Factory Packaged Controls

VCM-X Modular E-BUS Controller Technical Guide

VCM-X Modular E-BUS Controller: Tulsa - SS1030; Coil - SS1034
VCM-X WSHP E-BUS Controller: Tulsa - SS1032; Coil - SS1033
Requires System Manager Code: SS1028 Version 1.0 and up
Requires Service Tool Code: SS1027 Version 1.0 and up

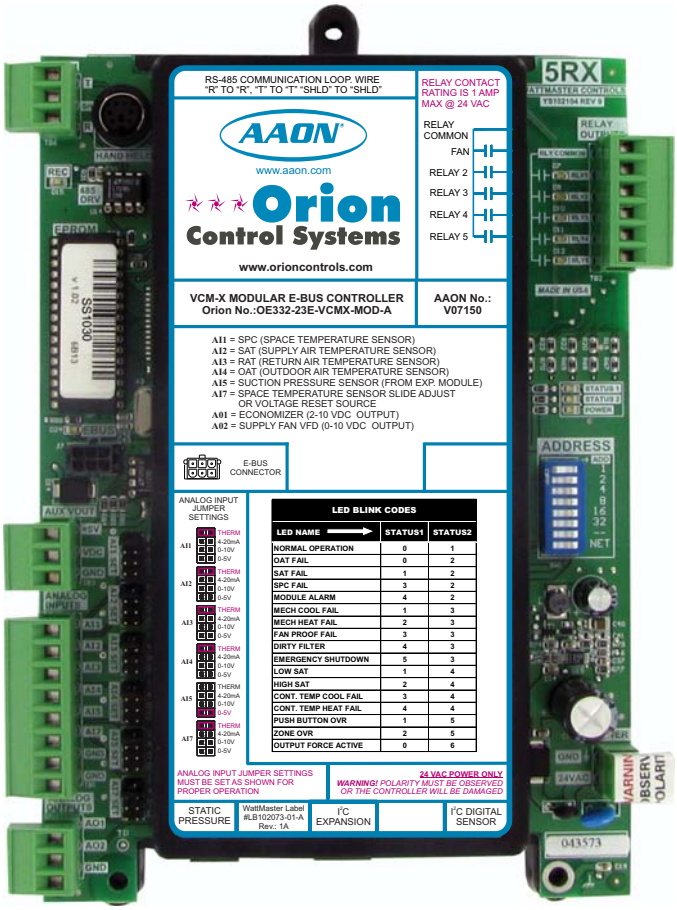

TABLE OF CONTENTS

AAON®

www.aaon.com

WattMaster Controls Inc.
8500 NW River Park Drive · Parkville , MO 64152
Toll Free Phone: 866-918-1100
PH: (816) 505-1100 · FAX: (816) 505-1101
E-mail: mail@wattmaster.com
Visit our web site at www.orioncontrols.com

WattMaster Form : AA-VCMX-EBUS-TGD-01K

Copyright April 2015 WattMaster Controls, Inc.

AAON Part Number: V09260

AAON® is a registered trademark of AAON, Inc., Tulsa, OK.
Copeland Digital Scroll™ is a registered trademark of Copeland Corporation, Sidney, OH. EBTRON® is a registered trademark of Ebtron, Inc., Loris, SC.
GreenTrol™ is a registered trademark of GreenTrol Automation, Inc. Loris, SC.
Neither WattMaster Controls, Inc. nor AAON® assumes any responsibility for errors or omissions in this document.
This document is subject to change without notice.

TABLE OF CONTENTS

Part Number Cross Reference

PART DESCRIPTION	ORION PART NUMBER	AAON TULSA PART NUMBER	AAON COIL PART NUMBER
VCM-X Modular E-BUS Controller - AAON Tulsa	OE332-23E-VCMX-MOD-A	V07150	N/A
VCM-X Modular E-BUS Controller - AAON Coil	OE332-23E-VCMX-MOD-C	N/A	31422
VCM-X WSHP E-BUS Controller - AAON Tulsa	OE332-23E-VCMX-WSHP-A	V07140	N/A
VCM-X WSHP E-BUS Controller - AAON Coil	OE332-23E-VCMX-WSHP-C	N/A	31423
VCM-X Expansion Module	OE333-23-EM	R69190	30308
VCM-X 12-Relay Expansion Module	OE358-23-12R	R69180	30309
VCM-X 4 Binary Input Expansion Module	OE356-01-BI	R82940	30313
Full Digital Module	OE370-23-FD-A	R74870	N/A
Dual Digital Module	OE370-23-DD-C	N/A	30311
One Condenser Head Pressure Module	OE370-23-HP1C	R74860	30648
Two Condenser Head Pressure Module	OE370-23-HP2C	R90230	30310
WSHP Module - R-410A	OE334-23-WPM-C	N/A	30318
WSHP Module - R-410A	OE334-23-WPM-A	R88350	N/A
WSHP Module - R-410A - 20% Glycol	OE334-23-WPM-C20	N/A	30830
WSHP Module - R-410A - 20% Glycol	OE334-23-WPM-A20	R99750	N/A
WSHP Module - R-410A - 40% Glycol	OE334-23-WPM-A40	R99760	N/A
WSHP Module - R-22	OE334-23-WPM-R22	R90680	N/A
Building Static Pressure Sensor	OE258-01	R37030	N/A
Bypass & Slave Interface Card	PL101824	N/A	N/A
Bypass Damper Actuator	OE281-04	N/A	N/A
CO_2 Sensor - Duct Mounted (RA or SA)	OE256-02	R82970	30316
CO_2 Sensor - Space	OE256-01	R82960	30315
CommLink 5 Communications Interface	OE361-13	V32950	N/A
Digital Room Sensor - Temp & Humidity	OE217-01	R83870	30317
Digital Room Sensor - Temp. Only	OE217-00	R83860	N/A
Duct Static Pressure Sensor	OE271	P87100	29629
Duct Temperature Sensor - 12" Probe	OE231	R44940 / P87140	28503
Duct Temperature Sensor - 6" Probe	OE230	R36340	N/A
E-BUS Adapter Board	OE365-15-EBA	V15840	N/A
IP Module Kit	OE415-02	R66770	N/A
MiniLink Polling Device	OE364-22	N/A	N/A
Modular Service Tool SD - Operator Interface	OE391-12	V28140	N/A
Modular System Manager SD - Operator Interface	OE392-12	V36570	N/A
Outdoor Air RH Sensor - 3% - 0-5 VDC Output	OE265-13	R34700	29569
Outdoor Air Temperature Sensor	OE250	P87150	28505
Remote Link II Modem Kit	OE419-06	R69760	N/A
Return Air RH Sensor - 3% - 0-5 VDC Output	OE265-14	R34650	29573
Room Mounted RH Sensor - 3% - 0-5 VDC Output	OE265-11	R34690	29644
Standard Room Sensor - Plain	OE210	R31480	N/A
Standard Room Sensor - W/ Override	OE211	P87040	N/A
Standard Room Sensor - W/ Override & Slide Adjust	OE213	P94320	28606
Standard Room Sensor - W/ Slide Adjust	OE212	P94100	N/A
Static Pressure Pickup Tube	OE290	S18780	N/A
Suction Pressure Transducer	OE275-01	R35890	29565
System Manager TS II - Operator Interface	OE392-10	N/A	N/A
USB-Link 2 Kit	OE366	R71870	N/A

Features

The VCM-X E-BUS series of controllers now consists of the VCM-X Modular E-BUS Controller and the VCM-X WSHP (Water Source Heat Pump) E-BUS Controller. The VCM-X Modular E-BUS Controller has replaced the standard VCM-X Controller. The E-BUS versions of these controllers now allow the various E-BUS modules to connect directly to the VCM-X E-BUS Controllers.

Each of these types of controllers has a version applicable to AAON® Tulsa units and a different version applicable to AAON® Coil units. The following is a breakdown of the different versions:

- AAON® Tulsa VCM-X Modular E-BUS Controller (OE332-23E-VCMX-MOD-A) uses software SS1030
- AAON® Tulsa VCM-X WSHP E-BUS Controller (OE332-23E-VCMX-WSHP-A) uses software SS1032
- AAON® Coil VCM-X Modular E-BUS Controller (OE332-23E-VCMX-MOD-C) uses software SS1034
- AAON® Coil VCM-X WSHP E-BUS Controller (OE332-23E-VCMX-WSHP-C) uses software SS1033

These controllers are designed with 7 analog inputs, 2 analog outputs, and 5 relay outputs. Each VCM-X E-BUS Controller's input and output capabilities can be expanded with the VCM-X Expansion Module (OE333-23-EM), the 12 Relay Expansion Module (OE358-23-12R), and the 4 Binary Input Expansion Module (OE356-01-BI) by means of a modular cable. Each VCM-X 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:

- Up to a Combined Total of 20 Stages of Heating & Cooling
- 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® MODGAS Modulating Natural Gas Controller
- Full Integration with the AAON® MHGRV Modulating Hot Gas Reheat Controller
- Configurable for Heat Pump Applications
- Advanced Dehumidification Capabilities
- Air Flow Monitoring of Outdoor Air, Supply Air, and Return Air Streams
- Air Flow Control of Outdoor Air Damper
- Single Zone VAV Control
- Primary/Secondary Heating Control
- Adaptive Supply Air Reset
- Micro Channel Condenser Control
- Selectable Control Sensor
- Fan Proving Interlock
- Dirty Filter Alarm
- Emergency Shutdown Input (Smoke Detector/Firestat or other Shutdown Conditions)
- Drybulb/Wetbulb Control of Economizer Operation
- Building Pressure Control
- Remote Override Capabilities
- IAQ Economizer Reset
- Title 24 Economizer Certified
- 7-Day, 2-Event-per-Day Scheduling
- 14 Holiday Event Scheduling
- Optimal Start Scheduling
- Trend Logging Capability
- Static Pressure Control for Filter Loading Applications
- Accepts Remote HVAC Mode Selection Via Contact Closure On VCM-X Expansion Module
- Configurable for AAON® PAC and DPAC Applications
- Heat Wheel - On/Off Control
- Configurable for R22 and R410-A refrigerant
- Head Pressure Control (VCM-X Modular E-BUS and VCM-X WSHP E-BUS)
- Full Digital and Dual Digital Control (VCM-X Modular E-BUS)
- Water Source Heat Pump Monitoring (VCM-X WSHP E-BUS)

Most common HVAC unit control applications can be configured using only the VCM-X E-BUS Controller. If the application requires more inputs and/or outputs, optional expansion modules are available to provide for additional analog, binary, or digital inputs and outputs as required.

The available expansion module configurations allow for 4 or 8 additional binary inputs, 4 additional analog inputs, 5 additional analog outputs, and up to 16 additional binary (relay) outputs. The various expansion modules plug into the VCM-X E-BUS Controller by means of a modular cable.

E-BUS Module Applications

VCM-X Modular E-BUS Controller

The AAON® Tulsa VCM-X Modular E-BUS Controller (OE332-23E-VCMX-MOD-A) will interface with the One Condenser Head Pressure Module (OE370-23-HP1C), the Two Condenser Head Pressure Module (OE370-23-HP2C), and the Full Digital Module (OE370-23-FD-A).

The AAON® Coil VCM-X Modular E-BUS Controller (OE332-23E-VCMX-MOD-C) will interface with the Two Condenser Head Pressure Module (OE370-23-HP2C) and the Dual Digital Module (OE370-23-DD-C).

In both cases, these E-BUS Modules allow independent control of multiple digital scroll compressors and control of the condenser fan(s) or valve(s). See **pages 38-47** of this manual and the individual manuals for each of these modules (referenced on those pages) for detailed wiring and application details.

VCM-X WSHP E-BUS Controller

The AAON® Tulsa VCM-X WSHP E-BUS Controller (OE332-23E-VCMX-WSHP-A) will interface with the One Condenser Head Pressure Module (OE370-23-HP1C), the Two Condenser Head Pressure Module (OE370-23-HP2C), and the Water Source Heat Pump Modules (OE334-23-WPM-A and OE334-23-WPM-22-A).

The AAON® Coil VCM-X WSHP E-BUS Controller (OE332-23E-VCMX-WSHP-C) will interface with the Two Condenser Head Pressure Module (OE370-23-HP2C) and the Water Source Heat Pump Module (OE334-23-WPM-C).

In both cases, these E-BUS Modules allow independent control of multiple digital scroll compressors and control of the condenser fan(s) or valve(s). See **pages 38-47** of this manual and the individual manuals for each of these modules (referenced on those pages) for detailed wiring and application details.

VCM-X E-BUS Controller Applications

Variable Air Volume Unit

The VCM-X E-BUS 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 VCM-X E-BUS .

VAV units are typically designed for occupied Cooling with Morning Warm-up Heating. This option is available with the VCM-X E-BUS. The VCM-X E-BUS can also be used for a Zoning System that needs Duct Static Pressure control and Occupied Cooling and Heating. The VCM-X E-BUS 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 VCM-X E-BUS 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 VCM-X E-BUS 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 VCM-X E-BUS can be configured to activate a Constant Volume Supply Fan. In most cases, this is a very basic unit with Space Temperature control. The VCM-X E-BUS can be used for kitchen, restaurant, or lab environments that are 100% Outdoor Air part of the time and Return Air part of the time. The Hood On input allows the VCM-X E-BUS to know when to switch to 100% Outdoor Air control based on an exhaust hood activating. The VCM-X E-BUS requires Outdoor and Indoor Air Temperature Sensors to accomplish this application.

Make-Up Air Unit

The VCM-X E-BUS 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.

AAON® PAC (Precision Air Control)

This control scheme can only be used on Constant Volume HVAC units that are equipped with a Return Air Bypass Damper and that use a Space Temperature Sensor as the Controlling Sensor.

AAON® PAC Control provides improved moisture removal capabilities while utilizing internal space loads for reheat by redirecting the Return Air path from the upstream side of the DX Evaporator Coil to the downstream side of the coil.

For AAON® PAC configured units, the Return Air Bypass Damper is only used during the Dehumidification Mode. When the VCM-X Controller is in Dehumidification Mode, the Return Air Bypass Damper will modulate open as the Space Temperature falls below the Cooling Setpoint. Modulation of the Return Air Bypass Damper is controlled using a proportional range from 0% (when the Space Temperature is equal to the Cooling Setpoint) up to 100% (when the Space Temperature falls to the halfway point between the Cooling and Heating Setpoints). A separate Return Air Damper Actuator will modulate the Return Air Damper slightly further towards its closed position as the Return Air Bypass Damper opens. This is to ensure that enough Return Air is bypassed around the Evaporator Coil through the Return Air Bypass Damper to raise its temperature. The rate which the Return Air Damper closes while the Return Air Bypass Damper is open is user-adjustable.

AAON® DPAC (Digital Precision Air Control)

This control scheme can only be used on Constant Volume HVAC units that are equipped with a Return Air Bypass Damper and a Copeland Digital Scroll™ Compressor. AAON® DPAC also uses a Space Temperature Sensor as the Controlling Sensor.

The AAON® DPAC control scheme provides improved moisture removal capabilities over the AAON® PAC control scheme and provides for tighter temperature control by combining a Copeland Digital Scroll™ Compressor with the Return Air Bypass Damper. See the Cooling Mode section on **page 56** for detailed Copeland Digital Scroll™ Compressor operation. Refer to AAON® PAC Control previously described for detailed Return Air Bypass Damper operation.

The Copeland Digital Scroll™ Compressor is used during both Cooling and Dehumidification Modes. The Return Air Bypass Damper is used only during the Dehumidification Mode.

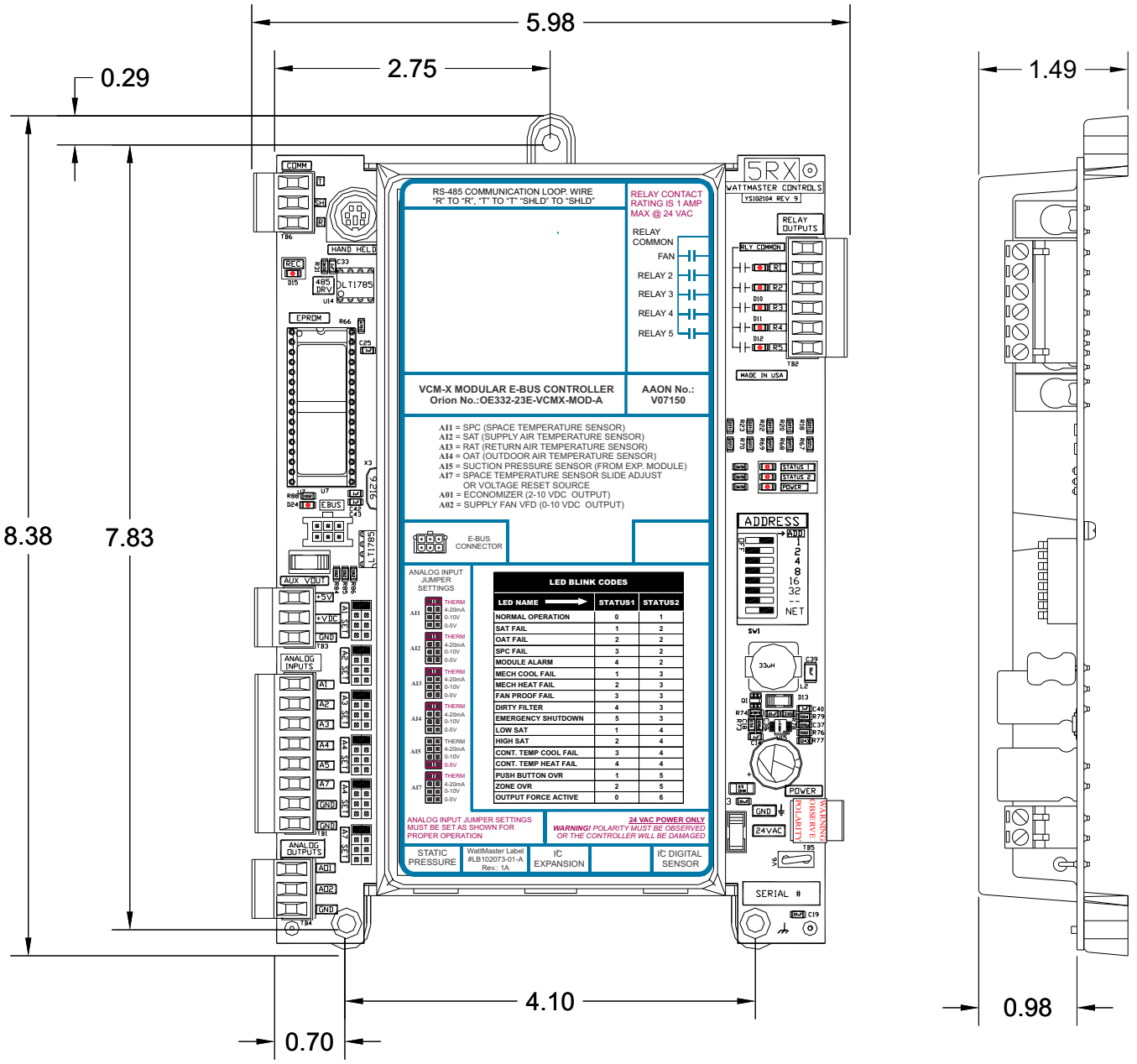

Figure 1: OE332-23E-VCMX MOD & WSHP – VCM-X E-BUS Controller Dimensions

VCM-X Expansion Module Dimensions

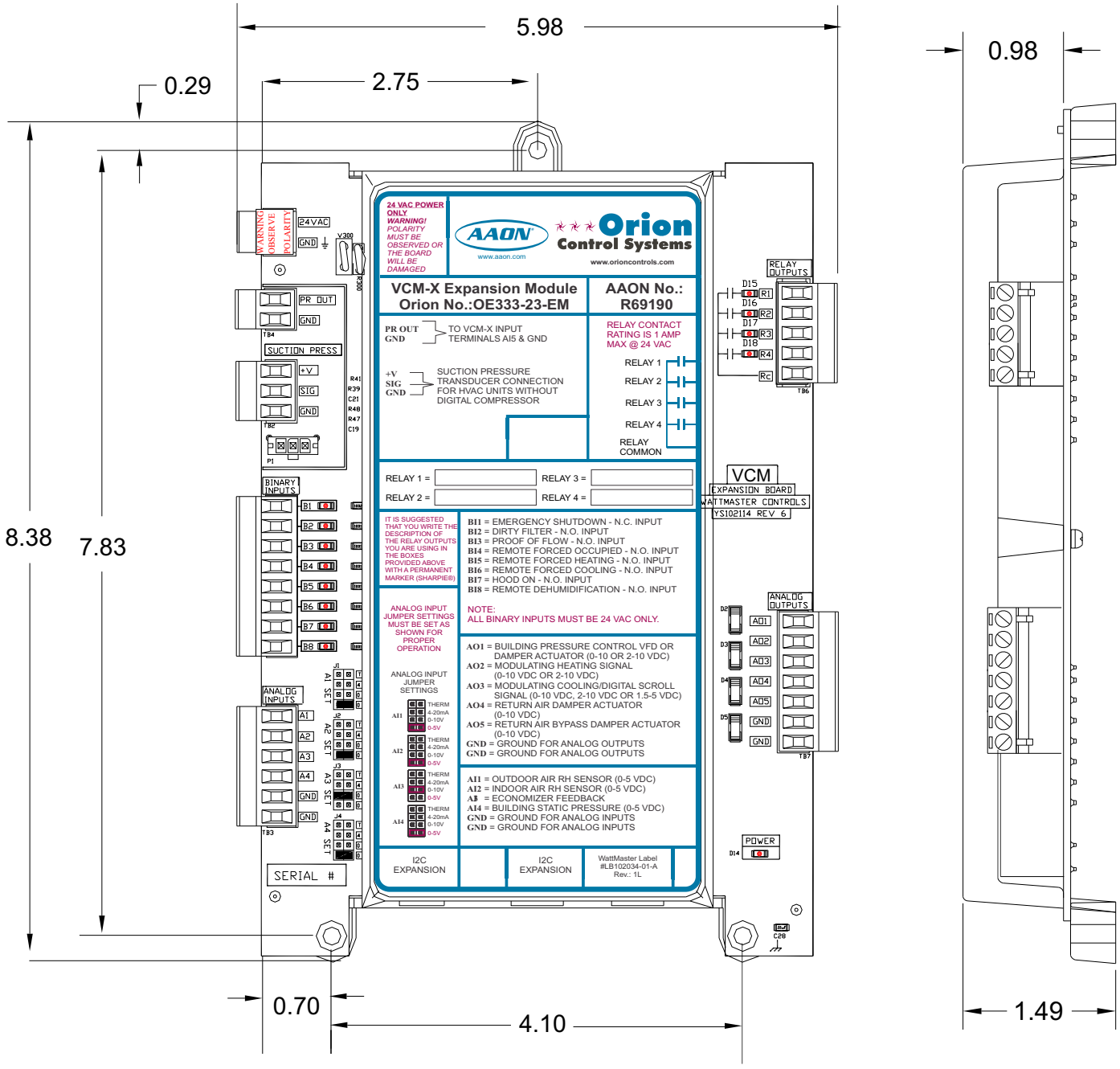

Figure 2: OE333-23-EM – VCM-X Expansion Module Dimensions

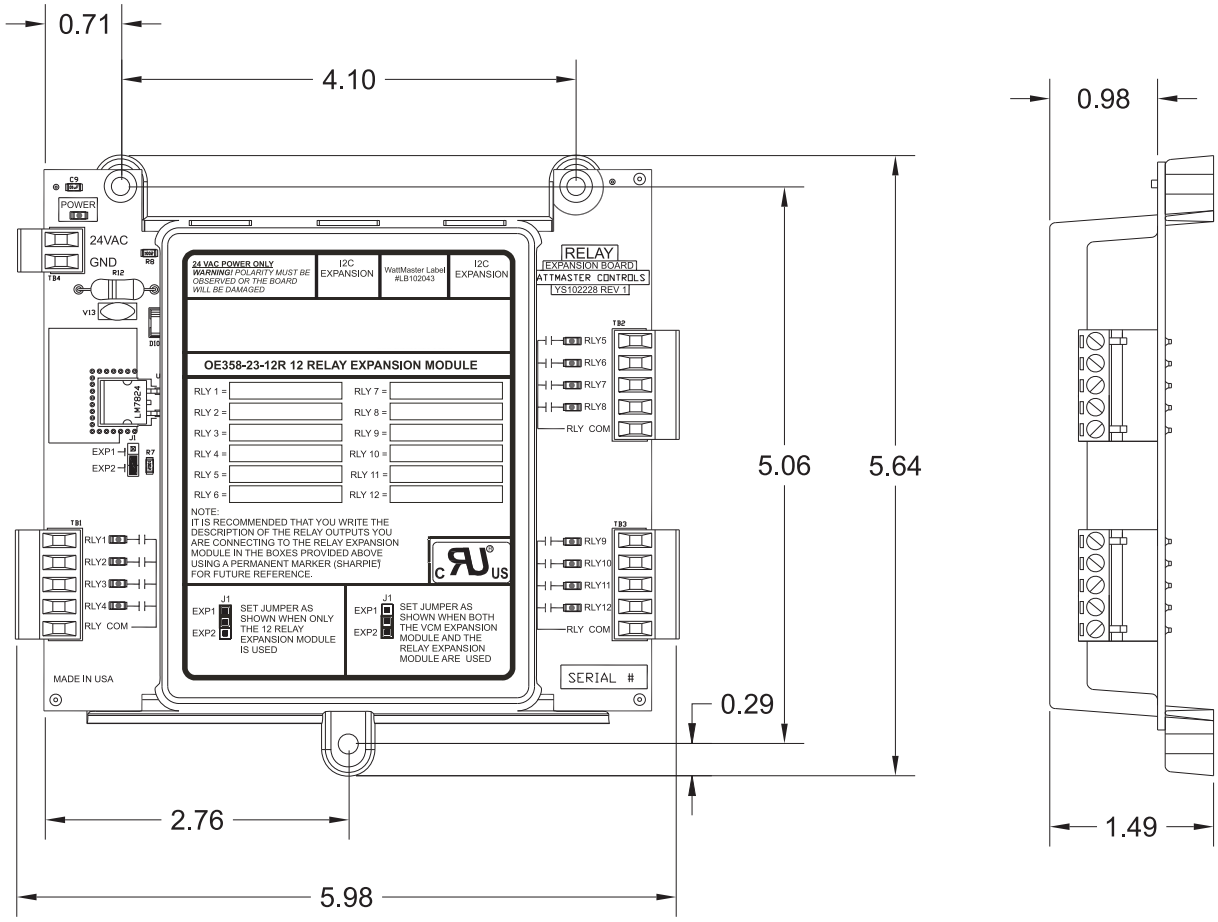

Figure 3: OE358-23-12R – 12-Relay Expansion Module Dimensions

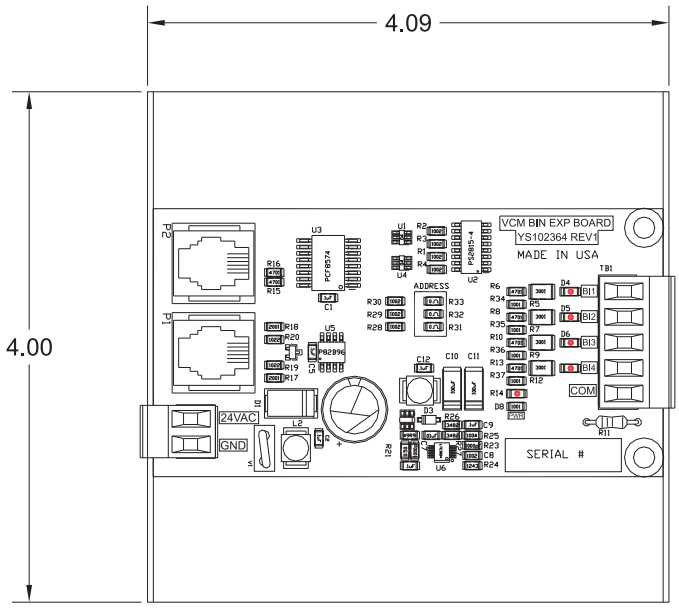

Figure 4: OE356-01-BI – 4 Binary Input Expansion Module Dimensions

Important Wiring Considerations

General

Correct wiring of the VCM-X E-BUS Controller is the most important factor in the overall success of the controller installation process. In general, most VCM-X E-BUS Controllers are factory installed and wired at the AAON® factory. It is also possible to purchase these controllers through your local AAON®/Orion representative for installation in the field. Some of the following information pertains to field wiring and may not apply to your installation since it was pre-wired at the factory. However, in the unlikely event that troubleshooting of the controller is required, it is a good idea to be familiar with the system wiring, no matter if it was factory or field wired.

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 VCM-X E-BUS Controller and associated expansion modules.

The VCM-X 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 VCM-X 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 VCM-X E-BUS Controller and expansion 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-VCMX VCM-X E-BUS Controller	24VAC	8	-30°F to 150°F	90% RH
OE333-23-EM VCM-X Expansion Module	24VAC	10	-30°F to 150°F	90% RH
OE358-23-12R Relay Expansion Module	24VAC	15	-30°F to 150°F	90% RH
OE356-01-BI 4 Binary Expansion Module	24VAC	5	-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 VCM-X E-BUS Controller and expansion modules.

Please carefully read and apply the following information when wiring the VCM-X E-BUS Controller or the Expansion Modules. See **Figure 5** on **page 11** for the VCM-X E-BUS Controller wiring diagram. See **Figures 16** and **17** on **pages 19 and 20** for 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 VCM-X 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 VCM-X E-BUS Controller, be sure to recheck all wiring connections and terminations **thoroughly**.

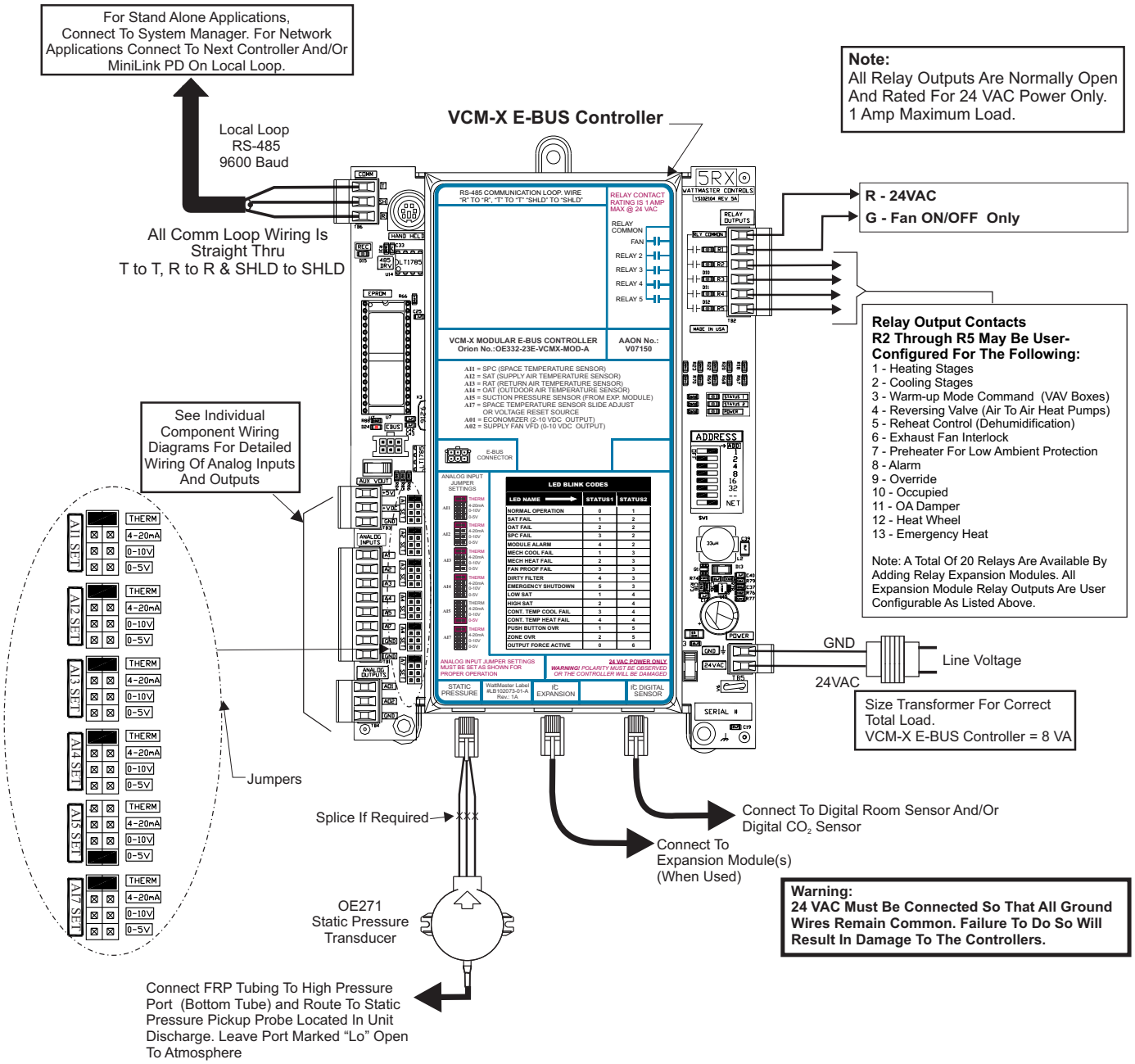

Figure 5: OE332-23E-VCMX – VCM-X E-BUS Controller Wiring

Digital Room Sensor & Wall Mounted Space CO_2 Sensor

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 VCM-X E-BUS Controller with the TSDRSC modular cable. It can be daisy-chained with the OE256-01 CO_2 Sensor for applications requiring both a room CO_2 sensor and room temperature sensor. 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.

Wall Mounted Space CO_2 Sensor

The OE256-01 Wall Mounted Space CO_2 Sensor is used to monitor CO_2 levels in the space served by the HVAC unit. The CO_2 Sensor connects to the VCM-X E-BUS Controller with the TSDRSC modular cable. It can be daisy-chained with the Digital Room Sensor (OE217) for applications requiring both a room CO_2 sensor and room temperature sensor. 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 7** for wiring details and installation notes. A Duct Mounted CO_2 Sensor can be used if desired instead of the Wall Mounted Space CO_2 Sensor. See **Figure 8** for Duct Mounted CO_2 Sensor wiring details.

Note: When Only The Digital Room Sensor Is Used, It Connects Directly To The VCM-X E-BUS Controller Using A TSDRSC Cable Of The Appropriate Length. The Maximum Length Allowed Is 160 Feet. See **Figure 7** For Connection When The Space CO_2 Sensor Is Also Used.

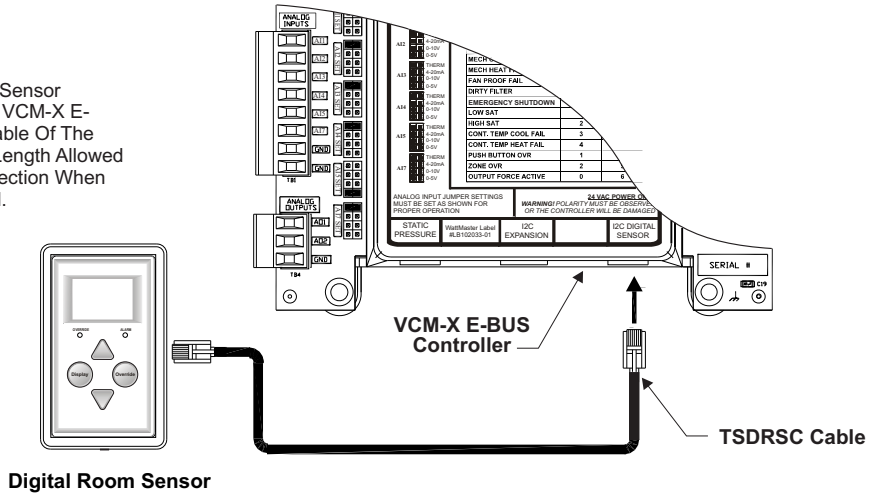

Figure 6: OE217-00/01 – Digital Room Sensor Wiring

Note: When a Digital Room Sensor Is Used In Combination With The CO_2 Sensor, The CO_2 Sensor Always Connects To The VCM-X E-BUS Controller First Using a TSDRSC Cable Of The Required Length. The Digital Room Sensor Then Connects To The CO_2 Sensor With Another TSDRSC Cable. Mount Sensor(s) At Least 5 Feet Above Floor. See The *E-BUS CO_2 Sensor Technical Guide* For Further Wiring

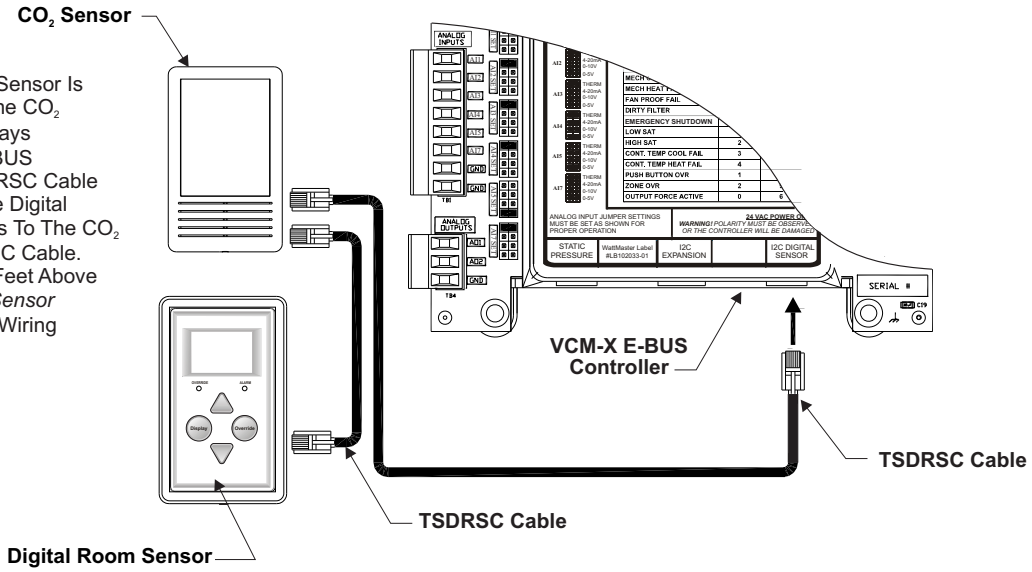

Figure 7: OE256-01 – Wall Mounted Space CO_2 Sensor Wiring

Duct Mounted CO_2 Sensor

The OE256-02 CO_2 Sensor is used for sensing the current CO_2 level in the HVAC unit's return air stream. This is useful when you want an average CO_2 reading in the area served by the HVAC unit or when you don't want a wall mounted CO_2 sensor due to sensor tampering concerns in the space.

The OE256-02 Duct Mounted Return Air CO_2 Sensor is comprised of the OE256-01 CO_2 Sensor and the WattMaster Aspiration Box Assembly.

The Duct Mounted Return Air CO_2 Sensor is designed to be mounted in the return air duct of the HVAC unit and uses its integral aspiration box to sample the CO_2 level in the duct. See the dimensional and installation information in **Figure 8** below for wiring and installation details.

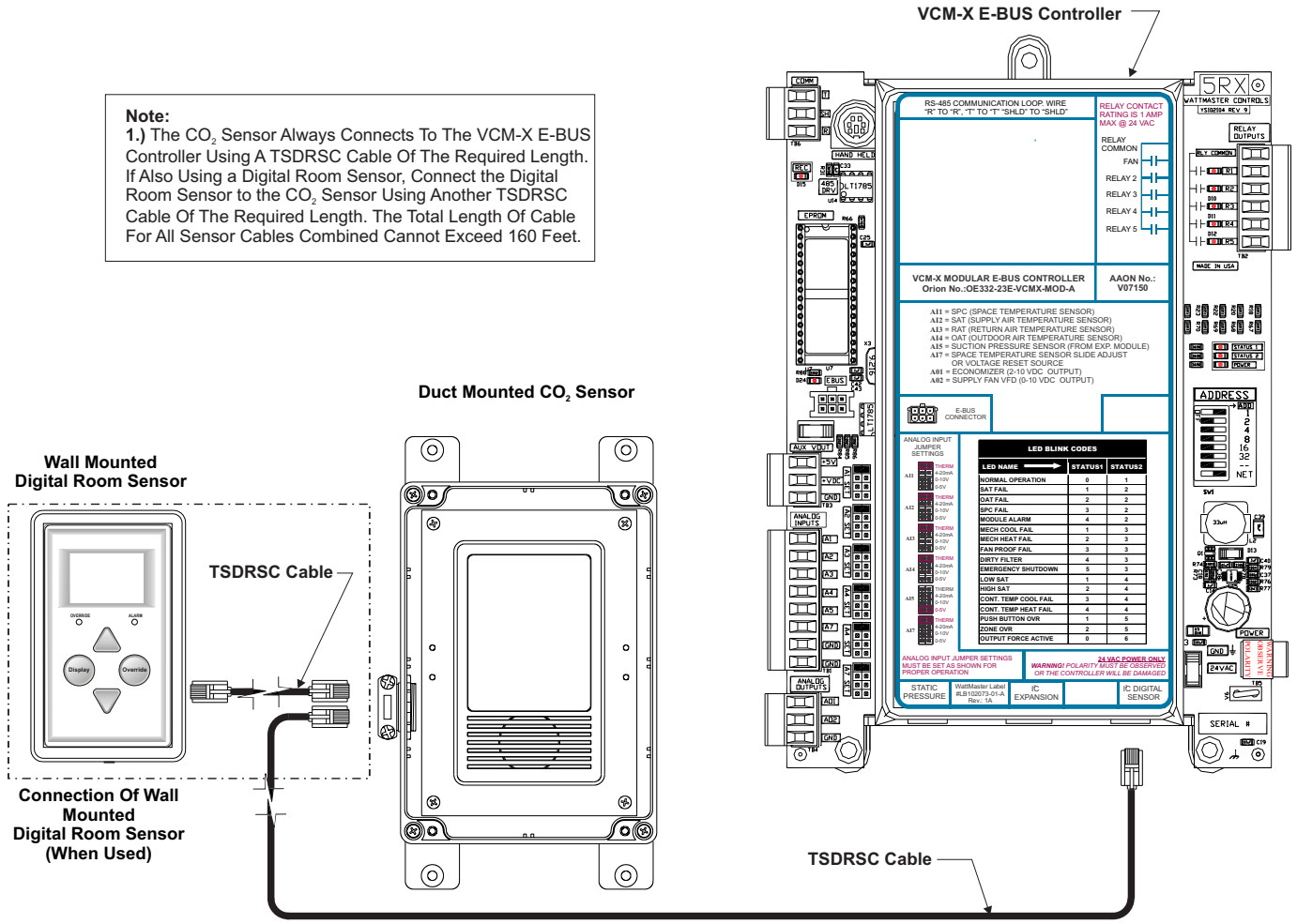

Figure 8: OE256-02 - Duct Mounted CO_2 Sensor Wiring

Remote SAT Reset Signal

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 VCM-X E-BUS Controller.

See **Figure 9** 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 VCM-X E-BUS Controller.

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

See **Figure 10** below for complete Remote SAT Reset Signal wiring details.

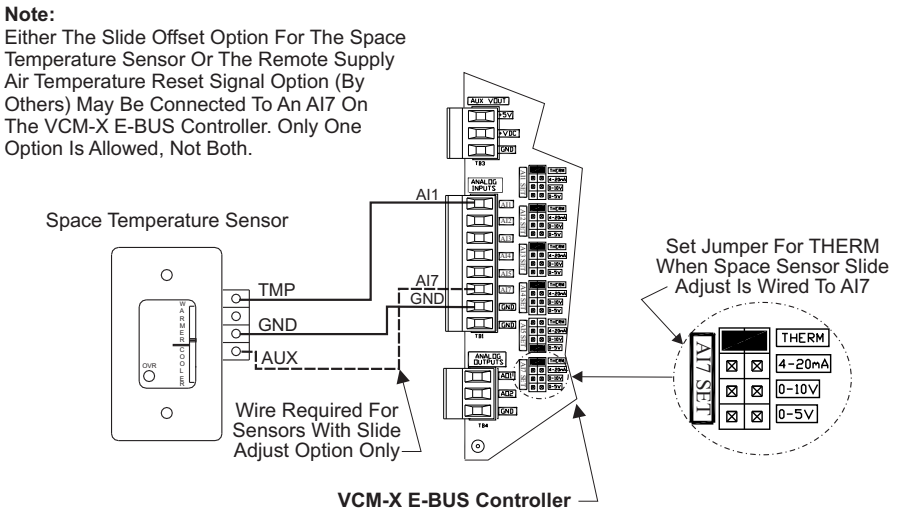

Figure 9: OE210, OE211, OE212, OE213 – Space Temperature Sensor Wiring

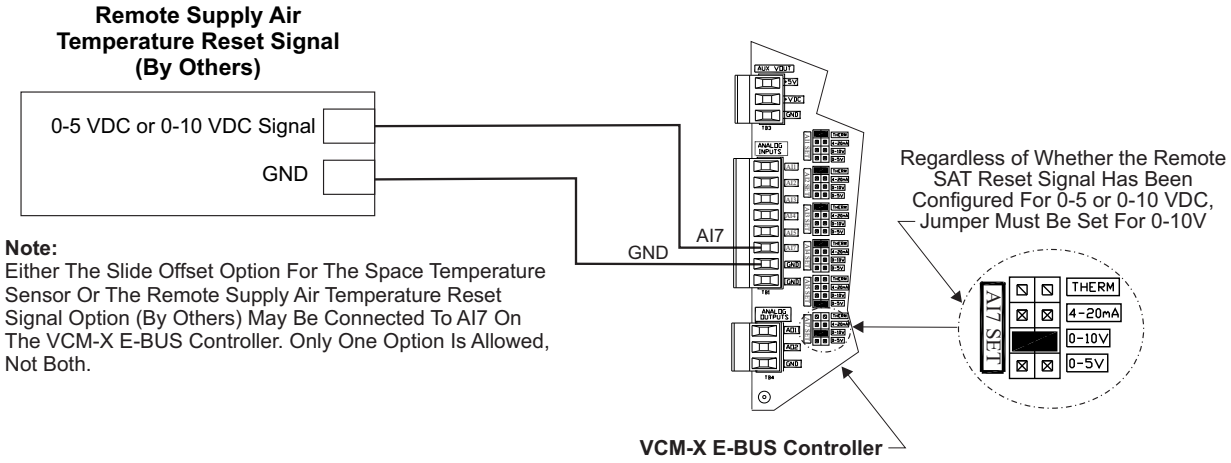

Figure 10: Remote Supply Air Temperature Reset Signal Wiring

Supply Air & Return Air Temperature Sensor

The OE231 Supply Air & Return Air Temperature Sensors must be wired as shown in **Figure 11** below for proper operation. The Supply Air & Return Air Temperature Sensors are 10K Type III thermistor sensors. The Supply Air Temperature Sensor should be mounted in the unit discharge plenum or in the supply air duct. The Return Air Temperature Sensor should be mounted in the return air duct. If the system has a Zoning Bypass Damper installed, be sure the return air sensor is located upstream of the bypass duct connection.

NOTE: Previously, if your AAON® HVAC unit used the AAON® MODGAS Controller and/or the AAON® MHGRV Controller, the Supply Air Sensor had to be wired to one of these controllers. This is no longer the case. The Supply Air Temperature Sensor must always be connected to the VCM-X E-BUS Controller unless you are using the AAON® MODGAS and/or AAON® MHGRV Controllers as stand-alone.

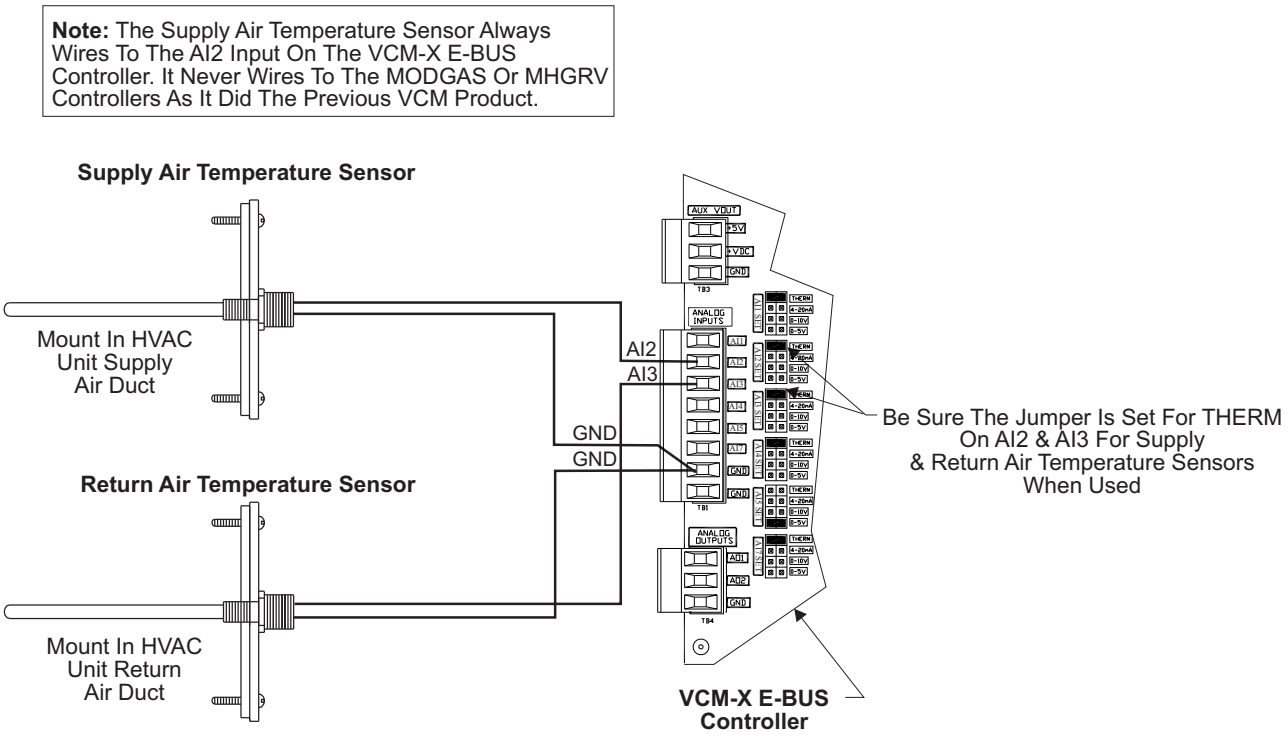

Figure 11: OE231 – Supply Air and Return Air Temperature Sensor Wiring

OAT Sensor Wiring

Outdoor Air Temperature Sensor

The OE250 Outdoor Air Temperature Sensor must be wired as shown in **Figure 12** below for proper operation of the VCM-X E-BUS Controller. The Outdoor Air Temperature Sensor is a 10K Type III thermistor sensor. The sensor should be mounted in the upright position as shown in an area that is protected from the elements and direct sunlight. Be sure to make the wiring splices inside of the Outdoor Air Temperature Sensor weather-tight enclosure.

For MUA applications with a Heat Wheel, the Outdoor Air Temperature Sensor is mounted downstream of the Heat Wheel.

Caution: Be sure to mount the Outdoor Air Temperature Sensor in an area that is not exposed to direct sunlight. The shaded area under the HVAC unit rain hood is normally a good location. Unused conduit opening(s) must have closure plugs installed and must be coated with sealing compound to provide a rain-tight seal. Water can damage the sensor.

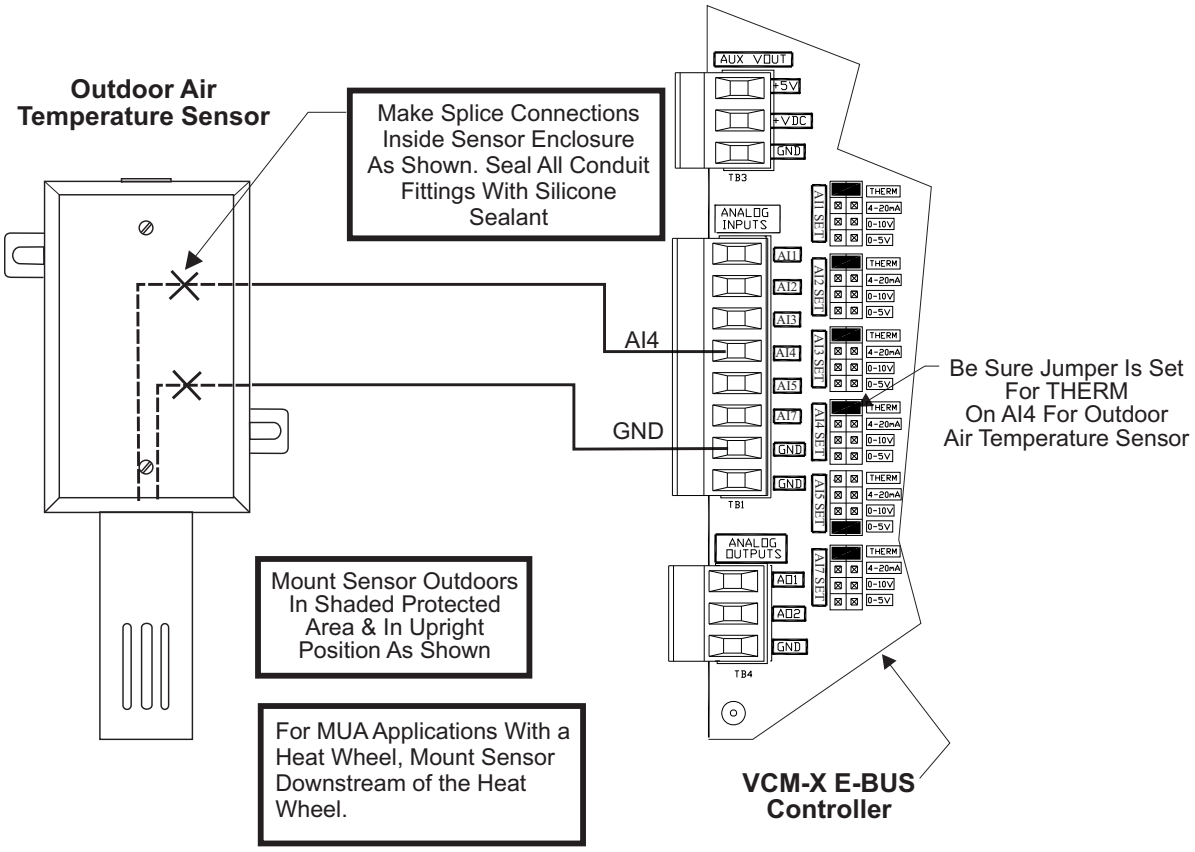

Figure 12: OE250 – Outdoor Air Temperature Sensor Wiring

Economizer Damper Actuator

The Economizer Damper Actuator signal voltage output is a 2-10 VDC output. This signal output is used by the VCM-X E-BUS Controller to modulate the Economizer Damper Actuator in order to control the amount of Outdoor Air delivered to the HVAC unit for Free Cooling and/or Indoor Air Quality requirements. See **Figure 13** for detailed 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 will result in damage to the actuator or VCM-X E-BUS Controller.

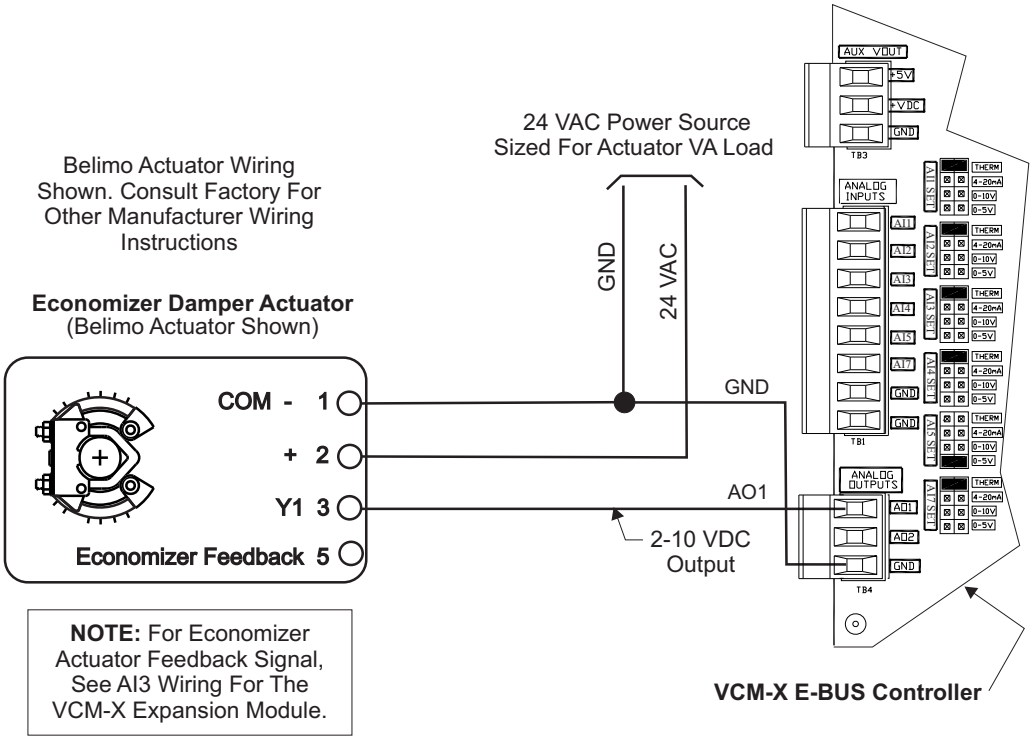

Figure 13: Economizer Damper Actuator Wiring

Supply Fan VFD Signal and Zoning Bypass Damper Actuator

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. 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 VCM-X 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 VCM-X 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** below 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.

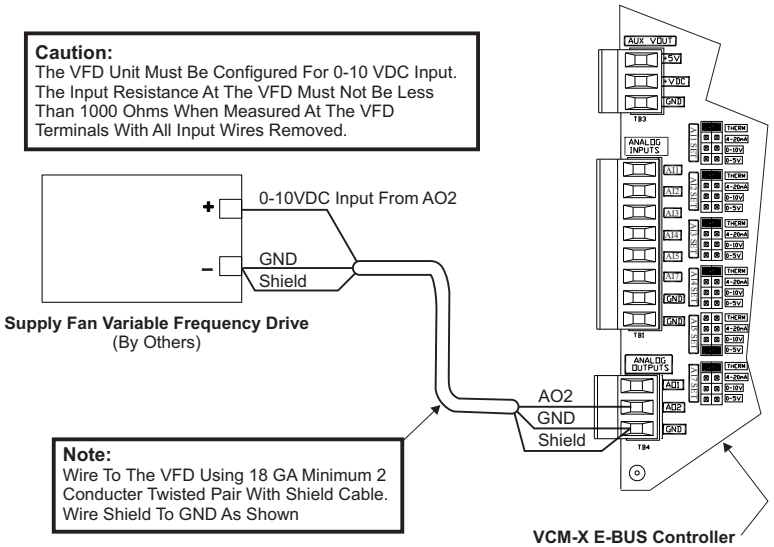

Figure 14: Supply Fan VFD Wiring

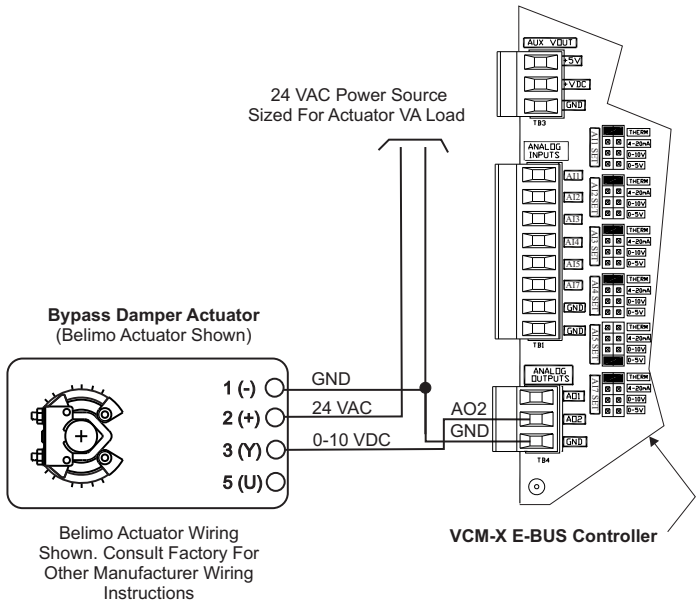

Figure 15: Zoning Bypass Damper Actuator Wiring

VCM-X Expansion Module

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

The VCM-X Expansion Module (OE333-23-EM) provides 8 Binary Inputs, 4 Analog Inputs, 4 Relay Outputs, and 5 Analog Outputs. See **Figures 16 below** and **17, page 20** for complete wiring details.

The VCM-X Expansion Module can be used in conjunction with the 12-Relay Expansion Module (OE358-23-12R-A).

The 4 Binary Input Expansion Module (OE356-01-BI) can be used in place of the VCM-X Expansion Module if your system does not need any other inputs or outputs.

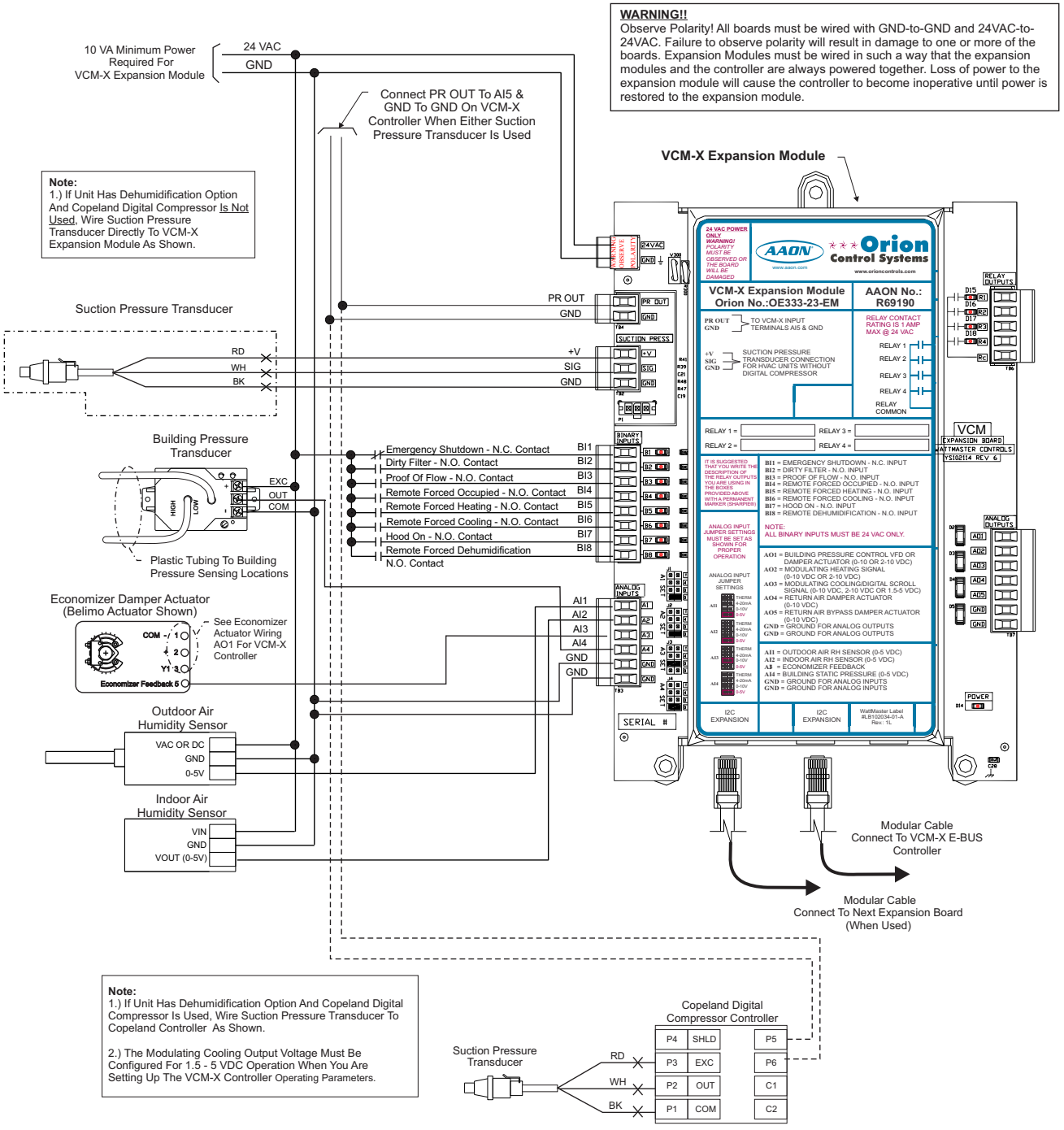

Figure 16: OE333-23-EM – VCM-X Expansion Module Input Wiring

VCM-X Expansion Module Output Wiring

The VCM-X 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 VCM-X Expansion Module, its contacts must be wired as wet contacts (connected to 24 VAC).

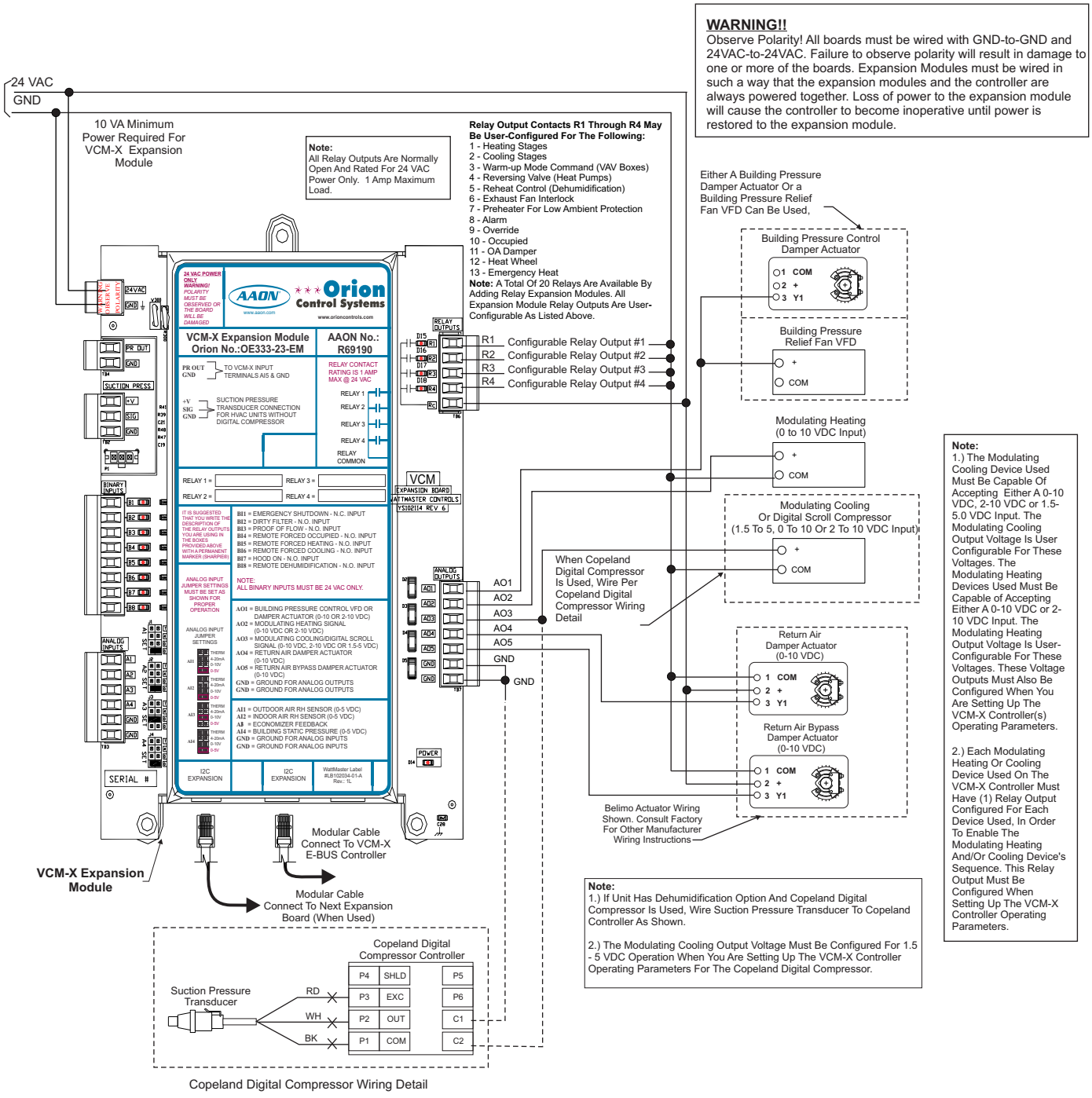

Figure 17: OE333-23-EM – VCM-X Expansion Module Output Wiring

Suction Pressure Transducer Without Copeland Digital Scroll™ Compressor

The OE275-01 Suction Pressure Transducer is required for any VCM-X application with DX Cooling that requires Dehumidification.

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 VCM-X E-BUS Controller. This temperature is used by the VCM-X E-BUS Controller to accurately control the compressors and reheat cycle components to provide optimum performance from the system during Dehumidification operation.

When used in dehumidification applications on HVAC units without Copeland Digital Scroll™ Compressors, the Suction Pressure Transducer wires to the VCM-X Expansion Module as shown in **Figure 18** below. In this application, the Suction Pressure Transducer connects to the VCM-X Expansion Module plus V, SIG, and GND terminals through a cable. The cable is supplied with a 3-pin Packard mating connector for attachment to the sensor on one end and has 3 color-coded stripped wires on the other end. The stripped wire ends can be spliced to other wires to extend the wiring length when required.

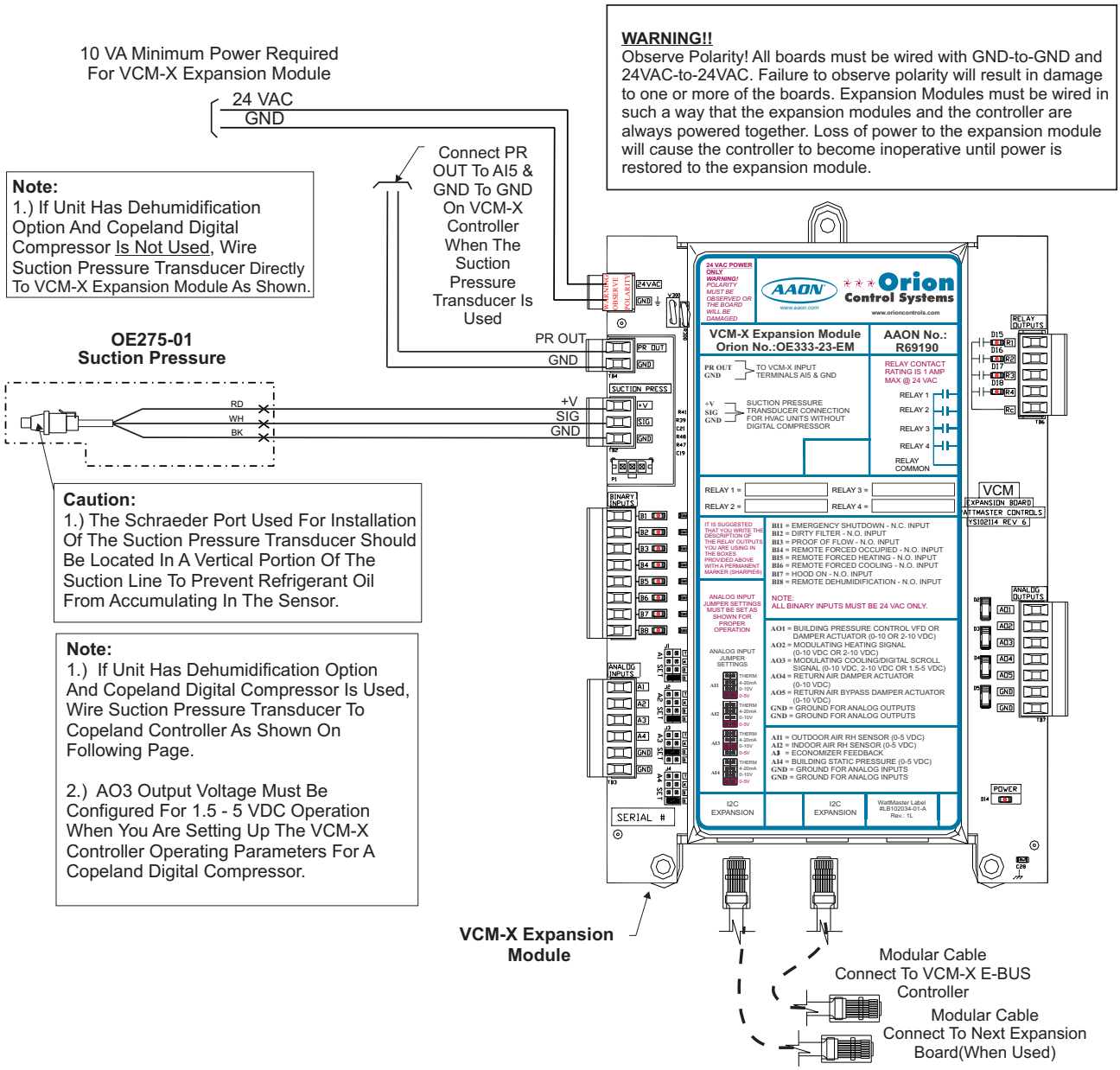

Figure 18: OE275-01 – Suction Pressure Transducer Wiring (Units Without Copeland Digital Scroll™ Compressors)

Suction Pressure Transducer Wiring

Suction Pressure Transducer With Copeland Digital Scroll™ Compressor

For applications that use a Copeland Digital Scroll™ Compressor, the OE275-01 Suction Pressure Transducer wires directly to the Copeland Digital Scroll™ Compressor Controller supplied by the compressor manufacturer. See **Figure 19** below for wiring details.

In this application, the Suction Pressure Transducer connects to the Copeland Digital Scroll™ Compressor with a prefabricated cable similar to the one used in the previous application. The signal conditioning is controlled by the Copeland Digital Scroll™ Compressor Controller. This cable also has a 3-pin Packard mating connector for attachment to the sensor on one end and has 3 color-coded stripped wires on the other end. The stripped wire ends can be spliced to other wires to extend the wiring when required to connect the Copeland Digital Scroll™ Compressor Controller.

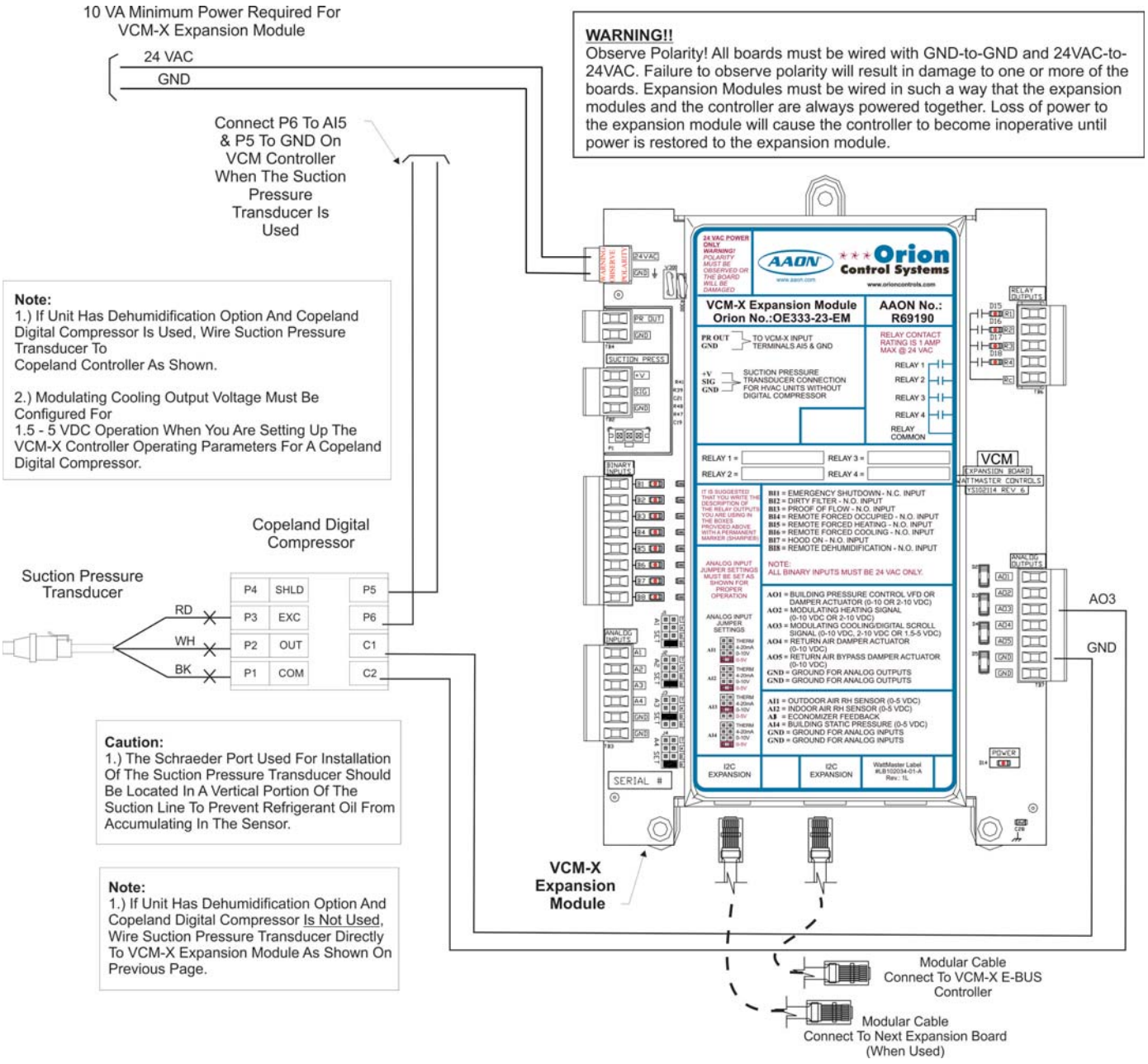

Figure 19: OE275-01 – Suction Pressure Transducer Wiring (Units With Copeland Digital Scroll™ Compressors)

8 Binary Inputs Located On VCM-X Expansion Module

If your HVAC unit only requires an Emergency Shutdown (Smoke Detector/Firestat or other shutdown conditions), Dirty Filter, Proof of Flow or Remote Forced Occupied Inputs or all of these 4 inputs and you don't need any of the other inputs or outputs provided on the OE333-23-EM VCM-X Expansion Module, you can use the OE356-01-BI 4 Binary Input Expansion Module for these inputs. See **Figure 21, page 24** for wiring. If you require any other Binary Inputs or require any other of the Analog Inputs or Outputs that are provided on the VCM-X Expansion Module, you will need to use it instead for all of your Binary Inputs.

The transformer used for powering the VCM-X Expansion Module must also be used to power the binary inputs. See **Figure 20** below for detailed wiring.

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.

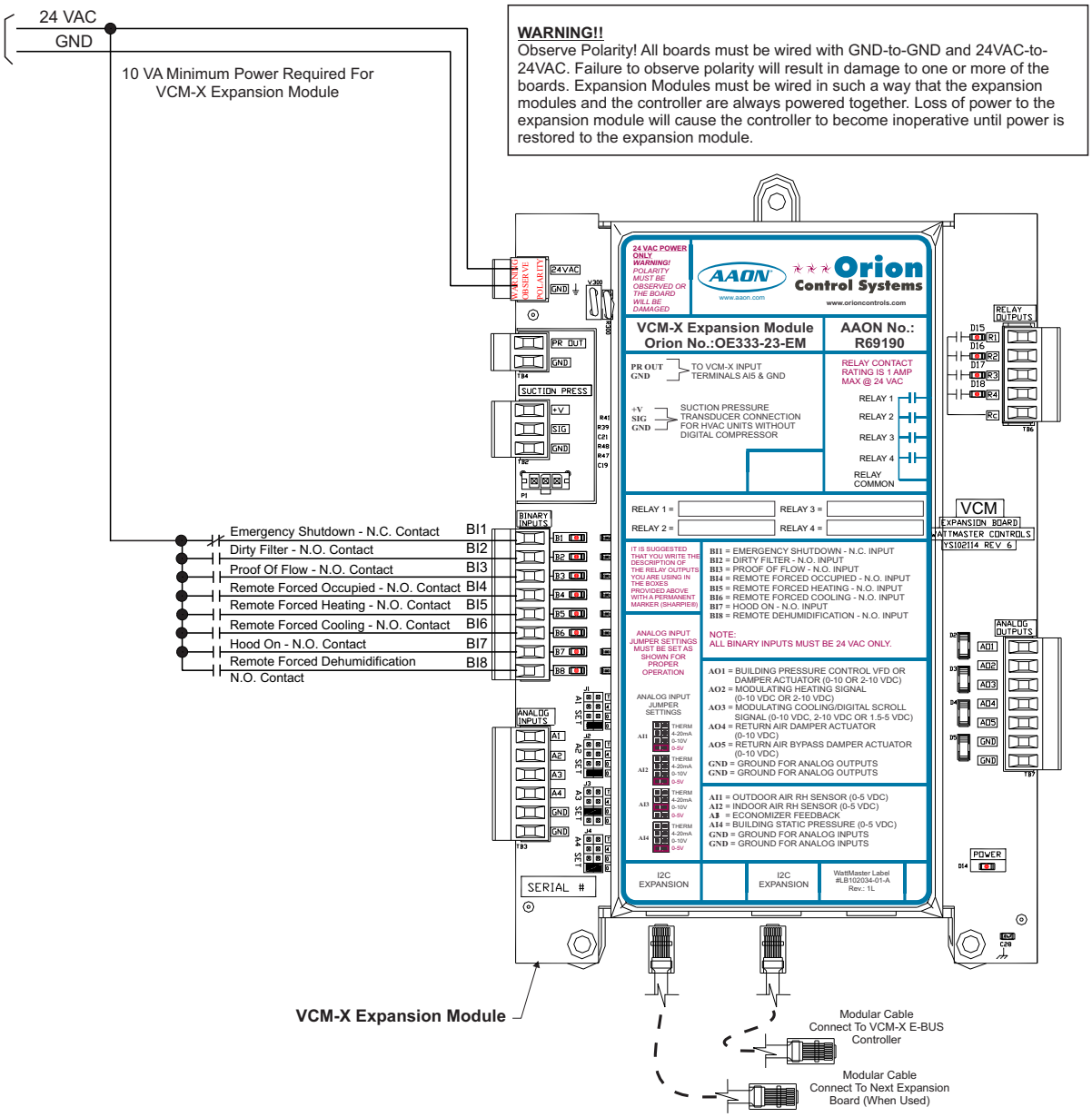

Figure 20: OE333-23-EM – VCM-X Expansion Module 8 Binary Inputs Wiring

Binary Inputs Wiring

4 Binary Inputs Located On 4 Binary Input Expansion Module

If your HVAC unit only requires an Emergency Shutdown (Smoke Detector/Firestat or other shutdown conditions), Dirty Filter, Proof of Flow or Remote Forced Occupied Inputs or all of these 4 inputs and you don't need any of the other inputs or outputs provided on the OE333-23-EM VCM-X Expansion Module, you can use the OE356-01-BI 4 Binary Input Expansion Module for these inputs.

The transformer used for powering the 4 Binary Input Expansion Module must also be used to power the binary inputs. See **Figure 21** below for detailed wiring.

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.

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.

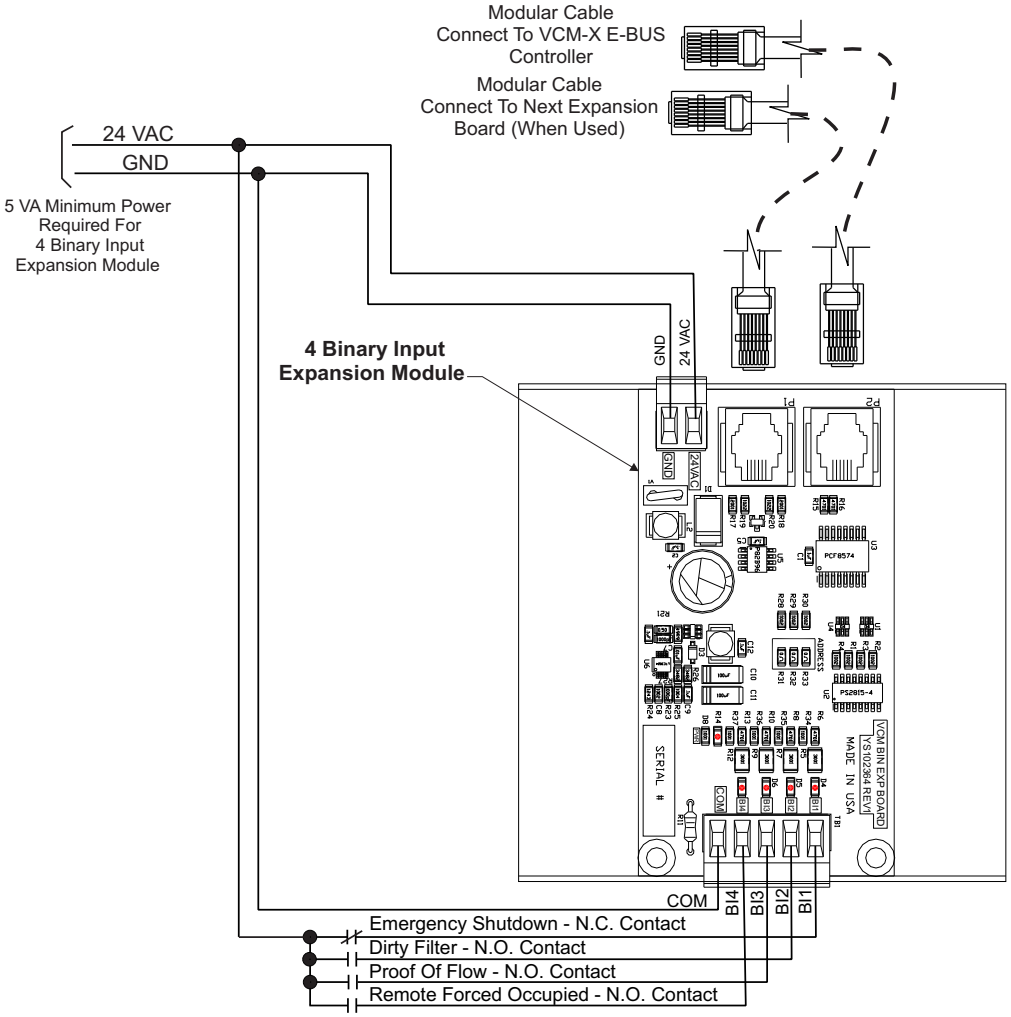

Figure 21: OE356-01-BI – 4 Binary Input Expansion Module Wiring

Outdoor Air Humidity Sensor

The OE265-13 Outdoor Air Humidity Sensor is connected to the system by wiring it to the AI1 input on the VCM-X Expansion Module. It must be wired as shown in **Figure 22** 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 OA Humidity Sensor or VCM-X Expansion Module.

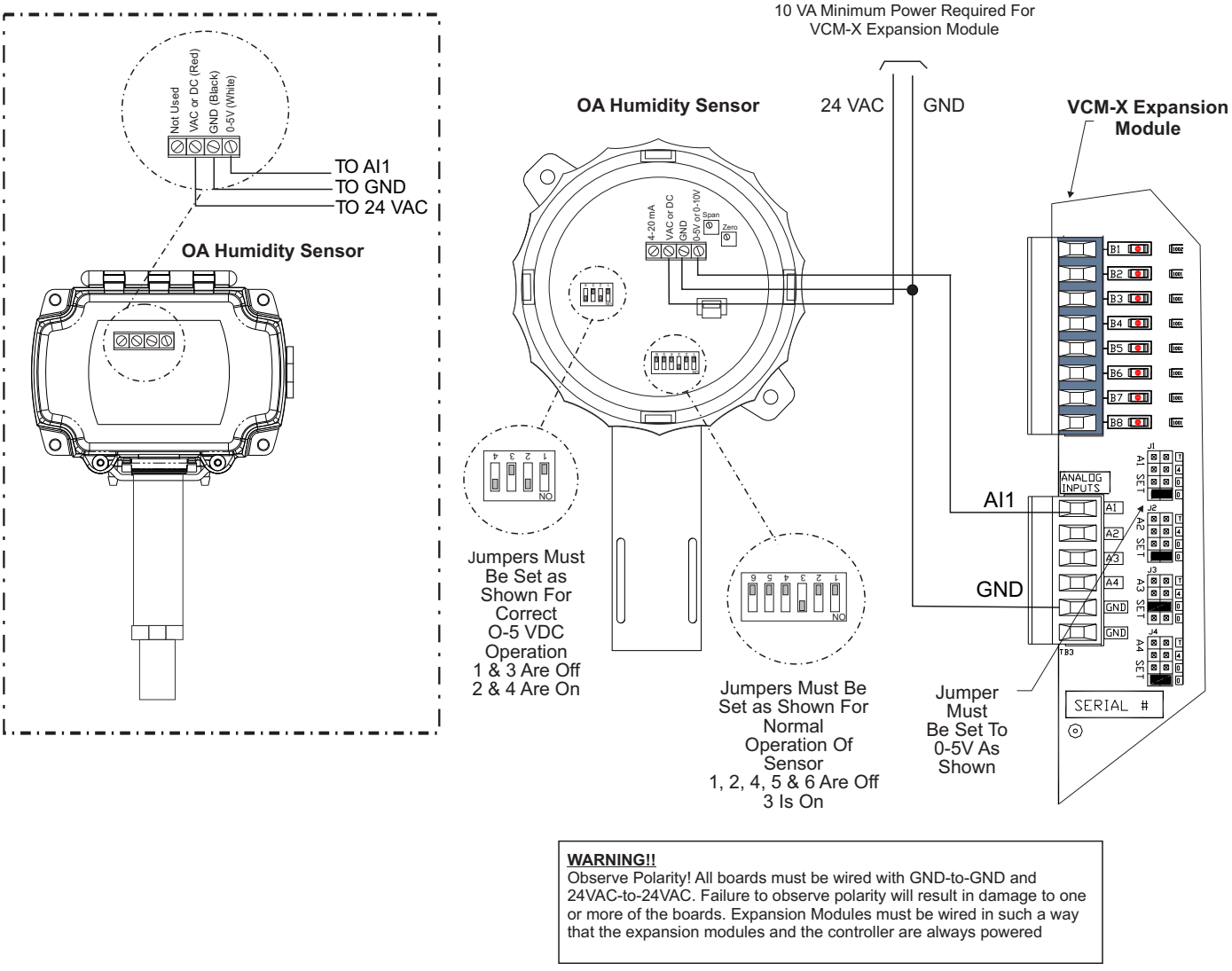

Figure 22: OE265-13 – Outdoor Air Humidity Sensor Wiring

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 VCM-X Expansion Module. It must be wired as shown in **Figure 23** below for proper controller operation. Either the Space Humidity Sensor or the RA Humidity Sensor can be wired into this input, but not both.

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 VCM-X Expansion Module.

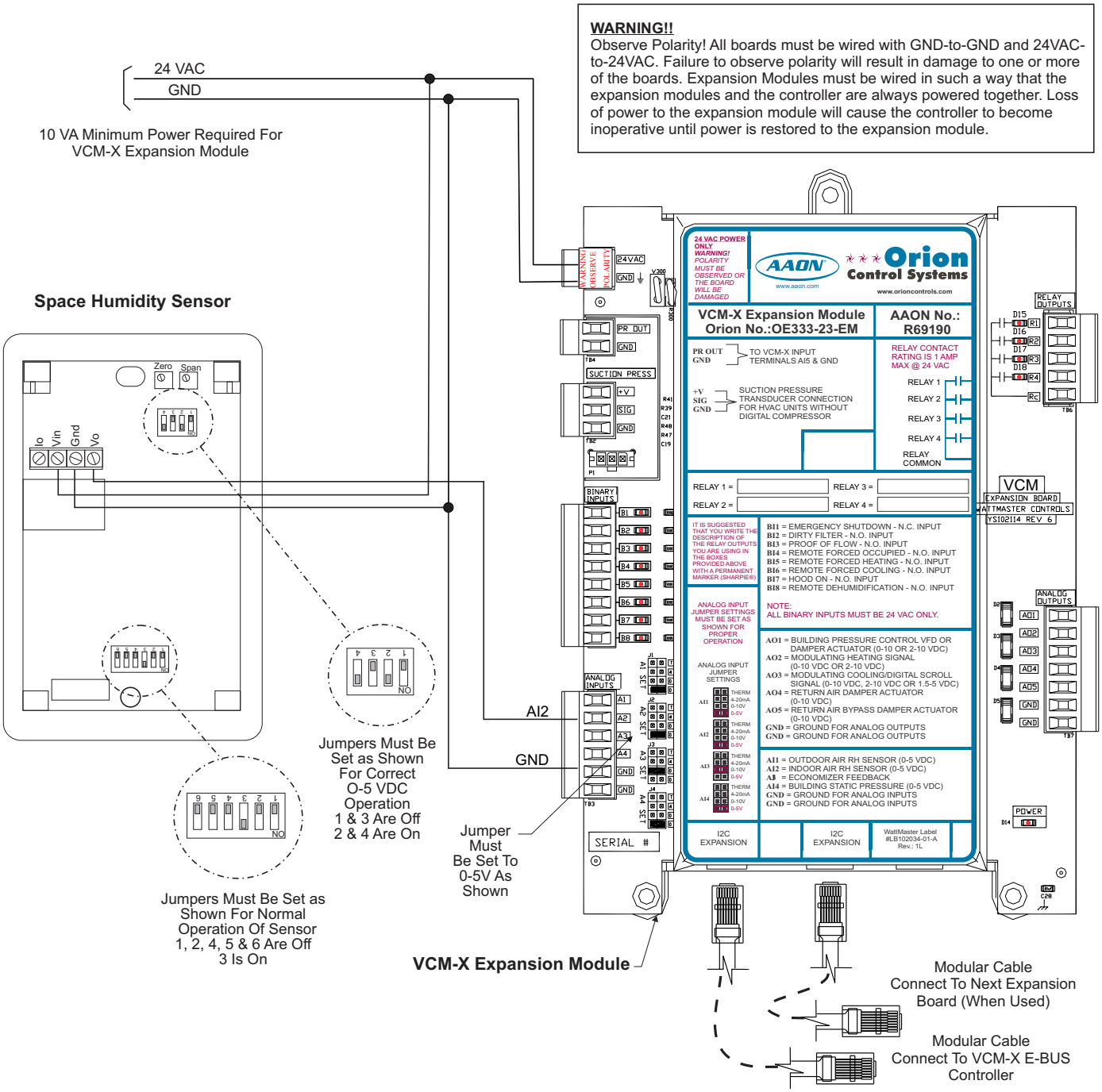

Figure 23: OE265-11 – Indoor Wall-Mounted Humidity Sensor Wiring

Return Air Mounted Humidity Sensor

When used, the OE265-14 Return Air Mounted Humidity Sensor is connected to the system by wiring it to the AI2 input on the VCM-X Expansion Module. It must be wired as shown in **Figure 24** below for proper controller operation. Either the RA Humidity Sensor or the Space Humidity Sensor can be wired into this input, but not both.

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 RA Humidity Sensor or controller.

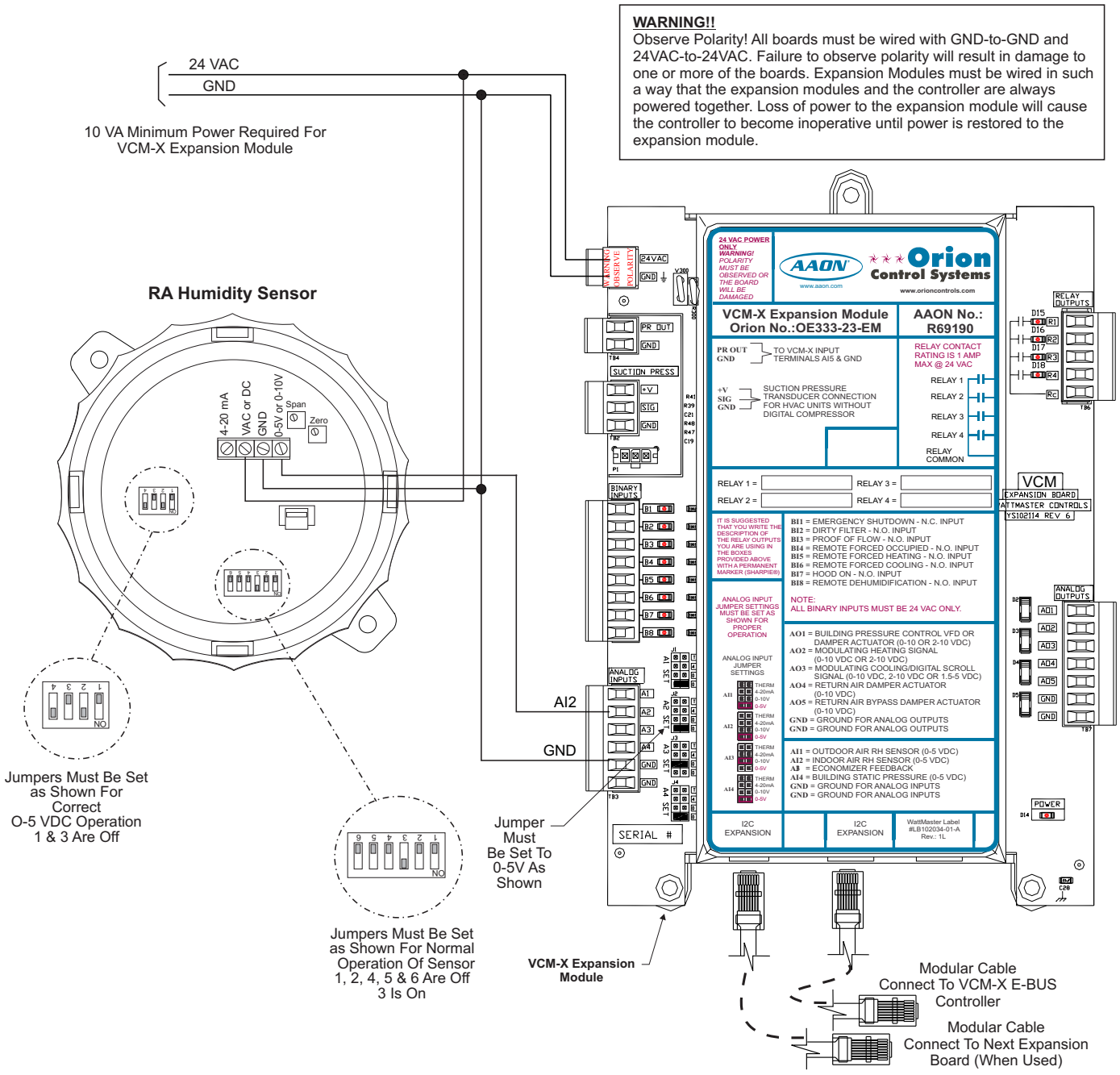

Figure 24: OE265-14 – Indoor Return Air-Mounted Humidity Sensor Wiring

Title 24 Economizer Actuator Feedback

Title 24 Economizer Actuator Feedback

If the controller has been configured for Title 24 Economizer operation, the Economizer Actuator Feedback signal is wired to the AI3 input on the VCM-X Expansion Module. It must be wired as shown in **Figure 25** 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 HVAC Unit Controller and the VCM-X Expansion Module.

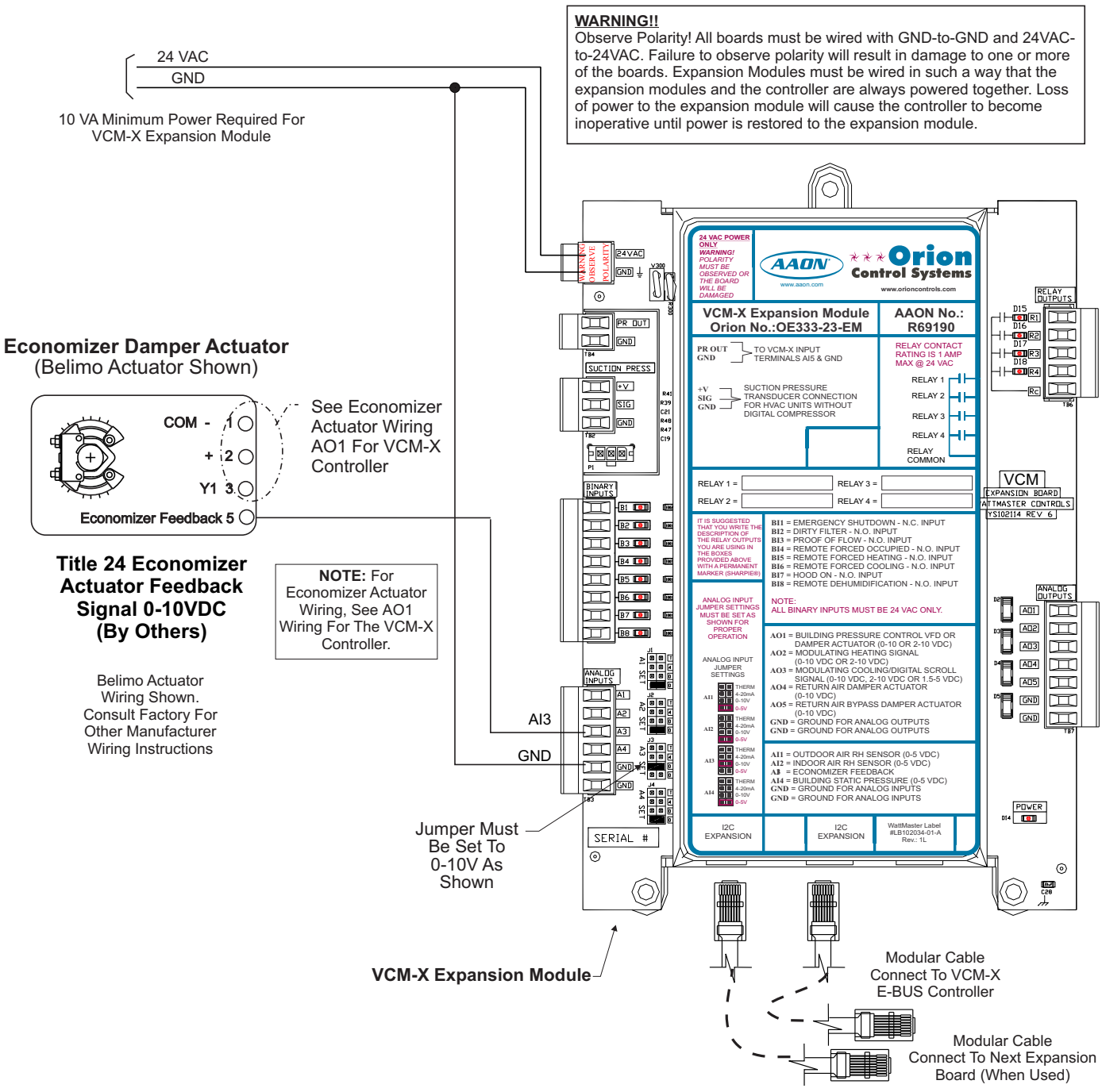

Figure 25: Title 24 Economizer Actuator Feedback Wiring

Building Pressure Sensor

The OE258-01 Building Pressure Sensor must be wired as shown in the illustration below for proper operation. There are 3 terminal connections on the Building Pressure Sensor. Connect the power side of the 24 VAC power source to the terminal labeled "+ EXC." Connect the GND side of the 24 VAC power source to the terminal labeled "- COM." Connect the remaining terminal labeled "OUT" to AI4 on the VCM-X Expansion Module terminal block. See **Figure 26** below for detailed wiring. The AI4 Jumper on the expansion module must be set for 0-5VDC operation for the Building Pressure Sensor to operate correctly.

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 HVAC Unit Controller, Building Pressure Sensor, and the VCM-X Expansion Module.

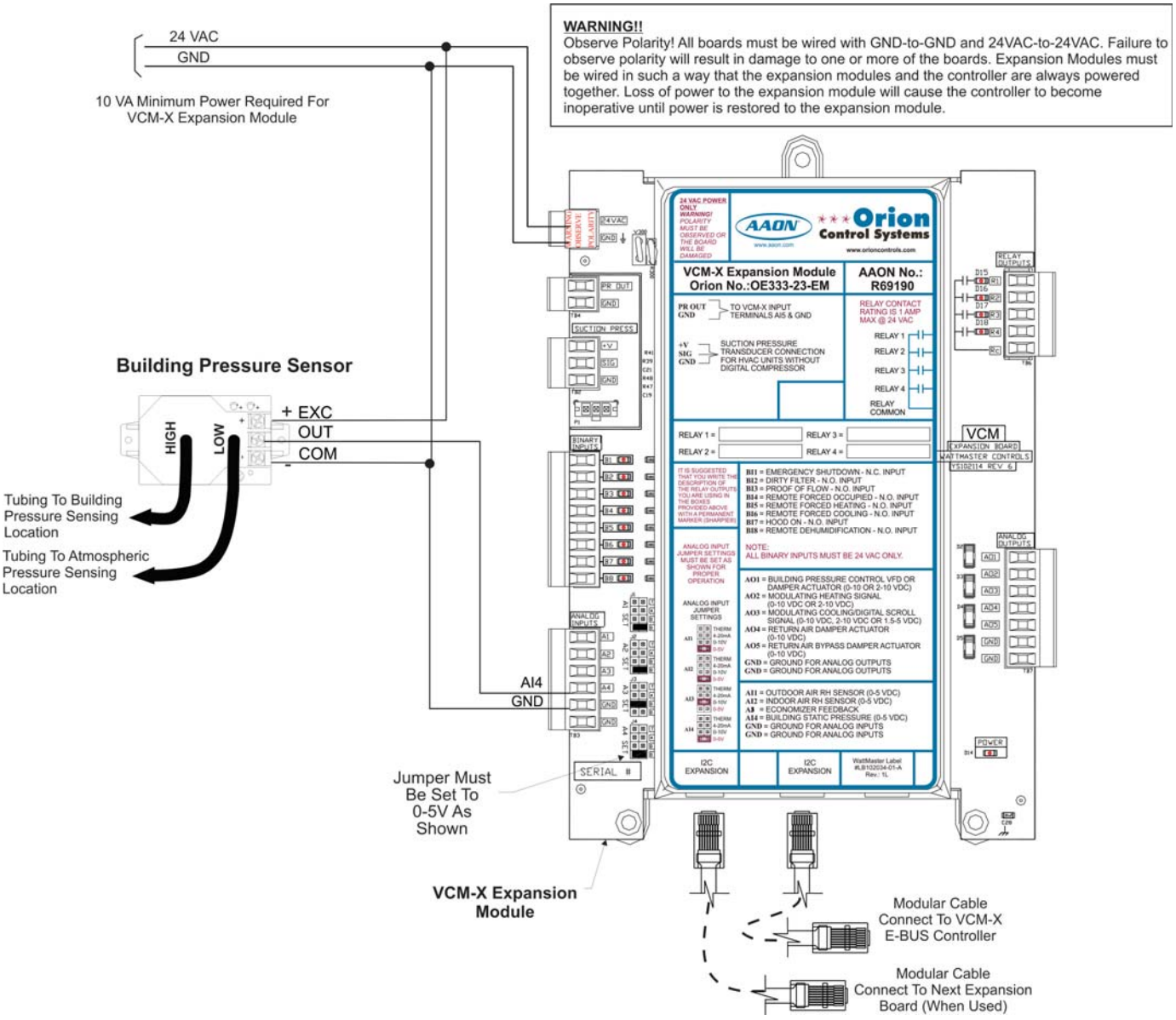

Figure 26: OE258-01 — Building Pressure Sensor Wiring

Building Pressure Control Output Wiring

Building Pressure Control Output

The Building Pressure Control Output is a 0-10 VDC or 2-10 VDC signal sent from the VCM-X Expansion Module. When using the output for Direct Building Pressure Control (output signal rises on a rise in building pressure), the output signal can be connected to either a Variable Frequency Drive controlling an exhaust fan or to a damper actuator controlling an exhaust damper. When used in this manner, the output signal must be configured for Direct Acting operation.

When using this output for Reverse Building Pressure Control (output signal rises on a fall in building pressure), a damper actuator controlling an OA Damper would be used. When using the OA damper for Reverse Building Pressure Control, the output signal must be configured for Reverse Acting operation. A Building Pressure Sensor connected to AI4 on the VCM-X Expansion Module is used to sense and control the signal to the Building Pressure Output. The OE258-01 Building Pressure Sensor must be connected in order for the Building Pressure Output to operate correctly.

See **Figure 27** below for detailed wiring of the Building Pressure Control Output Signal.

Caution: Variable Frequency Drive units can cause large transient noise spikes that 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.

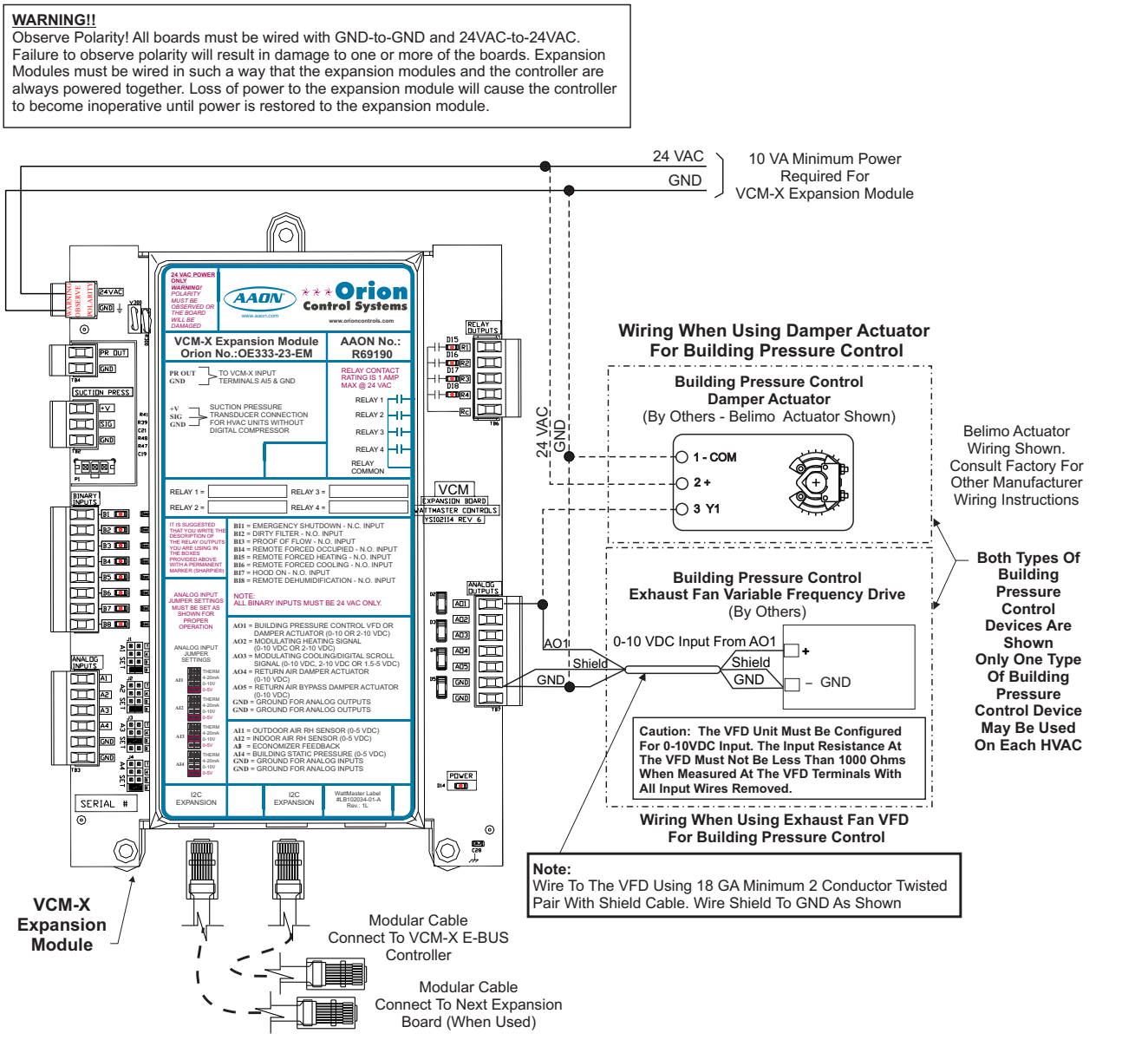

Figure 27: Building Pressure Control Output Wiring

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 28** 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 VCM-X Expansion Module.

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.

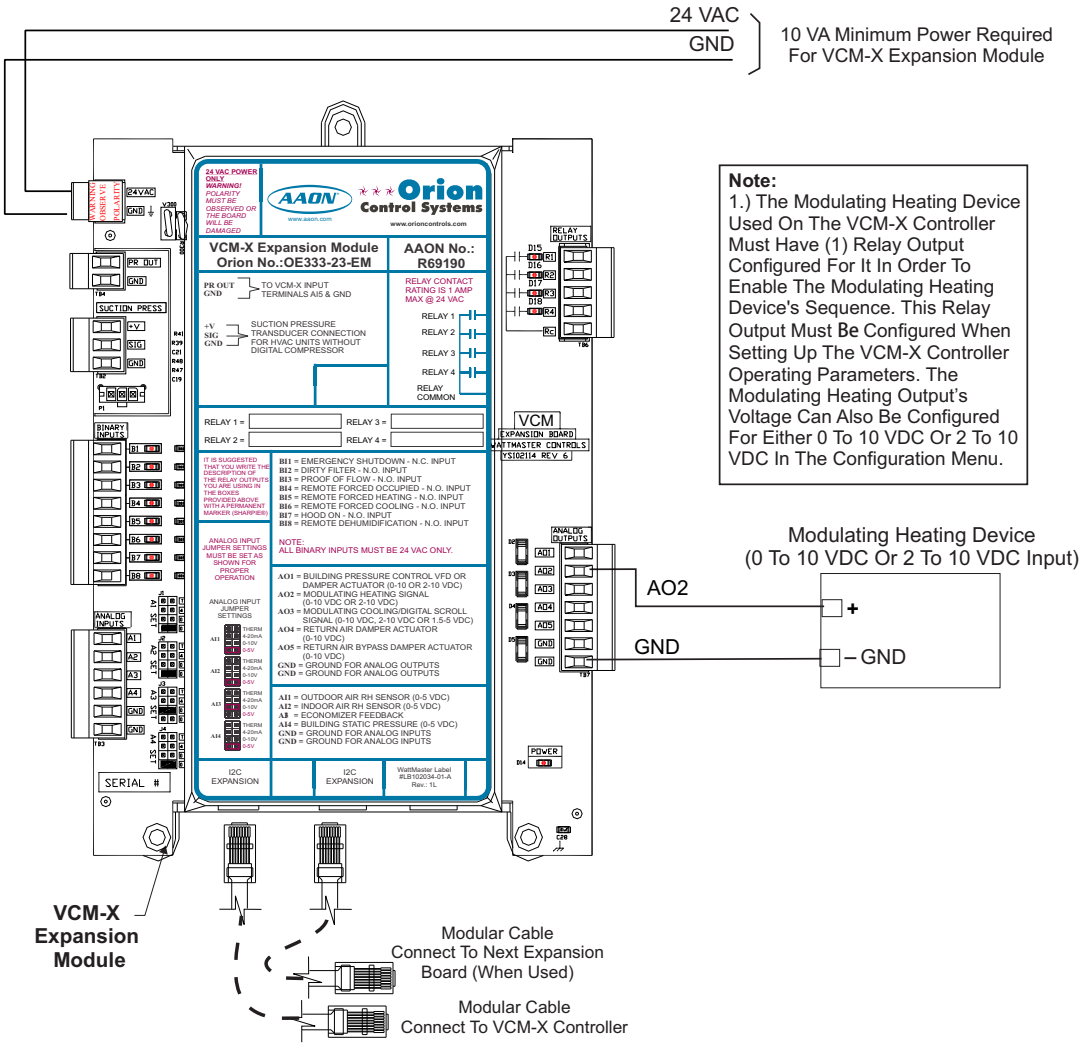

Figure 28: Modulating Heating Device Wiring

Modulating Cooling Device

The Modulating Cooling Device signal can be configured for either a 0-10 VDC, 2-10 VDC, or 1.5-5.0 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 normally be connected to a Modulating Chilled Water Valve or Copeland Digital Scroll™ Compressor Controller.

See **Figure 29** below for detailed wiring of the Modulating Cooling Device when using a Chilled Water Valve. When this output is used with a Copeland Digital Scroll™ Compressor, the Suction Line Pressure Transducer must be wired to the Copeland Digital Scroll™ Compressor Controller instead of the VCM-X E-BUS Controller, and the Modulating Cooling Output signal must be configured for a 1.5 to 5.0 VDC output signal. For Copeland Digital Scroll™ Compressor wiring details, see **Figure 19, page 22**.

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 VCM-X Expansion Module.

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.

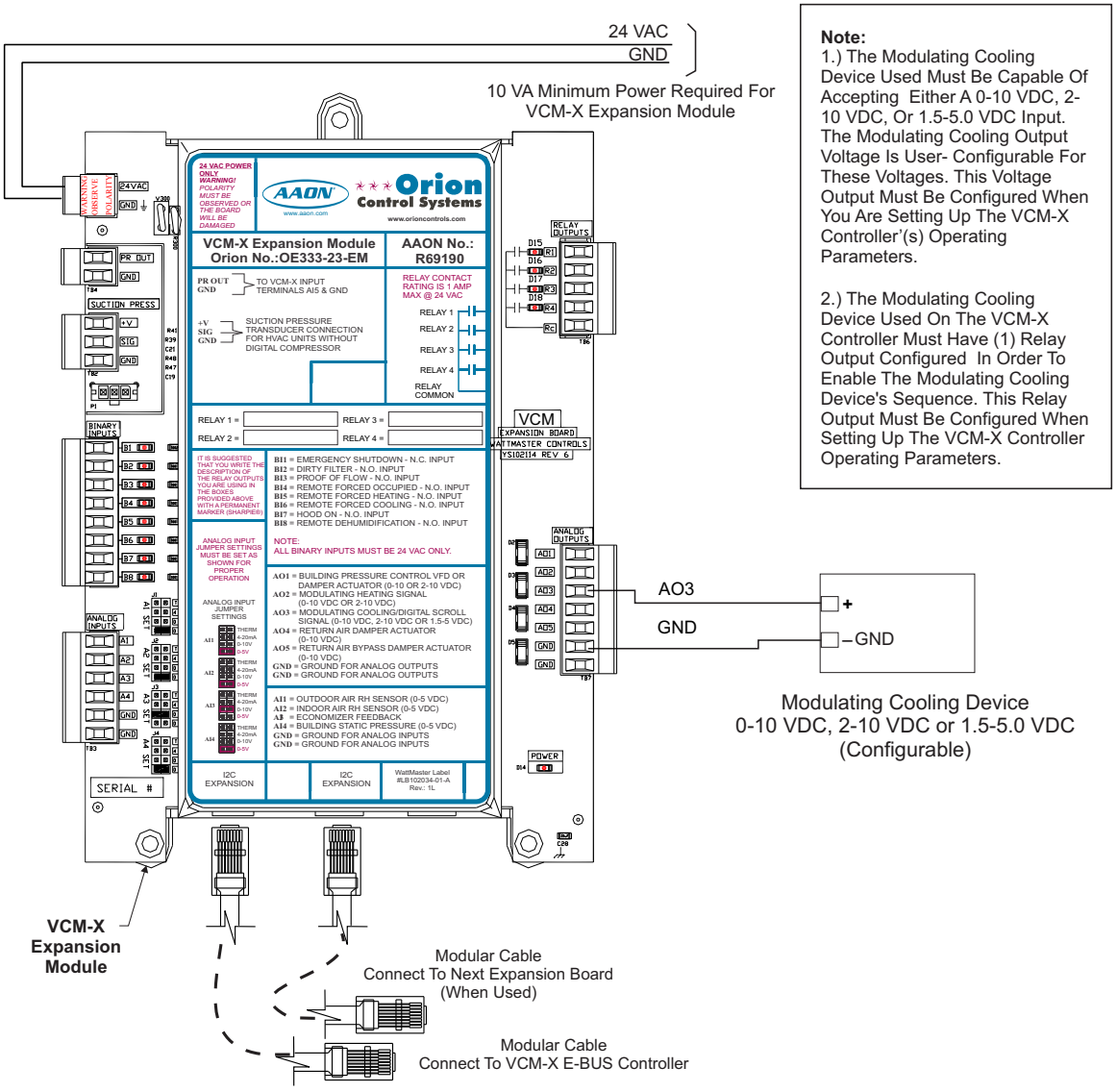

Figure 29: Modulating Cooling Device Wiring

Return Air Bypass

The VCM-X E-BUS Controller can be configured for AAON® PAC or DPAC control schemes. Both AAON® PAC and DPAC control schemes provide improved moisture removal capabilities while utilizing internal space loads for reheat by redirecting the Return Air around the Evaporator Coil instead of through the coil. See the AAON® PAC and DPAC applications section of this manual on **page 6** for complete operation details.

The AAON® PAC and DPAC control schemes utilize a Return Air Bypass Damper Actuator and a Return Air Damper Actuator to modulate the Return Air and Return Air Bypass Dampers to control the amount of air that is redirected around the Evaporator Coil.

The AAON® DPAC control scheme provides improved moisture removal capabilities and tighter temperature control than the AAON® PAC controls scheme by combining Copeland Digital Scroll™ Compressor control in addition to Return Air Bypass control.

See **Figure 30** below for detailed wiring of the Return Air Bypass and Return Air Damper Actuators. See **Figure 19**, **page 22** for detailed wiring of the Copeland Digital Scroll™ Compressor.

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 Damper Actuator or the VCM-X Expansion Module.

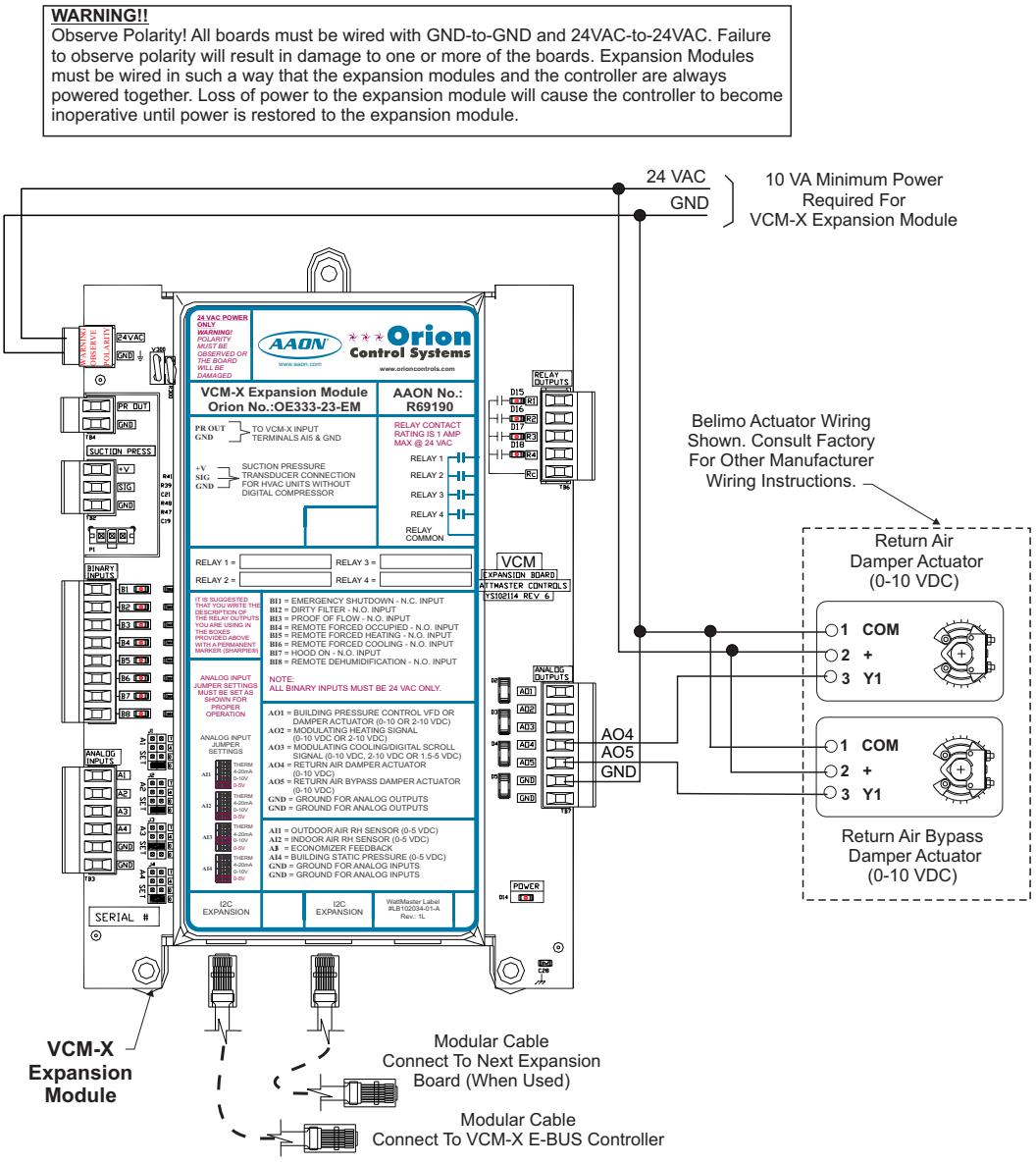

Figure 30: Return Air Bypass Wiring

12-Relay Expansion Module Wiring and Jumper Settings

12-Relay Expansion Module

Three different Expansion Modules are available for use with the VCM-X E-BUS Controller to provide additional inputs and outputs beyond those found on the VCM-X E-BUS Controller. They are the VCM-X Expansion Module (OE333-23-EM), the 4 Binary Input Expansion Module (OE356-01-BI) which can be used in place of the VCM-X Expansion Module if your system does not need any other inputs or outputs, and the 12-Relay Expansion Module (OE358-23-12R).

The 12-Relay Expansion Module provides for 12 Dry Contact Configurable Relay Outputs. See **Figure 31** below for complete wiring details.

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 VCM-X 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 31** 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.

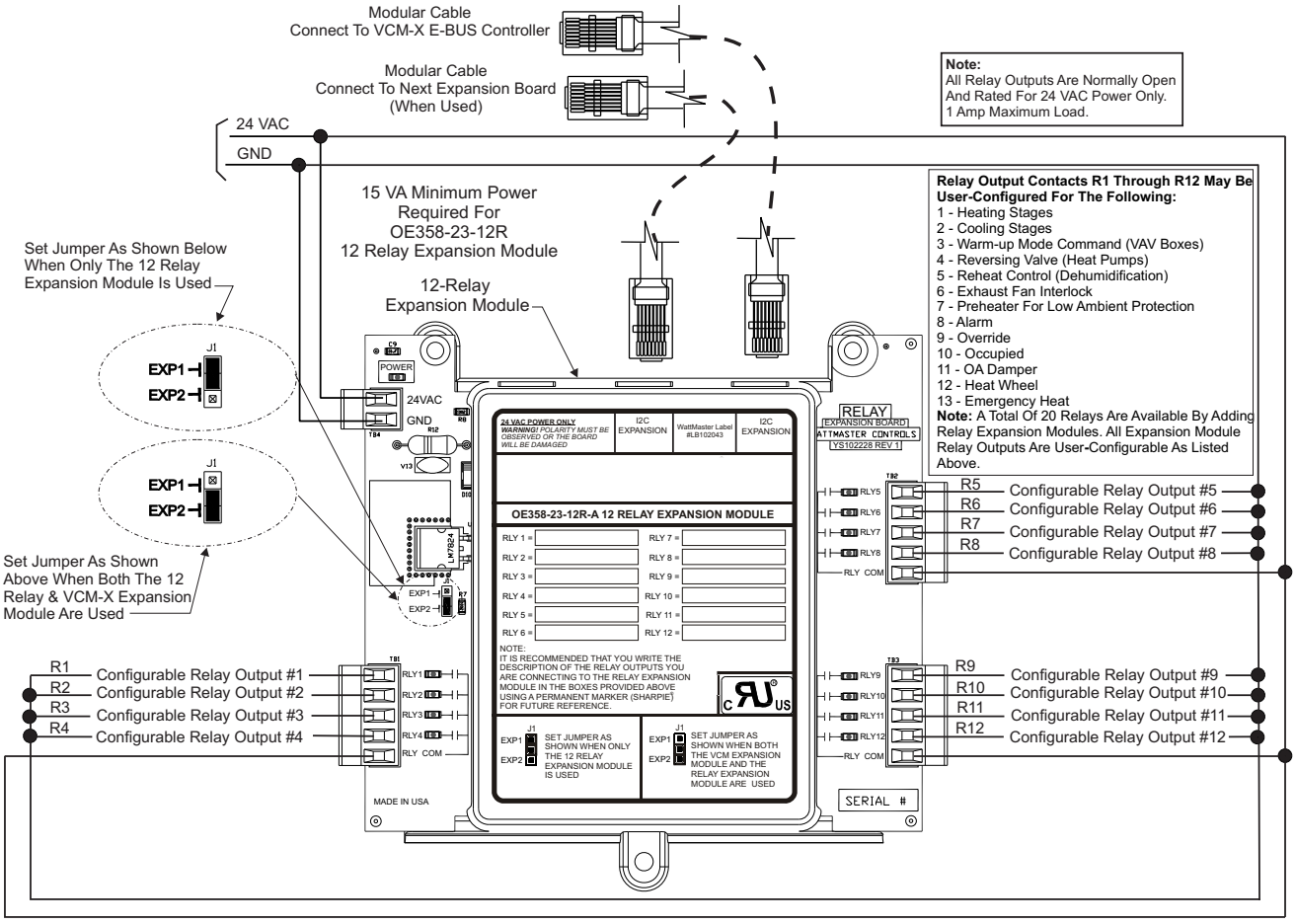

Figure 31: OE358-23-12R – 12-Relay Expansion Module Wiring and Jumper Settings

Air Flow Monitoring Station Installation and Wiring

The OE365-15-EBA E-BUS Adapter Board is used to connect selected Air Flow Monitoring Stations to the VCM-X Controller. Currently, there are up to three Air Flow Monitoring Station options that are supported in our standard software.

- EBTRON® – GTC-116 Series Air Flow Monitoring Station*
- GreenTrol™ Automation – GA-200-N Module used with any GF Series Air Flow Monitoring Station
- Paragon MicroTrans[EQ] series Air Flow Monitoring Station

The wiring for all three Air Flow Monitoring Stations are the same and are shown in **Figure 32**.

NOTE: The Airflow Station's baud rate needs to be set to 9600 in order to communicate with the VCM-X Controller.

*NOTE: When configuring the GTC-116 Series, be sure to set the Parity to "NO PARITY, 1 STOP BIT."

NOTE: Up to 3 EBTRON®, GreenTrol™, or Paragon Airflow Measurement Digital Transmitters can be attached to each Adapter Board.

NOTE: If using multiple E-BUS Sensors or Modules, the E-BUS Hub (HZ-EBC-248 or MS000248) may be required.

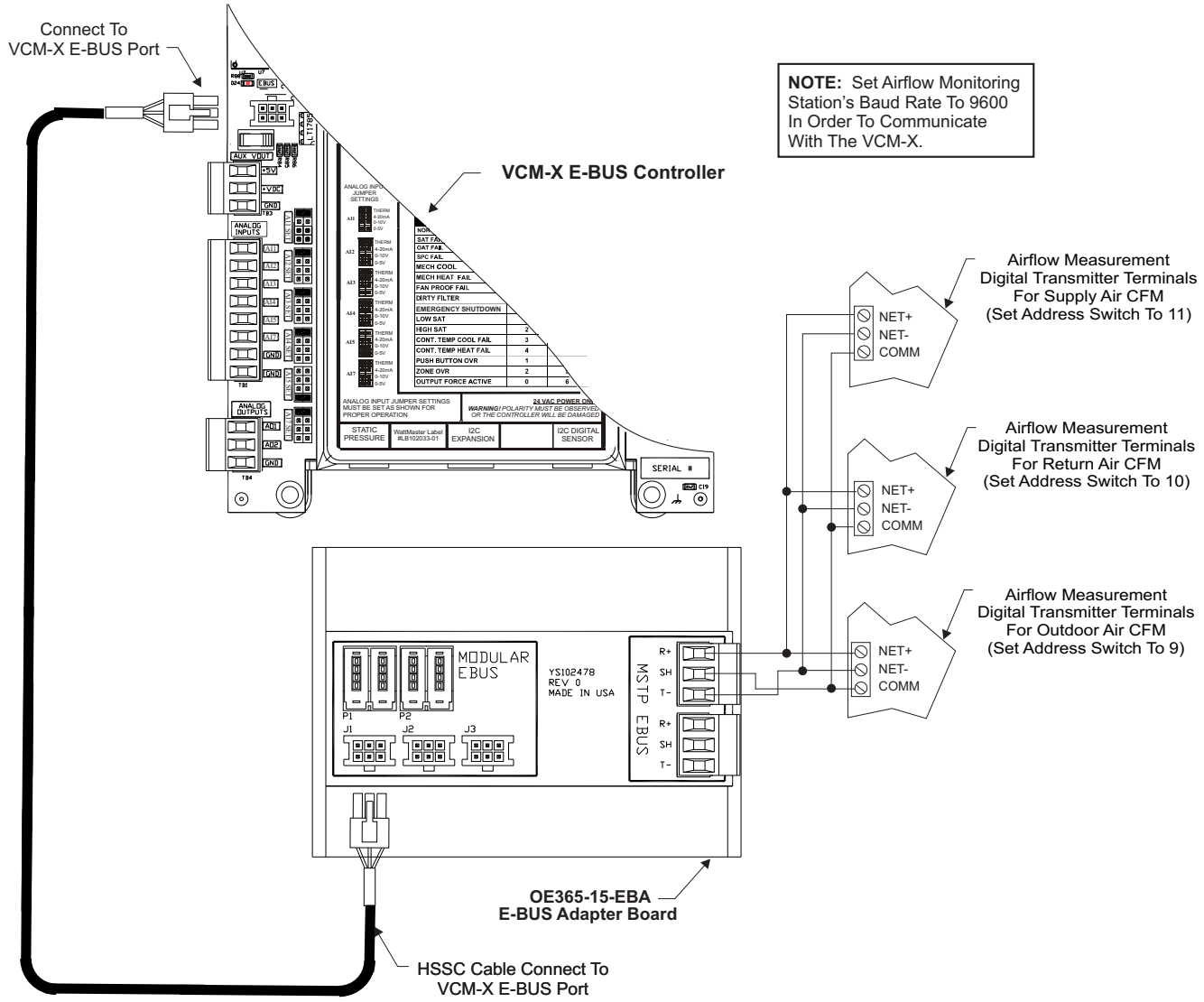

Figure 32: OE365-15-EBA - EBTRON® GTC116 Series, GreenTrol™ GA-200-N Series, and Paragon MicroTrans[EQ] Series Air Flow Measurement Digital Transmitter Wiring

VCM-X E-BUS Controller to E-BUS Module Wiring

VCM-X Modular E-BUS Controller and VCM-X WSHP E-BUS Controller to E-BUS Module Wiring

The VCM-X E-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 33** below for an example of E-BUS Controller to E-BUS Module wiring.

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

See **Figures 34-40, pages 38-47** for specific E-BUS Module wiring.

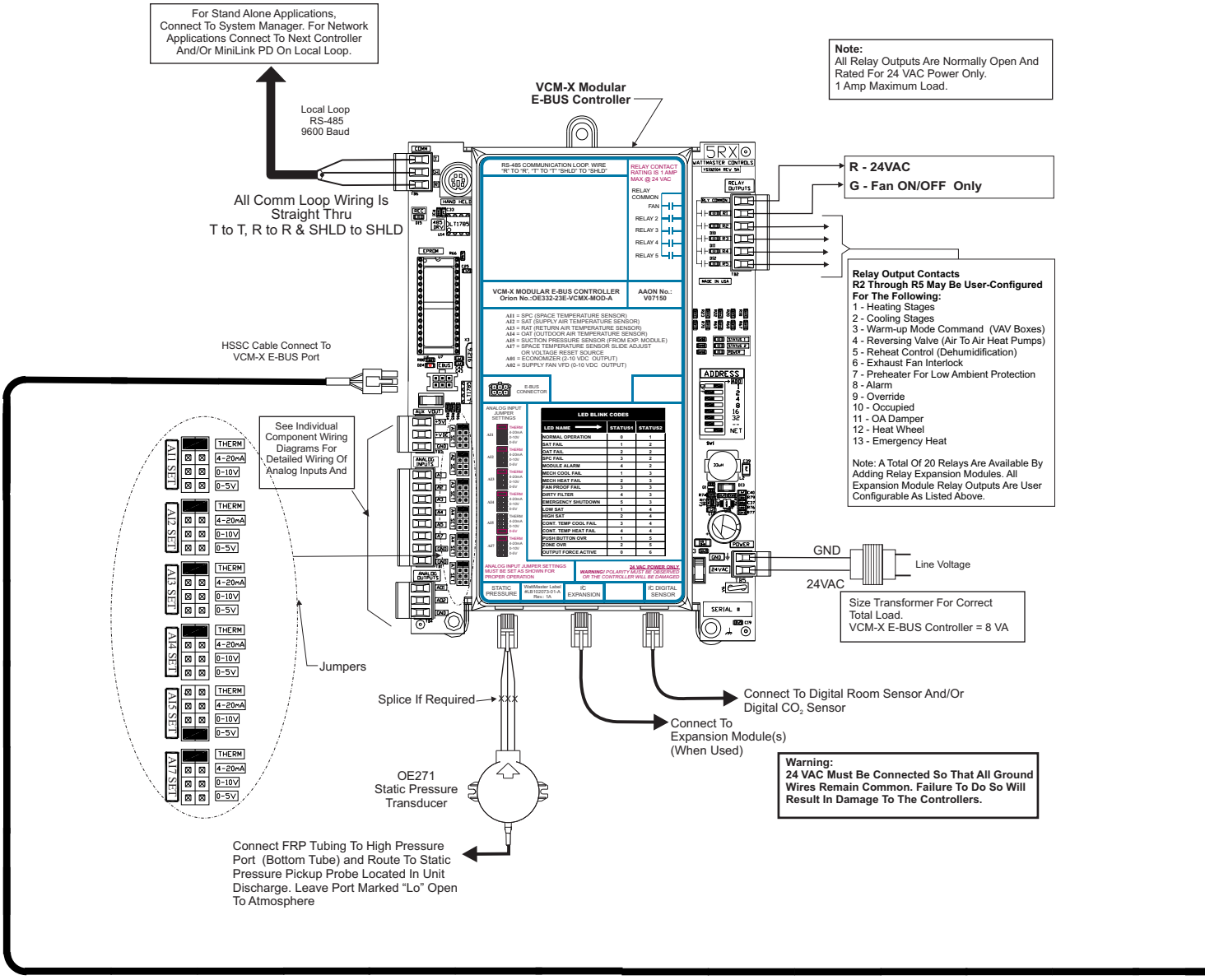

Figure 33: VCM-X E-BUS Controller to E-BUS Module Wiring Diagram

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.

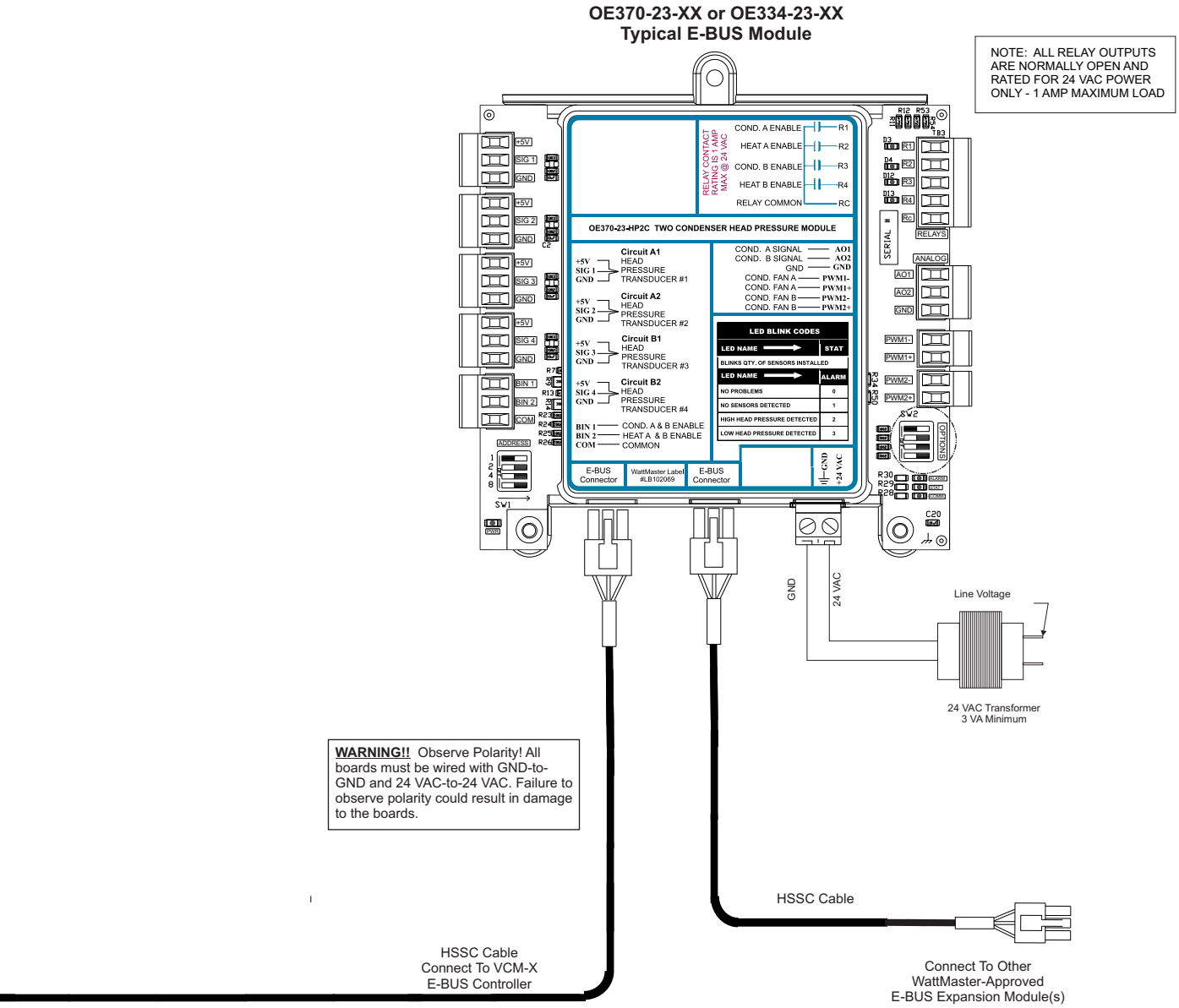

Figure 33, cont.: VCM-X E-BUS Controller to E-BUS Module Wiring Diagram

One Condenser Head Pressure Module Overview and Wiring

One Condenser Head Pressure Module

The One Condenser Head Pressure Module (OE370-23-HP1C) monitors four individual head pressure transducers and controls the Condenser Fan or Water Valve based on the highest of the four readings. A pulse width modulation (PWM) signal or 0-10 volt output signal is used to control the condenser fan.

The One Condenser Head Pressure Module connects to the VCM-X Modular E-BUS Controller (OE332-23E-VCMX-MOD-A) or VCM-X WSHP E-BUS Controller (OE332-23E-VCMX-WSHP-A). This allows the One Condenser Head Pressure Module to receive setpoints from the VCM-X Modular E-BUS Controller or VCM-X WSHP E-BUS Controller. See **Figure 34** below for wiring diagram.

The One 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 *One Condenser Head Pressure Module Technical Guide*.

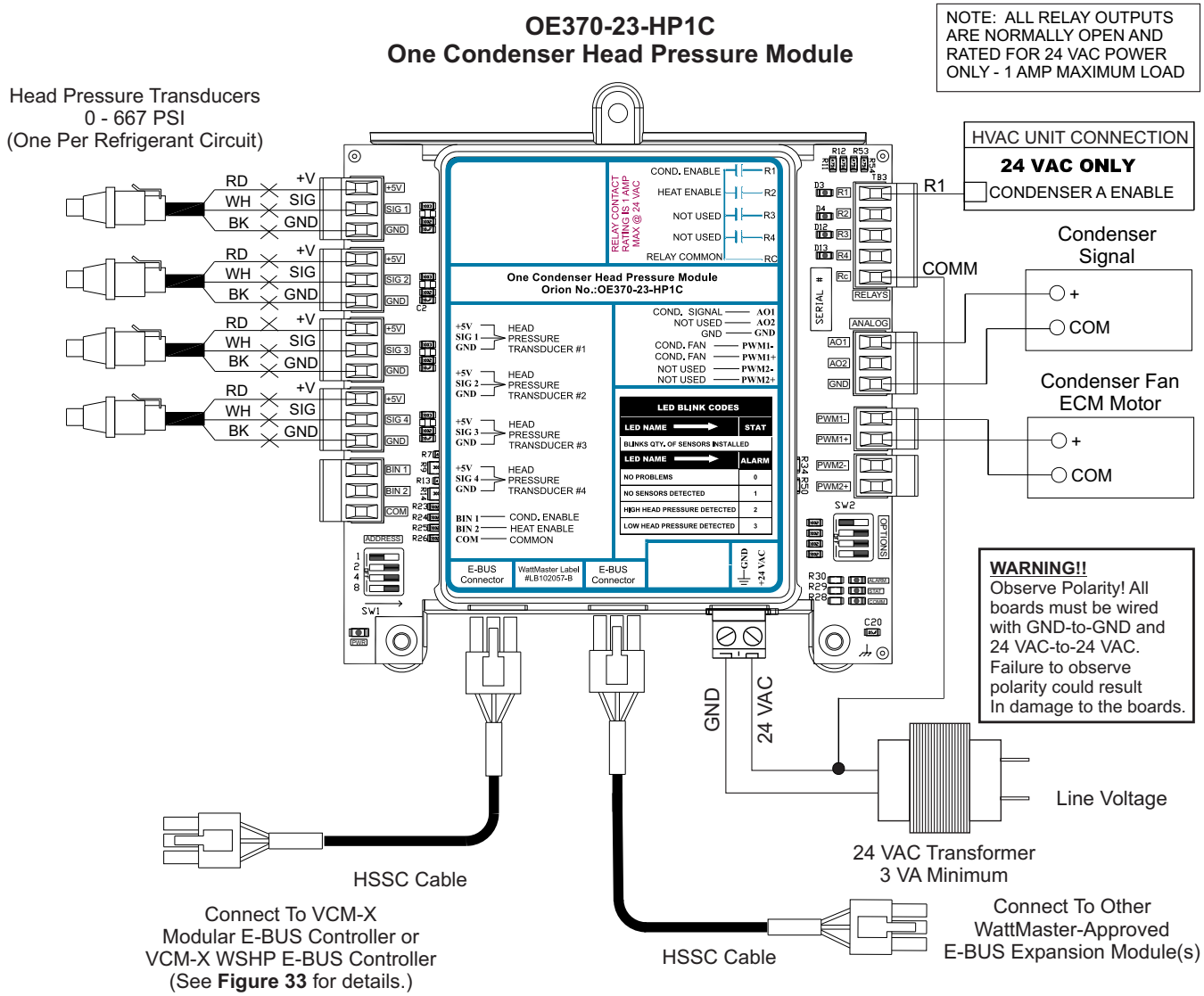

Figure 34: One Condenser Head Pressure Module Wiring Diagram

Two Condenser Head Pressure II Module

The Two Condenser Head Pressure II Module (OE370-23-HP2C2) 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. If this is a heat pump unit, the module is able to detect when the unit is in Heat Pump Heating mode and will force the condenser signal to 100% until it leaves this mode. A pulse width modulation (PWM) signal or 0-10 volt output signal is used to control the condenser fans.

The Two Condenser Head Pressure II Module connects to the VCM-X Modular E-BUS Controller (OE332-23E-VCMX-MOD-A or -C) or the VCM-X WSHP E-BUS Controller (OE332-23E-VCMX-WSHP-A or -C). This allows the Two Condenser Head Pressure II Module to receive setpoints from the VCM-X Modular E-BUS Controller or VCM-X WSHP E-BUS Controller. See **Figure 35** below for wiring diagram.

The Two Condenser Head Pressure II 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 II Module Technical Guide*.

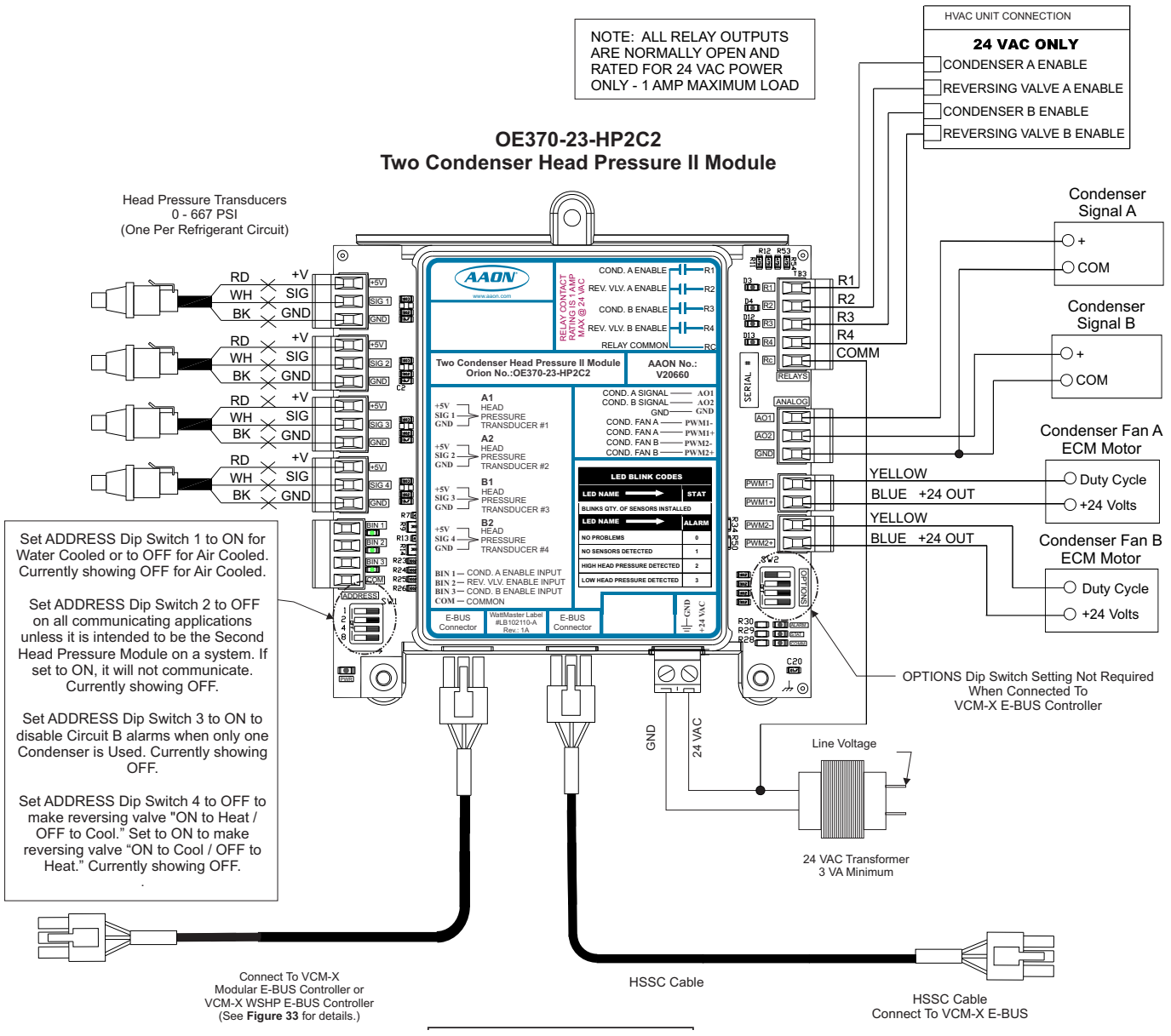

Figure 35: Two Condenser Head Pressure II Module Wiring Diagram

Four Compressor Micro Channel Condenser Wiring for the HP2C2

Two (2) Two Condenser Head Pressure II Modules (OE370-23-HP2C2) can be used to monitor four head pressure transducers and control four condenser fans or water valves (two circuits per module). A pulse width modulation (PWM) signal or a 0-10 VDC output signal is used to control these condenser devices. See **Figure 36** for the wiring details.

The Two Condenser Head Pressure II Modules are connected together and then back to the Full Digital Module, a Water Source Heat Pump Module, or the VCM-X E-BUS Controller with HSSC cables. This allows setpoints, status values, and alarms to be communicated between the VCM-X Controller and the Two Condenser Head Pressure II Modules. This module requires a 24 VAC power connection with an appropriate VA rating.

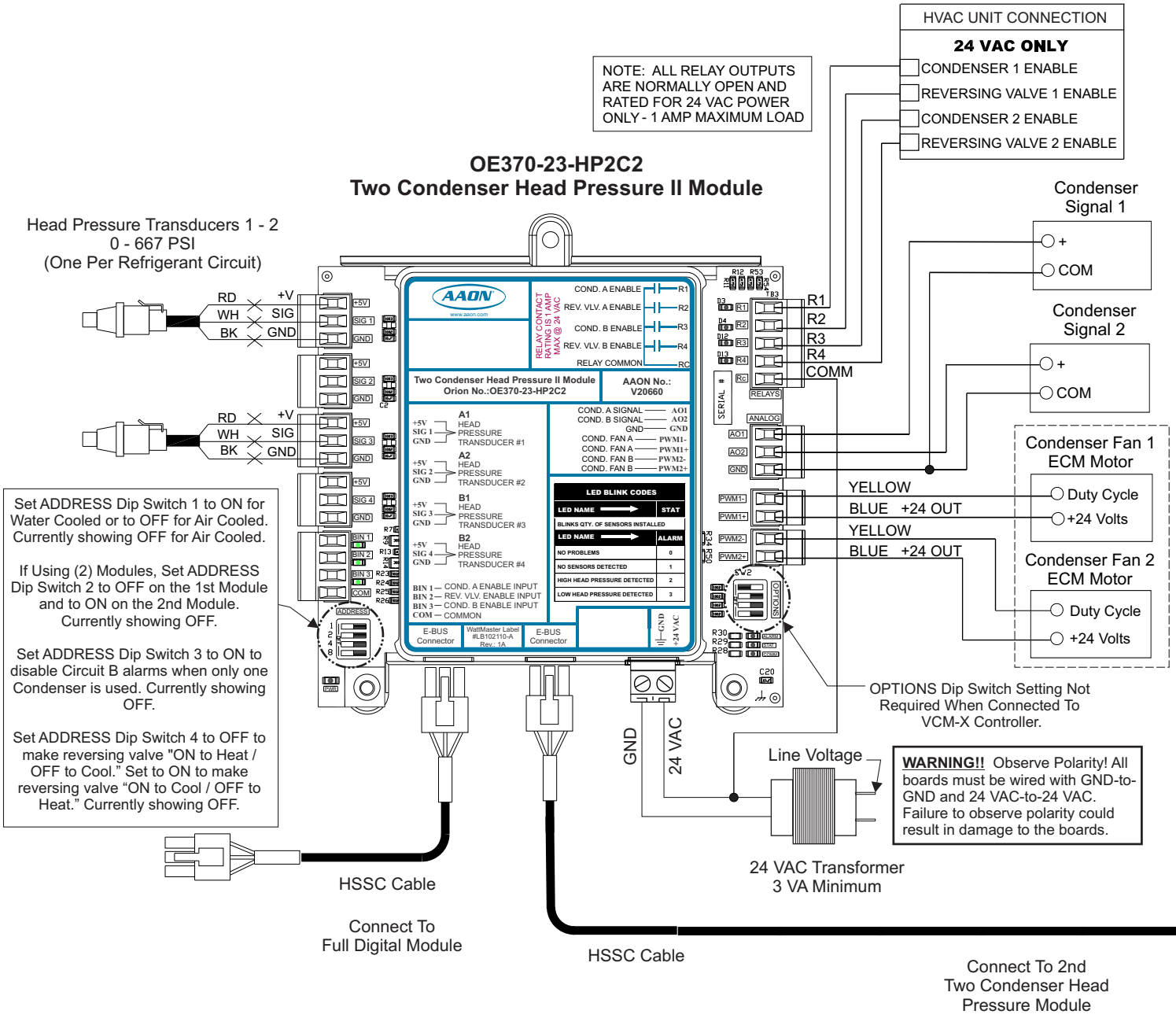

Figure 36: Four Compressor Micro Channel Condenser Wiring for the HP2C2

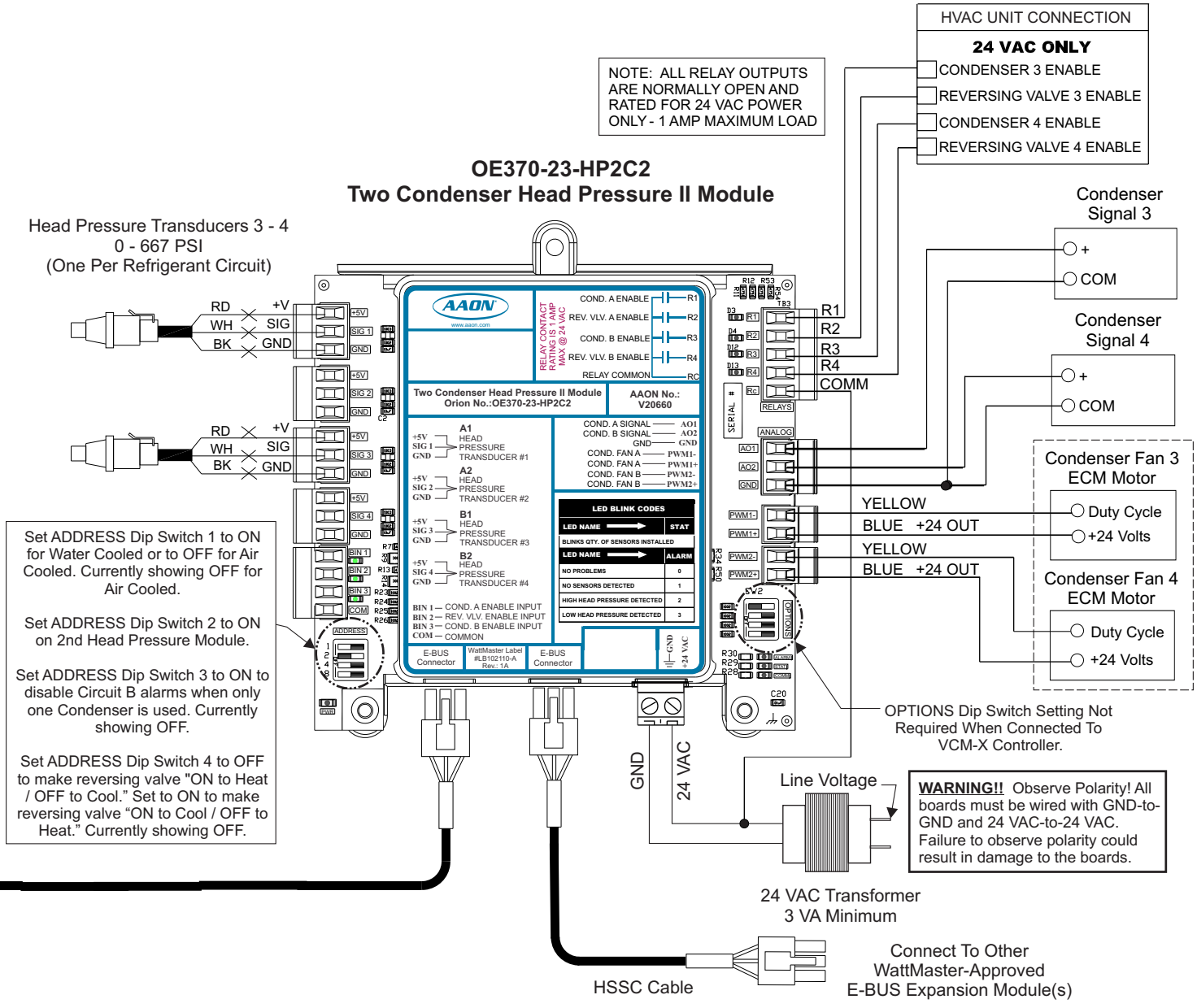

Figure 36, cont.: Four Compressor Micro Channel Condenser Wiring for the HP2C2

AAON® Tulsa Full Digital Module Overview and Wiring

AAON® Tulsa Full Digital Module

The Full Digital Module (OE370-23-FD-A) is a device that enables and modulates up to four digital compressors on HVAC Units controlled by the VCM-X Modular E-BUS Controller (OE332-23E-VCMX-MOD-A). The Full Digital Module will control the digital compressors to satisfy the cooling, dehumidification, and heat pump requirements of the VCM-X Modular E-BUS Controller.

The Full Digital Module connects to the VCM-X Modular E-BUS Controller. This allows the Full Digital Module to receive setpoints and monitor the Supply Air Temperature from the VCM-X Modular E-BUS Controller. See **Figure 37** below for wiring diagram.

The Full Digital Module requires a 24 VAC power connection with an appropriate VA rating.

NOTE: The Compressor Relays on the Full Digital Module are used rather than the relay outputs on the VCM-X Modular E-BUS Controller.

NOTE: For complete information, including the sequence of operation, refer to the *Full Digital Module Technical Guide.*

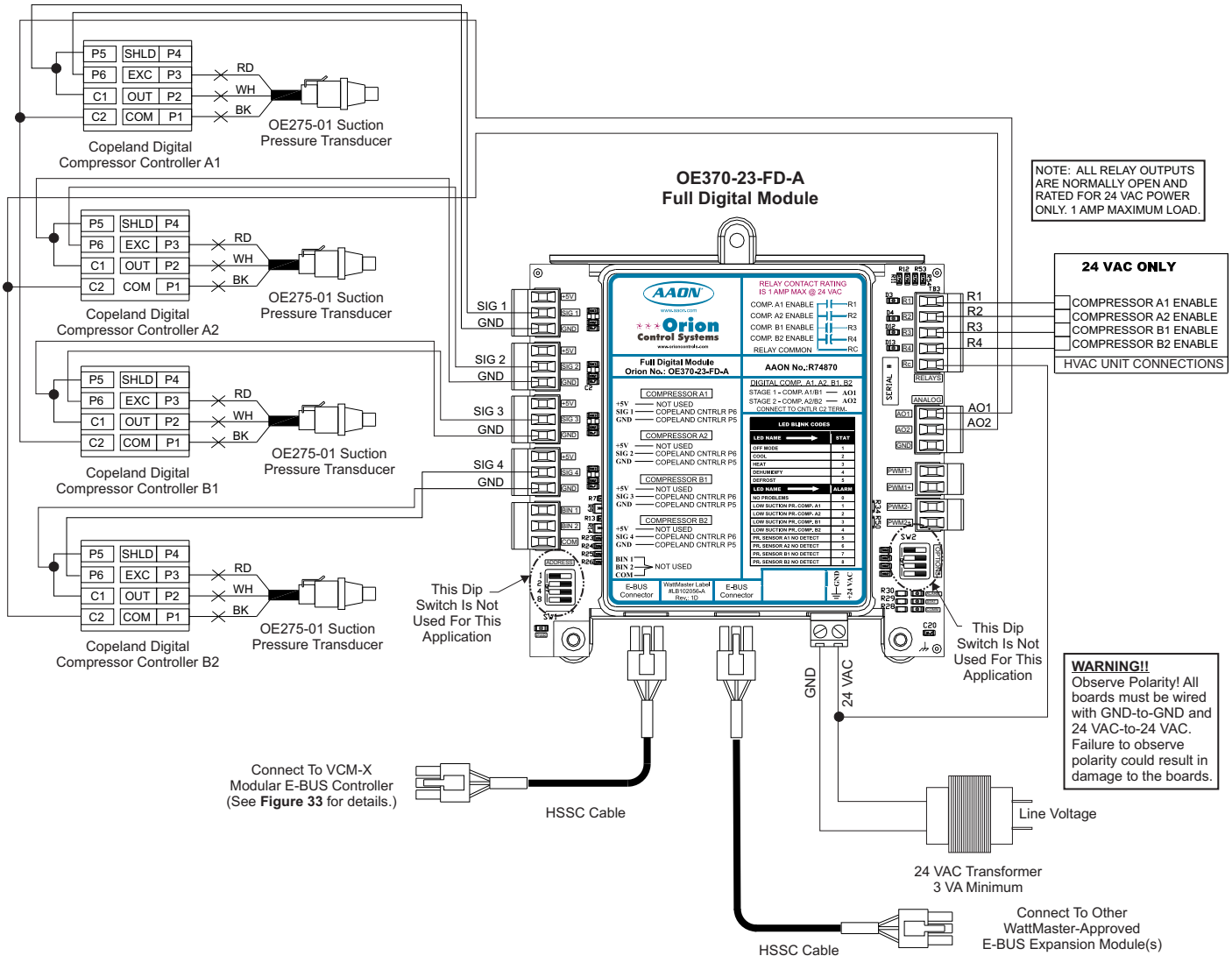

Figure 37: AAON Tulsa's Full Digital Module Wiring Diagram

AAON® Coil Dual Digital Module

The Dual Digital Module (OE370-23-DD-C) is a device that enables and modulates two digital compressors on HVAC Units controlled by the VCM-X Modular E-BUS Controller (OE332-23E-VCMX-MOD-C). The Dual Digital Module will control the digital compressors to satisfy the cooling, dehumidification, and heat pump requirements of the VCM-X Modular E-BUS Controller.

The Dual Digital Module connects to the VCM-X Modular E-BUS Controller. This allows the Dual Digital Module to receive setpoints and monitor the Supply Air Temperature from the VCM-X Modular E-BUS Controller. See **Figure 38** below for wiring diagram.

The Dual Digital Module requires a 24 VAC power connection with an appropriate VA rating.

NOTE: The Compressor Relays on the Dual Digital Module are used rather than the relay outputs on the VCM-X Modular E-BUS Controller.

NOTE: For complete information, including the sequence of operation, refer to the *Dual Digital Module Technical Guide*.

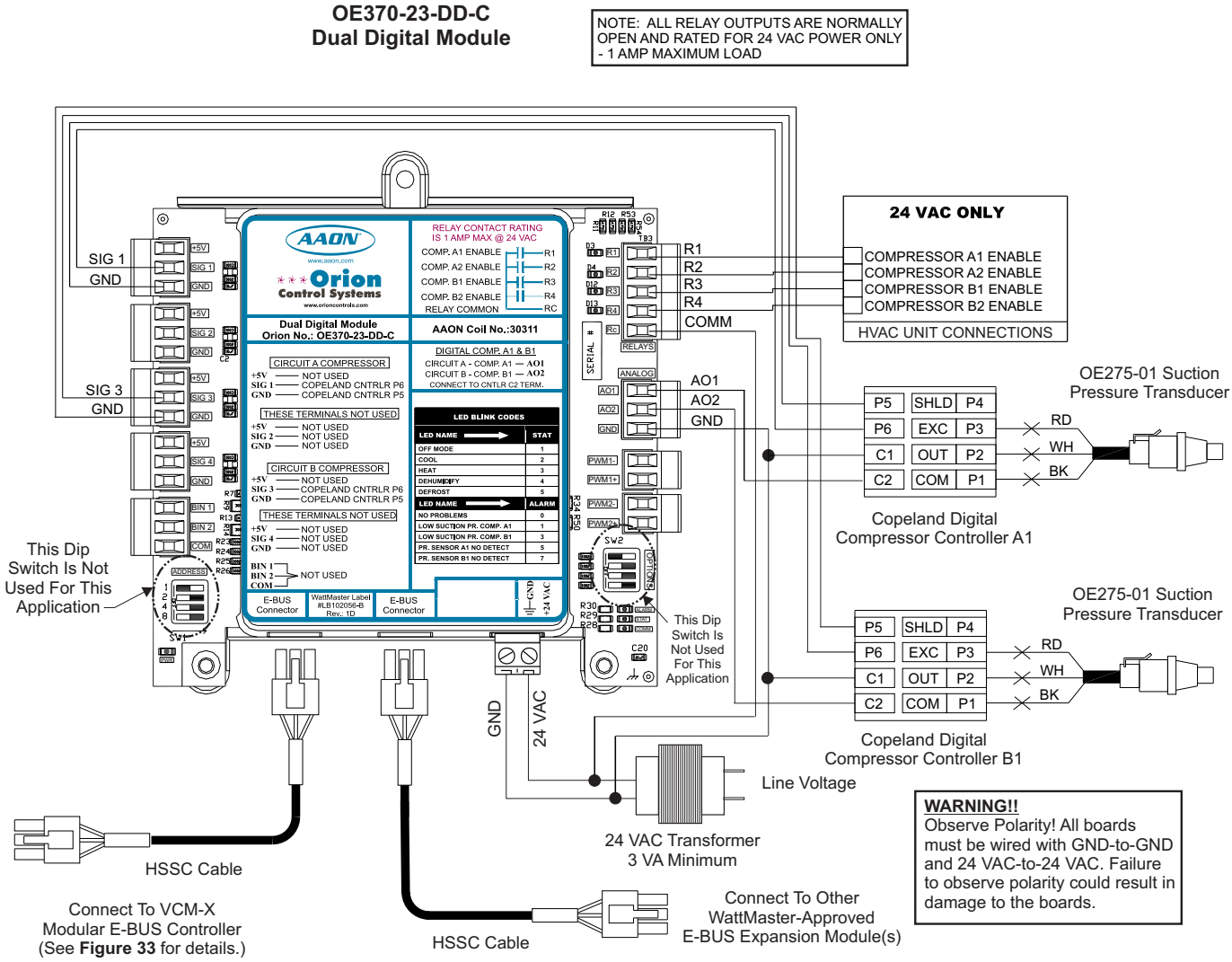

Figure 38: AAON Coil Dual Digital Module Wiring Diagram

AAON® WSHP-X2 Module Overview and Wiring

AAON® Water Source Heat Pump X2 Module Single Water Circuit

The OE334-26-WSHP-X2 Water Source Heat Pump X2 (WSHP-X2) Module monitors the compressors on an AAON® Water Source Heat Pump unit and can disable the compressors based on low Suction Pressure, Leaving Water Temperature, and Water Proof of Flow inputs. It also utilizes a Delay Timer to prevent the compressors from turning on at the same time.

The WSHP-X2 Module's water circuit configuration can be either single or dual. There are eight R410-A glycol configurations for the WSHP-X2 Module—0%-40% in increments of 5%. There are two refrigerant selections—R410-A refrigerant and R-22 refrigerant. If R-22 refrigerant is selected, the glycol will automatically default to 0%.

The WSHP-X2 Module connects to the VCM-X WSHP E-BUS Controller (OE332-23E-VCMX-WSHP-A). This allows the Water Source Heat Pump Module to receive control data and alarms from the VCM-X WSHP E-BUS Controller. See **Figure 39** below for a single water circuit wiring diagram.

NOTE: The WSHP-X2 Module is factory set for R410-A and 0% glycol.

NOTE: For complete information, including the sequence of operation, refer to the *WSHP-X2 Module Technical Guide*.

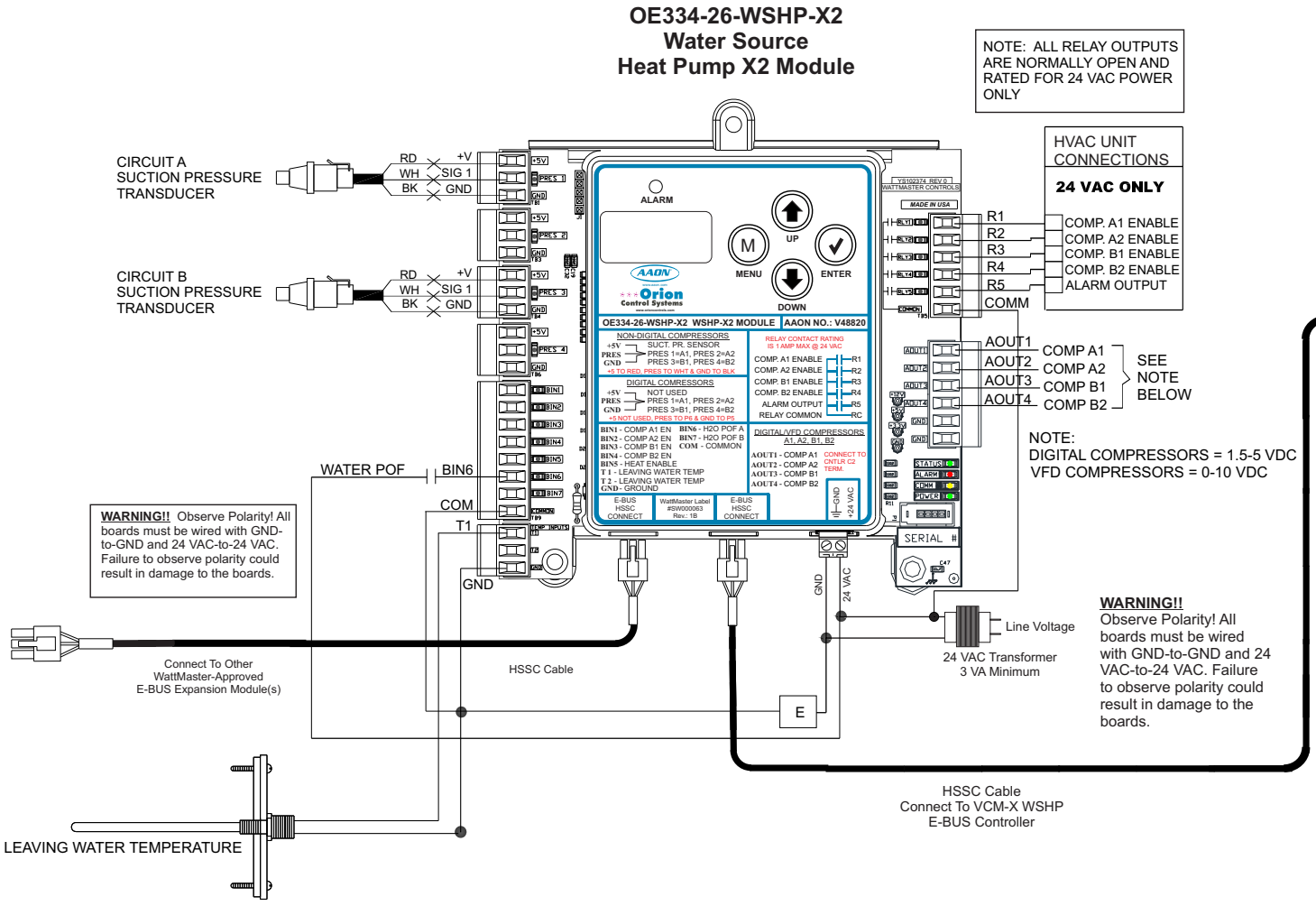

Figure 39: WSHP-X2 Module Single Water Circuit Wiring Diagram

The WSHP-X2 Module connects to the E-BUS Controller using a modular HSSC cable. The WSHP-X2 Module requires a 24 VAC power connection with an appropriate VA rating.

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

NOTE: When using the WSHP-X2 Module, all compressors will be wired from the WSHP-X2 Module, not the VCM-X WSHP E-BUS Controller or SA E-BUS Controller.

NOTE: Contact Factory for the correct HSSC cable length for your application. Cables are available in ½ & 3 Meter lengths and 100 and 150 Foot lengths.

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

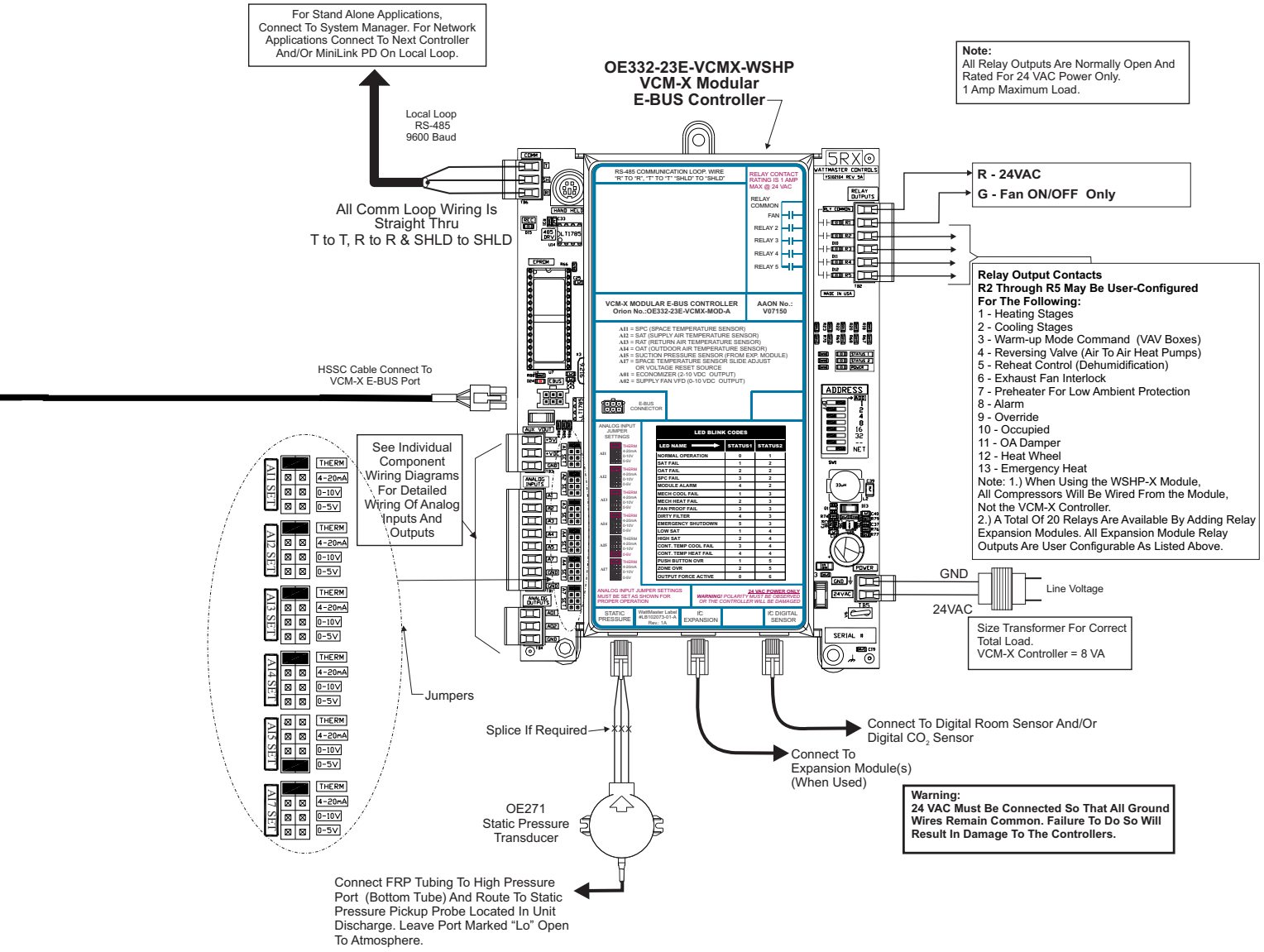

Figure 39: WSHP-X2 Module Single Water Circuit Wiring Diagram, continued

AAON® Water Source Heat Pump X2 Module Dual Water Circuit

The OE334-26-WSHP-X2 Water Source Heat Pump X2 (WSHP-X2) Module monitors the compressors on an AAON® Water Source Heat Pump unit and can disable the compressors based on low Suction Pressure, Leaving Water Temperature, and Water Proof of Flow inputs. It also utilizes a Delay Timer to prevent the compressors from turning on at the same time.

The WSHP-X2 Module's water circuit configuration can be either single or dual. There are eight R410-A glycol configurations for the WSHP-X2 Module—0%-40% in increments of 5%. There are two refrigerant selections—R410-A refrigerant and R-22 refrigerant. If R-22 refrigerant is selected, the glycol will automatically default to 0%.

The WSHP-X2 Module connects to the VCM-X WSHP E-BUS Controller (OE332-23E-VCMX-WSHP-A). This allows the Water Source Heat Pump Module to receive control data and alarms from the VCM-X WSHP E-BUS Controller. See **Figure 40** below for a Dual water circuit wiring diagram.

NOTE: The WSHP-X2 Module is factory set for R410-A and 0% glycol.

NOTE: For complete information, including the sequence of operation, refer to the *WSHP-X2 Module Technical Guide*.

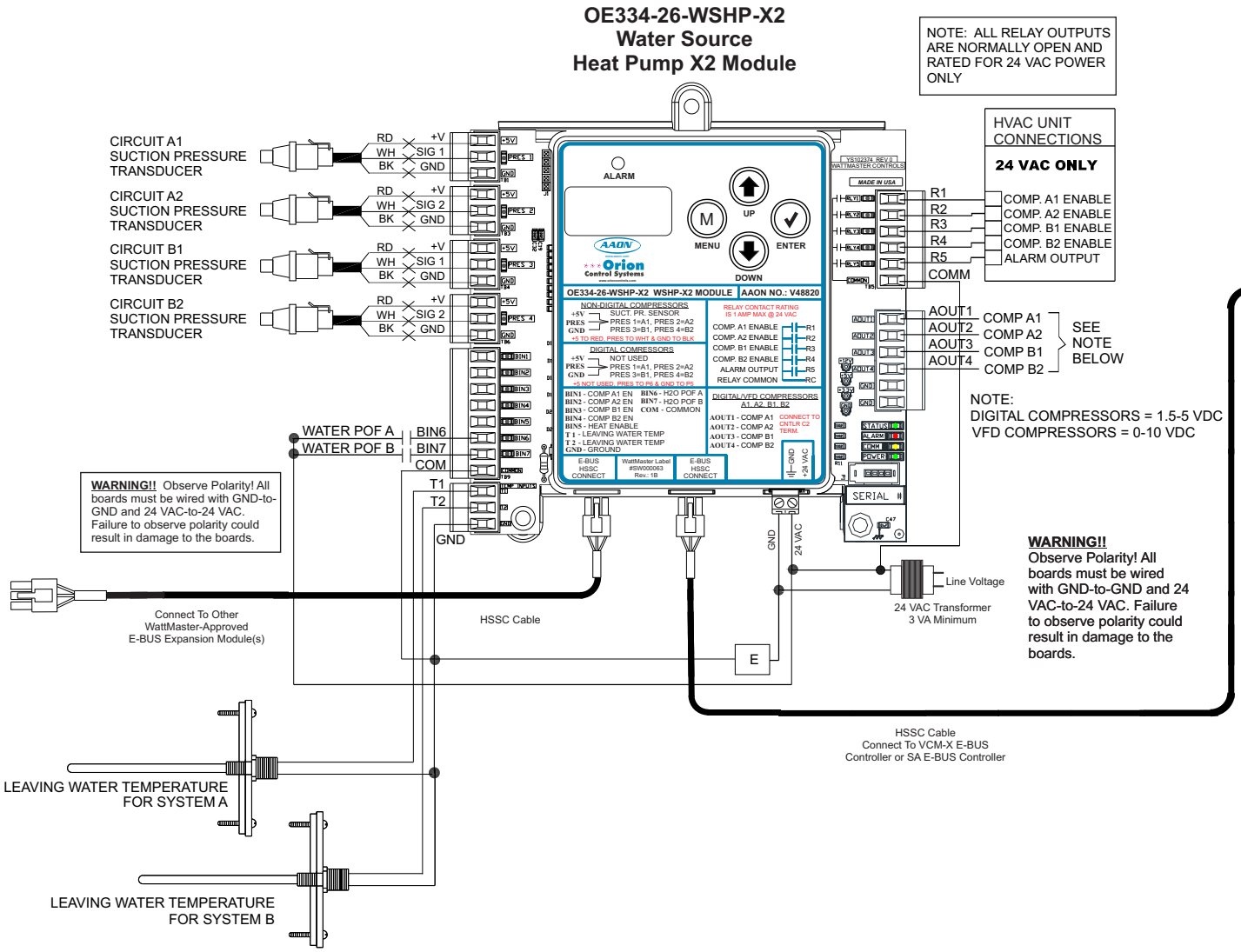

Figure 40: WSHP-X2 Module Dual Water Circuit Wiring Diagram

AAON® WSHP-X2 Module Overview and Wiring

The WSHP-X2 Module connects to the E-BUS Controller using a modular HSSC cable. The WSHP-X2 Module requires a 24 VAC power connection with an appropriate VA rating.

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

NOTE: When using the WSHP-X2 Module, all compressors will be wired from the WSHP-X2 Module, not the VCM-X WSHP E-BUS Controller or SA E-BUS Controller.

NOTE: Contact Factory for the correct HSSC cable length for your application. Cables are available in ½ & 3 Meter lengths and 100 and 150 Foot lengths.

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

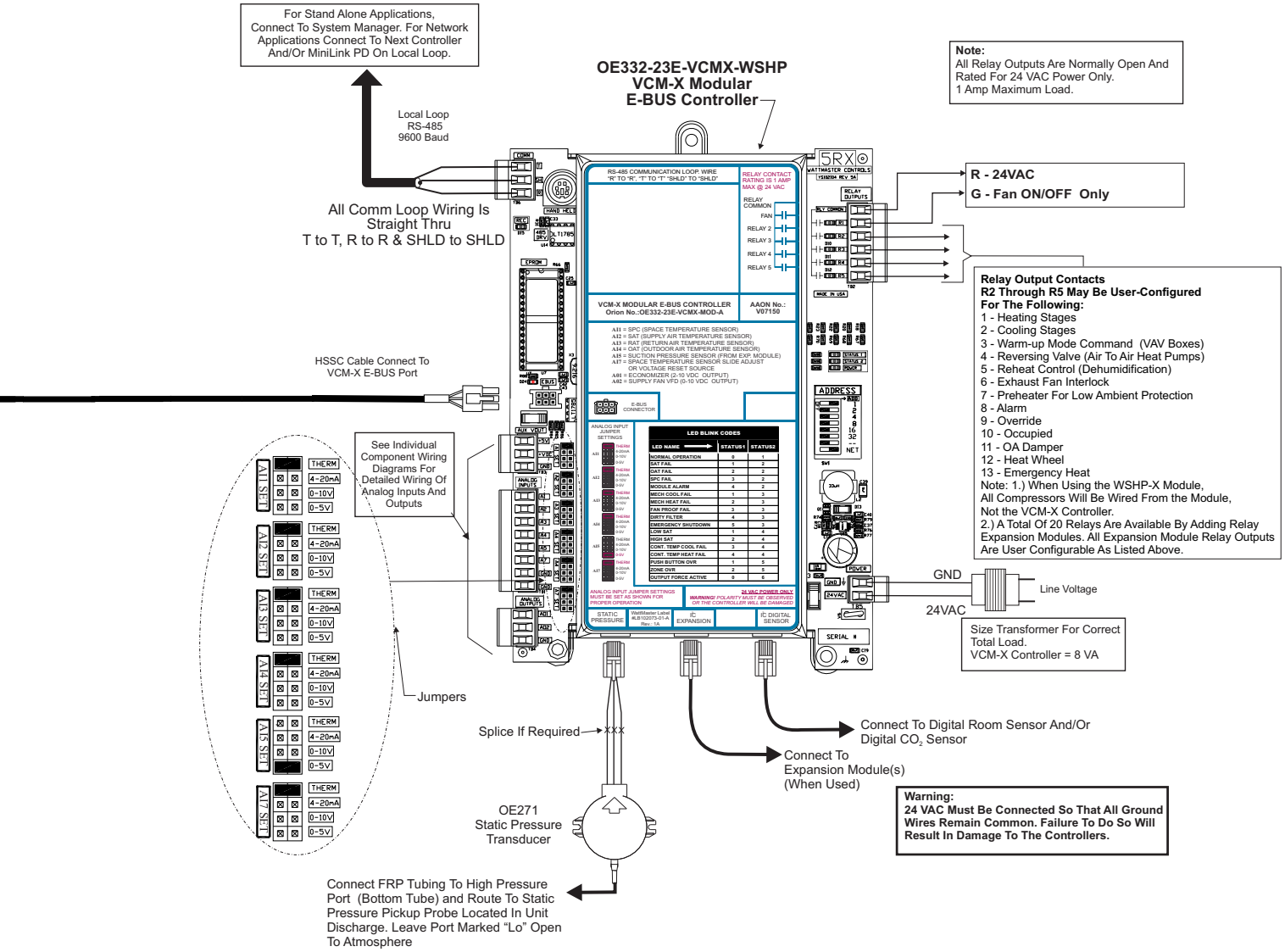

Figure 40: WSHP-X2 Module Dual Water Circuit Wiring Diagram, continued

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 VCM-X E-BUS Controllers are equipped with address switches. If the VCM-X 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 VCM-X 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 VCM-X E-BUS Controller will be used with VAV/Zone Controllers, the VCM-X E-BUS Controller's address switch must be set as address 59, no exceptions. See **Figure 41** below for address switch setting information. For detailed information regarding communication wiring and connection for interconnected and networked systems, please see the *Orion Systems Technical Guide—OR-SYS-TGD-XX*.

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 VCM-X E-BUS Controller requires 8 VA of power delivered to it at 24 VAC. Each VCM-X Expansion Module requires 10 VA at 24 VAC and each 12-Relay Expansion Module requires 15 VA at 24 VAC. 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.

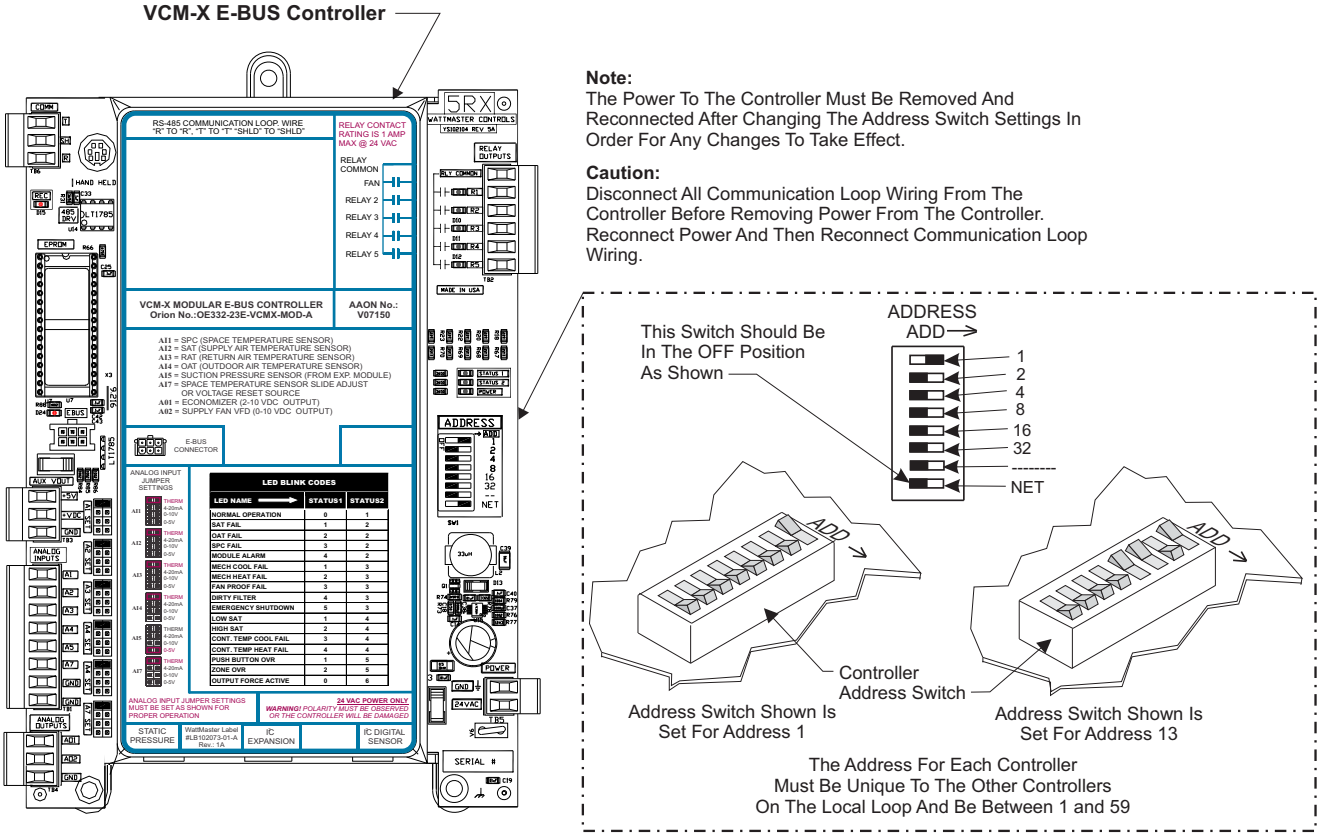

Figure 41: VCM-X E-BUS Controller Address Switch Setting

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. Expansion modules must be wired in such a way that the Expansion modules and the VCM-X 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 VCM-X E-BUS Controller. Be sure any expansion modules connected to the VCM-X E-BUS Controller are also correctly wired just as you did for the VCM-X E-BUS Controller.

After all the above wiring checks are complete, apply power to the VCM-X E-BUS Controller and all expansion modules 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 69** 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 VCM-X E-BUS Controller, you must use an operator interface. Four different operator interfaces are available for programming and monitoring of the VCM-X E-BUS Controller These are as follows:

- Modular Service Tool SD
- Modular System Manager SD
- System Manager Touch Screen II
- Computer with Prism 2 Software Installed and the CommLink 5 Communications Interface

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, Modular System Manager, or System Manager TS II with your system, refer to the *VCM-X / RNE Operator Interfaces SD Technical Guide* and the *System Manager Touch Screen II Technical Guide* for complete VCM-X E-BUS Controller programming instructions.

If using a computer and the Prism 2 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 VCM-X 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 42: Modular Service Tool SD, Modular System Manager SD, System Manager Touch Screen II, and Prism 2 Software Operator Interfaces

VCM-X 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 not required for Cooling Only HVAC units configured for Supply Air Temperature control as the HVAC Mode Enable Sensor unless Night Setback operation is required. The Space Temperature 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. Heating will only occur during Morning Warm-up. After Morning Warm-up expires, the Supply Air Temperature will be maintained at the Supply Air Temperature Cooling Setpoint. The HVAC unit must always have a Supply Air Temperature Sensor installed.

AI3 - Return Air Temperature Sensor Input

If you want to generate occupied Heating and Cooling demands based on Return Air Temperature, select this Sensor as the HVAC Mode Enable Sensor. The Return Air Temperature Sensor is also used to initiate or cancel the Morning Warm-up Period on VAV-configured units. This temperature must be at least 5°F above the Outdoor Air Temperature to allow Economizer Cooling operation.

AI4 - Outdoor Air Temperature Sensor Input

The Outdoor 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 Outdoor Air Temperature Sensor can also be used to provide Low Ambient Temperature Protection in the building. If the Outdoor 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. When using 100% (MUA Units) Outdoor Air applications, the Outdoor Air Temperature Sensor should be configured as the HVAC Mode Enable Sensor. The Outdoor Air Temperature Sensor is also used in combination with the Outdoor Air Humidity Sensor for Dewpoint calculations. For MUA applications with a Heat Wheel, the Outdoor Air Temperature Sensor is mounted downstream of the Heat Wheel.

AI5 - Suction Pressure Signal Input

The Suction Pressure Sensor signal is connected to this input. The Suction pressure Signal is supplied either from the VCM-X Expansion Module "PR OUT" terminal when a standard non-digital compressor is used or from the "P6" terminal of the Copeland ® Compressor Digital Controller when a digital compressor is used. This Suction Pressure Sensor signal input is required when using Dehumidification with DX Cooling units. The VCM-X E-BUS Controller converts the Suction Pressure reading to Suction Temperature. This calculated Evaporator Coil Temperature is considered to be the Saturation Vapor Pressure of the refrigerant leaving the evaporator coil. In most cases, the Supply Air Temperature leaving the Evaporator coil will be 10°F to 15°F higher than the calculated Evaporator Coil Temperature.

NOTE: All temperature Sensors must be Thermistor Type III which provide 77.0°F @ 10K Ohms Resistance.

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 VCM-X 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 Return 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 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, or 0 VDC, and so that its setpoint will be at the warmest Supply Air Temperature, or 5 VDC.

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 14** for details.

VCM-X E-BUS Outputs and Expansion Module Inputs & Outputs

VCM-X E-BUS Controller Outputs

AO1 - Economizer Control Signal

This voltage signal (2-10 VDC) is used to position the Outdoor Air Damper during Economizer Control. It is also used to maintain the Outdoor Air Damper at its Minimum Position during the Occupied Mode when the Outdoor Air Temperature and/or Outdoor Humidity is not suitable for Economizer Cooling purposes.

AO2 - Duct Static Pressure Control Signal

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 VCM-X E-BUS Controller.

R1 - Supply Fan (Enable)

This is a non-configurable output.

R2-R5 - User-Configurable Relays

These relays are configurable by the user. For all the available configuration options, see **Table 2, page 52**. By using all (4) of the available relay outputs on the VCM-X E-BUS Controller and the (4) relay outputs on the VCM-X Expansion Module, you have the ability to configure up to a combined total of (8) relay outputs for Heating Stages, Cooling Stages, and options 3 through 12 listed in **Table 2, page 50**. With the addition of the 12-Relay Expansion Module, you have an additional (12) relay outputs available for a combined total of 20.

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.

VCM-X Expansion Module

AI1 - Outdoor Air Humidity Sensor Input

This input is used to connect an Outdoor Air Humidity Sensor that when combined with the Outdoor Air Temperature Sensor reading is used to calculate a Dewpoint and/or Wetbulb Temperature. The Outdoor Air Dewpoint Temperature is used to activate the Dehumidification Mode on MUA and CAV configured units which utilize the MUA/CAV Dual Damper Mode (Hood On/Off) control feature. The Wetbulb Temperature is used for Economizer enthalpy control.

AI2 - Indoor Air Humidity Sensor Input

The Indoor Air Humidity Sensor is used to activate Dehumidification Mode on a VAV or CAV unit. The Sensor can be a Wall-Mounted Space Humidity Sensor or a Return Air Duct Mounted Humidity Sensor.

AI3 - Economizer Feedback

If Title 24 Economizer operation has been configured, this input will be used for the 0-10 VDC Feedback Signal from the Economizer actuator.

AI4 - Building Pressure Sensor Input

This Sensor is only required if you wish to configure the VCM-X E-BUS Controller for Building Pressure Control. Building Pressure Control can be accomplished by using one of two main control methods. One control method uses the 0-10 VDC signal to control an Exhaust Fan VFD or an Exhaust Damper Actuator for Direct Acting Pressure Control applications. In addition, for Reverse Acting Pressure Control applications, it can control an Outdoor Air Damper Actuator. The other available control method is to configure one of the Output Relays as an Exhaust Fan output that will activate the Exhaust Fan any time the Building Pressure is above the Building Pressure Setpoint.

SIG

The Suction Pressure Sensor Signal Output is connected to this input when a standard non-digital compressor is used and dehumidification is required.

+V - 5 VDC Power

This output is a 5 VDC output that supplies power to the Suction Pressure Sensor when a standard non-digital compressor is used and dehumidification is required.

AO1 - Building Pressure Control Signal

This voltage signal (0-10 VDC or 2-10 VDC) is used to provide an output signal to a Building Pressure Control device. The output signal can be connected to either an Exhaust Fan VFD or an Exhaust Damper Actuator when Direct Acting Building Pressure Control is required. When Reverse Acting Building Pressure Control is required, the output signal would be connected to an Outdoor Air Damper Actuator. When used in this application, the output signal must be configured for Reverse Acting Operation.

AO2 - Modulating Heating Signal

This output signal can be configured for either a 0-10 VDC or a 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.

AO3 - Modulating Cooling Signal

This output signal can be configured for either 0–10 VDC, 2-10 VDC, or 1.5-5.0 VDC output signals. This signal can be configured for either Direct Acting or Reverse Acting operation. This output signal is used to operate an AAON® Modulating Cooling Device to maintain the Cooling Supply Air Temperature Setpoint. If your unit uses a Copeland Digital Scroll™ Compressor, this must be configured for a 1.5-5.0 VDC output signal.

AO4 - Return Air Damper Signal

This output signal is a Direct Acting 0-10 VDC output signal that is used to modulate a Return Air Damper Actuator in concert with a Return Air Bypass Damper Actuator for AAON® PAC or DPAC control schemes.

AO5 - Return Air Bypass Damper Signal

This output signal is a Direct Acting 0-10 VDC output signal that is used to modulate a Return Air Bypass Damper Actuator in concert with a Return Air Damper Actuator for AAON® PAC or DPAC control schemes.

PR OUT - Suction Pressure Signal

This output is used when dehumidification is required and a standard non-digital compressor is used. It wires to AI5 on the VCM-X E-BUS Controller.

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.

Expansion Modules Inputs & Outputs

BI1 - 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.

BI2 - 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.

*BI3 - Proof of Flow Input

A 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 Proof of Flow Switch contact opens while the Supply Fan is operating, all Heating and Cooling is suspended or disabled. The Proof of Flow Switch is an optional input. This means that you must configure the VCM-X E-BUS Controller to recognize this input signal.

BI4 - Remote Forced Occupied Mode Input

When this wet contact input closes, it will force the VCM-X 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 - Remote Forced Heating Mode Input

This wet contact input is used to provide a means for another BAS or control device (by others) to force the unit into Heating Mode when it closes. See the note regarding Remote Force Mode Setting that follows.

BI6 - Remote Forced Cooling Mode Input

This wet contact input is used to provide a means for another BAS or control device (by others) to force the unit into Cooling Mode when it closes. See the note regarding Remote Force Mode Setting that follows.

NOTE: Remote Forced Heating or Cooling Modes require that you enter a value of 1 for both the Heating and the Cooling Setpoints for the HVAC Mode Enable and the Mode Enable Sensor must be set as Supply Air Temperature. The VCM-X E-BUS Controller will then look for wet contact closures on the Remote Forced Cooling Mode and Remote Forced Heating Mode inputs to enable the HVAC Modes. If both the Remote Forced Heating and Remote Forced Cooling Modes are active, the unit will operate in Vent Mode. The unit may also be operated in Vent Mode by providing a wet contact closure signal to the Remote Occupied Input.

BI7 - Exhaust Hood On Input

When this wet contact input closes, the VCM-X E-BUS Controller switches from Indoor Air Control to Outdoor Air Control. This is typically used on CAV applications requiring MUA/CAV Dual Damper (Hood On/Off) Modes.

BI8 - Remote Forced Dehumidification

This wet contact input is used to provide a means for another BAS or control device (by others) to force the VCM-X E-BUS Controller into Dehumidification Mode. You must set the Dehumidification Spt Indoor RH to 100% for the Remote Forced Dehumidification feature to function.

*4 Binary Input Expansion Module

A 4 Binary Input Module can be used in lieu of using the VCM-X Expansion Module when only the first 4 Binary Inputs are required. You can use the VCM-X Expansion Module or the 4 Binary Input Expansion Module, but not both.

12-Relay Expansion Module

Please refer to the user-configurable relays in **Table 2**, below, for relay definitions.

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**	**Configure (1) Relay for On/Off reheat when used.**
6	**Exhaust Fan**	**Configure (1) Relay for enabling exhaust fan when building pressure control is used.**
7	**Pre-Heater (Low Ambient Protection)**	**Configure (1) Relay for pre-heat coil when required. Activated when the outdoor air temperature drops below the ambient protection setpoint.**
8	**Alarm**	**Configure (1) Relay to initiate an alarm output when any VCM-X alarm occurs.**
9	**Override**	**Configure (1) Relay to initiate an output signal when space temperature override button is pushed.**
10	**Occupied**	**Configure (1) Relay to initiate an output signal any time the VCM-X is in occupied mode.**
11	**OA Damper**	**Configure (1) Relay to initiate an output signal when the OA damper moves beyond its minimum during economizer operation, or when the OA damper opens in a MUA application, or when the damper opens during Hood On operation.**
12	**Heat Wheel**	**Configure (1) Relay that turns heat wheel on when in occupied operation and turns heat wheel off when in economizer mode.**
13	**Emergency Heat**	**Configure (1) Relay for fixed stage Emergency Heat in a heat pump unit. Not available on VCM-X WSHP E-BUS controller.**

Table 2: User-Configurable Relay Outputs

Occupied/Unoccupied Mode of Operation

The VCM-X 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 VCM-X 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 VCM-X 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 66** for more information on the Optimal Start feature.

Push-Button Override Signal

During Unoccupied hours, you can force the VCM-X 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 VCM-X 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 AI1 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 7 possible HVAC Modes of Operation. They are as follows:

- Vent Mode
- Cooling Mode
- Dehumidification Mode
- Heating Mode
- Heat Pump
- 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, Return, or Outdoor Air Temperature Sensor is selected as the HVAC Mode Enable Sensor. Vent Mode can also occur if the Supply Air Temperature Sensor is the HVAC Mode Enable Sensor and the VCM-X has been configured for Remote Forced Heating and Cooling. See the Remote Control of HVAC Mode section on **page 60** for complete details.

NOTE: During Vent Mode, all Cooling and Heating Stages are deactivated and the Economizer Damper is maintained at a Minimum Position to provide fresh air into the building. 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 is above the HVAC Mode Enable Cooling Setpoint. Unoccupied Cooling Mode only occurs if a Space Temperature Sensor is connected to the VCM-X or a broadcast of Space Temperature is being received from an Averaging Broadcast Controller and only then if the Space Temperature is above the Cooling Setpoint plus the Night Offset value.

The Mechanical Cooling will be disabled if the Outdoor 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 Outdoor 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 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 Economizer Operation section on **page 54** for a more detailed operating sequence.

No matter which Sensor is configured for the HVAC Mode Enable or if the Remote BAS sets the Mode through Remote Forced Cooling, the Supply Air Temperature is always regulated to the Active Supply Air Cooling Setpoint while in the Cooling Mode.

Cooling Mode

Stage Control Window

The Cooling Stage Control Window Setpoint determines when the compressors start to stage up and 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 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.

The VCM-X E-BUS can control one of two Modulating Cooling sources, such as a Chilled Water Valve or a Copeland Digital Scroll™ Compressor. Whichever source is used, the VCM-X E-BUS will control the Modulating Cooling source to maintain the Active Supply Air Temperature Setpoint.

A Copeland Digital Scroll™ Compressor is a Variable Capacity Compressor that has a 10-to-1 turn down ratio. The VCM-X E-BUS is capable of handling a single-stage Cooling unit with a Copeland Digital Scroll™ Compressor as its only stage. It is also capable of handling multistage Cooling units with a Copeland Digital Scroll™ Compressor. The Copeland Digital Scroll™ Compressor is always the first stage of Cooling. On multistage Cooling units with a Copeland Digital Scroll™ Compressor, Fixed Capacity Compressors will stage up while the Copeland Digital Scroll™ Compressor modulates to achieve the Active Supply Air Temperature Setpoint.

To stage up the extra compressor(s), the SAT needs to be above the Active Supply Air Cooling Setpoint and the Digital Compressor needs to be at 100% for a period of time equal to the Stage Up Delay. Once a fixed compressor is enabled, the digital compressor signal will go to 50% and modulate up as needed. This will repeat as additional fixed compressors are staged up. For compressors to stage on, Minimum Off Times (adj.) must be satisfied as well as Stage Up Delays (adj.).

To stage down the extra compressor(s), the SAT needs to be below the Active Supply Air Cooling Setpoint minus the Cooling Stage Control Window, the Digital Compressor needs to be below 30%, and the Stage Down Delay requirement met. Once a fixed compressor stages off, the digital compressor will go to 50% and modulate down as needed. This will repeat as additional fixed compressors stage off.

For compressors to stage down, Minimum Run Times (adj.) must be satisfied as well as Stage Down Delays (adj.). The digital compressor is always the last compressor to be deactivated.

Economizer Operation

This section assumes you have configured your HVAC unit to control the Outdoor Air Dampers in an Economizer Mode of operation.

The Economizer is used as the first stage of Cooling if the Outdoor Air or Wetbulb Temperature is below the Economizer Enable Setpoint. For Wetbulb control of the Economizer, an Outdoor Air Humidity Sensor must be installed. If the unit is equipped with a Return Air Temperature Sensor, the Outdoor Air or Wetbulb temperature must be at least 5°F colder than the Return Air Temperature to allow the Economizer to modulate. By using the Return Air Temperature reference, it allows the VCM-X E-BUS to calculate whether the Outdoor Air Temperature will assist in Free Cooling. The Return Air Temperature and Space Temperature must be above 50°F for the Economizer operation to occur.

The VCM-X E-BUS Controller can monitor an Outdoor Air Humidity Sensor and combine that reading with the Outdoor Air Temperature reading to calculate a Wetbulb Temperature. If this Wetbulb Temperature is not available, only the Outdoor Air Temperature will be used. Whichever temperature is available, it must be below the Economizer Enable Setpoint by 1°F to enable the Economizer during the Cooling Mode of operation. When the temperature rises 1°F above the Economizer Enable Setpoint, the Economizer will be disabled and return to the Minimum Position.

As soon as the Cooling Mode is started, the Economizer will calculate a starting damper position based on the Outdoor Air Temperature and the differential between the Supply Air Temperature and the Active Supply Air Temperature Setpoint. After it moves to this initial Setpoint, further adjustments will be made in small increments to fine tune the damper

position to maintain the Active Supply Air Temperature Setpoint. If the Economizer reaches 100% open and the Supply Air Temperature is still too warm, the Mechanical Cooling will be enabled to operate to provide additional stages of Cooling. Once a Mechanical Cooling Stage has been activated, the Economizer will remain full open until the Mechanical Cooling Stages are off or until the Outdoor Air Temperature or Wetbulb Temperature causes the Economizer to be disabled.

If the Economizer is not enabled to provide Cooling during the Occupied Mode, it will still maintain the Minimum Position programmed to provide minimum fresh air into the building. During the Unoccupied Mode, the Economizer will be closed. If during the Unoccupied Mode there is a call for Cooling and the Economizer is enabled by Outdoor Air Drybulb or Wetbulb temperature, it will modulate between full closed and full open to provide Free Cooling.

The Supply Air Temperature must be above the Supply Air Temperature Setpoint before the Mechanical Cooling can be activated.

During Dehumidification, the Economizer will remain at its minimum position.

Supply Air Tempering

Warning: Because of the lower compressor lockouts used for Water Source Heat Pump Units, the Supply Air Tempering sequence will not function in those applications.

For units configured as VAV units (Supply Air Temperature Sensor is configured as the controlling sensor), unit heat can be used to maintain a leaving air temperature near the Cooling Leaving Air Setpoint. This may be necessary in conditions very cold outdoor air is being introduced into the unit preventing it from maintaining the Supply Air Temperature (SAT) Cooling Setpoint of 55º (Adj). There are four conditions that must be met before the heating can be activated in this sequence:

1. The outdoor air temperature must fall below the Low Ambient Protection Setpoint (the Low Ambient Protection Setpoint must always be below the Mechanical Cooling Lockout Setpoint).
2. The SAT must fall below a special Tempering SAT Heating Setting (used only in this sequence) which is 2º below the SAT Cooling Setpoint (not adjustable).
3. The economizer must be at its minimum position. This prevents heating from coming on before the controller has had a chance to bring the SAT under control by closing the economizer to its minimum position.
4. The VFD must be operating above the Heating Minimum VFD Setpoint.

Once these conditions are met, the VCM-X E-BUS Controller will activate and stage heat as needed to try to achieve the Tempering SAT Heating Setting. If a stage of heat or ModGas heat overshoots the Tempering SAT Heating Setting, the economizer will be allowed to modulate open to bring the SAT down to the SAT Cooling Setpoint. If, after the heating minimum run time has been satisfied, the economizer has not been able to bring the SAT down within the heat staging window, then the controller will stage down/off the heat.

If this is an Air to Air Heat Pump unit, heating for the Supply Air Tempering operation will only use Auxiliary Heat (and Emergency Heat if available). Compressor heat cannot be use for the tempering function.

NOTE: During this mode of operation, the standard Heating Staging Window will be used.

There is a Maximum OA Damper Position During Tempering Setpoint that allows you to set a maximum damper position the economizer can open to while the heat is running during this tempering mode (to prevent potential wasting of energy).

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% Outdoor Air applications, the Outdoor Air Dewpoint initiates the Dehumidification Mode when the Outdoor Air Dewpoint rises 2°F above the Outdoor Air Dewpoint Setpoint during the Occupied Mode of operation and likewise stops Dehumidification when the Outdoor Air Dewpoint drops more than 2°F below the Outdoor Air Dewpoint Setpoint during the Occupied Mode of operation. The Outdoor Air Dewpoint is calculated by using an Outdoor Air Temperature Sensor and an Outdoor Air Humidity Sensor.

During the Dehumidification Mode, the VCM-X E-BUS 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. 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. Please read the warning that follows regarding applications that operate Heating and Cooling simultaneously.

Warning: Simultaneous Heating and Cooling cannot be approved unless the HVAC unit has been specifically designed for this purpose. A Special Price Authorization (SPA) must be obtained from the AAON® factory for these applications to avoid warranty and/or rating problems. WattMaster Controls Inc. assumes no liability for any Simultaneous Heating and Cooling application if a SPA is not obtained from the AAON® Factory at the time the HVAC unit is ordered.

When Heating is used for Reheat instead of Hot Gas Reheat, the VCM-X E-BUS 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 Drybulb Temperature than what Hot Gas Reheat can provide. When Heating is used in conjunction with Reheat, the VCM-X E-BUS restricts the Heating to one form of Modulating Heat or one stage of Gas or Electric Heat.

NOTE: MODGAS cannot be used in conjunction with Hot Gas Reheat to add additional Reheat.

Dehumidification Mode

For DX Cooling Stages, the VCM-X E-BUS activates the Cooling Stages based on the actual Evaporator Coil Temperature compared to the Evaporator Coil Temperature Setpoint. The Evaporator Coil Temperature is calculated by using the Suction Pressure Sensor and converting the pressure to temperature.

For Copeland Digital Scroll™ Compressor units, the VCM-X E-BUS will modulate the Copeland Digital Scroll™ Compressor to maintain the Evaporator Coil Temperature Setpoint and activate Fixed Capacity Compressors as necessary.

If the Fixed Capacity Compressor is activated, the Copeland Digital Scroll™ Compressor will only be allowed to modulate within the range of 70% - 100% in order to prevent the loss of reheat capacity during low load conditions. If, with both compressors on, the digital compressor has modulated down to its 70% minimum and the Coil Suction Temperature falls below the Coil Temperature Setpoint minus the Cooling Stage Control Window, then the second compressor will stage off once its Compressor Minimum Run Time and the Stage Down Delay Timers have been met. At that point, the Copeland Digital Scroll™ Compressor can modulate down as needed to maintain the Coil Temperature Setpoint.

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

If you configured your VCM-X E-BUS for Dehumidification control, you need to install a Humidity Sensor on the optional Analog Input Expansion module. If the VCM-X E-BUS is configured as an MUA unit, use an Outdoor Air Humidity Sensor. If the VCM-X E-BUS is configured as a VAV or CAV unit, use an Indoor Air Humidity Sensor such as a Wall-Mounted or Duct-Mounted Sensor. If the VCM-X E-BUS is to be used for MUA/CAV Dual Damper Modes during Occupied hours, use both Indoor and Outdoor Air Humidity Sensors. As an example, this could be used in a kitchen application when you have a CAV unit using both Outdoor Air and Return Air. This unit could be configured to operate using Return Air when the Exhaust Hood is off or 100% Outdoor Air when the Exhaust Hood is on.

If the unit is equipped with a Modulating Hot Gas Reheat Controller (MHGRV), it is automatically detected by the VCM-X 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.

The Dehumidification Mode can be configured to have Dehumidification Priority. If configured, the VCM-X E-BUS 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 by the Active Supply Air Temperature Setpoint. The Active Supply Air 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 VCM-X E-BUS will only enter the Dehumidification Mode and use Reheat 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.

Remote Forced Dehumidification

Dehumidification Mode is normally controlled by using a Humidity Sensor connected to the VCM-X Expansion Module input AI1 or AI2. If desired, Dehumidification Mode can also be determined by using a remote BAS or other user-supplied remote device. The VCM-X E-BUS will check BI8 input on the VCM-X Expansion Module for a 24 VAC signal. If the signal is present, it will force the VCM-X E-BUS into Dehumidification Mode regardless of the mode it is currently operating in if Dehumidification Priority Mode has been configured. If Dehumidification Priority Mode has not been configured, the unit will only be forced into Dehumidification Mode if it is operating in the Vent Mode during the time the remote signal is being supplied to input BI8.

NOTE: When using the Remote Forced Dehumidification function, set the Dehumidification Spt Indoor RH to 100% for the Remote Forced Dehumidification feature to function.

Coil Temperature Offset for Split Systems

On split 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 30ºF, but the actual temperature of the Evaporator Coil in the air handler may be 45ºF. To compensate, you can put in a 15ºF offset so that the Calculated Coil Temperature reading will read 45ºF. The maximum amount of offset allowed is ± 30ºF.

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 5ºF. For example, if the Coil Temperature Setpoint is 45ºF and the Indoor Humidity Setpoint is 50% with an actual humidity reading of 55%, the new Coil Temperature Setpoint will be 40ºF. If the humidity is below the Indoor Humidity Setpoint, then the Coil Temperature Setpoint will be increased by a maximum of 5ºF.

Return Air Bypass Damper Control

The Return Air Bypass (RAB) Damper is only used on constant air volume units with space temperature configured as the HVAC Mode Enable sensor. The RAB damper is only active during the dehumidification mode and is used as the first form of reheat. If the HVAC unit is equipped with modulating hot gas reheat, the RAB damper needs to be at 100% before the modulating hot gas reheat can be used. The RAB damper modulates from 0-100% as the space temperature falls below the cooling setpoint. When the space temperature is equal to the cooling setpoint, the RAB damper will be at 0%. When the space temperature falls to halfway between the cooling and heating setpoints, the RAB damper will be at 100%.

If the HVAC unit is equipped with separate actuators for the outdoor air and return air dampers, the return air damper will proportionally close more as the RAB damper opens. The rate at which the return air damper closes is user-adjustable. The purpose of closing the return air damper more as the RAB damper opens is to allow more air to bypass the evaporator coil through the RAB damper. If you want more air to pass through the RAB damper, enter a larger number in the Return Air Damper Factor setpoint. If you want less air to pass through the RAB damper, enter a smaller number in the Return Air Damper Factor setpoint.

NOTE: See **page 6** for specific AAON® DPAC and PAC operation.

Heating Mode Operation

Occupied Heating Mode occurs whenever the HVAC Mode Enable Temperature is below the HVAC Mode Enable Heating Setpoint. Unoccupied Heating Mode only occurs if a Space Temperature Sensor is connected to the VCM-X E-BUS or a broadcast of Space Temperature is being received from an Averaging Broadcast Controller.

The Mechanical Heating will be disabled if the Outdoor 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 Outdoor 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 or if the Remote BAS sets the Mode through Remote Forced Heating, the Supply Air Temperature is always controlled to the Active Supply Air Temperature Setpoint while in Heating Mode.

Stage Control Window

The Heating Stage Control Window Setpoint determines when the Heating Stages begin to stage up and stage down. 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.

AAON® MODGAS Controller

The AAON® MODGAS Controller is treated as a single stage of gas heating when connected to the VCM-X's expansion port. The Supply Air Temperature is broadcast from the AAON® MODGAS Controller to the VCM-X. The Supply Air Temperature Setpoint is broadcast from the VCM-X E-BUS to the AAON® MODGAS Controller. When the VCM-X E-BUS enters the Heating Mode, it broadcasts a command to activate the MODGAS Controller. The AAON® MODGAS Controller modulates the Natural Gas Valve to maintain the Supply Air Temperature Setpoint. See the *MODGAS Controller Technical Guide* for detailed operation information of the AAON® MODGAS Controller.

AAON® MODGAS Controller with Additional Stages of Heat

The VCM-X E-BUS can activate the AAON® MODGAS Controller and additional stages of heating if needed. If this configuration is needed, a heating relay must be configured on the VCM-X E-BUS for the AAON® MODGAS Controller, but it will not be connected to anything. The AAON® MODGAS Controller will always be the first stage of heating in this configuration. Additional heating relays can be configured and connected to Staged Heating sources, such as Natural Gas or Electric Heat. In order for the additional stages to activate, the AAON® MODGAS Controller must be at 100%, and then the Stage Up Delay begins. Once the Stage Up Delay expires and the Gas Valve is still at 100%, another Fixed Stage of Heating will activate. This will be the VCM-X's second stage of heat. The AAON® MODGAS Controller will modulate to achieve the Active Supply Air Temperature Setpoint.

If the AAON® MODGAS Controller modulates to 0% and the Supply Air Temperature is above the Active Supply Air Setpoint plus the Heating Stage Control Window, the Stage Down Delay begins. Once the Stage Down Delay expires and the Supply Air Temperature has remained above the Active Supply Air Setpoint plus the Heating Stage Control Window, the Fixed Stage of Heating will be deactivated. The AAON® MODGAS will remain active, even at the minimum valve position unless the Supply Air Temperature remains above the Active Supply Air Setpoint plus the Heating Stage Control Window. The AAON® MODGAS Controller will be the last stage of heating to be deactivated.

Modulating Heating

The VCM-X E-BUS 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 VCM-X E-BUS will modulate the Heat Source to achieve the Active Supply Air Temperature Setpoint. Modulating Natural Gas is a form of Modulating Heat, but is controlled by the AAON® MODGAS Controller. The VCM-X E-BUS only activates the AAON® MODGAS as a stage of heat; therefore, the Modulating Heating Proportional Window does not apply when the VCM-X E-BUS is connected to the AAON® MODGAS Controller and is the only form of Heating activated by the VCM-X.

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 VCM-X E-BUS 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. The Secondary Heat Source used can be Modulating Natural Gas (AAON® MODGAS Controller), Staged Gas Heat, or Staged Electric Heat.

Primary Modulating Heat and Secondary Heat with AAON® MODGAS Controller

The Modulating Heating Proportional Window is used to determine the signal to the Primary Heat Source and is user-adjustable. The Heating Stage Control Window is used to determine stage up and stage down of the Secondary Heat Source. In the Heating Mode, the Primary Heat Source will modulate to achieve the Active Supply Air Temperature Setpoint. When the Primary Heat Source reaches 100%, the Heating Stage Up Delay begins. If the Primary Heat Source is still at 100% after the Heating Stage Up Delay expires, the Secondary Heat Source, which is controlled by the AAON® MODGAS Controller, will activate. The Primary Heat Source will then be forced to 0%, allowing the AAON® MODGAS Controller to modulate the gas valve to achieve the Active Supply Air Temperature Setpoint.

When the Secondary Heat Source reaches 100%, the Heating Stage Up Delay begins. If the Secondary Heat Source is still at 100% after the Heating Stage Up Delay expires, the Primary Heat Source will be forced to 100%. The Primary Heat Source will remain at 100% to allow the Secondary Heat Source to modulate to achieve the Active Supply Air Temperature Setpoint. If the Supply Air Temperature rises above the Active Supply Air Temperature Setpoint plus the Heating Stage Control Window, the Heating Stage Down Delay begins. If the Supply Air Temperature is still above the Active Supply Air Temperature Setpoint plus the Heating Stage Control Window and the Heating Stage Down Delay expires, the Primary Heat Source will forced to 0%. If the Secondary Heat Source modulates to 0%, the Heating Stage Down Delay begins. If the Secondary Heat Source remains at 0% and the Heating Stage Down Delay expires, the Secondary Heat Source will be deactivated, and the Primary Heat Source will modulate to achieve the Active Supply Air Temperature Setpoint. If the Supply Air Temperature rises above the Active Supply Air Temperature Setpoint plus the Heating Stage Control Window, the Primary Heat Source modulates as needed to allow the Supply Air Temperature to cool off.

Primary Modulating Heat and Secondary Heat with Staged Gas or Electric Heat

The Modulating Heating Proportional Window is used to determine the signal to the Primary Heat Source and is user-adjustable. The Heating Stage Control Window is used to determine stage up and stage down of the Secondary Heat Source. In the Heating Mode, the Primary Heat Source will modulate to achieve the Active Supply Air Temperature Setpoint. When the Primary Heat Source reaches 100%, the Heating Stage Up Delay begins. If the Primary Heat Source is still at 100% after the Heating Stage Up Delay expires, the Secondary Heat Source will activate. The Primary Heat Source will then modulate to achieve the Active Supply Air Temperature Setpoint. If the Secondary Heat Source is activated and the Primary Heat Source has modulated to 0%, the Heating Stage Down Delay will begin. If the Primary Heat Source is still at 0% after the Heating Stage Down Delay expires, the Secondary Heat Source will deactivate. If the Supply Air Temperature rises above the Active Supply Air Temperature Setpoint plus the Heating Stage Control Window, the Primary Heat Source will modulate to 0% to allow the Supply Air Temperature to cool off.

Heat Pump Operation

The VCM-X E-BUS can be configured to control a Heat Pump. The compressors are used for both Heating and Cooling. With the VCM-X 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 51-53** of this manual. In the Heating Mode, the VCM-X E-BUS activates the Reversing Valve and stages compressors to provide Heating if the Outdoor Air Temperature is above the OAT Cooling Lockout Setpoint. The compressor heating stages are activated as needed to achieve the Active Supply Air Setpoint. Staged or Modulating Auxiliary Heat can be activated to supplement Compressor Heating in order to achieve the Active Supply Air Setpoint if the Outdoor Air Temperature is below the OAT Heating Lockout Setpoint. If the Outdoor Air Temperature is below the OAT Cooling Lockout Setpoint, only Auxiliary Heating will occur. If the Outdoor Air Temperature is above the OAT Heating Lockout, only Compressor Heating will occur.

Emergency Heat stages can also be configured. If the Outdoor Air Temperature is above the Compressor Lockout Temperature, Emergency Heating is disabled. If the Outdoor Air Temperature is below the Compressor Lockout Temperature, Emergency Heating is enabled and can stage up after Auxiliary Heat.

Note: If using the VCM-X WSHP (Water Source Heat Pump) Controller, the Compressor Lockouts are ignored. Since Emergency Heat can only be used below the Compressor Lockouts, Emergency Heat is therefore not available.

If a heat pump unit is used in a VAV application using Supply Air Tempering, then Morning Warm-Up mode will only use Auxiliary Heat. Heating for the Supply Air Tempering operation will only use Auxiliary Heat (and Emergency Heat if available).

For VCM-X Modular E-BUS 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 VCM-X Modular 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.

Morning Warm-Up Mode Operation

When the VCM-X E-BUS Controller is configured as a VAV unit (Cooling only)and switches to the Occupied Mode of Operation (not Override Mode), the unit compares the Return Air Temperature to a Morning Warm-Up Target Temperature. If the Return Air Temperature is below this Setpoint, the Warm-Up Mode is initiated. This Mode remains in effect until the Return 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. The Outdoor Air Damper remains closed during Warm-Up Mode.

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 VCM-X E-BUS Controller enters the Off Mode. During the Off Mode, the Supply Fan is off and the Outdoor Air Dampers are closed.

Remote Control of HVAC Mode & Supply Air Control

Remote Control of HVAC Mode

NOTE: When using the Remote Control of HVAC Mode, both of the Heating and Cooling HVAC Mode Enable Setpoints must be set to 1 and the Mode Enable Sensor must be set as Supply Air Temperature.

The Heating Mode, Cooling Mode, and Vent Mode can be determined by a remote Building Automation System (BAS). The VCM-X E-BUS will check the VCM-X Expansion Module for a 24 VAC input signal on BI5 and BI6. BI5 is used for Remote Forced Heating Mode. BI6 is used for Remote Forced Cooling Mode. If a 24 VAC signal is present on both BI5 and BI6, the VCM-X E-BUS will be in Remote Forced Venting Mode. Remote Forced Venting Mode is considered to be Occupied Fan-Only operation. Once the Remote Forced Mode has been set, normal Heating, Cooling, or Venting Modes of operations will occur. All other user-adjustable setpoints, such as the Heating and Cooling Supply Air Temperature Setpoints, are used in the actual control of the equipment.

During Dehumidification, if a Reset Source is not configured, the Supply Air Temperature Setpoint will be 70°F.

The Remote Occupied Input on the VCM-X Expansion Module, BI4, can also be used for Occupied Fan Only operation when the Remote Forced Heating or Cooling inputs are not activated.

Supply Air Temperature Setpoint Reset

The VCM-X 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, Return Air Temperature, Outdoor 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 VCM-X E-BUS uses the HVAC Mode Enable Setpoints to determine the mode of operation. Once the HVAC Mode has been determined, the VCM-X E-BUS 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 *VCM-X / RNE Controller Operator Interfaces SD Technical Guide* in the Supply Air Reset configuration screens #4 & #5 and setpoint screens #4 through #7.

If you configure Space Temperature, Return Air Temperature, or Outdoor 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 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 (set jumper to 0-10V). 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 it 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.

Air Flow Monitoring/Control

The VCM-X E-BUS Controller with the E-BUS Distribution Module can monitor airflow of the outside air, the supply air, and the return/exhaust air streams by utilizing EBTRON® GTN116 and GTC116 Airflow Monitoring Stations. The VCM-X E-BUS will control the Outdoor Air Damper to maintain an Outdoor Air CFM Setpoint. No other control functions are available at this time.

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 VCM-X E-BUS can be configured for Fan Cycle Mode.

Duct Static Pressure Control

The VCM-X 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 VCM-X 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 (Direct Acting Operation) or a Zoning Bypass Damper Actuator (Reverse Acting Operation).

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 or 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 VCM-X E-BUS 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 VCM 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.

Building Pressure Control

The VCM-X E-BUS can maintain Building Static Pressure any time the Supply Fan is operating by activating a Constant Volume Exhaust Fan, a VFD Exhaust Fan, or Modulating Exhaust Damper, or by modulating the Outdoor Air Damper. A Building Pressure Transducer must be connected to the VCM-X's Expansion Module. For Constant Volume Exhaust Fan applications, only an Exhaust Fan Relay needs to be configured for on/off operation of the Exhaust Fan. VFD or Modulating Building Pressure control must be configured in order for this feature to operate. An Exhaust Fan Relay can also be configured along with Modulating Building Pressure control for an Enable output. Building Pressure can be maintained by either Direct or Reverse Acting control.

Direct Acting Modulating Control

If configured, a VFD Exhaust Fan or Modulating Exhaust Damper will be controlled by varying a 0-10 or 2-10 VDC control signal. If an enable output is required, an Exhaust Fan Relay can also be configured. The Exhaust Fan Relay and the Modulating Signal will activate when the Building Static Pressure rises above the Building Static Pressure Setpoint plus the Deadband. The Exhaust Fan Relay will remain active until the Building Static Pressure falls below the Building Static Pressure Setpoint minus the Deadband and the Modulating Signal falls to 0%.

Direct Acting On/Off Control

If you do not require a Modulating Control Signal, you can also configure one of the Relay Outputs as an Exhaust Fan Relay to activate whenever the Building Static Pressure is above the Building Static Pressure Setpoint plus the Deadband. The Exhaust Fan Relay will deactivate when the Building Static Pressure falls below the Building Static Pressure Setpoint minus the Deadband. Only one Relay Output should be configured for this operation. There is no staging of additional Exhaust Fan Relays.

Reverse Acting Modulating Control

If configured, on a drop in building static pressure below the building pressure setpoint minus the deadband, a 2-10 VDC signal will modulate to open the outside air damper. When this option is selected, no economizer-free cooling or IAQ operation will be available.

CAV/MUA Dual Mode (Hood On/Off Operation)

The VCM-X E-BUS Controller can be configured as a CAV controller but switch to MUA operation when an exhaust hood is energized. This MUA force mode occurs when a 24 VOut wet contact closure is received on the Hood On binary input on a VCM-X E-BUS Controller Expansion Module. Under normal operation (CAV), the unit will operate as a recirculating space temperature (and space humidity) controlled unit. When the Hood On contact is made, the unit will open the Outdoor Air Damper to its full open position. The Heating and Cooling Modes will then be determined by the Outdoor Air Temperature Sensor using the same Heating and Cooling Setpoints that were used in the CAV mode. Dehumidification would then be initiated by an Outdoor Dewpoint Setpoint. When the Hood On Force Mode is removed, the unit will revert to CAV operation with the Outdoor Damper returning to its minimum position (unless economizer operation is enabled) and with mode control initiated by the Space Temperature and Humidity Sensors.

MUA Unoccupied Operation

Normally, an MUA unit is off during the Unoccupied Mode. However, if the unit has Return Air, it can be configured to operate as a recirculating Night Setback Controlled unit during Unoccupied Hours. This is accomplished by simply configuring Night Setback Temperature Setpoints (anything other than the default 30ºF) on a unit that is also configured for Outdoor Temperature Control (MUA). With this configuration, when the unit goes Unoccupied, it will close the Outdoor Air Damper and begin to use a Space Temperature Sensor in conjunction with the existing Heating and Cooling Setpoints, offset by the Night Setbacks, to make Night Setback calls. If a Space Humidity Sensor is installed, and the unit is configured for Night Humidity control, the VCM-X E-BUS Controller will use the Space Humidity Setpoint for unoccupied Dehumidification calls.

IAQ (CO_2) Operation

If you have configured the VCM-X E-BUS Controller to monitor and control CO_2 levels, the Economizer operation will be modified as follows:

1. The Maximum Reset Position the Economizer can open to is determined by a user-adjustable setpoint called the CO_2 Protection Limit Max Level.
2. The Minimum Position the Economizer can close down to is reset higher as the level of CO_2 increases above the CO_2 Protection Limit Max Level programmed. As the CO_2 level increases above the adjustable CO_2 Setpoint, the Outdoor Air Damper will start opening beyond its Minimum Position. At the CO_2 Protection Limit Reset Range above Setpoint, the Economizer will be held to its Maximum Reset Position and not allowed to open any further.

If doing both CO_2 and CFM (using an Airflow Station) control of the Economizer, CFM control will not override the CO_2 Max Economizer Position.

Pre-Heater Operation

In colder climates where freezing temperatures are sometimes experienced, it is desirable to preheat the Outdoor 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 Outdoor 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 Outdoor 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.

If using the Preheat-X Controller, an SCR preheater and/or stages of preheat can be controlled. If the Entering Air Temperature (sensor connected to the Preheat-X) falls below the Pre-Heat Setpoint, then preheat will be controlled to either a Cooling, Heating or Vent Mode Preheater

Leaving Air Setpoint - depending on if the VCM-X is currently in the Cooling, Heating, or Vent mode of operation. These setpoints are all set in the VCM-X Controller. See the *PREHEAT-X Controller Technical Guide* for more details.

Heat Wheel

One of the relay outputs can be configured as a Heat Wheel Relay. This relay will enable the Heat Wheel when the unit goes into the Occupied Mode. If the unit is configured for Economizer Operation, this relay will disable the Heat Wheel when the unit goes into Economizer Mode. If the Heat Wheel Relay is active, a Heat Wheel Defrost Cycle will occur that will disable the Heat Wheel Relay for 2 minutes if the Outdoor Air Temperature is below the Heat Wheel Defrost Setpoint and 30 minutes have elapsed since the last Heat Wheel Defrost Cycle.

Single Zone VAV Mode

In this application, the VCM-X E-BUS will modulate the Supply Fan VFD to maintain the Space Cooling or Heating Setpoint while the unit's cooling or heating source is modulating to maintain the appropriate Supply Air Setpoint. This sequence will operate optimally only when the HVAC unit has modulating heating and cooling. Staged heating and cooling should not be used and will not provide satisfactory performance.

When the Space Temperature rises one deadband above the Space Cooling Setpoint, the cooling mode is initiated. The Supply Fan will energize and begin operating at 30% speed. Cooling will modulate to maintain the Active Supply Air Cooling Setpoint. The Supply Fan will then proportionally modulate as needed between 30% and 100% as the Space Temperature rises within the Space Reset Window created by configuring a Cooling Reset Source Low Setpoint and a Cooling Reset Source High Setpoint. The Cooling Mode is disabled when the space temperature falls one deadband below the Space Cooling Setpoint.

When the Space Temperature falls one deadband below the Space Heating Setpoint, the Heating Mode is initiated. The Supply Fan will energize and begin operating at 50% speed. Heating will modulate to maintain the Active Supply Air Heating Setpoint. The Supply Fan will then proportionally modulate as needed between 50% and 100% as the Space Temperature falls within the Space Reset Window created by configuring a Heating Reset Source High Setpoint and a Heating Reset Source Low Setpoint. When Heat Pump heating is operating, the Supply Fan VFD will operate from 75% to 100%. The heating mode is disabled when the space temperature rises one deadband above the Space Heating Setpoint.
When the Space Temperature is satisfied and the unit is in the Vent Mode of operation, the fan will operate at 30%. During Dehumidification, the fan will operate as described above, depending on if the Space Temperature is calling for Heating, Cooling, or Vent Mode operation.

Whenever the unit is in CO_2 override operation of the Outdoor Air Damper, the minimum VFD fan speed is forced to 75% and can modulate up from there.

In order for the VCM-X E-BUS to operate in Single Zone VAV (SZ VAV) mode, the unit must be configured as follows:

Mode Enable Sensor = Space Temperature
Reset Source = SZ VAV or SZ VAV with CAV Heating
Duct Static Pressure Control = No

Configure the Cooling Reset Source High and Low Setpoints and the Heating Reset Source High and Low Setpoints to establish the Space Temperature Cooling and Heating range over which the VFD will modulate in those modes.

Outdoor Air Lockouts

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

When the Outdoor Air Temperature is below the Cooling Lockout Setpoint, no Mechanical Cooling can operate. However, if the unit is equipped with an Economizer and the VCM-X E-BUS is configured to use the Economizer, 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 Outdoor Air Heating Lockout operates so that when the Outdoor Air Temperature is above the Outdoor 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. Also, the Outside Air Damper will move to its Minimum Economizer Position.

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 VCM-X E-BUS is in Economizer 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, the Supply Air Fan will shut off, and the Outdoor Air Dampers will close. If the VCM-X E-BUS 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 VCM-X E-BUS goes from Occupied to Unoccupied or from Unoccupied to Occupied Mode.
3. The VCM-X's power is cycled.

VCM-X 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.

Outdoor Air Temperature Sensor Failure Alarm

The Outdoor Air Temperature Sensor Failure Alarm is generated when the controller detects an open or short circuit on the Outdoor Air Temperature Sensor input. When this occurs, the Outdoor Air reading will be artificially set to the half point between the Cooling and Heating Lockout Setpoints. This will allow the cooling and the heating to continue operating.

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 VCM-X relay outputs.

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

These alarms only apply when Space or Return Air is configured ad the Mode Enable Sensor.

When the Controlling Sensor Temperature rises 5 degrees above the Cooling Mode Enable Setpoint for one hour, the controller will generate a High Control Temp Failure Alarm.

When the Controlling Sensor Temperature drops 5 degrees below the Heating Mode Enable Setpoint for one hour, the controller will generate a Low Control Temp Failure Alarm.

Dropping below the Cooling Mode Enable Setpoint or rising above the Heating Mode Enable Setpoint will clear the alarm.

Module Alarm

This alarm applies to any E-BUS Modules or Controllers that are communicating with the VCM-X Controller. The E-BUS modules include the Full Digital Module, Dual Digital Module, One or Two Condenser Head Pressure Module, Water Source Heat Pump-X2 Module. The Controllers include the MHGRV-X Controller and Preheat-X Controller. If any of these modules stop communicating with the VCM-X Controller or if there is an alarm on one of these modules, this Module Alarm will be generated.

Title 24 Economizer Alarms

Economizer Temperature Sensor Failure

Outside Air or Supply Air Temperature Sensor is shorted or missing.

Economizer Not Economizing When it Should

Economizer is enabled but not following the desired Economizer position commanded.

Economizer Is Economizing When It Should Not

Economizer is not enabled but the feedback signal indicates a position more open than the minimum.

Economizer Damper Not Modulating

Economizer is enabled but not within 10% of desired position within 150 seconds.

Economizer Excess Outdoor Air Filter

Economizer feedback is lost or Economizer is not following commanded position.

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 and Internal Trend Logging

Scheduling

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

The Internal Scheduling in the VCM-X 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 VCM-X 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 VCM-X E-BUS Controller.

No adjustments other than the Soak Multiplier are required because the VCM-X 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 VCM-X 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 VCM-X 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
- Mode (Status Bits)
- Return Air Temperature
- Outdoor Air Temperature
- Supply Air Temperature
- Supply Air Temperature Setpoint
- Coil Suction Temperature
- Outdoor Air Dewpoint
- Indoor Air Humidity
- Duct Static Pressure
- Building Static Pressure
- Economizer Signal Percentage
- Supply Fan VFD/Zoning Bypass Damper Signal Percentage
- Exhaust Fan VFD/Exhaust Damper Signal Percentage
- Modulating Heat Signal Percentage
- Modulating Cooling Signal Percentage
- Space Temperature
- On Board Relay Status (Bit Pattern)
- Expansion Module Relay Status (Bit Pattern)
- Head Pressure
- Condenser Fan Signal Percentage
- Outdoor Air CFM
- Supply Air CFM
- Return or Space CO_2
- ModGas II Module Signal Percentage
- Modulating Hot Gas Reheat II Module Signal Percentage

These items and values are explained in greater detail in the *Prism 2 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 VCM-X 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 VCM-X. 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 VCM-X E-BUS Controller is designed to communicate with Orion VAV/Zone Controllers. The VCM-X E-BUS can be configured to broadcast its Internal Schedule, Time, and Date, Fan and Heat Status, and Supply Air Temperature. The VCM-X E-BUS 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 VCM-X E-BUS Controller based on Setbacks.

If you are using another manufacturer's VAV Terminal Unit Controllers, the VCM-X E-BUS Controller can activate a relay to inform the VAV/Zone Controllers that the VCM-X E-BUS Controller is operating in Warm-up Mode. No other information can be passed between the VCM-X 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 VCM-X 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 VCM-X E-BUS goes into the Occupied Mode, it initiates Morning Warm-up if the Return 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 VCM-X E-BUS Controller. Once Morning Warm-up has been satisfied, the VCM-X E-BUS 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 VCM-X E-BUS 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 VCM-X E-BUS Controller automatically configures itself for Voting Control when the MiniLink Polling Device is installed and is configured as a Voting System. The VCM-X E-BUS Controller sets the HVAC Mode Enable to the Return 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 VCM-X should be in. The MiniLink Polling Device broadcasts a forced Heating, Cooling, or Vent Mode of operation to the VCM-X. Once the VCM-X receives the broadcast to set the HVAC Mode, it operates as previously described in the VCM-X Sequence of Operations. If communications are lost, the VCM-X returns to its own control and will maintain the HVAC Mode Enable Setpoints by using the Return Air Temperature Sensor as the Controlling Sensor.

Using LEDs To Verify Operation

The VCM-X E-BUS Controller is equipped with 4 LEDs that can be used as very powerful troubleshooting tools. See **Figure 43** 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 VCM-X 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 VCM-X 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 VCM-X 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 69**. See **Figure 41** on **page 48** 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 VCM-X E-BUS Controller. If you are using one of the System Manager Operator’s Interfaces, see the *VCM-X / RNE Controller Operator Interfaces SD 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 VCM-X Component & System Wiring Technical Guide* for more information or contact the factory for further assistance.

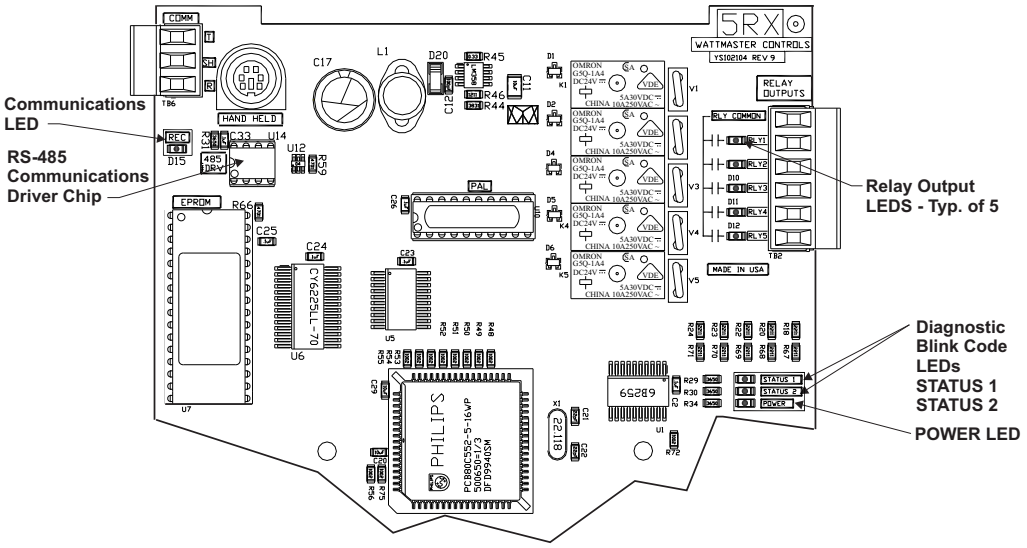

Figure 43: VCM-X E-BUS Controller Diagnostic LED Locations

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 41** on **page 48** 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 Sensor Failure	**1**	**2**
Outdoor Air Sensor Failure	**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**
Low Supply Temp Alarm	**1**	**4**
High Supply Temp Alarm	**2**	**4**
Control Temp Cooling Failure	**3**	**4**
Control Temp Heating Failure	**4**	**4**
Economizer Title 24 Alarm	**5**	**4**
Push Button Override	**1**	**5**
Zone Override	**2**	**5**
Force Outputs Override	**0**	**6**

Table 3: Diagnostic LED Blink Code Interpretation

System Configuration Options

The VCM-X E-BUS Controller can be used as a Stand-Alone System (one VCM-X E-BUS Controller only), connected together on an Interconnected System (multiple VCM-X E-BUS Controllers only) or connected together on a Network System (multiple VCM-X 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 VCM-X 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
- System Manager TS II
- 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 VCM-X E-BUS Controller only. Programming and status monitoring are accomplished by selecting and installing one or more of the Operator Interfaces.

See **Figure 45** on **page 71** for a Typical Stand-Alone System Layout diagram.

Interconnected System

The Interconnected System is used when you have multiple VCM-X 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 46** on **page 72** for a Typical Interconnected System Layout diagram.

Networked System

If you have 1 to 59 VCM-X 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 VCM-X E-BUS Controllers.

The Networked Multiple Loop system is used when you have more than 59 VCM-X E-BUS Controllers and/or are using multiple VCM-X 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 47** on **page 73** for a Typical Networked System Layout diagram.

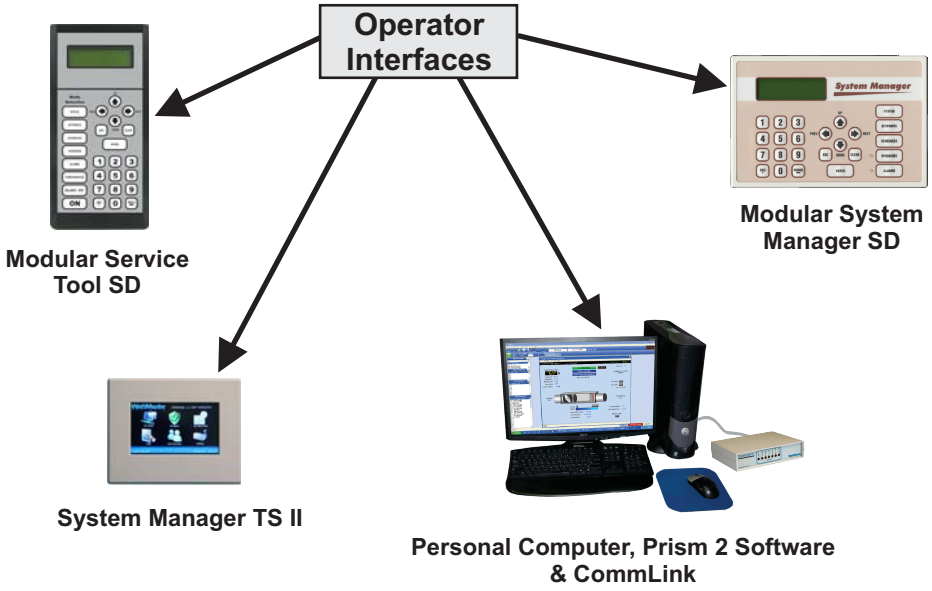

Figure 44: Available Operator Interfaces

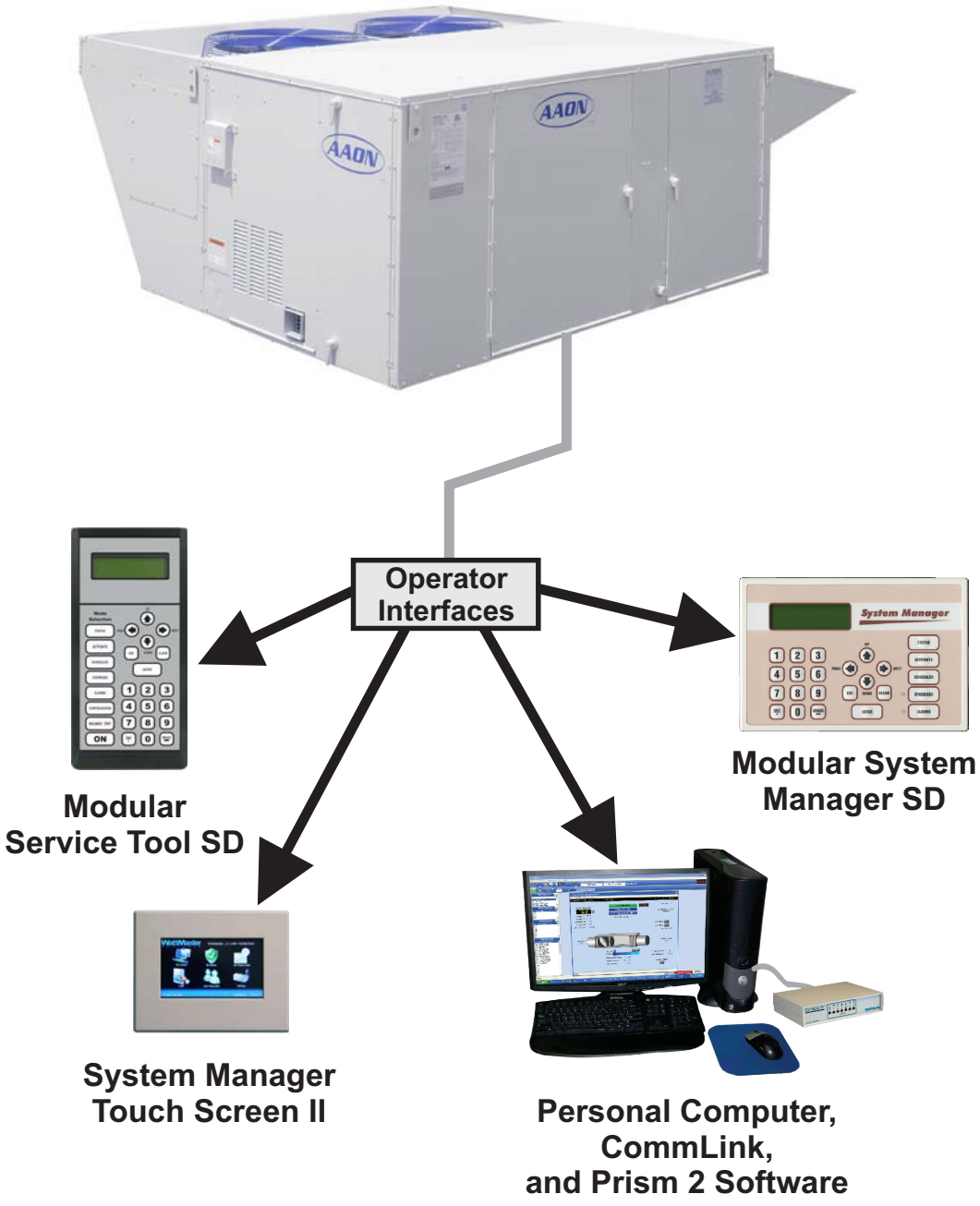

Figure 45: Typical Stand-Alone System Layout

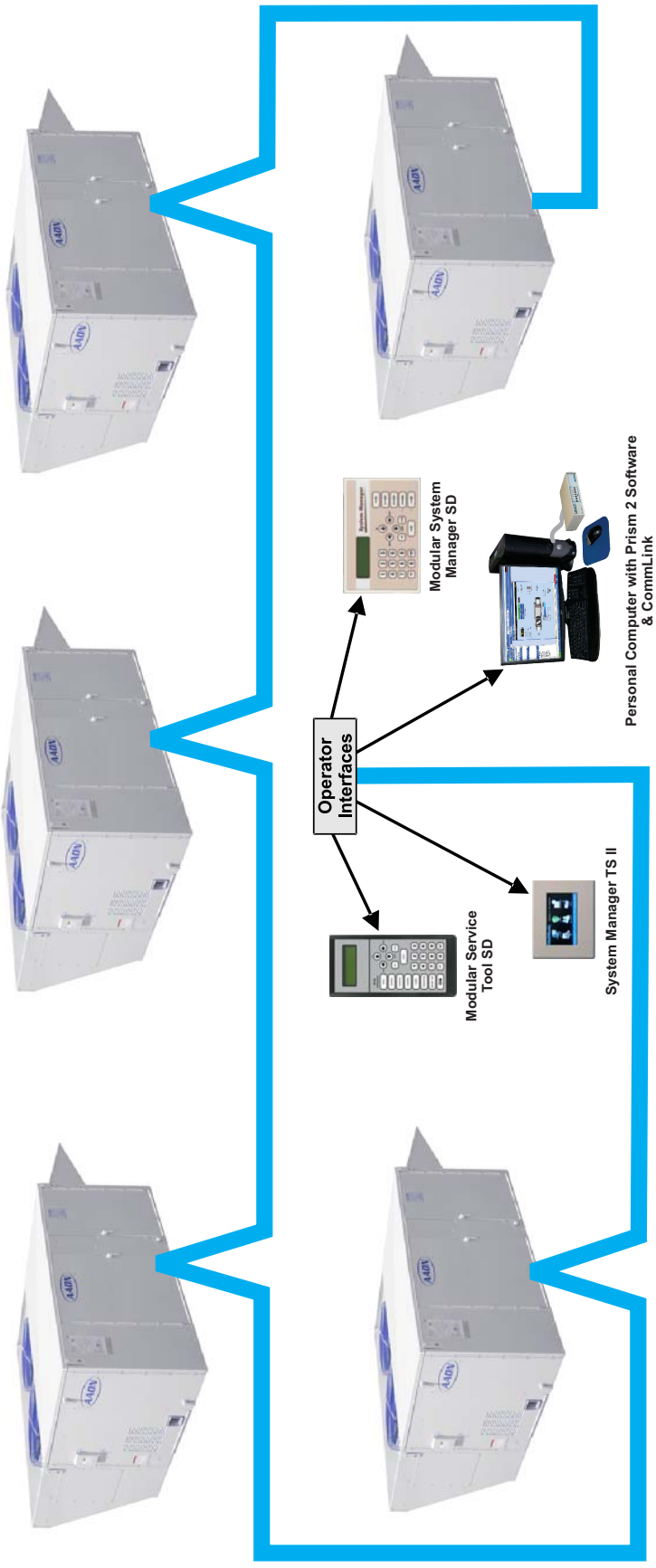

Figure 46: Typical Interconnected System Layout

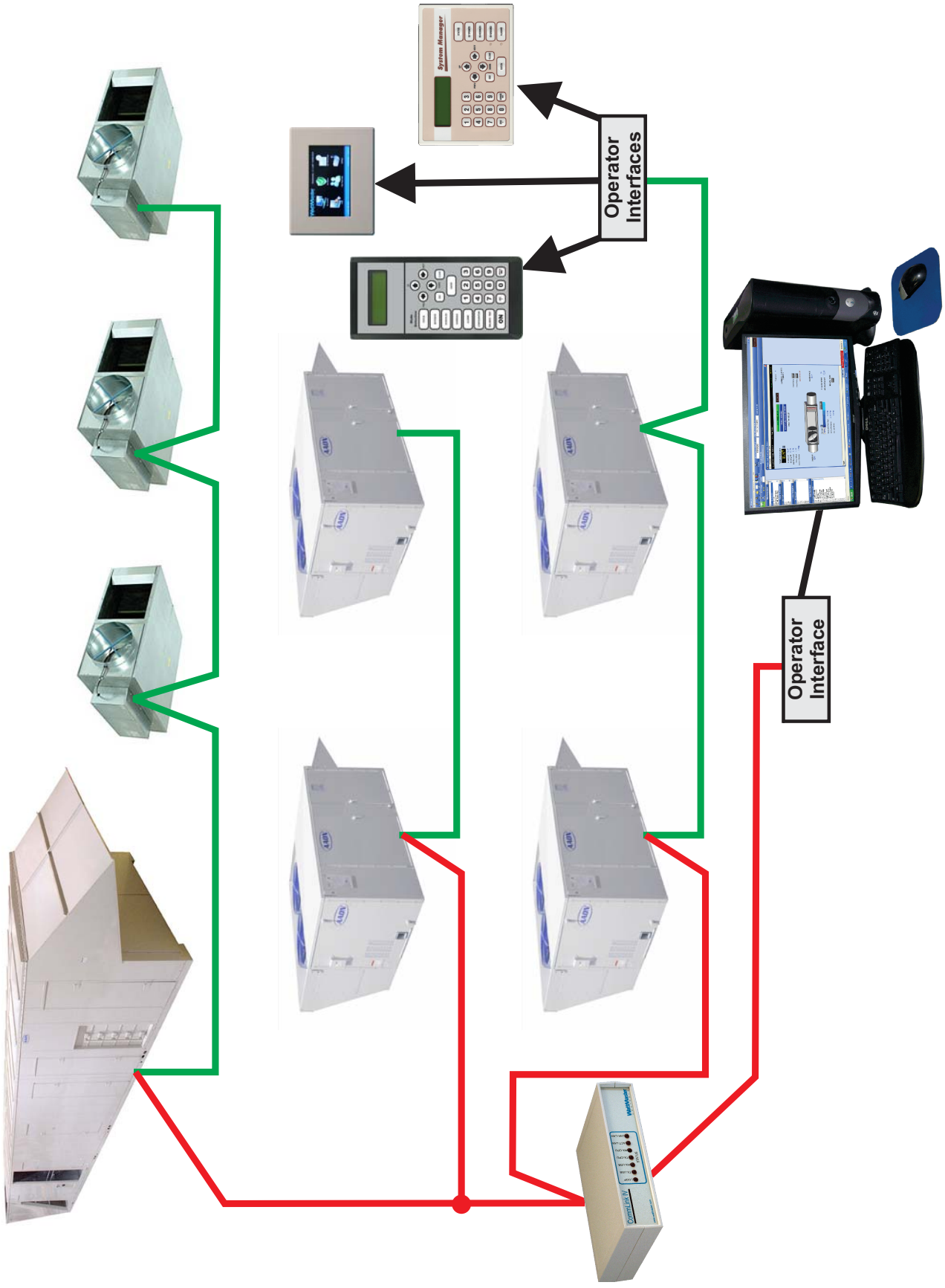

Figure 47: Typical Networked System Layout

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 (ºF)	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 (ºF)	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, OE265-13, and OE265-14 Relative Humidity Sensors.

OE265-11, -13 & -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, -13 & -14 Humidity Sensors

OE265-11, OE265-13, 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 & OE258-01 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.

OE258-01 Pressure Sensor Testing

The table below is used to troubleshoot the OE258-01 Building Pressure Sensors.

OE258-01 Building Pressure Sensor			
Pressure @ Sensor (“ W.C.)	Voltage @ Input (VDC)	Pressure @ Sensor (“ W.C.)	Voltage @ Input (VDC)
-0.25	0.00	0.01	2.60
-0.24	0.10	0.02	2.70
-0.23	0.20	0.03	2.80
-0.22	0.30	0.04	2.90
-0.21	0.40	0.05	3.00
-0.20	0.50	0.06	3.10
-0.19	0.60	0.07	3.20
-0.18	0.70	0.08	3.30
-0.17	0.80	0.09	3.40
-0.16	0.90	0.10	3.50
-0.15	1.00	0.11	3.60
-0.14	1.10	0.12	3.70
-0.13	1.20	0.13	3.80
-0.12	1.30	0.14	3.90
-0.11	1.40	0.15	4.00
-0.10	1.50	0.16	4.10
-0.09	1.60	0.17	4.20
-0.08	1.70	0.18	4.30
-0.07	1.80	0.19	4.40
-0.06	1.90	0.20	4.50
-0.05	2.00	0.21	4.60
-0.04	2.10	0.22	4.70
-0.03	2.20	0.23	4.80
-0.02	2.30	0.24	4.90
-0.01	2.40	0.25	5.00
0.00	2.50		

Table 7: Building Static Pressure/Voltage for OE258-01 Building Pressure Sensors

OE258-01 Building Pressure Sensor Testing Instructions

Use the voltage column to check the Building Static Pressure Sensor while connected to a powered expansion module. Read voltage with meter set on DC volts. Place the “-” (minus) lead on terminal labeled GND and the “+” lead on terminal AIN4 on the Analog Input/Output Expansion Module.

OE275-01 Suction Pressure Transducer Testing for R22 and 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 VCM-X Expansion Module. The VCM-X and the VCM-X 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 VCM-X 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 VCM-X 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 R22 and R410A Refrigerant testing (**Tables 8** and **9)**. The charts 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 R22 Refrigerant					
Temperature °F	Pressure PSI	Signal DC Volts	Temperature °F	Pressure PSI	Signal DC Volts
20.00	31.13	1.0	55.32	93.39	2.0
20.00	37.36	1.1	58.86	99.62	2.1
20.46	43.58	1.2	62.13	105.84	2.2
25.71	49.80	1.3	65.27	112.07	2.3
30.84	56.03	1.4	68.42	118.29	2.4
35.41	62.26	1.5	71.39	124.52	2.5
39.98	68.49	1.6	75.20	130.75	2.6
44.00	74.71	1.7	77.00	136.97	2.7
48.00	80.94	1.8	79.80	143.20	2.8
51.78	87.16	1.9	80.00	149.42	2.9

Table 8: Coil Pressure/Voltage/Temp for OE275-01 Suction Pressure Transducers - R22 Refrigerant

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

A

B

C

D

E

F

G

H

I

J

L

M

N

O

P

R

S

T

U

V

W

Z

2425 So. Yukon Ave • Tulsa, OK 74107-2728
Ph: (918) 583-2266 • Fax: (918) 583-6094
AAON® Manual Part No. V09260
WattMaster Manual Form No: AA-VCMX-EBUS-TGD-01K