Hillphoenix®

A DOVER™ COMPANY

# SMART VALVE™

## SERVICE & OPERATIONS MANUAL

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*To ensure proper functionality and optimum performance, it is STRONGLY recommended that Hillphoenix display cases be installed/serviced by qualified technicians who have experience working with commercial refrigerated display merchandisers and storage cabinets. For a list of Hillphoenix-authorized installation/service contractors, please visit our Web site at www.hillphoenix.com.*

NSF COMPONENT c UL us


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V1.01
05/13

## REVISION HISTORY

*VERSION 1 (08/08)*
- New manual

*V1.01 (05/13)*
- Updated Components and Installation sections

## PRECAUTIONARY NOTICES

At Hillphoenix®, the safety of our customers and employees, as well as the ongoing performance of our products, are top priorities. To that end, we call out important messages in all Hillphoenix installation and operations handbooks with an accompanying alert symbol paired with the words "DANGER!", "WARNING!", or "ATTENTION!". All of these important messages will inform you of potential hazards and dangers to personal safety and health - as well as risks of case damage - if the instructions are not carefully followed.

**ATTENTION!**

Indicates an important point of information that is key to ensuring that case equipment functions properly.

**CAUTION!**

Indicates the potential threat of death or serious injury if all instructions are not followed carefully.

**DANGER!**

Indicates an immediate threat of death or serious injury if all instructions are not followed carefully.

## SERVICE NOTICE

To ensure proper functionality and optimum performance, it is strongly recommended that Hillphoenix display cases be installed/serviced by qualified technicians who have experience working with commercial refrigerated display merchandisers and storage cabinets. For a list of Hillphoenix-authorized installation/service contractors, please visit our Web site at www.hillphoenix.com.

**CAUTION!**

Under no circumstance should any component be replaced or added without consulting Hillphoenix Field Service Engineering. Utilizing improper components may result in serious injury to persons or damage to the refrigeration system.

## INTRODUCTION

Smart Valve is a stand-alone system designed to regulate superheat in a refrigerated fixture. It performs the same basic function as a typical, mechanical thermostatic expansion valve; however, it automatically adjusts superheat to pre-determined target values based on whether or not the application is for low- or medium-temperature operation. In addition, Smart Valve does not require periodic adjustments, as it automatically regulates superheat in response to changing ambient conditions, system parameter changes, and case-load changes.

## COMPONENTS

The components of Smart Valve include the following: refrigeration valve with stator, control module with power cord, pressure transducer, and temperature sensor (see Fig. 1 below).

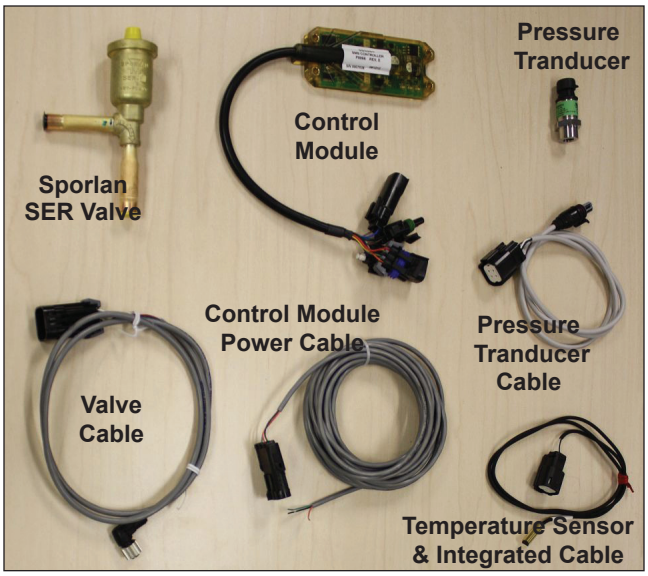



Fig. 1 Smart Valve components

A 24-volt AC transformer is also required to power the system, and a three-wire power cable is used to connect the transformer to the control module.

## INSTALLATION

***Refrigeration Valve***

- The refrigeration valve should be oriented and installed with the stator located slightly higher than the outlet of the refrigeration valve to prevent debris from blocking the orifice and needle assembly.
- The inlet and outlet of the refrigeration valve are depicted in Figure 2.

**ATTENTION!**

When brazing, the refrigeration valve must be wrapped in a wet cloth to prevent damage to the internal components.

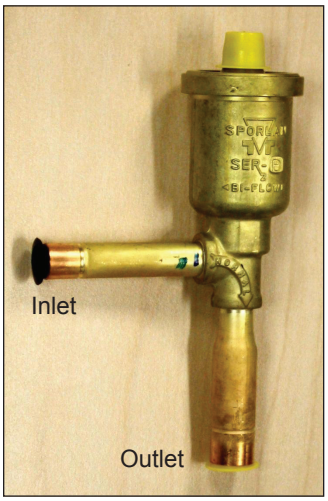



Fig. 2: Refrigeration Valve

***Refrigeration Valve (cont'd)***

- There are four refrigeration valves currently in use today: SER AA, SER A, SER B, and SER C. One of these valve names will be engraved on the valve stator—an example of this can be seen on the SER B valve shown in Figure 2).

***Valve Cable***

- All SER valves are supplied with the valve body and stator as an integrated unit. The valve is connected to the module via the provided valve cable. The valve cable has been designed to only fit one connector attached to the module.

**ATTENTION!**

Ensure that the pins in the valve cable's connector are fully engaged before tightening when attaching to the valve. Failure to do so may result in damage to the wiring.

***Control Module with Power Cord***

- The control module is an over-molded electronics board with a four- or five-connector pigtail. The mounting holes in the module are utilized to attach the module to a fixed surface—for example, the tank surface, mounting plate, etc.

**ATTENTION!**

Be certain to mount the control module to a flat surface to avoid damaging it.

- Each of the connectors on the four-connector pigtail are unique and should be plugged into only its matching connector from the temperature sensor, pressure transducer, power input, or stator.
- The power cord is connected to the control module via the matching connector. The pigtail end of the power cord is hard-wired to the transformer.
- Each connector should be fastened together until a slight click is heard or visually checked to ensure the locking tab on the side of the connector is engaged.

**ATTENTION!**

Do not jump- or cross-wire the connectors to avoid damaging the control module and/or components.

**ATTENTION!**

Ensure that all wiring is installed at a safe distance from any electrical defrost heaters when the heaters are energized. Failure to do so may result in wire damage.

**ATTENTION!**

Connecting the power cord directly to the pressure transducer may cause damage to the transducer.

***Pressure Transducer***

- The pressure transducer is connected to the control module via a snap-in cable.
- The transducer cable should never be plugged directly into the power supply as damage to the transducer could result.
- To attach the transducer to the Schraeder fitting on the suction line, clean the flare fitting mating surface with a Scotch Bright® pad prior to transducer installation. Apply a thin layer of oil around the mating surface and install the transducer. The transducer must be torqued to 120 in-lbs.
- The transducer is sensitive to heat; therefore, it should be removed if any brazing or soldering is being done to the suction line within 2 feet of the transducer.
- The transducer can be left installed while a vacuum is applied to the system.
- Use a thin layer of oil from the packet provided with the sensor when attaching the pressure transducer to the pressure transducer cable.

***Temperature Sensor***

- The temperature sensor is connected to the control module via a connector at the end of the sensor wires.
- The temperature sensor must be attached to the suction line in the same fashion as a capillary tube utilized on a mechanical valve.
  - ► For 7/8-inch pipes or larger, the sensor should be firmly attached longitudinally along the suction line in the 4 o'clock or 8 o'clock position.
  - ► For pipes smaller than 7/8-inches, the sensor should be attached on the top portion of the pipe between the 3 o'clock and 9 o'clock position.
- The temperature sensor must be removed if brazing or soldering is being done to the suction line within 2 feet of the sensor.

***Transformer***

- The required transformer is a 24-VAC transformer with a minimum rating of 20 VA. The transformer must also be grounded.
- The ground wire must be utilized with the line voltage.
- The ground wire leading to the control module must be trimmed and wrapped with electrical tape.
- A maximum transformer rating of 50 VA can be utilized to energize Smart Valve.

**ATTENTION!**

DO NOT connect the green wire on the power cable to the ground. Doing so may result in case damage.

## OPERATION, ERROR CODES & FAILSAFE OPERATION

Smart Valve is equipped with a three-colored LED light panel that is capable of steady-on or blinking operation. When voltage is applied to the system, the control module will begin its startup and verify LED operation by cycling through all of the panel's lights. The amber light will engage, indicating that the module is working correctly and that all of the sensors have been checked.

The module will open the refrigeration valve and attempt to reach the superheat target. Upon reaching the target value, the amber light will turn off and the green light will engage to indicate proper superheat has been achieved. If the superheat target can not be achieved, the module will indicate the error.

| Lights Display | Error Description |
|---|---|
| G Y R | Superheat within target range |
| Y | Controller functioning, superheat not within target range |
| Y R | Superheat too high for over 2 hours |
| G Y R | Superheat too low for over 2 hours |
| B Y B | Valve Connection Problem |
| Y B | Transducer Connection Problem |
| B Y | Temperature Probe - Connection Problem |
| G | Solid |
| B | Blinking |

Fig. 3: Error Codes

If an error code is displayed, the control module will default to "safe mode" operation, which is based on historical data collected by Smart Valve during normal case operation. The average valve capacity over a 24-hour period is collected and stored under a signature value that is specific to the case and application.

When Smart Valve operates in safe mode, the signature value is utilized to provide a safe level of refrigeration until maintenance can be completed. The system will continue to operate in this mode until the condition is corrected and then will return to normal operation.

If a sensor failure is detected, a corresponding error code will be displayed via the panel lights (see Fig. 3). The first response should be to check all connections and wiring points, as well as to visually inspect sensors for cracks in the wiring, excessive heat, etc. If the problem persists, replace the sensor and cycle the power to reset the control module.

In the event of errors related to the superheat target not being achieved (not sensor failures), the system will default to its safe mode and attempt to reach its target superheat every 45 minutes. If superheat is not reached within 15 minutes, the system will default back to safe mode.

**ATTENTION!**

DO NOT connect the green wire on the power cable to the ground. Doing so may result in case damage.

In some rare instances, 15 minutes may not be long enough for the system to reach the target superheat; if so, it may be necessary to cycle the power to immediately reset the system and provide an additional 15 minutes to reach superheat. Also, if the system has been turned on without refrigeration, it may be necessary to cycle the power to the unit several times to achieve proper performance.

If superheat can not be achieved and accurately maintained, Smart Valve will continue to default to safe mode. Further troubleshooting measures should be undertaken as soon as possible, such as ensuring a full column of liquid refrigerant is at the refrigeration valve, determining that the system is performing adequately, and affirming that all sensors are attached correctly and reading accurately.

## COMMUNICATION

Smart Valve can communicate externally via infrared (IR) technology. The control module has an onboard emitter and receiver (see Fig. 5 below).

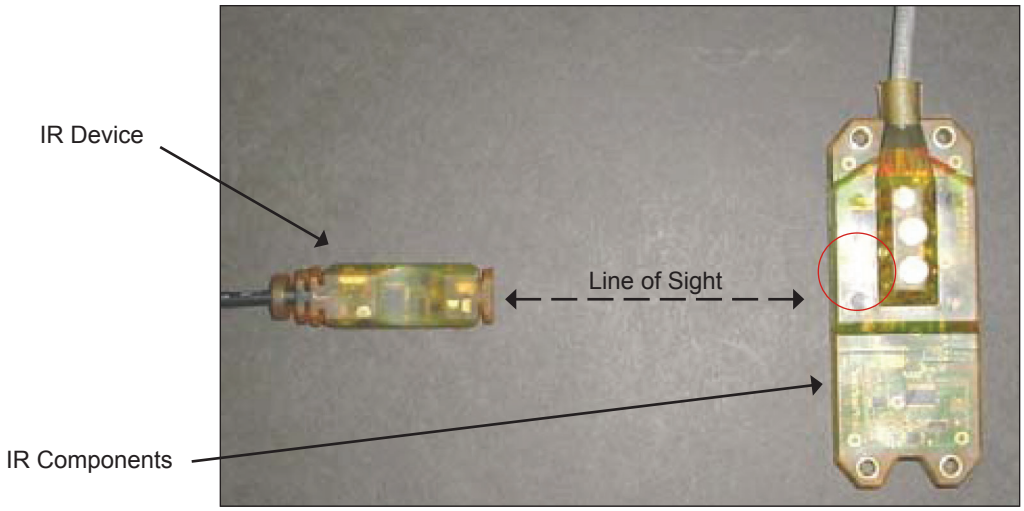



Fig. 4: Infrared (IR) Devices

An IR device (see Fig. 4) is required to connect the control module to a PC using a USB port. IR technology requires that the module and the IR device be in line-of-sight with one another and somewhere between 3-inches to 2-feet apart. The illustration above also demonstrates the correct orientation of the components for communication. The Smart Valve software, as well as the drivers for the IR device, must be installed on a PC.

## REFRIGERANT SELECTION

Smart Valve is capable of handling a wide variety of refrigerants and has the ability to select or change the refrigerant through an IR device and a PC. Upon installing and launching the Smart Valve software, a Quick Start interface screen will appear (see Fig. 5).

Select the circle adjacent to the desired refrigerant and click the “Send Settings to Controller” button. The software will monitor the change in parameters and display whether or not the change was successful (see Fig. 6).

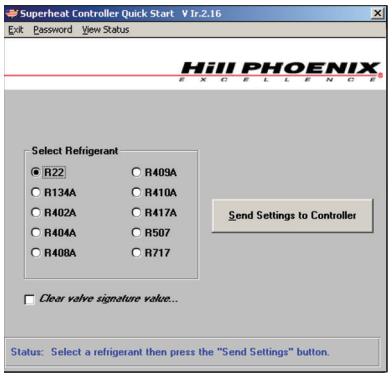



Fig. 5: Quick Start Interface

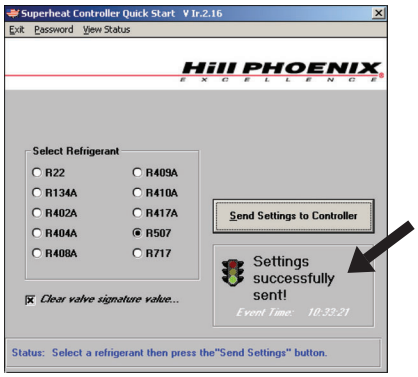



Fig. 6: Selecting Refrigerant

If the settings were not successfully sent, the connection to the IR device should be checked; additionally, the orientation of the IR device and control module should be examined to ensure that there is nothing blocking the line of sight between the IR device and the module.

The signature value of the controller can also be reset by checking the box next to “Clear valve signature value”, selecting the desired refrigerant, and clicking the “Send Settings to Controller” button. For example, it may be necessary to reset this value if switching a controller to a different case or if a refrigerant change is made.

## DIAGNOSTICS/ VIEW STATUS

The Smart Valve software is also capable of displaying in-depth information about system performance. Normal operation does not warrant the use of these functions but could aid in diagnosing system performance issues.

To utilize this functionality, the IR device needs to be set-up as detailed above in the refrigerant selection section. When the software is initialized and the Quick Start screen is displayed, the “View Status” heading at the top of the screen must be selected (see Fig. 7).

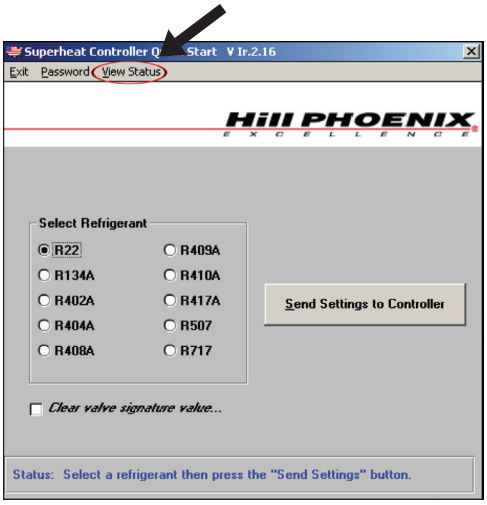



Fig. 7 View Status

When the status screen is displayed, click on the “Connect to Controller” button. The buttons marked Rx and Tx should blink from green-to-red, and a status summary will be displayed at the bottom of the screen. The software should indicate that the connection was successful, and the current settings and readings of the sensors will be displayed in real time. A graph will record the readings as measured by the software and display them.

The control module does not store data, so data cannot be pulled from the module. The graph can be started and then viewed later to look at system performance. Values to be displayed are listed on the right side of the graph, with checked boxes indicating those values (see Fig. 8).

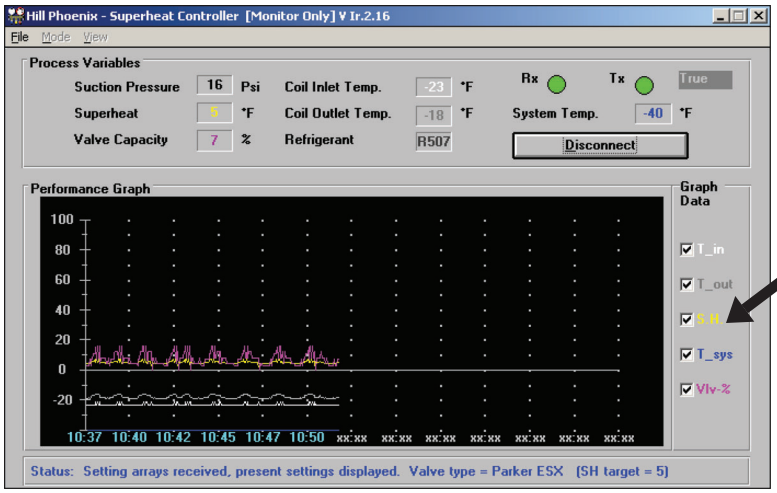



Fig. 8: Control Module

The following is a list of readings and parameters that are available for display:

- Suction Pressure – Displays the suction pressure as recorded by the pressure transducer.
- Coil Inlet Temp. – Displays the saturated suction temperature converted from the pressure recorded by the transducer and based on the refrigerant selected.
- Superheat – Displays the calculated superheat based on the temperature sensor and the coil inlet temperature.
- Coil Outlet Temp. – Displays the coil outlet temperature as recorded by the temperature sensor.
- Refrigeration Valve Capacity – Displays the percentage of full capacity the valve is currently operating at.
- Refrigerant – Displays refrigerant selected in the software.
- System Temp – Not used at this time.

## QUESTIONS?

If you have any questions or concerns, please contact Hill PHOENIX at 1-800-283-1109 (select extension “2444”).

HILL PHOENIX
EXCELLENCE
A DOVER COMPANY

# Smart Valve

## Supplemental Manual for Low-Temperature CO2 (R-744) DX Cascade Applications

SEE LAST PAGE FOR
HILL PHOENIX
MANUFACTURING LINE
WIRING INFORMATION

SMART VALVE

**Version 1**
**July 2009**

R796929

# Hill PHOENIX Smart Valve
# Supplemental Manual for Low-Temperature CO2 (R-744)
# DX Cascade Applications

This document is a supplement to Hill PHOENIX's Smart Valve Operation Manual. It describes the operation of Smart Valve controller in low-temperature systems using CO2 (R-744) as a direct expansion refrigerant for display case and walk-in freezer applications including Hill PHOENIX Second Nature SNLTX2 and SNMT2LX products. This manual does not cover systems using CO2 as a low-temperature secondary coolant (SNLT2 systems). Differences in hardware, installation, wiring, software, and features are highlighted between systems using CO2 and conventional HFC operation.

**Smart Valve Hardware for CO2 Applications**

The Smart Valve assembly used in CO2 applications includes a control module, an electronic expansion valve, a pressure transducer (P) and TWO temperature sensors (T1 & T2) compared to one temperature sensor (T1) for typical HFC applications. Table 1 lists the hardware requirements for CO2 application s with the Smart Valve. The primary differences between typical HFC applications and CO2 applications are: the second temperature sensor (T2) is connected to an additional plug on the control module cable (pigtail) and provides additional control functionalities for the Smart Valve system, and, the pressure transducer P is 0-500 PSIG range for CO2 vs. 0-150 psig for typical HFC applications. A new version firmware is embedded in the control module and can be upgraded by trained personnel. A Sporlan Y1268 electronic expansion valve is used for each coil. The control module is powered by a 120/24VAC transformer from a dedicated, continuous source.

| ITEM | COMPONENT | QTY | DESCRIPTION/SPECIFICATION | MOUNTING LOCATION |
|---|---|---|---|---|
| 1 | Control module | 1 | Stepper motor controller firmware V3.C0 and above with five-connector pigtail | Return air duct between return air grill and coil |
| 2 | Electronic expansion valve | 1 | Stepped motor valve Y1268 2500 steps 700 PSIG | Coil inlet |
| 3 | Pressure transducer P | 1 | Coil outlet pressure 500 PSIG | Coil outlet |
| 4 | 1st Temperature sensor T1 | 1 | Coil outlet temperature 3K resistance | Coil outlet |
| 5 | 2nd Temperature sensor T2 | 1 | System temperature 3K resistance used for discharge air temperature | Discharge air honeycomb |
| 6 | Transformer | 1 | Power supply 120/24VAC 20VA | Raceway or electrical Box on the top of or underneath the case |

**Table 1.** Smart Valve Hardware for CO2 Applications

**Smart Valve Software for CO2 Applications**

New version of firmware (V3.C0 and above) embedded in the control module integrates the second temperature sensor T2 into the dedicated algorithm to achieve precise control of temperature. The Smart Valve firmware includes refrigerant choices for CO2 (R744) and R410A in addition to R22, R134A, R402A, R404A, R408A, R409A, R417A, R507, and R422D. When R744 is selected as refrigerant, the 500 PSIG pressure transducer must be used and the pressure signal is automatically converted and calculated in the range of 0-500 PSIG for superheat control.

Control and Monitor software (V IR3.09 and above) can be installed on a local computer to set up communication with a Smart Valve control module through a USB IR Fob. The latest version can be downloaded at www.hillphoenix.com. Table 2 below outlines the default values for CO2 application.

| No. | Parameters | Default Values |
|---|---|---|
| 1 | Firmware | V3.C0 and above |
| 2 | P | 20 |
| 3 | I | 10 |
| 4 | D | 5 |
| 5 | Min Cap | 0 |
| 6 | Max Cap | 100 |
| 7 | Cut-in | -26 |
| 8 | Cut-out | -28 |
| 9 | SH (med) | 8 |
| 10 | SH (low) | 8 |
| 11 | M.O.P. | 300 |
| 12 | Cycling Time | 3 |
| 13 | Vlv_Sig% | 20 |
| 14 | Valve Selection | SER 2500 steps |
| 15 | Refrigerant | R744 |

**Table 2.** Default Values of CO2 Parameters

**The 2nd Temperature Input of Smart Valve Control Module**

The second temperature input of the Smart Valve control module is used for multiple functions including closing the valve for defrost and controlling case discharge air temperature. The second input is wired with a combination of a refrigeration/defrost relay (dry contact) and a temperature sensor (T2) with or without a dual-temperature switch (see figure 4). When the input signal is an open circuit, the valve is directed to the 100% closed position. When the input signal is shorted out, the controller will control valve superheat only, regardless of changes in discharge air temperature. When the input signal is the thermistor source (T2) the valve will control both superheat and discharge air temperature by

periodically closing the valve based on the Cut-In and Cut-Out temperatures programmed into the control module. The required Cut-In and Cut-Out temperatures are dependent on both the display case model, the product being refrigerated, and customer specification for desired product temperature. An example of possible Cut-In and Cut-Out temperatures for Frozen Food would be -10°F Cut-Out, -8°F Cut-In, and an example of Cut-In and Cut-Out temperatures for Fresh Meat would be +30°F Cut-Out, +28°F Cut-In

Once communication is connected between a control module and a computer, the second temperature input is shown on the Monitor screen as "System Temp" representing the air temperature at the discharge honeycomb (see Figure 1).

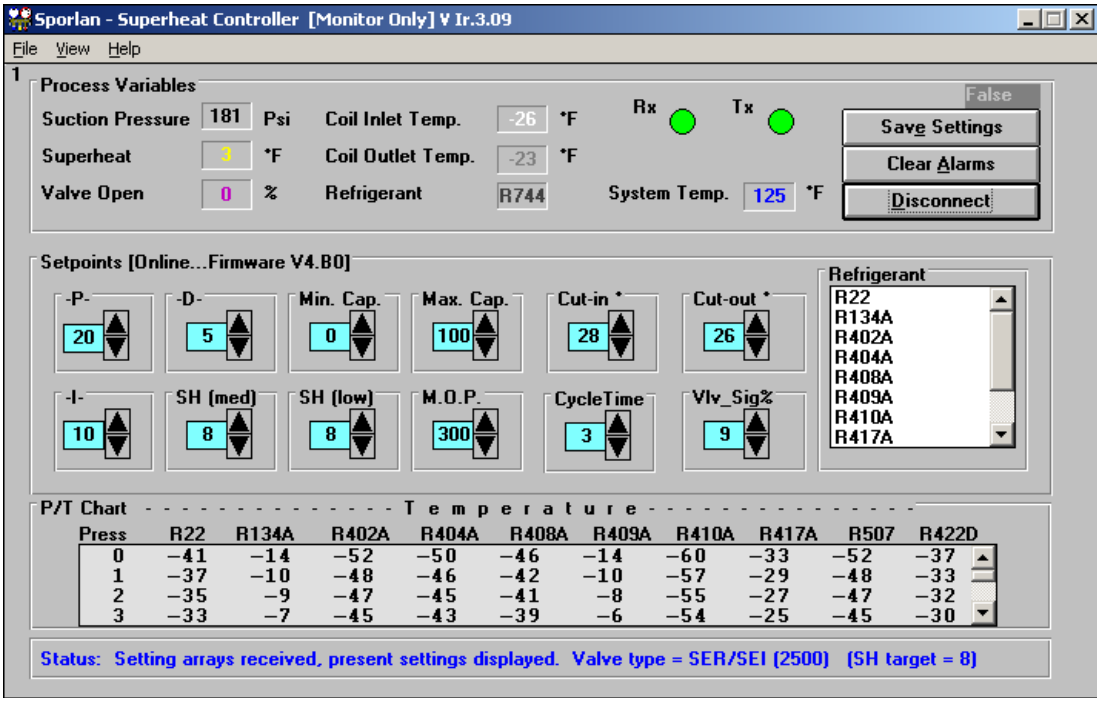



**Figure 1.** Smart Valve Control and Monitor Interface

**Installation and Wiring for CO2 Applications**

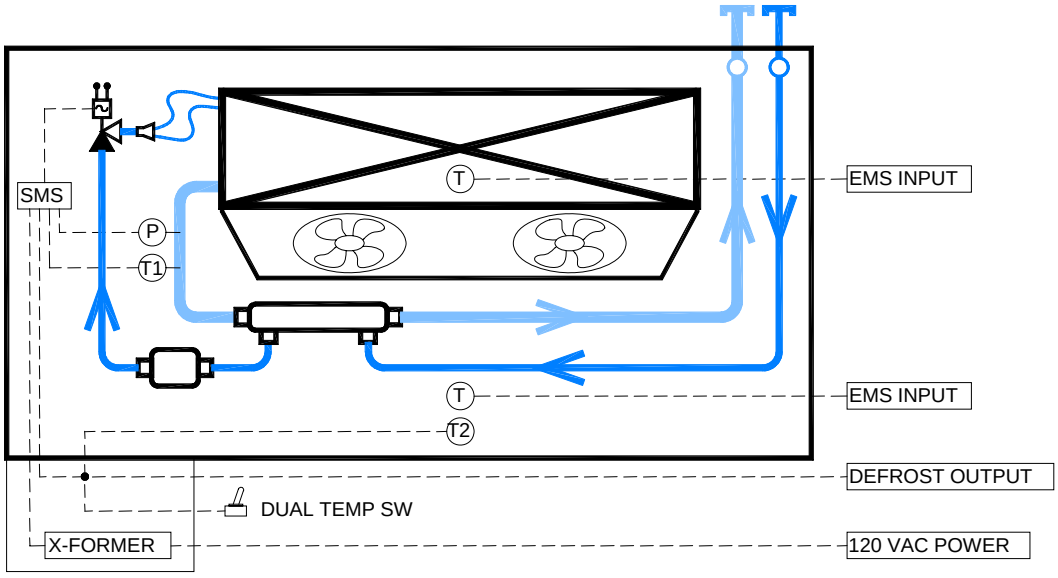



**Figure 2.** Smart Valve Hardware Locations

The first temperature sensor T1 of a Smart Valve is installed at the coil piping outlet and the second one T2 at the discharge air honeycomb (see Figure 2).

When a case operates in low-temperature (LT) mode, the second temperature sensor T2 is wired in series with a refrigeration/defrost relay (dry contact output) from the EMS controller (see Figure 3). When a case goes defrost, the refrigeration relay is open. The “System Temp” shows -40°F and the valve will be fully closed. After defrost is finished, the refrigeration relay is closed. The “System Temp” T2 measures air temperature at discharge honeycomb and the valve is regulating the superheat. The case temperature is controlled at the rack CO2 suction pressure. The cutin / cutout settings of control module remain the default values at -26/-28°F.

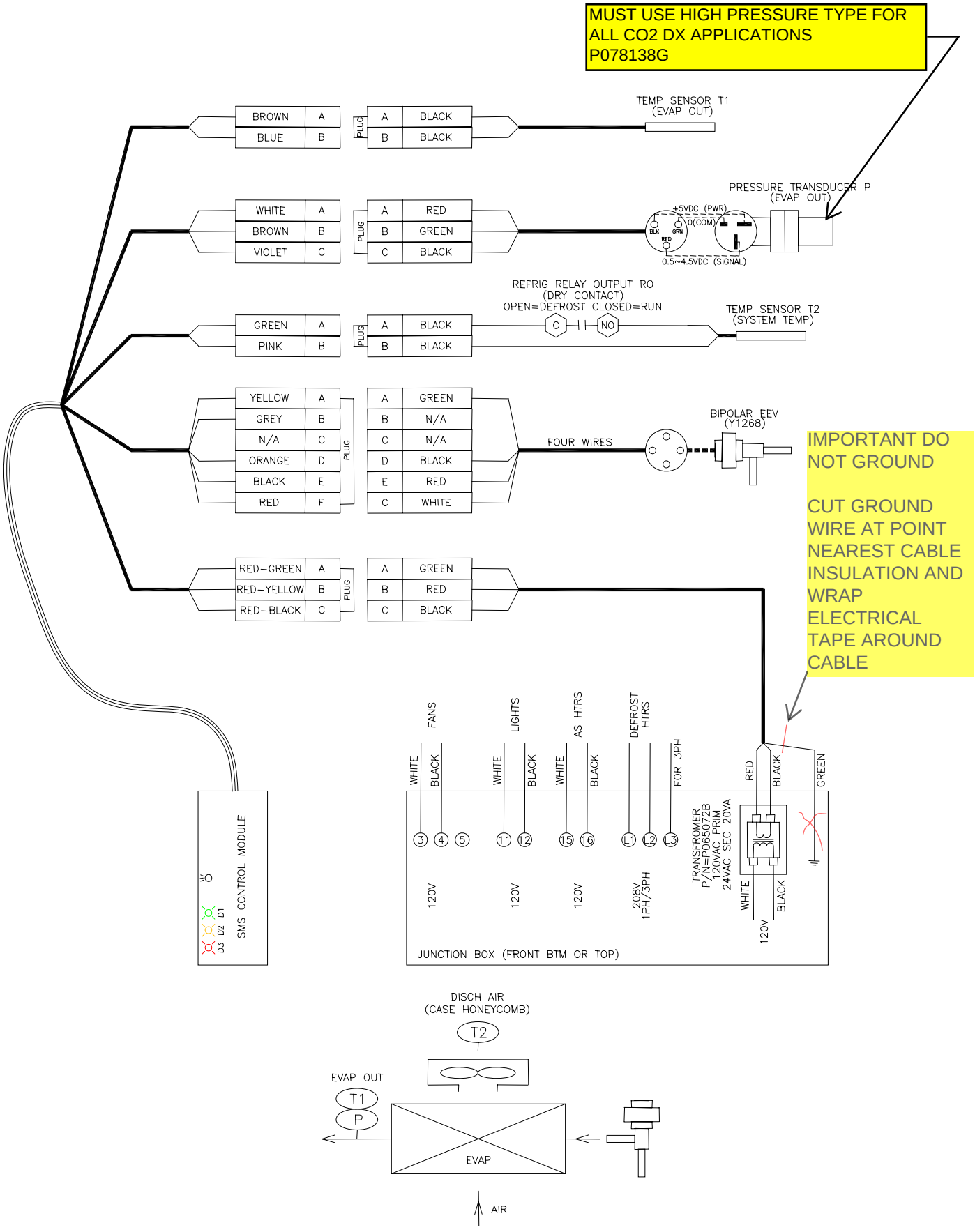



**Figure 3**. Basic Smart Valve Wiring Without Dual-Temp Control

**Dual Temperature LT/MT Control**

When a case is required to operate in dual-temperature LT/MT mode, a dual temp switch or controller relay output RO is wired in parallel to the second temperature sensor T2 (see figure 4). The cutin/cutout should be set to 28/26 in this case. The dual temp switch is typically located in the raceway or electrical box on the top of or underneath the case.

When a case operates at low temperature, the dual temp switch is turned to closed position LT and the "System Temp" T2 displays 125°F. When a case is at medium temperature, the dual temp switch is turned to open position MT. The "System Temp" T2 measures air temperature at discharge honeycomb. When T2 is higher than cutin=28°F, the valve is regulating the superheat and can be at any opening position between 0 and 100%. When T2 is lower than cutout=26°F, The valve is fully closed.

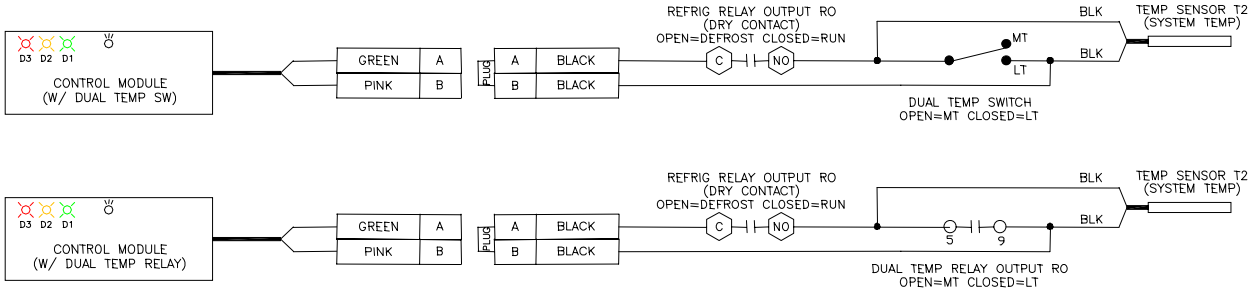



**Figure 4.** System Temp (T2) wiring for Dual-Temperature Control with local dual-temp switch (above) and rack-initiated dual-temp control (below).

**One Case with Multiple Coils (set for the concurrent defrost)**

In a display case with more than one coil as evaporators, each coil is equipped with a set of Smart Valve assembly. Each second temperature sensor T2 is wired to an individual dry contact output of a relay R1 (see figure 5). This relay is typically located in the raceway or electrical box on the top of or underneath the case. All the coils will defrost concurrently, but each coil is able to control different temperatures either in LT mode or in MT mode.

**One Lineup of Cases with Multiple Coils**

In a lineup of display case with more than one coil as evaporators, each coil is equipped with a set of Smart Valves assembly. Each second temperature sensor T2 is wired to an individual dry contact output of a relay R1.If the number of the coils is more than the number of the relay dry contact outputs, the excess second temperature sensors T2 are wired to the second relay R2 (see figure 6). The lineup of

cases will defrost concurrently, but each coil is able to control different temperature during normal operation if it wired in dual temp mode.

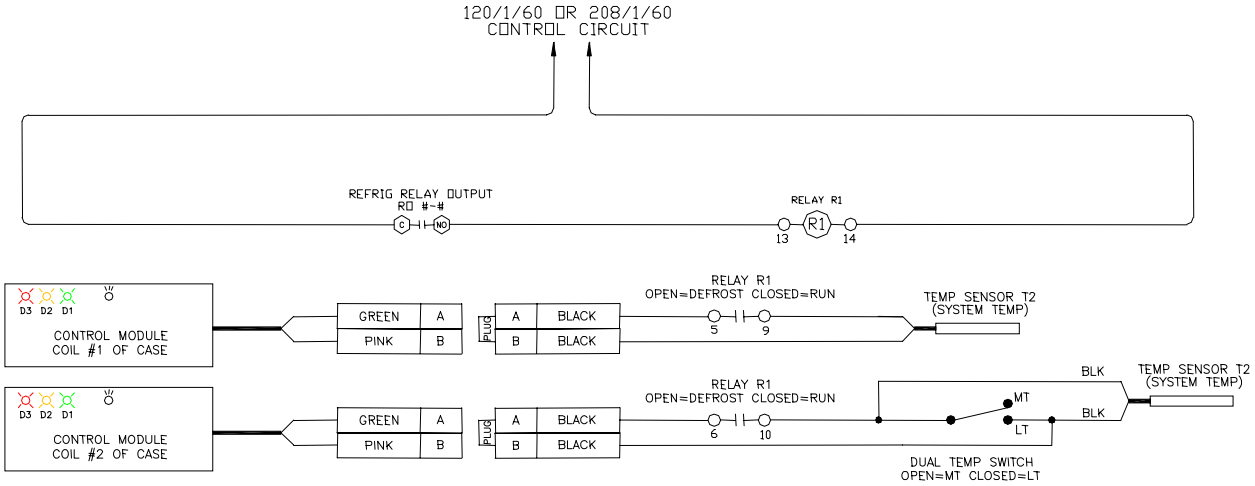
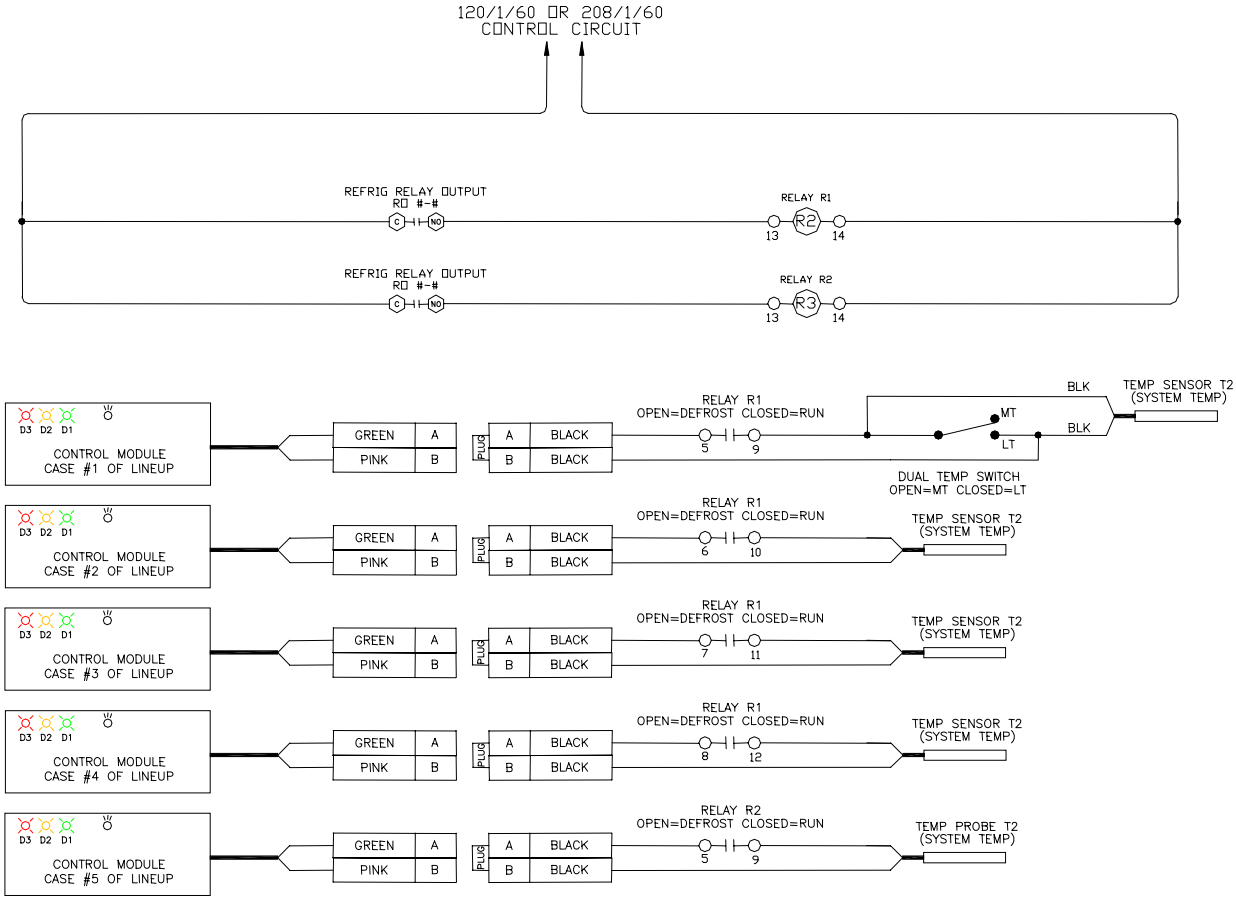



**Figure 5.** One Case with Multiple Coils



# WIRING DIAGRAM FOR T2

PLACE T2 IN DISCHARGE AIR

TEMP SENSOR T2
(SYSTEM TEMP)

LOCATE NEXT TO DISCHARGE AIR PROBE

MUST USE HIGH PRESSURE TYPE FOR ALL CO2 DX APPLICATIONS
P078138G

TEMP SENSOR T1
(EVAP OUT)

| | | | | |
|---|---|---|---|---|
| BROWN | A | PLUG A | BLACK | |
| BLUE | B | PLUG B | BLACK | |

PRESSURE TRANSDUCER P
(EVAP OUT)

| | | | | |
|---|---|---|---|---|
| WHITE | A | PLUG A | RED | +5VDC (PWR) |
| BROWN | B | PLUG B | GREEN | 0 (COM) |
| VIOLET | C | PLUG C | BLACK | 0.5~4.5VDC (SIGNAL) |

CUT PLUG OFF END OF T2

SPLICE TO END OF DRY CONTACT P077881C

DRY CONTACT P077881C

| | | | | |
|---|---|---|---|---|
| GREEN | A | PLUG A | BLACK | |
| PINK | B | PLUG B | BLACK | |

| | | | | |
|---|---|---|---|---|
| YELLOW | A | PLUG A | GREEN | |
| GREY | B | PLUG B | N/A | |
| N/A | C | PLUG C | N/A | |
| ORANGE | D | PLUG D | BLACK | |
| BLACK | E | PLUG E | RED | |
| RED | F | PLUG C | WHITE | |

FOUR WIRES

BIPOLAR EEV
(Y1264)

| | | | | |
|---|---|---|---|---|
| RED-GREEN | A | PLUG A | GREEN | |
| RED-YELLOW | B | PLUG B | RED | |
| RED-BLACK | C | PLUG C | BLACK | |

IMPORTANT
DO NOT GROUND

CUT GROUND WIRE AT POINT NEAREST CABLE INSULATION AND WRAP ELECTRICAL TAPE AROUND CABLE

SMS CONTROL MODULE

B1 B2 B3

JUNCTION BOX (FRONT BTM OR TOP)

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| WHITE | BLACK | | WHITE | BLACK | WHITE | BLACK | | | | | RED | BLACK | GREEN | |
| FANS | | | LIGHTS | | AS HTRS | | DEFROST HTRS | | FOR 3PH | | | | | |
| 3 | 4 | 5 | 11 | 12 | 15 | 16 | L1 | L2 | L3 | | | | | |
| 120V | | | 120V | | 120V | | 208V 1PH/3PH | | | | | | | |

TRANSFORMER P/N=P0650728 120VAC PRIM 24VAC SEC 20VA

WHITE 120V BLACK

MUST LOOP DRY CONTACT THROUGH JUNCTION BOX

APPLY LABEL: "T2"

FIELD CONNECTIONS:

REFRIG RELAY OUTPUT RO
(DRY CONTACT)
OPEN=DEFROST CLOSED=RUN

C — NO — SPLICE INTO ONE SIDE

FRANK BAZE
09/04/09

Hillphoenix

A DOVER COMPANY

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**1925 Ruffin Mill Road, Colonial Heights, VA 23834**



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