Variable Speed Outdoor Reset "00" Circulator (00-VR)

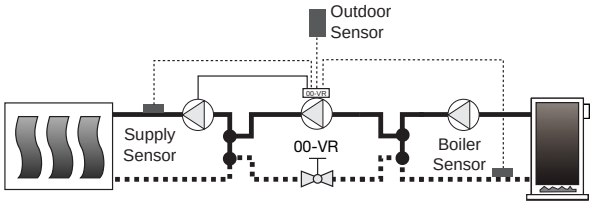
EFFECTIVE: March 1, 2004

SUPERSEDES: New

OVERVIEW

Variable Speed Outdoor Reset "00" Circulator (00-VR)

The 00-VR is a microprocessor-based variable speed circulator designed to regulate the supply water temperature to a heating system based on a reset ratio, so that the heat supplied to the building or zone equals the heat lost by the building. A full featured outdoor reset control is built right on board the circulator. All sensor, low voltage and line voltage connections are made directly to the circulator. The 00-VR modulates its speed to inject hot water from the boiler loop into the radiant or reduced temperature loop while providing Outdoor Reset to a heating system. Available in any style 003-0014, the 00-VR also comes with a boiler sensor to protect the boiler against low return temperatures. The 00-VR circulator is the ultimate for protection, control, ease of installation, and trouble free operation.



Variable Speed Injection Mixing

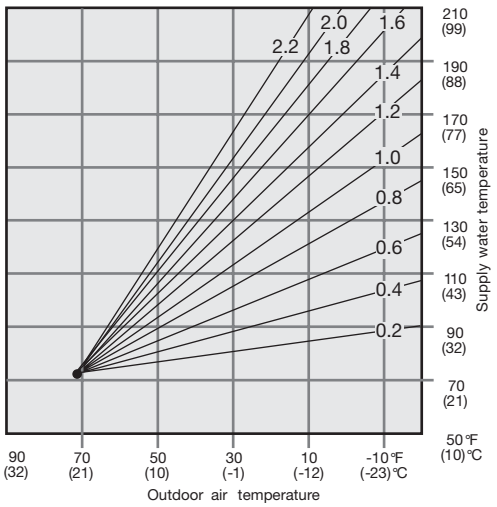
CONTROL STRATEGY

Outdoor Reset

In order to properly control a hot water heating system, the heat supplied to the building must equal the heat lost by the building.

- The heat supplied to the building is directly proportional to the temperature of the water and the surface area of the heating element. The higher the temperature of the water flowing through the heating terminal, the higher the heat output.
- The heat lost from a building is dependent on the outdoor temperature. As the outdoor temperature drops, the building heat loss increases.

These two facts lead to the concept of outdoor reset, based on a reset ratio, which increases the supply water temperature as the outdoor temperature drops. Using this approach, the heat lost from the building is matched by the heat provided by the terminal units, therefore providing more comfort and energy savings.



Features:

- **Available in all styles of 003-0014**
- **All-in-one pump / control**
- **LED status panel**
- **Sensors included**
- **Easy to wire**
- **UL approved**
- **Snap-in PC board**
- **Fuse protected**
- **Plug-in low voltage wiring terminal**
- **Optional integral flow check**
- **Adjustable heating curve (0.2 to 2.2)**
- **Selectable maximum supply temperature (110°F, 130°F, 150°F or OFF)**
- **Selectable minimum boiler return temperature (120°F, 135°F or OFF)**
- **Minimum supply temperature (85°F or OFF – default to heating curve)**
- **System and / or boiler pump contact (line voltage, 5 amp max.)**
- **Pump exercise (10 seconds after 3 days of no operation)**
- **Post purge (20 seconds)**
- **Fail safe mode (assumes outdoor temperature of 32°F)**
- **2 second start delay prevents short cycling**

Reset Ratio

The Reset Ratio sets the relationship between outdoor temperature and supply water temperature. It determines the amount the supply water temperature is raised for every 1 degree outdoor temperature drop. For example, if a Reset Ratio of 1.2 is selected, the supply water temperature is increased by 1.2 degrees of every 1 degree of outdoor temperature drop.

DESIGN

In order to properly accomplish this mixing method, the following piping details should be considered.

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, primary/secondary piping techniques are used as shown in Figure 1.

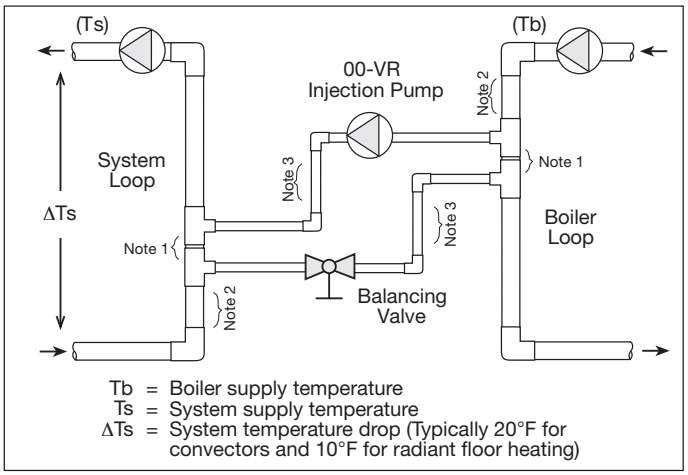


Figure 1

This piping arrangement requires that the injection piping be at least one pipe diameter smaller than the piping of the boiler and system loops. There must be no more than 4 pipe diameters between the tees in the boiler and system loops (Note 1), in order to prevent ghost flow when the injection pump is off and the system or boiler pump is on. Also, there must be at least 6 pipe diameters of straight pipe on either side of the tees (Note 2), in order to prevent the momentum of water from the boiler and system loops from pushing flow through the injection loop. Finally, there should be a minimum of 1 foot drop in the injection loop in order to create a thermal trap (Note 3) in order to prevent convective heat transfer through the injection loop.

PUMP SIZING AND SELECTION

In order to properly size the pump, follow the design procedure below:

1. Determine the design operating temperatures of the system loop and boiler. (Ts and Tb from Figure 1)
2. Determine the flow rate and design temperature drop (ΔT - Delta T) in the system loop. If one of these variables is unknown use Equation 1 or 2 to calculate the other variable.
3. Compute Tb - Ts. Look up the ratios in Figure 2.
4. The design injection flow rate for direct injection is calculated from Equation 3. If the injection flow rate is greater than 40 US GPM, a 3-way or 4-way valve may be required.
5. Decide whether or not to include a balancing valve in the injection piping. A balancing valve allows adjustment when the injection pump is larger than needed. A balancing valve also provides the possibility of manual operation of the system by turning the injection pump fully on and adjusting the balancing valve to obtain the desired supply water temperature.
6. The injection piping size and model of Taco 00-VR pump to install can now be looked up in Figure 3. Do not oversize the injection system. If the injection system is not able to provide enough heat, the boiler's aquastat may be increased.

$$\text{Eq. 1: System Flow Rate (US GPM)} = \frac{\text{Design Heating Load (BTU/hr)}}{500 \times \Delta\text{Ts (°F)}}$$

$$\text{Eq. 2: } \Delta\text{Ts (°F)} = \frac{\text{Design Heating Load (BTU/hr)}}{500 \times \text{System Flow Rate (US GPM)}}$$

$$\text{Eq. 3: Design Injection Flow Rate (US GPM)} = \text{System Flow Rate (US GPM)} \times \text{Flow Ratio}$$

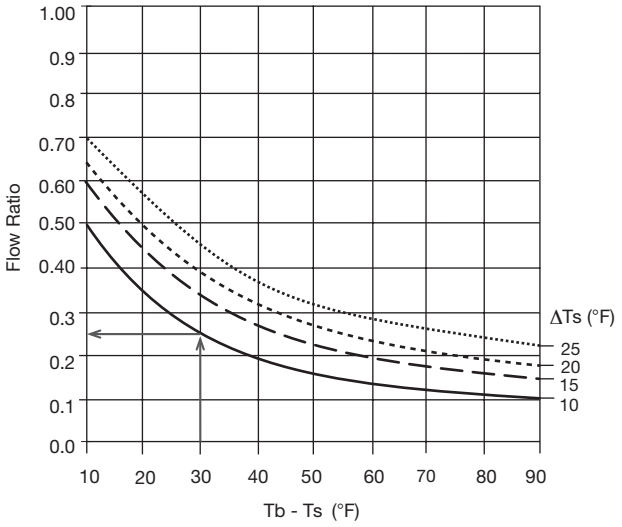


Figure 2

Design Injection Flow Rate (US GPM)	Balancing Valve Position (% open)	Balancing Valve Cv	Nominal Pipe Diameter (inches)	TACO Pump
1.5	30	2.4	0.5	003
2	40	4.5	0.5	003
3	40	4.5	0.5	006
4	100	15	0.5	006
7	40	6.9	0.75	007
8	50	10.4	0.75	007
9	30	5.76	1	007
12	40	10.8	1	007
14	40	10.8	1	0010
16	100	36	1	0010
20	50	19.8	1.25	0010
25	50	28.8	1.5	0010
30	30	18.2	2	0012
40	40	34.2	2	0012

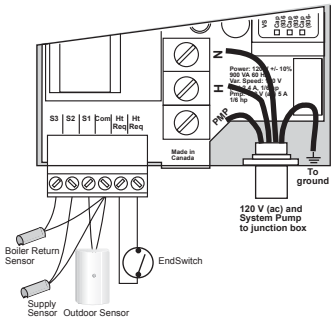
This table assumes there are 5 feet of pipe, 4 elbows, and 4 branch tees of the listed diameter. Balancing valve is assumed to be a ball valve. The approximate Cv value is provided in order to allow for proper balancing device. Valve characteristics may vary for the same size and type of ball valve from manufacturer to manufacturer.

Figure 3

OPERATION

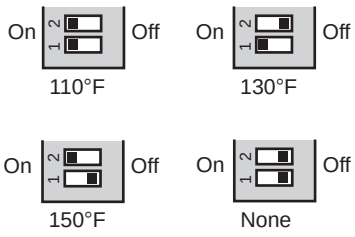
Power Up and Heat Request

Whenever the control is powered up, the green PWR LED turns on. The 00-VR starts operating once a heat request signal is present at the Heat Request (Ht Req) terminals. A heat request signal may be provided by external end switches from zone valves or ZVC/SR Zone Controls, applying a dry contact closure or a powered 24 V (ac) signal across the Ht Req terminals. If end switches or switching relays are not available, a jumper must be installed to provide a heat request. Once a heat request is present, the HEAT REQ LED turns on.



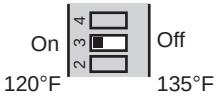
Maximum System Supply Temperature (DIP switch 1 & 2)

The 00-VR has a maximum supply function used to set a maximum supply water target temperature. The maximum temperature is selected using DIP switches 1 & 2. Select the desired Maximum System Supply temperature based on the DIP switch settings shown. If the actual supply water temperature approaches the maximum system supply, the control reduces the speed of the injection pump and the reduced output (RED. OUT) LED is turned on. This function may be disabled by setting the DIP switches 1 & 2 to off.



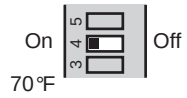
Minimum Boiler Return Temperature (DIP switch 3)

The 00-VR includes a boiler protection function which minimizes low temperatures back to the boiler. Whenever the boiler sensor is installed and a heat request is present, the 00-VR monitors the boiler return temperature and backs off the pump speed when the return temperature is near the minimum setting. The minimum setting is selected via the DIP switch 3. When the switch is turned on, the minimum temperature is set to 120°F and when the DIP is turned off the minimum is 135°F. When using low temperature boilers such as condensing or electric, the boiler minimum temperature may be disabled by powering up the control without a boiler return sensor connected.



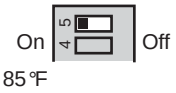
Warm Weather Shut Down (WWSD) (DIP switch 4)

When the outdoor temperature is warmer than 70°F, the 00-VR and system pump turns off and ignores any heat request. The WWSD LED turns on during warm weather shut down. This function may be turned on by setting the DIP switch 4 to the on position.



Minimum System Supply Temperature (DIP switch 5)

A minimum system supply temperature may be set on the 00-VR. This function is selectable by turning on DIP switch 5. Even though the reset ratio strategy requires a lower temperature during mild outdoor temperatures, the 00-VR will target a minimum of 85°F. This function is useful for applications such as floor warming.



System Pump

The 00-VR is capable of controlling a system pump. Whenever a heat request is present and the control is not in WWSD, the system pump contact (PMP) is turned on. The pump relay is rated for a maximum of 5 amps.

Exercising

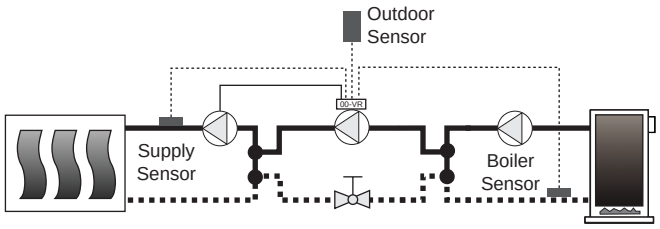
During long periods of no operation, the 00-VR is designed to exercise itself and the system pump for 10 seconds every 3 days of no operation in order to prevent precipitate build-up in the pump. The % OUT LED turns on during the exercising function. The 00-VR and system pump outputs are exercised sequentially in order to prevent uncontrolled heat transfer to the heating system.

Pump Purge

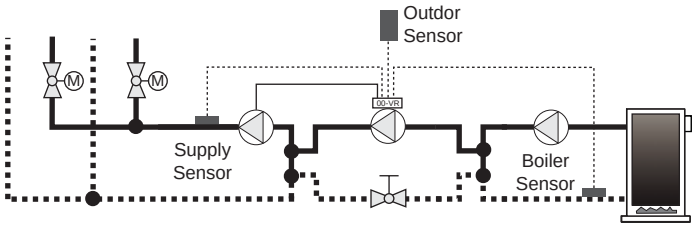
Whenever the heat request signal is removed or the 00-VR enters WWSD, the 00-VR continues to operate for 20 seconds at the last speed used. This function increases efficiency by injecting the stand by heat from the boiler loop into the system loop.

INSTALLATION

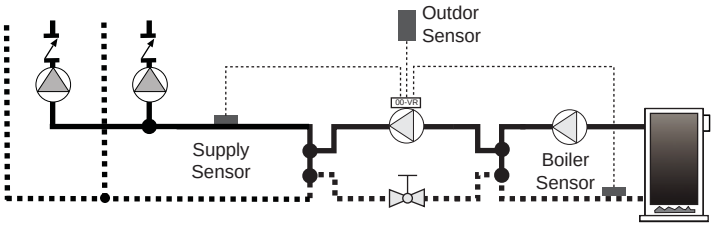
For installations where boiler protection is **NOT** required, the boiler sensor does not need to be installed.



Variable Speed Injection Mixing



Variable Speed Injection Mixing with Low Temperature Zones



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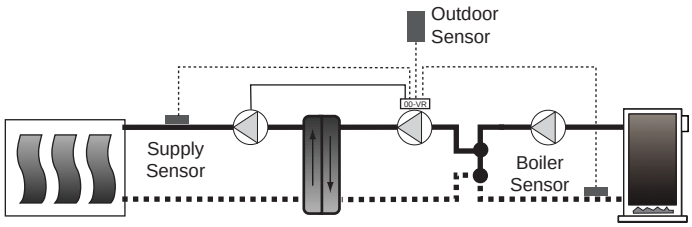
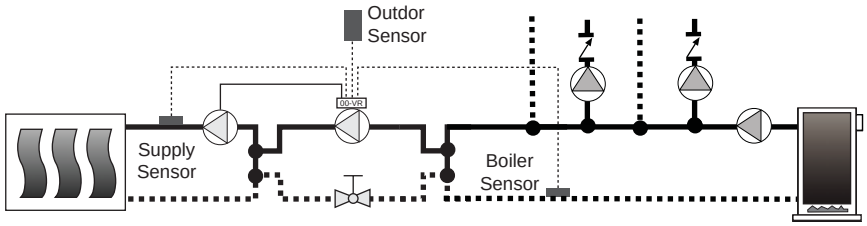
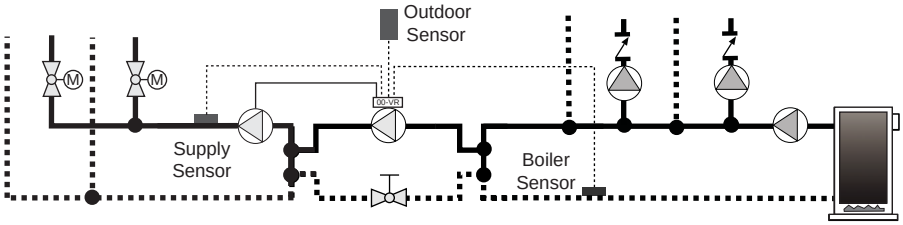


Variable Speed Injection Mixing with Heat Exchanger



Multiple Temperature System



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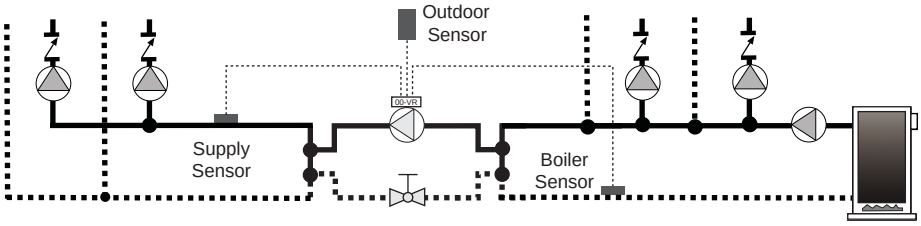

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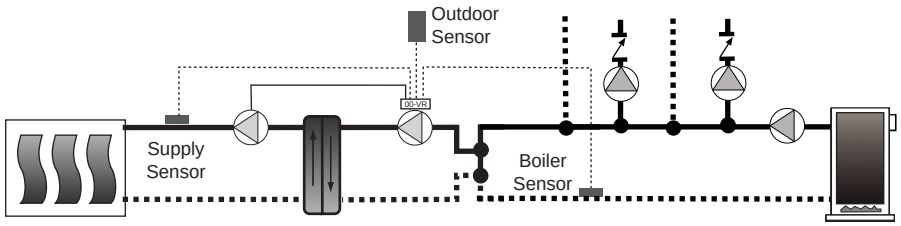
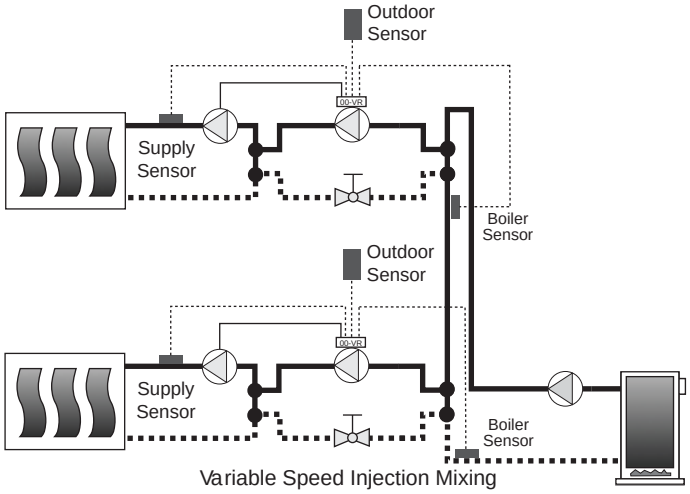
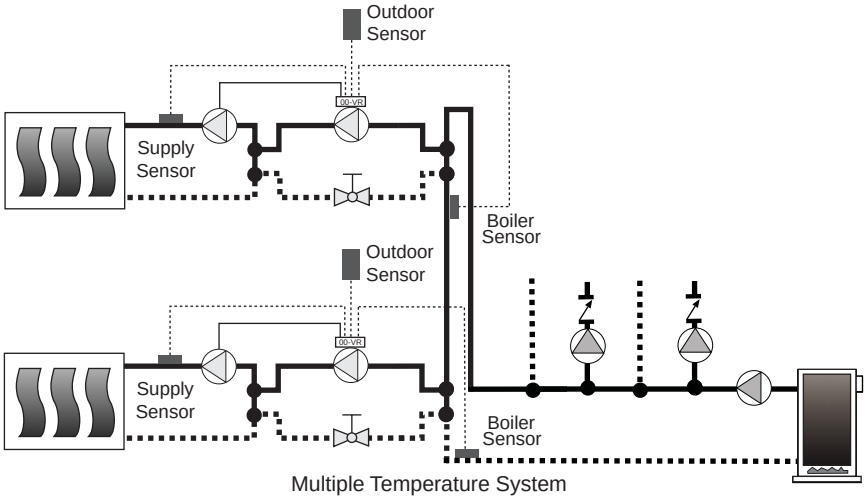


Installation with Boiler Protection



Variable Speed Injection Mixing



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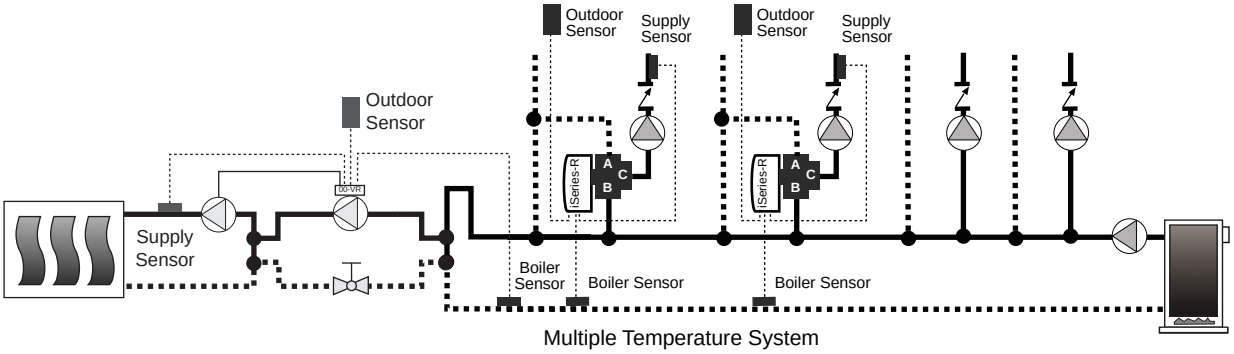

Multiple Temperature System

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