Application 2550: BACnet MS/TP Two-Pipe Fan Coil Unit Cooling or Heating

Table of Contents

Overview

In Application 2550, the controller modulates a valve in the fan coil unit for heating or cooling mode. It can also control an optional second valve for heating. The fan coil unit also has a fan to circulate room air. In order for the fan coil unit to work properly, the central plant must provide chilled water in the cooling mode and hot water in the heating mode. See Figure 2550-1 and Figure 2550-2.

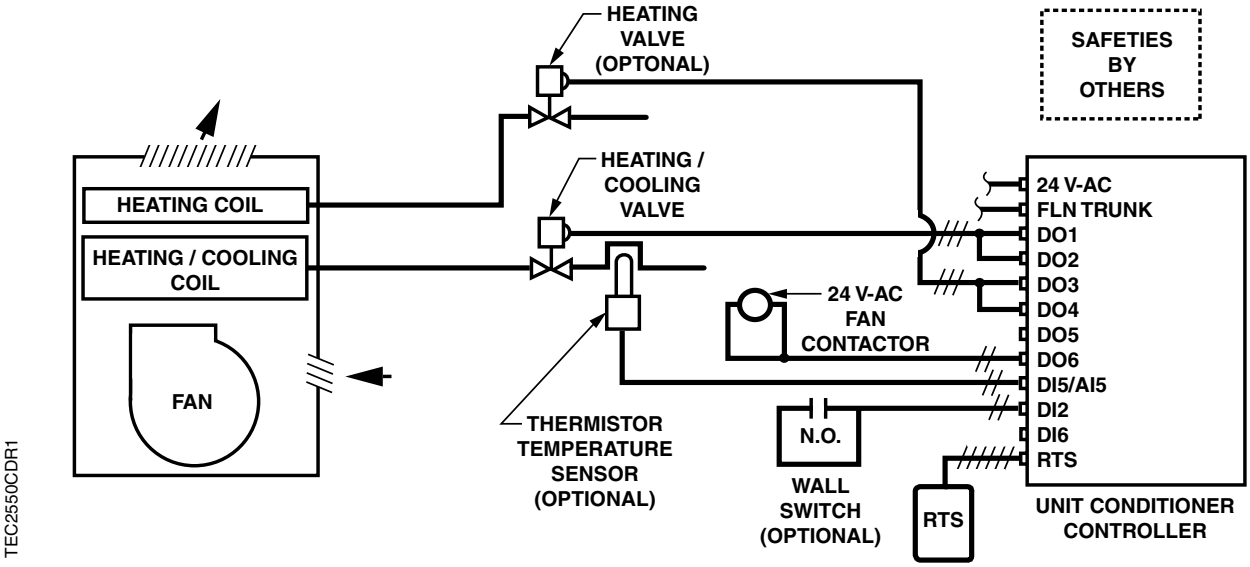


Figure 2550-1. Application 2550 Control Drawing.

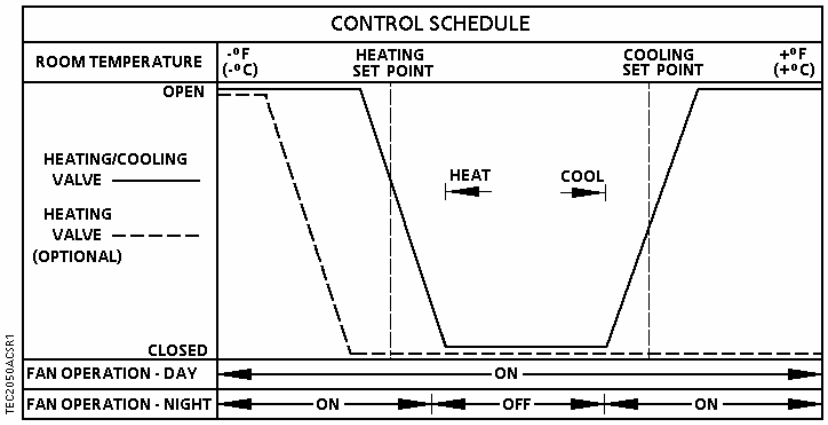
BACnet

The BACnet MS/TP Unit Conditioner Controller communicates using BACnet MS/TP protocol for open communications on BACnet MS/TP networks.

Table 2550-1. Supported BIBBs

Product	Supported BIBBs	BIBB Name
BTEC	DS-RP-B	Data Sharing-Read Property-B
	DS-RPM-B	Data Sharing-Read Property Multiple-B
	DS-WP-B	Data Sharing-Write Property-B
	DM-DDB-B	Device Management-Dynamic Device Binding-B
	DM-DOB-B	Device Management-Dynamic Object Binding-B
	DM-DDC-B	Device Management-Device Communication Control-B

Figure 2550-1. Application 2550 Control Drawing.



1. See *Sequence of Operation, Control Temperature Setpoints*.
2. See *Sequence of Operation, Heating/Cooling Switchover*.
3. The reheat valves are shown operating sequenced (optional). The reheat valves can operate sequenced, parallel, or overlapping with each other (optional). See *Sequencing Logic*.

Figure 2550-2. Application 2550 Control Schedule.

Hardware Inputs

Analog

- Pipe temperature sensor (optional)
- Room temperature sensor
- Room temperature setpoint dial (optional)

Digital

- Night mode override (optional)
- Wall switch (optional)

Hardware Outputs

Analog

- None

Digital

- Fan (switched 24 Vac, pilot duty)
- 1st valve actuator (required)
- 2nd valve actuator (optional)

Ordering Notes

BACnet MS/TP Unit Conditioner Controller	550-789A

See *APOGEE Automation Configuration and Sizing Guidelines* on InfoLink for product numbers.

Pipe temperature sensor (optional)
Terminal Equipment Controller room temperature sensor
First valve actuator (required)
Second valve actuator (optional)

Point Database

Table 2550-2 presents the point database information for Application 2550.

Sequence of Operation

The following paragraphs present the sequence of operation for Application 2550, "Two-Pipe Fan Coil Unit Cooling or Heating".

Control Temperature Setpoints

Depending on the controller's current operational mode (day or night), CTL STPT (Point 92) holds the value of one of the following setpoints:

Day Mode – CTL STPT holds the value of DAY CLG STPT (Point 6) or DAY HTG STPT (Point 7). If the room temperature sensor has a setpoint dial and STPT DIAL (Point 14) = YES, CTL STPT holds the value of RM STPT DIAL (Point 13).

If the setpoint dial is used and RM STPT DIAL < RM STPT MIN (Point 11), CTL STPT holds the value of RM STPT MIN. If RM STPT DIAL > RM STPT MAX (Point 12), CTL STPT holds the value of RM STPT MAX.

Night Mode – CTL STPT holds the value of NGT CLG STPT (Point 8) or NGT HTG STPT (Point 9).

Room Temperature Offset

NOTE: The Room Temperature Offset feature is optional.

RMTMP OFFSET (Point 3) is a user-adjustable offset that will compensate for deviations between the value of ROOM TEMP (Point 4) and the actual room temperature. This corrected value is displayed in CTL TEMP (Point 78).

CTL TEMP (Point 78) = ROOM TEMP (Point 4) + RMTMP OFFSET (Point 3)

EXAMPLE: If the actual room temperature is 72.0°F, and the value of ROOM TEMP is 73.0°F, then the value entered into RMTMP OFFSET is –1.0. In this case, the value of ROOM TEMP would read 73.0°F, but the value of CTL TEMP would read 72.0°F.

Day and Night Modes

The day/night status of the space is determined by the status of DAY.NGT (Point 29). The control of this point differs depending on whether the controller is monitoring the status of a wall switch or if the controller is connected to a field panel.

When a wall switch is physically connected to the termination strip on the controller at DI 2 (The BACnet MS/TP Unit Conditioner Controller communicates using BACnet MS/TP protocol for open communications on BACnet MS/TP networks.

Table 2550-1. Supported BIBBs

Product	Supported BIBBs	BIBB Name
BTEC	DS-RP-B	Data Sharing-Read Property-B
	DS-RPM-B	Data Sharing-Read Property Multiple-B
	DS-WP-B	Data Sharing-Write Property-B
	DM-DDB-B	Device Management-Dynamic Device Binding-B
	DM-DOB-B	Device Management-Dynamic Object Binding-B
	DM-DDC-B	Device Management-Device Communication Control-B

Figure 2550-1 and Figure 2550-4), and WALL SWITCH (Point 18) = YES, the controller monitors the status of DI 2. When the status of DI 2 (Point 24) is ON (the switch is closed), DAY.NGT will be set to DAY, indicating that the controller is in day mode. When the status of DI 2 is OFF (the switch is open), DAY.NGT will be set to NIGHT, indicating that the controller is in night mode.

When WALL SWITCH = NO, the controller does not monitor the status of the wall switch, even if one is connected to it. In this case, the controller is operating stand-alone and stays in day mode all the time. If the controller is operating with centralized control, connected to a field panel, the field panel can send an operator command to override the status of DAY.NGT.

Night Mode Override Switch

If an override switch is present on the room temperature sensor and a value (in hours) other than zero has been entered into OVRD TIME (Point 20), pressing the override switch will reset the controller to day mode for the amount of time set in OVRD TIME. The status of NGT OVRD (Point 21) changes to DAY. After the override time elapses, the controller returns to night mode and NGT OVRD changes back to NIGHT.

The override switch on the room sensor will only affect the controller when in night mode.

Heating/Cooling Switchover

There are three options for the heating/cooling switchover for this application. In order for the controller to function properly, one of the following three options must be used:

1. A temperature sensor is attached to the supply water pipe. The controller uses the measured temperature point, SUPPLY TEMP (Point 15), to determine whether it is in heating or cooling mode.

   When SUPPLY TEMP < COOL TEMP (Point 61), the controller sets HEAT.COOL (Point 5) to COOL, switching the controller to cooling mode.

   When SUPPLY TEMP > HEAT TEMP (Point 62), the controller sets HEAT.COOL (Point 5) to HEAT, switching the controller to heating mode.

2. If the controller is connected to a field panel, the field panel can command the supply temperature point, SUPPLY TEMP (Point 15).

   When SUPPLY TEMP is commanded below the value of COOL TEMP (Point 61), the controller sets HEAT.COOL (Point 5) to COOL, switching the controller to cooling mode.

   When SUPPLY TEMP is commanded above the value of HEAT TEMP (Point 62), the controller sets HEAT.COOL (Point 5) to HEAT, switching the controller to heating mode.

3. If the controller is connected to a field panel, the field panel can switch the controller between heating and cooling modes by commanding HEAT.COOL (Point 5) to HEAT or COOL.

Control Loops

The fan coil unit is controlled by two Proportional, Integral, and Derivative (PID) temperature loops.

Temperature Loops – The two temperature loops are a cooling loop and a heating loop. The active temperature loop maintains room temperature at the value set in CTL STPT (Point 92). See *Control Temperature Setpoints*.

Cooling Operation

In cooling mode, the controller uses CTL STPT (Point 92) and CTL TEMP (Point 78) as inputs for the cooling loop. The central plant must provide chilled water. The output of the cooling loop is CLG LOOPOUT (Point 79), which modulates the heating/cooling valve, VLV 1 COMD (Point 48). HTG LOOPOUT (Point 80) is set to 0%.

Heating Operation

In heating mode, the controller uses CTL STPT (Point 92) and CTL TEMP (Point 78) as inputs for the heating loop. The central plant must provide hot water. The output of the heating loop is HTG LOOPOUT (Point 80), which modulates the heating/cooling valve, VLV 1 COMD (Point 48) and the optional second heating valve, VLV 2 COMD (Point 52). CLG LOOPOUT (Point 79) is set to 0%.

Hot Water Reheat

The heating loop modulates the heating/cooling valve and the optional second heating valve in order to warm-up the space as follows:

- If there is only one heating valve, VALVE CNT (Point 88) = 1. The position of the heating/cooling valve, VLV 1 COMD (Point 48), is calculated using the following formula:

  (HTG LOOPOUT – VLV 1 START) ÷ (VLV 1 END – VLV 1 START) × 100%, limited between 0 and 100%.

  As the demand for heating rises, the valve will begin opening when HTG LOOPOUT (Point 80) rises above VLV 1 START (Point 16), and will be fully open when HTG LOOPOUT reaches VLV 1 END (Point 17). VLV 2 COMD (Point 52) will not be used.

- If there are two heating valves, VALVE CNT = 2. The position of the first heating valve, VLV 1 COMD, is calculated as above. Similarly, the position of the optional second heating valve, VLV 2 COMD, is calculated using the following formula:

  (HTG LOOPOUT – VLV 2 START) ÷ (VLV 2 END – VLV 2 START) × 100%, limited between 0 and 100%.

  As the demand for heating rises, the second valve will begin opening when HTG LOOPOUT rises above VLV 2 START (Point 22), and will be fully open when HTG LOOPOUT reaches VLV 2 END (Point 23). See *Sequencing Logic* for information on how the two heating valves can be sequenced.

NOTE: If a valve's start and end point values are set to the same value, the valve will not be used.
VLV 1 START and VLV 1 END are used to calculate the heating/cooling valve position only in the heating mode. In cooling mode, these points are not used. In cooling mode, VLV 1 COMD = CLG LOOPOUT (Point 79).

Sequencing Logic (optional)

In heating mode, this application includes logic that allows two heating valves to operate in sequence, parallel, or overlapping. This algorithm is very similar to the spring range sequencing of valves and dampers. Portions of the output of the heating loop, HTG LOOPOUT (Point 80), will drive the two heating valves from 0 to 100%. See the following three examples. The ladder diagrams in Figure 2550-3 show sequenced, parallel, and overlapping valve operations. The vertical bars show the output of heating loopout from 0 to 100%. The horizontal bars (valve 1 start, valve 1 end, etc.) show the action that occurs when the loop output rises above the horizontal bar. The relative positions shown on the graphs are for illustration purposes only and may differ from the examples.

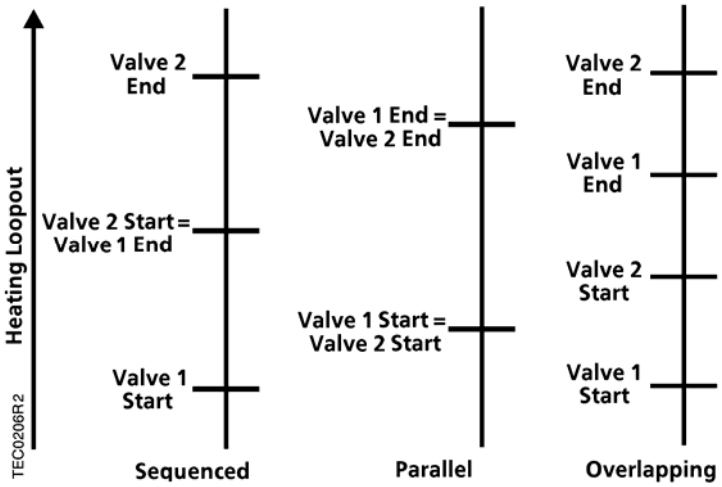


Figure 2550-3. Sequenced, Parallel, and Overlapping Loop Operations with Hot Water Reheat.

Example 1

Assume that your system has two hot water valves that are to operate in *sequence*. If:

- VLV 1 START (Point 16) = 0%
- VLV 1 END (Point 17) = 50%
- VLV 2 START (Point 22) = 50%
- VLV 2 END (Point 23) = 100%

then,

- When HTG LOOPOUT = 0%, VLV 1 COMD (Point 48) will equal 0% open and VLV 2 COMD (Point 52) will equal 0% open.
- When HTG LOOPOUT = 25%, VLV 1 COMD will equal 50% open and VLV 2 COMD will equal 0% open.
- When HTG LOOPOUT = 50%, VLV 1 COMD will equal 100% open and VLV 2 COMD will equal 0% open.
- When HTG LOOPOUT = 75%, VLV 1 COMD will equal 100% open and VLV 2 COMD will equal 50% open.
- When HTG LOOPOUT = 100%, VLV 1 COMD will equal 100% open and VLV 2 COMD will equal 100% open.

Example 2

Assume that your system has two hot water valves that are to operate in *parallel*. If:

- VLV 1 START = 0%
- VLV 1 END = 100%
- VLV 2 START = 0%
- VLV 2 END = 100%

then,

- When HTG LOOPOUT = 0%, VLV 1 COMD and VLV 2 COMD will equal 0% open.
- When HTG LOOPOUT = 50%, VLV 1 COMD and VLV 2 COMD will equal 50% open.
- When HTG LOOPOUT = 100%, VLV 1 COMD and VLV 2 COMD will equal 100% open.

Example 3

Assume that your system has two hot water valves that are to operate *overlapping*. If:

- VLV 1 START = 0%
- VLV 1 END = 75%
- VLV 2 START = 25%
- VLV 2 END = 100%

then,

- When HTG LOOPOUT = 0%, VLV 1 COMD and VLV 2 COMD will equal 0% open.
- When HTG LOOPOUT = 37.5%, VLV 1 COMD will equal 50% open and VLV 2 COMD will equal 17% open.
- When HTG LOOPOUT = 62.5%, VLV 1 COMD will equal 83% open and VLV 2 COMD will equal 50% open.
- When HTG LOOPOUT = 100%, VLV 1 COMD and VLV 2 COMD will equal 100% open.

Fan Operation

Day Mode – The fan may be set to stay ON at all times or to cycle to save energy. If CYCLE FAN (Point 60) = NO, the fan will be ON during the day. If CYCLE FAN = YES, the fan will cycle according to the following conditions:

1. If either VLV 1 COMD (Point 48) or VLV 2 COMD (Point 52) is open more than the value of STAGE FAN (Point 84), the fan will turn ON.
2. If both valves are closed below the value of SWITCH LIMIT (Point 85), the fan will turn OFF.
3. If neither of the above two conditions is met, the condition of the fan remains unchanged.

NOTE: The above conditions are true whether or not a second heating valve is being used. If the second valve is not being used, it is not looked at by the fan.

Night Mode – The fan cycles using the same three conditions described in the day mode section above, regardless of the setting of CYCLE FAN. If NGT OVRD (Point 21) = DAY (indicating that the night mode override button has been pressed), the fan is controlled as in day mode.

Calibration

The controller will regularly calibrate the valve(s) based on the value of CAL TIMER (Point 96). A value of 12 indicates that the controller will calibrate the valve(s) once every 12 hours.

The calibration consists of driving the valve(s) closed, and then resetting the value of VLV 1 POS (Point 49) to 0. If a second valve is used, VLV 2 POS (Point 53) is also set to 0. The actuators are then released to normal control.

Fail-Safe Operation

If the room temperature sensor fails or the pipe temperature sensor fails, the controller operates using the last known temperature value.

Application Notes

1. If temperature swings in the room are excessive or there is trouble maintaining the setpoint, the cooling loop, the heating loop, or both need to be tuned. See *iKnow Troubleshooting Tool* for more information.
2. The controller as shipped from the factory keeps all associated equipment OFF. See the Start-up documentation for information on how to release the controller and its equipment to application control.
3. Spare DOs can be used as auxiliary points that are controlled by the field panel after being defined in the field panel's database. If a second heating valve is not being controlled by the application, DO 3 and DO 4 may be used as auxiliary motor points. If using a pair of spare DOs to control a motor, you must make sure that the motor setup, motor timing, and motor rotation angle are enabled correctly before you unbundle VLV 2 COMD (Point 52).

Wiring Diagram

The point wiring for Application 2550 is shown in Figure 2550-4.

CAUTION:

The controller's DOs control 24 Vac loads only. The maximum rating is 12 VA for each DO. Use an interposing 220V 4-relay module for any of the following:

- VA requirements higher than the maximum
- 110 or 220 Vac requirements
- DC power requirements
- Separate transformers used to power the load

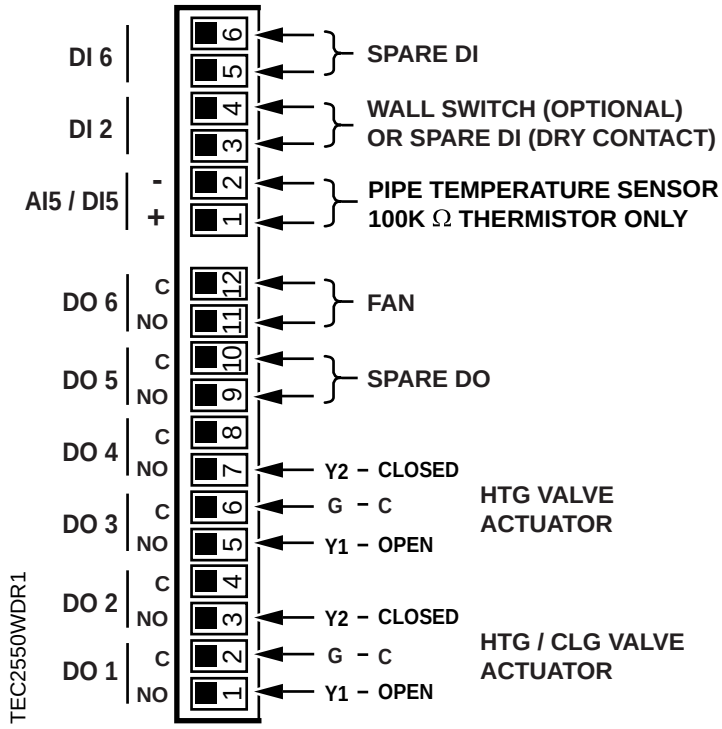


Figure 2550-4. Application 2550 Wiring Diagram.

Point Database

Table 2550-2. Point Database for Application 2550

Object Type [a]	Object Instance (Point Number) [b]	Object Name (Descriptor)	Factory Default (SI Units) [c]	Engr Units (SI Units) [c]	Range	Active Text	Inactive Text
AO	01	CTLR ADDRESS	99	--	0 to 255	--	--
AO	02	APPLICATION	2591	--	0 to 32767	--	--
AO	03	RMTMP OFFSET	0.0 (0.0)	DEG F (DEG C)	-31.75 to 32.0	--	--
AI	{04}	ROOM TEMP	74.0 (23.44888)	DEG F (DEG C)	48.0 to 111.75	--	--
BO	{05}	HEAT.COOL	COOL	--	Binary	HEAT	COOL
AO	06	DAY CLG STPT	74.0 (23.44888)	DEG F (DEG C)	48.0 to 111.75	--	--
AO	07	DAY HTG STPT	70.0 (21.20888)	DEG F (DEG C)	48.0 to 111.75	--	--
AO	08	NGT CLG STPT	82.0 (27.92888)	DEG F (DEG C)	48.0 to 111.75	--	--
AO	09	NGT HTG STPT	65.0 (18.40888)	DEG F (DEG C)	48.0 to 111.75	--	--
BI	{10}	DI 6	OFF	--	Binary	ON	OFF
AO	11	RM STPT MIN	55.0 (12.80888)	DEG F (DEG C)	48.0 to 111.75	--	--
AO	12	RM STPT MAX	90.0 (32.40888)	DEG F (DEG C)	48.0 to 111.75	--	--
AI	{13}	RM STPT DIAL	74.0 (23.44888)	DEG F (DEG C)	48.0 to 111.75	--	--
BO	14	STPT DIAL	NO	--	Binary	YES	NO
AI	{15}	SUPPLY TEMP	74.0 (23.495556)	DEG F (DEG C)	37.5 to 165.0	--	--
AO	16	VLV 1 START	0.0	PCT	0.0 to 102.0	--	--
AO	17	VLV 1 END	100.0	PCT	0.0 to 102.0	--	--
BO	18	WALL SWITCH	NO	--	Binary	YES	NO
BI	{19}	DI OVRD SW	OFF	--	Binary	ON	OFF
AO	20	OVRD TIME	0	HRS	0 to 255	--	--
BO	{21}	NGT OVRD	NIGHT	--	Binary	NIGHT	DAY

a Object Types are; Analog Input (AI), Analog Output (AO), Binary Input (BI) and Binary Output (BO).
b Points not listed are not used in this application.
c A single value in a column means that the value is the same in English units and in SI units.
d Point numbers that appear in brackets { } may be unbundled at the field panel.

Table 2550-2. Point Database for Application 2550

Object Type [a]	Object Instance (Point Number) [b]	Object Name (Descriptor)	Factory Default (SI Units) [c]	Engr Units (SI Units) [c]	Range	Active Text	Inactive Text
AO	22	VLV 2 START	0.0	PCT	0.0 to 102.0	--	--
AO	23	VLV 2 END	0.0	PCT	0.0 to 102.0	--	--
BI	{24}	DI 2	OFF	--	Binary	ON	OFF
BO	{29}	DAY.NGT	DAY	--	Binary	NIGHT	DAY
BO	{41}	DO 1	OFF	--	Binary	ON	OFF
BO	{42}	DO 2	OFF	--	Binary	ON	OFF
BO	{43}	DO 3	OFF	--	Binary	ON	OFF
BO	{44}	DO 4	OFF	--	Binary	ON	OFF
BO	{45}	DO 5	OFF	--	Binary	ON	OFF
BO	{46}	FAN	OFF	--	Binary	ON	OFF
AO	{48}	VLV 1 COMD	0.0	PCT	0.0 to 102.0	--	--
AO	{49}	VLV 1 POS	0.0	PCT	0.0 to 102.0	--	--
AO	51	MTR 1 TIMING	130	SEC	0 to 511	--	--
AO	{52}	VLV 2 COMD	0.0	PCT	0.0 to 102.0	--	--
AO	{53}	VLV 2 POS	0.0	PCT	0.0 to 102.0	--	--
AO	55	MTR 2 TIMING	130	SEC	0 to 511	--	--
AO	56	MTR1 ROT ANG	90	--	0 to 255	--	--
AO	57	MTR2 ROT ANG	90	--	0 to 255	--	--
AO	58	MTR SETUP	0	--	0 to 255	--	--
AO	59	DO DIR. REV	0	--	0 to 255	--	--
BO	60	CYCLE FAN	NO	--	Binary	YES	NO
AO	61	COOL TEMP	65.0 (18.455556)	DEG F (DEG C)	37.5 to 165.0	--	--
AO	62	HEAT TEMP	80.0 (26.855556)	DEG F (DEG C)	37.5 to 165.0	--	--
AO	63	CLG P GAIN	20.0 (36.0)	--	0.0 to 63.75	--	--
AO	64	CLG I GAIN	0.01 (0.018)	--	0.0 to 1.023	--	--
AO	65	CLG D GAIN	0 (0.0)	--	0 to 510	--	--
AO	66	CLG BIAS	0.0	PCT	0.0 to 102.0	--	--
AO	67	HTG P GAIN	10.0 (18.0)	--	0.0 to 63.75	--	--

a Object Types are; Analog Input (AI), Analog Output (AO), Binary Input (BI) and Binary Output (BO).
b Points not listed are not used in this application.
c A single value in a column means that the value is the same in English units and in SI units.
d Point numbers that appear in brackets { } may be unbundled at the field panel.

Table 2550-2. Point Database for Application 2550

Object Type [a]	Object Instance (Point Number) [b]	Object Name (Descriptor)	Factory Default (SI Units) [c]	Engr Units (SI Units) [c]	Range	Active Text	Inactive Text
AO	68	HTG I GAIN	0.01 (0.018)	--	0.0 to 1.023	--	--
AO	69	HTG D GAIN	0 (0.0)	--	0 to 510	--	--
AO	70	HTG BIAS	0.0	PCT	0.0 to 102.0	--	--
AO	{78}	CTL TEMP	74.0 (23.44888)	DEG F (DEG C)	48.0 to 111.75	--	--
AO	{79}	CLG LOOPOUT	0.0	PCT	0.0 to 102.0	--	--
AO	{80}	HTG LOOPOUT	0.0	PCT	0.0 to 102.0	--	--
AO	84	STAGE FAN	10.0	PCT	0.0 to 102.0	--	--
AO	85	SWITCH LIMIT	5.2	PCT	0.0 to 102.0	--	--
AO	88	VALVE CNT	1	--	0 to 255	--	--
AO	{92}	CTL STPT	74.0 (23.44888)	DEG F (DEG C)	48.0 to 111.75	--	--
AO	96	CAL TIMER	12	HRS	0 to 255	--	--
AO	98	LOOP TIME	5	SEC	0 to 255	--	--
AO	{99}	ERROR STATUS	0	--	0 to 255	--	--

a Object Types are; Analog Input (AI), Analog Output (AO), Binary Input (BI) and Binary Output (BO).
b Points not listed are not used in this application.
c A single value in a column means that the value is the same in English units and in SI units.
d Point numbers that appear in brackets { } may be unbundled at the field panel.