PREHEAT-X-EXT Controller Technical Guide
<table>
<thead>
<tr>
<th>PART DESCRIPTION</th>
<th>ORION</th>
<th>AAON TULSA</th>
<th>AAON COIL</th>
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<tbody>
<tr>
<td>PREHEAT-X-EXT Controller</td>
<td>OE377-26-00061-1</td>
<td>V48511</td>
<td>V48511</td>
</tr>
<tr>
<td>VCCX2 Controller</td>
<td>OE338-23B-VCCX2</td>
<td>V87900</td>
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</tr>
<tr>
<td>VCC-X Controller</td>
<td>OE338-23B-VCCX</td>
<td>V43420</td>
<td>N/A</td>
</tr>
<tr>
<td>VCB-X Controller</td>
<td>OE332-26B-VCBX</td>
<td>V28940</td>
<td>J00142</td>
</tr>
<tr>
<td>VCM-X E-BUS Controller</td>
<td>OE332-23E-VCMX</td>
<td>V07150</td>
<td>31422</td>
</tr>
<tr>
<td>Leaving Air Temperature Sensor</td>
<td>OE231</td>
<td>P87140</td>
<td>28503</td>
</tr>
<tr>
<td>Entering Air Temperature Sensor</td>
<td>OE250</td>
<td>P87150</td>
<td>N/A</td>
</tr>
<tr>
<td>EBC E-BUS Cables - varying lengths</td>
<td>EBC-XXXF</td>
<td>V167XX</td>
<td>N/A</td>
</tr>
<tr>
<td>HSSC Cables - varying lengths</td>
<td>HSSC-XXXF</td>
<td>Varies</td>
<td>N/A</td>
</tr>
</tbody>
</table>

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# TABLE OF CONTENTS

**GENERAL INFORMATION** ............................................................................................................. 4
  - Overview .......................................................................................................................................... 4
  - Features ........................................................................................................................................... 4

**INSTALLATION & WIRING** ............................................................................................................... 5
  - Important Wiring Considerations ...................................................................................................... 5
  - Input Wiring ....................................................................................................................................... 6
  - Output Wiring .................................................................................................................................... 7

**INPUTS/OUTPUTS** ............................................................................................................................ 8

**OPERATION MODES** ....................................................................................................................... 9
  - Stand-Alone Mode ............................................................................................................................... 9
  - Communicating Mode .......................................................................................................................... 9

**LCD DISPLAY SCREENS** .................................................................................................................. 12

**TROUBLESHOOTING** ..................................................................................................................... 21
  - LED Diagnostics ............................................................................................................................... 21
  - Troubleshooting Conditions & Alarms .............................................................................................. 21
  - Temperature Sensors ....................................................................................................................... 22

**APPENDIX A - Temperature Sensors** ............................................................................................ 23
  - Leaving Air Temperature Sensor Installation ................................................................................... 23
  - Leaving Air Temperature Sensor Wiring Chart ................................................................................ 24

**APPENDIX B - PREHEAT-X-EXT BACnet®** .................................................................................. 25
  - PREHEAT-X-EXT BACnet® MS/TP Connection .............................................................................. 25
  - PREHEAT-X-EXT BACnet® Points ................................................................................................... 26
**Overview**

The OE377-26-00061-1 PREHEAT-X-EXT Controller (AAON Part No. V48511) is designed to control fixed stages of Preheat and optional modulating Preheat to maintain a desired Preheat Leaving Air Temperature Setpoint. See Figure 1 for dimensions.

The controller can be used as a stand-alone controller or communicating with an AAON Unit Controller. The PREHEAT-X-EXT Controller connects to an AAON unit controller via a modular cable. See Figure 2, page 5 for wiring details.

The PREHEAT-X-EXT Controller has an extended Leaving Air Temperature Setpoint range down to 0°F. It should only be used with the approval of AAON.

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**Features**

The PREHEAT-X-EXT Controller:

- Can be operated as a stand-alone controller or communicating with the VCCX2, VCC-X, VCB-X, and VCM-X E-BUS Controllers
- Monitors the Preheater Leaving Air Temperature and Leaving Air Reset Signal and controls to maintain Setpoint
- Has an extended Leaving Air Temperature Setpoint range down to 0°F
- Contains a 2 x 8 LCD character display and 4 buttons that allow for status display and setpoint changes

**NOTE:** The PREHEAT-X-EXT Controller contains no user-serviceable parts. Contact qualified technical personnel if your PREHEAT-X-EXT Controller is not operating correctly.

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![Figure 1: OE377-26-00061-1 PREHEAT-X-EXT Controller Dimensions (In Inches)](image-url)
Important Wiring Considerations

Please read carefully and apply the following information when wiring the PREHEAT-X-EXT Controller. The PREHEAT-X-EXT Controller requires the following electrical connections:

1. 18 gauge minimum wire unless otherwise noted.
2. 24 VAC power connection with an appropriate VA rating.
3. Leaving Air Temperature Sensors, Entering Air Temperature Sensor, and Heat Enable must have 24 gauge minimum wire.
4. 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 module and connected devices.
5. All wiring is to be in accordance with local and national electrical codes and specifications.
6. 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 transducers required for your system are mounted in the appropriate location and wired into the correct terminals.

WARNING: Observe polarity! All boards must be wired GND-to-GND and 24 VAC-to-VAC. Failure to observe polarity could result in damage to the board.
Inputs Wiring

The PREHEAT-X-EXT Controller works as Stand-Alone or communicating with the VCCX2, VCC-X, VCB-X or VCM-X E-BUS Controller. For connection to a VCCX2, VCC-X, VCB-X or VCM-X E-BUS Controller, use an E-BUS Cable connecting to the appropriate E-BUS ports on those controllers. The Reset Input and Heat Enable are only used in Stand-Alone Mode. See Figure 2 below for Inputs Wiring.

Figure 2: PREHEAT-X-EXT Inputs Wiring Diagram
Outputs Wiring

The PREHEAT-X-EXT Controller works as Stand-Alone or communicating with the VCCX2, VCC-X, VCB-X or VCM-X E-BUS Controller. For connection to a VCCX2, VCC-X, VCB-X or VCM-X E-BUS Controller, use an E-BUS Cable connecting to the appropriate E-BUS ports on those controllers. See Figure 3 below for Outputs Wiring.

![PREHEAT-X-EXT Outputs Wiring Diagram](image)

**Figure 3: PREHEAT-X-EXT Outputs Wiring Diagram**
**INPUTS & OUTPUTS**

**Inputs and Outputs**

---

**I/O Map**

See Table 1 below to reference the inputs and outputs that are available on the PREHEAT-X-EXT Controller.

<table>
<thead>
<tr>
<th>Analog Inputs</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Leaving Air Temperature 1 (LAT1)</td>
<td></td>
</tr>
<tr>
<td>2 Leaving Air Temperature 2 (LAT2)</td>
<td></td>
</tr>
<tr>
<td>3 Entering Air Temperature Sensor</td>
<td></td>
</tr>
<tr>
<td>4 Reset In (0-10 VDC)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Binary Inputs</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Heat Enable</td>
<td></td>
</tr>
<tr>
<td>2 Emergency Shutdown</td>
<td></td>
</tr>
<tr>
<td>3 Future Use</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Analog Outputs</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1 0-10 VDC Mod SCR</td>
<td></td>
</tr>
<tr>
<td>2 PWM SSR</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Relays</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Alarm</td>
<td></td>
</tr>
<tr>
<td>2 Heat 1</td>
<td></td>
</tr>
<tr>
<td>3 Heat 2</td>
<td></td>
</tr>
<tr>
<td>4 Heat 3</td>
<td></td>
</tr>
<tr>
<td>5 Heat 4</td>
<td></td>
</tr>
<tr>
<td>6 Heat 5</td>
<td></td>
</tr>
<tr>
<td>7 Heat 6</td>
<td></td>
</tr>
</tbody>
</table>

**NOTE:** For AIN1 through AIN3, all Temperature Sensors must be Thermistor Type III which provide 77.0°F @ 10K Ohms Resistance.

**Reset Input (0-10 VDC)**

Used only in stand-alone operation. The Leaving Air Temperature Setpoint can be reset by supplying a 0-10 VDC signal to the RST 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**

**Heat Enable Contact (HEAT EN)**

This input is only required when the controller is used in stand-alone operation; it is not required when communicating with an AAON Unit Controller. The Heat Enable input is activated by a 24VAC signal supplied from a building automation system to enable the PREHEAT-X-EXT Controller. The controller will not operate without 24VAC being applied to this input terminal when used in a stand-alone configuration. When the Heat Enable signal is lost or turned off, all stages de-activate immediately.

**Emergency Shutdown Input**

This wet contact (24 V AC) input is used to initiate shutdown of the HVAC unit when a N.C. Smoke Detector (by others), Firestat (by others), or other shutdown condition (by others) occurs and the contact is opened. The controller remains active and can initiate alarm relays.

**Analog Outputs**

**0-10 VDC Modulating SCR**

Depending on the type of Heat used, this output will supply a 0-10 VDC output signal for control of the modulating SCR Heat.

**Pulse Width Modulating SSR**

Depending on the type of Heat used, this output will supply a 12 V PWM Output Signal for control of the modulating SSR Heat.

**Relay Outputs**

**Relay #1 - Alarm**

This relay sends a signal when an alarm is enabled.

**Relays #2 - 6—Fixed Stage Heat Outputs**

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**Table 1: PREHEAT-X-EXT Controller Inputs & Outputs**

**Analog Inputs**

**Leaving Air Temperature 1 (LAT1)**

When enabled, the PREHEAT-X-EXT Controller will control to a Leaving Air Temperature Setpoint. The Controller can be configured to use only LAT 1 for this purpose. Typically, the average of LAT1 and LAT2 is used.

**Leaving Air Temperature 2 (LAT2)**

When enabled, the PREHEAT-X-EXT Controller will control to a Leaving Air Temperature Setpoint. The Controller can be configured to use only LAT 2 for this purpose. Typically, the average of LAT1 and LAT2 is used.

**Entering Air Temperature**

When the Entering Air Temperature falls below the Entering Air Temperature Setpoint, preheat will be enabled.
**Operation Modes**

The PREHEAT-X-EXT Controller can be used stand-alone or communicating with an AAON Unit Controller using a modular cable.

**Stand-Alone Mode**

When used in a stand-alone application, the PREHEAT-X-EXT Controller will modulate SCR or SSR Heat and stage any additional fixed stages to maintain the Leaving Air Temperature setpoint configured on the PREHEAT-X-EXT Controller LCD display. The PREHEAT-X-EXT Controller is activated by a 24VAC signal to the HEAT EN input.

**Communicating Mode**

When the PREHEAT-X-EXT Controller is connected and communicating with an AAON Unit Controller via a modular cable, the necessary information will be passed between the PREHEAT-X-EXT and the Main Unit Controller to properly operate in the Heating Mode.

If the communication is interrupted between the PREHEAT-X-EXT Controller and the Main Controller, both boards will show an alarm and the PREHEAT-X-EXT outputs will turn off. When communication is restored, the alarms will go away.

In this configuration, the Leaving Air Temperature Setpoints and the Preheat Enable Setpoints are set using the Main Controller.
SEQUENCE OF OPERATIONS

Preheat Enable

Stand Alone Mode
Enabled when the Binary Input is closed and the Entering Air Temperature is below setpoint.

E-BUS Communications Mode
Enabled by an E-BUS command when the Entering Air Temperature falls below the Preheat Setpoint.

BACnet Communications Mode
Enabled by BACnet command or Binary Input, whichever occurs first.

Leaving Air Temperature Sensor
The controller can be configured to use one of three sensor configurations for control.
- Leaving Air Temperature Sensor 1 only (LAT1)
- Leaving Air Temperature Sensor 2 only (LAT2)
- Average Leaving Air Temperature which averages LAT1 and LAT2

Leaving Air Temperature Setpoint

Stand Alone
- Leaving Air Temperature Setpoint can be reset between the LAT Setpoint and LAT Setpoint Reset Limit.
- The Reset Source is based on a 0-10 VDC input and range can be adjusted using the LAT Setpoint Reset Source Low and LAT Setpoint Reset Source High Setpoints.

E-BUS and BACnet Communications Mode
- A Leaving Air Temperature Setpoint will be sent to the controller.
- This value is stored in volatile memory and will be lost at reset.
- There are separate Leaving Air Temperature Setpoints, depending on if the unit is in Heating, Vent, or Cool Mode.

Modulating Heat

- If configured, the Modulating Heat output will be used as the first stage of heat.
- Analog Voltage Output can be adjusted between 0-10 VDC as needed to maintain the Leaving Air Setpoint.
- Controlled by an Internal PID Loop.

Heat Staging Up
The following conditions must be met before the first (next) stage of heat can be energized:
- Preheat Enable Signal/Command must be active.
- The LAT must be below the LAT Setpoint by any amount.
- If Mod Heat is configured, it must be at 100% for the Stage Up Delay.
- The Minimum Off Time must be met.
- The Stage Up Delay must be met (for second stage and above).

Heat Staging Down
The following conditions must be met before a stage of heat can be de-energized:
- Preheat Enable Signal/Command is deactivated -OR- the LAT must be above the LAT Setpoint by the LAT Deadband.
- If Modulating Heat is configured, it must be at 0% for the stage down delay.
- The Minimum Run time must be met.
- The Stage Down Time must be met.
**Emergency Shutdown**

The Emergency Shutdown input must always be used and wired as a 24 VAC normally closed contact. If an Emergency Shutdown occurs, and that contact opens:

- All outputs will be immediately de-energized.
- An alarm will be generated.

**High Leaving Air Temperature Alarm**

- If the Leaving Air Temperature is above the LAT High Temperature Alarm Limit for more than the Alarm Delay all heating outputs will be de-energized immediately.
- An alarm will be generated.
- A manual reset will be required.

**Low Leaving Air Temperature Alarm**

If the Leaving Air Temperature is below the LAT Low Temperature Alarm Limit for more than 2 minutes, the heat will remain on but an alarm will be generated.
Navigation Keys

LCD Display Screen & Navigation Keys

The PREHEAT-X-EXT 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 4 and refer to Table 2 for descriptions.

Table 2: Navigation Key Functions

<table>
<thead>
<tr>
<th>NAVIGATION KEY</th>
<th>KEY FUNCTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>MENU</td>
<td>Use the MENU key to navigate through the PREHEAT-X-EXT Main Menu Screens.</td>
</tr>
<tr>
<td>UP</td>
<td>Use this key to adjust setpoints and change configurations.</td>
</tr>
<tr>
<td>DOWN</td>
<td>Use this key to adjust setpoints and change configurations.</td>
</tr>
<tr>
<td>ENTER</td>
<td>Use the Enter key to move through screens within Main Menu categories. Also, use this key to save setpoints and configuration changes.</td>
</tr>
<tr>
<td>LCD DISPLAY SCREENS</td>
<td></td>
</tr>
<tr>
<td>----------------------</td>
<td></td>
</tr>
<tr>
<td><strong>Main Screens Map</strong></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>PREHEAT CONTROL</th>
<th>STATUS</th>
<th>SET POINTS</th>
<th>ALARMS</th>
<th>CONFIG</th>
<th>COMM CONFIG</th>
</tr>
</thead>
<tbody>
<tr>
<td>SS1099 VER X.XX</td>
<td>LA SPT 70.0</td>
<td>NO ALARMS</td>
<td>HEAT STG 3</td>
<td>COM MODE S-ALONE</td>
<td></td>
</tr>
<tr>
<td>PREHEAT ENABLED</td>
<td>RST LMT 70.0</td>
<td>E-SHDN OK</td>
<td>MOD HEAT YES</td>
<td>EBUS CFG VCB-X</td>
<td></td>
</tr>
<tr>
<td>CONT TMP 50.3</td>
<td>EA EN SP 55.0</td>
<td>LA1 SENS OK</td>
<td>LAT CFG AVERAGE</td>
<td>MAC ADDR 0</td>
<td></td>
</tr>
<tr>
<td>LA SPT 70.0</td>
<td>LA1 CAL 0.0</td>
<td>LA2 SENS OK</td>
<td>AOUT VLO 0.0</td>
<td>BAC ID 15000</td>
<td></td>
</tr>
<tr>
<td>STGS ON 2</td>
<td>LA2 CAL 0.0</td>
<td>LOW LAT OK</td>
<td>AOUT VHI 10.0</td>
<td>BAC BAUD 38.400</td>
<td></td>
</tr>
<tr>
<td>MOD HEAT 32%</td>
<td>EA CAL 0.0</td>
<td>HI LAT OK</td>
<td>MOD Kp 15.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LA1 TEMP 50.6</td>
<td></td>
<td></td>
<td>MOD Ki 6.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LA2 TEMP 50.0</td>
<td></td>
<td></td>
<td>MOD TIME 10.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>AVG TEMP 50.3</td>
<td></td>
<td></td>
<td>MOD Kd 4.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ENT AIR 26.6</td>
<td></td>
<td></td>
<td>STG UP 20</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>STG DWN 20</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>MIN RUN 20</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>MIN OFF 20</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>SCALING DEG.F</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Figure 5: PREHEAT-X-EXT Main Screens Map*
PREHEAT-X-EXT Main Screens

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

**PREHEAT CONTROL**
Press \(\checkmark\) to scroll through PREHEAT Screens.
Press M to go to STATUS Screens.

**STATUS**
Press \(\checkmark\) to scroll through STATUS Screens.
Press M to go to SETPOINTS Screens.

**SET POINTS**
Press \(\checkmark\) to scroll through SETPOINTS Screens.
Press M to go to ALARMS Screens.

**ALARMS**
Alarms will display automatically.
Press M to go to CONFIGURATION Screens.

Press \(\checkmark\) to scroll through CONFIGURATION Screens.
Press M to go to COMM Configuration Screens.

Press \(\checkmark\) to scroll through COMM Screens.
Press M to scroll through SETPOINTS 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.

STATUS

PREHEAT ENABLED/DISABLED

Gives the Enabled status for the Preheat Mode. The controller can be enabled from one of the following: (1) Binary Input in Stand-Alone Mode, (2) E-BUS command from VCCX2, VCC-X, VCB-X or VCM-X, (3) BACnet Point.

CONT TEMP XX.X

CONTROL TEMPERATURE

Displays the current controlling temperature. This could be one of the following based on configuration: (1) Leaving Air Sensor 1, (2) Leaving Air Sensor 2, or (3) the average of both.

LA SPT

LEAVING AIR TEMPERATURE SETPOINT

Displays the current Leaving Air Setpoint that the controller is trying to maintain. This value can come from the following based on configuration: (1) Internal Setpoints +/- Setpoint Reset Input, (2) E-BUS input from VCCX2, VCC-X, VCB-X, VCM-X, or (3) BACnet Point.

LA1 TEMP XX.X

LEAVING AIR TEMPERATURE 1

Displays the Leaving Air Temperature 1 Sensor’s current reading.

LA2 TEMP XX.X

LEAVING AIR TEMPERATURE 2

Displays the Leaving Air Temperature 2 Sensor’s current reading.

AVG TEMP XX.X

AVERAGE TEMPERATURE

Displays the current average temperature of both Leaving Air Temperature Sensors.

ENT AIR XX.X

ENTERING AIR TEMPERATURE

Displays the current Entering Air Temperature Sensor reading.

STGS ON #

CURRENT NUMBER OF ACTIVE STAGES

Displays the number of heat stages currently energized. This includes the First Modulating Stage of Heat.

MOD HEAT XX.X%

MODULATING HEATING OUTPUT

Displays the current Modulation output Percentage of both the Analog and PWM outputs (they control together).
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.

**NOTE:** When the PREHEAT-X-EXT is operating in Communications Mode, these setpoint screens will not appear on the LCD display because they are controlled by the Main Controller.

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

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

<table>
<thead>
<tr>
<th>Minimum</th>
<th>Default</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>0°F</td>
<td>70°F</td>
<td>90°F</td>
</tr>
<tr>
<td>-17.7°C</td>
<td>21°C</td>
<td>32°C</td>
</tr>
</tbody>
</table>

**RESET LIMIT SETPOINT**
Will display and be used only in stand-alone mode. If Remote Reset is being utilized, this will be the Leaving Air Setpoint when the Reset Voltage Input is at 10VDC.

<table>
<thead>
<tr>
<th>Minimum</th>
<th>Default</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>0°F</td>
<td>70°F</td>
<td>120°F</td>
</tr>
<tr>
<td>-17.7°C</td>
<td>21°C</td>
<td>48.8°C</td>
</tr>
</tbody>
</table>

**ENTERING AIR ENABLE SETPOINT**
This is the temperature at which Preheat is enabled. The Entering Air Enable Setpoint is set by the LCD Display in stand-alone mode and is set by the Main Controller in communicating mode.

<table>
<thead>
<tr>
<th>Minimum</th>
<th>Default</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>-40°F</td>
<td>55°F</td>
<td>90°F</td>
</tr>
<tr>
<td>-40°C</td>
<td>12.7°C</td>
<td>32°C</td>
</tr>
</tbody>
</table>

**LEAVING AIR SENSOR 1 CALIBRATION OFFSET**
If the sensor is reading incorrectly, you can use this screen to enter an offset temperature to adjust the sensor’s temperature. Enter a positive value to raise the sensor’s temperature or a negative value to lower the sensor’s temperature.

<table>
<thead>
<tr>
<th>Minimum</th>
<th>Default</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>-100.0°F</td>
<td>0.0°F</td>
<td>100.0°F</td>
</tr>
<tr>
<td>-55.5°C</td>
<td>0.0°C</td>
<td>55.5°C</td>
</tr>
</tbody>
</table>

**LEAVING AIR SENSOR 2 CALIBRATION OFFSET**
If the sensor is reading incorrectly, you can use this screen to enter an offset temperature to adjust the sensor’s temperature. Enter a positive value to raise the sensor’s temperature or a negative value to lower the sensor’s temperature.

<table>
<thead>
<tr>
<th>Minimum</th>
<th>Default</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>-100.0°F</td>
<td>0.0°F</td>
<td>100.0°F</td>
</tr>
<tr>
<td>-55.5°C</td>
<td>0.0°C</td>
<td>55.5°C</td>
</tr>
</tbody>
</table>
**Alarm Screens**

Refer to the following map when viewing Alarm Screens. These screens will display automatically when alarms are present. For alarm troubleshooting, see pages 21-22.

![ALARMS](image)

The alarms are as follows:

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

**E-SHDN:** If 24VAC is removed from the Emergency Shutdown Input, this alarm will activate and the controller will turn off all outputs. The alarm will be disabled when voltage has returned.

**LA1 SENS:** The first Leaving Air Temperature Sensor has been disconnected, shorted, open, or missing for more than 60 seconds. This alarm will be disabled when the sensor is working again.

**LA2 SENS:** The second Leaving Air Temperature Sensor has been disconnected, shorted, open, or missing for more than 60 seconds. This alarm will be disabled when the sensor is working again.

**LO LAT:** This indicates a Leaving Air Temperature Cutoff Alarm condition which is activated if the Controlling Leaving Air Temperature has dropped below 0°F for more than 2 minutes. The alarm will be disabled if after a fixed delay period the Leaving Air Temperature has risen above 0°F.

**HI LAT:** This indicates a Leaving Air Temperature Cutoff Alarm condition which is activated if the Controlling Leaving Air Temperature has risen above 120°F. All outputs will stage off.

**EA SENS:** The Entering Air Temperature Sensor has been disconnected, open, shorted, or missing for more than 60 seconds. This alarm will be disabled when the sensor is working again.

**COM STAT:** Communications have been lost with the main controller for more than 30 seconds. This alarm will disable when communications resume.

---

**ENTERING AIR SENSOR CALIBRATION OFFSET**

If the sensor is reading incorrectly, you can use this screen to enter an offset temperature to adjust the sensor’s temperature. Enter a positive value to raise the sensor’s temperature or a negative value to lower the sensor’s temperature.

<table>
<thead>
<tr>
<th>Minimum</th>
<th>Default</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>-100.0°F</td>
<td>0.0°F</td>
<td>100.0°F</td>
</tr>
<tr>
<td>-55.5°C</td>
<td>0.0°C</td>
<td>55.5°C</td>
</tr>
</tbody>
</table>

**EA CAL**

**XX.X°F**

**XX.X°C**
Configuration Screens

Refer to the following map when navigating through the Configuration Screens. From the CONFIG Screen, press <ENTER> to scroll through the screens and change setpoints. Use the <UP> and <DOWN> arrow keys to change your selections. Press <ENTER> to save any changes.

**CONFIG**

**HEAT STG**
0-6

# OF HEAT STAGES
Select the total number of Heat Stages including the Modulating Stage. Range is 0-6. Default is 0.

**MOD HEAT**
YES/NO

MODULATING HEAT
If either the Analog or PWM Modulating Heat output is being used, this must be set to YES. Default is NO.

**LAT CFG**
LAT1, LAT2, AVERAGE

LEAVING AIR TEMPERATURE SENSOR CONFIGURATION
LAT1: Use Leaving Air Temperature Sensor 1 as the Controlling Temp.
LAT2: Use Leaving Air Temperature Sensor 2 as the Controlling Temp.
AVERAGE: Use the Average of LAT1 & LAT2 as the Controlling Temp. Default is AVERAGE.

**AOUT VLO**
0.0-10.0 VOLTS

MINIMUM SCR VOLTAGE
This is the Low Voltage setting for the Analog Output. It sets the voltage level needed for 0%. Range is 0 -10. Default is 0.

**AOUT VHI**
0.0-10.0 VOLTS

MAXIMUM SCR VOLTAGE
This is the High Voltage setting for the Analog Output. It sets the voltage level needed for 100%. Range is 0 -10. Default is 10.

**MOD Kp**
15.0

INTEGRAL CONSTANT
This is the Internal PID Kp Constant. Do not make changes to this value unless told to do so by WattMaster Technical Support.

**MOD Ki**
6.0

AIRFLOW INTEGRAL
This is the Internal PID Ki Constant. Do not make changes to this value unless told to do so by WattMaster Technical Support.

**MOD TIME**
1-120 SEC

MODULATION RATE
This is the time period setting that determines how often a change is made to the modulating output. Range is 1 - 120 seconds. Default is 20.

**MOD Kd**
6.0

DERIVATIVE CONSTANT
This is the Internal PID Kd Constant. Do not make changes to this value unless told to do so by WattMaster Technical Support.
STAGE UP DELAY
If configured for SCR modulation, this is the amount of time (in seconds) the controller must wait to activate an additional stage of heat if the Min Off Time is met. Range is 0 - 1200. Default is 180.

STAGE DOWN DELAY
If configured for SCR modulation, this is the amount of time (in seconds) the controller must wait to deactivate a stage of heat if the Min Run time is met. Range is 0 - 1200. Default is 180.

MINIMUM RUN TIME
This is the amount of time (in seconds) a stage of heat must remain on before it can be deactivated. Range is 0 - 1200. Default is 120.

MINIMUM OFF TIME
This is the amount of time (in seconds) a stage of heat must remain off before it can be activated. Range is 0 - 1200. Default is 60.

TEMPERATURE SCALE
Fahrenheit (default) or Celsius. This setting is used only in stand-alone mode.
Communication Configuration Screens

Refer to the following map when navigating through the Communicating Configuration Screens. From the COM CONFIG Screen, press <ENTER> to scroll through the screens and change setpoints. Use the <UP> and <DOWN> arrow keys to change your selections. Press <ENTER> to save any changes.

COMMUNICATION MODE
This setting configures the communications mode. The choices are (1) BACNET, (2) EBUS, or (3) S-ALONE (default).

E-BUS CONFIGURATION
Select the type of controller that the PREHEAT-X-EXT is connected to. The choices are VCCX2, VCC-X, VCB-X, VCM-X, or NONE (default).

NOTE: You must cycle power after changing this setting.
**LED Diagnostics**

The PREHEAT-X-EXT Controller is equipped with LEDs that can be used to verify operation and perform troubleshooting. See Figure 6, below 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:

**STATUS LEDs**

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

**Diagnostic LEDs**

**ALARM** - This red LED located on the PREHEAT-X-EXT Controller’s cover above the LCD display will light up to indicate an alarm. The type of alarm(s) will be shown on the LCD display.

**Communication LED**

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

**Relay LEDs**

**RLY 1-6** - These green LEDs will light up and stay lit as long as the Heat Relay(s) is active.

**Binary Input LEDs**

**HEAT EN** - This green LED will light up when Heat is enabled.

**EMERGENCY SHUTDOWN** - This green LED will light up when Emergency Shutdown is enabled.

---

**Figure 6: PREHEAT-X-EXT Controller LED Locations and Descriptions**
Troubleshooting Alarms

Mechanical Failure:
- Check relay outputs on the PREHEAT-X-EXT for 24 VAC output.
- Verify output voltage (VOUT and GND) to SCR or PWM
- Verify that the Leaving Air Temperature Sensor(s) is connected to AIN1 and/or AIN2 and GND on the PREHEAT-X-EXT
- Verify Leaving Air Temperature Sensor probe(s) is mounted correctly
- Remove AIN1 and AIN2 and GND wiring from the PREHEAT-X-EXT and ohm the sensor out (this may indicate open or failed wiring). Refer to chart in back of this guide for readings.

Leaving Air Temperature Failure:
- Verify that the Leaving Air Temperature Sensor(s) is connected to the AIN1 and/or AIN2 and GND on the PREHEAT-X-EXT.
- Remove AIN1 and AIN2 and GND wiring from the PREHEAT-X-EXT and ohm the sensor out (this may indicate open or failed wiring). Refer to chart in back of this guide for readings.

Communications Loss:
- Check COMM LED on PREHEAT-X-EXT.
- Verify 24 VAC power to all interconnected WattMaster controllers.
- Verify connection between the PREHEAT-X-EXT and associated WattMaster controllers.
- In communication mode (connected to a an AAON Unit with modular cable), verify PREHEAT-X-EXT configuration on AAON unit.
Mounting the Leaving Air Temperature Sensor

- The Leaving Air Temperature (LAT) Sensor should be located in PREHEAT-X-EXT box’s output location.
- Locate the sensor in the center of the widest part of the PREHEAT-X-EXT box wall. 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 box wall 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 box wall, over the sensor. This will help prevent thermal gradients from affecting the sensor.

WARNING: Make sure your Leaving Air Temperature Sensor(s) are 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.


Connect Leads to "AIN1 And/Or "AIN2" And “GND” On PREHEAT-X-EXT Controller. See Figure 2 on page 5 for details.

Figure 7: Leaving Air Temperature Sensor Installation
LAT Sensor Testing

Leaving Air Temperature Sensor

If you suspect the Leaving 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 Leaving 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 Table 3.

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 Table 3.

<table>
<thead>
<tr>
<th>Temperature to Resistance/Voltage Chart</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temp (°F)</td>
</tr>
<tr>
<td>-----------</td>
</tr>
<tr>
<td>68</td>
</tr>
<tr>
<td>69</td>
</tr>
<tr>
<td>70</td>
</tr>
<tr>
<td>71</td>
</tr>
<tr>
<td>72</td>
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<tr>
<td>73</td>
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<td>74</td>
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<td>75</td>
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<td>76</td>
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<td>78</td>
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<td>82</td>
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<tr>
<td>84</td>
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<td>86</td>
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<tr>
<td>88</td>
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<tr>
<td>110</td>
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<tr>
<td>115</td>
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<tr>
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<td>125</td>
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<tr>
<td>130</td>
</tr>
<tr>
<td>135</td>
</tr>
<tr>
<td>140</td>
</tr>
<tr>
<td>145</td>
</tr>
</tbody>
</table>

Table 3, continued: 0-3.3 V 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.
APPENDIX B

PREHEAT-X-EXT BACnet® Connection To MS/TP Network

Figure 8: PREHEAT-X-EXT BACnet® Connection to MS/TP Network

Programming Note:
Use Communication Configuration Screens In LCD Display To Program The BACnet Settings. See Page 20 For Details.

Wiring Notes:
1.) All wiring to be in accordance with local and national electrical codes and specifications.

2.) All communication wiring to be 18 gauge minimum, 2 conductor twisted pair with shield. Use Belden #82760 or equivalent.

MS/TP Connection To BACnet®

Typical Terminal Blocks.

<table>
<thead>
<tr>
<th>T</th>
<th>R+</th>
</tr>
</thead>
<tbody>
<tr>
<td>SHLD</td>
<td></td>
</tr>
</tbody>
</table>

Size Transformer For Correct Total Load.
PREHEAT-X-EXT Controller = 11 VA
APPENDIX B

PREHEAT-X-EXT BACnet® Points

<table>
<thead>
<tr>
<th><strong>BACnet® Properties for the PREHEAT-X-EXT</strong></th>
<th><strong>BACnet® Properties for the PREHEAT-X-EXT</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PARAMETER</strong></td>
<td><strong>OBJECT</strong></td>
</tr>
<tr>
<td>Active Controlling Setpoint</td>
<td>AI: 1</td>
</tr>
<tr>
<td>Number of Heat Stages On</td>
<td>AI: 2</td>
</tr>
<tr>
<td>Modulating Output Position</td>
<td>AI: 3</td>
</tr>
<tr>
<td>All Alarms Bitfield</td>
<td>AI: 4</td>
</tr>
<tr>
<td>Entering Air Temperature</td>
<td>AI: 5</td>
</tr>
<tr>
<td>Leaving Air Temp Sensor 1</td>
<td>AI: 6</td>
</tr>
<tr>
<td>Leaving Air Temp Sensor 2</td>
<td>AI: 7</td>
</tr>
<tr>
<td>Leaving Air Average Temp</td>
<td>AI: 8</td>
</tr>
<tr>
<td>Reset Input Percentage</td>
<td>AI: 9</td>
</tr>
<tr>
<td>Enable Input Value</td>
<td>BI: 1</td>
</tr>
<tr>
<td>Shutdown Input Value</td>
<td>BI: 2</td>
</tr>
<tr>
<td>Preheat Enable Status</td>
<td>BI: 3</td>
</tr>
<tr>
<td>Alarm Relay Status</td>
<td>BI: 4</td>
</tr>
<tr>
<td>Heat 1 Relay Status</td>
<td>BI: 5</td>
</tr>
<tr>
<td>Heat 2 Relay Status</td>
<td>BI: 6</td>
</tr>
<tr>
<td>Heat 3 Relay Status</td>
<td>BI: 7</td>
</tr>
<tr>
<td>Heat 4 Relay Status</td>
<td>BI: 8</td>
</tr>
<tr>
<td>Heat 5 Relay Status</td>
<td>BI: 9</td>
</tr>
<tr>
<td>Heat 6 Relay Status</td>
<td>BI: 10</td>
</tr>
</tbody>
</table>

**PREHEAT-X-EXT BACnet® Property Identifier**

BACNETPropertyIdentifier:

AllAlarmGroup1Bits ::= BIT STRING {
  Reserved (0),
  BadLeavingAir1 (1),
  BadLeavingAir2 (2),
  LowLeavingAir (3),
  HighLeavingAir (4),
  Reserved (5),
  BadEnteringAir (6),
  CommAlarm (7),
  ShutDownAlarm (8)