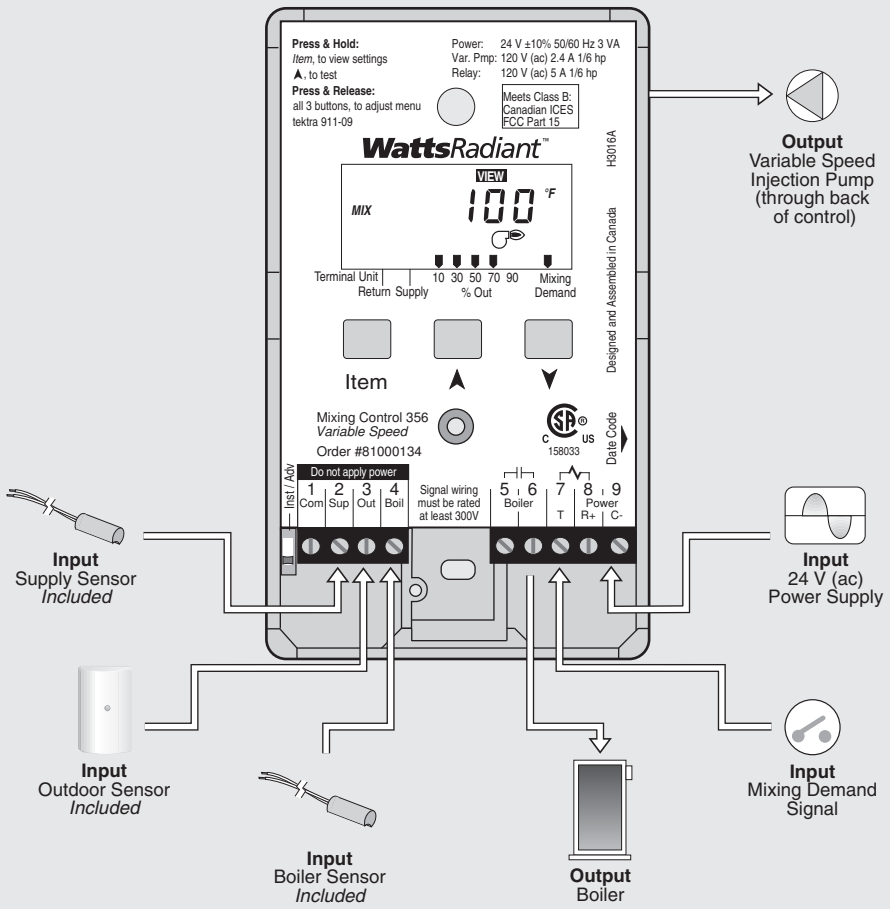
Installation & Operation Manual

Mixing Control 356

The Mixing Control 356 is designed to operate a mixing pump to control the temperature in a hot water heating system using Outdoor Temperature Reset. It can be used in applications ranging from in-floor radiant to commercial baseboard systems for boiler protection with full reset. This control regulates a single heating water temperature through Outdoor Temperature Reset. It provides mixing by speeding up or slowing down a single permanent capacitor (standard wet rotor) circulator.

Additional functions include:

- Quick Setup for easy installation and programming of control
- User comfort adjustment to increase or decrease building space temperature
- Advanced settings to fine-tune building requirements
- Boiler Control for improved energy savings
- Test sequence to ensure proper component operation
- CSA C US certified (approved to applicable UL standards)



Important Safety Information

⚠ WARNING

It is the installers responsibility to ensure that this control is safely installed according to all applicable codes and standards. Watts Radiant is not responsible for damages resulting from improper installation and/or maintenance.

To avoid serious personal injury and damage to the equipment:

- Read Manual and all product labels BEFORE using the equipment. Do not use unless you know the safe and proper operation of this equipment.
- Keep this Manual available for easy access by all users.
- Replacement Manuals are available at WattsRadiant.com

- Disconnect all power before opening the control.
- Improper installation and operation of this control could result in damage to the equipment and possibly even personal injury or death.
- This electronic control is not intended for use as a primary limit control. Other controls that are intended and certified as safety limits must be placed into the control circuit.
- Do not attempt to service the control. There are no user serviceable parts inside the control. Attempting to do so voids warranty.

Radio Frequency Interference

The installer must ensure that this control and its wiring are isolated and/or shielded from strong sources of electromagnetic noise. Conversely, this Class B digital apparatus complies with Part 15 of the FCC Rules and meets all requirements of the Canadian Interference-Causing Equipment Regulations. However, if this control does cause harmful interference to radio or television reception, which is determined by turning the control off and on, the user is encouraged to try to correct the interference by re-orientating or relocating the receiving antenna, relocating the receiver with respect to this control, and/or connecting the control to a different circuit from that to which the receiver is connected.

Cet appareil numérique de la classe B respecte toutes les exigences du Règlement sur le matériel brouilleur du Canada.

Getting Ready

Check the contents of this package. If any of the contents listed are missing or damaged, please contact your wholesaler or Watts Radiant sales representative for assistance.

Type 356 includes: One Mixing Control 356, One Outdoor Sensor 070, Two Universal Sensors 082, Installation and Operation Manual IOM-WR-Mixing_Control_356.

Carefully read the details of the Sequence of Operation to ensure that you have chosen the proper control for your application.

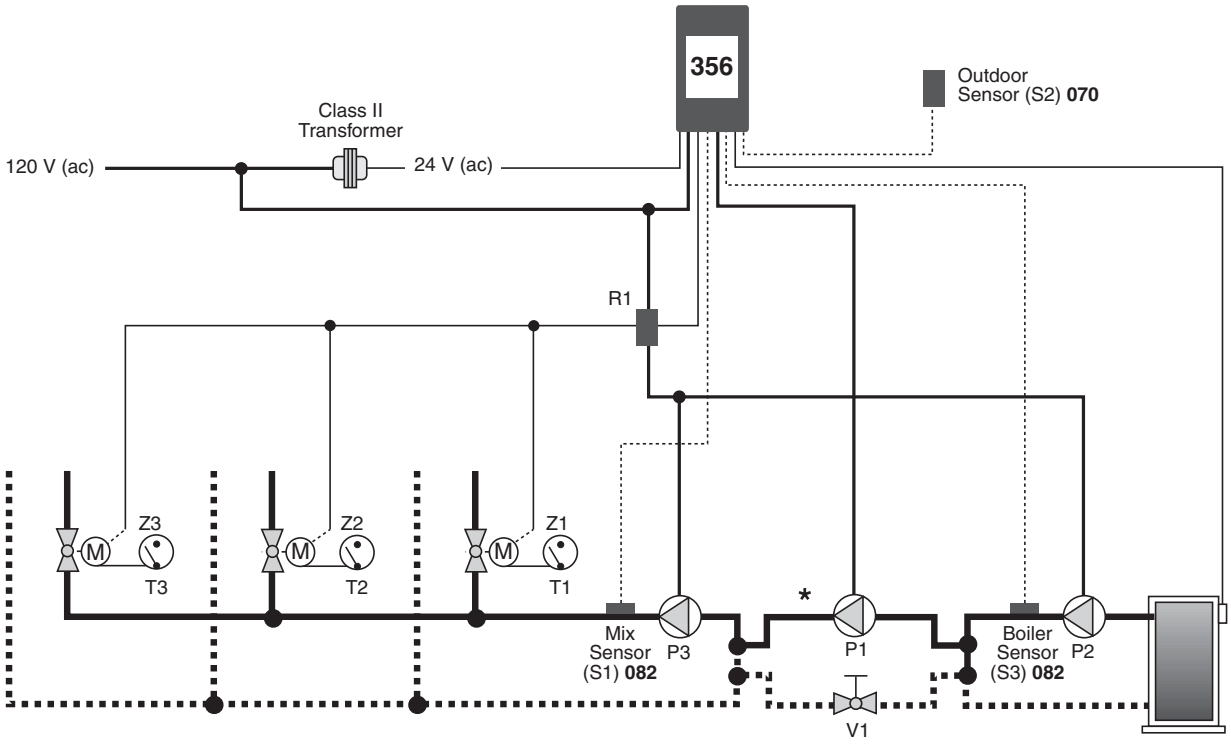
How to Use the Brochure

This brochure is organized into four main sections. They are: 1) Sequence of Operation, 2) Installation, 3) Control Settings, and 4) Troubleshooting. The Sequence of Operation section has three sub-sections. We recommend reading Section A: General Operation of the Sequence of Operation, as this contains important information on the overall operation of the control. Then read the sub-sections that apply to your installation. For quick installation and setup of the control, refer to the Installation and DIP Switch Setting sections.

The Control Settings section (starting at DIP Switch Setting) of this brochure, describes the various items that are adjusted and displayed by the control. The control functions of each adjustable item are described in the Sequence of Operation.

Table of Contents

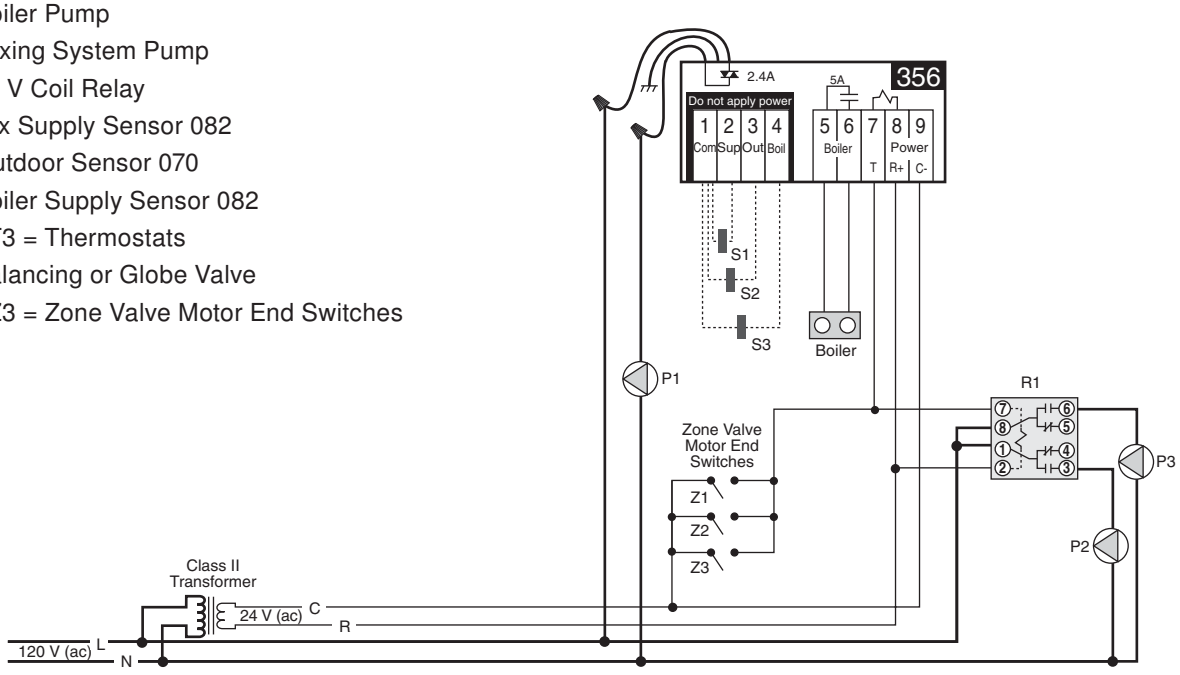
Application Drawing — A 356 - 1 Mechanical



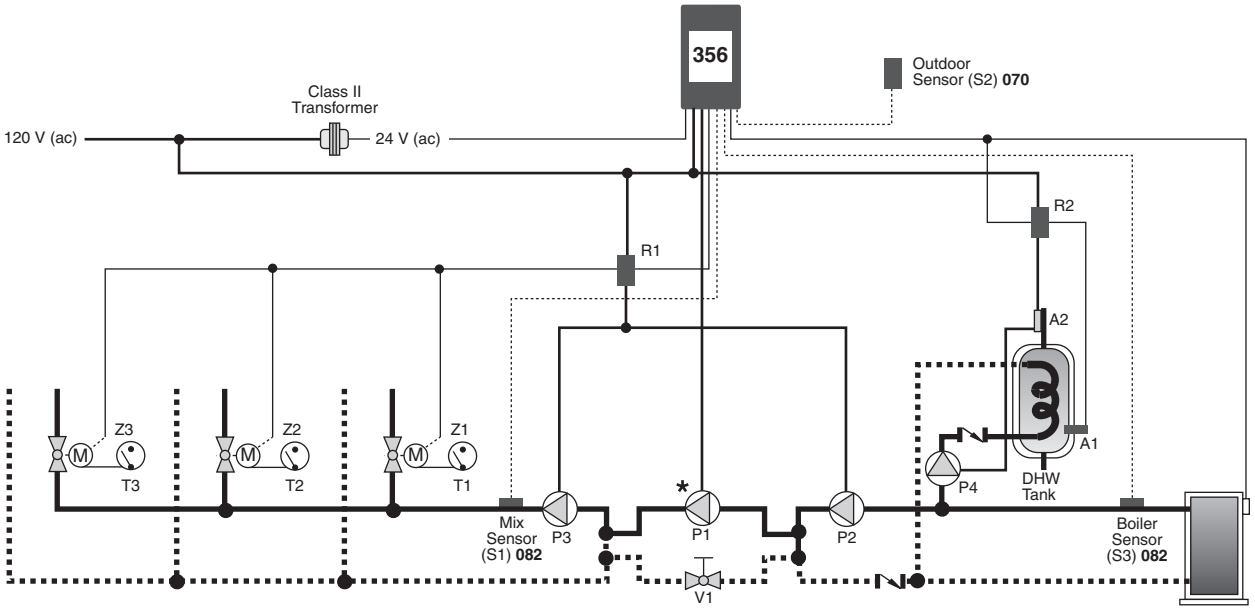
*Read the 'Piping for Variable Speed Injection Mixing' section in the Sequence of Operation for important details about pipe diameters and spacing.

Application Drawing — A 356 - 1 Electrical

P1 = Variable Speed Injection Pump
P2 = Boiler Pump
P3 = Mixing System Pump
R1 = 24 V Coil Relay
S1 = Mix Supply Sensor 082
S2 = Outdoor Sensor 070
S3 = Boiler Supply Sensor 082
T1, ..., T3 = Thermostats
V1 = Balancing or Globe Valve
Z1, ..., Z3 = Zone Valve Motor End Switches



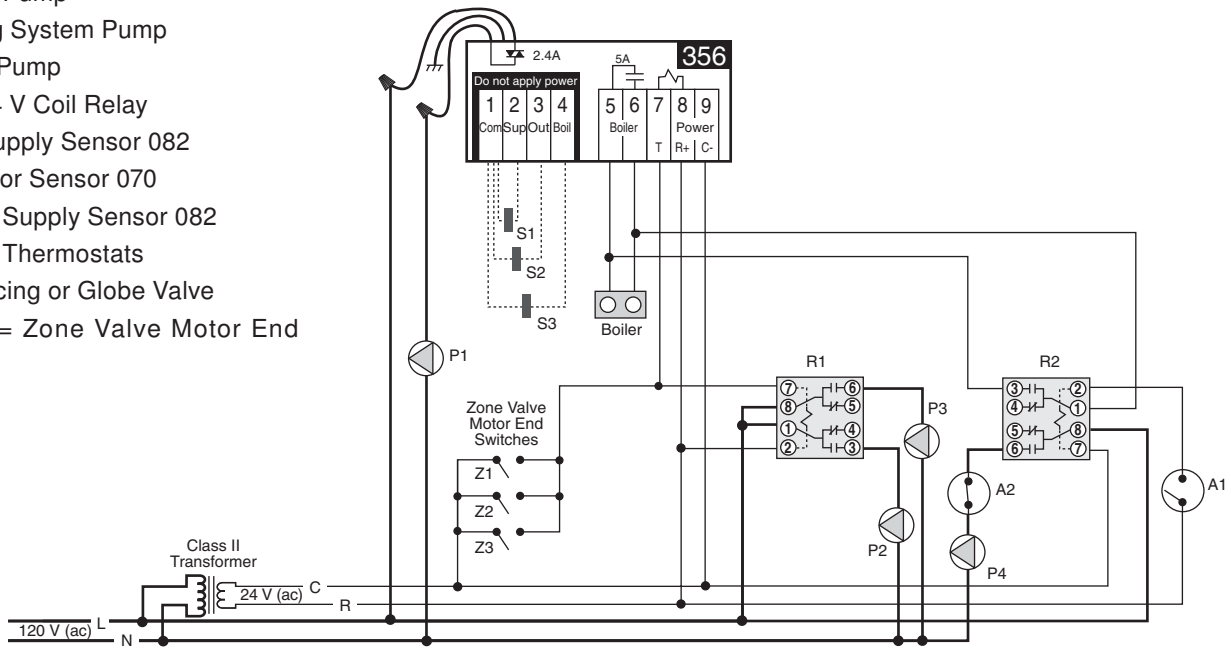
Application Drawing — A 356 - 2 Mechanical



*Read the 'Piping for Variable Speed Injection Mixing' section in the Sequence of Operation for important details about pipe diameters and spacing.

Application Drawing — A 356 - 2 Electrical

A1 = DHW Aquastat
A2 = DHW High Limit Aquastat
P1 = Variable Speed Injection Pump
P2 = Boiler Pump
P3 = Mixing System Pump
P4 = DHW Pump
R1, R2 = 24 V Coil Relay
S1 = Mix Supply Sensor 082
S2 = Outdoor Sensor 070
S3 = Boiler Supply Sensor 082
T1, ..., T3 = Thermostats
V1 = Balancing or Globe Valve
Z1, ..., Z3 = Zone Valve Motor End Switches

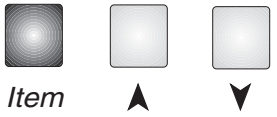


User Interface

The 356 uses a Liquid Crystal Display (LCD) as the method of supplying information. You use the LCD in order to set up and monitor the operation of your system. The 356 has three push buttons (Item, Up, Down) for selecting, viewing, and adjusting settings. As you program your control, record your settings in the ADJUST menu table which is found in the second half of this brochure.

Item

The abbreviated name of the selected item will be displayed in the item field of the display. To view the next available ***item***, press and release the Item button. Once you have reached the last available item, pressing and releasing the Item button will return the display to the first item.



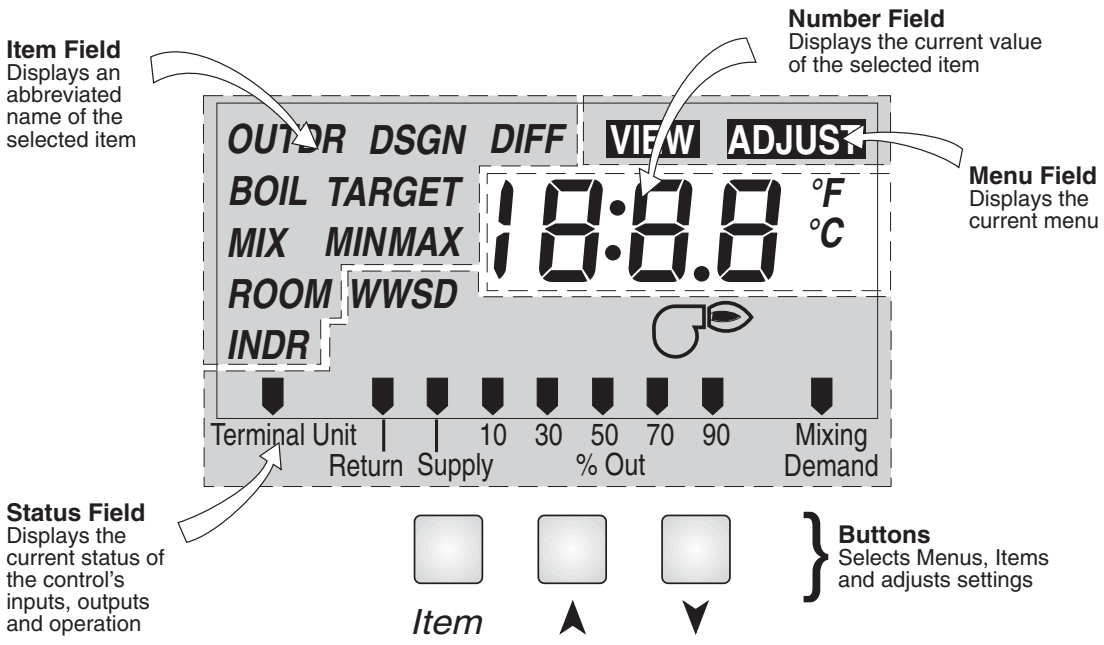
Adjust

To make an adjustment to a setting in the control, press and hold simultaneously for 1 second, the Item, Up and Down buttons. The display will then show the word ADJUST in the top right corner. Then select the desired item using the Item button. Finally, use the Up and / or Down button to make the adjustment.

To exit the ADJUST menu, either select the ESC item and press the Up or Down button, or leave the adjustment buttons alone for 20 seconds. When the Item button is pressed and held in the VIEW menu, the display scrolls through all the control adjust items in both access levels.

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

Display



Symbol Description

	Burner Displays when the boiler relay is turned on.		**Pointer** Displays the control operation as indicated by the text.
°F, °C	**°F, °C** Displays the unit of measure that all of the temperatures are to be displayed in the control.		

Sequence of Operation

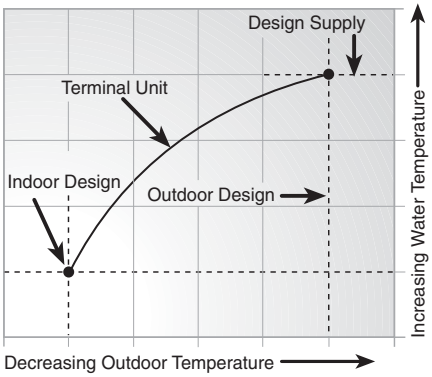
Section A - General Operation

POWERING UP THE CONTROL

When the Mixing Control 356 is powered up, the control displays the control type number in the LCD for 2 seconds. Next, the software version is displayed for 2 seconds. Finally, the control enters into the normal operating mode and the LCD defaults to displaying the current outdoor air temperature.

OPERATION

The 356 uses a variable speed injection pump to control the supply water temperature to a hydronic system. The supply water temperature is based on either the current outdoor temperature, or a fixed setpoint.



Outdoor Reset

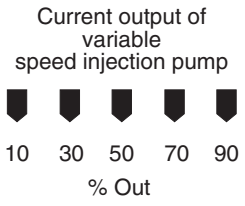
When the outdoor design (OUTDR DSGN) setting is not set to OFF, the 356 calculates a mixing supply temperature based on the current outdoor air temperature and the Characterized Heating Curve settings.

Setpoint Control

When the outdoor design (OUTDR DSGN) setting is set to OFF, the 356 supplies a fixed mixing supply temperature equal to the MIX TARGET setting. An outdoor sensor is not required during this mode of operation.

VARIABLE SPEED INJECTION

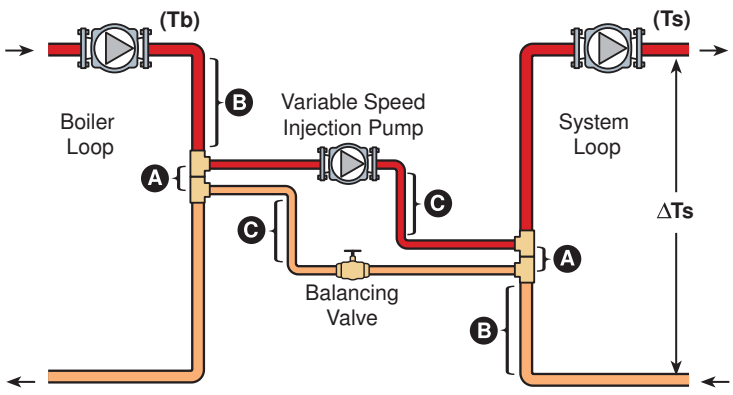
A standard wet rotor circulator is connected to the 356 at the back of the control. The 356 increases or decreases the power output to the circulator when there is a mixing demand. The circulator speed varies to maintain the correct mixed supply water temperature at the mix sensor. A visual indication of the current variable speed output is displayed in the LCD in the form of a horizontal bar graph.



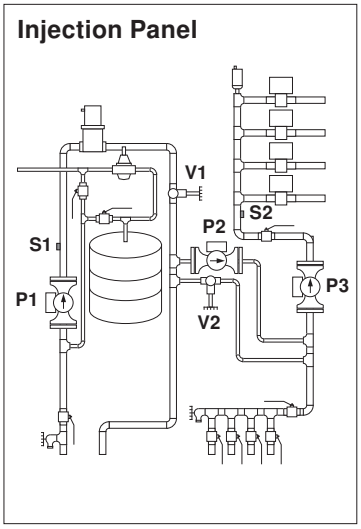
PIPING FOR VARIABLE SPEED INJECTION MIXING

Variable speed injection systems require complete isolation between the boiler loop and system loop. For example, when the injection pump is turned off, there must be no heat transfer from the boiler loop to the system loop. In order to avoid this unwanted heat transfer, standard primary-secondary piping techniques are used as shown.

- This piping arrangement requires that the injection piping be at least one pipe diameter smaller than the piping of the boiler and system loops.
- The tees in the boiler and system loops must be closely spaced (not exceeding 4 pipe diameters) in order to prevent ghost flow when the variable speed injection pump is off and either the boiler pump or system pump is on. (refer to A)
- There must be at least 6 pipe diameters of straight pipe on either side of the tees in order to prevent the momentum of water in the boiler and system loops from pushing flow through the injection loop. (refer to B)
- There should be a minimum 1 foot drop to create a thermal trap in order to prevent convective heat transfer through the injection loop. (refer to C)



Tb = Boiler supply temperature
Ts = System supply temperature
ΔTs = System temperature drop (Typically 20°F for convectors and 10°F for radiant floor heating)



This panel shows a typical piping arrangement for a variable speed injection pump system.

P1 = Boiler Pump
P2 = Variable Speed Injection Pump
P3 = System Pump
S1 = Boiler Sensor
S2 = Supply Sensor
V1, V2 = Globe Valve

DESIGN PROCEDURE FOR VARIABLE SPEED INJECTION MIXING

STEP 1

Determine the following design values:

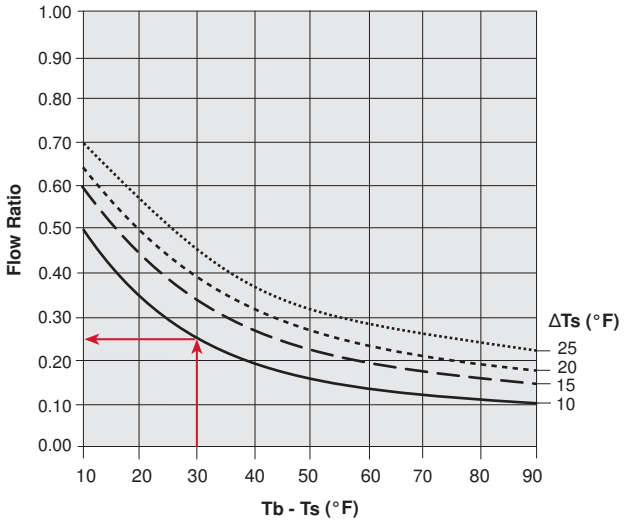
- Boiler Supply Temperature (Tb)
- System Supply Temperature (Ts)
- System Flow Rate (US GPM) and System Loop Temperature Drop (ΔTs). If one of these variables is unknown, use Equation 1 or 2 to calculate the other variable.

STEP 2

Calculate Tb - Ts

STEP 3

Look up the required Flow Ratio in the table below.



STEP 4

Calculate the design injection flow rate using Equation 3.

STEP 5

Decide whether or not to include a balancing valve in the injection piping. A balancing (globe) valve allows adjustment when the injection pump is larger than needed. A balancing valve also provides the possibility of manual operation of the heating system by turning the injection pump fully on and adjusting the balancing valve to obtain the desired system supply water temperature.

STEP 6

The injection piping size and model of pump to install can now be looked up in the table on page 16.

Equation 1

$$\text{System Flow Rate (US GPM)} = \frac{\text{Design Heating Load (Btu/hr)}}{500 \times \Delta Ts\ (°F)}$$

Equation 2

$$\Delta Ts\ (F°) = \frac{\text{Design Heating Load (Btu/hr)}}{500 \times \text{System Flow Rate (US GPM)}}$$

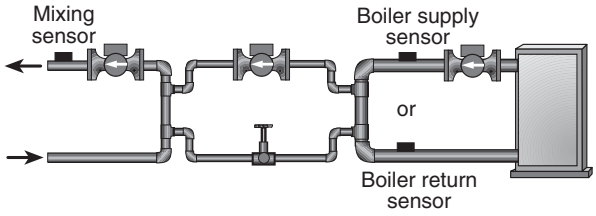
Equation 3

$$\text{Design Injection Flow Rate (US GPM)} = \text{System Flow Rate (US GPM)} \times \text{Flow Ratio}$$

SEE PG.16 FOR MANUFACTURER APPROVED PUMP MODELS

BOILER PROTECTION (BOIL MIN)

The 356 is capable of providing boiler protection from cold mixing system return water temperatures. If the boiler sensor temperature is cooler than the BOIL MIN setting while the boiler is firing, the 356 reduces the output to the variable speed injection pump. This limits the amount of cool return water to the boiler, and allows the boiler temperature to recover. This feature can only be used if a boiler sensor is installed.



EXERCISING

The 356 has a built-in exercising function. If the pump has not been operated at least once every 3 days, the control turns on the output for 10 seconds. This minimizes the possibility of the pump seizing during a long period of inactivity.

The exercising function does not work if power to the control or pump is disconnected.

FACTORY DEFAULTS

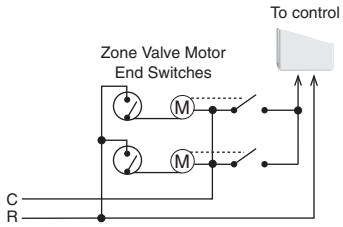
The control comes preset with several factory defaults. These defaults are based on the terminal unit selection (see section B2). To fine-tune building requirements, these defaults may be changed. If a factory default value for a terminal unit is changed, the terminal unit number will flash when selected in the ADJUST menu. To reload the factory defaults listed in section B2, power down the control and wait for 10 seconds. Power up the control while simultaneously holding the Item and down buttons. The terminal unit number should now be displayed constantly in the LCD rather than flashing.

Section B: Mixing Operation

SECTION B1: GENERAL

Mixing Demand

A mixing demand is required in order for the 356 to provide heat. A mixing demand is generated by connecting terminal T(7) to terminal C-(9) through a switching device. Once the switching device closes, the Mixing Demand pointer is displayed in the LCD. The 356 calculates a MIX TARGET supply temperature based on the outdoor air temperature and settings. If required, the 356 operates the boiler in order to provide heat to the variable speed injection pump.



Characterized Heating Curve

When used as a mixing reset control, the 356 varies the supply water temperature based on the outdoor air temperature. The control takes into account the type of terminal unit that the system is using. Since different types of terminal units transfer heat to a space using different proportions of radiation, convection and conduction, the supply water temperature must be controlled differently. Once the control is told what type of terminal unit is used, the control loads the factory defaults and varies the supply water temperature according to the type of terminal unit. This improves the control of the air temperature in the building.

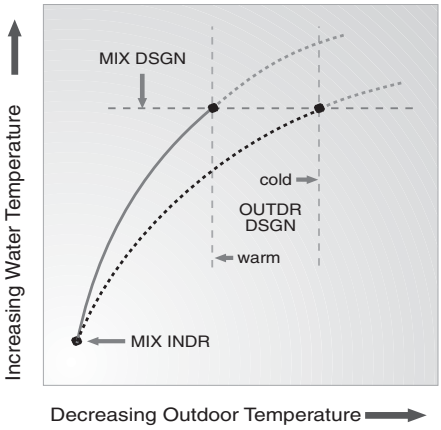
Mixing Temperature Target (MIX TARGET)

When used as a mixing reset control, the MIX TARGET temperature is determined from the Characterized Heating Curve settings and outdoor air temperature. When used as a setpoint control, the installer will set the MIX TARGET temperature. The control displays the temperature that it is currently trying to maintain as the mixing supply temperature. If the control does not have a mixing demand, "---" is displayed as the MIX TARGET.

SECTION B2: INSTALLER SETTINGS

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 the heat loss calculations for the building. If a cold outdoor design temperature is selected, the mixing supply temperature rises gradually as the outdoor temperature drops. If a warm outdoor design temperature is selected, the mixing supply temperature rises rapidly as the outdoor temperature drops.



Setpoint Operation (MIX TARGET)

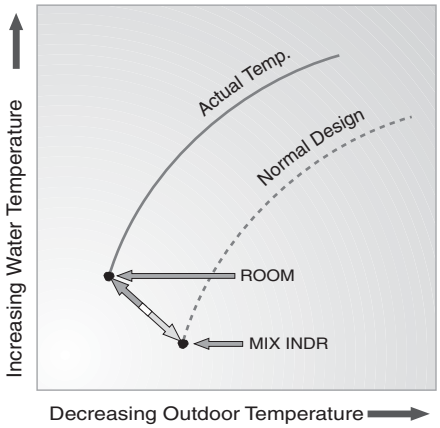
For setpoint operation, set the OUTDR DSGN to OFF. The MIX TARGET becomes the setpoint supply temperature that the control is to maintain. The MIX TARGET temperature is set by the installer in the ADJUST menu. An outdoor sensor is not required during this mode of operation.

Room (ROOM)

The ROOM is the desired room temperature for the mixing zones, and it provides a parallel shift of the Characterized Heating Curve. The room temperature desired by the occupants is often different from the design indoor temperature (MIX INDR). If the room temperature is not correct, adjusting the ROOM setting increases or decreases the amount of heat available to the building.

Terminal Units

When using a Characterized Heating Curve, the control requires the selection of a terminal unit. The terminal unit determines the shape of the Characterized Heating Curve according to how the terminal unit delivers heat into the building space. The 356 provides for selection between six different terminal unit types: two types of radiant floor heat, fancoil, fin-tube convector, radiator and baseboard. When a terminal unit is selected, the control automatically loads the design supply temperature (MIX DSGN) and maximum supply temperature (MIX MAX). The factory defaults are listed below. To change defaults, refer to section B3. If a default has been changed, refer to section A to reload the factory defaults.

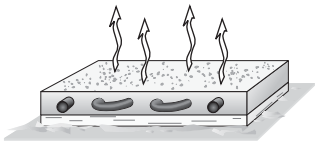


Terminal Unit	High Mass Radiant (1)	Low Mass Radiant (2)	Fancoil (3)	Fin-tube Convector (4)	Radiator (5)	Baseboard (6)
MIX DSGN	120°F (49°C)	140°F (60°C)	190°F (88°C)	180°F (82°C)	160°F (71°C)	150°F (66°C)
MIX MAX	140°F (60°C)	160°F (71°C)	210°F (99°C)	200°F (93°C)	180°F (82°C)	170°F (77°C)

High Mass Radiant (1)

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.

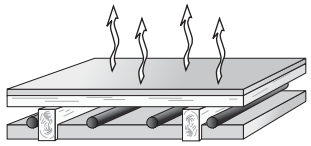
Default values: MIX DSGN = 120°F (49°C), MIX MAX = 140°F (60°C)



Low Mass Radiant (2)

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 sub-floor and the surface. This type of radiant system has a relatively low thermal mass and responds faster than a high mass system.

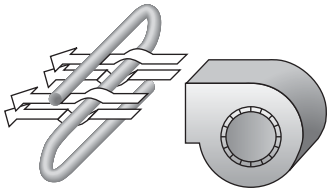
Default values: MIX DSGN = 140°F (60°C), MIX MAX = 160°F (71°C)



Fancoil (3)

A fancoil terminal unit or air handling unit (AHU) consists 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.

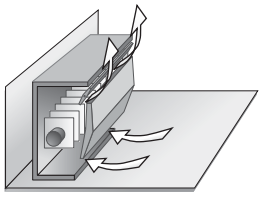
Default values: MIX DSGN = 190°F (88°C), MIX MAX = 210°F (99°C)



Fin-tube Convector (4)

A convector 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 to the space is dependant on the supply water temperature to the heating element and the room air temperature.

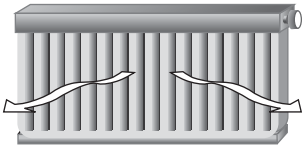
Default values: MIX DSGN = 180°F (82°), MIX MAX = 200°F (93°C)



Radiator (5)

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.

Default values: MIX DSGN = 160°F (71°C), MIX MAX = 180°F (82°C)



Baseboard (6)

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 convector.

Default values: MIX DSGN = 150°F (66°C), MIX MAX = 170°F (77°)

SECTION B3: ADVANCED SETTINGS

Mixing Indoor (MIX INDR)

The MIX INDR is the room temperature used in the original heat loss calculations for the building. This setting establishes the beginning of the Characterized Heating Curve for the mixing zones.

Mixing Design (MIX DSGN)

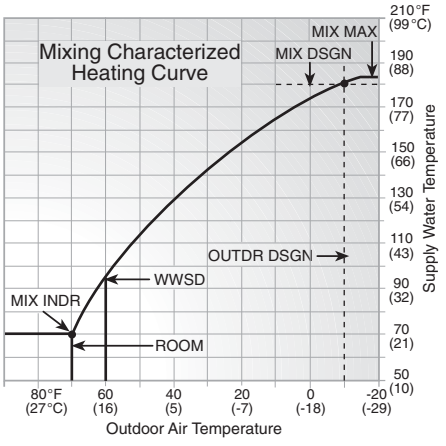
The MIX DSGN temperature is the supply water temperature required to heat the mixing zones when the outdoor air is as cold as the OUTDR DSGN temperature.

Mixing Maximum (MIX MAX)

The MIX MAX sets the highest water temperature that the control is allowed to calculate as the MIX TARGET temperature. If the control does target the MIX MAX setting, and the MIX temperature is near the MIX MAX, the MAX segment will be displayed in the LCD while either the MIX TARGET temperature or the MIX temperature is being viewed.

Warm Weather Shut Down (WWSD)

When the outdoor air temperature rises above the WWSD setting, the 356 turns on the WWSD segment in the display. When the control is in Warm Weather Shut Down, the Mixing Demand pointer is displayed, if there is a demand. However, the control does not operate the heating system to satisfy this demand. If the control is in setpoint mode, the WWSD feature is not functional.



Section C: Boiler Operation

SECTION C1: GENERAL OPERATION

Boiler Operation

When the 356 determines that boiler operation is required, the Boiler contact terminals (5 and 6) close. While the Boiler contact is closed, the burner segment in the LCD is displayed.

Boiler Minimum (BOIL MIN)

Most boilers require a minimum water temperature in order to prevent flue gas condensation. The BOIL MIN adjustment is set to the boiler manufacturer's minimum recommended operating temperature. Only when the boiler temperature is measured by a boiler sensor can the 356 provide boiler protection. In this case, when the boiler is firing and the boiler temperature is below the BOIL MIN setting, the 356 turns on the MIN segment and reduces the heating load on the boiler by limiting the output of the variable speed injection pump. If the installed boiler is designed for low temperature operation, set the BOIL MIN adjustment to OFF.

Boiler Protection

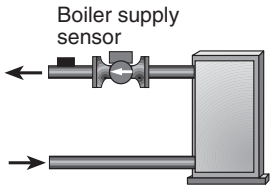
Refer to section A for a description of boiler protection.

SECTION C2: BOILER SENSOR PLACEMENT

Boiler Sensor on the Supply (BOIL = Supply)

The boiler sensor can be located on the boiler supply if the 356 is the only control that is operating the boiler. When in the supply mode, the 356 determines the required operating temperature of the boiler using Boiler Load Reset. With Boiler Load Reset, the 356 operates the boiler at the lowest possible supply temperature that is sufficient to satisfy the requirements of the variable speed injection pump. If this mode of operation is selected, the boiler pump should operate continuously.

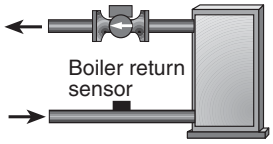
The boiler pump should not be operated by the boiler's aquastat, as this may lead to improper cycling of the boiler because of inconsistent flow past the boiler supply sensor.



Boiler Sensor on the Return (BOIL = Return)

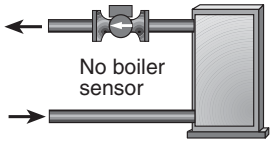
The boiler sensor should be located on the boiler return if the 356 is one of many controls that can call for boiler operation. When in the return mode, the 356 provides a boiler enable. The 356 no longer tries to control the boiler supply water temperature directly, but allows the boiler to operate at its operating aquastat setting when required. If this mode of operation is selected, the boiler pump should operate continuously.

The boiler pump should not be operated by the boiler's aquastat, as this may lead to improper cycling of the boiler because of inconsistent flow past the boiler return sensor.



No Boiler Sensor

The 356 is capable of operating without a boiler sensor if desired. Without a boiler sensor the 356 provides a boiler enable, and is unable to provide boiler protection. This type of application is typical if the 356 is drawing heat from a heat source that already incorporates some form of boiler protection.



Installation

⚠ CAUTION

Improper installation and operation of this control could result in damage to the equipment and possibly even personal injury. It is your responsibility to ensure that this control is safely installed according to all applicable codes and standards. This electronic control is not intended for use as a primary limit control. Other controls that are intended and certified as safety limits must be placed into the control circuit.

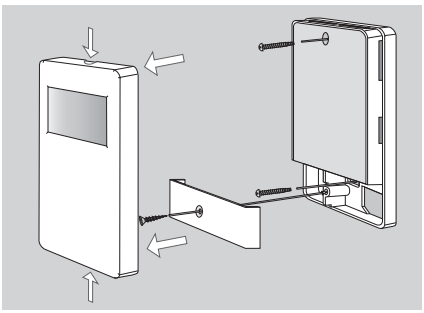
The nonmetallic enclosure does not provide grounding between conduit connections. Use grounding type bushings and jumper wires.

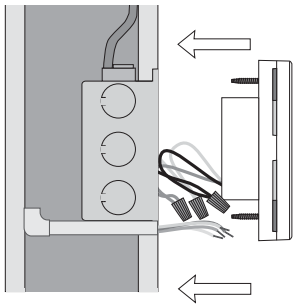
Un boîtier nonmétallique n'assure pas la continuité électrique des conduits. Utiliser des manchons ou des fils de accord spécialement conçus pour la mise á la terre.

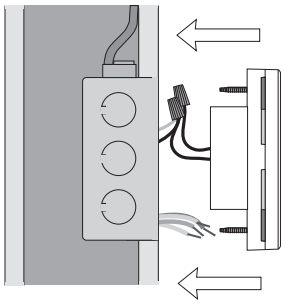
Mounting the Control

Grasp the front cover by the fingertip grips on the top and bottom of the enclosure and pull the front cover off. Remove the wiring cover screw. The mounting holes in the enclosure accept #6 screws.

The control can be mounted on a 2" x 4" duplex electrical box with a minimum depth of 1.75". Rough-in wiring is made to the electrical box using standard wiring practices. High voltage wiring connections are made inside the electrical box directly to the wires exiting the back of the control. Low voltage and sensor wiring enters the wiring chamber through the back or bottom of the enclosure depending on local electrical code requirements.



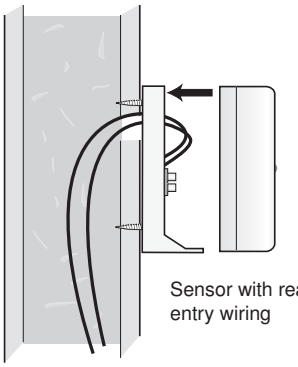




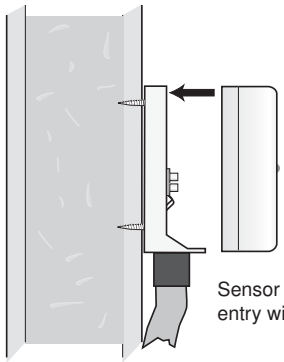
Outdoor Sensor Installation

The temperature sensor (thermistor) is built into the sensor enclosure.

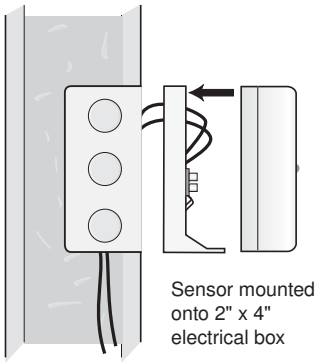
- Remove the screw and pull the front cover off the sensor enclosure.
- The outdoor sensor can either be mounted directly onto a wall or a 2" x 4" electrical box. When the outdoor sensor is wall mounted, the wiring should enter through the back or bottom of the enclosure. Do not mount the outdoor sensor with the conduit knockout facing upwards as rain could enter the enclosure and damage the sensor.
- In order to prevent heat transmitted through the wall from affecting the sensor reading, it may be necessary to install an insulating barrier behind the enclosure.
- The outdoor sensor should be mounted on a wall which best represents the heat load on the building (a northern wall for most buildings and a southern facing wall for buildings with large south facing glass areas). The outdoor sensor should not be exposed to heat sources such as ventilation or window openings.
- The outdoor sensor should be installed at an elevation above the ground that will prevent accidental damage or tampering.



Sensor with rear entry wiring

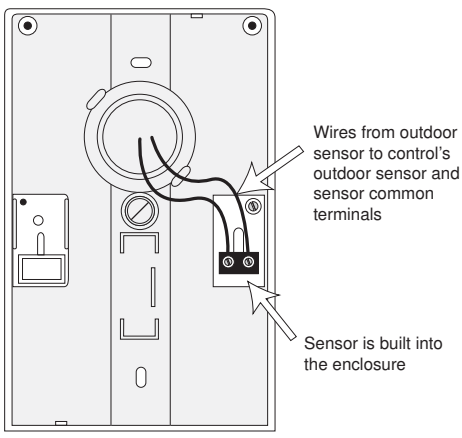


Sensor with bottom entry wiring



Sensor mounted onto 2" x 4" electrical box

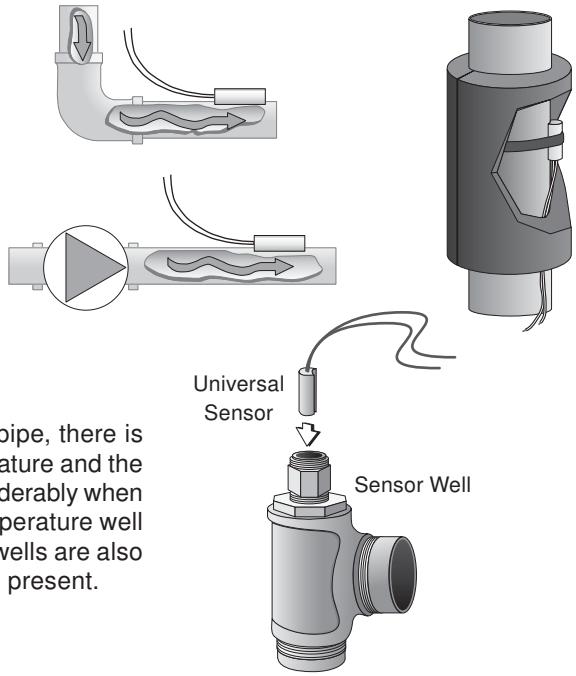
- Connect 18 AWG or similar wire to the two terminals provided in the enclosure and run the wires from the outdoor sensor to the control. Do not run the wires parallel to telephone or power cables. If the sensor wires are located in an area with strong sources of electromagnetic interference (EMI), shielded cable or twisted pair should be used or the wires can be run in a grounded metal conduit. If using shielded cable, the shield wire should be connected to the Com terminal on the control and not to earth ground.
- Follow the sensor testing instructions in this brochure and connect the wires to the control.
- Replace the front cover of the sensor enclosure.



Universal Sensor Installation

These sensors are designed to mount on a pipe or in a temperature immersion well.

The Universal Sensor should be placed downstream of a pump or after an elbow or similar fitting. This is especially important if large diameter pipes are used as the thermal stratification within the pipe can result in erroneous sensor readings. Proper sensor location requires that the fluid is thoroughly mixed within the pipe before it reaches the sensor.



Strapped to Pipe

The Universal Sensor can be strapped directly to the pipe using the cable tie provided. Insulation should be placed around the sensor to reduce the effect of air currents on the sensor measurement.

Immersion Well

If a Universal Sensor is mounted onto 1" (25 mm) diameter L type copper pipe, there is approximately an 8 second delay between a sudden change in water temperature and the time the sensor measures the temperature change. This delay increases considerably when mild steel (black iron) pipe is used. In general, it is recommended that a temperature well be used for steel pipe of diameter greater than 1-1/4" (32 mm). Temperature wells are also recommended when large diameter pipes are used and fluid stratification is present.

Testing the Wiring

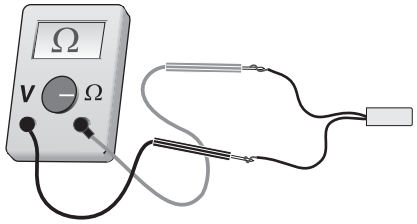
No wires should be connected to the control during testing.

The following tests are to be performed using standard testing practices and procedures, and should only be carried out by properly trained and experienced persons. A good quality electrical test meter, capable of reading from at least 0 - 300 V (ac) and at least 0 - 2,000,000 Ohms, is essential to properly test the wiring and sensors.

Test the Sensors

A good quality test meter capable of measuring up to 5,000 kΩ (1 kΩ = 1000 Ω) is required to measure the sensor resistance. In addition to this, the actual temperature must be measured with either a good quality digital thermometer, or if a thermometer is not available, a second sensor can be placed alongside the one to be tested and the readings compared.

First measure the temperature using the thermometer and then measure the resistance of the sensor at the control. The wires from the sensor must not be connected to the control while the test is performed. Using the chart below, estimate the temperature measured by the sensor. The sensor and thermometer readings should be close. If the test 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.



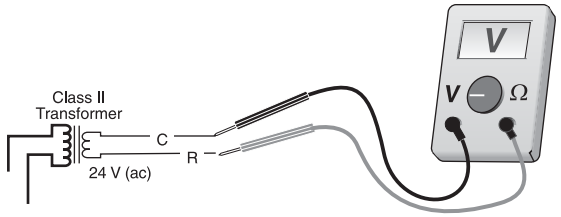
⚠ CAUTION

Do not apply voltage to a sensor at any time as damage to the sensor may result.

Temperature		Resistance	Temperature		Resistance	Temperature		Resistance	Temperature		Resistance
°F	°C	Ω	°F	°C	Ω	°F	°C	Ω	°F	°C	Ω
-50	-46	490,813	20	-7	46,218	90	32	7,334	160	71	1,689
-45	-43	405,710	25	-4	39,913	95	35	6,532	165	74	1,538
-40	-40	336,606	30	-1	34,558	100	38	5,828	170	77	1,403
-35	-37	280,279	35	2	29,996	105	41	5,210	175	79	1,281
-30	-34	234,196	40	4	26,099	110	43	4,665	180	82	1,172
-25	-32	196,358	45	7	22,763	115	46	4,184	185	85	1,073
-20	-29	165,180	50	10	19,900	120	49	3,760	190	88	983
-15	-26	139,403	55	13	17,436	125	52	3,383	195	91	903
-10	-23	118,018	60	16	15,311	130	54	3,050	200	93	829
-5	-21	100,221	65	18	13,474	135	57	2,754	205	96	763
0	-18	85,362	70	21	11,883	140	60	2,490	210	99	703
5	-15	72,918	75	24	10,501	145	63	2,255	215	102	648
10	-12	62,465	80	27	9,299	150	66	2,045	220	104	598
15	-9	53,658	85	29	8,250	155	68	1,857	225	107	553

Test the Power Supply

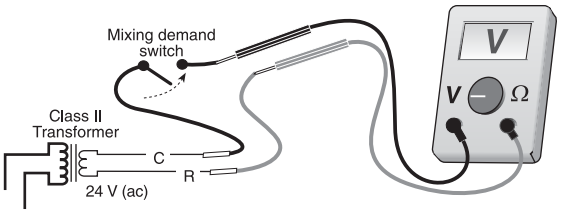
Make sure exposed wires and bare terminals are not in contact with other wires or grounded surfaces. Turn on the power and measure the voltage across the 24 V (ac) power supply with an AC voltmeter. The reading should be between 22 and 26 V (ac).



Test the Powered Inputs

Mixing Demand

Measure the voltage between the mixing demand wire and the power wire that goes to R+ of the control. The voltmeter should read between 22 and 26 V (ac) when the mixing demand device calls for heat.



Test The Outputs

Boiler

Make sure power to the boiler circuit is off and short the boiler wires. When the boiler circuit is powered up, the boiler should fire. If the boiler does not turn on, refer to any installation or troubleshooting information supplied with the boiler. (The boiler may have a flow switch that prevents firing until the boiler loop pump is running). If the boiler operates properly, remove power from the boiler circuit.

Variable Speed Injection Pump

Short the variable speed injection pump wires and power up the pump circuit; the variable speed pump should operate at full speed. If the pump does not operate, check the wiring, and refer to any installation or troubleshooting information supplied with the pump. If the pump operates properly, remove the power from the variable speed injection pump circuit.

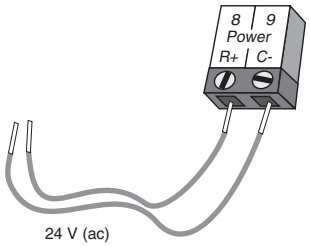
Electrical Connections to the Control

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

Powered Input Connections

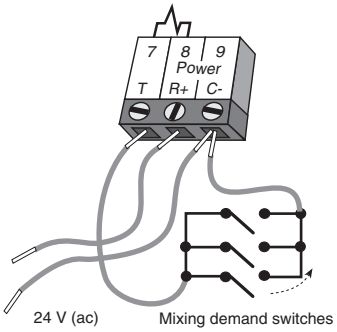
24 V (ac) Power

Connect the 24 V (ac) power supply to the Power R+ and Power C-terminals (8 and 9). This connection provides power to the microprocessor and display of the control.



Mixing Demand

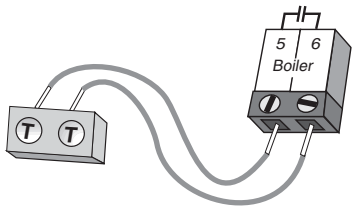
To generate a mixing demand, terminal T(7) must be connected to terminal C-(9) through a switching device.



Output Connections

Boiler Contact

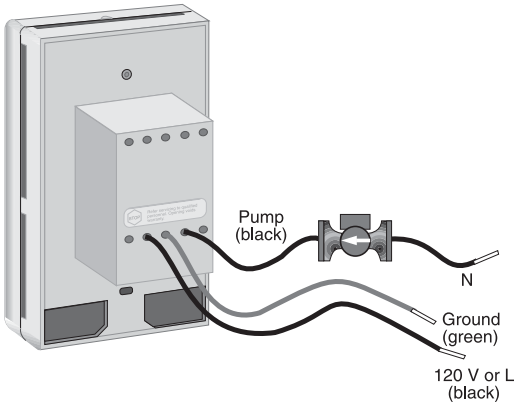
The Boiler terminals (5 and 6) are an isolated output in the 356. There is no power available on these terminals from the control. These terminals are to be used as a switch to either make or break the boiler circuit. When the 356 requires the boiler to fire, it closes the contact between terminals 5 and 6.



Variable Speed Injection Pump

The 356 can vary the speed of a permanent capacitor, impedance protected, or equivalent pump motor that has a locked rotor current of less than 2.4 A. Most small wet rotor circulators are suitable as described in section A. The 356 has an internal overload protection circuit which is rated at 2.5 A 250 V (ac). Contact your Watts Radiant sales representative for details on the repair procedures if this circuit is blown.

Connect one of the wires from the variable speed injection pump to one of the black wires from the back of the control. Connect the second black wire from the back to the live (L) side of the 120 V (ac) power source. The other wire on the variable speed injection pump must be connected to the neutral (N) side of the 120 V (ac) power supply. Connect the green wire on the back of the control to ground.

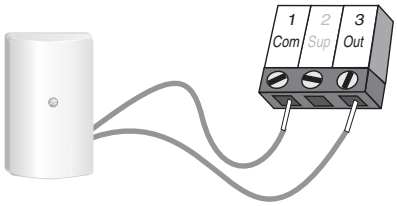


Sensor and Unpowered Input Connections

Do not apply power to these terminals as this will damage the control.

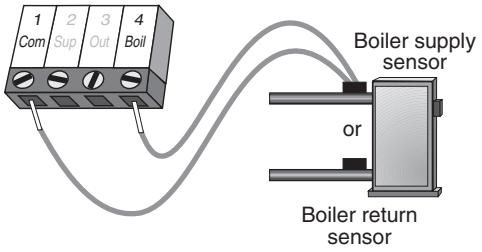
Outdoor Sensor

Connect the two wires from the Outdoor Sensor 070 to the Com and Out terminals (1 and 3). The outdoor sensor is used by the 356 to measure the outdoor air temperature.



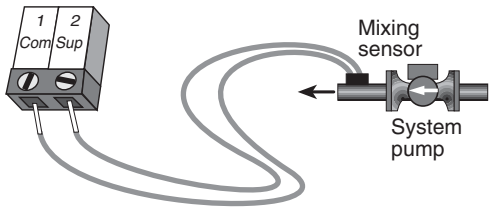
Boiler Sensor

Connect the two wires from the Boiler Sensor 082 to the Com and Boil terminals (1 and 4). The boiler sensor is used by the 356 to measure the boiler temperature.



Mixing Sensor

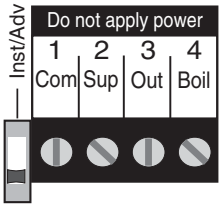
Connect the two wires from the Mixing Sensor 082 to the Com and Sup terminals (1 and 2). The mixing sensor is used by the 356 to measure the supply water temperature after the variable speed injection pump. Normally the sensor is attached to the pipe downstream of the system pump.



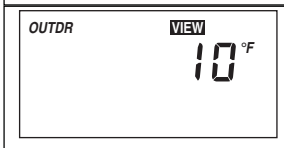
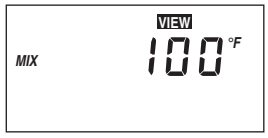
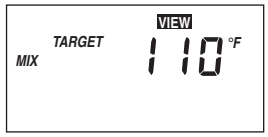
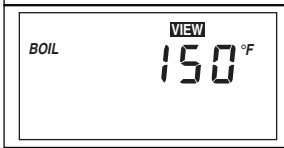
DIP Switch Setting

ADVANCED / INSTALLER

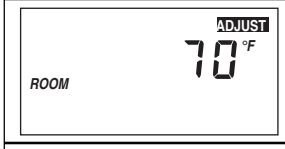
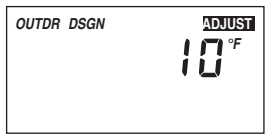
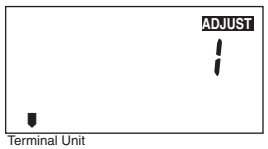
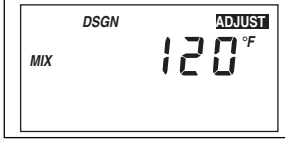
The Advanced / Installer DIP switch is used to select which items are available to be viewed and / or adjusted in the user interface.



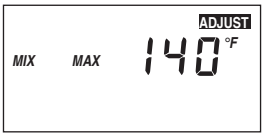
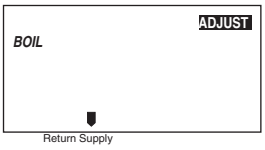
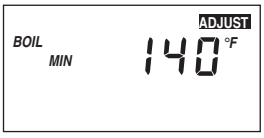
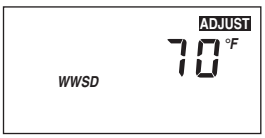
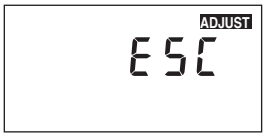
View Menu (1 of 1)

Display	Section	Installer	Advanced	Description	Range
		○	●	Current outdoor air temperature as measured by the outdoor sensor. This is also the default display for the control. **(OUTDR DSGN ≠ OFF)**	-67 to 149°F (-55 to 65°C)
	B3	○	●	Current mixed supply water temperature as measured by the mixing sensor.	14 to 266°F (-10 to 130°C)
	B1 B2 B3	○	●	Target mixed supply is the temperature the control is currently trying to maintain at the mixing sensor. "---" is displayed when the control is not operating the mixing device.	---, 14 to 266°F (---, -10 to 130°C)
		○	●	Current boiler temperature as measured by the boiler sensor. **(Boiler sensor is present)**	14 to 266°F (-10 to 130°C)

Adjust Menu (1 of 2)

Display	Section	Installer	Advanced	Description	Range	Actual Setting
	B2	○	●	The desired room air temperature. **(OUTDR DSGN ≠ OFF)**	35 to 100°F (2 to 38°C)	
	B2	○	●	Mixing setpoint temperature. **(OUTDR DSGN = OFF)**	OFF, 60 to 200°F (OFF, 16 to 93°C)	
	B2	○	●	The design outdoor air temperature used in the heat loss calculation for the heating system. For setpoint operation, set the OUTDR DSGN to OFF.	-60 to 32°F, OFF (51 to 0°C, OFF)	
	B2	○	●	The type of terminal units that are being used in the heating system. **(OUTDR DSGN ≠ OFF)**	1 (High Mass Radiant), 2 (Low Mass Radiant), 3 (Fancoil), 4 (Fin-tube Convector), 5 (Radiator), 6 (Baseboard)	
	B3		●	The design indoor air temperature used in the heat loss calculation for the heating system. **(OUTDR DSGN ≠ OFF)**	35 to 100°F (2 to 38°C)	
	B3		●	The design supply water temperature used in the heat loss calculation for the heating system. **(OUTDR DSGN ≠ OFF)**	70 to 220°F (21 to 104°C)	

Adjust Menu (2 of 2)

Display	Section	Installer	Advanced	Description	Range	Actual Setting
	B3		●	The maximum supply temperature for the mixing system. **(OUTDR DSGN ≠ OFF)**	80 to 225°F (27 to 107°C)	
	C2		●	The location of the boiler sensor. This effects operation of the boiler contact. **(Boiler sensor is present)**	Return, Supply	
	C1		●	The minimum temperature allowed for the boiler target temperature. **(Boiler sensor is present)**	OFF, 80 to 180°F (OFF, 27 to 82°C)	
	B3		●	The system's warm weather shut down.	35 to 100°F, OFF (2 to 38°C, OFF)	
		○	●	The units of measure that all of the temperatures are to be displayed in the control.	°F, °C	
		○	●	This item exits the ADJUST menu by pressing either the ▲ or ▼ button.		

Manufacturer Approved Pump Models

Manufacturer Approved Pump Models

Design Injection Flow Rate (US GPM)		Turns open of the	Nominal Pipe	Grundfos (F)				Taco				B&G			Armstrong	
Without Globe Valve	With Globe Valve	Globe Valve (%)	Diameter (inches)	15-42		26-64	43-75	003	007	0010	0012	NRF 9	NRF 22	**NRF** 33	Astro	
				2*	3**										30	50
-	1.5 - 2.0	20	0.5	☒	☒				☒				☒		☒	
2.5	2	100	0.5					☒								
4 - 5.5	3.0 - 4.5	100	0.5	☒	☒				☒			☒	☒		☒	
4.5 - 6.5	4 - 5.5	100	0.75					☒				☒				
9 - 10.5	7.5 - 8.5	100	0.75		☒				☒				☒		☒	
9	8	100	1									☒				
14 - 15	12 - 13	100	1		☒				☒				☒			
19	17	100	1.25													☒
22 - 24	19 - 21	100	1.25			☒				☒				☒		
26 - 28	-	100	1.5			☒				☒				☒		
35 - 37	31 - 32	100	1.5				☒				☒					
33	30	100	2											☒		
41 - 45	39 - 42	100	2				☒				☒					

* Speed 2, ** Speed 3 (Brute)
This table assumes there are 5 feet of pipe, 4 elbows, and 4 branch tees of the listed diameter.These circulators have been tested and approved by the manufacturers for use with the tekmar variable speed electronics.

Testing the Control

The Mixing Control 356 has a built-in test routine which is used to test the main control functions. The 356 continually monitors the sensors and displays an error message whenever a fault is found. See the following pages for a list of the 356's error messages and possible causes.

Quick Test

Press and hold the up button, the Boiler relay closes and the variable speed injection pump turns on to 100% of its output speed. Once the up button is released, the output relays return to normal operation.

Troubleshooting

When troubleshooting any heating system, it is always a good idea to establish a set routine to follow. By following a consistent routine, many hours of potential headaches can be avoided. Below is an example of a sequence that can be used when diagnosing or troubleshooting problems in a hydronic heating system.

Establish the Problem

Establish the problem. Get as much information from the customer as possible about the problem. Is there too much heat, not enough heat, or no heat? Is the problem only in one particular zone or area of the building, or does the problem affect the entire system? Is this a consistent problem or only intermittent? How long has the problem existed for? This information is critical in correctly diagnosing the problem.

Understand the Sequence of Operation

Understand the sequence of operation of the system. If a particular zone is not receiving enough heat, which pumps or valves in the system must operate in order to deliver heat to the affected zone? If the zone is receiving too much heat, which pumps, valves, or check valves must operate in order to stop the delivery of heat?

Sketch the Piping in the System

Sketch the piping of the system. This is a relatively simple step that tends to be overlooked, however, it can often save hours of time in troubleshooting a system. Note flow directions in the system paying close attention to the location of pumps, check valves, pressure bypass valves, and mixing valves. Ensure correct flow direction on all pumps. This is also a very useful step if additional assistance is required.

Document the Control

Document the control for future reference. Before making any adjustments to the control, note down all of the items that the control is currently displaying. This includes items such as error messages, current temperatures and settings, and which devices should be operating as indicated by the LCD. This information is an essential step if additional assistance is required to diagnose the problem.

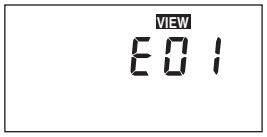
Isolate the Problem

Isolate the problem between the control and the system. Now that the sequence of operation is known and the system is sketched, is the control operating the proper pumps and valves at the correct times? Is the control receiving the correct signals from the system as to when it should be operating? Are the proper items selected in the menus of the control for the device that is to be operated?

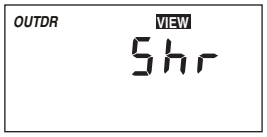
Test the Contacts Voltages & Sensors

Test the contacts, voltages and sensors. Using a multimeter, ensure that the control is receiving adequate voltage to the power terminals and the demand terminals as noted in the technical data. Use the multimeter to determine if the internal contacts on the control are opening and closing correctly. Follow the instructions in the testing the wiring section to simulate closed contacts on the terminal blocks as required. Test the sensors and their wiring as described in the sensor testing section.

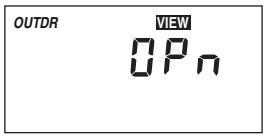
Error Messages



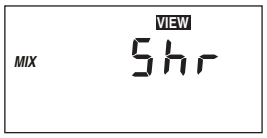
The control was unable to read a piece of information from its EEPROM. This error can be caused by a noisy power source. The control will load the factory defaults and stop operation until all the settings are verified.



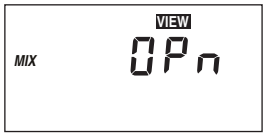
The control is no longer able to read the outdoor sensor due to a short circuit. In this case the control assumes an outdoor temperature of 32°F (0°C) and continues operation. Locate and repair the problem as described in the testing section of this brochure. To clear the error message from the control after the sensor has been repaired, press the Item button.



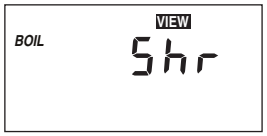
The control is no longer able to read the outdoor sensor due to an open circuit. In this case the control assumes an outdoor temperature of 32°F (0°C) and continues operation. Locate and repair the problem as described in the testing section of this brochure. To clear the error message from the control after the sensor has been repaired, press the Item button.



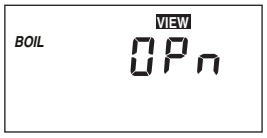
The control is no longer able to read the mixing supply sensor due to a short circuit. In this case the control will operate the injection pump at a fixed output as long as there is a mixing demand. Locate and repair the problem as described in the testing section of this brochure. To clear the error message from the control after the sensor has been repaired, press the Item button.



The control is no longer able to read the mixing supply sensor due to an open circuit. In this case the control will operate the injection pump at a fixed output as long as there is a mixing demand. Locate and repair the problem as described in the testing section of this brochure. To clear the error message from the control after the sensor has been repaired, press the Item button.

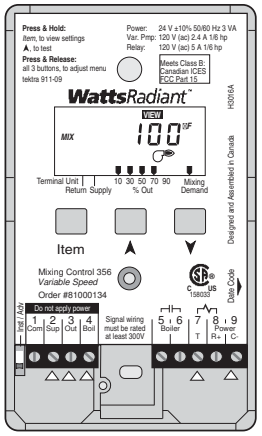


The control is no longer able to read the boiler sensor due to a short circuit. If the BOIL MIN adjustment is higher than 100°F (38°C), the control closes the Boiler contact when the injection pump starts to operate. The boiler temperature is limited by the operating aquastat. If the BOIL MIN adjustment is lower than 100°F (38°C), the control does not operate the Boiler contact. Locate and repair the problem as described in the testing section of this brochure. To clear the error message from the control after the sensor has been repaired, press the Item button.



The control is no longer able to read the boiler sensor due to an open circuit. If the BOIL MIN adjustment is higher than 100°F (38°C), the control closes the Boiler contact when the injection pump starts to operate. The boiler temperature is limited by the operating aquastat. If the BOIL MIN adjustment is lower than 100°F (38°C), the control does not operate the Boiler contact. Locate and repair the problem as described in the testing section of this brochure. If the boiler sensor is deliberately removed, the control must be powered down, and then powered back up. To clear the error message from the control after the sensor has been repaired, press the Item button.

Technical Data



Mixing Control 356 *Variable Speed, includes outdoor & 2 universal sensors*

Literature	-	IOM-WR-Mixing_Control_356, ES-WR-Mixing_Control_356
Control	-	Microprocessor control. This is not a safety (limit) control
Packaged weight	-	1.5 lb. (670 g)
Dimensions	-	4-3/4” H x 2-7/8” W x 1-7/8” D (120 x 74 x 48 mm)
Enclosure	-	White PVC plastic, NEMA type 1
Approvals	-	CSA C US, meets class B: ICES & FCC Part 15
Ambient conditions	-	Indoor use only, 32 to 104°F (0 to 40°C), RH ≤90% Non-condensing
Power supply	-	24 V (ac) ±10%, 50/60 Hz, 3 VA
Var. pump	-	120 V (ac) 2.4 A, 1/6 hp
Relays	-	120 V (ac) 5 A, 1/6 hp
Mixing demand	-	24 V (ac) 2 VA
Sensors	-	NTC thermistor, 10 kΩ @ 77°F (25°C ±0.2°C) ß=3892
-Included		Outdoor Sensor 070 and 2 of Universal Sensor 082

Outdoor Sensor 070

Packaged weight	-	0.4 lb. (180 g)
Dimensions	-	4-1/2" H x 2-7/8" W x 1-1/2" D (73 x 114 x 38 mm)
Enclosure	-	White PVC plastic, NEMA type 2
Approvals	-	CSA C US
Operating range	-	-58 to 140°F (-50 to 60°C)
Sensor	-	NTC thermistor, 10 kΩ @ 77°F (25°C ±0.2°C), ß=3892

Universal Sensor 082

Packaged weight	-	0.1 lb. (50 g)
Dimensions	-	3/8” OD x 3/4” (9.5 OD x 19 mm)
Sensor material	-	Brass sleeve, 8’ (2438 mm) 20 AWG, 300V PVC insulated zipcord
Approvals	-	CSA C US
Operating range	-	-58 to 221°F (-50 to 105°C)
Sensor	-	NTC thermistor, 10 kΩ @ 77°F (25°C ±0.2°C), ß=3892

Hydronic System Electronic Controls and Thermostats Limited Warranty

Watts Radiant (the Company) warrants its hydronic system electronic controls and thermostats (the Product) to be free from defects in materials and workmanship under normal usage for a period of one year from the documented date of installation of the Product. In the event of defects within the warranty period, the Company will replace the Product without charge. This remedy is the sole and exclusive remedy for breach of warranty. This warranty is transferable to subsequent owners.

Under this Limited Warranty, the Company will provide the following:

In order to make a claim, you must:

(a) Provide the Company with sufficient details relating to the nature of the defect, the installation, the history of operation, and any repairs that may have been made.
(b) At the Company's discretion and at the owner's expense, ship the Product to the Company or the Company's local representative or distributor.
(c) Provide proof that the Product was installed in accordance with the applicable Product Installation Manual and any special written design or installation guidelines by the Company for this project.
(d) Provide proof that the Product was installed in accordance with the National Electrical Code (NEC) or the Canadian Electrical Code (CEC), and all applicable local building and electrical codes.
(e) Provide a retail sales receipt or proof of purchase.

The following are not covered by this Limited Warranty:

(a) Any incidental or consequential damage, including inconvenience, loss of time or loss of income.
(b) Any labor or materials required to repair or replace the Product that are not authorized in writing by the Company.
(c) Any labor or materials required to remove, repair or replace materials other than the Products.
(d) Any freight or delivery costs related to the Product or any related electrical products.

Watts Radiant assumes no responsibility under this Limited Warranty for any damage to the Product caused by any trades people, visitors on the job site, or damage caused as a result of post-installation work. This Limited Warranty shall be invalidated by any abuse, misuse, misapplication or improper installation of the Products. The staff at the Company is available to answer any questions regarding the proper installation or application of the Product at this toll-free phone number: 800-276-2419 (USA/International) or 888-208-8927 (Canada). If you are ever in doubt about the correct installation procedure to follow, or if the Product appears to be damaged, you must call us before proceeding with the installation or proposed repair.

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Some states/provinces do not allow the exclusion or limitation of incidental or consequential damages and some states/provinces do not allow limitations on how long implied warranties may last. Therefore, the above limitations or exclusions may not apply to you. This warranty gives you specific legal rights and you may also have other rights, which vary from state to state or province to province. SO FAR AS IS CONSISTENT WITH APPLICABLE STATE/PROVINCIAL LAW, ANY IMPLIED WARRANTIES THAT MAY NOT BE DISCLAIMED, INCLUDING IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE ARE LIMITED IN DURATION TO ONE YEAR FROM THE DATE OF MANUFACTURE.

Effective: May 1, 2013. This warranty applies to all Products purchased after this date.

WattsRadiant™

A Watts Water Technologies Company

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