

# Application 2552: BACnet MS/TP Fan Coil Unit 2-Stage Cooling and Electric Heat

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## Overview

In Application 2552, the controller energizes a maximum of two stages of cooling and a maximum of three stages of electric heat in the fan coil unit. The fan coil unit also has a fan to circulate room air. See Figure 2552-1 and Figure 2552-2.

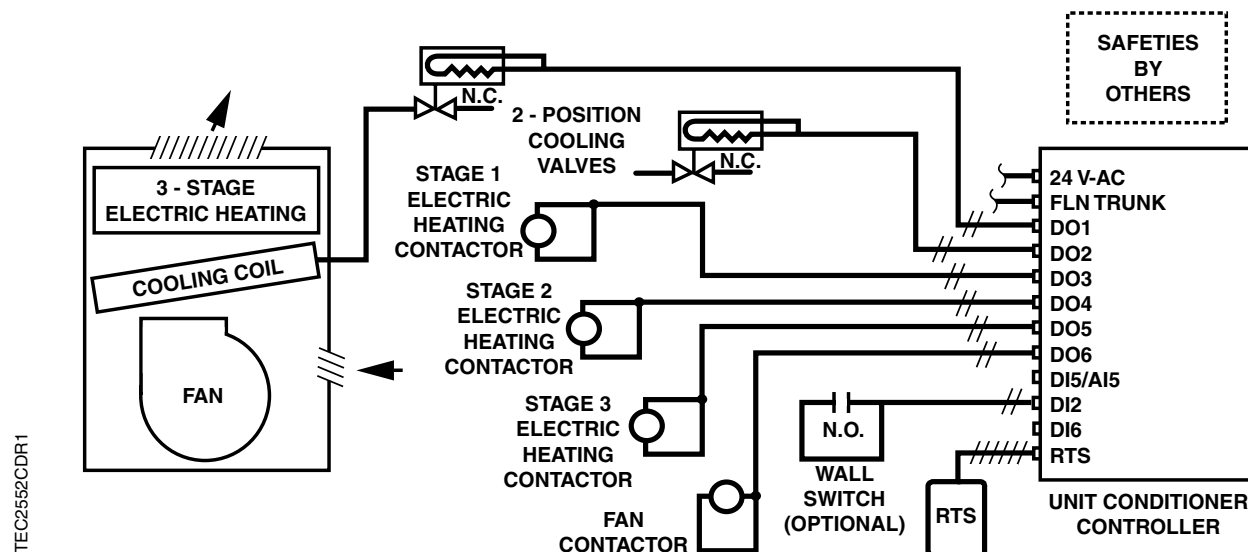


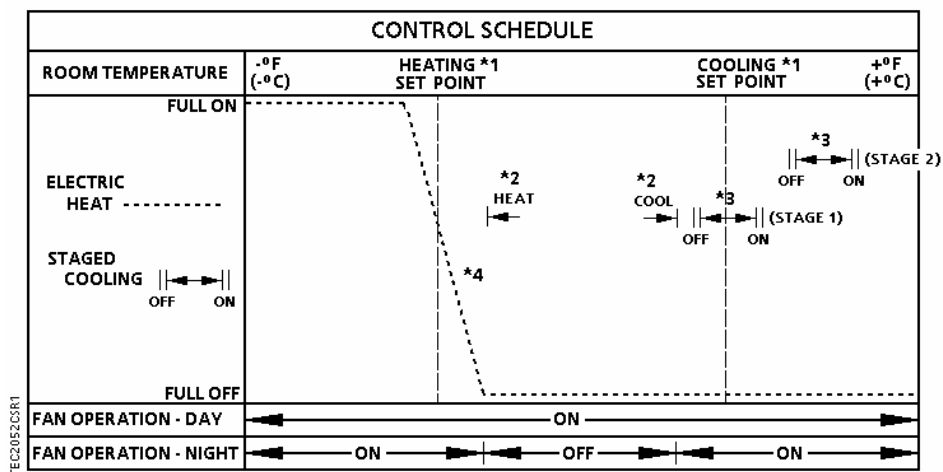
Figure 2552-1. Application 2552 Control Drawing.

## BACnet

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

Table 2552-1. 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. See *Sequence of Operation, Cooling Operation*.
4. The electric heat is time-modulated. This allows it to be controlled proportionally rather than with deadbands.

**Figure 2552-2. Application 2552 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 cooling (2-position valve actuator, or cooling compressor)
- Stage 2 cooling (2-position valve actuator, or cooling compressor)
- Stage 1 electric heat
- Stage 2 electric heat
- Stage 3 electric heat

## 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

## Point Database

Table 2552-2 presents the point database information for Application 2552.

## Sequence of Operation

The following paragraphs present the sequence of operation for Application 2552, “Fan Coil Unit 2-Stage 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).

$$\text{CTL TEMP (Point 78)} = \text{ROOM TEMP (Point 4)} + \text{RMTMP OFFSET (Point 3)}$$

**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 2552-1 and Figure 2552-3), 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 that is 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

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. The cooling loop controls up to two stages of cooling as defined by the value of CLG STG CNT (Point 75).

The staged cooling operates as follows:

CLG STG 1 (Point 41) will turn ON when CLG LOOPOUT (Point 79) > CLG 1 ON (Point 71), provided that CLG STG 1 has been OFF for at least the time set in CLG MIN OFF (Point 77).

CLG STG 2 (Point 42) will turn ON when CLG LOOPOUT > CLG 2 ON (Point 73), provided that CLG STG 2 has been OFF for at least the time set in CLG MIN OFF.

CLG STG 2 will turn OFF, when CLG LOOPOUT < CLG 2 OFF (Point 74), provided that CLG STG 2 has been ON for at least the time set in CLG MIN ON (Point 76).

CLG STG 1 will turn OFF, when CLG LOOPOUT < CLG 1 OFF (Point 72), provided that CLG STG 1 has been ON for at least the time set in CLG MIN ON.

HTG LOOPOUT (Point 80) = 0%.

When in heating mode, both stages of cooling are OFF.

## 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, HTG LOOPOUT (Point 80), modulates the electric reheat in order to warm up the space. CLG LOOPOUT (Point 79) is set to 0%.

## Electric Reheat



### 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.

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  |

## 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 the first heating stage, the first cooling stage, or the second cooling stage is ON, the fan will turn ON.
2. If the first heating stage is OFF and has been OFF for a complete duty cycle, HTG STG TIME (Point 89), and the first and second cooling stages are OFF and have been OFF for the minimum off time, 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.

## Fail-safe Operation

If the room temp 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. 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 2552 is shown in Figure 2552-3.



### 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

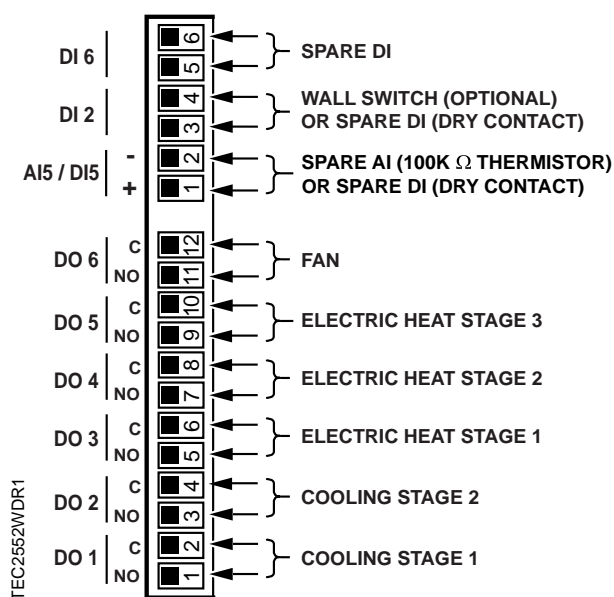


Figure 2552-3. Application 2552 Wiring Diagram.



## Point Database

Table 2552-2. Point Database for Application 2552

| Object Type <sup>a</sup> | Object Instance (Point Number) <sup>b</sup> | Object Name (Descriptor) | Factory Default (SI Units) <sup>c</sup> | Engr Units (SI Units) <sup>c</sup> | 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           |
| BI                       | {25}  | DI 5                     | OFF                                     | --                                 | Binary         | ON          | OFF           |

<sup>a</sup> Object Types are; Analog Input (AI), Analog Output (AO), Binary Input (BI) and Binary Output (BO).

<sup>b</sup> Points not listed are not used in this application.

<sup>c</sup> A single value in a column means that the value is the same in English units and in SI units.

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

Table 2552-2. Point Database for Application 2552

| Object Type <sup>a</sup> | Object Instance (Point Number) <sup>b</sup> | Object Name (Descriptor) | Factory Default (SI Units) <sup>c</sup> | Engr Units (SI Units) <sup>c</sup> | Range          | Active Text | Inactive Text |
|--------------------------|---|--------------------------|---|------------------------------------|----------------|-------------|---------------|
| BO                       | {29}  | DAY.NGT                  | DAY                                     | --                                 | Binary         | NIGHT       | DAY           |
| BO                       | {41}  | CLG STG 1                | OFF                                     | --                                 | Binary         | ON          | OFF           |
| BO                       | {42}  | CLG STG 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                       | 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                       | 71  | CLG 1 ON                 | 40.0                                    | PCT                                | 0.0 to 102.0   | --          | --            |
| AO                       | 72  | CLG 1 OFF                | 20.0                                    | PCT                                | 0.0 to 102.0   | --          | --            |
| AO                       | 73  | CLG 2 ON                 | 80.0                                    | PCT                                | 0.0 to 102.0   | --          | --            |
| AO                       | 74  | CLG 2 OFF                | 60.0                                    | PCT                                | 0.0 to 102.0   | --          | --            |
| AO                       | 75  | CLG STG CNT              | 2                                       | --                                 | 0 to 255       | --          | --            |
| AO                       | 76  | CLG MIN ON               | 120                                     | SEC                                | 0 to 255       | --          | --            |
| AO                       | 77  | CLG MIN OFF              | 120                                     | SEC                                | 0 to 255       | --          | --            |
| 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   | --          | --            |

<sup>a</sup> Object Types are; Analog Input (AI), Analog Output (AO), Binary Input (BI) and Binary Output (BO).

<sup>b</sup> Points not listed are not used in this application.

<sup>c</sup> A single value in a column means that the value is the same in English units and in SI units.

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

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|--------------------------|---|--------------------------|---|------------------------------------|----------------|-------------|---------------|
| AO                       | {81}  | AVG HEAT OUT             | 0.0                                     | PCT                                | 0.0 to 409.2   | --          | --            |
| 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                       | 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.