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TOTAL CONTROL
Turbocor Controller

Powered by Sporlan

User's Manual

2/27/2009

This document describes the functionality and use of the Turbocor controller.

Description

The Turbocor Controller (TC) is a standalone superheat controller. The TC may be connected with a MODBUS master to give remote access to pressure and temperature readings in addition to viewing and editing the controller's setpoints. The user can also take advantage of the easy to use local display to accomplish the same task.

1. TC Configuration

Specifications

- Input Voltage: 24 VAC (± 10%), 40 VA minimum to board with external transformer
- Operating ambient temperature: -40°F to 120°F
- LEDs: Power LED, Alarm LED, Liquid Line Solenoid LED
- Communications: 2 RS485 Ports
- 3 Digit alphanumeric display
- Inputs:
    - Optical Encoder (Knob)
    - One Pressure Input
    - One Temperature Input
    - One Digital Input
    - One Analog (0 to 5 VDC) Input
- Valve Control of all Sporlan Valves and Danfoss Valves
- Triac for Liquid Line Solenoid

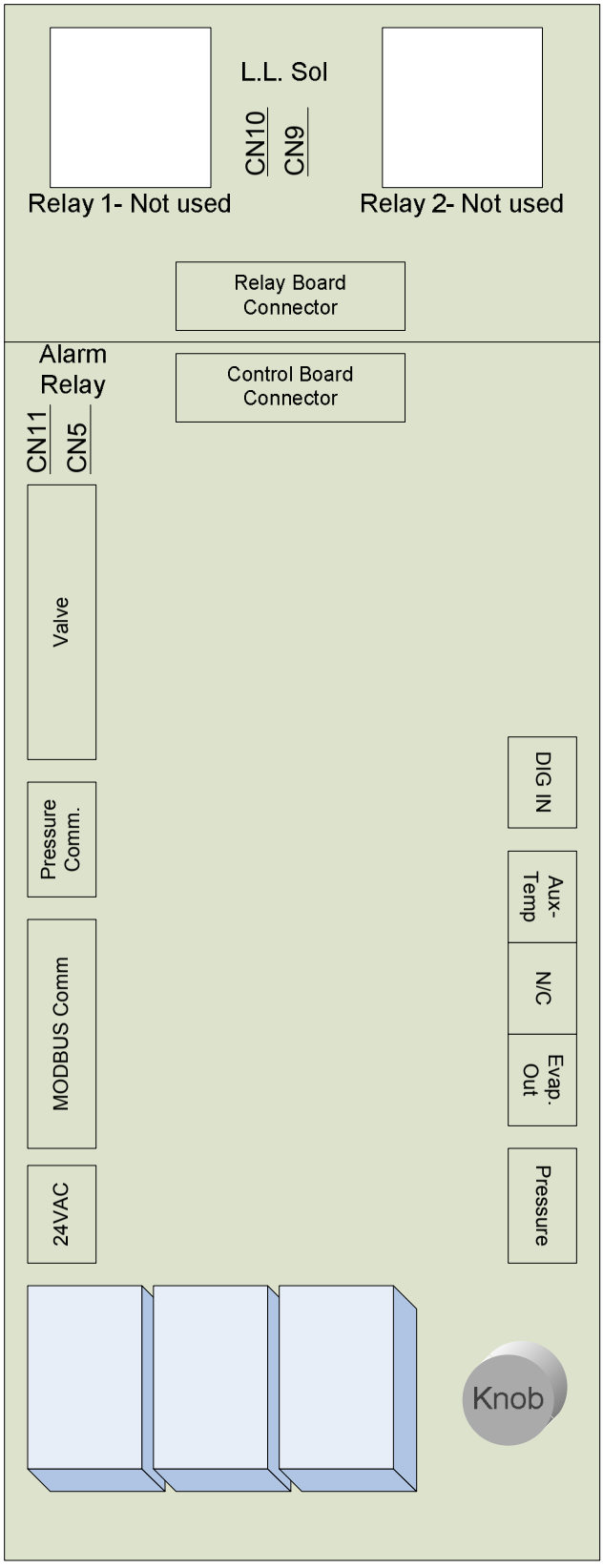
2. TC Connections

The TC has removable screw terminals on the each side of the controller. The controller should be hooked as noted by the silk screen.

The RS-485-1 block is used for MODBUS communications. The RS-485-2 is used when the TCs are networked together in the event that only one TC will have a Suction Pressure transducer and the networked controllers receive the pressure from this 'master'.

The other block of note is the Aux-Temp block. It will be used for the analog input. The last connection on the Aux-Temp block should be connected to the voltage input. The other pin is the ground.

A drawing of the hookup can be seen on the following page.


L.L. Sol
CN10
CN9
Relay 1- Not used
Relay 2- Not used
Relay Board Connector
Alarm Relay
Control Board Connector
CN11
CN5
Valve
Pressure Comm.
MODBUS Comm
24VAC
DIG IN
Aux-Temp
N/C
Evap. Out
Pressure
Knob

3. TC Display

The TC has a 3 digit alphanumeric display for user menus. The menu scheme is based off a layering methodology. The top layer displays the current mode. The next layer down gives the user a choice of Process Values, Setpoints or clearing alarms. The final layer would be when the user chooses to view the Process Values, view and edit Setpoints or clear alarms.

Table 1 Root Menu

Process Value Text	Meaning
Esc	Travel up
P_V	View Process Values
S_P	View/Edit Setpoints
CLR	Clear Alarms

The next layer down can be seen in the following tables.

3.1. Process Value Menu

Table 2 Process Value Menus

Process Value Text	Meaning	Range
Esc	Travel up	-
Suc	Suction Pressure	0 to 150[1] PSI
S/H	Superheat	0 to 165°F
Vlv	Valve Position	0 to 100 %Open
SuT	Saturation Temperature	-40 to 125°F
TSt	Suction Temperature	-40 to 125°F
SSs	Start/Stop Status	OFF/RUN
Sol	Solenoid Status	CLS/OPN
Alm	Alarm Status	Active alarms
ASH	Active Superheat	0 to 165°F

The user can enter the Process Values menu by pressing the knob when "P_V" is displayed. The user can then turn the knob to view the other process values of their system. Pressing the knob will alternate between the process values identity and value. For ease of use, the value that is displayed for a process value may come in the form of text to eliminate the need of 'looking up the meaning'. The menu text and meanings for process values are described in Table 2.

[1] The maximum value varies based on which refrigerant is selected. (410A is 300 PSI and all others are 150 PSI)

The user can leave this menu by pressing the knob when “Esc” is being displayed.

3.2. Setpoint Menu

The user may also view/edit the setpoints by pressing the knob when “S_P” is displayed. The user may change the setpoints to the value he desires in order to obtain optimum system performance. The menu text and meanings for setpoint values are described in Table 3. *Setpoints are saved to the controller when the user leaves the Setpoint that is being edited.*

The user can leave the Setpoint menu by pressing the knob when “Esc” is being displayed.

Table 3 Setpoint Menu

Setpoint Text	Meaning	Range
ESC	Travel up a layer	-
S/H	Superheat Setpoint	5 to 25 °F Default = 10 °F
SRS	Superheat Offset Scale	0 to 20 °F Default = 0 °F
SsD	Solenoid Start Delay	0 to 300 seconds Default = 0 secs
Clp	Cycle Time	1 to 10 seconds Default = 3 secs
SuM	Suction Sensor Mode (Location)	Local, Local and Broadcast or Remote Default = Local (Loc)
Unu	MODBUS address	1 to 32 Default = 1
Rfg	Refrigerant	R22, R134A, 407C Default = R22
_P_	Proportional coefficient	0 to 100 Default = 20
_I_	Integral coefficient	0 to 100 Default = 45
_D_	Derivative coefficient	0 to 100 Default = 5
MOP	Maximum Operating Pressure	0 to 150[2] PSI Default = 120 PSI
VMX	Valve Max	0 to 100 % Default = 100 %
VMN	Valve Minimum	0 to 100 %

[2] The maximum value varies based on which refrigerant is selected. (410A is 300 PSI and all others are 150 PSI)

Setpoint Text	Meaning	Range
		Default = 5 %
VSP	Valve Start Position	0 to 100 % Default = 12 %
VSD	Valve Start Delay	0 to 300 seconds Default = 90 secs
Vty	Valve Type	Sporlan Valves Default = 32K
		ESX, 16K, 25K, 32K, 64K
		Danfoss Valves
		50, 100, 250, 400
MVP	Manual Valve Position	0 to 100 %

4. Sequence of Operation

1.) Digital Input On/Off = Off, Solenoid is Off, Expansion Valve is Closed

2.) Digital Input On/Off = On, Expansion Valve goes to Valve Start Position (VSP).
Solenoid Start Delay (SSD) timer starts, turns on solenoid after timer expires.
Expansion Valve Start Delay (VSD) timer starts and holds Valve Start Position (VSP) till timer expires.

3.) After Expansion Valve Start Delay (VSD) timer expires the Turboboard will control on Active Superheat Setpoint (ASH).

4.) Active Superheat Setpoint (ASH) is the Superheat Setpoint (S/H) – Superheat Reset Value

5.) The Superheat Reset Value is calculated from the Reset Signal (0-5vdc) which is scaled by the Superheat Offset Scale (SRS). Example – If Reset Signal = 2.5 volts and Superheat Offset Scale (SRS) = 10, the reset value is 5. The Active Superheat Setpoint (ASH) = 10 (15-5). If no reset signal is used (0 vdc) than the Active Superheat Setpoint (ASH) = Superheat Setpoint (S/H)

6.) Limits
Maximum Operating Pressure (MOP) – prevents the evaporator pressure (psi) from rising above this value by closing the expansion valve.
Valve Max (VMX) – sets the limit in percentage (0-100%) on how far the expansion valve will open during normal operation.

Valve Min (VMN) – sets the limit in percentage (0-100%) on how far the expansion valve will close during normal operation.

7.) Features

Cycle Time (Clp) – Control loop speed (0-10 sec). This is the time interval that the controller surveys and updates the inputs. Can be used to speed up or slow down controller without changing PID settings.

Suction Sensor Mode (SuM) – This tells the controller where to look for the suction pressure input. Local (Loc) means that the suction pressure transducer is located at that controller. Local and Broadcast (LoS) means the suction pressure transducer is located at that controller and sending the value via RS485-2 to other controllers. Remote (Rmt) means the controller is receiving the suction pressure input from another controller.

8.) MODBUS Address (Unu) – Controller Identification (1-32)

9.) Refrigerant (Rfg) – Type of refrigerant (R22, R134a, R407c)

10.) Proportional Coefficient (P) – The larger the proportional coefficient, or gain, the larger change in valve position. If the gain is too high it will cause the system to become unstable. If the gain is too small the valve response will be lower than the necessary response to correct the disturbances in the system. This will also determine how quickly the valve can respond to disturbances in the system.

11.) Integral Coefficient (I) – The integral coefficient assists the proportional coefficient in reaching the superheat setpoint and also eliminates steady-state error from the proportional coefficient. The larger the value here the more the overshoot of the superheat value around the setpoint.

12.) Derivative Coefficient (D) – The larger values here will decrease the overshoot caused by the integral but will slow down the response and could lead to instability if the value becomes too large.

13.) Valve Type (Vty) – Valve Type and number of steps.

13.1. 16k – Sporlan SER-1.5, SER-6, SER-11, SER-20

13.2. 25k – Sporlan SER(I)-G, SER(I)-J, SER(I)-K

13.3. 32k – Sporlan SEI-30,

13.4. 64k – Sporlan SEI-50, SEH(I)-100, SEH(I)-175, Y1231

13.5. ESX – Sporlan ESX

13.6. Danfoss – 50, 100, 250, 400

14.) Manual Valve Position (MVP) – Allows user to override controller and manually set valve position. Will default back to regular control after 60 minutes.

15.) TC MODBUS

The TC can communicate with a MODBUS master. The TC will transfer process values and setpoints via MODBUS.

The TC only supports the RTU transmission mode. The serial settings are as follows:

- 9600 baud
- 8 data bits
- 1 stop bit
- Even parity

The TC supports the 'Read Input Registers', 'Read Holding Register', and 'Write Single Register' function codes. Any other request will result in an exception response. The TC will allow a full and partial block read of the Input and Holding registers.

15.1. MODBUS Memory Map

Table 4 Memory Map

MODBUS Function Code	Mapped Data	Data Map	Range
Read Holding Register (0x03)	Setpoints	0. Superheat Setpoint	5 to 25 °F
		1. Superheat Offset Scale	0 to 20 °F
		2. Solenoid Start Delay	0 to 300 seconds
		3. Cycle Time	1 to 10 seconds
		4. Suction Sensor Mode	0 = Local, 1 = Local and broadcast, 2 = Remote
		5. MODBUS Address	1 to 32
		6. Refrigerant	0 = R22, 1 = R134A, 2 = R410A
		7. Proportional coefficient	0 to 100
		8. Integral coefficient	0 to 100
		9. Derivative coefficient	0 to 100

MODBUS Function Code	Mapped Data	Data Map	Range
		10. MOP	0 to 150[3] PSI
		11. Valve Max	0 to 100 %
		12. Valve Min	0 to 100 %
		13. Valve Start Position	0 to 100 %
		14. Valve Start Delay	0 to 300 seconds
		15. Valve Type	0 = ESX, 1 = 16K, 2 = 25K, 3 = 32K, 4 = 64K, 5 = 050, 6 = 100, 7 = 250, 8 = 400
		16. Manual Valve Position	0 to 100 %
Read Input Registers (0x04)	Process Variables	0. Suction Pressure	0 to 150 PSI
		1. Superheat	0 to 165 °F
		2. Valve Percent Open	0 to 100 %
		3. Suction Temperature	-40 to 125°F
		4. Saturation Temperature	-40 to 125°F
		5. Start/Stop Status	0 = OFF, 1 = RUN
		6. Solenoid Status	0 = CLOSED, 1 = OPEN
		7. Alarm Status	If Bit set then alarm is active: Bit 0 = Suction Transducer Failure Bit 1 = SuT Sensor Failure Bit 2 = High Superheat Bit 3 = Low Superheat Bit 4 = Comm. Alarm
		8. Active Superheat Setpoint	0 to 45 °F
Write Single Register (0x06)	Setpoints	Same as above.	The max number of registers written at a time is 1. The limits can be seen above in the 'Read Holding Register' definition.

[3] The maximum value varies based on which refrigerant is selected. (410A is 300 PSI and all others are 150 PSI)

16.) TC Alarms

The TC has 5 alarms. The following table lists the possible alarms and the text that is seen on the controller. The controller's alarm status can be viewed via MODBUS and the local display.

Table 5 Alarms

Alarm Text	Meaning
NoA	No Alarms active
SSA	Pressure Sensor alarm
CSA	Suction Coil Temp. Sensor alarm
CMA	Communications Alarm

If the user travels to the Alarm Status process value they will be able to see all the active alarms.

Strong Points

Sporlan Turbocor EXV Controller Service Supplement

Introduction

This is a supplement to the following Sporlan document

Turbocor Controller User's Manual

This document supplement the manuals dated 12/17/2008, and the manual dated 02/27/2009.

Expansion Valve Controls

Every expansion circuit should have its own metering device (Expansion Valve). Even if the heat exchanger sections are the same size, the fluid (Air or Water) flow over the heat exchanger will be different.

For the same reason, every valve should have individual control

Turbocor Expansion Valve Control

Some expansion valve controllers do not work correctly with a Turbocor compressor. The compressor ramps up slowly,

There have been instances where the compressor is waiting for the expansion valve to open before ramping up, while at the same time the expansion valve controller is waiting for the compressor tor ramp up before opening the expansion valve

Sporlan created a special "Turbocor Controller" to control electronic expansion valves used with Turbocor compressors.

About this Service Supplement

The User's Manual mentioned above was created while the product was under development.

This document provides supplemental information until the next official document is created.

Parts

At this time, parts are available through Refrigeration Supplies Distributor (www.rsd.net).

You should order the following three parts to control one expansion valve

SPO EXV BOARD
SPO EXV PRES TRANSDUCER (Pressure)
SPO EXV SENSOR AND WELL (Temperature)

To find these parts easily, type "Turbocor" in the search box.

If you are controlling multiple EXV's on the same refrigerant circuit you can save money by installing one pressure sensor at a common location and having it send a signal to one board.

You then connect communications wires between all boards. You configure the one board to transmit the pressure, and the other board to receive the pressure

Installation

Install the temperature sensor and pressure sensor at the same location you would install the TXV Sensing Bulb and External Equalizer line.

Configuration – Step 17 (Valve Type)

The display does not show a decimal, so you must interpret what is says (16K, 25K, 32K, 64K) with what it means (1.6K, 2.5K, 3.2K, 6.4K). Here is a summary:

DSP	STEPS	VALVES
ESX		Sporlan ESX Valve
16K	1,596	SER 1.5, 6, 11, 20
25K		SEI/SER G, J, K
32K	3,193	SEI 30
64K	6,386	SEI/SEH 50, 100, 175, Y1231
050	2.625	Danfoss 25, 50-ton EXV
100	3,530	Danfoss 100-ton EXV
250	3,810	Danfoss 250-ton EXV
400	3,810	Danfoss 400-ton EXV

Operation

The valve is enabled when the dry, non-voltage contacts on an external relay connected to terminals DIG IN close.

The valve is disabled when these contacts open.

They contacts should not close until after the Turbocor RUN contacts have closed to energize the external relay.

EXV Wiring

The Danfoss and Sporlan electronic expansion valves can be controlled by the same controller

For both valves the wire colors are Black, White, Green, Red.

For most Sporlan controllers, the Danfoss valves can be connected is one pair of wires (Either Black-White, or Red-Green) has its color swapped from the Sporlan colors.

However, I think for this controller, the color swap is not necessary. The signal is swapped when Danfoss valves are selected in the configuration.

Note:

This document is still a draft. I have not yet had time to test all these features myself

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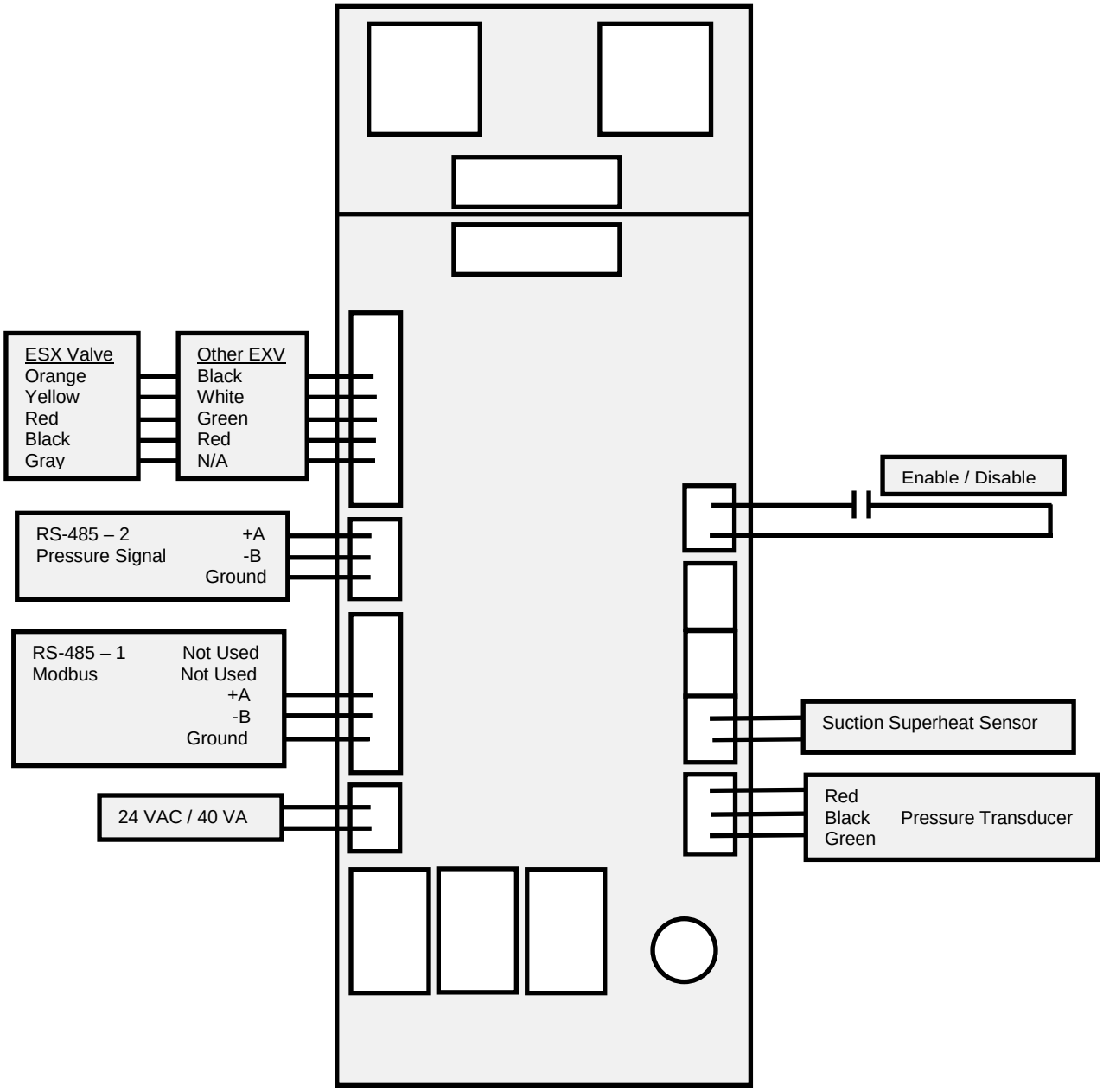
Wiring


ESX Valve
Orange
Yellow
Red
Black
Gray
Other EXV
Black
White
Green
Red
N/A
RS-485 – 2
Pressure Signal
+A
-B
Ground
RS-485 – 1
Modbus
Not Used
Not Used
+A
-B
Ground
24 VAC / 40 VA
Enable / Disable
Suction Superheat Sensor
Red
Black
Green
Pressure Transducer