

# tekmar® - Data Brochure

## Mixing Reset Module 421

tN4

D421

08/07

### 1 Information Brochure

Choose controls to match application

### 2 Application Brochure

Design your mechanical applications

### 3 Rough-in Wiring

Rough-in wiring instructions

### 4 Wiring Brochure

Wiring and installation of specific control

### 5 Data Brochure

Control settings and sequence of operation

### 6 Job Record

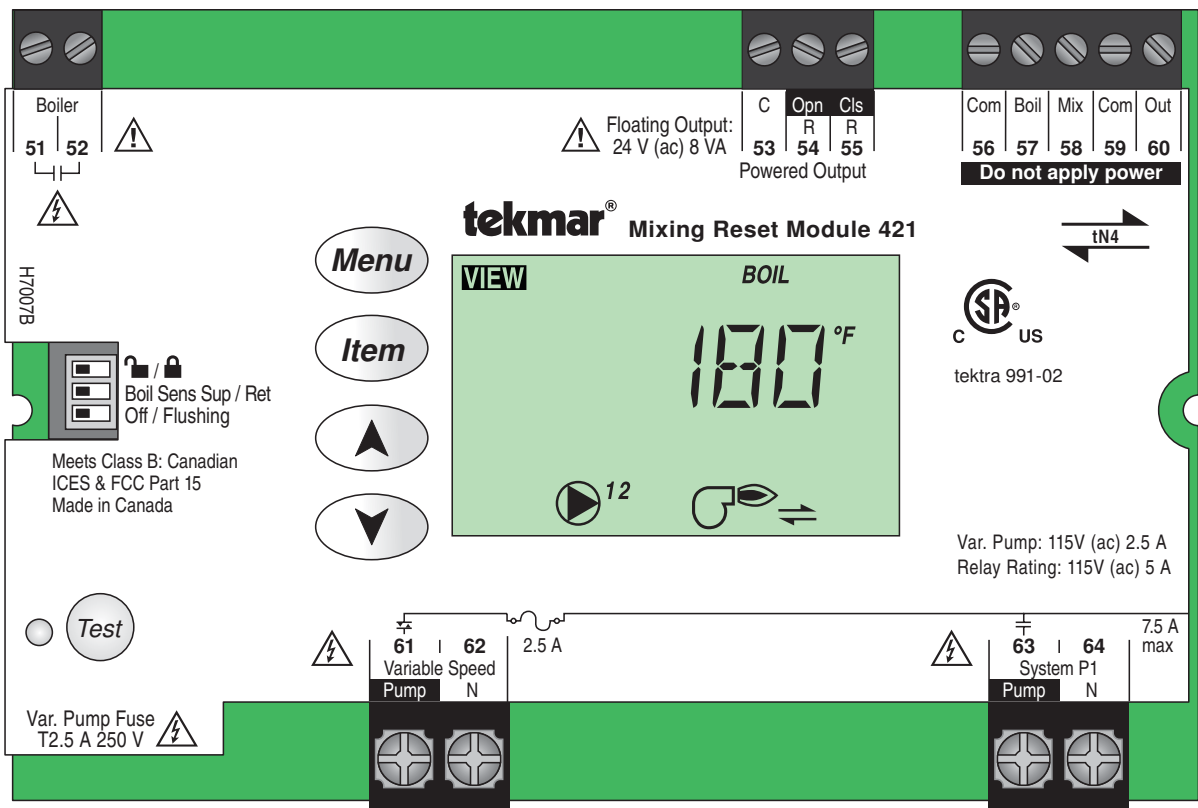
Record settings & wiring details for future reference

## Introduction

The Mixing Reset Module 421 provides outdoor reset to a hydronic heating system in order to maximize comfort and efficiency. The 421 can operate a single on / off boiler and a single mix water temperature. The mix output can operate a floating action mixing valve or a variable speed injection pump.

## Features:

- tN4 Compatible
- Outdoor Reset
- Single On-Off Boiler
- Powered Pump Outputs
- Variable Speed Injection Pump
- Floating Action Valve
- Includes Sensors



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## Display and DIP Switches

### Dip Switch Settings

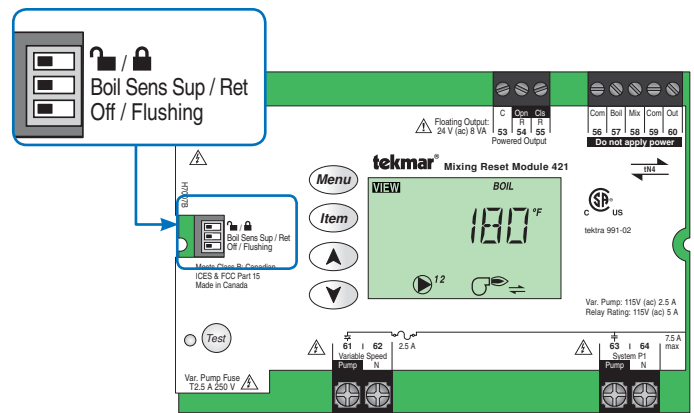
Set the DIP switch settings prior to making adjustments to the control through the user interface. Setting the DIP switches determines which menu items are displayed in the user interface.

If you change a DIP switch setting while the control is powered up, the LCD display returns to the View menu.

#### Lock / Unlock

Use the Lock/Unlock DIP switch to lock and unlock the Access Level of the 421 and all connected tN4 devices, including tN4 thermostats. For details, see “Access Levels”

- Once locked, the access level in all devices cannot be viewed or changed.
- To determine if the control is currently locked a small segment representing a padlock is viewed in the bottom right hand corner of the display.
- To unlock the Access Level, set the DIP switch to Unlock.
- To lock the Access Level, set the DIP switch to Lock.



### Boiler Sup/Ret

Use the Boiler Sensor Supply/Return DIP switch to select the location of the boiler sensor.

- If the boiler sensor is located on the supply, this DIP switch should be set to Sup. The 421 is the control that determines the boiler water temperature. Set the boiler's aquastat at least 20°F (11.0°C) higher than the Boiler Maximum setting.
- If the 421 provides a heat demand to an external boiler control, this DIP switch must be set to Ret. Install the boiler sensor on the return side of the boiler loop. The boiler's operating temperature is controlled by its aquastat, or an external boiler reset control.

### Off/Flushing

The Off/Flushing DIP switch selects whether the control operates a Flushing feature. Heating systems that use potable water require periodic flushing to prevent the water from stagnating.

The flushing operation occurs if any zone has not operated for 7 days. All zones, mixing device(s), and applicable system pumps are turned on for 4 minutes.

- To activate the Flushing feature, set to Flushing.
- To deactivate the Flushing feature, set to Off.

### Access Level

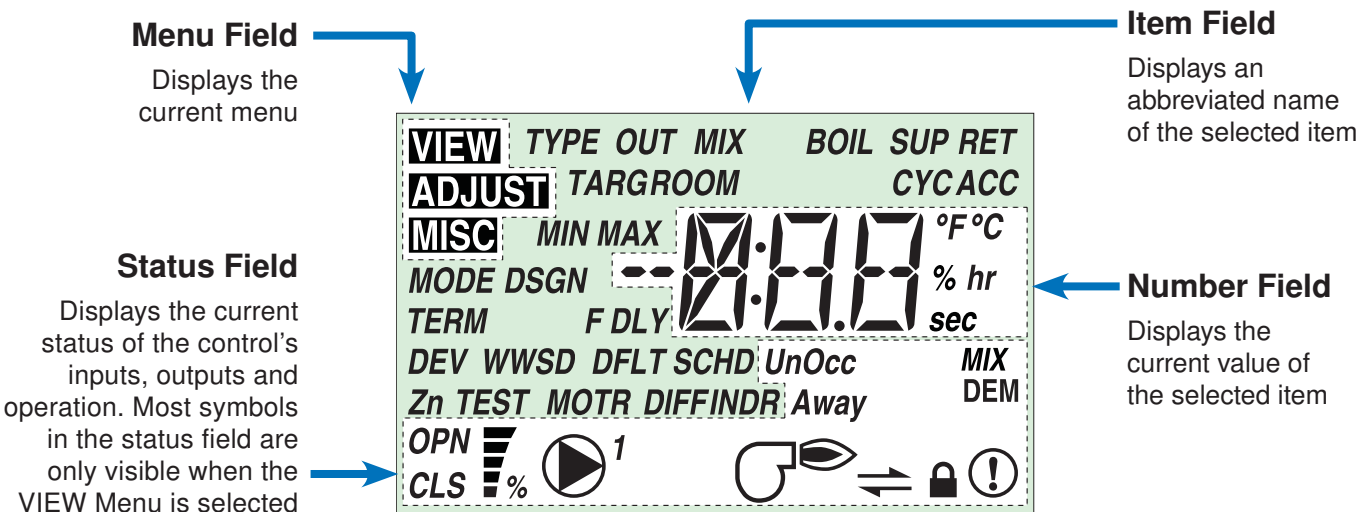
The Access Level restricts the number of Menus, Items, and Adjustments that can be accessed by the user. The Access Level setting is found in the Miscellaneous (MISC) menu. Select the appropriate access level for the people who work with the control on a regular basis.

There are two Access Level settings:







- Installer (InS): This is the factory default setting. This access level is sufficient for the normal set up of the control.
- Advanced (Ad): All of the control settings are available to the user.

In the following menu tables, the access level the item is visible in is shown in the access column.

## Display



Symbols	Description
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 <p><b>PUMP</b> Displays when the mixing pump is in operation.</p>	<p><b>°F °C</b> <b>% hr</b> <b>sec</b></p> <p><b>°F, °C, %, HOURS, MINUTES</b> Units of measurement.</p>
 <p><b>BURNER</b> Displays when the burner contact is closed.</p>	<p><b>MIX1</b> <b>DEM</b></p> <p><b>MIX 1 DEMAND</b> Displays when a mix 1 demand is present.</p>
 <p><b>LOCK</b> Displays when the access levels are locked.</p>	 <p><b>DEVICE OUTPUT SCALE</b> Displays output of the injection pump or mixing valve.</p>
 <p><b>WARNING</b> Displays when an error exists.</p>	<p><b>OPN</b> <b>CLS</b></p> <p><b>OPEN / CLOSE</b> Displays whether the actuator is opening or closing the mixing valve.</p>
 <p><b>COMMUNICATION BUS</b> Displays when tN4 thermostats are connected.</p>	

## User Interface

Use the User Interface available on the Liquid Crystal Display (LCD) to setup and monitor the operation of the system. Use the four push buttons to the left of the LCD (Menu, Item, Up, Down) to select settings. As you enter settings, record the settings in the Job Record J 421.

### Menu

The menu display in the Menu Field at the top left side of the LCD. Three menus are available: View, Adjust, and Miscellaneous.

- To select a menu, press and release the Menu button.

### Item

In each menu, a group of items can be selected. The abbreviated name of the selected item displays in the Item field of the LCD display.

- To view the next available item, press and release the Item button.
- To view the previous item, hold down the Item button, and press and release the Up button.

## Adjusting a Setting

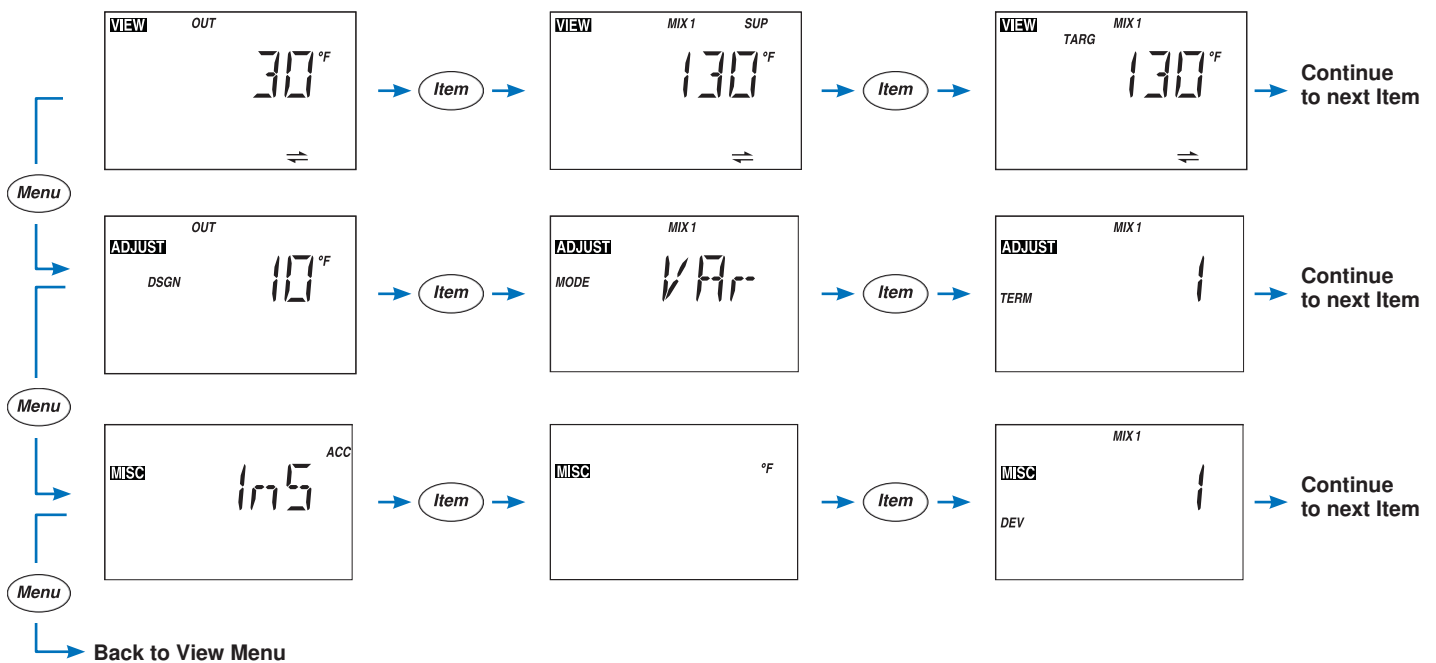
To adjust a setting:

1. Select the appropriate menu using the Menu button.
2. Select the item using the Item button.
3. Use the Up or Down button to make the adjustment.

### Default Item

- To set the default item in the View menu, display the item for more than five seconds.

After navigating menus, the display reverts back to the default item after 60 seconds of button inactivity.



# Display Menus

## View Menu (1 of 1)

Menu

Item

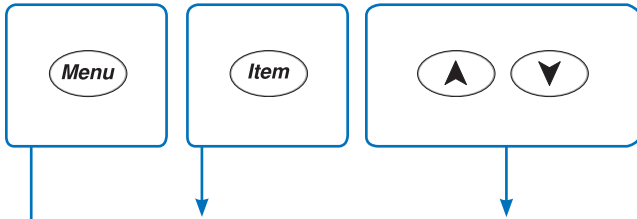
The View menu items display the current operating temperatures and status information of the system.

VIEW MENU

Item Field	Range	Access	Description
<div>VIEW OUT</div> <div>30°F</div> <div>⇒</div>	-76 to 149°F (-60.0 to 65.0°C)	InS Ad	<b>OUTDOOR</b> <a href="#">SECTION B</a> Current outdoor air temperature as measured by the outdoor sensor.
<div>VIEW MIX 1 SUP</div> <div>130°F</div> <div>⇒</div>	-22 to 266°F (-30.0 to 130.0°C)	InS Ad	<b>MIX SUPPLY</b> <a href="#">SECTION B</a> Current mix supply water temperature as measured by the mix supply sensor.
<div>VIEW MIX 1 TARG</div> <div>130°F</div> <div>⇒</div>	---, 35 to 230°F (---, 1.5 to 110.0°C)	Ad	<b>MIX TARGET</b> <a href="#">SECTION C</a> The Mix target is the temperature the control is currently trying to maintain at the mix supply sensor. "---" is displayed when no heat is required for mix zones.
<div>VIEW BOIL SUP</div> <div>160°F</div> <div>⇒</div>	-22 to 266°F (-30.0 to 130.0°C)	InS Ad	<b>BOILER SUPPLY</b> <a href="#">SECTION C</a> Current boiler supply water temperature as measured by the boiler sensor. <b>Note:</b> This item is only available when the Boiler Sensor Sup / Ret DIP switch is set to Sup.
<div>VIEW BOIL RET</div> <div>140°F</div> <div>⇒</div>	-22 to 266°F (-30.0 to 130.0°C)	InS Ad	<b>BOILER RETURN</b> Current boiler return water temperature as measured by the boiler sensor. <b>Note:</b> This item is only available when the Boiler Sensor Sup / Ret DIP switch is set to Ret.
<div>VIEW BOIL</div> <div>0 hr</div>	0 to 9999 hr	InS Ad	<b>BOILER RUN TIME</b> The total running time of the boiler since this item was last cleared. To clear this item, press the Up and Down buttons simultaneously while viewing this item. <b>Note:</b> This item is only available when the Boiler Sensor Sup / Ret DIP switch is set to Sup.

After the last item, the control returns to the first item in the menu.

## Adjust Menu (1 of 2)



The Adjust Menu items are the programmable settings used to operate the mechanical equipment.


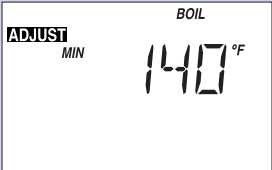
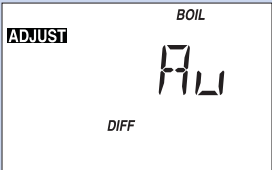


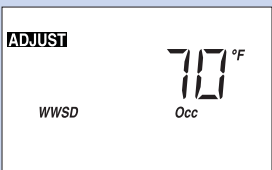
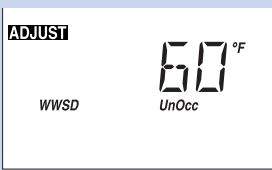
### ADJUST MENU

Item Field	Range	Access	Description
<div>OUT</div> <div>ADJUST DSGN 10°F</div>	-60 to 45°F (-51.0 to 7.0°C) Default = 10°F (-12.0°C)	InS Ad	<b>OUTDOOR DESIGN</b> <a href="#">SECTION B</a> The design outdoor air temperature used in the heat loss calculations for the heating system. Typically set to the temperature of the coldest day of the year.
<div>MIX 1</div> <div>ADJUST MODE VAR</div>	VAR, FLt Default = VAR	InS Ad	<b>MIX MODE</b> Select the type of mixing device to be used for mixing. Options are variable speed injection pump (VAR) or floating action (FLt).
<div>MIX 1</div> <div>ADJUST TERM 1</div>	1 HRF1 2 HRF2 3 Fancoil 4 Fin-tube Convactor 5 Radiator 6 Baseboard Default = 1	InS Ad	<b>MIX TERMINAL</b> <a href="#">SECTION B</a> The type of heating terminal units that are being used in the mix temperature zones.
<div>MIX 1</div> <div>ADJUST INDR 70°F</div>	40 to 100°F (4.5 to 38.0°C) Default = 70°F (21.0°C)	Ad	<b>MIX INDOOR</b> <a href="#">SECTION B</a> The design indoor air temperature used in the heat loss calculation for mix zones. Typically set to 70°F (21.0°C).
<div>MIX 1</div> <div>ADJUST DSGN 120°F</div>	70 to 220°F (21.0 to 104.5°C) Default = 120°F (49.0°C)	InS Ad	<b>MIX DESIGN</b> <a href="#">SECTION B</a> The supply water temperature required for the mix temperature zones on the typical coldest day of the year.
<div>MIX 1</div> <div>ADJUST MIN OFF</div>	OFF, 40 to 150°F (OFF, 4.5 to 65.5°C) Default = OFF	Ad	<b>MIX MINIMUM</b> <a href="#">SECTION C</a> The minimum allowed mix target temperature.
<div>MIX 1</div> <div>ADJUST MAX 140°F</div>	80 to 220°F, OFF (26.5 to 104.5°C, OFF) Default = 140°F (60.0°C)	Ad	<b>MIX MAXIMUM</b> <a href="#">SECTION C</a> The maximum allowed mix target temperature.

Continued on next page.

## Adjust Menu (2 of 2)

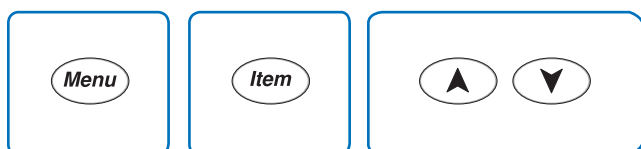
### ADJUST MENU

Item Field	Range	Access	Description
	30 to 230 seconds Default = 105	Ad	<b>MIX MOTOR</b> The time that the actuating motor requires to operate from fully closed to fully open. <b>Note:</b> This item is only available when the Mix Mode setting is set to floating action (FLt).
	OFF, 80 to 180 °F (OFF, 26.5 to 82.0 °C) Default = 140 °F (60.0 °C)	InS Ad	<b>BOILER MINIMUM</b> <a href="#">SECTION D</a> The minimum allowed boiler target temperature and boiler return protection temperature. Check the boiler manufacturer's manual for recommend supply water temperatures.
	Au, 2 to 42 °F (Au, 1 to 23.5 °C) Default = Au	Ad	<b>BOILER DIFFERENTIAL</b> <a href="#">SECTION D</a> The temperature differential that the control is to use when it is operating the boiler. <b>Note:</b> This item is only available when the Boiler Sensor Sup / Ret DIP switch is set to Sup and the tN4 DIP switch is set to Boiler.
	Au, 5 to 30 min Default = Au	Ad	<b>CYCLES PER HOUR</b> The cycle length that all tN4 device heating zones will synchronize to.
	NONE, Mbr1, Mbr2, Mbr3, Mbr4 Default = NONE	InS Ad	<b>SCHEDULE</b> Selects which network setback schedule the control will follow.
	40 to 100 °F, OFF (4.5 to 38.0 °C, OFF) Default = 70 °F (21.0 °C)	InS Ad	<b>WWSD OCCUPIED</b> <a href="#">SECTION B</a> The system's warm weather shut down temperature during the Wake and Occupied periods.
	40 to 100 °F, OFF (4.5 to 38.0 °C, OFF) Default = 60 °F (15.5 °C)	Ad	<b>WWSD UNOCCUPIED</b> <a href="#">SECTION B</a> The system's warm weather shut down temperature during the Sleep and Unoccupied period. <b>Note:</b> This item is only available when the Schedule is not set to OFF.

After the last item, the control returns to the first item in the menu.



## Misc (Miscellaneous) Menu (1 of 1)



The Miscellaneous Menu Items set control and display options such as access level and temperature units.

MISC MENU

Item Field	Range	Access	Description
<div>MISC</div> <div>1n5<sup>ACC</sup></div>	InS (Installer) Ad (Advanced)	InS Ad	<b>ACCESS LEVEL</b> The access level that is to be used by the control. <b>Note:</b> This item is only available when the Lock / Unlock DIP switch is set to Unlock.
<div>MISC</div> <div>°F</div>	°F, °C Default = °F	InS Ad	<b>UNITS</b> Select temperature units between Fahrenheit and Celsius.
<div>MISC</div> <div>MIX 1</div> <div>DEV</div> <div>1</div>	0 to 24	Ad	<b>BUS 1 DEVICES</b> Displays the number of devices on bus 1 (Mixing).
<div>MISC</div> <div>OFF</div> <div>DFLT</div>	OFF, SEL	Ad	<b>FACTORY DEFAULT</b> Loads the factory defaults when the Up and Down buttons are held down for 1 second.
<div>MISC</div> <div>TYPE</div> <div>421</div>	421	InS Ad	<b>TYPE</b> Displays the type number of this product. The software version is displayed when the Up button is held.

- After the last item, the control returns to the first item in the menu.

## Testing the Control

The control has a built-in test routine that tests the main control functions. The control continually monitors the sensors and displays an error message whenever a fault is found. The individual outputs and relays are tested using a test sequence.

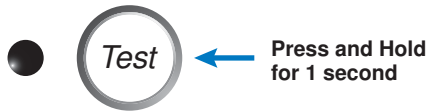
### Test Sequence

Each step in the test sequence lasts 10 seconds.

- Start the test sequence by pressing the Test button.
- Pause the test sequence by pressing the Test button again. To advance to the next step, press the Test button again.
- If the test sequence is paused for more than five minutes, the control exits the entire test routine.
- To advance to a particular step, repeatedly press and release the Test button to display the appropriate device.

### **HAZARD**

Access to the Test button requires the removal of the front cover and exposes hazardous voltage while the control is powered. Only trained, qualified and competent personnel should operate the Test button.



- Step 1** The mix 1 device ramps up to 100% over 10 seconds or according to the motor speed 1 setting.
- Step 2** The mix 1 device ramps down to 0% over 10 seconds or according to the motor speed 1 setting.
- Step 3** The system pump turns on for 10 seconds then shuts off.
- Step 4** The boiler contact turns on the boiler for 10 seconds and then shuts off.
- Step 5** The control exits the test sequence.

If a device fails to operate during the test sequence, refer to the W 421 Wiring Brochure to check the operation of the control. If the control works properly, refer to any troubleshooting information supplied by the equipment manufacturer.

## **Max Heat**

The control has a function called Max Heat. In this mode, the control turns on and operates the system up to the maximum set temperatures as long as there is a demand for heat. tN4 thermostats operate to meet the occupied setting +5°F (3°C). The control operates in this mode for up to 24 hours or until the Test button is pressed. Use this mode to run the circulators during system start-up to purge air from the piping.

- The Mix Maximum setting is available in the Adjust menu when in Max Heat.

### **HAZARD**

Access to the Test button requires the removal of the front cover and exposes hazardous voltage while the control is powered. Only trained, qualified and competent personnel should operate the Test button.



To enable Max Heat:

Press and hold the Test button for more than 3 seconds and less than 6 seconds.

If there is a demand for heat, the 'TEST' and 'MAX' segments are displayed on screen and the control will turn on all outputs for up to 24 hours.

If there is no demand for heat, the 'TEST' and 'MAX' segments are still displayed but no outputs are turned on until there is a demand for heat present.

To Cancel Max Heat:

Press the test button to cancel Max Heat manually or wait 24 hours and the control will automatically leave the Max Heat mode.

## **Zone Test**

In Zone Test mode, each tN4 device is individually turned on one at a time. The control tests each zone for up to 5 minutes of no button activity. Use this feature to purge air out of each zone and assist in troubleshooting.

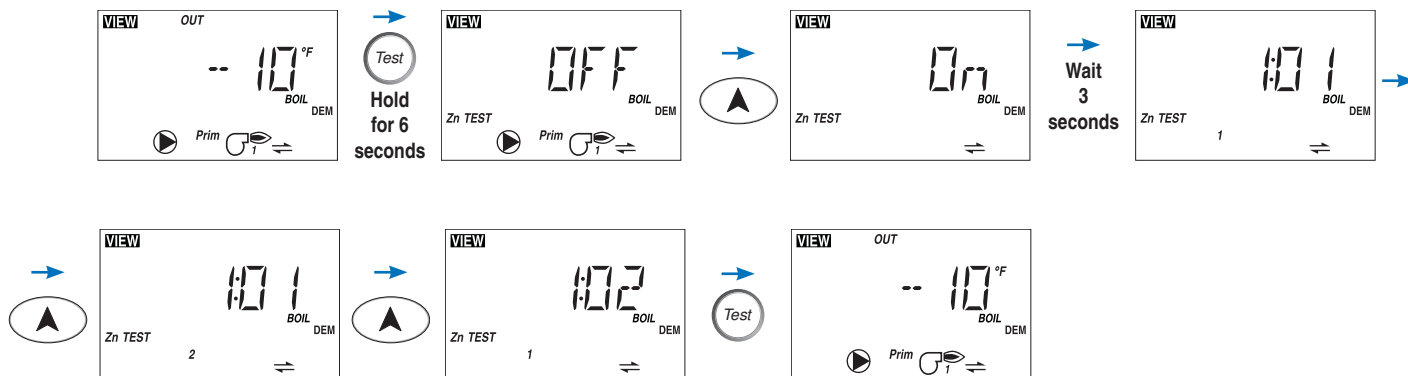
### **HAZARD**

Access to the Test button requires the removal of the front cover and exposes hazardous voltage while the control is powered. Only trained, qualified and competent personnel should operate the Test button.



To enable Zone Test:

1. Press and hold the Test button for more than 6 seconds. The control displays ZN TEST OFF.
2. Press the Up button to change the display to ZN TEST ON. After 3 seconds, the boiler, all pumps, and the mixing valves are shut off.
3. The control operates stage one of the tN4 device with the lowest address number. Device number one of the boiler bus (b:01) has the lowest address number and device 24 of bus 3 (3:24) has the highest address number. All other tN4 zones are shut off.
4. Pressing the Up button will turn off stage 1, and turn on stage 2 of the same device (if that device has a second stage) or turn on stage 1 of the device with the next lowest address. The Down button can be pressed to move to a device with a lower address number. The Up and Down buttons will only move through devices on the same bus.
5. Press the Item button to switch busses. The Up and Down buttons can then be used to move through the devices and the heating stages of each device on the next bus.
6. To cancel the Zone Test, press the Test button. Once the Zone Test ends or is cancelled, the control resumes normal operation.



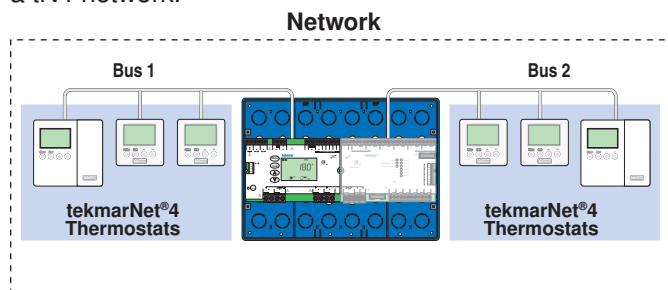
## Sequence of Operation

### tekmarNet®4 Communication

### Section A

tekmarNet®4 (tN4) communicates between tN4 devices (thermostats, Reset Module and Expansion Modules). Each tN4 device is connected to a tN4 communication bus using two wires. Each tN4 bus adjusts a single water temperature in the system using indoor temperature feedback. The Mixing Reset Module 421 allows for one tN4 bus. This allows you to control a system with one water temperature.

A system that has more than one tN4 bus is referred to as a tN4 network.



### Outdoor Reset Module

The Mixing Reset Module 421 is the system control for a hydronic heating system. The 421 operates a single heat source such as a boiler and one mixing device. The 421 also coordinates and optimizes the operation of all the tN4 thermostats.

### tN4 Thermostat

The tN4 thermostat operates heating, cooling, and/or ventilation equipment for a zone. Several tN4 thermostats may work in a group when operating a cooling system. Up to 24 tN4 thermostats can connect to a single tN4 bus.

### Outdoor Reset

### Section B

In a heating system, the rate of heat supplied to the building must equal the rate of which heat is lost. If the two rates are not equal, the building will either cool off or over heat.

The rate of building heat loss depends mostly on the outdoor temperature. Outdoor Reset allows a hot water heating system to increase the water temperature, adding heat to the building, as the outdoor temperature drops. The rate at which the water temperature is changed is defined by the characterized heating curve.

### Characterized Heating Curves

A characterized heating curve determines the amount the supply water temperature is raised for every 1° drop in outdoor air temperature. There is a characterized heating curve for each tN4 communication bus.

The characterized heating curve takes into account the type of terminal unit that the system is using. Since different types of heating terminal units transfer heat to a space using

different proportions of radiation, convection and conduction, the supply water temperature must be controlled differently. Each tN4 bus is assigned a terminal unit setting that the control uses to vary the supply water temperature to suit to the terminal unit used. This improves the control of the air temperature in the building.

### Indoor Temperature Feedback

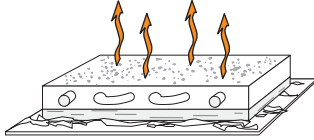
Most buildings have internal heat gains due to people, passive solar heating and mechanical or electrical equipment. Likewise, wind loads cause a building to lose heat faster than during design conditions. If only the outdoor temperature is measured, the control cannot compensate for these internal heat gains or losses and the building may over or under heat. In order to maintain the most comfortable temperature, the control uses indoor temperature feedback from tN4 thermostats in order to adjust the water temperature on each tN4 bus on a continual basis.

## Terminal Unit

There is a terminal unit setting for each tN4 bus. The Terminal Unit setting is found in the Adjust menu.

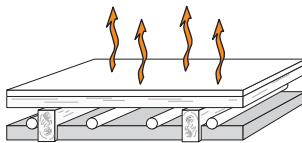
### Hydronic Radiant Floor (1)

Terminal type 1 is a heavy, or high mass, hydronic radiant floor system. This type of a hydronic radiant floor is embedded in either a thick concrete or gypsum pour. This heating system has a large thermal mass and is slow acting.



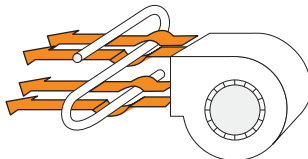
### Hydronic Radiant Floor (2)

Terminal type 2 is a light, or low mass, hydronic radiant floor system. Most commonly, this type of radiant heating system is either attached to the bottom of a wood sub floor, suspended in the joist space, or sandwiched between the subfloor and the surface. This type of radiant system has a relatively low thermal mass and responds faster than a high mass system.



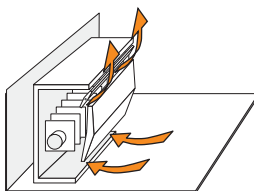
### Fancoil (3)

Terminal type 3 is a fancoil terminal unit or air handling unit (AHU) consisting of a hydronic heating coil and either a fan or blower. Air is forced across the coil at a constant velocity by the fan or blower and is then delivered into the building space.



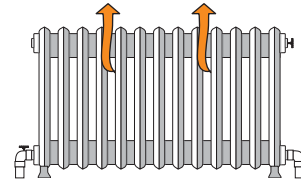
### Fin-tube Convactor (4)

Terminal type 4 is a convactor terminal unit is made up of a heating element with fins on it. This type of terminal unit relies on the natural convection of air across the heating element to deliver heated air into the space. The amount of natural convection is dependant on the supply water temperature to the heating element and the room air temperature.



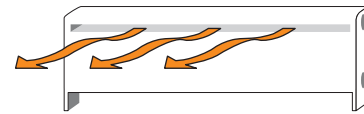
### Radiator (5)

Terminal type 5 is a radiator terminal unit has a large heated surface that is exposed to the room. A radiator provides heat to the room through radiant heat transfer and natural convection.



### Baseboard (6)

Terminal type 6 is a baseboard terminal unit is similar to a radiator, but has a low profile and is installed at the base of the wall. The proportion of heat transferred by radiation from a baseboard is greater than that from a fin-tube convactor.



## Outdoor Design Temperature

The outdoor design temperature is typically the coldest outdoor air temperature of the year. This temperature is used when doing the heat loss calculations for the building and is used to size the heating system equipment. If a cold outdoor design temperature is selected, the supply water temperature rises gradually as the outdoor temperature drops. If a warm outdoor design temperature is selected, the supply water temperature rises rapidly as the outdoor temperature drops.

The outdoor design setting is found in the Adjust menu.

## Warm Weather Shut Down (WWSD)

The Warm Weather Shut Down is the outdoor temperature at which hydronic heating is no longer required. The control closes mixing valves and variable speed pumps are not operated.

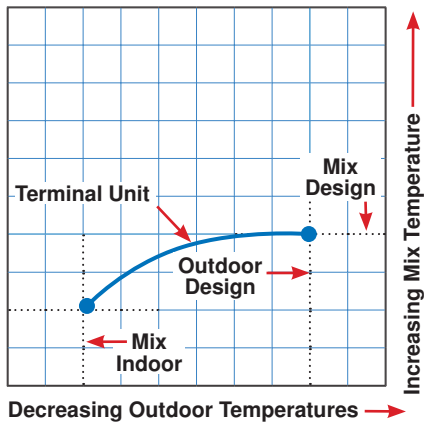
The WWSD setting is found in the Adjust menu.

## Terminal Unit Defaults

When a terminal unit is selected, the control loads default values for the mix design, mix maximum supply, and mix minimum supply temperatures. The factory defaults can be changed to better match the installed system.

- Locate the Mix terminal unit setting in the Adjust menu.

**Mix Characterized Heating Curve**



Terminal Unit	MIX DSGN	MIX MAX	MIX MIN
High Mass Radiant (1)	120°F (49°C)	140°F (60°C)	OFF
Low Mass Radiant (2)	140°F (60°C)	160°F (71°C)	OFF
Fancoil (3)	190°F (88°C)	210°F (99°C)	100°F (38°C)
Fin-Tube Convector (4)	180°F (82°C)	200°F (93°C)	OFF
Radiator (5)	160°F (71°C)	180°F (82°C)	OFF
Baseboard (6)	150°F (76°C)	170°F (77°C)	OFF

## Mix Indoor Design

The Mix indoor design temperature is the indoor temperature the heating designer picked while calculating the heat loss for the building for the Mix water heated zones. This temperature is typically 70°F (21.0°C). This setting establishes the beginning of the Mix characterized heating curve.

- Locate the Mix Indoor Design setting in the Adjust menu.

## Mix Design Temperature

The Mix design supply temperature is the mix supply water temperature required to heat the zones when the outdoor temperature is as cold as the outdoor design temperature.

## Mixing Operation

## Section C

When tN4 thermostats are connected to a communication bus assigned to mixing, the tN4 thermostat determines the necessary water temperature to heat the zone and then requests this water temperature from the reset control. The 421 responds by indicating a Mix Demand symbol in the display, then determines the highest heat requirement of all the zones, and then operates the mixing device to maintain a mix target water temperature.

## Mix Mode

A mixing device allows the control to reduce the boiler water temperature down to a lower water temperature. A mixing device when used with a boiler sensor also allows the control to protect the boiler from sustained flue gas condensation and thermal shock.

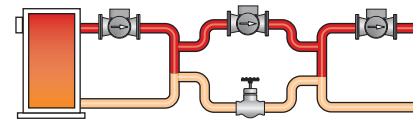
The Mix outputs are built-in to the 421. The type of mixing device is selected using the Mix Mode setting. The mixing devices that can be selected are variable speed injection (VAr) and floating action (FLt).

- Locate the Mix Mode setting in the Adjust menu.

## Variable Speed Injection

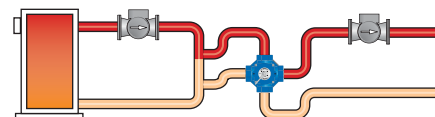
A standard wet rotor circulator can be connected to the Variable Speed output on the control. The control increases or decreases the power output to the circulator when there is a requirement for mixing. The circulator speed varies to maintain the correct mixed supply water temperature at the mix supply sensor. For correct sizing and piping of the

variable speed injection circulator, refer to essay E 021. A visual indication of the current variable speed output is displayed in the LCD in the form of a bar graph.



## Floating Action

A floating action actuator motor can be connected to the control on the Opn and Cls terminals. The control pulses the actuator motor open or close to maintain the correct supply water temperature at the mix supply sensor when there is a requirement for mixing. The mixing valve that the actuator is connected to can be either a 2-way, 3-way or 4-way valve. A visual indication as to whether the control is currently opening or closing the mixing valve is displayed in the LCD with the words OPN and CLS while viewing the Mix Supply or Mix Target temperatures. Also, a visual indication of the current position of the valve is displayed in the form of a bar graph.





## Mix Minimum

The Mix Minimum settings are the lowest temperature that the control is allowed to use as a mix target temperature. During mild conditions, if the control calculates a mix target temperature that is below the mix minimum setting, the mix target temperature is adjusted to match the mix minimum setting. During this condition, if the mixing supply temperature is near the mix minimum setting, the Min segment turns on in the LCD when either the mix target temperature or the mix supply temperature is being viewed.

- Locate the Mix Minimum setting in the Adjust menu.

## Mix Maximum

The Mix Maximum set the highest water temperature that the control is allowed to use as a mix target temperature. If the control does target the mix maximum setting, and the mix supply temperature is near the mix maximum temperature, the Max segment turns on in the LCD when either the mix target temperature or the mix supply temperature is viewed.

- Locate the Mix Maximum setting in the Adjust menu.

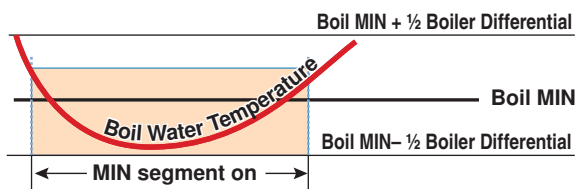
## Boiler Temperature Control

### Section D

To improve boiler efficiency, the boiler sensor can be located on the supply pipe leading from the boiler and the 421's boiler sensor DIP switch is set to Supply. The boiler target temperature is determined using Boiler Load Reset, in which the boiler water temperature is maintained at the lowest possible temperature that satisfies the heating load of the mixing device.

### Boiler Minimum Protection

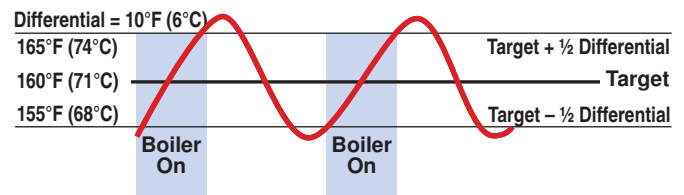
The control is capable of providing boiler protection from cold mixing system return water temperatures. If the boiler water temperature is cooler than the Boiler Minimum setting while the boiler is firing, the control reduces the output from the mixing device. Reducing the mixing output limits the amount of cool return water to the boiler and allows the boiler water temperature to recover. This feature can only be used if the boiler sensor is on the supply or on the return but is not available when the boiler sensor is not present.



### Differential

An on / off heat source must be operated with a differential in order to prevent short cycling. With the control, either a fixed or an auto differential may be selected. The boiler differential is divided around the boiler target temperature. The boiler contact closes when the supply water temperature is 1/2 of the differential setting below the boiler target temperature. As the supply temperature reaches 1/2 of the differential above the boiler target temperature, the boiler is shut off.

- Locate the Boiler Differential setting in the Adjust menu.

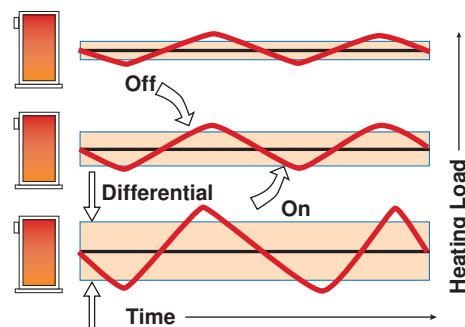


### Fixed Differential

If the user desires to have a fixed differential, this is set using the Boiler Differential setting in the Adjust menu.

### Auto Differential

In order to decrease temperature swings and increase boiler efficiency, the Auto Differential feature automatically changes the on / off differential of the boiler based on the heating load. As the load increases, the differential will decrease to minimize temperature swings. As the load decreases, the differential will increase to prevent short cycling.



## Boiler Enable

## Section E

If the 421 is one of many controls that can call for heat to a single boiler or there is a boiler sequencer other than a tekmar Stager (Boiler Control 264, 265, 268), operating multiple boilers or multiple stages, then the boiler sensor must be located on the return pipe of the boiler(s).

When the sensor is located on the return, the 421 provides a boiler enable. The 421 no longer tries to control the boiler supply water temperature directly, but allows another operating control such as an aquastat to regulate the boiler supply temperature.

When there is a requirement for heat from the 421 mixing device, the 421 boiler contact closes to enable the boiler. The boiler contact remains closed until heat is no longer required.

When the boiler sensor is located on the boiler return, the control is able to provide boiler return protection through the use of a mixing device. This protects the boiler sustained flue gas condensation and thermal shock.

To operate the control without a boiler sensor and prevent the control from displaying an error message, set the boiler sensor DIP switch to Return and power up the control without the boiler sensor connected.

The control operation will be similar to that as having the boiler sensor on the return except that boiler return protection is no longer provided.

## Pump Operation

## Section F

### System Pump P1

The system pump P1 is switched on in the following situation:

- There is a Mix Demand.

### Variable Speed Pump

The variable speed injection pump output operates only when there is a Mix Demand and the Mixing item in the Adjust menu is set to variable speed injection pump (VAr).

## Pump Exercising

## Section G

The system control will exercise all pumps and mixing valves every three days for ten seconds. If there is a heat demand, the control will wait for the demand to be over before the start of exercising.

# Error Messages

## Local Errors and Device Errors

Error messages are used to indicate a problem somewhere in the system. There are two types of error messages: Local Errors and Device Errors.

A Local Error indicates an error specific to a device. For example, a thermostat with a sensor short circuit will show a Sensor Short Error on its display. No other devices will show this specific error (unless they also have a sensor short circuit).

A Device Error is used to indicate that there is a local error somewhere else on the system. For example, if a thermostat has a sensor short circuit, that thermostat will show a Local Error indicating specifically what the problem is. All other devices on the network will show Device Errors, indicating the address of the device with the Local Error. In other words, Device Errors are nothing more than pointers, showing you that there is a local error somewhere on the system and where to find it.

## Error Priority

Only one error can be shown on a particular device at a time. If there is more than one error on the system, the highest priority error will be the one that is shown. The table on pages 22 and 23 lists error messages in order of high priority to low priority.

## How to Locate an Error Message

If the warning symbol (flashing circle with exclamation mark) is visible on screen, this indicates that there is an error somewhere on the system. To view the error message, you must first put the control into the Advanced or Installer access level (available in MISC menu). When an error message is present, it is available as an item in the VIEW menu.

While in the View Menu, press the item button until the error message is displayed. You may have to advance through several View Menu items before the message is displayed.



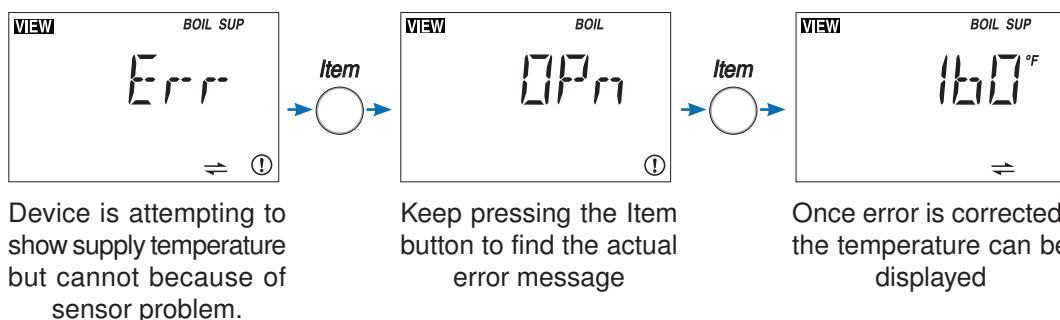
If the error message is a Device Error (if “DEV” or “DEV ERR” is shown on screen), read the address shown and go to the device with that address. That device will have a Local Error indicating specifically what the problem is. When the problem is corrected, the error message will automatically clear.

## Access Levels

In some cases, it is not desirable to let day-to-day users view error messages. In these cases, by lowering the access level of the thermostat or setpoint device to ‘User’ or lower, error messages cannot be seen in the View menu and the warning symbol only appears if there is a local error or a device error caused by a critical error on another device. If there is an error message on the system that you cannot find on a particular thermostat, make sure that the access level on that thermostat is set to Installer or Advanced.

## Sensor Temperature Errors

If a control is unable to display a temperature due to a sensor malfunction or communication problem, the word “Err” is displayed in place of the temperature. This usually indicates that there is an error somewhere on the system but is not the actual error message. Keep looking through the View menu to find the actual error message.

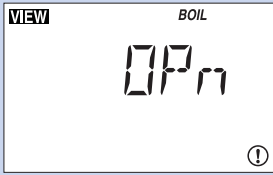
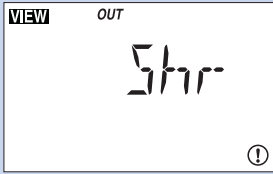
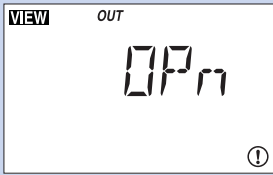
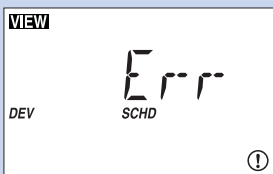
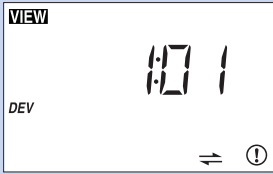




## Error Messages (1 of 2)

Error Message	Description
<div>VIEW</div> <div>E01</div> <div>ⓘ</div>	<b>ADJUST ERROR</b> The control failed to read the Adjust menu settings, and reloaded the factory default settings. Operation stops until you check the Adjust menu settings. <b>Note:</b> To clear the error, the access level must be set to Advanced and the settings in the Adjust menu must be checked.
<div>VIEW</div> <div>E05</div> <div>ⓘ</div>	<b>MISCELLANEOUS ERROR</b> The control failed to read the Miscellaneous menu settings, and reloaded the factory default settings. Operation stops until you check the Miscellaneous menu settings. <b>Note:</b> To clear the error, the access level must be set to Advanced and the settings in the Misc menu must be checked.
<div>VIEW</div> <div>MIX 1</div> <div>Err</div> <div>⇌ ⓘ</div>	<b>MIX BUS ERROR</b> Communication has been lost on the boiler bus. Check the tN4, C and R wires for each tN4 device. Check the polarity of the C and R wires. Check for loose or broken wires.
<div>VIEW</div> <div>MIX 1</div> <div>101</div> <div>⇌ ⓘ</div>	<b>MIX BUS DEVICE LOST</b> Communication is lost to tN4 device AA on the Mix bus. The LCD on the lost device displays Bus 1 OPn. Ensure that there is power to the lost device. Trace the wires from the control to the lost device looking for loose or damaged wires. Once the error is corrected, press any button to clear the error. <b>Note:</b> If you deliberately remove a tN4 device, hold the Up and Down buttons to clear the error.
<div>VIEW</div> <div>MIX 1</div> <div>MOD</div> <div>Err</div> <div>ⓘ</div>	<b>MIX MODULE ERROR</b> A Mixing Module has been connected to the Mix bus. Ensure that there is not a Mixing Module on the Mix bus.
<div>VIEW</div> <div>MIX 1</div> <div>Shr</div> <div>ⓘ</div>	<b>MIX SENSOR SHORT CIRCUIT</b> Due to a short circuit, the control failed to read the Mix supply sensor. As a result, the control operates mixing device at a fixed output as long as there is a call for heat. Locate and repair the problem as described in the Data Brochure D 070.
<div>VIEW</div> <div>MIX 1</div> <div>OPn</div> <div>ⓘ</div>	<b>MIX SENSOR OPEN CIRCUIT</b> Due to an open circuit, the control failed to read the Mix supply sensor. The control operates the mixing device at a fixed output as long as there is a call for heat. Locate and repair the problem as described in the Data Brochure D 070.
<div>VIEW</div> <div>BOIL</div> <div>Shr</div> <div>ⓘ</div>	<b>BOILER SENSOR SHORT CIRCUIT</b> Due to a short circuit, the control failed to read the boiler sensor. When there is a call for heat, the control no longer controls the boiler(s). Instead, the control provides a boiler enable to the boiler's aquastat or boiler control until the sensor is repaired. The control will not operate the boiler contact if the Boil Minimum setting is less than 100°F (38.0°C). Locate and repair the problem as described in the Data Brochure D 070.

## Error Messages (2 of 2)

Error Message	Description
 <p>The display shows 'VIEW' in the top left, 'BOIL' in the top right, and 'OPn' in the center. A circled '1' is in the bottom right corner.</p>	<p><b>BOILER SENSOR OPEN CIRCUIT</b></p> <p>Due to an open circuit, the control failed to read the boiler sensor. The control no longer controls the boiler. Instead, the control provides a boiler enable to the boiler's aquastat or boiler control until the sensor is repaired. The control will not operate the boiler contact if the Boil Minimum setting is less than 100°F (38.0°C). Locate and repair the problem as described in the Data Brochure D 070.</p> <p><b>Note:</b> If you deliberately remove the boiler sensor, set the Boiler Sensor Return/Supply DIP switch to Return. Power down for 10 seconds then restart the control.</p>
 <p>The display shows 'VIEW' in the top left, 'OUT' in the top right, and 'Shr' in the center. A circled '1' is in the bottom right corner.</p>	<p><b>OUTDOOR SENSOR SHORT CIRCUIT</b></p> <p>Due to a short circuit, the control failed to read the outdoor sensor. As a result, the control assumes an outdoor temperature of 32°F (0.0°C) and continues operation. Locate and repair the problem as described in the Data Brochure D 070.</p>
 <p>The display shows 'VIEW' in the top left, 'OUT' in the top right, and 'OPn' in the center. A circled '1' is in the bottom right corner.</p>	<p><b>OUTDOOR SENSOR OPEN CIRCUIT</b></p> <p>Due to an open circuit, the control failed to read the outdoor sensor. As a result, the control assumes an outdoor temperature of 32°F (0.0°C) and continues operation. Locate and repair the problem as described in the Data Brochure D 070.</p>
 <p>The display shows 'VIEW' in the top left, 'DEV' in the bottom left, 'SCHD' in the bottom right, and 'Err' in the center. A circled '1' is in the bottom right corner.</p>	<p><b>DEV SCHD</b></p> <p>The selected system schedule is no longer available. Either the system schedule master is no longer connected to the network or the system schedule number has been changed on the schedule master.</p>
 <p>The display shows 'VIEW' in the top left, 'DEV' in the bottom left, and '1:01' in the center. A double arrow icon and a circled '1' are in the bottom right corner.</p>	<p><b>DEVICE ERROR AT ADDRESS #:#</b></p> <p>#:# is the address of the device with the error. The bus number displays before the colon, and the device number displays after. Go to the device with the address displayed.</p> <p><u>Possible Addresses:</u></p> <p><b>1:01 to 1:24</b> - Device Error on Bus 1</p>

# Troubleshooting

Symptom	Possible Causes	Corrective Action
Boiler does not fire when there is a mix demand.	Boiler contact is not connected to boiler thermostat connection.	Trace wires from boiler contact to boiler thermostat connection. Use the Test sequence to check the boiler contact.
Mixing valve will not open.	No voltage present on actuator motor.	Mix 1 Mode setting must be set to FLt.
	Boiler Return Protection.	Mixing valve will not open until the boiler supply temperature exceeds the boiler minimum setting.
	Actuator rotating in wrong direction to open valve.	Reverse open and close wires on actuator.
Variable speed injection pump does not operate.	No current present on variable speed injection pump.	Mix 1 Mode setting must be set to VAr.
	Boiler Return Protection.	Variable speed injection pump will not operate until the boiler supply temperature exceeds the boiler minimum setting.
	A non-wet rotor pump has been installed.	Variable speed injection will only operate with wet rotor pumps. Read E021 and check pump type.
	Fuse is blown.	Determine if pump is jammed or seized. Replace fuse.
Display is not on.	No voltage to control.	Check breaker panel or disconnect. Check voltage using a voltmeter.
	Plugs are not connected between the 421 to the Zone Manager.	Ensure the plugs are secured to the Zone Manager pins.
	Fuse is blown.	Check fuse on Zone Manager. Check total VA draw on all thermostats and zone valves connected to the Zone Manager. This cannot exceed 40 VA.

## Limited Warranty and Product Return Procedure

**Limited Warranty** *The liability of tekmar under this warranty is limited. The Purchaser, by taking receipt of any tekmar product ("Product"), acknowledges the terms of the Limited Warranty in effect at the time of such Product sale and acknowledges that it has read and understands same.*

The tekmar Limited Warranty to the Purchaser on the Products sold hereunder is a manufacturer's pass-through warranty which the Purchaser is authorized to pass through to its customers. Under the Limited Warranty, each tekmar Product is warranted against defects in workmanship and materials if the Product is installed and used in compliance with tekmar's instructions, ordinary wear and tear excepted. The pass-through warranty period is for a period of twenty-four (24) months from the production date if the Product is not installed during that period, or twelve (12) months from the documented date of installation if installed within twenty-four (24) months from the production date.

The liability of tekmar under the Limited Warranty shall be limited to, at tekmar's sole discretion: the cost of parts and labor provided by tekmar to repair defects in materials and/or workmanship of the defective product; or to the exchange of the defective product for a warranty replacement product; or to the granting of credit limited to the original cost of the defective product, and such repair, exchange or credit shall be the sole remedy available from tekmar, and, without limiting the foregoing in any way, tekmar is not responsible, in contract, tort or strict product liability, for any other losses, costs, expenses, inconveniences, or damages, whether direct, indirect, special, secondary, incidental or consequential, arising from ownership or use of the product, or from defects in workmanship or materials, including any liability for fundamental breach of contract.

The pass-through Limited Warranty applies only to those defective Products returned to tekmar during the warranty period. This Limited Warranty does not cover the cost of the parts or labor to remove or transport the defective Product, or to reinstall the repaired or replacement Product, all such costs and expenses being subject to Purchaser's agreement and warranty with its customers.

Any representations or warranties about the Products made by Purchaser to its customers which are different from or in excess of the tekmar Limited Warranty are the Purchaser's sole responsibility and obligation. Purchaser shall indemnify and hold tekmar harmless from and against any and all claims, liabilities and damages of any kind or nature which arise out of or are related to any such representations or warranties by Purchaser to its customers.

The pass-through Limited Warranty does not apply if the returned Product has been damaged by negligence by persons other than tekmar, accident, fire, Act of God, abuse or misuse; or has been damaged by modifications, alterations or attachments made subsequent to purchase which have not been authorized by tekmar; or if the Product was not installed in compliance with tekmar's instructions and/or the local codes and ordinances; or if due to defective installation of the Product; or if the Product was not used in compliance with tekmar's instructions.

THIS WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, WHICH THE GOVERNING LAW ALLOWS PARTIES TO CONTRACTUALLY EXCLUDE, INCLUDING, WITHOUT LIMITATION, IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE, DURABILITY OR DESCRIPTION OF THE PRODUCT, ITS NON-INFRINGEMENT OF ANY RELEVANT PATENTS OR TRADEMARKS, AND ITS COMPLIANCE WITH OR NON-VIOLATION OF ANY APPLICABLE ENVIRONMENTAL, HEALTH OR SAFETY LEGISLATION; THE TERM OF ANY OTHER WARRANTY NOT HEREBY CONTRACTUALLY EXCLUDED IS LIMITED SUCH THAT IT SHALL NOT EXTEND BEYOND TWENTY-FOUR (24) MONTHS FROM THE PRODUCTION DATE, TO THE EXTENT THAT SUCH LIMITATION IS ALLOWED BY THE GOVERNING LAW.

**Product Warranty Return Procedure** All Products that are believed to have defects in workmanship or materials must be returned, together with a written description of the defect, to the tekmar Representative assigned to the territory in which such Product is located. If tekmar receives an inquiry from someone other than a tekmar Representative, including an inquiry from Purchaser (if not a tekmar Representative) or Purchaser's customers, regarding a potential warranty claim, tekmar's sole obligation shall be to provide the address and other contact information regarding the appropriate Representative.



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