RQ SERIES

Variable Speed Scroll Compressor Supplement

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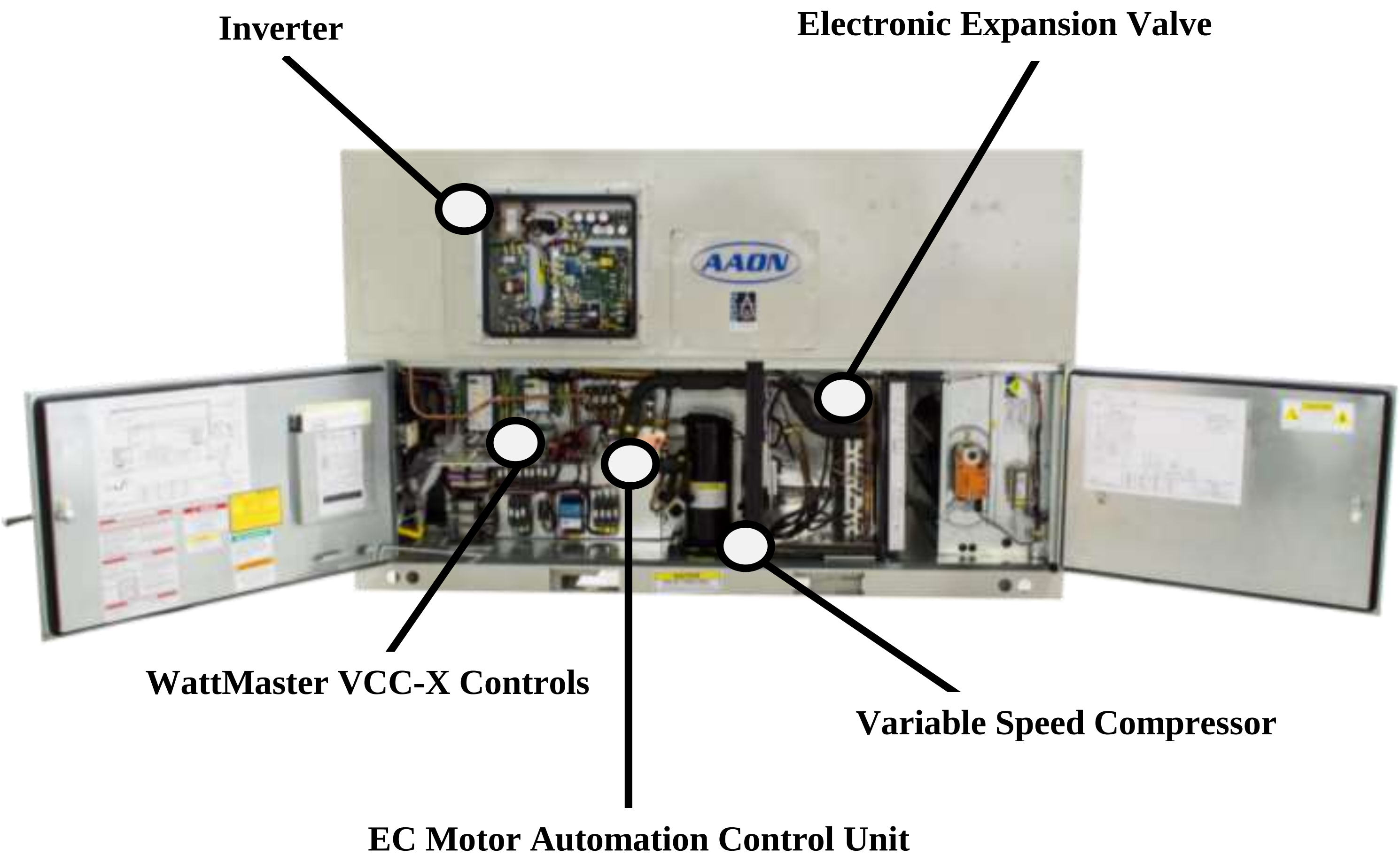

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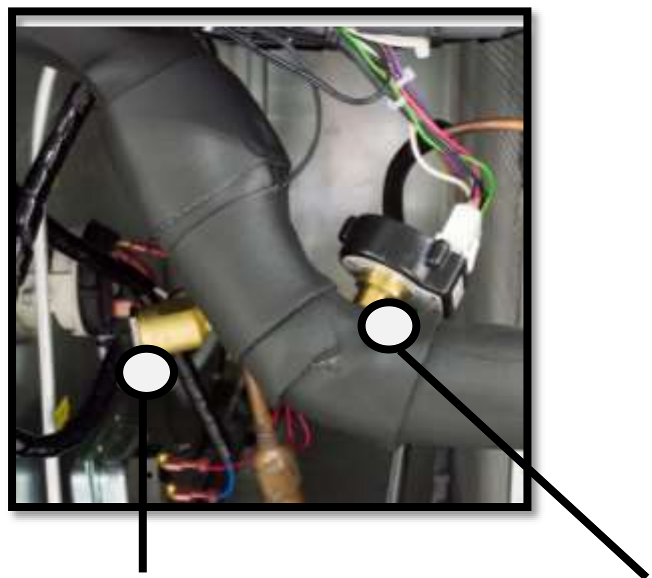

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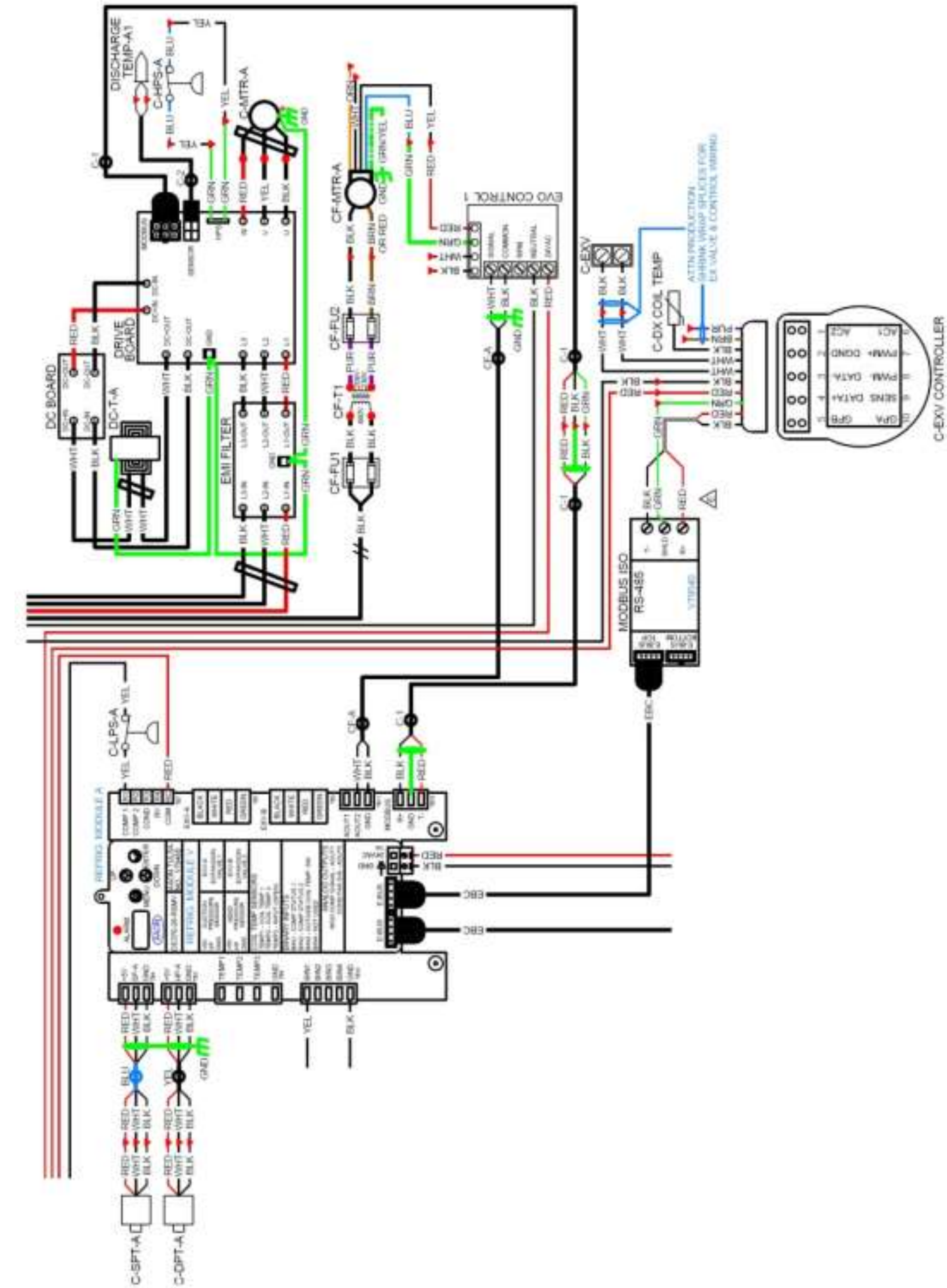


Example Wiring Diagram showing WattMaster Refrigeration System Module for Variable Speed Compressors, Copeland Inverter, Electronic Expansion Valve, and Variable Speed Condenser Fan Control

Introduction

This document provides instructions on how the variable speed scroll compressor and inverter drive are applied to a variable speed compressor in a safe and reliable manner. The variable speed scroll compressor will be referred to throughout this document as the “variable speed compressor” or the “compressor”. The inverter drive will be referred to throughout this document as the “inverter drive” or simply the “drive”.

Variable Speed Scroll Compressors

Product Description

The variable speed compressor has a speed range of 900 (refer to operating envelope for low speed operation) to 5000 revolutions per minute and is intended for use in commercial air conditioning, chiller, and heat pump applications. The variable speed scrolls utilize three-phase brushless permanent magnet (BPM) motors. The compressors have been qualified for use with drives which have been developed and qualified for BPM motor-compressors.

Compressor Motor

The brushless permanent magnet (BPM) motor in the variable speed scroll consists of a three-phase stator and a rotor embedded with high energy permanent magnets. The input voltage is a series of pulses of varying frequency at 120 degree intervals between phases.

Oil Pump

The variable speed scroll is equipped with an oil pump to ensure an adequate supply of oil to the bearing system throughout the operating speed range of 900 to 5000 RPM.

Compressor Temperature Protection

A discharge line thermistor must be used to protect the compressor. The drive will shut down the compressor when the thermistor temperature exceeds 275°F (135°C).

Oil Recovery

An oil recovery cycle is required if compressor speed is below 1,800 rpm for 2 hours. When this occurs, the unit controls will increase the compressor speed to 3,600 rpm for five minutes.

Motor Protection

The drive includes motor protection features for the compressor. The drive sets the maximum current limit, low voltage fold back which allows the compressor to ride through low voltage situations, which helps keep the compressor running to avoid nuisance trips.

Starting and Stopping Routine

The drive controls the starting and stopping routine of the variable speed scroll. This routine allows soft starting and controlled stopping, an advantage over traditional on-off control of fixed capacity units. Please refer to Table 4 for an exact explanation of the starting and stopping process.

The variable speed scroll compressor incorporates a fluid brake design to help mitigate reverse rotation during shutdown. A momentary reverse rotation sound may be heard.

Oil Type

Variable speed scrolls are charged with polyolester (POE) oil. See the compressor nameplate for the original oil charge. A complete recharge should be approximately four fluid ounces (118cc) less than the nameplate value. Copeland™ Ultra 32 3MAF, available from Emerson Wholesalers, should be used if additional oil is needed in the field. Mobil Arctic EAL22CC, Emkarate RL22, Emkarate 32CF and Emkarate 3MAF are acceptable alternatives.

⚠ Caution

POE oil must be handled carefully and the proper protective equipment (gloves, eye protection, etc.) must be used when handling POE lubricant. POE must not come into contact with any surface or material that might be harmed by POE, and spills should be cleaned up quickly with paper towels, soap and water.

Maximum Tilt Angle

Service personnel may be required to maneuver a unit through a stairwell or other cramped area that might require tilting the unit. The maximum allowable tilt angles from horizontal for individual compressors (not tandem or trio applications) are summarized below:

Max. tilt angle with compressor not running = 60°

Contaminant Control

Moisture levels should be maintained below 50 ppm for optimal performance. **A filter-drier is required on all R-410A and POE lubricant systems to prevent solid particulate contamination, oil dielectric strength degradation, ice formation, oil hydrolysis, and metal corrosion**. Molecular sieve and activated alumina are two filter-drier materials designed to remove moisture and mitigate acid formation. A 100% molecular sieve filter can be used for maximum moisture capacity. A more conservative mix, such as 75% molecular sieve and 25% activated alumina, should be used for service applications.

Discharge Check Valve

The compressor uses a shutdown valve located in the discharge fitting. This check valve is not a low-leak-back check valve and will leak when pressure differential across the check valve is low.

Electrical Troubleshooting

⚠ Caution

Bypassing the variable frequency drive and connecting AC line voltage directly to the compressor can cause irreversible damage to the compressor.

The BPM motors used in the variable speed scrolls are three-phase. The three windings should always have line to line continuity because there is no internal overload at the center of the motor windings to open and take the motor off-line. If one or more of the windings shows continuity to ground, the compressor must be replaced.

⚠ Caution

Energizing a variable speed scroll with a grounded winding can cause irreversible damage to the drive.

Measuring the current in the three individual wires feeding the compressor will provide no useful information to the service technician, other than to show that each winding of the compressor is drawing current. The more appropriate measurement is the current input to the drive. Current input to the drive can be compared to the published values of MCC and RLA.

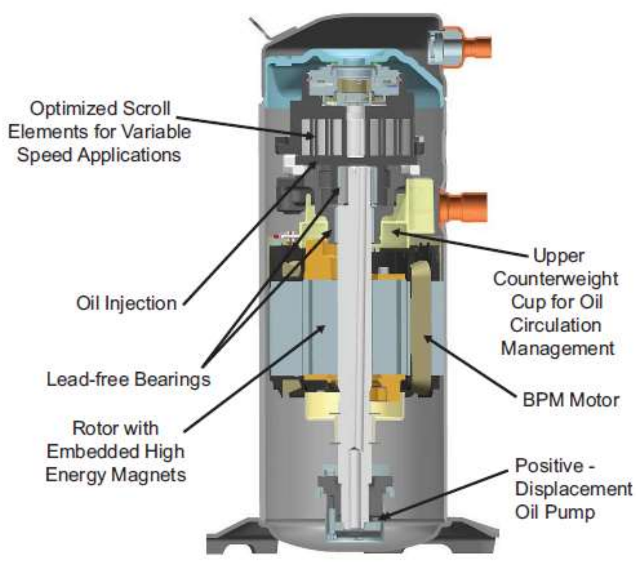


Figure 1 – Variable Speed Scroll Design Features

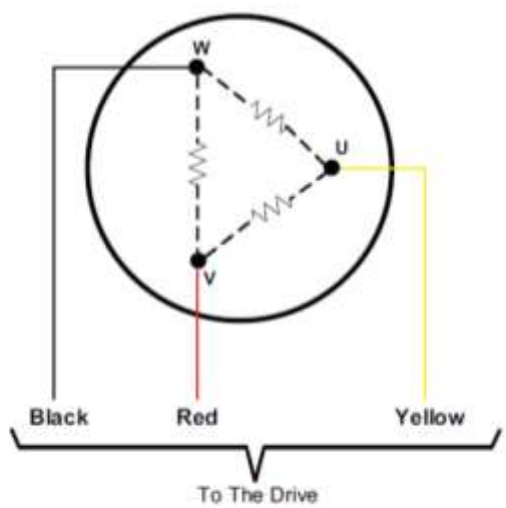


Figure 2 – Motor Winding Diagram

⚠ WARNING

Electric shock hazard. Disconnect and lock out power before servicing. Discharge all capacitors before servicing.

Three Phase Series Variable Speed Drives

Product Description

The inverter drive has been developed specifically for the variable speed compressor. The drive will power the compressor, control the compressor running speed, provide compressor and drive protection and communicate with the master controller. The drive requires cooling and is typically installed in the unit near the compressor.

Theory of Drive Operation

The primary purpose of the drive is to convert the 60 Hz AC input voltage into a variable frequency, variable voltage output to power the variable speed scroll compressor. The drive conditions the AC input Voltage through a series of conditioning processes to arrive at the desired output. The drive first converts the AC input voltage into a DC bus. The DC voltage is then pulse-width modulated to replicate a sinusoidal current at the desired frequency and voltage.

Nomenclature

The model number of the drive includes the power rating and nominal voltage input to the drive. Figure 3 provides a complete explanation of all of the alpha and numeric characters in the drive model number.

Temperature & Humidity

Drive operating temperature range:
-20°C to 60°C

Drive storage temperature range:
-40°C to 85°C

Maximum Relative Humidity: 95%

⚠ Caution

Check the drive carefully before using it. Make sure that all wires are correctly and tightly connected. Improper operation may cause fire or injury to persons.

Power On/Off

NOTICE

The drive should use rated AC power supply: 50/60Hz, 380-480V on EV20XXM-KX-XXX models and 208-240V on EV20XXM-JX-XXX drive models. Wrong use of power supply voltage levels may cause drive to be damaged. User should check the power supply, drive model being used before powering on the drive When power off the drive, make sure to wait at least 10 minutes to ensure that the drive is completely turned off.

Communication Setting

The drive is designed to be used in a master-slave configuration where the master is a unit controller.

Input Voltage and Input Current

The drives are designed for rated AC power supply: 50/60Hz, 380-480V on EV20XXM KX-XXX models and 208-240V on EV20XXM-JX-XXX drive models.

Drive	AC Input Overcurrent Protection
EV2080J	24A RMS
EV2080K	15A RMS
EV2055J	18A RMS
EV2055K	12A RMS

Power Factor Correction

Drive has passive power factor correction, which is capable of improving efficiencies.

Speed Control

The frequency range of the drive is from 15Hz to 120Hz. If the frequency set by unit controller is less than 15Hz but not zero, then the compressor will work at 15Hz. Similarly, if the frequency set by unit controller is greater than 120Hz, then the compressor will work at 120Hz.

There are three cases for unit shut down.

Case I (Controlled shut down): Unit shut down the compressor.

Case II (Faulted condition): When drive faults occur, the drive will shut down the compressor. Major and minor faults have different shutdown sequences. For major faults, the drive trips the compressor immediately (from running frequency to zero frequency). For minor faults, it has the same sequence as Case I. As mentioned above clear faults using the 'Fault Clearing' method shown below.

Case III: Loss of power shut down, this control procedure is the same as major fault shut down.

Fault Clearing

Faults are cleared through unit controls interface.

Status Indication

There are two control chips on the drive board and all of them have their own LED for status display. COMMS MCU has three LED indicators, DSP has one LED indicator.

LED for COMMS MCU

Operation Indicating LED (Green LED805)

When the drive is in normal state (no protection and fault), the drive is in standby state and the compressor does not work, the LED will blink every 2 seconds. If the compressor is running, the LED will always be on.

Protection Indicating LED (Yellow LED804)

When the drive is under protection, the yellow LED will blink. Refer to **Troubleshooting Table** more information.

Hardware Fault Indicating LED (Red LED803)

When the drive is under hardware fault, the red LED will blink. Refer to **Troubleshooting Table** for more information.

LED for Drive Control DSP Chip (Green LED802)

When the drive is in normal state, whether the compressor is running or standby, the LED will blink every 1 second. When the drive is under protection or hardware fault, the LED will blink every 1/8 of a second.

Drive Over Temperature Protection
The drive is self protected against high internal temperatures. There are different modes of protection; temperature high and foldback. For foldback protection refer to Table 8 for more information.

Power Interrupt
Power interrupts can result in a drive trip that won't harm the drive. The drive can withstand interrupts of a short duration (1-2 power cycles), but will trip on anything longer.

Air Cooled Heat Exchanger
Drives cooled by the aluminum air cooled heat exchanger are designed to be in the air flow stream of the condenser.

Foldback
To protect the drive components or the compressor, the compressor speed will 'foldback' or slow down to help reduce risk to components. The foldback event(s) will be flagged in the unit controller. This will allow the operating system to respond and mitigate the conditions causing foldback.

Troubleshooting

The drive may indicate fault or protection for various reasons. If fault or protection occurs, users should power down the drive, check the drive, and check the drive running condition carefully. For the description, check and handling of these faults or protections, please refer to **Troubleshooting Table**.

The yellow and red LED of COMM will be displayed in a circulation of blinking for N times (N is the protection code) then be off for 3 seconds. For detailed description of the protections, please refer to **Troubleshooting Table.**

• Immediate shutdown = The drive will execute an immediate shut down due to a condition that may cause damage to the drive.

• Controlled shutdown = The drive will execute a controlled shut down due to systemic or temperature related problems.

• First faults latched = When a fault occurs it may cause other faults to happen as well. In order to capture the fault that happened first, these registers only record the ‘first fault latched’.

• Current faults = These registers display all faults that are currently logged by the drive, including the first faults latched.

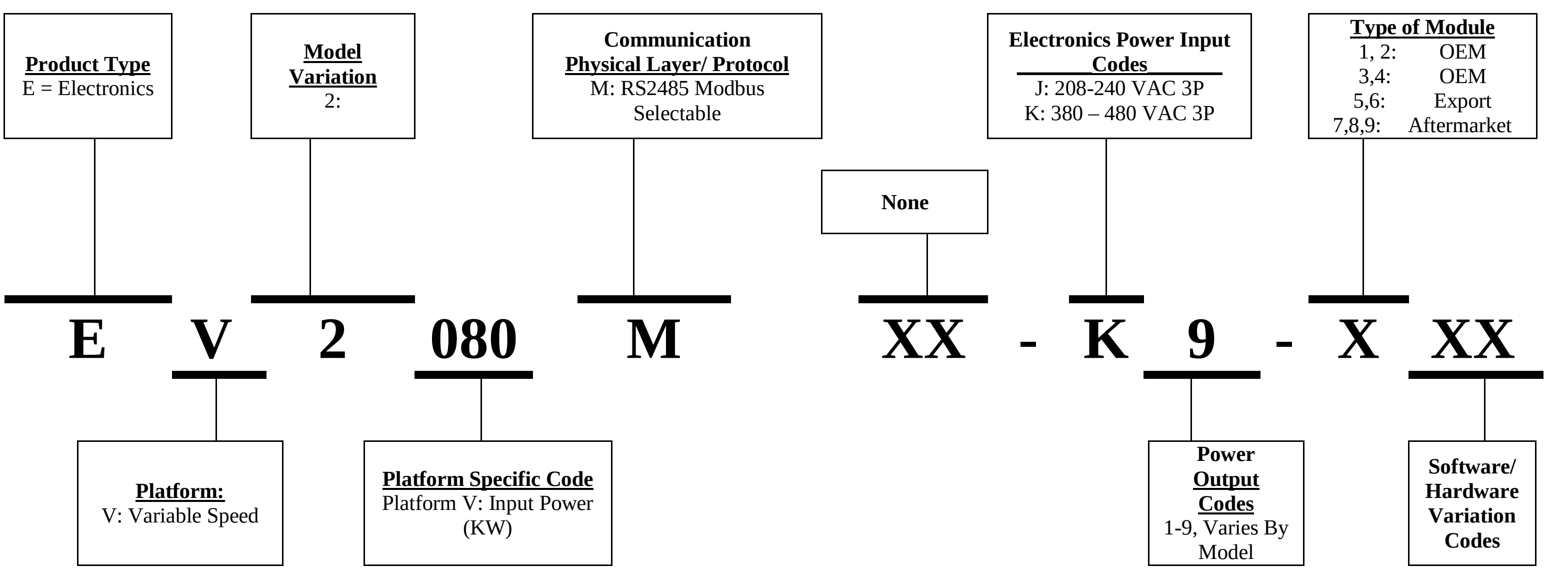
Table 1 - Troubleshooting – Fault and Protection

NO.	Fault and Protection	Description	Check and Handling	Comms Led Blink Code LED604 LED603
1	Compressor phase over-current	Compressor phase instant over-current (38A/32A peak)*	Check the compressor U/V/W and the PIM module. Make sure the circuit is not short. Check the compressor U/V/W connection; make sure that they are tightly connected.	1 or 3
		Compressor phase current sampling circuit open or short	Sensor on drive not reading properly - replace the drive.	4
2	Compressor phase current foldback timeout	Compressor phase current ≥ foldback protection value (for 30 seconds)	The compressor load is too heavy, check the compressor load.	16
3	AC input over current	AC current exceeds design limits	AC input voltage too low. The compressor load is too heavy, check the compressor load.	11
4	AC input current sampling fault	AC input current sampling circuit error	If the AC input voltage too low, replace the drive.	5
5	DC bus over voltage	VDC exceed 800V* VDC exceed 450V*	Check the AC power supply and if the right voltage is supplied according to the drive model. The drive running condition is not stable. Check the compressor load and makes sure it is OK. Restart the drive again.	7
6	DC bus under voltage	VDC lower than 300V* VDC lower than 170V*	Check the AC power supply and if the right voltage is supplied according to the drive model. The drive running condition is not stable. Check the compressor load and makes sure it is OK. Restart the drive again.	8
7	AC input over voltage	VDC exceed 575V* VDC exceed 275V*	Check the AC power supply and if the right voltage is supplied according to the drive model.	10
8	AC input under voltage	VDC lower than 295V* VDC lower than 170V*	Check the AC power supply and if the right voltage is supplied according to the drive model.	9
9	Power module over temp	Power module temperature exceeds normal design limits	Verify proper airflow over the heat-sink of the drive. Remove any obstructions. Check that the compressor is operating within specified limits. Check the mounting screws on the drive, make sure they are tight. If the problem still persists replace the drive.	4
10	Sensor 2 (thermistor, DLT) low temp or open	DLT temperature sensor circuit open	Check the DLT temperature sensor connection; make sure that is connected and configured. If the problem persists replace the drive.	3
11	Compressor phase current imbalance	Phases current difference ≥4A (RMS) for 10S	Check the compressor U/V/W connection; make sure that they are tightly connected.	14
12	Microelectronic fault	DSP shelf-check error	Restart the drive again, if the fault appears again, change the drive.	13
13	EEPROM fault	EERPOM invalid	Restart the drive again, if the fault appear again, change the drive.	12

NO.	Fault and Protection	Description	Check and Handling	Comms Led Blink Code LED604 LED603
14	Lost rotor position	Compressor loss of phase, rotor locked, lost rotor position.	Check the compressor U/V/W connection. Check system charge levels, if too high this problem can occur.	2
15	DC bus voltage low	Voltage is below the design limits.	Check the AC power supply and if the right voltage is supplied according to the drive model. The drive running condition is not stable. Check the compressor load and makes sure it is OK. Restart the drive again.	17
16	Modbus communication lost	The drive can't communicate with the system controller for 30S	Check the communication wire connection. Check the communication parameter set is right.	11
17	Sensor 2 (thermistor, DLT) high temp	DLT temperature is high	Check the DLT/scroll thermistor connection. Check the compressor is operating within specified limits.	6
18	Power module temp high	Power module temperature exceeds normal design limits	Verify proper airflow over the heat-sink of the drive. Remove any obstructions. Check that the compressor is operating within specified limits. Check the mounting screws on the drive, make sure they are tight. If the problem still persists replace the drive.	18
19	Power module temp foldback timeout	Power module temperature exceeds normal design limits	1. Verify proper airflow over the heatsink of the drive. Remove any obstructions. 2. Check the compressor is operating with in specified limits. 3. If the problem still persists, replace the drive.	21
20	Sensor 1 (high pressure switch open)	Condensing Pressure beyond limit, system issue.	Check that the compressor is operating within specified limits, could be system issue.	20
21	Sensor 1 (low pressure) fault	For future use, not available at this time	Condensing pressure below limit, system issue.	N/A
22	Compressor model configuration error	Compressor model and configuration code do not match.		22
23	High pressure sensor type configuration error	Pressure sensor and configuration code do not match.		23
24	Comms to DSP communication lost	COMM MCU and DSP communication fault	1. Check mod-bus communication cable connections. 2. Check the communication parameters are set right. 3. Power cycle the drive. 4. If problem persists, replace the drive.	8
25	Power module temp low or sensor open fault	Power module temperature sampling circuit open or short	Check that the compressor is operating within specified limits. If the problem still persists replace the drive.	2

NO.	Fault and Protection	Description	Check and Handling	Comms Led Blink Code LED604 / LED603
26	AC input voltage sampling fault	Sensor on drive not reading properly. Replace the drive		6
27	DC BUS voltage sampling fault	Sensor on drive not reading properly. Replace the drive		7
28	AC input lost of phase protection	Input missing phase	Check input connections	16
29	Fault limit lockout	Certain faults have a trip limit, see modbus map for details		N/A
30	Motor weak magnetic protection	Input voltage or bus voltage too low. Check the input voltage and compressor is operating within limits.		12

*Note: Two Different values are for EV2080M and EV2055M Models



Model Numbers	Capacity
EV2080M-K9-XXX	080 = 8.0kW
EV2080M-J9-XXX	080 = 8.0kW
EV2055M-K9-XXX	055 = 5.5kW
EV2055M-J9-XXX	055 = 5.5kW

Figure 3- Electronics Nomenclature

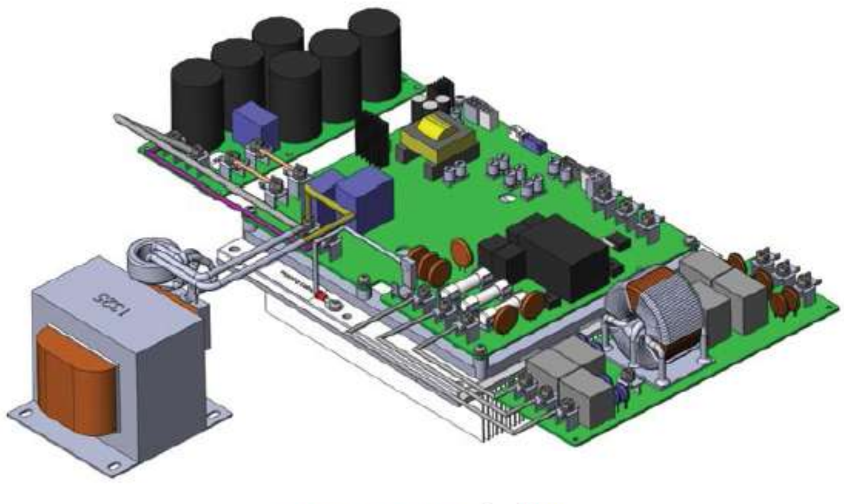


Figure 4 - U.S. Drive Model Wiring Diagram

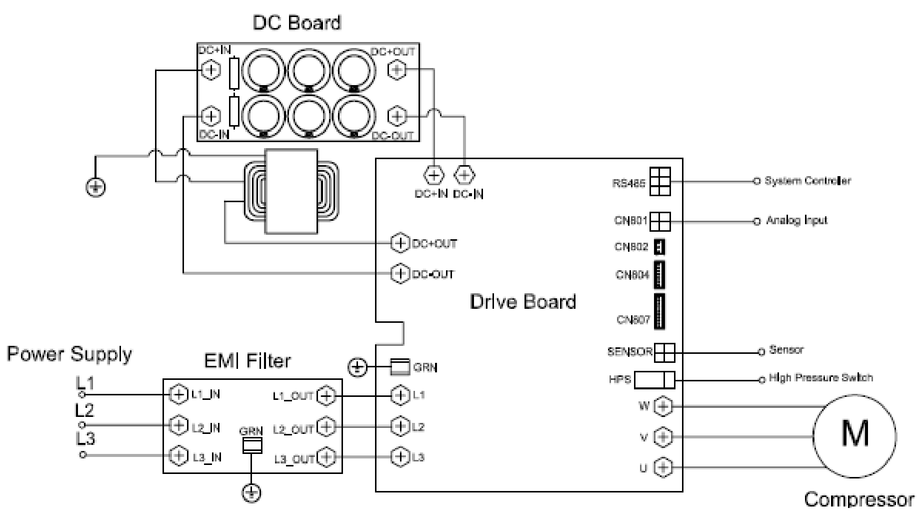


Figure 5 - U.S. Wiring Diagram

Table 2 - Communication Connector Pin Definition

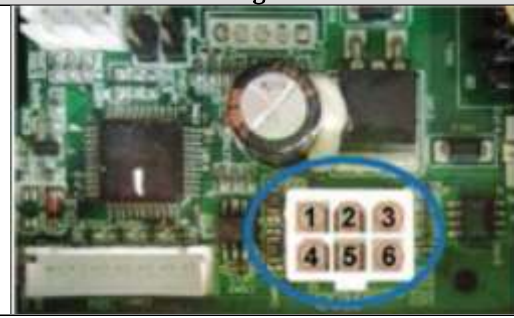
<table>
<tr><th>Pin Number</th><th>Description</th><th>Figure</th></tr>
<tr><td>1</td><td>RS485 (+)</td><td rowspan="6">
</td></tr>
<tr><td>2</td><td>Not Used</td></tr>
<tr><td>3</td><td>Not Used</td></tr>
<tr><td>4</td><td>RS485 (-)</td></tr>
<tr><td>5</td><td>Common</td></tr>
<tr><td>6</td><td>EMI Drain Wire</td></tr>
</table>

Table 3 - Sensor Connector Pin Definition

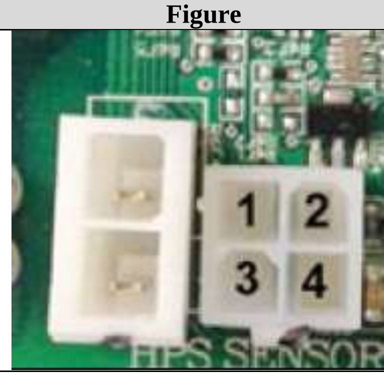
<table>
<tr><th>Pin Number</th><th>Description</th><th>Figure</th></tr>
<tr><td>1</td><td>Sensor Pin</td><td rowspan="6">
</td></tr>
<tr><td>2</td><td>3.3VDC</td></tr>
<tr><td>3</td><td>Not Used</td></tr>
<tr><td>4</td><td>Not Used</td></tr>
<tr><td>A1</td><td>High Pressure Signal</td></tr>
<tr><td>A2</td><td>3.3VDC</td></tr>
</table>

Table 4 - Ramp Up Procedure

Stage	Description	Target Frequency (Hz)	Ramp Up Rate (Hz/s)	Duration (S)
I	Compressor command started.	20	10	2
II	Compressor reaches minimum start frequency.	25	1	5
III	Compressor remains at platform frequency.	25	-	10
IV	Compressor reaches commanded frequency.	Commanded	1	-

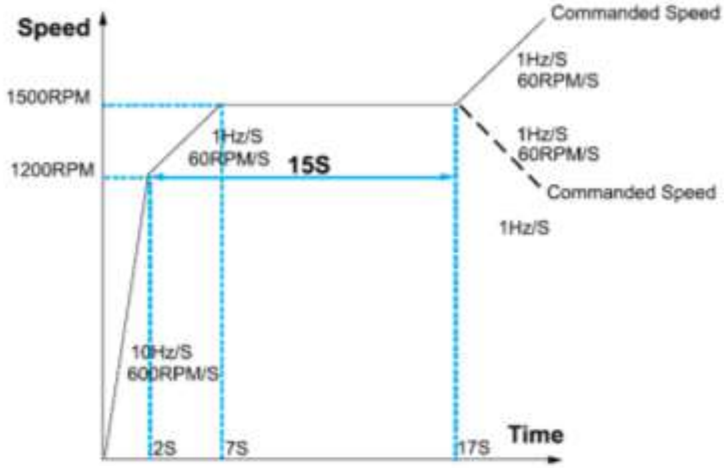


Table 5 - Ramp Down Sequence

Stage	Description	Target Frequency (Hz)	Ramp Down Rate (Hz/s)
I	Compressor gets to 30Hz	30	2
II	Compressor gets to minimum frequency	15	2.5
III	Compressor stop	-	-

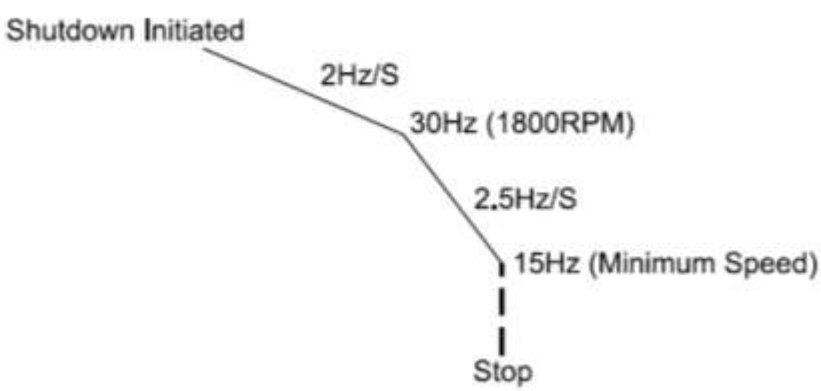


Table 6 - Input Current Foldback

	Condition	Action taken by the Drive
1	Input Current >= Foldback Current	Will reduce the speed to minimum speed at rate of 20 rpm/s
2	Recovering Current <= Input Current <Foldback Current	Will remain in the current speed
3	Input Current < Recovering Current	Speed will be recovered to commanded speed
4	Drive in foldback state for >=30 sec	Compressor will be tripped

Table 7 - Output Current Foldback

	Condition	Action taken by the Drive
1	Output Current >= Foldback Limit of operating speed range	Will reduce to minimum speed of the speed range at rate of 20 rpm/s
2	Recovering Current <= Output Current < Foldback Limit of operating speed range	Will remain in the current speed
3	Output Current < Recovering Current	Speed will be recovered to commanded speed
4	Drive in foldback state for >=30 sec	Compressor will be tripped

Table 8 - Inverter Temperature Feedback

	Condition	Action taken by the Drive
1	Inverter Temperature >= Foldback Temperature	Will reduce the speed to minimum speed at rate of 20 rpm/s
2	Recovering Temperature <= Inverter Temperature <Foldback Temperature	Will remain in the current speed
3	Inverter Temperature < Recovering Temperature	Speed will be recovered to commanded speed
4	Drive in foldback state for >=30 sec	Compressor will be tripped

Variable Speed Compressor Temperature Control

WattMaster VCC-X Unit Controller and WattMaster Refrigerant System Module for Copeland VFD Compressors (RSMVC-P) work together to control the unit operation and control the variable speed compressor capacity.

The RSMVC-P Module provides the following:
• Controls the Compressors to satisfy the Supply Air
Temperature Setpoint (Supply Air Temperature sent by VCCX-P Controller) during Cooling Mode. During Dehumidification Mode, it controls the Compressors to the Suction (Saturation) Temperature Setpoint
• Communicates to the Copeland VFD Drive for control and fault monitoring
• Modulates the Condenser Fan to maintain the Head Pressure Setpoint
• Provides alarms and safeties for the compressor and condenser operation.
• Contains a 2 x 8 LCD character display and 4 buttons that allow for status display, setpoint changes, and configuration changes.

Cooling Mode Operation
In the Cooling Mode, as the Supply Air Temperature (SAT) rises above the Active SAT Cooling Setpoint, the compressors will stage on and modulate to maintain the Active SAT Cooling Setpoint. Minimum off times must also be met before compressors can stage on and minimum run times must be met before compressors can stage off.

Figure 6 - WattMaster VCC-X Controller and Refrigeration System Control Module

For more information about the VCC-X Controller or RSMVC-P Controller reference the VCC-X Controller Technical Guide (V57140) and the RSMVC-P Technical Guide (V73400).

Modular Silicon Expansion Valve and Universal SuperHeat Controller/Sensor Hardware Installation

Additional Product Markings for USHC-G1.3b and USHS-G1.3b

- Operating Control
- Independently Mounted
- Pollution Degree 2
- Impulse Voltage: 300 V
- SELV Circuit Voltage I/O
- Operating Pressure: 21 to 240 psia
- Proof Pressure: 600 psi
- Burst Pressure: 1500 psi

About the MSEV and USHX

The Modular Silicon Expansion Valve (MSEV) shown in Figure 7, is a two-stage proportional control expansion valve which utilizes DunAn Microstaq's patented silQflo™ microelectromechanical systems microvalve technology to provide precise mass flow control for industry-standard HVAC and refrigeration applications. The MSEV consists of a MEMS pilot valve which acts as a first stage valve that applies varying fractions of fluid line pressure onto the second stage spool valve according to the command signal provided by the Universal SuperHeat Controller (USHC). The MSEV is installed at the inlet of the evaporator.

Figure 7 - Modular Silicon Expansion Valve

The **Universal SuperHeat Controller/Sensor** (USHX), shown in Figure 8 is offered either as a:

a. Universal SuperHeat **Controller** (USHC): To drive and control the MSEV.

b. Universal SuperHeat **Sensor** (USHS): To measure and report temperature, pressure, and superheat values.

The USHX consists of an internal MEMS pressure sensor and a processing unit. It uses a wiring harness, shown in Figure 9, to measure the evaporator temperature and control the MSEV**.** The USHX is installed at the outlet of the evaporator; it mounts onto a ¼" access fitting and utilizes the Modbus RTU communication protocol for user interaction. The USHX and its wiring harness pin assignments are shown in Table 9.

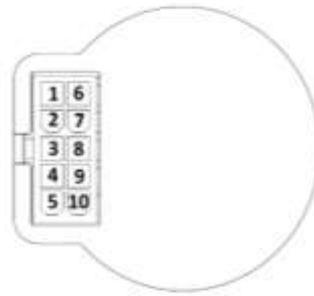
Figure 8 - USHX

Figure 9 - USHZ Wiring Harness

Table 9 - USHX and Wiring Harness Pin Assignments

USHX – G1.3b Series Model Numbers

- USHC-G1.3b-BAAAXXX
- USHS-G1.3b-BAAAXXX



Pin Number	Pin Name	Pin Function	Type of Wire	Wiring Harness Model WH-USHX-AX
Pin 1	AC2	Power Input	Red, 18 AWG	✓
Pin 6	AC1	Power Input	Black, 18 AWG	✓
Pin 3	DATA-	RS485- Communication	Black, 24 AWG, Shielded	✓
Pin 4	DATA+	RS485+ Communication	Red, 24 AWG, Shielded	✓
Pin 2	SENS	Digital Signal Ground and Thermistor Signal Ground	Black, 24 AWG	✓
Pin 9	SENS	Thermistor Power	Black, 24 AWG	✓
Pin 7	PWM+	PWM Output	White, 18 AWG	✓
Pin 8	PWM-	PWM Output	White, 18 AWG	✓
Pin 5	GPB	General Purpose-Not Utilized	Brown, 20 AWG	✓
Pin 10	GPA	General Purpose-Not Utilized	Purple, 20 AWG	✓

Note:

✓ = Available

× = Not Available

Mechanical Installation

This section describes the mechanical installation of the MSEV and USHX Figure 10 below shows an example of a typical system the MSEV and USHX devices would be integrated into. Like conventional thermostatic expansion valves (TXVs) or electronic expansion valves (EEVs), the MSEV is installed at the inlet of the evaporator. The USHC, which drives and controls the MSEV, is installed at the outlet of the evaporator, in place of the TXV bulb or EEV controller sensing device. The MSEV and USHC are connected together by a wiring harness. A thermistor at the outlet of the evaporator measures the temperature, and the USHC is powered by the Class 2 power source.

⚠ WARNING

Do not turn the power source ON until installation of MSEV, USHX and wiring harness is complete. For the user's own safety, **only** Class 2 power source should be used to power the MSEV and USHX devices.

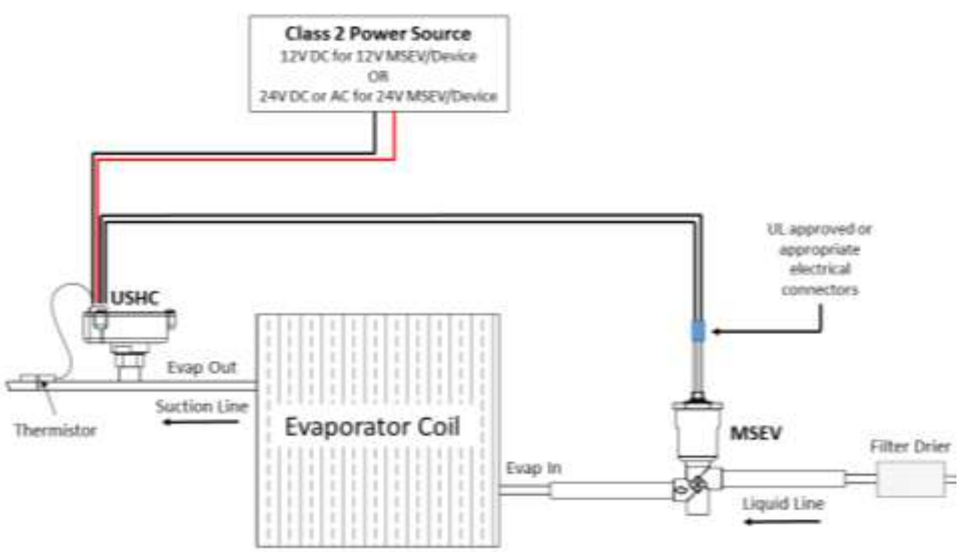


Figure 10 - MSEV and USHC installation schematic

Installing the MSEV
To install the MSEV, complete the following steps:

1. Pump down and recover any residual refrigerant from the system.
2. Remove the current TXV and its bulb or EEV and its controller by cutting. Take care to minimize the risk of introducing contaminates into the system when removing the existing valve.
3. Before continuing, clean the copper connections of the MSEV. The MSEV comes with a standard 3/8'' outside diameter (OD) copper tubes that are 3" in length on both sides of the main body.
    a. Do not reduce the length of the copper tubes when brazing.
    b. Flare fittings should be used if the copper tubes length is reduced.
4. Position the MSEV as displayed in Figure 11 and ensure the arrow mark aligns with the direction of fluid flow. The blue arrows show which way fluid is supposed to flow through the valve. Also ensure that the MSEV is installed in an upwards orientation or at any angle less than 90° in either direction (represented by the curved green arrows).
    a. The MSEV cannot be installed in a downwards orientation (shown in curved red arrows). It will not function as intended if installed in such a way.
5. Wrap the valve body with a wet cloth before brazing.
6. Connect the MSEV to the inlet of the evaporator by brazing. Allow the valve to air-cool after brazing.
    a. While brazing, direct heat away from the valve body. Ensure that the temperature of the valve body does not exceed 221°F (105°C).
7. It is mandatory to install a brand new filter drier at the inlet of the MSEV as indicated in Figure 10. It can be installed at about 6" away from the MSEV. The MSEV must be protected against contaminants to ensure its optimal operation.

WARNING

DMQ highly recommends using a filter drier with a 20 micron filtration rating.

8. The MSEV installation process is now complete.

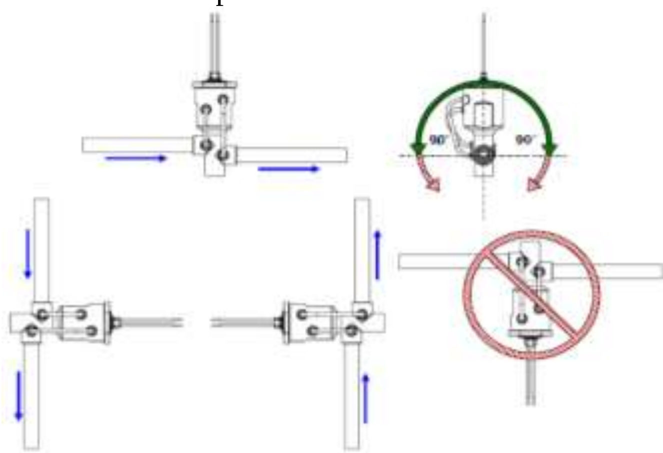


Figure 11 - MSEV installation orientation

Installing the USHX

To install the USKX, complete the following steps:

1. Pump down and recover any residual refrigerant from the system. This may have already been done if a MSEV was installed before this step.
2. Obtain any ¼” access fitting that is compatible with the system. In this section, a ¼” access fitting with a 3/16” OD extended tube is used as an example to demonstrate the installation process.
3. See Figure 12 and Figure 13 for the proper orientation of the USHX. When installing the device on a horizontal copper line as shown in Figure 12, the USHX can only be installed up to a 45° angle from the vertical axis in either direction (represented by the curved green arrows). When installing the device on a vertical copper line as shown in Figure 13, the USHX cannot be installed at a downward angle (represented by the red arrow).
4. Drill a hole into the copper line that extended tubes may fit in to. The location of this hole should be about 6” away from the outlet of the evaporator.
    a. Care must be taken to not introduce copper shavings into the copper line while the hole is being drilled.
5. Remove the valve core of the access fitting before brazing.
6. Braze the access fitting to the copper line and allow it to air-cool after brazing.
7. Place the valve core back onto the access fitting and tighten the connection. This step completes the installation of the ¼” access fitting. The final result should look similar to what is shown below in Figure 14.

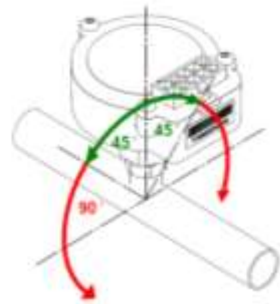


Figure 12 - USHX installation orientation on a horizontal copper line

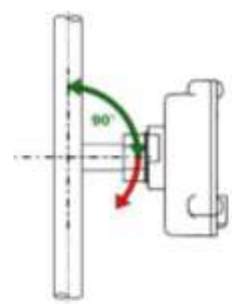


Figure 13 - USHX installation orientation on vertical copper line

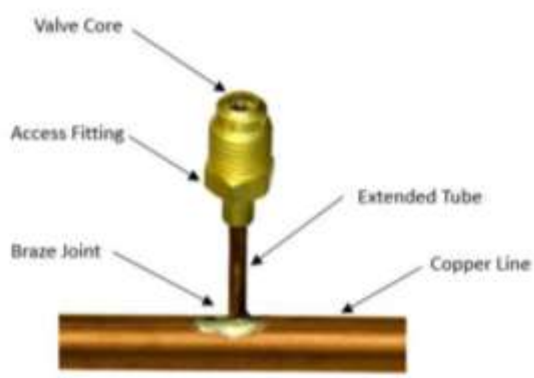


Figure 14 - Brazed access fitting

8. Mount the USHX onto the access fitting. Turn the USHX housing clockwise by hand until some resistance is met and then use 7/16" and 9/16" wrenches in tandem as shown below in Figure 15 to further tighten the USHX connection. This will ensure that the brazed joint is not damaged by the torque of the tightening.

> ⚠ **WARNING**
>
> **Do not turn the power source ON during the installation of the wiring harness.**

9. Attach the wiring harness (10-pin connector) to the USHX as shown below in Figure 15.
    a. If the USHX is located in a wet or potentially wet environment, apply silicone grease inside the 10-pin connector of the wiring harness.

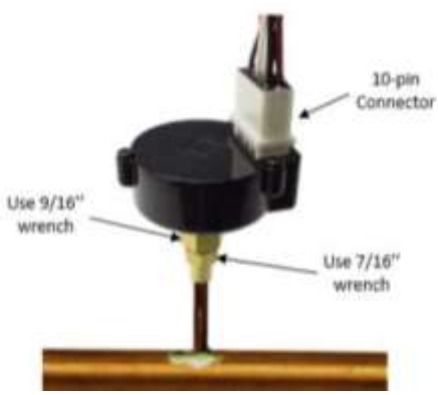


Figure 15 - Installed USHX with attached 10-pin wiring harness

10. Install the thermistor at the outlet of the evaporator and close to the access fitting using a zip tie, as shown below in Figure 16. The thermistor should be located at either the 10 o'clock or 2 o'clock position only.
    a. Ensure that the thermistor wire is not tied down to the tubing. The zip tie should only be tied around the thermistor body.
    b. Apply thermal grease between the thermistor and the copper line to obtain the most accurate temperature readings.

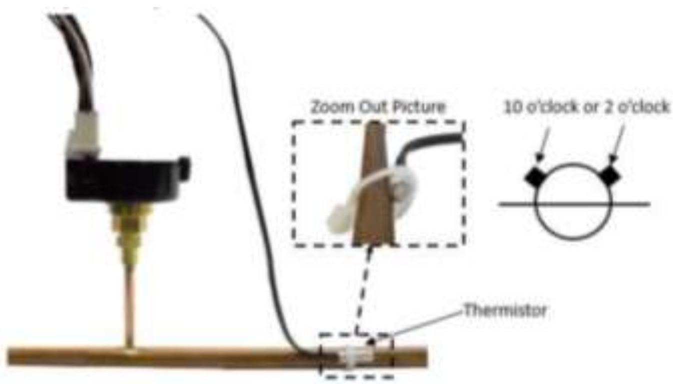


Figure 16 - Thermistor installation at evaporator outlet

11. Wrap the thermistor with the insulation material and secure the insulation in place using a zip tie. The final result should be similar to what is shown below in Figure 17.

Figure 17 - Insulation secured to the thermistor

12. Check for leaks at all the braze joints after brazing.
13. Pull a vacuum on the system until 250 microns is reached.
14. Restore refrigerant to the system.
15. Perform another check for leaks at all braze joints.
16. Refer to *Electrical Wiring* section to complete the electrical wiring of the system.
17. Refer to USHX Software User Interface Manual to set up communications between the USHX and the computer.
18. Supply power to the USHX with a power supply and power it on.
19. Ensure that the settings in the GUI meet the system requirements (i.e. double check the Refrigerant, Target Superheat, Device Mode, and other settings).
20. Power on the HVAC/R system and the MSEV and USHX will automatically begin functioning.
21. Observe the superheat temperature values in the GUI Status tab to ensure that the system is performing nominally. Adjust the system settings through the GUI if necessary.

Electrical Wiring

After the mechanical installation of the MSEV(s) and/or USHX(s) into the system, complete the electrical wiring of the system by completing the following steps.

Single USHC-MSEV or Single USHS

⚠ WARNING

Do not turn the power source ON until all electrical wiring setup is complete.

1. Check the voltage type – either 12 V or 24 V – of the MSEV. It can be found on the MSEV model number label. The power source required will be based on the MSEV voltage type.

⚠ WARNING

Ensure that the power source voltage matches the MSEV voltage type. If a 12 V MSEV is powered by a 24 V power source, the MSEV will fail due to an over-voltage. If a 24 V MSEV is powered by a 12 V power source, the MSEV will not fully open due to an under-voltage.

2. Obtain a Class 2 24 VAC transformer with a capacity of 40 to 100 VA and an output of 24 VAC at a frequency of 60 Hz. Alternatively, a 120 VAC to 12 VDC or 120 VAC to 24 VDC Class 2 step-down power supply with a 40 to 100 W power rating may be used. The schematics of the power sources are shown below in Figure 18.

    a. For the user's own safety, only Class 2 power sources should be used to power the MSEV and USHX devices.

3. Double check the power source output voltage (AC transformer secondary or DC power supply output).

    a. The reading should be at or near 12 VDC, 24 VDC, or 24 VAC depending on the MSEV and power source. When supplying 24 V, the voltage must be within the range of 20.4 V to 27.6 V. When supplying 12 V, the voltage must be within the range of 10.2 V to 13.8 V.

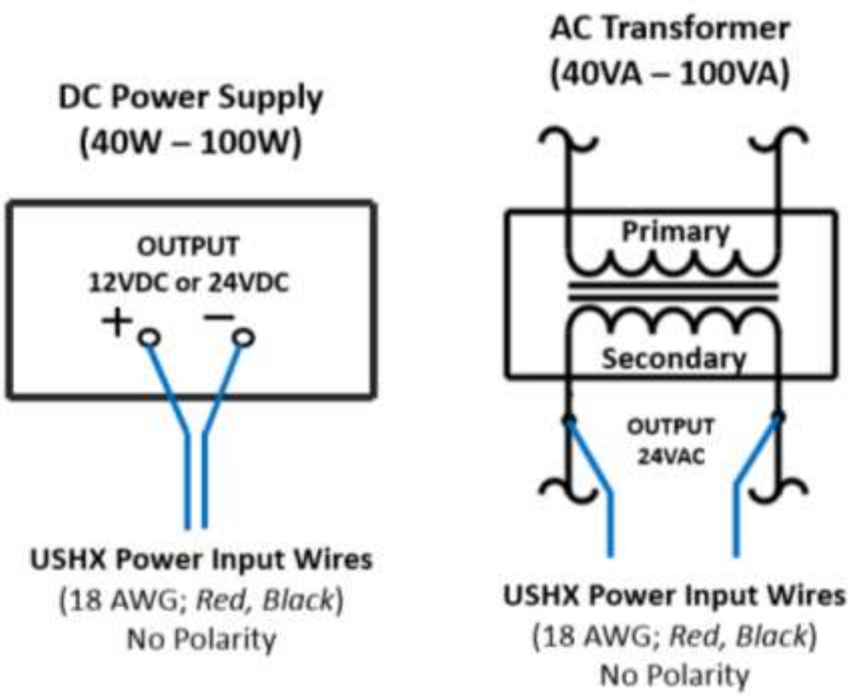


Figure 18 - Class 2 DC and AC power sources

4. Once the power source output voltage has been identified and checked to be accurate, ensure that the power supply is off before continuing with the steps below.
5. The power input wires (18 AWG red/black wires) on the wiring harness should be connected to the power source as shown below in Figure 19.
    a. The USHX power input wires are non-polar, so the wire ordering and colors are not significant for the purposes of this step in the procedure. All connectors used between the USHX, power source, and MSEV should be UL-approved.
    b. The wiring schemes of the ‘Single USHC-MSEV Setup’ and ‘Single USHS Setup’ are the same except that the PWM output wires of the USHS for the ‘Single USHS Setup’ process should be disconnected, terminated with wire nuts, and wrapped with electrical tape so that they do not form short circuits with each other or any other wires or metal surfaces. As for the ‘Single USHC-MSEV Setup’ process, the PWM output wires should be connected to the MSEV as shown below in Figure 19.

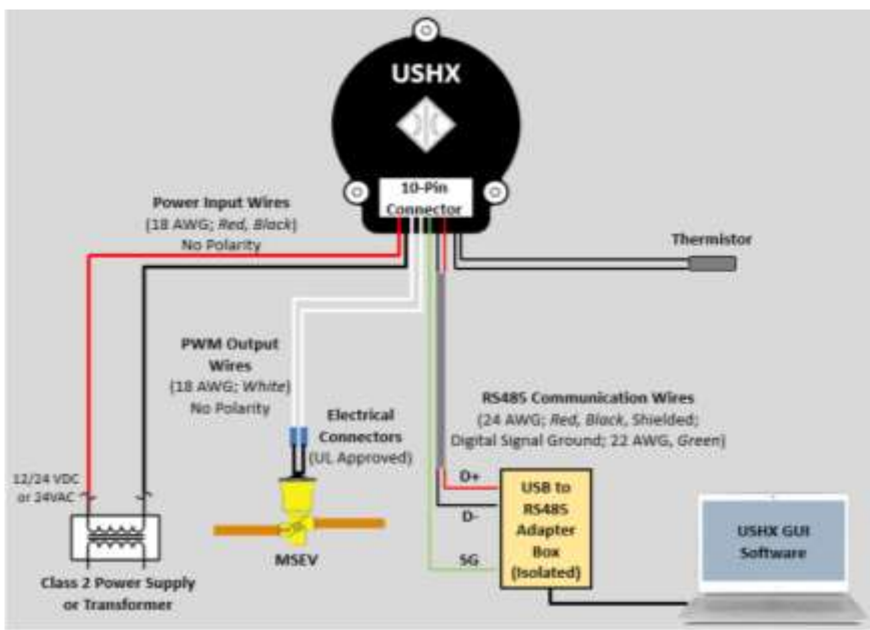


Figure 19 - Single USHC-MSEV or single USHS wiring diagram

6. Connect the RS485 communication wires (2-wire gray cord that contains a red and a black wire and the green data ground wire) to the D+, D-, and SG terminals on the USB-to-RS485 converter as shown below in Figure 20. For the USHX setup, the RS485 will require an adapter with built-in electrical isolation.

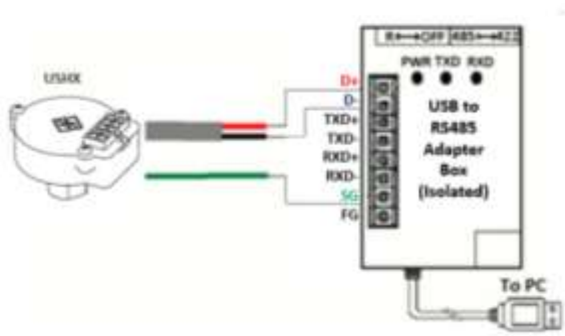


Figure 20 - USHX-to-RS485 converter connection

7. Connect the RS485 adapter box to the computer via a USB port.
8. Connect the PWM output wires (two 18 AWG white wires) to the MSEV electrical connections, shown below in Figure 21. These wires are non-polar.

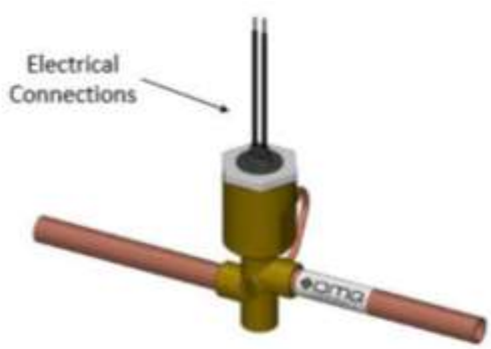


Figure 21 - MSEV electrical connections

9. The general purpose wires (20 AWG brown/purple wires), if they exist on the harness, must remain unconnected, be terminated with wire nuts, and wrapped with electrical tape so that they do not form short circuits with each other or any other wires or metal surfaces.
10. Tape any dangling wires to existing structures such as copper and water lines with at least 4-5 sections of electrical tape each. Use zip ties on top of the electrical tape in a neat and organized manner to further secure the wires.

⚠ WARNING

Ensure that all cables are distanced from fans, high voltage wires (120-208 VAC), and potential areas of water. Ensure that any bare cable leads are covered with electrical tape and do not touch other wire leads or any metal structures.

11. The electrical wiring for a single USHC-MSEV setup or a single USHS setup is now complete.

Troubleshooting

The following section describes troubleshooting procedures for the USHX and MSEV. If the system is running abnormally, first check the wiring for broken or shorted connections. Repair broken wires and remove short circuits between touching wires or between wires and any metal surfaces. If there are no wiring problems, then use the following table to further diagnose the problem (assuming everything else in the system such as the compressor, evaporator, filter drier, etc. is working properly).

Problem	*Possible Cause*	*Action*
High Superheat: *This may indicate that the MSEV is not fully opening. Common symptoms include compressor short cycling.*	**Inadequate Power to the Valve**	Check the power source voltage. The voltage leaving the transformer and entering the USHX should be close to the intended supply voltage (24V or 12V). If the transformer voltage is too low, there is a problem with the transformer or its wiring. If the voltage entering the USHX is low and the transformer voltage is normal, there is a problem with the terminal connections or interconnecting wiring to the USHX.
	Temperature Sensor Incorrectly Mounted	Check the mounting of the USHC temperature sensor. The sensor should be firmly mounted to the outlet of the evaporator at a 10 o'clock or 2 o'clock position. Check that the temperature sensor is wrapped with insulated tape.
	Over Voltage to MSEV	Check the resistance across the valve terminals. Remove both power connections from the MSEV and measure its resistance with a multimeter. The resistance reading should be between 26-34 Ω for a 24 V valve and between 6-13 Ω for a 12 V valve. If the resistance is significantly out of this range (or zero), the MSEV is damaged and should be replaced.
	MSEV Slow to Open	Check that the USHX Gain settings meet the system requirements. (Also applicable if the MSEV opens too quickly.)
		Connect and disconnect the power to the valve several times to manually actuate the valve.
Low Superheat: *This may indicate that the MSEV is staying open. Common symptoms include compressor frosting.*	**MSEV Slow to Close**	Check that the USHX Gain settings meet the system requirements. (Also applicable if the MSEV closes too quickly.)
		Connect and disconnect the power to the valve several times to manually actuate the valve.
	Temperature Sensor Incorrectly Mounted	Check the mounting of the USHC temperature sensor. The sensor should be firmly mounted to the outlet of the evaporator at a 10 o'clock or 2 o'clock position. Check that the temperature sensor is wrapped with insulated tape.
	Severely Oversized Valve	Determine the capacity of the evaporator and check the valve model number to confirm that the two are compatible regarding their capacities.

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