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SPORLAN

Secondary Fluid Control

Installation and Operation Instructions

Controller v. A

Parker

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Contents

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Introduction

The **Sporlan Secondary Fluid Control** is an innovative solution for managing heat exchangers on medium temperature secondary fluid applications. The controller is designed for use with Sporlan SFV series electric valves and eliminates the need for case mounted balancing valves and pulse width (on/off) solenoid controls. The Secondary Fluid Control provides unique algorithms to optimize heat exchanger efficiency during start up, after defrosts and steady state conditions. It displays actual liquid entering, liquid leaving and discharge air temperatures. It also allows manual control of the valve position and a commissioning feature to help reduce start up time.

Features

- AUTO PID with self optimizing control logic
- Multi-level fault analysis for alarming
- Built in commissioning tool
- One dial for setting discharge air temperature
- Single Valve control (Sporlan Type SFV)
- 4-digit LED display
- Controller networking via MODBUS RS-485
- One digital input
- Three temperature inputs (Sporlan Type 3k)

1. Installation

Refer to *Appendix F – Wiring Diagram*.

TOOLS REQUIRED:

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

VALVE

The SFV series valve can be mounted in conditioned spaces, such as walk in coolers or refrigerated display cases.

1. Using standard brazing practices, install the valve on the return line leaving the heat exchanger. Recommended distance from heat exchanger outlet to valve inlet is shown in *Appendix F – Wiring Diagram*. The valve can be installed complete (without removing the motor kit); internal temperatures must not exceed 250°F/121°C. Ensure that the valve motor is kept at or above horizontal position as shown in *Appendix I – Valve Motor Position*.
2. Route the valve cable back to the controller and secure with cable ties.

Note: Take caution to keep valve motor enclosure and cable away from defrost heaters. If the motor kit is removed from the valve body, ensure that the valve motor is not powered while it is removed. Valve must be open before removing motor kit.

CONTROLLER AND SENSORS

1. Mount the controller in a rain-tight, protected location using the supplied DIN rail. To leave enough working space, the suggested mounting area is 10 inches high and 5 inches wide. The minimum depth is 3 inches. See Figures 1 and 2.
2. Mount the blue Inlet Liquid (supply) sensor to the copper tube feeding the coil. The recommended distance is shown

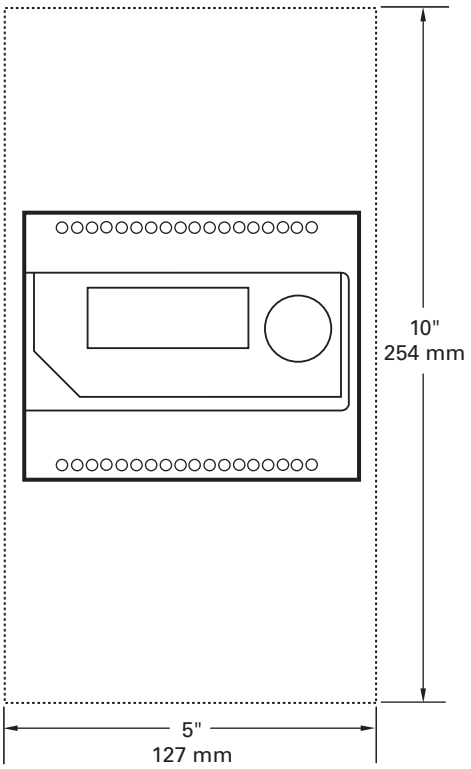


Figure 1 - Recommended Mounting Clearance

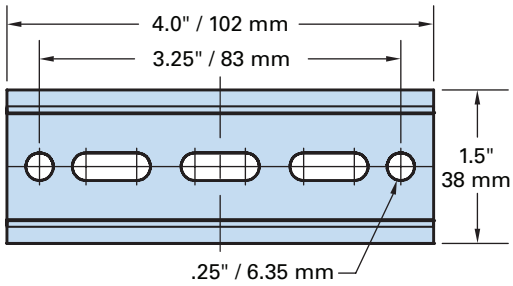


Figure 2 - DIN Rail Detail

in *Appendix F – Wiring Diagram.* Secure the sensor with two cable ties; one on the sensor and one on the sensor cable 2-3 inches from the brass sensor housing. Do not over tighten the cable ties.

3. Mount the black Outlet Liquid (return) sensor to the copper tube leaving the coil. The recommended distance is shown in *Appendix F – Wiring Diagram.*
4. Thermally insulate the inlet and outlet sensors using appropriate material such as Armaflex. The insulation should completely cover the brass sensor.
5. Mount the green Discharge Air sensor to the inside or outside of the discharge air honeycomb at the center of the case. The sensor may also be installed to the plenum directly behind the honeycomb. For walk in coolers, the sensor is placed in the return air stream.
6. Connect the Inlet Liquid Temperature sensor wires to terminals 29 and 30 (blue jacket). The sensor is not polarized. **Maximum torque on screw terminals is 3.5 in-lbs.**
7. Connect the Outlet Liquid Temperature sensor wires to terminals 27 and 28 (black jacket). The sensor is not polarized.
8. Connect the Discharge Air Temperature sensor wires to terminals 31 and 32 (green jacket). The sensor is not polarized.
9. Connect terminals 25 and 26 to a Normally Open dry contact. A short or closed contact from an external relay will position the valve for defrost. See *Section 4 – System Operation.*
10. Connect the Sporlan SFV wires to terminals 5, 6, 7, and 8. Valve wires are color coded. See *Appendix F – Wiring Diagram.*
11. Connect power to terminals 1 and 2. Transformer requirements are 24 volts AC at 40 VA, Class II.
12. Remove the protective clear film from the front of the Secondary Fluid Control.

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

NOTE: The Sporlan SFV 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. There are no user-serviceable components inside controller. Opening the case will void the warranty.

NOTE: Sensor leads may be extended to 100 ft. (30.5 m) with 18 awg wires and Scotchlok™ UR connectors for long-term integrity.

2. Setup

TEMPERATURE CONTROL

Ensure all connections have been made and the defrost signal is inactive before applying power. Upon start up, the SFV will initialize, and then position the valve 50% open. 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.

To change setup parameters, press the select knob to enter setpoint range, scroll to desired selection and then press the select knob.

1. Set dASP, Discharge Air Setpoint. Default is 28F.
2. Set dtYP, Defrost Type. Default is oFF for off time defrost. If warm fluid defrost is required, select FLUd.
3. Once setup is complete, the controller will display dA ir (Discharge Air) temperature. After the system is in operation, verify that the Discharge Air Setpoint, dASP, is met.
4. If additional controllers are being installed, refer to *Section 4 – System Operation and Section 5 – Controller Networking* to aid in network set up and available commissioning tool.

3. Setpoint Menu Operation

To make final setpoint changes, refer to *Appendix C – Setpoint Parameters.* The noted values are for verification; change them if necessary. All other values are for information purposes.

NOTE: The Parameter Menu times out after 60 seconds of inactivity and all changes will be lost.

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* for the variables that the Secondary Fluid Control monitors.

4. System Operation

The Sporlan Secondary Fluid Control has been designed to manage heat exchangers (coils) on medium temperature secondary fluid applications. The control package includes the controller, one Secondary Fluid Valve and three temperature sensors per coil. With standard Modbus communications, each controller may be wired back to the enterprise or host controller for access to key system parameters. A defrost input from the host controller is required. The use of the Secondary Fluid solution eliminates multiple balancing valves and solenoid valves traditionally seen in secondary applications. The SFV is mounted on the outlet of the heat exchanger and the sensors are installed to measure coil inlet temperature, coil outlet temperature and coil discharge air temperature. The controller monitors the sensor inputs during operation and adjusts the electronic valve to optimize "air to fluid" heat transfer and control refrigerated space temperature.

This unique combination increases performance and reduces secondary fluid pump requirements. The controller also incorporates an automatic self-optimizing algorithm along with a commissioning feature to help with start up.

REGULATING DISCHARGE AIR TEMPERATURE

Refrigeration Control

Refrigerated space temperature control is achieved by modulating the flow of secondary fluid in the heat exchanger. As temperature in the conditioned space transgresses the set point value, the valve position is adjusted accordingly.

- A transgression above set point is countered by an increase in secondary fluid flow (valve opening).
- A transgression below set point is countered by a decrease in secondary fluid flow (valve closure).

The control utilizes an adaptive algorithm for temperature control and requires that only the desired space temperature (commonly discharge air) set point be configured in the control parameters.

NOTE: During normal operation, the valve is never positioned fully closed except during defrost or when requested during manual valve operation. The minimum valve position is 0.5% and is non-adjustable.

Defrost

The control will initiate and terminate coil defrost action in response to a signal from a host controller. This signal from the enterprise control may be in the form of:

- Contact closure across the T4 input
- MODBUS communication

MODBUS and T4 input are mutually exclusive for initiation and termination of a defrost cycle.

When configured for Off Time defrost, the control will stop secondary fluid flow by closing the electric valve. If configured for warm fluid defrost, the electric valve will open to 100% for the duration of the defrost. The valve will remain in defrost position, closed or open, until signaled by the host that the defrost cycle has been terminated. Temperature control and all alarms are disabled during the duration of the defrost period. At defrost termination, the pull down cycle is initiated.

Pull Down Control

After defrost, refrigeration begins when the control is signaled by the host controller by either opening the defrost (T4) input or the appropriate MODBUS coil is cleared. The Secondary Fluid Control uses a unique algorithm after defrost to maximize heat transfer of the secondary fluid coil. The control uses multiple temperature inputs and adjusts the control logic based on discharge air, coil inlet and outlet temperatures.

No Defrost Operation

If configured for Warm Fluid Defrost or no defrost schedule exists, the valve will be initialized or "homed" once every 24 hours. This will not occur during defrost or pull down and will have negligible effect on the system.

ADVANCED FEATURES

Manual Valve Position

The Secondary Fluid Control can be used to manually control the electric valve, either locally or remotely. To access this feature, press and hold the SELECT knob for 5 seconds. Rotate the knob to enter the password " 111" and press the SELECT knob again. Scroll to SPoS, push SELECT knob and scroll to the desired valve position (between 0 and 100% of full stroke). The 0.5% minimum valve position is ignored when operating in this mode. The system will time out after 60 minutes of inactivity while in manual control. To end manual control sooner, simply press the SELECT knob. To use this feature remotely, a proper network connection and Modbus software is needed.

The electric valve can also be manually controlled via Modbus. Writing a 1 to the "Manual Valve Enabled" coil activates manual control, and the desired position can then be written to the "Manual Valve Position" register. See *Appendix G – Modbus Memory Map.*

Service Mode

For commissioning multiple systems, such as refrigerated cases in supermarkets, the controller can be placed in an indefinite manual valve position to a user-defined position. This feature is similar to the manual valve position except with the time out disabled. This mode can be used when starting up new systems or when purging air from the system. To initiate this feature, follow directions above under Manual Valve Position. When the display is showing valve position, press and hold the SELECT button until valve position on display starts flashing. The controller is locked out indefinitely in manual valve mode when display is flashing. To escape, press the SELECT button again to go back to manual valve mode with time out.

ADDITIONAL HELPFUL SYSTEM PARAMETERS MUST BE SET FOR PROPER OPERATION

Discharge Air Alarm Value, dAAL – the temperature threshold for high discharge temperature alarm. This is a user defined value within a range specified in *Appendix C – Setpoint Parameters*. Note: The lowest alarm value can only be set within 2 degrees of Discharge Air Setpoint, dASP.

Discharge Air Alarm Delay, AdLY – the delay (in minutes) after the measured temperature exceeds dAH ı before the high temperature alarm is activated.

T1 Temperature Calibration, CLt 1 – allows a temperature offset to be applied to the temperature sensor T1, Discharge Air. For additional information, see *Section 7 – Troubleshooting.*

T2 Temperature Calibration, CLt2 – allows a temperature offset to be applied to the temperature sensor T2, Inlet Liquid.

T3 Temperature Calibration, CLt3 – allows a temperature offset to be applied to the temperature sensor T3, Outlet Liquid.

PROCESS VALUE MENU

During operation, the controller status can be viewed through the Process Value menu. When no other operation is active, the controller will display the Process Menu. By default, the display will read Discharge Air temperature, dA ır, followed by the current temperature measured on T1. Rotating the SELECT knob will allow the user to view the following:

Discharge Air Temperature, dA ır – displays the current temperature measured by temperature sensor T1.

Coil Inlet Temperature, t- in – displays the current temperature measured by temperature sensor T2. This temperature measures the secondary fluid temperature as it enters the coil. Also known as the "supply."

Coil Outlet Temperature, toUt – displays the current temperature measured by temperature sensor T3. This temperature measures the secondary fluid temperature as it leaves the coil. Also known as "return."

Coil Delta Temperature, dELt - displays the current temperature delta measured by the difference between T2 and T3. This temperature measures the secondary fluid temperature difference as it enters and leaves the coil.

Current Valve Position, PoSn – displays the current position of the electric valve as percent open.

Operating Status, StAt – displays current operating status of the controller. See *Appendix B – Process Values for description of display parameters.*

Alarm Status, ALS – displays a list of all active alarms on the controller. If no alarms are active, the controller will display nonE. For a list of all alarm types, see *Section 6 – Troubleshooting.*

5. Controller Networking

The Sporlan Secondary Fluid Control can communicate with a MODBUS communication master via RS485 to transfer process values and setpoints.

The Secondary Fluid 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 Secondary Fluid 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 Secondary Fluid Control will allow a full and partial block read of the Input and Holding registers and coils.

Scaling for Temperature

For better precision, scaling is used for Temperature units. Fahrenheit and Celsius values contain 1 decimal place for 10ths of a degree. See *Appendix K - MODBUS Memory Map.*

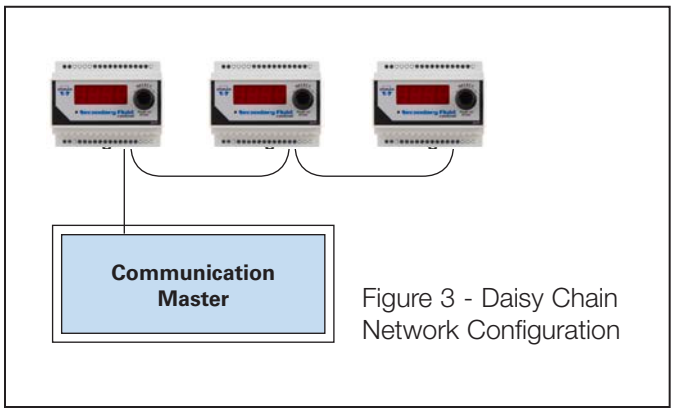


Figure 3 - Daisy Chain Network Configuration

Temperature values transferred via MODBUS are 10X. A value of 45 will be transferred for the Temperature when the actual temperature is 4.5°F/-15.3°C. Remember this when changing a setpoint.

Setup

The Sporlan Secondary Fluid 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 Host 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 unique address. Refer to *Section 3 – Setpoint Menu Operation* 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.'

MODBUS Communication Requirements

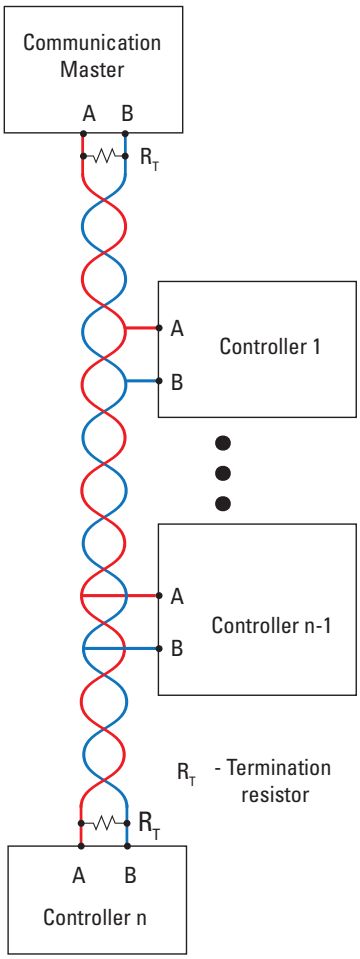
See *Figure 4 - MODBUS Wiring*.

Wire Type: 22-24 AWG Universal Twisted Pair

Maximum Number of Network Nodes: 100

Maximum Run Length: 4000 ft.

Figure 4 - Modbus Wiring



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* 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.

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 G - MODBUS Memory Map,* page 11. Also, refer to the documentation supplied with the communication master for additional RS485 network requirements.

6. Troubleshooting

As with any refrigeration component troubleshooting, actual system conditions should be verified with proper tools. This system information is valuable in determining whether it is component related or system related.

Sensors

Failed sensors will trigger an alarm, which will persist until the problem is corrected. Failed temperature sensors may read extremely low or infinite resistance when tested with an ohmmeter. Readings should be taken with the sensor disconnected from the Secondary Fluid Control. A missing or disconnected temperature sensor will read -60.0 on the controller.

Temperature sensor accuracy can be checked by measuring the voltage across the sensor. With the cotroller powered on and the sensor connected, measure the DC voltage between the sensor's two terminals on the controller. Compare this voltage to the expected values in *Appendix H*. The controller can be configured with a Temperature Calibration Offset, CLt1, CLt2, CLt3, for each sensor, of +- 5°F/-20.6°C. Greater discrepancies may indicate a faulty or misplaced sensor. For more information on sensor troubleshooting, please consult *Sporlan's Pressure Transducer and Temperature Sensor Installation Instructions (Form SD-245).*

Alarms

When certain temperature or equipment problems arise, the Secondary Fluid Control will activate an alarm. See Table 2 for a complete list of alarms and how the controller responds when each alarm is active. To view alarms from the Process Menu, rotate the SELECT knob until the display reads AL5. The controller will now display all active alarms one at a time. If no alarms are active, the controller will display nonE. See *Section 4 – System Operation* for alarm temperature thresholds and delays. Alarms will persist until the problem is corrected. All alarms are self clearing and control will resume once alarm condition no longer exists.

See Table 1 for a troubleshooting checklist.

Table 1 - Troubleshooting

SYMPTOM	CHECK
Will not power up	Wiring terminals for power at transformer and controller
	Supply Voltage (See Appendix E Technical Specifications)
Temperature Below Setpoint	Temperature sensor wiring / location (ensure sensor locations are correct, wiring intact)
	Sensor location
	Electric valve seat leak
	Electric valve wiring connections to controller
Temperature Above Setpoint	Heat exchanger sizing
	Liquid supply temperature correct
	Evaporator fans operating
	Evaporator coil (icing, fouling)
	Return air not blocked
	Supply pumps operating
	Sensor location
	Electric valve wiring connections to controller
	Temperature sensor wiring / location (ensure sensor locations are correct, wiring intact)
Display Reads -60.0 when displaying temperature(s)	Temperature sensor not connected
	Faulty temperature sensor
Display Reads 150.0 when displaying temperature(s)	Shorted temperature sensor or wiring
Temperature Reading(s) Unstable	Wiring terminals (power) at transformer and controller
	Wiring terminals (sensors) at controller
	Sensor location(s)
	Primary heat exchanger (Chiller) operation
No Communication	Wiring terminals at controller and master device
	Controller addresses correct
Communication Errors	Wiring terminals at controller and Master device
	Proper network shielding
	Network termination installation / location
	Network parameters same in all networked devices (controllers, master device) parity, baud rate, data bits
	Third-Party controllers on control network
	Communication wires in same conduit as or ran with high voltage wiring
Setpoints Not Saved	ESC must be set within 60 seconds of last setpoint change
Cannot Find Setpoints	See Section 3 - Setpoint Menu Operation

Table 2 - Alarm Actions

ALARM	DESCRIPTION	ACTION
dAH1	High Discharge Air Temperature	Valve moves to recovery position
t1-F	T1 (Discharge Air) Sensor Fault	Valve moves to recovery position
t2-F	T2 (Coil Inlet) Sensor Fault	Notification
t3-F	T3 (Coil Outlet) Sensor Fault	Notification
CtrL	Unable to Control Case Temperature	Valve moves to recovery position
nonE	No Active Alarms	

APPENDIX A - Setup Menu

DISPLAY	DESCRIPTION		OPTIONS	
dASP	Discharge Air Setpoint	Counterclockwise	10.0°F to 65.0°F (-12°C to 18°C) Default is 28° F	Clockwise
dtYP	Defrost Type		oFF Off Time FLUd Warm Fluid	

Default values are highlighted.

APPENDIX B - Process Values

DISPLAY	DESCRIPTION	RANGE	
dA ir	Discharge Air Temperature	-49.9°F to 149.9°F (-45.5°C to 65.5°C)	
t_ in	Inlet Temperature	-49.9°F to 149.9°F (-45.5°C to 65.5°C)	
toUt	Outlet Temperature	-49.9°F to 149.9°F (-45.5°C to 65.5°C)	
dELt	Delta Temperature (Inlet – Outlet)	-49.9°F to 149.9°F (-45.5°C to 65.5°C)	
PoSn	Current Valve Position	0.0 to 100%	
StAt	Operating Status	dA_c	Discharge Air Control
		dEF	Defrost Active
		Ct_C	Coil Temperature Delta Control
		dA-F	Discharge Air Fail*
		tCtL	Temperature Control Fail*
ALS	Alarm Status (Lists all active alarms)	See ALARMS TABLE (Section 6 - Troubleshooting)	

* Valve at recovery position

APPENDIX C - Setpoint Parameters

PARAMETERS				
Counterclockwise	ESC	Escape and Save Changes	-	Clockwise
	dASP	Discharge Air (DA) Setpoint	10.0°F to 65.0°F (-12.2°C to 18.3°C)	
	dtYP	Defrost Type	oFF Off time FLUd Warm Fluid	
	SPoS	Manual Valve Position	0 to 100% Default is Current Position	
	Addr	Unit Address	1 to 254 Default is 1	
	bAUd	Network BAUD Rate	96, 192, 384 Default is 96	
	nPAr	Network Parity	nOnE None EuEn Even Parity Odd Odd Parity	
	Un_t	Units of Measure	F / C Default is F	
	CLt 1	T1 (Discharge Air) Calibration	+- 5.0°F / °C Default is 0	
	CLt2	T2 (Coil Inlet) Calibration	+- 5.0°F / °C Default is 0	
	CLt3	T3 (Coil Outlet) Calibration	+- 5.0°F / °C Default is 0	
	dAAL	Discharge Air Alarm Setpoint	10.0°F to 80.0°F / -12.2°C to 26.7°C Default is 40F	
	AdLY	Discharge Air Alarm Delay	5 to 120 minutes Default is 120	
	CAdr	Display Address	0 to 99 Default is 0	

Default values are highlighted.

APPENDIX D - Accessories

DESCRIPTION	ITEM	NOTES
Secondary Fluid Control	953464	Standalone Controller with display
Parker Sporlan Temperature Probes 3K Sensor 3K Sensor Kit	 952571 953473	 Surface or air type. Single 20' replacement sensor. Surface or air type. Kit comes with 3, 15' sensors.
Secondary Fluid Valve	Contact Sporlan	Electronic modulating valve
Troubleshooting Accessories SMA-12	953276	Handheld digital instrument for testing electric valve performance

APPENDIX E - 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
3 Temperature Sensors
(3 Kohm)

Relay Outputs
100-240VAC, 3A ind/250V
22-28VDC, 250mA digital output w/ground
(Not currently used)

Digital Display
LED - Red, 7 segment, 4 digit

Indicators
LED - Red, Power

User Interface
Optical Encoder (SELECT knob)

Data Interface
RS485, MODBUS

MECHANICAL - CONTROLLER

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

MECHANICAL - VALVE

Operating Temperature
0°F to 140°F (18°C to 60°C)

Phase Resistance
65 ohms ± 10%

MRP
300 psig (21 bar)

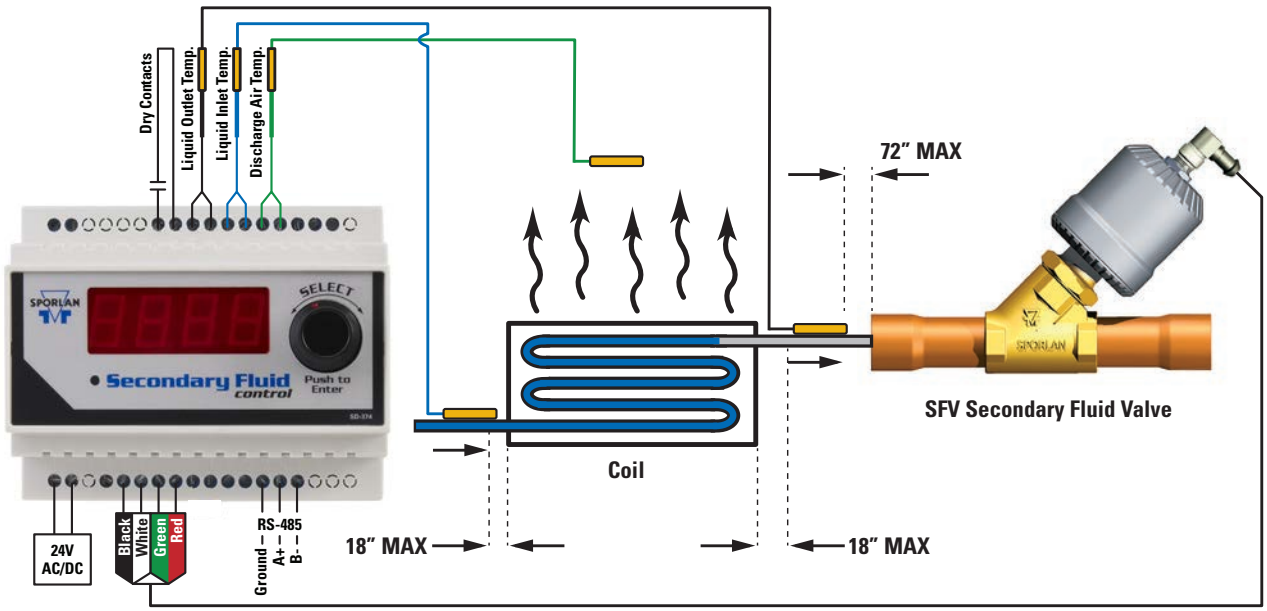
Flow Coefficients
Cv = 12 (SFV-9)
Kv = 10.3 (SFV-9)

COMPLIANCE

Environmental
RoHS
WEEE

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

APPENDIX F - Wiring Diagram



NOTE: PIPING AND SENSOR INSULATION NOT SHOWN.

NOTE: Use caution when working around high voltage components.

APPENDIX G - MODBUS Memory Map

MODBUS FUNCTION CODE	PARAMETER	ADDRESS	R/W	RANGE
Read Coils (0x01)	Manual Valve Control	0	R	0 = Disabled 1 = Enabled
	Manual Timeout Active*	1	R	0 = Inactive 1 = Active
	Defrost Status	2	R	0 = Inactive 1 = Active
Read Holding Registers (0x03) Setpoints	Discharge Air Setpoint	0	R/W	10.0°F to 65.0°F (-12.2°C to 18.3°C)
	Discharge Air High Alarm Setpoint	1	R/W	10.0°F to 65.0°F (-12.2°C to 18.3°C)
	Manual Valve Position	4	R/W	0.0 to 100%
	Alarm Delay	5	R/W	5 to 120 Minutes
	Network Address	6	R	1 - 254
	Display Units	7	R/W	0 = F, 1 = C
	T1 Offset	8	R/W	-5.0°F to 5.0°F / °C
	T2 Offset	9	R/W	-5.0°F to 5.0°F / °C
	T3 Offset	10	R/W	-5.0°F to 5.0°F / °C
	Display Address	12	R	N/A
	Defrost Type	13	R/W	0 = Off Time, 1 = Fluid
Read Input Registers (0x04) Process Variables	Discharge Air Temperature	0	R	-49.9°F to 149.9°F (-45.5°C to 65.5°C)
	Inlet Temperature	1	R	-49.9°F to 149.9°F (-45.5°C to 65.5°C)
	Outlet Temperature	2	R	-49.9°F to 149.9°F (-45.5°C to 65.5°C)
	Coil Temperature Delta	3	R	-49.9°F to 149.9°F (-45.5°C to 65.5°C)
	Valve Position	4	R	0.0 to 100%
	Relay Active	5	R	0 = OFF, 1 = ON

APPENDIX G - MODBUS Memory Map (continued)

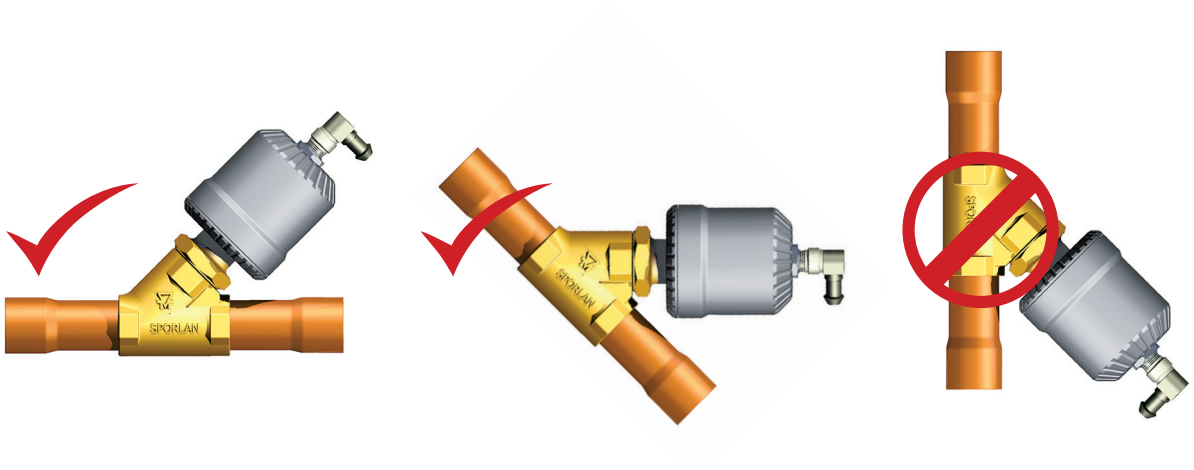
MODBUS FUNCTION CODE	PARAMETER	ADDRESS	R/W	RANGE
Read Input Registers (0x04) Process Variables (continued)	Alarm Flags	6	R	1 = Discharge Air High Limit Alarm
				2 = Sensor T2, Coil Inlet Sensor Fail
				4 = Sensor T3, Coil Outlet Sensor Fail
				8 = Sensor T1, Discharge Air Sensor Fail
				16 = Temperature Control Fail
	System Mode	7	R	1 = Start Up
				2 = Fluid Defrost
				4 = Off Time Defrost
				8 = Discharge Air Control
				16 = Delta T Control
				32 = Manual Control
				64 = Homing Mode
				128 = Discharge Sensor Fail
				256 = Temp Control Fail
	Firmware Version	8	R	
	Adaptive P Gain	9	R	50 – 200
	Adaptive I Gain	10	R	50 – 200
	Adaptive D Gain	11	R	0 – 1
	P Output	12	R	50 – 10000
	I Output	13	R	50 – 10000
	D Output	14	R	-1 to 1
	PID Cycle Counter	15	R	1 – 60
	Active PID Error	16	R	-100 to 100
	Cycle Time	17	R	1 – 60 Seconds
	Adaptive % Error	18	R	-3276.8 to 3276.8
	Recovery Position	19	R	.5 to 100.00% (calculated)
	Temperature Delta Minimum	20	R	Calculated
	Saved Integral Component	21	R	0 – 10000
	Discharge Air Alarm Timer	22	R	0 – 7200 Seconds
Write Single Coil (0x05)	Manual Valve Control	0	R/W	0 = Disables 1 = Enabled
	Manual Timeout Active*	1	R/W	0 = Inactive 1 = Active
	Defrost Status	2	R/W	0 = Inactive 1 = Active
Write Single Register (0x06) Setpoints	Discharge Air Setpoint	0	R/W	10.0°F to 65.0°F (-12.2°C to 18.3°C)
	Discharge Air High Alarm Setpoint	1	R/W	10.0°F to 80.0°F (-12.2°C to 26.7°C)
	Manual Valve Position	4	R/W	0.0 to 100.0%
	Alarm Delay	5	R/W	5 to 120 Minutes
	Network Address	6	R	1 – 254
	Display Units	7	R/W	0 = F, 1 = C
	T1 Offset	8	R/W	-5.0°F to 5.0°F (-15°C to -15°C)
	T2 Offset	9	R/W	-5.0°F to 5.0°F (-15°C to -15°C)
	T3 Offset	10	R/W	-5.0°F to 5.0°F (-15°C to -15°C)
	Display Address	12	R	N/A
	Defrost Type	13	R/W	0 = Offtime 1 = Fluid

* Disables 60 minute manual mode timeout for Startup and Service.

APPENDIX H - Temperature Sensor Specifications

TEMPERATURE		VDC
°F	°C	3K
0	-17.8	3.929
10	-12.2	3.643
20	-6.7	3.326
30	-1.1	2.988
40	4.4	2.644
50	10.0	2.306
60	15.6	1.985
70	21.1	1.691
80	26.7	1.428
90	32.2	1.198
100	37.8	1.002
110	43.3	0.835
120	48.9	0.696
130	54.4	0.579
140	60.0	0.483
150	65.6	0.404

APPENDIX I - Valve Motor Position



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