

Application 2554: BACnet MS/TP Fan Coil Unit Cooling and Electric Heat

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Overview

In Application 2554, the controller energizes a valve or damper for cooling and controls a maximum of three stages of electric heat for heating in the fan coil unit. The fan coil unit also has a fan to circulate room air. This application can also be used to control a pressure-dependent terminal box with electric heat. If a damper is being controlled, the central plant must supply chilled air in the cooling mode in order for the terminal box to work properly. See Figure 2554-1 through Figure 2554-4.

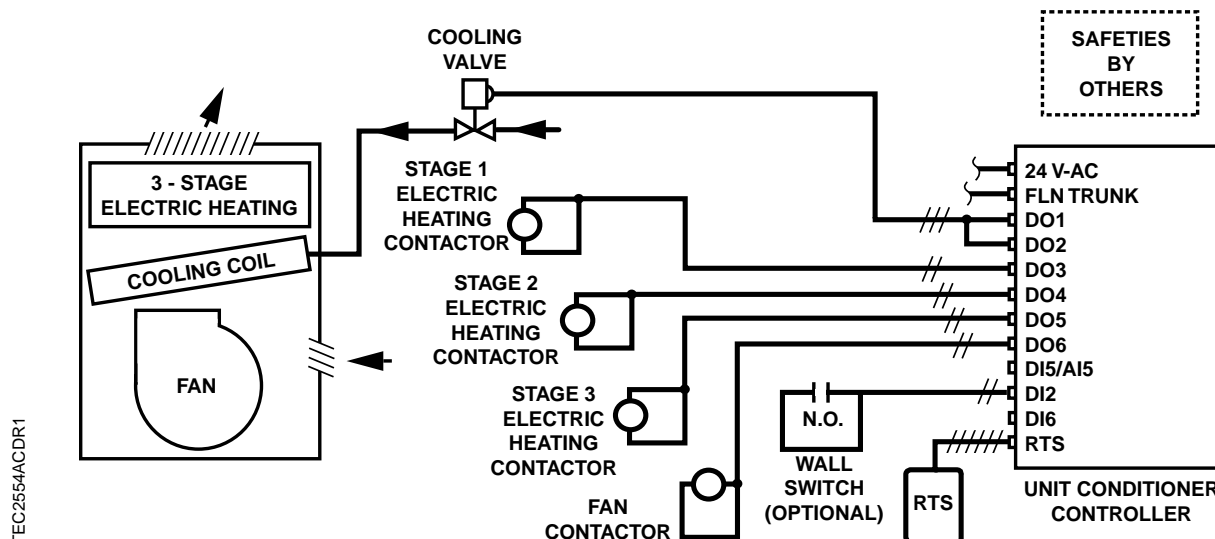


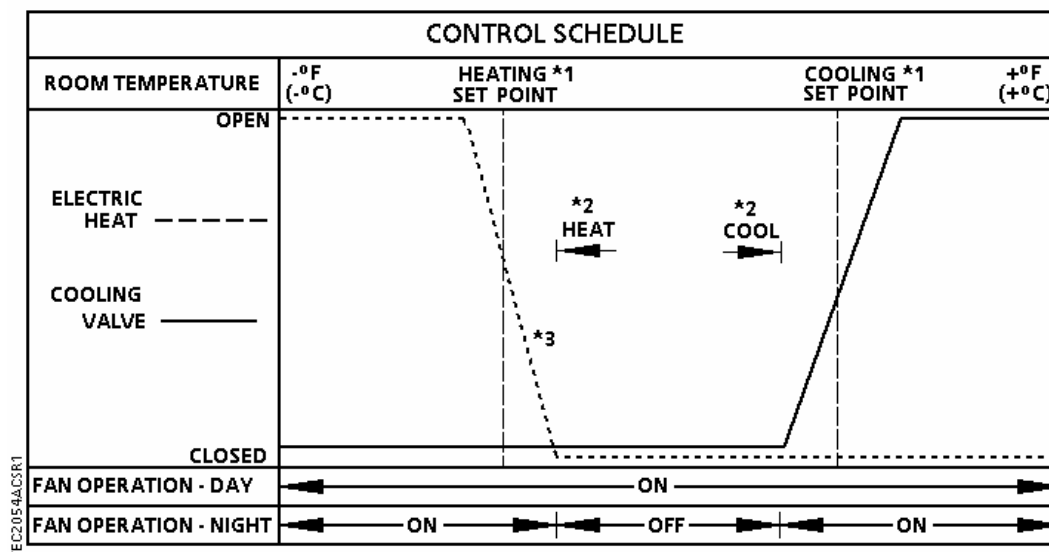
Figure 2554-1. Application 2554 Control Drawing.

BACnet

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

Table 2554-1. 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



1. See Sequence of Operation, Control Temperature Setpoints.
2. See Sequence of Operation, Heating/Cooling Switchover.
3. The electric heat is time-modulated. This allows it to be controlled proportionally rather than with deadbands.

Figure 2554-2. Application 2554 Control Schedule.

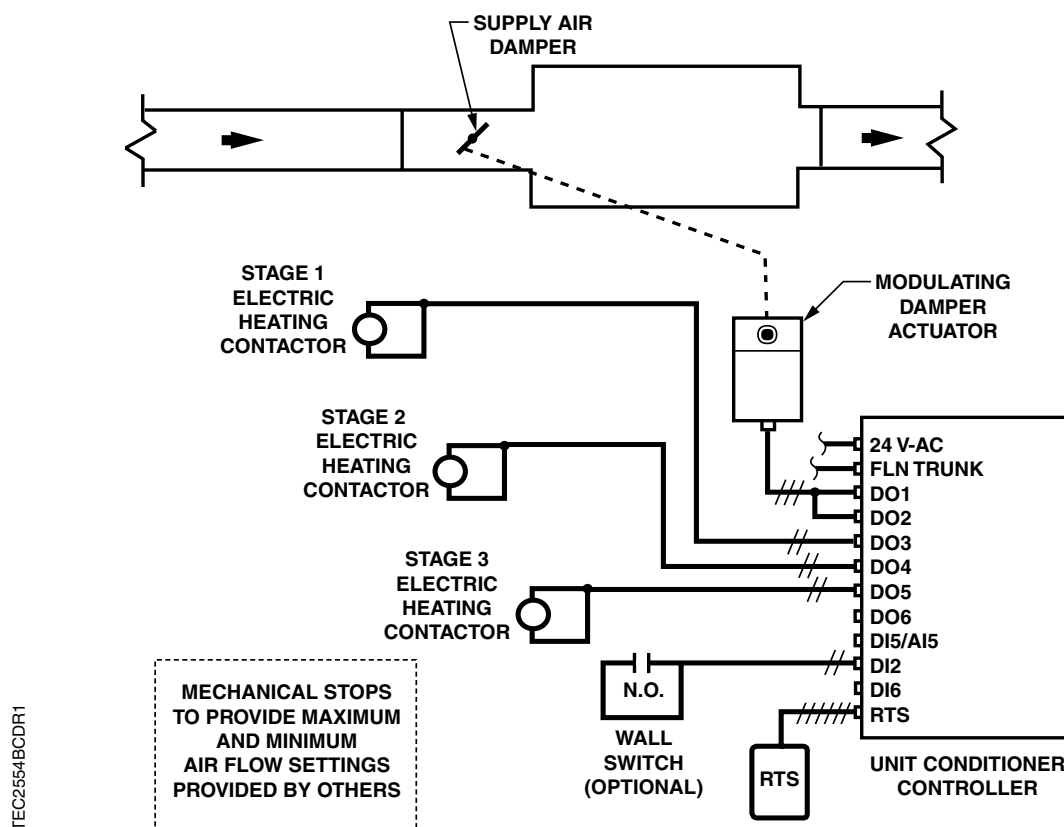
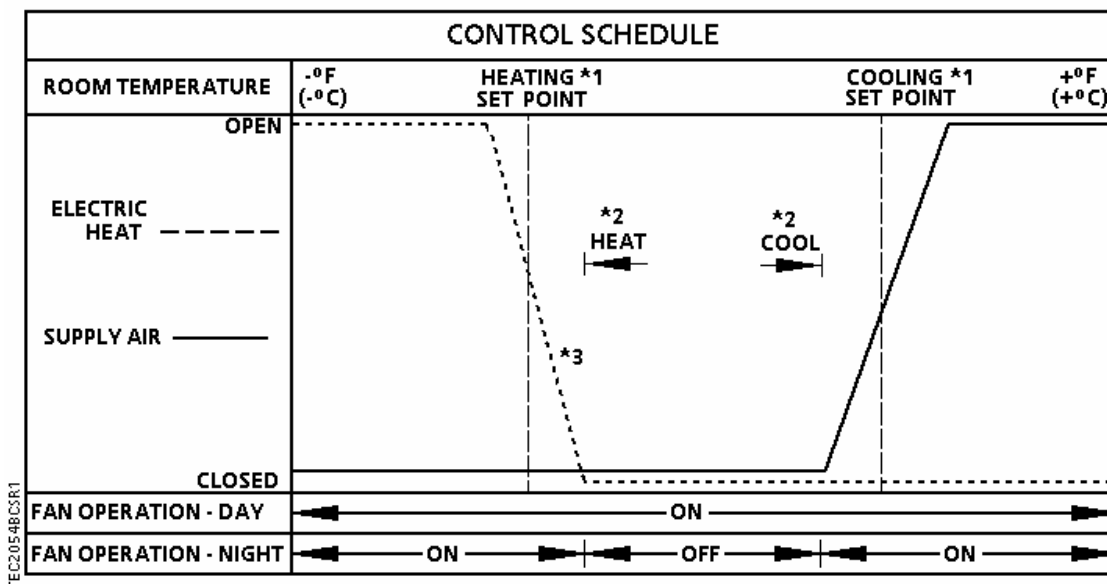


Figure 2554-3. Application 2554 Control Drawing.



1. See *Sequence of Operation, Control Temperature Setpoints*.
2. See *Sequence of Operation, Heating/Cooling Switchover*.
3. The electric heat is time-modulated. This allows it to be controlled proportionally rather than with deadbands.

Figure 2554-4. Application 2554 Control Schedule.

Hardware Inputs

Analog

- 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)
- Stage 1 electric heat
- Stage 2 electric heat
- Stage 3 electric heat
- Valve actuator; or, damper actuator

Ordering Notes

BACnet MS/TP Unit Conditioner Controller

550-789A

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

Terminal Equipment Controller room temperature sensor

Valve actuator; or, damper actuator

Point Database

Table 2554-2 presents the point database information for Application 2554.

Sequence of Operation

The following paragraphs present the sequence of operation for Application 2554, “Fan Coil Unit Cooling and Electric Heat”.

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 (Figure 2554-1, Figure 2554-3, and Figure 2554-5), 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 is entered into OVRD TIME (Point 20), pressing the override switch resets 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 the status of 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

The heating/cooling switchover determines whether the controller is in heating or cooling mode by monitoring the room temperature and the demand for heating and cooling (as determined by the temperature control loops).

If the following conditions are met for the length of time set in SWITCH TIME (Point 86), the controller switches from heating to cooling mode by setting HEAT.COOL (Point 5) to COOL:

- HTG LOOPOUT (Point 80) < SWITCH LIMIT (Point 85).
- CTL TEMP (Point 78) > CTL STPT (Point 92) by at least the value set in SWITCH DBAND (Point 90).
- CTL TEMP > the appropriate cooling setpoint minus SWITCH DBAND.

If the following conditions are met for the length of time set in SWITCH TIME, the controller switches from cooling to heating mode by setting HEAT.COOL to HEAT:

- CLG LOOPOUT (Point 79) < SWITCH LIMIT.
- CTL TEMP < CTL STPT by at least the value set in SWITCH DBAND.
- CTL TEMP < the appropriate heating setpoint plus SWITCH DBAND.

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 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. If a valve is being controlled, the central plant must provide chilled water. If a damper is being controlled, the central plant must provide cool air. The output of the cooling loop is CLG LOOPOUT (Point 79), which modulates either the cooling valve or the supply air damper, VLV 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 output of the heating loop is HTG LOOPOUT (Point 80), which modulates the electric reheat, in order to warm up the space. The valve is closed or the damper is resting on its mechanical stop. CLG LOOPOUT (Point 79) is set to 0%.

**CAUTION:**

Verify that the equipment is supplied with safeties by others to ensure that there is airflow across the heating coils when they are to be energized. If this application is controlling a damper, minimum position stops must be provided to ensure airflow across the electric heat elements.

The heating loop controls up to three stages of electric reheat to warm up the room. The electric reheat is time modulated using a duty cycle as shown in the following example. When the controller is in cooling mode, the electric heat is OFF at all times.

Example

If the duty cycle is 10 minutes (HTG STG TIME (Point 89) = 10 minutes) and the heating loop is calling for 60% of heating (HTG LOOPOUT (Point 80) = 60%) for every 10-minute period, the stages of electric auxiliary heat cycle are as follows:

	Stage 1: minutes		Stage 2: minutes		Stage 3: minutes	
	ON	OFF	ON	OFF	ON	OFF
With 1 stage of electric heat:	6	4	–	–	–	–
With 2 stages of electric heat:	10	0	2	8	–	–
With 3 stages of electric heat:	10	0	8	2	0	10

CLG LOOPOUT (Point 79) is set to 0%.

Fan Operation

NOTE: If this application is controlling a damper instead of a cooling valve, the fan operation is not applicable because there is no fan.

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 the first heating stage is ON or VLV COMD (Point 48) is open more than the value of STAGE FAN (Point 84), the fan will turn ON.
2. If the first heating stage is OFF and has been OFF longer than the time set in HTG STG TIME (Point 89), and the cooling valve is 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.

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 cooling valve or damper, whichever is being used, based on the value of CAL TIMER (Point 96). A value of 12 indicates that the controller will calibrate the actuator once every 12 hours.

The stages of electric heat are turned off during calibration. The calibration consists of driving the cooling valve or damper closed and resetting the value of VLV POS (Point 49) to 0. The actuator is then released to normal control.

Fail-Safe Operation

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

Application Notes

1. If temperature variations 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 cooling valve is not being controlled by the application, DO 1 and DO 2 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 COMD (Point 48). DO 3, DO 4, and DO 5 control the stages of electric heat. If less than three stages are being controlled by the application, the DOs that are not used will be spare.

Wiring Diagram

The point wiring for Application 2554 is shown in Figure 2554-5.



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

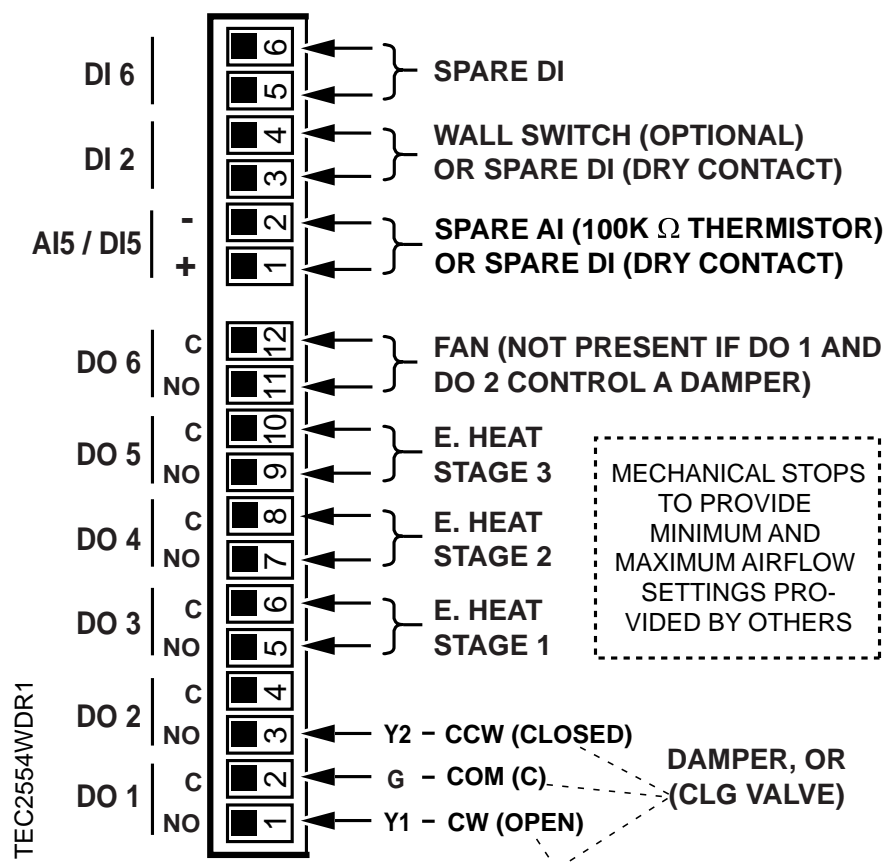


Figure 2554-5. Application 2554 Wiring Diagram.

Point Database

Table 2554-2. Point Database for Application 2554

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}	AUX TEMP AI5	74.0 (23.495556)	DEG F (DEG C)	37.5 to 165.0	--	--
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
BI	{24}	DI 2	OFF	--	Binary	ON	OFF

^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 2554-2. Point Database for Application 2554

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
BI	{25}	DI 5	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}	HTG STG 1	OFF	--	Binary	ON	OFF
BO	{44}	HTG STG 2	OFF	--	Binary	ON	OFF
BO	{45}	HTG STG 3	OFF	--	Binary	ON	OFF
BO	{46}	FAN	OFF	--	Binary	ON	OFF
AO	{48}	VLV COMD	0.0	PCT	0.0 to 102.0	--	--
AO	{49}	VLV POS	0.0	PCT	0.0 to 102.0	--	--
AO	51	MTR 1 TIMING	130	SEC	0 to 511	--	--
AO	56	MTR1 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	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	--	--
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	{81}	AVG HEAT OUT	0.0	PCT	0.0 to 409.2	--	--

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.

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d Point numbers that appear in brackets { } may be unbundled at the field panel.

Table 2554-2. Point Database for Application 2554

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	82	HTG STG MAX	90.0	PCT	0.0 to 102.0	--	--
AO	83	HTG STG MIN	10.0	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	86	SWITCH TIME	10	MIN	0 to 255	--	--
AO	88	HTG STG CNT	1	--	0 to 255	--	--
AO	89	HTG STG TIME	10	MIN	0 to 255	--	--
AO	90	SWITCH DBAND	1.0 (0.56)	DEG F (DEG C)	0.0 to 63.75	--	--
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.

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d Point numbers that appear in brackets { } may be unbundled at the field panel.