INSTALLATION & OPERATING INSTRUCTIONS

TEMP-TRACKER

B-40/B-41 Modulating Temperature Controller

For Raytherm™ Boilers & Water Heaters

H2 514-4001
WH2 2100-4001

Raypak®
A Rheem® Company

Catalog No. 5000.70 Effective: 12-21-11 Replaces: NEW P/N 241439 Rev. 1

CONTENTS

NOTE: Minimum 18 AWG, 105°C, stranded wire must be used for all low voltage (less than 30 volts) external connections to the unit. Solid conductors should not be used because they can cause excessive tension on contact points. Install conduit as appropriate. All high voltage wires must be the same size (105°C, stranded wire) as the ones on the unit or larger.

INTRODUCTION

The Temp-Tracker B-40/B-41 modulating temperature controller is designed to be mounted on Raytherm H2 heaters with motorized modulating actuators in order to provide accurate water temperature control in a variety of applications. The Controller may be used to provide a setpoint temperature, outdoor reset with domestic hot water (DHW) override, or dedicated DHW generation and several options for external heater control.

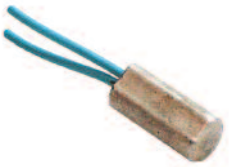
Fig. 1: Temp-Tracker Controller

The B-40 configuration is for modulating control without outdoor reset, and can be used on models H2 514-4001 and WH2 2100-4001. The B-41 configuration adds the air sensor needed for outdoor reset function, and is for use on models H2 514-4001 only.

When shipped loose, this package includes:

(1) Controller in enclosure
(3) Water sensors
(1) Outdoor air sensor (B-41 only)
(1) Well Assembly
(1) Mounting bracket
(1) Mounting panel

Well Assembly



Water Sensor (3)

Controller in Enclosure

Outdoor Air Sensor for B-41

Fig. 2: Temp-Tracker Controller Kit (shipped loose)

USER INTERFACE

The Controller uses a Liquid Crystal Display (LCD) as a method of supplying information. Use the LCD to setup and monitor the operation of your system. The Controller uses three push buttons (*Item*, ▲, ▼) for selecting and adjusting the settings (see Fig. 3). As you program your Controller, record your settings in the actual settings columns of the Adjust menu in tables H & I, found on pages 20 & 21.

Fig. 3: Controller Push Buttons

Menu

All of the items displayed by the Controller are organized into two menus. These menus are listed on the upper right-hand side of the display (Menu Field). The default menu for Controller is the View menu. While in

the View menu, the View segment is displayed. To select the Adjust menu, press and hold all three buttons simultaneously for one second (see Fig. 3). The display then advances to the Adjust menu and the Adjust segment is turned on in the display. The display will automatically revert back to the View menu after 20 seconds of keypad inactivity. Once in a menu, there will be a group of items that can be viewed within that menu.

Item

The abbreviated name of the selected item will be displayed in the item field of the display. To view the next available item in a menu, press and release the Item button. The display will return to the first item in the selected menu (see Fig. 4).

Fig. 4: Item Button

Adjust

To make an adjustment to a setting in the Controller, begin by selecting the Adjust menu by **pressing and holding simultaneously all three buttons for one second**, and then selecting the desired item using the Item button. Finally, use the ▲ or ▼ button to make the adjustment (see Fig. 5).

Fig. 5: Adjust Buttons

Additional information can be gained by observing the Status field of the LCD. The status field will indicate which of the Controller's outputs are currently active. Most symbols in the status are only visible when the View menu is selected.

Display

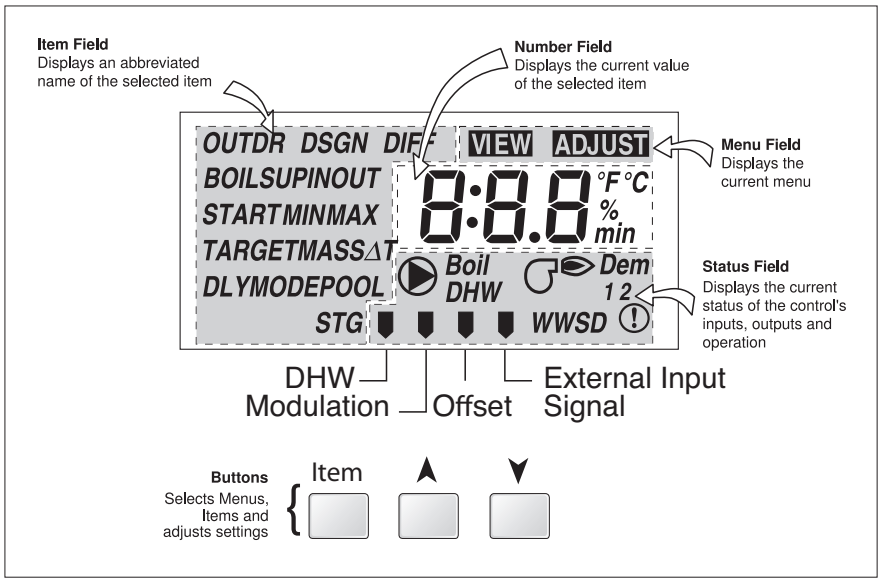


Fig. 6: Display

	BOILER PUMP *Displays when the boiler pump is in operation.*		*BURNER* *Displays when the burner is on*
	DHW PUMP *Displays when the DHW pump is in operation.*		*WARNING* *Displays when an error message is present*
Dem 1	*CFH* *Displays when a CFH is present*		*POINTERS* *Displays the operation as indicated by the text.*
Dem 2	*DHW OVERRIDE* *Displays when a DHW override is present*	*WWSD*	*WWSD* *Displays when the control is in Warm Weather Shut Down*

Fig. 7: Symbol Description

DIP Switch Setting

(A) Factory / Installer

The Factory / Installer DIP switch is used to select which items are available to be viewed and / or adjusted in the user interface. The Factory access level includes all the settings available in the control. The Installer access level includes the settings and items that are required for system setup.

(B) Soft Stop / Off

The Soft Stop / Off DIP switch is used to enable the soft stop feature once a demand is removed.

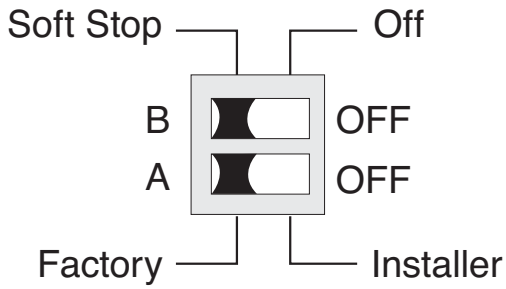


Fig. 8: DIP Switch Setting

SEQUENCE OF OPERATION

General

Powering up the Controller

When the Controller is powered up, it turns on all segments in the display for two seconds. Next, the software version is displayed for two seconds. Finally, the Controller enters into the normal operating mode.

Display Backlight

The control's display has a backlight that is permanently on while the control is powered.

Primary/Secondary Piping

In primary/secondary applications, the heater outlet temperature is typically higher than the system loop temperature. Therefore, the Controller uses an additional sensor (called the system sensor) to measure the temperature in the system. The operating sensor in primary / secondary piping applications is the system sensor. See Fig. 9.

Modes of Operation (Mode)

The Controller allows for eight modes of operation in order to define the Controller operation and piping arrangement used. The piping arrangement can be categorized into primary or primary/secondary. The mode of operation is selected using the MODE item in the adjust menu. The operating sensor measures the temperature being controlled out to the heating system.

NOTE: Mode of operation MUST be programmed into the Controller. See Figs. 9 through 14 on the following pages.

The piping arrangement determines which sensor the Controller uses as the operating sensor. The operating sensor is either the heater outlet sensor or the system sensor.

It is up to the designer to determine the necessary components for and the configuration of the particular system being designed, including additional equipment, isolation relays (for loads greater than the Controller's specified output rating), and any safety devices which in the judgment of the designer are appropriate, in order to properly size, configure and design that system and to ensure compliance with building and safety code requirements.

Typically, Raypak recommends Mode 2 for primary/secondary hydronics, Mode 3 for domestic hot water and Mode 5 for primary/secondary hydronics using outdoor reset.

NOTE: The illustrations for each mode are only mechanical concept drawings; they are not intended to describe a complete system, nor any particular system. Consult the factory for piping arrangements not depicted here.

Two Setpoints Operation, Primary Piping Mode 1 (Mode = 1) (Not Supported)

Mode 1 is designed for setpoint operation using Primary Piping. Once a Call for Heat (CFH) is present, the control modulates the heater to maintain the heater target 1 at the heater outlet sensor. Once an indirect DHW override is present, the control modulates the heater to maintain the heater target 2 at the heater outlet sensor. If both demands are present at the same time, the control operates at the higher of the two targets.

Two Setpoints with Primary/Secondary Piping
Mode 2 (Mode = 2)

Mode 2 is designed for setpoint operation using Primary/Secondary piping (see Fig. 9). A CFH is available to activate a setpoint for space heating. An indirect DHW override is available to activate a second setpoint for heating an indirect domestic hot water tank.

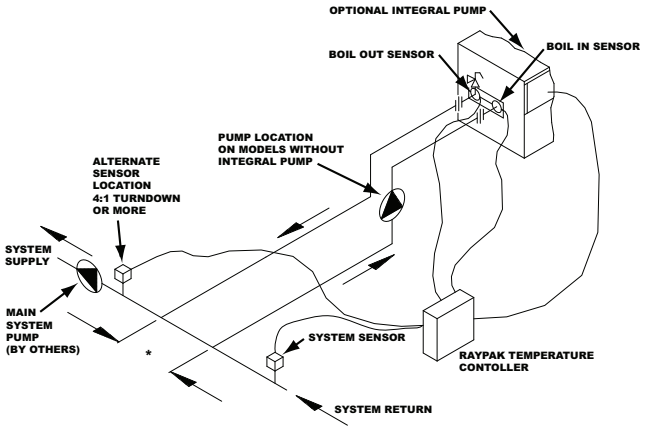


Fig. 9: Primary/Secondary Piping (Mode 2)

Once a CFH is present, the control modulates the heater to maintain the heater target 1 at the system supply sensor. Once an indirect DHW override is present, the control modulates the heater to maintain the heater target 2 at the system supply sensor. If both demands are present, the control operates at the higher of the two targets.

Mode 2 requires the use of three water sensors. The inlet water sensor is located in the inlet side of the in/out header. The outlet sensor is located in the outlet side of the in/out header. The system sensor (terminals 6 and 4) must be located as shown in Fig. 9.

Domestic Hot Water Operation, Uni-Temp 80 Piping (Mode 3)

Mode 3 is designed for dedicated DHW operation using Unitemp 80 piping. The Controller operates the heater to maintain a tank temperature at the system sensor.

Mode 3 requires the use of three water sensors. The inlet water sensor is located in the inlet side of the in/out header and the outlet sensor is located in the outlet side of the in/out header. The system sensor (terminals 6 and 4) must be located in the storage tank, as shown in Fig. 10.

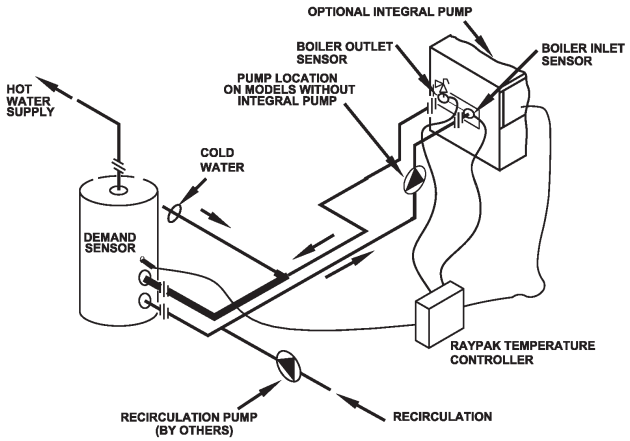


Fig. 10: Uni-Temp 80 Piping (Mode 3)

Outdoor Reset and Override Operation with Primary Piping
Mode 4 (Mode = 4)
(Not Supported)

Mode 4 is designed for outdoor reset and override operation using Primary Piping. Once a CFH is present, the control modulates the heater to maintain the calculated outdoor reset target at the heater outlet sensor. Once an indirect DWH override is present, the control modulates the heater to maintain the heater target 2 at the heater outlet sensor. If both demands are present at the same time, the control operates at the higher of the two targets.

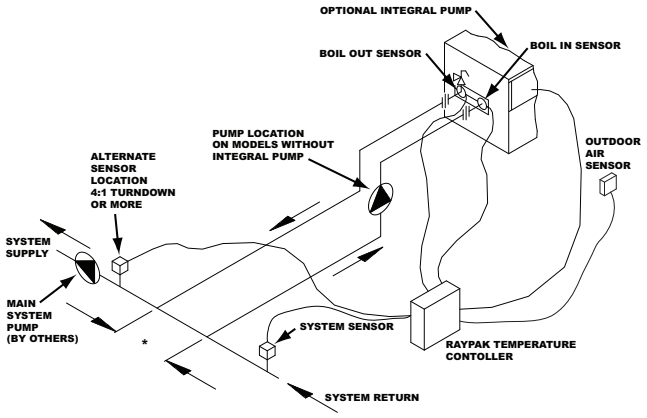
Outdoor Reset and Override Operation with Primary/Secondary Piping
Mode 5 (Mode = 5)

Mode 5 is designed for outdoor reset and override operation using Primary /Secondary Piping. The CFH is available to provide outdoor reset for hydronic heating systems. The override can be used to heat an indirect domestic hot water tank.

Once a CFH is present, the control modulates the heater to maintain the calculated outdoor reset target at the system supply sensor. Once an indirect DHW override is present, the control modulates the heater to maintain the heater target 2 at the system supply sensor. If both demands are present at the same time, the control operates at the higher of the two targets.

Mode 5 requires the use of three water sensors and one air sensor. The inlet water sensor is located in the inlet side of the in/out header. The outlet sensor is located in the outlet side of the in/out header. The system sensor (terminals 6 and 4) must be located in a dry well located on the system supply pipe, as shown in Fig. 11.

The outdoor air sensor must be located on the coldest side of the building in a shaded area out of direct sunlight.



*MAXIMUM 4 TIMES THE PIPE DIAMETER OR 12", WHICHEVER IS LESS.

Fig. 11: Primary/Secondary Piping with Outdoor Reset (Mode 5)

External Target Temperature Input and Override with Primary Piping Mode 6 (Mode = 6) (Not Supported)

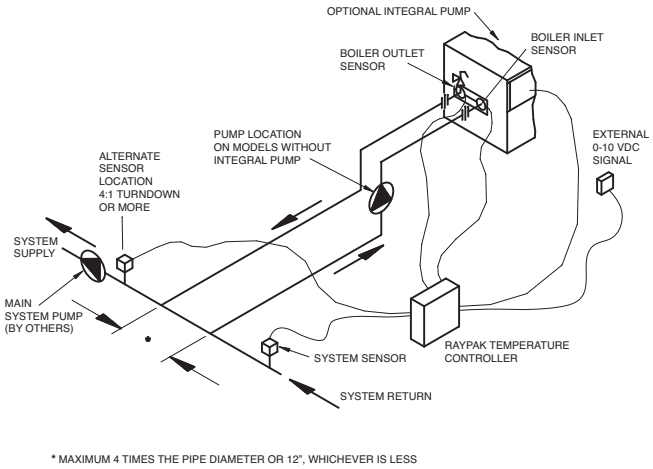
Mode 6 is designed for a 0-10VDC or a 4-20 mA external input signal and override operation using Primary Piping. The external input signal creates an internal CFH and changes the heater target according to a linear scale. The control modulates the heater to maintain the heater target at the heater outlet sensor.

External Target Temperature Input and Override with Primary/Secondary Piping Mode 7 (Mode = 7)

Mode 7 is designed for a 0-10VDC or a 4-20mA external input signal and override operation using Primary/Secondary Piping. The external input signal can be provided from a Building Management System. The override can be used to heat an indirect domestic hot water tank.

The external input signal creates an internal CFH and changes the heater target according to a linear scale. The control modulates the heater to maintain the heater target at the heater outlet sensor.

Once an indirect DHW override is present, the control modulates the heater to maintain the heater target at the heater system sensor. If both an external input signal and an indirect DHW override are present at the same time, the control operates at the higher of the two targets.



* MAXIMUM 4 TIMES THE PIPE DIAMETER OR 12", WHICHEVER IS LESS

Fig. 12: External Input Target Temperature and Setpoint Operation, Primary-Secondary Piping (Mode 7)

NOTE: To convert a 0-20 mA input signal to 0-10 VDC, a 500 Ω resistor must be added. See Fig. 13.

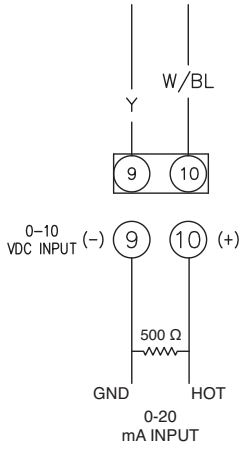


Fig. 13: 500 Ω Resistor for 4-20 mA Operation

External Direct Drive Operation Mode 8 (Mode = 8)

Mode 8 is designed for a 0-10VDC or a 4-20 mA external input signal from a building management system or external sequencer, such as the **Raypak Temp-Tracker Mod+ Hybrid**, to drive the modulation rate directly with Primary/Secondary piping. The indirect DHW override is disabled.

The control receives a CFH and analog signal provided from an external control. The control modulates the heater according to the input signal. The maximum outlet temperature is controlled by the BOIL MAX setting.

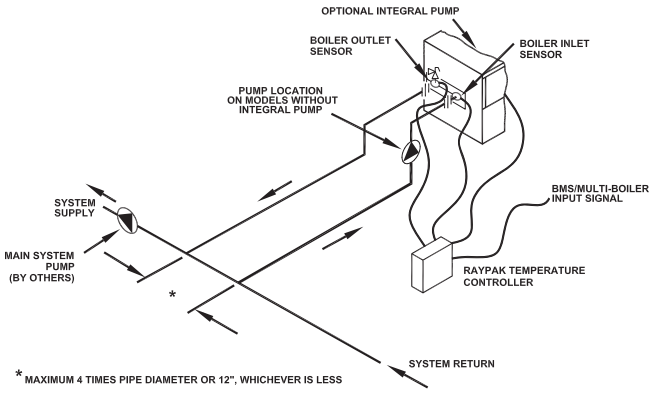


Fig. 14: External Direct Drive Operation (Mode 8)

Code Descriptions

Heater Differential (DIFF)

A heat source must be operated with a differential in order to prevent short cycling. The heater differential is divided around the heater target temperature. The stage contact will close when the water temperature at the operating sensor is 1/2 of the differential setting below the heater target temperature, and will open when the water temperature at the operating sensor is 1/2 of the differential setting above the heater target temperature.

Manual Differential

The differential can be manually set using the DIFF setting in the Adjust menu.

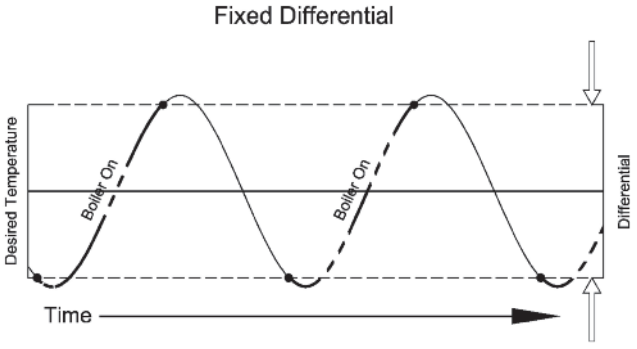


Fig. 15: Fixed Differential

Auto Differential

If Auto Differential is selected, the control automatically determines the best differential as the load changes, thereby improving efficiency. During light loads, the differential is increased to allow longer on and off times to reduce the potential for short-cycling. During large loads, the differential is narrowed thereby improving comfort in heating spaces by reducing temperature swing.

Tank Differential

Tank Differential is subtractive to the set point. For example, in the case of a 130°F set point with a 3°F differential, the control will energize the heater when the tank temperature drops to 127°F and then will shut the heater off at 130°F.

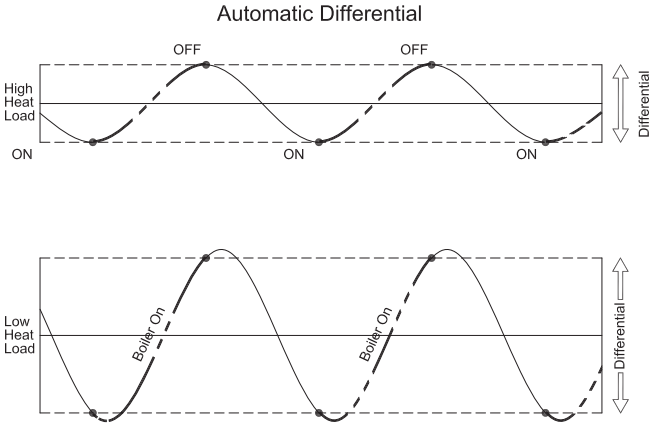


Fig. 16: Auto Differential

Proportional, Integral & Derivative (PID)

After the heater is turned on in the firing sequence, the Controller waits a minimum amount of time before modulating. The control error is determined using PID logic.

Proportional compares the actual operating sensor temperature to the heater target temperature. The colder the temperature, the sooner the heater modulates up.

Integral compares the operating sensor temperature offset (error) to the heater target temperature over a period of time.

Derivative determines how fast or slow the operating sensor temperature is changing. If the temperature is increasing slowly, the Controller modulates the heater more rapidly. If the temperature is increasing quickly, the Controller modulates the heater slowly, if at all.

Heater Mass (BOIL MASS)

The heater mass setting (1, 2 or 3) allows the installer to adjust the Controller to the thermal mass of different types of heat sources used. The heater mass setting automatically determines the minimum on time and minimum off time of the heater, and the PID modulation parameters. A higher thermal mass setting provides slower modulation, while a lower thermal mass provides faster modulation.

Heater Mass Definitions	
Mass 1	Low Volume, High Recovery
Mass 2	Medium Volume, Medium Recovery
Mass 3	High Volume Low Recovery

Table A: Heater Mass Definitions

NOTE: Always use a heater mass setting of 1 for Raypak equipment. If the Controller continues to respond too rapidly, contact Raypak.

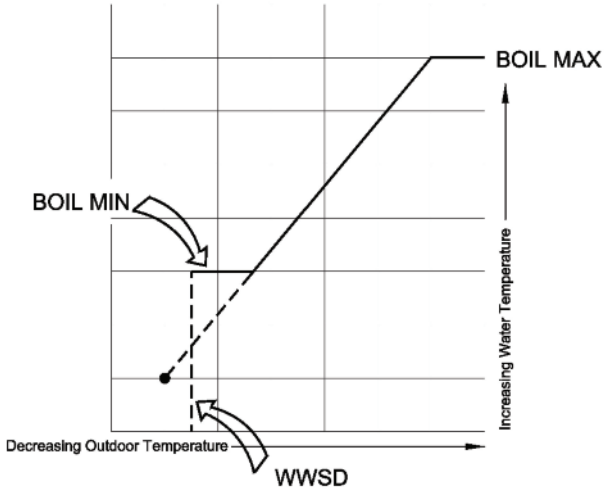


Fig. 17: Warm Weather Shutdown

Heater Minimum (BOIL MIN)

The BOIL MIN is the lowest water temperature that the Controller is allowed to use as a heater target temperature (e.g. 105ºF). During mild conditions, if the Controller calculates a heater target temperature that is below the BOIL MIN setting, the heater target temperature is adjusted to at least the BOIL MIN setting.

During this condition, if the heater is operating, the MIN segment turns on in the LCD while the heater target temperature or heater operating sensor temperature is viewed.

Additional plumbing and/or controls may be required to maintain the heater at or above its minimum inlet temperature.

NOTE: If the installed heater is designed to operate at a target temperature less than 80°F, set the BOIL MIN adjustments to OFF and ensure that a cold water protection package is employed.

Heater Maximum (BOIL MAX)

The BOIL MAX is the highest water temperature that the Controller is allowed to use as a heater target temperature. If the Controller does target BOIL MAX, and the heater outlet sensor is near the BOIL MAX temperature, the MAX segment turns on in the LCD while the heater target, heater inlet, heater outlet or heater supply temperature is viewed.

Heater Target Temperature (BOIL TARGET)

The heater target temperature is determined from the mode of operation and type of demand applied. The Controller displays the temperature that it is currently trying to maintain at the operating sensor as BOIL TARGET in the view menu.

The operating sensor for modes 2, 3, 5 and 7 is the system sensor. If the Controller is not presently enabled for heat, it displays “- - -“ in the LCD. In Mode 8, no heater target temperature is generated.

Pump Contact Operation

The pump contact operates when:

- While the burner is firing and primary / secondary piping (Mode 2, 5, 7) is used. Once the burner is shut off the boiler pump is shut off. Primary / secondary piping reduces standby losses by isolating the boiler from the system while the burner is off.

- During a DHW demand the boiler pump contact is closed unless Indirect DHW priority is selected. During Indirect DHW priority, the boiler pump contact is off.
- After the burner shuts off the boiler pump remains on for the Pump DLY time setting in order to purge heat from the boiler to the system.
- During dedicated DHW operation (Mode 3), the boiler pump contact closes whenever there is an internal CFH.
- During external direct drive operation (Mode 8), the boiler pump contact closes whenever there is a CFH.

Pump Purge (DLY)

The controller operates the pump based on the Pump DLY setting. Once the heater shuts down, the controller keeps the pump running for the time selected.

When Pump DLY is set to OFF, there is no purging. When Pump DLY is set to ON, the pump runs continuously. When on is selected and the control is configured for outdoor reset, the pump continues to run even during Warm Weather Shut Down (Mode 5).

Pump Exercising

If the pump has not operated at least once every 70 hours, the control turns on the output for 10 seconds. This minimizes the possibility of the pump seizing during a long period of inactivity.

Setpoint Operation

A setpoint is a fixed water temperature target that the heater is to maintain at the system sensor. The heater maintains the heater target using the proportional or the PID logic together with the heater differential. The setpoint temperature is set using the BOIL TARGET item in the adjust menu.

Mode 2 and Enable (Dem 1)

A call for heat (CFH) is required whenever heat is required for the primary heating load. This CFH is generated when 24VAC is applied across the enable/disable connection P1 (terminals 1 and 2). Once the voltage is applied, the control turns on the Dem 1 segment in the display and the controller operates the heater to maintain the BOIL TARGET 1 at the system sensor.

Mode 2, 5 and 7, and Domestic Hot Water Override (Dem 2)

A CFH is required whenever heat is needed for the secondary heating load such as an indirect domestic hot water tank. A CFH is generated when 24VAC is applied across the DHW contacts P1 (terminals 1 and 3). Once the voltage is applied, the control turns on the Dem 2 segment in the display and the controller operates the heater stages to maintain the BOIL TARGET 2 at the system sensor.

Dedicated Domestic Hot Water (DHW) Operation

WARNING: DO NOT use DHW override on terminal 3.

When Mode 3 is selected, the Controller provides dedicated DHW operation.

Internal DHW Demand

A sensor is required to be installed in the tank and connected to the *Com* and the *Sys/D* terminals (6 and 4). A CFH for DHW is generated when the temperature at the DHW sensor drops the tank differential setting below the desired DHW tank temperature. The TANK TARGET setting is used to set the desired DHW tank temperature. Once a CFH is generated, the *Dem* segment turns on in the LCD.

The Controller then operates the heater to maintain the programmed heater target temperature at the heater outlet sensor. The heater target temperature is set using the BOIL TARGET item in the adjust menu.

Tank Differential (TANK DIFF)

Tank differential is subtractive to the set point that operates completely below the TANK TARGET. It is selected using the TANK DIFF item in the adjust menu.

Outdoor Reset Operation

When Mode 5 is selected, the Controller uses outdoor reset to control the water temperature. Outdoor reset adjusts the target temperature based on the outdoor air temperature and the reset ratio; as the outdoor air temperature rises, the need for heat drops and the setpoint is reduced The reset ratio is determined from the Heater Start, Heater Design, Outdoor Start and Outdoor Design settings.

Enable/Disable (Modes 2, 5 and 7)

A CFH is generated when a voltage of 24 VAC is applied across the Enable/Disable terminals (1 and 2). Once voltage is applied, the Controller turns on the *Dem 1* segment in the display. If the Controller is not in Warm Weather Shut Down (WWSD), it then operates the heater to maintain the target temperature.

NOTE: If the controller is in WWSD, the WWSD segment is shown in the display and the heater target in the view menu of the display remains " - - - " (no target).

Reset Ratio

The controller uses the following four settings to calculate the Reset Ration (RR):

$$\text{RESET RATIO (RR)} = \frac{\text{BOILER DESIGN} - \text{BOILER START}}{\text{OUTDOOR START} - \text{OUTDOOR DESIGN}}$$

For example, using the Mode 5 default values, the RR would be 0.56:1.

Heater Start (BOIL START)

The BOIL START temperature is the theoretical supply water temperature that the system requires when the outdoor air temperature equals the OUTDR START temperature setting. The BOIL START is typically set to the desired building temperature.

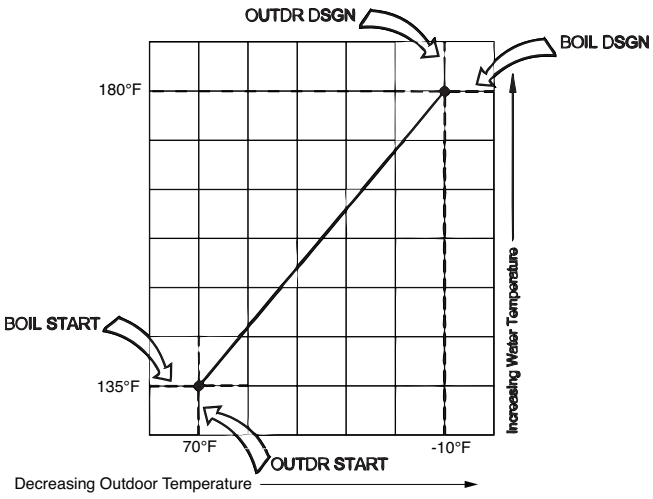


Fig. 18: Heater Start

Outdoor Start (OUTDR START)

The OUTDR START temperature is the outdoor air temperature at which the Controller provides the BOIL START water temperature to the system. The OUTDR START is typically set to the desired building temperature.

Outdoor Design (OUTDR DSGN)

The OUTDR DSGN is the outdoor air temperature that is the typical coldest temperature of the year where the building is located. This temperature is used when doing heat loss calculations for the building.

Heater Design (BOIL DSGN)

The BOIL DSGN is the water temperature required to heat the zones when the outdoor air is as cold as the OUTDR DSGN temperature.

Warm Weather Shut Down (WWSD)

When the outdoor air temperature rises above the WWSD setting, the Controller turns on the *WWSD* segment in the display. When the Controller is in Warm Weather Shut Down, the *Dem 1* segment is displayed if there is a heat demand. However, the Controller does not operate the heating system to satisfy this demand.

External Temperature Target Input

When Mode 7 is selected, the controller allows for an external control to operate the heater temperature through an input signal generated by a Building Management System (BMS) or Energy Management System (EMS).

CFH

A CFH is generated when a contact closure is present at the enable/disable connection on P1 pins 1 and 2 (or pins 1 and 3 for Indirect DHW Override), and an analog positive 0-10 VDC signal is applied to the +V (in) input (terminal 10). The negative V (DC) is applied to the Com/- input (terminal 9).

0-10 VDC or 0-20mA External Input (Mode 7)

NOTE: Changing the boiler minimum and/or boiler maximum default settings will result in changes to the boiler target temperature in Mode 7.

When the 0-10VDC range is selected, an input voltage of 1VDC corresponds to a heater target temperature of 50ºF (10ºC). An input voltage of 10VDC corresponds to a heater target temperature of 210ºF (99ºC). As the voltage varies linearly between 1VDC and 10 VDC, the heater target temperature varies linearly between 50ºF (10ºC) and 210ºF (99ºC). If a voltage below 0.5VDC is received, the heater target temperature is displayed as " - - -" indicating that there is no longer an internal CFH.

A 0-20 mA signal can be converted to a 0-10VDC signal by installing a 500 Ohm resistor in parallel to the input signal on the controller's terminals (terminals 9 & 10). See Fig. 13 on page 7.

0-10 VDC	0-20 mA*	Heater Target
0	0	- - - (OFF)
1	2	50ºF (10ºC)
2	4	68ºF (20ºC)
3	6	86ºF (30ºC)
4	8	103ºF (39ºC)
5	10	121ºF (49ºC)
6	12	139ºF (59ºC)
7	14	157ºF (69ºC)
8	16	174ºF (79ºC)
9	18	192ºF (89ºC)
10	20	210ºF (99ºC)

*Requires a 500 Ω resistor

Table B: 0-10 VDC or 0-20mA External Input (Mode 7)

2-10 VDC or 4-20 mA External Input Signal

The external input signal can be selected to be either 0-10 VDC or 2-10 VDC. When the 2-10 VDC range is selected, an input of 2 VDC corresponds to a heater target temperature of 50ºF (10ºC). An input voltage of 10 VDC corresponds to a heater target temperature of 210º F (99º C). As the voltage varies between 2 VDC and 10 VDC, the heater target temperature varies linearly between 50ºF (10ºC) and 210ºF (99ºC). If a voltage below 1.5 VDC is received the heater target temperature is displayed as " - - - " indicating that there is no longer an internal CFH.

A 4-20 mA signal can be converted to a 2-10 VDC signal by installing a 500 ohm resistor in parallel to the input signal on the controller's terminals (terminals 9 & 10).

2-10 VDC	4-20 mA*	Heater Target
0	0	- - - (OFF)
1	2	- - - (OFF)
2	4	50ºF (10ºC)
3	6	70ºF (21ºC)
4	8	90ºF (32ºC)
5	10	110ºF (43ºC)
6	12	130ºF (54ºC)
7	14	150ºF (66ºC)
8	16	170ºF (77ºC)
9	18	190ºF (88ºC)
10	20	210ºF (99ºC)

*Requires a 500 Ω resistor

Table C: 2-10 VDC or 4-20mA External Input (Mode 7)

OFFSET

The offset setting allows the heater target temperature to be fine tuned to the external input signal. The controller reads the external input signal and converts this to a heater target temperature. The offset is then added to the heater target temperature.

Example - for Range = 0-10 VDC:

If Input = 7 VDC	157ºF	(69ºC)
and Offset = + 5ºF (3ºC)	+ 5ºF	(3ºC)
then Heater Target =	162ºF	(72ºC)

External Direct Drive Operation (Mode 8)

When Mode 8 is selected, the controller allows for an external control to operate the heater through an analog direct drive input signal provided by a heater sequencing control, such as the **Raypak Temp-Tracker Mod+ Hybrid**. When in Mode 8, the indirect DHW override is disabled.

Direct Drive Input Signal

An external heater sequencer provides a positive 0-10 VDC input signal to the controller +V input (terminal 10). The negative VDC signal is applied to the Com/- input (terminal 9).

The heater remains off while the direct drive input signal is between 0.0 to 0.5 VDC. An external input signal of 1.0 VDC or 2.0 mA will energize the heater and then the firing rate of the unit is based upon the input signal as indicated in Table D below.

0-10 VDC	4-20 mA	Heater Firing %
0	0	- - - (OFF)
1	2	Ignition & Min Fire
2	4	33%
3	6	42%
4	8	50%
5	10	58%
6	12	67%
7	14	75%
8	16	83%
9	18	91%
10	20	100%

Table D: 0-10 VDC or 4-20mA External Input (Mode 8)

PUMP OPERATION

The pump is turned on as soon as the direct drive input signal reaches 0.5 VDC. Once the direct drive input signal falls below 0.5 VDC, the pump continues to operate until the Pump DLY purge expires, then the pump shuts off.

BOILER OUTLET MAXIMUM TEMPERATURE

The external sequencer is able to operate the heater temperature. However, the BOIL OUT MAX setting limits the highest temperature at the heater outlet sensor. Should the heater outlet setting exceed the BOIL OUT MAX setting, the stage contacts are opened to shut off the heater. The heater remains off for the minimum off time and the heater outlet temperature falls 2º F (1º C) below the BOIL OUT MAX setting.

NOTE: BOILER OUT MAX is set using DIP Switch "A": OFF = 235°F, ON = 200°F (see Fig. 23).

INSTALLATION

The following describes field installation:

For field installation, this controller is shipped inside a water-resistant enclosure (see Fig. 19). This kit includes an alarm relay and two terminal blocks (labeled P1 and P2) with built-in decals describing the various connections. See Fig. 23 for proper wiring.

CAUTION: The 24VAC connection must be applied to Terminal Block P3 (pins 1 and 2).

Electrical Connections to the Controller

The installer should test to confirm that no voltage is present at any of the wires during installation.

Powered Input Connections

Pump Contact

The Pump terminals (pins 17 and 18 on P2) are an isolated output in the controller. There is no power available on these terminals from the controller. This output is to be used as a switch to either make or break power to the pump. Since this is an isolated contact, it may switch voltage up to 120 VAC that does not to exceed 5 amps. For larger pumps, a contactor must be used.

Heater Contacts

The *Stg* terminals (11 and 12) are isolated outputs in the Controller. There is no power available on these terminals from the Controller. These terminals are to be used as a switch to either make or break the heater circuit. When the Controller requires the heater to fire, it closes the contact between these terminals.

Alarm Contact

For field installations, terminals 19 and 20 provide dry contacts for an alarm. The alarm contacts only provide notification of a controller fault.

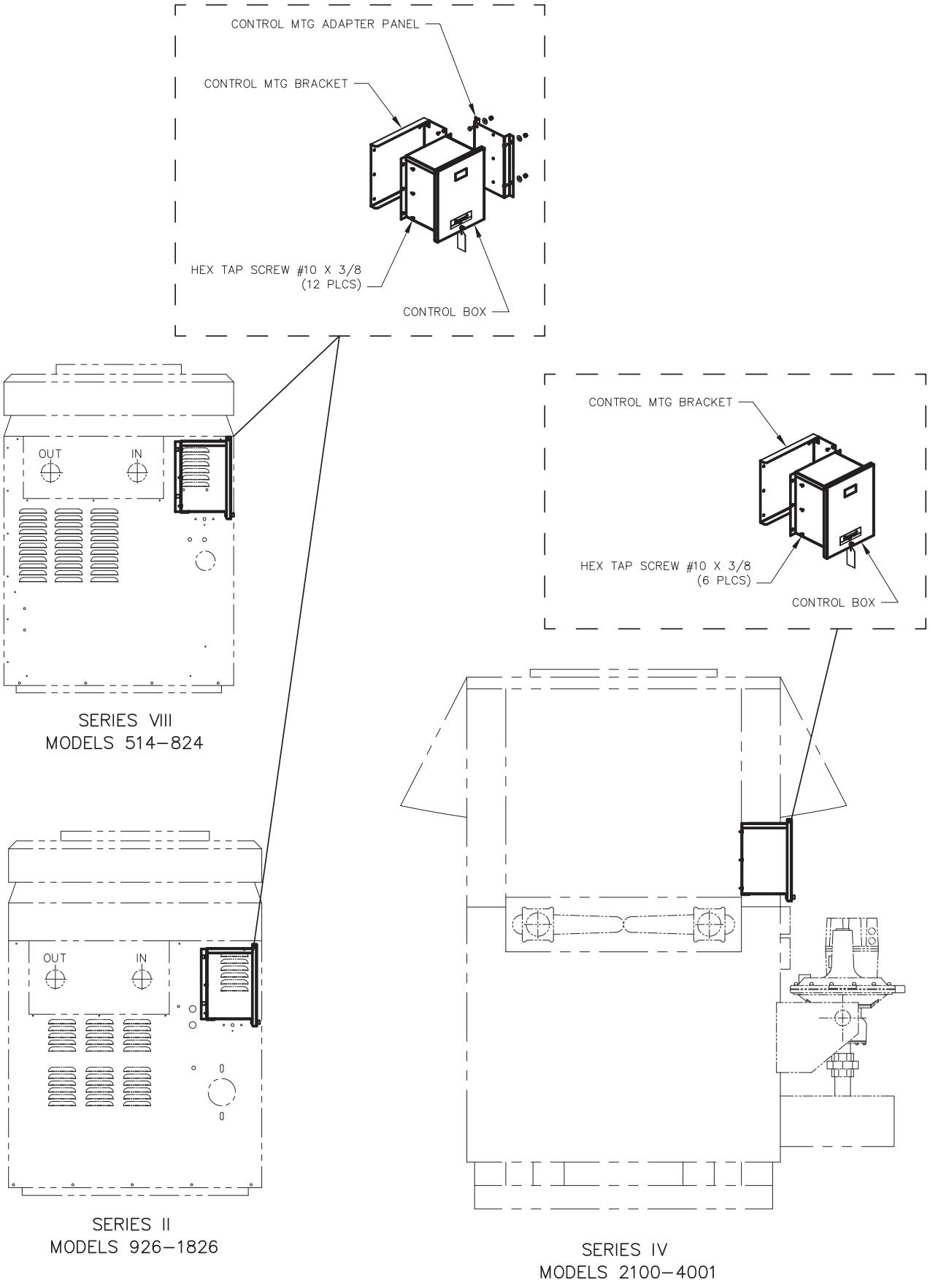


Fig. 19: Control Box Locations

Sensor and Unpowered Input Connections

NOTE: Do not apply power to these terminals as this damages the Controller.

Outdoor Sensor

Connect the two wires from the optional outdoor sensor to the *Com* (common sensor) and *Air* (outdoor air sensor) terminals (4 and 5). The outdoor sensor is used by the Controller to measure the outdoor air temperature.

Heater Outlet Sensor (Field Install)

Connect the two wires from the Heater Outlet Sensor to the *Com* (common sensor) and the *Boil Out* (heater outlet sensor) terminals (4 and 7). The heater outlet sensor is used by the Controller to measure the heater outlet water temperature from the heater.

NOTE: The heater outlet sensor is required for every mode of operation.

Heater Inlet Sensor (Field Install)

Connect the two wires from the Heater Inlet Sensor to the *Com* (common sensor) and the *Boil In* (heater inlet sensor) terminals (4 and 8). The heater inlet sensor is used by the Controller to measure the heater inlet water temperature to the heater.

Heater Sys/D or DHW Sensor

Either a System Sensor or DHW Sensor may be connected to the Controller. If a sensor is used, connect the two wires from the sensor to the *Com* (common sensor) and the *Sys/D* (demand/DHW sensor) terminals (4 and 6).

TROUBLESHOOTING

Field Testing the Power Supply

Verify that all exposed wires and bare terminals are not in contact with other wires or grounded surfaces. Turn on the power and measure the voltage between the 15 and 16 terminals on the P2 terminal block, using an AC voltmeter. The reading should be 24 VAC ± 10%, and the reading between terminals 16 and 4 must be less than 1.0 VAC.

CAUTION: The sensor must be disconnected in order to measure the correct ohms.

Testing the Sensors (10 kΩ)

In order to test the sensors, the actual temperature at each sensor location must be measured.

Using Table E on page 16, estimate the temperature measured by the sensor, based on ohm readings from various sensors to COM.

The sensor and thermometer readings should be close. If the meter reads a very high resistance, there may be a broken wire, a poor wiring connection or a defective sensor. If the resistance is very low, the wiring may be shorted, there may be moisture in the sensor or the sensor may be defective. To test for a defective sensor, measure the resistance directly at the sensor location.

Testing the Enable/Disable and DHW Field Install Inputs

When the Enable/Disable system calls for heat, you should measure between 22 VAC and 26 VAC at terminals 1 and 2 on P1. When the heat demand device is off, you should measure less than 1 VAC. For DHW override, use terminals 3 and 4.

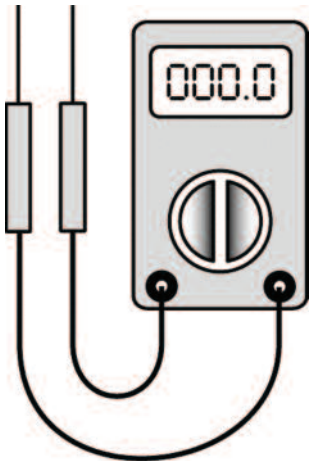


Fig. 20: Multi-meter

NOTE: Make sure ALL power to the devices and wiring harness is off.

Connecting the Controller

Apply power to the Controller. The operation of the Controller on power up is described in the *Sequence of Operation* section, starting on page 5 of this manual.

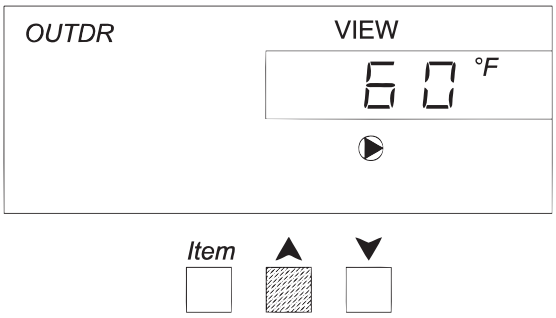


Fig. 21: Testing the Controller's Outputs

Testing the Controller's Outputs

The Controller has a built-in test routine, which is used to test the main control functions. The test sequence is enabled when the ▲ button is pressed and held for 3 seconds while in the *View* menu. The outputs are tested in the following sequence:

1. After 1 second, the pump is turned on.
2. After 10 seconds, the Controller drives to 50%.
3. After 30 seconds, the Controller drives to 100%.
4. After 40 seconds, the pump and heater are shut off. The alarm contacts are closed for 10 seconds.
5. The control exits the test sequence and resumes normal operation.

Sensor Resistance

Temperature (°F)	Resistance (Ω)
-50	490,813
-40	336,606
-30	234,196
-20	165,180
-10	118,018
0	85,362
10	62,465
20	46,218
30	34,558
40	26,099
50	19,900
60	15,311
70	11,883
77	10,000
80	9,299
90	7,334
100	5,828
110	4,665
120	3,760
130	3,050
140	2,490
150	2,045
160	1,689
170	1,403
180	1,172
190	983
200	829
210	703
220	598

Table E: Sensor Resistance

WIRING CONNECTIONS

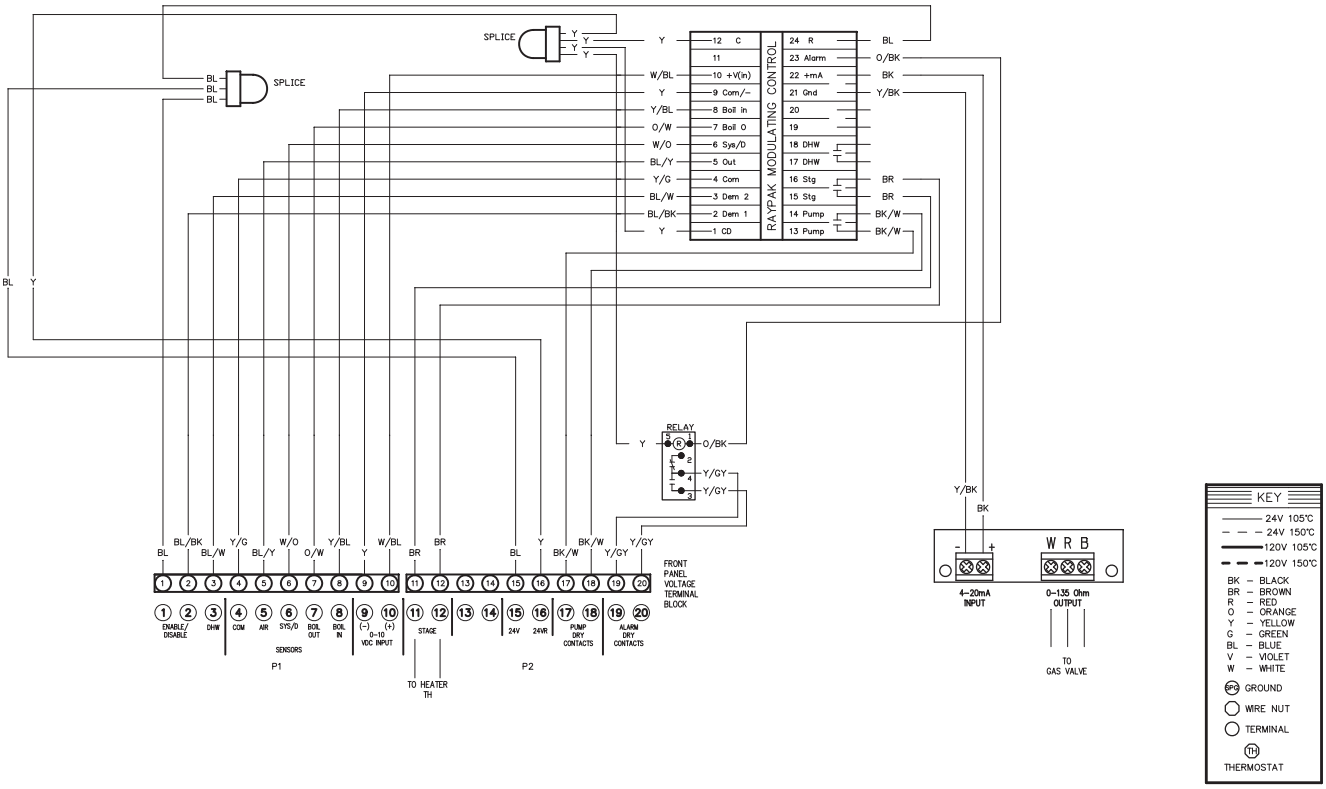


Fig. 22: Wiring Diagram

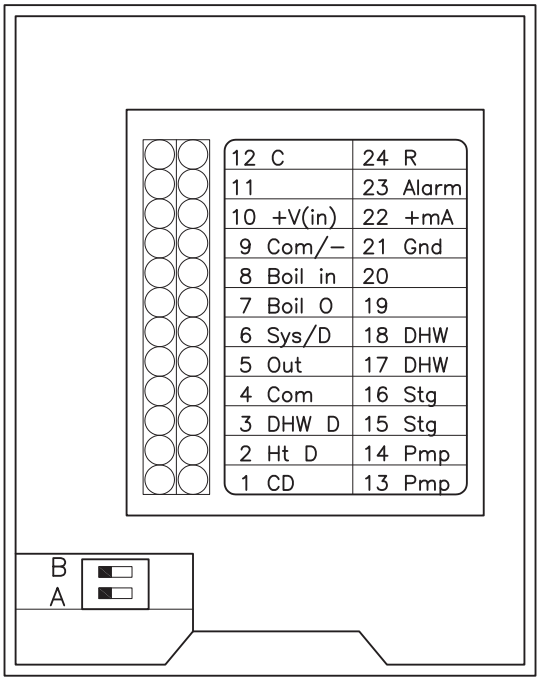


Fig. 23: DIP Switch Location

Field Installation

Field wiring must be connected to the terminal block below the controller inside the control box.

CONTROLLER SETTINGS

Tables F through S describe the “View” and “Adjust” menus. They also show the default settings as well as any possible adjustment ranges.

VIEW MENU

The View menu items display current operating temperatures and system status information. Use the Item button (see Fig. 4) to view items in this menu.

MODE 2
(With Default Settings Shown)

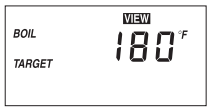
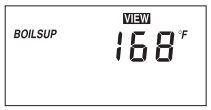
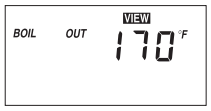
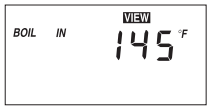
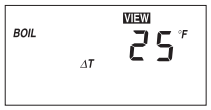
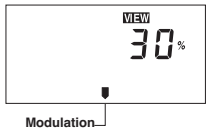
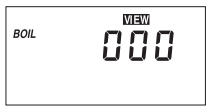
Item Field	Access	Description	Range
	Factory Installer	BOILER TARGET The boiler target is the temperature the control is currently trying to maintain at the boiler supply sensor or the boiler outlet sensor.	– – –, 35 to 226°F, OFF (– – –, 2 to 108°C, OFF)
	Factory Installer	BOILER SUPPLY Current boiler supply water temperature as measured by the boiler supply sensor. Note: This item is only available when MODE is set to 2.	14 to 266°F (-10 to 130°C)
	Factory Installer	BOILER OUTLET Current boiler outlet water temperature as measured by the boiler outlet sensor. Note: When MODE is set to 2 this item is only visible in the Factory access level.	14 to 266°F (-10 to 130°C)
	Factory Installer	BOILER INLET Current boiler inlet water temperature as measured by the boiler inlet sensor. Note: This item is only available when a boiler inlet sensor is installed.	14 to 266°F (-10 to 130°C)
	Factory	BOILER DELTA T Current temperature difference between the boiler outlet sensor and the boiler inlet sensor. Note: This item is only available when a boiler inlet sensor is installed.	0 to 252°F (0 to 140°C)
	Factory Installer	MODULATION Current modulating output percentage.	0 to 100%
	Factory	BOILER HOURS The total number of running hours of the boiler since this item was last cleared. Clear the numbers of hours by pressing and holding the Up and Down buttons together while viewing this item.	0 to 999

Table F: View Menu, Mode 2

ADJUST MENU
(Page 1 of 2)

MODE 2
(With Default Settings Shown)

The Adjust menu items are the programmable settings used to operate the system. Press and hold all three buttons for one second to enter the Adjust menu, then select the desired item using the Item button. Finally, use the ▲ or ▼ button to make the adjustment (see Fig. 5).

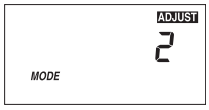
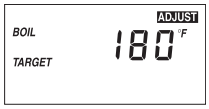
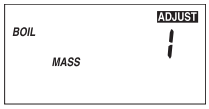
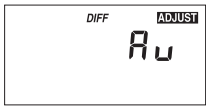
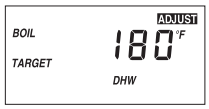
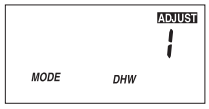
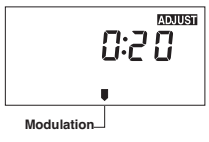
Item Field	Access	Description	Range	Settings
	Factory Installer	MODE Select the operating mode for the control.	1, 2, 3, 4, 5, 6, 7, 8 Default = 2	
	Factory Installer	BOILER TARGET Select the boiler target temperature for setpoint operation.	OFF, 70 to 220°F (OFF, 21 to 104°C) Default = 180°F (82°C)	
	Factory	BOILER MAXIMUM Select the maximum boiler target water temperature.	120 to 225°F, OFF (49 to 107°C, OFF) Default = 200°F (93°C)	
	Factory	BOILER MINIMUM Select the minimum temperature allowed for the boiler target temperature.	OFF, 80 to 180°F (OFF, 27 to 82°C) Default = 125°F (52°C)	
	Factory	FIRE DELAY Select the amount time required for combustion pre-purging, ignition and the flame to be established. The control will not adjust the modulation percentage from the Start Modulation percentage until this delay elapses.	0:00 to 3:00 minutes Default = 0:10 min (1 second increments)	
	Factory Installer	BOILER MASS Select the thermal mass of the boiler.	1 (low mass) 2 (medium mass) 3 (high mass) Default = 1	
	Factory	DIFFERENTIAL Select the differential that the control is to use when it is operating the boiler.	Au, 2 to 42°F (Au, 1 to 23°C) Default = Au	
	Factory	DHW BOILER TARGET Select the boiler target temperature while heating an indirect DHW tank.	OFF, 70 to 220°F (OFF, 21 to 104°C) Default = 180°F (82°C)	
	Factory	DHW MODE Select no priority (1) or priority (2) of indirect DHW heating over space heating. Note: This item is only available when MODE is set to 1.	1, 2 Default = 1	
	Factory	MODULATION Select the analog modulation signal range.	0:20 or 4:20 Default = 0:20	

Table G: Adjust Menu, Mode 2 (page 1 of 2)

ADJUST MENU
(Page 2 of 2)

MODE 2
(With Default Settings Shown)

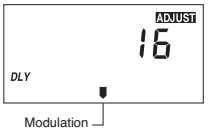
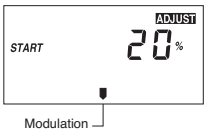
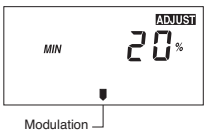
Item Field	Access	Description	Range	Settings
	Factory	MODULATION DELAY Select the rate at which the modulation signal changes from the Minimum Modulation setting to the Maximum Modulation setting.	10 to 230 seconds Default = 16 seconds	
	Factory	START MODULATION Select the percent modulation required for ignition.	0 to 50% Default = 20%	
	Factory	MINIMUM MODULATION Select the minimum modulation during burner operation.	0 to 50% Default = 20%	
	Factory	PUMP DELAY Select the boiler pump purge time after the burner is shut off.	OFF, 0:20 to 9:55 min, On Default = 5:00 min	
	Factory Installer	TEMPERATURE UNITS Select to display temperature in degrees Fahrenheit or in degrees Celsius.	°F, °C Default = °F	

Table H: Adjust Menu, Mode 2 (page 2 of 2)

VIEW MENU

The View menu items display current operating temperatures and system status information. Use the Item button (see Fig. 4) to view items in this menu.

MODE 3
(With Default Settings Shown)

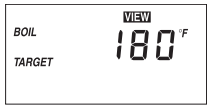
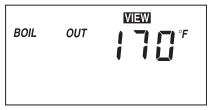
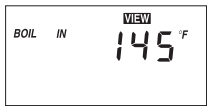
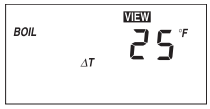
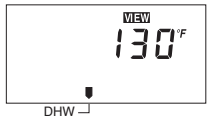
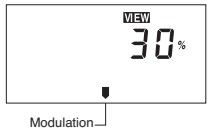
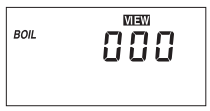
Item Field	Access	Description	Range
	Factory Installer	BOILER TARGET The boiler target is the temperature the control is currently trying to maintain at the boiler supply sensor or the boiler outlet sensor.	– – –, 35 to 226°F, OFF (– – –, 2 to 108°C, OFF)
	Factory Installer	BOILER OUTLET Current boiler outlet water temperature as measured by the boiler outlet sensor.	14 to 266°F (-10 to 130°C)
	Factory Installer	BOILER INLET Current boiler inlet water temperature as measured by the boiler inlet sensor. Note: This item is only available when a boiler inlet sensor is installed.	14 to 266°F (-10 to 130°C)
	Factory	BOILER DELTA T Current temperature difference between the boiler outlet sensor and the boiler inlet sensor. Note: This item is only available when a boiler inlet sensor is installed.	0 to 252°F (0 to 140°C)
	Factory Installer	DHW Current DHW tank temperature as measured by the DHW sensor.	14 to 266°F (-10 to 130°C)
	Factory Installer	MODULATION Current modulating output percentage.	0 to 100%
	Factory	BOILER HOURS The total number of running hours of the boiler since this item was last cleared. Clear the numbers of hours by pressing and holding the Up and Down buttons together while viewing this item.	0 to 999

Table I: View Menu, Mode 3

ADJUST MENU
(Page 1 of 2)

The Adjust menu items are the programmable settings used to operate the system. Press and hold all three buttons for one second to enter the Adjust menu, then select the desired item using the Item button. Finally, use the ▲ or ▼ button to make the adjustment (see Fig. 5).

MODE 3
(With Default Settings Shown)

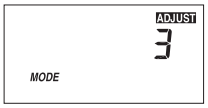
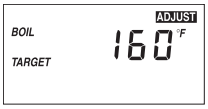
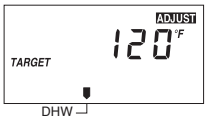
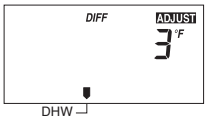
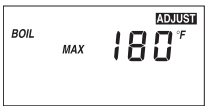
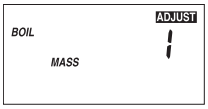
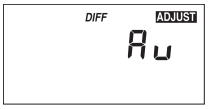
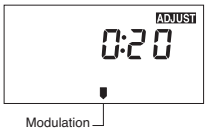
Item Field	Access	Description	Range	Settings
	Factory Installer	MODE Select the operating mode for the control.	1, 2, 3, 4, 5, 6, 7, 8 Default = 2	
	Factory Installer	BOILER TARGET Select the boiler target temperature for setpoint operation.	OFF, 70 to 220°F (OFF, 21 to 104°C) Default = 160°F (71°C)	
	Factory Installer	DHW TARGET Select the DHW tank temperature.	OFF, 70 to 190°F (OFF, 21 to 88°C) Default = 120°F (49°C)	
	Factory Installer	DHW DIFFERENTIAL Select the DHW tank differential.	2 to 10°F (1 to 5°C) Default = 3°F (1°C)	
	Factory	BOILER MAXIMUM Select the maximum boiler target water temperature.	120 to 225°F, OFF (49 to 107°C, OFF) Default = 180°F (82°C)	
	Factory	BOILER MINIMUM Select the minimum temperature allowed for the boiler target temperature.	OFF, 80 to 180°F (OFF, 27 to 82°C) Default = 125°F (52°C)	
	Factory	FIRE DELAY Select the amount of time required for combustion pre-purging, ignition and the flame to be established.	0:00 to 3:00 minutes Default = 0:10 min (1 second increments)	
	Factory Installer	BOILER MASS Select the thermal mass of the boiler.	1 (low mass) 2 (medium mass) 3 (high mass) Default = 1	
	Factory	DIFFERENTIAL Select the differential that the control is to use when it is operating the boiler.	Au, 2 to 42°F (Au, 1 to 23°C) Default = Au	
	Factory	MODULATION Select the analog modulation signal range.	0:20 or 4:20 Default = 0:20	

Table J: Adjust Menu, Mode 3 (page 1 of 2)

ADJUST MENU
(Page 2 of 2)

MODE 3
(With Default Settings Shown)

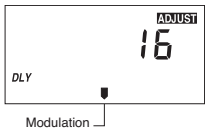
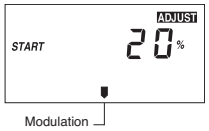
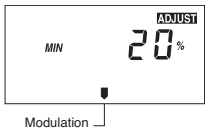
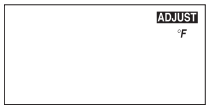
Item Field	Access	Description	Range	Settings
	Factory	MODULATION DELAY Select the rate at which the modulation signal changes from the Minimum Modulation setting to the Maximum Modulation setting.	10 to 230 seconds Default = 16 seconds	
	Factory	START MODULATION Select the percent modulation required for ignition.	0 to 50% Default = 20%	
	Factory	MINIMUM MODULATION Select the minimum modulation during burner operation.	0 to 50% Default = 20%	
	Factory	PUMP DELAY Select the boiler pump purge time after the burner is shut off.	OFF, 0:20 to 9:55 min, On Default = 5:00 min	
	Factory Installer	TEMPERATURE UNITS Select to display temperature in degrees Fahrenheit or in degrees Celsius.	°F, °C Default = °F	

Table K: Adjust Menu, Mode 3 (page 2 of 2)

VIEW MENU

The View menu items display current operating temperatures and system status information. Use the Item button (see Fig. 4) to view items in this menu.

MODE 5
(With Default Settings Shown)

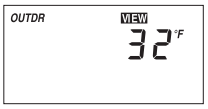
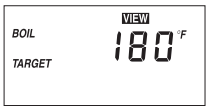
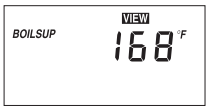
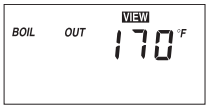
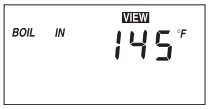
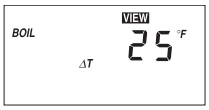
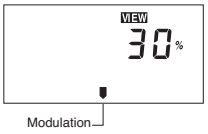
Item Field	Access	Description	Range
	Factory Installer	OUTDOOR Current outdoor air temperature as measured by the outdoor sensor.	-60 to 190°F (-51 to 88°C)
	Factory Installer	BOILER TARGET The boiler target is the temperature the control is currently trying to maintain at the boiler supply sensor or the boiler outlet sensor.	– – –, 35 to 226°F, OFF (– – –, 2 to 108°C, OFF)
	Factory Installer	BOILER SUPPLY Current boiler supply water temperature as measured by the boiler supply sensor. Note: This item is only available when MODE is set to 5.	14 to 266°F (-10 to 130°C)
	Factory Installer	BOILER OUTLET Current boiler outlet water temperature as measured by the boiler outlet sensor. Note: When MODE is set to 5 this item is only visible in the Factory access level.	14 to 266°F (-10 to 130°C)
	Factory Installer	BOILER INLET Current boiler inlet water temperature as measured by the boiler inlet sensor. Note: This item is only available when a boiler inlet sensor is installed.	14 to 266°F (-10 to 130°C)
	Factory	BOILER DELTA T Current temperature difference between the boiler outlet sensor and the boiler inlet sensor. Note: This item is only available when a boiler inlet sensor is installed.	0 to 252°F (0 to 140°C)
	Factory Installer	MODULATION Current modulating output percentage.	0 to 100%
	Factory	BOILER HOURS The total number of running hours of the boiler since this item was last cleared. Clear the numbers of hours by pressing and holding the Up and Down buttons together while viewing this item.	0 to 999

Table L: View Menu, Mode 5

ADJUST MENU
(Page 1 of 2)

The Adjust menu items are the programmable settings used to operate the system. Press and hold all three buttons for one second to enter the Adjust menu, then select the desired item using the Item button. Finally, use the ▲ or ▼ button to make the adjustment (see Fig. 5).

MODE 5
(With Default Settings Shown)

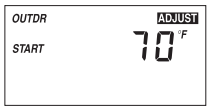
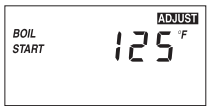
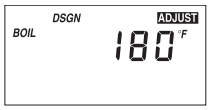
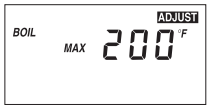
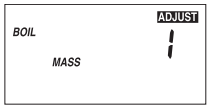
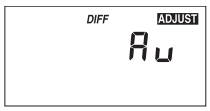
Item Field	Access	Description	Range	Settings
	Factory Installer	MODE Select the operating mode for the control.	1, 2, 3, 4, 5, 6, 7, 8 Default = 2	
	Factory Installer	OUTDOOR START The outdoor starting temperature used in the reset ratio for the heating system. Typically set to the desired building temperature.	35 to 85°F (2 to 29°C) Default = 70°F (21°C)	
	Factory Installer	OUTDOOR DESIGN The outdoor design temperature used in the reset ratio for the heating system. Set to the coldest annual outdoor temperature in the local area.	-60 to 32°F (-51 to 0°C) Default = -10°F (-23°C)	
	Factory Installer	BOILER START The starting water temperature used in the reset ratio calculation for the heating system. Typically set to the desired building temperature.	35 to 150°F (2 to 66°C) Default = 125°F (52°C)	
	Factory Installer	BOILER DESIGN The boiler design water temperature used in the reset ratio calculation for the heating system. Set to the boiler water temperature required to heat the building on the coldest annual outdoor temperature.	70 to 220°F (21 to 104°C) Default = 180°F (82°C)	
	Factory	BOILER MAXIMUM Select the maximum boiler target water temperature.	120 to 225°F, OFF (49 to 107°C, OFF) Default = 200°F (93°C)	
	Factory	BOILER MINIMUM Select the minimum temperature allowed for the boiler target temperature.	OFF, 80 to 180°F (OFF, 27 to 82°C) Default = 125°F (52°C)	
	Factory	FIRE DELAY The amount time required for combustion pre-purging, ignition and the flame to be established. The control will not adjust the modulation percentage from the Start Modulation percentage until this delay elapses.	0:00 to 3:00 minutes Default = 0:10 min (1 second increments)	
	Factory Installer	BOILER MASS Select the thermal mass of the boiler.	1 (low mass) 2 (medium mass) 3 (high mass) Default = 1	
	Factory	DIFFERENTIAL Select the differential that the control is to use when it is operating the boiler.	Au, 2 to 42°F (Au, 1 to 23°C) Default = Au	

Table M: Adjust Menu, Mode 5 (page 1 of 2)

ADJUST MENU
(Page 2 of 2)

MODE 5
(With Default Settings Shown)

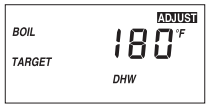
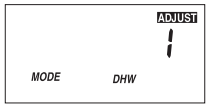
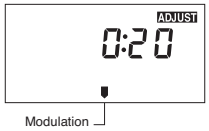
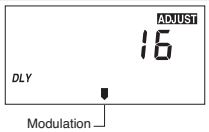
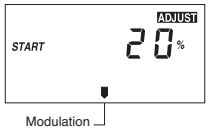
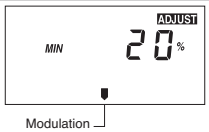
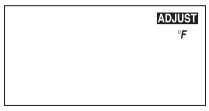
Item Field	Access	Description	Range	Settings
	Factory	DHW BOILER TARGET Select the boiler target temperature while heating an indirect DHW tank.	70 to 220°F (21 to 104°C) Default = 180°F (82°C)	
	Factory	DHW MODE Select no priority (1) or priority (2) of indirect DHW heating over space heating. Note: This item is only available when MODE is set to 4.	1, 2 Default = 1	
	Factory	MODULATION Select the analog modulation signal range.	0:20 or 4:20 Default = 0:20	
	Factory	MODULATION DELAY Select the rate at which the modulation signal changes from the Minimum Modulation setting to the Maximum Modulation setting.	10 to 230 seconds Default = 16 seconds	
	Factory	START MODULATION Select the percent modulation required for ignition.	0 to 50% Default = 20%	
	Factory	MINIMUM MODULATION Select the minimum modulation during burner operation.	0 to 50% Default = 20%	
	Factory	PUMP DELAY Select the boiler pump purge time after shutting off the burner.	OFF, 0:20 to 9:55 min, On Default = 5:00 min	
	Factory Installer	WARM WEATHER SHUT DOWN Select the space heating system's warm weather shut down when using outdoor reset. The control continues to respond to heat the DHW tank.	35 to 100°F, OFF (2 to 38°C, OFF) Default = 70°F (21°C)	
	Factory Installer	TEMPERATURE UNITS Select to display temperature in degrees Fahrenheit or in degrees Celsius.	°F, °C Default = °F	

Table N: Adjust Menu, Mode 5 (page 2 of 2)

VIEW MENU

The View menu items display current operating temperatures and system status information. Use the Item button (see Fig. 4) to view items in this menu.

MODE 7
(With Default Settings Shown)

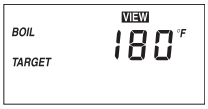
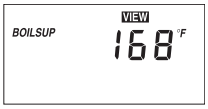
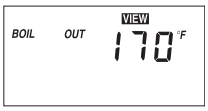
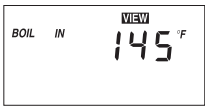
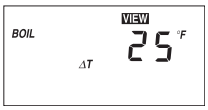
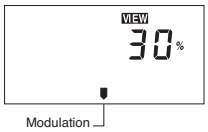
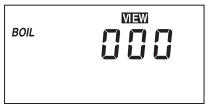
Item Field	Access	Description	Range
	Factory Installer	BOILER TARGET The boiler target is the temperature the control is currently trying to maintain at the boiler supply sensor or the boiler outlet sensor.	– – –, 35 to 226°F, OFF (– – –, 2 to 108°C, OFF)
	Factory Installer	BOILER SUPPLY SENSOR Current boiler supply water temperature as measured by the boiler supply sensor. Note: This item is only available when MODE is set to 7.	14 to 266°F (-10 to 130°C)
	Factory Installer	BOILER OUTLET Current boiler outlet water temperature as measured by the boiler outlet sensor. Note: When MODE is set to 7 this item is only visible in the Factory access level.	14 to 266°F (-10 to 130°C)
	Factory Installer	BOILER INLET Current boiler inlet water temperature as measured by the boiler inlet sensor. Note: This item is only available when a boiler inlet sensor is installed.	14 to 266°F (-10 to 130°C)
	Factory	BOILER DELTA T Current temperature difference between the boiler outlet sensor and the boiler inlet sensor. Note: This item is only available when a boiler inlet sensor is installed.	0 to 252°F (0 to 140°C)
	Factory Installer	MODULATION Current modulating output percentage.	0 to 100%
	Factory	BOILER HOURS The total number of running hours of the boiler since this item was last cleared. Clear the numbers of hours by pressing and holding the Up and Down buttons together while viewing this item.	0 to 999

Table O: View Menu, Mode 7

ADJUST MENU
(Page 1 of 2)

The Adjust menu items are the programmable settings used to operate the system. Press and hold all three buttons for one second to enter the Adjust menu, then select the desired item using the Item button. Finally, use the ▲ or ▼ button to make the adjustment (see Fig. 5).

MODE 7
(With Default Settings Shown)

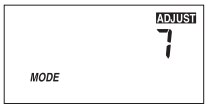
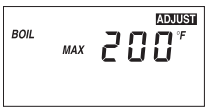
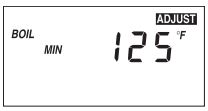
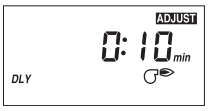
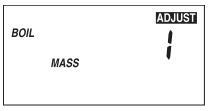
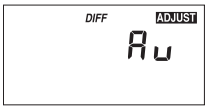
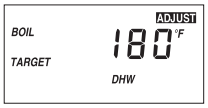
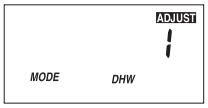
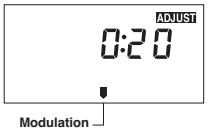
Item Field	Access	Description	Range	Settings
	Factory Installer	MODE Select the operating mode for the control.	1, 2, 3, 4, 5, 6, 7, 8 Default = 2	
	Factory	BOILER MAXIMUM Select the maximum boiler target water temperature.	120 to 225°F, OFF (49 to 107°C, OFF) Default = 200°F (93°C)	
	Factory	BOILER MINIMUM Select the minimum temperature allowed for the boiler target temperature.	OFF, 80 to 180°F (OFF, 27 to 82°C) Default = 125°F (52°C)	
	Factory	FIRE DELAY The amount time required for combustion pre-purging, ignition and the flame to be established. The control will not adjust the modulation percentage from the Start Modulation percentage until this delay elapses.	0:00 to 3:00 minutes Default = 0:10 min	
	Factory Installer	BOILER MASS Select the thermal mass of the boiler.	1 (low mass) 2 (medium mass) 3 (high mass) Default = 1	
	Factory	DIFFERENTIAL Select the differential that the control is to use when it is operating the boiler.	Au, 2 to 42°F (Au, 1 to 23°C) Default = Au	
	Factory	DHW BOILER TARGET Select the boiler target temperature while heating an indirect DHW tank.	OFF, 70 to 220°F (OFF, 21 to 104°C) Default = 180°F (82°C)	
	Factory	DHW MODE Select no priority (1) or priority (2) of indirect DHW heating over space heating. Note: This item is only available when MODE is set to 6.	1, 2 Default = 1	
	Factory	MODULATION Select the analog modulation signal range.	0:20 or 4:20 Default = 0:20	

Table P: Adjust Menu, Mode 7 (page 1 of 2)

ADJUST MENU
(Page 2 of 2)

MODE 7
(With Default Settings Shown)

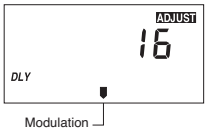
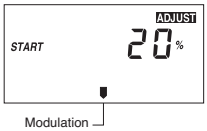
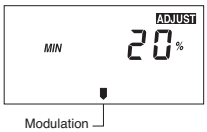
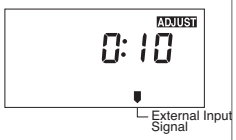
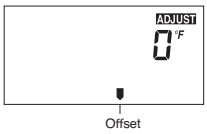
Item Field	Access	Description	Range	Settings
	Factory	MODULATION DELAY Select the rate at which the modulation signal changes from the Minimum Modulation setting to the Maximum Modulation setting.	10 to 230 secodns Default = 16 seconds	
	Factory	START MODULATION Select the percent modulation required for ignition.	0 to 50% Default = 20%	
	Factory	MINIMUM MODULATION Select the minimum modulation during burner operation.	0 to 50% Default = 20%	
	Factory	PUMP DELAY Select the boiler pump purge time after shutting off the burner.	OFF, 0:20 to 9:55 min, On Default = 5:00 min	
	Factory	EXTERNAL INPUT SIGNAL Select the range of the external input signal.	0:10 or 2:10 Default = 0:10	
	Factory	OFFSET Select the amount of offset when the boiler target is determined from an external input signal.	-10 to 10°F (-5 to +5°C) Default = 0°F (0°C)	
	Factory Installer	TEMPERATURE UNITS Select to display temperature in degrees Fahrenheit or in degrees Celsius.	°F, °C Default = °F	

Table Q: Adjust Menu, Mode 7 (page 2 of 2)

VIEW MENU

MODE 8
(With Default Settings Shown)

The View menu items display current operating temperatures and system status information. Use the Item button (see Fig. 4) to view items in this menu.

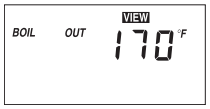
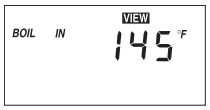
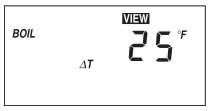
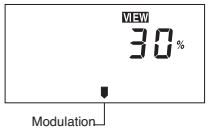
Item Field	Access	Description	Range
	Factory Installer	BOILER OUTLET Current boiler outlet water temperature as measured by the boiler outlet sensor.	14 to 266°F (-10 to 130°C)
	Factory Installer	BOILER INLET Current boiler inlet water temperature as measured by the boiler inlet sensor. Note: This item is only available when a boiler inlet sensor is installed.	14 to 266°F (-10 to 130°C)
	Factory	BOILER DELTA T Current temperature difference between the boiler outlet sensor and the boiler inlet sensor. Note: This item is only available when a boiler inlet sensor is installed.	0 to 252°F (0 to 140°C)
	Factory Installer	MODULATION Current modulating output percentage.	0 to 100%
	Factory	BOILER HOURS The total number of running hours of the boiler since this item was last cleared. Clear the numbers of hours by press and holding the Up and Down buttons together while viewing this item.	0 to 999

Table R: View Menu, Mode 8

ADJUST MENU

The Adjust menu items are the programmable settings used to operate the system. Press and hold all three buttons for one second to enter the Adjust menu, then select the desired item using the Item button. Finally, use the ▲ or ▼ button to make the adjustment (see Fig. 5).

MODE 8
(With Default Settings Shown)

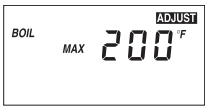
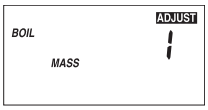
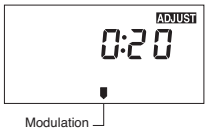
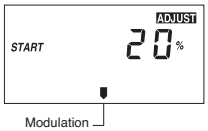
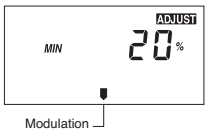
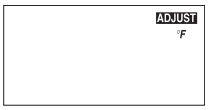
Item Field	Access	Description	Range	Settings
	Factory Installer	MODE Select the operating mode for the control.	1, 2, 3, 4, 5, 6, 7, 8 Default = 2	
	Factory	BOILER MAXIMUM Select the maximum boiler water temperature.	120 to 225°F, OFF (49 to 107°C, OFF) Default = 200°F (93°C)	
	Factory	FIRE DELAY Select the amount time required for combustion pre-purging, ignition and the flame to be established. The control will not adjust the modulation percentage from the Start Modulation percentage until this delay elapses.	0:00 to 3:00 minutes Default = 0:10 min (1 second increments)	
	Factory Installer	BOILER MASS Select the thermal mass of the boiler.	1 (low mass) 2 (medium mass) 3 (high mass) Default = 1	
	Factory	MODULATION Select the analog modulation signal range.	0:20 or 4:20 Default = 0:20	
	Factory	START MODULATION Select the percent modulation required for ignition.	0 to 50% Default = 20%	
	Factory	MINIMUM MODULATION Select the minimum modulation during burner operation.	0 to 50% Default = 20%	
	Factory	PUMP DELAY Select the boiler pump purge time after shutting off the burner.	OFF, 0:20 to 9:55 min, On Default = 5:00 min	
	Factory Installer	TEMPERATURE UNITS Select to display temperature in degrees Fahrenheit or in degrees Celsius.	°F, °C Default = °F	

Table S: Adjust Menu, Mode 8

ERROR MESSAGES

(Page 1 of 2)

ALL MODES

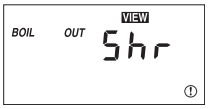
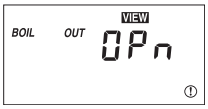
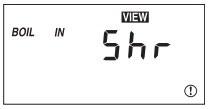
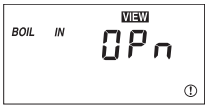
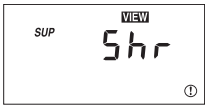
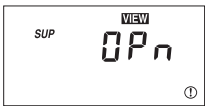
Error Message	Description
	E01 The control was unable to read a piece of information from its EEPROM memory. The control will stop operation until all settings in the Adjust menu have been checked by the user or installer. To clear the error message, set Access Level DIP Switch A to Factory (on position), then check all Adjust menu items.
	BOILER OUTLET SENSOR SHORT CIRCUIT The control is no longer able to read the boiler outlet sensor due to a short circuit. In this case, if the boiler inlet sensor is present and operational, the control will operate using the boiler inlet sensor. Otherwise, the control will not operate the burner. Test the boiler outlet sensor and related wiring. The error message will clear once the error condition is corrected and a button is pressed.
	BOILER OUTLET SENSOR OPEN CIRCUIT The control is no longer able to read the boiler outlet sensor due to an open circuit. In this case, if the boiler inlet sensor is present and operational, the control will operate using the boiler inlet sensor. Otherwise, the control will not operate the burner. Test the boiler outlet sensor and related wiring. The error message will clear once the error condition is corrected and a button is pressed.
	BOILER INLET SENSOR SHORT CIRCUIT The control is no longer able to read the boiler inlet sensor due to a short circuit. In this case, the control will continue operation. Test the boiler inlet sensor and related wiring. The error message will clear once the error condition is corrected and a button is pressed.
	BOILER INLET SENSOR OPEN CIRCUIT The control is no longer able to read the boiler inlet sensor due to an open circuit. In this case, the control will continue operation. Test the boiler inlet sensor and related wiring. The error message will clear once the error condition is corrected and a button is pressed.
	BOILER SUPPLY SENSOR SHORT CIRCUIT The control is no longer able to read the boiler supply sensor due to a short circuit. In this case, if the boiler outlet sensor is operational, the control will operate based on the boiler outlet sensor. If the boiler outlet sensor is not available and the boiler inlet sensor is present and operational, the control will operate using the boiler inlet sensor. Otherwise, the control will not operate the burner. Test the boiler supply sensor and related wiring. The error message will clear once the error condition is corrected and a button is pressed.
	BOILER SUPPLY SENSOR OPEN CIRCUIT The control is no longer able to read the boiler supply sensor due to an open circuit. In this case, if the boiler outlet sensor is operational, the control will operate based on the boiler outlet sensor. If the boiler outlet sensor is not available and the boiler inlet sensor is present and operational, the control will operate using the boiler inlet sensor. Otherwise, the control will not operate the burner. Test the boiler supply sensor and related wiring. The error message will clear once the error condition is corrected and a button is pressed.

Table T: Error Messages (page 1 of 2)

ERROR MESSAGES

(Page 2 of 2)

ALL MODES

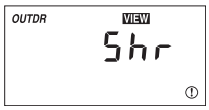
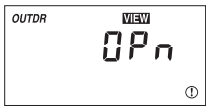
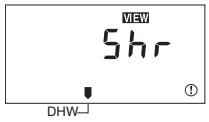
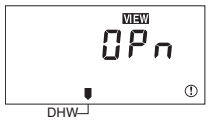
Error Message	Description
	OUTDOOR SENSOR SHORT CIRCUIT The control is no longer able to read the outdoor sensor due to a short circuit. In this case the control assumes an outdoor temperature of 32°F (0°C) and continues operation. Test the outdoor sensor and related wiring. The error message will clear once the error condition is corrected and a button is pressed.
	OUTDOOR SENSOR OPEN CIRCUIT The control is no longer able to read the outdoor sensor due to an open circuit. In this case the control assumes an outdoor temperature of 32°F (0°C) and continues operation. Test the outdoor sensor and related wiring. The error message will clear once the error condition is corrected and a button is pressed.
	DHW SENSOR SHORT CIRCUIT The control is no longer able to read the DHW sensor due to a short circuit. In this case the control will not operate the burner. Test the DHW sensor and related wiring. The error message will clear once the error condition is corrected and a button is pressed.
	DHW SENSOR OPEN CIRCUIT The control is no longer able to read the DHW sensor due to an open circuit. In this case the control will not operate the burner. Test the DHW sensor and related wiring. The error message will clear once the error condition is corrected and a button is pressed.

Table U: Error Messages (page 2 of 2)

TECHNICAL DATA
(Controller only)

Controller	Microprocessor PID control; This is not a safety (limit) control
Enclosure	Enclosure D, black Noryl plastic
Dimensions	4-3/4" H x 2-7/8" W x 1-7/8" D (120 x 74 x 48 mm)
Approvals	CSA C US, meets ICES & FCC regulations for EMI/RFI
Ambient Conditions	-40 to 140 ºF (-40 to -60ºC), <90% RH non-condensing
Power Supply	24 VAC ±10% 50/60 Hz, 75 VA
Demands	24VAC 3 VA without alarm; 24 VAC 75 VA with alarm
Pump/Stage 1 Relay	120 VAC 5 A 1/6 hp, pilot duty 240 VA
Modulating Analog (mA)	0/4-20 mA (1000Ω Maximum)
Modulating Digital (PWM)	3kHz carrier frequency, 0 to 100% PWM range, supply 26V (dc) through 13kΩ sink, 0.5V (dc) through 1kΩ
Alarm Relay	24 VAC 3 A 1/6 hp
Sensors	NTC thermistor, 10kΩ @ 77 ºF (25ºC ±0.2ºC) 3 universal water sensors - P/N 601755 1 outdoor air sensor - P/N 601756

Table V: Technical Data

QUICK START SET-UP & PROGRAMMING TIPS

1. Determine piping arrangement and mode number as depicted on pages 5 through 7.

2. Install system sensor and air sensor (for Mode 5 only) as positioned in the mode arrangements located on page 6.

3. Wire the sensors to the Controller as described in Fig. 22 on page 17.

4. Ensure that entire system is ready to start.

   a. Water piping properly filled and purged.
   b. Gas pipe properly installed and purged.
   c. Electrical connections properly installed in conduit.
   d. Vent properly installed and terminated.
   e. Sensor wires properly routed in separate conduit.

5. Turn on heater power to allow programming the Controller.

6. After piping mode has been determined, program Controller as described on pages 5 to 7. Remember that the "*Item*", "▲" & "▼" buttons (all three) must be pressed simultaneously for one second to enter the program mode.

7. Use mode settings as a guide to set up the Controller. Your settings may differ from the values given in the manual depending upon the temperature settings required.

8. After programming Controller, the settings will be automatically saved after 20 seconds of keypad inactivity.

9. If the Controller display indicates any error(s), turn to page 32 to identify and correct the error(s) that are displayed.

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