April 2024 / **Bulletin 100-50-14**

EQ Valve Module

Installation and Operation Instructions

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Contents

Introduction

The Parker – Sporlan EQ Valve Module is a controller designed for responsive superheat control in HVAC systems. Up to 2 coils (evaporators) can be measured and controlled. The controller will use pressure/temperature sensors to measure each coil's superheat and position up to 2 electronic expansion valves. The controller can be configured to control two coils that share a temperature and/or pressure (common suction or heat pump designs) or have individual suction lines (main compressor plus supplemental designs). The controller includes status LEDs and RS-485 network port connectivity to allow setup and readout of values.

Features

- Auto PID or manual-set PID superheat control
- 24 VDC operating voltage
- 2 x Coil outlet temperature thermistor inputs
- 2 x Pressure inputs
- 2 x Stepper outputs
- MODBUS over RS-485 Serial Communication Interface
- Status LED indicators
- DIN or screw mounting options

Specifications

Table 1: Controller Specifications

Input Power	24VDC ±10% Current: 0.75A minimum, 1.5A maximum Supply must be Class 2 and Class II rated. Maximum wire length between power supply and controller is 175 ft. Minimum wire width is 18AWG.
Temperature Inputs	10k Type 2 NTC Thermistor (default) or 2K, 3K (software selectable)
Pressure Inputs	0.5 – 4.5 VDC ratiometric transducer input. Pressure ranges: 150 PSI, 300 PSI, 500 PSI, 652 PSI and Custom (Absolute or Gauge software selectable)
Stepper Motor Outputs	Unipolar/Bipolar 13.5 VDC @ 400 mA per phase (All Sporlan Valves)
Data Interface	MODBUS Slave device over RS-485 (2 ports) Address selectable in software 120 Ω termination enabled via DIP switch 4 on port 1 (no hardware termination included on port 2) Settings: 38400 baud, Even parity, 8 data bits, 1 stop bit
Operating Temperature	-40°C to +70°C (-40°F to 158°F)
Operating Humidity	0 to 95% RH Non-condensing
Storage Temperature	-40°C to +70°C (-40°F to 158°F)
Compliance	UL, RoHS, FCC
Storage Humidity	0 to 90% RH Non-condensing

Settings and Operation

1. Sensors - the EQ Valve Module is designed to control superheat of up to 2 coils/evaporators using temperature and pressure measurements.
   a. The pressure or temperature sensors may be independent for each evaporator or shared (one sensor reading for both evapo rators). If sharing is used, the physical sensor must be con nected to Coil 1's sensor terminal on the controller. Both coils will use the value from the single sensor. Both sensors can be shared to allow for 2 valves to control superheat at the same location when not checked/overridden in heat pump designs.
   b. Each pressure transducer's type can be selected using the "Pressure x Select" setting or a custom transducer can be selected. If custom is used, additional setting of the range and gauge/absolute is needed. The controller assumes the sensors are ratiometric with a 0.5V - 4.5V output and driven by 5VDC. Each transducer can have a calibration offset applied before being used to control.
   c. The type of temperature sensors used with the controller are NTC thermistors. The curve can be selected as Sporlan 2K, Sporlan 3K, Sporlan 10K using the "Temp Select" setting. The setting applies to thermistors of both coils. Each thermis tor can have a calibration offset applied before being used to control.
   d. The present value measured on all connected sensors can be viewed in the Process Value holding registers (see Table 6).
   e. The superheat control will use the "Refrigerant Type" setting to determine the current superheat and saturation temperature using the sensor values.
2. Valves – the EQ Valve Module can control up to two independent expansion valves.
   a. The type of each selected valve is selected using the "Valve x Select" setting. The presets cover all compatible Sporlan valves, but "Custom" may be used for any other stepper valve. When using "Custom", the "Step Rate" in steps/sec, "Number of Steps", and "Polarity" (bipolar or unipolar) settings are used to set up the valve.
   b. Each valve has a "Bleed Position" setting, which limits the valve from closing lower than that position during normal operation.
   c. Each valve will be overdriven on power-up. The valves will overdrive closed a small amount periodically after that when ever the position is at zero. If bleed positions above 0% are used, the periodic overdrive will not occur unless the "Over drive at Bleed" setting is enabled.
   d. Each valve's position can be overridden to a user set position using the "Coil x Override Value" setting to set the position and the "Coil x Over ride Enable" to enable/disable holding at the set position. Once set, the override will hold until disabled or the next power cycle.
3. Superheat Control – the EQ valve module contains a superheat algorithm for each controlled evaporator. The default algorithm type is the Auto algorithm for air conditioning applications – which has no setup required. Alternatively, a generic yet powerful superheat PID algorithm with settable parameters may be used instead.
   a. Each evaporator has a settable superheat setpoint. The controller will attempt to maintain the chosen superheat.
   b. When the Auto algorithm is chosen, the controller will attempt to learn everything it needs to control from running on the system. A wide variety of A/C systems can be effectively controlled using the Auto algorithm with no input needed from the user. A brief learning routine is performed on first start of the system and again whenever the possibility of im proved performance is detected.
   c. When the PID algorithm is chosen, the output of each valve is determined by the PID settings. The algorithm is structured with a common "K" gain parameter applied to each branch where the proportional is the product of "K" and the error. The "I" gain is the "K" setting divided by the "Ti" integral time setting. The "D" gain is the "K" setting multi plied by the derivative time setting "Td".
4. Limits – the EQ valve module has configurable limits on superheat and saturation temperature (pressure). When the a value moves beyond its limit, the controller will prioritize resolving the problem. When limits are not active, the default priority is to maintain superheat on the entered setpoint.
   a. Minimum Superheat – if superheat is less than this value while the system is running, the control will prioritize reduc ing the expansion valve opening to bring superheat up. This limit applies to Auto and PID algorithms.
   b. Maximum Superheat – if superheat is above this value while the system is running, the control will prioritize increasing the expansion valve opening to bring superheat down. This limit applies to Auto and PID algorithms.
   c. Minimum Saturation Temp – if the current saturation temp is below this value, the control will prioritize raising the suction pressure provided the superheat is still within the set limits. The superheat limits have priority over this limit. This limit only applies to the Auto algorithm.
   d. Maximum Saturation Temp – if the current saturation temp is above this value, the control will prioritize lowering the suction pressure provided the superheat is still within the set limits. The superheat limits have priority over this limit. This limit only applies to the Auto algorithm.
   e. PID Limit Speedup – This parameter controls how aggressive the PID algorithm will be when trying to resolve a limit condition, compared to normal operation. The default value of 15 corresponds to 15% more response for each degree of superheat outside the limit. This setting has no effect on the Auto algorithm.
5. Networking – The EQ valve module has configurable settings for the communication ports.
   a. Network Slave ID 1 – Sets the slave ID for network 1 (on the DM/VM terminal). Can be set from 1 to 247. Default is 73.
   b. Network Slave ID 2 – Sets the slave ID for network 2 (on the RS-485 terminal). Can be set from 1 to 247. Default is 73.
   c. Baud Rate – Sets the communication data rate. Default rate is 38400, maximum rate is 57600.
   d. Parity – can be set to Odd (2), Even (1), or None (0). Default is Even.

Table 2: Terminal Connections

Block Label	Conductor Label	Wire Color (Sporlan sensors and parts)	Description
DM/VM	D+		Primary RS-485 Port Data+/A
	D-		Primary RS-485 Port Data-/B
Supply	Gnd		Ground/ RS-485 Gnd
	24VDC		Supply 24VDC
Sol/Pulse1	NO		Not used. Hardware not populated.
	COM		Not used. Hardware not populated.
Sol/Pulse2	NO		Not used. Hardware not populated.
	COM		Not used. Hardware not populated.
Stepper Valve 1	Ref		Evaporator 1 Valve Unipolar Gnd
	B	Black (bipolar)	Valve 1 Black
	W	White (bipolar)	Valve 1 White
	G	Green (bipolar)	Valve 1 Green
	R	Red (bipolar)	Valve 1 Red
Temperature Sensors	Coil Out 1	Blue	Evaporator 1 Thermistor
	* (gnd)	Blue	Evaporator 1 Thermistor
	Air 1		Not used
	Def 1		Not used
	* (gnd)	Blue	Evaporator 2 Thermistor
	Coil Out 2	Blue	Evaporator 2 Thermistor
	Air 2 L		Not used
	Air 2 R		Not used
	Def2 L	Black	Evaporator 2 Pressure 5VDC
	Def2 R	White	Evaporator 2 Pressure Signal
	<blank>	Green	Evaporator 2 Pressure Gnd
RS-485	Gnd		Ground
	D+		Secondary RS-485 Port Data+/A
	D-		Secondary RS-485 Port Data-/B
Stepper Valve 2	R	Red/	Valve 2 Red
	G	Green/	Valve 2 Green
	W	White/	Valve 2 White
	B	Black/	Valve 2 Black
	Ref		Evaporator 2 Valve Unipolar Gnd
Pressure	Gnd	Green	Evaporator 1 Pressure Gnd
	S	White	Evaporator 1 Pressure Signal
	5V	Black	Evaporator 1 Pressure 5VDC

Figure 1: Wiring Guide

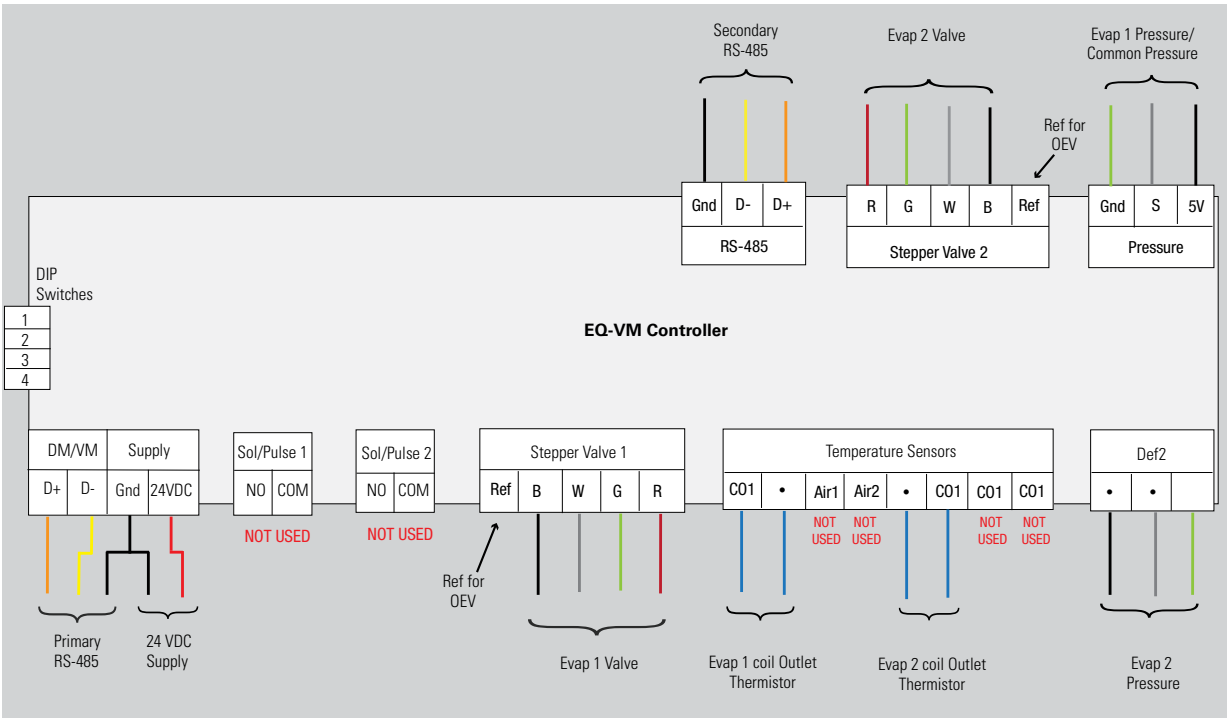


Figure 2: Controller

4 Installation

1. Tools needed:

   a. Small flat screwdriver for terminal connections
   b. Phillips and flat screwdriver
   c. Cordless screwdriver
   d. Needle-nose pliers
   e. Wire cutters/stripper
   f. Scotch-Brite(TM) pad
   g. 2- 4 #8 machine screws to either mount DIN rail or use mounting tabs

2. Mount the controller in a rain-tight protected location using #8 sheet metal screws; tighten to 14-16 in-lbs. DIN rail may also be used as alternate mounting. The suggested minimum mounting area is 3.5 inches high and 7.5 inches wide, depth is 2.2 inches.

3. For each evaporator, mount the suction temperature sensor to the suction line after the evaporator. The piping must be horizontal and free draining. Position the sensor at the 4 or 8 o'clock position on the suction. Connect the non-polarized sensor wires to the temperature inputs on the controller. Evaporator 1's sensor connects to "Coil Out 1". Evaporator 2's sensor (if used) connects to "Coil Out 2". Maximum torque on screw terminals is 3.5 in-lbs.

Figure 3: Sporlan 10K type 2 NTC

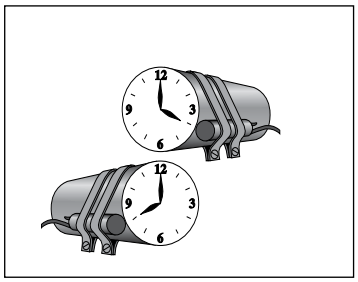
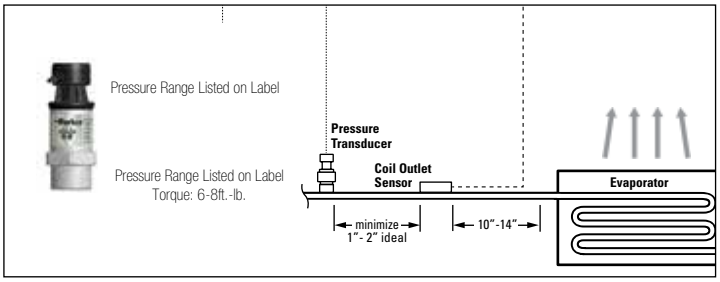


Figure 4: Pipe Mounting Location

4. Mount the pressure transducer on the suction line near the suction temperature sensor, positioned at 12 o'clock (upward). The piping must be horizontal and free draining. Tighten to 6-8 ft.-lb. Use of a copper gasket is not recommended between Schrader valve and transducer.

Figure 5: Pressure Transducer Installation



   a. If using only 1 coil, or if both evaporators have a com mon suction (same compressor) – use one pressure. Con nect the transducer to "Pressure" on the controller via cable. Conductor Black = "5V", White = "S", Green = "Gnd".

   b. If each evaporator has its own compressor/sensor location, use an additional pressure for coil 2. This transducer connects to the "Def 2" header. Under "Def 2", the left dot connects to Black ("5V"), the right dot (middle screw) connects to White ("S"), and the blank spot connects to Green ("Gnd"). See section on Wiring.

5. For each evaporator, connect the valves(s) to the controller.

   a. Install each valve according to the directions in the valve literature.

   b. For bipolar valves like the Sporlan SER/SERI/SEHI, there will be a 4-conductor cable to connect. The color scheme of Black, White, Green, and Red matches up with the B,W,G,R labels above the terminal block. The Ref connection is not used.

   c. For unipolar valves like the Sporlan SEV/OEV, there will be a 5-conductor cable to connect. The mapping of colors can be seen in the table to the right.

6. Connect the main RS-485 network to port 1:
   a. Connect the RS-485 D+/A conductor to "D+" on the "DM/VM" terminal
   b. Connect the RS-485 D-/B conductor to "D-" on the "DM/VM" terminal
   c. The third RS-485 GND conductor will share with Supply GND
7. Connect the secondary RS-485 network (port 2), if needed:
   a. Connect the RS-485 D+/A conductor to "D+" on the "RS-485" terminal
   b. Connect the RS-485 D-/B conductor to "D-" on the "RS-485" terminal
   c. Connect the RS-485 GND to "Gnd" on the "RS-485" terminal
8. Configure DIP switches:
   a. Switches 1,2,3 set the control profile. In most cases set these switches to OFF for standard superheat control. On a new controller, the switches may be set in different positions from the factory – set them before setting up over network. The other combinations are used in specific cases/troubleshooting. See Table 4 for the DIP profiles. If servicing a controller and a different combination is found, it may be correct for the application. Contact Sporlan for more information.
   b. Switch 4 sets if the 120 ohm termination resistor is in-circuit for port 1. Set to ON (down) to enable the termination if required.
9. Connect power to the controller 24VDC header marked "Supply"
10. Finish setup via MODBUS by writing any needed settings

5 Serial Communication

Communication is implemented using RS-485 (Half Duplex) and Modbus RTU protocol. Line biasing is implemented internally. External biasing of the RS-485 lines is not required. The device operates as a Slave device and will only transmit when requested to do so by a Master device. The RS-485 differential pair is internally biased to +5V and DC ground through 200K ohms.

The EQ Valve Module has two network ports allowing two independent devices to access the controller simultaneously. If this functionality is not needed, the primary connection should be used. The primary network is accessed through the "DM/VM" terminal connection. This network has an optional termination resistor are controlled by the DIP switch position 4.

Table 3: Valve Wire Colors

Controller Terminal Label	Bipolar (4 wire) Wire Color	Unipolor (5-wire) Wire Color
Ref	-	Gray
B	Black	Orange
W	White	Yellow
G	Green	Black
R	Red	Red

Table 4: Default Communication Parameters (Both ports)

Parameter	Value
Baud Rate	38400 Baud
Parity	Even
Data Bits	8
Stop Bits	1
Slave Address	73 default (settable in software)

Figure 6: DIP Switch

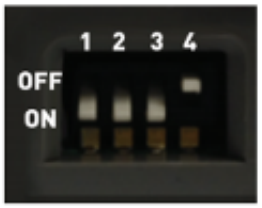


Table 5: DIP Switch Profile

	Switch 1	Switch 2	Switch 3	Profile
1	ON	ON	ON	Reserved
2	OFF	ON	ON	Reserved
3	ON	OFF	ON	Reserved
4	OFF	OFF	ON	Reserved
5	ON	ON	OFF	Reserved
6	OFF	ON	OFF	Reserved
7	ON	OFF	OFF	Reserved
8	OFF	OFF	OFF	Superheat Control

Table 6: Settings Holding Registers (Read/Write)

Address	Register name	Size	Type	Scaling	Range (Scaled)	Units	Default	Notes
1000	Coil 1 Superheat Setpoint	1	uint16	x10	0 to 300	deg F Supeheat	150	Sets the Superheat target for Coil 1
1001	Refrigerant Type	1	uint16	x1	0 to 32		4 (410a)	Refrigerant Indices: 0 -> R-22 1 -> R-134A 2 -> R-407A 3 -> R-407C 4 -> R-410A 5 -> R-417A 6 -> R-245FA 7 -> R-438A 8 -> R-434A 9 -> R-444B 10 -> R-450A 11 -> R-513A 12 -> R-1336MZZ 13 -> R-427A 14 -> R-422C 15 -> R-32 16 -> R-454B
1002	Pressure Shared	1	uint16	x1	0 to 1		0	1 -> Transducer connected to Coil 1 shared between the coils. Transducer on Coil 2 ignored. 0 -> Each coil uses its own pressure
1003	Temp Select	1	uint16	x1	0 to 2		2 (10K)	Thermistor Type Indices (Sporlan Thermistors) 0 -> 2k NTC 1 -> 3k NTC 2 -> 10k MT NTC
1004	Valve 1 Select	1	uint16	x1	0 to 5		0 (Uni-polar 500)	0 -> Unipolar 500 step 1 -> Bipolar 1596 step 2 -> Bipolar 2500 step 3 -> Bipolar 3193 step 4 -> Bipolar 6386 step 5 -> Use Custom Settings (choose a custom step count, step rate, and polarity)

Table 6: Settings Holding Registers (Read/Write), Continued

Address	Register name	Size	Type	Scaling	Range (Scaled)	Units	Default	Notes
1005	Pressure 1 Select	1	uint16	x1	0 to 4		1 (300 PSIG)	0 -> Sporlan 150 PSIG 1 -> Sporlan 300 PSIG 2 -> Sporlan 500 PSIG 3 -> Sporlan 652 PSIG 4 -> Use Custom Settings (choose a custom range and gauge type)
1006	Valve 2 Select	1	uint16	x1	0 to 5		0 (Uni-polar 500)	0 -> Unipolar 500 step 1 -> Bipolar 1596 step 2 -> Bipolar 2500 step 3 -> Bipolar 3193 step 4 -> Bipolar 6386 step 5 -> Use Custom Settings (choose a custom step count, step rate, and polarity)
1007	Pressure 2 Select	1	uint16	x1	0 to 4		1 (300 PSIG)	0 -> Sporlan 150 PSIG 1 -> Sporlan 300 PSIG 2 -> Sporlan 500 PSIG 3 -> Sporlan 652 PSIG 4 -> Use Custom Settings (choose a custom range and gauge type)
1008	Algorithm Select	1	uint16	x1	0 to 1		0 (Auto)	0 -> Auto - controller learns how to control automatically 1 -> PID - controller uses programmed PID gains to control
1009	PID K	1	uint16	x10	0 to 65535		20	Only active when PID algorithm is used. Scales the output's proportional, integral, and derivative
1010	PID Ti	1	uint16	x10	0 to 65535	sec	1200	Only active when PID algorithm is used. Scales the error per timestep added to the output's integral term
1011	PID Td	1	uint16	x100	0 to 65535	sec	0	Only active when PID algorithm is used. Scales the output's differential error term
1012	Minimum Super-heat Limit	1	uint16	x10	0 to 100	deg F Superheat	40	If superheat is below this value the control will prioritize raising the superheat
1013	Minimum Saturation Temp Limit	1	int16	x1	-40 to 160	deg F	-40	If the saturation temperature is below this value, the control will prioritize raising the pressure, provided the superheat is not low
1014	Maximum Saturation Temp Limit	1	int16	x1	-40 to 160	deg F	95	If the saturation temperature is above this value, the control will prioritize lowering the pressure.
1015	Custom Valve 1 Number Steps	1	uint16	x1	0-9999	Steps	2500	Total number of steps in Custom Valve 1
1016	Custom Valve 1 Step Rate	1	uint16	x1	0-999	PPS	200	Custom Valve 1's movement rate
1017	Custom Valve 1 Polarity	1	uint16	x1	0 to 1		1	0 -> 5-wire Unipolar, 1 -> 4-wire bipolar
1018	Custom Valve 2 Number Steps	1	uint16	x1	0-9999	Steps	2500	Total number of steps in Custom Valve 2
1019	Custom Valve 2 Step Rate	1	uint16	x1	0-999	PPS	200	Custom Valve 2's movement rate (pps)
1020	Custom Valve 2 Polarity	1	uint16	x1	0 to 1		1	0 -> 5-wire Unipolar, 1 -> 4-wire bipolar

Table 6: Settings Holding Registers (Read/Write), Continued

Address	Register name	Size	Type	Scaling	Range (Scaled)	Units	Default	Notes
1021	Custom Pressure 1 Range	1	uint16	x1	0-999	PSI	150	
1022	Custom Pressure 1 Gauge Type	1	uint16	x1	0 to 1		1	0 -> Absolute, 1 -> Gauge
1023	Custom Pressure 2 Range	1	uint16	x1	0-999	PSI	150	
1024	Custom Pressure 2 Gauge Type	1	uint16	x1	0 to 1		1	0 -> Absolute, 1 -> Gauge
1025	Temperature 1 Calibration Offset	1	int16	x10	-100 to 100	deg F	0	Set this value to compensate for known sensor error
1026	Pressure 1 Calibration Offset	1	int16	x10	-100 to 100	PSI	0	Set this value to compensate for known sensor error
1027	Temperature 2 Calibration Offset	1	int16	x10	-100 to 100	deg F	0	Set this value to compensate for known sensor error
1028	Pressure 2 Calibration Offset	1	int16	x10	-100 to 100	PSI	0	Set this value to compensate for known sensor error
1029	Temperature Shared	1	uint16	x1	0 to 1		0	If set to 1, the temperature connected for coil 1 will be used for both coils.
1030	Coil 1 Bleed Position	1	uint16	x1	0 to 100	% Open	0	Coil 1's Valve will not close to a lower valve than this setting (overdrives can still close the valve if allowed in the "Overdrive at Bleed Enabled" setting)
1031	Coil 2 Bleed Position	1	uint16	x1	0 to 100	% Open	0	Coil 2's Valve will not close to a lower valve than this setting (overdrives can still close the valve if allowed in the "Overdrive at Bleed Enabled" setting)
1032	PID Maximum Superheat Limit	1	uint16	X10	0 to 600	deg F Superheat	250	Response of the PID algorithm will be exaggerated when Superheat is above this value.
1033	PID Limit Speedup	1	uint16	x1	0 to 200	% extra response per degree of superheat outside limit	15	Controls the amount of exaggeration on the response when Superheat is outside the control limits in the PID algorithm
1034	Coil 2 Superheat Setpoint	1	uint16	x10	0 to 300	deg F Superheat	150	Sets the superheat target for Coil 2
1035	Coil 1 Override Enable	1	uint16	X1	0 to 1		0	When enabled, Coil 1's valve will modulate to the "Coil 1 Override Value". Control of superheat will pause while this is active.
1036	Coil 2 Override Enable	1	uint16	X1	0 to 1		0	When enabled, Coil 2's valve will modulate to the "Coil 2 Override Value". Control of superheat will pause while this is active.
1037	Coil 1 Override Value	1	uint16	X1	0 to 100	% Open	0	Sets Coil 1's valve position during override
1038	Coil 2 Override Value	1	uint16	X1	0 to 100	% Open	0	Sets Coil 2's valve position during override
1039	Network Slave ID 1	1	uint16	X1	1 to 247		73	Sets the slave ID for the primary network
1040	Network Slave ID 2	1	uint16	X1	1 to 247		73	Sets the slave ID for the secondary network
1041	Overdrive at Bleed Enabled	1	uint16	X1	0 to 1		0	Allow periodic overdrives to briefly re-overdrive the valve to zero when at the bleed position

Table 7: Process Value Holding Registers (Read Only)

Address	Register name	Size	Type	Units
2000	Coil 1 Temperature	2	float ABCD	°F
2001				
2002	Coil 1 Pressure	2	float ABCD	PSIG
2003				
2004	Coil 1 Superheat	2	float ABCD	°F Super-heat
2005				
2006	Coil 1 Sat. Suction Temp	2	float ABCD	°F
2007				
2008	Coil 1 Valve Position	2	float ABCD	% Open
2009				
2010	Coil 2 Temperature	2	float ABCD	°F
2011				
2012	Coil 2 Pressure	2	float ABCD	PSIG
2013				
2014	Coil 2 Superheat	2	float ABCD	°F Super-heat
2015				
2016	Coil 2 Sat. Suction Temp	2	float ABCD	°F
2017				
2018	Coil 2 Valve Position	2	float ABCD	% Open
2019				

Table 8: Process Value Holding Registers (Read Only)

Address	Register name	Size	Type	Notes
500	Board Reset	1	uint16	Always reads 0. Write anything here to trigger a board reset.
501	Factory Reset All Set-tings	1	uint16	Always reads 0. Write value 4012 (0x0FAC) to reset all settings registers to the default values.

Table 9: Version Control Input Registers (Read Only)

Address	Register name	Size	Type	Notes
0	Device Hardware ID	1	uint16	Tracks hardware version
1	Device Hardware Version	1	uint16	
2	Device Vendor ID	1	uint16	
3	Device Unit Number	2	int32	
4	Device Unit Number			
5	Program Number	1	uint16	Tracks product type/variant
6	Firmware Version Major Char 1	1	uint16	Tracks firmware version
7	Firmware Version Major Char 2	1	uint16	
8	Firmware Version Major Char 3	1	uint16	
9	Firmware Version Minor	1	uint16	
10	Bootloader Program Number	1	uint16	Tracks Bootloader version
11	Bootloader Version Major Char 1	1	uint16	
12	Bootloader Version Major Char 2	1	uint16	
13	Bootloader Version Major Char 3	1	uint16	
14	Bootloader Version Minor	1	uint16	

Parker Hannifin Corporation
Sporlan Division
206 Lange Drive, Washington, MO 63090 USA
phone 636 239 1111
fax 636 239 9130
www.sporlan.com