87	7866	1.20	129	3114	0.56
46	22232	2.35	88	7683	1.18	130	3051	0.55
47	21636	2.32	89	7505	1.16	131	2989	0.54
48	21059	2.28	90	7331	1.13	132	2929	0.53
49	20499	2.25	91	7162	1.11	133	2870	0.52
50	19955	2.22	92	6997	1.09	134	2813	0.51
51	19428	2.18	93	6836	1.07	135	2756	0.50
52	18917	2.15	94	6680	1.06	136	2701	0.49
53	18420	2.12	95	6528	1.04	137	2648	0.48
54	17939	2.09	96	6380	1.02	138	2595	0.47
55	17472	2.05	97	6236	1.00	139	2544	0.46
56	17018	2.02	98	6095	0.98	140	2494	0.46

Notes:
1. Overall accuracy for the sensor is at least +1 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.

Table 3-2: Saturated Cond. Refrigerant Temperature Sensor and Leaving and Entering Cond. Water Temperature Sensors

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)
15	54635	4.43	57	16578	3.51	99	5958	2.29
16	52987	4.41	58	16151	3.48	100	5825	2.26
17	51393	4.39	59	15736	3.45	101	5694	2.23
18	49852	4.38	60	15333	3.42	102	5567	2.21
19	48361	4.36	61	14942	3.39	103	5444	2.18
20	46920	4.34	62	14562	3.37	104	5324	2.15
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22	44176	4.31	64	13835	3.31	106	5092	2.10
23	42871	4.29	65	13487	3.28	107	4980	2.07
24	41608	4.27	66	13149	3.25	108	4871	2.04
25	40386	4.25	67	12820	3.22	109	4765	2.02
26	39203	4.24	68	12501	3.19	110	4662	1.99
27	38058	4.22	69	12190	3.17	111	4561	1.96
28	36951	4.20	70	11889	3.14	112	4462	1.94
29	35877	4.18	71	11596	3.11	113	4366	1.91
30	34839	4.16	72	11311	3.08	114	4273	1.89
31	33834	4.14	73	11034	3.05	115	4182	1.86
32	32862	4.11	74	10765	3.02	116	4092	1.84
33	31936	4.09	75	10503	2.99	117	4005	1.81
34	31039	4.07	76	10248	2.96	118	3921	1.79
35	30171	4.05	77	10001	2.93	119	3838	1.76
36	29330	4.03	78	9760	2.90	120	3757	1.74
37	28515	4.01	79	9526	2.87	121	3678	1.72
38	27726	3.98	80	9298	2.84	122	3602	1.69
39	26962	3.96	81	9076	2.81	123	3527	1.67
40	26221	3.94	82	8860	2.78	124	3454	1.65
41	25503	3.92	83	8650	2.75	125	3383	1.62
42	24808	3.89	84	8446	2.72	126	3313	1.60
43	24134	3.87	85	8248	2.69	127	3245	1.58
44	23480	3.84	86	8054	2.67	128	3179	1.56
45	22846	3.82	87	7866	2.64	129	3114	1.53
46	22232	3.79	88	7683	2.61	130	3051	1.51
47	21636	3.77	89	7505	2.58	131	2989	1.49
48	21059	3.74	90	7331	2.55	132	2929	1.47
49	20499	3.72	91	7162	2.52	133	2870	1.45
50	19955	3.69	92	6997	2.49	134	2813	1.43
51	19428	3.67	93	6836	2.46	135	2756	1.41
52	18917	3.64	94	6680	2.43	136	2701	1.39
53	18420	3.61	95	6528	2.40	137	2648	1.37
54	17939	3.59	96	6380	2.37	138	2595	1.35
55	17472	3.56	97	6236	2.35	139	2544	1.33
56	17018	3.53	98	6095	2.32	140	2494	1.31

Notes:
1. Overall accuracy for the sensor is at least +1 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.

Table 3-3: Saturated Evaporator Temperature Sensor

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)
-10	121326	3.78	32	32862	2.30	74	10764	1.09
-9	117371	3.75	33	31936	2.26	75	10503	1.07
-8	113555	3.72	34	31039	2.23	76	10248	1.05
-7	109877	3.69	35	30171	2.19	77	10001	1.03
-6	106328	3.65	36	29330	2.16	78	9760	1.01
-5	102905	3.62	37	28515	2.12	79	9526	0.99
-4	99603	3.59	38	27726	2.09	80	9298	0.97
-3	96417	3.56	39	26962	2.06	81	9076	0.96
-2	93342	3.52	40	26221	2.02	82	8861	0.94
-1	90375	3.49	41	25503	1.99	83	8651	0.92
0	87511	3.46	42	24808	1.96	84	8446	0.90
1	84746	3.42	43	24134	1.93	85	8248	0.88
2	82078	3.39	44	23480	1.89	86	8054	0.87
3	79501	3.36	45	22846	1.86	87	7866	0.85
4	77013	3.32	46	22232	1.83	88	7683	0.83
5	74610	3.29	47	21636	1.80	89	7504	0.82
6	72289	3.25	48	21059	1.77	90	7331	0.80
7	70048	3.21	49	20499	1.74	91	7162	0.79
8	67883	3.18	50	19955	1.71	92	6997	0.77
9	65790	3.14	51	19428	1.68	93	6837	0.76
10	63769	3.11	52	18917	1.65	94	6680	0.74
11	61816	3.07	53	18420	1.62	95	6528	0.73
12	59928	3.03	54	17939	1.59	96	6380	0.71
13	58104	3.00	55	17472	1.56	97	6236	0.70
14	56340	2.96	56	17018	1.53	98	6095	0.69
15	54635	2.92	57	16578	1.51	99	5958	0.67
16	52987	2.89	58	16151	1.48	100	5824	0.66
17	51393	2.85	59	15736	1.45	101	5694	0.65
18	49852	2.81	60	15333	1.42	102	5568	0.63
19	48361	2.78	61	14942	1.40	103	5444	0.62
20	46920	2.74	62	14562	1.37	104	5324	0.61
21	45525	2.70	63	14193	1.35	105	5206	0.60
22	44176	2.66	64	13835	1.32	106	5092	0.59
23	42871	2.63	65	13487	1.30	107	4980	0.57
24	41608	2.59	66	13149	1.27	108	4871	0.56
25	40386	2.55	67	12820	1.25	109	4765	0.55
26	39203	2.52	68	12501	1.23	110	4662	0.54
27	38058	2.48	69	12190	1.20	111	4561	0.53
28	36951	2.44	70	11889	1.18	112	4462	0.52
29	35877	2.41	71	11596	1.16	113	4366	0.51
30	34839	2.37	72	11311	1.14	114	4273	0.50
31	33834	2.33	73	11034	1.12	115	4181	0.49

Notes:
1. Overall accuracy for the sensor is at least +1 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.

Table 3-4: Compressor Discharge Temperature Sensor

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)
75	10503	2.99	117	4006	1.81	159	1727	0.99
76	10248	2.96	118	3921	1.79	160	1695	0.97
77	10001	2.93	119	3838	1.76	161	1663	0.96
78	9760	2.90	120	3757	1.74	162	1633	0.94
79	9525	2.87	121	3679	1.72	163	1603	0.93
80	9298	2.84	122	3601	1.69	164	1573	0.92
81	9076	2.81	123	3527	1.67	165	1544	0.90
82	8861	2.78	124	3454	1.65	166	1516	0.89
83	8650	2.75	125	3383	1.62	167	1488	0.88
84	8446	2.72	126	3313	1.60	168	1461	0.86
85	8248	2.69	127	3245	1.58	169	1435	0.85
86	8054	2.66	128	3179	1.56	170	1409	0.84
87	7866	2.64	129	3115	1.53	171	1383	0.82
88	7683	2.61	130	3051	1.51	172	1359	0.81
89	7505	2.58	131	2990	1.49	173	1334	0.80
90	7330	2.55	132	2929	1.47	174	1310	0.79
91	7161	2.52	133	2870	1.45	175	1287	0.78
92	6997	2.49	134	2813	1.43	176	1264	0.76
93	6837	2.46	135	2756	1.41	177	1241	0.75
94	6680	2.43	136	2701	1.39	178	1220	0.74
95	6528	2.40	137	2648	1.37	179	1198	0.73
96	6380	2.37	138	2595	1.35	180	1177	0.72
97	6236	2.35	139	2544	1.33	181	1156	0.71
98	6095	2.32	140	2494	1.31	182	1136	0.70
99	5958	2.29	141	2445	1.29	183	1116	0.69
100	5824	2.26	142	2397	1.27	184	1097	0.68
101	5695	2.23	143	2350	1.25	185	1078	0.67
102	5568	2.21	144	2304	1.24	186	1059	0.66
103	5444	2.18	145	2260	1.22	187	1040	0.65
104	5323	2.15	146	2216	1.20	188	1023	0.64
105	5206	2.12	147	2173	1.18	189	1005	0.63
106	5092	2.10	148	2131	1.16	190	988	0.62
107	4980	2.07	149	2090	1.15	191	971	0.61
108	4871	2.04	150	2050	1.13	192	954	0.60
109	4765	2.02	151	2011	1.11	193	938	0.59
110	4662	1.99	152	1973	1.10	194	922	0.58
111	4561	1.97	153	1936	1.08	195	906	0.57
112	4463	1.94	154	1899	1.07	196	891	0.57
113	4367	1.91	155	1863	1.05	197	876	0.56
114	4273	1.89	156	1828	1.03	198	862	0.55
115	4182	1.86	157	1794	1.02	199	847	0.54
116	4092	1.84	158	1760	1.00	200	833	0.53

Notes:
1. Overall accuracy for the sensor is at least +1 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.

Table 3-5: Outdoor Air Temperature Sensor

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)
-10	121326	4.72	32	32862	4.11	74	10764	3.02
-9	117371	4.71	33	31936	4.09	75	10503	2.99
-8	113555	4.70	34	31039	4.07	76	10248	2.96
-7	109877	4.69	35	30171	4.05	77	10001	2.93
-6	106328	4.69	36	29330	4.03	78	9760	2.90
-5	102905	4.68	37	28515	4.01	79	9526	2.87
-4	99603	4.67	38	27726	3.98	80	9298	2.84
-3	96417	4.66	39	26962	3.96	81	9076	2.81
-2	93342	4.65	40	26221	3.94	82	8861	2.78
-1	90375	4.63	41	25503	3.92	83	8651	2.75
0	87511	4.62	42	24808	3.89	84	8446	2.72
1	84746	4.61	43	24134	3.87	85	8248	2.69
2	82078	4.60	44	23480	3.84	86	8054	2.66
3	79501	4.59	45	22846	3.82	87	7866	2.64
4	77013	4.58	46	22232	3.79	88	7683	2.61
5	74610	4.57	47	21636	3.77	89	7504	2.58
6	72289	4.55	48	21059	3.74	90	7331	2.55
7	70048	4.54	49	20499	3.72	91	7162	2.52
8	67883	4.53	50	19955	3.69	92	6997	2.49
9	65790	4.51	51	19428	3.67	93	6837	2.46
10	63769	4.50	52	18917	3.64	94	6680	2.43
11	61816	4.49	53	18420	3.61	95	6528	2.40
12	59928	4.47	54	17939	3.59	96	6380	2.37
13	58104	4.46	55	17472	3.56	97	6236	2.35
14	56340	4.44	56	17018	3.53	98	6095	2.32
15	54635	4.43	57	16578	3.51	99	5958	2.29
16	52987	4.41	58	16151	3.48	100	5824	2.26
17	51393	4.39	59	15736	3.45	101	5694	2.23
18	49852	4.38	60	15333	3.42	102	5568	2.21
19	48361	4.36	61	14942	3.39	103	5444	2.18
20	46920	4.34	62	14562	3.37	104	5324	2.15
21	45525	4.33	63	14193	3.34	105	5206	2.12
22	44176	4.31	64	13835	3.31	106	5092	2.10
23	42871	4.29	65	13487	3.28	107	4980	2.07
24	41608	4.27	66	13149	3.25	108	4871	2.04
25	40386	4.25	67	12820	3.22	109	4765	2.02
26	39203	4.24	68	12501	3.19	110	4662	1.99
27	38058	4.22	69	12190	3.17	111	4561	1.97
28	36951	4.20	70	11889	3.14	112	4462	1.94
29	35877	4.18	71	11596	3.11	113	4366	1.91
30	34839	4.16	72	11311	3.08	114	4273	1.89
31	33834	4.14	73	11034	3.05	115	4181	1.86

Notes:
1. Overall accuracy for the sensor is at least +1 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.

Section 4 Current Transformer and Current Input

4-1. General

Each compressor motor has all three of its line currents monitored by torroid (doughnut) current transformers. The Starter module utilizes all of the signals and displays the phases under the compressor report. These currents are also 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” through the proper selection of the Current Transformer and the setting of the Current Overload Settings #1 and #2 in the Machine Configuration Menu. The following procedure is used to determine the current overload setting #1 and #2 in the UCP2 menu items. First determine the CT Factor:

$$\text{CT Factor(\%)} = \frac{\text{(Unit nameplate RLA)}}{\text{CT Rating (from 4-1)}} \quad \text{X 100}$$

Refer to 4-1 for the CT Rating. It should be larger than the unit name-plate RLA. The CT Factor must be 66% or greater but no more than 100% of the name plate RLA. In some cases, more than one selection is possible: select the CT Rating that gives the lowest CT Factor.

Table 4-1: Current Transformer Selection

CT Extension # (X13580269-)	CT Rating (Amps)	Winding Resistance (Ohms)
01	100 A	23.5
02	150 A	35.0
03	200 A	46.0
04	275 A	67.0
05	400 A	68.0
06	500 A	84.0
07	700 A	128.0
08	1000 A	235.0
09	50 A	11.5
10	75 A	17.0

From the calculated CT Factor, the Motor Current Overload Settings #1 and #2 can be found in 4-2.

The current transformers provide the input for seven basic functions of the Starter module:

1. Starter contactor interrupt failure. If currents corresponding to greater than 5% RLA are 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 control the liquid level, and the condenser water pump and chilled water pump will remain operating if controlled through UCP2. This condition will exist until the diagnostic is manually reset.
2. Phase Loss: Running. If the detection of any or all of the three motor phase currents falls below 10% RLA for 2.6 seconds while the branch circuit should be “energized”, UCP2 will trip out the compressor.
3. Phase Loss: Starting. Failure of a contactor to pull in will also cause the Phase Loss diagnostic if no current is detected 0.3 seconds after the start was commanded. However when reduced voltage starting is employed, it may take an additional 3 seconds to detect a phase loss at start-up, as phase loss protection is not active during the 3 second transition time.
4. Phase Reversal. 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 0.3 seconds of start-up, UCP2 will trip out the compressor, and the Phase Reversal diagnostics will be displayed.

Table 4-2: Current Overload Settings #1 and #2 as a Function of CT Factor

CT Factor	Setting #1	Setting #2
66	00	255
67	01	254
68	02	253
69	03	252
70	04	251
71	06	249
72	07	248
73	08	247
74	09	246
75	10	245
76	11	244
77	12	243
78	13	242
79	15	240
80	15	240
81	16	239
82	17	238
83	18	237
84	19	236
85	20	235
86	21	234
87	22	233
88	22	233
89	23	232
90	24	231

Table 4-2: Current Overload Settings #1 and #2 as a Function of CT Factor

CT Factor	Setting #1	Setting #2
91	25	230
92	25	230
93	26	229
94	27	228
95	28	227
96	28	227
97	29	226
98	30	225
99	30	225
100	31	224

5. Phase Unbalance. Using the current inputs, UCP2 provides Phase Unbalance Protection based on average three phase current. The ultimate phase unbalance trip point shall be 30% for 90 seconds (not including individual phase sensing error) based on the following calculation:

$$\% \text{ unbalance} = \frac{(I0x - Iave) \times 100}{Iave}$$

where:

$$Iave = \frac{I01 + I02 + I03}{3}$$

and: I0x = the phase with the largest difference from Iave.

Individual phase sensing error: 3% maximum (or 6% phase-to-phase max)

The 30% unbalance trip criteria is active down to 10% RLA for the chiller. In addition to the ultimate 30% unbalance trip criteria, the RLA of the motor shall be derated by resetting the Active Current Limit Setpoint based on the Current Unbalance. The UCP2 provides a means to disable the RLA Derate in the Field Startup Menu.

The 30% phase unbalance trip criteria shall be non-defeatable for the purpose of eliminating critical components from the compressor overload circuitry and providing ultimate protection for the motor.

Both the derate and the 30% phase unbalance protection shall be active in all running modes.

The Starter module will shut down the compressor if a phase current unbalance of 30% is detected by the current transformers for a period of 90 seconds. The phase unbalance diagnostics will be displayed.

6. Current Limit. This is a multistage control that acts to prevent chiller shutdown when the compressor motor current approaches the cutout setpoint by reducing chiller capacity. Chiller capacity is reduced via the following steps, providing increasingly aggressive action as the trip point is approached:

   Limit requests for capacity increases. (10% to 2% below Current Limit Setpoint). Limit Loading

   Prohibit requests for capacity increases. (2% to 0% below CLS). Hold

   Initiate stepped capacity reduction. (0% to 2% above CLS). Unload

   Initiate maximum capacity reduction. (more than 2% above CLS)

   The intent of this control is to provide maximum capacity while preventing chiller shutdown due to high compressor motor currents.

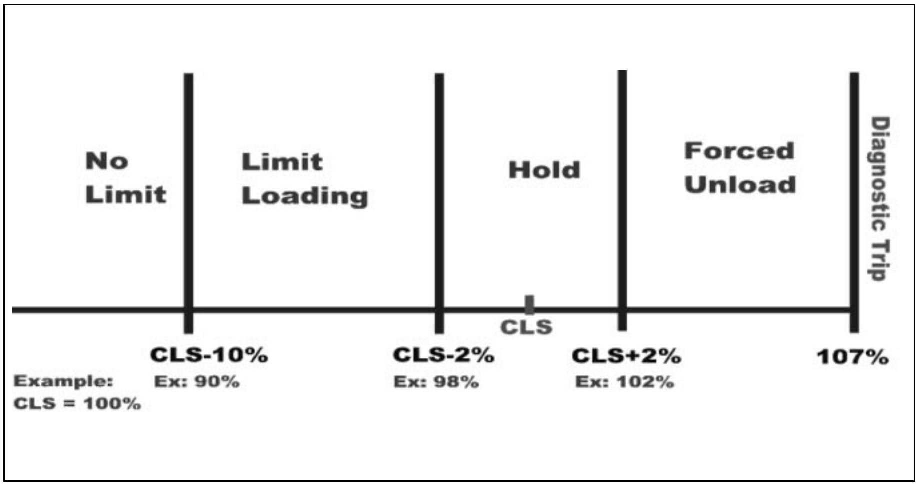

Figure 4-1.Current Limit

7. Momentary Power Loss. Power losses of 2.5 line cycles (.042 seconds) or longer will be detected and cause the unit to shutdown. The unit shall be disconnected from the line within 6 line cycles of detection. If enabled, Momentary Power Loss shall be active anytime the compressor is running. MPL shall not be active on wye-delta starters from the initial start signal through transition. Once the Transition Complete input is satisfied MPL is active.

8. Current overload starting. In the starting mode, the overload protection is the maximum acceleration time. If the motor is in a locked rotor condition or the currents do not drop below 85% RLA within the maximum acceleration time, a diagnostic will be called. In the run mode, a 'time-to-trip' curve is looked at to determine if a diagnostic should be called.

9. Current overload running. UCP2 continuously monitor compressor current to provide running overcurrent and locked rotor protection. Overcurrent protection shall be based on the phase with the highest current. It shall trigger a manually resettable diagnostic shutting down the affected compressor and associated refrigerant circuit when the current exceeds a specified time trip curve. The compressor overload shall be based on unit RLA.

   Overload Must Hold = 102% RLA

   Overload Must Trip in 20 +0 -3 seconds = 112% RLA

Note: The above gives a nominal 20 second must trip point of 107% RLA.

Overload Must Trip in 1.5 seconds = 140% RLA (Nominal)

Note: The current transformers are polarity and directionally sensitive. Visually inspect the current transformer for a dot that should be facing the incoming power line.

4-2. CT and Starter Module 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. Confirm that the Overload Settings #1 and #2 are set correctly. Determine the CT Factor. Refer to paragraph 4-1.

   If there is any question as to which 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 “Press Enter to Clear Active Diagnostics” display.

3. At start-up, verify that the appropriate contactor(s) pull-in. Record the exact diagnostic(s) produced.

⚠ WARNING

Hazardous Voltage!

Disconnect all electric power, including remote disconnects before servicing. Follow proper lockout/tagout procedures to ensure the power can not be inadvertently energized. Failure to disconnect power before servicing could result in death or serious injury.

4. 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 in the control panel. Refer to the Component Location Drawing in the panel to identify the current transformer(s). Locate the part number/UL tag on the transformer leads and note the Trane part number which identifies the transformers. Verify the proper current transformer using 4-1 in this section.

5. Utilizing the schematic wiring diagram, locate the termination of the transformer's wiring into the Phoenix connector on the Starter module. Unplug the appropriate connector from the Starter module.

CUATION

Equipment Damage!

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 Starter module. Take care to properly reconnect the CT's back to the Phoenix connector prior to attempted start of the compressor.

6. Using a digital volt-ohmmeter, measure the resistance of the transformers by probing the appropriate wires of the Phoenix connector. Use the leads on the meter and probe the screws used in the Phoenix connector to measure the resistances.

7. Refer to 4-1 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 Phoenix connector can be considered good. Go to step 9.

8. If the resistance reading is out of tolerance, the problem is either with the transformer, its wiring, or the Phoenix connector. First, double check the schematic to be sure you are working on the proper lead pair. Then disconnect the leads of the particular transformer at the Phoenix connector and repeat the resistance measurement by stripping insulation from the wire's end. Once the fault has been isolated, install a new transformer and/or install a new phoenix connector.

   More than one current transformer is terminated to a single Phoenix connector. When replacing, take care to note the proper positions of the respective transformer wire terminations on the Phoenix connector for the re-termination. The current transformers are polarity and directionally sensitive. The transformer lead wiring is #22 AWG, UL 1015 600V. If the fault can be isolated to the current transformer or its wiring apart from the connector, the connector can be reused.

   The CT’s are polarity sensitive. They have a directional dot that must face away from the motor or into the line side.

9. 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 connection.

10. To perform the following test, you will need to use a digital voltmeter with a diode test function. With the transformer's Phoenix connector disconnected and the power off to UCP2, perform a diode test across the corresponding pair of current transformer input pins on the Starter module (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 Starter module. If the diode voltage drops prove accurate, reconnect the transformers to the Starter module and re-power the unit.

11. With the CTs reconnected to the Starter module, attempt a restart of the chiller. As the 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 Starter module (using a digital volt-meter on a 0-20 VAC scale). Refer to Table 4-3 for the compressor phase current to output voltage relationship for each extension current transformer. Using 4-3, look up the 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%.

12. 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 with all phase currents to the compressors verified to be within the normal range, then the problem is either with the CT selection, Current Overload Settings #1 and #2, or the starter module's current input. Since the first two items were verified above, that leaves only the Starter module circuitry as an issue. It is advisable to replace the Starter module.

Table 4-3: Line Current vs. Current and Volts

Line Current (%RLA)	Terminal Input Current (mA RMS)	Terminal Volts (VAC RMS) (±5)
0	0	0
5	5	1.2
10	10	1.4
15	15	1.5
20	20	1.7
25	25	1.8
30	30	2.0
35	35	2.1
40	40	2.2
45	45	2.4
50	50	2.5
55	55	2.6
60	60	2.8
65	65	2.9
70	70	3.0
75	75	3.2
80	80	3.3
85	85	3.4
90	90	3.6
95	95	3.7
100	100	3.8
105	105	4.0
110	110	4.1
115	115	4.2
120	120	4.4
125	125	4.5
130	130	4.6

Table 4-3: Line Current vs. Current and Volts

Line Current (%RLA)	Terminal Input Current (mA RMS)	Terminal Volts (VAC RMS) (±5)
135	135	4.8
140	140	4.9
145	145	5.0
150	150	5.1
160	160	5.4
170	170	5.7
180	180	6.0
190	190	6.2
200	200	6.5
210	210	6.7
220	220	7.0
230	230	7.3
240	240	7.5
250	250	7.8
260	260	8.0
270	270	8.3
280	280	8.6
290	290	8.8
300	300	9.1

Section 5 Under-Over Voltage Transformer

5-1. General

The hardware required for the Under-Over Voltage sensing function of UCP2 is optional on RTHC units. This option must be installed in the Machine Configuration Menu (+-+-+-) and for Under-Over Voltage protection to be active, Under-Over Voltage protection must be enabled in the Field Start-up Menu (++--++). Three custom designed transformers whose primary is connected across the Line Voltage phases, provides a stepped down and isolated AC voltage to the Starter module at input J3. This secondary voltage is directly proportional to the line voltage applied to the primary.

The Compressor Report on the CLD can display the Compressor Phase to Phase Voltages and, when so enabled, can cause an MAR (machine shutdown-automatically resettable) diagnostic for High and Low Line voltage conditions. With the Under-Over Voltage Protection enabled, an Over Voltage diagnostic will start integrating to trip if the line voltage is above 10% of the nominal voltage set in the Machine Configuration Group under Service Settings menu. The Under Voltage diagnostic will start integrating to trip if the line voltage drops below 10% of the nominal voltage. Trip time is a minimum of 1 minute to a maximum of 5 minutes.

⚠ WARNING

Live Electrical Components!

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5-2. Under-Over Voltage Transformer Checkout

Locate the Under-Over Voltage Transformers [2T6, 2T7, 2T8] in the panel by referring to the Component Location Drawing. Carefully measure the primary voltage across each transformer and note the value in VAC rms.

Next, disconnect the transformer's secondary from J3 on the Starter module. Using voltmeter probes, measure and note the unloaded secondary voltage (VAC rms) (low voltage class 2 less than 32 VAC).

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.

Reconnect the secondary back to J3 and re-measure 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 Starter module and a 1 kOhm resistor connected across the secondary. Measuring the voltage across the 1 kOhm resistor should yield 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 UCP2 connected ratio is out of tolerance, suspect a bad Starter module. Before replacing the Starter module, double check the Unit Line Voltage programed in the Machine Configuration Menu under Service Settings. It should match the nameplate unit line voltage.

If the Under-Over Voltage Protection function continues to trip the unit, and all of the above measured ratios are within tolerance, and all CLD Under-Over Voltage setups have been verified, replace the Starter module.

Section 6 Compressor Load-Unload Solenoid

6-1. General

RTHC compressors are loaded and unloaded by means of an internal slide valve. In simple terms, the valve can regulate the amount of “bite” of the compressor rotors as they turn at relatively constant speeds.

The slide valve is moved by a piston located at the discharge end of the compressor. The hydraulic fluid is R-134a, unlike the RTHB compressor which uses oil. The movement of the piston is controlled by the load and unload solenoid valves, which either add refrigerant pressure from the high pressure side or relieve pressure to the low pressure side of the system.

Although the solenoids are “on - off” devices, effective modulation and high resolution of the slide valve (under steady state conditions) is possible by pulsing the solenoid valves on and off and varying the displaced volume of the cylinder/piston. When the compressor is operating, the 1U1 Chiller module will energize (apply 115 VAC) either the load or the unload solenoid, as necessary. The solenoids are energized for a period of between 40 and 400 milliseconds, once every 5 seconds to control the leaving evaporator water temperature or limit conditions.

After a compressor stop, the unload solenoid valve will remain energized for 60 minutes to prevent slide valve movement due to changing cylinder/compressor pressures.

The procedure below will allow the checkout of the Chiller module load and unload outputs. The subsequent 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 piston.

6-2. Check Procedure for 1U1 Load-Unload Outputs

The 1U1 controls the load and unload solenoid valves on the compressor with 115/220 VAC triacs (solid state relays). Unlike mechanical relays, a triac has a rather high leakage current when off 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. It is important to verify that the solenoid coil is providing a normal load. Connecting a known good load, such as a low wattage 115

Volt lamp, to the terminals when testing the outputs may help. Refer to the chiller control wiring diagrams and component location drawings for the following procedure.

⚠ WARNING

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The following procedure is done with power applied to the modules and control circuits. Use extreme caution when performing this procedure. As mentioned above, the unload solenoid valve will be powered by the 1U1 and remain energized if the compressor is off. Also, the compressor and associated solenoids. may be started or energized at any time under automatic control.

When a triac is off, about 1-2 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).

To determine if the solenoids are being energized perform the following steps:

1. Wire a low wattage (25-40 watt 120 VAC) lamp in series with the solenoids. If a low wattage lamp is not available, check for magnetism on top of the solenoids during each pulse with the tip a of a screwdriver.
2. Enter the Service Test Menu and change the “Slide Valve Control Setting is:” from Auto to Load. This will cause the compressor to load immediately

NOTE: The red alarm light on the front pannel will energize and remain steady any time an item in the Service Test menu is set to something other than “AUTO”.

NOTE: Adaptive control can alter the test if the chiller is in a limit or near setpoint. Monitor the operating mode to verify that the test is accurate.

3. Increase the next menu item, under the Service Test Menu, “Manual Load/Unload Duty Cycle”, up to 50%. This will provide a 2.5 second pulse every 5 seconds sent to the solenoids to ease in testing.

4. Measure the voltage from terminal J8-2 (load) to neutral. The voltage should increase to approximately 115 VAC for 2.5 seconds every 5 seconds and then decrease back to 0 VAC. Ensure that only the load solenoid is being energized.
5. Change the “Slide Valve Control” under Service Tests from “Load” to “Unload”.
6. Measure the voltage from terminal J10-2 (unload) to neutral. The voltage should increase to approximately 115 VAC for 2.5 seconds every 5 seconds and then decrease back to 0 VAC. Ensure that only the unload solenoid is being energized.
7. If either solenoid is not being energized when commanded check all wiring to and from the solenoids.
8. Measure the power supplied to the Starter module. Measure the voltage from J4-2 to ground and J6-2 to ground. The 115 VAC should be present at all times. If it is not present, the problem is either from the wiring or a faulty 2T4 120 V control power transformer.

If the solenoids and the 1U1 board pass the electrical test but the unit is still not loading properly, proceed to the next section.

6-3. Checkout Procedure for the Slide Valve and Load-Unload Solenoids

1. Connect a manifold gauge set to the schrader valve located at the end of the piston housing. This schrader allows access to the pressure behind the piston. Use hoses that are long enough to allow reading the gauges while viewing the CLD.

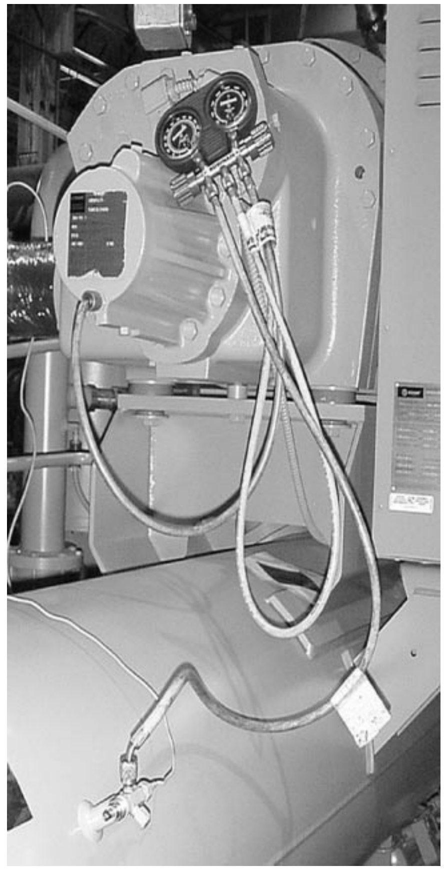

Figure 1: RTHC Compressor

⚠ WARNING

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2. Clamp on an ammeter to monitor the actual amp draw during this procedure.

3. Allow the compressor to start under normal conditions. At start-up, the pressure behind the piston must be close to suction pressure under normal operation.

4. Enter the Service Test menu on the CLD and scroll down to “Slide Valve Control is:”. Change the setting to “Load”.

NOTE: The red alarm light on the front panel will energize and remain steady any time an item in the Service Test menu is set to something other than “AUTO”.

5. Scroll to the next display “Manual Load/Unload Duty Cycle” and increase the percentage to 50%. This will provide a 2.5 second pulse every 5 seconds sent sent to the solenoids to load and unload the compressor faster.
6. Monitor the pressure behind the piston and the amp draw of the unit. Both should gradually increase with each pulse of the load solenoid. Ensure that the load solenoid is actually being energized.

NOTE: All limits are still active. If the chiller enters into a condenser, current, or evaporator limit it will affect the load signals sent to the solenoid. Continuously monitor the operating mode under the Chiller Report during this process.

7. After monitoring the unit for 5-10 minutes change the “Slide Valve Control is:” display under Service Tests from “Load” to “Hold”, after recording the pressure behind the piston.
8. In the “Hold” mode, the pressure behind the piston should remain relatively constant. (No more than 10-15 psi variation).
9. After monitoring for 5-10 minutes, change the “Slide Valve Control is:” display to “Unload”. The pressure behind the piston and the RLA of the unit should gradually decrease with each pulse sent to the unload solenoid.

NOTE: The pressure behind the piston should be approximately suction pressure when the compressor is fully unloaded. The RLA will be dependent on the application.

10. After monitoring the system in the three positions of load, hold, and unload, change the “Slide Valve Control Is:” display back to “Auto” to allow for automatic control of the slide valve.

With the results from the above checkout procedure use Table 6-1 to determine the possible causes of the loading problem

.

Table 6-1: Possible Causes to Loading Problem

Possible Operation	Recorded Measurement	Load	Unload	Hold
Operating properly	Piston Pressure	increase	decrease	remain constant
	Amp Draw	increase	decrease	remain constant
Stuck piston	Piston Pressure	increase	decrease	remain constant
	Amp Draw	remain constant	remain constant	remain constant
Leaking load solenoid, internal leak or leaking piston	Piston Pressure	increase	may drop initially but will increase as aoon as the unload is deenergized	increase
	Amp Draw	increase	may drop initially but will increase as aoon as the unload is deenergized	increase
Leaking unload solenoid	Piston Pressure	remain constant or decrease	decrease	decrease
	Amp Draw	remain constant or decrease	decrease	decrease

Section 7 Starter Dry Run

7-1. General

RTHC units can have Y-Delta or Solid State Starters. This section covers Y-Delta Starters.

7-2. Timing Requirements

Timing requirements to operate the “Stop”, “Start”, “Short”, “Transition”, and “Run” contact closure outputs are shown below. Prior to closing the “Short” contact, the transition complete input shall be verified to be open, otherwise an MMR diagnostic shall be generated.

Table 7-1: Timing Requirements

	Interval	Min.	Max	Units	Actual Design
A	Test for transition complete input open			msec	160 to 240
B	Time delay			msec	20
C	Close 1K1 Contactor and test for no current. Level 2 Contactor integrity test			msec	500
D				sec	1
E	Open 1K1			msec	200
F	Close shorting Contactor 1K3 and test for no current, then wait for start command. Starter integrity test.	100		msec	1
G	Close 1K1	2.0		sec	2
H	Wait 1.5 sec after phase current drops to 85%	1	2	sec	1.5
J	Begin transition sequence	85	100	msec	100
K	Open 1K3	250	300	msec	260
L	Close 1K2			msec	140
M	Wait to look for transition complete.			msec	2.32 to 2.38
N	Filtering time on transition complete input.			msec	160 to 240

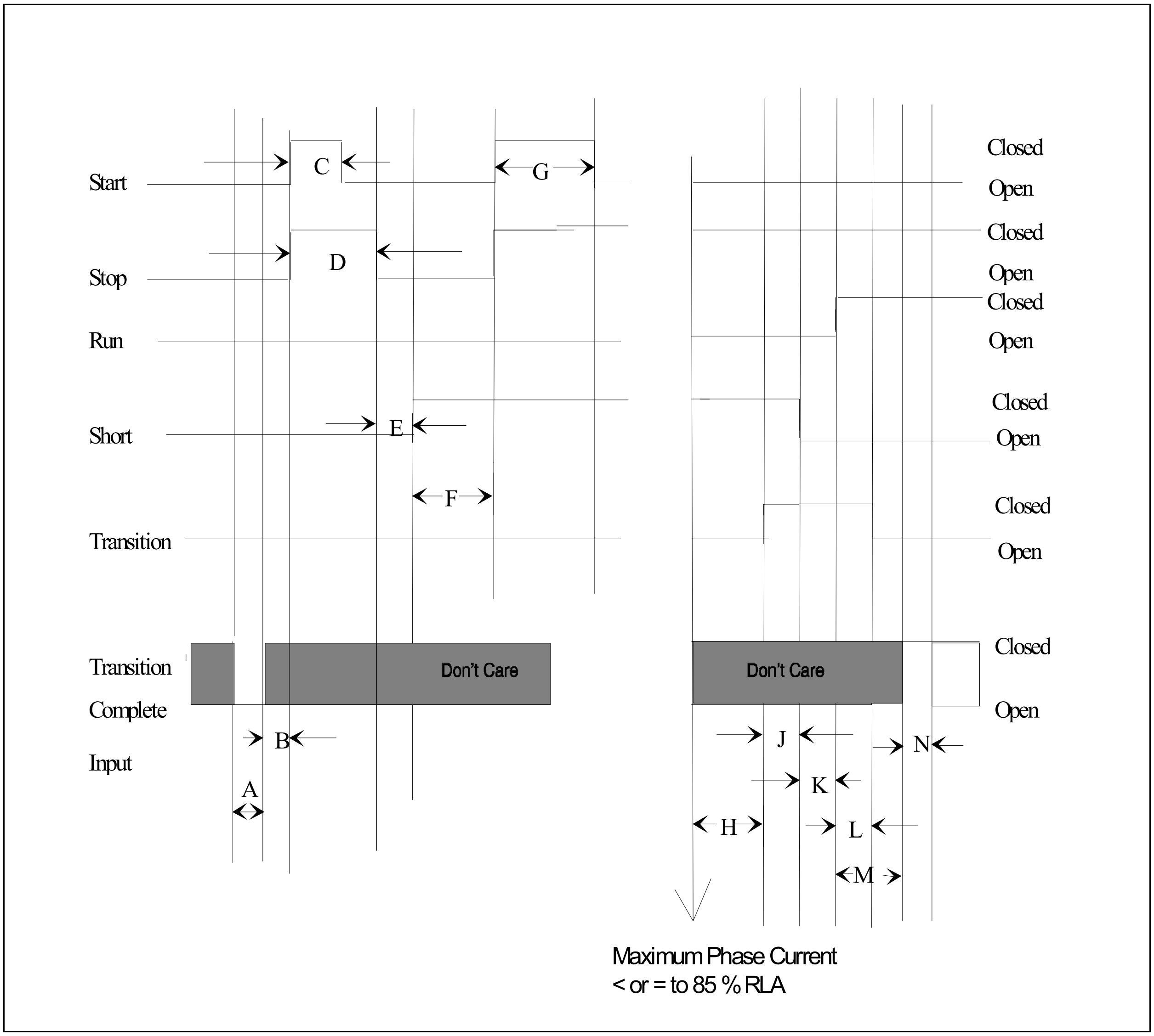

Figure 7-1.Timing Requirements

Note:

Time period F must be long enough to verify the absence of phase currents caused by the closing of the "Short" contacts.

The sum of intervals M and N are designed to be 2.5 Seconds.

The transition complete contact closure is expected to be an auxiliary contact to the "Run Contactor" (1K2).

The level 2 Contactor Integrity Test can be defeated, and the 1K1 contactor not be momentarily energized 1 second before start.

Steps A-E only when Starter Contact Test is enabled.

⚠ **Warning**

Hazardous Voltage!

Disconnect all electric power, including remote disconnects before servicing. Follow proper lockout/tagout procedures to ensure the power can not be inadvertently energized. Failure to disconnect power before servicing could result in death or serious injury.

CAUTION:

7-3. Dry Run Procedure

1. Remove Line Voltage.
2. Remove 1F4.
3. Remove the internal Busman Fuse on the 115 VAC tap of 1T5 (control power transformer) or remove the leads originating at the 1T5 transformer going to 1TB3-10, and 1TB3-1.

   This needs to be done to isolate the transformer and potential issues due to induction.
4. Apply an external 115VAC to 1TB3-10 to 1TB3-1.
5. Apply an external 24VAC in parallel with any of the J2 connectors on any of the modules…this to apply 24VAC control power.
6. Once control power is applied to the micro, **disable** the **under/ over voltage** protection.
7. **Starter Dry Run** is initiated in the “Service Test” group. This group is password protected (**+ + - - + +, Enter**). Step through the service test group to starter dry run and initiate the test.

Section 8 Electronic Expansion Valve

8-1. General

The Electronic Expansion Valve is a flow device which meters refrigerant into the evaporator as necessary. The valve uses a stepper motor consisting of two windings to modulate the.

The Stepper module monitors the liquid level under normal operating conditions and controls the EXV with the level of refrigerant in the evaporator. If the liquid level rises above the optimum value of 0.0” as displayed on the UCM the EXV will begin to close. If the liquid level falls below the optimum value of 0.0” as displayed on the UCM, the EXV will begin to open.

A malfunctioning EXV can exhibit several different diagnostics. A diagnostic will appear if the EXV is failing electrically or if the stepper module is defective. Use the following procedure to determine the cause of the diagnostic.

8-2. Stepper Module Checkout Procedure

The Stepper module must be powered for the operation of the electronic expansion valve. If any of the voltages listed in 8-1are out of range, either the 1U3 is receiving no or improper power, or the 1U3 Stepper module is malfunctioning.

Table 8-1: Stepper Module Voltage Limits for EXV

Connector	Voltage (VAC)	Voltage (VDC)
J2-1 to J2-2	20.4 to 33.12	0
J2-1 to case	10 to 17	13.12 to 21.81
TP1 (35V) to ground	100 mVAC to 72 mVAC	26 to 48
TP2 (5V) to ground	0	4.8 to 5.2
TP3 (14V) to ground	0	11.45 to 15.75
TP4 (24V) to ground	0	23.2 to 25.1

If the voltages do not fall within the acceptable range, the Stepper module needs to be replaced.

8-3. EXV Motor and Wiring Checkout Procedure

If the integrity of the EXV motor is suspect, use the following procedure to check the expansion valve motor and wiring.

8-3 a. Motor Winding Resistance Checkout

1. With UCP2 powered, press the “STOP” button once.
2. In the Service Test menu, change “EXV Control is:” to “Manual”.

NOTE: The red alarm light on the front panel will energize and remain steady anytime an item in the Service Test menu is set to something other than “AUTO”.

3. In the Service Test menu, change “Expansion Valve Position:” to 100% open.
4. Unplug the J2 connector (power) on the 1U3 stepper module.
5. Unplug the J8 connector from the 1U3.
6. Measure the resistance of the EXV motor windings across the disconnected J8 connector. Use 8-2for acceptable resistance values.

Table 8-2: EXV Resistance Values

Pin Connections	Acceptable Resistance Range	Nominal Resistance (Ohms)
W1: J8-4 to J8-2	50 milli ohm to 5 ohm	1.68
W2: J8-3 to J8-1	50 milli ohm to 5 ohm	1.68
NOTE: All other points to each other and to ground are open circuits.		

7. If the valve does not pass the resistance test, either the connector, wiring to the valve, or the valve is defective.
8. Verify EXV wiring and connector integrity before condeming the EXV.
9. Re-connect all plugs and change “EXV control is:” back to “Auto”.

8-3 b. Motor Voltage Checkout Procedures

If the resistance values are correct and the stepper module is being powered correctly, the motor voltages need to be measured while the valve is stroking.

1. In the Service Test menu, change “Expansion Valve Test:” to “Enabled”. With the test enabled, wait for the timing test to begin before recording voltages.
2. Use Table 8-3 to check voltages.

Table 8-3: EXV Motor Voltages

Connector Pin	Voltage (VAC)	Voltage (VDC)
J8-4 to J8-3	16.7 to 23.3	-250mV to 250 mV
J8-4 to J8-2	18.2 to 24.0	-30 mV to 30 mV
J8-4 to J8-1	16.7 to 23.3	-250 mV to 250 mV
J8-3 to J8-2	16.7 to 23.3	-250 mV to 250 mV
J8-3 to J8-1	18.2 to 24	-30 mV to 30 mV
J8-2 to J8-1	16.7 to 23.3	-250 mV to 250 mV
J8-4 to ground	11.1 to 15.7	6.6 to 7.0
J8-3 to ground	11.1 to 15.7	6.6 to 7.0
J8-2 to ground	11.1 to 15.7	6.6 to 7.0
J8-1 to ground	11.1 to 15.7	6.6 to 7.0

3. If the voltages do not fall within the acceptable range, the 1U3 stepper module needs to be replaced.

Section 9 Liquid Level Sensor Checkout

9-1. General

The sensor consists of a body made from an enclosed tube, fitting, and a magnetic float which slides over the tube. The liquid level sensor is required to provide input necessary for the control of the Electronic Expansion Valve(EXV).

The Stepper module monitors the Liquid Level Sensor (LLS) under normal operating conditions and modulates the EXV in accordance with the level of refrigerant in the evaporator. If the liquid level rises above the optimum value of 0.0” as displayed in the Refrigerant Report Menu, the EXV will begin to close. If the liquid level falls below the optimum value of 0.0” as displayed on UCP2, the EXV will begin to open.

A malfunctioning Liquid Level Sensor can exhibit several different diagnostics. A diagnostic will appear if the LLS is failing electrically or if the stepper module is defective. Use the following procedure to determine the cause of the diagnostic.

9-2. Checkout procedure

Use a Voltmeter set to DC Volts:

4. Measure the voltage from terminal J7-1 to J7-3. You should measure between 4.75 and 5.25 VDC.
5. If the measurement is between 4.75 and 5.25 volts, skip ahead to step 6.
6. If the above measurement does not fall between 4.75 and 5.25 VDC, disconnect the sensor from the module and re-measure the voltage at the module.
7. If the measurement with the sensor disconnected is still out of range, the module is defective and should be replaced.
8. If the measurement with the sensor disconnected is in range, the sensor is defective and should be replaced.
9. Measure the voltage from J7-2 to J7-3 on the RTHC Stepper module with the sensor connected.
10. The voltage should measure between 0.5 and 4.5 VDC. If it is not, replace the sensor.

11. Disconnect the sensor, and hook up a 1.5 Volt battery across Stepper module terminals J7-2 (to battery +) and J7-3 (to battery -). View the evaporator liquid level in the Refrigerant Report. The liquid level should read -0.4 inches. Connect the battery to terminals J7-1 (to battery +) and J7-2 (to battery -) The liquid level should read 0.5 inches. If either of these readings is incorrect, replace the RTHC Stepper module.

Section 10 Gas Pump Checkout

10-1. General

The falling film evaporator of the RTHC design is not a flooded evaporator like RTHB. Residual oil will not immediately be recovered by the oil separators and will eventually log in the evaporator. Oil cannot be returned as oil/liquid droplets pulled up the suction line of the compressor. The oil is instead returned by alternatively filling and draining a small tank with refrigerant from the bottom of the evaporator. The fill cycle is controlled by energizing the fill solenoid valve which vents the tank back to the evaporator, allowing a gravity feed of liquid through a check valve into the tank. This refrigerant which has anywhere from 3% to 8% oil, is then drained by energizing the drain valve which applies condenser pressure to the tank thus “pushing” the liquid up a line which drains directly to the suction of the compressor. The check valve prevents the liquid or high pressure gas from re-entering the evaporator. The solenoid valves are controlled directly by UCP2.

10-2. Gas Pump Checkout Procedure - Unit Off

To check the operation of the Gas Pump while the chiller is OFF, refer to RTHC-SB-1B and do the following:

1. Turn off chiller.
2. Close (front seat) the ¼” angle valve (49) downstream of the “cold” filter (48).
3. Back seat valve and Install gauge at (47). Re-open to read pressure
4. Close the ¼" angle valve (11) on the condenser which supplies the Gas Pump.
5. Make sure the gas pump solenoid valves (22 & 23) are de energized.
6. Pressurize the line between the Gas Pump and the ¼" angle valve (47) upstream of the "cold" filter using POE oil taken from the oil sump at (7). If desired, refrigerant from the condenser can be used as well.
7. Pressurize the line to approximately 115 psi.
8. Monitor the pressure leak rate in the line. It's typical to see an immediate 5 psi drop in pressure, and then a slow drop thereafter. A normal leak rate is 10 psi in 5 minutes. A rapidly falling pressure may indicate a leaking check valve (24), but may also indicate a

leaking solenoid valve (22). Further testing may be necessary to determine which component is leaking.

9. Before returning to service, make sure all valves and coils are returned to their normal positions.

10-3. Gas Pump Checkout Procedure - Unit On

To check the operation of the Gas Pump while the chiller is ON, refer to RTHC-SB-1B to do the following procedure:

Important: At least a 50 psi differential must exist between the evaporator and condenser before performing this test.

1. Turn the compressor off and close the valve on the oil return line from the Gas Pump to the compressor (49).
2. Back seat valve and Install gauge at (47). Re-open to read preasure.
3. Allow the unit to start.
4. Allow the Gas Pump to enter and complete a "fill" cycle (valve 22 will energize).
5. Allow the Gas Pump to enter a “drain” cycle (valve 22 will de-energize and valve 23 will energize). During the drain cycle de-energize the fill solenoid. Unplug J4-1 and J4-2 from the Chiller Module (1U1). Verify that the correct coil is de-energized. Or remove the electric coil from the valve (to disable the valve) and place a screwdriver or bolt shaft through the coil center to prevent overheating of the coil.
6. Monitor the gauge pressure at angle valve (47). The pressure should build toward condensing pressure. At the completion of the drain cycle de-energize the drain solenoid. Unplug J6-1 and J6-2 from the Chiller Module (1U1). Verify that the correct coil is de-energized. Or remove the electric coil from the drain valve (23) to disable the valve and place a screwdriver or bolt shaft through the coil center to prevent overheating of the coil. If the pressure holds to within 10 psi in 5 minutes, the system is functioning normally.
7. If the pressure fails to hold near condensing pressure, there may be a solenoid valve (22) or a check valve (24) leakage.
8. If the pressure falls rapidly to or near suction, either the "fill" solenoid (22) or the check valve (24) is leaking by.

9. To determine if the check valve (24) is leaking by, place a temperature probe on each side of the check valve (24). Monitor the temperature differential across the check valve (24) during the time that the “drain” solenoid (23) is energized. If the check valve is leaking, the temperature differential will be very small because condensing gas will push into the evaporator. In a properly operating system, the temperature differential across the check valve (24) during the drain cycle will be about 2-4 degrees depending on operation conditions.
10. If step 8 shows that there is a leak, but step 9 indicates it is NOT related to the check valve (24), the problem most likely resides in the "fill" solenoid (22), and it should be replaced.
11. Before returning to service, make sure all valves and coils are returned to their normal positions.

Note: If it is determined that the check valve (24) is leaking, it is recommended that the entire Gas Pump assembly be replaced because the check valve contains a teflon ball. Units with a Design Sequence of G0 and earlier have the check valve brazed in. It is very difficult to braze in without damaging the teflon ball. Design Sequence H0 changed this to a o-ring boss fitting and the check valve can be replaced independently

Section 11 Optical Sensor

11-1. General

The oil level detector is located in the lower part of a vertical section of the oil line feeding the compressor rotors (injection) . In conjunction with the oil flow differentail pressure switch, it proves that there is both adequate flow, and that the flow is liquid (as opposed to gas). The sensor uses infrared light reflected off the inside of a conical prism, back to a detector to sense the difference in refractive index of the prism /oil interface relative to that of the prism/vapor interface.

11-2. Checkout Procedure

CAUTION

Compressor Damage!

Never perform this test while the compressor is running. Turn the chiller off and ensure that the compressor will not start.

1. Verify that the wiring between the Optical Sensor on the Chiller Module (1U1) at J9-3, 4, and 5 is correct.
2. Remove the snap ring securing the sensor in the oil line. Remove the sensor from the line. Note: The optical sensor is separated from the refrigerant by a clear prism, therefore, it is not necessary to recover refrigerant when removing the sensor.
3. Place a mirror or white piece of paper ¼" from the face of the sensor.
4. On the UCP2 panel, enter the Service Test menu and view the Oil Loss Level Sensor Status. After 10 seconds, the status should read 'DRY'.
5. Place a piece of black electrical tape directly on the face of the sensor. After 10 seconds, the status should read 'WET'.
6. If the status does not change, disconnect the sensor leads from the Chiller Module (1U1) at J9-3, 4, and 5. Connect a 1.5 volt battery directly to the Chiller Module (1U1) at J9-3 and J9-4. After 10 seconds, the status should read 'WET'. If so, proceed to Step 7. If the status still reads 'DRY', the Chiller Module is defective and needs to be replaced.

7. If the status reads 'WET', connect a 24 VDC power supply to the Chiller Module (1U1) at J9-3 and J9-4. After 10 seconds, the status should change to 'DRY'. If the status does not change, the Chiller Module is defective and needs to be replaced. If the status reads correctly, the Optical Sensor is defective and needs to be replaced.

Section 12 Interprocessor Communication (IPC)

12-1. General

The respective modules communicate with each other via an InterProcessor Communication link (IPC). The IPC link allows the modules to work in a coordinated manner with the Chiler Module (1U1) directing overall chiller operation while each module handles specific subfunctions. This IPC link is integral and necessary to the operation of UCP2 and should not be confused with the Optional ICS (Integrated Comfort System) communication.

In the IPC communication protocol scheme, the 1U1 acts as the initiator and the arbitrator of all module communication. The 1U1 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, 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 1U1, or it will not answer.

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

12-2. IPC Diagnostics

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

1. Take specific action to safely shut-down (or to default) its controlled loads.

2. Report a diagnostic to the 1U1 (over the IPC link).

The 1U1 (if it properly receives such) will then report and display the diagnostic on the Clear Language Display. The diagnostic will:

1. Identify which module is reporting the communication problem.
2. Identify which module was to have sent the missing information.

The 1U1 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: Loss of Comm with Options” indicates that the 1U1 has detected a loss of IPC communication from the Options 1U5 module. When some problem exists with the IPC link or a module fails, it is common 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.

12-3. Troubleshooting Modules Using IPC Diagnostics

Communication problems can result from any of the following:

1. Opens or shorts in the twisted pair IPC wiring or connectors
2. Loss of power to a module
3. Internal module failure
4. Incorrect polarity
5. High levels of EMI (Electro-Magnetic Interference)
6. Module specific function selected without the Options module.
7. Loss of ground

These are discussed in more detail in the following paragraphs.

12-3 a. 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 the diagnosis of an open link.

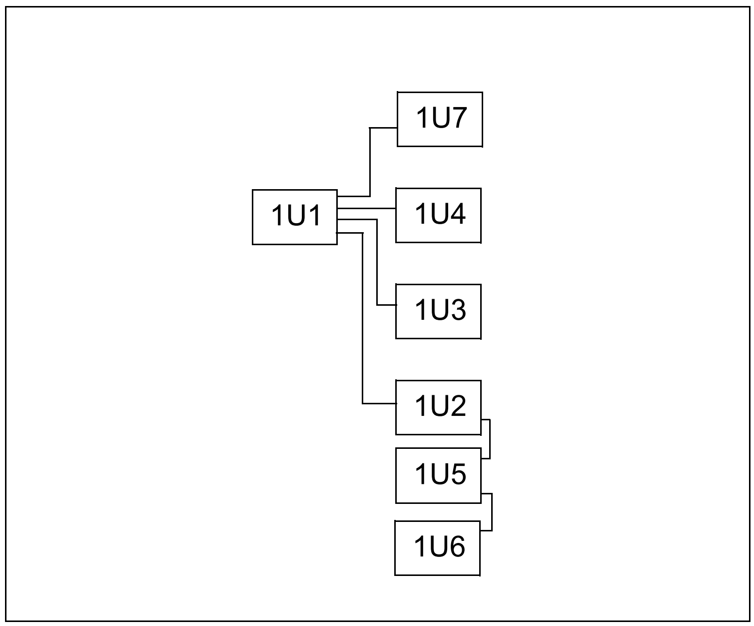

Figure 12-1 IPC Daisy Chain

12-3 b. 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.

NOTE: If the CLD is blank, check power to the CLD.

Loss of power can most directly be diagnosed by measuring the 24 VAC voltage at the 4 pin J2 connector on all modules. Each module will have between 20 and 28 VAC across J2 1-2 and J2 3-4.

12-3 c. 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 some communications. The former can be identified by analyzing all of the active diagnostics. The latter can be identified through a process of elimination, whereby each module, in turn, is taken out of the IPC link and a jumper is installed in its place. Reset the diagnostices and analyze the new diagnostics produced.

12-3 d. Incorrect Polarity:

Refer to the wiring schematic and confirm that all black wires in the twisted pair connect to the positive (+) terminals (either pin 1 or 3) of all the modules. Then confirm that all of the white wires of the twisted pair connect to the negative (-) terminals (either pin 2 or 4) of all the modules.

12-3 e. High levels of Electro-Magnetic Interference:

The modules and the IPC link have been qualified under numerous and severe EMI (both radiated and conducted) and the system judged 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.

12-3 f. 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, UCP2 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.

12-3 g. Loss of common ground:

Verify that a good ground exists between all modules. The CLD requires a dedicated green wire ground. Verify that it is in place and has a good connection.

12-4. Procedure for Troubleshooting IPC Communication Diagnostics

12-4 a. Communication Diagnostics

1. Place the UCP2 in “Stop” by pressing the stop key once. 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 RTHC-IOM manual.
2. Check the IPC connections to all modules. Make sure the twisted pair wires that plug into each modules' J1 connector are making good contact with the wire. Be sure each connector is not clamping down on the wire insulation.
3. Determine which modules are not talking. These modules must be affected by one of the previously stated problems. If the 1U1 is reporting that it cannot talk to any of the other modules. Suspect a bad 1U1. If the there is a comm loss involving the 1U2, 1U5, and 1U6, suspect a wiring problem early in the daisy chain link. If only one module is not talking, suspect a loss of power. Refer to figure 12-1 for IPC daisy chain wiring.
4. Determine which modules are still talking. Wiring to these is likely to be OK.
5. Try disconnecting the link or jumping out modules in the link at various places. Reset the diagnostics and note which diagnostics reappear.

   The 1U7, 1U2 and 1U3 are connected directly to the 1U1 and are not part of a daisy chain.
6. Verify that the polarity of the IPC link is correct.
7. Using a voltmeter set to AC volts, measure the voltage at the J2 connector on each module. It should read between 20 and 28 VAC. Also check the green connector to make sure it is securely plugged into the module. Inspect each screw terminal to be sure they are not clamping down on the wire insulation.
8. Most of the UCP2 modules have 24 VDC and 5 VDC test points on the board. They are clearly labeled and accessible without removing the sheet metal covers.
9. Using a voltmeter set to DC volts, measure the 5 volt test point. It should be between 4.75 VDC and 5.25 VDC. Measure the 24 volt test point. It should be between 23 VDC and 25 VDC. If any of the voltage measurements are not within the acceptable range, replace the module.

10. Verify that a good ground exists between all modules. The CLD requires a dedicated green wire ground. Verify this is in place, and has a good connection.
11. There are a large number of possible combinations of diagnostics. One must deduce what is causing the problem using all available information.

12-4 b. Troubleshooting Data Not Valid Diagnostics

If the IPC link between the CLD and the chiller module is broken or if there is a short on the IPC link it will produce:

No Communication, Data Not Valid

1. Check the IPC link between the 1U1 and the 1U4. Check the connector and ohm out the wire. If it is OK proceed with the next step.
2. Perform the above checkout procedure.
3. If the message still did not go away, unplug all of the IPC connections from the Chiller module except for the IPC link that goes to the Clear Language Display.
4. Establish communication with only the Chiller module and then plug the other IPC connections back onto the Chiller module one at a time. If the “No Communication, Data Not Valid” message suddenly reappears when you plug one of the connections back in, the IPC link that is causing the fault is identified. Carefully check that link for a lead to lead short or a short to ground.

12-4 c. For a "Loss of Comm with Stepper" diagnostic:

1. Make sure the wiring to the stepper motor is correct. If the wiring is not correct it will destroy the power supply on the module, and a “Loss of Comm with Stepper” will result.

   The correct stepper wiring follows

Table 12-1: Stepper Motor Connection

J8 Connector Pin# on Stepper Module	Motor Winding Output Signal Name	Motor Terminal Connection
4	1+	1
3	2+	3
2	1-	2
1	2-	4

Section 13 Module Power and Miscellaneous I/O

13-1. General

This section details the normal voltage levels present on each of the module inputs and outputs under various conditions or states. Typical operation of the I/0 will be discussed in terms of chiller operation. This should help the serviceman determine when and how the modules should function. Certain inputs have been presented in greater detail in earlier sections, and these are referenced where applicable.

13-2. Power Supply

All of the modules are powered from 24 VAC control power. This power is provided by a factory installed control power transformer. The modules have incoming power connected to J2. The terminal is arranged with two hot pins (1 and 3) and two neutral pins (4 and 2), for ease of “daisy chaining” power from one module to another. Pins 1 and 3 and pins 2 and 4 are internally jumpered. Incoming power can be verified by measuring the voltage between J2-1 or 3 to J2- 2 or 4. The voltage should read be approximately 24 VAC rms.

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 UCP2. Refer to Section 8 Interprocessor Communication for more information about communication diagnostics. If the Clear Language Display(CLD) is blank, 24 VAC power should be checked at the CLD.

13-3. Clear Language Display (CLD) Keypad Overview (1U4)

13-3 a. General

Local operator interface with the system is accomplished using the 16 keys on the front of the CLD 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. Depressing any key will activate the backlight. The backlight will stay activated for 10 minutes after the last key is pressed.

13-3 b. 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 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, Refrigerant and Compressor Reports are informational reports showing current status. Each report and its contents are discussed in detail on the following pages.

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. If the headers are disabled the display will be the display listed after the heading.

The Next and Previous keys 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.

13-3 c. 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 Select Report Group, above.

Setpoint values are increased by pressing the Plus (+) key and decreased by pressing the Minus (-) key. Once a setpoint is changed, press the Enter key to accept the new setting. If the Cancel key is pressed, the setpoint value on the display will be ignored and the original setpoint will remain. The display will not advance until either Enter or Cancel is pressed.

13-3 d. 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 Field Start-up Group, press:

+ + - - + + Enter

4. To enter into the Machine Configuration Group, press:

+ - + - + - Enter

Refer to the IOM for the list of items found in Start-up Group and Machine Configuration Group.

13-3 e. Select Report Group and Select Settings Group Flowcharts

Refer to the 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: STATUS, WTR TEMPS & SETPTS
“PRESS (NEXT) (PREVIOUS) TO CONTINUE”
```

Press Next to move down through the Chiller Report.

As shown in the figures, the flowchart explains the conditions that the UCP2 looks at to determine which readout is to be displayed next. For example:

Press Chiller Report to display the header

Press Next to display

```
OPERATING MODE                    [LINE 1]
OPERATING MODE                    [LINE 2]
```

Press Next to display

```
ACTIVE CHILLED WATER SETPT:       [XXX.X F/C]
EVAP LEAVING WATER TEMP:          [XXX.X F/C]
```

If the chiller is in the Ice Making or Ice Making Complete mode, the following display is substituted for the above display:

```
ACTIVE ICE TERMINATION SETPT:     [XXX.X F/C]
EVAP RETURN WATER TEMP:           [XXX.X F/C]
```

13-3 f. Auto/Stop Keys

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

Pressing the Stop key twice will initiate a panic stop. This method of stopping the chiller should only be used for emergency shutdowns, because the slide valve will not have a chance to return to the unloaded position for the next start.

If the chiller is in the Stop mode, pressing the Auto key will cause UCP2 to go into the Auto mode.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.

13-3 g. 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
```

NOTE: X's will be replaced with appropriate software revision numbers.

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

```
OPERATING MODE          [LINE 1]
OPERATING MODE          [LINE 2]
```

and the backlight will be activated.

13-3 h. LEDs

There are four LEDs located to the right of J1 of the CLD module. The left most TST LED should be on continuously.

If the TST LED blinks, it indicates the processor is repeatedly being reset. The module needs to be replaced if this is occurring.

The second LED from the left is the +5 VDC LED and should also be on continuously. It will go out if power drops below normal operating voltage. The TX LED (third from the left) should blink every second or two, as the CLD transmits on the IPC. The RX LED (fourth from the left) should blink continuously, indicating that other modules are communicating.

Table 13-1: CLD Nominal Terminal Voltage (1U4)

Terminal Designation	Description of Circuit	Nominal Terminal Voltages for Various Conditions
J1-1 (BK) J1-2 (W)	IPC Communication	19.2K Baud serial data 5 V signal level
J2-1, 2	24 VAC Power	18-30 VAC, neither side grounded

13-4. Chiller Module (1U1)

13-4 a. Test Points

There are two test points (TP) associated with the Chiller 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.

Do not use the aluminum module enclosure as the reference it has an anodized surface with insulating properties.

The DC voltages shall be within the following tolerances. If not, replace the module.

13-4 b. I/O Terminals

For the checkout of the I/O, refer to the Chiller Wiring Diagrams for both high and low voltage circuits. All voltages are measured between terminal pairs specified unless otherwise indicated. Nominal voltages are given and may vary by ±5%. Unregulated voltages (unreg) or 115 VAC voltages may vary by ± 15%.

Table 13-2: Test Point Voltages for 1U1 Module

Test Point	Voltage (VDC)
TP1	4.8 to 5.2
TP2	23 to 25

Table 13-3: Chiller Module Nominal Terminal Input and Output (1U1)

Terminal Designation	Description of Circuit	Normal Terminal Voltages for Various Conditions
J1A-1, 3 (BK) J1A-2, 4 (W) J1B-3 (BK) J1B-4 (W)	IPC Communications	19.2 kbaud serial data, RS485 signal level. Refer to Interprocessor Communication (IPC)
J2-1 or 3 to J2-2 or 4	Input Power	24 VAC, Refer to Power Supply
J3-1, 2	Evap. Entering Water Temp. Sensor	Refer to Temperature Sensor Checkout
J3-3, 4	Evap.Leaving Water Temp. Sensor	Refer to Temperature Sensor Checkout
J3-5, 6	Condenser Entering Water Temp. Sensor	Refer to Temperature Sensor Checkout
J3-7, 8	Condenser Leaving Water Temp. Sensor	Refer to Temperature Sensor Checkout
J4-2,1	Oil Return Gas Pump Fill Sol Valve and Coil:	Solenoid cycles on and off on a 1minute+50 sec. cycle for a variable duty cycle while the chiller is running. This valve opens a vent line to the evaporator to allow filling of the chamber.

Table 13-3: Chiller Module Nominal Terminal Input and Output (1U1)

Terminal Designation	Description of Circuit	Normal Terminal Voltages for Various Conditions
J5-1, 2	External Auto Stop	open: 20.6 VDC unreg -stopped closed: 0 VDC - normal Must be jumpered if feature is not used
J5-3, 4	Emergency Stop	open: 20.6 VDC unreg -stopped closed: 0 VDC - normal Must be jumpered if feature is not used
J5-5, 6	Outdoor Air Temp. Sensor	Refer to Temperature Sensor Checkout
J6-2,1	Oil Return Gas Pump Drain Sol Valve and Coil:	Solenoid is energized in inverse to 4L1 above. This valve opens a line to the high pressure in the condenser and causes the chamber to flush out its refrigerant oil mixture and return it to the compressor suction.
J7-11,12	External Base Load Setpoint Analog Input	Customer Connected 2-10 Vdc or 4-20-mA Input
J8-2,1	Slide Valve Load Solenoid Valve and Coil	Solenoid is pulsed allowing high pressure gas into slide valve piston, causing slide valve to move toward loaded position.
J9-3,4,5	Oil Loss Level Sensor	Non contact, binary, optical sensing of liquid level. Used for compressor oil loss/oil flow protection. Red: 24 VDC supply, Grn: Vout low=liquid, high=No liquid, Blk: Gnd
J10-2,1	Slide Valve Unload Solenoid Valve and Coil	Solenoid is pulsed allowing gas in slide valve piston to vent to suction causing slide valve to move toward unloaded position.
J12-1, 2	Chilled water pump starter (N.O. contact)	Dry SPST contact closes when chilled water demand switch closes, opens after time delay specified in UCP2 Evap Pump Off Delay specified under the Service Settings Menu.
J14-1, 2	Condenser water pump starter (N.O. contacts)	Dry SPST contact closes when call for cooling is established. Contact opens on compressor shutdown.
J16-3, 2,1	Programmable Relay Output #1	Customer programmable annunciation Relay
J18-3, 2,1	Programmable Relay Output #2	Customer programmable annunciation Relay

Table 13-3: Chiller Module Nominal Terminal Input and Output (1U1)

Terminal Designation	Description of Circuit	Normal Terminal Voltages for Various Conditions
J20-1, 2	Programmable Relay Output #3	Customer programmable annunciation Relay
J22-3, (Hot) J22-1(NO) & 1K11 or 1K400-33,34 (NO)	Master Oil Line Solenoid Valve	NO output controls NC Solenoid Valve in Service Override (Stop mode only) to allow for Oil Charging procedure. Otherwise in normal modes, solenoid is controlled by Relay 1K11 to open when compressor runs, and close when compressor stops.
J24-2(Hot),1(N)	High Pressure Cutout Switch	NC contact is hardwired into compressor starter circuit, NO contact is wired to this input for HPC sense Trip at 180±5 PSIG
J26-1, 2	Chilled Water Flow Switch input	open: 115 VAC - means no flow closed: <5 VAC - means flow (Software imposes a 6 second delay before responding to an open or closed contact.)
J28-1, 2	Condenser Water Flow Switch input	open: 115 VAC - means no flow closed: <5 VAC - means flow (Software imposes a 6 second delay before responding to an open or closed contact.)

13-5. Starter Module (1U2)

13-5 a. Test Points

There are two test points (TP) associated with the Starter 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 DC voltages shall be within the tolerances specified below. If not replace the module.

Table 13-4: Test Point Voltages for 1U2 Module

Test Point	Voltage (VDC)
TP1	23 to 25
TP2	4.8 to 5.2

Do not use the aluminum module enclosure as the reference as it has an anodized surface with insulating properties.

13-5 b. I/O Terminals

For the checkout of the I/O, refer to the Chiller Wiring Diagrams for both high and low voltage circuits. All voltages are measured between terminal pairs specified unless otherwise indicated. Nominal voltages are given and may vary by ±5%. Unregulated voltages (unreg) or 115 VAC voltages may vary by ± 15%.

Table 13-5: Starter Module Nominal Terminal Voltages (1U2)

Terminal Designation	Description of Circuit	Normal Terminal Voltages for Various Conditions
J1-1 (BK) J1-2 (W)	IPC Communications	19.2 kbaud serial data, RS485 signal level. Refer to Interprocessor Communication (IPC)
J2-1 to J2-2	Input Power	24 VAC, Refer to Power Supply
J3-1,2	Phase Sequence Monitor	NOT AVAILABLE
J3-3 and J3-4 (A-B) J3-5 and J3-6 (B-C) J3-7 and J3-8 (C-A)	Under-Over Voltage transformers	Refer to Under-Over Voltage Checkout.
J4-2 to J4-1	Opto Input (Up to speed signal and At Speed Signal)	Prior to transition (wye-delta only): J4-2 to GND = 0 VAC J4-1 to GND = 0 VAC After transition (wye-delta only): J4-2 to GND = 115 VAC J4-1 to GND = 115 VAC Prior to closure of Run contacts (Across-line rev 07 or later only): J4-2 to GND = 0 VAC J4-1 to GND = 0 vac After closure of Run contacts (Across the line Rev 07 of later only): J4-2 to GND = 115 VAC J4-1 to GND = 115 VAC
J5-1 and J5-2 (A) J5-3 and J5-4 (B) J5-5 and J5-6 (C)	Current transformers X13580269-xx	Refer to Current Transformers Checkout.
J6-3 to J8-2	Stop contacts	Open: 115 VAC - Normally open Close: 0VDC Use Starter Dry Run under Service Tests to confirm operation.
J6-3	HPC Switch (NC side)	Normal operation: 115VAC to GRD Loss of power: 0 VAC - Confirm operation and wiring of High Pressure Cutout switch Pin J6-1 internally commoned to Pin J8-2. Trip at 180 PSIG

Table 13-5: Starter Module Nominal Terminal Voltages (1U2)

Terminal Designation	Description of Circuit	Normal Terminal Voltages for Various Conditions
J7-1 and J7-2	Heat Sink Temperature Sensor (Solid State Starters only)	Refer to solid state starter service bulletin.
J7-3 and J7-4	Starter Fault Relay (Solid State Starters only)	Refer to solid state starter service bulletin.
J10-1 to J10-3	Run contact	Open: 115 VAC - Normally open at start-up, Close: 0VDC Use Starter Dry Run under Service Tests to confirm operation.
J10-1 to J4-2	Jumper	Required on Across the Line Starters with modules of X13650453-07 (software revision -07) or later.
J12-1 to J12-3	Shorting contact	Open: 115 VDC - Normally open at start-up. Close: 0VDC Use Starter Dry Run under Service Tests to confirm operation.
J14-1 to J14-3	Transition contact	Open: 115 VDC - Normally open at start-up, Close: 0VDC Use Starter Dry Run under Service Tests to confirm operation.

13-6. Stepper Module (1U3)

13-6 a. Test Points

There are four test points (TP) associated with the Stepper 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.

Do not use the aluminum module enclosure as the reference. The enclosure has an anodized surface with insulating properties.

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

Table 13-6: Test Point Voltages for 1U3 Module

Test Point	Voltage (VDC)
TP1	26 to 48
TP2	4.8 to 5.2
TP3	11 to 16
TP4	23 to 25

13-6 b. I/O Terminals

For the checkout of the I/O, refer to the Chiller Wiring Diagrams for both high and low voltage circuits. All voltages are measured between terminal pairs specified unless otherwise indicated. Nominal voltages are given and may vary by $\pm$5%. Unregulated voltages (unreg) or 115 VAC voltages may vary by $\pm$ 15%.

Table 13-7: Stepper Module Nominal Terminal Voltages (1U3)

Terminal Designation	Description of Circuit	Normal Terminal Voltages for Various Conditions
J1-1, 3 (BK) J1-2, 4 (W)	IPC Communications	19.2 kbaud serial data, RS485 signal level. Refer to Interprocessor Communication (IPC) NOTE: Polarity sensitive

Table 13-7: Stepper Module Nominal Terminal Voltages (1U3)

Terminal Designation	Description of Circuit	Normal Terminal Voltages for Various Conditions
J2-1 or 3 to J2-2 or 4	Input Power	24 VAC, Refer to Power Supply
J5-1, 2	Saturated Evaporator Refrigerant Temperature Sensor	Refer to Temperature Sensor Checkout X13790159-02
J5-3, 4	Compressor Discharge Sensor	Refer to Temperature Sensor Checkout X13790159-02
J7-1,2,3	Evap Refrigerant Liquid Level Sensor	5 VDC Supply, 0.7 to 4.2 Volts Linear output over range of ± 1". Midpoint of sensor mounted approx. 3.5" from bottom of evap.
J8-2, 4	EXV Winding 1	Refer to Section 7: Electronic Expansion valve Checkout
J8-1, 3	EXV Winding 2	Refer to Section 7: Electronic Expansion valve Checkout
J11-1, 2	Low Pressure Cutout	open: 24 VAC: Trip closed: 0 VAC: Normal operation If the switch is open for more than 0.5-2 seconds unit will trip on Low Evap Rfgt Pressure.
J11-3,4	Saturated Cond Rfgt Temp Sensor	Condenser Limit control and Differential pressure functions and protection. Refer to Temperature Sensor Checkout X13790159-02

13-7. Options Module (1U5)

13-7 a. Test Points

There are two test points (TP) associated with the Options 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.

Do not use the aluminum module enclosure as the reference as it has an anodized surface with insulating properties.

The DC voltages shall be within the following tolerances. If not, replace the module.

Table 13-8: Test Point Voltages for 1U5 Module

Test Point	Voltage (VDC)
TP1	4.8 to 5.2
TP2	23 to 25

13-7 b. I/O Terminals

For the checkout of the I/O, refer to the Chiller Wiring Diagrams for both high and low voltage circuits. All voltages are measured between terminal pairs specified unless otherwise indicated. Nominal voltages are given and may vary by ±5%. Unregulated voltages (unreg) or 115 VAC voltages may vary by ± 15%.

Table 13-9: Options Module Nominal Terminal Voltages (1U5)

Terminal Designation	Description of Circuit	Normal Terminal Voltages for Various Conditions
J1-3 (BK) J1-4 (W)	IPC Communications	19.2 kbaud serial data, RS485 volt signal level. Refer to Interprocessor Communication (IPC)
J2-1 or 3 to J2-2 or 4	Input Power	115 VAC, Refer to Power Supply
J3-7, 8	Ice Machine Control Input	open: 24 VDC: standard comfort cooling closed: 0 VDC: Ice making mode Unit remains in ice making unit contacts open or until the entering evap. water sensor reaches the ice termination setpoint. **NOTE**: “Ice Building Options” under Service Settings, Machine Configuration Group must be Enabled. The “Ice Building: (Enable/Disable)” under Operator Settings needs to be Disabled for normal operation. This option should only be enabled when the operator wants to put the chiller into ice making immediately from the front panel.
J7-1,2	Condenser Pressure Analog Output	Outputs analog signal proportional to Condenser Pressure per temp to pressure conversion for R134a. 0-10 VDC output
J7-3, 4	% Compressor RLA output	2-10 VDC output signal. 2 V = 0% RLA 10 V = 120% RLA NOTE: 4-20 mA is not available.
J7-7, 8	Tracer Temp. Sensor Input	An additional temperature sensor input to tie to Tracer. Not used on stand alone units.
J7-11, 12	External Current Limit Setpoint Input (Current or voltage option)	Refer to External Setpoint Inputs Unreferenced 2-10V or 4-20 mA Input (SW2-1)
J8-1, 2	Ice Machine Relay (N.O.)	Open: Normal operation Closed: Unit running in Ice Making mode The contacts are rated for a max. of 250 VAC or 30 VDC.

Table 13-9: Options Module Nominal Terminal Voltages (1U5)

Terminal Designation	Description of Circuit	Normal Terminal Voltages for Various Conditions
J9-4, 5	External Chilled Water Setpoint (Current or voltage option)	Refer to External Setpoint Inputs Unreferenced 2-10V or 4-20 mA Input (SW3-2)
J12-1, 2	Head Relief Request Relay (N.O.)	Open: Normal operation Closed: Operating mode of Condenser Limit The contacts are rated for a max. of 250 VAC or 30 VDC.
J18-3,2,1	Tracer Controlled Relay	This output contact is reserved for exclusive control through Tracer communication

13-7 c. Switch SW2

Switch SW2 is used to configure the External Current Limit Setpoint input for either a 2-10VDC, or a 4- 20mA signal. For use of a 2-10 VDC signal, set SW2-1 to "OFF". For use of a 4-20 mA signal, set the SW2-1 to "ON". SW2-2 and 3 are not used.

13-7 d. Switch SW3

Switch SW3 is used to configure the External Chilled Water Setpoint input for either a 2-10VDC, or a 4- 20 mA signal. For use of a 2-10 VDC signal, set SW3-1 to "OFF". For use of a 4-20 mA signal, set the SW3-1 to "ON". SW3-2 is not used.

13-7 e. External Setpoint Inputs (4-20mA/2-10VDC)

The chiller setpoint source should always be set to LOCAL when using any external inputs, except Tracer. When using 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 4-20 mA or 2-10 VDC signal from an external controller or programming resistor connected to an internal +5V source. The switches SW2-1 and SW3-1 are used to select either the voltage or current option for External Current Limit Setpoint and External Chilled Water Setpoint respectively. Refer to tables 13-11 and 13-12.

Items that must be set in UCP2 are:

Located in Service Settings, Machine Configuration Group (+-+-+-):

Ext Chilled Wtr Setpt: (Installed, Not Installed)

Ext Current Limit Setpt: (Installed, Not Installed)

External Analog Inputs: (4-20 mA, 2-10 VDC)

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

1. Is isolated (floats) with respect to ground, or
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 4-20 mA/2-10 VDC inputs may be tested in the following way:

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 (J9-4,5) or the External Current Limit Setpoint (J7-11, 12). The voltage measured at the terminals and the resulting setpoint, as read on the CLD, should agree with the Table 9-10 for Chilled Water Setpoint inputs and Table 9-11 for Current Limit Setpoints inputs. Be sure to wait long enough when reading the display as the values are filtered.

NOTE: A 9 volt battery works well when trying to diagnose a 2-10 VDC signal problem. Disconnect the signal and wire in the battery to simulate a 9 VDC signal. This is polarity sensitive. For Current Limit J7-11 is battery negative and J7-12 is battery positive. For Chilled Water Setpoint J9-4 is battery negative and J9-5 is battery positive,

1. Disconnect all wiring to these inputs. The setpoints should change back to the chiller's Front Panel settings

.

Table 13-10: Input values for External Chilled Water Setpoints

Current (mA)	Voltage (VDC)	Resulting Chilled Water Setpt (F) ±4F
4.0	2.0	0.0
5.2	2.6	5.0
6.5	3.2	10.0
7.7	3.9	15.0
8.9	4.5	20.0
10.2	5.1	25.0
11.4	5.7	30.0
12.6	6.3	35.0
13.8	6.9	40.0
15.1	7.6	45.0
16.3	8.2	50.0
17.5	8.8	55.0
18.8	9.4	60.0
20.0	10.0	65.0

Table 13-11: Input values for External Current Limit Setpoints

Input Current (mA)	Voltage (VDC)	Resulting Current Limit Setpt (%RLA) ±5%
4.0	2.0	40
6.0	3.0	50
8.0	4.0	60
10.0	5.0	70
12.0	6.0	80
14.0	7.0	90
16.0	8.0	100
18.0	9.0	110
20.0	10.0	120

13-8. TCI-COMM 3 and 4 (1U6)

13-8 a. Test Points

There are two test points (TP) associated with the TCI modules. They are easily read with a DC voltmeter by probing the PC board solder pads found in the upper left hand corner each module. The positive meter lead should be connected to the pad while referencing the negative meter lead to the board edge ground plane. The DC voltages shall be within the following tolerances. If not, replace the module.

Table 13-12: Test Point Voltages for 1U6 Module

Test Point	Voltage (VDC)
TP1	4.8 to 5.2
TP2	23 to 25

Do not use the aluminum module enclosure as the reference as it has an anodized surface with insulating properties.

13-8 b. ICS Communications

ICS communication is handled the same as on previous products using the Trane proprietary Comm3 or Comm4 standard 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 ICS Tracer should be able to communicate to the chiller for monitoring purposes, regardless of the Setpoint Source selection.
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 J3-1and 2 and J3-3 and 4.

Table 13-13: TCI-COMM 3 or 4 Module Nominal Terminal Voltages (1U6)

Terminal Designation	Description of Circuit	Normal Terminal Voltages for Various Conditions
J1A-3 (BK) J1A-4 (W) *J1A-1(BK) *J1A-2 (W) * If additional modules are used.	IPC Communications	19.2 kbaud serial data, RS485 signal level. Refer to Interprocessor Communication (IPC)
J2-1 or 3 to J2-2 or 4	Input Power	115 VAC, Refer to Power Supply
J3-1, 2	Twisted Pair to Tracer	Comm 3 or Comm 4 signal
J3-3, 4	Twisted Pair to tracer	Comm 3 or Comm 4 signal

4. Check for a diagnostic at the display indicating loss of IPC communications with the TCI module. This could indicate IPC bus problems or a dead TCI module. The TCI module needs to receive 4 good packets of data from the Chiller before it will talk on the ICS link.

13-8 c. I/O Terminals

For the checkout of the I/O, refer to the Chiller Wiring Diagrams for both high and low voltage circuits. All voltages are measured between terminal pairs specified unless otherwise indicated. Nominal voltages are given and may vary by ±5%. Unregulated voltages (unreg) or 115 VAC voltages may vary by ± 15%.

13-9. Printer Interface (1U7)

13-9 a. Test Points

There are two test points (TP) associated with the Printer Interface 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. The DC voltages shall be within the previous tolerances. If not, replace the module.

Table 13-14: Test Point Voltages for 1U7 Module

Test Point	Voltage (VDC)
TP1	4.8 to 5.2
TP2	23 to 25

Do not use the aluminum module enclosure as the reference as it has an anodized surface with insulating properties.

13-9 b. Recommended Printer Setup

A serial printer must be used with the printer interface module. Several settings in the UCP2 must match the printer settings identically.

The suggested serial communications settings in the UCP2 are in **bold** print below.

Located in Service Settings menu:

Printer Option: (Installed, Not Installed)
Set it to Installed.

NOTE: This setting is under the password protected Machine Configuration Group (+-+-+-) which must be “Installed” before the remaining displays will appear under the non-password protected items in Service Settings.

[ ] Print on Time Interval: (Enable, Disable)
[ ] Print Time Interval: (1-24 hrs)
[ ] Print on Diagnostic: (Enable, Disable)
[ ] Number of Pre-Diagnostic Reports: (1-5)
[ ] Printer, Baud Rate: **9600**
[ ] Printer, Parity: **None**
[ ] Printer, Data Bits: **8**
[ ] Printer, Stop Bits: **1**
[ ] Printer Handshaking: **XON-XOFF**

Table 13-15: Required Cable Part Numbers

Trane Part Number	Description
35914264	DB25 male/RJ-12 female
35914262	DB9 female/RJ-12 female
35914260	6 conductor cable with two RJ-12 male

The recommended parts needed to make the appropriate connection using Trane parts are listed in Table 13-16. If Trane parts are not used, a DB25 male to DB9 female serial printer cable is needed to make the connection.

For proper operation, do not use a null modem cable.

13-9 c. I/O Terminals

For the checkout of the I/O, refer to the Chiller Wiring Diagrams for both high and low voltage circuits. All voltages are measured between terminal pairs specified unless otherwise indicated. Nominal voltages are given and may vary by ±5%. Unregulated voltages (unreg) or 115 VAC voltages may vary by ± 15%.

Table 13-16: Printer Interface Module Nominal Terminal Voltages (1U7)

Terminal Designation	Description of Circuit	Normal Terminal Voltages for Various Conditions
J1A-3 (BK) J1A-4 (W) OR *J1A-1 (BK) *J1A-2 (W) * Dependent on other modules used with system, refer to unit wiring for details.	IPC Communications	19.2 kbaud serial data, RS485 signal level. Refer to Interprocessor Communication (IPC)
J2-1 or 3 to J2-2 or 4	Input Power	115 VAC, Refer to Power Supply
J4-1 thru 9	RS 232 Port	Standard RS232 signal

Section 14 Diagnostic Table

14-1. General

There are three diagnostic types listed in the following table. A latching diagnostic called an MMR will shutdown the entire unit and need a manual reset to come back on line. A non-latching diagnostic called an MAR will shut the entire machine down when the condition exists but will allow the unit to come back on line automatically once the diagnostic has cleared. The third type of diagnostic is informational only, the microprocessor will let you know that a condition exists but will allow the unit to operate.

Table 14-1: Diagnostic Types and Action

Diagnostic Type	Action	Reset
MMR	Machine Shutdown	Manual Reset
MAR	Machine Shutdown	Automatic Reset
IFW	Informational Warning - no action	None required

Table 14-2: Diagnostic Table

Diagnostic Description	Type/ Shutdown Action	Module Calling Out Diag.	Operating Modes Diagnostic is Active	Cause	Help Message
At Speed Input Opened	MMR immediate	Starter 1U2	All running modes	The At Speed input was found opened with the compressor running after successfully obtaining an at speed condition. Applies to solid state starters only	Refer to the solid state starter service bulletin. Refer to the starter module check-out.
At Speed Input Shorted	MMR n/a	Starter 1U2	Pre-start	The At Speed input was found shorted before the compressor was started. Applies only to the solid state starters.	Refer to the solid state starter service bulletin. Refer to the starter module check-out.
Check Clock	IFW n/a	Chiller 1U1	All	On loss of power the clock does not keep time, if there is an extended power loss (greater than 15 seconds) this diag. is also generated to alert the operator to check the clock.	Check Main Power Supply, Reset Clock

Table 14-2: Diagnostic Table

Diagnostic Description	Type/ Shutdown Action	Module Calling Out Diag.	Operating Modes Diagnostic is Active	Cause	Help Message
Chilled Water Flow Lost	MAR immediate	Chiller 1U1	All modes except STOP and EXTERNAL STOP	a) The chilled water flow switch input was open for more than 6-10 contiguous seconds. b) 6-10 seconds of contiguous flow shall clear this diagnostic.	Check Pump, Valves, Flow Switch
Chiller Mod Off-Brd 5V Range	IFW n/a	Chiller 1U1	all	An improper Off Board 5v voltage was detected at the Chiller Module. A 5vdc is used for off-board devices such as the pressure transducers. The micro checks to see that the A/D value falls within an acceptable range.	Replace Chiller Module
Chiller: Loss of Comm with Rfgt Monitor	IFW n/a	Chiller 1U1	All	The Chiller module lost communications with the Refrigerant Monitor for 15 contiguous seconds.	Check IPC Wiring/ Connections.
Chiller: Loss of Comm with TCI	IFW/ n/a	Chiller 1U1	All	The Tracer was setup as “installed” at the CLD and the chiller module lost communications with the TCI (comm 3 or comm 4) module for 15 contiguous seconds	Check IPC Wiring/ Connections.
Chiller: Loss of Comm with Local CLD	IFW n/a	Chiller 1U1	All	The chiller module lost communications with the LCLD module for 15 contiguous seconds.	Check IPC Wiring/ Connections.
Chiller: Loss of Comm with Options	IFW n/a	Chiller 1U1	All	The chiller module lost communications with the Options module for 15 contiguous seconds.	Check IPC Wiring/ Connections.
Chiller: Loss of Comm with Starter	MMR friendly	Chiller 1U1	All	The chiller module lost communications with the Starter module for 15 contiguous seconds.	Check IPC Wiring/ Connections.
Chiller: Loss of Comm with Stepper	MMR friendly	Chiller 1U1	All	The chiller module lost communications with the Stepper module for 15 contiguous seconds.	Check IPC Wiring/ Connections.
Chiller: Loss of Comm with TCI	IFW n/a	Chiller 1U1	All	The Tracer was setup as "installed" at the CLD and the chiller module lost communicaitons with the TCI (comm 3 or comm 4) module for 15 contiguous seconds	Check IPC wiring/ connections
Cond Entering Wtr Temp Sensor	IFW n/a	Chiller 1U1	All	Open or Short	Check sensor, wiring and connections.

Table 14-2: Diagnostic Table

Diagnostic Description	Type/ Shutdown Action	Module Calling Out Diag.	Operating Modes Diagnostic is Active	Cause	Help Message
Cond Leaving Wtr Temp Sensor	IFW n/a	Chiller 1U1	All	Open or Short.	Check sensor, wiring and connections.
Condenser Rfgt Temp Sensor	MMR friendly	Stepper 1U3	All	Open or Short	Check sensor, wiring and connections.
Condenser Water Flow Lost	MAR friendly	Chiller 1U1	Start and All Run Modes	The condenser water flow switch input was open for more than 6-10 contiguous seconds, 6-10 seconds of contiguous flow shall clear this diagnostic.	Check pumps, valves, and flow switch
Condenser Water Flow Overdue	MMR friendly	Chiller 1U1	Estab. Cond Water Flow	Condenser water flow was not proven within 4.25 minutes of the condenser pump relay being energized.	Check pumps, valves, and flow switch
Cprsr did not Accelerate Fully	MMR n/a	Starter 1U2	Starting	Used with Solid State Starters only. The UCM did not receive an Up to Speed or At Speed Signal within the Maximum Acceleration Timer Setting. Up to speed or At speed signals are received at the Starter module on J4-1 and 2.	Determine if SSS is ramping properly. Confirm compressor is starting unloaded. Confirm operation of current transformers. Refer to Starter module checkout.
Cprsr did not Accelerate: Shutdown	MMR immediate	Starter 1U2	Start Mode	The compressor did not come up to speed (get to <85% RLA) in the allotted time defined by the Maximum Acceleration Timer. The Human Interface setups defined “Shutdown” as the action when the Maximum Acceleration Timer was exceeded.	The 1K2 aux contacts did not close in the allotted time. Check main power supply & wiring. Check 1K2 aux. contacts. Check Starter module.
Cprsr Did Not Accelerate: Transition (The Motor is put across the line.)	IFW n/a	Starter 1U2	Start Mode	The compressor did not come up to speed (get to <85% RLA) in the allotted time defined by the Maximum Acceleration Timer. The Human Interface setups defined “Transition” as the action when the Maximum Acceleration Timer was exceeded.	The 1K2 aux. contacts did not close in the allotted time. Check main power supply & wiring. Check 1K2 aux. contacts. Check Starter module.
Current Overload	MMR immediate	Starter 1U2	All Running Modes	Motor current exceeded overload time vs. trip characteristic.	Check CT's. Confirm compressor is starting unloaded. Confirm refrigerant charge and overload settings.

Table 14-2: Diagnostic Table

Diagnostic Description	Type/ Shutdown Action	Module Calling Out Diag.	Operating Modes Diagnostic is Active	Cause	Help Message
Current Overload Setpts Error	IFW n/a	Starter 1U2	All	The redundant overload settings did not agree for 30 contiguous seconds.	Review Overload Set Up.
CWS/Leaving Wtr Temp. Cutout Setpt Overlap also Overlap of CWS and Low Refrigerant Temp Cutout.	None n/a	Chiller 1U1	All	No diagnostic, limit value to last legal value.	N/A
Discharge Temp Sensor	MMR friendly	Stepper 1U3	All	Open or Short	Check Sensor Wiring And Connections.
Emergency Stop Input	MMR friendly	Chiller 1U1	All	EMERGENCY STOP input is open. An external interlock has tripped. Time to trip from input opening to unit stop is 2 seconds.	Check Emergency Stop Input Device. Confirm Chiller Module operation.
Evap Entering Wtr Temp Sensor	IFW n/a	Chiller 1U1	All	Open or Short. Normal operation-no effects on control. Chilled Water Reset-will run at either normal CWS or will run at maximum reset permitted.	Check sensor wiring and connections.
Evap Leaving Water Temp Sensor	MMR friendly	Chiller 1U1	All	Open or Short	Check sensor wiring and connections.
Evap Rfgt Temp Sensor	MMR friendly	Stepper 1U3	All	Open or Short	Check sensor wiring and connections.
Evaporator Liquid Level Sensor	MMR friendly	Stepper 1U3	All	Open or short	Check Sensor, Wiring & Stepper Module
Evaporator Water Flow Overdue	MAR n/a	Chiller 1U1	Estab. Evap. Water Flow on going from STOP to AUTO.	Evaporator water flow was not proven within 4.25 minutes of the Evaporator pump relay being energized.	Check pump, valves and flow switch
External Chilled Water Setpoint	IFW-AR n/a	Options 1U5	All	Not “Enabled”-no diagnostics. “Enabled“-Out-Of-Range Low or High, set diagnostic, default CWS to next level of priority (e.g. Front Panel SetPoint). This IFW diagnostic will automatically reset if the input returns to the normal range.	Check signal at input on the Option module.

Table 14-2: Diagnostic Table

Diagnostic Description	Type/ Shutdown Action	Module Calling Out Diag.	Operating Modes Diagnostic is Active	Cause	Help Message
External Current Limit Setpoint	IFW-AR n/a	Options 1U5	All	Not "Enabled"- no diagnostics. "Enabled "- Out-Of-Range Low or High, set diagnostic, default CLS to next level of priority (e.g. Front Panel Setpoint. This IFW diagnostic will automatically reset if the input returns to the normal range.	Check signal at input on the Option module.
EXV Electrical Drive Circuit Open	MMR n/a	Stepper 1U3	On Demand and Pre-Start	Run the EXV electrical drive circuit test both on demand from the human interface and just before a start.	Check Stepper module, wiring, & motor.
High Cprsr Discharge Temp.	MMR	Stepper 1U3	All	The discharge temp. exceeded 190 F + or - 5F. Time to trip from trip value exceeded shall be 0.5 to 2.0 seconds.	Check Rfgt and Oil charge.
High Diff. Rfgt Pressure	MMR friendly	Stepper 1U3	Starter contactor energized	The difference between the Condenser pressure and the evaporator pressure exceeded 160 PSID for 0.8-5.0 seconds. 152PSID must hold, 152+ to trip in One Hour.	Check Cond and Evap water flow.
High Evaporator Liquid Level	MMR friendly	Stepper 1U3	Starter contactor energized	The liquid level sensor is seen to be at or near its high end of range for 80 contiguous minutes while the compressor is running	Check EXV, Sensor, Stpr Module & Rfgt Charge
High Pressure Cutout Tripped	MMR immediate	Chiller 1U1	All	A high pressure cutout was detected. C.O. on rise @ 180 psig, reset at 135 psig (+/-5 psid on switching tolerance) Note: Pressure relief valve is 200 Psi +- 2% ,	Check Cond Water Temp., Discharge Isolation Valves, and for Rfgt Over-Charge
High Restart Inhibit Timer Warning	IFW n/a	Starter 1U2	All	The Restart Inhibit timer has reached a maximum threshold for the host chiller. This is 15 minutes. This indicates excessive chiller cycling, steps should be taken to correct this.	Check for excessive chiller cycling.
Incorrect Chiller Software Installed	MMR n/a	Chiller 1U1	All	The incorrect Eprom was loaded into this module. This diagnostic is detected when a factory test computer sets the unit type to something other than what the Eprom software was intended for.	Replace Chiller Module
Incorrect Stepper Software Installed	MMR n/a	Stepper 1U3	All	The incorrect Eprom was loaded into this module. This diagnostic is detected when a factory test computer sets the unit type to something other than what the Eprom software was intended for.	Replace Stepper Module

Table 14-2: Diagnostic Table

Diagnostic Description	Type/ Shutdown Action	Module Calling Out Diag.	Operating Modes Diagnostic is Active	Cause	Help Message
Loss of Oil at Compressor (Running)	MMR immediate	Chiller 1U1	starter contactor energized	In Running modes , Oil sensor detects lack of oil in line for 1600 bit count-seconds seconds. (distinquishing a liquid flow from a vapor flow)	Check Oil System (Master Oil Line Solenoid Valve & Oil Return System & Oil Detector sensor)
Loss of Oil at Compressor (Stopped)	MMR n/a	Chiller 1U1	compressor pre-start	Oil Sensor detects a lack of oil trapped in line feeding compressor for 2 contiguous minutes after the oil line solenoid is opened for pre-start mode. Note: Compressor start is delayed (up to an additional 90s) from the normal 30 second s of pre-start, waiting for oil to be detected	Check Oil System (Master Oil Line Solenoid Valve, Oil Return System & Oil Detector sensor
Low Chilled Water Temp: Unit Off (Unit in Auto but not Starting or Running)	IFW n/a	Chiller 1U1	Unit in Auto	The chilled water temp. fell below the cutout setpoint while the compressor was not running for 30 degree F Seconds. Automatic Reset of the IFW diag shall occur 2 degrees F (1.1 C) above the cutout setpoint.	Check flow, sensor, & wiring.
Low Chilled Water Temp: Unit On (Unit Starting or Running)	MAR friendly	Chiller 1U1	Unit starting or running	The chilled water temp. fell below the cutout setpoint while the compressor (or Solution Pump) was running for 30 degree F Seconds. Automatic Reset of the MAR diag shall occur 2 degrees F (1.1 C) above the cutout setpoint.	Check flow, sensor, & wiring.
Low Diff Rfgt Pressue Switch	MAR	Chiller 1U1	Initiated at Prestart active in all modes	The Low Differential Rfgt Pressure Switch, sensing system differential pressure, (See diagnostic 297 above), has inhibited a start and was seen to be still closed 2 minutes after the intention to start.	Check Low Differential Pressure Switch & its valving, EXV
Low Diff Rfgt Pressure,m Cold Cond Water	MMR friendly	Stepper 1U3	Cprsr Energized	Inferred system differential pressure is less thatn 23.8 PSID for 3000PSID-sec.	Check cond water.

Table 14-2: Diagnostic Table

Diagnostic Description	Type/ Shutdown Action	Module Calling Out Diag.	Operating Modes Diagnostic is Active	Cause	Help Message
Low Discharge Superheat	MMR friendly	Stepper 1U3	Any Running Modes	a.While Running Normally, the Discharge Superheat was less than 12 degrees F +- 1F for more than 6500 degree F seconds. The must hold value is 13F while the must integrate value is 11F. b. At startup the UCP2 ignores the Discharge Superheat for a minimum of 5 minutes and a maximum of 5.5 minutes. This timer should be reset everytime the chiller starts up. Discharge superheat shall be monitored only while the chiller is in any of the run modes.	Confirm oil and refrigerant charges. Confirm EXV operation and liquid level sensor.
Low Evap Rfgt Temp.	MMR immediate	Stepper 1U3	Starter Contactor Energized	a. The Saturated Evap Rfgt Temp dropped below the Low Rfgt Temp. Cutout Setpoint when the circuit was running for 60 degree F seconds. Special note: During timeout of trip integral, the unload solenoid shall be energized continuously, and load solenoid de-energized continuously- Normal load unload operation will be resurmed in trip integral is reset by return to temps above cutout setpoint.	Confirm operation of sensor, EXV and Stepper module. Confirm refrigerant charge.
Low Evaporator Liquid Level	MMR friendly	Stepper 1U3	Starter contactor energized (all stop modes)	The liquid level sensor is seen to be at or near its low end of range for 80 contiguous minutes while the compressor is running	Check EXV, Sensor, Stpr Module & Rfgt Charge
Low Oil Flow	MMR friendly	Chiller 1U1	Cprsr Energized	The oil flow pressure switch detects no flow (high logic state) for 5 contiguous seconds.	Check Oil System (Master Oil Line Solenoid Valve & Oil Filter, Hand valves, and Differential Pressure switch)

Table 14-2: Diagnostic Table

Diagnostic Description	Type/ Shutdown Action	Module Calling Out Diag.	Operating Modes Diagnostic is Active	Cause	Help Message
Low Pressure Cutout	MMR immediate	Stepper 1U3	All	The Low Pressure Cutout opened for more than 0.5-2 Seconds. C.O. on fall @ 0 psig (+/- 3 psi), reset @ 20 psig (+/-5psi). The LPC is set primarily to detect significant charge loss and thus ignore times at startup are not required (The sat evap temp sensor is used for low temp / low pressure detection but it cannot function if saturated conditions are not present such as in the event of charge loss)	LPC switch, refrigerant charge.
Max Acceleration Setpts Error	IFW n/a	Starter 1U3	All	a. The redundant Maximum Acceleration settings did not agree for 30 contiguous seconds. (Continue to use the previous value for the 30 second time-out.) When this diagnostic occurs the affected Starter Module shall use 6 seconds as a default until either	Review Max Acceleration Set Up.
Memory Error Type I: NOVRAM	MMR friendly	Chiller 1U1	On UCM Power Up or following a Type II Memory error diag.	On UCM power up a Type II Memory Error a NOVRAM memory error was detected. The UCM is operating on all Engineering ROM defaults for all setup parameters. Check all setup parameters and continue to run chiller. Replace the Chiller module ASAP.	Reprogram all menus. If this occurs more than one time, replace the Chiller module.
Memory Error Type II: Shadow RAM	IFW n/a	Chiller 1U1	All	The UCM is operating on all last valid values (pulled from NOVRAM) for all setup parameters. Settings are not lost but if diagnostic is re-occurring replace the Chiller module.	Confirm settings are accurate.
Memory Error Type III	IFW n/a	Chiller 1U1	All	The UCM is operating on all last valid values (pulled from NOVRAM) for all setup parameters. Settings are not lost but if diagnostic is re-occurring replace the Chiller module.	Settings changed in the last 24 hours lost.
Memory Error Type IV	IFW n/a	Chiller 1U1	All	A page time-out error was detected while trying to write data into EPROM. There will likely be a recall of Engineering ROM defaults on the next reset or power transition. Replace the Chiller Module as soon as a replacement is available.	Reprogram all menus.

Table 14-2: Diagnostic Table

Diagnostic Description	Type/ Shutdown Action	Module Calling Out Diag.	Operating Modes Diagnostic is Active	Cause	Help Message
Momentary Power Loss	MAR immediate	Starter 1U2	All Running Modes	The current transformers experienced a loss of power. This protection can be defeated in the Service settings, Field Startup Group .	Check incoming power. Check operation of HPC. Check Starter module.
MPL Detect Circuit Inoperative	MMR friendly	Starter 1U2	All	Internal component in Starter module detecting a fault. A failure was detected in the Momentary Power Loss detect circuit. If there are no zero cross interrupts on Vab for 637.5 msec (Prior to Centravac Upgrade 4: approx. 3 half line cycles), the timer interrupt will trip and generate a diagnostic that indicates that our ability to detect MPL is gone. If Vab was truely gone the module would be powered down so if we can detect that Vab is gone then there must be a hardware failure on the board.	Replace the Starter module.
No Diff Rfgt Press, Cold Cond Water	MMR immediate	Chiller 1U1	Cprsr Energized	Differential Rfgt Pressure switch sensing system differential, is set to close @ 7.7, open @ 6 psid. Switch is ignored during the non-running modes but checked to be open at time of an attempted start. If not open, restart will be delayed and a different diagnostic may result (see Diagnostic E8 below). The switch is ignored for the first 20 seconds of compressor operation after start. Thereafter the switch must be proven closed (i.e. system dp greater than 8 PSID) with a 10 second filter implemented (initial value @ t=20s set to trip) or immediate shutdown and diagnostic results. The occurrence of this diagnostic will cause the "Low Diff Rfgt Press Integral" to saturate. This provides for a restart inhibit and compressor cool-down if the diagnostic is immediately reset.	Check Condenser Water Temp Too Low

Table 14-2: Diagnostic Table

Diagnostic Description	Type/ Shutdown Action	Module Calling Out Diag.	Operating Modes Diagnostic is Active	Cause	Help Message
Options Mod Off-Brd 5V Range	IFW n/a	Options 1U5	all	An improper Off Board 5v voltage was detected at the Options Module. A 5vdc is used for off-board devices such as the External CWS and CLS, and pressure transducers. The micro checks to see that the A/D value falls within an acceptable range.	Check Options Module Voltages
Options Mod Ref Voltage Calibration	IFW n/a	Option 1U5	all	An improper reference voltage was detected at the Options Module. A 2.5 vdc reference is used to calibrate the non-ratiometric analog I/O such as 2-10vdc and 4-20ma inputs as well as PWM Analog outputs. The micro checks to see that the A/D value falls within an acceptable range.	
Options: Loss of Comm with Chiller	IFW n/a	Option 1U5	All	The options module lost communications with the Chiller module for 15 contiguous seconds.	Check IPC Wiring/ Connections.
Options: Loss of Comm with Starter	IFW n/a	Option 1U5	All	The options module lost communications with the Starter module for 15 contiguous seconds.	Check IPC Wiring/ Connections.
Outdoor Air Temp Sensor (outdoor air reset selected)	IFW n/a	Chiller 1U1	All	Open or Short a. Use end of range value (whatever value the open or short gives). b. Clear diag. when the resistance returns to normal range.	Check Sensor, Wiring & Connections.
Outdoor Air Temp Sensor (Outdoor Air not selected.)	none n/a	none	All	Open or Short a. Display end of range value. (dashes "-----")	
Over Voltage	MAR friendly	Starter 1U2	Pre-Start	a. Line voltage above + 10% of nominal. (Must hold = + 10 % of nominal. Must trip = + 15 % of nominal. Reset differential = min. of 2% and max. of 4%. Time to trip = minimum of 1 min. 10 sec. and maximum of 5 min. 20 seconds) Design: Nominal trip: 60 s	Check main power supply & wiring. Check Under-Over Voltage Transformer.
Phase Loss	MMR immediate	Starter 1U2	Contactor Energized or all Start, and Run modes.	No current was sensed on one or more of the CT inputs. Time to trip shall be 1 second minimum, 3 seconds maximum. Actual trip point is 10%.	Check main power supply & wiring. Check current transformers.

Table 14-2: Diagnostic Table

Diagnostic Description	Type/ Shutdown Action	Module Calling Out Diag.	Operating Modes Diagnostic is Active	Cause	Help Message
Phase Reversal	MMR immediate	Starter 1U2	Contactor energized to transition command	A phase reversal was detected on the incoming current. On a compressor start-up the phase reversal logic must detect and trip in a maximum of 0.3 seconds from compressor start for RTHB.	Check main power supply & wiring. Check current transformers.
Phase Reversal Protection Lost	MMR immediate	Starter 1U2	Starter Contactor energized to transition command	The phase reversal protection on the compressor has become inoperative. The phase rotation protection system failed to detect 2 in a row of one of the four phase circuit states; Phase reversal, Phase rotation OK, Phase A lost, Phase B lost.	Check Starter Module.
Phase Seq Monitor: Phase Reversal	MMR immediate	Starter 1U2	Contactor energized to transition command	Diagnostic is not applicable for RTHC. Jumper must be installed on the Starter module between J3-1 and 2.	Check wiring and module.
Severe Phase Unbalance	MMR friendly	Starter 1U2	All Running Modes	A 30% Phase Unbalance diagnostic has been detected.	Check the current transformers. Check line voltage phase balance, all power wiring connections, the contactors and the motor. Check Starter module.
Solid State Starter Fault Relay Open	MMR immediate	Starter 1U2	Pre-start and Running Modes	The SSS fault relay is open.	See Solid State Starter Service Bulletin, check for an open wire.
Starter Contactor Interrupt Failure	MMR n/a	Sarter 1U2	Starter Contact not Energized	Welded starter contactor. Detected a welded compressor contactor when the compressor was commanded off but the current did not go to zero. Detection time shall be 5 second minimum and 10 seconds maximum.	Complete starter checkout required.

Table 14-2: Diagnostic Table

Diagnostic Description	Type/ Shutdown Action	Module Calling Out Diag.	Operating Modes Diagnostic is Active	Cause	Help Message
Starter did not Transition	MMR immediate	Starter 1U2	On the first check after transition.	**During start** -the Starter module did not receive a transition complete signal in the designated time from the command to transition. The must hold time from the transition command is 1 second. The Must trip time from the transition command is 6 seconds. **Prior to start** - Transition complete input shorted. Y- delta starters only	Complete starter checkout required.
Starter Dry Run Test	MMR immediate	Starter 1U2	Starter Dry Run Mode	While in the Starter Dry Run Mode either 50 % Line Voltage was sensed at the Potential Transformers or 10 % RLA Current was sensed at the Current Transformers.	Current or Voltage Detected. Complete starter checkout required.
Starter Fault Type I	MMR immediate	Starter 1U2	Starting	This is a specific starter test where 1M (2K1) is closed first and a check is made to ensure that there are no currents detected by the CT's. If currents are detected when only 1M is closed first at start, then one of the other contactors is shorted.	Complete starter checkout required.
Starter Fault Type II	MMR immediate	Starter 1U2	Starting	This is a specific starter test where the Shorting Contactor (S)(2K3) is individually energized and a check is made to ensure that there are no currents detected by the CT's. If current is detected when only S is energized at Start, then 1M is shorted.	Complete starter checkout required.
Starter Fault Type III	MMR immediate	Starter 1U2	Starting	As part of the normal start sequence to apply power to the compressor the Shorting Contactor (S) and then the Main Contactor (1M) were energized. 1.6 seconds later there were no currents detected by the CT's for the last 1.2 Seconds on all three phases.	Complete starter checkout required.
Starter Mod Ref Voltage Calibration	IFW n/a	Starter 1U2	all	An improper reference voltage was detected at the Starter Module. A 2.5 vdc reference is used to calibrate the non-ratiometric analog I/O such as 2-10vdc and 4-20ma inputs as well as PWM Analog outputs. The micro checks to see that the A/D value falls within an acceptable range. This diagnostic is not supported.	

Table 14-2: Diagnostic Table

Diagnostic Description	Type/ Shutdown Action	Module Calling Out Diag.	Operating Modes Diagnostic is Active	Cause	Help Message
Starter: Loss of Comm with Chiller	MMR immediate	Starter 1U2	All	The starter module lost communications with the Chiller module for 15 contiguous seconds.	Check IPC wiring and connections.
Stepper: Loss of Comm with Chiller	MMR friendly	Stepper 1U3	All	The Stepper #1 module lost communications with the Chiller module for 15 contiguous seconds.	Check IPC wiring and connections.
Stepper: Loss of Comm with Starter	MMR friendly	Stepper 1U3	All	The Stepper #1 module lost communications with the Starter module for 15 contiguous seconds.	Check IPC wiring and connections.
TCI: Loss of Comm with Chiller	IFW n/a	TCI 1U6	All	The TCI module lost communications with the Chiller module for 15 contiguous seconds.	Check IPC wiring and connections.
TCI: Loss of Comm with Options	IFW n/a	TCI 1U6	All	The TCI module lost communications with the Options module for 15 contiguous seconds.	Check IPC wiring and connections.
TCI: Loss of Comm with Starter	IFW n/a	TCI 1U6	All	The TCI module lost communications with the Starter module for 15 contiguous seconds.	Check IPC wiring and connections.
TCI: Loss of Comm with Stepper	IFW n/a	TCI 1U6	All	The TCI module lost communications with the Stepper #1 module for 15 contiguous seconds.	Check IPC wiring and connections.
Tracer Communications Lost	IFW n/a	TCI 1U6	All	The Tracer was setup as "installed" at the CLD and the TCI lost communications with the Tracer for 15 contiguous minutes after it had been established. Continue to run the chiller with the last valid Tracer Setpoints/ Mode.	Check Tracer to UCP wiring and connections.
Tracer failed to Establish Comm	IFW n/a	TCI 1U6	At power-up	The Tracer was setup as "installed" at the CLD and the Tracer did not communicate with the TCI within 2 minutes after power-up.	Check Tracer to UCP wiring and connections.
Tracer Outdoor Air Temp Sensor Fail	IFW n/a	Chiller 1U1	All	Tracer sensor open or shorted.	Check sensor, wiring, and connections.
Tracer Temperature Sensor	IFW n/a	Options 1U5	All	Input Shorted.	Check sensor, wiring, and connections.

Table 14-2: Diagnostic Table

Diagnostic Description	Type/ Shutdown Action	Module Calling Out Diag.	Operating Modes Diagnostic is Active	Cause	Help Message
Transition Complete Input Opened	MMR immediate	Starter 1U2	All running modes	Transition complete input was found open with compressor running after a successful completion of transition. This is only applicable on Y-Delta starters.	Check the transition complete input and the starter module.
Transition Complete Input Shorted	MMR n/a	Starter 1U2	Pre-start	Transition complete input was found shorted before the compressor was started. This is only applicable on Y-Delta starters.	Check the transition complete input and the starter module.
Under Voltage	MAR friendly	Starter 1U2	Pre-Start	Line voltage below - 10% of nominal or the Under/Overvoltage transformer is not connected. (Must hold = - 10 % of nominal. Must trip = - 15 % of nominal. Reset differential = min. of 2% and max. of 4%. Time to trip = min. of 1 min. and max. of 5 min.	Check main power supply & wiring. Check Under-Over Voltage Transformer.

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