

OVERVIEW

Variable Speed Setpoint "00" Circulator (00-VS)

The versatile Setpoint version of the Variable Speed "00" can be set up to deliver a fixed temperature, maintain a specific temperature drop between sensor locations (ΔT), used as a bypass/shunt pump or integrated into a fan coil package to vary the speed of the pump based on supply air temperature. A full featured setpoint control is built right on board the circulator. All sensor, low voltage and line voltage connections are made directly to the circulator.

The 00-VS can be either direct acting (speed increases on a temperature decrease) or reverse acting (speed increases on a temperature increase). A typical direct acting (limiting setpoint) application would be for boiler protection, where the 00-VS is installed on a bypass loop (see Figure 1). If the return temperature starts to drop below the set temperature (75°F - 165°F), then the speed of the pump will be increased, bypassing hot water to protect the boiler.

The 00-VS can be used in radiant injection mixing systems where you want to set a fixed supply water temperature (see Figure 2). Through the use of the setpoint dial on the PC board, any temperature from 30°F - 210°F can be selected. If desired, a boiler protection sensor can be installed to protect the boiler from flue gas condensation.

In the ΔT mode, the pump speed is varied to maintain a set temperature drop (5°F - 50°F) across a boiler or heat exchanger, ideal for snowmelt applications.

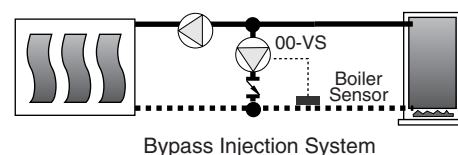


Figure 1

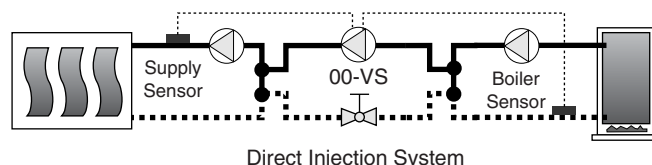


Figure 2

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 3.

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.

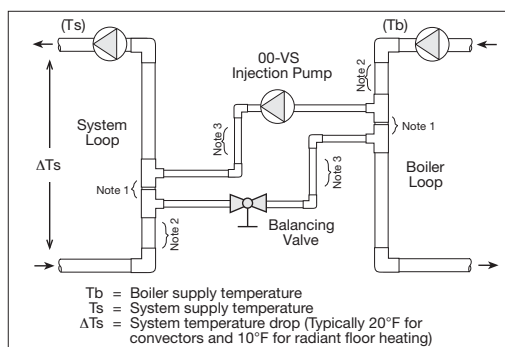


Figure 3

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.

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 setpoint (30°F - 210°F)
- Adjustable temperature difference (ΔT) (5°F - 50°F)
- Boiler protection (135°F)
- Boiler protection as a limit control (75°F - 165°F)
- Direct or reverse acting
- Selectable output response speed
- Linear or logarithmic output
- Pump exercise (10 seconds after 3 days of no operation)

PUMP SIZING AND SELECTION

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

1. Determine the design operating temperatures of the system loop and boiler. (Ts and Tb from Figure 3)
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 4.
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-VS pump to install can now be looked up in Figure 5. Do not oversize the injection system. If the injection system is not able to provide enough heat, the boiler's aquastat may be increased.

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

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

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

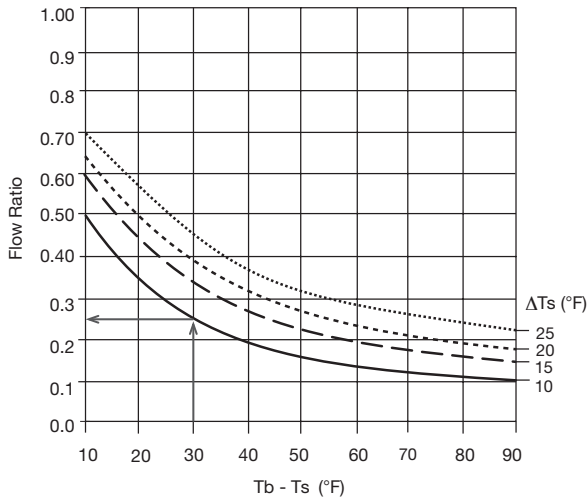


Figure 4

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 5

In order to properly size the pump for boiler protection based on the BTU load of the boiler, follow the sizing procedure below:

CIRCULATOR SIZING FOR THE BY-PASS LOOP

$$\text{Eq. 4: } (\frac{1}{4} \text{ to } \frac{1}{3} \text{ flow (gpm) of system pump}) \times \frac{1}{\# \text{ of boilers}}$$

EXAMPLE:

1,000,000 BTUH Boiler

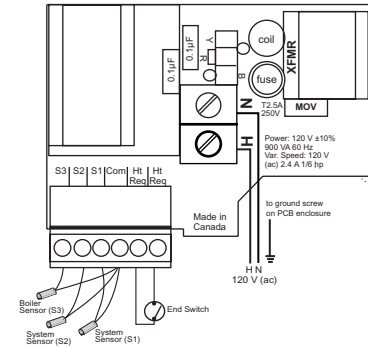
$$\text{System flow rate with } 20^{\circ}\Delta T \text{ through boiler} = \frac{1,000,000 \text{ btuh}}{10,000 \text{ btuh}} = 100 \text{ gpm}$$

$$\text{By-pass flow rate} = \frac{1}{4} \times 100 \text{ gpm} \times \frac{1}{1 \text{ boiler}} = 25 \text{ gpm} = 0010\text{-VS circulator}$$

OPERATION

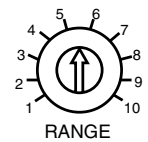
Power up and Heat Request

Whenever the 00-VS is powered up, the green PWR LED turns on. The 00-VS 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 series 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 signal is present, the green HEAT REQ LED turns on.



Mixing Operation

Once a heat request is present, the 00-VS operates to maintain a target temperature based on either a fixed setpoint or a fixed temperature difference (ΔT). The percent output (% OUT) LED flashes at different rates based on the speed of the pump. The target temperature is set using the RANGE dial, where the numbers on the dial correspond to the temperature ranges available in the applicable mode. Refer to the Setpoint and ΔT sections for a listing of the temperature ranges available.



The operation of the 00-VS is based on either direct acting or reverse acting operation.

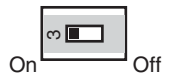
Direct Acting (DIP switch 3 = Off)

In direct acting operation, the 00-VS increases speed on a temperature decrease and decreases speed on a temperature increase. Direct acting operation is typically used in heating applications.



Reverse Acting (DIP switch 3 = On)

In reverse acting operation, the 00-VS increases speed on a temperature increase and decreases speed on a temperature decrease. Reverse acting operation is typically used in cooling applications.



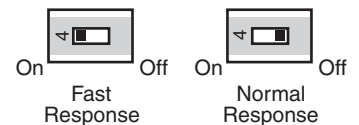
Note: Reverse acting operation is not available for Setpoint Operation with Boiler Protection.

Variable Speed Output Response

The 00-VS allows for adjustment to the response rate. The response rate is the speed at which the 00-VS operates to achieve target temperature. The response adjustment is made through DIP switch 4.

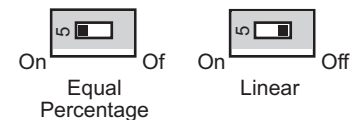
The normal response is typically used in applications where the temperature at the sensor being controlled changes gradually during operation.

The fast response is typically used in applications where the temperature at the sensor being controlled changes rapidly during operation.



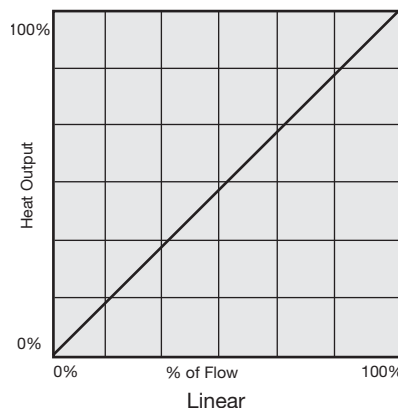
Output Characteristic

The 00-VS bases its output on a linear characteristic or an equal percentage characteristic. The output characteristic adjustment is made through DIP switch 5.



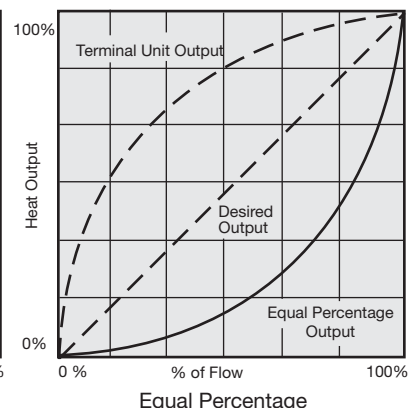
Linear Output (DIP switch 5 = Off)

The linear output characteristic assumes there is a linear relationship between percent of full flow of the pump and heat output of the terminal unit. The linear output characteristic is typical of applications in which the pump is injecting into a constant circulating loop which includes the terminal unit.



Equal Percentage Output (DIP switch 5 = On)

The equal percentage output characteristic assumes there is a non-linear relationship between percent of full flow of the pump and heat output of the terminal unit. In order to achieve the desired linear output, the 00-VS provides an equal percentage output. The equal percentage output characteristic is typical of applications in which the pump injects directly into the terminal unit.

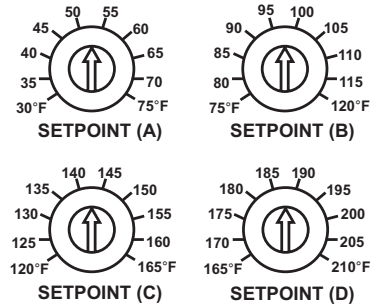


Setpoint Operation (DIP switch 1 = Off)

Once a heat request is present, the 00-VS operates to provide a fixed setpoint at either the system sensor (S1) or system sensor (S2) location. In this mode, the 00-VS uses the two sensors and DIP switch 2 in order to select different temperature ranges. Select from the four available temperature ranges listed in the table below, the temperature range in which the desired setpoint falls within. Then set the desired setpoint using the RANGE dial, where the first and last temperatures from the selected temperature range corresponds to 1 and 10 respectively on the RANGE dial, with the temperature increasing in 5°F increments.

Note: Only one of the sensors (S1 or S2) can be connected in this mode of operation.

Sensor installed	Setpoint Range	
	DIP switch 2 = Off	DIP switch 2 = On
S1	(A) 30° - 75°F	(B) 75° - 120°F
S2	(C) 120° - 165°F	(D) 165° - 210°F



Boiler Protection

When either system sensor (S1) or system sensor (S2) is installed for setpoint operation, and the boiler return sensor (S3) is installed on the return side of the boiler, the 00-VS can protect the boiler against flue gas condensation. When this sensor is installed, the 00-VS monitors the boiler return temperature. If the boiler return temperature is less than 135°F, the 00-VS flashes the reduced output (RED OUT) LED and decreases the speed of the pump.

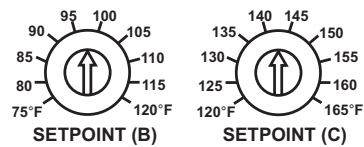
Note: This mode of operation is not available in reverse acting mode.

Setpoint Operation as a Limit (only S3 connected)

Once a heat request is present and only S3 is installed for setpoint operation, the 00-VS operates to provide a limiting setpoint. In this mode of operation, the 00-VS operates at full speed until the temperature drops below the desired setpoint. DIP switch 2 is used to select the different temperature ranges.

Select from the two available temperature ranges listed in the table below, the temperature range in which the desired setpoint falls within. Then set the desired setpoint using the RANGE dial, where the first and last temperatures from the selected temperature range corresponds to 1 and 10 respectively on the RANGE dial, with the temperature increasing in 5°F increments.

Sensor installed	Setpoint Range	
	DIP switch 2 = Off	DIP switch 2 = On
S3	(B) 75° - 120°F	(C) 120° - 165°F



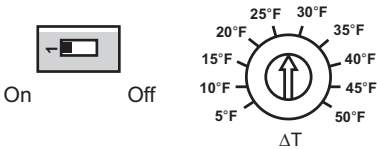
ΔT Operation (DIP switch 1 = On)

Once a heat request is present, the 00-VS operates to provide a fixed ΔT between the system sensor (S1) and the system sensor (S2). The S1 sensor is the system return sensor and S2 is the system supply sensor. The fixed ΔT is set using the RANGE dial, where 5°F and 50°F corresponds to 1 and 10 respectively on the RANGE dial, with the temperature increasing in 5°F increments.

Note: The S3 sensor is not functional in this mode of operation.

Exercising

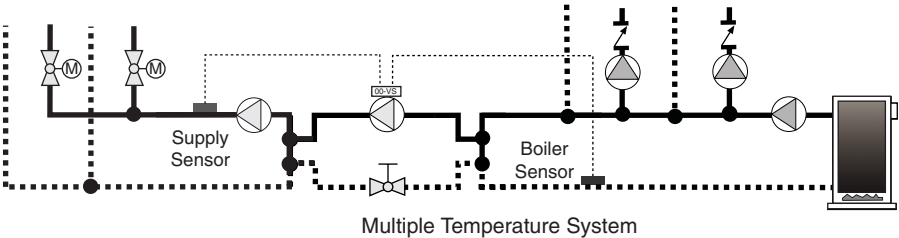
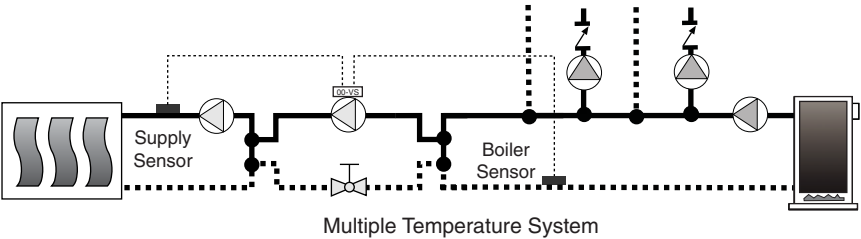
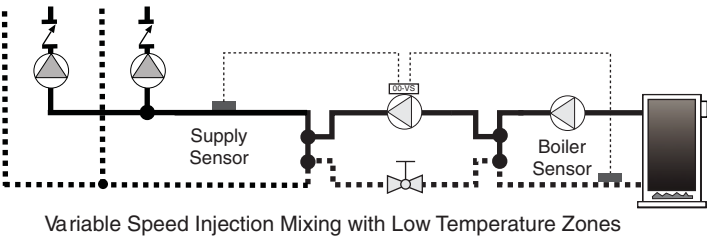
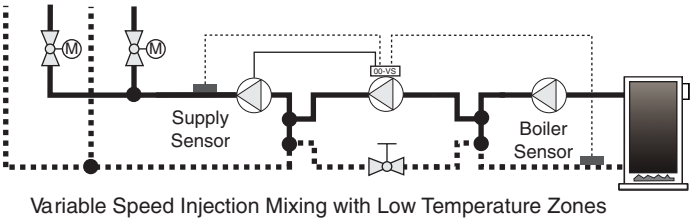
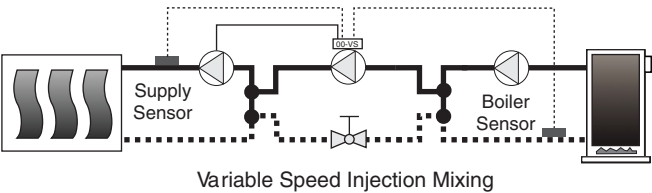
During long periods of no operation, the 00-VS is designed to exercise for 10 seconds every 3 days of no operation in order to prevent precipitate build-up in the pump. The % OUT LED turns on during the exercising function.

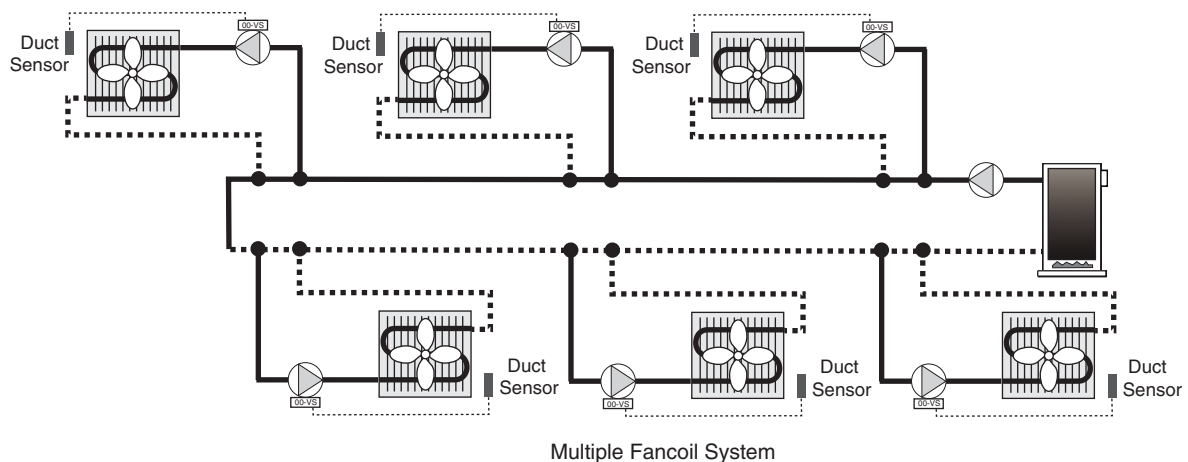
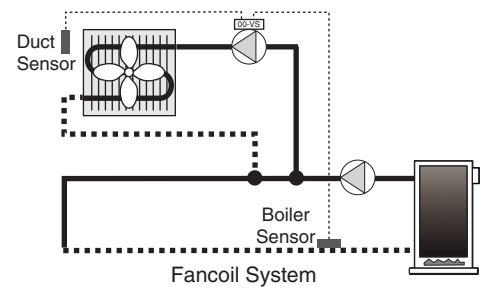
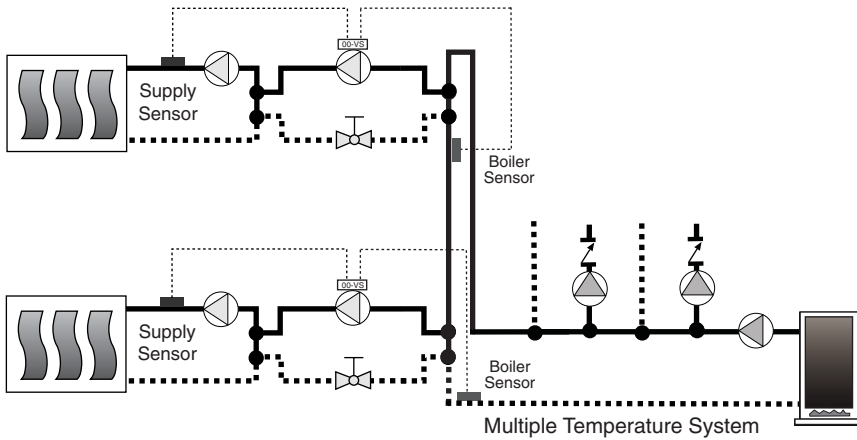
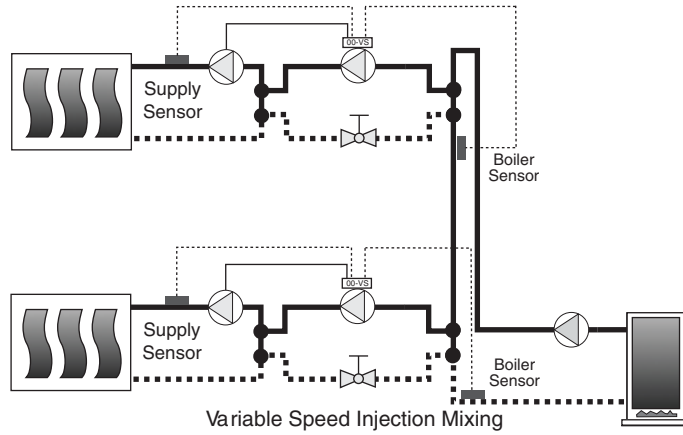
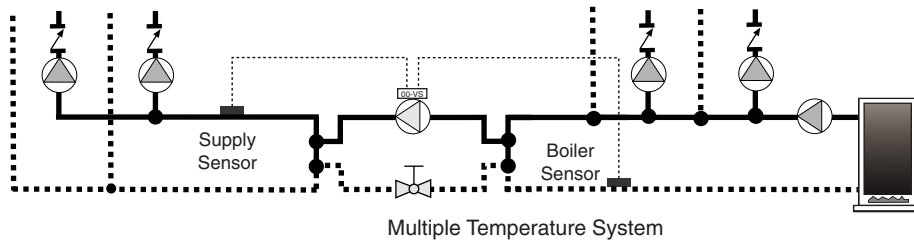


INSTALLATION

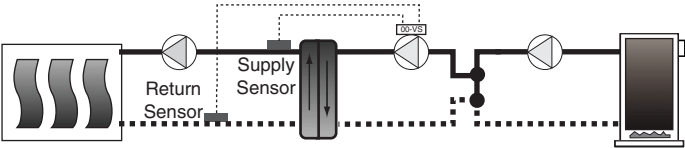
For installations where boiler protection is **NOT** required, the boiler sensor does not need to be installed.

Setpoint

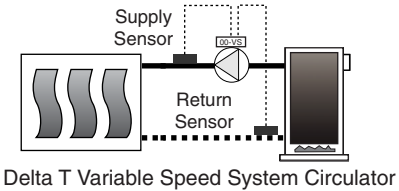




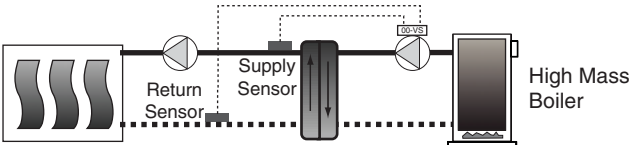
Temperature Differential (ΔT) Installations



Temperature Differential System

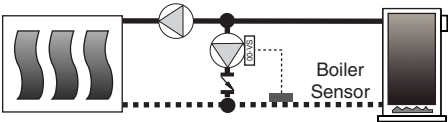


Delta T Variable Speed System Circulator

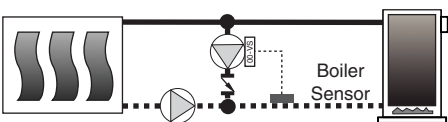


Temperature Differential System

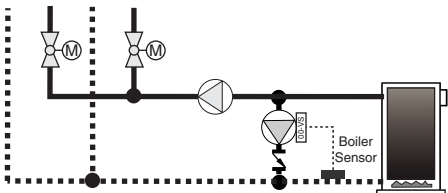
Bypass Injection (Boiler Protection) Installations



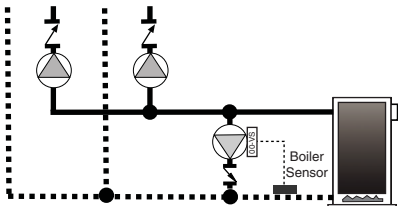
Bypass Injection System



Bypass Injection System



Variable Speed Bypass Circulator



Variable Speed Bypass Circulator

Radiant Made Easy™

TACO, INC., 1160 Cranston Street, Cranston, RI 02920 Telephone: (401) 942-8000 FAX: (401) 942-2360.

TACO (Canada), Ltd., 6180 Ordan Drive, Mississauga, Ontario L5T 2B3. Telephone: 905/564-9422. FAX: 905/564-9436.

Visit our web site at: <http://www.taco-hvac.com>

Printed in USA

Copyright 2004

TACO, Inc.