SIEMENS

Application 2557

BACnet VAV with 0-10V Series-Fan Speed Output and 3 Stage Electric Heat—3rd Heat Stage not used

TEC-0851a.08

Overview

NOTE: This document explains Application 2557 when it is controlling two or less stages of electric heat. For information on how Application 2557 operates when STAGE COUNT (Point 88) = 3, see document number *TEC-0851b.08*.

In Application 2557, when only two of the available three stages of electric heat are used, the supply air damper of the terminal box is modulated for cooling and up to two stages of electric heat are controlled for heating. When in heating, the terminal box maintains minimum airflow out of the supply air duct. The terminal box also has a variable air volume series fan for air circulation (an option exists to run this series fan at constant volume). In order for the terminal box to work properly, the central air handling unit must provide supply air. See Figures 2557-1 through 2557-6.

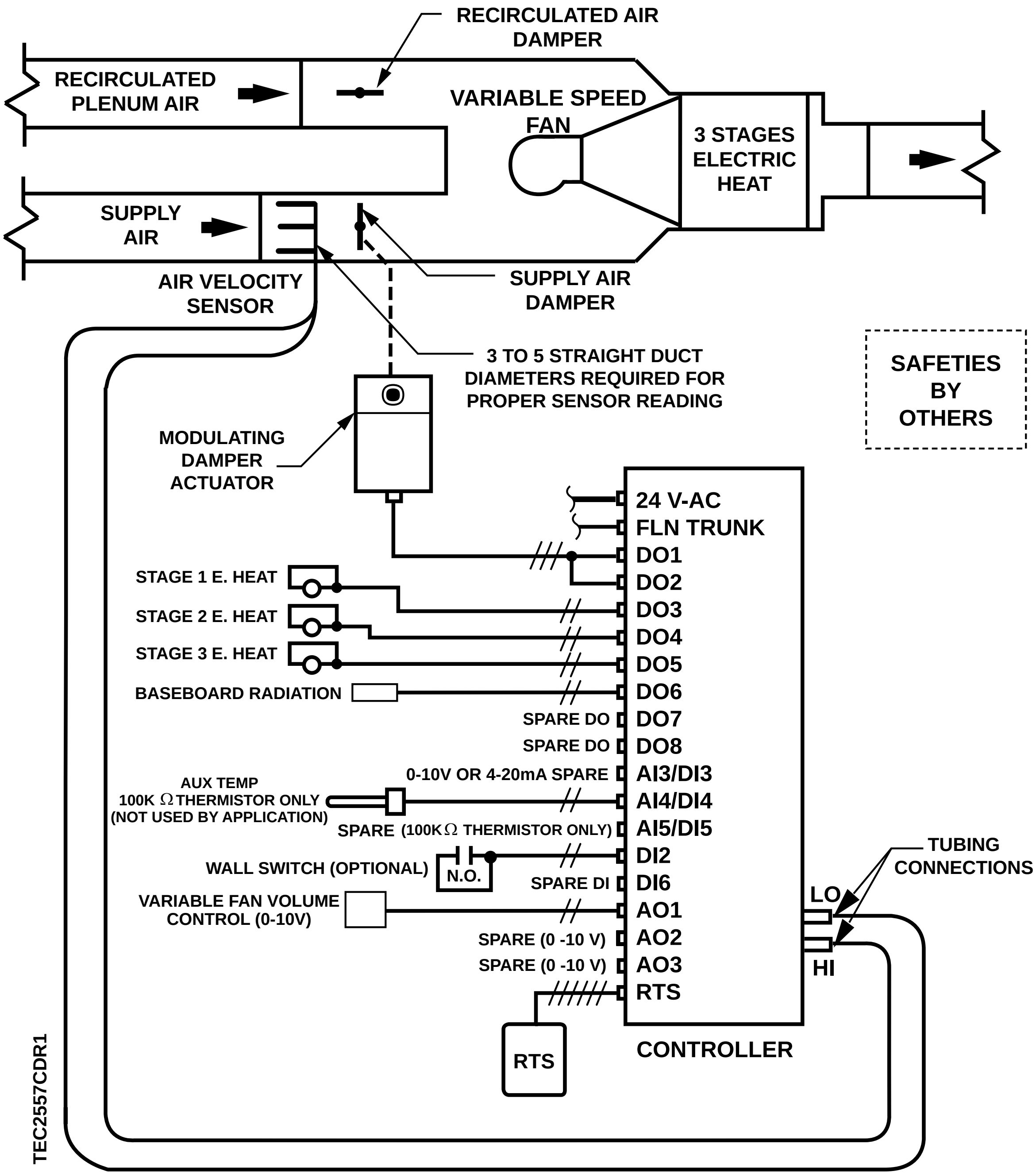
Certain control features of Application 2557 depend on whether the central air handling unit is ON or OFF. Application 2557 monitors VAV AHU (Point 61) for this information. Application 2557 does not command VAV AHU—it only reacts to it. To command VAV AHU, it must be unbundled at the field panel and PPCL must be written for it.

BACnet

BACnet MS/TP protocol for open communications on BACnet MS/TP networks.

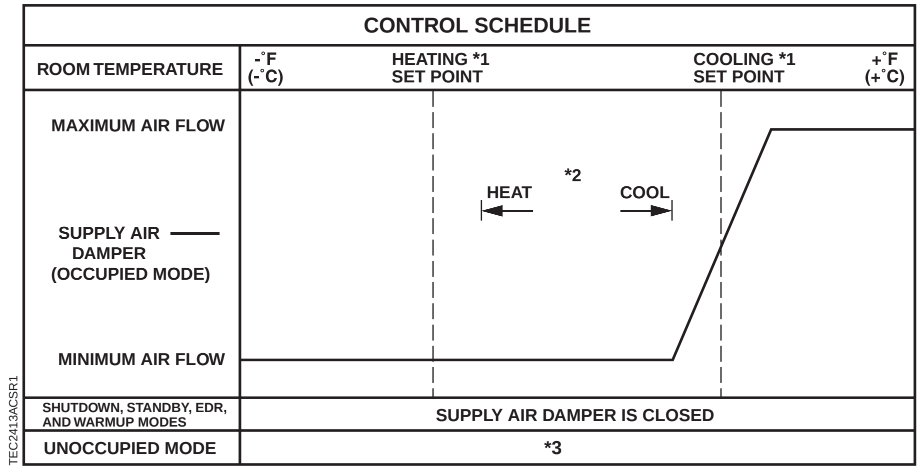
Table 2557-1. Supported BIBBs.

Product	Supported BIBBs	BIBB Name
BTEC	DS-RP-B	Data Sharing-ReadProperty-B
	DS-RPM-B	Data Sharing-ReadPropertyMultiple-B
	DS-WP-B	Data Sharing-WriteProperty-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



NOTE: Although three stages of electric heat are shown, this document describes Application 2557 when it is configured to use only two stages of electric heat (STAGE COUNT, Point 88 = 2). For a description of how application 2557 operates when three electric heat stages are used, see *TEC-0851b.08*.

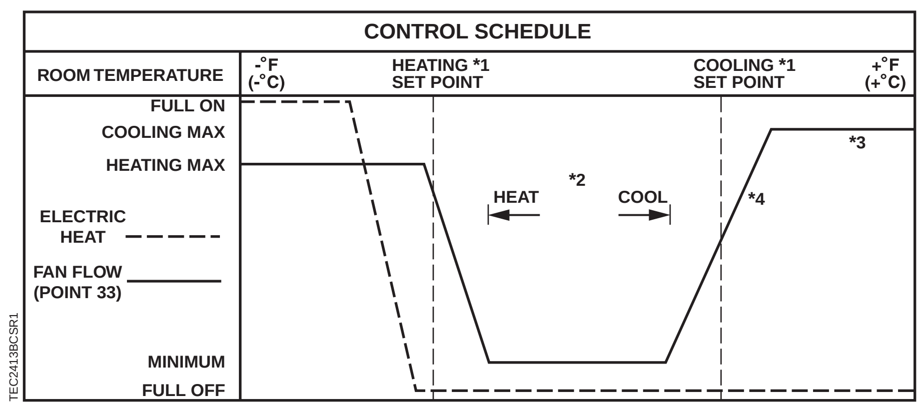
Figure 2557-1. Application 2557 Control Drawing.



NOTES:

1. See the *Control Temperature Setpoints* section.
2. See the *Heating/Cooling Switchover* section.
3. The supply damper remains closed in the unoccupied mode as long as HEAT.COOL (Point 5) equals HEAT. The supply damper also remains closed in the unoccupied mode if HEAT.COOL equals COOL **and** the room temperature remains less than TEMP HLIMIT (Point 69). Once the room temperature rises above TEMP HLIMIT while VAV AHU (Point 61) = ON, the supply damper is controlled as in the occupied cooling mode for as long as HEAT.COOL stays equal to COOL and VAV AHU remains ON. (See Note 4 in the *Application Notes* section for more information on VAV AHU.)

Figure 2557-2. Supply Air Damper Control Schedule.



FAN MODE = VARI.

Figure 2557-3. Operation of the Fan and One Stage of Electric Heat in Occupied Mode. (See Note 8)

FAN MODE (Point 16) has two possible settings, CONST or VARI (constant or variable—the default = VARI). It is configurable during controller start-up and can also be overwritten by the customer during operation.

NOTES:

1. See the *Control Temperature Setpoints* section.
2. See the *Heating/Cooling Switchover* section.
3. If FAN MODE (Point 16) = CONST, FAN FLOW (Point 33) remains at the highest possible maximum flow (FAN FLO CMAX, Point 85) throughout the entire occupied mode.

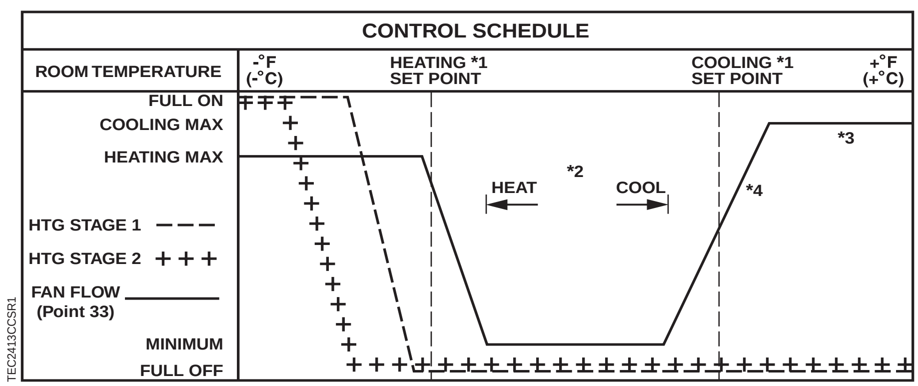
4. To regulate fan speed, Application 2557 uses FAN FLOW (Point 33) and embedded table statements to modulate the voltage of FAN AOV1 (Point 66). The particular table statement used depends on the box size.

   The following describes the operation of the fan and one stage of electric heat during the controller's other modes:

Shutdown Mode	The fan (see Note 5) and electric heat are both OFF.
Unoccupied Mode	See Note 6 for fan operation. See Note 7 for heat stage operation.
Electrical Demand Reduction (EDR) Mode	The fan is controlled as in the occupied heating mode. The heating stage is OFF.
Standby Mode	During standby and warm-up, the single electric heating stage and the fan are controlled the same as in the occupied heating mode.
Warm-up Mode	

5. FAN FLOW (Point 33) is set to 0 in shutdown mode, provided that the electric heating stage has been off for at least 30 seconds. If the electric heating stage has not been off for at least 30 seconds, then the fan's airflow remains where it was before the shutdown mode was entered. When FAN FLOW = 0, the fan is completely OFF.
6. During unoccupied mode, the fan stays OFF if the room temperature remains between TEMP LLIMIT (Point 65) and TEMP HLIMIT (Point 69), provided that the electric heating stage has been off for at least 30 seconds. If the electric heating stage has not been off for at least 30 seconds, then the fan's airflow remains where it was before the unoccupied mode was entered.

   If the room temperature drops below TEMP LLIMIT the fan will be controlled like it is during occupied heating for the remainder of the unoccupied mode. If the room temperature rises above TEMP HLIMIT—and VAV AHU is ON—the fan will be controlled like it is during occupied cooling for the remainder of the unoccupied mode. (See note 4 in the *Application Notes* section for more information on VAV AHU.)
7. In the unoccupied mode, the single stage of electric heat stays OFF unless the room temperature drops below TEMP LLIMIT. If this occurs, the heating stage is controlled like it is during occupied heating for the remainder of the unoccupied mode.
8. Regardless of the operational mode, the application will shut off the stage of electric heat if FAN FLOW (Point 33) is 0, **even if the electric heat stage was overridden to ON.** In other words, the application prevents any electric heating stages to be ON when there is no airflow coming out of the fan.



FAN MODE = VARI.

Figure 2557-4. Operation of the Fan and 2 Stages of Electric Heat in Occupied Mode. (See Note 8)

FAN MODE (Point 16) has two possible settings, CONST or VARI (constant or variable—the default = VARI). It is configurable during controller start-up and can also be overwritten by the customer during operation.

NOTE: In this figure, the application has been set up so that neither stage of electric heat can turn ON until the airflow out of the fan is at "HEATING MAX".

NOTES:

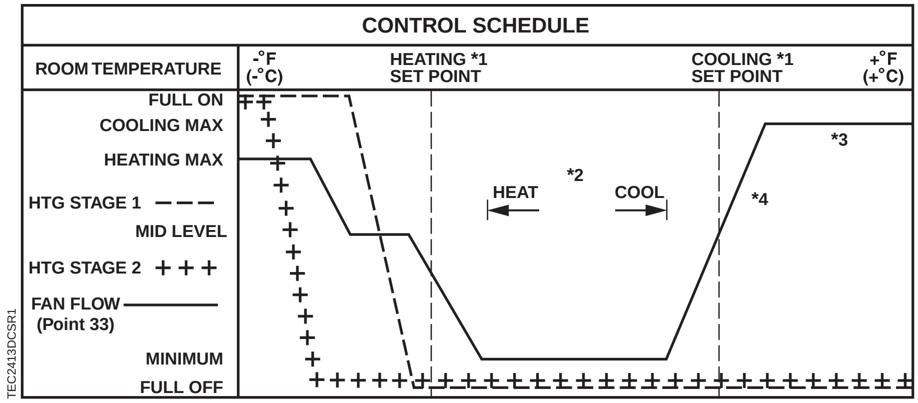
1. See the Control Temperature Setpoints section.
2. See the Heating/Cooling Switchover section.
3. NOTE: If FAN MODE (Point 16) = CONST, FAN FLOW (Point 33) remains at the highest possible maximum flow
(FAN FLO CMAX, Point 85) throughout the entire occupied mode.
4. To regulate fan speed, application 2557 uses FAN FLOW (Point 33) and embedded table statements to modulate the voltage of FAN AOV1 (Point 66). The particular table statement used depends on the box size.

   The following describes the operation of the fan and electric heat during the controller's other modes:

Shutdown Mode	The fan (see Note 5) and electric heating stages are OFF.
Unoccupied Mode	See Note 6 for fan operation. See Note 7 for operation of heating stages.
Electrical Demand Reduction (EDR) Mode	The fan is controlled as in the occupied heating mode. The heating stages are OFF.
Standby Mode	Both the fan and first heating stage are controlled as in the occupied heating mode. The second heating stage remains OFF.
Warm-up Mode	Both the fan and the heating stages are controlled as in the occupied heating mode.

5. FAN FLOW (Point 33) is set to 0 in shutdown mode, provided that all of the electric heating stages have been off for at least 30 seconds. If all of the electric heating stages have not been off for at least 30 seconds, then the fan's airflow remains where it was before the shutdown mode was entered. When FAN FLOW = 0, the fan is completely OFF.
6. During unoccupied mode, the fan stays OFF if the room temperature remains between TEMP LLIMIT (Point 65) and TEMP HLIMIT (Point 69), provided that all of the electric heating stages have been off for at least 30 seconds. If all of the electric heating stages have not been off for at least 30 seconds, then the fan's airflow remains where it was before the unoccupied mode was entered.

   If the room temperature drops below TEMP LLIMIT the fan will be controlled like it is during occupied heating for the remainder of the unoccupied mode. If the room temperature rises above TEMP HLIMIT—and VAV AHU is ON—the fan will be controlled like it is during occupied cooling for the remainder of the unoccupied mode. (See note 4 in the *Application Notes* section for more information on VAV AHU.)
7. In the unoccupied mode, the electric heat stages remain OFF unless the room temperature drops below TEMP LLIMIT. If this occurs, the electric heat stages are controlled like they are during occupied heating for the remainder of the unoccupied mode.
8. Regardless of the operational mode, the application will shut off all stages of electric heat if FAN FLOW (Point 33) is 0, **even if the electric heat stages were overridden to ON.** In other words, the application prevents any electric heating stages to be ON when there is no airflow coming out of the fan.



FAN MODE = VARI.

FAN MODE (Point 16) has two possible settings, CONST or VARI (constant or variable—the default = VARI). It is configurable during controller start-up and can also be overwritten by the customer during operation.

NOTE: In this figure, the application has been set up so that the first stage of electric heat can turn ON when the fan is producing a "MID LEVEL" airflow.

NOTES:

1. See the *Control Temperature Setpoints* section.
2. See the *Heating/Cooling Switchover* section.
3. If FAN MODE (Point 16) = CONST, FAN FLOW (Point 33) remains at the highest possible maximum flow (FAN FLO CMAX, Point 85) throughout the entire occupied mode.
4. To regulate fan speed, Application 2557 uses FAN FLOW (Point 33) and embedded table statements to modulate the voltage of FAN AOV1 (Point 66). The particular table statement used depends on the box size.

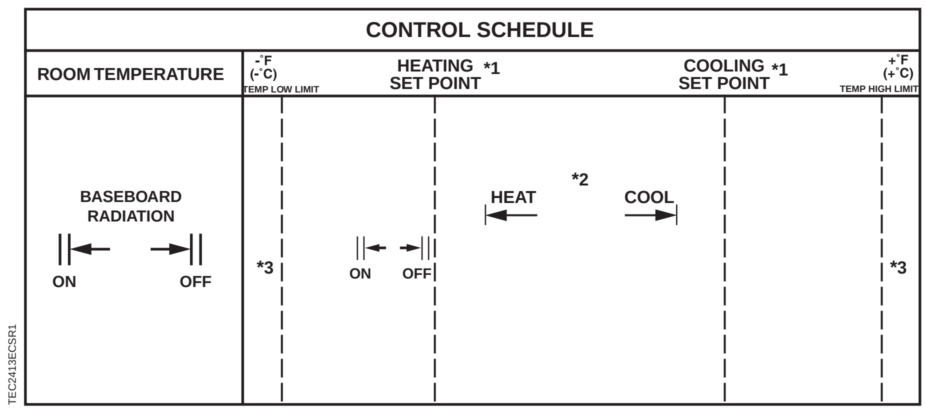
Figure 2557-5. Operation of the Fan and 2 Stages of Electric Heat in Occupied Mode. (See Note 8)

The following describes the operation of the fan and electric heat during the controller's other modes:

Shutdown Mode	The fan (see Note 5) and electric heating stages are OFF.
Unoccupied Mode	See Note 6 for fan operation. See Note 7 for operation of heating stages.
Electrical Demand Reduction (EDR) Mode	The fan is controlled as in the occupied heating mode. The heating stages are OFF.
Standby Mode	Both the fan and first heating stage are controlled as in the occupied heating mode. The second heating stage remains OFF.
Warm-up Mode	Both the fan and the heating stages are controlled as in the occupied heating mode.

5. FAN FLOW (Point 33) is set to 0 in shutdown mode, provided that all of the electric heating stages have been off for at least 30 seconds. If all of the electric heating stages have not been off for at least 30 seconds, then the fan's airflow remains where it was before the shutdown mode was entered. When FAN FLOW = 0, the fan is completely OFF.

6. During unoccupied mode, the fan stays OFF if the room temperature remains between TEMP LLIMIT (Point 65) and TEMP HLIMIT (Point 69), provided that all of the electric heating stages have been off for at least 30 seconds. If all of the electric heating stages have not been off for at least 30 seconds, then the fan's airflow remains where it was before the unoccupied mode was entered.
   If the room temperature drops below TEMP LLIMIT the fan will be controlled like it is during occupied heating for the remainder of the unoccupied mode. If the room temperature rises above TEMP HLIMIT—and VAV AHU is ON—the fan will be controlled like it is during occupied cooling for the remainder of the unoccupied mode. (See Note 4 in the *Application Notes* section for more information on VAV AHU.)
7. In the unoccupied mode, the electric heat stages remain OFF unless the room temperature drops below TEMP LLIMIT. If this occurs, the electric heat stages are controlled like they are during occupied heating for the remainder of the unoccupied mode.
8. Regardless of the operational mode, the application will shut off all stages of electric heat if FAN FLOW (Point 33) is 0, **even if the electric heat stages were overridden to ON.** In other words, the application prevents any electric heating stages to be ON when there is no airflow coming out of the fan.



NOTES:

1. See the *Control Temperature Setpoints* section.
2. See the *Heating/Cooling Switchover* section.
3. The baseboard radiation remains OFF for the remainder of the unoccupied period if the room temperature drops below TEMP LLIMIT or rises above TEMP HLIMIT. (If the room temperature drops below TEMP LLIMIT, the regular heating stage(s) are then controlled in order to maintain room temperature.)
4. Baseboard radiation is allowed ON only during unoccupied mode (see *Baseboard Radiation* section).

Figure 2557-6. Control Schedule for Baseboard Radiation During Unoccupied Mode.

Hardware Inputs

Analog

- Air velocity sensor
- Room temperature sensor
- Room temperature setpoint dial (optional)

Digital

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

Hardware Outputs

Analog

- Fan AOV

Digital

- Damper actuator
- Stage 1 electric heat
- Stage 2 electric heat (optional)
- Stage 3 electric heat (optional) (Note: Stage 3 is not explained in this document; see Document Number 0851Bp08 for information on Stage 3 electric heat operation)
- Baseboard radiation (optional)

Ordering Notes

P/N 550-785A

Sequence of Operation

The following paragraphs present the sequence of operation for Application 2557, *BACnet VAV with 0-10V Series-Fan Speed Output and 3 Stage Electric Heat—3rd Heat Stage not used*.

NOTE: This document explains Application 2557 when it is controlling two or less stages of electric heat. For information on how Application 2557 operates when STAGE COUNT (Point 88) = 3, see document number *TEC-0851b.08*.

Definition of MODE Point

In Application 2557, the DAY.NGT point is not used. A virtual AO point (MODE, Point 3) is used instead. Table 2557-2 shows the values that MODE can have, as well as the names of the modes that correspond to these different values.

Table 2557-2. Mode Point Explanation.

Value of MODE point	Corresponding Mode
0	Shutdown Mode
10	Unoccupied Mode
20	Electric Demand Reduction Mode (EDR)
30	Standby Mode
60	Occupied Mode

NOTE: For the rest of this document, the *names* of modes will be used instead of numeric values (for example, MODE = Standby instead of MODE = 30). This should make the application easier to understand.

Summary of Equipment Actions

Application 2557 controls several pieces of equipment throughout its different operational modes. For an overview of what each piece of equipment does in each mode, see Table 2557-3. (For brevity and clarity, Table 2557-3 provides only summaries of equipment actions. Full descriptions of detailed interactions between equipment pieces are provided in the related sections of the text.)

Occupied and Unoccupied Modes

The operational mode status of the space is determined by the status of MODE (Point 3). Control of this point differs depending on whether it is being controlled by a wall switch or by a field panel. If a wall switch is controlling this point, a field panel should not also control the point.

When a wall switch is physically connected to the termination strip on the controller at DI 2 (Figures 2557-1), and WALL SWITCH (Point 18) equals YES, the controller monitors the status of DI 2 (Point 24). When the status of DI 2 is ON (the switch is closed), MODE is set to occupied mode. When the status of DI 2 is OFF (the switch is open), MODE is set to unoccupied mode.

When WALL SWITCH equals NO, the controller does not monitor the status of the wall switch, even if one is connected to it. Instead, if the controller is operating stand-alone, then the controller stays in occupied mode all the time. If the controller is operating with centralized control (that is, it is connected to a field panel), then the field panel can send an operator or PPCL command to override the status of MODE. See *Powers Process Control Language (PPCL) User's Manual* (125-1896) and *Field Panel User's Manual* (125-1895) for more information.

CAUTION:

Do not turn a Wall Switch On and Off numerous times in rapid succession. This can cause HEAT STAGE 1 (Point 43) to turn On and Off numerous times in rapid succession, which will wear out the contactor of the 1st heating stage.

Table 2557-3. Summary of Equipment Action during Different Operational Modes.

Operational Modes	Fan constant volume configuration	Fan variable volume configuration	Supply Damper	Electric Heat (See Note 8)	Baseboard Radiation
Shutdown	OFF (See Note 9)	OFF (See Note 9)	Closed	OFF	OFF
Unoccupied (See Note 1) Room temp stays between TEMP LLIMIT (Point 65) and TEMP HLIMIT (Point 69)	OFF (See Note 9)	OFF (See Note 9)	Closed	OFF	See Note 4
Unoccupied Heating (See Note 2) Room temp has dropped below TEMP LLIMIT	Maximum flow at FAN FLO CMAX (**Point 85**)	Modulates from min to max flow based on heating demand	Closed	See Note 5	OFF
Unoccupied Cooling (See Note 3) Room temp has risen above TEMP HLIMIT	At maximum flow if VAV AHU (Point 61) is ON. (OFF if VAV AHU is OFF) (See Note 9)	See Note 6	See Note 7	OFF	OFF
Electrical Demand Reduction (EDR)	Maximum flow at FAN FLO CMAX	Modulates from min to max flow based on heating demand	Closed	OFF	OFF
Standby	Maximum flow at FAN FLO CMAX	Modulates from min to max flow based on heating demand	Closed	1st stage is time modulated based on heating demand. 2nd stage (if used) remains OFF.	OFF
Warm-up Occurs, if needed, at start of occupied mode	Maximum flow at FAN FLO CMAX	Modulates from min to max flow based on heating demand	Closed	See Note 5	OFF
Occupied Heating	Maximum flow at FAN FLO CMAX	Modulates from min to max flow based on **heating** demand	Provides minimum airflow for ventilation	See Note 5	OFF
Occupied Cooling		Modulates from min to max flow based on **cooling** demand	Modulates from min to max flow based on cooling demand	OFF	

NOTES:

1. Since the unoccupied mode is more complex than the other modes, three separate table rows are used to make it easier to understand. "Unoccupied," as described in this table, means that the room temperature **never** goes outside the range of TEMP LLIMIT to TEMP HLIMIT. Notes 2 and 3 (for Unoccupied Heating and Cooling, respectively) summarize what happens if it does leave this range.
2. Once the room temperature drops below TEMP LLIMIT (Point 65), this sequence of operation remains in effect **for the remainder of the entire unoccupied period** so long as the room temperature never rises as high as TEMP HLIMIT (Point 69).
3. Once the room temperature rises above TEMP HLIMIT (Point 69), this sequence of operation remains in effect **for the remainder of the entire unoccupied period** so long as the room temperature never falls all the way down to TEMP LLIMIT (Point 65).
4. Baseboard radiation is OFF in the unoccupied mode if HEAT.COOL (Point 5) equals COOL. If HEAT.COOL equals HEAT, the baseboard radiation cycles to maintain the room temperature at CTL STPT (Point 92).
5. During all heating modes (warm-up, occupied heating, and unoccupied heating), the 1st stage of electric heat is time modulated based on heating demand. The 2nd stage (if used) is also time modulated based on heating demand.
6. If VAV AHU (Point 61) is ON during unoccupied cooling, the fan — when configured for variable volume operation — modulates from minimum to maximum flow based on cooling demand. The fan is OFF during unoccupied cooling if VAV AHU is OFF, provided that all of the electric heating stages have been off for at least 30 seconds. If all of the heating stages have not been OFF for at least 30 seconds, then the fan's air volume (FAN FLOW (Point 33)) remains where it was before VAV AHU shut OFF.
7. If VAV AHU (Point 61) is ON during unoccupied cooling, the supply damper modulates from minimum to maximum flow based on cooling demand. The supply damper is closed during unoccupied cooling if VAV AHU is OFF.
8. Regardless of the operational mode, the application will shut off all stages of electric heat if FAN FLOW (Point 33) is 0, even if the electric heat stages were overridden to ON. In other words, the application prevents any electric heating stages to be ON when there is no airflow coming out of the fan.
9. The fan will be OFF only after all of the electric heating stages have been OFF for at least 30 seconds. If all of the electric heating stages have not been OFF for at least 30 seconds, then the fan's airflow remains where it was before this condition was entered.

Unoccupied 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), then by pressing the override switch a room occupant can reset the controller to occupied mode for the length of time set in OVRD TIME. The status of UNOCC OVRD (Point 21) changes to OCC and remains there until OVRD TIME elapses, at which point UNOCC OVRD changes back to UNOCC and the controller returns to unoccupied mode.

NOTE: Only during unoccupied mode (MODE = Unoccupied) can a room sensor's override switch set the controller to occupied mode. If MODE equals anything other than Unoccupied, UNOCC OVRD will equal UNOCC.

Control Temperature Setpoints

Depending on certain conditions, CTL STPT (Point 92) holds the value of one of the occupied or unoccupied cooling/heating setpoints, or it holds the value of the room setpoint dial. See the following:

Occupied CLG/HTG Setpoints – When STPT DIAL equals NO (default), CTL STPT holds the value of OCC CLG STPT (Point 6) or OCC HTG STPT (Point 7) if:

- MODE (Point 3) equals Occupied, EDR, or Standby.
- MODE equals Unoccupied, but UNOCC OVRD (Point 21) equals OCC.

Unoccupied CLG/HTG Setpoints – CTL STPT holds the value of UOC CLG STPT (Point 8) or UOC HTG STPT (Point 9) if:

- MODE equals Shutdown or Unoccupied, and UNOCC OVRD equals UNOCC.

Room Setpoint Dial – When STPT DIAL is set to YES, CTL STPT holds the value of RM STPT DIAL (Point 13) if:

- MODE equals Occupied, EDR, or Standby.
- MODE equals Unoccupied, but UNOCC OVRD equals OCC.

  NOTE: RM STPT DIAL must stay between the values of RM STPT MIN (Point 11) and RM STPT MAX (Point 12), or CTL STPT will use those values instead.

Room Temperature Offset

NOTE: The Room Temperature Offset feature is optional.

RMTMP OFFSET (Point 102) 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 102)

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.

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

- HTG LOOPOUT (Point 80) is less than 5%.
- CTL TEMP (Point 78) is above CTL STPT (Point 92) by at least the value set in SWITCH DBAND (Point 90).
- CTL TEMP is greater than the appropriate cooling setpoint minus SWITCH DBAND.

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

- CLG LOOPOUT (Point 79) is less than 5%.
- CTL TEMP is below CTL STPT by at least the value set SWITCH DBAND.
- CTL TEMP is less than the appropriate heating setpoint plus SWITCH DBAND.

CAUTION:

This heating/cooling switchover mechanism is not affected by the air temperature in the supply duct. To change the value of HEAT.COOL based on the supply air temperature, you must command it through PPCL. (This is required if the flow loop is used as a source of cooling in cooling mode and as a source of heating in heating mode.)

If the flow loop is used during heating mode in order to meet minimum air requirements, then the heating/cooling switchover mechanism operates as previously described in this section.

Control Loops

The terminal box is controlled by three Proportional, Integral, and Derivative (PID) control loops (two temperature loops and a flow loop).

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* for more information.

The cooling loop generates CLG LOOPOUT (Point 79) which is used to calculate FLOW STPT (Point 93) during the cooling mode. FLOW STPT is the result of scaling the cooling loopout to the appropriate range of values as determined by CLG FLOW MAX (Point 32) and CTL FLOW MIN (Point 76). See the following equation:

$$\frac{[\text{CLG LOOPOUT} \times (\text{CLG FLOW MAX} - \text{CTL FLOW MIN})] + \text{CTL FLOW MIN}}{\text{CLG FLOW MAX}} \times 100\% = \text{FLOW STPT}$$

Example

If CTL FLOW MIN = 200 cfm and CLG FLOW MAX = 1000 cfm, then,

when CLG LOOPOUT is 0%, FLOW STPT equals 20% flow.

$$\frac{[0\% \times (1000 - 200)] + 200}{1000} \times 100\% = 20\%$$

(This ensures that the airflow out of the terminal box is not less than CTL FLOW MIN.)

When CLG LOOPOUT is 50%, FLOW STPT equals 60% flow.

$$\frac{[50\% \times (1000 - 200)] + 200}{1000} \times 100\% = 60\%$$

When CLG LOOPOUT is 100%, FLOW STPT equals 100% flow.

$$\frac{[100\% \times (1000 - 200)] + 200}{1000} \times 100\% = 100\%$$

In addition to being used to set FLOW STPT, CLG LOOPOUT also controls FAN FLOW (Point 33) during the cooling mode (FAN FLOW is then used to control FAN AOV1). See the *Fan Operation* section for more information about FAN FLOW and FAN AOV1 control.

The Cooling Loop is operational under either of the following situations:

- The application is in the occupied mode, WARMUP (Point 60) is OFF, and HEAT.COOL (Point 5) equals COOL.

- The application is in the unoccupied mode, and
  - CTL TEMP is above TEMP HLIMIT.
  - HEAT.COOL equals COOL.
  - VAV AHU (Point 61) is ON. (See Note 4 of *Application Notes* for more information on VAV AHU.)

Once these conditions are met, the cooling loop will remain enabled for the rest of the entire unoccupied period as long as HEAT.COOL and VAV AHU do not change status and CTL TEMP does not fall to TEMP LLIMIT.

If the controller is in heating mode, the flow loop maintains airflow out of the terminal box equal to CTL FLOW MIN (Point 76), In addition, HTG LOOPOUT (Point 80) controls the electric heat and FAN FLOW (Point 33) in order to maintain the room temperature. FAN FLOW is used to control FAN AOV1. See the *Fan Operation* section for more information about FAN FLOW and FAN AOV1.

The heating loop is operational under any of the following conditions:

- The application is in the occupied mode and WARMUP (Point 60) is ON.
- The application is in the occupied mode, WARMUP is OFF, and HEAT.COOL (Point 5) equals HEAT.
- The application is in the EDR (electric demand reduction) mode or in standby mode.
- The application is in the unoccupied mode, CTL TEMP is below TEMP LLIMT, and HEAT.COOL equals HEAT. (Once these conditions are met, the heating loop remains enabled for the rest of the entire unoccupied period as long as HEAT.COOL does not change status and CTL TEMP never reaches TEMP HLIMIT.)

Flow Loop – The flow loop maintains minimum and maximum airflow through CTL FLOW MIN (Point 76) and CTL FLOW MAX (Point 77), respectively. CTL FLOW MAX holds different heating and cooling flow maximums. When HEAT.COOL equals HEAT, CTL FLOW MAX equals HTG FLOW MAX. When HEAT.COOL equals COOL, CTL FLOW MAX equals CLG FLOW MAX.

Separate flow minimums for heating and cooling modes are not used — CTL FLOW MIN is used for both. CTL FLOW MIN can be set equal to, but not greater than, CTL FLOW MAX. If the minimum and maximum values are set equal, the flow loop becomes a constant volume loop and loses its ability to control temperature.

The flow loop maintains FLOW STPT by modulating the supply air damper point, DMPR COMD (Point 48) to keep airflow between CTL FLOW MIN and CTL FLOW MAX.

FLOW (Point 75) is the input value for the flow loop. It is a percentage derived from the value of AIR VOLUME (Point 35)—that is, a value in the range of 0 cfm to CTL FLOW MAX. In the following text, this percentage is referred to as *% flow*.

- If AIR VOLUME equals 0 cfm, FLOW is 0% flow.
- If AIR VOLUME equals CTL FLOW MAX, FLOW is 100% flow.

The low limit of FLOW STPT is the percentage that corresponds to the volume given in CTL FLOW MIN. This percentage can be calculated as: (CTL FLOW MIN ÷ CTL FLOW MAX) × 100% flow. The flow loop ensures that the supply air volume will not be less than CTL FLOW MIN.

Example

If CTL FLOW MIN equals 250 cfm, and if CTL FLOW MAX equals 1000 cfm,

then,

the low limit of FLOW STPT = (250 cfm ÷1000 cfm) × 100% flow
= 0.25 × 100% flow
= 25% flow

Since 25% of 1000 cfm equals 250 cfm, the minimum airflow out of the terminal box is 250 cfm.

The flow loop is operational under either of the following situations:

- The application is in the occupied mode and WARMUP (Point 60) is OFF.
- The application is in the unoccupied mode, **and**
  - CTL TEMP is above TEMP HLIMIT.
  - HEAT.COOL equals COOL.
  - VAV AHU (Point 61) is ON. (See Note 4 in the *Application Notes* section for more information on VAV AHU.)

Once these conditions are met, the flow loop will remain active for the rest of the entire unoccupied period as long as HEAT.COOL and VAV AHU do not change status and CTL TEMP does not fall to TEMP LLIMIT.

Electric Heat

CAUTION:

To ensure airflow across the heating coils when they are energized, verify that others supply the equipment with safeties.

If FAN FLOW (Point 33) equals 0 and/or FAN AOV1 (Point 66) equals 0, then this application will shut off all of the electric heating stages **even if they have been overridden to ON**. In other words, the application prevents any electric heating stages to be ON when there is no airflow coming out of the fan. The rest of this section describes the operation of the electric heating stages when both FAN FLOW and FAN AOV1 are greater than 0.

Electric heat is operational when any of the following conditions occur:

- The application is in the occupied mode and WARMUP (Point 60) is ON
- The application is in the occupied mode, WARMUP is OFF, and HEAT.COOL (Point 5) equals HEAT.

- The application is in the standby mode. (Note: When in standby, HEAT STAGE 2 is not available.)
- The application is in the unoccupied mode, CTL TEMP is below TEMP LLIMT, and HEAT.COOL equals HEAT. (Note: Once CTL TEMP is less than TEMP LLIMIT, the electric heat remains under the control of HTG LOOPOUT for the remainder of the entire unoccupied period, as long as HEAT.COOL does not change and CTL TEMP never reaches TEMP HLIMIT.)

When FAN MODE (Point 16) equals VARI, the electric heat control depends on the amount of airflow coming from the series fan, as follows:

- The second stage of electric heat (if used) will not be allowed to turn ON until FAN FLOW (Point 33) is equal to or greater than 98% of FAN FLO HMAX (Point 84).
- The first stage of electric heat (if used) will not be allowed to turn ON until FAN FLOW (Point 33) is equal to or greater than 98% of FAN FLO HMAX under the following circumstances:
  - Only one stage of electric heat is used (that is, STAGE COUNT (Point 88) = 1).
  - Two stages of electric heat are used and FAN FLO MID (Point 83) has been configured to be greater than or equal to FAN FLO HMAX.
- If STAGE COUNT (Point 88) equals 2, and FAN FLO MID has been configured to be less than FAN FLO HMAX, the first stage of heat turns ON when FAN FLOW (Point 33) becomes equal to or greater than 98% of FAN FLO MID.

When FAN MODE equals CONST, airflow from the series fan will equal FAN FLO CMAX (Point 85) whenever the fan is running. Since this is considered more than enough airflow for safe operation of the heating coil(s), the electric heat stage(s) can operate whenever needed without the application having to calculate and verify a minimum airflow.

NOTE: If FAN MODE equals CONST, the electric heat will work best if FLOW END (Point 17) equals 0 and FAN FLO MID is set equal to or greater than FAN FLO HMAX.

If there are two stages of electric heat (STAGE COUNT (Point 88) = 2), the second stage cannot turn ON until after the first stage has been ON for the length of time in STG 1 TIME (Point 27). Conversely, the first stage of electric heat cannot turn OFF until after the second stage has been OFF for the length of time in STG 2 TIME (Point 28).

HTG LOOPOUT does not control the heating stages directly. Instead, it is used to fill out an embedded Table Statement that generates an internal control signal (this was done to properly sequence the electric heat with the VAV series fan). The control signal is then used to time modulate the electric heating stage(s) through a duty cycle, as shown in the following example.

EXAMPLE: If the duty cycle is 10 minutes (STAGE TIME (Point 89) equals 10 minutes) and the internal control signal is calling for 60% of heating, then for every 10-minute period, the stages of electric heat cycle as follows:

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

As the following paragraphs explain, control of the electric heat differs depending on whether one or two stages are operational and whether the first stage is allowed to modulate at a lower FAN FLOW value than the second stage, as when FAN FLOW MID is less than FAN FLO HMAX. (Regardless of these differences, Application 2557's heating stage(s) are always controlled by an internal control signal which is generated by an embedded Table Statement that is driven by HTG LOOPOUT.)

FAN FLOW MID ≥ FAN FLO HMAX

When FAN FLOW MID **≥** FAN FLO HMAX, the relationship between HTG LOOPOOUT and the internal control signal is as follows:

- When HTG LOOPOUT is less than FLOW END (Point 17), the control signal is set to 0.
- When HTG LOOPOUT equals 100, the control signal equals 100.
- When HTG LOOPOUT is between FLOW END and 100, linear interpolation is used to scale the control signal to a value between 0 and 100.

NOTE: As HTG LOOPOUT goes from 0 to FLOW END, FAN FLOW (Point 33) goes from FAN FLOW MIN (Point 82) to FAN FLO HMAX (Point 84).

FAN FLOW MID < FAN FLO HMAX

When FAN FLOW MID < FAN FLO HMAX, the relationship between HTG LOOPOOUT and the internal control signal is as follows:

- When HTG LOOPOUT is less than FLOW 1 END (Point 23), the control signal is set to 0.
- As HTG LOOPOUT goes from FLOW 1 END to FLOW 2 START (Point 22), the control signal goes from 0 to 50.
- As HTG LOOPOUT goes from FLOW 2 START to FLOW END (Point 17), the control signal remains at 50.
- When HTG LOOPOUT is between FLOW END and 100, the control signal goes from 50 to 100.

NOTE: As HTG LOOPOUT goes from 0 to FLOW 1 END, FAN FLOW goes from FAN FLOW MIN to FAN FLOW MID (Point 83). As HTG LOOPOUT goes from FLOW 2 START to FLOW END, FAN FLOW goes from FAN FLOW MID to FAN FLO HMAX.

The following paragraphs describe the relationship between the Table Statement's internal control signal and the electric heating stage(s).

Single Stage Electric Heat

When the internal control signal is less than 10, HEAT STAGE 1 (Point 43) is OFF. When the internal control signal is greater than 90, HEAT STAGE 1 is ON. When the control signal is between 10 and 90, HEAT STAGE 1 is time modulated.

Two Stages of Electric Heat

When the internal control signal is less than 5, HEAT STAGE 1 is OFF throughout the entire duty cycle. When the internal control signal is greater than 45, HEAT STAGE 1 is ON throughout the entire duty cycle. When the internal control signal is between 5 and 45, HEAT STAGE 1 is time modulated.

When the internal control signal is less than 55, HEAT STAGE 2 (Point 44) is OFF throughout the entire duty cycle. When the internal control signal is greater than 95, HEAT STAGE 2 is ON throughout the entire duty cycle. When the internal control signal is between 55 and 95, HEAT STAGE 2 is time modulated.

Fan Operation

CAUTION:

On series fan powered terminal boxes, the terminal box fan must be controlled/interlocked to start either before or at the same time as the central air handler. Failure to do so may cause the terminal box fan to rotate backwards and cause damage at start up.

In Application 2557, the two points most directly related to the fan’s operation are FAN FLOW (Point 33) and FAN AOV1 (Point 66). FAN AOV1 is the analog output that controls the fan's airflow, and FAN FLOW is the desired airflow for the fan. The rest of this section describes how these points are determined and their operation.

FAN FLOW (Point 33)

For the fan to be OFF, FAN FLOW must = 0 and all of the stages of electric heat must be OFF for at least 30 seconds. Even after all of the electric heating stages have been OFF for at least 30 seconds, FAN FLOW is assured of equaling 0 in only the following four specific circumstances:

1. The application is in the shutdown mode.

2. The application is in the unoccupied mode, CTL TEMP (Point 78) is below TEMP LLIMIT (Point 65), and HEAT.COOL equals COOL. (FAN FLOW will remain at 0. and the fan will be OFF, for the rest of the entire unoccupied period as long as HEAT.COOL does not change and CTL TEMP never reaches TEMP HLIMIT (Point 69).

3. The application is in the unoccupied mode, **and**

   – CTL TEMP is above TEMP HLIMIT.

   – VAV AHU (Point 61) is OFF **and/or** HEAT.COOL equals HEAT. (See Note 4 in the *Application Notes* section for more information on VAV AHU.)

(Once these conditions are met, FAN FLOW will remain at 0, and the fan will be OFF, for the rest of the unoccupied mode as long as HEAT.COOL and/or VAV AHU do not change in status and CTL TEMP does not fall to TEMP LLIMIT.)

4. The application is in the unoccupied mode and CTL TEMP has remained between TEMP LLIMIT and TEMP HLIMIT throughout the entire unoccupied mode.

In the above four cases, if all of the electric heating stages have not been OFF for at least 30 seconds, then FAN FLOW will remain where it was before that case was entered. For instance, if the application goes into the shutdown mode and all of the electric heating stages have not been OFF for at least 30 seconds, then FAN FLOW will remain where it was before the shutdown mode was entered.

In any condition other than the four listed above, FAN FLOW will not equal 0 and the series fan will be running. In this case, the value of FAN MODE (Point 16) greatly effects the fan's operation. FAN MODE can equal VARI or CONST (variable or constant). If FAN MODE = CONST, FAN FLOW runs steadily at the rate indicated by FAN FLO CMAX (Point 85). If FAN MODE = VARI, FAN FLOW is controlled by either the cooling loop or the heating loop as described in the following paragraphs.

FAN FLOW Controlled by CLG LOOPUT (Point 79) – When FAN MODE = VARI, CLG LOOPUT controls FAN FLOW under either of the following conditions:

1. The application is in the occupied mode, WARMUP equals OFF, and HEAT.COOL is set to COOL.

2. The application is in the unoccupied mode, **and**
   - CTL TEMP is above TEMP HLIMT.
   - HEAT.COOL equals COOL.
   - VAV AHU is ON. (See Note 4 in the *Application Notes* section for more information on VAV AHU, Point 61.)

     (Once these conditions are met, FAN FLOW remains under the control of CLG LOOPOUT for the rest of the entire unoccupied period as long as HEAT.COOL and VAV AHU do not change status, and CTL TEMP does not fall to TEMP LLIMIT.)

CLG LOOPOUT controls FAN FLOW via an embedded Table Statement as follows:

- When CLG LOOPOUT is zero, FAN FLOW is set to FAN FLOW MIN (Point 82).
- When CLG LOOPOUT is 100, FAN FLOW is set to FAN FLO CMAX.
- When CLG LOOPOUT is between 0 and 100, linear interpolation is used to scale FAN FLOW to a value between FAN FLOW MIN and FAN FLO CMAX.

FAN FLOW Controlled by HTG LOOPUT (Point 80) – When FAN MODE = VARI, HTG LOOPUT controls FAN FLOW under any of the following conditions:

- The application is in occupied mode and WARMUP (Point 60) is ON.
- The application is in occupied mode, WARMUP is OFF, and HEAT.COOL equals HEAT.

- The application is in the unoccupied mode, CTL TEMP is below TEMP LLIMT, and HEAT.COOL equals HEAT. (Once these conditions are met, FAN FLOW remains under the control of HTG LOOPOUT for the rest of the entire unoccupied period as long as HEAT.COOL does not change and CTL TEMP never reaches TEMP HLIMIT.)

- The application is in the EDR (electric demand reduction) mode or in standby mode.

Because the operation of the series fan must be coordinated with the electric heating stage(s), controlling FAN FLOW with HTG LOOPOUT is more complicated than controlling it with CLG LOOPOUT. Whereas CLG LOOPOUT uses only one embedded Table Statement to adjust the value of FAN FLOW, HTG LOOPOUT uses one of several embedded Table Statements to control FAN FLOW depending on the circumstances. See the following:

FAN FLOW Control and 1 Stage of Electric Heat – When STAGE COUNT (Point 88) equals 1 and HEAT STAGE 1 (Point 43) is ON, FAN FLOW is set to FAN FLO HMAX (Point 84). Once this occurs, FAN FLOW is not allowed to change in value until HEAT STAGE 1 turns OFF *and remains OFF* for longer than the amount of time set in STAGE TIME (Point 89).

Whenever HEAT STAGE 1 remains OFF for longer than STAGE TIME, a “speed limit”—in addition to the Table Statement’s control signal—is used to control FAN FLOW. However, for the speed limit to be used, HTG LOOPOUT must be changing rapidly. If HTG LOOPOUT is constant or changing slowly, the Table Statement works as follows:

- When HTG LOOPOUT is 0, FAN FLOW is set equal to FAN FLOW MIN.

- When HTG LOOPOUT is equal to or greater than FLOW END (Point 17), FAN FLOW is set equal to FAN FLO HMAX. (Note: when HTG LOOPOUT is greater than FLOW END, the electric heat will time modulate.)

- When HTG LOOPOUT is between 0 and FLOW END, linear interpolation is used to scale FAN FLOW to a value between FAN FLOW MIN (Point 82) and FAN FLO HMAX.

When HTG LOOPOUT changes rapidly, the speed limit works as follows:

Regardless of how rapidly HTG LOOPOUT changes, FAN FLOW cannot change faster than (LOOP TIME (Point 98) ÷ FAN TIME (Point 71)) × FLOW END (Point 17). Even if HTG LOOPOUT changes suddenly from 0 to 100, the amount of time stored in FAN TIME must still elapse before FAN FLOW may change from FAN FLOW MIN to FAN FLO HMAX. (If FAN TIME is less than LOOP TIME, the speed limit is disabled and FAN FLOW can change as fast as HTG LOOPOUT changes.)

FAN FLOW Control when 2 Stages of Electric Heat are Used and FAN FLOW MID ≥ FAN FLOW HMAX

If FAN FLOW MID (Point 83) is equal to or greater than FAN FLO HMAX (Point 84), and STAGE COUNT (Point 88) equals 2, FAN FLOW is set to FAN FLO HMAX when HEAT STAGE 2 (Point 44) is either ON, or has been OFF for less than STAGE TIME. Other than this, the control of FAN FLOW is identical to when STAGE COUNT equals 1.

FAN FLOW Control when 2 Stages of Electric Heat are Used and FAN FLOW MID < FAN FLOW HMAX

If FAN FLOW MID is less than FAN FLO HMAX, and STAGE COUNT equals 2, FAN FLOW is set to FAN FLO HMAX when HEAT STAGE 2 is ON or has been OFF for less than STAGE TIME. When HEAT STAGE 2 has been OFF for longer than STAGE TIME, but HEAT STAGE 1 has **not** been OFF for longer than STAGE TIME, FAN FLOW is controlled by a Table Statement and a speed limit. (This is the difference between having FAN FLOW MID be **less than** FAN FLO HMAX, and having it be **equal to or greater than** FAN FLO HMAX (FAN FLOW MID is configurable during controller start-up).

If FAN FLOW MID is equal or greater than FAN FLO HMAX, both heating stages are identical in terms of how their ON/OFF status influences the control of FAN FLOW (see Figure 2557-4). But, if FAN FLOW MID is *less* than FAN FLO HMAX, then FAN FLOW's relationship to the heating stages — specifically, the values FAN FLOW gets set to — differs for each heating stage. See Figure 2557-5.)

Whenever HEAT STAGE 2 has been OFF for longer than STAGE TIME, but HEAT STAGE 1 has not, a "speed limit" — in addition to the Table Statement's control signal — is used to control FAN FLOW. However, for the speed limit to be used, HTG LOOPOUT must be changing rapidly. If HTG LOOPOUT is constant or changing slowly, the Table Statement works as follows:

- When HTG LOOPOUT is equal to or less than FLOW 2 START (Point 22), FAN FLOW is set equal to FAN FLOW MID.
- When HTG LOOPOUT is equal to or greater than FLOW END (Point 17), FAN FLOW is set equal to FAN FLO HMAX.
- When HTG LOOPOUT is between FLOW 2 START and FLOW END, linear interpolation is used to scale FAN FLOW to a value between FAN FLOW MID and FAN FLO HMAX.

When HTG LOOPOUT changes rapidly, the speed limit works as follows:

Regardless of how rapidly HTG LOOPOUT changes, FAN FLOW cannot change faster than (LOOP TIME ÷ FAN TIME) × (FLOW END – FLOW 2 START). Even if HTG LOOPOUT changes suddenly from FLOW 2 START to FLOW END, the amount of time stored in FAN TIME must still elapse before FAN FLOW can change from FAN FLOW MID to FAN FLO HMAX. (If FAN TIME is less than LOOP TIME, the speed limit is disabled and FAN FLOW can change as fast as HTG LOOPOUT changes.)

When **both** heating stages have been OFF for longer than STAGE TIME, FAN FLOW is controlled by **two** speed limits and the Table Statement's control signal. However, for the speed limits to be used, HTG LOOPOUT must be changing rapidly. If HTG LOOPOUT is constant or changing slowly, the Table Statement works as follows

- When HTG LOOPOUT equals 0, FAN FLOW is set equal to FAN FLOW MIN (Point 82).
- When HTG LOOPOUT is between 0 and FLOW 1 END (Point 23), linear interpolation is used to scale FAN FLOW to a value between FAN FLOW MIN and FAN FLO MID.
- When HTG LOOPOUT equals FLOW 1 END, FAN FLOW is set equal to FAN FLOW MID. (If HTG LOOPOUT rises above FLOW 1 END but stays below FLOW 2 START, FAN FLOW remains equal to FAN FLO MID while HEAT STAGE 1 time modulates.)
- When HTG LOOPOUT is between FLOW 2 START and FLOW END, linear interpolation is used to scale FAN FLOW to a value between FAN FLOW MID and FAN FLO HMAX.

- When HTG LOOPOUT is equal to or greater than FLOW END, FAN FLOW is set equal to FAN FLO HMAX. (Note: when HTG LOOPOUT is greater than FLOW END, HEAT STAGE 2 will time modulate.)

When HTG LOOPOUT changes rapidly, the speed limits work as follows:

If HTG LOOPOUT is less than or equal to FLOW 2 START, FAN FLOW will not be allowed to change faster than (LOOP TIME ÷ FAN TIME) × FLOW 1 END, no matter how quickly HTG LOOPOUT changes. If HTG LOOPOUT is greater than FLOW 2 START, FAN FLOW cannot change faster than (LOOP TIME ÷ FAN TIME) × (FLOW END – FLOW 2 START).

Since FLOW 1 END and the value of FLOW END – FLOW 2 START are likely to be different, two different speed limits are used even though the value of FAN TIME remains the same. The speed limit used at any given time depends on the value of HTG LOOPOUT (as explained in the previous paragraph). If FAN TIME is less than LOOP TIME, the speed limits are disabled and FAN FLOW can change as quickly as HTG LOOPOUT changes.

FAN AOV1 (Point 66)

Once a value for FAN FLOW (the fan's desired airflow) has been determined, a Table Statement in the firmware calculates the proper value for FAN AOV1 (FAN AOV1 is the analog output that controls the fan's airflow). Application 2557 actually contains four such Table Statements, but only one is used. Which one gets used depends on the value of BOX SIZE (Point 31). See the following:

BOX SIZE (Point 31) = 3, 5 or 7 – When BOX SIZE is set to 3, 5 or 7, the application uses 1 of 3 pre-coded Table Statements with pre-determined FAN AOV1 voltage levels. The voltage values are fixed and cannot be changed by the user.

> **NOTE:** BOX SIZE (Point 31) should be set to 3, 5, or 7 **only** if you have a Nailor box of size 3, 5, or 7.

BOX SIZE (Point 31) = 0 – When BOX SIZE is set to 0, the application uses a general purpose Table Statement to adjust the value of FAN AOV1.

> **NOTE:** BOX SIZE (Point 31) should be set to 0 if the box being used is either a Nailor box with a size other than 3, 5, or 7, or any box made by a manufacturer other than Nailor.

The flow and voltage values of the general purpose table statement are not pre-coded and must be entered by the user as follows:

- FLO LO (Point 39) – The lowest flow the fan can produce. (FLO LO must be less than or equal to FAN FLOW MIN (Point 82), and may be set to 0 cfm, if desired.)
- FLO LO VOLTS (Point 37) – The voltage used by FAN AOV1 that tells the fan to produce an airflow equal to FLO LO.
- FLO HI (Point 87) – The highest flow that the fan can produce. (FLO HI must be greater than or equal to both FAN FLO HMAX and FAN FLO CMAX.)
- FLO HI VOLTS (Point 38) – The voltage used by FAN AOV1 that tells the fan to produce an airflow equal to FLO HI.

Once properly set up, the Table Statement works as follows:

- When FAN FLOW is less than or equal to FLO LO, FAN AOV1 will be set to FAN LO VOLTS.
- When FAN FLOW is greater than or equal to FAN HI, FAN AOV1 is set to FAN HI VOLTS.
- When FAN FLOW is between FLO LO and FLO HI, linear interpolation is used to scale FAN AOV1 to a value that is between FAN LO VOLTS and FAN HI VOLTS.

Once FAN AOV1 is set to a particular voltage, the signal is sent to an intelligent motor controller that controls the fan. This intelligent motor controller is **provided by others**. It must be set up to know what the fan's airflow should be for a given value of FAN AOV1 voltage. Consult the operating instructions provided by the manufacturer for information on how to do this.

NOTES: 1. FAN FLOW (Point 33) is a calculated value, not a measured value. The application does not measure the airflow coming out of the fan.

2. This application does not have a DO that turns the fan ON and OFF. To turn the fan OFF, FAN FLOW must be set equal to 0.

Warm-Up

Warm-up mode is only allowed to operate during occupied heating. At no other time may the application enter warm-up mode.

WARMUP (Point 60) is turned ON only if **all** of the following circumstances are true:

- MODE (Point 3) has just changed from Unoccupied to Occupied (MODE currently equals occupied, but equaled unoccupied one LOOP TIME (Point 98) a while back).
- HEAT.COOL (Point 5) equals HEAT.
- The room temperature is not warm enough.
  CTL TEMP (Point 78) < (CTL STPT (Point 92) – MORN DBAND (Point 74))

The warm-up mode remains in effect until CTL TEMP becomes equal to or greater than (CTL STPT – MORN DBAND). Once this occurs, WARMUP is set to OFF. Once OFF, WARMUP cannot be turned back ON for the rest of the Occupied period.

Baseboard Radiation

For baseboard radiation (BASE DO6, Point 46) to turn ON, the application must be in unoccupied heating (MODE = UNOCC, UNOCC OVRD = UNOCC, and HEAT.COOL = HEAT), and both of the following must be true:

- CTL TEMP (Point 78) is between TEMP LLIMIT (Point 65) and TEMP HLIMIT (Point 69).
- The room temperature is not warm enough:
  CTL TEMP < (CTL STPT (Point 92) – HTG DBAND (Point 73)).

At all other times, BASE DO6 is OFF.

Once ON, baseboard radiation remains ON until CTL TEMP becomes equal to or greater than CTL STPT. When CTL TEMP is between CTL STPT and (CTL STPT – HTG DBAND), the baseboard radiation remains in its last commanded state: If ON, it remains ON; if OFF, it remains OFF.

If CTL TEMP becomes less than TEMP LLIMIT or greater than TEMP HLIMIT, BASE DO6 is shut OFF and not allowed to turn back ON for the remainder of the unoccupied heating mode.

Flow Temperature Alarm

The status of FLOW TEMP (Point 62) indicates whether the supply airflow is properly cooling down the control temperature (CTL TEMP, Point 78) during cooling. Basically, this feature checks whether the supply airflow is both great enough and cool enough to cool down the room.

FLOW TEMP is sent to ALARM only when all of the following are true:

- HEAT.COOL (Point 5) equals COOL.
- MODE (Point 3) equals occupied, or UNOCC OVRD (Point 21) equals OCC, while MODE equals unoccupied.
- FLOW (Point 75) < FLOW STPT (Point 93), and CTL TEMP > CTL STPT (Point 92). Both of these must be true for at least the amount of time stored in ALARM TIME (Point 26).

At all other times FLOW TEMP = NORMAL.

NOTE: During occupied cooling, FLOW TEMP equals NORMAL when: FLOW ≥ (FLOW STPT – LOW FLOW, Point 30) and/or CTL TEMP ≤ CTL STPT.

Fail-Safe Operation

If the air velocity sensor fails, the controller uses pressure dependent control with the temperature loop controlling the damper's position. If the room temperature sensor fails, the controller operates using the last known temperature value.

Calibration

The controller's air velocity transducer requires periodic calibration to maintain accurate air velocity readings. CAL SETUP (Point 95) is configured during controller startup to allow calibration to take place either automatically or manually. The status of CAL AIR (Point 94) indicates whether calibration is in progress. During calibration, CAL AIR = YES. Note that the damper is commanded closed to get a zero airflow reading during calibration. At the end of a calibration sequence, CAL AIR automatically returns to NO and the damper returns to normal control.

Application Notes

1. If the temperature swings in the room are excessive or there is trouble maintaining the setpoint, then either the cooling loop, the heating loop, or both need to be tuned. If FLOW (Point 75) is oscillating while FLOW STPT (Point 93) is constant, then the flow loop requires tuning.

2. Unless overridden, the value of CTL TEMP (Point 78) equals ROOM TEMP (Point 4) plus RMTMP OFFSET (Point 102).

3. The controller, as shipped from the factory, keeps all associated equipment OFF. See the Start-up document for how to release the controller and its equipment to application control.

4. Certain control features of Application 2557 depend on whether the central air handling unit is ON or OFF. Application 2557 monitors VAV AHU (Point 61) for this information. Application 2557 does not command VAV AHU — it only reacts to it. To command VAV AHU, it must be unbundled at the field panel and PPCL must be written for it.

5. Since Application 2557 has no fan DO, the only way to manually shut the fan OFF is to set FAN FLOW to 0.

6. In Application 2557, DOs 3 and 4 cannot be used as auxiliary floating-control motor points, even if the application is not using them. The same is true for DOs 5 and 6 and also DOs 7 and 8. Floating control logic is not present in the firmware for these DOs. However, these DOs can otherwise be used as spare points if the application is not using them for other purposes (DOs 7 and 8 are always spare).

7. If FAN FLOW (Point 33) equals 0 and/or FAN AOV1 (Point 66) equals 0, the application will shut off all stages of electric heating **even if they have been overridden to ON**. Thereafter, if both FAN FLOW and FAN AOV1 become greater than 0, the application will not automatically turn the electric heat stages back on due to the previous user command. Instead, the application will control them normally.

Point Database

NOTE: The slave mode point database follows this database.

Table 2557-4. Point Database for Application 2557.

Object Type [a]	Object Instance (Point Number)	Object Name (Descriptor)	Factory Default (SI Units) [b]	Engr Units (SI Units)	Range	Active Text	Inactive Text
AO	01	CTLR ADDRESS	99	--	0-255	--	--
AO	02	APPLICATION	2599	--	0-32767	--	--
AO	{03} [c]	MODE	0	--	0-255	--	--
AI	{04}	ROOM TEMP	74.0 (23.44888)	DEG F (DEG C)	48-111.75	--	--
BO	{05}	HEAT.COOL	COOL	--	Binary	HEAT	COOL
AO	06	OCC CLG STPT	74.0 (23.44888)	DEG F (DEG C)	48-111.75	--	--
AO	07	OCC HTG STPT	70.0 (21.20888)	DEG F (DEG C)	48-111.75	--	--
AO	08	UOC CLG STPT	82.0 (27.92888)	DEG F (DEG C)	48-111.75	--	--
AO	09	UOC HTG STPT	65.0 (18.40888)	DEG F (DEG C)	48-111.75	--	--
BI	{10}	DI 5	OFF	--	Binary	ON	OFF
AO	11	RM STPT MIN	52.5 (11.40888)	DEG F (DEG C)	48-111.75	--	--
AO	12	RM STPT MAX	74.25 (23.58888)	DEG F (DEG C)	48-111.75	--	--
AI	{13}	RM STPT DIAL	74.0 (23.44888)	DEG F (DEG C)	48-111.75	--	--
BO	14	STPT DIAL	NO	--	Binary	YES	NO
AI	{15}	AI 3	0.0	PCT	0-102	--	--
BO	{16}	FAN MODE	VARI	--	Binary	CONST	VARI
AO	17	FLOW END	75.2	PCT	0-102	--	--
BO	18	WALL SWITCH	NO	--	Binary	YES	NO
BI	{19}	DI OVRD SW	OFF	--	Binary	ON	OFF
AO	20	OVRD TIME	0	HRS	0-255	--	--
BO	{21}	UNOCC OVRD	UNOCC	--	Binary	UNOCC	OCC
AO	22	FLOW 2 START	30.0	PCT	0-102	--	--
AO	23	FLOW 1 END	15.2	PCT	0-102	--	--
BI	{24}	DI 2	OFF	--	Binary	ON	OFF
BI	{25}	DI 3	OFF	--	Binary	ON	OFF
AO	26	ALARM TIME	5	MIN	0-255	--	--

a Object Types are; Analog Input (AI), Analog Output (AO), Binary Input (BI) and Binary Output (BO).
b A single value in a column means that the value is the same in English units and in SI units.
c Point numbers that appear in brackets { } may be unbundled at the field panel.

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Table 2557-4. Point Database for Application 2557.

Object Type [a]	Object Instance (Point Number)	Object Name (Descriptor)	Factory Default (SI Units) [b]	Engr Units (SI Units)	Range	Active Text	Inactive Text
AO	27	STG 1 TIME	120	SEC	0-255	--	--
AO	28	STG 2 TIME	120	SEC	0-255	--	--
AO	30	LOW FLOW	5.0	PCT	0-127.75	--	--
AO	31	BOX SIZE	3	--	0-255	--	--
AO	32	CLG FLOW MAX	2200 (1038.18)	CFM (LPS)	0-131068	--	--
AO	{33}	FAN FLOW	0 (0.0)	CFM (LPS)	0-4092	--	--
AO	34	HTG FLOW MAX	2200 (1038.18)	CFM (LPS)	0-131068	--	--
AI	{35}	AIR VOLUME	0 (0.0)	CFM (LPS)	0-131068	--	--
AO	36	FLOW COEFF	1.0	--	0-2.55	--	--
AO	{37}	FLO LO VOLTS	0.0	VOLTS	0-10.23	--	--
AO	{38}	FLO HI VOLTS	10.0	VOLTS	0-10.23	--	--
AO	{39}	FLO LO	0 (0.0)	CFM (LPS)	0-4092	--	--
BI	{40}	DI 4	OFF	--	Binary	ON	OFF
BO	{41}	DO 1	OFF	--	Binary	ON	OFF
BO	{42}	DO 2	OFF	--	Binary	ON	OFF
BO	{43}	HEAT STAGE 1	OFF	--	Binary	ON	OFF
BO	{44}	HEAT STAGE 2	OFF	--	Binary	ON	OFF
BO	{45}	HEAT STAGE 3	OFF	--	Binary	ON	OFF
BO	{46}	BASE DO6	OFF	--	Binary	ON	OFF
BI	{47}	DI 6	OFF	--	Binary	ON	OFF
AO	{48}	DMPR COMD	0.0	PCT	0-102	--	--
AO	{49}	DMPR POS	0.0	PCT	0-102	--	--
AI	{50}	AUX TEMP	74.0 (23.495556)	DEG F (DEG C)	37.5-165	--	--
AO	51	MTR1 TIMING	95	SEC	0-511	--	--
AO	52	FLOW 2 END	45.2	PCT	0-102	--	--
AO	53	FLOW 3 START	60.0	PCT	0-102	--	--
AI	{54}	AI 5	74.0 (23.495556)	DEG F (DEG C)	37.5-165	--	--
AO	55	FAN FLO MORE	2500 (1179.75)	CFM (LPS)	0-4092	--	--
AO	56	DMPR ROT ANG	90	--	0-255	--	--
AO	57	STG 3 TIME	120	SEC	0-255	--	--

a Object Types are; Analog Input (AI), Analog Output (AO), Binary Input (BI) and Binary Output (BO).
b A single value in a column means that the value is the same in English units and in SI units.
c Point numbers that appear in brackets { } may be unbundled at the field panel.

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Table 2557-4. Point Database for Application 2557.

Object Type [a]	Object Instance (Point Number)	Object Name (Descriptor)	Factory Default [b] (SI Units)	Engr Units (SI Units)	Range	Active Text	Inactive Text
AO	58	MTR SETUP	0	--	0-255	--	--
AO	59	DO DIR. REV	0	--	0-255	--	--
BO	{60}	WARMUP	OFF	--	Binary	ON	OFF
BO	{61}	VAV AHU	OFF	--	Binary	ON	OFF
BO	{62}	FLOW TEMP	NORMAL	--	Binary	ALARM	NORMAL
AO	63	CLG P GAIN	20.0 (36.0)	--	0-63.75	--	--
AO	64	CLG I GAIN	0.01 (0.018)	--	0-1.023	--	--
AO	65	TEMP LLIMIT	55.0 (12.80888)	DEG F (DEG C)	48-111.75	--	--
AO	{66}	FAN AOV1	0.0	VOLTS	0-10.23	--	--
AO	67	HTG P GAIN	10.0 (18.0)	--	0-63.75	--	--
AO	68	HTG I GAIN	0.01 (0.018)	--	0-1.023	--	--
AO	69	TEMP HLIMIT	85.0 (29.60888)	DEG F (DEG C)	48-111.75	--	--
AO	{70}	AOV 2	0.0	VOLTS	0-10.23	--	--
AO	71	FAN TIME	60	SEC	0-255	--	--
AO	72	FLOW I GAIN	0.02	--	0-1.023	--	--
AO	73	HTG DBAND	2.0 (1.12)	DEG F (DEG C)	0.5-64.25	--	--
AO	74	MORN DBAND	2.0 (1.12)	DEG F (DEG C)	0-63.75	--	--
AO	{75}	FLOW	0.0	PCT	0-1023.75	--	--
AO	76	CTL FLOW MIN	220 (103.818)	CFM (LPS)	0-131068	--	--
AO	{77}	CTL FLOW MAX	2200 (1038.18)	CFM (LPS)	0-131068	--	--
AO	{78}	CTL TEMP	74.0 (23.44888)	DEG F (DEG C)	48-111.75	--	--
AO	{79}	CLG LOOPOUT	0.0	PCT	0-102	--	--
AO	{80}	HTG LOOPOUT	0.0	PCT	0-102	--	--
AO	{81}	AVG HEAT OUT	0.0	PCT	0-409.2	--	--
AO	82	FAN FLOW MIN	220 (103.818)	CFM (LPS)	0-4092	--	--
AO	83	FAN FLOW MID	2500 (1179.75)	CFM (LPS)	0-4092	--	--
AO	84	FAN FLO HMAX	2200 (1038.18)	CFM (LPS)	0-4092	--	--
AO	85	FAN FLO CMAX	2200 (1038.18)	CFM (LPS)	0-4092	--	--
AO	86	SWITCH TIME	10	MIN	0-255	--	--
AO	{87}	FLO HI	2200 (1038.18)	CFM (LPS)	0-4092	--	--

a Object Types are; Analog Input (AI), Analog Output (AO), Binary Input (BI) and Binary Output (BO).
b A single value in a column means that the value is the same in English units and in SI units.
c Point numbers that appear in brackets { } may be unbundled at the field panel.

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Table 2557-4. Point Database for Application 2557.

Object Type [a]	Object Instance (Point Number)	Object Name (Descriptor)	Factory Default (SI Units) [b]	Engr Units (SI Units)	Range	Active Text	Inactive Text
AO	88	STAGE COUNT	2	--	0-255	--	--
AO	89	STAGE TIME	10	MIN	1-256	--	--
AO	90	SWITCH DBAND	1.0 (0.56)	DEG F (DEG C)	0-63.75	--	--
AO	{91}	AOV 3	0.0	VOLTS	0-10.23	--	--
AO	{92}	CTL STPT	74.0 (23.44888)	DEG F (DEG C)	48-111.75	--	--
AO	{93}	FLOW STPT	0.0	PCT	0-255.75	--	--
BO	{94}	CAL AIR	NO	--	Binary	YES	NO
AO	95	CAL SETUP	4	--	0-255	--	--
AO	96	CAL TIMER	12	HRS	0-255	--	--
AO	97	DUCT AREA	1.0 (0.09292)	SQ. FT (SQ M)	0-6.375	--	--
AO	98	LOOP TIME	5	SEC	0-255	--	--
AO	{99}	ERROR STATUS	0	--	0-255	--	--
AO	102	RMTMP OFFSET	DEG F (DEG C)	0.0 (0.0)	-31.75-32	--	--
BO	{103}	DO 7	--	OFF	Binary	ON	OFF
BO	{104}	DO 8	--	OFF	Binary	ON	OFF

a Object Types are; Analog Input (AI), Analog Output (AO), Binary Input (BI) and Binary Output (BO).
b A single value in a column means that the value is the same in English units and in SI units.
c Point numbers that appear in brackets { } may be unbundled at the field panel.

Slave Mode Point Database, Application 2599

Table 2557-5. Point Database for Application 2599.

Object Type [a]	Object Instance (Point Number)	Object Name (Descriptor)	Factory Default (SI Units) [b]	Engr Units (SI Units)	Range	Active Text	Inactive Text
AO	01	CTLR ADDRESS	99	--	0-255	--	--
AO	02	APPLICATION	2599	--	0-32767	--	--
AI	{04} [c]	ROOM TEMP	74.0 (23.44888)	DEG F (DEG C)	48-111.75	--	--
BI	{10}	DI 5	OFF	--	Binary	ON	OFF
AI	{13}	RM STPT DIAL	74.0 (23.44888)	DEG F (DEG C)	48-111.75	--	--
AI	{15}	AI 3	0.0	PCT	0-102	--	--
BO	18	WALL SWITCH	NO	--	Binary	YES	NO
BI	{19}	DI OVRD SW	OFF	--	Binary	ON	OFF
BI	{24}	DI 2	OFF	--	Binary	ON	OFF
BI	{25}	DI 3	OFF	--	Binary	ON	OFF
AI	{35}	AIR VOLUME	0 (0.0)	CFM (LPS)	0-131068	--	--
AO	36	FLOW COEFF	1.0	--	0-2.55	--	--
BI	{40}	DI 4	OFF	--	Binary	ON	OFF
BO	{41}	DO 1	OFF	--	Binary	ON	OFF
BO	{42}	DO 2	OFF	--	Binary	ON	OFF
BO	{43}	HEAT STAGE 1	OFF	--	Binary	ON	OFF
BO	{44}	HEAT STAGE 2	OFF	--	Binary	ON	OFF
BO	{45}	HEAT STAGE 3	OFF	--	Binary	ON	OFF
BO	{46}	BASE DO6	OFF	--	Binary	ON	OFF
BI	{47}	DI 6	OFF	--	Binary	ON	OFF
AO	{48}	DMPR COMD	0.0	PCT	0-102	--	--
AO	{49}	DMPR POS	0.0	PCT	0-102	--	--
AI	{50}	AUX TEMP	74.0 (23.495556)	DEG F (DEG C)	37.5-165	--	--
AO	51	MTR1 TIMING	95	SEC	0-511	--	--
AI	{54}	AI 5	74.0 (23.495556)	DEG F (DEG C)	37.5-165	--	--
AO	56	DMPR ROT ANG	90	--	0-255	--	--
AO	58	MTR SETUP	0	--	0-255	--	--
AO	59	DO DIR. REV	0	--	0-255	--	--

a Object Types are; Analog Input (AI), Analog Output (AO), Binary Input (BI) and Binary Output (BO).
b A single value in a column means that the value is the same in English units and in SI units.
c Point numbers that appear in brackets { } may be unbundled at the field panel.

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Table 2557-5. Point Database for Application 2599.

Object Type [a]	Object Instance (Point Number)	Object Name (Descriptor)	Factory Default (SI Units) [b]	Engr Units (SI Units)	Range	Active Text	Inactive Text
AO	{66}	FAN AOV1	0.0	VOLTS	0-10.23	--	--
AO	{70}	AOV 2	0.0	VOLTS	0-10.23	--	--
AO	{78}	CTL TEMP	74.0 (23.44888)	DEG F (DEG C)	48-111.75	--	--
AO	{91}	AOV 3	0.0	VOLTS	0-10.23	--	--
BO	{94}	CAL AIR	NO	--	Binary	YES	NO
AO	95	CAL SETUP	4	--	0-255	--	--
AO	96	CAL TIMER	12	HRS	0-255	--	--
AO	97	DUCT AREA	1.0 (0.09292)	SQ. FT (SQ M)	0-6.375	--	--
AO	{99}	ERROR STATUS	0	--	0-255	--	--
AO	102	RMTMP OFFSET	DEG F (DEG C)	0.0 (0.0)	-31.75-32	--	--
BO	{103}	DO 7	--	OFF	Binary	ON	OFF
BO	{104}	DO 8	--	OFF	Binary	ON	OFF

a Object Types are; Analog Input (AI), Analog Output (AO), Binary Input (BI) and Binary Output (BO).
b A single value in a column means that the value is the same in English units and in SI units.
c Point numbers that appear in brackets { } may be unbundled at the field panel.

SIEMENS

Application 2557

VAV with 0-10V Series-Fan Speed Output and 3 Stage Electric Heat

TEC-0851b.08

Overview

NOTE: This document explains when Application 2557 is controlling three stages of electric heat (STAGE COUNT, Point 88 = 3). For more information on how Application 2557 operates when STAGE COUNT is 2 or less, see document number TEC-0851a.08.

In Application 2557, the supply air damper of the terminal box is modulated for cooling, and up to three stages of electric heat are controlled for heating. When in heating, the terminal box maintains minimum airflow out of the supply air duct. The terminal box also has a variable air volume series fan for air circulation (an option exists to run this series fan at constant volume). In order for the terminal box to work properly, the central air handling unit must provide supply air. See Figures 2557-1 through 2557-7.

Certain control features of Application 2557 depend on whether the central air handling unit is ON or OFF. Application 2557 monitors VAV AHU (Point 61) for this information. Application 2557 does not command VAV AHU — it only reacts to it. To command VAV AHU, it must be unbundled at the field panel and PPCL must be written for it.

BACnet

BACnet MS/TP protocol for open communications on BACnet MS/TP networks.

Table 2557-1. Supported BIBBs.

Product	Supported BIBBs	BIBB Name
BTEC	DS-RP-B	Data Sharing-ReadProperty-B
	DS-RPM-B	Data Sharing-ReadPropertyMultiple-B
	DS-WP-B	Data Sharing-WriteProperty-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

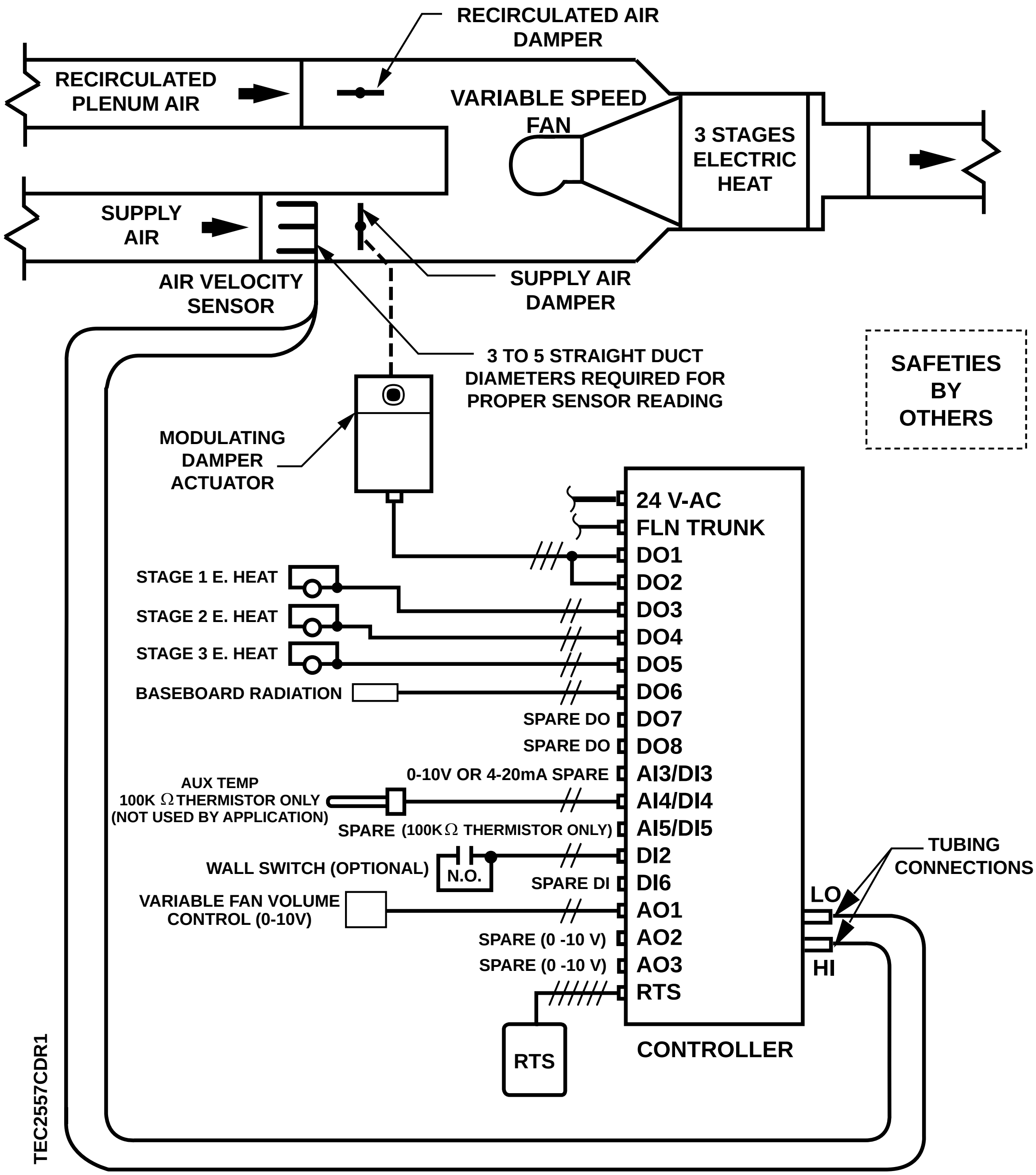
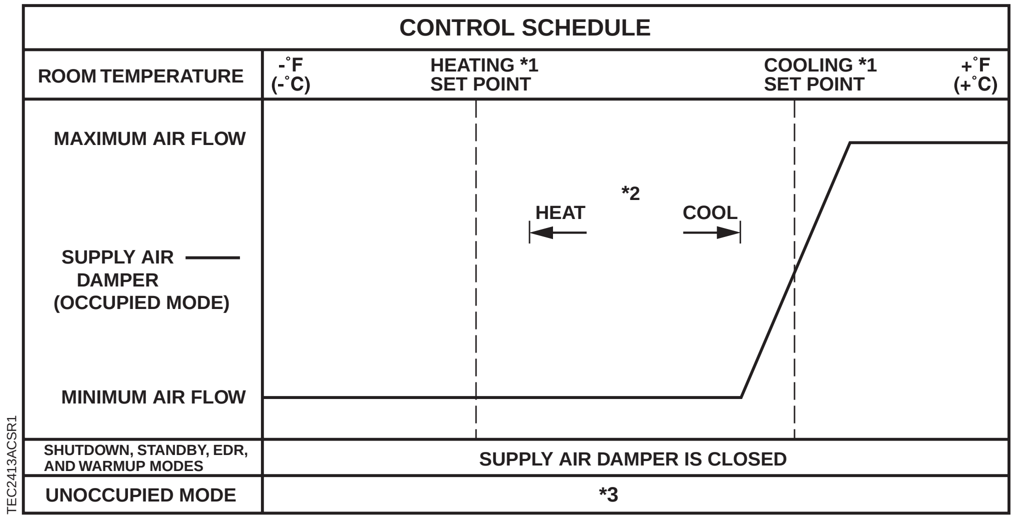


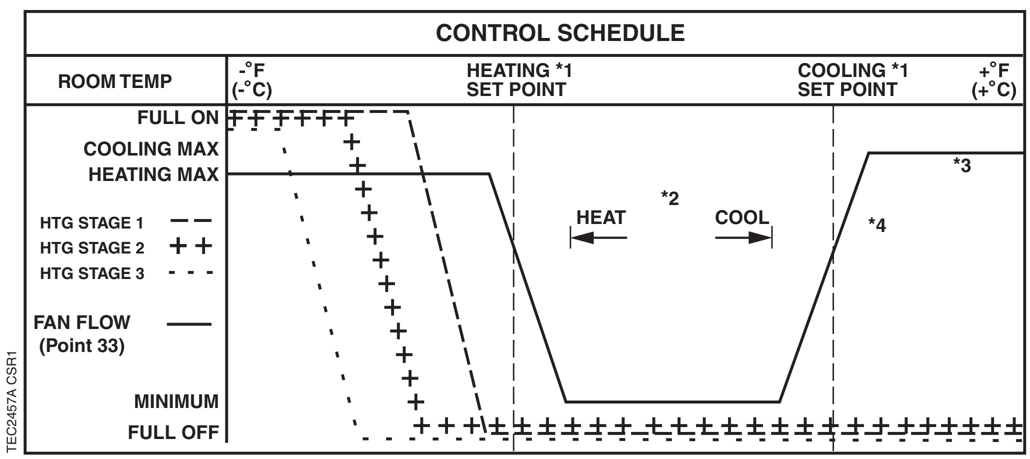
Figure 2557-1. Application 2557 Control Drawing.



NOTES:

1. See the *Control Temperature Setpoint* section.
2. See the *Heating/Cooling Switchover* section.
3. The supply damper remains closed in the unoccupied mode as long as HEAT.COOL (Point 5) equals HEAT. The supply damper also remains closed in the unoccupied mode if HEAT.COOL equals COOL **and** the room temperature remains less than TEMP HLIMIT (Point 69). Once the room temperature rises above TEMP HLIMIT while VAV AHU (Point 61) = ON, the supply damper is controlled as in the occupied cooling mode for as long as HEAT.COOL stays equal to COOL and VAV AHU remains ON. (See Note 4 in the *Application Notes* section for more information on VAV AHU.)

Figure 2557-2. Supply Air Damper Control Schedule.



FAN MODE (Point 16) = VARI.

Figure 2557-3. Operation of the Fan and 3 Stages of Electric Heat in Occupied Mode. (See Note 8)

NOTE: In this figure, the application has been set up so that no stage of electric heat can turn ON until the airflow out of the fan is at "HEATING MAX".

FAN MODE (Point 16) has two possible settings, CONST or VARI (constant or variable—the default = VARI). It is configurable during controller start-up and can also be overwritten by the customer during operation.

NOTES:

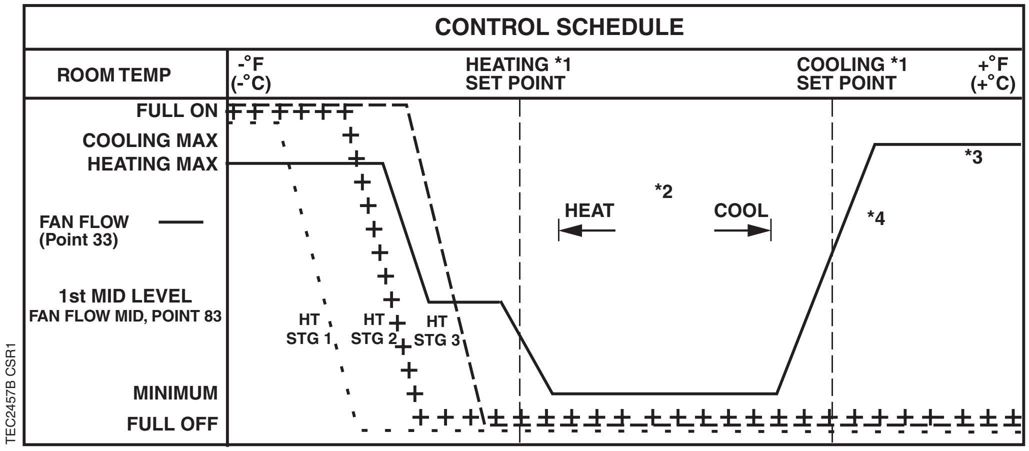
1. See the *Control Temperature Setpoints* section.
2. See the *Heating/Cooling Switchover* section.
3. NOTE: If FAN MODE (Point 16) = CONST, FAN FLOW (Point 33) remains at the highest possible maximum flow (FAN FLO CMAX, Point 85) throughout the entire occupied mode.
4. To regulate fan speed, Application 2557 uses FAN FLOW (Point 33) and embedded table statements to modulate the voltage of FAN AOV1 (Point 66). The particular table statement used depends on the box size.

   The following describes the operation of the fan and electric heat during the controller's other modes:

Shutdown Mode	The fan (see Note 5) and electric heating stages are OFF.
Unoccupied Mode	See Note 6 for fan operation. See Note 7 for operation of heating stages.
Electrical Demand Reduction (EDR) Mode	The fan is controlled as in the occupied heating mode. The heating stages are OFF.
Standby Mode	Both the fan and first heating stage are controlled as in the occupied heating mode. The second and third heat stages remain OFF.
Warm-up Mode	Both the fan and the heating stages are controlled as in the occupied heating mode.

5. FAN FLOW (Point 33) is set to 0 in shutdown mode, provided that all of the electric heating stages have been off for at least 30 seconds. If all of the electric heating stages have not been off for at least 30 seconds, then the fan's airflow remains where it was before the shutdown mode was entered. When FAN FLOW = 0, the fan is completely OFF.
6. During unoccupied mode, the fan stays OFF if the room temperature remains between TEMP LLIMIT (Point 65) and TEMP HLIMIT (Point 69), provided that all of the electric heating stages have been off for at least 30 seconds. If all of the electric heating stages have not been off for at least 30 seconds, then the fan's airflow remains where it was before the unoccupied mode was entered.

   If the room temperature drops below TEMP LLIMIT, the fan is controlled like it is during occupied heating for the remainder of the unoccupied mode. If the room temperature rises above TEMP HLIMIT—and VAV AHU is ON—the fan is controlled like it is during occupied cooling for the remainder of the unoccupied mode. (See Note 4 in the *Application Notes* section for more information on VAV AHU.)
7. In the unoccupied mode, the electric heat stages remain OFF unless the room temperature drops below TEMP LLIMIT. If this occurs, the electric heat stages are controlled like they are during occupied heating for the remainder of the unoccupied mode.
8. Regardless of the operational mode, the application will shut off all stages of electric heat if FAN FLOW (Point 33) is 0, **even if the electric heat stages were overridden to ON.** In other words, the application prevents any electric heating stages to be ON when there is no airflow coming out of the fan.



FAN MODE = VARI.

Figure 2557-4. Operation of the Fan and 3 Stages of Electric Heat in Occupied Mode. (See Note 8)

NOTE: In this figure, the application has been set up so that the first stage of electric heat can turn ON when the fan is producing a "1st MID LEVEL" airflow.

FAN MODE (Point 16) has two possible settings, CONST or VARI (constant or variable—the default = VARI). It is configurable during controller start-up and can also be overwritten by the customer during operation.

NOTES:

1. See the *Control Temperature Setpoints* section.
2. See the *Heating/Cooling Switchover* section.
3. If FAN MODE (Point 16) = CONST, FAN FLOW (Point 33) remains at the highest possible maximum flow (FAN FLO CMAX, Point 85) throughout the entire occupied mode.
4. To regulate fan speed, Application 2557 uses FAN FLOW (Point 33) and embedded Table Statements to modulate the voltage of FAN AOV1 (Point 66). The particular Table Statement used depends on the box size.

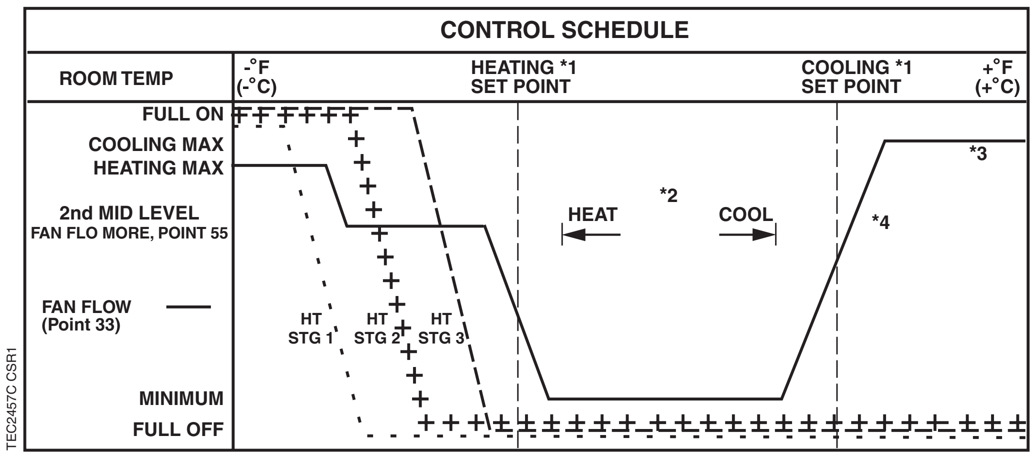
   The following describes the operation of the fan electric heat during the controller's other modes:

Shutdown Mode	The fan (see Note 5) and electric heating stages are OFF.
Unoccupied Mode	See Note 6 for fan operation. See Note 7 for operation of heating stages.
Electrical Demand Reduction (EDR) Mode	The fan is controlled as in the occupied heating mode. The heating stages are OFF.
Standby Mode	Both the fan and first heating stage are controlled as in the occupied heating mode. The second and third heat stages remain OFF.
Warm-up Mode	Both the fan and the heating stages are controlled as in the occupied heating mode.

5. FAN FLOW (Point 33) is set to 0 in shutdown mode, provided that all of the electric heating stages have been off for at least 30 seconds. If all of the electric heating stages have not been off for at least 30 seconds, then the fan's airflow remains where it was before the shutdown mode was entered. When FAN FLOW = 0, the fan is completely OFF.

6. During unoccupied mode, the fan stays OFF if the room temperature remains between TEMP LLIMIT (Point 65) and TEMP HLIMIT (Point 69), provided that all of the electric heating stages have been off for at least 30 seconds. If all of the electric heating stages have not been off for at least 30 seconds, then the fan's airflow remains where it was before the unoccupied mode was entered.

   If the room temperature drops below TEMP LLIMIT, the fan will be controlled like it is during occupied heating for the remainder of the unoccupied mode. If the room temperature rises above TEMP HLIMIT—and VAV AHU is ON—the fan will be controlled like it is during occupied cooling for the remainder of the unoccupied mode. (See Note 4 in the *Application Notes* section for more information on VAV AHU.)
7. In the unoccupied mode, the electric heat stages remain OFF unless the room temperature drops below TEMP LLIMIT. If this occurs, the electric heat stages are controlled like they are during occupied heating for the remainder of the unoccupied mode.
8. Regardless of the operational mode, the application will shut off all stages of electric heat if FAN FLOW (Point 33) is 0, **even if the electric heat stages were overridden to ON.** In other words, the application prevents any electric heating stages to be ON when there is no airflow coming out of the fan.



FAN MODE = VARI.

Figure 2557-5. Operation of the Fan and 3 Stages of Electric Heat in Occupied Mode. (See Note 8)

NOTE: In this figure, the application has been set up so that the first and second stages of electric heat can turn ON when the fan is producing a "2nd MID LEVEL" airflow.

FAN MODE (Point 16) has two possible settings, CONST or VARI (constant or variable—the default = VARI). It is configurable during controller start-up and can also be overwritten by the customer during operation.

NOTES:

1. See the *Control Temperature Setpoints* section.
2. See the *Heating/Cooling Switchover* section.
3. If FAN MODE (Point 16) = CONST, FAN FLOW (Point 33) remains at the highest possible maximum flow (FAN FLO CMAX, Point 85) throughout the entire occupied mode.

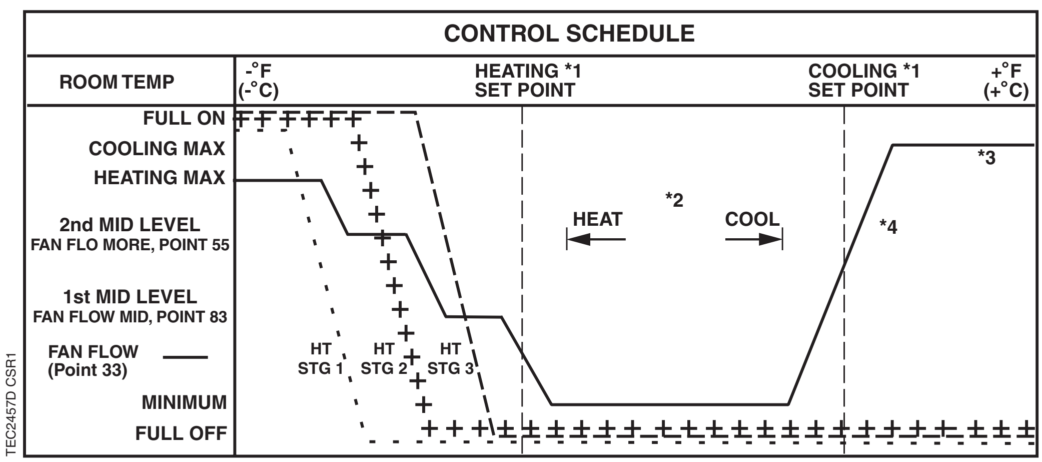
4. To regulate fan speed, application 2557 uses FAN FLOW (Point 33) and embedded Table Statements to modulate the voltage of FAN AOV1 (Point 66). The particular table statement used depends on the box size.

   The following describes the operation of the fan electric heat during the controller's other modes:

Shutdown Mode	The fan (see Note 5) and electric heating stages are OFF.
Unoccupied Mode	See Note 6 for fan operation. See Note 7 for operation of heating stages.
Electrical Demand Reduction (EDR) Mode	The fan is controlled as in the occupied heating mode. The heating stages are OFF.
Standby Mode	Both the fan and first heating stage are controlled as in the occupied heating mode. The second and third heat stages remain OFF.
Warm-up Mode	Both the fan and the heating stages are controlled as in the occupied heating mode.

5. FAN FLOW (Point 33) is set to 0 in shutdown mode, provided that all of the electric heating stages have been off for at least 30 seconds. If all of the electric heating stages have not been off for at least 30 seconds, then the fan's airflow remains where it was before the shutdown mode was entered. When FAN FLOW = 0, the fan is completely OFF.
6. During unoccupied mode, the fan stays OFF if the room temperature remains between TEMP LLIMIT (Point 65) and TEMP HLIMIT (Point 69), provided that all of the electric heating stages have been off for at least 30 seconds. If all of the electric heating stages have not been off for at least 30 seconds, then the fan's airflow remains where it was before the unoccupied mode was entered.

   If the room temperature drops below TEMP LLIMIT, the fan will be controlled like it is during occupied heating for the remainder of the unoccupied mode. If the room temperature rises above TEMP HLIMIT—and VAV AHU is ON—the fan will be controlled like it is during occupied cooling for the remainder of the unoccupied mode. (See Note 4 in the *Application Notes* section for more information on VAV AHU.)
7. In the unoccupied mode, the electric heat stages remain OFF unless the room temperature drops below TEMP LLIMIT. If this occurs, the electric heat stages are controlled like they are during occupied heating for the remainder of the unoccupied mode.
8. Regardless of the operational mode, the application will shut off all stages of electric heat if FAN FLOW (Point 33) is 0, **even if the electric heat stages were overridden to ON.** In other words, the application prevents any electric heating stages to be ON when there is no airflow coming out of the fan.



FAN MODE = VARI.

Figure 2557-6. Operation of the Fan and 3 Stages of Electric Heat in Occupied Mode. (See Note 8)

NOTE: In this figure, the application has been set up so that the first stage of electric heat can turn ON when the fan is producing a "1st MID LEVEL" airflow, the second stage of electric heat can turn ON when the fan is producing a "2nd MID LEVEL" airflow, and then the 3rd stage of electric heat can turn ON when the fan goes to HEATING MAX.

FAN MODE (Point 16) has two possible settings, CONST or VARI (constant or variable—the default = VARI). It is configurable during controller start-up and can also be overwritten by the customer during operation.

NOTES:

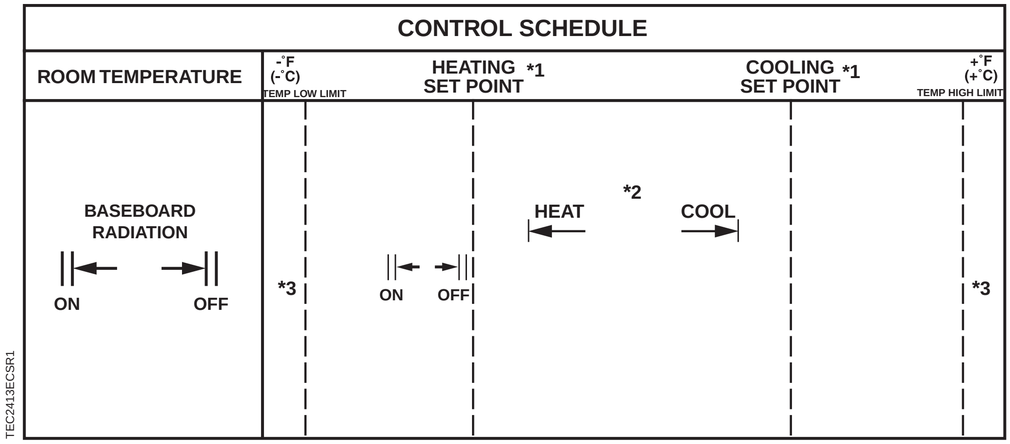
1. See the *Control Temperature Setpoints* section.
2. See the *Heating/Cooling Switchover* section.
3. If FAN MODE (Point 16) = CONST, FAN FLOW (Point 33) remains at the highest possible maximum flow (FAN FLO CMAX, Point 85) throughout the entire occupied mode.
4. To regulate fan speed, Application 2557 uses FAN FLOW (Point 33) and embedded Table Statements to modulate the voltage of FAN AOV1 (Point 66). The particular Table Statement used depends on the box size.

   The following describes the operation of the fan electric heat during the controller's other modes:

Shutdown Mode	The fan (see Note 5) and electric heating stages are OFF.
Unoccupied Mode	See Note 6 for fan operation. See Note 7 for operation of heating stages.
Electrical Demand Reduction (EDR) Mode	The fan is controlled as in the occupied heating mode. The heating stages are OFF.
Standby Mode	Both the fan and first heating stage are controlled as in the occupied heating mode. The second and third heat stages remain OFF.
Warm-up Mode	Both the fan and the heating stages are controlled as in the occupied heating mode.

5. FAN FLOW (Point 33) is set to 0 in shutdown mode, provided that all of the electric heating stages have been off for at least 30 seconds. If all of the electric heating stages have not been off for at least 30 seconds, then the fan's airflow remains where it was before the shutdown mode was entered. When FAN FLOW = 0, the fan is completely OFF.
6. During unoccupied mode, the fan stays OFF if the room temperature remains between TEMP LLIMIT (Point 65) and TEMP HLIMIT (Point 69), provided that all of the electric heating stages have been off for at least 30 seconds. If all of the electric heating stages have not been off for at least 30 seconds, then the fan's airflow remains where it was before the unoccupied mode was entered.

   If the room temperature drops below TEMP LLIMIT the fan will be controlled like it is during occupied heating for the remainder of the unoccupied mode. If the room temperature rises above TEMP HLIMIT—and VAV AHU is ON—the fan will be controlled like it is during occupied cooling for the remainder of the unoccupied mode. (See Note 4 in the Application Notes section for more information on VAV AHU.)
7. In the unoccupied mode, the electric heat stages remain OFF unless the room temperature drops below TEMP LLIMIT. If this occurs, the electric heat stages are controlled like they are during occupied heating for the remainder of the unoccupied mode.
8. Regardless of the operational mode, the application will shut off all stages of electric heat if FAN FLOW (Point 33) is 0, **even if the electric heat stages were overridden to ON.** In other words, the application will not allow any electric heating stages to be ON when there is no airflow coming out of the fan.



NOTES:

1. See the *Control Temperature Setpoints* section.
2. See the *Heating/Cooling Switchover* section.
3. The baseboard radiation remains OFF for the remainder of the unoccupied period if the room temperature drops below TEMP LLIMIT or rises above TEMP HLIMIT. (If the room temperature drops below TEMP LLIMIT, the regular heating stage(s) are then controlled in order to maintain room temperature.)
4. Baseboard radiation is allowed ON only during unoccupied mode (see *Baseboard Radiation* section for more information).

Figure 2557-7. Control Schedule for Baseboard Radiation During Unoccupied Mode.

Hardware Inputs

Analog

- Air velocity sensor
- Room temperature sensor
- Room temperature setpoint dial (optional)

Digital

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

Hardware Outputs

Analog

- Fan AOV

Digital

- Damper actuator
- Stage 1 electric heat
- Stage 2 electric heat (optional)
- Stage 3 electric heat (optional)
- Baseboard radiation (optional)

Ordering Notes

P/N 550-785A

Sequence of Operation

The following paragraphs present the sequence of operation for Application 2557, *VAV with 0-10V Series-Fan Speed Output and 3 Stage Electric Heat*.

NOTE: This document explains Application 2557 when it is controlling three stages of electric heat (STAGE COUNT, Point 88 = 3). When STAGE COUNT equals 2 or less, Application 2557 behaves exactly like Application 2413 (with the exception that the baseboard radiation is moved from DO5 to DO6). See document number TEC-0851a.08 for more information on how Application 2557 operates when STAGE COUNT is 2 or less.

Definition of MODE Point

In Application 2557, the DAY.NGT point is not used. A virtual AO point (MODE, Point 3) is used instead. Table 2557-2 shows the values that MODE can have, as well as the names of the modes that correspond to these different values.

Table 2557-2. Mode Point Explanation.

Value of MODE point	Corresponding Mode
0	Shutdown Mode
10	Unoccupied Mode
20	Electric Demand Reduction Mode (EDR)
30	Standby Mode
60	Occupied Mode

NOTE: For the rest of this document, the *names* of modes will be used instead of numeric values (for example, MODE = Standby instead of MODE = 30). This should make the application easier to understand.

Summary of Equipment Actions

Application 2557 controls several pieces of equipment throughout its different operational modes. For an overview of what each piece of equipment does in each mode, see Table 2557-3. (For brevity and clarity, Table 2557-3 provides only summaries of equipment actions. Full descriptions of detailed interactions between equipment pieces are provided in the related sections of the text.)

Occupied and Unoccupied Modes

The operational mode status of the space is determined by the status of MODE (Point 3). Control of this point differs depending on whether it is being controlled by a wall switch or by a field panel. If a wall switch is controlling this point, it should not also be controlled by a field panel.

When a wall switch is physically connected to the termination strip on the controller at DI 2 (Figures 2557-1 and 2557-8), and WALL SWITCH (Point 18) equals YES, the controller monitors the status of DI 2 (Point 24). When the status of DI 2 is ON (the switch is closed), MODE is set to occupied mode. When the status of DI 2 is OFF (the switch is open), MODE is set to unoccupied mode.

When WALL SWITCH equals NO, the controller does not monitor the status of the wall switch, even if one is connected to it. In this case, and if the controller is operating stand-alone, then the controller stays in occupied mode all the time. If the controller is operating with centralized control (that is, it is connected to a field panel), then the field panel can send an operator or PPCL command to override the status of MODE. See *Powers Process Control Language (PPCL) User's Manual* (125-1896) and *Field Panel User's Manual* (125-1895) for more information.

CAUTION:

Do not turn a Wall Switch On and Off numerous times in rapid succession. This can cause HEAT STAGE 1 (Point 43) to turn ON and Off numerous times in rapid succession, which will wear out the contactor of the first heating stage.

Table 2557-3. Summary of Equipment Action During Different Operational Modes.

Operational Modes	Fan **constant volume configuration**	Fan **variable volume configuration**	**Supply Damper**	**Electric Heat** **(See Note 8)**	**Baseboard Radiation**
Shutdown	OFF (See Note 9)	OFF (See Note 9)	Closed	OFF	OFF
Unoccupied (See Note 1) Room temp stays between TEMP LLIMIT (Point 65) and TEMP HLIMIT (Point 69)	OFF (See Note 9)	OFF (See Note 9)	Closed	OFF	See Note 4
Unoccupied Heating (See Note 2) Room temp has dropped below TEMP LLIMIT	Maximum flow at FAN FLO CMAX (**Point 85**)	Modulates from min to max flow based on heating demand	Closed	See Note 5	OFF
Unoccupied Cooling (See Note 3) Room temp has risen above TEMP HLIMIT	At max flow if VAV AHU (Point 61) is ON. (OFF if VAV AHU is OFF) (See Note 9)	See Note 6	See Note 7	OFF	OFF
Electrical Demand Reduction (EDR)	Maximum flow at FAN FLO CMAX	Modulates from min to max flow based on heating demand	Closed	OFF	OFF
Standby	Maximum flow at FAN FLO CMAX	Modulates from min to max flow based on heating demand	Closed	First stage is time modulated based on heating demand. Second and third stages remain OFF.	OFF
Warm-up Occurs, if needed, at start of occupied mode	Maximum flow at FAN FLO CMAX	Modulates from min to max flow based on heating demand	Closed	See Note 5	OFF

<table>
<tr><td>Occupied Heating</td><td rowspan="2">Maximum flow at FAN FLO CMAX</td><td>Modulates from min to max flow based on heating demand</td><td>Provides minimum airflow for ventilation</td><td>See Note 5</td><td rowspan="2">OFF</td></tr>
<tr><td>Occupied Cooling</td><td>Modulates from min to max flow based on cooling demand</td><td>Modulates from min to max flow based on cooling demand</td><td>OFF</td></tr>
</table>

NOTES:

1. Since the unoccupied mode is more complex than the other modes, three separate table rows are used to make it easier to understand. "Unoccupied," as described in this table, means that the room temperature **never** goes outside the range of TEMP LLIMIT to
TEMP HLIMIT. Notes 2 and 3 (for Unoccupied Heating and Cooling, respectively) summarize what happens if it does leave this range.
2. Once the room temperature drops below TEMP LLIMIT (Point 65), this sequence of operation remains in effect **for the remainder of the entire unoccupied period** so long as the room temperature never rises as high as TEMP HLIMIT (Point 69).
3. Once the room temperature rises above TEMP HLIMIT (Point 69), this sequence of operation remains in effect **for the remainder of the entire unoccupied period** so long as the room temperature never falls all the way down to TEMP LLIMIT (Point 65).
4. Baseboard radiation is OFF in the unoccupied mode if HEAT.COOL (Point 5) equals COOL. If HEAT.COOL equals HEAT, the baseboard radiation cycles to maintain the room temperature at CTL STPT (Point 92).
5. During all heating modes (warm-up, occupied heating, and unoccupied heating), the 1st Stage, 2nd Stage and 3rd Stage of electric heat are time modulated based on heating demand.
6. If VAV AHU (Point 61) is ON during unoccupied cooling, the fan—when configured for variable volume operation—modulates from minimum to maximum flow based on cooling demand. The fan is OFF during unoccupied cooling if VAV AHU is OFF, provided that all of the electric heating stages have been off for at least 30 seconds. If all of the heating stages have not been OFF for at least 30 seconds, then the fan's air volume (FAN FLOW (Point 33)) remains where it was before VAV AHU shut OFF.
7. If VAV AHU (Point 61) is ON during unoccupied cooling, the supply damper modulates from minimum to maximum flow based on cooling demand. The supply damper is closed during unoccupied cooling if VAV AHU is OFF.
8. Regardless of the operational mode, the application will shut off all stages of electric heat if FAN FLOW (Point 33) is 0, even if the electric heat stages were overridden to ON. In other words, the application will not allow any electric heating stages to be ON when there is no airflow coming out of the fan.
9. The fan will be OFF only after all of the electric heating stages have been OFF for at least 30 seconds. If all of the electric heating stages have not been OFF for at least 30 seconds, then the fan's airflow remains where it was before this condition was entered.

Unoccupied 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), then by pressing the override switch, a room occupant can reset the controller to occupied mode for the length of time set in OVRD TIME. The status of UNOCC OVRD (Point 21) changes to OCC and remains there until OVRD TIME elapses, at which point UNOCC OVRD changes back to UNOCC and the controller returns to unoccupied mode.

NOTE: Only during unoccupied mode (MODE = Unoccupied) can a room sensor's override switch set the controller to occupied mode; if MODE equals anything other than Unoccupied, UNOCC OVRD will equal UNOCC.

Control Temperature Setpoints

Depending on certain conditions, CTL STPT (Point 92) holds the value of one of the occupied or unoccupied cooling/heating setpoints, or it holds the value of the room setpoint dial. See the following:

Occupied CLG/HTG Setpoints – When STPT DIAL equals NO (default), CTL STPT holds the value of OCC CLG STPT (Point 6) or OCC HTG STPT (Point 7) if:

- MODE (Point 3) equals Occupied, EDR, or Standby.
- MODE equals Unoccupied but UNOCC OVRD (Point 21) equals OCC.

Unoccupied CLG/HTG Setpoints – CTL STPT holds the value of UOC CLG STPT (Point 8) or UOC HTG STPT (Point 9) if:

- MODE equals Shutdown or Unoccupied, and UNOCC OVRD equals UNOCC.

Room Setpoint Dial – When STPT DIAL is set to YES, CTL STPT holds the value of RM STPT DIAL (Point 13) if:

- MODE equals Occupied, EDR, or Standby.
- MODE equals Unoccupied but UNOCC OVRD equals OCC.

NOTE: RM STPT DIAL must stay between the values of RM STPT MIN (Point 11) and RM STPT MAX (Point 12) or CTL STPT will use those values instead.

Room Temperature Offset

NOTE: The Room Temperature Offset feature is optional.

RMTMP OFFSET (Point 102) 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 102)

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.

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

- HTG LOOPOUT (Point 80) is less than 5%.
- CTL TEMP (Point 78) is above CTL STPT (Point 92) by at least the value set in SWITCH DBAND (Point 90).
- CTL TEMP is greater than the appropriate cooling setpoint minus SWITCH DBAND.

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

- CLG LOOPOUT (Point 79) is less than 5%.
- CTL TEMP is below CTL STPT by at least the value set SWITCH DBAND.
- CTL TEMP is less than the appropriate heating setpoint plus SWITCH DBAND.

CAUTION:

This heating/cooling switchover mechanism is not affected by the air temperature in the supply duct. To change the value of HEAT.COOL based on the supply air temperature, you must command it through PPCL. (This is required if the flow loop is used as a source of cooling in cooling mode and as a source of heating in heating mode.)

If the flow loop is used during heating mode just to meet minimum air requirements, then the heating/cooling switchover mechanism operates as previously described in this section.

Control Loops

The terminal box is controlled by three Proportional, Integral, and Derivative (PID) control loops (two temperature loops and a flow loop).

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* for more information.

The cooling loop generates CLG LOOPOUT (Point 79) which is used to calculate FLOW STPT (Point 93) during the cooling mode. FLOW STPT is the result of scaling the cooling loopout to the appropriate range of values as determined by CLG FLOW MAX (Point 32) and CTL FLOW MIN (Point 76), and as shown in the following equation:

$$\frac{[\text{CLG LOOPOUT} \times (\text{CLG FLOW MAX} - \text{CTL FLOW MIN})] + \text{CTL FLOW MIN}}{\text{CLG FLOW MAX}} \times 100\% = \text{FLOW STPT}$$

Example

If <u>CTL FLOW MIN</u> = 200 cfm and CLG FLOW MAX = 1000 cfm, then,

when CLG LOOPOUT is 0%, FLOW STPT equals 20% flow.

$$\frac{[0\% \times (1000 - 200)] + 200}{1000} \times 100\% = 20\%$$

(This ensures that the airflow out of the terminal box is not less than <u>CTL FLOW MIN</u>.)

When CLG LOOPOUT is 50%, FLOW STPT equals 60% flow.

$$\frac{[50\% \times (1000 - 200)] + 200}{1000} \times 100\% = 60\%$$

When CLG LOOPOUT is 100%, FLOW STPT equals 100% flow.

$$\frac{[100\% \times (1000 - 200)] + 200}{1000} \times 100\% = 100\%$$

In addition to being used to set FLOW STPT, CLG LOOPOUT is also used to control FAN FLOW (Point 33) during the cooling mode (FAN FLOW is then used to control FAN AOV1). See the *Fan Operation* section for more information about FAN FLOW and FAN AOV1 control.

The Cooling Loop is operational under either of the following situations:

- The application is in the occupied mode, WARMUP (Point 60) is OFF, and HEAT.COOL (Point 5) equals COOL.
- The application is in the unoccupied mode, and
  - CTL TEMP is above TEMP HLIMIT.
  - HEAT.COOL equals COOL.
  - VAV AHU (Point 61) is ON. (See Note 4 of *Application Notes* for more information on VAV AHU.)

    (Once these conditions are met, the cooling loop will remain enabled for the rest of the entire unoccupied period as long as HEAT.COOL and VAV AHU do not change status and CTL TEMP does not fall to TEMP LLIMIT.)

If the controller is in heating mode, the flow loop maintains airflow out of the terminal box equal to CTL FLOW MIN (Point 76), and HTG LOOPOUT (Point 80) controls the electric heat and FAN FLOW (Point 33) in order to maintain the room temperature. (FAN FLOW is used to control FAN AOV1; see the *Fan Operation* section for more information about FAN FLOW and FAN AOV1.)

The heating loop is operational under any of the following conditions:

- The application is in the occupied mode and WARMUP (Point 60) is ON.
- The application is in the occupied mode, WARMUP is OFF, and HEAT.COOL (Point 5) equals HEAT.
- The application is in the EDR (electric demand reduction) mode or in standby mode.
- The application is in the unoccupied mode, CTL TEMP is below TEMP LLIMT, and HEAT.COOL equals HEAT. (Once these conditions are met, the heating loop remains enabled for the rest of the entire unoccupied period as long as HEAT.COOL does not change status and CTL TEMP never reaches TEMP HLIMIT.)

Flow Loop – The flow loop maintains minimum and maximum airflow through CTL FLOW MIN (Point 76) and CTL FLOW MAX (Point 77), respectively. CTL FLOW MAX holds different heating and cooling flow maximums. When HEAT.COOL equals HEAT, CTL FLOW MAX equals HTG FLOW MAX. When HEAT.COOL equals COOL, CTL FLOW MAX equals CLG FLOW MAX.

Separate flow minimums for heating and cooling modes are not used—CTL FLOW MIN is used for both. CTL FLOW MIN can be set equal to, but not greater than CTL FLOW MAX. If the minimum and maximum values are set equal, the flow loop becomes a constant volume loop and loses its ability to control temperature.

The flow loop maintains FLOW STPT by modulating the supply air damper point, DMPR COMD (Point 48) to keep airflow between CTL FLOW MIN and CTL FLOW MAX.

FLOW (Point 75) is the input value for the flow loop. It is a percentage derived from the value of AIR VOLUME (Point 35)—that is, a value in the range of 0 cfm to CTL FLOW MAX. In the following text, this percentage is referred to as *% flow*.

- If AIR VOLUME equals 0 cfm, FLOW is 0% flow.
- If AIR VOLUME equals CTL FLOW MAX, FLOW is 100% flow.

The low limit of FLOW STPT is the percentage that corresponds to the volume given in CTL FLOW MIN. This percentage can be calculated as: (CTL FLOW MIN ÷ CTL FLOW MAX) × 100% flow. The flow loop ensures that the supply air volume will not be less than CTL FLOW MIN.

Example

If CTL FLOW MIN equals 250 cfm, and if CTL FLOW MAX equals 1000 cfm,

then,

the low limit of FLOW STPT = (250 cfm ÷ 1000 cfm) × 100% flow
= 0.25 × 100% flow
= 25% flow

Since 25% of 1000 cfm equals 250 cfm, the minimum airflow out of the terminal box is 250 cfm.

The flow loop is operational under either of the following situations:

- The application is in the occupied mode and WARMUP (Point 60) is OFF.
- The application is in the unoccupied mode, **and**
  - CTL TEMP is above TEMP HLIMIT.
  - HEAT.COOL equals COOL.
  - VAV AHU (Point 61) is ON. (See Note 4 in the *Application Notes* section for more information on VAV AHU.)

Once these conditions are met, the flow loop will remain active for the rest of the entire unoccupied period as long as HEAT.COOL and VAV AHU do not change status and CTL TEMP does not fall to TEMP LLIMIT.

Electric Heat

CAUTION:

To ensure airflow across the heating coils when they are energized, verify that others supply the equipment with safeties.

If FAN FLOW (Point 33) equals 0 and/or FAN AOV1 (Point 66) equals 0, then this application will shut off all of the electric heating stages **even if they have been overridden to ON**. In other words, the application will not allow any electric heating stages to be ON when there is no airflow coming out of the fan. The rest of this section describes the operation of the electric heating stages when both FAN FLOW and FAN AOV1 are greater than 0.

Electric heat is operational when any of the following conditions occur:

- The application is in the occupied mode and WARMUP (Point 60) is ON.
- The application is in the occupied mode, WARMUP is OFF, and HEAT.COOL (Point 5) equals HEAT.
- The application is in the standby mode. (Note: When in standby, HEAT STAGE 2 and HEAT STAGE 3 are not available.)
- The application is in the unoccupied mode, CTL TEMP is below TEMP LLIMT, and HEAT.COOL equals HEAT. (Note: Once CTL TEMP is less than TEMP LLIMIT, the electric heat remains under the control of HTG LOOPOUT for the remainder of the entire unoccupied period as long as HEAT.COOL does not change and CTL TEMP never reaches TEMP HLIMIT.)

When FAN MODE (Point 16) equals VARI, the electric heat control depends on the amount of airflow coming from the series fan, as follows:

- The third stage of electric heat will not be allowed to turn ON until FAN FLOW (Point 33) is equal to or greater than 98% of FAN FLO HMAX (Point 84).
- The second stage of electric heat will not be allowed to turn ON until FAN FLOW (Point 33) is equal to or greater than 98% of FAN FLO HMAX under the following circumstances:
  - Both FAN FLOW MID (Point 83) and FAN FLO MORE (Point 55) are greater than FAN FLO HMAX.
  - FAN FLOW MID is less than FAN FLO HMAX and FAN FLO HMAX is less than FAN FLO MORE.
- The second stage of electric heat will not be allowed to turn ON until FAN FLOW (Point 33) is equal to or greater than 98% of FAN FLO MORE under the following circumstances:
  - FAN FLOW MORE is less than FAN FLOW MID and FAN FLOW MID is less than FAN FLO HMAX.
  - FAN FLO MORE is less than FAN FLO HMAX and FAN FLO HMAX is less than FAN FLOW MID.
  - FAN FLOW MID is less than FAN FLO MORE and FAN FLO MORE is less than FAN FLO HMAX.
- The 1st stage of electric heat will not be allowed to turn ON until FAN FLOW (Point 33) is equal to or greater than 98% of FAN FLO HMAX whenever both FAN FLOW MID (Point 83) and FAN FLO MORE (Point 55) are greater than FAN FLO HMAX.
- The 1st stage of electric heat will not be allowed to turn ON until FAN FLOW (Point 33) is equal to or greater than 98% of FAN FLO MORE under the following circumstances:
  - FAN FLOW MORE is less than FAN FLOW MID and FAN FLOW MID is less than FAN FLO HMAX.
  - FAN FLO MORE is less than FAN FLO HMAX and FAN FLO HMAX is less than FAN FLOW MID.

- The 1st stage of electric heat will not be allowed to turn ON until FAN FLOW (Point 33) is equal to or greater than 98% of FAN FLOW MID under the following circumstances:
  - FAN FLOW MID is less than FAN FLO HMAX and FAN FLO HMAX is less than FAN FLO MORE.
  - FAN FLOW MID is less than FAN FLO MORE and FAN FLO MORE is less than FAN FLO HMAX.

When FAN MODE equals CONST, airflow from the series fan will equal FAN FLO CMAX (Point 85) whenever the fan is running. Since this is considered more than enough airflow for safe operation of the heating coil(s), the electric heat stage(s) can operate whenever needed without the application having to calculate and verify a minimum airflow.

NOTE: If FAN MODE equals CONST, the electric heat will work best if FLOW END (Point 17) equals 0, and both FAN FLOW MID and FAN FLO MORE are set greater than FAN FLO HMAX.

Regardless of the heating demand and the amount of airflow from the VAV series fan, the following timing conditions hold:

- HEAT STAGE 2 (Point 44) will not be allowed to turn ON until HEAT STAGE 1 (Point 43) has been ON longer than STG 1 TIME (Point 27).
- HEAT STAGE 3 (Point 45) will not be allowed to turn ON until HEAT STAGE 2 has been ON longer than STG 2 TIME (Point 28).
- HEAT STAGE 2 will not be allowed to turn OFF until HEAT STAGE 3 has been OFF longer than STG 3 TIME (Point 57).
- HEAT STAGE 1 will not be allowed to turn OFF until HEAT STAGE 2 has been OFF longer than STG 2 TIME.

HTG LOOPOUT does not control the heating stages directly. Instead, it is used to fill out an embedded Table Statement that generates an internal control signal (this was done to properly sequence the electric heat with the VAV series fan). The control signal is then used to time modulate the electric heating stages through a duty cycle, as shown in the following example.

Example: If the duty cycle is 10 minutes, STAGE TIME (Point 89) equals 10 minutes, and the internal control signal is calling for 60% of heating, then for every 10-minute period, the stages of electric heat cycle as follows:

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

The following paragraphs explain how control of the electric heat differs depending on the values of FAN FLOW MID (Point 83), FAN FLO MORE (Point 55) and FAN FLO HMAX (Point 84). (Regardless of these differences, Application 2557's heating stages are always controlled by an internal control signal which is generated by an embedded Table Statement that is driven by HTG LOOPOUT.)

FAN FLOW MID ≥ FAN FLO HMAX and FAN FLO MORE ≥ FAN FLO HMAX

When FAN FLOW MID ≥ FAN FLO HMAX and FAN FLO MORE ≥ FAN FLO HMAX, the relationship between HTG LOOPOOUT and the internal control signal is as follows:

- When HTG LOOPOUT is less than FLOW END (Point 17), the control signal is set to 0.
- When HTG LOOPOUT equals 100, the control signal equals 100.
- When HTG LOOPOUT is between FLOW END and 100, linear interpolation is used to scale the control signal to a value between 0 and 100.

NOTE: As HTG LOOPOUT goes from 0 to FLOW END, FAN FLOW (Point 33) goes from FAN FLOW MIN (Point 82) to FAN FLO HMAX (Point 84).

FAN FLOW MID < FAN FLO HMAX and FAN FLO MORE ≥ FAN FLO HMAX

When FAN FLOW MID < FAN FLO HMAX and FAN FLO MORE ≥ FAN FLO HMAX, the relationship between HTG LOOPOOUT and the internal control signal is as follows:

- When HTG LOOPOUT is less than FLOW 1 END (Point 23), the control signal is set to 0.
- As HTG LOOPOUT goes from FLOW 1 END to FLOW 2 START (Point 22), the control signal goes from 0 to 33.
- As HTG LOOPOUT goes from FLOW 2 START to FLOW 2 END (Point 52), the control signal remains at 33.
- When HTG LOOPOUT is between FLOW 2 END and 100, the control signal goes from 33 to 100.

NOTE: As HTG LOOPOUT goes from 0 to FLOW 1 END, FAN FLOW goes from FAN FLOW MIN to FAN FLOW MID (Point 83). As HTG LOOPOUT goes from FLOW 2 START to FLOW 2 END, FAN FLOW goes from FAN FLOW MID to FAN FLO HMAX.

FAN FLO MORE ≤ FAN FLOW MID < FAN FLO HMAX or
FAN FLO MORE ≤ FAN FLO HMAX < FAN FLOW MID

When FAN FLO MORE ≤ FAN FLOW MID < FAN FLO HMAX or FAN FLO MORE ≤ FAN FLOW HMAX < FAN FLO MID, the relationship between HTG LOOPOOUT and the internal control signal is as follows:

- When HTG LOOPOUT is less than FLOW 1 END (Point 23), the control signal is set to 0.
- As HTG LOOPOUT goes from FLOW 1 END to FLOW 3 START (Point 53), the control signal goes from 0 to 66.
- As HTG LOOPOUT goes from FLOW 3 START to FLOW END (Point 17), the control signal remains at 66.
- When HTG LOOPOUT is between FLOW END and 100, the control signal goes from 66 to 100.

As HTG LOOPOUT goes from 0 to FLOW 1 END, FAN FLOW goes from FAN FLOW MIN to FAN FLO MORE (Point 55). As HTG LOOPOUT goes from FLOW 3 START to FLOW END, FAN FLOW goes from FAN FLO MOR to FAN FLO HMAX.

FAN FLOW MID < FAN FLO MORE < FAN FLO HMAX

When FAN FLOW MID < FAN FLO MORE < FAN FLO HMAX, the relationship between HTG LOOPOOUT and the internal control signal is as follows:

- When HTG LOOPOUT is less than FLOW 1 END (Point 23), the control signal is set to 0.
- As HTG LOOPOUT goes from FLOW 1 END to FLOW 2 START (Point 22), the control signal goes from 0 to 33.
- As HTG LOOPOUT goes from FLOW 2 START to FLOW 2 END (Point 52), the control signal remains at 33.
- As HTG LOOPOUT goes from FLOW 2 END to FLOW 3 START (Point 53), the control signal goes from 33 to 66.
- As HTG LOOPOUT goes from FLOW 3 START to FLOW END (Point 17), the control signal remains at 66.
- When HTG LOOPOUT is between FLOW END and 100, the control signal goes from 66 to 100.

As HTG LOOPOUT goes from 0 to FLOW 1 END, FAN FLOW goes from FAN FLOW MIN to FAN FLOW MID (Point 83). As HTG LOOPOUT goes from FLOW 2 START to FLOW 2 END, FAN FLOW goes from FAN FLOW MID to FAN FLO MORE. As HTG LOOPOUT goes from FLOW 3 START to FLOW END, FAN FLOW goes from FAN FLO MOR to FAN FLO HMAX.

The following paragraphs describe the relationship between the Table Statement's internal control signal and the electric heating stage(s) when STAGE COUNT (Point 88) equals 3.

When the internal control signal is less than 3.33, HEAT STAGE 1 is OFF throughout the entire duty cycle. When the internal control signal is greater than 30, HEAT STAGE 1 is ON throughout the entire duty cycle. When the internal control signal is between 3.33 and 30, HEAT STAGE 1 is time modulated.

When the internal control signal is less than 36.66, HEAT STAGE 2 (Point 44) is OFF throughout the entire duty cycle. When the internal control signal is greater than 63.333, HEAT STAGE 2 is ON throughout the entire duty cycle. When the internal control signal is between 36.66 and 63.33, HEAT STAGE 2 is time modulated.

When the internal control signal is less than 70, HEAT STAGE 3 (Point 45) is OFF throughout the entire duty cycle. When the internal control signal is greater than 96.66, HEAT STAGE 3 is ON throughout the entire duty cycle. When the internal control signal is between 70 and 96.66, HEAT STAGE 3 is time modulated.

Fan Operation

CAUTION:

On series fan powered terminal boxes, the terminal box fan must be controlled/interlocked to start either before or at the same time as the central air handler. Failure to do so may cause the terminal box fan to rotate backwards and cause consequent damage at start up.

In Application 2557, the two points most directly related to the fan's operation are FAN FLOW (Point 33) and FAN AOV1 (Point 66). FAN AOV1 is the analog output that controls the fan's airflow, and FAN FLOW is the desired airflow for the fan. The rest of this section describes how these points are determined and their operation.

FAN FLOW (Point 33)

For the fan to be OFF, FAN FLOW must = 0 and all of the stages of electric heat must be OFF for at least 30 seconds. Even after all of the electric heating stages have been OFF for at least 30 seconds, FAN FLOW is assured of equaling 0 only in the following four specific circumstances. :

1. The application is in the shutdown mode.

2. The application is in the unoccupied mode, CTL TEMP (Point 78) is below TEMP LLIMIT (Point 65), and HEAT.COOL equals COOL. (FAN FLOW will remain at 0 (and the fan will be OFF) for the rest of the entire unoccupied period as long as HEAT.COOL does not change and CTL TEMP never reaches TEMP HLIMIT (Point 69).

3. The application is in the unoccupied mode, **and**

   – CTL TEMP is above TEMP HLIMIT.

   – VAV AHU (Point 61) is OFF **and/or** HEAT.COOL equals HEAT. (See Note 4 in the *Application Notes* section for more information on VAV AHU.)

   (Once these conditions are met, FAN FLOW will remain at 0 (and the fan will be OFF) for the rest of the unoccupied mode as long as HEAT.COOL and/or VAV AHU do not change in status and CTL TEMP does not fall to TEMP LLIMIT.)

4. The application is in the unoccupied mode and CTL TEMP has remained between TEMP LLIMIT and TEMP HLIMIT throughout the entire unoccupied mode.

In the above four cases, if all of the electric heating stages have not been OFF for at least 30 seconds, then FAN FLOW will remain where it was before that case was entered. For instance, if the application goes into the shutdown mode and all of the electric heating stages have not been OFF for at least 30 seconds, then FAN FLOW will remain where it was before the shutdown mode was entered.

In any condition other than the four above, FAN FLOW will not equal 0 and the series fan will be running. In this case, the value of FAN MODE (Point 16) makes a big difference in the fan's operation. FAN MODE can equal VARI or CONST (variable or constant). If FAN MODE = CONST, FAN FLOW runs steadily at the rate indicated by FAN FLO CMAX (Point 85). If FAN MODE = VARI, FAN FLOW is controlled by either the cooling loop or the heating loop as described in the following paragraphs

FAN FLOW Controlled by CLG LOOPUT (Point 79) – When FAN MODE = VARI, CLG LOOPUT controls FAN FLOW under either of the following conditions:

1. The application is in the occupied mode, WARMUP equals OFF, and HEAT.COOL is set to COOL.

5. The application is in the unoccupied mode, **and**
   - CTL TEMP is above TEMP HLIMT.
   - HEAT.COOL equals COOL.
   - VAV AHU is ON. (See Note 4 in the Application Notes section for more information on VAV AHU, Point 61.)

     (Once these conditions are met, FAN FLOW will remain under the control of CLG LOOPOUT for the rest of the entire unoccupied period as long as HEAT.COOL and VAV AHU do not change status and CTL TEMP does not fall to TEMP LLIMIT.)

CLG LOOPOUT controls FAN FLOW via an embedded Table Statement as follows:

- When CLG LOOPOUT is zero, FAN FLOW is set to FAN FLOW MIN (Point 82).
- When CLG LOOPOUT is 100, FAN FLOW is set to FAN FLO CMAX.
- When CLG LOOPOUT is between 0 and 100, linear interpolation is used to scale FAN FLOW to a value between FAN FLOW MIN and FAN FLO CMAX.

FAN FLOW Controlled by HTG LOOPUT (Point 80) – When FAN MODE = VARI, HTG LOOPUT controls FAN FLOW under any of the following conditions:

- The application is in occupied mode and WARMUP (Point 60) is ON.
- The application is in occupied mode, WARMUP is OFF, and HEAT.COOL equals HEAT.
- The application is in the unoccupied mode, CTL TEMP is below TEMP LLIMT, and HEAT.COOL equals HEAT. (Once these conditions are met, FAN FLOW will remain under the control of HTG LOOPOUT for the rest of the entire unoccupied period as long as HEAT.COOL does not change and CTL TEMP never reaches TEMP HLIMIT.)
- The application is in the EDR (electric demand reduction) mode or in standby mode.

Because the operation of the series fan must be coordinated with the electric heating stage(s), controlling FAN FLOW with HTG LOOPOUT is more complicated than controlling it with CLG LOOPOUT. Whereas CLG LOOPOUT uses only one embedded Table Statement to adjust the value of FAN FLOW, HTG LOOPOUT will use one of several embedded Table Statements to control FAN FLOW depending on the circumstances. (Keep in mind that in all of the following circumstances the application is also controlling three stages of electric heat; that is STAGE COUNT (Point 88) equals 3.) Refer to the following:

FAN FLOW Control when both FAN FLOW MID and FAN FLO MORE are greater than or equal to FAM FLO HMAX – When both FAN FLOW MID (Point 83) and FAN FLO MORE (Point 55) are greater than or equal to FAN FLO HMAX (Point 84) and HEAT STAGE 1 (Point 43) is ON, FAN FLOW will be set to FAN FLO HMAX (Point 84). Once this occurs, FAN FLOW is not allowed to change in value until HEAT STAGE 1 turns OFF *and remains OFF* for longer than the amount of time set in STAGE TIME (Point 89).

Whenever HEAT STAGE 1 remains OFF for longer than STAGE TIME, a “speed limit”—in addition to the Table Statement’s control signal—is used to control FAN FLOW. However, for the speed limit to be used, HTG LOOPOUT must be changing rapidly. If HTG LOOPOUT is constant or changing slowly, the Table Statement works as follows:

- When HTG LOOPOUT is 0, FAN FLOW is set equal to FAN FLOW MIN.
- When HTG LOOPOUT is equal to or greater than FLOW END (Point 17), FAN FLOW is set equal to FAN FLO HMAX. (Note: When HTG LOOPOUT is greater than FLOW END, the electric heat will time modulate.)
- When HTG LOOPOUT is between 0 and FLOW END, linear interpolation is used to scale FAN FLOW to a value between FAN FLOW MIN (Point 82) and FAN FLO HMAX.

When HTG LOOPOUT changes rapidly, the speed limit works as follows:

Regardless of how rapidly HTG LOOPOUT changes, FAN FLOW is not allowed to change faster than (LOOP TIME (Point 98) ÷ FAN TIME (Point 71)) × FLOW END (Point 17). Even if HTG LOOPOUT changes suddenly from 0 to 100, the amount of time stored in FAN TIME must still elapse before FAN FLOW may change from FAN FLOW MIN to FAN FLO HMAX. (If FAN TIME is less than LOOP TIME, the speed limit is disabled and FAN FLOW can change as fast as HTG LOOPOUT changes.)

FAN FLOW Control when FAN FLOW MID ≤ FAN FLO HMAX < FAN FLO MORE
If FAN FLOW MID is less than or equal to FAN FLO HMAX and FAN FLO HMAX is less than FAN FLO MORE, FAN FLOW will be set to FAN FLO HMAX when HEAT STAGE 2 is ON or has been OFF for less than STAGE TIME. When HEAT STAGE 2 has been OFF for longer than STAGE TIME, but HEAT STAGE 1 has **not** been OFF for longer than STAGE TIME, FAN FLOW is controlled by a Table Statement and a speed limit.

Whenever HEAT STAGE 2 has been OFF for longer than STAGE TIME, but HEAT STAGE 1 has not, a “speed limit”—in addition to the Table Statement’s control signal—is used to control FAN FLOW. However, for the speed limit to be used, HTG LOOPOUT must be changing rapidly. If HTG LOOPOUT is constant or changing slowly, the Table Statement works as follows:

- When HTG LOOPOUT is equal to or less than FLOW 2 START (Point 22), FAN FLOW is set equal to FAN FLOW MID.
- When HTG LOOPOUT is equal to or greater than FLOW2 END (Point 52), FAN FLOW is set equal to FAN FLO HMAX.
- When HTG LOOPOUT is between FLOW 2 START and FLOW2 END, linear interpolation is used to scale FAN FLOW to a value between FAN FLOW MID and FAN FLO HMAX.

When HTG LOOPOUT changes rapidly, the speed limit works as follows:

Regardless of how rapidly HTG LOOPOUT changes, FAN FLOW is not allowed to change faster than (LOOP TIME ÷ FAN TIME) × (FLOW2 END – FLOW 2 START). Even if HTG LOOPOUT changes suddenly from FLOW 2 START to FLOW2 END, the amount of time stored in FAN TIME must still elapse before FAN FLOW may change from FAN FLOW MID to FAN FLO HMAX. (If FAN TIME is less than LOOP TIME, the speed limit is disabled and FAN FLOW can change as fast as HTG LOOPOUT changes.)

When **all three** heating stages have been OFF for longer than STAGE TIME, FAN FLOW is controlled by **two** speed limits and the Table Statement's control signal. However, for the speed limits to be used, HTG LOOPOUT must be changing rapidly. If HTG LOOPOUT is constant or changing slowly, the Table Statement works as follows

- When HTG LOOPOUT equals 0, FAN FLOW is set equal to FAN FLOW MIN (Point 82).
- When HTG LOOPOUT is between 0 and FLOW 1 END (Point 23), linear interpolation is used to scale FAN FLOW to a value between FAN FLOW MIN and FAN FLOW MID.
- When HTG LOOPOUT equals FLOW 1 END, FAN FLOW is set equal to FAN FLOW MID. (If HTG LOOPOUT rises above FLOW 1 END, but stays below FLOW 2 START, FAN FLOW remains equal to FAN FLOW MID while HEAT STAGE 1 time modulates.)
- When HTG LOOPOUT is between FLOW 2 START and FLOW2 END, linear interpolation is used to scale FAN FLOW to a value between FAN FLOW MID and FAN FLO HMAX.
- When HTG LOOPOUT is equal to or greater than FLOW2 END, FAN FLOW is set equal to FAN FLO HMAX. (Note: When HTG LOOPOUT is greater than FLOW2 END, HEAT STAGE 2 and HEAT STAGE 3 will time modulate.)

When HTG LOOPOUT changes rapidly, the speed limits work as follows:

If HTG LOOPOUT is less than or equal to FLOW 2 START, FAN FLOW will not be allowed to change faster than (LOOP TIME ÷ FAN TIME) × FLOW 1 END, no matter how quickly HTG LOOPOUT changes. Therefore, even if HTG LOOPOUT changes suddenly from 0 to FLOW 2 START, the amount of time stored in FAN TIME must still elapse before FAN FLOW may change from FAN FLOW MIN to FAN FLOW MID.

If HTG LOOPOUT is greater than FLOW 2 START, FAN FLOW cannot change faster than (LOOP TIME ÷ FAN TIME) × (FLOW2 END – FLOW 2 START). Therefore, even if HTG LOOPOUT changes suddenly from FLOW 2 START to FLOW2 END, the amount of time stored in FAN TIME must still elapse before FAN FLOW may change from FAN FLOW MID to FAN FLO HMAX.

Since FLOW 1 END and the value of FLOW2 END – FLOW 2 START are likely to be different, two different speed limits will be used even though the value of FAN TIME remains the same. The speed limit being used at any given time will depend on the value of HTG LOOPOUT (as explained in the previous paragraph). If FAN TIME is less than LOOP TIME, the speed limits are disabled and FAN FLOW can change as quickly as HTG LOOPOUT changes.

FAN FLOW Control when FAN FLO MORE < FAN FLOW MID < FAN FLO HMAX or FAN FLO MORE < FAN FLO HMAX < FAN FLOW MID

If FAN FLO MORE is less than FAN FLO HMAX and FAN FLO HMAX is less than FAN FLOW MID or if FAN FLO MORE is less than FAN FLOW MID and FAN FLOW MID is less than FAN FLO HMAX, FAN FLOW will be set to FAN FLO HMAX when HEAT STAGE 3 is ON or has been OFF for less than STAGE TIME. When HEAT STAGE 3 has been OFF for longer than STAGE TIME, but HEAT STAGE 2 has **not** been OFF for longer than STAGE TIME, FAN FLOW is controlled by a Table Statement and a speed limit.

Whenever HEAT STAGE 3 has been OFF for longer than STAGE TIME, but HEAT STAGE 2 has not, a "speed limit"—in addition to the Table Statement's control signal —is used to control FAN FLOW. However, for the speed limit to be used, HTG LOOPOUT must be changing rapidly. If HTG LOOPOUT is constant or changing slowly, the Table Statement works as follows:

- When HTG LOOPOUT is equal to or less than FLOW 3 START (Point 53), FAN FLOW is set equal to FAN FLO MORE.
- When HTG LOOPOUT is equal to or greater than FLOW END (Point 17), FAN FLOW is set equal to FAN FLO HMAX.
- When HTG LOOPOUT is between FLOW 3 START and FLOW END, linear interpolation is used to scale FAN FLOW to a value between FAN FLO MORE and FAN FLO HMAX.

When HTG LOOPOUT changes rapidly, the speed limit works as follows:

Regardless of how rapidly HTG LOOPOUT changes, FAN FLOW is not allowed to change faster than (LOOP TIME ÷ FAN TIME) × (FLOW END – FLOW 3 START). Even if HTG LOOPOUT changes suddenly from FLOW 3 START to FLOW END, the amount of time stored in FAN TIME must still elapse before FAN FLOW may change from FAN FLO MORE to FAN FLO HMAX. (If FAN TIME is less than LOOP TIME, the speed limit is disabled and FAN FLOW can change as fast as HTG LOOPOUT changes.)

When **all three** heating stages have been OFF for longer than STAGE TIME, FAN FLOW is controlled by **two** speed limits and the Table Statement's control signal. However, for the speed limits to be used, HTG LOOPOUT must be changing rapidly. If HTG LOOPOUT is constant or changing slowly, the Table Statement works as follows

- When HTG LOOPOUT equals 0, FAN FLOW is set equal to FAN FLOW MIN (Point 82).
- When HTG LOOPOUT is between 0 and FLOW 1 END (Point 23), linear interpolation is used to scale FAN FLOW to a value between FAN FLOW MIN and FAN FLO MORE.
- When HTG LOOPOUT equals FLOW 1 END, FAN FLOW is set equal to FAN FLO MORE. (If HTG LOOPOUT rises above FLOW 1 END, but stays below FLOW 3 START, FAN FLOW remains equal to FAN FLO MORE, while HEAT STAGE 1 and HEAT STAGE 2 time modulate.)
- When HTG LOOPOUT is between FLOW 3 START and FLOW END, linear interpolation is used to scale FAN FLOW to a value between FAN FLO MORE and FAN FLO HMAX.
- When HTG LOOPOUT is equal to or greater than FLOW END, FAN FLOW is set equal to FAN FLO HMAX. (Note: When HTG LOOPOUT is greater than FLOW END, HEAT STAGE 3 will time modulate.)

When HTG LOOPOUT changes rapidly, the speed limits work as follows:

If HTG LOOPOUT is less than or equal to FLOW 3 START, FAN FLOW will not be allowed to change faster than (LOOP TIME ÷ FAN TIME) × FLOW 1 END, no matter how quickly HTG LOOPOUT changes. Therefore, even if HTG LOOPOUT changes suddenly from 0 to FLOW 3 START, the amount of time stored in FAN TIME must still elapse before FAN FLOW may change from FAN FLOW MIN to FAN FLO MORE. If HTG LOOPOUT is greater than FLOW 3 START, FAN FLOW cannot change faster than (LOOP TIME ÷ FAN TIME) × (FLOW END – FLOW 3 START). Therefore, even if HTG LOOPOUT changes suddenly from FLOW 3 START to FLOW END, the amount of time stored in FAN TIME must still elapse before FAN FLOW may change from FAN FLO MORE to FAN FLO HMAX.

Since FLOW 1 END and the value of FLOW END – FLOW 3 START are likely to be different, two different speed limits will be used even though the value of FAN TIME remains the same. The speed limit being used at any given time will depend on the value of HTG LOOPOUT (as explained in the previous paragraph). If FAN TIME is less than LOOP TIME, the speed limits are disabled and FAN FLOW can change as quickly as HTG LOOPOUT changes.

FAN FLOW Control when FAN FLOW MID < FAN FLO MORE < FAN FLO HMAX
If FAN FLOW MID is less than FAN FLO MORE and FAN FLO MORE is less than FAN FLO HMAX, FAN FLOW will be set to FAN FLO HMAX when HEAT STAGE 3 is ON or has been OFF for less than STAGE TIME. When HEAT STAGE 3 has been OFF for longer than STAGE TIME, but HEAT STAGE 2 has **not** been OFF for longer than STAGE TIME, FAN FLOW is controlled by a Table Statement and a speed limit.

Whenever HEAT STAGE 3 has been OFF for longer than STAGE TIME, but HEAT STAGE 2 has not, a “speed limit”—in addition to the Table Statement’s control signal—is used to control FAN FLOW. However, for the speed limit to be used, HTG LOOPOUT must be changing rapidly. If HTG LOOPOUT is constant or changing slowly, the Table Statement works as follows:

- When HTG LOOPOUT is equal to or less than FLOW 3 START (Point 53), FAN FLOW is set equal to FAN FLO MORE.
- When HTG LOOPOUT is equal to or greater than FLOW END (Point 17), FAN FLOW is set equal to FAN FLO HMAX.
- When HTG LOOPOUT is between FLOW 3 START and FLOW END, linear interpolation is used to scale FAN FLOW to a value between FAN FLO MORE and FAN FLO HMAX.

When HTG LOOPOUT changes rapidly, the speed limit works as follows:

Regardless of how rapidly HTG LOOPOUT changes, FAN FLOW is not allowed to change faster than (LOOP TIME ÷ FAN TIME) × (FLOW END – FLOW 3 START). Even if HTG LOOPOUT changes suddenly from FLOW 3 START to FLOW END, the amount of time stored in FAN TIME must still elapse before FAN FLOW may change from FAN FLO MORE to FAN FLO HMAX. (If FAN TIME is less than LOOP TIME, the speed limit is disabled and FAN FLOW can change as fast as HTG LOOPOUT changes.)

When HEAT STAGE 3 and HEAT STAGE 2 have both been OFF for longer than STAGE TIME but HEAT SATGE 1 has not, FAN FLOW is controlled by **two** speed limits and the Table Statement’s control signal. However, for the speed limits to be used, HTG LOOPOUT must be changing rapidly. If HTG LOOPOUT is constant or changing slowly, the Table Statement works as follows

- When HTG LOOPOUT is equal to or less than FLOW 2 START (Point 22), FAN FLOW is set equal to FAN FLOW MID.
- When HTG LOOPOUT is between FLOW 2 START and FLOW 2 END (Point 52), linear interpolation is used to scale FAN FLOW to a value between FAN FLOW MID and FAN FLO MORE.
- When HTG LOOPOUT equals FLOW 2 END, FAN FLOW is set equal to FAN FLO MORE. (If HTG LOOPOUT rises above FLOW 2 END but stays below FLOW 3 START, FAN FLOW remains equal to FAN FLO MORE, while HEAT STAGE 1 and HEAT STAGE 2 time modulate.)
- When HTG LOOPOUT is between FLOW 3 START and FLOW END, linear interpolation is used to scale FAN FLOW to a value between FAN FLO MORE and FAN FLO HMAX.

- When HTG LOOPOUT is equal to or greater than FLOW END, FAN FLOW is set equal to FAN FLO HMAX. (Note: When HTG LOOPOUT is greater than FLOW END, HEAT STAGE 3 will time modulate.)

When HTG LOOPOUT changes rapidly, the speed limits work as follows:

If HTG LOOPOUT is less than or equal to FLOW 3 START, FAN FLOW will not be allowed to change faster than (LOOP TIME ÷ FAN TIME) × (FLOW 2 END – FLOW 2 START), no matter how quickly HTG LOOPOUT changes. Therefore, even if HTG LOOPOUT changes suddenly from FLOW 2 START to FLOW 3 START, the amount of time stored in FAN TIME must still elapse before FAN FLOW may change from FAN FLOW MID to FAN FLO MORE.

If HTG LOOPOUT is greater than FLOW 3 START, FAN FLOW cannot change faster than (LOOP TIME ÷ FAN TIME) × (FLOW END – FLOW 3 START). Therefore, even if HTG LOOPOUT changes suddenly from FLOW 3 START to FLOW END, the amount of time stored in FAN TIME must still elapse before FAN FLOW may change from FAN FLO MORE to FAN FLO HMAX.

Since the value of FLOW 2 END – FLOW 2 START and the value of FLOW END – FLOW 3 START are likely to be different; two different speed limits will be used even though the value of FAN TIME remains the same. The speed limit being used at any given time will depend on the value of HTG LOOPOUT (as explained in the previous paragraph). If FAN TIME is less than LOOP TIME, the speed limits are disabled and FAN FLOW can change as quickly as HTG LOOPOUT changes.

When **all three** heating stages have been OFF for longer than STAGE TIME, FAN FLOW is controlled by **three** speed limits and the Table Statement's control signal. However, for the speed limits to be used, HTG LOOPOUT must be changing rapidly. If HTG LOOPOUT is constant or changing slowly, the Table Statement works as follows:

- When HTG LOOPOUT equals 0, FAN FLOW is set equal to FAN FLOW MIN (Point 82).
- When HTG LOOPOUT is between 0 and FLOW 1 END (Point 23), linear interpolation is used to scale FAN FLOW to a value between FAN FLOW MIN and FAN FLOW MID.
- When HTG LOOPOUT equals FLOW 1 END, FAN FLOW is set equal to FAN FLOW MID. (If HTG LOOPOUT rises above FLOW 1 END but stays below FLOW 2 START, FAN FLOW remains equal to FAN FLOW MID while HEAT STAGE 1 time modulates.)
- When HTG LOOPOUT is between FLOW 2 START and FLOW 2 END (Point 52), linear interpolation is used to scale FAN FLOW to a value between FAN FLOW MID and FAN FLO MORE.
- When HTG LOOPOUT equals FLOW 2 END, FAN FLOW is set equal to FAN FLO MORE. (If HTG LOOPOUT rises above FLOW 2 END, but stays below FLOW 3 START, FAN FLOW remains equal to FAN FLO MORE while HEAT STAGE 2 time modulates.)
- When HTG LOOPOUT is between FLOW 3 START and FLOW END, linear interpolation is used to scale FAN FLOW to a value between FAN FLO MORE and FAN FLO HMAX.
- When HTG LOOPOUT is equal to or greater than FLOW END, FAN FLOW is set equal to FAN FLO HMAX. (Note: When HTG LOOPOUT is greater than FLOW END, HEAT STAGE 3 will time modulate.)

When HTG LOOPOUT changes rapidly, the speed limits work as follows:

If HTG LOOPOUT is less than or equal to FLOW 2 START, FAN FLOW will not be allowed to change faster than (LOOP TIME ÷ FAN TIME) × FLOW 1 END, no matter how quickly HTG LOOPOUT changes. Therefore, even if HTG LOOPOUT changes suddenly from 0 to FLOW 2 START, the amount of time stored in FAN TIME must still elapse before FAN FLOW may change from FAN FLOW MIN to FAN FLOW MID.

If HTG LOOPOUT is greater than FLOW 2 START and less than or equal to FLOW 3 START, FAN FLOW will not be allowed to change faster than (LOOP TIME ÷ FAN TIME) × (FLOW 2 END – FLOW 2 START), no matter how quickly HTG LOOPOUT changes. Therefore, even if HTG LOOPOUT changes suddenly from FLOW 2 START to FLOW 3 START, the amount of time stored in FAN TIME must still elapse before FAN FLOW may change from FAN FLOW MID to FAN FLO MORE.

If HTG LOOPOUT is greater than FLOW 3 START, FAN FLOW cannot change faster than (LOOP TIME ÷ FAN TIME) × (FLOW END – FLOW 3 START). Therefore, even if HTG LOOPOUT changes suddenly from FLOW 3 START to FLOW END, the amount of time stored in FAN TIME must still elapse before FAN FLOW may change from FAN FLO MORE to FAN FLO HMAX.

Since FLOW 1 END, FLOW 2 END – FLOW 2 START and FLOW END – FLOW 3 START are all likely to be different, three different speed limits will be used even though the value of FAN TIME remains the same. The speed limit being used at any given time will depend on the value of HTG LOOPOUT (as explained in the previous paragraph). If FAN TIME is less than LOOP TIME, the speed limits are disabled and FAN FLOW can change as quickly as HTG LOOPOUT changes.

FAN AOV1 (Point 66)

Once a value for FAN FLOW (the fan’s desired airflow) has been determined, a Table Statement in the firmware calculates the proper value for FAN AOV1 (FAN AOV1 is the analog output that controls the fan's airflow). Application 2557 actually contains four such Table Statements, but only one will be used. Which one gets used depends on the value of BOX SIZE (Point 31). Refer to the following:

BOX SIZE (Point 31) = 3, 5 or 7 – When BOX SIZE is set to 3, 5 or 7, the application uses one of three pre-coded Table Statements with pre-determined FAN AOV1 voltage levels. The voltage values are fixed and cannot be changed by the user.

> **NOTE:** BOX SIZE (Point 31) should be set to 3, 5, or 7 **only** if you have a Nailor box of size 3, 5, or 7.

BOX SIZE (Point 31) = 0 – When BOX SIZE is set to 0, the application uses a general purpose Table Statement to adjust the value of FAN AOV1.

> **NOTE:** BOX SIZE (Point 31) should be set to 0 if the box being used is either a Nailor box with a size other than 3, 5, or 7, or any box made by a manufacturer other than Nailor.

The flow and voltage values of the general purpose table statement are not pre-coded and must be entered by the user as follows:

- FLO LO (Point 39) – The lowest flow the fan can produce. (FLO LO must be less than or equal to FAN FLOW MIN (Point 82), and may be set to 0 cfm, if desired.)
- FLO LO VOLTS (Point 37) – The voltage used by FAN AOV1 that tells the fan to produce an airflow equal to FLO LO.

- FLO HI (Point 87) – The highest flow that the fan can produce. (FLO HI must be greater than or equal to both FAN FLO HMAX and FAN FLO CMAX.)
- FLO HI VOLTS (Point 38) – The voltage used by FAN AOV1 that tells the fan to produce an airflow equal to FLO HI.

Once properly set up, the Table Statement works as follows:

- When FAN FLOW is less than or equal to FLO LO, FAN AOV1 will be set to FAN LO VOLTS.
- When FAN FLOW is greater than or equal to FAN HI, FAN AOV1 will be set to FAN HI VOLTS.
- When FAN FLOW is between FLO LO and FLO HI, linear interpolation is used to scale FAN AOV1 to a value that is between FAN LO VOLTS and FAN HI VOLTS.

Once FAN AOV1 is set to a particular voltage, the signal is sent to an intelligent motor controller that controls the fan. This intelligent motor controller is **provided by others**. It must be set up to know what the fan's airflow should be for a given value of FAN AOV1 voltage. Consult the operating instructions provided by the manufacturer for information on how to do this.

NOTES: 1. FAN FLOW (Point 33) is a calculated value, not a measured value. The application does not measure the airflow coming out of the fan.

2. This application does not have a DO that turns the fan ON and OFF. To turn the fan OFF, FAN FLOW must be set equal to 0.

Warm-Up

Warm-up mode is only allowed to operate during occupied heating. At no other time may the application enter warm-up mode.

WARMUP (Point 60) is turned ON only if **all** of the following circumstances are true:

- MODE (Point 3) has just changed from Unoccupied to Occupied (MODE currently equals occupied, but previously equaled unoccupied one LOOP TIME (Point 98)).
- HEAT.COOL (Point 5) equals HEAT.
- The room temperature is not warm enough.
  CTL TEMP (Point 78) < (CTL STPT (Point 92) – MORN DBAND (Point 74))

The warm-up mode remains in effect until CTL TEMP becomes equal to or greater than (CTL STPT – MORN DBAND). Once this occurs, WARMUP is set to OFF. Once OFF, WARMUP cannot be turned back ON for the rest of the Occupied period.

Baseboard Radiation

For baseboard radiation (BASE DO6, Point 46) to turn ON, the application must be in unoccupied heating (MODE = UNOCC, UNOCC OVRD = UNOCC, and HEAT.COOL = HEAT), and both of the following must be true:

- CTL TEMP (Point 78) is between TEMP LLIMIT (Point 65) and TEMP HLIMIT (Point 69).

- The room temperature is not warm enough:
  CTL TEMP < (CTL STPT (Point 92) – HTG DBAND (Point 73))

At all other times, BASE DO6 will be OFF.

Once ON, baseboard radiation remains ON until CTL TEMP becomes equal to or greater than CTL STPT. When CTL TEMP is between CTL STPT and (CTL STPT – HTG DBAND), the baseboard radiation remains in its last commanded state: If ON, it remains ON; if OFF, it remains OFF.

If CTL TEMP becomes less than TEMP LLIMIT or greater than TEMP HLIMIT, BASE DO6 is shut OFF and not allowed to turn back ON for the remainder of the unoccupied heating mode.

Flow Temperature Alarm

The status of FLOW TEMP (Point 62) indicates whether the supply airflow is properly cooling down the control temperature (CTL TEMP, Point 78) during cooling. Basically, this feature checks whether the supply airflow is both great enough and cool enough to cool down the room.

FLOW TEMP is sent to ALARM only when all of the following are true:

- HEAT.COOL (Point 5) equals COOL.
- MODE (Point 3) equals occupied, or UNOCC OVRD (Point 21) equals OCC while MODE equals unoccupied.
- FLOW (Point 75) < FLOW STPT (Point 93), and CTL TEMP > CTL STPT (Point 92), both of these being true for at least the amount of time stored in ALARM TIME (Point 26).

At all other times, FLOW TEMP = NORMAL.

> **NOTE:** During occupied cooling, FLOW TEMP equals NORMAL when:
> FLOW ≥ (FLOW STPT – LOW FLOW, Point 30) and/or CTL TEMP ≤ CTL STPT.

Fail-Safe Operation

If the air velocity sensor fails, the controller uses pressure dependent control with the temperature loop controlling the damper's position. If the room temperature sensor fails, the controller operates using the last known temperature value.

Calibration

The controller's air velocity transducer requires periodic calibration to maintain accurate air velocity readings. CAL SETUP (Point 95) is configured during controller startup to allow calibration to take place either automatically or manually. The status of CAL AIR (Point 94) indicates whether calibration is in progress. During calibration CAL AIR = YES. Note that the damper is commanded closed to get a zero airflow reading during calibration. At the end of a calibration sequence, CAL AIR returns to NO automatically and the damper returns to normal control.

Application Notes

1. If the temperature swings in the room are excessive or there is trouble maintaining the setpoint, then either the cooling loop, the heating loop, or both need to be tuned. If FLOW (Point 75) is oscillating while FLOW STPT (Point 93) is constant, then the flow loop requires tuning.

2. Unless overridden, the value of CTL TEMP (Point 78) equals ROOM TEMP (Point 4) plus RMTMP OFFSET (Point 102).

3. The controller as shipped from the factory keeps all associated equipment OFF. See the Start-up document for how to release the controller and its equipment to application control.

4. Certain control features of Application 2557 depend on whether the central air handling unit is ON or OFF. Application 2557 monitors VAV AHU (Point 61) for this information. Application 2557 does not command VAV AHU—it only reacts to it. To command VAV AHU, it must be unbundled at the field panel and PPCL must be written for it.

5. Since Application 2557 has no fan DO, the only way to manually shut the fan OFF is to set FAN FLOW to 0.

6. In Application 2557, DOs 3 and 4 cannot be used as auxiliary floating-control motor points, even if the application is not using them. The same is true for DOs 5 and 6 and also DOs 7 and 8. Floating control logic is not present in the firmware for these DOs. However, these DOs can otherwise be used as spare points if the application is not using them for other purposes (DOs 7 and 8 are always spare).

7. If FAN FLOW (Point 33) equals 0 and/or FAN AOV1 (Point 66) equals 0, the application will shut off all stages of electric heating **even if they have been overridden to ON**. Thereafter, if both FAN FLOW and FAN AOV1 become greater than 0, the application will not automatically turn the electric heat stages back on due to the previous user command. Instead, the application will control them normally.

Point Database

NOTE: The slave mode point database follows this database.

Table 2557-4. Point Database for Application 2557.

Object Type [a]	Object Instance (Point Number)	Object Name (Descriptor)	Factory Default (SI Units) [b]	Engr Units (SI Units)	Range	Active Text	Inactive Text
AO	01	CTLR ADDRESS	99	--	0-255	--	--
AO	02	APPLICATION	2599	--	0-32767	--	--
AO	{03} [c]	MODE	0	--	0-255	--	--
AI	{04}	ROOM TEMP	74.0 (23.44888)	DEG F (DEG C)	48-111.75	--	--
BO	{05}	HEAT.COOL	COOL	--	Binary	HEAT	COOL
AO	06	OCC CLG STPT	74.0 (23.44888)	DEG F (DEG C)	48-111.75	--	--
AO	07	OCC HTG STPT	70.0 (21.20888)	DEG F (DEG C)	48-111.75	--	--
AO	08	UOC CLG STPT	82.0 (27.92888)	DEG F (DEG C)	48-111.75	--	--
AO	09	UOC HTG STPT	65.0 (18.40888)	DEG F (DEG C)	48-111.75	--	--
BI	{10}	DI 5	OFF	--	Binary	ON	OFF
AO	11	RM STPT MIN	52.5 (11.40888)	DEG F (DEG C)	48-111.75	--	--
AO	12	RM STPT MAX	74.25 (23.58888)	DEG F (DEG C)	48-111.75	--	--
AI	{13}	RM STPT DIAL	74.0 (23.44888)	DEG F (DEG C)	48-111.75	--	--
BO	14	STPT DIAL	NO	--	Binary	YES	NO
AI	{15}	AI 3	0.0	PCT	0-102	--	--
BO	{16}	FAN MODE	VARI	--	Binary	CONST	VARI
AO	17	FLOW END	75.2	PCT	0-102	--	--
BO	18	WALL SWITCH	NO	--	Binary	YES	NO
BI	{19}	DI OVRD SW	OFF	--	Binary	ON	OFF
AO	20	OVRD TIME	0	HRS	0-255	--	--
BO	{21}	UNOCC OVRD	UNOCC	--	Binary	UNOCC	OCC
AO	22	FLOW 2 START	30.0	PCT	0-102	--	--
AO	23	FLOW 1 END	15.2	PCT	0-102	--	--
BI	{24}	DI 2	OFF	--	Binary	ON	OFF
BI	{25}	DI 3	OFF	--	Binary	ON	OFF

a Object Types are; Analog Input (AI), Analog Output (AO), Binary Input (BI) and Binary Output (BO).
b A single value in a column means that the value is the same in English units and in SI units.
c Point numbers that appear in brackets { } may be unbundled at the field panel.

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Table 2557-4. Point Database for Application 2557.

Object Type [a]	Object Instance (Point Number)	Object Name (Descriptor)	Factory Default (SI Units) [b]	Engr Units (SI Units)	Range	Active Text	Inactive Text
AO	26	ALARM TIME	5	MIN	0-255	--	--
AO	27	STG 1 TIME	120	SEC	0-255	--	--
AO	28	STG 2 TIME	120	SEC	0-255	--	--
AO	30	LOW FLOW	5.0	PCT	0-127.75	--	--
AO	31	BOX SIZE	3	--	0-255	--	--
AO	32	CLG FLOW MAX	2200 (1038.18)	CFM (LPS)	0-131068	--	--
AO	{33}	FAN FLOW	0 (0.0)	CFM (LPS)	0-4092	--	--
AO	34	HTG FLOW MAX	2200 (1038.18)	CFM (LPS)	0-131068	--	--
AI	{35}	AIR VOLUME	0 (0.0)	CFM (LPS)	0-131068	--	--
AO	36	FLOW COEFF	1.0	--	0-2.55	--	--
AO	{37}	FLO LO VOLTS	0.0	VOLTS	0-10.23	--	--
AO	{38}	FLO HI VOLTS	10.0	VOLTS	0-10.23	--	--
AO	{39}	FLO LO	0 (0.0)	CFM (LPS)	0-4092	--	--
BI	{40}	DI 4	OFF	--	Binary	ON	OFF
BO	{41}	DO 1	OFF	--	Binary	ON	OFF
BO	{42}	DO 2	OFF	--	Binary	ON	OFF
BO	{43}	HEAT STAGE 1	OFF	--	Binary	ON	OFF
BO	{44}	HEAT STAGE 2	OFF	--	Binary	ON	OFF
BO	{45}	HEAT STAGE 3	OFF	--	Binary	ON	OFF
BO	{46}	BASE DO6	OFF	--	Binary	ON	OFF
BI	{47}	DI 6	OFF	--	Binary	ON	OFF
AO	{48}	DMPR COMD	0.0	PCT	0-102	--	--
AO	{49}	DMPR POS	0.0	PCT	0-102	--	--
AI	{50}	AUX TEMP	74.0 (23.495556)	DEG F (DEG C)	37.5-165	--	--
AO	51	MTR1 TIMING	95	SEC	0-511	--	--
AO	52	FLOW 2 END	45.2	PCT	0-102	--	--
AO	53	FLOW 3 START	60.0	PCT	0-102	--	--
AI	{54}	AI 5	74.0 (23.495556)	DEG F (DEG C)	37.5-165	--	--
AO	55	FAN FLO MORE	2500 (1179.75)	CFM (LPS)	0-4092	--	--
AO	56	DMPR ROT ANG	90	--	0-255	--	--

a Object Types are; Analog Input (AI), Analog Output (AO), Binary Input (BI) and Binary Output (BO).
b A single value in a column means that the value is the same in English units and in SI units.
c Point numbers that appear in brackets { } may be unbundled at the field panel.

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Table 2557-4. Point Database for Application 2557.

Object Type [a]	Object Instance (Point Number)	Object Name (Descriptor)	Factory Default (SI Units) [b]	Engr Units (SI Units)	Range	Active Text	Inactive Text
AO	57	STG 3 TIME	120	SEC	0-255	--	--
AO	58	MTR SETUP	0	--	0-255	--	--
AO	59	DO DIR. REV	0	--	0-255	--	--
BO	{60}	WARMUP	OFF	--	Binary	ON	OFF
BO	{61}	VAV AHU	OFF	--	Binary	ON	OFF
BO	{62}	FLOW TEMP	NORMAL	--	Binary	ALARM	NORMAL
AO	63	CLG P GAIN	20.0 (36.0)	--	0-63.75	--	--
AO	64	CLG I GAIN	0.01 (0.018)	--	0-1.023	--	--
AO	65	TEMP LLIMIT	55.0 (12.80888)	DEG F (DEG C)	48-111.75	--	--
AO	{66}	FAN AOV1	0.0	VOLTS	0-10.23	--	--
AO	67	HTG P GAIN	10.0 (18.0)	--	0-63.75	--	--
AO	68	HTG I GAIN	0.01 (0.018)	--	0-1.023	--	--
AO	69	TEMP HLIMIT	85.0 (29.60888)	DEG F (DEG C)	48-111.75	--	--
AO	{70}	AOV 2	0.0	VOLTS	0-10.23	--	--
AO	71	FAN TIME	60	SEC	0-255	--	--
AO	72	FLOW I GAIN	0.02	--	0-1.023	--	--
AO	73	HTG DBAND	2.0 (1.12)	DEG F (DEG C)	0.5-64.25	--	--
AO	74	MORN DBAND	2.0 (1.12)	DEG F (DEG C)	0-63.75	--	--
AO	{75}	FLOW	0.0	PCT	0-1023.75	--	--
AO	76	CTL FLOW MIN	220 (103.818)	CFM (LPS)	0-131068	--	--
AO	{77}	CTL FLOW MAX	2200 (1038.18)	CFM (LPS)	0-131068	--	--
AO	{78}	CTL TEMP	74.0 (23.44888)	DEG F (DEG C)	48-111.75	--	--
AO	{79}	CLG LOOPOUT	0.0	PCT	0-102	--	--
AO	{80}	HTG LOOPOUT	0.0	PCT	0-102	--	--
AO	{81}	AVG HEAT OUT	0.0	PCT	0-409.2	--	--
AO	82	FAN FLOW MIN	220 (103.818)	CFM (LPS)	0-4092	--	--
AO	83	FAN FLOW MID	2500 (1179.75)	CFM (LPS)	0-4092	--	--
AO	84	FAN FLO HMAX	2200 (1038.18)	CFM (LPS)	0-4092	--	--
AO	85	FAN FLO CMAX	2200 (1038.18)	CFM (LPS)	0-4092	--	--
AO	86	SWITCH TIME	10	MIN	0-255	--	--

a Object Types are; Analog Input (AI), Analog Output (AO), Binary Input (BI) and Binary Output (BO).
b A single value in a column means that the value is the same in English units and in SI units.
c Point numbers that appear in brackets { } may be unbundled at the field panel.

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Table 2557-4. Point Database for Application 2557.

Object Type [a]	Object Instance (Point Number)	Object Name (Descriptor)	Factory Default (SI Units) [b]	Engr Units (SI Units)	Range	Active Text	Inactive Text
AO	{87}	FLO HI	2200 (1038.18)	CFM (LPS)	0-4092	--	--
AO	88	STAGE COUNT	2	--	0-255	--	--
AO	89	STAGE TIME	10	MIN	1-256	--	--
AO	90	SWITCH DBAND	1.0 (0.56)	DEG F (DEG C)	0-63.75	--	--
AO	{91}	AOV 3	0.0	VOLTS	0-10.23	--	--
AO	{92}	CTL STPT	74.0 (23.44888)	DEG F (DEG C)	48-111.75	--	--
AO	{93}	FLOW STPT	0.0	PCT	0-255.75	--	--
BO	{94}	CAL AIR	NO	--	Binary	YES	NO
AO	95	CAL SETUP	4	--	0-255	--	--
AO	96	CAL TIMER	12	HRS	0-255	--	--
AO	97	DUCT AREA	1.0 (0.09292)	SQ. FT (SQ M)	0-6.375	--	--
AO	98	LOOP TIME	5	SEC	0-255	--	--
AO	{99}	ERROR STATUS	0	--	0-255	--	--
AO	102	RMTMP OFFSET	DEG F (DEG C)	0.0 (0.0)	-31.75-32	--	--
BO	{103}	DO 7	--	OFF	Binary	ON	OFF
BO	{104}	DO 8	--	OFF	Binary	ON	OFF

a Object Types are; Analog Input (AI), Analog Output (AO), Binary Input (BI) and Binary Output (BO).
b A single value in a column means that the value is the same in English units and in SI units.
c Point numbers that appear in brackets { } may be unbundled at the field panel.

Slave Mode Point Database, Application 2599

Table 2557-5. Point Database for Application 2599.

Object Type [a]	Object Instance (Point Number)	Object Name (Descriptor)	Factory Default (SI Units) [b]	Engr Units (SI Units)	Range	Active Text	Inactive Text
AO	01	CTLR ADDRESS	99	--	0-255	--	--
AO	02	APPLICATION	2599	--	0-32767	--	--
AI	{04} [c]	ROOM TEMP	74.0 (23.44888)	DEG F (DEG C)	48-111.75	--	--
BI	{10}	DI 5	OFF	--	Binary	ON	OFF
AI	{13}	RM STPT DIAL	74.0 (23.44888)	DEG F (DEG C)	48-111.75	--	--
AI	{15}	AI 3	0.0	PCT	0-102	--	--
BO	18	WALL SWITCH	NO	--	Binary	YES	NO
BI	{19}	DI OVRD SW	OFF	--	Binary	ON	OFF
BI	{24}	DI 2	OFF	--	Binary	ON	OFF
BI	{25}	DI 3	OFF	--	Binary	ON	OFF
AI	{35}	AIR VOLUME	0 (0.0)	CFM (LPS)	0-131068	--	--
AO	36	FLOW COEFF	1.0	--	0-2.55	--	--
BI	{40}	DI 4	OFF	--	Binary	ON	OFF
BO	{41}	DO 1	OFF	--	Binary	ON	OFF
BO	{42}	DO 2	OFF	--	Binary	ON	OFF
BO	{43}	HEAT STAGE 1	OFF	--	Binary	ON	OFF
BO	{44}	HEAT STAGE 2	OFF	--	Binary	ON	OFF
BO	{45}	HEAT STAGE 3	OFF	--	Binary	ON	OFF
BO	{46}	BASE DO6	OFF	--	Binary	ON	OFF
BI	{47}	DI 6	OFF	--	Binary	ON	OFF
AO	{48}	DMPR COMD	0.0	PCT	0-102	--	--
AO	{49}	DMPR POS	0.0	PCT	0-102	--	--
AI	{50}	AUX TEMP	74.0 (23.495556)	DEG F (DEG C)	37.5-165	--	--
AO	51	MTR1 TIMING	95	SEC	0-511	--	--
AI	{54}	AI 5	74.0 (23.495556)	DEG F (DEG C)	37.5-165	--	--
AO	56	DMPR ROT ANG	90	--	0-255	--	--
AO	58	MTR SETUP	0	--	0-255	--	--
AO	59	DO DIR. REV	0	--	0-255	--	--

a Object Types are; Analog Input (AI), Analog Output (AO), Binary Input (BI) and Binary Output (BO).
b A single value in a column means that the value is the same in English units and in SI units.
c Point numbers that appear in brackets { } may be unbundled at the field panel.

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Table 2557-5. Point Database for Application 2599.

Object Type [a]	Object Instance (Point Number)	Object Name (Descriptor)	Factory Default (SI Units) [b]	Engr Units (SI Units)	Range	Active Text	Inactive Text
AO	{66}	FAN AOV1	0.0	VOLTS	0-10.23	--	--
AO	{70}	AOV 2	0.0	VOLTS	0-10.23	--	--
AO	{78}	CTL TEMP	74.0 (23.44888)	DEG F (DEG C)	48-111.75	--	--
AO	{91}	AOV 3	0.0	VOLTS	0-10.23	--	--
BO	{94}	CAL AIR	NO	--	Binary	YES	NO
AO	95	CAL SETUP	4	--	0-255	--	--
AO	96	CAL TIMER	12	HRS	0-255	--	--
AO	97	DUCT AREA	1.0 (0.09292)	SQ. FT (SQ M)	0-6.375	--	--
AO	{99}	ERROR STATUS	0	--	0-255	--	--
AO	102	RMTMP OFFSET	DEG F (DEG C)	0.0 (0.0)	-31.75-32	--	--
BO	{103}	DO 7	--	OFF	Binary	ON	OFF
BO	{104}	DO 8	--	OFF	Binary	ON	OFF

a Object Types are; Analog Input (AI), Analog Output (AO), Binary Input (BI) and Binary Output (BO).
b A single value in a column means that the value is the same in English units and in SI units.
c Point numbers that appear in brackets { } may be unbundled at the field panel.