



Factory Packaged Controls

SA E-BUS Controller Technical Guide

SA E-BUS Controller Code: Y200921
Requires System Manager Code: Y200921SM Version 1.0 and up
Requires Service Tool Code: Y200921HH Version 1.0 and up

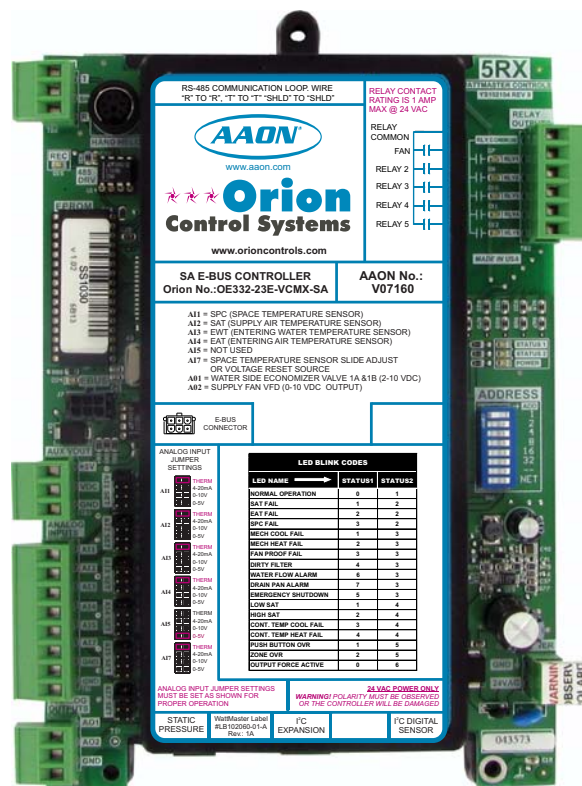


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Part Number Cross Reference

PART DESCRIPTION	ORION PART NO:	AAON TULSA PART NO:
SA E-BUS Controller	OE332-23E-VCMX-SA-A	V07160
SA Expansion Module	OE333-23-SA-A	R96180
12-Relay Expansion Module	OE358-23-12R	R69180
Two Condenser Head Pressure Module	OE370-23-HP2C	R90230
Water Source Heat Pump Protection Module - 410A	OE334-23-WPM-A	R88350
Water Source Heat Pump Protection Module - 410A - 20% Glycol	OE334-23-WPM-A20	R99750
Water Source Heat Pump Protection Module - 410A - 40% Glycol	OE334-23-WPM-A40	R99760
Bypass & Slave Interface Card	PL101824	N/A
Bypass Damper Actuator	OE281-04	N/A
CommLink 5 Communications Interface	OE361-13	V32950
Digital Room Sensor - Temp & Humidity	OE217-01	R83870
Digital Room Sensor - Temp. Only	OE217-00	R83860
Duct Static Pressure Sensor	OE271	P87100
Duct Temperature Sensor - 12" Probe	OE231	R44940 / P87140
Duct Temperature Sensor - 6" Probe	OE230	R36340
IP Module Kit	OE415-02	R66770
MiniLink Polling Device	OE364-22	N/A
Modular Service Tool SD - Operator Interface	OE391-12	V28140
Modular System Manager SD - Operator Interface	OE392-12	V36570
Entering Air RH Sensor - 3% - 0-5 VDC Output	OE265-14	R34700
Entering Air Temperature Sensor	OE250	R34650
Room Mounted RH Sensor - 3% - 0-5 VDC Output	OE265-11	R34690
Standard Room Sensor - Plain	OE210	R31480
Standard Room Sensor - w/ Override	OE211	P87040
Standard Room Sensor - w/ Override & Slide Adjust	OE213	P94320
Standard Room Sensor - w/ Slide Adjust	OE212	P94100
Static Pressure Pickup Tube	OE290	S18780
Suction Pressure Transducer	OE275-01	R28390
USB-Link 2 Kit	OE366	R71870

Features

The Series A Controller (OE332-23E-VCMX-SA)—SA E-BUS Controller—is designed with 6 analog inputs, 2 analog outputs, and 5 relay outputs. Most common HVAC unit control applications can be configured using only the SA E-BUS Controller; however, if needed, the SA E-BUS Controller's input and output capabilities can be expanded with the SA Expansion Module (OE333-23-SA) or 12-Relay Expansion Module (OE358-23-12R) by means of a modular cable. The SA Expansion Module provides an additional 4 analog inputs, 5 analog outputs, 8 binary inputs, and 4 configurable relays. The 12-Relay Expansion Module provides an additional 12 configurable relays.

The SA E-BUS Controller can also use the Two Condenser Head Pressure Module (OE370-23-HP2C) for those applications requiring Head Pressure Control. The SA E-BUS Controller can also use the WSHP Module (OE334-23-WPM-A) for Water Source Heat Pump applications.

Each SA E-BUS Controller can be configured for control of VAV Units (with or without VAV/Zone Controllers), Constant Volume Units, and Make-Up Air Units. Features include the following:

- Modulating Cooling Output (Copeland Digital Scroll™ Compressor or Chilled Water Valve Control)
- Modulating Heating Output (Hot Water Valve, Steam Valve, SCR Electric Heat Control)
- Full Integration with the AAON® MHGRV Modulating Hot Gas Reheat Valve Controller
- Configurable for Air to Air and Water Source Heat Pump Applications
- Advanced Dehumidification Capabilities
- Adaptive Supply Air Reset
- Selectable Control Sensor
- Fan Proving Interlock
- Dirty Filter Alarm
- Emergency Shutdown Input (Smoke Detector/Firestat or other Shutdown Conditions)
- Water Side Economizer Option
- Remote Occupied Capabilities
- 7-Day, 2-Event-per-Day Scheduling
- 14 Holiday Event Scheduling
- Optimal Start Scheduling
- Trend Logging Capability
- Static Pressure Control for Filter Loading Applications
- Head Pressure Control (with optional Two Condenser Head Pressure Module)
- Additional Water Safeties (with optional Water Source Heat Pump Module)

Applications

Variable Air Volume Unit

The SA E-BUS Controller can be configured to control a VFD Supply Fan for Duct Static Pressure control. If the unit is not equipped with a VFD, but Duct Static Pressure control is needed, a modulating Zoning Bypass Damper can be controlled by the SA E-BUS Controller.

VAV units are typically designed for occupied Cooling with Morning Warm-up Heating. This option is available with the SA E-BUS Controller. The SA E-BUS Controller can also be used for a Zoning System that needs Duct Static Pressure control and Occupied Cooling and Heating. The SA E-BUS Controller also has the ability to be configured for Duct Static Pressure Control by controlling the Supply Fan VFD for the purpose of maintaining proper Duct Static Pressure in response to varying filter loading conditions.

The SA E-BUS Controller allows Dehumidification Priority on a VAV unit. This could be useful on a building with a very low internal sensible load, but which has a high internal and/or external latent load. During VAV Dehumidification, the SA E-BUS Controller activates Cooling based on the Evaporator Coil Temperature and activates AAON® Modulating Hot Gas Reheat to warm the Supply Air Temperature to the Active Supply Air Temperature Setpoint.

Constant Air Volume Unit

The SA E-BUS Controller can be configured to activate a Constant Volume Supply Fan. In most cases, this is a very basic unit with Space Temperature control.

Make-Up Air Unit

The SA E-BUS Controller can be configured for 100% Outdoor Air control for Make-Up Air. All HVAC Modes are determined from the Outdoor Air Sensors. The Outdoor Air Volume must always be at least 50% or higher to be configured for Outdoor Air control.

Single or Dual Cabinet Unit

The SA E-BUS Controller can control an SA Series Single Cabinet Unit or an SA Series Dual Cabinet Unit. Wiring for Dual Cabinet Units is shown and noted on applicable Single Cabinet Unit diagrams.

SA E-BUS Controller Dimensions





12-Relay Expansion Module Dimensions

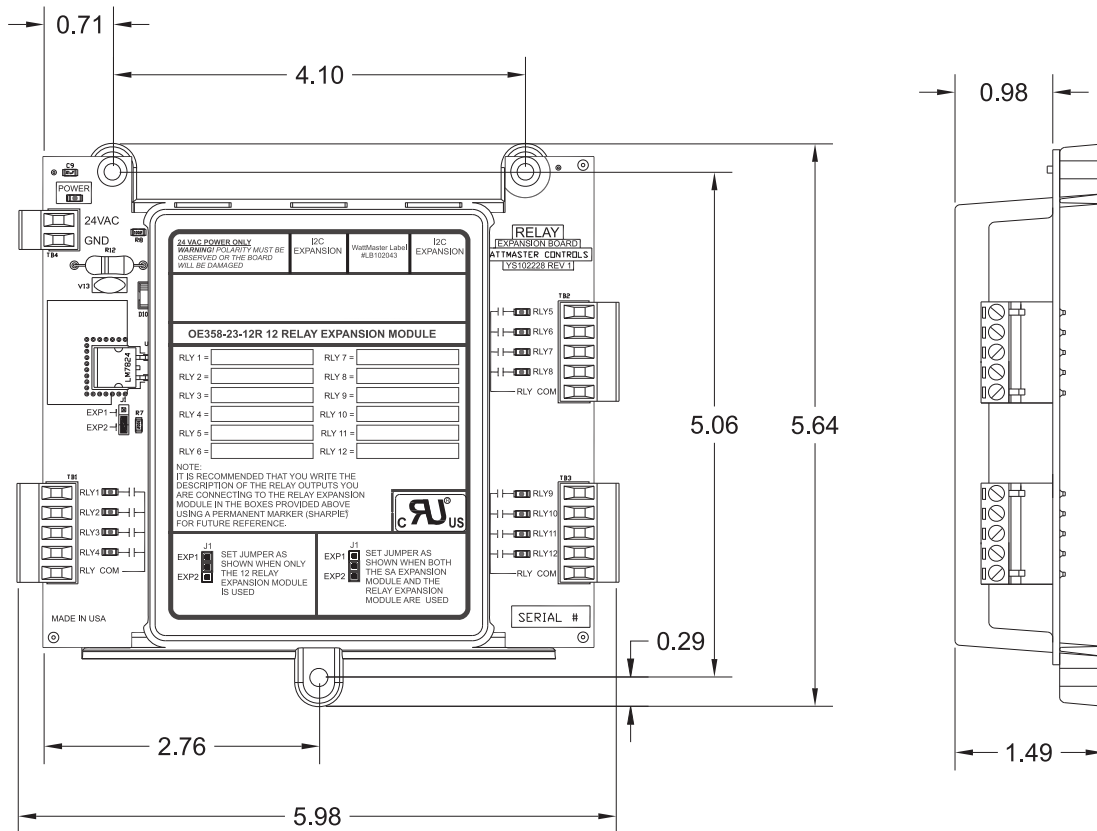


Figure 3: OE358-23-12R – 12-Relay Expansion Module Dimensions

SA E-BUS Controller Component Locations

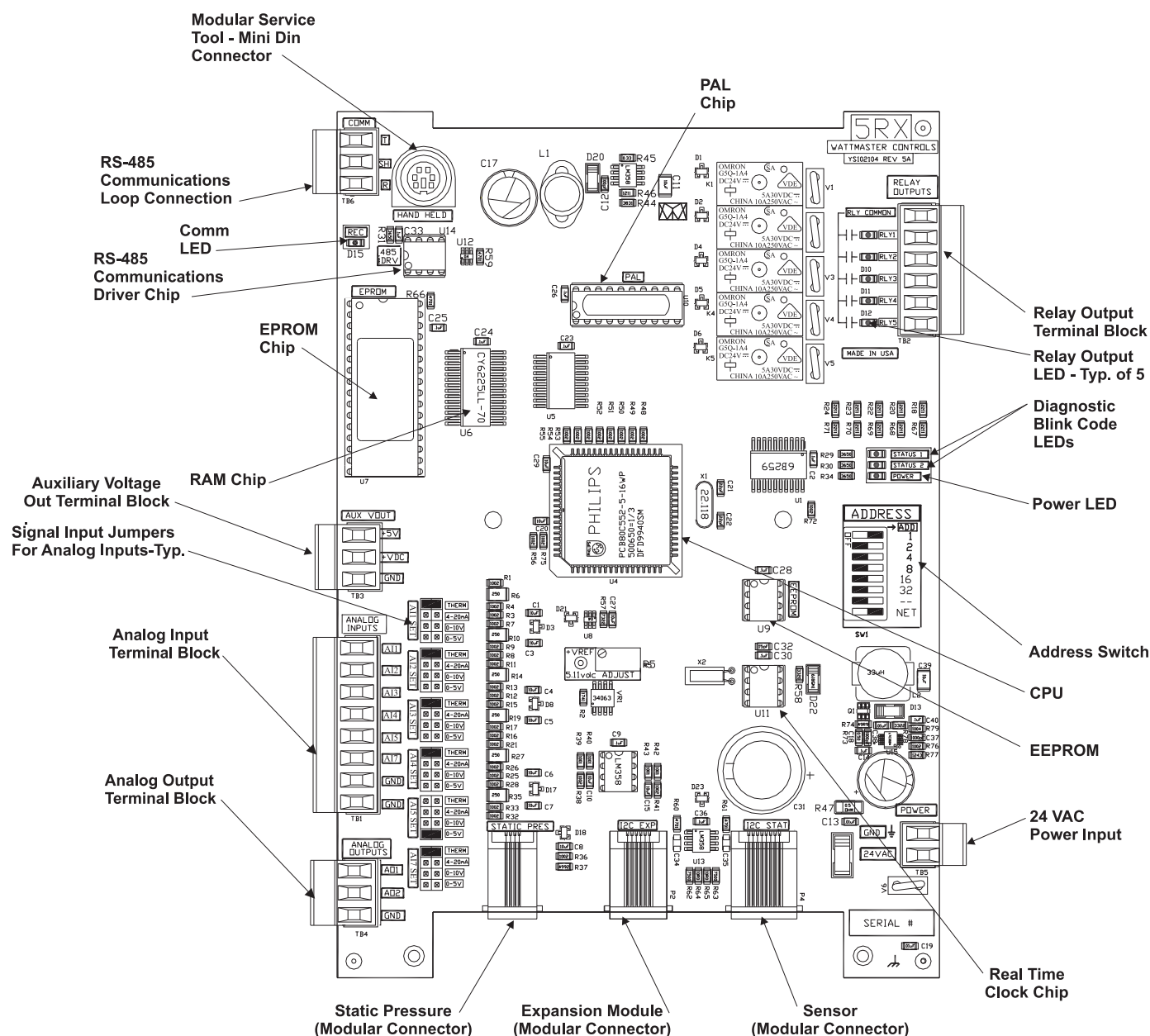


Figure 4: OE332-23E-SA – SA E-BUS Controller Component Locations

General

Correct wiring of the SA E-BUS Controller is the most important factor in the overall success of the controller installation process. In general, most SA E-BUS Controllers are factory installed and wired at the AAON® factory.

Controller Mounting

When the controller is to be field mounted, it is important to mount the controller in a location that is free from extreme high or low temperatures, moisture, dust, and dirt. See **Table 1** for a list of the required operating conditions for the SA E-BUS Controller and associated modules.

The SA E-BUS Controller is housed in a plastic enclosure. It is designed to be mounted by using the 3 mounting holes in the enclosure base. The SA E-BUS Controller needs to be installed in an environment which can maintain a temperature range between -30°F and 150°F not to exceed 90% RH levels (non-condensing). It is important to mount the controller in a location that is free from extreme high or low temperatures, moisture, dust, and dirt. Be careful not to damage the electronic components when mounting the controller.

Considerations

The SA E-BUS Controller and associated modules must be connected to a 24 VAC power source of the proper size for the calculated VA load requirements. All transformer sizing should be based on the VA rating listed in **Table 1**.

Control Device	Voltage	VA Load	Temperature	Humidity (Non-Condensing)
OE332-23E-SA E-BUS Controller SA E-BUS Controller	24VAC	8	-30°F to 150°F	90% RH
OE333-23-SA SA Expansion Module	24VAC	10	-30°F to 150°F	90% RH
OE358-23-12R 12-Relay Expansion Module	24VAC	15	-30°F to 150°F	90% RH
OE370-23-HP2C Two Condenser Head Pressure Module	24VAC	5	-30°F to 150°F	90% RH
OE334-23-WPM-A Water Source Heat Pump Module	24VAC	8	-30°F to 150°F	90% RH

Table 1: Voltage and Environment Requirements

Warning: When using a single transformer to power more than one controller or expansion module, the correct polarity must always be maintained between the boards. Failure to observe correct polarity will result in damage to the SA E-BUS Controller and associated modules.

Please carefully read and apply the following information when wiring the SA E-BUS Controller or its associated modules. See **Figure 5** on page 11 for the SA E-BUS Controller wiring diagram. See **Figures 16** and **17** on pages 20 and 21 for SA Expansion Module wiring. And see **Figure 25** on page 31 for 12-Relay Expansion Module wiring.

1. All wiring is to be in accordance with local and national electrical codes and specifications.
2. Minimum wire size for 24 VAC wiring should be 18-gauge.
3. Minimum wire size for all sensors should be 24-gauge. Some sensors require 2-conductor wire and some require 3-or 4-conductor wire.
4. Be sure that all wiring connections are properly inserted and tightened into the terminal blocks. Do not allow wire strands to stick out and touch adjoining terminals which could potentially cause a short circuit.
5. When communication wiring is to be used to interconnect SA E-BUS Controllers together or to connect to other communication devices, all wiring must be plenum-rated, minimum 18-gauge, 2-conductor, twisted pair with shield. WattMaster can supply communication wire that meets this specification and is color coded for the network or local loop. Please consult your WattMaster distributor for information. If desired, Belden #82760 or equivalent wire may also be used.
6. Before applying power to the SA E-BUS Controller, be sure to recheck all wiring connections and terminations **thoroughly**.

SA E-BUS Controller

The Series A Controller (OE332-23E-SA)—SA E-BUS Controller—is designed with 6 analog inputs, 2 analog outputs, and 5 relay outputs. Most common HVAC unit control applications can be configured using only the SA E-BUS Controller; however, if needed, the SA E-BUS Controller's input and output capabilities can be expanded with the SA Expansion Module (OE333-23-SA) or 12-Relay Expansion Module (OE358-23-12R) by means of a modular cable.

NOTE: Only one SA E-BUS Controller is required whether the SA Unit is a Single Cabinet or Dual Cabinet Unit. Additional wiring for Dual Cabinet Units is shown and noted as such on the applicable Single Cabinet Unit Diagrams.

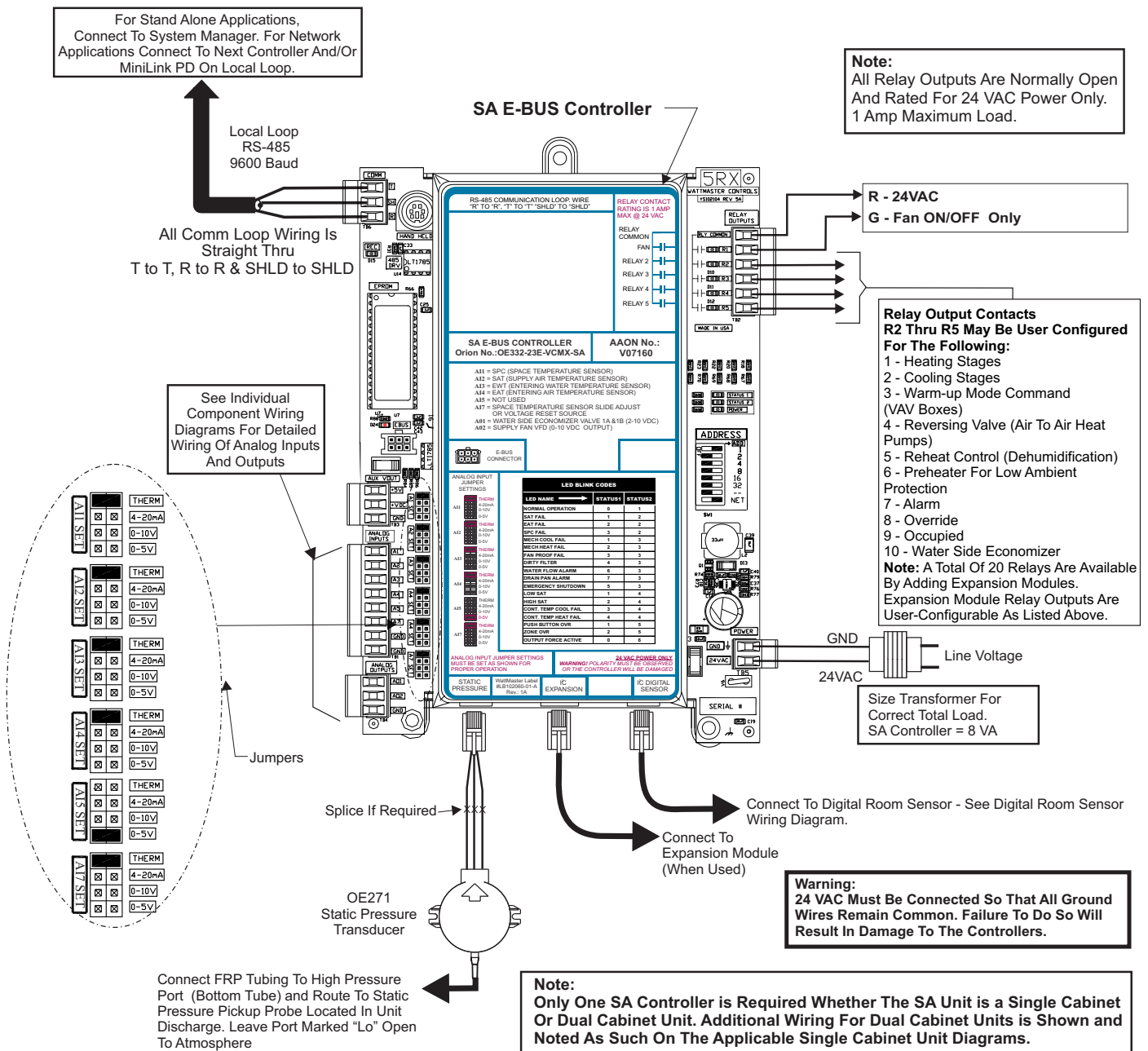


Figure 5: OE332-23E-SA E-BUS Controller – SA E-BUS Controller Wiring

Digital Room Sensor

The OE217-00 Digital Room Sensor is used to sense Space Temperature and the OE217-01 Digital Room Sensor is used to sense Space Temperature and Space Humidity. The Sensor connects to the SA E-BUS Controller with the TSDRSC modular cable. It should be mounted at approximately 5 ft. above the floor on the wall in an area that does not have drafts or is exposed to direct sunlight. See **Figure 6** for wiring details.

Note: The Digital Room Sensor Connects Directly To The SA E-BUS Controller Using A TSDRSC Cable Of The Appropriate Length. The Maximum Length Allowed Is 160 Feet.

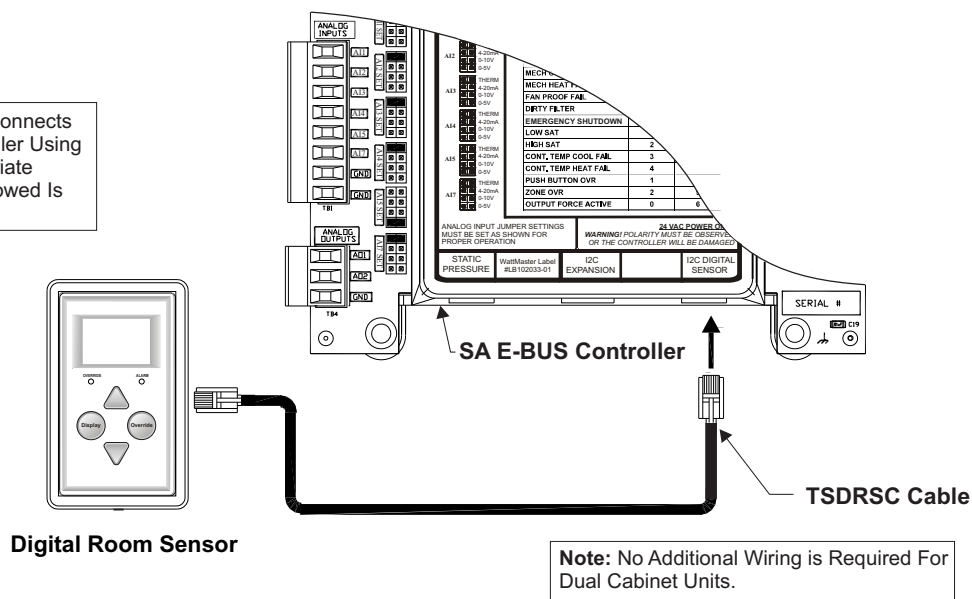


Figure 6: OE217-00 & OE217-01 – Digital Room Sensor Wiring

SAT & Remote SAT Reset Signal Wiring

Space Temperature Sensor

The OE210, OE211, OE212, OE213 Space Temperature Sensor is typically used for constant volume HVAC unit applications controlling one zone. The Space Temperature Sensor is a 10K Type III thermistor sensor and should be mounted approximately 5 feet above the floor in the space that is to be controlled. The Space Temperature Sensor is available as a sensor only, sensor with override button, sensor with slide adjust, and sensor with slide adjust and override configurations.

When the Remote Supply Air Temperature Reset Signal option is needed, the Slide Offset option on the Room Sensor cannot be used. Only one of these options may be used on the SA E-BUS Controller.

See **Figure 7** below for complete Space Temperature Sensor wiring details.

Remote SAT Reset Signal

A Remote Supply Air Temperature Reset Signal can be connected to AI7 for applications requiring remote reset of the Supply Air Temperature Setpoint.

When the Slide Offset option on the Room Sensor is used, the Remote Supply Air Temperature Reset Signal cannot be used. Only one of these options may be used on the SA E-BUS Controller.

The SA E-BUS Controller can accept either a 0-5 VDC signal or a 0-10 VDC signal on this input.

See **Figure 8** below for complete Remote SAT Reset Signal wiring details.

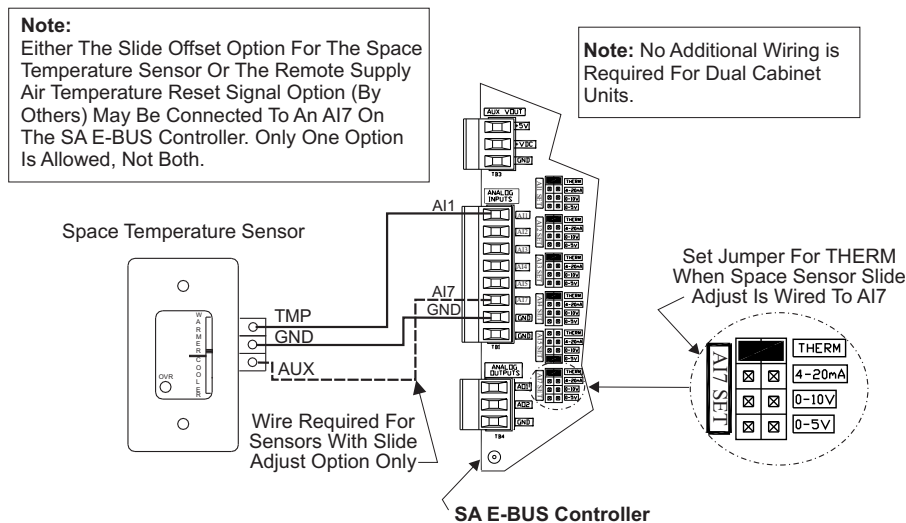


Figure 7: OE210, OE211, OE212, OE213 – Space Temperature Sensor Wiring

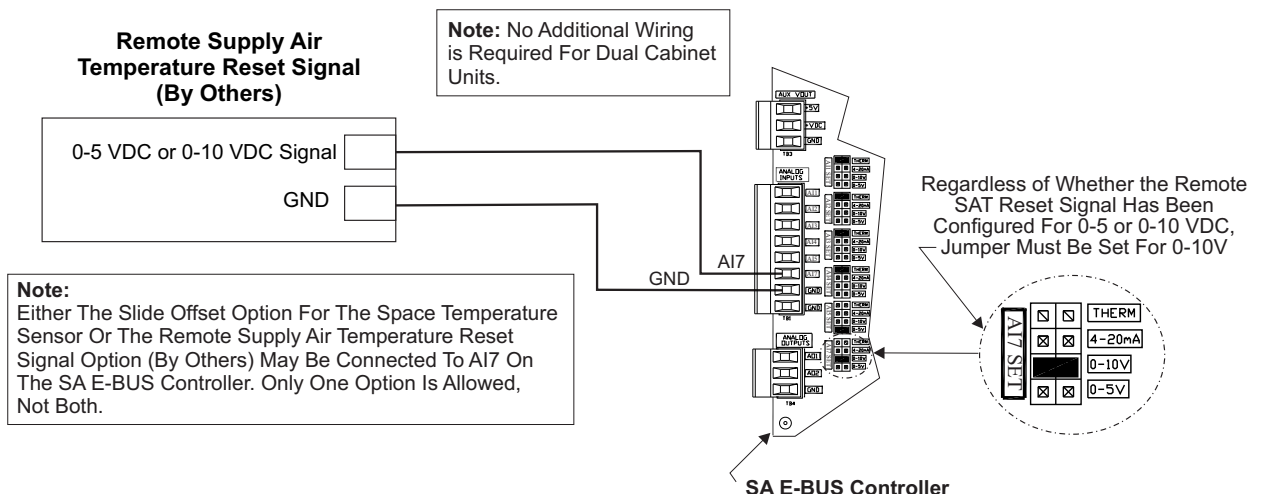


Figure 8: Remote Supply Air Temperature Reset Signal Wiring

SAT Sensor Wiring

Supply Air Temperature Sensor

The OE231 Supply Air Temperature Sensor must be wired as shown in **Figure 9** below for proper operation. The Supply Air Temperature Sensor is a 10K Type III thermistor sensor. The Supply Air Temperature Sensor should be mounted in the unit discharge plenum or in the supply air duct.

NOTE: For Dual Cabinet Units, mount the Supply Air Temperature Sensor in a Supply Air Ducting area that is common to both SA Units.

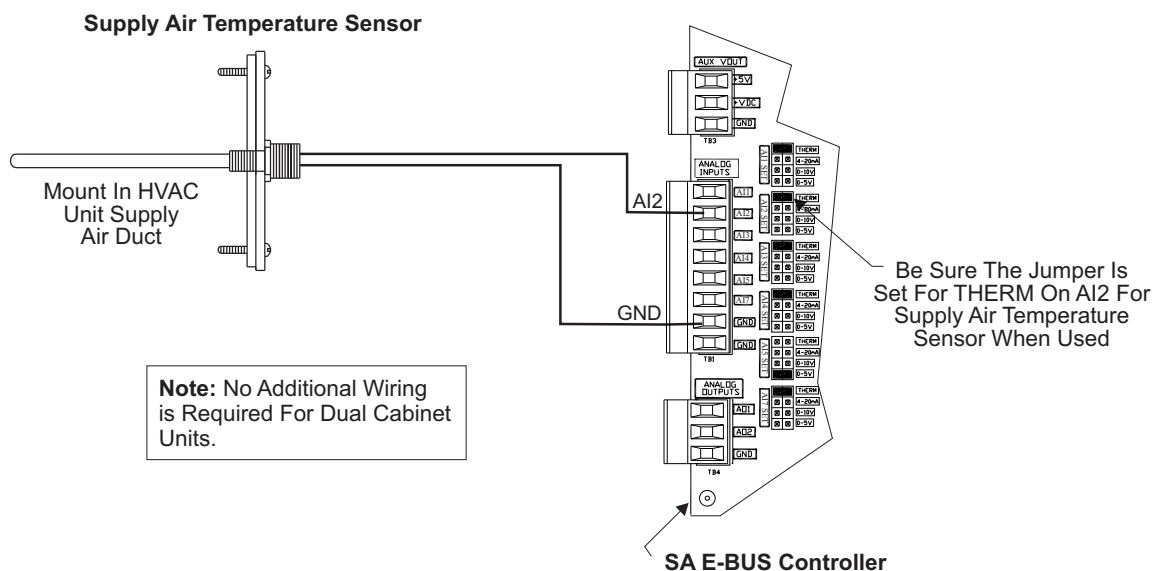


Figure 9: OE231 – Supply Air Temperature Sensor Wiring

Entering Water Temperature Sensor Wiring

Entering Water Temperature Sensor

The OE233 Entering Water Temperature Sensor must be wired as shown in **Figure 10** below for proper operation. The Entering Water Temperature Sensor is a 10K Type III thermistor sensor. The Entering Water Temperature Sensor should be mounted in the entering water piping.

NOTE: For Dual Cabinet Units, mount the Entering Water Temperature Sensor in an Entering Water Piping area that is common to both SA Units.

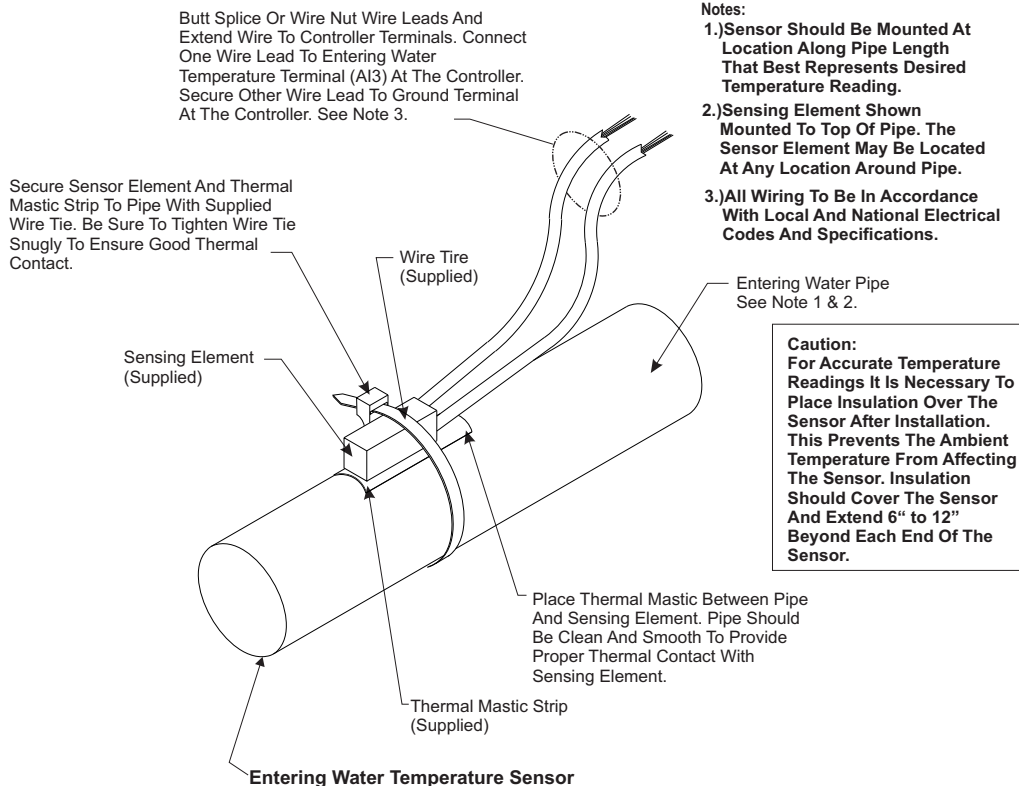
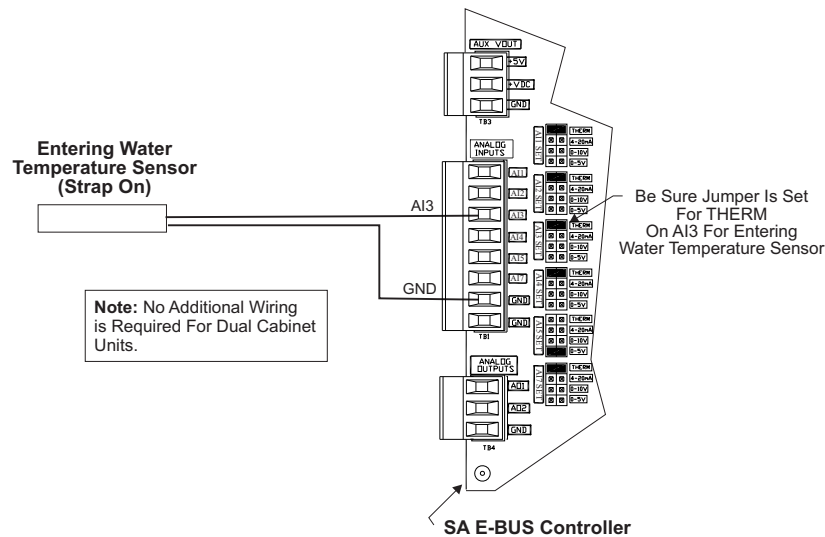


Figure 10: OE233 – Entering Water Temperature Sensor Installation & Wiring

Entering Air Temperature Sensor Wiring

Entering Air Temperature Sensor

The OE231 Entering Air Temperature Sensor must be wired as shown in **Figure 11** below for proper operation of the SA E-BUS Controller. The Entering Air Temperature Sensor is a 10K Type III thermistor sensor. The sensor should be mounted as shown in an area that is protected from the elements and direct sunlight.

NOTE: For Dual Cabinet Units, mount the Entering Air Temperature Sensor in an Entering Air Duct area that is common to both SA Units.

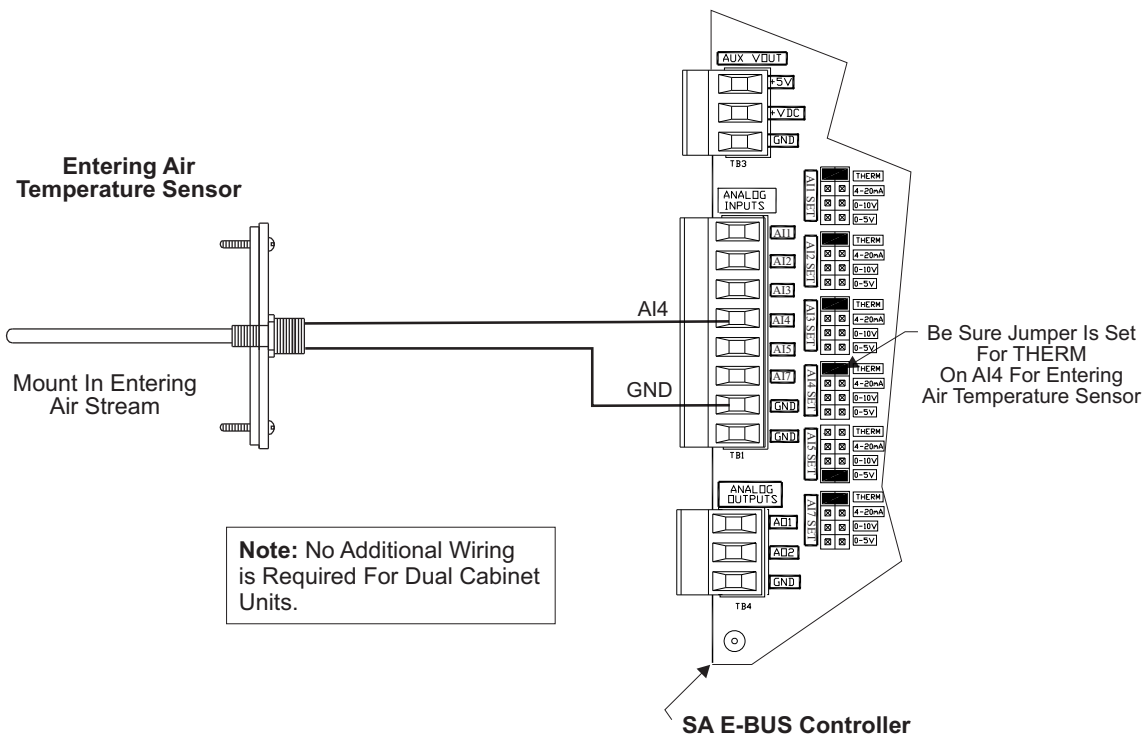


Figure 11: OE231 – Entering Air Temperature Sensor Wiring

Water Side Economizer (WSE) Valve(s)

The Water Side Economizer Valve(s) must be wired as shown in **Figure 12** below for proper operation of the SA E-BUS Controller. The Water Side Economizer Valve(s) connects to AO1 on the SA E-BUS Controller.

NOTE: For Dual Cabinet Units, wire the Second Cabinet's WSE Valve Actuator in parallel with the First Cabinet's WSE Valve Actuator.

Water Side Economizer (WSE) Bypass Valve

The Water Side Economizer Bypass Valve(s) must be wired as shown in **Figure 13** below for proper operation of the SA E-BUS Controller. The Water Side Economizer Bypass Valve(s) are wired to AO4 and AO5 on the SA Expansion Module.

NOTE: For Dual Cabinet Units, wire the Second Cabinet's WSE Bypass Valve Actuator to AO5 on the SA Expansion Module.

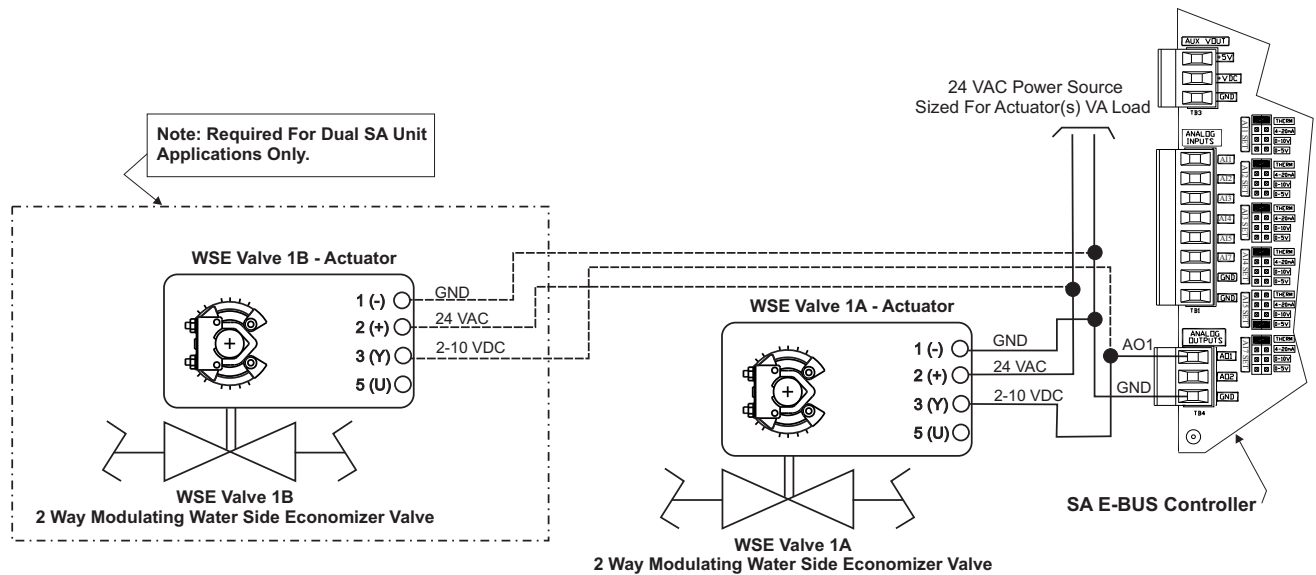


Figure 12: Water Side Economizer Valve Wiring

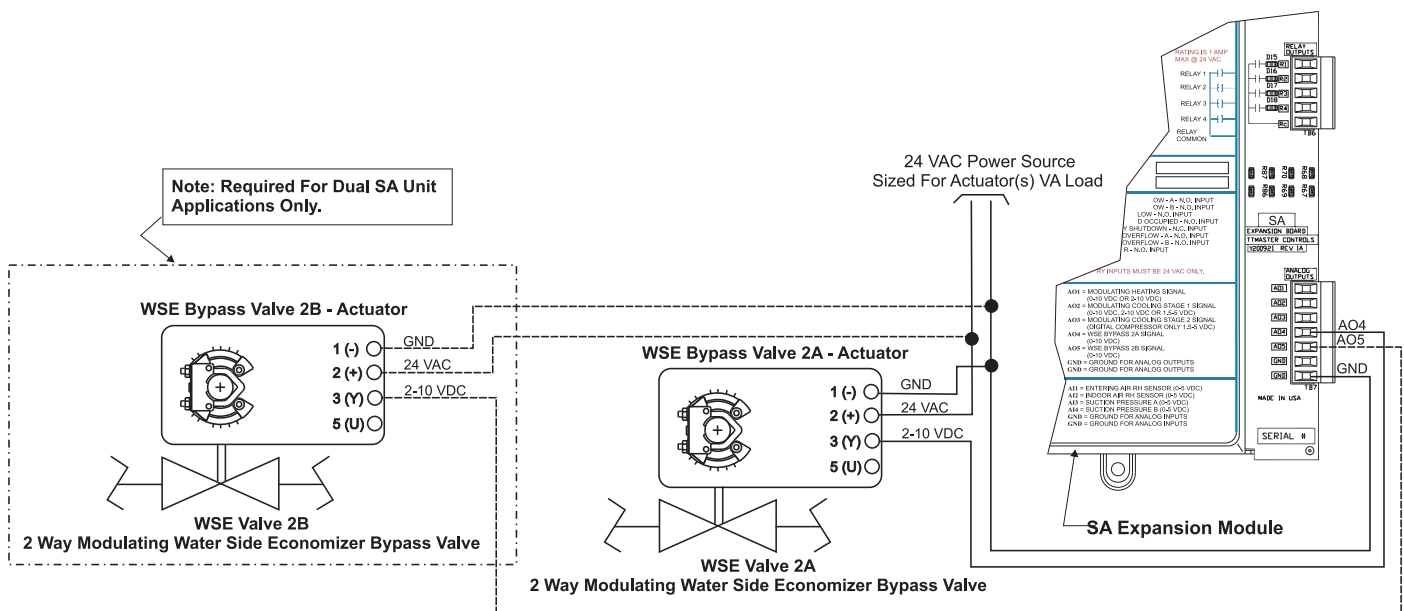


Figure 13: Water Side Economizer Bypass Valve Wiring

Supply Fan VFD Signal

Supply Fan VFD Signal or Zoning Bypass Damper Actuator Signal

The Supply Fan VFD or Zoning Bypass Damper Actuator Signal is a 0-10 VDC output from AO2 on the SA E-BUS Controller. This signal output can be connected to the Supply Fan Variable Frequency Drive to modulate the Supply Fan speed and control Duct Static Pressure utilizing the Duct Static Pressure Sensor connected to the SA E-BUS Controller. Alternatively, it can be connected to a Zoning Bypass Damper Actuator that will modulate the Zoning Bypass Damper Actuator to control Duct Static Pressure utilizing the Duct Static Pressure Sensor connected to the SA E-BUS Controller. A Duct Static Pressure Sensor must be connected in order for the VFD or Zoning Bypass Damper Actuator to operate. See **Figures 14** and **15** for detailed wiring.

Caution: Variable Frequency Drive units can cause large transient noise spikes which can cause interference to be propagated on other electronic equipment. Use shielded wire wherever possible and route all sensor and controller wiring away from the Variable Frequency Drive and the HVAC Unit electrical wiring.

NOTE: For Dual Cabinet Units, VFD #2 must be wired in parallel to VFD #1 as shown in **Figure 14** below.

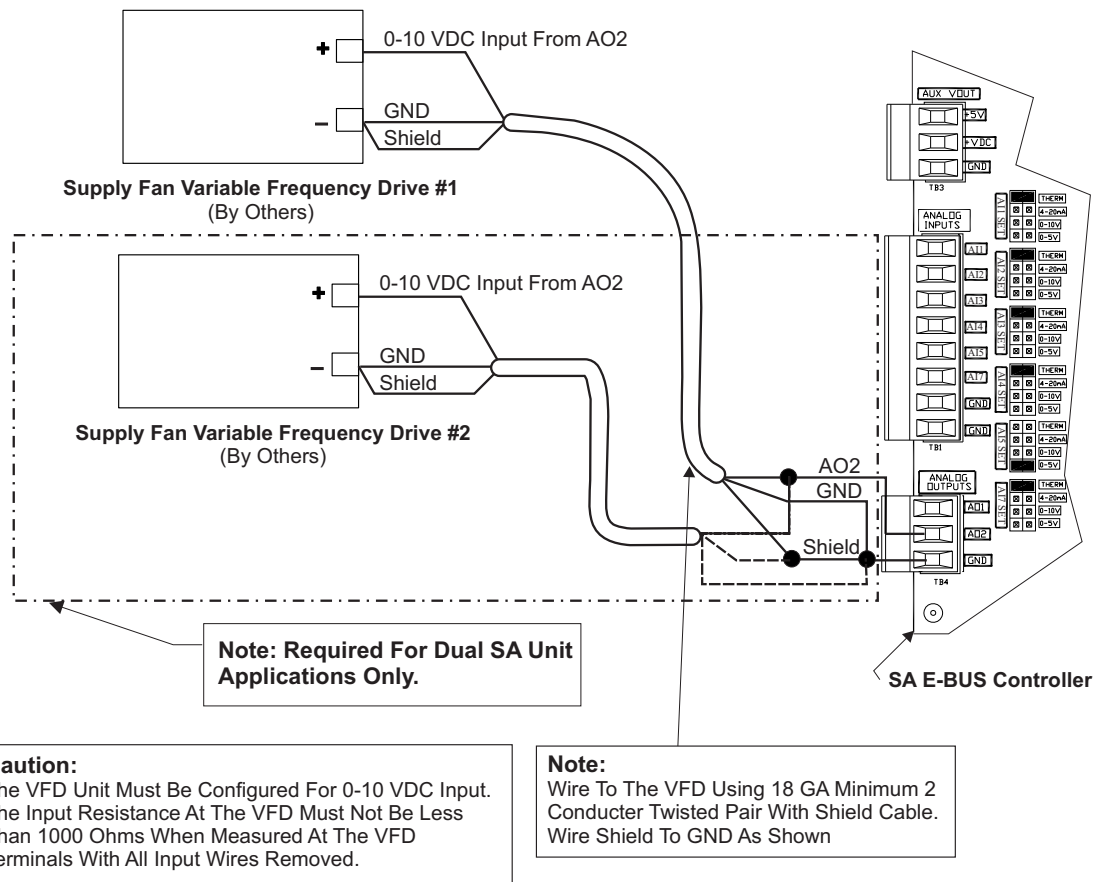


Figure 14: Supply Fan VFD Wiring

Supply Fan VFD Signal or Zoning Bypass Damper Actuator Signal

When the Bypass Damper is used (Zoning applications), be sure the Bypass Duct and Damper are designed so that Supply Air will bypass to the Entering Air Duct, ensuring equal airflow to both cabinets.

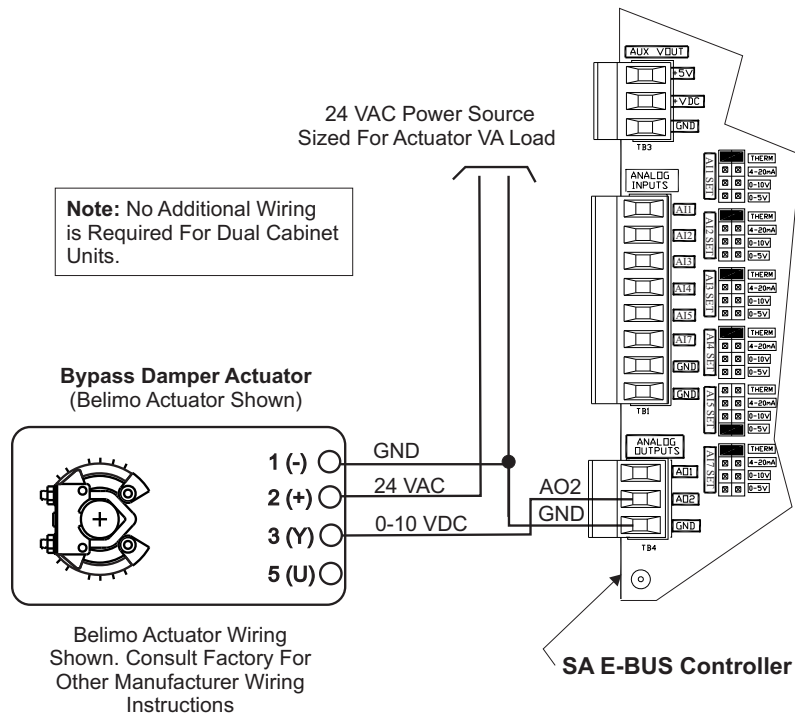


Figure 15: Zoning Bypass Damper Actuator Wiring

SA Expansion Module Input Wiring

SA Expansion Module

Two different Expansion Modules are available for use with the SA E-BUS Controller to provide additional inputs and outputs beyond those found on the SA E-BUS Controller.

The SA Expansion Module (OE333-23-SA E-BUS Controller) provides 8 Binary Inputs, 4 Analog Inputs, 5 Analog Outputs, and 4 Configurable Relay Outputs. See **Figures 16** and **17** for complete wiring details.

The 12-Relay Expansion Module (OE358-23-12R) provides for 12 Dry Contact Configurable Relay Outputs. See **Figure 25** for complete wiring details.

The expansion modules can be used individually or together to provide the required inputs and outputs for your specific applications.

The SA Expansion Module must be connected to 24 VAC as shown in the wiring diagram below. Please see **Table 1** on page 10 for correct VA requirements to use when sizing the transformer(s) used for powering the expansion module. Also please note that when wiring the SA Expansion Module, its contacts must be wired as wet contacts (connected to 24 VAC).

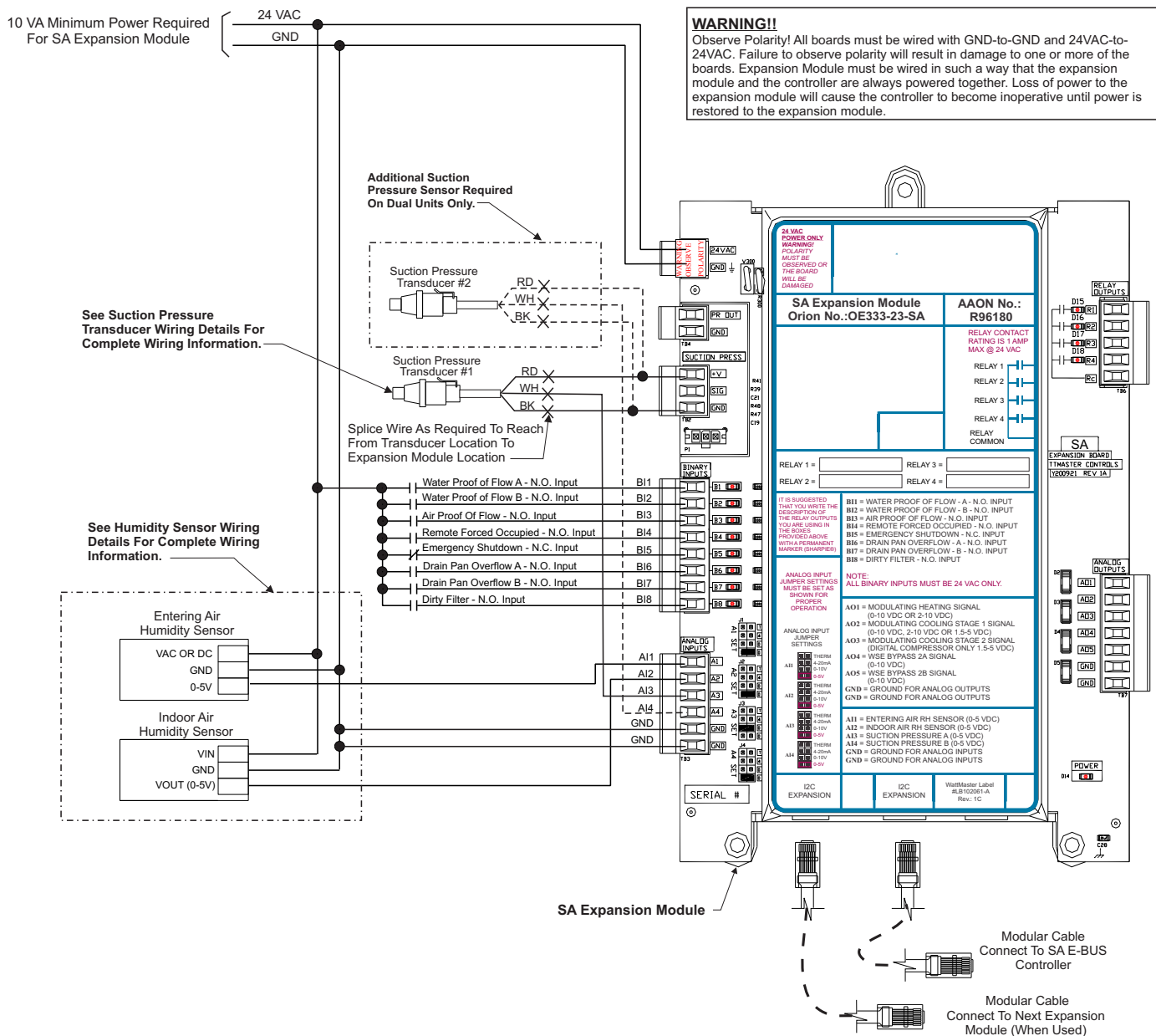


Figure 16: OE333-23-SA – SA Expansion Module Input Wiring

Installation & Wiring

SA Expansion Module Output Wiring

NOTE: The Modulating Cooling device used must be capable of accepting either a 0-10 VDC, 2-10 VDC or 1.5-5.0 VDC input. The Modulating Cooling output voltage is user-configurable for these voltages. The Modulating Heating devices used must be capable of accepting either a 0-10 VDC or 2-10 VDC input. The Modulating Heating output voltage is user-configurable for these voltages. These voltage outputs must also be configured when you are setting up the SA Controller(s) operating parameters.

NOTE: Each Modulating Heating or Cooling device used on the SA Controller must have a relay configured for it in order to properly sequence the devices. Compressors must always be wired in the following order: A1, A2, B1, B2. See the Sequence of Operations for the description of the staging.

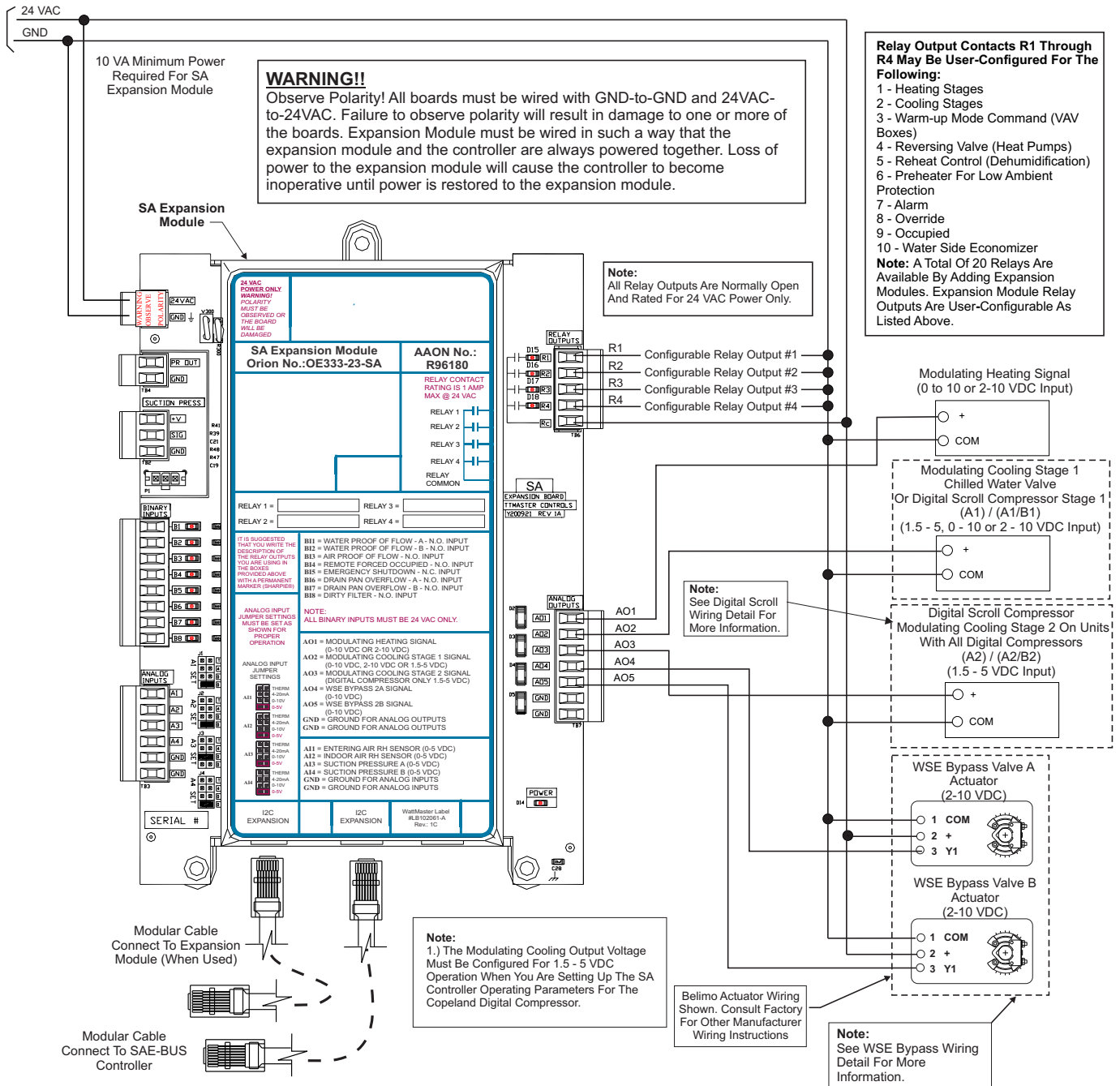


Figure 17: OE333-23-SA – SA Expansion Module Output Wiring

Installation & Wiring

Suction Pressure Transducer Wiring

Suction Pressure Transducer

The OE275-01 Suction Pressure Transducer always wires directly to the Digital Scroll Compressor Controller. See **Figure 18** below for wiring details.

The Suction Pressure Transducer is used to measure suction pressure at the HVAC unit's DX evaporator coil suction line. This suction line pressure is converted to saturated refrigerant temperature by the SA E-BUS Controller. This temperature is used by the SA E-BUS Controller to accurately control the compressors and reheat cycle components to provide optimum performance from the system during Dehumidification operation.

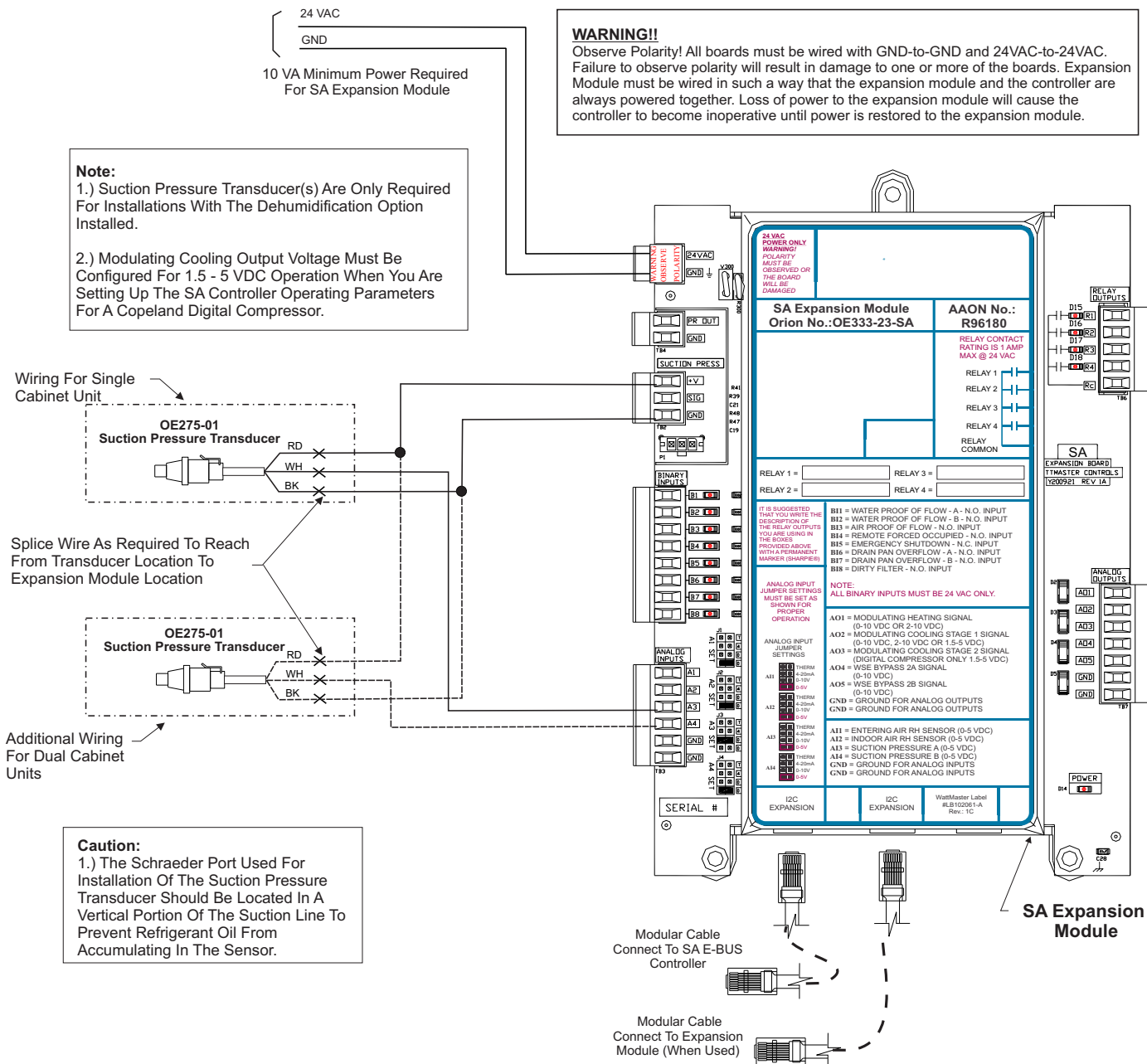


Figure 18: OE275-01 – Suction Pressure Transducer Wiring

SA Expansion Module Binary Inputs

The SA Expansion Module provides 8 Binary Inputs. See **Figure 19** below for detailed wiring.

The transformer used for powering the SA Expansion Module must also be used to power the binary inputs.

Warning: Do not apply any voltage greater than 24 VAC to the binary inputs. Higher voltages will damage the expansion module and possibly other components on the system.

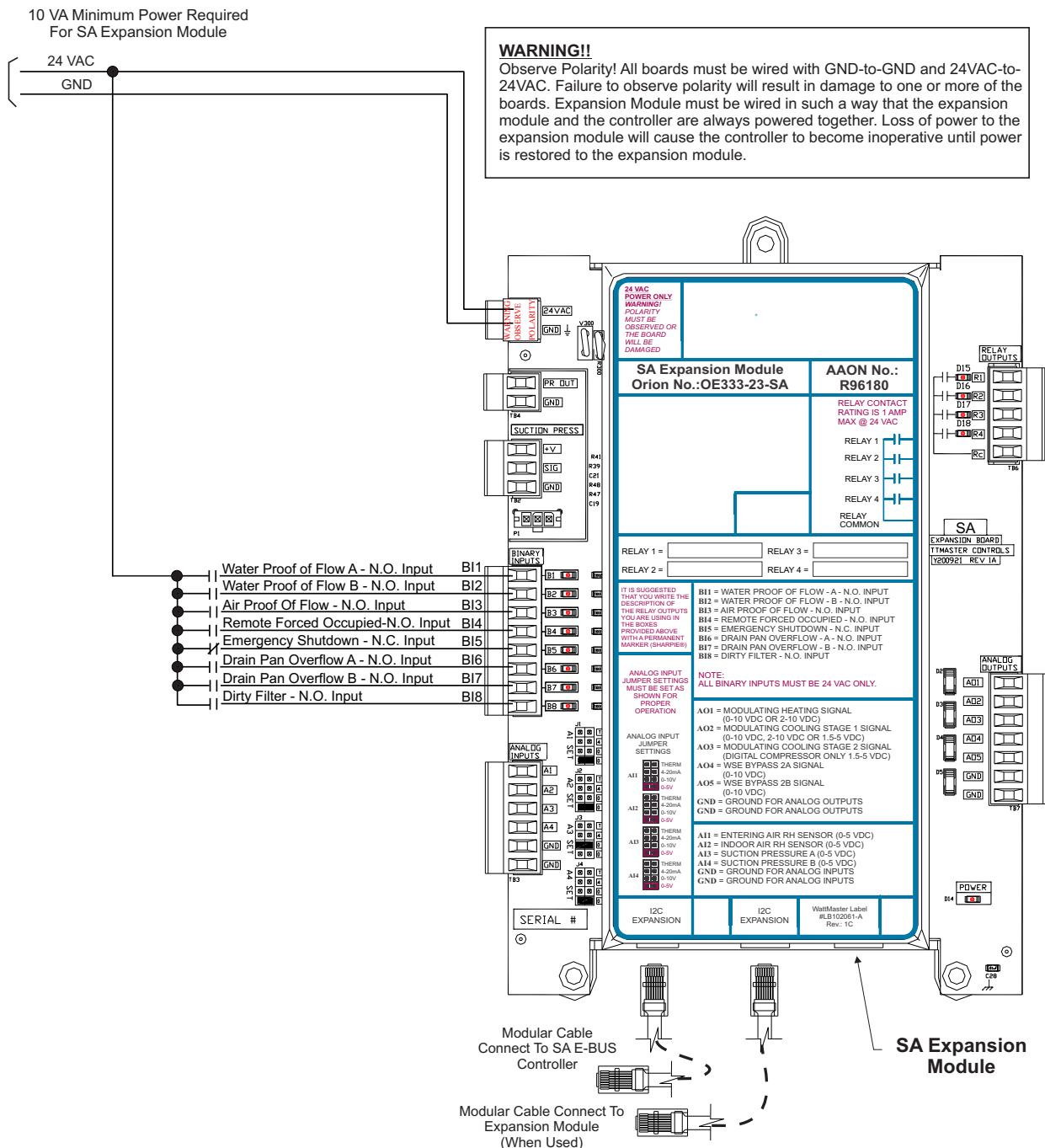


Figure 19: OE333-23-SA – SA Expansion Module 8 Binary Inputs Wiring

Installation & Wiring

Entering Air Humidity Sensor Wiring

Entering Air Humidity Sensor

The OE265-14 Entering Air Humidity Sensor is connected to the system by wiring it to the AI1 input on the SA Expansion Module. It must be wired as shown in **Figure 20** below for proper controller operation.

Warning: It is very important to be certain that all wiring is correct as shown in the wiring diagram below. Failure to observe the correct polarity will result in damage to the Entering Air Humidity Sensor or SA Expansion Module.

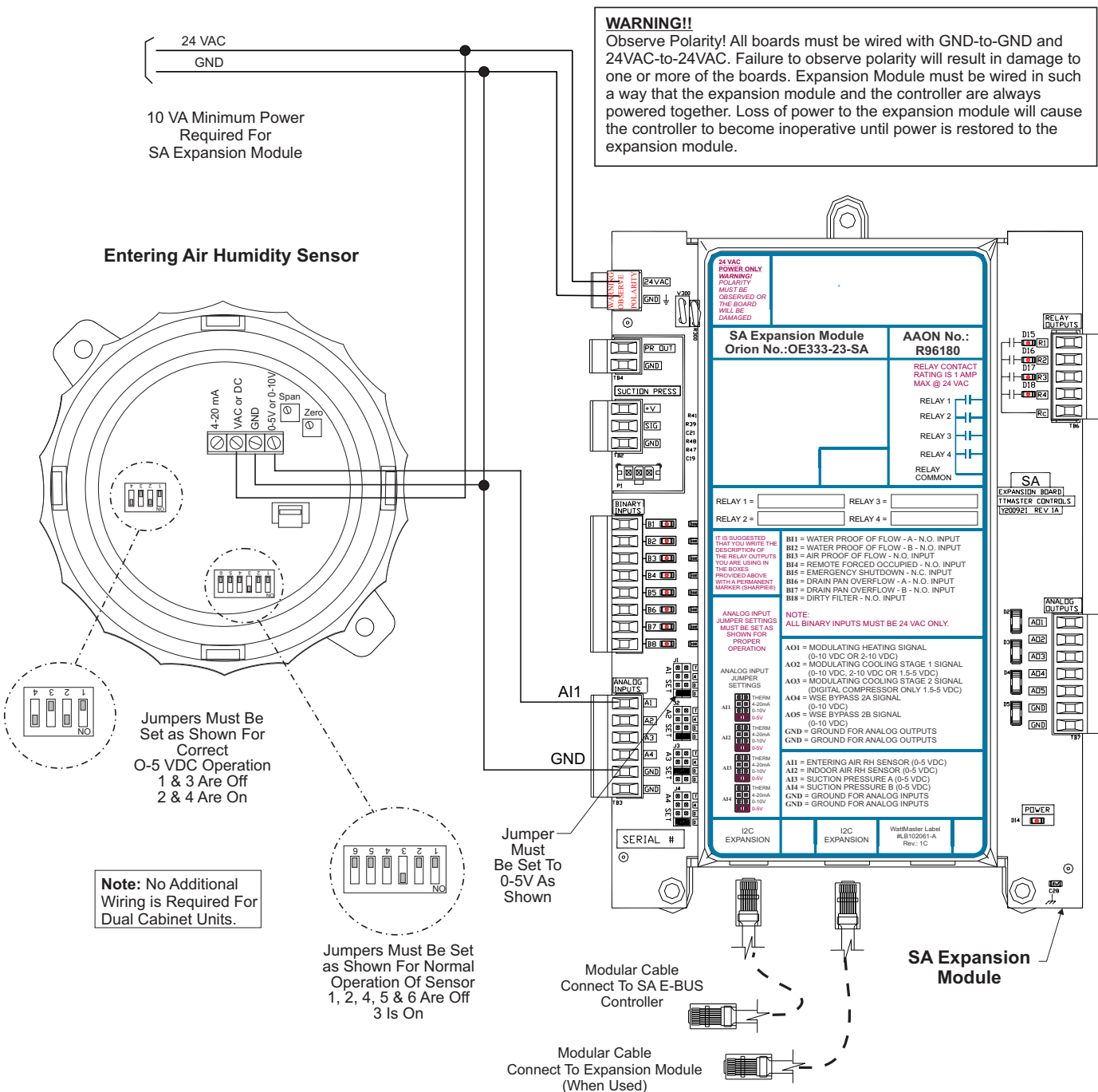


Figure 20: OE265-14 – Entering Air Humidity Sensor Wiring

Installation & Wiring

Indoor Wall-Mounted Humidity Sensor Wiring

Indoor Wall-Mounted Humidity Sensor

When used, the OE265-11 Indoor Wall-Mounted Humidity Sensor is connected to the system by wiring it to the AI2 input on the SA Expansion Module. It must be wired as shown in **Figure 21** below for proper controller operation.

Warning: It is very important to be certain that all wiring is correct as shown in the wiring diagram below. Failure to observe the correct polarity will result in damage to the Space Humidity Sensor or SA Expansion Module.

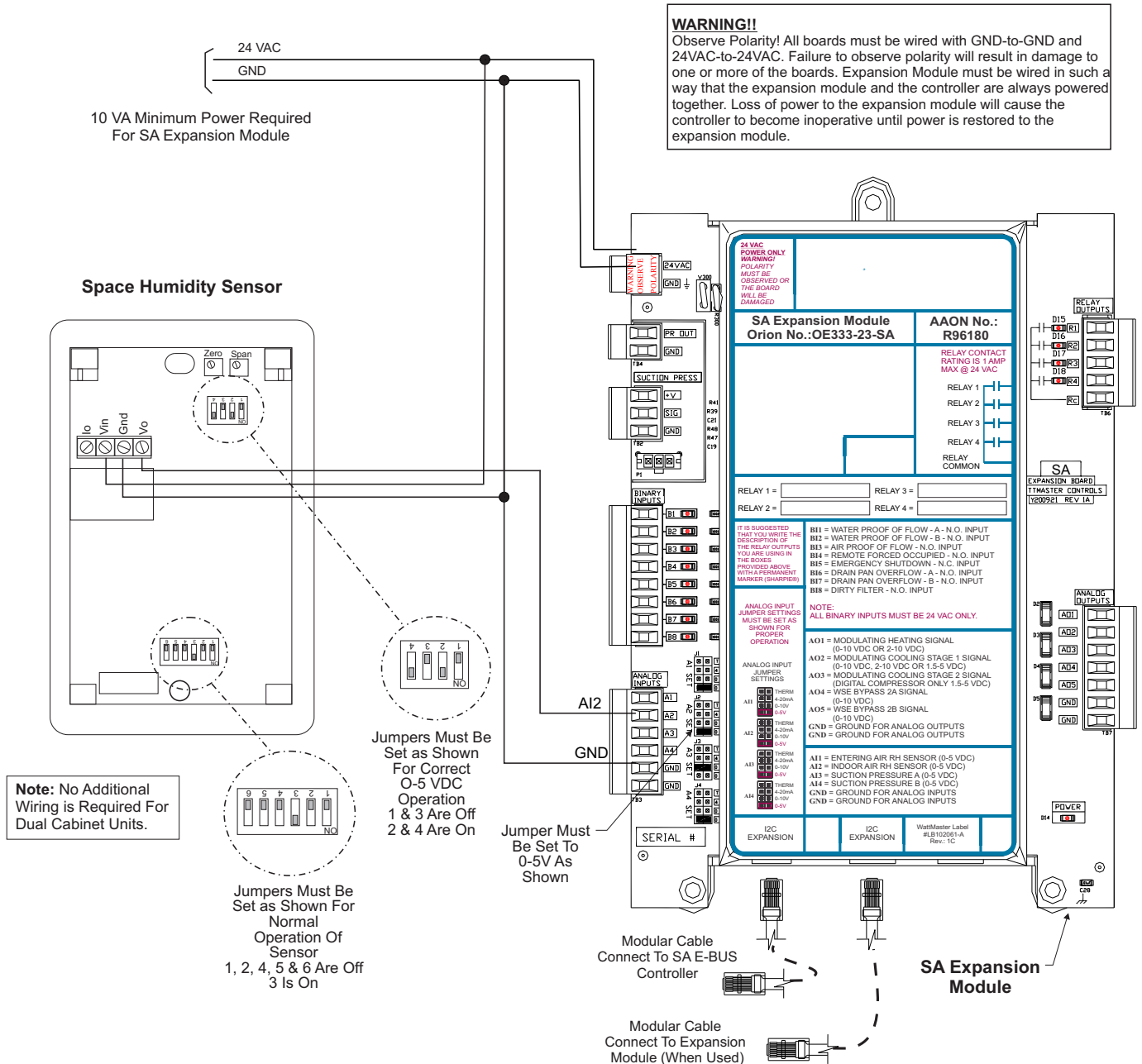


Figure 21: OE265-11 – Indoor Wall-Mounted Humidity Sensor Wiring

Installation & Wiring

Modulating Heating Device Wiring

Modulating Heating Device

The Modulating Heating Device signal can be configured for either a 0-10 VDC or 2-10 VDC output signal when programming the controller. The output signal can be configured for either Direct Acting or Reverse Acting operation as required.

The Output signal is normally used to control a Modulating Hot Water Valve or Modulating Steam Valve or is used for SCR Control of an Electric Heating Coil.

See **Figure 22** below for detailed wiring of the Modulating Heating Device.

Warning: It is very important to be certain that all wiring is correct as shown in the wiring diagram below. Failure to observe the correct polarity could result in damage to the Modulating Heating Device or the SA Expansion Module.

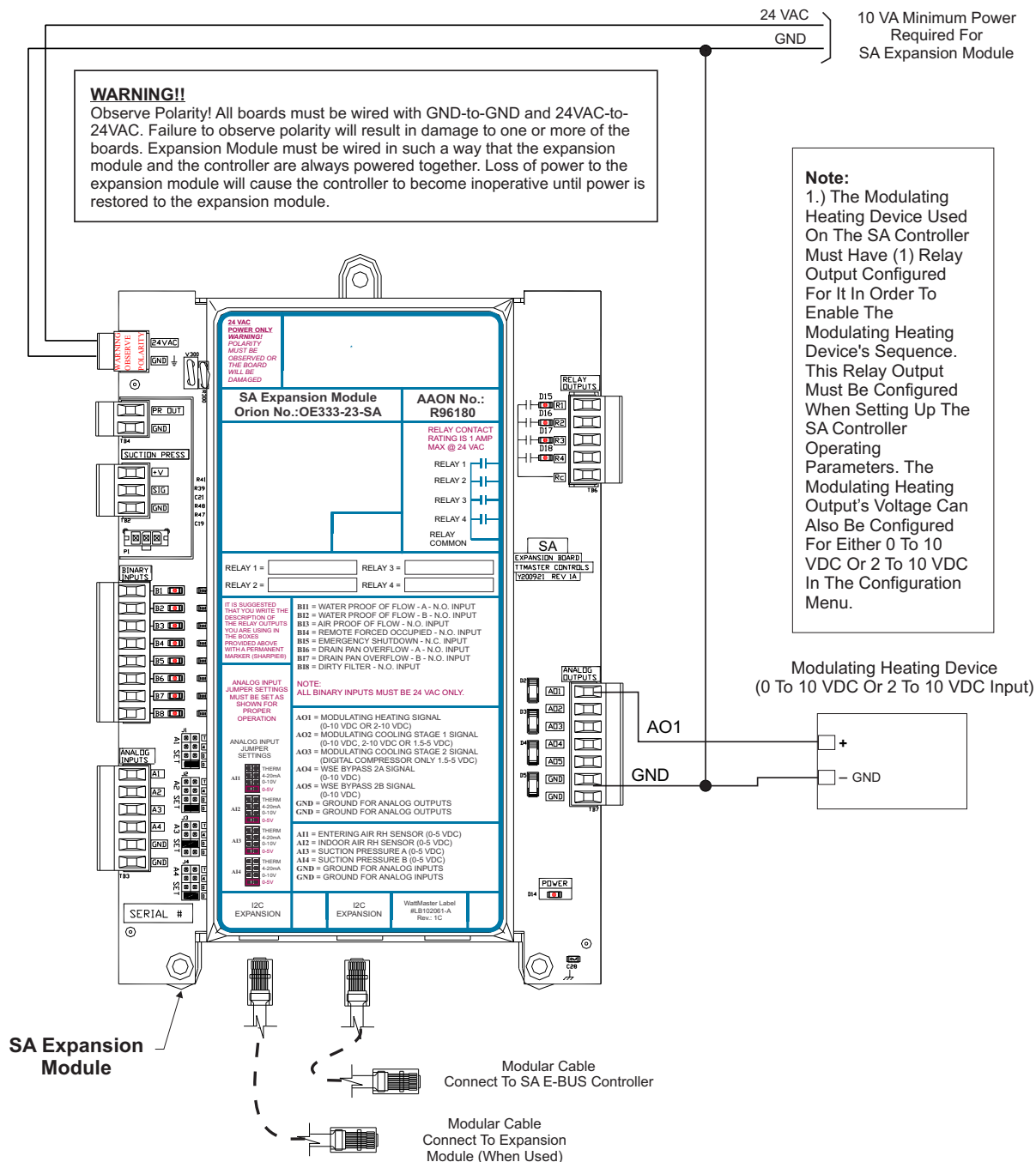


Figure 22: Modulating Heating Device Wiring

Chilled Water Valve

For Chilled Water Applications, the Modulating Cooling Signal(s) can be configured for either a 0-10 VDC or 2-10 VDC output signal when programming the controller. The output signal can also be configured for either Direct Acting or Reverse Acting operation as required by your application. This signal output would be connected to a Modulating Chilled Water Valve.

Warning: It is very important to be certain that all wiring is correct as shown in the wiring diagram below. Failure to observe the correct polarity could result in damage to the Modulating Cooling Device or the SA Expansion Module.

See **Figure 23** below for detailed wiring of a Chilled Water Valve.

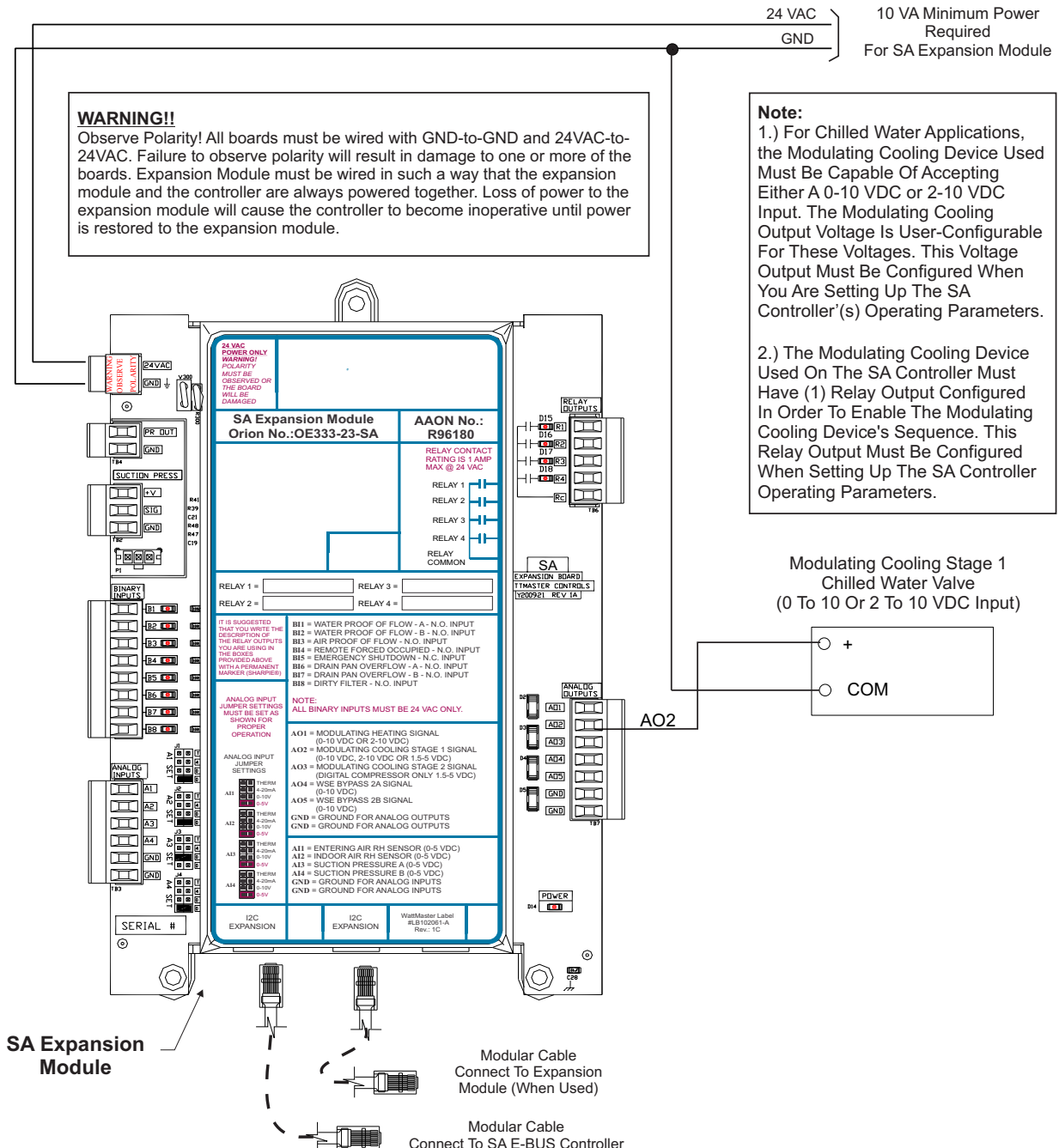


Figure 23: Chilled Water Valve Wiring

Modulating Cooling Device Wiring

Digital Scroll Compressor Wiring

For Digital Scroll Applications, the Modulating Cooling Signal(s) must be configured for a 1.5-5.0 VDC output signal when programming the controller. This signal output would be connected to a Digital Scroll Compressor Controller.

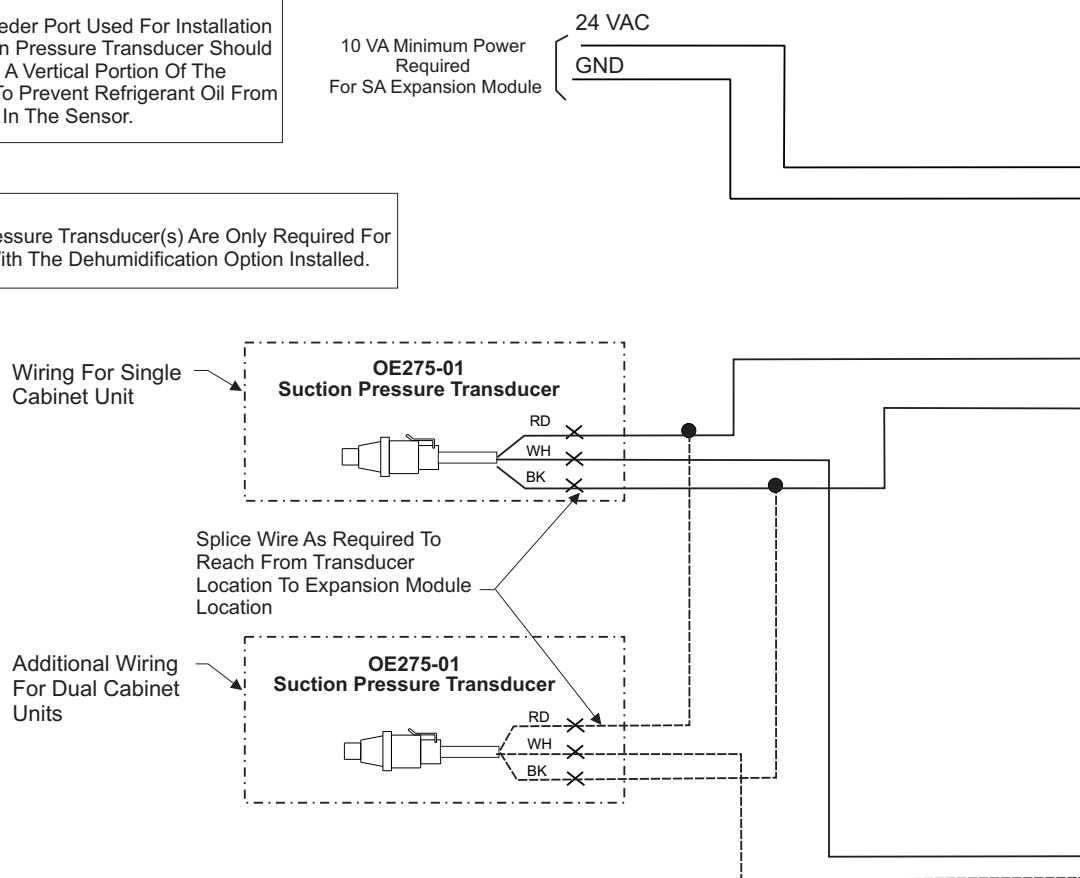
For Digital Scroll Compressor wiring details, see **Figure 24** below.

Caution:

1.) The Schraeder Port Used For Installation Of The Suction Pressure Transducer Should Be Located In A Vertical Portion Of The Suction Line To Prevent Refrigerant Oil From Accumulating In The Sensor.

Note:

1.) Suction Pressure Transducer(s) Are Only Required For Installations With The Dehumidification Option Installed.



WARNING!!

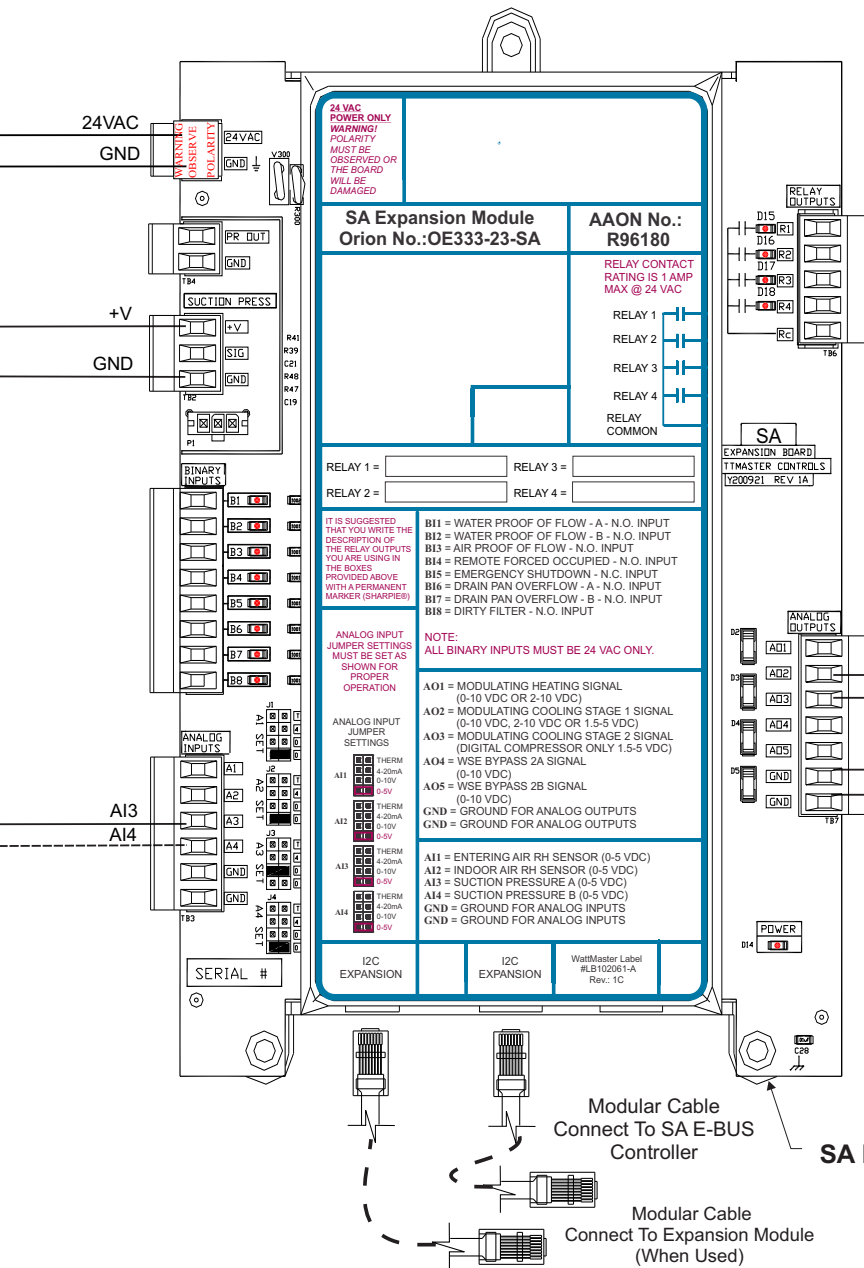
Observe Polarity! All boards must be wired with GND-to-GND and 24VAC-to-24VAC. Failure to observe polarity will result in damage to one or more of the boards. Expansion Module must be wired in such a way that the expansion module and the controller are always powered together. Loss of power to the expansion module will cause the controller to become inoperative until power is restored to the expansion module.

Figure 24: Digital Scroll Compressor Wiring

Installation & Wiring

Modulating Cooling Device Wiring

Warning: It is very important to be certain that all wiring is correct as shown in the wiring diagram below. Failure to observe the correct polarity could result in damage to the Modulating Cooling Device or the SA Expansion Module.



Note:

- 1.) All Digital Compressors Must Have The Cooling Output Voltage Configured For 1.5-5 VDC. This Voltage Output Must Be Configured When You Are Setting Up The SA Controller'(s) Operating Parameters.
- 2.) Each Modulating Heating or Cooling Device Used on the SA Controller Must Have A Relay Configured For It In Order To Properly Sequence The Devices. Compressors Must Always Be Wired In The Following Order: A1, A2, B1, B2. See The Sequence Of Operations For The Description Of The Staging.
- 3.) For Dual Cabinet Units With 1 Digital Scroll Compressor And 1 Fixed Compressor In Each Unit, Both Digital Compressors Will Be Controlled Together Using AO #2. The Separate Relays For Those Compressors Will Be Simultaneously Enabled Using The Relays for A1 and B1.

Wiring For Single Cabinet Units With 2 Digital Scroll Compressors

Additional Wiring For Dual Cabinet Units With 2 Digital Scroll Compressors

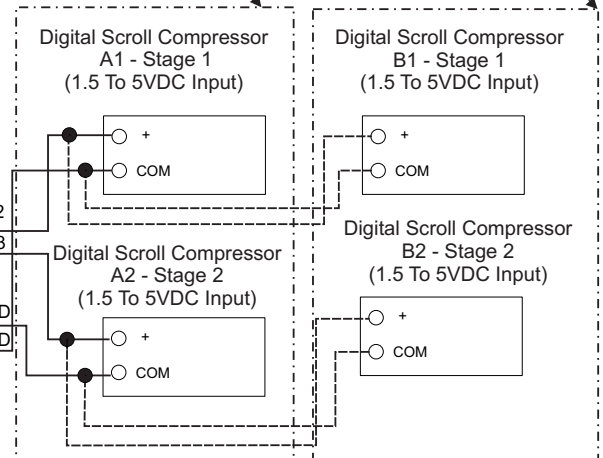


Figure 24: Digital Scroll Compressor Wiring, continued

12-Relay Expansion Module Overview and Wiring

12-Relay Expansion Module

Two different Expansion Modules are available for use with the SA E-BUS Controller to provide additional inputs and outputs beyond those found on the SA E-BUS Controller.

The SA Expansion Module (OE333-23-SA) is provided with 8 Binary Inputs, 4 Analog Inputs, 4 Relay Outputs, and 5 Analog Outputs. See **Figures 16 and 17** on page 20 and 21 for complete wiring details.

The 12-Relay Expansion Module (OE358-23-12R) provides for 12 Dry Contact Configurable Relay Outputs. See **Figure 25** below for complete wiring details.

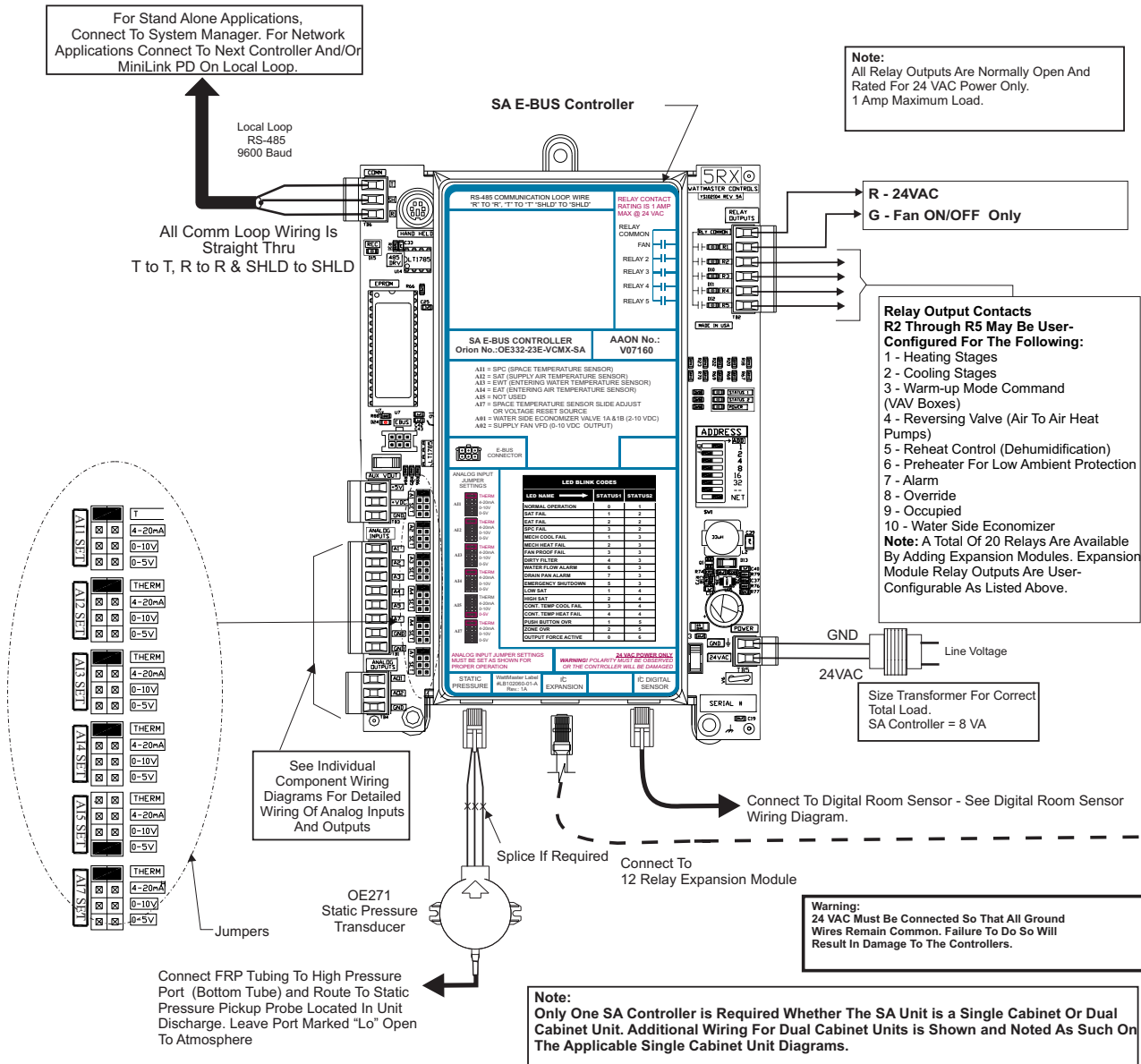


Figure 25: OE358-23-12R – 12-Relay Expansion Module Wiring and Jumper Settings

12-Relay Expansion Module Overview and Wiring

The expansion modules can be used individually or together to provide the required inputs and outputs for your specific applications.

When using the 12-Relay Expansion Module, you must correctly configure a set of jumpers on the board depending on whether it will be used by itself or in addition to the SA Expansion Module.

The jumpers are located on the edge of the 12-Relay Expansion Module on the same side of the module as the power connection. See **Figure 25** below for details regarding setting the switch correctly for your application.

WARNING!!

Observe Polarity! All boards must be wired with GND-to-GND and 24VAC-to-24VAC. Failure to observe polarity will result in damage to one or more of the boards. Expansion Modules must be wired in such a way that the expansion modules and the controller are always powered together. Loss of power to the expansion module will cause the controller to become inoperative until power is restored to the expansion module.

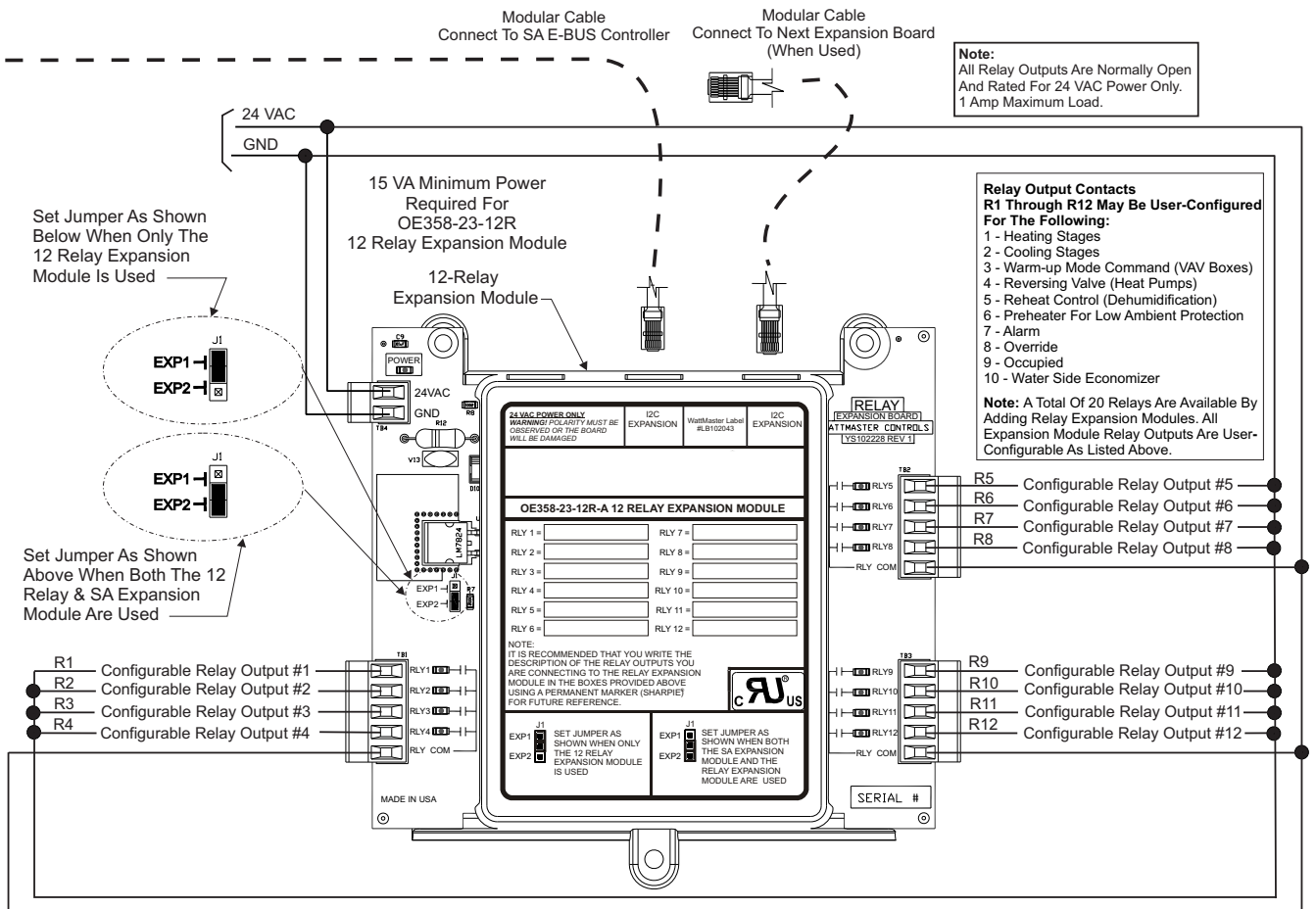


Figure 25, cont.: OE358-23-12R – 12-Relay Expansion Module Wiring and Jumper Settings

SA E-BUS Controller to E-BUS Module Wiring

SA E-BUS Controller to E-BUS Module Wiring

The SAE-BUS Controller connects to the E-BUS Modules using a modular HSSC cable. E-BUS Modules require a 24 VAC power connection with an appropriate VA rating. See **Figure 26** below for an example of E-BUS Controller to E-BUS Module wiring.

The E-BUS Modules can be connected to the SAE-BUS Controller's E-BUS port or can be daisy-chained together using HSSC cables.

See **Figures 27-28** for specific E-BUS Module wiring.

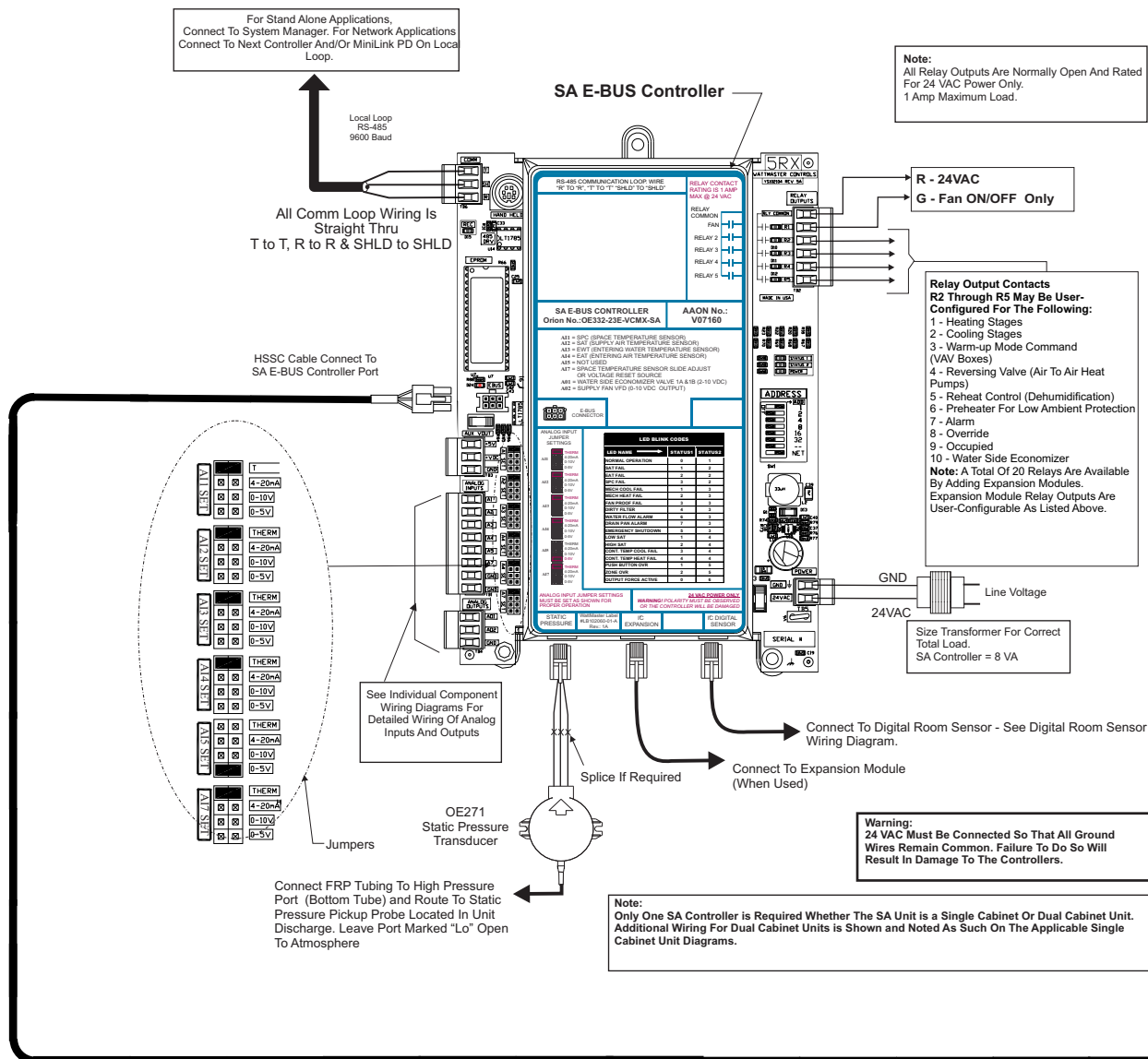


Figure 26: SA E-BUS Controller to E-BUS Module Wiring Diagram

SA E-BUS Controller to E-BUS Module Wiring

NOTE: Contact Factory for the correct HSSC cable length for your application. Cables are available in ½ meter, 3 meter, 100 foot, and 150 foot lengths.

WARNING: Be sure all controllers and modules are powered down before connecting or disconnecting HSSC cables.

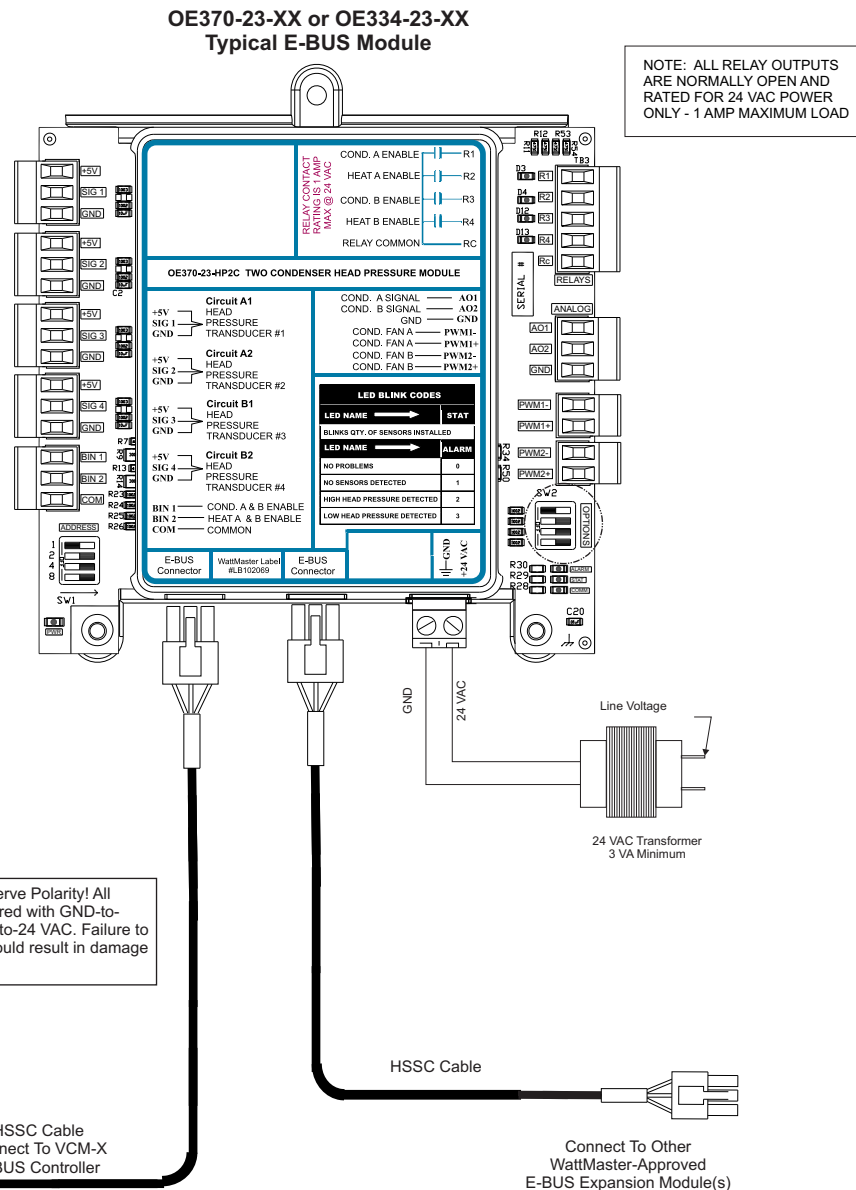


Figure 26, cont.: SA E-BUS Controller to E-BUS Module Wiring Diagram

Additional Applications

Two Condenser Head Pressure Module Overview and Wiring

Two Condenser Head Pressure Module

The Two Condenser Head Pressure Module (OE370-23-HP2C) monitors four individual head pressure transducers and controls two Condenser Fans or Water Valves on units with two physically separate condenser sections. The highest reading of head pressure transducers 1 & 2 controls Condenser Signal A. The highest reading of head pressure transducers 3 & 4 controls Condenser Signal B. A pulse width modulation (PWM) signal is used to control the Condenser Fans. A 0-10 volt output signal is used to control the valves.

The Two Condenser Head Pressure Module connects to the SA E-BUS Controller, allowing the Two Condenser Head Pressure Module to receive setpoints from the SA E-BUS Controller. See **Figure 27** below for wiring diagram.

The Two Condenser Head Pressure Module requires a 24 VAC power connection with an appropriate VA rating.

NOTE: For complete information, including the sequence of operation, refer to the *Two Condenser Head Pressure Module Technical Guide*.

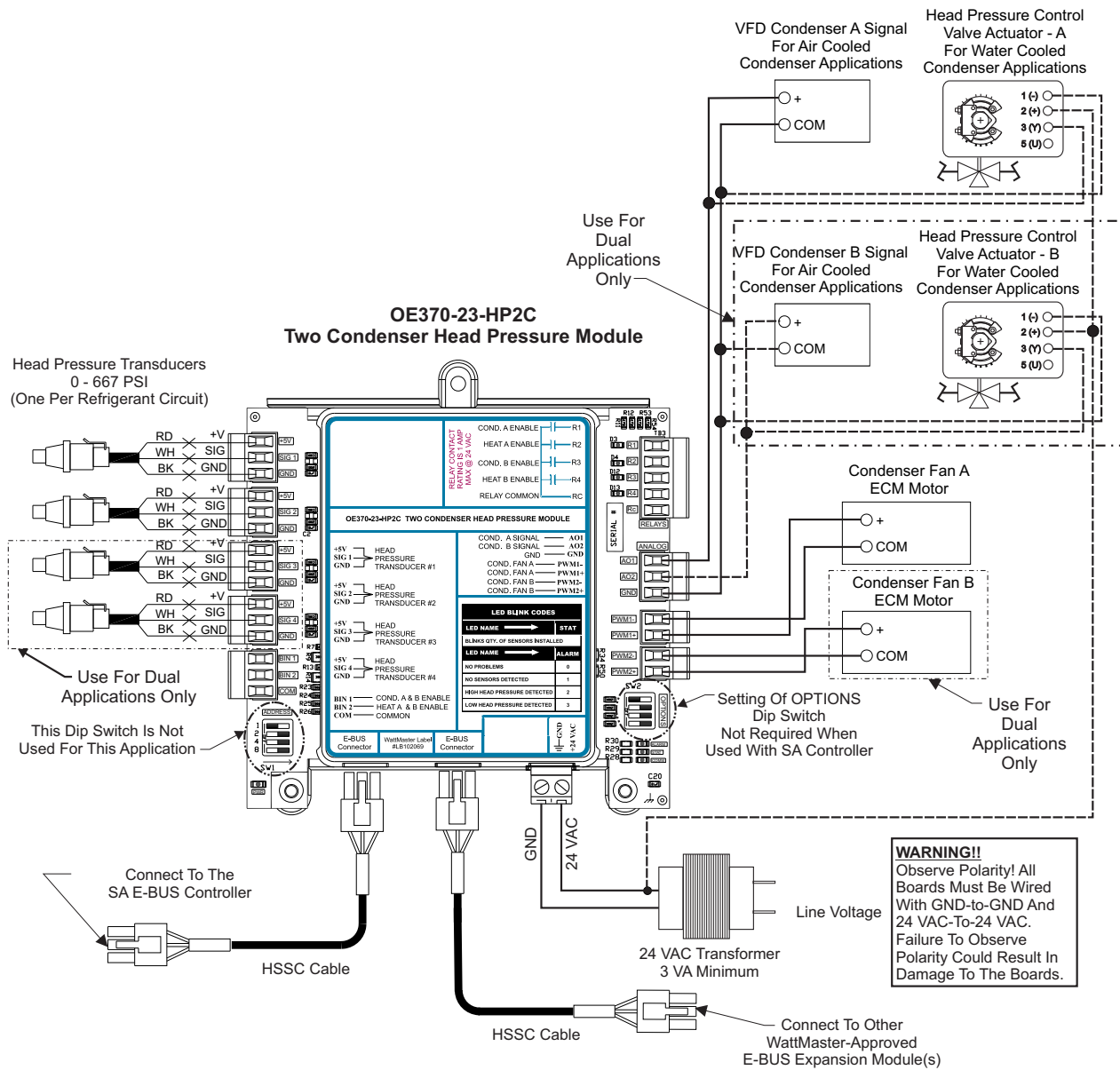


Figure 27: Two Condenser Head Pressure Module to E-BUS Distribution Module Wiring Diagram

Water Source Heat Pump Protection Module Overview and Wiring

Water Source Heat Pump Protection Module

The Water Source Heat Pump Protection Module (OE-334-23-WPM-A) protects the compressors on an AAON Water Source Heat Pump unit from damage by monitoring Suction Pressure, Leaving Water Temperature, and Water Proof of Flow. It also utilizes a Delay Timer to prevent the compressors from turning on at the same time.

There is one water-only version of the Water Source Heat Pump Protection Module—the OE-334-23-WPM-A which uses R-410A refrigerant. There are also two 410-A glycol versions—the OE-334-23-WPM-A20 which uses 20% glycol and the OE-334-23-WPM-A40 which uses 40% glycol.

NOTE: When using the WSHP Protection Module, the compressors are wired to this module instead of the SA E-BUS Controller and SA Expansion Module.

The Water Source Heat Pump Protection Module connects to the SA E-BUS Controller, allowing the Water Source Heat Pump Protection Module to receive control data and alarms from the SA E-BUS Controller. See **Figure 28** below for wiring diagram.

The Water Source Heat Pump Protection Module requires a 24 VAC power connection with an appropriate VA rating.

NOTE: For complete information, including the sequence of operation, refer to AAON Tulsa's *Water Source Heat Pump Protection Module Technical Guide*.

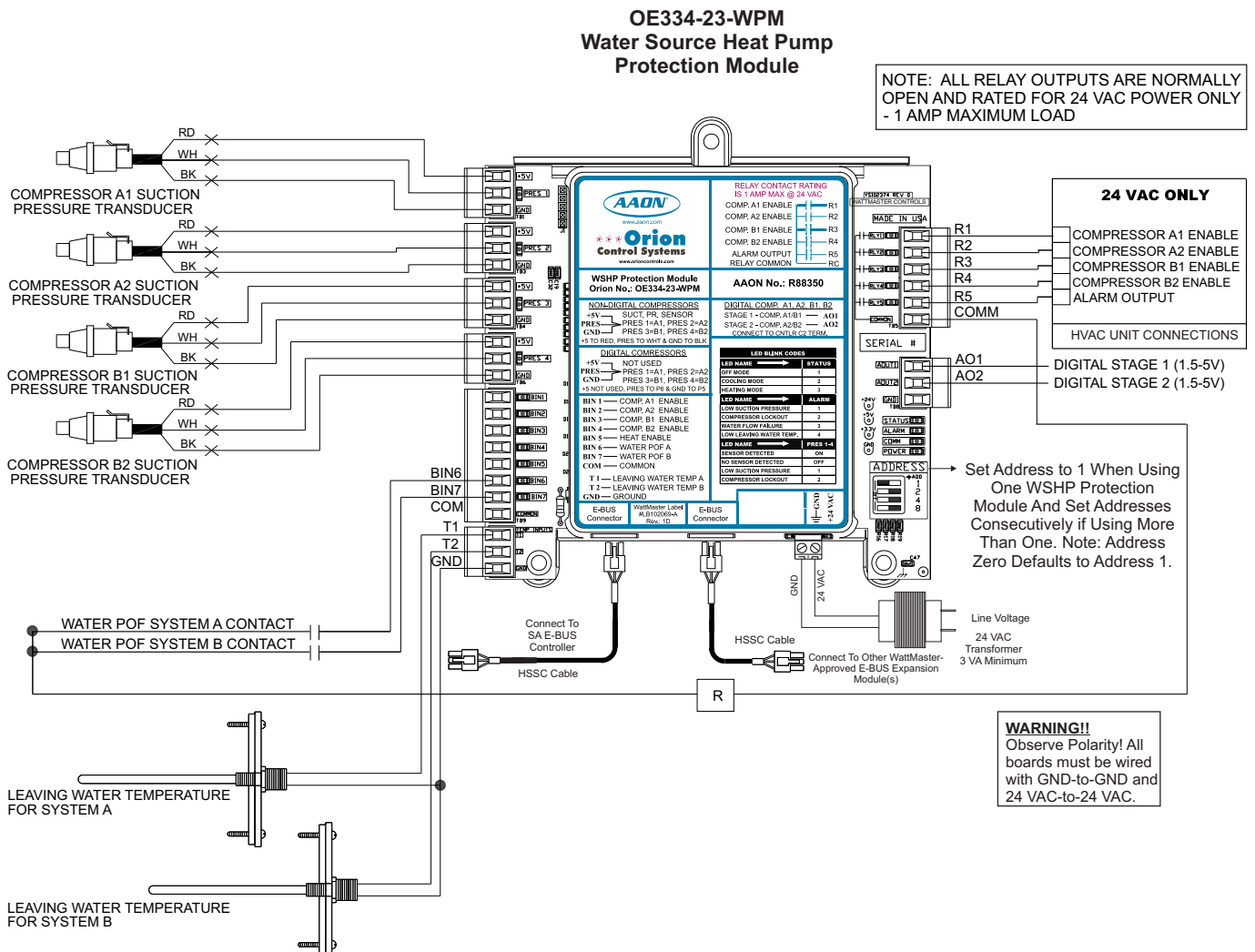


Figure 28: Water Source Heat Pump Protection Module to E-BUS Distribution Module Wiring Diagram

Start-Up & Commissioning

Addressing & Powering Up

Before Applying Power

In order to have a trouble free start-up, it is important to follow a few simple procedures. Before applying power for the first time, it is very important to correctly address the controller and run through a few simple checks.

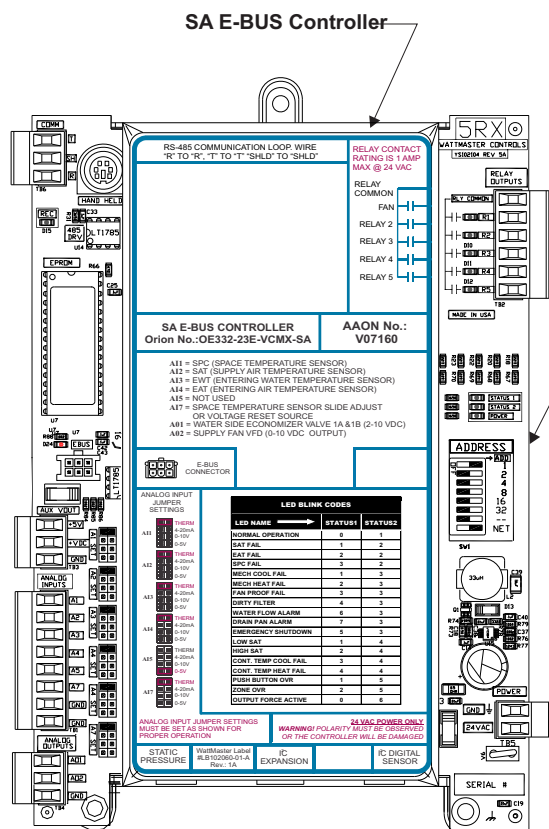
Controller Addressing

All SA E-BUS Controllers are equipped with address switches. If the SA E-BUS Controller is to operate as a stand-alone system (not connected to any other HVAC unit or VAV/Zone Controllers), the controller address switch should be set for address 1. When using the Modular Service Tool or System Manager to program and configure the SA E-BUS Controller, you would enter this address to communicate with the controller. When the system is to be connected to other HVAC unit controllers on a communication loop, each controller's address switch must be set with a unique address between 1 and 59. When the SA E-BUS Controller

will be used with VAV/Zone Controllers, the SA E-BUS Controller's address switch must be set as address 59, no exceptions. See **Figure 29** below for address switch setting information.

Power Wiring

One of the most important checks to make before powering up the system for the first time is to confirm proper voltage and transformer sizing for each controller. Each SA E-BUS Controller requires 8 VA of power delivered to it at 24 VAC and each of the modules require different VA loads (see **Table 1** on page 10 for details). You may use separate transformers for each device (preferred) or power several devices from a common transformer. If several devices are to be powered from a single transformer, correct polarity must be followed.



Note:

The Power To The Controller Must Be Removed And Reconnected After Changing The Address Switch Settings In Order For Any Changes To Take Effect.

Caution:

Disconnect All Communication Loop Wiring From The Controller Before Removing Power From The Controller. Reconnect Power And Then Reconnect Communication Loop Wiring.

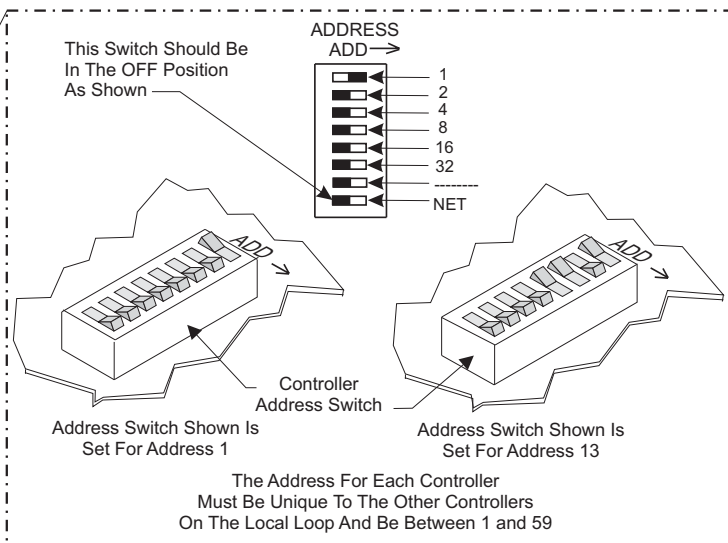


Figure 29: SA E-BUS Controller Address Switch Setting

Warning: Observe Polarity! All boards must be wired with GND-to-GND and 24 VAC-to-24 VAC. Failure to observe polarity will result in damage to one or more of the boards. The Expansion Module must be wired in such a way that the Expansion Module and the SA E-BUS Controller are always powered together. Loss of power to the Expansion Module will cause it to become inoperative until power is restored to the Expansion Module.

Check all wiring leads at the terminal block for tightness. Be sure that wire strands do not stick out and touch adjacent terminals. Confirm that all sensors required for your system are mounted in the appropriate location and wired into the correct terminals on the SA E-BUS Controller. Be sure any Expansion Module connected to the SA E-BUS Controller is also correctly wired just as you did for the SA E-BUS Controller.

After all the above wiring checks are complete, apply power to the SA E-BUS Controller and any Expansion Module connected to it.

Initialization

On system power up, a 30-second startup delay is performed where all default setpoints are initialized, LED's are initialized, and all outputs are turned off.

When power is first applied, LED1 and LED2 will flash out the controller address. LED1 will flash to represent the tens position. LED2 will flash to represent the ones position. After the controller address is complete, there will be a short pause and then 60 fast flashes to represent controller initialization. There will be no controller operation or communications during initialization. After initialization, LED1 and LED2 will continuously flash the status code.

Example of a controller address of 59:

LED1 will flash 5 times. LED2 will flash 9 times.

See **Table 3** on page 55 in the Troubleshooting Section of this manual for detailed diagnostic blink code information.

Operating Summary

There is a standard set of operating instructions that are continuously repeated during normal operations. They are listed below.

1. Read Analog Inputs for Temperatures, Pressures, and Binary Contact Closures.
2. Calculate Occupied/Unoccupied Mode of Operation.
3. Calculate HVAC Mode of Operation.
4. Set all outputs to match calculations for Heating or Cooling or Vent Mode.
5. Broadcast information to other controllers if configured.
6. Log all temperatures and output conditions.
7. Repeat steps 1 through 6 continuously.

Programming the Controller

The next step is programming the controller for your specific requirements. In order to configure and program the SA E-BUS Controller, you must use an operator interface. Three different operator interfaces are available for programming and monitoring of the SA E-BUS Controller. These are as follows:

- Modular Service Tool SD
- Modular System Manager SD
- Computer with Prism 2 Computer Front-End Software Installed

Any of these devices or a combination of them can be used to access the status, configuration, and setpoints of any controller on your communications loop.

If using the Modular Service Tool SD or Modular System Manager SD with your system, refer to the *SA E-BUS Controller Operator Interfaces Technical Guide* for complete SA E-BUS Controller programming instructions.

If using a computer and the Prism Computer Front End Software, refer to the *Prism 2 Technical Guide*.

No matter which operator interface you use, we recommend that you proceed with the programming and setup of the SA E-BUS Controller in the order that follows:

1. Configure the Controller for your application.
2. Program the Controller setpoints.
3. Program the Controller operation schedules.
4. Set the Controller current time and date.
5. Review Controller status screens to verify system operation and correct Controller configuration.



Figure 30: Modular Service Tool SD, Modular System Manager SD, and Prism 2 Operator Interfaces

SA E-BUS Controller Inputs

SA E-BUS Controller Inputs

AI1 - Space Temperature Sensor Input

If you want to generate Occupied or Unoccupied Heating and Cooling demands based on Space Temperature, select this Sensor for the HVAC Mode enable. The Space Temperature Sensor can be used for Night Setback control regardless of the HVAC Mode Sensor selected. If the Space Temperature Sensor used is equipped with the optional Push-Button Override Feature, this input will detect user overrides from Unoccupied back to Occupied operation for a user-adjustable amount of time. This Sensor is only required for Space Temperature Control or Night Setback. The Space Temperature Sensor can also be configured to reset the Supply Air Temperature Setpoint. The Space Temperature Sensor is the only Sensor that can be used for Night Setback operation during the Unoccupied Mode.

AI2 - Supply Air Temperature Sensor Input

The Supply Air Temperature Sensor is the default HVAC Mode Enable Sensor. For typical VAV units that are Cooling Only with Morning Warm-up, this Sensor should be configured as the HVAC Mode Enable Sensor. For all applications, the Supply Air Temperature Sensor is the sensor used for Staging Control. The HVAC unit must always have a Supply Air Temperature Sensor installed.

AI3 - Entering Water Temperature Sensor Input

The Entering Water Temperature is used to determine when to initiate Water Side Economizer operation. If the unit is in Cooling Mode and the Entering Water Temperature drops 10°F (adj.) below the Entering Air Temperature, the unit will begin to modulate the Water Side Economizer Valve as part of the cooling operation. See Water Side Economizer in the Sequence of Operation Section of this manual for a full description of this operation.

AI4 - Entering Air Temperature Sensor Input

The Entering Air Temperature Sensor can be used as the controlling sensor for 100% Entering Air units. The Entering Air Temperature is used to lock out Heating or Cooling to conserve energy at whatever temperature you deem appropriate for each Mode of Operation. The Entering Air Temperature Sensor can also be used to provide Low Ambient Temperature Protection in the building. If the Entering Air Temperature is below the Low Ambient Temperature Setpoint, the Preheat Relay Output will be maintained during Occupied operation and will not be allowed to stage off unless the Supply Fan is turned off. The Entering Air Temperature Sensor is also used in combination with the Entering Air Humidity Sensor for Dewpoint calculations.

AI5 - Not Utilized At This Time

AI6 - Duct Static Pressure Sensor Input

This special phone jack-style input connection accepts a Duct Static Pressure Sensor input modular cable. The Duct Static Pressure Sensor reading is used to determine current Duct Static Pressure. This Static Pressure reading is used to control the output signal supplied to the Supply Fan VFD or Zoning Bypass Damper Actuator. If you have configured the HVAC unit for Constant Volume operation, this Sensor is optional. If it is installed on a Constant Volume unit, it will not affect operation, but rather will be used as a status-only reading.

AI7 - Space Temperature Sensor Slide Adjust or Remote SAT Reset Signal Input

AI7 on the SA E-BUS Controller is a dual-purpose input. It can be used for the Space Sensor Slide Adjust option or for connection of the Remote Supply Air Setpoint Reset Signal option. Only one or the other can be used, not both.

Space Temperature Sensor Slide Adjust

If the Space Temperature Sensor being used has the optional Slide Adjust feature, its AUX output is connected to this input. The Slide Adjust control is used to vary the HVAC Mode Heating and Cooling Setpoints by a user-configured maximum amount. The Slide Adjustment adjusts whichever Temperature Sensor has been configured as the HVAC Mode Enable Sensor, even if that Sensor is not the installed Space Temperature Sensor.

If Space Temperature or Entering Air Temperature is configured as the SAT/Reset Source, the Slide Adjustment adjusts both the HVAC Mode Enable Heating and Cooling setpoints and the SAT/Reset Source Heating and Cooling setpoints simultaneously by a user-configurable maximum amount.

Remote Supply Air Temperature Reset Signal

When a 0-5 or 0-10 VDC Remote Supply Air Temperature Reset Signal is to be used, the controller must be configured for it, and the Room Sensor Slide Offset setpoint must be set to zero for this option. If the slide offset is not set to zero, the Supply Air Temperature Reset will not function.

The Remote Supply Air Temperature Reset signal must be configured so that its setpoint will be at the coldest Supply Air Temperature at 0 VDC, and so that its setpoint will be at the warmest Supply Air Temperature at 5 or 10 VDC, depending on the voltage signal required.

The jumper AI7 must be set to 0-10V regardless of whether the controller is configured for 0-5 or 0-10VDC operation. See the wiring diagram on page 13 for details.

SA E-BUS Controller Outputs and SA Expansion Module I/Os

SA E-BUS Controller Outputs

AO1 - Water Side Economizer Valve Signal

This 2-10 VDC signal is used to modulate the Water Side Economizer valve(s) of either a single SA Unit or a dual SA Unit during Water Side Economizer operation.

AO2 - Supply Fan VFD

This voltage signal (0-10 VDC) can be connected to a Supply Fan VFD or to Proportional Inlet Vanes to control the Duct Static Pressure. This signal can also be connected to a 0-10 VDC Modulating Zoning Bypass Damper Actuator to control Duct Static Pressure. When this signal is used to control a Zoning Bypass Damper Actuator, the Zoning Bypass Damper Actuator needs to be mechanically configured to close the Zoning Bypass Damper on an increase of the 0-10 VDC output signal. This is necessary because the signal is Direct Acting and is not configurable as a Reverse Acting Signal on the SA E-BUS Controller.

R1 - Supply Fan (Enable)

This is reserved for the Supply Fan and cannot be configured for any other option.

R2-R5 - User-Configurable Relays

These relays are configurable by the user. For all the available configuration options, see **Table 2** on page 40.

By using all (4) of the available relay outputs on the SA E-BUS Controller, all (4) of the relay outputs on the SA Expansion Module, and all 12 of the relay outputs on the 12 Relay Expansion Module, you have the ability to configure up to a combined total of (20) relay outputs for Heating Stages, Cooling Stages, and options 3 through 10 listed in **Table 2**.

NOTE: The Binary Inputs require wet contacts (24 VAC only) to recognize an active input. If you provide dry contacts, the contact closure will not be recognized.

SA Expansion Module Inputs and Outputs

AI1 - Entering Air Humidity Sensor Input

This input is used to connect an Entering Air Humidity Sensor that when combined with the Entering Air Temperature Sensor reading is used to calculate a Dewpoint Temperature. The Entering Air Dewpoint Temperature is used to activate the Dehumidification Mode on Entering Air configured units.

AI2 - Indoor Air Humidity Sensor Input

The Indoor Air Humidity Sensor is used to activate Dehumidification Mode when the unit is configured for Supply Air Control or Space Temperature Control on a VAV or CAV unit. This sensor can be used as a reset sensor for Entering Air Controlled units.

AI3 - Suction Pressure A Input

The Suction Pressure Transducer (0-5 VDC input) is used to measure the suction pressure at the HVAC Unit's DX evaporator coil suction line. This suction line pressure is converted to saturated refrigerant temperature by the SA E-BUS Controller. This temperature is used by the SA E-BUS Controller to accurately control the compressor's cycle to provide optimum performance from the system during Dehumidification operation.

AI4 - Suction Pressure B Input

The Suction Pressure Transducer (0-5 VDC input) is used to measure the suction pressure at the HVAC Unit's DX evaporator coil suction line. This suction line pressure is converted to saturated refrigerant temperature by the SA E-BUS Controller. This temperature is used by the SA E-BUS Controller to accurately control the compressor's components to provide optimum performance from the system during Dehumidification operation.

AO1 - Modulating Heating Signal

This output signal can be configured for either a 0-10 VDC or 2-10 VDC output signal. This signal can be configured for either Direct Acting or Reverse Acting operation. This output signal is used to operate a AAON® Modulating Heating Device to maintain the Heating Supply Air Temperature Setpoint.

AO2 - Modulating Cooling Stage 1 Signal

This output is used to control either a Copeland Digital Scroll Compressor™ or a Modulating Chilled Water Valve to maintain the Cooling Supply Air Temperature Setpoint. If used for a Copeland Digital Scroll Compressor, the output is configured for a 1.5-5.0 VDC operation. If used for a Modulating Chilled Water Valve, the output is configured for either 0-10 VDC or 2-10 VDC operation and can be configured for direct acting or reverse acting operation.

AO3 - Modulating Cooling Stage 2 Signal

This output signal must be configured for a 1.5-5.0 VDC output signal. This output signal is used to operate a Copeland Digital Scroll™ Compressor to maintain the Cooling Supply Air Temperature Setpoint.

AO4 - Water Side Economizer Bypass Actuator Valve A

This output signal is a Direct Acting 2-10 VDC output signal that is used to modulate the Water Side Economizer Bypass Actuator on a Single SA Unit or Unit A of a Dual SA Unit.

AO5 - Water Side Economizer Bypass Actuator Valve B

This output signal is a Direct Acting 2-10 VDC output signal that is used to modulate the Water Side Economizer Bypass Actuator of Unit B of a Dual SA Unit.

SA Expansion Module Binary Inputs

R1-R4 - User-Configurable Relay Outputs

Configure relays as indicated by the factory wiring diagram when mounted controls are used. The options are listed in **Table 2** below.

BI1 - Water Proof of Flow Input A

This input is for the Water Proof of Flow Switch for a single SA Unit or for Unit A of a Dual SA Unit. If the Water Proof of Flow Switch contact opens while the Condenser Valve is operating, the Unit will enter Water Proof of Flow Failure mode. In this mode, the mechanical cooling will deactivate and the Condenser Valve will be forced to 100%. The Unit will exit this mode when the Water flow Switch is closed again and Water Flow is proven.

BI2 - Water Proof of Flow Input B

This input is for the Water Proof of Flow Switch for Unit B of a Dual SA Unit. If the Water Proof of Flow Switch contact opens while the Condenser Valve is operating, the Unit will enter Water Proof of Flow Failure mode. In this mode, the mechanical cooling will deactivate and the Condenser Valve will be forced to 100%. The Unit will exit this mode when the Water flow Switch is closed again and Water Flow is proven.

BI3 - Air Proof of Flow Input

An Air Proof of Flow Switch that provides a wet contact closure whenever the HVAC Unit Supply Fan is operating can be connected to this input. If the Air Proof of Flow Switch contact opens while the Supply Fan is operating, all Heating and Cooling is suspended or disabled. The Air Proof of Flow Switch is an optional input. This means that you must configure the SA E-BUS Controller to recognize this input signal.

BI4 - Remote Forced Occupied Mode Input

When this wet contact input closes, it will force the SA E-BUS Controller into the Occupied Mode. When the Remote Forced Occupied Signal is removed, the controller will revert to the Unoccupied Mode of operation if no internal or external schedule has been configured or is in effect when this occurs.

BI5 - Emergency Shutdown Input

This wet contact input is used to initiate shutdown of the HVAC Unit when an N.C. Smoke Detector (by others), Firestat (by others), or other shutdown condition (by others) contact is opened. The controller remains active and can initiate alarm relays.

BI6 - Drain Pan Overflow Input A

This input is for the Drain Pan Overflow Switch for a single SA Unit or for Unit A of a Dual SA Unit. When the drain pan is in an overflow condition, a Drain Pan Overflow Switch will provide a 24 VAC wet contact closure to this input. When this contact closure is initiated, the controller will enter Drain Pan Overflow Failure Mode and deactivate mechanical cooling.

BI7 - Drain Pan Overflow Input B

This input is for the Drain Pan Overflow Switch for Unit B of a Dual SA Unit. When the drain pan is in an overflow condition, a Drain Pan Overflow Switch will provide a 24 VAC wet contact closure to this input. When this contact closure is initiated, the controller will enter Drain Pan Overflow Failure Mode and deactivate mechanical cooling.

BI8 - Dirty Filter Contact Closure Input

This wet contact input is required for Filter Status Indication and requires a Differential Pressure Switch to initiate “Dirty Filter” indication.

No.	Relay Description	Details
1	Heating Stages	Configure (1) Relay for each stage of heat. Configure (1) Relay for Mod heat.
2	Cooling Stages	Configure (1) Relay for each stage of cooling. For Chilled Water, configure (1) Relay for cooling.
3	Warm-Up Mode (VAV Boxes)	Configure (1) Relay for Warm-Up Mode when Non-Orion VAV/Zone Controllers are used.
4	Reversing Valve (Heat Pumps)	Configure (1) Relay for Reversing Valve operation. Can be configured for heating or cooling.
5	Reheat (Dehumidification)	Configure (1) Relay for On/Off reheat when used.
6	Pre-Heater (low ambient protection)	Configure (1) Relay for pre-heat coil when required. Activated when the Entering Air Temperature drops below the Ambient Protection Setpoint.
7	Alarm	Configure (1) Relay to initiate an alarm output when any SA E-BUS Controller alarm occurs.
8	Override	Configure (1) Relay to initiate an output signal when Space Temperature override button is pushed.
9	Occupied	Configure (1) Relay to initiate an output signal any time the SA E-BUS Controller is in Occupied Mode.
10	Water Side Economizer	Configure (1) Relay to initiate an output signal any time the SA E-BUS Controller is in Economizer Mode.

Table 2: User-Configurable Relay Outputs

Occupied/Unoccupied Mode of Operation

The SA E-BUS Controller can utilize several methods for determining the Occupied Mode of Operation. These are as follows:

- Forced Schedule
- Remote Forced Occupied Signal
- Internal Week Schedule
- Push-Button Override Signal

Forced Schedule

The SA E-BUS Controller can be forced into the Occupied Mode by inputting a Forced Schedule from any operator interface.

Remote Forced Occupied Signal

When this wet contact input closes, it will force the SA E-BUS Controller into the Occupied Mode. When the Remote Forced Occupied Signal is removed, the controller will revert to the Unoccupied Mode of operation if no Internal or External Schedule has been configured or is in effect when this occurs.

NOTE: When using Remote Forced Occupied Mode, set all the Internal Week Schedules to '0' so that the Internal Schedule always commands the Unoccupied Mode.

Internal Week Schedule

An Internal Week Schedule, which supports up to two start/stop events per day, is available for determining Occupied and Unoccupied Schedules. If you are using the Internal Schedule, an Optimal Start calculation is also available. See the Scheduling Section on page 52 for more information on the Optimal Start feature.

Push-Button Override Signal

During Unoccupied hours, you can force the SA E-BUS Controller back to Occupied operation by pressing the Override Button on the Space Temperature Sensor for a period of less than 3 seconds. This initiates the Override or resets the Override Timer back to zero during Unoccupied hours of operation.

During Override operations, you can cancel the Override by pressing the Override Button for a period of time between 3 seconds and 10 seconds. This restores the SA E-BUS Controller to Normal Unoccupied Operation.

If the Override Button is held for more than 10 seconds, it causes a Space Sensor Failure Alarm. This is due to the fact that the Override Button actually shorts the Space Temperature Sensor input to ground. If this input is shorted to ground or left floating with no Space Temperature Sensor detected for more than 10 seconds, it is considered a Space Temperature Sensor failure.

You can still use the Space Temperature Sensor input for an Override Command even when a Space Temperature Sensor is not connected. Simply provide a Momentary Push-Button connected between A11 and the Ground Terminal on the same terminal block. Follow the same procedure for initiating Overrides, even on Supply Air Temperature Controlled Cooling-Only HVAC units.

HVAC Modes of Operation

There are 8 possible HVAC Modes of Operation. They are as follows:

- Vent Mode
- Cooling Mode
- Dehumidification Mode
- Heating Mode
- Heat Pump
- Water Side Economizer
- Warm-Up Mode
- Off Mode

Vent Mode Operation

This Mode only applies to the Occupied Mode of Operation. The Vent Mode is defined as the Supply Fan running with no Heating, Cooling, or Dehumidification demand.

Vent Mode can occur during the Occupied Mode if the Space or Entering Air Temperature Sensor is selected as the HVAC Mode Enable Sensor.

NOTE: During Vent Mode, all Cooling and Heating Stages are deactivated. The Static Pressure is still maintained by the Supply Fan VFD or Zoning Bypass Damper Signal since the Supply Fan is still operating in this Mode.

Cooling Mode Operation

Occupied Cooling Mode occurs whenever the HVAC Mode Enable Temperature rises one deadband above the HVAC Cooling Mode Enable Setpoint. The unit will leave the Cooling Mode when the HVAC Mode Enable Temperature falls one deadband below the HVAC Mode Enable Cooling Setpoint. Unoccupied Cooling Mode only occurs if a Space Temperature Sensor is connected to the SA E-BUS Controller or a broadcast of Space Temperature is being received from a General Broadcast Controller and if the Space Temperature is above the Cooling Setpoint.

The Mechanical Cooling will be disabled if the Entering Air Temperature is below the Cooling Lockout Setpoint by 1°F. This gives a 2°F hysteresis around the Cooling Lockout Setpoint to prevent unwanted cycling in and out of Mechanical Cooling Mode. If the Entering Air Temperature disables the Mechanical Cooling while it is currently operating, the Mechanical Cooling will stage off if all staging and run times are satisfied.

If the Water Side Economizer has been enabled for operation, it is used as the first stage of Cooling, and the Mechanical Cooling will be activated if necessary. See the Water Side Economizer Operation section on page 43 for a more detailed operating sequence.

No matter which Sensor is configured for the HVAC Mode Enable, the Supply Air Temperature is always controlled to the Active Supply Air Temperature Setpoint while in the Cooling Mode.

Cooling Mode

Stage Control Window

The Cooling Stage Control Window Setpoint determines when the compressors start to stage down. In the Cooling Mode, as the Supply Air Temperature rises above the Active Supply Air Temperature Setpoint, the Cooling Stages will begin to stage on based on the Cooling Stage Up Delay setting. The Cooling Stages will continue to run until the Supply Air Temperature drops below the Active Supply Air Temperature Setpoint minus the Cooling Stage Control Window. For example, if the Supply Air Temperature Setpoint is 55° and the Cooling Stage Control Window is 5°, as the Supply Air Temperature drops below 50°, the Cooling Stages will begin to stage off based on the Cooling Stage Down Delay setting.

Cooling Staging Delay

Minimum Off Time

A Cooling Stage cannot be activated unless it has been off for this amount of time.

Minimum Run Time

After a Cooling Stage has been activated, it must remain on for this amount of time.

Staging Up Delay

After the first Cooling Stage has been activated, this delay prevents additional stages from activating too quickly before they are needed to achieve the Active Supply Air Temperature Setpoint.

Staging Down Delay

After a Cooling Stage has met its Minimum Run Time and is not needed, this delay prevents additional stages from deactivating too quickly in case they are needed to maintain the Active Supply Air Temperature Setpoint Temperature.

Modulating Cooling

The SA E-BUS Controller can control one of two Modulating Cooling sources. This can either be a Chilled Water Valve or a Copeland Digital Scroll™ Compressor(s). A Copeland Digital Scroll™ Compressor is a Variable Capacity Compressor that has a 10-to-1 turn down ratio. Whichever source is used, the SA E-BUS Controller will control the Modulating Cooling source to maintain the Active Supply Air Temperature Setpoint.

The Modulating Cooling Proportional Window is used to determine the signal to the Modulating Cooling Source and is user-adjustable. The Modulating Cooling signal is calculated based on the differential between the Supply Air Temperature and the Active Supply Air Temperature Setpoint based on the Modulating Cooling Proportional Window.

The Maximum Signal Adjustment per Time Period is 10% and is not user-adjustable. The Minimum Signal Adjustment per Time Period is based on the Modulating Cooling Proportional Window. The larger the Modulating Cooling Proportional Window, the smaller the signal adjustment will be per Time Period. The Time Period is the delay between another increase or decrease in the Modulating Cooling Source Signal and is user-adjustable. For example, if the Modulating Cooling Proportional Window is 5°F, the signal would adjust 2% per °F each Time Period above or below the Active Supply Air Temperature Setpoint. When the Supply Air Temperature is above or below the Active Supply Air Temperature Setpoint by 5°F or more, the signal would adjust 10% each Time Period.

DX Cooling

If the unit is in the Cooling Mode and the Supply Air Temperature is above the Active Supply Air Cooling Setpoint, the following staging sequences will occur.

Units with 2 Digital Compressors

Two Stages of Cooling need to be configured for the two Compressors. If the Water Side Economizer is active, the Economizer valve needs to reach 100% before activating mechanical cooling. When mechanical cooling is active, the Compressors will modulate to maintain the Active Supply Air Cooling Temperature Setpoint.

The First Stage of Cooling (A1) will modulate as required using Analog Output 2 (AO2). If the first stage rises above 60% and remains there for the Stage Up Delay and the Supply Air Temperature (SAT) is above the Active Supply Air Cooling Temperature Setpoint, then the Second Stage of Cooling (A2) will activate. The two Compressors will go to half the position of the first Compressor and will modulate together to maintain the Active Supply Air Cooling Temperature Setpoint.

If both Compressors fall below 30% and remain there for the Stage Down Delay and the Supply Air Temperature Setpoint is below the SAT Setpoint minus the Cooling Stage Control Window, then the Second Stage will deactivate. The first Compressor will go to 60% and it will modulate to maintain the Active Supply Air Cooling Temperature Setpoint.

Units with 4 Digital Compressors (Dual Unit)

The Compressors will Stage Up and Stage Down the same as 2 Digital Compressors. Number 1 Compressors from both units (A1/B1) will modulate together using AO2 and number 2 Compressors from both units (A2/B2) will modulate together using AO3.

Units with 1 Digital Compressor and 1 ON/OFF Compressor

Two Stages of Cooling need to be configured for the two Compressors. If the Economizer is active, the Economizer valve needs to reach 100% before activating mechanical cooling. When mechanical cooling is active, the Digital Compressor will modulate to maintain the Active Supply Air Cooling Temperature Setpoint.

The First Stage of Cooling (A1) will modulate up using AO2. If the First Stage stays at 100% for the Stage Up Delay and the Supply Air Temperature is above the Supply Air Temperature Setpoint, then the Second Stage (ON/OFF A2) will activate while the First Stage is allowed to modulate.

If the Digital Compressor falls below 20% and remains there for the Stage Down Delay and the Supply Air Temperature is below the Supply Air Temperature Setpoint minus the Cooling Stage Control Window, then the Second Stage (ON/OFF) will deactivate.

Units with 2 Digital Compressors and 2 ON/OFF Compressors (Dual Unit)

The Compressors will Stage Up and Stage Down similar to 1 Digital Compressor and 1 ON/OFF Compressor. The two Digital Compressors modulate together as Stage One. The two ON/OFF Compressors are considered the 2nd and 3rd Stage of Cooling.

The first Stage (Digital Compressors A1/B1) will modulate up using AO2. If the First Stage stays at 100% for the Stage Up Delay and the Supply Air Temperature is above the Supply Air Temperature Setpoint, then the Second Stage (A2) will activate while the First Stage is allowed to modulate. This sequence will repeat for the Third Cooling Stage (B2).

If the two Digital Compressors fall below 20% and remain there for the Stage Down Delay and the Supply Air Temperature is below the Supply Air Temperature Setpoint minus the Cooling Stage Control Window, then the Second Stage will deactivate. This sequence will repeat for the Third Cooling Stage.

Air Cooled Condenser Fan Operation

If this is an Air Cooled SA Unit that has an installed Two Condenser Head Pressure Module, whenever the compressor(s) are first activated the signal to the condenser fan will go to 50% for 30 seconds. After this 30 second period, the unit will then monitor the Head Pressure Transducer(s) and modulate the Condenser Fan(s) to maintain the Head Pressure Setpoint (275 psi adjustable). The SA E-BUS Controller can monitor up to two Head Pressure Transducers on a Single SA Unit or up to two Head Pressure Transducers in each unit of a Dual SA Unit. The highest of the two readings in each unit will be used to control the Condenser Fan in that unit.

During Heat Pump Defrost, the Condenser Fan signal will go to 0%. When compressors are not active the Condenser Fan signal will go to 100%.

Water Side Economizer Operation (Valves 1 & 2)

The Water Side Economizer (WSE) is only available if using a Water Cooled Condenser. The WSE is only active in the Cooling Mode and is activated when the Entering Water Temperature drops 10°F (Adjustable) below the Entering Air Temperature.

If the Compressors are Active:

The WSE (Valve 1) will open to 100% and the WSE Bypass (Valve 2) will close to 0%.

If the Compressors are not Active:

If the unit is configured for Constant Flow, the WSE (Valve 1) will modulate to maintain the Active Supply Air Cooling Temperature Setpoint and the WSE Bypass (Valve 2) will modulate opposite.

If the unit is configured for Variable Flow, the WSE (Valve 1) will modulate to maintain the Active Supply Air Cooling Temperature Setpoint and the WSE Bypass (Valve 2) will close.

The Economizer Deactivates as follows:

When the Entering Water Temperature rises to 8°F below the Entering Air Temperature, the WSE will deactivate.

If the unit is configured for Constant Flow, the WSE (Valve 1) will close to 0% and the Economizer Bypass (Valve 2) will open to 100%.

If the unit is configured for Variable Flow, the WSE (Valve 1) will close to 0% and the WSE Bypass (Valve 2) will modulate to maintain Head Pressure (275 psi adjustable). A Two Condenser Head Pressure Module is required.

Water Cooled Condenser (Valve 3)

If the SA Unit has a Water Cooled Condenser and an installed Two Condenser Head Pressure Module, the SA E-BUS Controller can monitor up to two Head Pressure Transducers on a Single SA Unit or up to two Head Pressure Transducers in each unit of a Dual SA Unit. The highest of the two readings in each unit will be used to control the Condenser Valve in that unit.

If the unit is configured for Constant Flow:

When the compressor(s) are first called to activate for Cooling, Dehumidification, or Heat Pump Heating Mode, the signal to the condenser valve will go to 75% for 3 minutes in order to prove water flow. After this 3 minute period, the compressor(s) will energize and the Condenser Valve will modulate to maintain the Head Pressure Setpoint (275 PSI adjustable).

During Heat Pump Heating, the Condenser Valve signal will go to 100%. When compressors are not active, the Condenser Valve signal will go to 100%.

Once Water Flow has been initially proven, the compressors are energized for Cooling, Dehumidification, or Heat Pump Heating. Once the compressor(s) are energized, the only time a loss of water flow will be recognized during Cooling or Dehumidification is if the Condenser Valve is above 70%. If this happens, an alarm will be generated and the compressors(s) will be de-energized. During Heat Pump Heating, anytime there is a loss of water flow, an alarm will be generated and the compressors(s) will be de-energized.

If the unit is configured for Variable Flow and has no Water Side Economizer (WSE):

When compressor(s) are first called to activate, the signal to the Condenser Valve will go to 75% for 3 minutes in order to prove water flow. After this 3 minute period, compressor(s) will energize and the Condenser Valve will modulate to maintain the Head Pressure Setpoint (275 PSI adjustable). During Heat Pump Heating, the Condenser Valve signal will go to 100%.

Water Flow must always be initially proven for the compressors to energize for Cooling, Dehumidification, or Heat Pump Heating. Once the compressor(s) are energized, the only time a loss of water flow will be recognized during Cooling or Dehumidification is if the Condenser Valve is above 70%. If this happens, an alarm will be generated and the compressors(s) will be de-energized. During Heat Pump Heating, anytime there is a loss of water flow, an alarm will be generated and the compressors(s) will be de-energized.

When compressors are not active, the Condenser Fan signal will go to 0%.

Dehumidification Mode

If the unit is configured for Variable Flow and has a Water Side Economizer (WSE):

When compressor(s) are first called to activate, the signal to the Condenser Valve will go to 75% for 3 minutes in order to prove water flow. During this period, the WSE Bypass Valve signal will go to 100%. After this 3 minute period, the compressor(s) will energize, the Condenser Valve signal will go to 100%, and the WSE Bypass Valve will modulate to maintain the Head Pressure Setpoint (275 PSI adjustable). During Heat Pump Heating, the WSE Bypass Valve signal will go to 100%.

Water Flow must always be initially proven for the compressors to energize for Cooling, Dehumidification, or Heat Pump Heating. Once the compressor(s) are energized, the only time a loss of water flow will be recognized during Cooling or Dehumidification is if the WSE Bypass Valve is above 70%. If this happens, an alarm will be generated and the compressors(s) will be de-energized. During Heat Pump Heating, anytime there is a loss of water flow, an alarm will be generated and the compressors(s) will be de-energized.

When compressors are not active, the WSE Bypass Valve signal will go to 100%. When the unit is off, the Economizer (WSE) Valve and WSE Bypass Valve will be closed.

calculated by using an Entering Air Temperature Sensor and an Entering Air Humidity Sensor.

For Chilled Water units, the SA E-BUS Controller opens the Chilled Water Valve to a fixed 100% position to provide full moisture removal capabilities.

For DX Cooling Units, the SA E-BUS Controller will modulate the Copeland Digital Scroll™ Compressor(s) and activate the Fixed Stages as necessary to maintain the Evaporator Coil Temperature Setpoint. The Evaporator Coil Temperature is calculated by using the Suction Pressure Transducer and converting the pressure to temperature.

Coil Temperature Reset

Any time an Indoor Humidity Sensor is used, the Coil Temperature Setpoint will be automatically reset as the humidity rises above or drops below the Indoor Humidity Setpoint. It can reset the Coil Temperature Setpoint by a maximum of 5°F. For example, if the Coil Temperature Setpoint is 45°F and the Indoor Humidity Setpoint is 50% with an actual humidity reading of 55%, the new Coil Temperature Setpoint will be 40°F. If the humidity is below the Indoor Humidity Setpoint, then the Coil Temperature Setpoint will be increased by a maximum of 5°F.

Economizer Flush Cycle

If the Economizer has been closed for 72 hours, a Flush Cycle will be initiated the next time the compressor is activated or at the next 6:00 AM time slot, whichever happens first. During the Flush Cycle, the Economizer Valve will open for 5 minutes and then close again. The 72 hour timer will restart once the Flush Cycle is completed or the Economizer has been activated and has closed again.

Chilled Water Cooling

One Stage of Cooling needs to be configured for the Chilled Water Valve. If the Water Side Economizer is active, the Economizer valve needs to reach 100%, before activating the Chilled Water Valve. When the Chilled Water Valve is active, the valve will modulate to maintain the Active Supply Air Cooling Temperature Setpoint.

External Cooling

The SA E-BUS Controller can be configured to control stages of cooling that are external to the SA Unit.

Dehumidification Mode

On VAV or CAV applications, the Indoor Air Humidity initiates Dehumidification when the Indoor Air Humidity rises 5% above the Indoor Air Humidity Setpoint during the Occupied Mode of operation and likewise stops Dehumidification when the Indoor Air Humidity drops more than 5% below the Indoor Air Humidity Setpoint during the Occupied Mode of operation.

On 100% Entering Air applications, the Entering Air Dewpoint initiates the Dehumidification Mode when the Entering Air Dewpoint rises 2°F above the Entering Air Dewpoint Setpoint during the Occupied Mode of operation and likewise stops Dehumidification when the Entering Air Dewpoint drops more than 2°F below the Entering Air Dewpoint Setpoint during the Occupied Mode of operation. The Entering Air Dewpoint is

Units with 2 Digital Compressors

This application requires 2 Suction Pressure Transducers. The lowest Coil Temperature is used for the Compressor control. Two Stages of Cooling need to be configured for the 2 Compressors. When mechanical cooling is active, the Compressors will modulate to maintain the Coil Temperature Setpoint.

The First Stage of Cooling (A1) will modulate as required using Analog Output 2 (AO2). If the First Stage reaches 100% for the Stage Up Delay and the Coil Temperature is above the Coil Temperature Setpoint, then the Second Stage of Cooling (A2) will activate. The First Stage of Cooling will Lock at 100% and modulate the Second Stage of Cooling.

If the second compressor reaches 0% for the Stage Down Delay and the Coil Temperature is below the Coil Temperature Setpoint minus the Cooling Stage Control Window, then the Second Stage of Cooling will deactivate. The first Compressor will then modulate to maintain the Coil Temperature Setpoint.

Units with 4 Digital Compressors (Dual Unit)

The Compressors will Stage Up and Stage Down the same as 2 Digital Compressors. Number 1 Compressors from both units (A1/B1) will modulate together using AO2 and number 2 Compressors from both units (A2/B2) will modulate together using AO3.

This application requires 2 Suction Pressure Transducers. The lowest Coil Temperature is used for the Compressor control.

Units with 1 Digital Compressor and 1 ON/OFF Compressor

This application requires 2 Suction Pressure Transducers. The lowest Coil Temperature is used for the Compressor control. Two Stages of Cooling need to be configured for the 2 Compressors. When mechanical cooling is active, the Digital Compressor will modulate to maintain the Coil Temperature Setpoint.

The First Stage of Cooling (Digital Compressor A1) will modulate up using AO2. If the First Stage stays above 100% for the Stage Up Delay and the Coil Temperature is above the Coil Temperature Setpoint, then the Second Stage (ON/OFF Compressor A2) will activate. The First Compressor will modulate between 70-100% to provide energy in the Reheat Coil.

If the Digital Compressor stays at 70% for the Stage Down Delay and the Coil Temperature is below the Coil Temperature Setpoint minus the Cooling Stage Control Window, then the Second Stage will deactivate.

Units with 2 Digital Compressors and 2 ON/OFF Compressors (Dual Unit)

The Compressors will Stage Up and Stage Down similar to 1 Digital Compressor and 1 ON/OFF Compressor. The two Digital Compressors modulate together as Stage One. The two ON/OFF Compressors are considered the 2nd and 3rd Stage of Cooling.

This application requires 2 Suction Pressure Transducers. The lowest Coil Temperature is used for the Compressor control.

The First Stage (Digital Compressors A1/B1) will modulate up using AO2. If the First Stage stays above 100% for the Stage Up Delay and the Coil Temperature is above the Coil Temperature Setpoint, then the Second Stage (A2) will activate. The First Compressor will modulate between 70-100% to provide energy in the Reheat Coil. This sequence will repeat for the Third Cooling Stage (B2).

If the two Digital Compressors stay at 70% for the Stage Down Delay and the Coil Temperature is below the Coil Temperature Setpoint minus the Cooling Stage Control Window, then the Second Stage will deactivate. This sequence will repeat for the Third Cooling Stage.

Dehumidification Configuration Options

The SA E-BUS Controller can be configured to have Dehumidification Priority. If configured, the SA E-BUS Controller will enter the Dehumidification Mode when the Dewpoint or Humidity is above the Setpoint regardless of the current Heating or Cooling demands. The Reheat is always controlled to the Active Supply Air Cooling Temperature Setpoint. The Active Supply Air Cooling Temperature Setpoint will change during Heating, Cooling, or Vent Modes. During the Vent Mode, the Supply Air Temperature Setpoint will be a Calculated Setpoint that is halfway between the HVAC Mode Setpoints.

If Dehumidification Priority has not been configured, the SA E-BUS Controller will only enter the Dehumidification Mode during the Vent Mode. The Reheat will be controlled to a Calculated Supply Air Temperature Setpoint that is halfway between the HVAC Mode Setpoints.

Night Dehumidification can also be configured and is used primarily for CAV units that require an Unoccupied Mode of Dehumidification. Night Dehumidification is only activated when the Indoor Air Humidity is above the Indoor Air Humidity Setpoint during the Unoccupied Mode.

NOTE: Compressor Lockout Setpoints are ignored during dehumidification as the compressors are controlled by coil temperature.

Reheat Control

This application requires that at least one Cooling Stage is active. The Modulating Hot Gas Reheat Valve Controller (MHGRV) will modulate the Reheat Valve to maintain the Supply Air Setpoint.

During the Dehumidification Mode, the SA E-BUS Controller activates Cooling to extract moisture from the Supply Air and utilizes either Modulating Hot Gas Reheat, On/Off Hot Gas Reheat, or Heating to warm the Supply Air before entering the building. Modulating Hot Gas Reheat is the standard form of Reheat. The HVAC unit's Heat Source or a Heat Source located in the Supply Air Duct can be used for Reheat if the unit is not equipped with Hot Gas Reheat.

If the unit is equipped with a Modulating Hot Gas Reheat Controller, it is automatically detected by the SA E-BUS Controller. In Dehumidification Mode, as the Cooling causes the Supply Air Temperature to drop, the MHGRV will bypass Hot Gas to the Hot Gas Reheat Coil, raising the Supply Air Temperature back up to the Active Supply Air Temperature Setpoint.

If the unit is equipped with an On/Off Hot Gas Valve, then one of the relays will be configured for Reheat. The Reheat Relay will be activated if the Supply Air Temperature is less than the HVAC Mode Enable Heating Setpoint. The Hot Gas Reheat Relay will remain on during the Dehumidification Mode regardless of the Supply Air Temperature. This is to ensure a steady Supply Air Temperature.

When Heating is used for Reheat instead of Hot Gas Reheat, the SA E-BUS Controller can activate the Heat Source(s) discussed in the Heating Mode section. Heating can also be used in conjunction with Hot Gas Reheat to add additional Reheat for applications that require a higher Supply Air Temperature than what Hot Gas Reheat can provide. When Heating is used in conjunction with Reheat, the SA E-BUS Controller restricts the Heating to one form of Modulating Heat or one stage of External Heat.

Coil Temperature Offset

On systems that have the condensing unit mounted a considerable distance from the air handling unit, the actual Evaporator Coil Temperature can be quite a bit different than the Calculated Coil Temperature based on the Suction Pressure Transducer reading in the condensing unit. You can put in a temperature offset to the Calculated Coil Temperature reading so that it will more closely match the actual Evaporator Coil Temperature. For example, the Suction Pressure Transducer in the condensing unit may give you a Calculated Coil Temperature reading of 30°F, but the actual temperature of the Evaporator Coil in the air handler may be 45°F. To compensate, you can put in a 15°F offset so that the Calculated Coil Temperature reading will read 45°F. This offset prevents the unit from shutting off compressors prematurely based on the fixed 32°F Suction Temperature Low Limit Safety Cutoff Temperature. The maximum amount of offset allowed is $\pm 30^\circ\text{F}$.

Heating Mode

Heating Mode

Occupied Heating Mode occurs whenever the HVAC Mode Enable Temperature falls one deadband below the HVAC Heating Mode Enable Setpoint. The unit will leave the Heating Mode when the HVAC Mode Enable Temperature rises one deadband above the HVAC Heating Mode Enable Setpoint. Unoccupied Heating Mode only occurs if a Space Temperature Sensor is connected to the SA E-BUS Controller or a broadcast of Space Temperature is being received from an General Broadcast Device (GBD-X).

The Mechanical Heating will be disabled if the Entering Air Temperature is above the Heating Lockout Setpoint by 1°F. This gives a 2°F hysteresis around the Heating Lockout Setpoint to prevent unwanted cycling in and out of Mechanical Heating Mode. If the Entering Air Temperature disables the Mechanical Heating while it is currently operating, the Mechanical Heating will stage off if all staging and run times are satisfied.

No matter which Sensor is configured for the HVAC Mode Enable, the Supply Air Temperature is always controlled to the Active Supply Air Temperature Setpoint while in Heating Mode.

Stage Control Window

In the Heating Mode, as the Supply Air Temperature falls below the Active Supply Air Temperature Setpoint, the Heating Stages will begin to stage on based on the Heating Stage Up Delay. The Heating Stages will continue to run until the Supply Air Temperature rises above the Active Supply Air Temperature Setpoint plus the Heating Stage Control Window. For example, if the Supply Air Temperature Setpoint is 140°F and the Heating Stage Control Window is 5°F, as the Supply Air Temperature rises above 145°F, the Heating Stages will begin to stage off based on the Heating Stage Down Delay.

Heating Staging Delay

Minimum Off Time

A Heating Stage cannot be activated unless it has been off for this amount of time.

Minimum Run Time

After a Heating Stage has been activated, it must remain on for this amount of time.

Staging Up Delay

After the first Heating Stage has been activated, this delay prevents additional stages from activating too quickly before they are needed to achieve the Active Supply Air Temperature Setpoint.

Staging Down Delay

After a Heating Stage has met its Minimum Run Time and is not needed, this delay prevents additional stages from deactivating too quickly in case they are needed to maintain the Active Supply Air Temperature Setpoint.

The SA E-BUS Controller supports various forms of Modulating Heat such as SCR Electric Heat, Modulating Hot Water Heat, and Modulating Steam Heat. Whichever form of Modulating Heating is used, the SA E-BUS Controller will modulate the Heat Source to achieve the Active Supply Air Temperature Setpoint.

Modulating Hot Water or Steam Heating

One Stage of Heating needs to be configured for the Modulating Hot Water or Modulating Steam Valve. When the Hot Water or Steam Valve is active, the Valve will modulate to maintain the Active Heating Supply Air Temperature Setpoint.

The Modulating Heating Proportional Window is used to determine the signal to the Modulating Heating Source and is user-adjustable. The Modulating Heating Signal is calculated by the differential between the Supply Air Temperature and the Active Supply Air Temperature Setpoint based on the Modulating Heating Proportional Window. The maximum signal adjustment per Time Period is 10% and is not user-adjustable. The minimum signal adjustment per Time Period is based on the Modulating Heating Proportional Window. The larger the Modulating Heating Proportional Window, the smaller the signal adjustment will be per Time Period. The Time Period is the delay between another increase or decrease in the Modulating Heating source signal and is user-adjustable. For example, if the Modulating Heating Proportional Window is 5°F, the signal will be adjusted 2% per °F each Time Period above or below the Active Supply Air Temperature Setpoint. When the Supply Air Temperature is above or below the Active Supply Air Temperature Setpoint by 5°F or more, the signal will adjust 10% each Time Period. The SA E-BUS Controller can activate two forms of Heating that are classified as Primary and Secondary Heat Sources. The Primary Heat Source used can be SCR Electric Heat, Modulating Hot Water Heat, or Modulating Steam Heat.

External Heat

The SA E-BUS Controller can be configured to control heat sources that are external to the SA Unit. Contact WattMaster Controls for options that can be used in your application.

Air to Air Heat Pump Operation

The SA E-BUS Controller can be configured for Heat Pump applications. The compressors are used for both Heating and Cooling. With the SA E-BUS Controller, the Reversing Valve is activated during Heating operation as the default because AAON® units are typically built to fail to Cooling operation. The Reversing Valve can be configured to activate during Cooling operation for equipment that is built to fail to Heating operation.

Auxiliary Heating Stages are configured as Heat Relays and are used to supplement the Compressor Heating Stages. If the unit is not equipped with Auxiliary Heating Stages, Heating Relays do not need to be configured in order for the unit to provide Heating. Auxiliary Heating can also be Modulating Heat in the form of SCR Electric, Hot Water, or Steam.

The Cooling and Dehumidification Modes operate in the same manner as described under the Cooling and Dehumidification titled sections on pages 41 through 45 of this manual. In the Heating Mode, the SA E-BUS Controller activates the Reversing Valve and stages compressors to provide Heating if the Entering Air Temperature (EAT) is above the EAT Cooling Lockout Setpoint. The compressor heating stages are activated as needed to achieve the Active Supply Air Heating Setpoint. Staged or Modulating Auxiliary Heat can be activated to supplement Compressor Heating in order to achieve the Active Supply Air Heating Setpoint if the EAT is below the EAT Heating Lockout Setpoint. If the EAT is below the EAT Cooling Lockout Setpoint, only Auxiliary Heating will occur. If the EAT is above the EAT Heating Lockout, only Compressor Heating will occur.

For SA applications with an installed Suction Pressure Transducer, a Head Pressure Module and a Head Pressure Transducer(s), a Defrost Mode is available during the Heat Pump Heating operation. The SA E-BUS Controller converts the Suction Pressure to a Suction Temperature. A user-adjustable Suction Temperature Setpoint determines when the unit will go into Defrost Mode during Heat Pump Heating. The unit will operate in Defrost Mode for 10 minutes or until the Head Pressure reaches 450 PSIG.

An Adaptive Defrost Adjustment configuration is available that will automatically adjust the length of the Defrost Timer (interval between Defrost Modes) depending on if the unit stays in Defrost Mode for the full 10 minutes or leaves the Defrost Mode early because of reaching a Head Pressure of 450 PSIG. If Adaptive Defrost is configured and the Defrost Mode is terminated because the 10 minute timer has elapsed, this could indicate that the unit needs more defrost time. In this case, the Adaptive Defrost Adjustment value will be subtracted from the original Defrost Timer to shorten the interval between defrost cycles. If the Defrost Cycle is terminated between the 8th and 9th minute, the Defrost Timer value will not be changed. If the Defrost Cycle is terminated before the 8th minute, this could indicate that the Defrost Timer is too short. In this case the Adaptive Defrost Adjustment value will be inversely proportionally added to the original Defrost Timer as the termination time shortens from 8 minutes to 0 minutes.

Water Source Heat Pump Operation

For Water Source Heat Pump applications, the SA E-BUS Controller is used in conjunction with the Water Source Heat Pump Protection Module. Heating, Cooling, and Dehumidification would operate in the same manner as described in Air to Air Heat Pump Operation; however, defrost operation would not apply.

The Water Source Heat Pump Protection Module provides safeties for Proof of Flow, Low/Unsafe Suction Pressure, and Low Leaving Water Temperature. An E-BUS Distribution Module is used to provide communication from the SA E-BUS Controller to the Water Source Heat Pump Protection Module.

For more detailed sequence and wiring information, see the AAON Tulsa version of the *Water Source Heat Pump Protection Module Technical Guide*.

Morning Warm-Up Mode

For Morning Warm-Up application, the unit must be configured as a VAV unit (Supply Air Temperature control). When the SA E-BUS Controller switches to the Occupied Mode of Operation (not Override Mode), the unit compares the Entering Air Temperature to a Morning Warm-Up Target Temperature. If the Entering Air Temperature is below this Setpoint, the Warm-Up Mode is initiated. This Mode remains in effect until the Entering Air Temperature rises above the Target Temperature or a user-adjustable Time Period expires. Warm-Up Mode is not initiated by Push-Button Overrides or Unoccupied Heating demands.

Once the Warm-Up Mode has been terminated, it cannot resume until the unit has been through a subsequent Unoccupied Mode. Only one Warm-Up Mode is allowed per Occupied cycle.

If you have stand-alone VAV boxes that need to be forced wide open during the Warm-Up Mode, you can configure one of the relay outputs to be used during this Mode. If the Warm-Up Mode is active, the relay is activated. This relay then becomes the Force Open Command for all VAV boxes to which it is wired.

Off Mode

If the schedule has set the Unoccupied Mode and no Heating, Cooling, or Dehumidification demands exist, the SA E-BUS Controller enters the Off Mode. During the Off Mode, the Supply Fan is off.

Supply Air Temperature Setpoint Reset

The SA E-BUS Controller incorporates a dynamic Supply Air Temperature Reset function based on a selected Reset Source. The available Reset Source options are Space Temperature, Entering Air Temperature, Supply Fan VFD Signal, or a Remote Reset Signal. In each case, for the heating mode and the cooling mode, a Low and a High Reset Source Setpoint must be entered that will correspond to a Low and High Supply Air Setpoint. Since the Supply Air Setpoints are not fixed during reset, we refer to them as the “Active Supply Air Temperature Setpoints.” The SA E-BUS Controller uses the HVAC Mode Enable Setpoints to determine the mode of operation. Once the HVAC Mode has been determined, the SA E-BUS Controller will proportionally reset the Supply Air Temperature Setpoint based on the Reset Source condition relative to the Reset Source Low and High Setpoints. For each of the Reset Source options discussed below there is an example of how to set it up in the SA E-BUS Controller Operator Interfaces Technical Guide in the Supply Air Reset configuration screens #4 & #5 and setpoint screens #4 through #7.

If you configure Space Temperature or Entering Air Temperature as the Reset Source, then separately, for the heating mode and the cooling mode you will need to enter a Low and High Reset Source Setpoint and a Low and High Supply Air Temperature Setpoint. This creates a range of Reset Source Temperature Setpoints and a range of Supply Air Temperature Setpoints. As the Reset Source Temperature varies within its range, it will proportionally reset the Supply Air Temperature Setpoint within its reset range. When the temperature at the Reset Source is at the Reset Source Low Setpoint, the Supply Air Temperature Setpoint would be reset to the Supply Air High Setpoint. When the temperature at the Reset Source is at the Reset Source High Setpoint, the Supply Air Temperature Setpoint would be reset to the Supply Air Low Setpoint. When the temperature at the Reset Source is in between its Low and High Setpoints, the Supply Air Setpoint will be proportionally reset between its High and Low Setpoints. When the unit is in the Vent Mode or Vent Dehumidification Mode, the Supply Air Temperature Setpoint will be calculated to be halfway between the HVAC Mode Enable Setpoints. If Dehumidification Priority has been configured and the unit is in Heating Dehumidification or Cooling Dehumidification Mode, the Supply Air Temperature Setpoint is proportionally reset in the same way as in the Heating and Cooling Modes described above in this paragraph.

If the Supply Fan VFD Signal is configured as the Reset Source, then separately, for the heating mode and the cooling mode, you will need to enter a Low and High VFD Signal Setpoint and a Low and a High Supply Air Setpoint. This creates a range of VFD Signal Setpoints and

Duct Static Pressure Control

a range of Supply Air Temperature Setpoints. As the VFD Signal varies within its range, it will proportionally reset the Supply Air Temperature Setpoint within its range. For example, in the Cooling Mode, when the Supply Fan VFD Signal is at its low setpoint, the Supply Air Cooling Setpoint will be reset to its high setpoint; when the Supply Fan VFD signal is at its high setpoint, the Supply Air Cooling Setpoint will be reset to its low setpoint. In the heating mode, the Supply Air Heating Setpoint reset would react in the opposite fashion with the VFD signal at its highest setpoint the Supply Air Heating Setpoint is reset to its highest setpoint, and with the VFD signal at its lowest setpoint the Supply Air Heating Setpoint is reset to its lowest setpoint. In either mode, if the VFD signal is halfway (for instance) between the Low Signal Setpoint and the High Signal Setpoint, the Supply Air Setpoint would be reset to halfway between its High and Low Setpoint. If Dehumidification Priority has been configured and the unit is in Heating Dehumidification or Cooling Dehumidification Mode, the Supply Air Temperature Setpoint is proportionally reset in the same way as in the Heating and Cooling Modes described above in this paragraph. When the unit is in the Vent Mode or Vent Dehumidification Mode, the Supply Air Temperature Setpoint will be calculated to be halfway between the HVAC Mode Enable Setpoints.

If a Remote Reset Signal is configured as the Reset Source, a 0-5 or 0-10 VDC signal can be used to reset the Supply Air Temperature Setpoint. Separately, for the Heating Mode and the Cooling Mode you will need to enter a Low and a High Supply Air Setpoint.

As an example when using a 0-5 VDC signal, when the Reset Signal is at 0 VDC, the Supply Air Setpoint will be at its lowest setpoint for both Heating and Cooling. When the Reset Signal is at 5 VDC, the Supply Air Setpoint will be at its highest setpoint for both Heating and Cooling. As the voltage signal changes between 0 VDC and 5 VDC, the Supply Air Setpoint will be proportionally reset between the Low and High Supply Air Temperature Setpoint for both Heating and Cooling. If Dehumidification Priority has been configured and the unit is in Heating Dehumidification or Cooling Dehumidification Mode, the Supply Air Temperature Setpoint is proportionally reset in the same way as in the Heating and Cooling Modes described above in this paragraph. When the unit is in the Vent Mode or Vent Dehumidification Mode, the Supply Air Temperature Setpoint will be calculated to be halfway between the HVAC Mode Enable Setpoints.

Supply Fan Control

Any time the Supply Fan is requested to start, a timer is checked to make sure the Supply Fan has been off for at least 1 minute. This 1-minute delay is a protection against rapid cycling of the Supply Fan. Once the 1-minute delay has been satisfied, the Supply Fan relay is activated and all other outputs are verified to be in the off condition for a period of 1 to 2 minutes. This short period of Supply Fan-Only Operation serves to purge the stagnant air from the duct before any Heating or Cooling occurs.

Normally, the Supply Fan runs continuously during the Occupied Mode of operation. If the fan is only required to run in the Occupied Mode during Heating, Cooling, or Dehumidification Modes, the SA E-BUS Controller can be configured for Fan Cycle Mode. This means the Fan will only run during Heating, Cooling, or Dehumidification and will be off the rest of the time.

Duct Static Pressure Control

The SA E-BUS Controller reads and controls Static Pressure in the duct system if the Supply Fan has been configured for Duct Static Pressure Control. Any time the Supply Fan is operating, the SA E-BUS Controller is controlling Duct Static Pressure. The Duct Static Pressure Setpoint and Deadband limits are user-adjustable along with a Control Interval. This Control Interval is the amount of time that elapses between each adjustment to the Duct Static Pressure Control Output Signal. The default period is 10 seconds and should not be changed unless close observation reveals that the Supply Fan is hunting and not maintaining a stable pressure reading. The Static Pressure Control Output Signal can be used to control a Supply Fan VFD or a Zoning Bypass Damper Actuator.

The Duct Static Pressure Control Output Signal is a non-configurable Direct Acting Signal (0-10 VDC). This Output Signal can be used to directly connect to a Supply Fan VFD. The Output Signal increases (increases VFD Speed) if the Duct Static Pressure is below the Duct Static Pressure Setpoint by the Deadband amount, and the Output Signal decreases (decreases VFD Speed) if the Static Pressure is above the Setpoint by the Deadband amount.

Since the Duct Static Pressure Control Output Signal is a non-configurable Direct Acting Signal (0-10 VDC), when you are using a Zoning Bypass Damper Actuator to control the Duct Static Pressure, you must set up the Zoning Bypass Damper Actuator on the Zoning Bypass Damper so that it is Reverse Acting in operation. The Output Signal increases (closes Zoning Bypass Damper) if the Duct Static Pressure is below the Duct Static Pressure Setpoint by the Deadband amount, and the Output Signal decreases (opens Zoning Bypass Damper) if the Static Pressure is above the Setpoint by the Deadband amount.

If the Static Pressure ever rises 0.5" above the Duct Static Pressure Setpoint, the Duct Static Pressure Control Output Signal will be cut in half every control period until the Static Pressure is brought under control. This is to prevent damage to the ductwork if all the VAV boxes are closed or some other blockage occurs in the ductwork.

Warning: The manufacturer does not assume responsibility for protecting the equipment from over-pressurization! You should always install mechanical high static protection cutoffs to protect your system!

Any time the Supply Fan is off, the Duct Static Pressure Control Output Signal will remain at zero volts. If the Supply Fan control is not configured for Duct Static Pressure Control, you can still monitor the Duct Static Pressure if the Duct Static Pressure Sensor is installed; however, no control will occur.

Duct Static Pressure Control for Filter Loading

In order to maintain a constant CFM through the supply air ducts on a mixed air CAV unit, the SA E-BUS Controller can utilize a Duct Static Pressure Sensor (used to monitor the discharge pressure) in conjunction with a Supply Fan VFD. If the filters are getting dirty, the SA E-BUS Controller will ramp up the VFD to compensate for the decrease in airflow. To utilize this feature, the unit must be configured to use VFD Fan Control. This feature cannot be used if this is a VAV or Zoning application with typical Duct Static Pressure Control.

Pre-Heater Operation, Entering Air Lockouts & Supply Air Cutoffs

Pre-Heater Operation

In colder climates where freezing temperatures are sometimes experienced, it is desirable to preheat the Entering Air being drawn into the HVAC unit before it reaches the Water Coils to prevent freezing. The Pre-Heater control option is available by setting a Low Ambient Protection Setpoint and by configuring one of the relay outputs as a Pre-Heater. Only one relay can be configured for this option, and therefore, staging of Pre-heater relays is not available. The Pre-Heater operation will only operate in the Occupied Mode.

The Pre-Heater sequence operates so that any time during the Occupied mode, if the Entering Air Temperature is below the Low Ambient Protection Setpoint and the Supply Fan is running, the Pre-heater Relay will activate. It will remain on until the Entering Air Temperature rises 1°F above the Setpoint or until the Supply Fan shuts down. If the Proof of Flow option is installed and configured, its signal must also be active for the Pre-Heater Relay to activate.

Entering Air Lockouts

The Entering Air Cooling and Heating Lockouts Setpoints are designed to prevent unwanted Mechanical Heating or Cooling operation during certain Entering Air Temperature conditions.

When the Entering Air Temperature is below the Cooling Lockout Setpoint, no Mechanical Cooling can operate. However, if the unit is equipped with a Water Side Economizer (WSE) and the SA E-BUS Controller is configured to use the WSE, it can be used to provide free Cooling when the Mechanical Cooling is locked out. For Heat Pumps, the Cooling Lockout also applies to Compressor Heating, which means it usually will be a lower setting than on Cooling units that are not Heat Pumps.

The Entering Air Heating Lockout operates so that when the Entering Air Temperature is above the Entering Air Heating Lockout Setpoints, no Mechanical Heating can operate. This applies to any type of Heating except Compressor Heating as used on Heat Pumps. The lockout for Compressor Heating is explained in the previous paragraph regarding Cooling Lockout Setpoints.

Supply Air Cutoffs

The Supply Air Temperature Cutoffs are designed to prevent extremely High and Low Temperature Supply Air from entering the building.

High Supply Air Temperature Cutoff

High Supply Air Temperature Cutoff is initiated when the Supply Air Temperature rises above the HI SAT Cutoff Setpoint. When this occurs, Heating stages will be deactivated until the Supply Air Temperature falls 5°F below the HI SAT Cutoff Setpoint.

Low Supply Air Temperature Cutoff

Low Supply Air Temperature Cutoff is initiated when the Supply Air Temperature falls below the LO SAT Cutoff Setpoint. If the SA E-BUS Controller is in WSE Operation, Vent Mode, or Heating Mode and the Supply Air Temperature falls below the LO SAT Cutoff Setpoint for 10 minutes, it is assumed a Mechanical Failure has occurred and all Heating will be deactivated and the Supply Air Fan will shut off. If the SA E-BUS Controller is in the Cooling or Dehumidification Mode and the Supply Air Temperature falls below the LO SAT Cutoff Setpoint, the Cooling Signal or Cooling Stages will immediately begin deactivating.

To restore normal operation, one of the following three things must occur:

1. The Supply Air Temperature rises above the LO SAT Cutoff Setpoint by 5°F.
2. The SA E-BUS Controller goes from Occupied to Unoccupied or from Unoccupied to Occupied Mode.
3. The SA E-BUS Controller's power is cycled.

SA E-BUS Controller Alarms

Sensor Failure Alarms

Supply Air Temperature Sensor Failure Alarm

The Supply Air Temperature Sensor Failure Alarm is generated when the controller detects an open or short circuit on the Supply Air Temperature Sensor input. Once the alarm is generated, the unit will be completely shut down. If a sensor is properly detected after the unit has alarmed, the alarm will be cleared and the unit will restart operations.

Entering Air Temperature Sensor Failure Alarm

The Entering Air Temperature Sensor Failure Alarm is generated when the controller detects an open or short circuit on the Outdoor Air Temperature Sensor input.

Space Temperature Sensor Failure Alarm

If the Space Sensor is configured as the Controlling Sensor (Mode Enable Sensor) or as the Reset Sensor, and if the controller detects an open or short circuit on the Space Sensor input, then a Space Temperature Sensor Failure Alarm is generated. If the Space Sensor is configured as the Controlling Sensor and the Failure Alarm is generated, the unit will shut down. If the Space Sensor is only configured as a Reset Sensor and the Failure Alarm is generated, the Space Temperature will default to a value half way between the Heating and Cooling Mode Enable Setpoints, and the unit will continue to run.

Mechanical Failure Alarms

Mechanical Cooling Failure

The Mechanical Cooling Failure Alarm is generated if the Supply Air Temperature fails to drop 5 degrees (within a user-adjustable time period) from the temperature the supply air was at when the cooling was activated. The alarm will be cleared when the Supply Air Temperature drops the 5 degrees and sets the failure timer back to zero. This alarm does not apply for Modulating Cooling.

Mechanical Heating Failure

The Mechanical Heating Failure Alarm is generated if the Supply Air Temperature fails to rise 5 degrees (within a user-adjustable time period) from the temperature the supply air was at when the heating was activated. The alarm will be cleared when the Supply Air Temperature rises the 5 degrees and sets the failure timer back to zero. This alarm does not apply for Modulating Heating.

Proof of Air Flow Alarm

A Proof of Flow switch (by others) provides a 24 VAC wet contact closure when the Supply Fan is operating. If this contact opens while the fan is being called to run, all heating and cooling is disabled, and a Fan Proving Alarm is generated. Fan Proving needs to be configured for this alarm to occur.

Dirty Filter Alarm

A differential pressure switch (by others) is used to provide a 24 VAC wet contact closure to indicate a dirty filter status. A Dirty Filter Alarm is then generated. Dirty Filter needs to be configured for this alarm to occur.

Emergency Shutdown (Smoke) Alarm

A 24 VAC wet contact input is available to be used when a N.C. Smoke Detector, Firestat, or other shutdown condition occurs. If this contact opens, it will initiate shutdown of the SA and will generate an alarm condition. This contact closure does not produce an instantaneous shutdown. Emergency Shutdown needs to be configured for this alarm to occur.

For instantaneous shutdown, the device initiating the open condition on this contact should also be wired to cut the 24 V common to the SA relay outputs.

Proof of Water Flow Failure

A Proof of Water Flow Switch, that provides a wet contact closure whenever the Condenser Water Valve is operating, can be connected to this unit.

If the Proof of Flow Switch contact opens while the Condenser Water Valve is operating, the unit will enter the Water Proof of Flow Failure mode. In this mode, the mechanical cooling will be deactivated and the Condenser Water Valve will be forced to 100%.

The unit will exit this mode when the Water Proof of Flow Switch is closed again and water flow is proven.

Drain Pan Overflow Failure

A Drain Pan Overflow Switch provides a wet contact closure whenever the Supply Fan is operating and the Drain Pan is not in an overflow condition. If this contact opens while the Supply Fan is operating, the controller will enter Drain Pan Overflow Failure Mode and deactivate mechanical cooling.

Failure Mode Alarms

High and Low Supply Temp Alarm

These alarms are activated when the Supply Air Temperature (SAT) rises above the High Cutoff Temperature Setpoint (immediate) or drops below the Low Cutoff Temperature Setpoint (for 10 minutes). Both cutoff setpoints are user-adjustable. This mode shuts off the unit (with a 3 minute fan off delay) until the mode is cancelled.

This mode is cancelled when the SAT drops 5 degrees below the High Cutoff Temperature Setpoint or rises 5 degrees above the Low Temp Cutoff Temperature Setpoint, or when the unit changes back into Occupied Operation.

High and Low Control Temp Failure

When the Controlling Sensor Temperature rises above the Cooling Mode Enable Setpoint plus the Control Mode High Alarm Offset setpoint, the controller will generate a High Control Temp Failure Alarm.

When the Controlling Sensor Temperature drops below the Heating Mode Enable Setpoint minus the Control Mode Low Alarm Offset setpoint, the controller will generate a Low Control Temp Failure Alarm.

Both offset setpoints are user-adjustable.

Module Alarm

This alarm applies to any E-BUS Module communicating with the SA E-BUS Controller. The E-BUS modules include the Two Condenser Head Pressure Module and Water Source Heat Pump Module. If any of these modules stop communicating with the SA E-BUS Controller or if there is an alarm on one of these modules, this Module Alarm will be generated.

VAV/Zone Controller Alarms

Space Sensor Failure Alarm

If the controller detects an open or short on the Space Sensor input, this alarm will be generated.

CFM Sensor Failure Alarm

If the Air Flow Constant (K Factor) is set to any value other than zero, and the controller does not detect the Airflow Sensor, this alarm will be generated.

Damper Opening Alarm

After initial calibration, if the damper is called to be fully open and cannot reach that position within approximately 2 minutes, this alarm will be generated.

Damper Closing Alarm

After initial calibration, if the damper is called to be fully closed and cannot reach that position within approximately 2 minutes, this alarm will be generated.

High Space Temp Alarm

If the zone temperature is above the Cooling Setpoint by the Hi Zone Alarm Offset (user adj.) for the Zone Alarm Delay Period (user adj.), this alarm will be generated.

Low Space Temp Alarm

If the zone temperature is below the Heating Setpoint by the Lo Zone Alarm Offset (user adj.) for the Zone Alarm Delay Period (user adj.), this alarm will be generated.

Damper Feedback Failure Alarm

If the controller fails to detect the actuator feedback signal, this alarm will be generated.

Scheduling

The SA E-BUS Controller has an internal power source for the Real Time Clock (RTC) that allows the controller to keep the time and accurately control scheduling. It can also broadcast the time to the VAV/Zone Controllers if that option is configured.

The SA E-BUS Controller has an internal 7-day Schedule with 2 Start/Stop Events per day. You can also have 1 Holiday Schedule with 2 Start/Stop Events per day. This Holiday Schedule can be used for 14 different Holiday periods.

You can change the time on the SA E-BUS Controller through the Modular Service Tool, Modular System Manager, or the System Manager TS. You can also broadcast the time and date to all SA E-BUS Controllers by using a Personal Computer and the Prism Computer Front-End Software.

The Internal Scheduling in the SA E-BUS Controller also includes a Self-Teaching Optimal Start Routine that can be activated by entering a value of 1.0 or greater for the Soak Multiplier Setpoint. The Optimal Start function can only be used if your SA E-BUS Controller has a Space Temperature Sensor installed and it is being used as the Controlling Sensor or if you are using WattMaster VAV/Zone controllers with the SA E-BUS Controller.

No adjustments other than the Soak Multiplier are required because the SA E-BUS Controller monitors how long it takes to reach the Target Temperature each day and adjusts the Starting Time accordingly. That means the first day you operate your HVAC unit, it will not be able to Optimally Start because it does not have a history of previous Starts and their results. After the first day, the SA E-BUS Controller will begin adjusting the Start Time, and after six Normally Scheduled Starts have occurred, the Optimal Start Routine will have gathered enough data to provide an accurate Pre-Start based on the learned conditions. This is an ongoing learning process of the six previous starts, so the unit automatically adjusts for the changing seasons. If you don't need this feature, but you are using the Space Temperature Sensor as the Controlling Sensor, you can set the Soak Multiplier to zero to eliminate the Optimal Start Routines.

Internal Trend Logging

The SA E-BUS Controller continuously maintains an Internal Trend Log, which records a fixed set of values at a user-programmed interval. These values can be retrieved only with the Prism Computer Front-End Software. If you do not have a computer with Prism Software installed and connected to the system communications loop, you do not have access to these logs.

There are 120 log positions available. Once the last (120th) position has been recorded, the log jumps back to the first position and begins overwriting the old data. This means the you will need to retrieve the logs at an interval that is shorter than the duration of the last 120 logs

Shown below are some log intervals and the duration of 120 logs.

1 minute interval	= 2 hours
12 minute interval	= 24 hours
15 minute interval	= 30 hours
30 minute interval	= 60 hours
60 minute interval	= 120 hours

The fixed items in the log are listed below:

- Date
- Time
- Space Temperature
- Entering Water Temperature
- Entering Air Temperature
- Cooling Setpoint
- Heating Setpoint
- Supply Air Temperature
- Supply Air Temperature Setpoint
- Entering Humidity
- Space Humidity
- Water Side Economizer Position (Analog Output #1)
- VFD Fan (Analog Output #2)
- Modulating Heating (Analog Output #1)
- Modulating Cooling Stage 1 (Analog Output #2)
- Digital Compressor Stage 2 (Analog Output #3)
- Modulating Reheat Position
- Coil A Suction Pressure
- Coil B Suction Pressure
- Circuit A Head Pressure
- Circuit B Head Pressure
- Condenser Signal A
- Condenser Signal B
- WSE Bypass A
- WSE Bypass B
- On Board Relay Status (Bit Pattern)
- Expansion Module Relay Status (Bit Pattern)

These items and values are explained in greater detail in the *Prism Computer Front-End Software Technical Guide*.

Force Modes or Overrides

Warning: No equipment protection is available during the Force Mode of operation. That means you could start a compressor without running the Supply Fan or could create other conditions that WILL damage the equipment. WattMaster Controls assumes no responsibility or liability for the misuse of Overrides that cause damage to the equipment!

The SA E-BUS Controller relay and analog outputs can be user-overridden if the Modular Service Tool or the Prism Computer Front-End Software is used. The System Manager cannot be used for these Force Modes. The Modes of operation for the relays are as follows:

- 0 = Normal Operation
- 1 = Forced ON
- 2 = Forced OFF

The Analog Outputs are Forced when you specify a value between 0.0 and 10.0 VDC. To cancel the Force Mode, you must enter a value less than zero, such as -1.0 VDC.

When the Analog Outputs are Forced, the display on the Modular Service Tool or Prism program can be interpreted as the actual voltage. During normal operation, the display indicates the percentage signal applied based on the user-defined voltage limits. For example, if you define a 2.0 VDC to 10.0 VDC range, then 50% would be 6.0 VDC instead of the 5.0 VDC applied when the range is 0.0 VDC to 10.0 VDC.

As previously mentioned, Force Modes can only be activated when using either the Modular Service Tool or the Prism Computer Front-End Software. Furthermore, the Override condition can only remain in effect as long as one of these Operator Interface devices is connected and communicating with the SA E-BUS Controller. That means that you cannot Force an Override condition and then walk away from the equipment with the Override still active. The loss of communications, removal, or shutdown of the Operator Interface will automatically terminate the Override within 10 minutes. This protects the equipment and prevents an Override condition from remaining active indefinitely, resulting in inefficient or dangerous operation of the equipment.

VAV Terminal Unit Controller Compatibility

The SA E-BUS Controller is designed to communicate with Orion VAV/Zone Controllers. The SA E-BUS Controller can be configured to broadcast its Internal Schedule, Time, and Date, Fan and Heat Status, and Supply Air Temperature. The SA E-BUS Controller can also broadcast Force to Max or Force to Fixed Position during Morning Warm-up. The Orion VAV/Zone Controllers broadcast Push-Button Overrides from Unoccupied to Occupied. The controllers can also generate Unoccupied Heating and Cooling calls to the SA E-BUS Controller based on Setbacks.

If you are using another manufacturer's VAV Terminal Unit Controllers, the SA E-BUS Controller can activate a relay to inform the VAV/Zone Controllers that the SA E-BUS Controller is operating in Warm-up Mode. No other information can be passed between the SA E-BUS Controller and the other manufacturer's VAV Terminal Unit Controllers. This means that Overrides or Unoccupied Heating and Cooling calls cannot activate the SA E-BUS Controller. If you need any of these capabilities, you must use only Orion VAV/Zone Controllers for controlling all of your VAV Terminal Units.

VAV/Zone System

When the SAE-BUS Controller goes into the Occupied Mode, it initiates Morning Warm-up if the Entering Air Temperature is below the Morning Warm-up Target Temperature Setpoint. During Morning Warm-Up, the VAV/Zone Controllers will modulate open if the Space Temperatures are too cold. They can also move to their Maximum Airflow or Fixed Airflow Position Setpoint if they receive this broadcast from the SA E-BUS Controller. Once Morning Warm-up has been satisfied, the SA E-BUS Controller enters the Cooling Mode and the VAV/Zone Controllers will modulate to satisfy their Space Temperature Setpoints. If the Space Temperature falls below the Heating Setpoint, staged or modulating Reheat can be activated to warm the space.

Communications between the SA E-BUS Controller and the VAV/Zone Controllers are handled by the MiniLink Polling Device. Alarm Polling and Tenant Overrides are also monitored by the MiniLink Polling Device. Tenant Overrides are overrides generated by the Space Temperature Sensor's push button. The MiniLink Polling Device records the start and stop times and total run times of the overrides on a daily and monthly basis. A computer running Prism Computer Front-End Software is required to retrieve all data acquired by the MiniLink Polling Device.

Zoning System

The SA E-BUS Controller automatically configures itself for Voting Control when the MiniLink Polling Device is installed and is configured as a Voting System. The SA E-BUS Controller sets the HVAC Mode Enable to the Entering Air Temperature Sensor as soon as communication is acquired with the MiniLink Polling Device. If the VAV/Zone controllers are configured for Voting, the MiniLink Polling Device totals the Heating and Cooling demands and determines which HVAC Mode the SA E-BUS Controller should be in. The MiniLink Polling Device broadcasts a forced Heating, Cooling, or Vent Mode of operation to the SA E-BUS Controller. Once the SA E-BUS Controller receives the broadcast to set the HVAC Mode, it operates as previously described in the SA E-BUS Controller Sequence of Operations. If communications are lost, the SA E-BUS Controller returns to its own control and will maintain the HVAC Mode Enable Setpoints by using the Entering Air Temperature Sensor as the Controlling Sensor.

Using LEDs To Verify Operation

The SA E-BUS Controller is equipped with 4 LEDs that can be used as very powerful troubleshooting tools. See **Figure 31** below for the LED locations. The LEDs and their uses are as follows:

REC - This LED will light up to indicate system communications.

POWER - This LED will light up to indicate that 24 VAC power has been applied to the controller.

STATUS 1 - This is the diagnostic blink code LED. It will light up and blink out diagnostic codes. STATUS 1 LED also represents the tens column in the address blink code.

STATUS 2 - This is the diagnostic blink code LED. It will light up and blink out diagnostic codes. STATUS 2 LED also represents the ones column in the address blink code.

POWER LED Operations

When the SA E-BUS Controller is powered up, the POWER LED should light up and stay on continuously. If it does not light up, check to be sure that you have 24 VAC connected to the controller, that the wiring connections are tight, and that they are wired for the correct polarity. The 24 VAC power must be connected so that all ground wires remain common. If after making all these checks, the POWER LED does not light up, please contact WattMaster Controls Technical Support for assistance.

REC LED Operations

When power is applied to the controller, the REC LED will also light up. If this is a Stand Alone System (one controller only on the loop) or an Interconnected System (several SA E-BUS Controllers tied together without a CommLink), the REC LED will glow continuously. The REC LED will flicker when you are connected to the SA E-BUS Controller and you are entering setpoints with the Modular Service Tool or one of the System Managers. It will also flicker if this is a Networked System. If this is a Networked System (the system has a CommLink installed),

the REC LED should flicker rapidly, indicating that the system is communicating. A “flicker” is defined as a brief moment when the LED turns off and then back on. It may be easier to see this “flicker” if you cup your hand around the LED.

If the REC LED does not operate as indicated above, first check the address switch setting. Verify the address switch as outlined in the Diagnostic LEDs Operations section on page 55. See **Figure 29** on page 36 for complete address switch setting instructions.

NOTE: STATUS 1 LED represents the tens position and STATUS 2 LED represents the ones position of the controller address. If the address of the controller is set to 59 with the address switch, first STATUS 1 LED will blink 5 times, and then STATUS 2 LED will blink 9 times.

If the address switch setting is correct and the REC LED still does not behave as indicated above, check to be sure the operator’s interface is connected correctly. If you are using the Modular Service Tool, verify that it is plugged in securely to the DIN connection on the SA E-BUS Controller. If you are using one of the System Manager Operator’s Interfaces, see the *SA E-BUS Controller Operator Interfaces Technical Guide* or the *System Manager TS Operator Interfaces Technical Guide* for a connection diagram.

If the REC LED still does not behave correctly, check the voltages at the communications terminal block. Be sure the Controller is powered up for this test. Unplug the communications terminal block from the controller and check the DC voltage between T and SHLD and between R and SHLD. Check the voltage with a digital multimeter set to DC volts. The voltage should be between 3.0 to 3.2 VDC between SHLD and either T or R. If the voltage is not in this range, you probably have a damaged driver chip that must be replaced.

For driver chip replacement instructions, please see the *Orion Controls SA E-BUS Controller Component & System Wiring Technical Guide* for more information or contact the factory for further assistance.

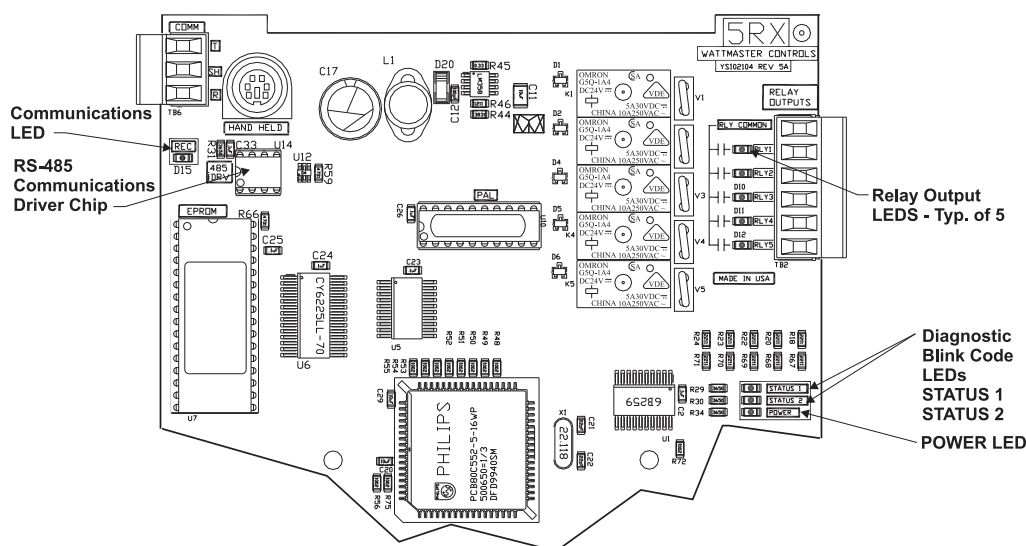


Figure 31: SA E-BUS Controller Diagnostic LED Locations

Diagnostic LED Operation

When power is first applied, the STATUS 1 and STATUS 2 LEDs will be off for 1 second. At this time, both LEDs will blink to indicate the setting of the address switch and then will extinguish for 5 seconds. Verify that the address switch setting is correct by counting the number of blinks.

If the address switch is not correct, first remove the communication loop terminal plug from the controller and then from the power terminal plug. Set the address dip switches correctly. See **Figure 29** on page 36 for correct address switch setting instructions. After you are sure the address switch setting is correct, first reconnect the power connection and then reconnect the communication loop connection to the controller.

NOTE: You must always cycle power to the Controller being addressed after changing address switch settings in order for the changes to take effect.

Reapply power to the controller and observe the blink code to verify the address is set correctly. If the STATUS 1 and STATUS 2 LEDs now blink the correct address, your controller is addressed correctly. If they don't light up at all, the controller is not operating correctly and could be defective. Once the controller is done blinking the address, STATUS 2 LED will blink continuously for 30 seconds while the controller calibrates. Once the controller is done calibrating, the LEDs will blink a code every 10 seconds to indicate controller status. See **Table 3** for a list of the various blink codes and their meanings.

If all of these tests are made and the controller still doesn't operate, please contact WattMaster Controls Technical Support at 866-918-1100.

Blink Code Description	STATUS 1 LED Blinks	STATUS 2 LED Blinks
Normal Operation	0	1
Supply Air Temp Sensor Fail	1	2
Entering Air Temp Sensor Fail	2	2
Space Sensor Failure	3	2
Module Alarm	4	2
Mechanical Cooling Failure	1	3
Mechanical Heating Failure	2	3
Fan Proving Failure	3	3
Dirty Filter Alarm	4	3
Emergency Shutdown	5	3
Water Flow Alarm	6	3
Drain Pan Alarm	7	3
Low Supply Air Temp Alarm	1	4
High Supply Air Temp Alarm	2	4
Control Temp Cooling Failure	3	4
Control Temp Heating Failure	4	4
Push Button Override	1	5
Zone Override	2	5
Output Force Active	0	6

Table 3: Diagnostic LED Blink Code Interpretation

System Configurations

System Configuration Options

The SA E-BUS Controller can be used as a Stand-Alone System (one SA E-BUS Controller only), connected together on an Interconnected System (multiple SA E-BUS Controllers only) or connected together on a Network System (multiple SA E-BUS Controllers, VAV/Zone Controllers, or Add-On Controllers) to form a complete Orion Controls System that can be programmed and monitored with one or more of the available Orion Operator Interfaces.

For detailed information about the various Orion Controls Systems that are available and their related wiring requirements and options, please see the *Orion Systems Technical Guide*.

Operator Interfaces

The Orion Operator Interfaces are designed to provide for programming and monitoring of SA E-BUS Controller(s) and/or any VAV/Zone or Add-on Controller(s) connected to your Orion System. The Operator Interfaces available for use with the Orion Systems are as follows:

- Modular Service Tool SD
- Modular System Manager SD
- Personal Computer with Prism 2 Computer Front End Software Installed

You can use any one of these interfaces or all of them on the same Orion System.

Stand-Alone System

The Stand-Alone System is used when you have a single SA E-BUS Controller only. Programming and status monitoring are accomplished by selecting and installing one or more of the Operator Interfaces.

See **Figure 33** on page 57 for a Typical Stand-Alone System Layout diagram.

Interconnected System

The Interconnected System is used when you have multiple SA E-BUS Controllers on your job. With this system, you simply connect the controllers together using WattMaster communications wire or 18-gauge, 2-conductor twisted pair with shield wire (Belden #82760 or equivalent). This allows for all controllers that are connected on the communications loop to be programmed and monitored from one or more of the available Operator Interfaces connected on the communications loop.

See **Figure 34** on page 58 for a Typical Interconnected System Layout diagram.

Networked System

If you have 1 to 59 SA E-BUS Controllers that require information sharing, simply connect the controllers together using WattMaster communications wire or 18-gauge, 2-conductor twisted pair with shield wire (Belden #82760 or equivalent). The Networked Single Loop System requires that either a MiniLink PD communication interface and/or CommLink communication interface are purchased and wired into the communications loop in a similar manner to the SA E-BUS Controllers.

The Networked Multiple Loop system is used when you have more than 59 SA E-BUS Controllers and/or are using multiple SA E-BUS Controllers that are connected to VAV/Zone controllers. These groups of controllers are broken up into multiple “Local Loops” that connect to each other via the “Network Loop.” Each individual MiniLink PD handles its specific local loop’s communications requirements. The CommLink communications interface handles all the communications between the individual MiniLink PDs to form the network loop. Up to 60 local loops can be connected together with this configuration. This provides the capability for over 3500 controllers to be networked together.

See **Figure 35** on page 59 for a Typical Networked System Layout diagram.

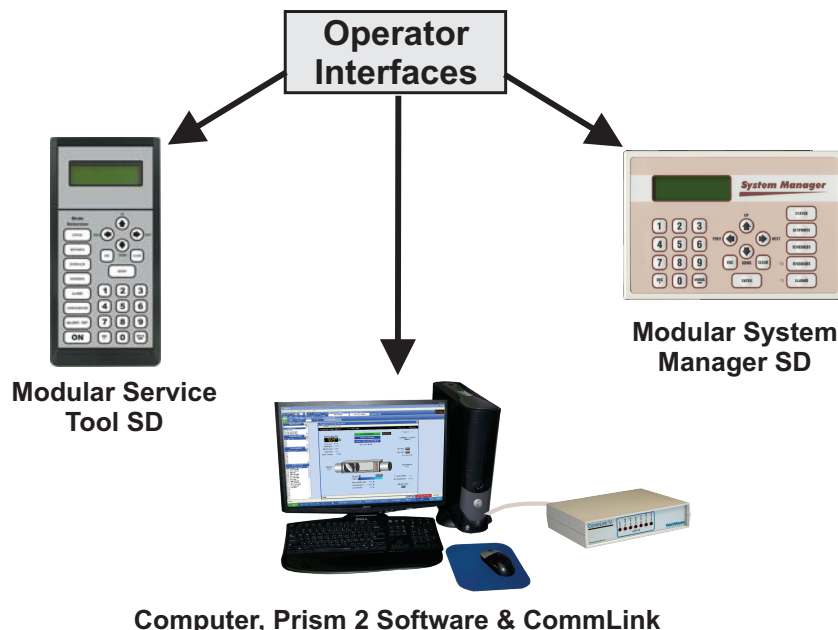


Figure 32: Available Operator Interfaces

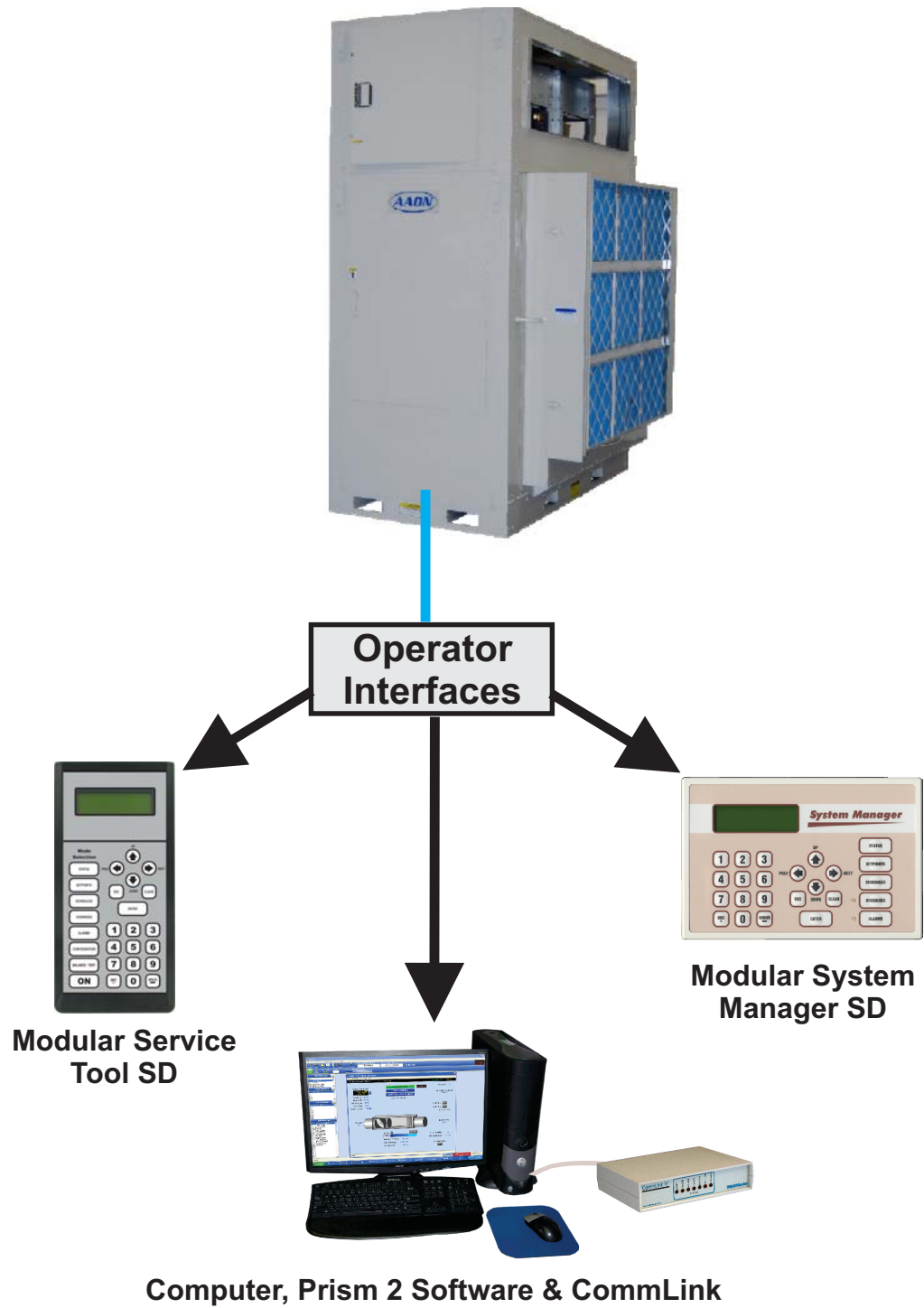


Figure 33: Typical Stand-Alone System Layout

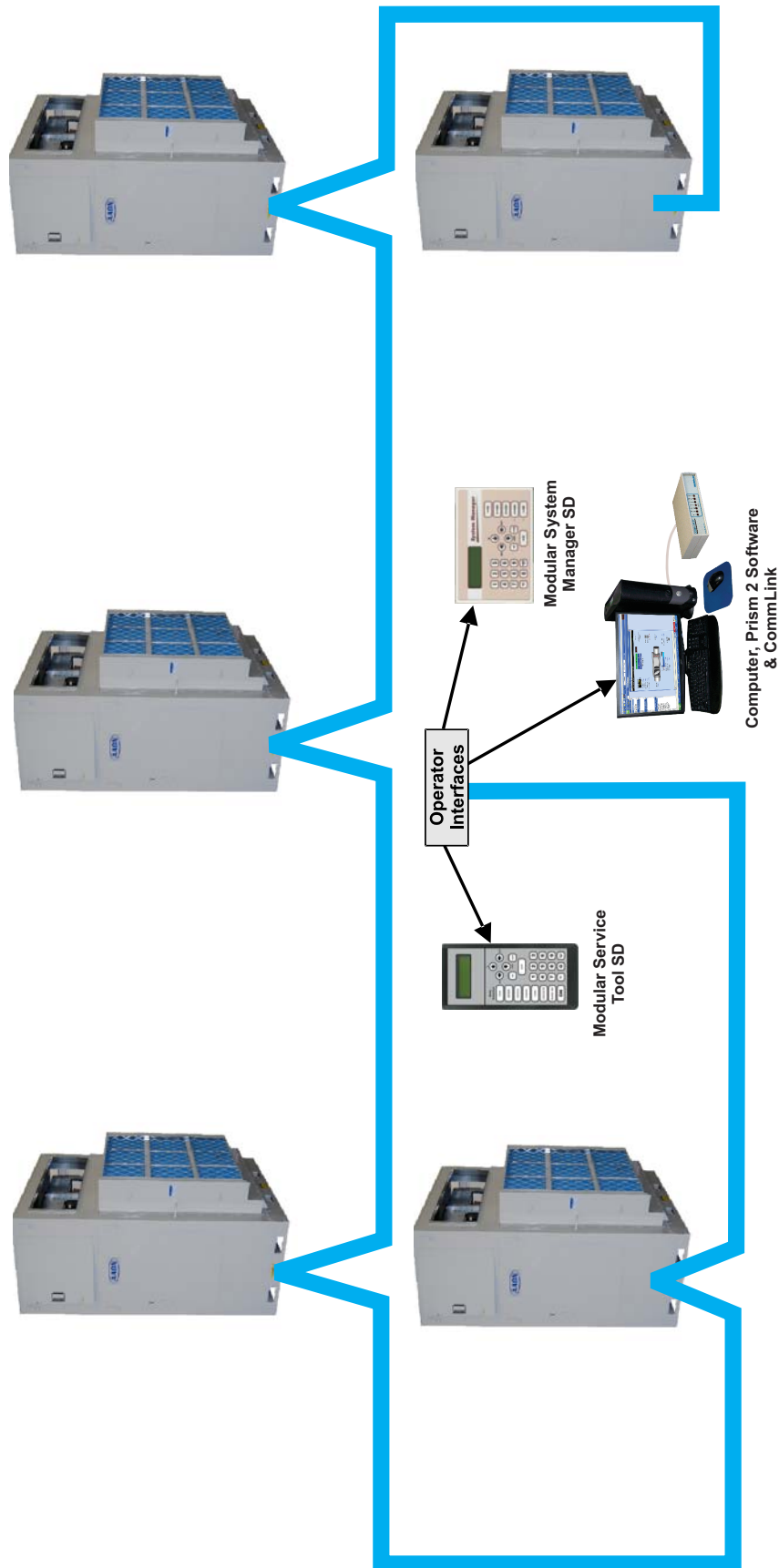


Figure 34: Typical Interconnected System Layout

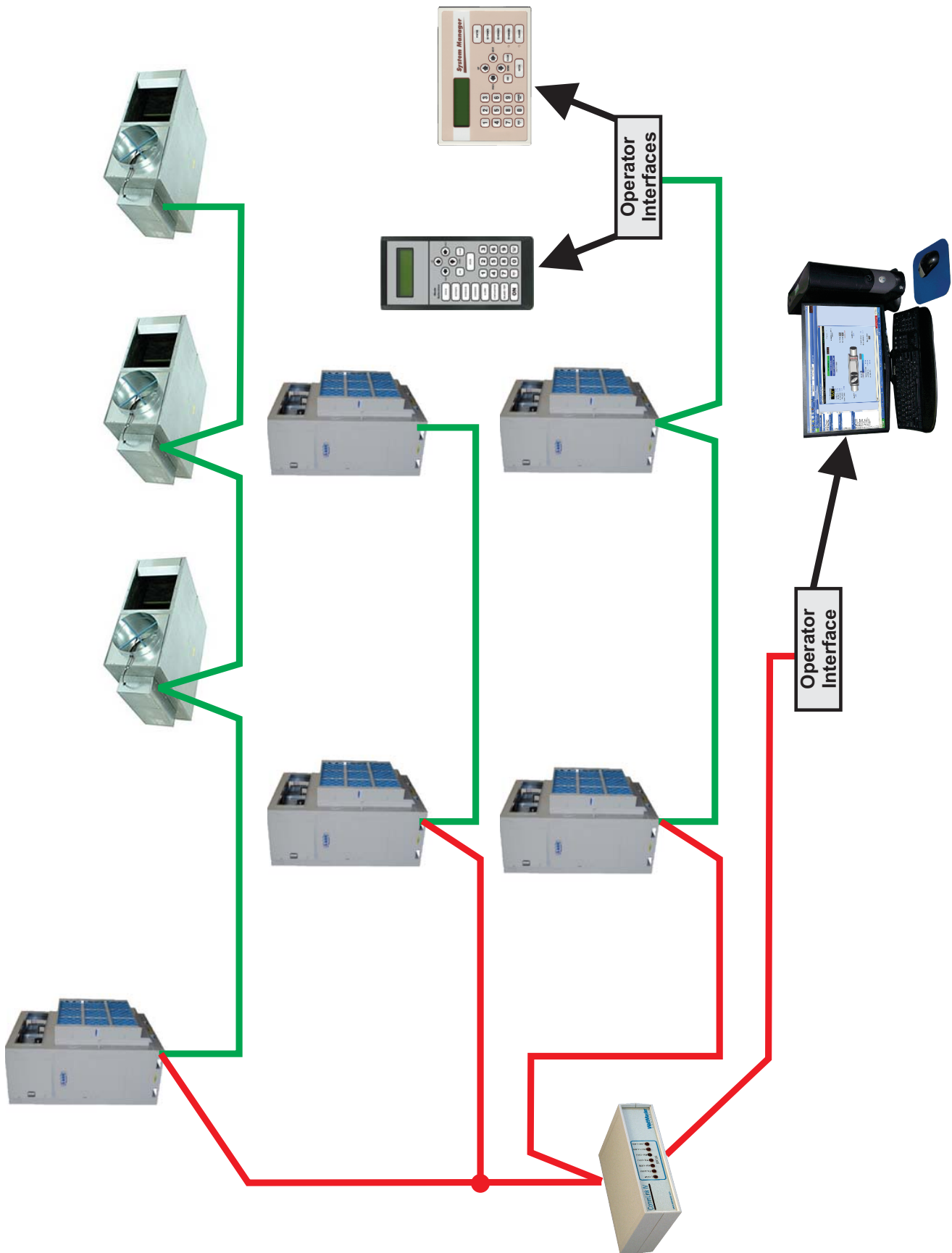


Figure 35: Typical Networked System Layout

Temperature Sensor Testing

Temperature Sensor Testing

The following sensor voltage and resistance tables are provided to aid in checking sensors that appear to be operating incorrectly. Many system operating problems can be traced to incorrect sensor wiring. Be sure all sensors are wired per the wiring diagrams in this manual.

If the sensors still do not appear to be operating or reading correctly, check voltage and/or resistance to confirm that the sensor is operating correctly per the tables. Please follow the notes and instructions below each chart when checking sensors.

Temperature – Resistance – Voltage for Type III 10 K Ohm Thermistor Sensors		
Temp (°F)	Resistance (Ohms)	Voltage @ Input (VDC)
-10	93333	4.620
-5	80531	4.550
0	69822	4.474
5	60552	4.390
10	52500	4.297
15	45902	4.200
20	40147	4.095
25	35165	3.982
30	30805	3.862
35	27140	3.737
40	23874	3.605
45	21094	3.470
50	18655	3.330
52	17799	3.275
54	16956	3.217
56	16164	3.160
58	15385	3.100
60	14681	3.042
62	14014	2.985
64	13382	2.927
66	12758	2.867
68	12191	2.810
69	11906	2.780
70	11652	2.752
71	11379	2.722
72	11136	2.695
73	10878	2.665

Table 4: Temperature/Resistance for Type III 10K Ohm Thermistor Sensors

Temperature – Resistance – Voltage for Type III 10 K Ohm Thermistor Sensors		
Temp (°F)	Resistance (Ohms)	Voltage @ Input (VDC)
74	10625	2.635
75	10398	2.607
76	10158	2.577
78	9711	2.520
80	9302	2.465
82	8893	2.407
84	8514	2.352
86	8153	2.297
88	7805	2.242
90	7472	2.187
95	6716	2.055
100	6047	1.927
105	5453	1.805
110	4923	1.687
115	4449	1.575
120	4030	1.469
125	3656	1.369
130	3317	1.274
135	3015	1.185
140	2743	1.101
145	2502	1.024
150	2288	0.952

Table 4, cont.: Temperature/Resistance for Type III 10K Ohm Thermistor Sensors

Thermistor Sensor Testing Instructions

Use the resistance column to check the thermistor sensor while disconnected from the controllers (not powered).

Use the voltage column to check sensors while connected to powered controllers. Read voltage with meter set on DC volts. Place the “-” (minus) lead on GND terminal and the “+” (plus) lead on the sensor input terminal being investigated.

*If the voltage is above 5.08 VDC, then the sensor or wiring is “open.”
If the voltage is less than 0.05 VDC, then the sensor or wiring is shorted.*

OE265 Series RH Sensor Testing

The chart below is used to troubleshoot the OE265-11 and OE265-14 Relative Humidity Sensors.

OE265-11 & OE265-14 Relative Humidity Transmitters – Humidity vs. Voltage for 0-5 VDC Sensors			
Humidity Percentage (RH)	Voltage @ Input (VDC)	Humidity Percentage (RH)	Voltage @ Input (VDC)
0%	0.00	52%	2.60
2%	0.10	54%	2.70
4%	0.20	56%	2.80
6%	0.30	58%	2.90
8%	0.40	60%	3.00
10%	0.50	62%	3.10
12%	0.60	64%	3.20
14%	0.70	66%	3.30
16%	0.80	68%	3.40
18%	0.90	70%	3.50
20%	1.00	72%	3.60
22%	1.10	74%	3.70
24%	1.20	76%	3.80
26%	1.30	78%	3.90
28%	1.40	80%	4.00
30%	1.50	82%	4.10
32%	1.60	84%	4.20
34%	1.70	86%	4.30
36%	1.80	88%	4.40
38%	1.90	90%	4.50
40%	2.00	92%	4.60
42%	2.10	94%	4.70
44%	2.20	96%	4.80
46%	2.30	98%	4.90
48%	2.40	100%	5.00
50%	2.50		

Table 5: Humidity/Voltage for OE265-11 & -14 Humidity Sensors

OE265-11 & OE265-14 Relative Humidity Sensor Testing Instructions

Use the voltage column to check the Humidity Sensor while connected to a powered expansion module. Read voltage with meter set on DC volts.

Place the “-” (minus) lead on the terminal labeled GND and the “+” lead on the AIN terminal that the Humidity sensor is connected to on the Analog Input/Output Expansion Module.

OE271 Pressure Sensor Testing

OE271 Pressure Sensor Testing

The table below is used to troubleshoot the OE271 Duct Static Pressure Sensors.

OE271 Duct Static Pressure Sensor			
Pressure @ Sensor (" W.C.)	Voltage @ Input (VDC)	Pressure @ Sensor (" W.C.)	Voltage @ Input (VDC)
0.00	0.25	2.60	2.33
0.10	0.33	2.70	2.41
0.20	0.41	2.80	2.49
0.30	0.49	2.90	2.57
0.40	0.57	3.00	2.65
0.50	0.65	3.10	2.73
0.60	0.73	3.20	2.81
0.70	0.81	3.30	2.89
0.80	0.89	3.40	2.97
0.90	0.97	3.50	3.05
1.00	1.05	3.60	3.13
1.10	1.13	3.70	3.21
1.20	1.21	3.80	3.29
1.30	1.29	3.90	3.37
1.40	1.37	4.00	3.45
1.50	1.45	4.10	3.53
1.60	1.53	4.20	3.61
1.70	1.61	4.30	3.69
1.80	1.69	4.40	3.77
1.90	1.77	4.50	3.85
2.00	1.85	4.60	3.93
2.10	1.93	4.70	4.01
2.20	2.01	4.80	4.09
2.30	2.09	4.90	4.17
2.40	2.17	5.00	4.25
2.50	2.25		

Table 6: Duct Static Pressure/Voltage for OE271 Duct Static Pressure Sensors

OE271 Pressure Sensor Testing Instructions

Use the voltage column to check the Duct Static Pressure Sensor while connected to powered controllers. Read voltage with meter set on DC volts. Place the “-” (minus) lead on the GND terminal and the “+” (plus) lead on the 0-5 pin terminal on (TP) with the jumper removed. Be sure to replace the jumper after checking.

OE275-01 Suction Pressure Transducer Testing

OE275-01 Suction Pressure Transducer Testing for R410A Refrigerant

The Evaporator Coil Temperature is calculated by converting the Suction Pressure to Temperature. The Suction Pressure is obtained by using the OE275-01 Suction Pressure Transducer, which is connected into the Suction Line of the Compressor.

Use the voltage column to check the Suction Pressure Transducer while connected to the SA Expansion Module. The SAE-BUS Controller and the SA Expansion Module must be powered for this test. Read voltage with a meter set on DC volts. Place the positive lead from the meter on the PR OUT terminal located on the SA Expansion Module terminal block. Place the negative lead from the meter on the ground (GND) terminal located adjacent to the PR OUT terminal on the SA Expansion Module terminal block. Use a refrigerant gauge set and/or an accurate electronic thermometer to measure the temperature or suction line pressure near where the Suction Pressure Transducer is connected to the suction line. Measure the Voltage at the terminals PR OUT and GND terminals and compare it to the appropriate chart depending on the refrigerant you are using. If the temperature/voltage or pressure/voltage readings do not align closely with the chart, your Suction Pressure Transducer is probably defective and will need to be replaced.

See the OE275-01 Suction Pressure Transducer, Pressure, Temperature, and Voltage Chart for R410A Refrigerant testing (**Table 7**). The chart show a temperature range from 20°F to 80°F. For troubleshooting purposes, the DC Voltage readings are also listed with their corresponding temperatures and pressures.

OE275-01 Suction Pressure Transducer Coil Pressure - Temperature - Voltage Chart for R410A Refrigerant					
Temperature °F	Pressure PSI	Signal DC Volts	Temperature °F	Pressure PSI	Signal DC Volts
21.19	80.94	1.8	59.03	168.10	3.2
24.49	87.16	1.9	61.17	174.32	3.3
27.80	93.39	2.0	63.19	180.55	3.4
30.99	99.62	2.1	65.21	186.78	3.5
33.89	105.84	2.2	67.23	193.00	3.6
36.80	112.07	2.3	69.24	199.23	3.7
39.71	118.29	2.4	71.15	205.46	3.8
42.30	124.52	2.5	72.95	211.68	3.9
44.85	130.75	2.6	74.76	217.91	4.0
47.39	136.97	2.7	76.57	224.14	4.1
49.94	143.2	2.8	78.37	230.36	4.2
52.23	149.42	2.9	80.18	236.59	4.3
54.50	155.65	3.0			
56.76	161.88	3.1			

Table 7: Coil Pressure/Voltage/Temp for OE275-01 Suction Pressure Transducers - R410A Refrigerant

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