



Factory Packaged Controls

OE377-26-00059 (AAON Part No. V12100) MHGRV-X Controller Field Technical Guide

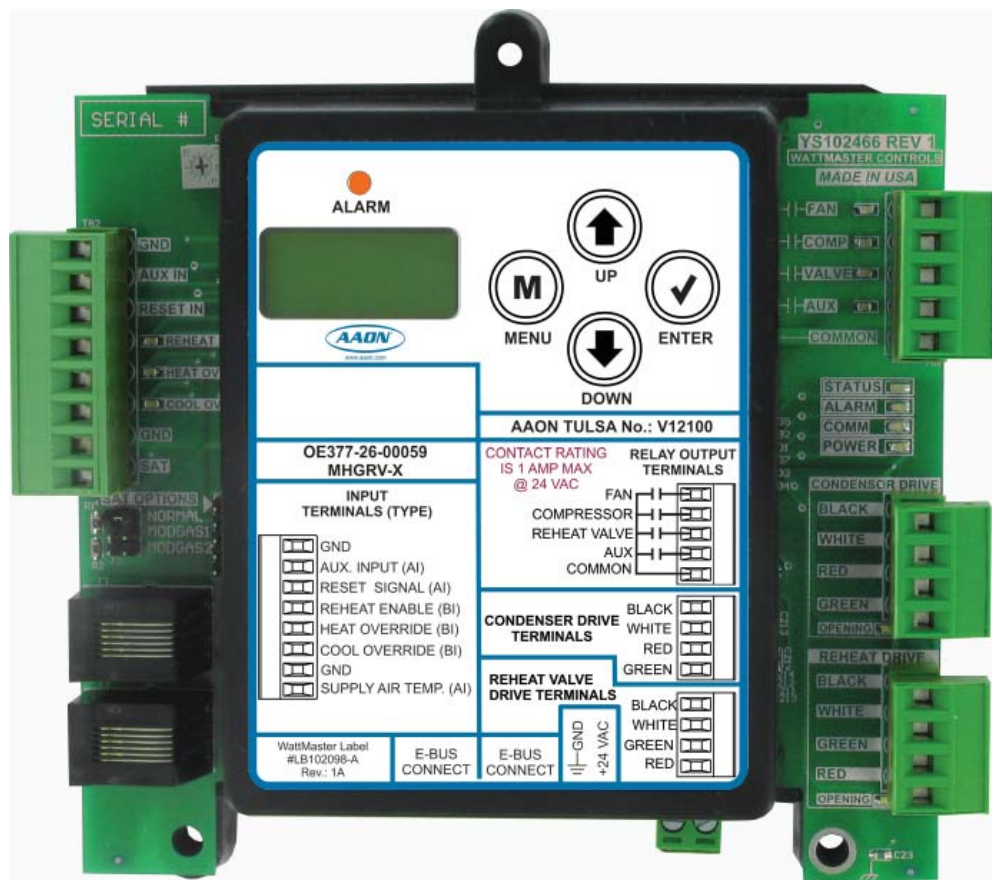


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PART NUMBER CROSS REFERENCE TABLE		
PART DESCRIPTION	ORION	AAON TULSA
MHGRV-X Controller	OE377-26-00059	V12100
MODGAS-X Controller	OE377-26-00058	V12090
VCB-X Controller	OE335-23-VCBX	V04740
Supply Air Temperature Sensor	OE231	P87140
EBC E-BUS Cables - varying lengths	EBC-XXXF	N/A



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
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General

The OE377-26-00059 MHGRV-X Controller (AAON Part No. V12100) is designed to control a Modulating Hot Gas Reheat Valve to maintain a desired Supply Air Temperature and Dehumidification setpoint. The controller can be used as a stand-alone controller or it can be connected to and used in conjunction with the VCB-X Controller (Orion Part No. OE335-23-VCBX; AAON Part No. V04740). The MHGRV-X controller is connected to the VCB-X Controller via a modular expansion cable and corresponding connectors on the controllers.

Features

The MHGRV-X provides the following:

- Contains a 2x8 LCD character display and 4 buttons that allow for status display, setpoint changes, and configuration changes
- Can be operated as a stand-alone controller or integrated with the VCB-X Controller
- Provides for Supply Air Temperature Setpoint reset when required
- Second stage reheat capability when using 2 Hot Gas Reheat Valves
- Control of reheat solenoid valve to provide coil flushing for positive refrigerant oil return

**MHGRV-X CONTROLLER
(OE377-26-00059)**

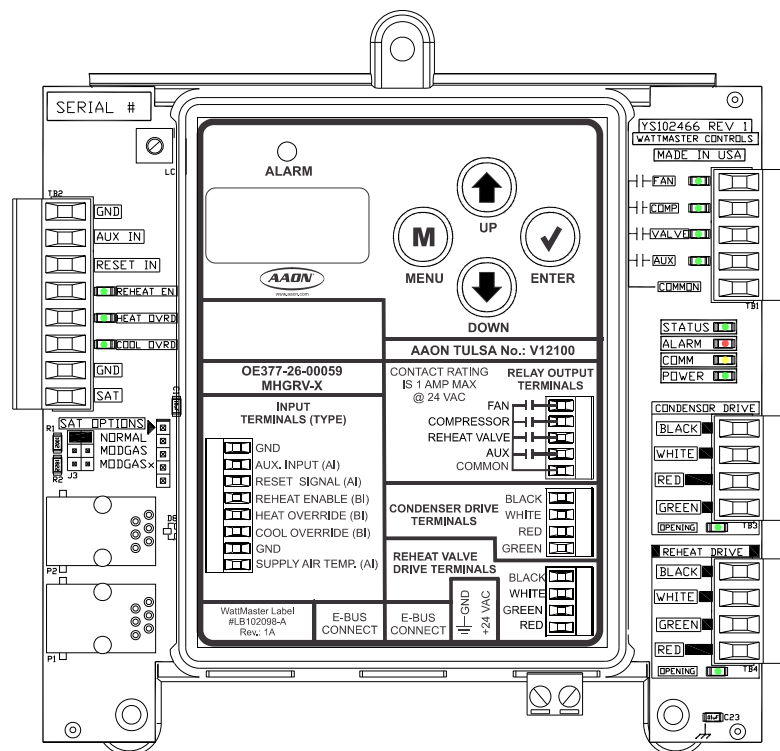


Figure 1: OE377-26-00059 MHGRV-X Controller

Supply Air Temperature Sensor Installation

Mounting the Supply Air Temperature Sensor

The supply air temperature sensor should be located in the ductwork downstream of the unit supply air connection. Locate the sensor in the center of the widest part of the duct. Use the supplied template and a 5/16" drill to make a hole for the sensor. Install the gasket over the probe and mount securely to the duct using the supplied sheet metal screws. Be sure the gasket is compressed to provide an air tight seal. For best accuracy, apply insulation on the outside of the duct, over the sensor. This will help prevent thermal gradients from affecting the sensor.

WARNING: Make sure your Supply Air Temperature Sensor is mounted and wired according to these instructions prior to testing the unit or else the modulating valve will not control properly and may damage your equipment.

Stand-Alone Mode

If using the SAT Sensor in Stand-Alone Mode, the Sensor is connected to the MHGRV-X Controller. If the MHGRV-X is used in conjunction with a MODGAS Controller, the SAT Sensor is shared between the two controllers. See **Table 1** for SAT Options Jumper Settings and see **Figure 4** for wiring.

Communication Mode

If using the SAT Sensor in Communication Mode, the Sensor is connected to the Main Controller. See **Figure 3** for wiring.

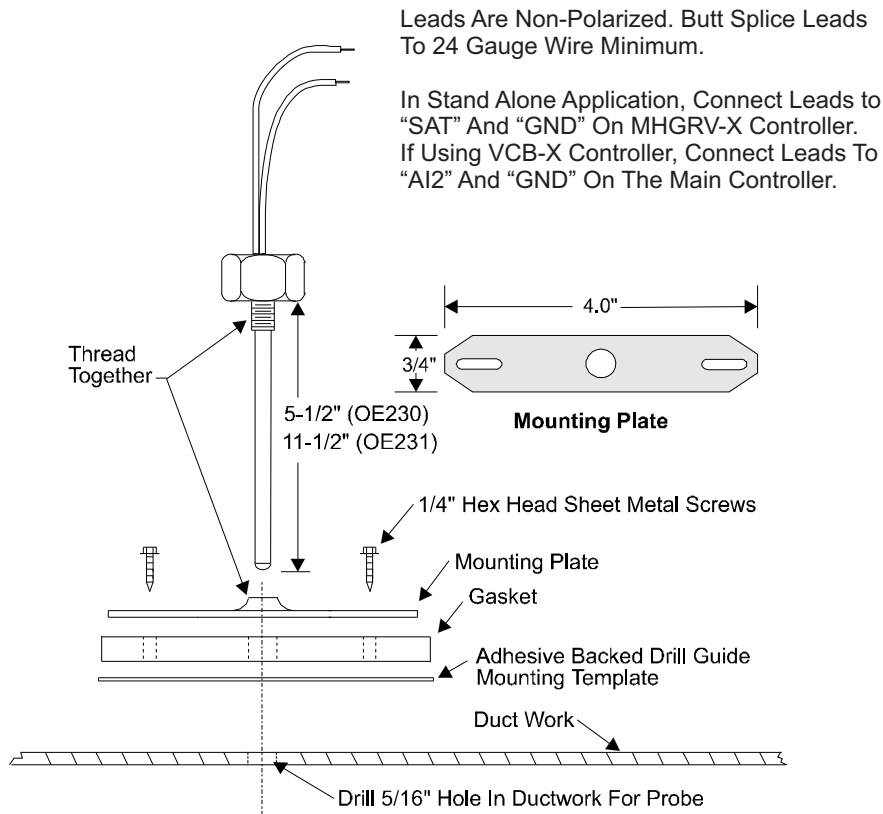


Figure 2: Supply Air Temperature Sensor Installation

SAT Options Jumper Settings

The SAT OPTIONS jumper settings are only used in Stand-Alone Mode. Refer to **Table 1** to determine the settings.

STAND-ALONE MODE SAT OPTIONS JUMPER SETTINGS*	
CONDITION	SETTING
MHGRV-X Only	Normal
MHGRV-X with MODGAS-X**	MODGAS-X
MHGRV-X with MODGAS	MODGAS
* For SAT Sensor testing, use Table 6 for Normal & MODGAS-X jumper setting and use Table 7 for MODGAS jumper setting.	
** In this situation, also set MODGAS-X SAT Option to Jumper Setting 2. See the <i>MODGAS-X Technical Guide</i> for more information.	

Table 1: SAT OPTIONS Jumper Settings

General Wiring Information

Please carefully read and apply the following information when wiring the MHGRV-X controller.

1. All 24 VAC wiring must be connected so that all ground wires remain common. Failure to follow this procedure can result in damage to the controller and connected devices.
2. All wiring is to be in accordance with local and national electrical codes and specifications.
3. Minimum wire size for 24 VAC wiring should be 18 gauge.
4. Minimum wire size for all sensors should be 24 gauge.
5. 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.

Important Wiring Considerations

Depending on if the MHGRV-X controller is to be connected to the HVAC controller or is to be used as a stand-alone controller determines how the MHGRV-X should be wired. For the wiring diagram to use when the MHGRV-X controller is connected to a VCB-X Controller, see **Figure 3**. For the stand-alone wiring diagram, see **Figure 4**. Please carefully read and apply the following information when wiring the MHGRV-X controller.

Supply Air Temperature Sensor Wiring Considerations

If using the MHGRV-X Controller as Stand-Alone, connect the Supply Air Temperature Sensor to the SAT Analog Input. In Stand-Alone Mode, if using a MODGAS or MODGAS-X Controller with an attached Supply Air Temperature Sensor, set the SAT jumper appropriately for MODGAS or MODGAS-X. See **Figure 4** for more information.

If using the MHGRV-X connected to a VCB-X Controller, the Supply Air Temperature Sensor should be connected to the Analog input on the VCB-X Controller. In either case—stand-alone or other—the SAT jumper should be set to Normal.

MHGRV-X to VCB-X Controller Wiring

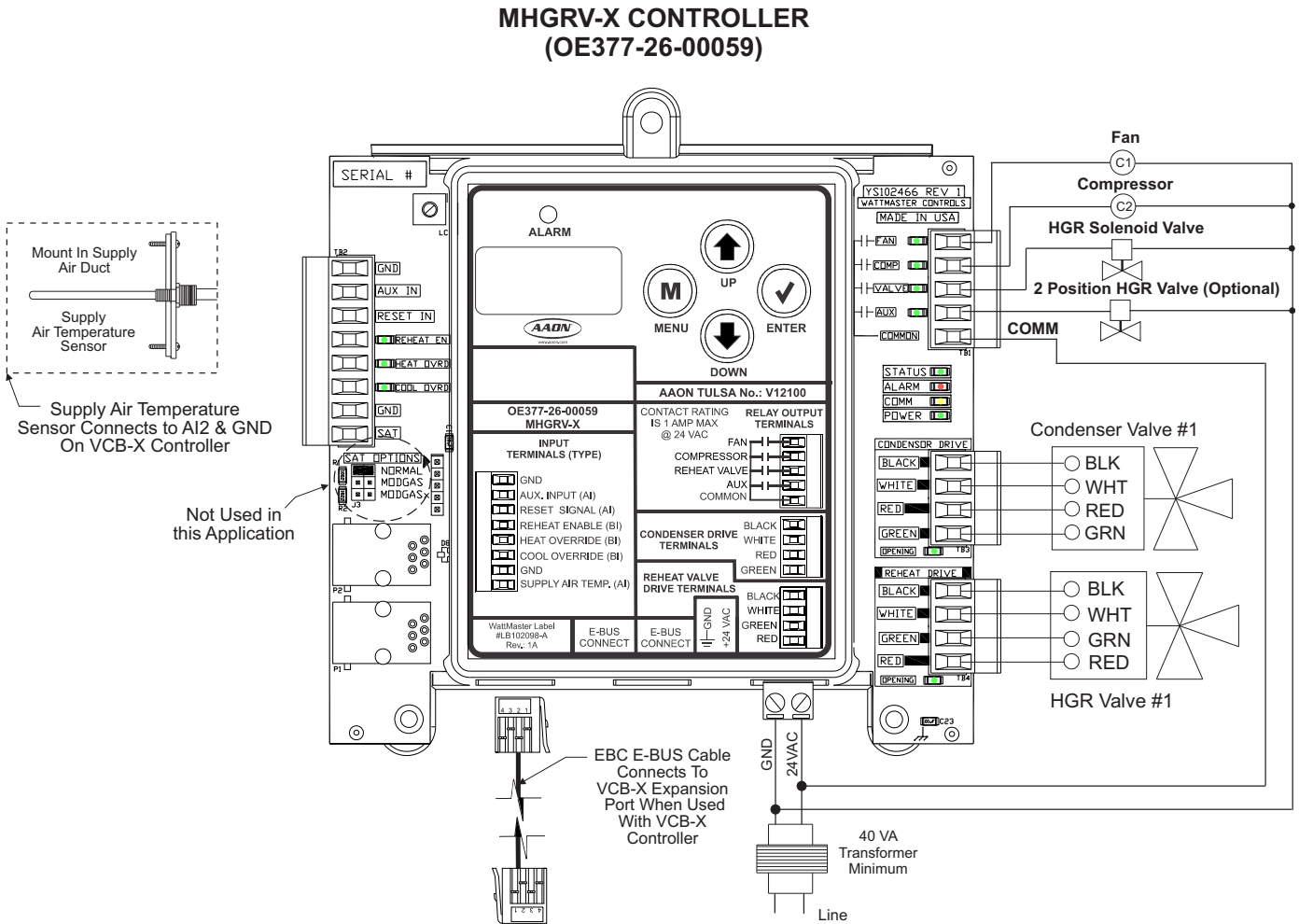


Figure 3: MHGRV-X Controller to VCB-X Controller (V04740) Wiring

MHGRV-X Stand-Alone Wiring

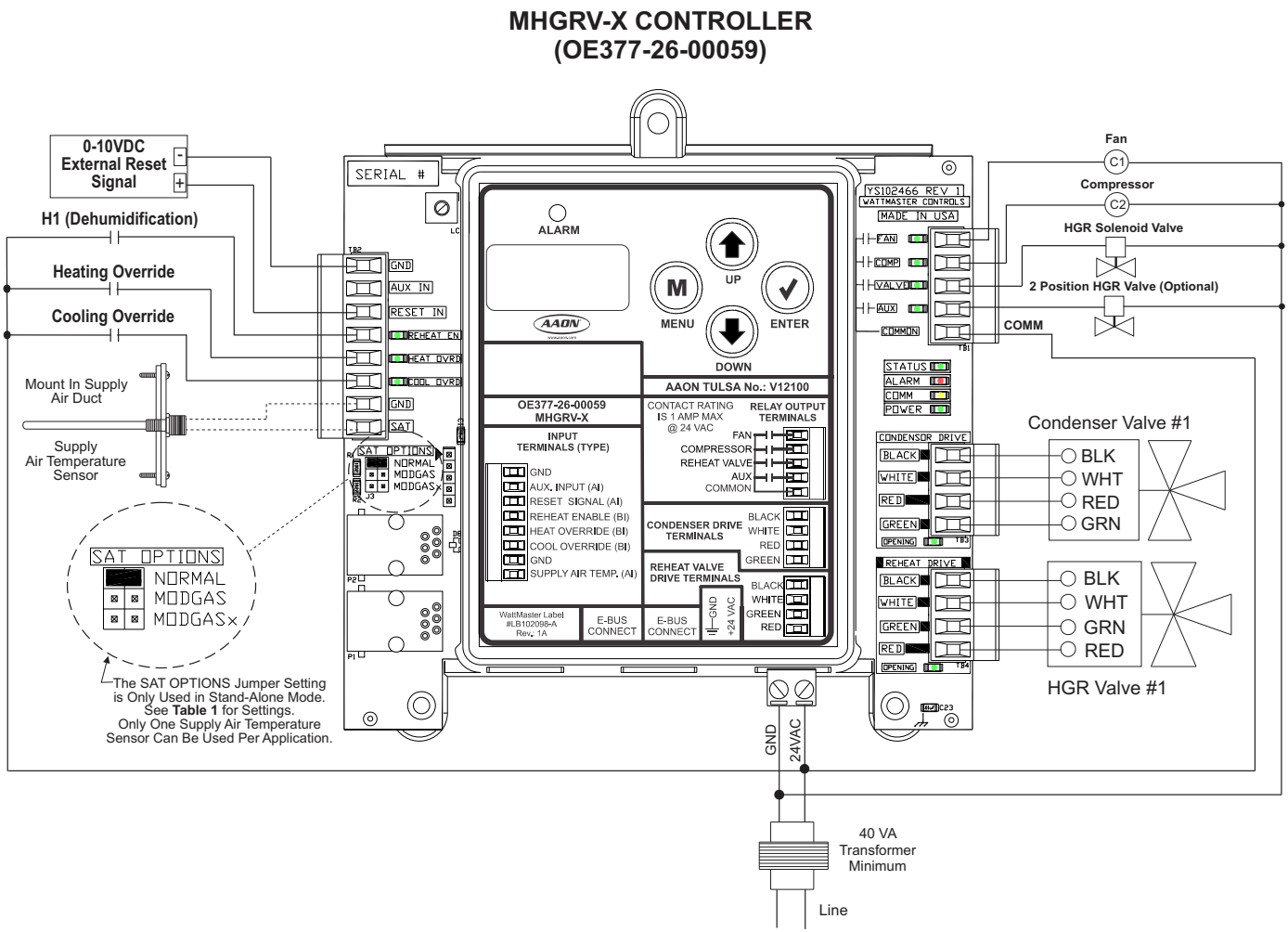


Figure 4: MHGRV-X Controller Stand-Alone Wiring

Inputs and Outputs

I/O Map

The following inputs and outputs are available on the MHGRV-X Controller. See **Table 2** below to reference the Input/Output Map.

Analog Inputs	
1	Supply Temperature
2	Reset Signal
3	AUX Input - Future Application
Binary Inputs	
1	Reheat Enable
2	Heating Override
3	Cooling Override
Relays	
1	Fan
2	Compressor
3	Reheat Valve

Table 2: MHGRV-X Controller Inputs & Outputs

NOTE: All analog and 24 VAC contact closure inputs are used only in Stand Alone operation.

Analog Inputs

SAT: Supply Air Temperature Sensor

Used only in stand-alone operation. The Supply Air Temperature Sensor is the main control input. This sensor has to be installed for the unit to operate. The Supply Air Temperature Sensor is located in the discharge air stream and monitors the HVAC unit's Supply Air Temperature to maintain the Supply Air Temperature Setpoint.

RST IN: Reset Signal

Used only in stand-alone operation. The Discharge Temperature Setpoint can be reset by supplying a 0-10 VDC signal to the RESET IN low voltage terminal block. This reset signal is optional and need only be used if you require resetting of the discharge air temperature.

Binary Inputs

REHEAT EN: Reheat Enable Contact

Used only in stand-alone operation. When a call for dehumidification is initiated by another controller, this interlocked 24 VAC wet contact closure is used to enable the MHGRV-X controller.

HEAT OVR: Heating Override

Used only in stand-alone operation. When a call for heating is initiated by the HVAC unit, this interlocked 24 VAC wet contact closure is used to override the MHGRV-X controller dehumidification mode.

COOL OVR: Cooling Override

Used only in stand-alone operation. When a call for cooling is initiated by the HVAC unit, this interlocked 24 VAC wet contact closure is used to override the MHGRV-X controller dehumidification mode.

Relay Outputs

FAN: Fan Enable

When a call for Dehumidification, Cooling Override, or Heating Override is received, this relay output will be closed to energize the HVAC unit Supply Fan.

CMP: Compressor Enable

When a call for Dehumidification or Cooling Override is received, this relay output will be closed to energize the Compressor(s).

VALVE: Reheat Solenoid Valve

When a call for Dehumidification is active for 30 seconds, this relay output will be closed to energize the Hot Gas Solenoid Valve.

AUX: 2 Position HGR Valve

Used on larger capacity systems that have an optional 2 Position HGR Valve in addition to the Modulating HGR Valve. When a call for Dehumidification is received and the modulating HGR valve is at 100%, this relay output will be closed to energize the 2 Position HGR Valve. The relay will open when the modulating HGR valve is at 0%. The modulating valve is then able to modulate as needed to maintain the Heating Supply Air Setpoint. If the modulating valve falls below 30%, the Auxiliary Heat Relay will disable.

COM: Relay Common

Requires 24 VAC from transformer.

Initialization

The MHGRV-X Controller uses on-board LEDs to indicate various diagnostic conditions during power-up and operation. It also uses the LCD Display to show initialization. Please review this information for a complete description of the controller initialization sequence.

Modulating Hot Gas Valves

The MHGRV-X Controller utilizes two modulating valves to control the flow of Hot Gas through the Hot Gas Reheat Coil. One of these valves is the Condenser Hot Gas Valve and the other is the Reheat Hot Gas Valve. The valves are wired to the MHGRV-X Controller Modulating Hot Gas Valve Output terminals on the controller. These valves work in concert with each other to create a “three-way valve” configuration. As one closes, the other opens, etc. All modes of operation that follow referring to the Hot Gas Reheat Valve are actually a combination of these two valves working together to achieve the specified sequence of operation.

Modes of Operation

The MHGRV-X Controller can be used in two different modes of operation. These modes behave in a similar manner; the main difference is the way they receive information to control the dehumidification process. The following is a description of these modes:

Stand-Alone Operation

As the name implies, in this mode the controller behaves as an independent unit. The controller begins the dehumidification process when the Dehumidification Input “HI” receives a 24 VAC signal from an outside source. When the signal is received, the controller will activate the “FAN” output to energize the HVAC unit fan. At the same time, the controller will initiate Cooling Mode by energizing the “CMP” output starting the HVAC unit compressor. In addition, the controller will open the Hot Gas Reheat Coil by activating the “VALVE” output. At this time, the MHGRV-X Controller will start to modulate the Modulating Hot Gas Reheat valve. The controller will modulate the MHGR valve to maintain the Supply Air Temperature Setpoint by activating the stepper motor outputs on the MHGR valve. The Supply Air Setpoint is configured with the Setpoint Screen in the LCD Display. If Supply Air Temperature Reset is used, it will initiate when a 0-10 VDC signal is supplied to the “RESET IN” input. As the voltage increases from 0 to 10 Volts at the “RESET IN” input, the Supply Air Temperature will be reset towards the Supply Air Reset Temperature Setpoint. This setpoint is configured with the Setpoint Screen in the LCD Display. When a 10 Volt input signal is received at the “RESET IN” input, it will be controlling at the Supply Air Temperature Reset Setpoint. The controller will conclude the Dehumidification process when input “HI” is deactivated, the input “Cool Override” is activated, or the input “Heat Override” is activated.

Operation in Communicating Mode

In this mode, the MHGRV-X Controller behaves as an expansion board for a VCB-X controller. The controller begins the dehumidification process when the HVAC Unit controller makes a request to the MHGRV-X Controller for dehumidification. At that time, the controller will activate the “FAN” output to energize the HVAC unit fan. At the same time, the controller will initiate Cooling Mode by energizing the “CMP” output starting the HVAC unit compressor. In addition, the controller will open the Hot Gas Reheat Coil by activating the “VALVE” output which opens the Reheat Solenoid Valve. At this time, the MHGRV-X Controller will start to modulate the Modulating Hot Gas Reheat valve. The controller will modulate the MHGR valve to maintain the Supply Air Temperature Setpoint by activating the stepper motor outputs on the MHGR valve. The Supply Air Setpoint is set by programming the HVAC unit controller. If Supply Air Temperature Reset is used, it will initiate when the HVAC sends a request to reset the Supply Air Temperature. The Supply Air Temperature will be reset towards the Supply Air Reset Temperature Setpoint stored in the HVAC controller. It will send a request to move towards the Supply Air Temperature Reset Setpoint based on its setpoints and configuration. The controller will conclude the Dehumidification process when the HVAC control sends a request to terminate Dehumidification or a Cooling or Heating Override request is made by the HVAC unit controller. Any setpoints or signals at the inputs to the MHGRV-X Controller will be ignored.

Additional Features

The following are features which are also designed into the MHGRV-X Controller:

Reheat Coil Flush

To assure positive oil return to the compressor, the Hot Gas Reheat Coil will be flushed of liquid refrigerant by moving the Modulating Gas Reheat Valve to its maximum position for a short interval. If the unit is in cooling mode, a flush will occur every hour. If the unit is in dehumidification mode and the valve is below 70% for 30 minutes, a flush will occur.

Optional Second Stage Reheat

On larger systems, where more hot gas reheat capacity may be required, a 2 Position Hot Gas Reheat valve can be connected to the MHGRV-X Controller to be used in conjunction with the Modulating Hot Gas Reheat valve. Any time the reheat demand moves above the Modulating Hot Gas Reheat valve capacity, this 2 position valve would be energized to supply additional hot gas to the Hot Gas Reheat coil. As the reheat demand is satisfied, the MHGRV-X Controller will de-energize the 2 position valve and control reheat with the Modulating Hot Gas Reheat valve.

Reheat Solenoid Valve Control

The Hot Gas Reheat Solenoid valve for the Reheat Coil is activated when there is a call for Dehumidification. In this mode, the Hot Gas Reheat Solenoid will be deactivated 2 minutes after the reheat demand ceases. The Hot Gas Reheat Solenoid valve will be reactivated when a request for reheat is received by the MHGRV-X Controller.

Navigation Keys

LCD Display Screen & Navigation Keys

The MHGRV-X Controller allows you to make configuration changes, view status, change setpoints, create force modes, and perform diagnostics using the keypad next to the LCD display. See **Figure 5** and refer to **Table 3** for descriptions.

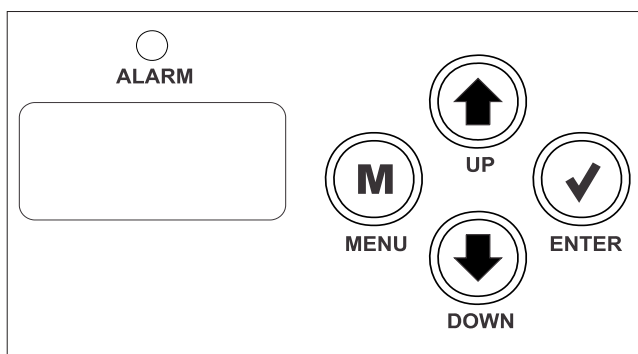


Figure 5: LCD Display and Navigation Keys





Navigation Key	Key Function
MENU 	Use the MENU key to navigate through the Main Menu Screens
UP 	Use this key to adjust setpoints and change configurations. This key is also used to turn Valve Force Mode on.
DOWN 	Use this key to adjust setpoints and change configurations. This key is also used to turn Valve Force Mode off.
ENTER 	Use the Enter key to move through screens within Main Menu categories. Also, use this key to save setpoints and configuration changes.

Table 3: Navigation Key Functions

Main Screens and Map Main MHG REHEAT Screens

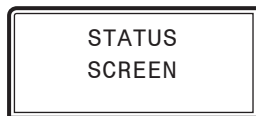
Main Screens Map

Refer to the following map when navigating through the LCD Main Screens. The first screen is an initialization screens. To scroll through the rest of the screens, press the <MENU> button.



Press to scroll through MHG REHEAT Screens.

Press to go to STATUS Screens.



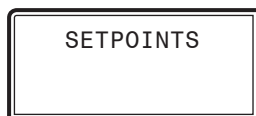
Press to scroll through STATUS Screens.

Press to go to ALARMS Screens.



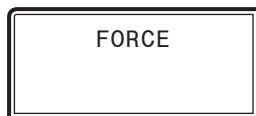
Press to scroll through ALARMS Screens.

Press to go to SETPOINTS Screens.



Press to scroll through SETPOINTS Screens.

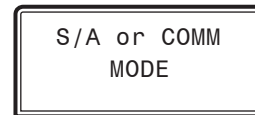
Press to go to FORCE Screens.



Press to scroll through FORCE Screens.

Main MHG REHEAT Screens

Refer to the following map when navigating through the Main Screens. From the MHG REHEAT Screen, press <ENTER> to scroll through the screens.



In Stand-Alone Mode, the screen will only display S/A MODE.

In Communications Mode, the screen will display COMM MODE and the items below will scroll through the screen:

1. Number of good packets being received. This will roll over after 9999. Example: +XXXX
2. Number of checksum errors. This will stop at 9999. Example: C-XXXX
3. Number of packet length errors. This will stop at 9999 until power is cycled. Example: P-XXXX



CURRENT SOFTWARE VERSION



CURRENT BOARD ADDRESS



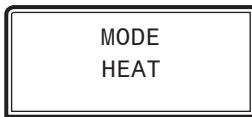
Status & Alarm Screens

Status Screens

Refer to the following map when navigating through the Status Screens. From the STATUS Screen, press <ENTER> to scroll through the screens.



Status Screens shown below will scroll automatically if LCD display is left on this screen for 20 seconds.



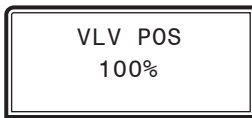
MODE

This screen displays the current mode of operation of the MHGRV-X Controller. The mode options are:

OFF: This mode will display if the unit is not in Dehumidification Mode and there is no call for Modulating Hot Gas Reheat (MHGR).

REHEAT: During Dehumidification, the unit will enter the Reheat Mode and will begin to modulate the MHGR Valve to maintain the Supply Air Temperature Setpoint. The unit will leave the Reheat Mode when the unit leaves the Dehumidification Mode.

FLUSH: If the unit is in the Dehumidification Mode and the MHGR Valve has remained below 70% for 30 minutes, the unit will enter the Flush Mode. The unit will leave the Flush Mode once a short flush operation is completed.



VALVE POSITION

0 to 100 percent

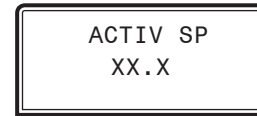


SUPPLY AIR TEMPERATURE

40°F to 150°F or 5°C to 65°C.

If no sensor is detected, screen will display "NO SENSR"

The SAT is set by the LCD Display in stand-alone mode and is set by the Main Controller in communicating mode.



ACTIVE SUPPLY AIR SETPOINT

Calculated from SAT setpoint and reset signal in stand-alone mode. In communicating mode, the Main Controller sends the setpoint.



Alarm Screens

Refer to the following map when viewing Alarm Screens. These screens will display automatically when alarms are present. For more information, see [page 14](#).



ALARMS

The alarms are as follows:

NO ALARMS: This will be shown if there are no current alarms.

SAT FAIL ERROR: The Supply Air Temperature sensor has been disconnected for more than 60 seconds. This alarm will be disabled when the sensor is reconnected.

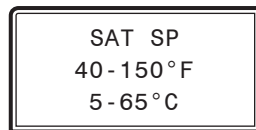
COMM T/O ERROR: Communications have been lost with the main controller. This alarm will disable when communications resume.

Setpoint & Force Screens

Setpoint Screens

Refer to the following map when navigating through the Setpoint Screens. From the SETPOINTS Screen, press <ENTER> to scroll through the screens and change setpoints. Use the <UP> and <DOWN> arrow keys to change your selections. Then press <ENTER> to save the new setpoint.

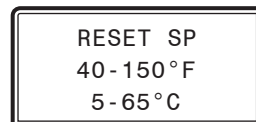
WARNING: When the MHGRV-X is operating in Communications Mode, these setpoints screens will not appear on the LCD display because they are controlled by the Main Controller.



REHEAT SUPPLY AIR TEMPERATURE SETPOINT

This is the target temperature while reheat is enabled. If you are using the reset signal, this is the setpoint it will calculate to at zero volts. Will display only in stand-alone mode.

Minimum	Default	Maximum
40°F	70°F	150°F
5°C	21°C	65°C



RESET REHEAT SUPPLY AIR SETPOINT

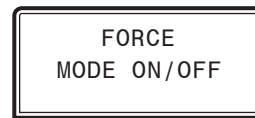
This is maximum temperature at which the Supply Air Temperature will reset to. Will display only in stand-alone mode.

Minimum	Default	Maximum
40°F	70°F	150°F
5°C	21°C	65°C

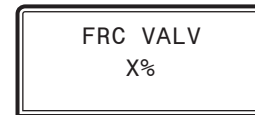


Force Screens

Refer to the following map when navigating through the Force Screens. From the FORCE Screen, press <ENTER>. At the FORCE MODE ON/OFF screen, press the <UP> arrow key to turn the FORCE MODE on and press the <DOWN> arrow key to turn the FORCE MODE off. Use the <UP> and <DOWN> arrow keys to increase and decrease the percentage.



Press the <UP> button to turn the Force Mode on. Press the <DOWN> button to turn the Force Mode off.



FORCE VALVE PERCENTAGE

This screen only appears when Force Mode is on.

Press the <UP> button to increase the percentage. Press the <DOWN> button to decrease the percentage.

NOTE: When you turn the Force Mode back off or after 1 hour has elapsed, the valve will reinitialize to zero.



FORCE MODE TIME OUT

This screen will appear when the Force Mode times out after 1 hour.

Troubleshooting

LED Diagnostics

The MHGRV-X Controller is equipped with LEDs that can be used to verify operation and perform troubleshooting. There are LEDs for communication, operation modes, and diagnostic codes. The module has 14 LEDs—12 used for operation & status, and 2 used for alarms.

See **Figure 6** for the LED locations. The LEDs associated with these inputs and outputs allow you to see what is active without using a voltmeter. The LEDs and their uses are as follows:

Operation LEDs

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

STATUS - This green LED will light up and blink the board address at startup. It will then blink according to what mode the controller is in. See **Table 4**. Only the highest priority failure code will be shown. You must correct the highest priority alarm before other problems will be indicated.

No. of Blinks	STATUS LED
1	Off Mode
2	Reheat Mode
3	Flush Mode
4	Force Mode
5	SAT Sensor Failure Mode

Table 4: STATUS LED Blink Codes

Diagnostic LEDs

ALARM - This red LED will light up to indicate an alarm. The type of alarm will display on the LCD display. The ALARM LED also blinks when the expansion valve is initializing at startup.

No. of Blinks	ALARM LED
1	Supply Air Temperature Sensor Failure
2	Communications Time Out Error

Table 5: ALARM LED Blink Codes

Communication LED

COMM - This yellow LED will light up and blink when communications are detected.

Relay LEDs

FAN - This green LED will light up to indicate that the relay for the “FAN” output is energized and its Normally Open Contact is closed.

COMP - This green LED will light up to indicate that the relay for the “COMP” output is energized and its Normally Open Contact is closed.

VALVE - This green LED will light up to indicate that the relay for the “VALVE” output is energized and its Normally Open Contact is closed.

AUX - This green LED will light up to indicate that the relay for the “AUX” output is energized and its Normally Open Contact is closed.

Binary Input LEDs

REHEAT ENABLE - This green LED will light up when the Reheat is enabled.

HEAT OVERRIDE - This green LED will light up when Heat Override is enabled.

COOL OVERRIDE - This green LED will light up when Cool Override is enabled.

Analog Output LEDs

CONDENSER VALVE DRIVE - This LED is on any time the condenser valve is moving.

REHEAT VALVE DRIVE - This LED is on any time the modulating hot gas reheat valve is moving.

LED Troubleshooting

“POWER” LED: When the MHGRV-X 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 the power wiring is connected to the board, the connections are tight, and the transformer is powered. If after making all these checks, the POWER LED does not light up, the board is probably defective.

“STAT” LED: As previously described, when the board is first powered up, the STAT LED will do the following:

- On for 10 seconds
- Blinks 30 times
- Blinks 3 times rapidly (after STEP LED is on for 45 seconds)
- Status code is repeatedly blinked every ten seconds to indicate controller status

Alarm Troubleshooting

Supply Air Temperature Failure:

- Verify that the Supply Air Temperature Sensor is connected to the SAT and GND on the MHGRV-X (stand-alone mode) or to AI2 and GND on the Main Controller (communicating mode).
- Remove SAT and GND wiring from MHGRV-X and ohm sensor out (this may indicate open or failed wiring). Refer to chart in back of this guide for readings.
- Verify the SAT OPTIONS jumper settings on the MHGRV-X for the Supply Air Temperature Sensor.

Communications Loss:

- Check COMM LED on MHGRV-X.
- Verify 24 VAC power to all interconnected WattMaster controllers.
- Verify E-BUS connection between the MHGRV-X and associated WattMaster controllers.
- In communication mode (connected to a VCB-X Controller with modular cable), confirm that VCB-X Controller’s MHGRV-X status screen displays MHGRV-X’s Position % and that Main MHG Reheat screens show COMM MODE.

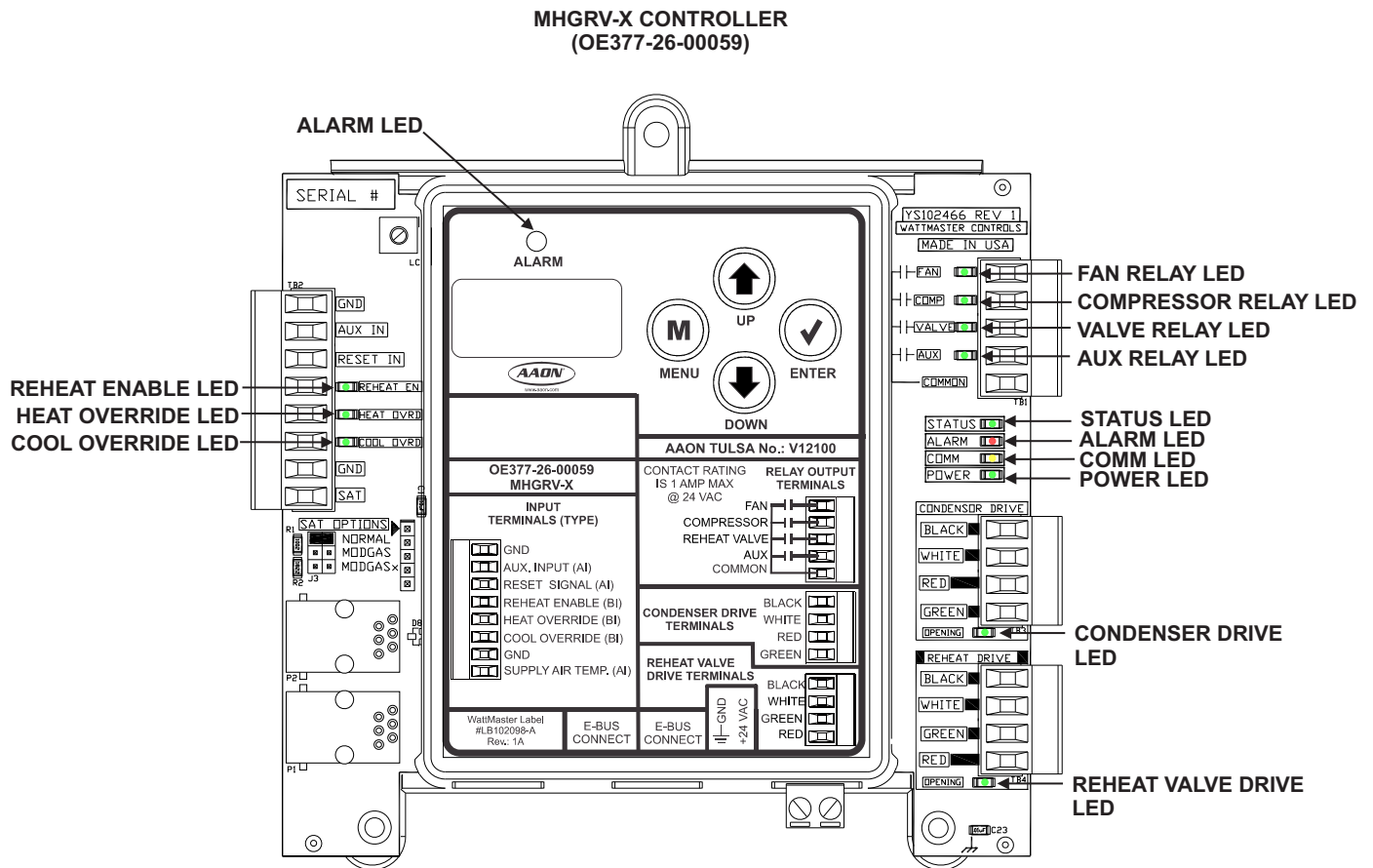


Figure 6: MHGRV-X Controller LED Locations and Descriptions

Troubleshooting

Other Checks

0-3V (SAT OPTIONS Jumper Settings Normal and MODGAS-X) & 0-5V (SAT OPTIONS Jumper Setting MODGAS) Supply Air Temperature Sensor

If you suspect the Supply Air Temperature Sensor is not reading correctly, make sure the wiring terminal connections are tight and that any wiring splices are properly connected. You can check the operation of the Supply Air Temperature Sensor by measuring the resistance or voltage using a digital multimeter. Set the meter to DC Volts. Place the positive probe on the AIN terminal and the negative probe on the GND terminal. Read the DC Volts and find that voltage in **Tables 6 & 7**

Read the temperature corresponding with that voltage and determine if this is close to the actual temperature the sensor is exposed to. If the temperature from the chart is different by more than a few degrees, you probably have a defective or damaged sensor. You can also check the sensor resistance to determine correct operation. To read the resistance, set the meter to Ohms. Unplug the sensor connector from the board and measure the resistance across the disconnected wires. This resistance should match the corresponding temperature from **Tables 6 & 7**.

Temperature to Resistance/Voltage Chart			
Temp (°F)	Temp (°C)	Resistance (Ohms)	Voltage @ Input (VDC)
-10	-23.3	93333	2.98
-5	-20.6	80531	2.94
0	-17.8	69822	2.89
5	-15.0	60552	2.83
10	-12.2	52500	2.77
15	-9.4	45902	2.71
20	-6.7	40147	2.64
25	-3.9	35165	2.57
30	-1.1	30805	2.49
35	1.6	27140	2.41
40	4.4	23874	2.33
45	7.2	21094	2.24
50	10.0	18655	2.15
52	11.1	17799	2.11
54	12.2	16956	2.08
56	13.3	16164	2.04
58	14.4	15385	2.00
60	15.6	14681	1.96
62	16.7	14014	1.93
64	17.8	13382	1.89

Table 6: 0-3V Temperature Sensor - Voltage & Resistance for Type III Sensors

Temperature to Resistance/Voltage Chart			
Temp (°F)	Temp (°C)	Resistance (Ohms)	Voltage @ Input (VDC)
66	18.9	12758	1.85
68	20.0	12191	1.81
69	20.6	11906	1.79
70	21.1	11652	1.78
71	21.7	11379	1.76
72	22.2	11136	1.74
73	22.7	10878	1.72
74	23.3	10625	1.70
75	23.9	10398	1.68
76	24.4	10158	1.66
78	25.6	9711	1.63
80	27.8	9302	1.59
82	27.8	8893	1.55
84	28.9	8514	1.52
86	30.0	8153	1.48
88	31.1	7805	1.45
90	32.2	7472	1.41
95	35.0	6716	1.33
100	37.8	6047	1.24
105	40.6	5453	1.16
110	43.3	4923	1.09
115	46.1	4449	1.02
120	48.9	4030	.95
125	51.7	3656	.88
130	54.4	3317	.82
135	57.2	3015	.76
140	60.0	2743	.71

Table 6, continued: 0-3V Temperature Sensor - Voltage & Resistance for Type III Sensors

Thermistor Sensor Testing Instructions

- 1.) Use the resistance column to check the thermistor sensor while disconnected from the controllers (not powered).
- 2.) 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 3.3 VDC, the sensor or wiring is “open.” If the voltage is less than 0.05 VDC, the sensor or wiring is shorted.

Temperature to Resistance/Voltage Chart			
Temp (°F)	Temp (°C)	Resistance (Ohms)	Voltage @ Input (VDC)
-10	-23.3	93333	4.620
-5	-20.6	80531	4.550
0	-17.8	69822	4.474
5	-15.0	60552	4.390
10	-12.2	52500	4.297
15	-9.4	45902	4.200
20	-6.7	40147	4.095
25	-3.9	35165	3.982
30	-1.1	30805	3.862
35	1.6	27140	3.737
40	4.4	23874	3.605
45	7.2	21094	3.470
50	10.0	18655	3.330
52	11.1	17799	3.275
54	12.2	16956	3.217
56	13.3	16164	3.160
58	14.4	15385	3.100
60	15.6	14681	3.042
62	16.7	14014	2.985
64	17.8	13382	2.927
66	18.9	12758	2.867
68	20.0	12191	2.810
69	20.6	11906	2.780
70	21.1	11652	2.752
71	21.7	11379	2.722
72	22.2	11136	2.695
73	22.7	10878	2.665
74	23.3	10625	2.635
75	23.9	10398	2.607
76	24.4	10158	2.577
78	25.6	9711	2.520
80	27.8	9302	2.465
82	27.8	8893	2.407
84	28.9	8514	2.352
86	30.0	8153	2.297
88	31.1	7805	2.242
90	32.2	7472	2.187
95	35.0	6716	2.055

Table 7: 0-5V Temperature Sensor - Voltage & Resistance for Type III Sensors

Temperature to Resistance/Voltage Chart			
Temp (°F)	Temp (°C)	Resistance (Ohms)	Voltage @ Input (VDC)
100	37.8	6047	1.927
105	40.6	5453	1.805
110	43.3	4923	1.687
115	46.1	4449	1.575
120	48.9	4030	1.469
125	51.7	3656	1.369
130	54.4	3317	1.274
135	57.2	3015	1.185
140	60.0	2743	1.101
145	62.8	2502	1.024
150	65.6	2288	0.952

Table 7, cont.: 0-5V Temperature Sensor - Voltage & Resistance for Type III Sensors

Thermistor Sensor Testing Instructions

- 1.) Use the resistance column to check the thermistor sensor while disconnected from the controllers (not powered).
- 2.) 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, the sensor or wiring is “open.” If the voltage is less than 0.05 VDC, the sensor or wiring is shorted.

Notes



2425 So. Yukon Ave • Tulsa, OK • 74107-2728
Ph: (918) 583-2266 • Fax: (918) 583-6094
AAON® Part No.: V16950

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