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SPORLAN

Chiller Control

Installation and Operation Instructions

Controller v. A

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Contents

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Introduction

The **Sporlan Chiller Control** is a simple means of controlling the Electronic Expansion Valve (EEV) on most compact chillers.
The Chiller Control provides liquid temperature and superheat (pressure-temperature) control for common refrigerants. It displays actual leaving liquid temperature, superheat, suction pressure, valve position, controller status, and alarms. It also allows manual control of the valve position.

Features

- One dial for setting superheat and liquid temperature
- One EEV control (bipolar step motor)
- 4-digit LED display
- Low temperature cut out
- MODBUS and BACnet communication
- One pressure input (Sporlan transducer)
- One digital input (for external switch or relay)
- Three temperature inputs (Sporlan surface or air sensors)

1. Installation

Refer to *Appendix I - Wiring Diagram* and *Appendix J - Sensor Installation*

TOOLS REQUIRED:

- Small flat screwdriver for terminal connections
- Cordless screwdriver
- Phillips and flat screwdrivers
- Needle-nose pliers
- Wire cutters
- Scotch-Brite™ pad
- Two #8 x ½" self-tapping screws to mount DIN rail

1. Mount the controller in a rain-tight, protected location using the supplied DIN rail. The suggested mounting area is 10 inches (254 mm) high and 5 inches (127 mm) wide. The minimum depth is 3 inches (76 mm).
2. Mount the liquid temperature sensor to the liquid outlet using the instructions provided with the sensor. Connect the non-polarized temperature sensor wires to terminals 29 and 30. **Maximum torque on screw terminals is 3.5 in/lbs.**
3. Mount the suction temperature sensor to the suction line after the evaporator following the instructions provided with the sensor. Connect the non-polarized sensor wires to terminals 31 and 32.
4. Mount the pressure transducer on the suction line near the suction temperature sensor, positioned at 12 o'clock. Connect the pressure transducer wires to terminals 33, 34, and 35. If the cable is spliced to extend its length, ensure that the new wire is properly connected.
5. Connect terminals 25 and 26 to a digital input. A short or a closed contact from an external relay will close the valve for pump down.
6. Connect the Sporlan Electric Expansion Valve (EEV) wires to terminals 5, 6, 7, and 8.
7. Connect power to terminals 1 and 2. Transformer requirements are 24 volts AC at 40 VA, Class II.

WARNING: Use caution when working around high voltage components. Safety covers should be used for personal safety on high voltage panels.

NOTE: The Sporlan Chiller Control should be installed only by a qualified professional. All other system components (valves and sensors) should be supplied by Sporlan to ensure compatibility and proper operation. For optimal performance, a counterflow heat exchanger is recommended. There are no user-serviceable components inside the Sporlan Chiller Control. Opening the case will void the warranty.

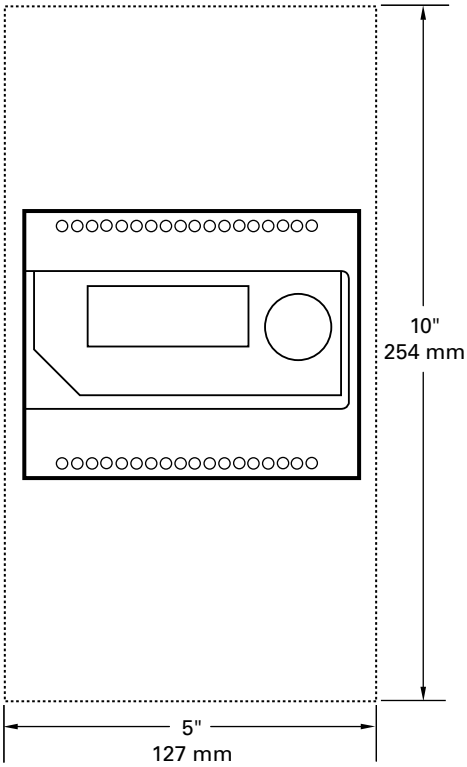


Figure 1 - Recommended Mounting Clearance

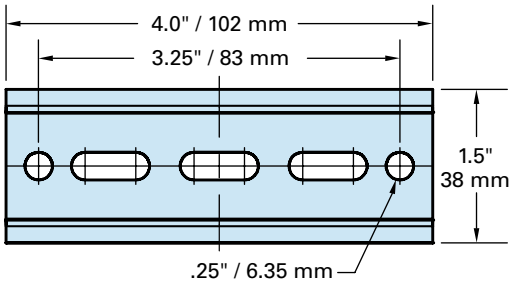


Figure 2 - DIN Rail Detail

Table 1 - Pressure Transducer Wire Colors

	CONTROLLER TERMINAL	OLD PIGTAIL LEADS	NEW HERMETIC CABLE
+	35	Red	Black
S	33	Green	White
–	34	Black	Green

Table 2 - Sporlan Electric Expansion Valves

SPORLAN MODEL NUMBERS	STEPS
SEI-.5, SEI-1, SER-1.5, SEI-2, SEI-3.5, SEI-6, SER-6, SEI-11, SER-11, SER-20	1596
SER-AA, SER-A, SER-B, SER-C, SER-D, SER-G, SER-J, SER-K, SER-L	2500
SEI-30	3193
SEI-50, SEH-100, SEH-175	6386

2. Setup

Enter values for four basic system variables; refer to *Appendix A - Setup Menu,* page 10. The EEV is closed upon startup and the system will not operate until completing setup.

Once powered up, the controller will display the firmware versions for the display and the controller. It will then display the first variable to set.

1. Set StEP, Step Motor Stroke. Press and then turn the SELECT button to select the correct number of steps for the EEV being used. Default is 2500. Press the SELECT button again to enter the value. The next variable is displayed.
2. Set rEFr, Refrigerant. Select the **actual** refrigerant used in the system, following the steps above. Default is 404A.

   CAUTION: Select the actual refrigerant used in the system.
3. Set PtYP, Pressure Sensor Type. Select Absolute or Gauge, following the steps above. Default is Gauge.
4. Set Prn9, Pressure Sensor Range. Select 150, 300, or 500 following the steps above. Default is 300.
5. Set LoSP, Liquid Outlet Temperature. Select the desired leaving liquid temperature using the steps above.
   NOTE: For tube and fin designs, Sensor T2 can also be placed in the discharge or return air stream for controlling air temperature. Default is 45°F.
6. Set LtLo, Low Temperature Cutout. Select the minimum desired temperature for the leaving liquid using the steps above. Default is 35°F.
7. Once setup is complete, the display will alternate between LoUt and actual Liquid Outlet Temperature. After the system is in operation, verify that the Liquid Outlet Temperature Setpoint, LoSP, is met.

NOTE: If using a 3K temperature probe (or if unsure which probe you are using) refer to Appendix E, page 11, and follow the instructions to set the controller to the correct probe profile. Images of 2K and 3K probes are shown in Figure 8, page 16.

3. Setpoint Menu Operation

Make final setpoint changes; refer to *Appendix E - Setpoint Parameters,* page 11. The noted values are for verification; change them if necessary. All other values are for informational purposes.

NOTE: The Parameter Menu times out after 60 seconds of inactivity and you will lose all changes entered.

1. Enter the Parameter Menu: Press and hold the SELECT knob for 5 seconds. Rotate the knob to enter the password "111" and press the SELECT knob again.
2. To change a parameter, rotate the SELECT knob to the desired parameter and press the SELECT knob. The default value will display.
3. Turn the SELECT knob to change the value and then press the SELECT knob to enter the value and return to the Parameter Menu.
4. After all parameters are set, turn the SELECT knob to "ESC" and press the SELECT knob to save all changes. Observe the system for proper operation.

The system is now operational. See *Appendix B - Process Values,* page 10, for the variables that the Chiller Control monitors.

4. System Operation

The Sporlan Chiller Control is designed for use on primary chillers for secondary systems such as glycol systems in supermarkets and commercial buildings. By incorporating an interactive control scheme using liquid outlet temperature and superheat, the controller optimizes the use of the heat exchanger based on the load demand of the system.

For systems that currently use a master controller for cut-in / cut-out temperature control method using a liquid line solenoid, it is required to install the Chiller Control according to the wiring diagram in this manual. The temperature cut out setpoint on the master controller may also need to be adjusted below the Liquid Outlet Setpoint, LoSP, to allow the Chiller Control to function correctly. If needed, a signal (short) can be supplied from the master controller to terminals 25 and 26 on the Chiller Control to initiate pumpdown and turn off cooling. In any case, the pumpdown signal must be used when either a suction stop valve or liquid line solenoid closes.

Cooling Mode

A Sporlan EEV is used on the direct expansion side to regulate refrigerant flow into the heat exchanger. During cooling mode, the display will show Cool and the Chiller Control will modulate the EEV based on system load to achieve desired liquid outlet temperature. Superheat will be limited to a safe value during operation and is set by the parameter SUPH. Since the system will automatically regulate to a desired liquid outlet setpoint, there is no need for a cut-in and cut-out temperature. This operation improves system stability and shock that is traditionally seen with temperature regulated solenoid valve designs.

Pumpdown Mode

To enable pumpdown, an external digital signal (short) is sent to terminals 25 and 26. The display will show Pdn, the EEV will close and stop flow and the normally closed solenoid valve upstream of the EEV will close. The controller will remain in pumpdown mode until the signal is removed. This operation can be used to pump down the system and isolate the refrigerant or used to shut down cooling.

Manual Mode

The Sporlan Chiller Control offers the ability to control the electric expansion valve manually. This feature can be used in troubleshooting to determine if the expansion valve responds to an open or closed position signal directly from the controller. In normal operation, the manual mode should never be used. When in this mode, the display will show StPo for stepper override and the user can adjust the position of the EEV from 0% to 100% position.

WARNING: Be sure to avoid floodback while using the manual valve feature. Start with the valve in a low position. Do not leave system unattended while in manual mode.

Prior to entering manual mode, attach a gauge set and calibrated temperature sensor to the suction line to measure superheat. This will allow the user to maintain a minimum superheat while in manual mode by adjusting the valve position. If the valve is positioned too far open while in manual mode, superheat will drop and liquid may enter the suction line. It is always better to start with the valve position low and work up to a higher position gradually while observing superheat. Superheat should never be allowed to drop below 2°F. If this condition occurs, reduce valve position and allow the system to respond (superheat should increase).

To enter manual mode, press and hold the Select knob, select 111, scroll to SPoS and push the knob. The valve will start at the current position. The display will show percent valve opening. To verify if the valve is functioning, lower the valve position by rotating the knob counter-clockwise and note the change in superheat (increase). From this, increase the valve position slowly and note the change in superheat (decrease). It may be necessary to allow appropriate time for system to respond to changes. Ensure that the superheat does not drop below that described above. To exit manual mode, press Select knob, scroll to ESC, and press the knob again. After exiting manual mode, observe the system for proper operation.

Off Mode

The Chiller Control will be placed into off mode when the Low Temperature Cutout, LtCo is met. The display will show OFF, the EEV will close and stop flow and the normally closed solenoid valve upstream of the EEV will close. The controller will remain in off mode until the temperature increases within safe limits above the Low Temperature Cutout.

Power Loss

To avoid refrigerant migration during power loss, a normally closed solenoid valve must be installed upstream of the EEV. The solenoid valve should be installed on terminals 19 and 20 in accordance to the wiring diagram. If power is lost to the controller, the solenoid valve will close. Once power is re-established, the controller will reinitialize the EEV and open the solenoid valve to start cooling.

ADVANCED FEATURES

Low Temperature Cut-Out

The Chiller Control has a built in feature to limit liquid outlet temperature to a minimum value. This feature uses the input from T2 (liquid outlet temperature) and limits the outlet temperature based on the low temperature cut out parameter, LtCo. Once the liquid outlet temperature falls below the cut out temperature, the controller will close the liquid line solenoid and EEV. The display will show OFF while the temperature remains below the setpoint. Once the liquid outlet temperature increases within safe limits, the controller will activate cool mode.

Return Gas High Limit

The Return Gas High Limit parameter, rGhL, limits the suction gas temperature based on input from T1 (evaporator outlet temperature). When the evaporator outlet temperature reaches the rGhL, the controller will limit the superheat to the value calculated by (rGhL – tSAt). If the system reaches this condition, the liquid outlet temperature, Lout, may fall below the setpoint. If the liquid outlet temperature continues to decrease, the controller will limit the liquid outlet temperature by the low temperature cut-out parameter, LtCo. By default, the return gas high limit is set to its maximum value.

Low Superheat Integral

The Low Superheat Integral parameter, LSH I, allows for additional adjustments to the control scheme to increase EEV response when low superheat conditions occur. Decreasing this parameter will close the valve faster during low superheat conditions. Increasing this parameter will close the valve slower during low superheat conditions.

PROCESS VALUE MENU

Liquid Outlet Temperature, Lout – displays the current liquid outlet temperature as measured by the temperature sensor T2.

Superheat, SUPH – displays the current suction superheat value measured by the pressure transducer and evaporator outlet temperature, T1.

Suction Pressure, SucP – displays the current suction pressure measured by the transducer.

Saturation Temperature, tSAt – displays the calculated saturation temperature based on the suction pressure and refrigerant.

Evaporator Outlet Temperature, tout – displays the current temperature as measured by the temperature sensor T1.

EEV Position, PoSn – displays the current electronic valve position in percent open.

Liquid Inlet Temperature (optional), L In – displays the current temperature measured by the temperature sensor T3.

Auxiliary Temperature, S-4 – displays the current temperature measured by the auxiliary temperature sensor T4.

Status, StAt – displays the current status of the controller. See Appendix C and D for status descriptions.

Alarms, ALS – displays the current alarms. See Appendix G for alarms descriptions.

Liquid Outlet Low Temperature, LoL – provides a 24 hour absolute minimum liquid outlet temperature for the system. This value is calculated automatically and refreshes every 24 hours. For the first 24 hours, the display will show the default value of 150 Fahrenheit. This can be used to verify system operation.

Liquid Outlet High Temperature, LoH – provides a 24 hour absolute maximum liquid outlet temperature for the system. This value is calculated automatically and refreshes every 24 hours. For the first 24 hours, the display will show the default value of -60 Fahrenheit. This can be used to verify system operation.

5. Controller Networking

The Sporlan Chiller Control can communicate with a MODBUS or BACnet communication master via RS485 to transfer process values and setpoints. See *Appendix K - MODBUS Memory Map or Appendix L - BACnet Memory Map,* pages 17-23.

The Chiller Control supports only the RTU transmission mode. The serial settings are:

- 9600 baud (default), 19200 baud, 38400 baud
- 8 data bits
- 1 stop bit
- Even parity (default), odd parity, no parity

The Chiller Control supports the 'Read Input Registers', 'Read Holding Register', 'Write Single Register', 'Read Multiple Coils' and 'Write Single Coil' function codes. Other requests will cause an exception response. The Chiller Control will allow a full and partial block read of the Input and Holding registers and coils.

Scaling for Celsius / Bar

For better precision, scaling is used for Bar or Celsius units. PSI and Fahrenheit values are whole numbers and have no scaling. See *Appendix K - MODBUS Memory Map,* page 17.

Celsius values transferred via MODBUS are 10X. A value of 45 will be transferred for the Superheat when the actual Superheat temperature is 4.5°C. Remember this when changing a setpoint.

Bar values transferred via MODBUS are 100X. A value of 1034 will be transferred for the Maximum Operating Pressure when the actual pressure is 10.34 bar. Remember this when changing a setpoint.

Setup

The Sporlan Chiller Control can be networked to communicate process variables back to a master controller. This information can be used for verifying system performance or updating individual setpoints via RS-485 and PC interface. Data can be accessed remotely thru the master controller. For further information on remote monitoring, see corresponding manuals for the master controller.

Prior to establishing the network, each controller must be assigned a separate address on the MODBUS or BACnet network. Refer to *Section 3 – Setpoint Menu Operation,* page 4 to enter setpoint menu. Once in the Setpoint menu, scroll to Addr and set each controller on the network with individual addresses.

Note: No two controllers can have the same address. Default address for each controller is '1'.

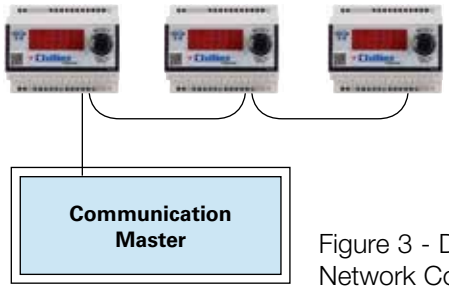
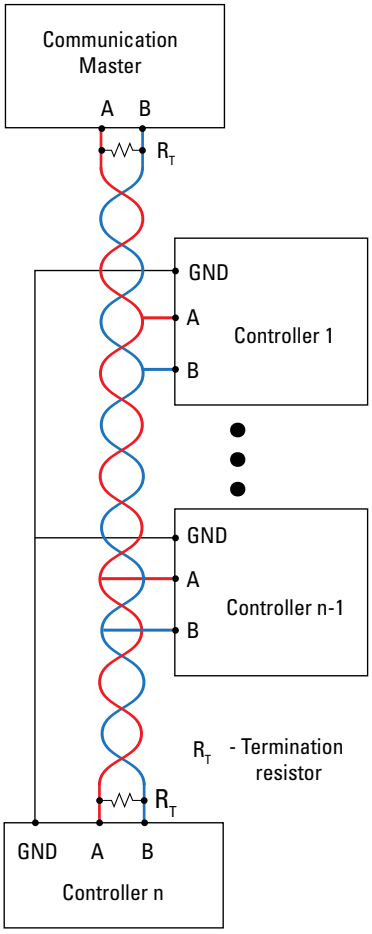


Figure 3 - Daisy Chain Network Configuration

Figure 4 - Modbus Wiring



MODBUS Communication Requirements

See *Figure 4 - MODBUS Wiring*.

Wire Type: 22-24 AWG Universal Twisted Pair

Maximum Number of Network Nodes: 100

Maximum Run Length: 4000 ft

Recommended Network Configuration: Daisy Chain, a single continuous transmission line from one end to the other. Other configurations involving triple-lug connections, such as star, are not recommended. See Figure 3.

Addr - The address of the controller on the MODBUS network. See *Section 3 - Setpoint Menu Operation,* page 4 to change it.

Noise Reduction: Termination resistance (R_T in Figure 4) is recommended to reduce reflections and noise on the data transmission lines. Place the resistance at the extreme ends of the cable with the resistance value matching the characteristic impedance of the transmission line (typically 120 ohms for twisted pair cables).

Shielding prevents noise from EMI sources. If the cable is shielded, connect the shield to earth ground at one end only. Do not connect shield to RS485 GND.

Keep RS485 wiring away from high voltage AC lines to reduce noise and data errors on communication lines. RS485 communication cable should be perpendicular to AC lines at any intersection.

Grounding: Connect a third conductor to RS485 GND (pin 13) to prevent ground potentials from node to node. This conductor should be included in the shield of the twisted pair cable to prevent noise. Do not connect RS485 GND to earth ground.

Third Party Controllers: To avoid nuisance "network errors", the use of third party controllers on the same RS485 network with Sporlan controllers and master is not recommended. If necessary, use a separate communication board on the master to connect separate third-party controllers.

See *Appendix K - MODBUS Memory Map or Appendix L - BACnet Memory Map,* pages 17 - 23. Also, refer to the documentation supplied with the communication master for additional RS485 network requirements.

6. PID Tuning

The Sporlan Chiller Control is factory programmed with default Proportional–Integral–Derivative (PID) settings that will provide efficient control. It may be necessary, however, to fine tune the PID settings in applications where systems experience rapid transient conditions (such as frequent "impulse" changes in loading or mass flow rates).

The controller offers PID adjustments for both Liquid temperature and Superheat control. In most instances, adjustments to the PI set-points are adequate. If tuning is needed, see *Section 3 - Setpoint Menu Operation,* page 4 to enter the PID setpoint menu. The following guidelines should be followed:

LP (Liquid Proportional Coefficient) – Increase value to increase valve response to Liquid out temperature.

L i (Liquid Integral Coefficient) – Increase value to decrease valve response to Liquid out temperature over a given time period.

Ld (Liquid Derivative Coefficient) – Increase value to increase valve response to rate of change in Liquid out temperature.

SP (Superheat Proportional Coefficient) – Increase value to increase valve response to Superheat.

S i (Superheat Integral Coefficient) – Increase value to decrease valve response to Superheat over a given time period.

Sd (Superheat Derivative Coefficient) – Increase value to increase valve response to rate of change in Superheat.

LSH i (Low Superheat Integral Coefficient) – Increase value to decrease valve response to superheat over a given time period (Only in low Superheat conditions).

If PID adjustments are made, allow adequate time for the system to respond to the changes.

Large oscillations in Liquid temperature or Superheat may require adjustments to the respective PID values. If Liquid and Superheat are equally unstable, adjust the Superheat PID values first, followed by the liquid PID values.

- When the Superheat is oscillating to extremes, the Proportional value may be too high and/or the Integral value may be too low.
- If the Superheat is not oscillating to extremes, but the Liquid control is very inconsistent around setpoint, then the Proportional value may need to be reduced or the Integral value increased.

These actions are inversely proportional in nature. If the liquid outlet temperature or Superheat are slow to react to a transient system change, then the Proportional may be too low and or the Integral value may be too high in value.

Note: Not all refrigeration systems are designed alike. Use caution when tuning PID setpoints.

7. Troubleshooting

Recommendations

As with any refrigeration component troubleshooting, actual system conditions should be verified with a gauge set and calibrated temperature sensor (i.e verify actual superheat, subcooling and refrigerant condition). This system information is valuable in determining whether it is component related or system related.

For systems or applications that experience light loads on the Chiller control circuit, it is important that the Heat exchanger and refrigerant lines are sized correctly. This will ensure

proper oil return and will minimize the effects of oil logging in the Heat exchanger. Many Heat exchanger manufacturers recommend a hot gas bypass for loads below 50%. Refer to the heat exchanger manufacturer's installation instructions.

Sensors

Failed sensors will trigger an alarm. An alarm code will show which sensor is mis-wired, disconnected, or faulty. See *Appendix G - Alarms and Failsafes*, page 14. The alarm will persist until the problem is corrected.

Failed temperature sensors will generally read extremely low or infinite resistance when tested with an ohmmeter. Readings should be taken with the sensor disconnected from the Chiller Control. A missing or disconnected temperature sensor will read -60 on the controller.

Temperature sensor output can be checked by measuring the DC voltage across the sensor wire using the tables in Appendix M, page 25 and Appendix N, page 26.

Since the liquid and suction temperature sensors are identical, no alarm will be triggered if the sensors are switched (i.e. liquid sensor on the suction line). **Severe system damage may occur if these two sensor locations are interchanged.**

Pressure transducers must be installed tight enough to depress the valve stem in the fitting. Failure to do so will result in erroneous pressure readings and possibly leaks.

Pressure transducers should be tested while connected to the controller and powered. Test at the controller terminals. Voltage between terminals 34 and 35 should be 4.8 - 5.2 volts DC. Voltage between 33 and 34 should be between 0.5 and 4.5 volts DC. See *Table 1 - Pressure Transducer Wire Colors*, page 4.

To test the accuracy of the transducer, use a gauge set to obtain the actual system pressure. For volts-to-pressure conversion, measure the voltage between terminals 33 and 34. Identify the pressure transducer used and find the correct range Prng in *Table 3.*

Substitute the measured voltage (**v**) in the formula in the PSI column. The result should be within 3 psi of the actual system pressure shown on the gauge set. If not, check transducer for proper installation, correct schrader valve, and verify the pressure range identified on the transducer.

To test the transducer cable, disconnect the cable from the transducer and check for 4.8 - 5.2 volts between terminals **+** and **–** . See *Figure 5 - Pressure Sensor Cable.*

Figure 5 - Pressure Sensor Cable

Table 3 - Pressure Transducer Specifications

LABEL COLOR	Prng	PSI
Green	150	(v-.5) x 37.5
None / Silver	300	(v-.5) x 75
Yellow	500	(v-.5) x 125

Table 4 - Troubleshooting

SYMPTOM	CHECK
Will not power up	Wiring terminals (power) at transformer and controller
	Supply voltage (see Appendix H - Technical Specifications, page 14)
Liquid temperature below setpoint	EPR valve setting (too low)
	Pressure Transducer Range (correct transducer set up in controller; 0-300, etc.)
	Pressure Transducer Type (correct transducer set up in controller; gauge/sealed versus absolute)
	Temperature Sensor Type (correct sensor set up in controller; 2K or 3K (see Appendix J - Sensor Installation, page 16)
	Temperature Sensor wiring (ensure sensor locations are not mis-matched)
	Proper foam insulation on piping and sensors
	Return Gas High Limit (rGhL) set too low
Liquid temperature above setpoint	EPR valve setting (too high)
	Liquid condition entering expansion valve
	Pressure Transducer Range (correct transducer set up in controller; 0-300, etc.)
	Temperature Sensor Type (correct sensor set up in controller; 2K or 3K, see Appendix J - Sensor Installation, page 16)
	Chiller Control expansion valve (correct valve set up in controller; 1596, 2500 steps, etc.)
	Chiller Control expansion valve sizing (if valve position in controller is at 100% when symptom exists, valve may be undersized)
	Heat exchanger sizing
	Proper system refrigerant charge
	Oil return (oil logging in heat exchanger)
	Liquid line filter (clogging or excessive pressure drop)
No EEV movement	EEV Wiring
	Chiller Control power
	Pump down signal (ensure terminals 25 and 26 are open)
	Sensor (Alarms)
Unstable liquid temperature	Wiring terminals (power) at transformer and controller
	Wiring terminals (sensors) at controller
	Sensor locations
	Sensor operation (See additional information under Section 7 - Troubleshooting, page 7)
	Proper heat exchanger flow direction
	Stability of head pressure control valves (upstream of Chiller Control expansion valve)
	Stability of suction pressure control valves (downstream of Chiller Control expansion valve)
	Stability of rack controller (verify compressors are not short cycling)
	Controller PID setting (See Section 6 - PID Tuning, page 7)
No Communication	Wiring at controller and master communication board
	Addresses of controllers (see Section 5 - Controller Networking, page 6)
Communication errors	Wiring terminals at controller and master communication board
	Network wiring from controller to master communication board (see Section 5 - Controller Networking, page 6)
	Proper network wire grounding (see Section 5 - Controller Networking, page 6)
	Termination resistors (see Section 5 - Controller Networking, page 6)
	Network parameters in controller and master communication board (baud rate, parity, etc; see Section 5, page 6)
	Third party controllers on Chiller Control network
Setpoints not saved	ESC must be set within 60 seconds of changes being made

APPENDIX A - Setup Menu

SETUP MENU

Counterclockwise

Clockwise

StEP	Valve Type Default is 2500	**Display Readout** / **Description** 1596 – 1596 Step Bipolar Valve 3193 – 3193 Step Bipolar Valve **2500** – 2500 Step Bipolar Valve 6386 – 6386 Step Bipolar Valve
rEFr	Refrigerant Type Default is 404A NOTE: Select the actual refrigerant used in the system.	**Display Readout** / **Description** r22 – R-22 134A – R-134a 402A – R-402A **404A** – R-404A 407A – R-407A 407C – R-407C 410A – R-410A 417A – R-417A 422A – R-422A 422d – R-422D r507 – R-507A r744 – R-744 245F – R-245FA r-E5 – R-E5 438A – R-438A 401b – R-401B 407F – R-407F 408A – R-408A 508A – R-508A 508b – R-508B
PtYP	Pressure Sensor Type Default is Gauge	**Display Readout** / **Description** AbSL – Absolute Pressure Type **GAUG** – Gauge (Sealed) Pressure Type
Prng	Pressure Sensor Range Default is 300	**Display Readout** / **Description** 150 – 0-150 PSI (0-10.3 Bar) **300** – 0-300 PSI (0-20.7 Bar) 500 – 0-500 PSI (0-34.5 Bar)
LoSP	Liquid Outlet Temperature Default is 45°F (7.2°C)	0 to 100°F (-17.8 to 37.8°C)
LtCo	Low Temperature Cut Out Default is 35°F (1.7°C)	-5 to 50°F (-20.6 to 10°C)

Default values are highlighted.

APPENDIX B - Process Values

PROCESS	DESCRIPTION
End	Controller display address CAdr must be reset*
Lout	Liquid Outlet Temperature
SuPH	Superheat (*tout-tsat*)
SucP	Suction Pressure
tSAt	Conversion of suction pressure to its saturated temperature
tout	Sensible heat out of the evaporator

PROCESS	DESCRIPTION
PoSn	Position of the EEV step motor
L in	Liquid Inlet Temperature (Optional)
S-4	Status of the Auxiliary Temperature Input
StAt	Controller Status
ALS	Controller Alarms
LoL	Liquid Outlet Low Temperature
LoH	Liquid Outlet High Temperature

*If the controller display is alternating between Ctrl, and either a number 1-99 or LocL, then scroll to LocL and press the Select knob to view the local controller attached to this display. Then press and hold the Select knob for approximately 5 seconds and enter password 111 when prompted. Scroll to CAdr (Controller address) and set it to 0. Exit the setpoint menu.

APPENDIX C - Controller Status

DISPLAY	DESCRIPTION
CooL	Chiller On (Valve modulating)
Pdn	Pumpdown (Valve closed)
StPo	Stepper Override (Manual valve control) Shown when manually controlling valve through remote display or Modbus
OFF	Chiller Off (Valve closed) When Low Temperature Cut Out, LtCo, has been met.

APPENDIX D - Miscellaneous Displays

DISPLAY	DESCRIPTION
End	Press SELECT knob to exit menu
bAd	The wrong password has been entered
LocL	Shows that readings refer to current controller
Ctrl	Shows which controller is displayed

APPENDIX E - Setpoint Parameters

PARAMETERS			
Counterclockwise	ESC	Escape and Save Settings	—
	LoSP	Liquid Outlet Temperature Setpoint Change to desired Liquid Out Temperature	-25 to 100°F (-31.7 to 37.8°C) Default is 45°F (7.2°C)
	rGhL	Return Gas High Limit	40 to 120°F (4.4 to 48.8°C) Default is 120°F (48.8°C)
	LtCo	Low Temperature Cut Out	-30 to 50°F (-34.4 to 10°C) Default is 35°F (1.7°C)
	SHSP	Superheat Setpoint Change to desired Superheat Setpoint	5 to 45°F (2.8 to 25°C) Default is 10°F (5.5°C)
	rEFr Chosen at Setup	Refrigerant Type Change to desired Refrigerant Type	**Readout / Description** r22 R-22 134A R-134a 402A R-402A 404A R-404A 407A R-407A 407C R-407C 410A R-410A 417A R-417A 422A R-422A 422d R-422D r507 R-507A r744 R-744 245F R-245FA r-E5 R-E5 438A R-438A 401b R-401B 407F R-407F 408A R-408A 508A R-508A 508b R-508B
	HiCP	Maximum Valve Capacity	0 to 100% Default is 100
	-LP-	Liquid Proportional Coefficient	0 to 25.5 Default is 1.0 *Increase value to increase valve response to liquid out temperature*
	-LI-	Liquid Integral Coefficient	0 to 255 Default is 60 *Increase value to decrease valve response to liquid out temperature over time*
	-Ld-	Liquid Derivative Coefficient	0 to 255 Default is 0 *Increase value to increase valve response to change in liquid out temperature*
	-SP-	Superheat Proportional Coefficient	0 to 25.5 Default is 1.0 *Increase value to increase valve response to superheat*
			Clockwise

Default values are highlighted.

APPENDIX E - Setpoint Parameters (continued)

PARAMETERS

Counterclockwise

-SI-	Superheat Integral Coefficient	0 to 255 Default is 120 *Increase value to decrease valve response to superheat over time*
-Sd-	Superheat Derivative Coefficient	0 to 255 Default is 0 *Increase value to increase valve response to change in superheat*
LSH1	Low Superheat Integral Coefficient	1 to 255 Default is 10 *Increase value to decrease valve response to superheat over time, low Superheat condition*
CYCt	Cycle Time	1 to 10 seconds Default is 1
StEP Chosen at Setup	Valve Type	**Readout** / **Description** 1596 / 1596 Step Bipolar Valve 3193 / 3193 Step Bipolar Valve 2500 / 2500 Step Bipolar Valve 6386 / 6386 Step Bipolar Valve
SPoS	Manual Valve Position	0 to 100% Open Default is 0
nEt	Network Type	MODBUS (nbUS) Default or BACnet (bnEt)
Addr	MODBUS Network Address	1 to 255 Default is 1
bAud	MODBUS Baud Rate	**Readout** / **Description** 96 / 9600 192 / 19200 384 / 38400
nPAr	MODBUS Network Parity	**Readout** / **Description** nonE / No Parity EuEn / Even Parity Odd / Odd Parity
Un_P	Pressure Units	**Readout** / **Description** PSI / Pounds Force Per Square Inch bAr / Bars
Un_t	Temperature Units	**Readout** / **Description** FAHr / Fahrenheit CELS / Celsius
ttYP	Temperature Sensor Type	**Readout** / **Description** tYP3 / 3k tYP2 / 2k
PtYP Chosen at Setup	Pressure Sensor Type	**Readout** / **Description** AbSL / Absolute Pressure Type GAuG / Gauge (Sealed) Pressure Type
PrnG Chosen at Setup	Pressure Sensor Range	**Readout** / **Description** 150 / 0-150 PSI 300 / 0-300 PSI 500 / 0-500 PSI
CALP	Pressure Sensor Calibration Offset	-5 to 5 PSI (-0.34 to 0.34 Bar) Default is 0
CLt1	Suction Temperature Calibration Offset	-5 to 5°F (-2.7 to 2.7°C) Default is 0
CLt2	Liquid Outlet Temperature Calibration Offset	-5 to 5°F (-2.7 to 2.7°C) Default is 0
CLt3	Liquid Inlet Temperature Calibration Offset	-5 to 5°F (-2.7 to 2.7°C) Default is 0
CLt4	Auxiliary Temperature Calibration Offset	-5 to 5°F (-2.7 to 2.7°C) Default is 0
CAdr	Controller Display Address	0 to 99 Default is 0, Do not change

Clockwise

Default values are highlighted.

APPENDIX F - Parameter Definitions

DISPLAY	MEANING	DESCRIPTION
ESC	Escape	Escape from the Settings Menu and Return to Process Variables Menu
LoSP	Liquid Outlet Temperature Control Setpoint	The target control temperature of the liquid leaving the heat exchanger
rGhL	Return Gas High Limit	Limits the temperature of the superheated refrigerant to a maximum target value
LtCo	Low Temperature Cut Out	The temperature that the liquid outlet temperature must fall below in order to switch to OFF mode. Will switch back to cooling after the liquid outlet temperature rises above the liquid outlet temperature setpoint.
SHSP	Superheat Setpoint	The minimum target superheat setpoint that the superheat PID can try to maintain
rEFr	Refrigerant	The currently selected refrigerant used to calculate the saturation temperature based on suction pressure
H iCP	Maximum Stepper % Open	The maximum % open of the valve referenced to full stroke
-LP-	Liquid Proportional Gain Coefficient	Liquid Proportional Gain Coefficient
-LI-	Liquid Integral Gain Coefficient	Liquid Integral Gain Coefficient
-Ld-	Liquid Derivative Gain Coefficient	Liquid Derivative Gain Coefficient
-SP-	Superheat Proportional Gain Coefficient	Superheat Proportional Gain Coefficient
-SI-	Superheat Integral Gain Coefficient	Superheat Integral Gain Coefficient
-Sd-	Superheat Derivative Gain Coefficient	Superheat Derivative Gain Coefficient
LSH i	Low Superheat Integral Gain Coefficient	The integral gain coefficient to use for the superheat PID loop if the superheat is below 3 degrees F (1.7 degrees C)
CYCt	Cycle Time	The PID update time
StEP	Stepper Type	The number of steps of resolution for the stepper valve at full stroke
SPoS	Manual Stepper Position	Overrides the stepper valve position and moves to the desired percent open relative to full stroke of the valve
nEt	Network Type	The type of network used in system; MODBUS or BACnet
Addr	Network Address	The address of the controller on the MODBUS network
bAud	Network Baud Rate	The baud rate in hundreds of bits per second of the MODBUS network
nPAr	Network Parity Mode	The network parity mode of the MODBUS network
Un_P	Units of Pressure	The units of pressure the controller uses to display (PSI or Bar)
Un_t	Units of Temperature	The units of temperature the controller uses to display (Fahrenheit or Celsius)
ttYP	Temperature Sensor Type	The type of thermistor connected to the controller (2K type or 3K type)
PtYP	Pressure Sensor Type	The type of pressure sensor connected to the controller (absolute or gauge type)
PrnG	Pressure Sensor Range	The range of the pressure sensor connected to the controller (0-150 PSI / 0-10.3 Bar, 0-300 PSI / 0-20.7 Bar, or 0-500 PSI / 0-34.5 Bar)
CALP	Pressure Calibration Offset	Adds a constant offset to the pressure reading
CLt1	T1 Temperature Calibration Offset	Adds a constant offset to the T1 temperature reading
CLt2	T2 Temperature Calibration Offset	Adds a constant offset to the T2 temperature reading
CLt3	T3 Temperature Calibration Offset	Adds a constant offset to the T3 temperature reading
CLt4	T4 Temperature Calibration Offset	Adds a constant offset to the T4 temperature reading
CAdr	Controller Address on Display Network	Controller must be set to 0 (Standalone) No display networking option

APPENDIX G - Alarms and Failsafes

READOUT	DESCRIPTION	CAUSE and FAILSAFE
nonE	No Active Alarms	Normal Operation
PSAL	Pressure Sensor Alarm	When the pressure is outside the operating range. Will force a pump-down.
tSAL	Suction Temperature Sensor Alarm	When the suction temperature is outside the operating range. (under -60°F / -51.1°C, over 150°F / 65.6°C) Will force a pump-down.
LSAL	Liquid Outlet Temperature Sensor Alarm	When the liquid outlet temperature is outside the operating range. Will force a pump-down.
LSHA	Low Superheat Alarm	When superheat is below 3 degrees F (1.7 degrees C) for 30 cumulative seconds or more.

APPENDIX H - Technical Specifications

ELECTRICAL

Supply Voltage
20-26VAC 50/60Hz or 22-26.6VDC; Class II input

Digital Inputs
0-5VDC Maximum Range
Interface to dry contact or open collector

Analog Inputs
4 Temperature Sensors - 3 Kohm (2 Kohm optional)

1 Pressure Transducer .5 - 4.5VR
150 psig / 0-10.3 bar
300 psig / 0-20.7 bar
500 psig / 0-34.5 bar

Digital Display
LED - Red, 7 segment, 4 digit

Indicators
LED - Red, Power

User Interface
Optical Encoder (SELECT knob)

Data Interface
RS485, Modbus, BACnet

MECHANICAL

Operating Temperature
-40°F to 158°F (-40°C to 70°C)

Humidity
0-95%RH (Non-Condensing)

Enclosure
PC - Light Gray

Wiring
Screw terminal

Mounting
DIN Rail - EN 50 022

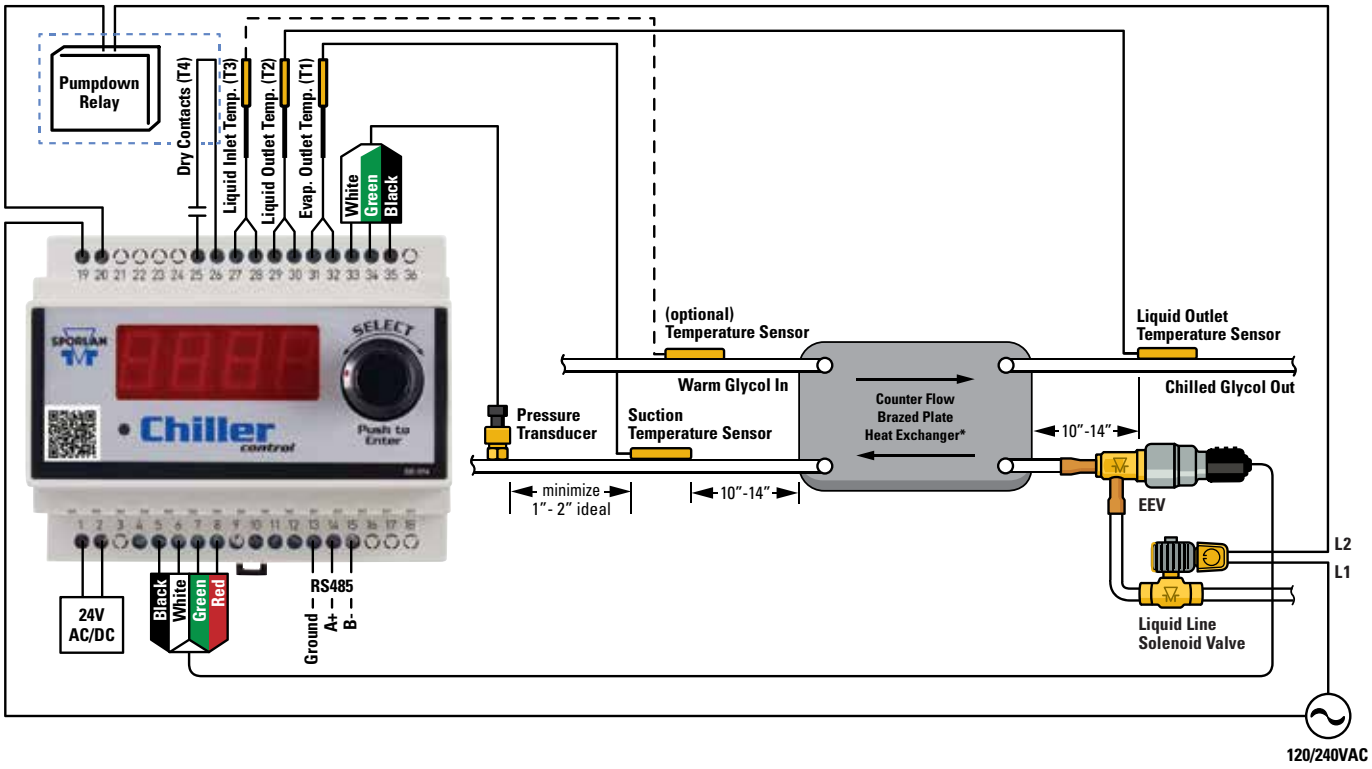
COMPLIANCE

Environmental
RoHS
WEEE

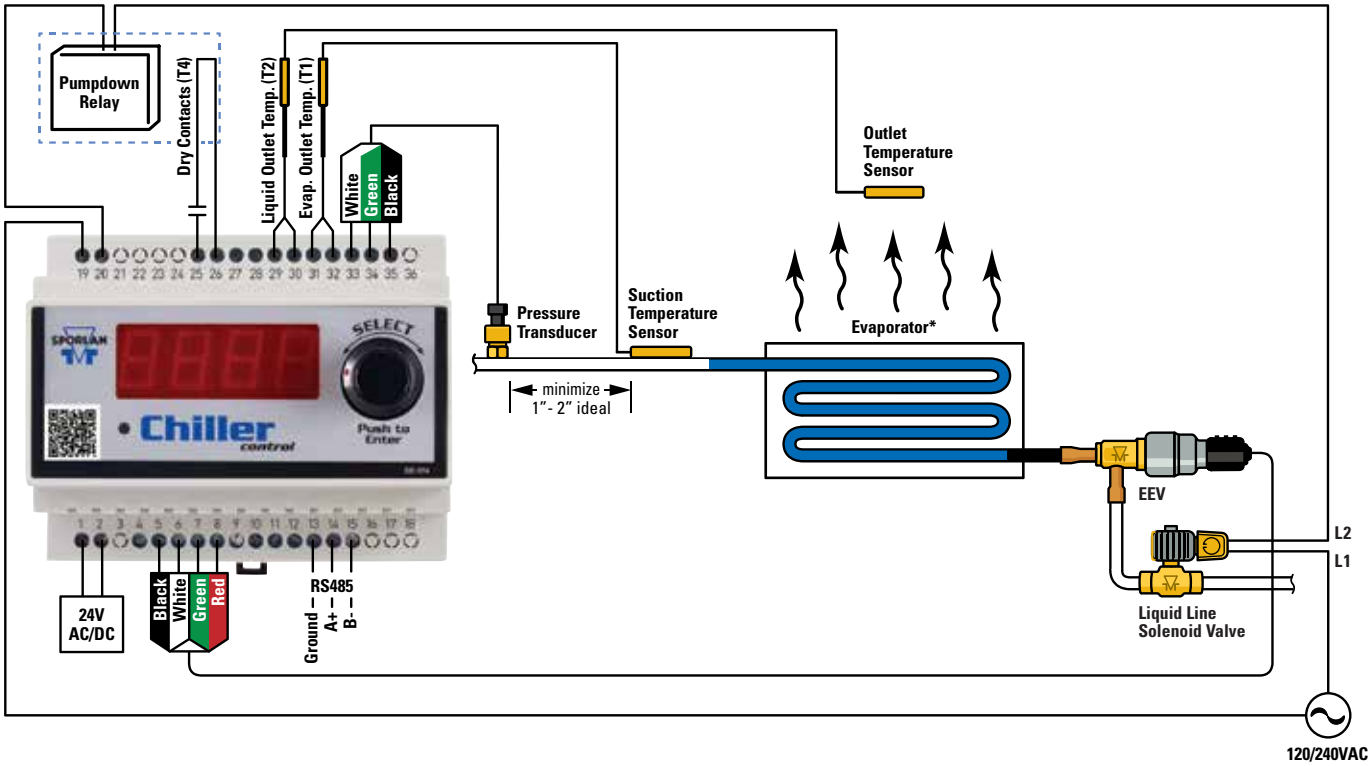
Electrical
CE
UL/CUL (Recognized per 873)
FCC (Class A, part 15)
C-tick

APPENDIX I - Wiring Diagrams

Liquid Heat Exchanger



Air Coil - Fin and Tube



* Refer to manufacturer's installation/orientation instructions.

NOTE: Use caution when working around high voltage components. Safety covers should be used for personal safety on high voltage panels.

APPENDIX J - Sensor Installation

Refer to *Appendix I - Wiring Diagram,* page 15 for sensor locations.

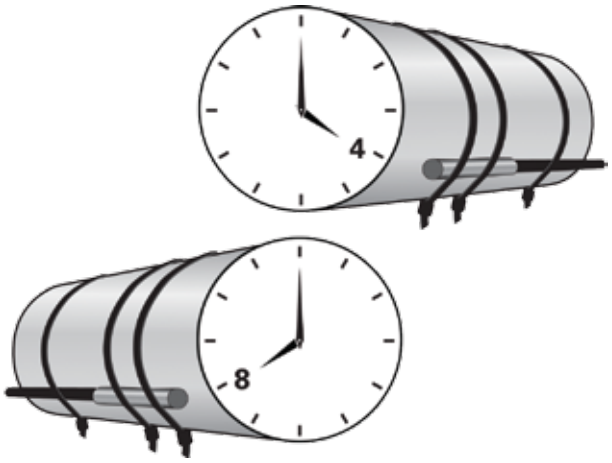
Mount the Pressure Transducer

1. Position the suction return gas pressure access port near the outlet of the heat exchanger.
2. Verify that the pressure range matches the expected system operating pressure (i.e 0-150 psig / 0-10.3 bar, etc).
3. Install transducer on access port at 12 o'clock, minimizing distance from temperature sensor. Check for leaks.
4. For safety, ensure Schrader core is installed in access fitting (only if ¼" SAE is used). **Use caution when removing Schrader cap to avoid contacting expanding refrigerant.**
5. Connect pressure transducer cable to transducer.
6. Route and secure transducer cable away from hot surfaces and high power A/C voltage lines.
7. Attach wires to the Chiller Control.
8. Ensure pressure range and type (i.e gauge or absolute) are configured properly in the Chiller Controller, See *Section 2 - SETUP,* page 4.
9. After startup, use a gauge set to verify proper pressure reading through the Chiller Control. An improperly installed Schrader core can cause erroneous pressure readings.
10. Check for leaks after system is in operation.

Mount the Temperature Sensors – Suction and Liquid

1. Per *Appendix I - Wiring Diagram*, page 15, measure and mark locations on copper pipe. Position sensors 10-14 inches from the heat exchanger on a free-draining horizontal line.
2. Remove all insulation and adhesives at the marked location. Using Scotch-Brite™, clean the copper line to remove oxides and dirt. This will increase sensor accuracy.
3. Fasten the temperature sensors in orientation shown in *Figure 6*. Carefully note the locations of temperature sensors for Suction Gas and Liquid.
   - Mount the suction temperature sensor on the suction line after the heat exchanger, near the pressure transducer.
   - Mount the liquid outlet temperature sensor on the liquid outlet.
4. Attach and secure temperature sensor cables, routing them away from hot surfaces and high power A/C voltage lines.
5. Ensure that the Chiller Control is configured properly (i.e 2K or 3K sensor selection), See *Section 2 - SETUP,* page 4. **NOTE: 2K and 3K sensors have approximately 1.9kΩ and 2.8kΩ, respectively, at 80°F measured across the sensor wires.**
6. Wrap temperature sensors and copper tube with foam insulation to minimize ambient temperature effects, see Figure 7.

Figure 6 - Temperature Sensor Positioning



Temperature sensor should be mounted at either 4 or 8 o'clock, on a free-draining horizontal line.

Figure 7 - Cutaway of Pipe Insulation

2K sensor shown

Figure 8 - Temperature Sensors

2K sensor

3K sensor

WARNING: Ensure that "Suction" and "Liquid" temperature sensor locations are not reversed. Severe system damage may occur if these two sensor locations are interchanged.

APPENDIX K - MODBUS Memory Map

FUNCTION CODE	DATA ADDRESS	DATA DESCRIPTION	RANGE
Read Coils (0x01)	0	Manual Valve Enabled Flag	0 = Disabled 1 = Enabled
	1	Manual Valve Duration Enabled Flag	0 = Disabled 1 = Enabled
	2	Pumpdown Enabled Flag	0 = Disabled 1 = Enabled
Read Holding Registers (0x03)	0	Liquid Outlet Temperature Setpoint	-25 to 100°F (-31.7 to 37.8°C)
	1	Return Gas High Limit	40 to 120°F (4.4 to 48.9°C)
	2	Low Temperature Cut Out	-30 to 50°F (-34.4 to -10.0°C)
	3	Superheat Setpoint	5 to 45°F (2.8 to 25°C)
	4	Refrigerant Type	0 = R-22 1 = R-134a 2 = R-402A 3 = R-404A 4 = R-407A 5 = R-407C 6 = R-410A 7 = R-417A 8 = R-422A 9 = R-422D 10 = R-507A 11 = R-744 12 = R-245FA 13 = R-E5 14 = R-438A 15 = R-401B 16 = R-407F 17 = R-408A 18 = R-508A 19 = R-508B
	5	Valve Maximum	0 to 100 (0 to 100%) Open
	6	Liquid Proportional Coefficient	0 to 255 (0 to 25.5)
	7	Liquid Integral Coefficient	0 to 255
	8	Liquid Derivative Coefficient	0 to 255
	9	Superheat Proportional Coefficient	0 to 255 (0 to 25.5)
	10	Superheat Integral Coefficient	0 to 255
	11	Superheat Derivative Coefficient	0 to 255
	12	Cycle Time	1 to 10 seconds
	13	Valve Type	0 = 1596 1 = 3193 2 = 2500 3 = 6386
	14	Manual Valve Position	0 to 1000 (0 to 100.0%) Open
	15	MODBUS Network Address	1 to 247
	16	Pressure Units	0 = PSI 1 = BAR
	17	Temperature Units	0 = FAHR 1 = CELS
	18	Pressure Sensor Type	0 = ABSL 1 = GauG
	19	Pressure Range	1 = 150 PSI (10.3 Bar) 2 = 300 PSI (20.7 Bar) 3 = 500 PSI (34.5 Bar)
	20	Pressure Calibration Offset	-5 to 5 PSI (-0.34 to 0.34 Bar)
	21	Suction Temperature Calibration Offset	-5 to 5°F (-2.8 to 2.8°C)
	22	Liquid Outlet Temperature Calibration Offset	-5 to 5°F (-2.8 to 2.8°C)
	23	Liquid Inlet Temperature Calibration Offset	-5 to 5°F (-2.8 to 2.8°C)
	24	Auxiliary Temperature Calibration Offset	-5 to 5°F (-2.8 to 2.8°C)
	25	Temperature Sensor Type	0 = 3K 1 = 2K
	26	Low Superheat Integral	1-255
	27	User Password	1 to 999

APPENDIX K - MODBUS Memory Map (continued)

FUNCTION CODE	DATA ADDRESS	DATA DESCRIPTION	RANGE
Read Input Registers (0x04)	0	Controller FW Rev Level	0 to 65,535
	1	Liquid Outlet Temperature	-60 to 150°F (-51.1 to 65.6°C)
	2	Superheat	0 to 165°F (0 to 91°C)
	3	Suction Pressure	Depends on Pressure Sensor Range and Type (-15 to 500 PSI, -1.01 to 34.47 Bar)
	4	Saturation Temperature	-60 to 150°F (-51.1 to 65.6°C)
	5	Suction Temperature	-60 to 150°F (-51.1 to 65.6°C)
	6	Valve Position (% of Max. Stroke)	0 to 1000 (0 to 100.0%) Open
	7	Liquid Inlet Temperature	-60 to 150°F (-51.1 to 65.6°C)
	8	Auxiliary Temperature	-60 to 150°F (-51.1 to 65.6°C)
	9	System State	If Bit is set, then mode is active: Bit 0 = Setup Mode Bit 1 = Off Cycle Bit 2 = Cooling Cycle Bit 3 = Pump-down Cycle Bit 4 = Manual Valve Override Mode
	10	Alarm Status	If Bit is set, then alarm is active: Bit 0 = Pressure Sensor Failure Alarm Bit 1 = Suction Temperature Sensor Failure Alarm Bit 2 = Liquid Outlet Temperature Sensor Failure Alarm Bit 3 = Low Superheat Alarm
	11	Liquid Outlet Maximum Temperature	-60 to 150°F (-51.1 to 65.6°C)
	12	Liquid Outlet Minimum Temperature	-60 to 150°F (-51.1 to 65.6°C)
Write Single Coil (0x05)	0	Manual Valve Enabled Flag	0 = Disabled, 1 = Enabled The other coils are read-only.
	1	Read Only	
	2	Pumpdown Enabled Flag	0 = Disabled, 1 = Enabled
Write Single Register (0x06)		Same as 'Read Holding Register' Definitions	Selected Register to Write
		User Password	Enables parameter modification

APPENDIX L - BACnet Map

DEVICE OBJECT

OBJECT INSTANCE	OBJECT NAME	WRITEABLE PROPERTY RANGES	OPTIONAL PROPERTIES SUPPORTED
<Controller Address>	"CHILLER_CONTROL-###" where "###" is the controller address. Ex. "CHILLER_CONTROL-001" for controller address 1	None	None

DEVICE PROPERTY DESCRIPTION	RANGE
System Status	Operational
Vendor Name	"Parker Hannifin"
Vendor Identifier	287
Model Name	"KELVIN II - 4 TEMP"
Firmware Revision	Latest Revision formatted as <Major Version> '.' <Minor Version>
Application Software Version	Firmware Date formatted as <Month> '/' <Day> '/' <Year>
Protocol Version	1
Protocol Revision	14
Protocol Services Supported	Read Property Write Property Who-Is I-Am
Object Types Supported	Analog Input Object Analog Value Object Binary Output Object Binary Value Object Device Object Loop Object Multistate Value Object
Object List	List of all objects in Device
Maximum APDU Size	480
Segmentation Support	Segmentation Not Supported
APDU Timeout	3000 milliseconds
Number of APDU Retries	1
Device Address Binding	None
Database Revision	1

APPENDIX L - BACnet Map (continued)

ANALOG INPUT OBJECTS

OBJECT INSTANCE	OBJECT NAME	PROPERTY	RANGE	WRITEABLE
1	"PRESSURE"	Present Value	0.0 to 500.0	No
		Status Flags	None	No
		Event State	Normal	No
		Out of Service	False	No
		Units	PSI	No
2	"TEMPERATURE-1"	Present Value	-60.0 to 150.0	No
		Status Flags	None	No
		Event State	Normal	No
		Out of Service	False	No
		Units	°F	No
3	"TEMPERATURE-2"	Present Value	-60.0 to 150.0	No
		Status Flags	None	No
		Event State	Normal	No
		Out of Service	False	No
		Units	°F	No
4	"TEMPERATURE-3"	Present Value	-60.0 to 150.0	No
		Status Flags	None	No
		Event State	Normal	No
		Out of Service	False	No
		Units	°F	No
5	"TEMPERATURE-4"	Present Value	-60.0 to 150.0	No
		Status Flags	None	No
		Event State	Normal	No
		Out of Service	False	No
		Units	°F	No

ANALOG VALUE OBJECTS

OBJECT INSTANCE	OBJECT NAME	PROPERTY	RANGE	WRITEABLE
1	"LIQ_OUT_TEMP_SETPT"	Present Value	-25.0 to 100.0	Yes
		Status Flags	None	No
		Event State	Normal	No
		Out of Service	False	No
		Units	°F	No
2	"RETURN_GAS_HI_LMT"	Present Value	40.0 to 120.0	Yes
		Status Flags	None	No
		Event State	Normal	No
		Out of Service	False	No
		Units	°F	No
3	"LOW_TEMP_CUTOUT"	Present Value	-30.0 to 50.0	Yes
		Status Flags	None	No
		Event State	Normal	No
		Out of Service	False	No
		Units	°F	No
4	"SUPERHEAT_SETPT"	Present Value	5.0 to 45.0	Yes
		Status Flags	None	No
		Event State	Normal	No
		Out of Service	False	No
		Units	Δ°F	No
5	"MAXIMUM_VALVE_POSITION"	Present Value	0.00 to 100.00	Yes
		Status Flags	None	No
		Event State	Normal	No
		Out of Service	False	No
		Units	%	No
6	"CYCLE_TIME"	Present Value	1 to 10	Yes
		Status Flags	None	No
		Event State	Normal	No
		Out of Service	False	No
		Units	Seconds	No

APPENDIX L - BACnet Map (continued)

ANALOG VALUE OBJECTS (continued)

OBJECT INSTANCE	OBJECT NAME	PROPERTY	RANGE	WRITEABLE
7	"PRESSURE_CALIB_OFFSET"	Present Value	-5.0 to 5.0	Yes
		Status Flags	None	No
		Event State	Normal	No
		Out of Service	False	No
		Units	PSI	No
8	"T1_OFFSET"	Present Value	-5.0 to 5.0	Yes
		Status Flags	None	No
		Event State	Normal	No
		Out of Service	False	No
		Units	Δ°F	No
9	"T2_OFFSET"	Present Value	-5.0 to 5.0	Yes
		Status Flags	None	No
		Event State	Normal	No
		Out of Service	False	No
		Units	Δ°F	No
10	"T3_OFFSET"	Present Value	-5.0 to 5.0	Yes
		Status Flags	None	No
		Event State	Normal	No
		Out of Service	False	No
		Units	Δ°F	No
11	"T4_OFFSET"	Present Value	-5.0 to 5.0	Yes
		Status Flags	None	No
		Event State	Normal	No
		Out of Service	False	No
		Units	Δ°F	No
12	"MANUAL_VALVE_POSITION"	Present Value	0.00 to 100.00	Yes
		Status Flags	None	No
		Event State	Normal	No
		Out of Service	False	No
		Units	%	No
13	"CURRENT_VALVE_POSITION"	Present Value	0.00 to 100.00	No
		Status Flags	None	No
		Event State	Normal	No
		Out of Service	False	No
		Units	%	No
14	"LOW_SUPERHEAT_INTEGRAL"	Present Value	1 to 255	Yes
		Status Flags	None	No
		Event State	Normal	No
		Out of Service	False	No
		Units	No Units	No
15	"LIQ_OUT_LOW""	Present Value	-60 to 150	No
		Status Flags	None	No
		Event State	Normal	No
		Out of Service	False	No
		Units	°F	No
16	"LIQ_OUT_HIGH"	Present Value	-60 to 150	No
		Status Flags	None	No
		Event State	Normal	No
		Out of Service	False	No
		Units	°F	No
17	"SUPERHEAT"	Present Value	0.0 to 210	No
		Status Flags	None	No
		Event State	Normal	No
		Out of Service	False	No
		Units	Δ°F	No
18	"SATURATION_TEMPERATURE"	Present Value	-140.0 to 160.0	No
		Status Flags	None	No
		Event State	Normal	No
		Out of Service	False	No
		Units	°F	No

APPENDIX L - BACnet Map (continued)

BINARY OUTPUT OBJECTS

OBJECT INSTANCE	OBJECT NAME	PROPERTY	RANGE	WRITEABLE
1	"RELAY-1"	Present Value	0 or 1	Yes
		Status Flags	None	No
		Event State	Normal	No
		Out of Service	False	No
		Inactive Text	DE-ENERGIZED	No
		Active Text	ENERGIZED	No
		Priority Array	N/A	Not directly
		Relinquish Default	0 or 1	No

BINARY VALUE OBJECTS

OBJECT INSTANCE	OBJECT NAME	PROPERTY	RANGE	WRITEABLE
1	"MANUAL_VALVE_CONTROL"	Present Value	0 or 1	Yes
		Status Flags	None	No
		Event State	Normal	No
		Out of Service	False	No
		Inactive Text	DISABLED	No
		Active Text	ENABLED	No
2	"MANUAL_VALVE_DURATION"	Present Value	0 or 1	No
		Status Flags	None	No
		Event State	Normal	No
		Out of Service	False	No
		Inactive Text	DISABLED	No
		Active Text	ENABLED	No
3	"PRESSURE_SENSOR_TYPE"	Present Value	0 or 1	Yes
		Status Flags	None	No
		Event State	Normal	No
		Out of Service	False	No
		Inactive Text	ABSOLUTE	No
		Active Text	GAUGE	No
4	"PUMPDOWN_STATUS"	Present Value	0 or 1	Yes
		Status Flags	None	No
		Event State	Normal	No
		Out of Service	False	No
		Inactive Text	DISABLED	No
		Active Text	ENABLED	No
5	"LOW_SUPERHEAT_ALARM"	Present Value	0 or 1	No
		Status Flags	None	No
		Event State	Normal	No
		Out of Service	False	No
		Inactive Text	INACTIVE	No
		Active Text	ACTIVE	No

APPENDIX L - BACnet Map (continued)

LOOP OBJECTS

OBJECT INSTANCE	OBJECT NAME	PROPERTY	RANGE	WRITEABLE
1	"LIQUID_CONTROL_LOOP"	Present Value	Minimum Output to Maximum Output	Yes
		Status Flags	Out of Service Flag	No
		Event State	Normal	No
		Out of Service	True or False	No
		Output Units	Δ°F	No
		Manipulated Variable Reference	Loop Instance 2 Setpoint	No
		Controlled Variable Reference	Analog Input Instance 3 Present Value	No
		Controlled Variable Value	Liquid Out Temperature	No
		Controlled Variable Units	°F	No
		Setpoint Reference	Analog Value Instance 1 Present Value	No
		Setpoint	Liquid Out Temperature Setpoint	No
		Action	Reverse	No
		Priority for Writing	16	No
		Proportional Constant	0 to 25.5	Yes
		Proportional Constant Units	No Units	No
		Integral Constant	0 to 255	Yes
		Integral Constant Units	No Units	No
		Derivative Constant	0 to 255	Yes
		Derivative Constant Units	No Units	No
		Maximum Output	Return Gas High Limit – Saturation Temperature	No
		Minimum Output	Superheat Setpoint	No
2	"SUPERHEAT_CONTROL_LOOP"	Present Value	Minimum Output to Maximum Output	Yes
		Status Flags	Out of Service Flag	No
		Event State	Normal	No
		Out of Service	True or False	No
		Output Units	%	No
		Manipulated Variable Reference	Analog Value Instance 12 Present Value	No
		Controlled Variable Reference	Analog Input Instance 17 Present Value	No
		Controlled Variable Value	Superheat	No
		Controlled Variable Units	Δ°F	No
		Setpoint Reference	Loop Instance 1 Present Value	No
		Setpoint	Liquid Loop Present Value	No
		Action	Direct	No
		Priority for Writing	16	No
		Proportional Constant	0 to 25.5	Yes
		Proportional Constant Units	No Units	No
		Integral Constant	0 to 255	Yes
		Integral Constant Units	No Units	No
		Derivative Constant	0 to 255	Yes
		Derivative Constant Units	No Units	No
		Maximum Output	Maximum Valve Position	No
		Minimum Output	0%	No

APPENDIX L - BACnet Map (continued)

MULTISTATE VALUE OBJECTS

OBJECT INSTANCE	OBJECT NAME	PROPERTY	RANGE	WRITEABLE
1	"PRESSURE_TRANSDUCER_RANGE"	Present Value	1 to 3	Yes
		Status Flags	None	No
		Event State	Normal	No
		Out of Service	False	No
		Number of States	3	No
		State Text	150 PSI 300 PSI 500 PSI	No
2	"VALVE_STEPS"	Present Value	1 to 4	Yes
		Status Flags	None	No
		Event State	Normal	No
		Out of Service	False	No
		Number of States	4	No
		State Text	1596 3193 2500 6386	No
3	"REFRIGERANT_TYPE"	Present Value	1 to 20	Yes
		Status Flags	None	No
		Event State	Normal	No
		Out of Service	False	No
		Number of States	20	No
		State Text	R-22 R-507A R-134a R-744 R-402A R-245FA R-404A R-E5 R-407A R-438A R-407C R-401B R-410A R-407F R-417A R-408A R-422A R-508A R-422D R-508B	No
4	"TEMPERATURE_SENSOR_TYPE"	Present Value	1 to 2	Yes
		Status Flags	None	No
		Event State	Normal	No
		Out of Service	False	No
		Number of States	2	No
		State Text	3K, 2K	No
5	"TEMPERATURE_UNITS"	Present Value	1 to 2	Yes
		Status Flags	None	No
		Event State	Normal	No
		Out of Service	False	No
		Number of States	2	No
		State Text	Degrees F Degrees C	No
6	"CONTROLLER_ADDRESS"	Present Value	1 to 247	Yes
		Status Flags	None	No
		Event State	Normal	No
		Out of Service	False	No
		Number of States	247	No
7	"PASSWORD_WRITE"	Present Value	1 to 999	Yes
		Status Flags	None	No
		Event State	Normal	No
		Out of Service	False	No
		Number of States	999	No
8	"PRESSURE_UNITS"	Present Value	1 to 2	Yes
		Status Flags	None	No
		Event State	Normal	No
		Out of Service	False	No
		Number of States	2	No
		State Text	PSI, Bar	No

APPENDIX M - 2k Temperature Sensor Specifications

°C	°F	RANGE VDC
-51.1	-60	4.375 - 4.555
-50.6	-59	4.361 - 4.539
-50.0	-58	4.345 - 4.524
-49.4	-57	4.330 - 4.508
-48.9	-56	4.314 - 4.492
-48.3	-55	4.299 - 4.475
-47.8	-54	4.282 - 4.458
-47.2	-53	4.266 - 4.441
-46.7	-52	4.249 - 4.423
-46.1	-51	4.232 - 4.406
-45.6	-50	4.214 - 4.387
-45.0	-49	4.196 - 4.369
-44.4	-48	4.178 - 4.350
-43.9	-47	4.160 - 4.331
-43.3	-46	4.141 - 4.311
-42.8	-45	4.122 - 4.291
-42.2	-44	4.102 - 4.271
-41.7	-43	4.083 - 4.251
-41.1	-42	4.063 - 4.230
-40.6	-41	4.042 - 4.209
-40.0	-40	4.022 - 4.187
-39.4	-39	4.001 - 4.165
-38.9	-38	3.979 - 4.143
-38.3	-37	3.958 - 4.121
-37.8	-36	3.936 - 4.098
-37.2	-35	3.914 - 4.075
-36.7	-34	3.891 - 4.052
-36.1	-33	3.868 - 4.028
-35.6	-32	3.845 - 4.004
-35.0	-31	3.822 - 3.980
-34.4	-30	3.798 - 3.955
-33.9	-29	3.774 - 3.930
-33.3	-28	3.750 - 3.905
-32.8	-27	3.726 - 3.880
-32.2	-26	3.701 - 3.854
-31.7	-25	3.676 - 3.828
-31.1	-24	3.651 - 3.802
-30.6	-23	3.625 - 3.775
-30.0	-22	3.600 - 3.749
-29.4	-21	3.574 - 3.722
-28.9	-20	3.548 - 3.694
-28.3	-19	3.521 - 3.667
-27.8	-18	3.495 - 3.639
-27.2	-17	3.468 - 3.611
-26.7	-16	3.441 - 3.583
-26.1	-15	3.414 - 3.555
-25.6	-14	3.386 - 3.527
-25.0	-13	3.359 - 3.498
-24.4	-12	3.331 - 3.469
-23.9	-11	3.303 - 3.440
-23.3	-10	3.275 - 3.411
-22.8	-9	3.247 - 3.381
-22.2	-8	3.218 - 3.352
-21.7	-7	3.190 - 3.322
-21.1	-6	3.161 - 3.293
-20.6	-5	3.133 - 3.263
-20.0	-4	3.104 - 3.233
-19.4	-3	3.075 - 3.203
-18.9	-2	3.046 - 3.173
-18.3	-1	3.017 - 3.142
-17.8	0	2.988 - 3.112
-17.2	1	2.958 - 3.082
-16.7	2	2.929 - 3.051
-16.1	3	2.900 - 3.021
-15.6	4	2.871 - 2.990
-15.0	5	2.841 - 2.960
-14.4	6	2.812 - 2.929
-13.9	7	2.782 - 2.899
-13.3	8	2.753 - 2.868
-12.8	9	2.724 - 2.837
-12.2	10	2.694 - 2.807
-11.7	11	2.665 - 2.776
-11.1	12	2.636 - 2.746
-10.6	13	2.607 - 2.716
-10.0	14	2.577 - 2.685
-9.4	15	2.548 - 2.655
-8.9	16	2.519 - 2.625
-8.3	17	2.490 - 2.595
-7.8	18	2.462 - 2.565
-7.2	19	2.433 - 2.535
-6.7	20	2.404 - 2.505
-6.1	21	2.376 - 2.475
-5.6	22	2.347 - 2.446
-5.0	23	2.319 - 2.416
-4.4	24	2.291 - 2.387
-3.9	25	2.263 - 2.358
-3.3	26	2.235 - 2.329
-2.8	27	2.207 - 2.300
-2.2	28	2.179 - 2.271
-1.7	29	2.152 - 2.242
-1.1	30	2.125 - 2.214
-0.6	31	2.098 - 2.186
0.0	32	2.071 - 2.158
0.6	33	2.044 - 2.130
1.1	34	2.017 - 2.102
1.7	35	1.991 - 2.075
2.2	36	1.965 - 2.048
2.8	37	1.939 - 2.021
3.3	38	1.913 - 1.994
3.9	39	1.888 - 1.967
4.4	40	1.862 - 1.941
5.0	41	1.837 - 1.915
5.6	42	1.812 - 1.889
6.1	43	1.788 - 1.863
6.7	44	1.763 - 1.837
7.2	45	1.739 - 1.812
7.8	46	1.715 - 1.787
8.3	47	1.691 - 1.763
8.9	48	1.668 - 1.738
9.4	49	1.644 - 1.714
10.0	50	1.621 - 1.690
10.6	51	1.598 - 1.666
11.1	52	1.576 - 1.642
11.7	53	1.554 - 1.619
12.2	54	1.531 - 1.596
12.8	55	1.510 - 1.573
13.3	56	1.488 - 1.551
13.9	57	1.467 - 1.529
14.4	58	1.446 - 1.507
15.0	59	1.425 - 1.485
15.6	60	1.404 - 1.463
16.1	61	1.384 - 1.442
16.7	62	1.363 - 1.421
17.2	63	1.344 - 1.400
17.8	64	1.324 - 1.380
18.3	65	1.305 - 1.360
18.9	66	1.285 - 1.340
19.4	67	1.266 - 1.320
20.0	68	1.248 - 1.301
20.6	69	1.229 - 1.281
21.1	70	1.211 - 1.262
21.7	71	1.193 - 1.244
22.2	72	1.175 - 1.225
22.8	73	1.158 - 1.207
23.3	74	1.141 - 1.189
23.9	75	1.124 - 1.171
24.4	76	1.107 - 1.154
25.0	77	1.090 - 1.137
25.6	78	1.074 - 1.120
26.1	79	1.058 - 1.103
26.7	80	1.042 - 1.086
27.2	81	1.026 - 1.070
27.8	82	1.011 - 1.054
28.3	83	0.996 - 1.038
28.9	84	0.981 - 1.022
29.4	85	0.966 - 1.007
30.0	86	0.951 - 0.992
30.6	87	0.937 - 0.977
31.1	88	0.923 - 0.962
31.7	89	0.909 - 0.948
32.2	90	0.895 - 0.933
32.8	91	0.882 - 0.919
33.3	92	0.868 - 0.905
33.9	93	0.855 - 0.892
34.4	94	0.842 - 0.878
35.0	95	0.830 - 0.865
35.6	96	0.817 - 0.852
36.1	97	0.805 - 0.839
36.7	98	0.792 - 0.826
37.2	99	0.780 - 0.814
37.8	100	0.769 - 0.801
38.3	101	0.757 - 0.789
38.9	102	0.746 - 0.777
39.4	103	0.734 - 0.766
40.0	104	0.723 - 0.754
40.6	105	0.712 - 0.743
41.1	106	0.702 - 0.731
41.7	107	0.691 - 0.720
42.2	108	0.681 - 0.710
42.8	109	0.670 - 0.699
43.3	110	0.660 - 0.688
43.9	111	0.650 - 0.678
44.4	112	0.641 - 0.668
45.0	113	0.631 - 0.658
45.6	114	0.621 - 0.648
46.1	115	0.612 - 0.638
46.7	116	0.603 - 0.629
47.2	117	0.594 - 0.619
47.8	118	0.585 - 0.610
48.3	119	0.576 - 0.601
48.9	120	0.568 - 0.592
49.4	121	0.559 - 0.583
50.0	122	0.551 - 0.574
50.6	123	0.543 - 0.566
51.1	124	0.535 - 0.557
51.7	125	0.527 - 0.549
52.2	126	0.519 - 0.541
52.8	127	0.511 - 0.533
53.3	128	0.504 - 0.525
53.9	129	0.496 - 0.517
54.4	130	0.489 - 0.510
55.0	131	0.482 - 0.502
55.6	132	0.475 - 0.495
56.1	133	0.468 - 0.488
56.7	134	0.461 - 0.480
57.2	135	0.454 - 0.473
57.8	136	0.447 - 0.466
58.3	137	0.441 - 0.460
58.9	138	0.434 - 0.453
59.4	139	0.428 - 0.446
60.0	140	0.422 - 0.440
60.6	141	0.416 - 0.433
61.1	142	0.410 - 0.427
61.7	143	0.404 - 0.421
62.2	144	0.398 - 0.415
62.8	145	0.392 - 0.409
63.3	146	0.386 - 0.403
63.9	147	0.381 - 0.397
64.4	148	0.375 - 0.391
65.0	149	0.370 - 0.386
65.6	150	0.365 - 0.380

APPENDIX N - 3k Temperature Sensor Specifications

°C	°F	RANGE VDC
-51.1	-60	4.747 - 4.941
-50.6	-59	4.741 - 4.935
-50.0	-58	4.735 - 4.928
-49.4	-57	4.728 - 4.921
-48.9	-56	4.722 - 4.915
-48.3	-55	4.715 - 4.907
-47.8	-54	4.708 - 4.900
-47.2	-53	4.700 - 4.893
-46.7	-52	4.693 - 4.885
-46.1	-51	4.685 - 4.877
-45.6	-50	4.677 - 4.868
-45.0	-49	4.669 - 4.860
-44.4	-48	4.660 - 4.851
-43.9	-47	4.651 - 4.842
-43.3	-46	4.642 - 4.832
-42.8	-45	4.633 - 4.823
-42.2	-44	4.623 - 4.813
-41.7	-43	4.613 - 4.802
-41.1	-42	4.603 - 4.792
-40.6	-41	4.593 - 4.781
-40.0	-40	4.582 - 4.769
-39.4	-39	4.571 - 4.758
-38.9	-38	4.559 - 4.746
-38.3	-37	4.547 - 4.734
-37.8	-36	4.535 - 4.721
-37.2	-35	4.523 - 4.708
-36.7	-34	4.510 - 4.695
-36.1	-33	4.497 - 4.681
-35.6	-32	4.484 - 4.667
-35.0	-31	4.470 - 4.653
-34.4	-30	4.456 - 4.638
-33.9	-29	4.441 - 4.623
-33.3	-28	4.426 - 4.608
-32.8	-27	4.411 - 4.592
-32.2	-26	4.395 - 4.576
-31.7	-25	4.379 - 4.559
-31.1	-24	4.363 - 4.542
-30.6	-23	4.346 - 4.525
-30.0	-22	4.329 - 4.507
-29.4	-21	4.312 - 4.489
-28.9	-20	4.294 - 4.470
-28.3	-19	4.275 - 4.451
-27.8	-18	4.256 - 4.431
-27.2	-17	4.237 - 4.411
-26.7	-16	4.218 - 4.391
-26.1	-15	4.198 - 4.370
-25.6	-14	4.177 - 4.349
-25.0	-13	4.157 - 4.327
-24.4	-12	4.135 - 4.305
-23.9	-11	4.114 - 4.283
-23.3	-10	4.092 - 4.260
-22.8	-9	4.069 - 4.237
-22.2	-8	4.046 - 4.213
-21.7	-7	4.023 - 4.189
-21.1	-6	3.999 - 4.164
-20.6	-5	3.975 - 4.139
-20.0	-4	3.951 - 4.114
-19.4	-3	3.926 - 4.088
-18.9	-2	3.901 - 4.062
-18.3	-1	3.875 - 4.035
-17.8	0	3.849 - 4.008
-17.2	1	3.823 - 3.981
-16.7	2	3.796 - 3.953
-16.1	3	3.769 - 3.924
-15.6	4	3.741 - 3.896
-15.0	5	3.713 - 3.867
-14.4	6	3.685 - 3.837
-13.9	7	3.657 - 3.808
-13.3	8	3.628 - 3.778
-12.8	9	3.598 - 3.747
-12.2	10	3.569 - 3.717
-11.7	11	3.539 - 3.686
-11.1	12	3.509 - 3.654
-10.6	13	3.478 - 3.623
-10.0	14	3.448 - 3.591
-9.4	15	3.417 - 3.558
-8.9	16	3.385 - 3.526
-8.3	17	3.354 - 3.493
-7.8	18	3.322 - 3.460
-7.2	19	3.290 - 3.427
-6.7	20	3.258 - 3.393
-6.1	21	3.226 - 3.360
-5.6	22	3.193 - 3.326
-5.0	23	3.160 - 3.292
-4.4	24	3.127 - 3.257
-3.9	25	3.094 - 3.223
-3.3	26	3.061 - 3.189
-2.8	27	3.028 - 3.154
-2.2	28	2.994 - 3.119
-1.7	29	2.961 - 3.084
-1.1	30	2.927 - 3.049
-0.6	31	2.894 - 3.014
0.0	32	2.860 - 2.979
0.6	33	2.826 - 2.944
1.1	34	2.792 - 2.909
1.7	35	2.758 - 2.874
2.2	36	2.725 - 2.838
2.8	37	2.691 - 2.803
3.3	38	2.657 - 2.768
3.9	39	2.623 - 2.733
4.4	40	2.590 - 2.698
5.0	41	2.556 - 2.663
5.6	42	2.522 - 2.628
6.1	43	2.489 - 2.593
6.7	44	2.455 - 2.558
7.2	45	2.422 - 2.524
7.8	46	2.389 - 2.489
8.3	47	2.356 - 2.455
8.9	48	2.323 - 2.421
9.4	49	2.290 - 2.386
10.0	50	2.258 - 2.353
10.6	51	2.226 - 2.319
11.1	52	2.193 - 2.285
11.7	53	2.161 - 2.252
12.2	54	2.130 - 2.219
12.8	55	2.098 - 2.186
13.3	56	2.067 - 2.154
13.9	57	2.036 - 2.121
14.4	58	2.005 - 2.089
15.0	59	1.974 - 2.057
15.6	60	1.944 - 2.026
16.1	61	1.914 - 1.994
16.7	62	1.884 - 1.963
17.2	63	1.854 - 1.932
17.8	64	1.825 - 1.902
18.3	65	1.796 - 1.872
18.9	66	1.767 - 1.842
19.4	67	1.739 - 1.812
20.0	68	1.711 - 1.783
20.6	69	1.683 - 1.754
21.1	70	1.656 - 1.725
21.7	71	1.628 - 1.697
22.2	72	1.602 - 1.669
22.8	73	1.575 - 1.641
23.3	74	1.549 - 1.614
23.9	75	1.523 - 1.587
24.4	76	1.497 - 1.561
25.0	77	1.472 - 1.534
25.6	78	1.447 - 1.508
26.1	79	1.422 - 1.483
26.7	80	1.398 - 1.457
27.2	81	1.374 - 1.432
27.8	82	1.351 - 1.408
28.3	83	1.327 - 1.383
28.9	84	1.304 - 1.360
29.4	85	1.282 - 1.336
30.0	86	1.259 - 1.313
30.6	87	1.237 - 1.290
31.1	88	1.216 - 1.267
31.7	89	1.194 - 1.245
32.2	90	1.173 - 1.223
32.8	91	1.153 - 1.202
33.3	92	1.132 - 1.180
33.9	93	1.112 - 1.159
34.4	94	1.093 - 1.139
35.0	95	1.073 - 1.119
35.6	96	1.054 - 1.099
36.1	97	1.035 - 1.079
36.7	98	1.017 - 1.060
37.2	99	0.998 - 1.041
37.8	100	0.981 - 1.022
38.3	101	0.963 - 1.004
38.9	102	0.946 - 0.986
39.4	103	0.929 - 0.968
40.0	104	0.912 - 0.951
40.6	105	0.895 - 0.934
41.1	106	0.879 - 0.917
41.7	107	0.863 - 0.900
42.2	108	0.848 - 0.884
42.8	109	0.832 - 0.868
43.3	110	0.817 - 0.852
43.9	111	0.803 - 0.837
44.4	112	0.788 - 0.822
45.0	113	0.774 - 0.807
45.6	114	0.760 - 0.792
46.1	115	0.746 - 0.778
46.7	116	0.732 - 0.764
47.2	117	0.719 - 0.750
47.8	118	0.706 - 0.736
48.3	119	0.693 - 0.723
48.9	120	0.681 - 0.710
49.4	121	0.668 - 0.697
50.0	122	0.656 - 0.684
50.6	123	0.644 - 0.672
51.1	124	0.633 - 0.660
51.7	125	0.621 - 0.648
52.2	126	0.610 - 0.636
52.8	127	0.599 - 0.624
53.3	128	0.588 - 0.613
53.9	129	0.577 - 0.602
54.4	130	0.567 - 0.591
55.0	131	0.557 - 0.580
55.6	132	0.547 - 0.570
56.1	133	0.537 - 0.560
56.7	134	0.527 - 0.550
57.2	135	0.518 - 0.540
57.8	136	0.508 - 0.530
58.3	137	0.499 - 0.520
58.9	138	0.490 - 0.511
59.4	139	0.481 - 0.502
60.0	140	0.473 - 0.493
60.6	141	0.464 - 0.484
61.1	142	0.456 - 0.475
61.7	143	0.448 - 0.467
62.2	144	0.440 - 0.459
62.8	145	0.432 - 0.450
63.3	146	0.424 - 0.442
63.9	147	0.417 - 0.435
64.4	148	0.409 - 0.427
65.0	149	0.402 - 0.419
65.6	150	0.395 - 0.412

APPENDIX 0 - Accessories

ITEM DESCRIPTION	ITEM NO.	NOTES
Sporlan Controllers		
Chiller Control	953463	
Kelvin II d	952568	Remote display unit
Parker Sporlan Temperature Probes		
2K Well Sensor Kit	952795	Brass well with nickel plated brass housing
2K Sensor	952662	Nickel plated brass housing, used with well. Can be used without well.
3K Well Sensor Kit	953156	Brass well with stainless steel housing
3K Surface Sensor	952551	Brass, not used with well
Brass Well	952969	Brass well only, no sensor
Parker Sporlan Pressure Transducers		
PSPT0500SVSP-S	952576	0-500 psig / 0-34.5 bar transducer (R-744 subcritical)
PSPT0300SVSP-S	952574	0-300 psig / 0-20.7 bar transducer (R-410A)
PSPT0150SVSP-S	952572	0-150 psig / 0-10.3 bar transducer (all other refrigerants)
Transducer Cables		
PSPT000000CP50	953100	5 meter cable
PSPT000000CP20	953192	2 meter cable
Troubleshooting Accessories		
SMA-12	953276	Handheld digital instrument for testing electric valve performance.

* Transducer selection is based on the refrigerant being used.
  R-744 requires 500 psi
  R-410A requires 300 psi or higher
  All others require 150 psi or higher

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