iCold and RCS Controller

Introduction

The Refrigeration Controller System (RCS) is a microprocessor-based system designed to precisely control refrigeration evaporators in walk-in cooler and freezer applications. Its state-of-the-art design accurately controls refrigerant flow in the evaporator by means of a Sporlan Electric Expansion Valve (EEV). By using pressure and temperature sensor inputs, the RCS is able to control evaporator temperature more accurately and consistently than mechanical thermostatic expansion valves typically employed in traditional refrigeration systems.

The iCold is a turnkey package containing the RCS controller in an enclosure with a transformer, fuse holder and all sensors necessary for refrigerated room control. Only an Electric Expansion Valve (EEV) and liquid line solenoid, if desired, need to be purchased separately.

In addition to evaporator control, the RCS is configured with relays to control evaporator fans and defrost heaters. A large alphanumeric LED display and two button encoder interface simplifies system setup, while allowing programming flexibility for full system optimization. The RCS has many useful features described in this bulletin. Figure 1 provides a general layout of the system. This wiring diagram also appears inside the enclosure cover.

The RCS package includes the components necessary to control all of the Sporlan family of Electronic Expansion Valves. The kit includes:

- RCS Control Board
- NEMA 12K rated enclosure
- Room Temperature Sensor
- Defrost Termination Sensor
- Superheat Temperature Sensor
- Pressure Transducer
- 115/230 to 24VAC transformer
- On board 250V Metal Oxide Varistors
- Installed 250V GMC1 fuse

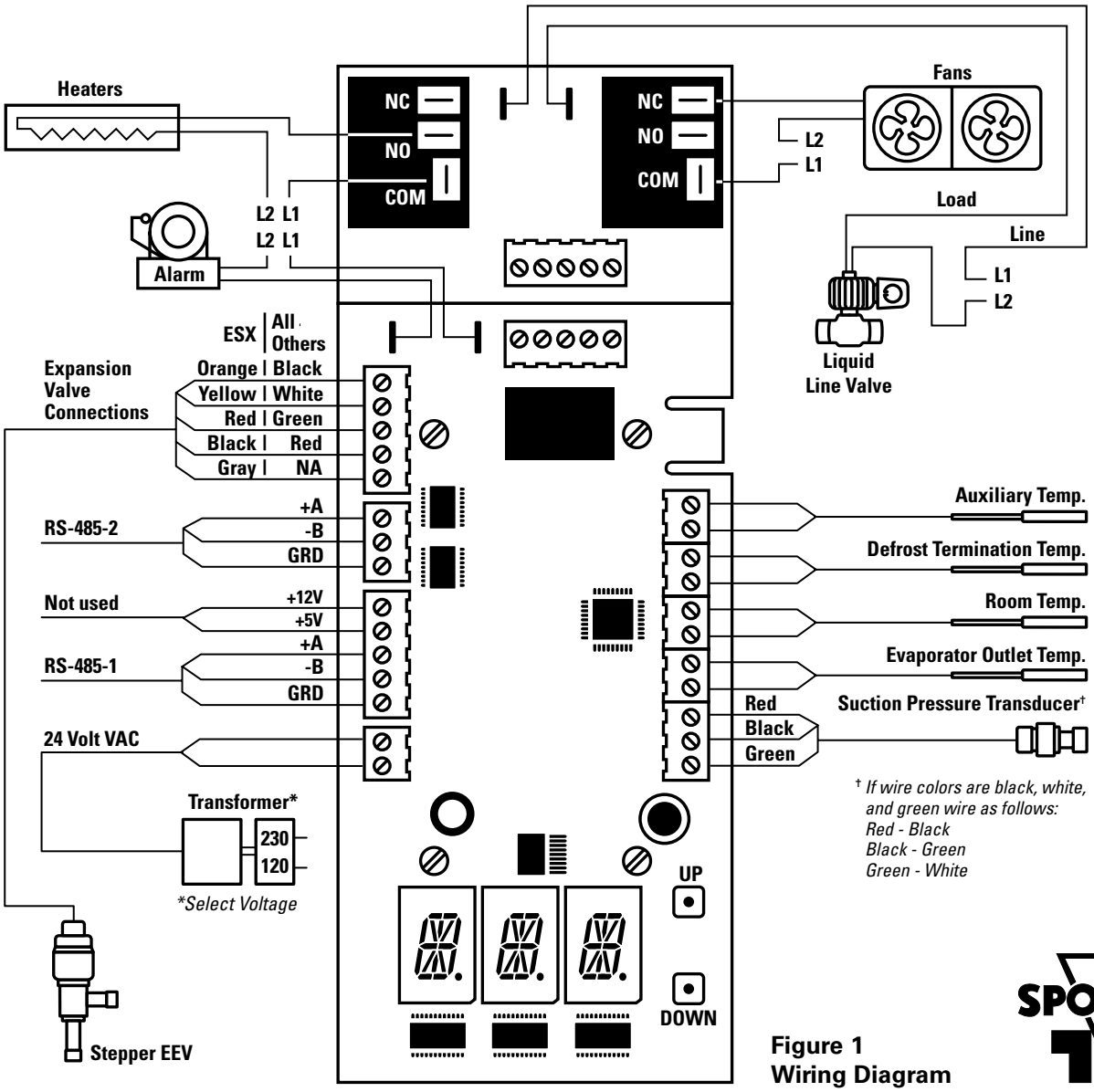


Figure 1
Wiring Diagram

Table 1
Step-Motor Wires and Connections

ESX - 5 Wire	All Others - 4 Wire
Orange	Black
Yellow	White
Red	Green
Black	Red
Grey	N/A

The NEMA 12K rated enclosure gives the installer the flexibility to place the control system near the condenser, in the space, or by the entrance to the refrigerated space, where it can be used as a digital thermometer.

To further simplify the installation, the RCS, 24VAC transformer, 250V MOVs, GMC1 250V fuse, and 115/230V input selector switch are already mounted and wired in the enclosure.

Knockouts have been provided in 5 separate locations around the enclosure to facilitate the installation of the main power, sensors, and valve wiring. Local regulations must be followed for all wiring. The wiring schematic is for illustration only, Sporlan accepts no responsibility for incorrect wiring.

The onboard display allows the controller to be field configured for refrigerants: R-22, R-404A, R-507, or R-134a. It may also be set to control any of the Sporlan EEVs: ESX, SER, SEI, or SEH.

Installation

iCold

The iCold may be installed in any indoor or protected location and waterproof connections should be used in wet areas. UV light may fade or damage the transparent cover so the iCold should be mounted away from sunlight.

Figure 5 gives the dimensions for mounting the iCold. Self tapping #6 x 1" or longer should be used in the cover retention fastener holes to maintain water resistance.

Step-Motor EEV

The EEV should be installed at the inlet to the evaporator or distributor using standard brazing practices. Please refer to valve installation instructions SD-243 available at www.sporlan.com.

Refer to the specific figures when making connections to the RCS Controller Board. Plug-in terminals are provided for most connections. Make connections directly to the board using the screw terminals, or make a connection off of the board by unplugging the terminal first.

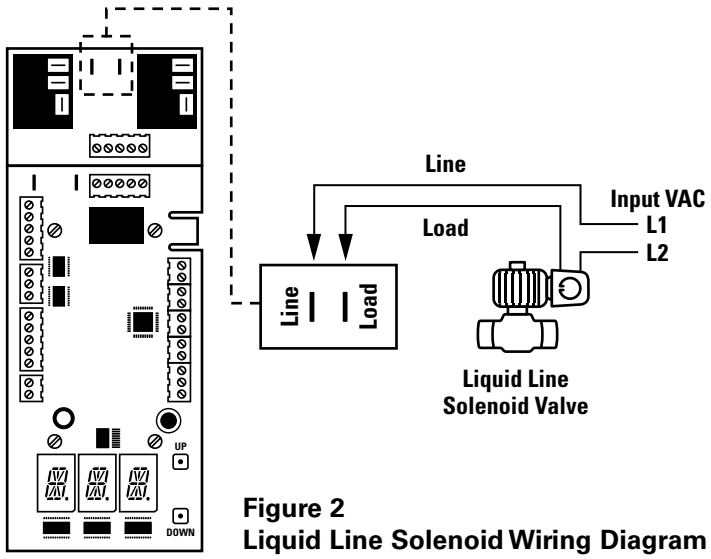
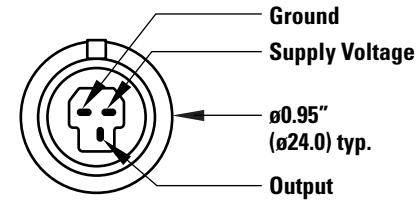
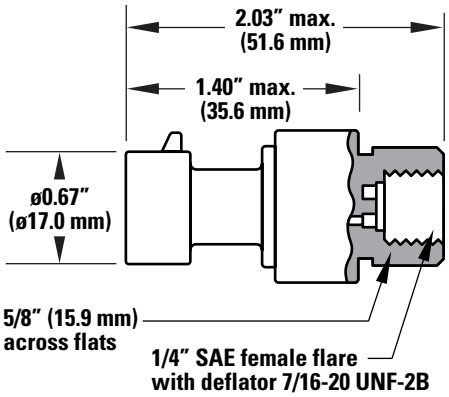


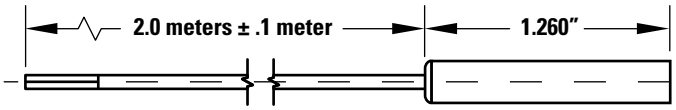
Figure 2
Liquid Line Solenoid Wiring Diagram

Figure 3
Pressure Transducer and Temperature Sensors Wiring Detail





Pressure Transducer



Temperature Sensor

Connect step-motor wires to the color coded terminals labeled CN2 on the board. See Table 1 and Figure 1.

Liquid Line Solenoid Valve

Operation of a liquid line solenoid valve requires an external power source of 24 – 240VAC (120 –240V 3A). See Figure 2 for wiring detail.

1. Consult the solenoid valve label to ensure that you are using the correct voltage coil.
2. Use a suitable length of two-conductor electrical cable (18 gauge minimum) for routing to the intended voltage source and controller location.
3. Crimp a 1/4" female spade terminal to one solenoid lead and one voltage source lead.
4. Connect the "hot" leg lead from the power supply to the "line" terminal labeled CN9 on the board.
5. Connect one end of the other lead to the "load" terminal labeled CN10 on the board, and the other end to one lead or terminal on the solenoid coil.
6. Connect the neutral leg of the power supply to the other lead or terminal on the solenoid coil.

The solenoid will be on during normal refrigeration and off when the refrigerated space achieves temperature setpoint.

Sensor
The pressure transducer and superheat temperature sensor should be installed on the suction line at the outlet of the evaporator. The transducer must be installed to a 1/4 SAE fitting near the top of the suction line. The temperature sensor should be installed with the included straps on the side of the suction line close to the transducer location. Defrost termination sensors, room temperature and auxiliary sensors should be postitioned in the most appropriate location for the system. Please refer to sensor installation instructions SD-245 available at www.sporlan.com.

Pressure Transducer
The transducer is equipped with a 2 meter (6 ft.) cable harness that plugs into the transducer at one end and is wired into the RCS Controller Board. See Figure 3 for dimensions.
1. Plug the cable harness into the transducer.
2. Connect the cable leads to the three color coded terminals of the connector labeled CN3 on the board. See Figure 1.

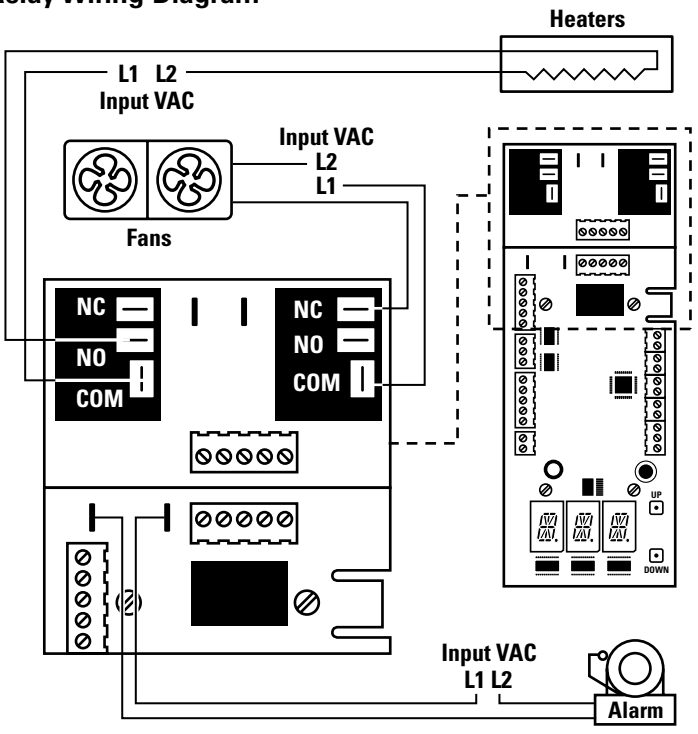
Temperature Sensors
Each Temperature Sensor is supplied with 2 meter (6 ft.) long wire leads for wiring to the RCS Control Board. If additional length is required, use 22-26 AWG shielded, twin twisted cable. Wiring splice connections should be made by using Scotch™ brand "UR" gel filled self-piercing connectors to ensure long term integrity.

Connect the two leads from each sensor to the RCS Controller Board as shown in Figure 1. The sensor leads are not polarized but care should be taken to assure proper location of each sensor.

Fan Relay
Refer to Figure 4 for the following wiring instructions.
1. Crimp two 1/4" female quick connect terminals to two extension wires that will be used on the relay. One of the extension wires will be for the fan-input power and other for the supply voltage connections.
2. Connect the "hot" leg lead from the power supply to the common (COM) terminal on the fan relay.
3. Connect the normally closed (N.C.) relay output to one lead or terminal on the fan.
4. Connect the neutral leg of the power supply to the other lead or terminal on the fan.

The fans will be on during normal refrigeration and off during defrost and drip time as set by menu option CDT, defaulted to 3 minutes.

Figure 4
Relay Wiring Diagram



Heater Relay
Refer to Figure 4 for the following wiring instructions.
1. Crimp two 1/4" female quick connect terminals to two of extension wires that will be used on the relay. One extension lead is used for the heater-input power and other for the supply voltage.
2. Connect the "hot" leg lead from the power supply to the common (COM) terminal on the heater relay.
3. Connect the normally open (N.O.) relay output to one lead or terminal on the heater.
4. Connect the neutral leg of the power supply to the other lead or terminal on the heater.

The heater will be off during normal refrigeration and on during defrost as set by menu options DSh and DSm for start time and DPd for defrosts per day. Default for first defrost start is 10:15 and default number of defrosts per day is 3.

Alarm Relay
Refer to Figure 4 for the following wiring instructions.
1. Crimp 1/4" female quick connect terminals to one end of a pair of extension wires to be used for wiring the alarm circuit.
2. Connect the "hot" leg lead from the power supply to the Alarm terminal labeled CN5 on the board.
3. Connect one end of an extension lead to the Alarm terminal labeled CN11 on the board. Connect the other end to one terminal or lead on the alarm.
4. Connect the neutral leg of the high voltage power supply to the other lead or terminal on the alarm.

The Alarm will be silent until any of the set alarm thresholds are reached. Refer to Table 3.

Optional Communications Wiring
There are two optional communication methods.

- **RCS to PC DIRECT ACCESS**
  A personal computer is used for direct access to the RCS Controller Board. Communication will require customer supplied RS-485 to USB adapter. When connected, care should be taken to assure polarity and proper lead termination. The RCS incorporates termination resistors. Remote monitoring and setting requires installation of Sporlan supplied software on the PC.
- **RCS to REMOTE PC ACCESS**
  The same procedure should be followed as above with the addition of a stand-alone communications modem.

RCS controllers may be daisy-chained using either, or both, of the RS-485 terminals, refer to Figure 1. Each RCS must be given a unique address by changing value of "unu" shown on Table 4.

Controller Configuration

Specifications

— **RCS GENERAL SYSTEM SPECIFICATION**
Input voltage 115/230 VAC (iCold only)
24 VAC (± 10%), 40 VA minimum to board with external transformer (included with iCold package)
Operating ambient temperature
-40°F to 120°F
Control temperature range
-20°F to 60°F
Superheat setpoint range
5°F to 30°F
Room temperature setpoint range
-20°F to 60°F
True superheat regulation
+/-2°F
LED Display
3 character, 16 element alphanumeric display

— **COMMUNICATIONS**
Remote setting and monitoring
(2) RS485

— **BATTERY LIFE**
Real time clock battery backup
>10 years (during active operation)

— **PRESSURE TRANSDUCER (Suction Pressure)**
Maximum seal temperature range
-40°F to 120°F
Seal type
Neoprene
Pressure range
0 to 150 psig
Transducer accuracy
% of F.S. 1%
Supply voltage (supplied from RCS)
5 Volts DC +/- 0.5 VDC
Output range
0.5 V (0 psi) to 4.5 (150 psi) Volts DC
Electrical connection
Mates with Packard 12065287 connector

— **THERMISTOR**
Nominal
3000 ohms at 25°C, Non-polarized (NTC)

Accuracy
-4°F to 122°F = ±1°F

Table 2
Power Up Menu

Code	Definition
V_	Firmware version
>>>	Arrows indicate stepper seating
V=_	Electric valve type
MST	Controller status
H_ _	Time of day in hours
M_ _	Time of day in minutes

Controller Operation

On power up, controller will display parameters shown in Table 2. Upon completing the initialization sequence, the controller will begin to display the automatic menu. The display will alternate between the room temperature and the current process status. For process status nomenclature refer to Table 4.

To view the current list of parameters without entering the setpoint mode, press and hold the down (Dn) button. When the down button is pressed and held the Process Variables in Table 4 are displayed. To toggle between the parameter and the value, press the up and down button simultaneously. The down button also gives access to the manual defrost menu. Table 4 illustrates menu format and options.

Silencing Alarms

The display will indicate the presence of an alarm by alternating between alarm indicator, *A*, and the fault currently recognized by the controller. An additional indicator may be used through the alarm relay outputs. The output is a closed relay.

Pressing the up button silences the alarm. The display will return to normal once the cause of the alarm is corrected.

Figure 5
NEMA Enclosure Dimensions

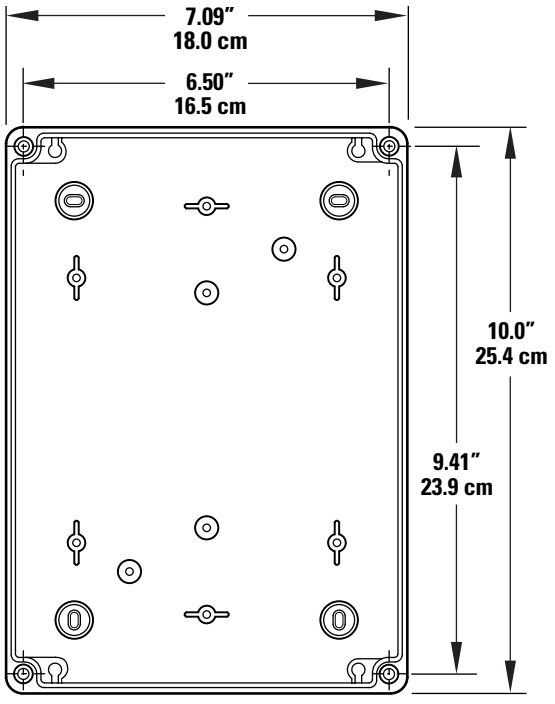


Table 3
Controller Setpoints

Below is the list of codes and the default factory settings.

Note: The RCS is defaulted to control a medium temperature application at 35°F. Room temperature setpoints must be adjusted to desired room temperature.

Code	Description	Factory Default Settings	Units	Range	User
Esc	Escape back to main menu	N/A	N/A	---	N/A
S/H	Target superheat setpoint	008	°F	5 to 30	
RTN	Room temperature on setpoint	035	°F	-20 to 60	
RTF	Room temperature off setpoint	033	°F	-21 to 59	
DTT	Defrost termination setpoint	054	°F	40 to 70	
FDT	Fan delay temperature setpoint	028	°F	10 to 32	
CDT	Coil drain time	003	M	1 to 10	
DFT	Defrost failsafe time	035	M	15 to 120	
DSh	First defrost start time (hour)	010	H	0 to 23	
DSm	First defrost start time (minutes)	015	M	0 to 55	
DPd	Defrosts per day	003	QTY	0 to 6	
SuH	High suction pressure setpoint	127	PSI	50 to 120	
SuL	Low suction pressure setpoint	000	PSI	0 to 20	
SuD	Suction pressure alarm delay	060	M	0 to 120	
CoH	High coil outlet temperature	100	°F	40 to 120	
CoL	Low coil outlet temperature	-40	°F	-39 to 30	
CoD	Coil outlet alarm delay	060	M	0 to 120	
RmH	High room temperature alarm	050	°F	40 to 80	
RmL	Low room temperature alarm	028	°F	-20 to 30	
RmD	Room temperature alarm delay	060	M	0 to 120	
TtH	High termination temperature alarm	120	°F	60 to 120	
TtL	Low termination temperature	-40	°F	-39 to 0	
TtD	Termination temp alarm delay	060	M	0 to 120	
AxH	High auxiliary temperature alarm	120	°F	40 to 120	
AxL	Low auxiliary temperature alarm	-40	°F	-39 to 30	
AxD	Auxiliary temp alarm delay alarm	060	M	0 to 120	
ShH	High superheat alarm	020	°F	20 to 50	
ShL	Low superheat alarm	000	°F	0 to 15	
ShD	Superheat alarm delay	060	M	0 to 120	
t_H	Current time in hours	Last time set or 00	H	0 to 23	
t_M	Current time in minutes	Last time set or 00	M	0 to 59	
MVO	Manual valve open	000	%	0 to 99	
P/W	Change current password	111	N/A	0 to 120	
Unu	Remote communication unit number	000	N/A	0 to 126	
REꟻ	Refrigerant	001 (404A)	N/A	1 to 4	
P	Proportional	020	N/A	0 to 75	
I	Integral	025	N/A	0 to 75	
D	Derivative	002	N/A	0 to 75	
MOP	Maximum operating pressure	120	PSI	-20 to 120	
VMX	Valve max (open)	100	%	30 to 100	
VMN	Valve min for bleed	000	%	0 to 15	
HST	History data log interval	005	Min	0 to 60	
TT2	One or two temp probes for defrost	001	---	1 to 2	
MST	Status	1(Master)	N/A	---	
VtY	Valve type	1(SMALL)	N/A	1 to 4	
RES	FloodGuard protection level	000	N/A	0 to 30	

Table 4

RCS v2.9 Process Status

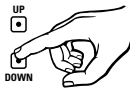
REF – Refrigerating mode
OFF – Room temperature satisfied
DEF – Defrost active
DRN – Drain time active
FAN – Fan delay active
A – Alarms active

Status screens alternate with the value of the room temperature in degrees F.

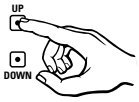
Alarm screen (when active) alternates with alarm(s) ID.

SELECT key combination

DOWN key



UP key



Resets displayed alarm

Password Entry

P/W >> 111

Use UP and DOWN keys to adjust the password value, press SELECT key combination to commit the transaction.

Correct password will allow access to Controller Setpoints.

Alarm(s) ID

ShL – Superheat low
ShH – Superheat high
RmL – Room temperature low
RmH – Room temperature high
SuL – Suction pressure low
SuH – Suction pressure high
CoL – Coil outlet low
CoH – Coil outlet high
TtL – Termination temperature low
TtH – Termination temperature high
AxL – Auxiliary low
AxH – Auxiliary high

Process Variable and Manual Defrost Init.

VLV >>> Valve percent value
S_H >>> Superheat value
S_P >>> Suction pressure value
OUT >>> Coil outlet temperature value
TMP >>> Room temperature value
TRM >>> Termination temperature value
AUX >>> Auxiliary temperature value
DEF >>> "ini" - manual defrost

Pressing the SELECT key combination on any entry will return to main menu.

Pressing the SELECT key combination on DEF will initiate a defrost cycle and then return to main menu.

Controller Setpoints

Esc – Escape back to main menu
S/H – Target superheat setpoint
RTN – Room temperature on setpoint
RTF – Room temperature off setpoint
DTT – Defrost termination setpoint
FDT – Fan delay temperature setpoint
CDT – Coil drain time (minutes)
DFT – Defrost failsafe time (minutes)
DSh – First defrost start time (hour)
DSm – First defrost start time (minutes)
DPd – Defrosts per day
SuH – High suction pressure setpoint
SuL – Low suction pressure setpoint
SuD – Suction pressure alarm delay
CoH – High coil outlet temperature
CoL – Low coil outlet temperature
CoD – Coil outlet alarm delay
RmH – High room temperature
RmL – Low room temperature
RmD – Room temperature alarm delay
TtH – High termination temperature
TtL – Low termination temperature
TtD – Termination temp. alarm delay
AxH – High auxiliary temperature
AxL – Low auxiliary temperature
AxD – Auxiliary temperature alarm delay
ShH – High superheat temperature
ShL – Low superheat temperature
ShD – Superheat alarm delay
t_H – Current time in hours
t_M – Current time in minutes
MVO – Manual valve open (percent)
P/W – Change current password
Unu – Remote communication unit number

Toggle between Setpoint Text and Setpoint Value using SELECT key combination.

When Setpoint TEXT is visible, up and down arrows allow viewing all setpoints.

When Setpoint VALUE is visible, up and down arrows change this setpoint value.

Press SELECT key combination on ESC to return to main menu.

Rfg – Refrigerant 1 = R-404A
2 = R-507
3 = R-22
4 = R-134a
P – Proportional coefficient
I – Integral coefficient
D – Differential coefficient
MOP – Maximum operating pressure
Vmx – Valve max (open)
Vmn – Valve min (alarm contingency)
Hst – History data log interval (minutes)
TT2 – Use 1 or 2 temps. for Def-Term.
MST – Status 1-Master
VTY – Valve type 1 = Small (1596)
2 = Medium (3193)
3 = Large (6386)
4 = ESX (400)
Res – FloodGuard protection level ESX
0 = disabled
1 = implicit unwind
2 = implicit
5 – 30 = explicit w/aux. input

RCS Power-Up Screens

The RCS power-up sequence displays important information regarding the controller status.

MASTER	DEFINITION	SLAVE
Vxx	firmware version	**Vxx**
>>>	arrows indicate step seating	>>>
v=x	x = electric valve type	v=x
MST	controller status	SLV
Hxx	time of day in hours	Hxx
Mxx	time of day in minutes	Mxx

The power-up screens each have one second minimum persistence and once completed, the controller reverts to the **Process Status** above.

All setpoints and parameters can be erased by holding the SELECT key combination during power up.

CAUTION: All parameters must be reinstalled to allow proper operation. Failure to do so may cause system damage.

Table 5
Troubleshooting

Problem	Check	Solution
Controller board not powering up – no leds illuminated	Fuse (iCold only)	Replace with 1 amp 250 volt fuse
	Supply voltage	Correct supply
	Voltage selector switch (iCold only)	Toggle to correct input voltage
	24 volt supply jumper (iCold only)	Check wire and connector for contact
	Wiring	Correct per instructions
Board powers up but display characters not recognizable		Replace board
Board indicates active alarm status	Cancel alarm by SELECT keystroke	Correct cause of alarm, check sensors
	Wiring	Correct per instructions
Erratic superheat	Sensor location	Relocate to horizontal, clean suction line at 3 or 9 o'clock
	Pressure transducer location	Top of line near temp sensor
	Temperature sensor and transducer wiring	Assure wire contact in connectors
		Assure wire contact in splices
		Asssure no corrosion in connectors
		Correct per instructions
	Valve wiring and function	Refer to valve service instruction SD-243
High superheat	Superheat setpoint	Set correct setpoint
	Sensor location	See above
	Temperature sensor and transducer wiring	See above
	System refrigerant charge	Correct charge
	Valve wiring and function	Refer to valve service instruction SD-243
	RCS refrigerant selection	Change to system refrigerant
Low superheat	Superheat setpoint	Set correct setpoint
	Sensor location	See above
	Temperature sensor and transducer wiring	See above
	System refrigerant charge	Correct charge
	RCS refrigerant selection	Change to system refrigerant
	Valve wiring and function	Refer to valve service instruction SD-243
Fan relay inoperative	Relay jumpers to board	Correct wiring to jumper connectors
Fans always on	Relay wiring	Correct wiring to N.C. terminals
		Correct per instructions
	Relay contacts	Common to N.O. should have infinite resistance
	Fan and defrost parameters	Correct
	Relay jumpers to board	Correct wiring to jumper connectors
Fans always off	Wiring	Correct wiring to N.C. terminals
		Correct per instructions
	Relay contacts	Common to N.C. should have zero resistance
	Fan and defrost parameters	Correct
	Relay jumpers to board	Correct wiring to jumper connectors
Heater relay inoperative	Wiring	Correct per instructions
		Correct wiring to N.O. terminals
Heater always on	Relay contacts	Common to N.O. should have infinite resistance
Heater always off	Fan and defrost parameters	Correct
	Relay jumpers to board	Correct wiring to jumper connectors
	Relay wiring	Correct wiring to N.C. terminals
		Correct per instructions
	Relay contacts	Common to N.O. should have infinite resistance
	Fan and defrost parameters	Correct
Liquid line solenoid inoperable	Solenoid coil	Replace
	Solenoid voltage	Correct or replace coil
	Solenoid wiring	Correct per instructions