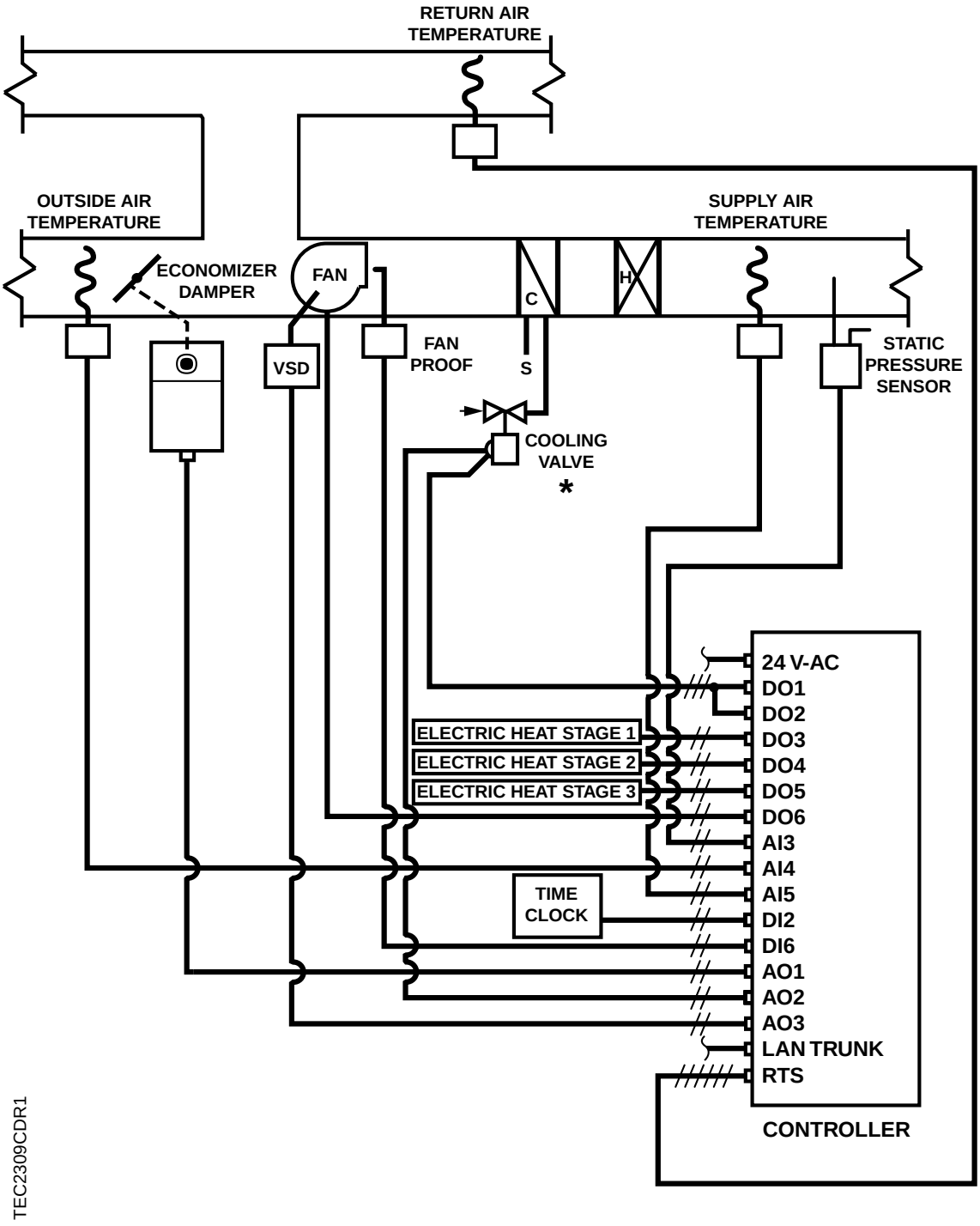
Application 2309 VAV AHU with CHW, Electric Heat, Economy Cycle and Static Pressure Control

Overview

Application 2309 controls an air-handling unit with the following features:

- Chilled water valve for cooling.
- Cooling supply air loop with set point that is reset by return air temperature in cool-down mode and by maximum room temperature during occupied mode.
- Up to 3 stages of electric heat.
- Heating supply air loop with set point that is reset by return air temperature in warm-up mode and by maximum room temperature during occupied mode.
- Static pressure loop that controls a variable speed drive.
- Equipment shutdown if static pressure sensor fails.
- Outside air damper that has minimum position during occupancy that is varied inversely proportional to speed of variable speed drive.
- Ability to use outside air as source of free cooling during night purge and cool-down modes when outside air is cool enough to use as source of free cooling.
- Fan alarm.
- Ability to operate either stand-alone or with a field panel.

Refer to Figures 2309-1 through 2309-8.



***** Cooling valve can be controlled using either an AO or DO's.

Figure 2309-1. Application 2309 Control Drawing.

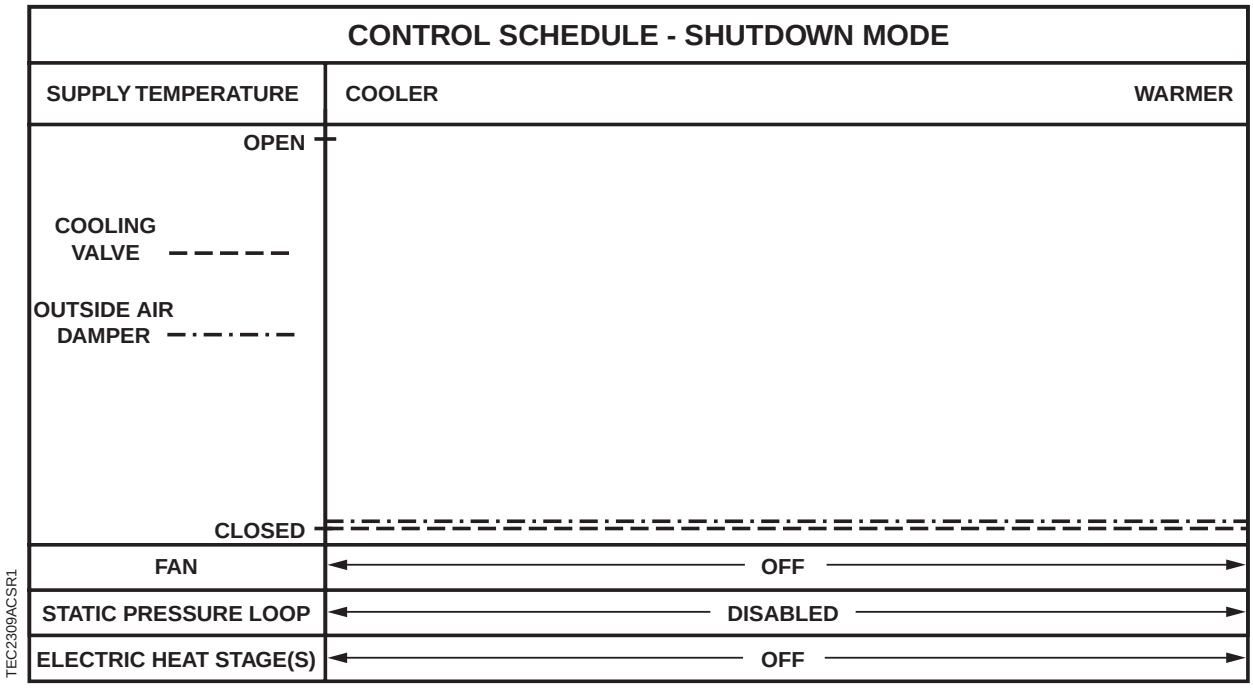


Figure 2309-2. Application 2309 Control Schedule.

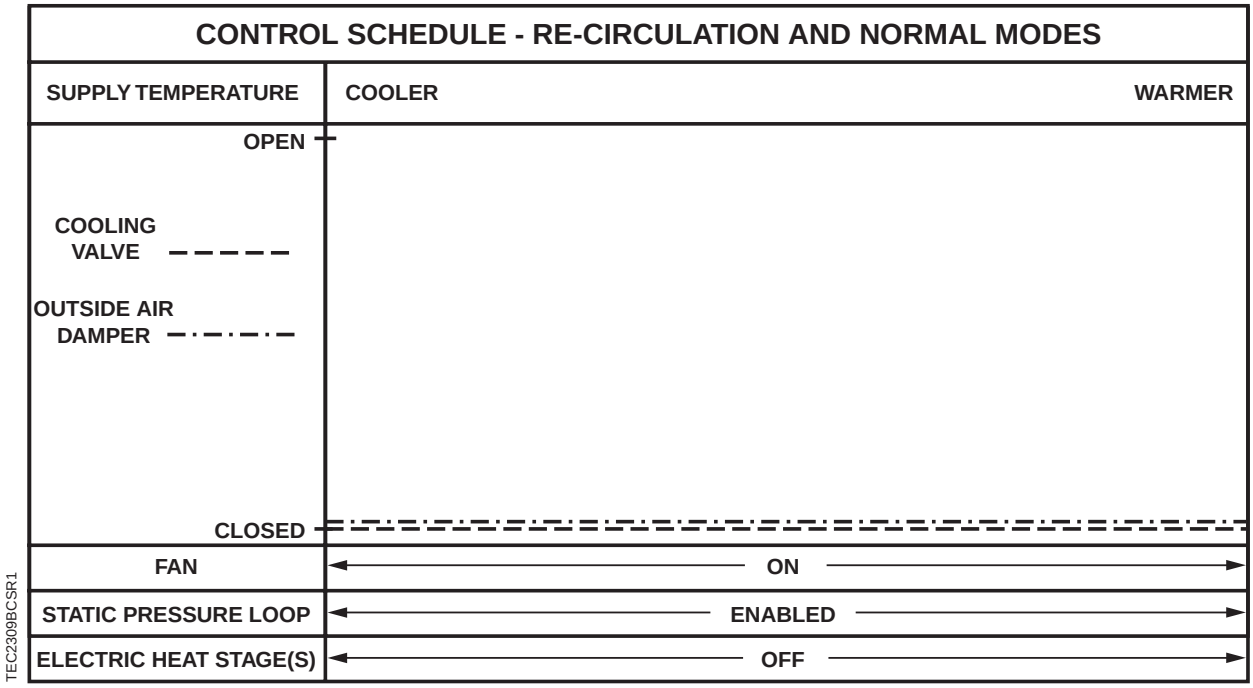


Figure 2309-3. Application 2309 Control Schedule.

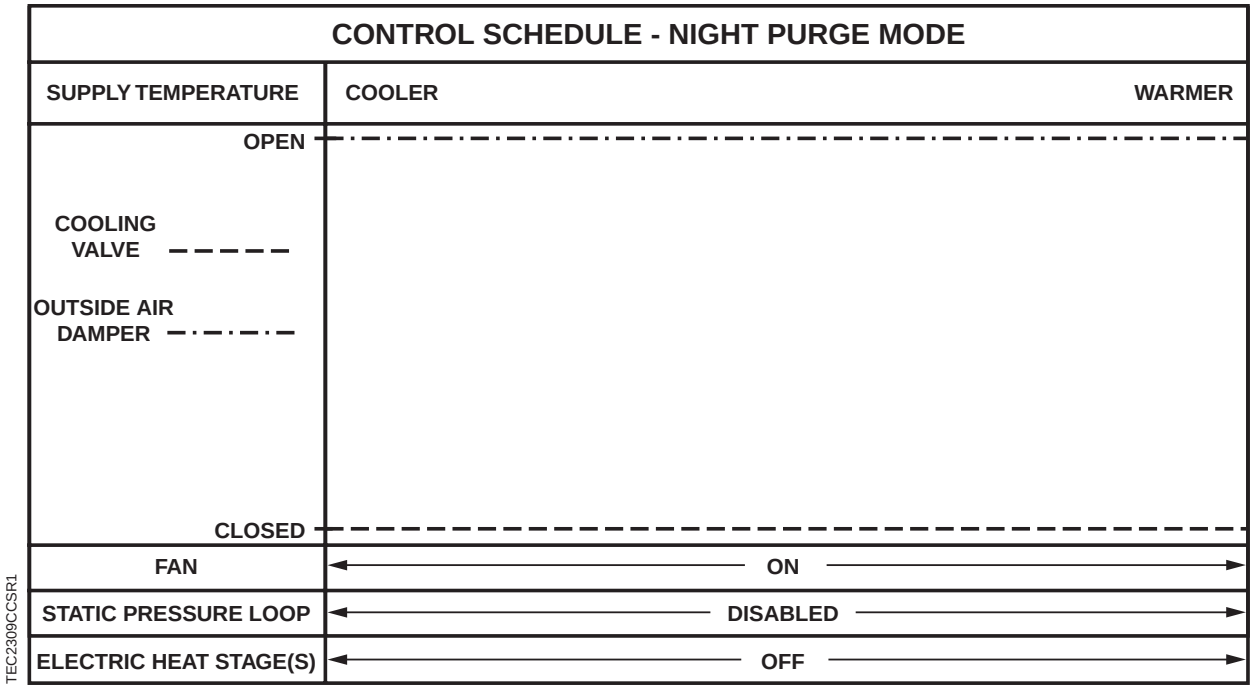
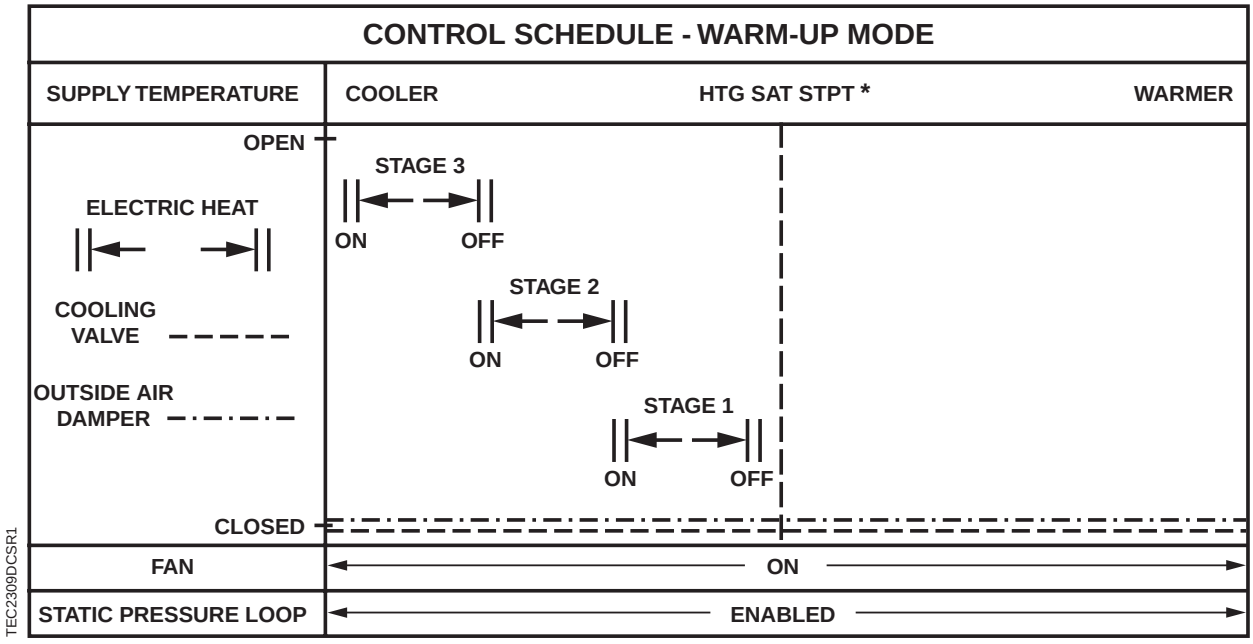
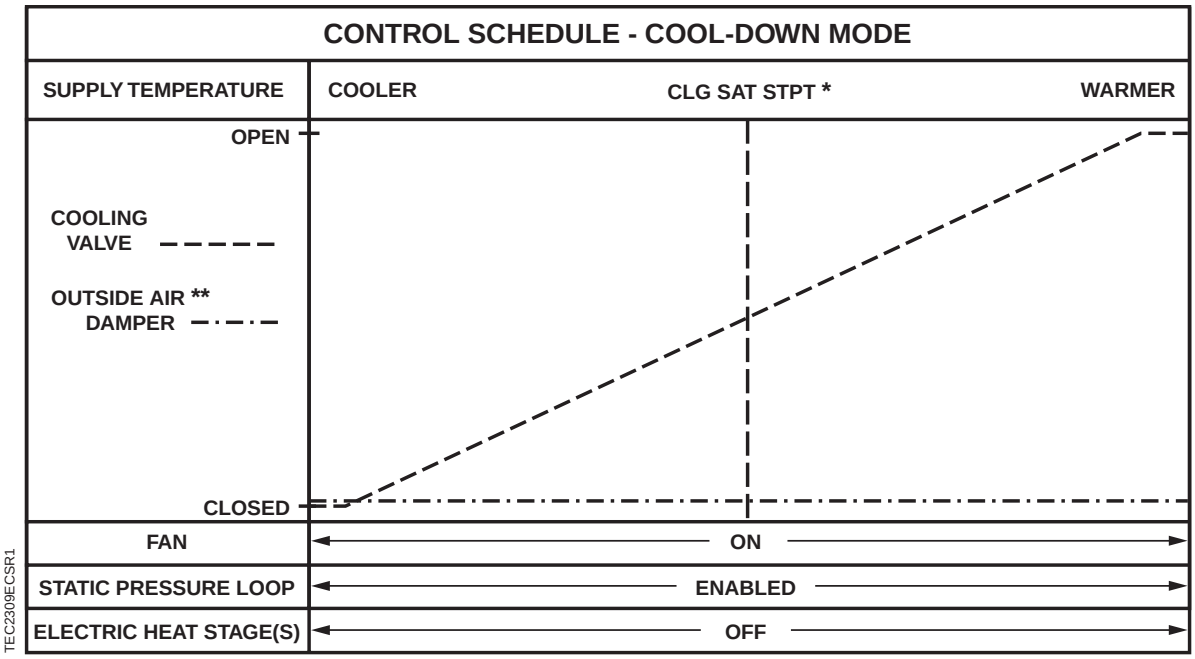


Figure 2309-4. Application 2309 Control Schedule.



***** HTG SAT STPT (Point 10) is adjusted by a table statement based on return air temperature. Refer to the *Warm-up mode* section for more information.

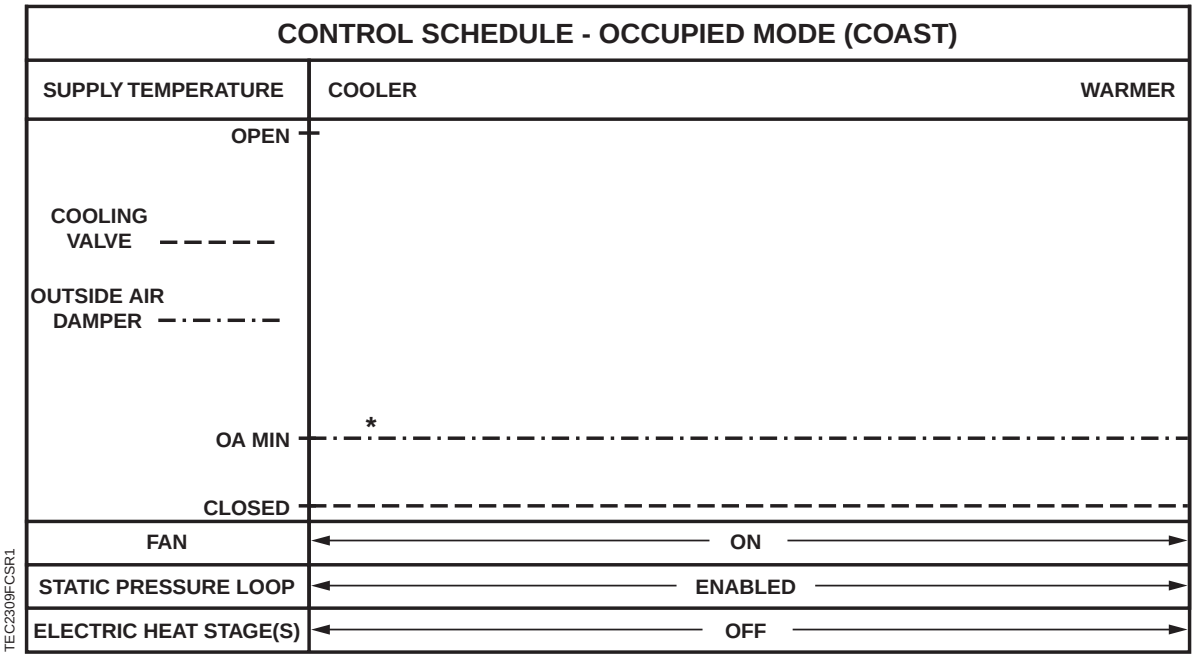
Figure 2309-5. Application 2309 Control Schedule.



***** The point CLG SAT STPT (number 9) is adjusted by a table statement based on return air temperature. Refer to the *Cool-down mode* section for more information.

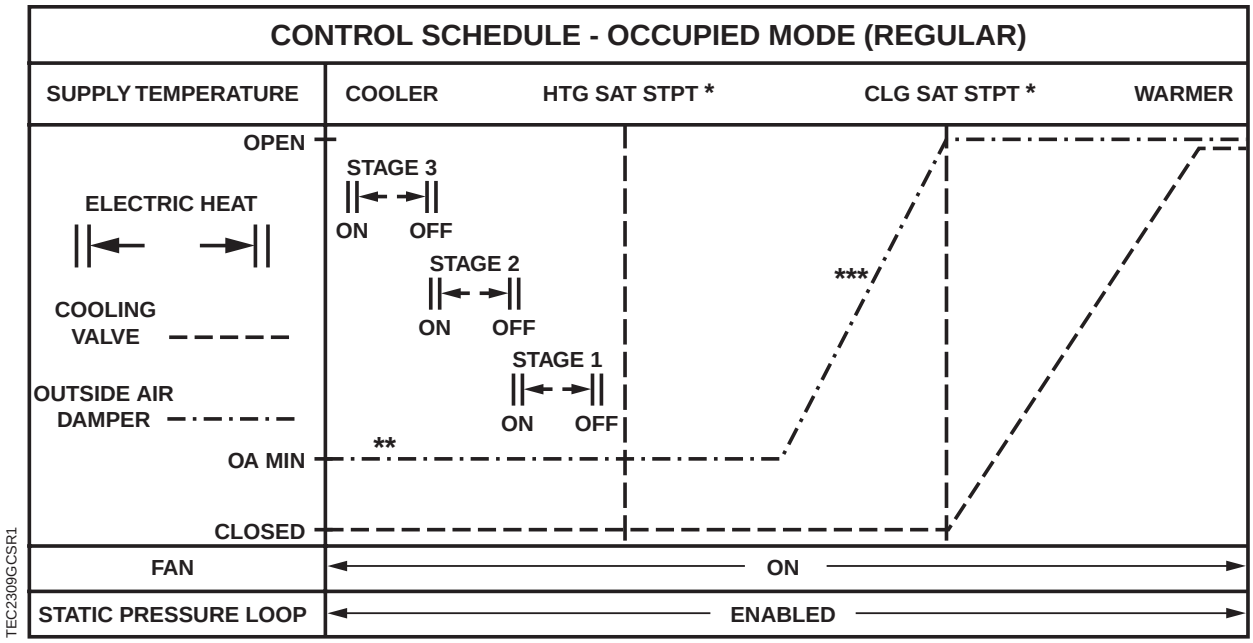
****** The OA damper is modulated to take advantage of free cooling whenever the outside air is cool enough. Refer to the *Cool-down mode* section for more information.

Figure 2309-6. Application 2309 Control Schedule.



***** The outside air damper minimum position varies as the VSD speed changes. Refer to the *Occupied mode* section for more information.

Figure 2309-7. Application 2309 Control Schedule.



***** The points CLG SAT STPT (number 9) and HTG SAT STPT (number 10) are adjusted by table statements based on MAX RM TEMP (Point 21). Refer to the *Occupied mode* section for more information.

****** The outside air damper minimum position varies as the VSD speed changes. Refer to the *Occupied mode* section for more information.

*******If free cooling is not available, then the outside air damper stays at minimum position at all times. Refer to the *Cooling valve, outside air damper interaction in occupied mode* section for more information.

Figure 2309-8. Application 2309 Control Schedule.

Hardware inputs

Analog

- Outside air temperature (100K Ω thermistor)
- Static pressure (0-10V, 4-20 mA)
- Supply air temperature (100K Ω thermistor)

Digital

- Fan proof
- Time clock

Hardware outputs

Analog

- Cooling valve (0-10V), **OR*** (see digital outputs)
- Outside air damper (0-10V)
- Variable speed fan drive (0-10V)

Digital

- Fan
- Staged electric heat (up to 3 stages)
- ***Cooling valve (2 DOs required)

Sequence of Operation

The following paragraphs present the sequence of operation for Application 2309, “VAV AHU with CHW, Electric Heat, Economy Cycle and Static Pressure Control.”

Modes

There are several modes in this application. The value of the point MODE (number 25) determines which mode the application is in. The following table lists MODE values that correspond to the different modes used by this application.

Table 2309-1. Modes and Values.

Mode	Value
shutdown	0
night purge	10
recirculation	20
normal	30
warm-up	40
cool-down	50
occupied	60
undefined	70 and greater

It is important to understand the operational modes available, what happens in them, and how the application can get into them. The following section begins with the application going from the occupied mode into the shutdown mode. It is assumed the point TIME CLOCK (number 81) is set to NO. (Later, it will be described how the application changes modes when TIME CLOCK equals YES.)

Shutdown mode

To go from occupied mode to shutdown mode, the field panel must change the point MODE (number 25) to the shutdown value of 0. After this has been done, the field panel must release MODE so the controller can change it as needed.

When shutdown takes place, the following occurs:

- The outside air damper closes (OA DAMPER, point number 84).
- The cooling valve closes (the cooling valve uses point AOV 2, number 39).
- All stages of electric heat are immediately shut OFF.
  - Stage 1 uses the point DO 3 (number 43).
  - Stage 2 uses the point DO 4 (number 44).
  - Stage 3 uses the point DO 5 (number 45).

NOTE: To determine how many stages of electric heat this application controls, see the point HTG STAGE (number 85). If not used for staged heating, DOs 3, 4, or 5 become spare DOs that can be controlled by PPCL for other purposes.

The point FAN (number 46) does not turn OFF right away. Instead, it remains ON until the application has been in shutdown mode for longer than the length of time held in the point SHUTDN TIME (number 60). Once this occurs, the fan shuts OFF. When the fan shuts OFF, the following events occur:

- The variable speed drive is set to 0.
- The fan's status goes back to normal (fan point comes out of failure) if it is not there already. The fan does not go into alarm (its status letter does not change from N to F) when the fan is OFF.

During the shutdown period, the static pressure loop, the heating loop, and the cooling loop are all disabled (this prevents reset windup).

Shutdown to night purge

During the shutdown mode, it is possible to send the application to the night purge mode. The transition from shutdown to night purge involves an interaction between the field panel and the controller and is explained as follows:

- The field panel must set the point PURGE OK (number 82) to YES.
- The controller must determine that the point MAX RM TEMP (number 21) is greater than the point PURGE START (number 27). When this occurs, the controller (not the field panel) places the point MODE (number 25) into the night purge mode (MODE = 10).

Then the following occurs:

- The fan turns ON. This enables the fan alarm feature.
- The static pressure loop is enabled and the variable speed drive is modulated to maintain the static pressure.
- The point OA DAMPER (number 84) is set to 100% open.

Ending night purge

Night purge usually ends with a return to shutdown mode. When the controller determines that the point MAX RM TEMP (number 21) is less than the point PURGE END (number 28), it sends the point MODE (number 25) back to the shutdown value of 0 and shutdown proceeds as before. Keep in mind that the fan does not turn OFF right away (see the *Shutdown mode* section for more information).

The other common way for night purge to end is for the application to be set to the recirculation mode as described in the following section.

NOTE: When MAX RM TEMP is between the point PURGE START (number 27) and PURGE END, MODE remains in its last commanded state. If MODE was commanded to shutdown, it remains in shutdown; if it was commanded to night purge, it remains in night purge. This deadband was put in to minimize excessive mode switching.

Recirculation mode

The most common way to get into the recirculation mode is from the shutdown mode. Another common way to enter the recirculation mode is from the night purge mode. Either way, the operation of the recirculation mode is the same.

To go to the recirculation mode, the field panel must change the point MODE (number 25) to the recirculation mode value of 20. After this has been done, the field panel must release MODE back to normal control so the controller can change it as needed. When the application is in the recirculation mode, the following occurs:

- The fan turns ON (this enables the fan alarm feature).
- The static pressure loop is enabled and the variable speed drive is modulated to maintain the static pressure.
- Everything else remains the way it was in the shutdown mode:
  - The cooling valve remains shut.
  - The electric heat stages remain OFF.
  - The outside air damper remains shut.
  - The heating and cooling loops remain disabled.

The application stays in the recirculation mode for the amount of time stored in the point RECIRC TIME (number 61). After RECIRC TIME is up, the controller determines what mode to send the application into next: the warm-up mode, the cool-down mode or the normal mode.

Warm-up mode

This mode can be entered from the recirculation mode. When the return air temperature, point RAT.RTS (number 04), is less than the point HTG NEEDED (number 51), the controller sets the MODE point to the warm-up value of 40. During warm-up mode the following occurs:

- The point FAN (number 46) remains ON and the fan alarm remains enabled.
- The static pressure loop remains enabled and the variable speed drive is modulated to maintain the static pressure.
- The cooling valve remains shut, the outside air damper remains shut, and the cooling loop remains disabled.
- The heating loop is enabled and the electric heat stages are controlled to maintain the point HTG SAT STPT (number 10). Refer to the *Electric heat control* section later in this document for a more detailed explanation of how this application controls electric heat.

- The HTG SAT STPT value is adjusted by a table statement located in the controller. When the return air temperature rises, HTG SAT STPT falls and vice versa. The user can adjust this table statement with the following parameters:
  - Point RAT LOH (number 48) – The lowest return air temperature this table statement looks at.
  - Point HSTP HI (number 11) – The highest HTG SAT STPT used. This is used when RAT.RTS equals RAT LOH.
  - Point RAT HIH (number 47) – The highest return air temperature that this table statement looks at.
  - Point HSTP LO (number 12) – The lowest HTG SAT STPT used. This is used when RAT.RTS equals RAT HIH.

The controller will set MODE to the normal mode value of 30 if the return air temperature (RAT.RTS) rises above HTG NEEDED + OFFSET (OFFSET is an internal point equal to 1.11°C).

NOTE: If RAT.RTS is between the values of HTG NEEDED and HTG NEEDED + OFFSET, then MODE will remain in its last known state. If it was commanded to normal mode, then it remains in normal mode (value = 30); if it was commanded to warm-up, it remains in warm-up.

Cool-down mode

This mode can be entered from the recirculation mode. If the return air temperature, point RAT.RTS (number 04), is greater than point CLG NEEDED (number 52), then the controller sends MODE (number 25) to the cool-down value of 50. The following occurs during cool-down:

- The point FAN (number 46) remains ON and the fan alarm remains enabled.
- The static pressure loop remains enabled and the variable speed drive is modulated to maintain the static pressure.
- The electric heat stages remain OFF and the heating loop remains disabled.
- The cooling loop is enabled and controls both the cooling valve (point AOV 2, number 39) and outside air damper (point OA DAMPER, number 84) in sequence to maintain the point CLG SAT STPT (number 9). Refer to the *Cooling valve, outside air damper interaction in cool-down mode* section for a detailed explanation of cooling valve and outside air damper control during the cool-down mode.
- The CLG SAT STPT value is adjusted by a table statement located in the controller. When the return air temperature rises, CLG SAT STPT falls and vice versa. The user can adjust this table statement with the following parameters:
  - Point RAT LOC (number 17) – The lowest return air temperature that this table statement looks at.
  - Point CSTP HI (number 5) – The highest CLG SAT STPT used. This is used when RAT.RTS equals RAT LOC.
  - Point RAT HIC (number 16) – The highest return air temperature that this table statement looks at.
  - Point CSTP LO (number 6) – The lowest CLG SAT STPT used. This is used when RAT.RTS equals RAT HIC.

The controller will set MODE to the normal mode value of 30 if the return air temperature point (RAT.RTS) drops below CLG NEEDED – OFFSET (OFFSET is an internal point equal to 1.11°C).

NOTE: If RAT.RTS is between the values of CLG NEEDED and CLG NEEDED – OFFSET, then MODE remains in its last known state. If it was commanded to cool-down, then it remains in cool-down; if it was commanded to normal mode, then it remains in normal mode.

Normal mode

There are three common ways to get to the normal mode (MODE = 30). In each case it is the controller that determines when to go into normal mode.

- The controller sends the application from recirculation mode to normal mode if both of the following are true:
  - The application has been in the recirculation mode for the amount of time in the point RECIRC TIME (number 61).
  - The value of point RAT.RTS (number 04) is between HTG NEEDED (number 51) and CLG NEEDED (number 52) when the amount of time held in RECIRC TIME is over.
- The controller sends the application from warm-up mode to normal mode if RAT.RTS is less than CLG NEEDED – OFFSET and greater than HTG NEEDED + OFFSET (OFFSET is an internal point equal to 1.11°C). If RAT.RTS is between the values of HTG NEEDED and HTG NEEDED + OFFSET, then MODE (number 25) remains in its last known state. If it was commanded to warm-up, then it remains in warm-up; if it was commanded to normal mode, it remains in normal mode.
- The controller sends the application from cool-down mode to normal mode if RAT.RTS is less than CLG NEEDED – OFFSET and greater than HTG NEEDED + OFFSET. If RAT.RTS is between the values of CLG NEEDED and CLG NEEDED – OFFSET, then MODE remains in its last known state. If it was commanded to cool-down, then it remains in cool-down; if it was commanded to normal mode, it remains in normal mode.

When the application is in the normal mode, the following conditions are in effect:

- The point FAN (number 46) remains ON and the fan alarm remains enabled.
- The static pressure loop remains enabled and the variable speed drive is modulated to maintain the static pressure.
- The cooling valve and outside air damper remain shut.
- The electric heat stages remain OFF.

The warm-up, cool-down and normal modes are pre-conditioning modes. They place the building at a proper temperature level before normal occupancy.

Occupied mode

After pre-conditioning is done (warm-up, cool-down or normal mode), the application is set to the occupied mode (value 60). This requires a field panel. The field panel must change the value of the point MODE (number 25) to the occupied mode value of 60. The field panel must then release MODE back to normal control so the controller can change it as needed.

The occupied mode has two distinct parts to it: the coast period and the regular occupied period. When the application is first sent into the occupied mode, the controller starts the coast period which stays in effect for the amount of time stored in the point OCC TIME (number 62). After the amount of time stored in OCC TIME has elapsed, the controller places the application into the regular occupied period.

The following occurs during the coast period:

- The point FAN (number 46) remains ON and the fan alarm remains enabled.
- The static pressure loop remains enabled and the variable speed drive is modulated to maintain the static pressure.
- The cooling valve remains shut.
- The electric heat stages remain OFF.
- The outside air damper is set to minimum position. This minimum position changes with the speed of the variable speed drive, and is controlled by a table statement in the application's firmware. When the drive speeds up, the damper closes more. When the drive slows down, the damper opens more. The user can adjust this table statement with the following parameters:
  - Point VSD LO (number 90) – The lowest drive speed this table statement looks at.
  - Point OA DPR HI (number 91) – The highest minimum OA DAMPER position used. This is used when the point AOV 3 (number 40) equals VSD LO.
  - Point VSD HI (number 89) – The highest drive speed this table statement looks at.
  - Point OA DPR LO (number 92) – The lowest minimum OA DAMPER position used. This is used when AOV 3 equals VSD HI.

The application does the following during the regular occupied period:

- FAN remains ON and the fan alarm remains enabled.
- The static pressure loop remains enabled and the variable speed drive is modulated to maintain the static pressure.
- The heating loop is enabled and the heating stages are controlled in order to maintain the HTG SAT STPT. Refer to the *Electric heat control* section for more information
- The HTG SAT STPT value is adjusted by a table statement located in the controller. When the point MAX RM TEMP (number 21) rises, HTG SAT STPT falls and vice versa. The user can adjust this table statement with the following parameters:
  - Point RM LOH (number 50) – The lowest maximum room temperature that this table statement looks at.
  - Point HSTP HIO (number 13) – The highest HTG SAT STPT used. This is used when MAX RM TEMP equals RM LOH.
  - Point RM HIH (number 49) – The highest maximum room temperature that this table statement looks at.
  - Point HSTP LOO (number 14) – The lowest HTG SAT STPT used. This is used when MAX RM TEMP equals RM HIH.
- The cooling loop is enabled and controls both the cooling valve and the outside air damper in sequence to maintain the point CLG SAT STPT (number 9). Refer to the *Cooling valve, outside air damper interaction in occupied mode* section for a detailed explanation of cooling valve and outside air damper control during the regular occupied period.

- The CLG SAT STPT value is adjusted by a table statement located in the controller. When MAX RM TEMP rises, CLG SAT STPT falls and vice versa. The user can adjust this table statement with the following parameters:
  - Point RM LOC (number 19) – The lowest maximum room temperature that this table statement looks at.
  - Point CSTP HIO (number 7) – The highest CLG SAT STPT used. This is used when MAX RM TEMP equals RM LOC.
  - Point RM HIC (number 18) – The highest maximum room temperature that this table statement looks at.
  - Point CSTP LOO (number 8) – The lowest CLG SAT STPT used. This is used when MAX RM TEMP equals RM HIC.

NOTE: Since the heating and cooling loops are both fully operational during the regular occupied period, the user must choose the parameters in the table statements carefully to avoid simultaneous heating and cooling. These parameters should be set such that CLG SAT STPT is always greater than HTG SAT STPT. (These parameters are: RM LOH, HSTP HIO, RM HIH, HSTP LOO, RM LOC, CSTP HIO, RM HIC and CSTP LOO). Refer to *Set point selection* section for more information.

Undefined mode

It is possible to adjust the point MODE (number 25) to be in an undefined mode (for example, a value of 80). When this occurs, the following happens:

- The point FAN (number 46) turns ON.
- The static pressure loop remains enabled and the variable speed drive is modulated to maintain the static pressure.
- The cooling loop is disabled, and the point SA CLO (number 34) equals 0.
- The cooling valve is shut.
- The heating loop is disabled, and the point SA HLO (number 33) equals 0.
- The electric heat stages are OFF.
- The outside air damper is set to minimum position. This minimum position changes with the speed of the variable speed drive, and is controlled by a table statement in the application's firmware. (The OA damper behaves exactly like it does in the coast period of the occupied mode.)

Application mode operation when TIME CLOCK equals YES

Up until now, all explanations of mode operation have shared the assumption that the point TIME CLOCK (number 81) equals NO. Mode operation will now be explained with TIME CLOCK equal to YES.

When TIME CLOCK equals YES, the application mode is determined by the point TIME CLK DI2 (number 24). A field panel is not needed to change the value of the point MODE (number 25). Since TIME CLK DI2 has just two states (open and closed), only two modes are used when TIME CLOCK equals YES. When TIME CLK DI2 is open, MODE is set to the shutdown mode (value 0); when TIME CLK DI2 is closed, MODE is set to the occupied mode (value 60). The operation of the shutdown and occupied modes is identical to that explained previously, the only exception being the regular period of the occupied mode.

In the regular period of the occupied mode (when TIME CLOCK equals YES), both the points HTG SAT STPT (number 10) and CLG SAT STPT (number 9) are set from table statements driven by the point MAX RM TEMP (number 21). When TIME CLOCK equals NO, MAX RM TEMP is a temperature value that is adjusted by a field panel. When TIME CLOCK equals YES, MAX RM TEMP is a temperature *differential* value between the point RAT.RTS (number 04) and the set point dial. Refer to *Set point selection* for more information.

Fan alarm

The fan is considered to be in alarm if airflow is not detected a short while after the fan has been turned ON. Air detection comes from a fan proof connected to the point FAN PROOF (number 26). The amount of time that is allowed to pass before airflow must be detected is user adjustable and held in the point ALARM TIME (number 63). When an alarm condition occurs, the fan's status changes from normal to failed (status letter of FAN point (number 46) changes from N to F). The fan's status then remains failed (even if the alarm condition goes away) for at least the amount of time stored in the point OCC TIME (number 62). After the fan's status has been failed for the amount of time stored in OCC TIME, this module checks the status of the fan proof DI. If it is ON, then the fan's status is returned to normal (FAN status changes from F to N). If it is still OFF (while the fan DO is ON), then the fan's status remains failed (again) for at least the amount of time stored in OCC TIME.

When FAN is OFF, the fan's status is reset to normal.

When the fan's status is failed, this application operates as follows:

- FAN is ON.
- The static pressure loop is enabled, and the variable speed drive is controlled normally.
- The cooling loop is disabled and the cooling valve is shut.
- The heating loop is disabled and the electric heat stages are OFF.
- The OA damper will be in one of three positions:
  - Speed adjusted minimum position: if MODE (number 25) equals occupied (value 60) or undefined (value 70).
  - Fully open: if MODE equals night purge (value 10).
  - Fully closed: if MODE equals shutdown (value 0), recirculation (value 20), warm-up (value 40), normal (value 30) or cool-down (value 50).

Electric heat control

The number of heating stages available is stored in the point HTG STAGES (number 85). If a heating stage is not available, the application will not try to control it. For example, no attempt will be made to control the third stage of electric heat, DO 5, if HTG STAGES is 2 or less. This allows for spare digital outputs that may be used for other things.

A heating stage will be OFF if at least one of the following is true:

- The fan is OFF.
- The fan is in alarm.
- The heat load is small enough that this stage of heat can be turned OFF. (See *SA HLO FALLING* below.)

A heating stage may turn back ON only if **all** of the following are true:

- The fan is ON.
- The fan's status is normal.
- The heat load is large enough to justify turning on this particular stage of electric heat. (See *SA HLO RISING* below.)

The heat load is determined by the heating loop's output, SA HLO. Specifically, SA HLO controls the stages of electric heat as follows:

SA HLO RISING

- When SA HLO rises above the point HTG STG1 ON (number 30), the first heating stage (DO 3) turns on.
- When SA HLO rises above the point HTG STG2 ON (number 31), the second heating stage (DO 4) turns on.
- When SA HLO rises above 96%, the third heating stage (DO 5) turns on.

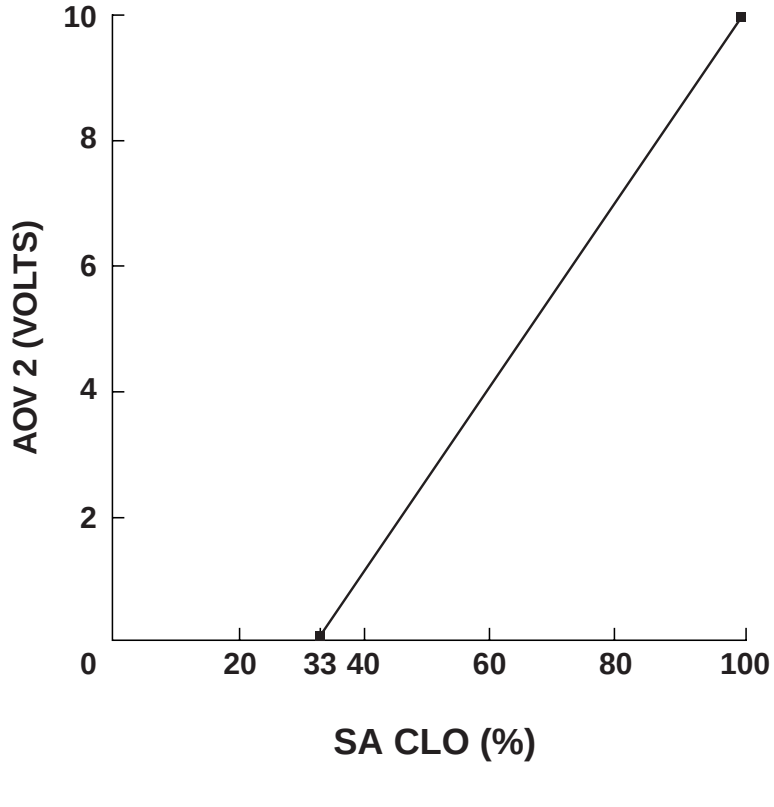
SA HLO FALLING

- When SA HLO drops below HTG STG2 ON, the third heating stage (DO 5) turns off.
- When SA HLO drops below HTG STG1 ON, the second heating stage (DO 4) turns off.
- When SA HLO drops below 5%, the first heating stage (DO 3) turns off.

In the calculations that determine, on the basis of heat load, whether a stage of electric heat should be turned ON or OFF, a deadband is included to prevent digital ON/OFF points from wearing out due to excessive toggling. For example, if SA HLO drops below 5% and then rises to a value halfway between 5% and HTG STG1 ON, then the first stage of heat will be OFF. However, if SA HLO rises above HTG STG1 ON and then drops to a value halfway between 5% and HTG STG1 ON, then the first stage of heat will be ON.

Cooling valve, outside air damper interaction in cool-down mode

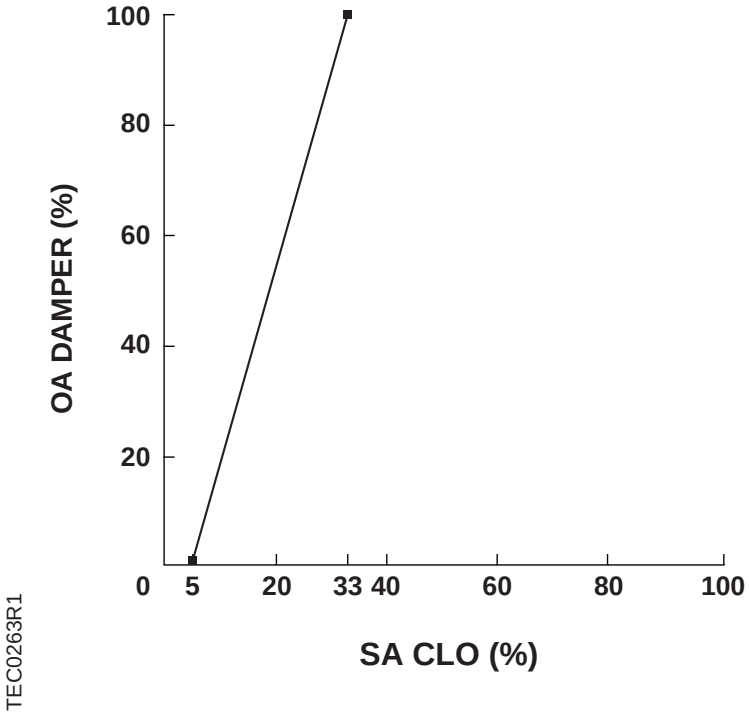
During the cool-down mode, the cooling loop modulates the cooling valve to maintain the current point CLG SAT STPT (number 9). The cooling valve does not start opening until the output of the cooling loop point SA CLO (number 34) is greater than 33%. This allows the cooling loop to use the outside air damper as a source of free cooling when weather permits. The cooling valve uses the point AOV 2 (number 39). The AOV 2 value is scaled to go from 0 to 10 volts as SA CLO goes from 33% to 100%. Refer to Figure 2309-9.



NOTE: As the point SA CLO (number 34) goes from 33% to 100%, the point AOV 2 (number 39) goes from 0 to 10 volts. This causes the cooling valve to go from fully closed to fully open.

Figure 2309-9. Control of Cooling Valve in Cool-down Mode.

During cool-down, the outside air damper is either a source of free cooling or it is shut. When the outside air temperature (OA TEMP, number 22) is greater than the point TOO HOT (number 23), free cooling is unavailable and the outside air damper is shut. When OA TEMP is less than TOO HOT – 1.11°C, free cooling is available, and the cooling loop modulates the outside air damper to maintain the current CLG SAT STPT, with the damper scaled from 0% to 100% open as SA CLO goes from 5% to 33%. Refer to Figure 2309-10.



NOTE: As the point SA CLO (number 34) goes from 5% to 33%, the point OA DAMPER (number 84) goes from 0% open to 100% open.

Figure 2309-10. Control of OA Damper in Cool-Down Mode.

When used as a source of free cooling, the outside air damper is not allowed below the speed adjusted minimum position, regardless of how low SA CLO gets. This speed adjusted minimum position comes from the following table statement which is built into the application:

TABLE(AOV 3, OA DAMPER, VSD LO, OA DPR HI, VSD HI, OA DPR LO)

This table statement operates the same as a PPCL table statement. Its parameters were explained earlier in the *Occupied mode* section.

When the outside air temperature is less than TOO HOT and greater than TOO HOT – 1.11°C, the operation of the outside air damper remains unchanged. If it was closed before, it remains closed, while if it was used as a source of free cooling before, it continues as a source of free cooling.

Cooling valve, outside air damper interaction in occupied mode

In this mode, unlike the cool-down mode, the outside air damper does not shut completely when the outside air temperature is too warm to be used as a source of free cooling (OA TEMP > TOO HOT). Instead, the damper will be used for ventilation and adjusted to the speed adjusted minimum position. This speed adjusted minimum position comes from the following table statement which is built into the application:

TABLE(AOV 3, OA DAMPER, VSD LO, OA DPR HI, VSD HI, OA DPR LO)

This table statement operates the same as a PPCL table statement. Its parameters were explained earlier in the *Occupied mode* section.

Except for the action of the outside air damper when it is not being used as a source of free cooling, the interaction of the cooling valve and the outside air damper during the occupied mode (regular period) is identical to their interaction during the cool-down mode.

Set point selection

This application changes the heating and cooling supply air temperature set points as the mode changes. The selection process differs depending on whether a physical set point dial is used with the room/return air temperature sensor.

NOTE: Whether or not the temperature sensor is used in a room or in the return air, its point is called RAT.RTS (number 04) for *return air temperature/room temperature sensor* (this conserves points).

This section does not include information on static pressure set point selection (SP STPT, number 57), except to say that the static pressure loop's set point selection process is simple: the user types in a desired static pressure set point which remains in effect until the user types in a new one.

The heating and cooling supply air temperature set point selection process is explained in 3 parts:

- Set point selection that does not depend on the presence or absence of a physical set point dial
- Set point selection unique to the absence of a physical set point dial
- Set point selection unique to the presence of a physical set point dial

Set point selection that does not depend on the presence or absence of a physical set point dial.

The heating supply air temperature set point (HTG SAT STPT, number 10) and cooling supply air temperature set point (CLG SAT STPT, number 9) are set to drive the cooling valve closed and turn the electric heating stages OFF when at least one of the following conditions is in effect (regardless of whether a physical set point dial is used):

- The point FAN (number 46) is OFF.

- The point MODE (number 25) is in shutdown (value 0), night purge (value 10), recirculation (value 20) or normal (value 30).
- The application is in the coast period of the occupied mode.

To ensure that the cooling valve is driven shut and the electric heat stages are turned OFF, the point HTG SAT STPT is set to SAT – 5°C and the point CLG SAT STPT is set to SAT + 5°C.

Set point selection that is unique to the absence of a physical set point dial.

A room/return air temperature sensor without a physical set point dial is only used when a field panel is available to assist the controller in setting the value of MODE. In such cases the temperature sensor is more likely to be located in the return air rather than in a room. If TIME CLOCK (number 81) equals NO, then the application assumes a physical set point dial is not being used.

When MODE equals warm-up (value 40) or cool-down (value 50), both HTG SAT STPT and CLG SAT STPT are set from internal table statements driven by the point RAT.RTS. Refer to the *Warm-up mode* section for a detailed description of the table statement that sets HTG SAT STPT; refer to the *Cool-down mode* section for a detailed description of the table statement that sets CLG SAT STPT.

The cooling supply air temperature loop is not active during the warm-up mode; likewise, the heating supply air temperature loop is not active during the cool-down mode. Therefore, the cooling table statement and heating table statement can be set as desired for the cool-down and warm-up modes without worrying about simultaneous heating and cooling.

When the application is in the regular period of the occupied mode, HTG SAT STPT and CLG SAT STPT are set from table statements driven by the point MAX RM TEMP (number 21). Unless the field panel changes the value of MAX RM TEMP, the table statements are worthless because MAX RM TEMP will remain constant, as will HTG SAT STPT and CLG SAT STPT. The specific forms of these two table statements are:

TABLE(MAX RM TEMP, CLG SAT STPT, RM LOC, CSTP HIO, RM HIC, CSTP LOO)

TABLE(MAX RM TEMP, HTG SAT STPT, RM LOH, HSTP HIO, RM HIH, HSTP LOO)

During the regular period of the occupied mode, both the heating and cooling supply air temperature loops are active. Therefore, care must be taken when setting up these table statements to avoid simultaneous heating and cooling. The user adjustable parameters are explained here for a better understanding of how to do this:

HTG SAT STPT (when MAX RM TEMP rises, HTG SAT STPT falls and vice versa):

- Point RM LOH (number 50) – The lowest value of MAX RM TEMP that this table statement looks at.
- Point HSTP HIO (number 13) – The highest HTG SAT STPT used. This is used when MAX RM TEMP equals RM LOH.
- Point RM HIH (number 49) – The highest value of MAX RM TEMP that this table statement looks at.
- Point HSTP LOO (number 14) – The lowest HTG SAT STPT used. This is used when MAX RM TEMP equals RM HIH.

CLG SAT STPT (when MAX RM TEMP rises, CLG SAT STPT falls and vice versa):

- Point RM LOC (number 19) – The lowest value of MAX RM TEMP that this table statement looks at.
- Point CSTP HIO (number 7) – The highest CLG SAT STPT used. This is used when MAX RM TEMP equals RM LOC.
- Point RM HIC (number 18) – The highest value of MAX RM TEMP that this table statement looks at.
- Point CSTP LOO (number 8) – The lowest CLG SAT STPT used. This is used when MAX RM TEMP equals RM HIC.

A recommended way of setting up the parameters of the two table statements to avoid simultaneous heating and cooling is as follows:

1. Set RM LOC equal to RM LOH.
2. Set RM HIC equal to RM HIH.
3. Set CSTP HIO higher than HSTP HIO by 1°C.
4. If you set CSTP HIO 1°C higher than HSTP HIO, then set CSTP LOO 1°C higher than HSTP LOO.

Figure 2309-11 graphically illustrates the table statements with parameters set as suggested.

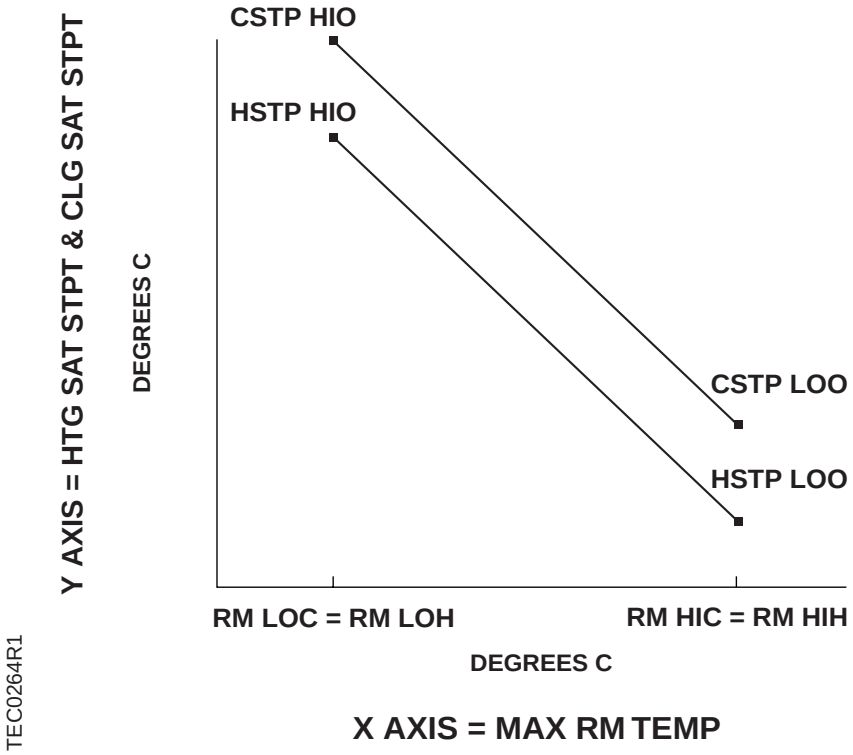


Figure 2309-11. Setting Up Table Statement Parameters to Avoid Simultaneous Heating and Cooling (Set Point Dial Not Used).

If the table statement parameters are set as suggested, then one of three things occurs:

- The supply air temperature is higher than CLG SAT STPT. When this occurs, the supply air temperature is also higher than HTG SAT STPT. While the cooling valve opens to satisfy CLG SAT STPT, the electric heat stages will be OFF because the supply air temperature is already warmer than HTG SAT STPT.
- The supply air temperature is lower than HTG SAT STPT. When this occurs, the supply air temperature is also lower than CLG SAT STPT. While the electric heat stages will be controlled to satisfy HTG SAT STPT, the cooling valve will close because the supply air temperature is already cooler than CLG SAT STPT.
- The supply air temperature is between HTG SAT STPT and CLG SAT STPT. In this case, both set points are satisfied. The cooling valve will be driven shut and the electric heat stages will be turned OFF.

Set point selection that is unique to the presence of a physical set point dial.

A room/return air temperature sensor with a physical set point dial is only used when a field panel is not available and the controller is stand-alone. In such cases the temperature sensor is located in a room rather than in the return air duct. (If it were located in the return air duct, the customer would have to climb into this duct to change the set point dial.) Even though the sensor is located in a room it is still called RAT.RTS. If TIME CLOCK (number 81) equals YES, then the application assumes a physical set point dial is being used.

When a physical set point dial is being used and TIME CLOCK equals YES, only two modes are used: shutdown (value 0) and occupied (value 60). If MODE is accidentally set to either warm-up (value 40) or cool-down (value 50), then CLG SAT STPT and HTG SAT STPT are set to drive the cooling valve closed and the electric heat stages OFF. This is done by setting HTG SAT STPT equal to SAT – 5°C. and CLG SAT STPT equal to SAT + 5°C.

The physical set point dial affects the heating and cooling supply air temperature set points only when the application is in the regular period of the occupied mode. During this period, the application will not use all of the physical set point dial's range — both high and low limits are placed on the range of the physical set point dial. Two points are used to achieve this. The physical set point dial uses the point RM STPT DIAL (number 95). The application uses an internal point (one that is not visible to the user) called RTS_DIAL_USED.

- When RM STPT DIAL is between the values of 18°C and 26°C, RTS_DIAL_USED equals RM STPT DIAL.
- If RM STPT DIAL is less than 18°C, then RTS_DIAL_USED equals 18°C.
- If RM STPT DIAL is greater than 26°C, then RTS_DIAL_USED equals 26°C.

During the occupied mode (regular period) with a physical set point dial present, HTG SAT STPT and CLG SAT STPT are set from internal table statements driven by the point MAX RM TEMP. MAX RM TEMP differs depending on whether a set point dial is present or absent. In the absence of a set point dial, MAX RM TEMP is a temperature value. When a set point dial is present, MAX RM TEMP is **a differential plus a constant:**

MAX RM TEMP = RAT.RTS – RTS_DIAL_USED + 22.5°C

The functional part of MAX RM TEMP is the differential (RAT.RTS – RTS_DIAL_USED). The 22.5°C is added to conserve points (it allows the differential to be stored in MAX RM TEMP because the slope and intercept of MAX RM TEMP do not need to be changed even though MAX RM TEMP is now being used as a differential and not a temperature).

The specific forms of the table statements driven by MAX RM TEMP are as follows:

TABLE(MAX RM TEMP, CLG SAT STPT, RM LOC, CSTP HIO, RM HIC, CSTP LOO)

TABLE(MAX RM TEMP, HTG SAT STPT, RM LOH, HSTP HIO, RM HIH, HSTP LOO)

Because both the heating and cooling supply air temperature loops are active during the regular period of the occupied mode, care must be taken when setting up the table statements to avoid simultaneous heating and cooling. The user adjustable parameters are explained here again for a better understanding of how to do this:

HTG SAT STPT (when MAX RM TEMP rises, HTG SAT STPT falls and vice versa):

- Point RM LOH (number 50) – The lowest value of MAX RM TEMP that this table statement looks at.
- Point HSTP HIO (number 13) – The highest HTG SAT STPT used. This is used when MAX RM TEMP equals RM LOH.
- Point RM HIH (number 49) – The highest value of MAX RM TEMP that this table statement looks at.
- Point HSTP LOO (number 14) – The lowest HTG SAT STPT used. This is used when MAX RM TEMP equals RM HIH.

CLG SAT STPT (when MAX RM TEMP rises, CLG SAT STPT falls and vice versa):

- Point RM LOC (number 19) – The lowest value of MAX RM TEMP that this table statement looks at.
- Point CSTP HIO (number 7) – The highest CLG SAT STPT used. This is used when MAX RM TEMP equals RM LOC.
- Point RM HIC (number 18) – The highest value of MAX RM TEMP that this table statement looks at.
- Point CSTP LOO (number 8) – The lowest CLG SAT STPT used. This is used when MAX RM TEMP equals RM HIC.

The following is a recommended way of setting up these table statement parameters to avoid simultaneous heating and cooling. Keep in mind that MAX RM TEMP is a differential and not a normal temperature value.

1. Determine how far below the set point dial you want the room temperature to be for maximum heating to occur. Add 22.5°C to this value and store it in RM LOH. For example, if you want HTG SAT STPT to equal HSTP HIO when RAT.RTS is 3°C less than RTS_DIAL_USED, then RM LOH equals –3°C + 22.5°C, or 19.5°C.
2. Set RM LOC equal to RM LOH.

3. Determine how far you want the room temperature to be above the set point dial for maximum cooling to occur. Add 22.5°C to this value and store it in RM HIC. For example, if you want CLG SAT STPT to equal CSTP LOO when RAT.RTS is 3°C greater than RTS_DIAL_USED, then RM HIC equals 3°C + 22.5°C, or 25.5°C.
4. Set RM HIH equal to RM HIC.
5. Set CSTP HIO higher than HSTP HIO by 1°C.
6. If you set CSTP HIO 1°C higher than HSTP HIO, then set CSTP LOO 1°C higher than HSTP LOO.

Figure 2309-12 graphically illustrates the table statements with parameters set as suggested.

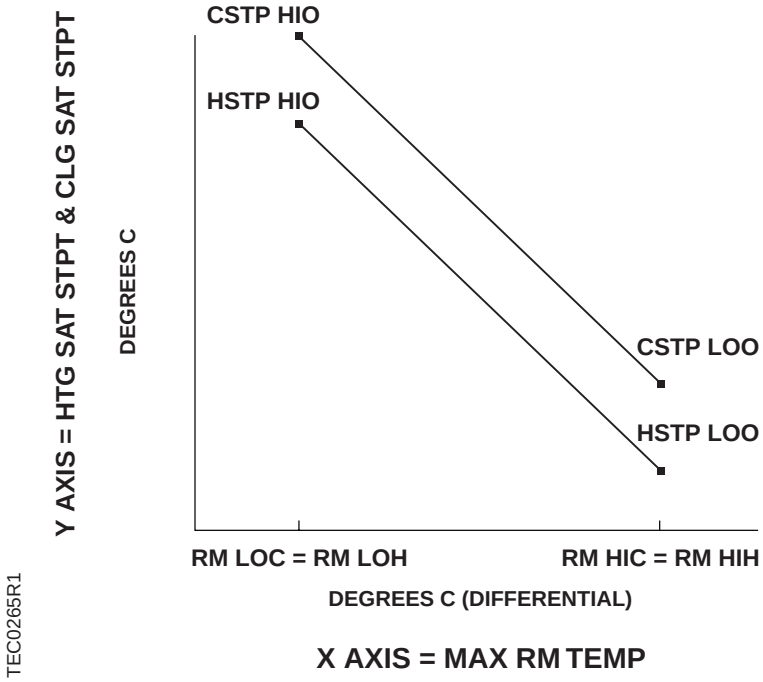


Figure 2309-12. Setting Up Table Statement Parameters to Avoid Simultaneous Heating and Cooling (Set Point Dial Used).

If the table statement parameters are set this way, then one of three things occurs:

- The supply air temperature is higher than CLG SAT STPT. When this occurs, the supply air temperature is also higher than HTG SAT STPT. While the cooling valve opens to satisfy CLG SAT STPT, the electric heat stages will be OFF because the supply air temperature is already warmer than HTG SAT STPT.
- The supply air temperature is lower than HTG SAT STPT. When this occurs, the supply air temperature is also lower than CLG SAT STPT. While the electric heat stages will be controlled to satisfy HTG SAT STPT, the cooling valve will close because the supply air temperature is already cooler than CLG SAT STPT.
- The supply air temperature is between HTG SAT STPT and CLG SAT STPT. In this case, both the set points are satisfied. The cooling valve will be driven shut and the electric heating stages will be turned OFF.

When a physical set point dial is being used, MAX RM TEMP changes in value if either the room temperature sensor or the set point dial change in value. However, the table statement values are constant; they do not change in value as the room temperature sensor and the set point dial change. (Table statement parameters are RM LOC, RM HIC, CSTP HIO, CSTP LOO, RM LOH, RM HIH, HSTP HIO, HSTP LOO).

Static pressure sensor failure

If the static pressure sensor fails, then the following occurs:

- The fan shuts OFF immediately (no waiting for the shutdown timer to time out).
- The static pressure loop is disabled, and the variable speed drive, point AOV 3 (number 40), is set to 0 volts.
- The heating and cooling loops are disabled. The points SA CLO (number 34) and SA HLO (number 33) will both equal 0.
- The cooling valve and outside air damper are shut.
- The electric heating stages are OFF.
- The point MODE (number 25) remains unchanged.

The application will resume operation in its last known mode if the static pressure sensor returns to normal, provided the value of MODE was not changed by the field panel, the point TIME CLK DI2 (number 24) or the user while the static pressure sensor was failed.

Application notes

1. The point FAN (number 46) can be commanded directly. When FAN is commanded OFF, the application behaves as though it were in shutdown mode (the application shuts down immediately without waiting for the shutdown timer to time out). The value of MODE (number 25) is not affected, so that when FAN is released to normal control, the application resumes regular operation according to the value held in MODE.

2. This application uses the point PURGE OK (number 82) to determine whether to go into the night purge mode. However, the application does not command PURGE OK; that must be done using PPCL in a field panel.

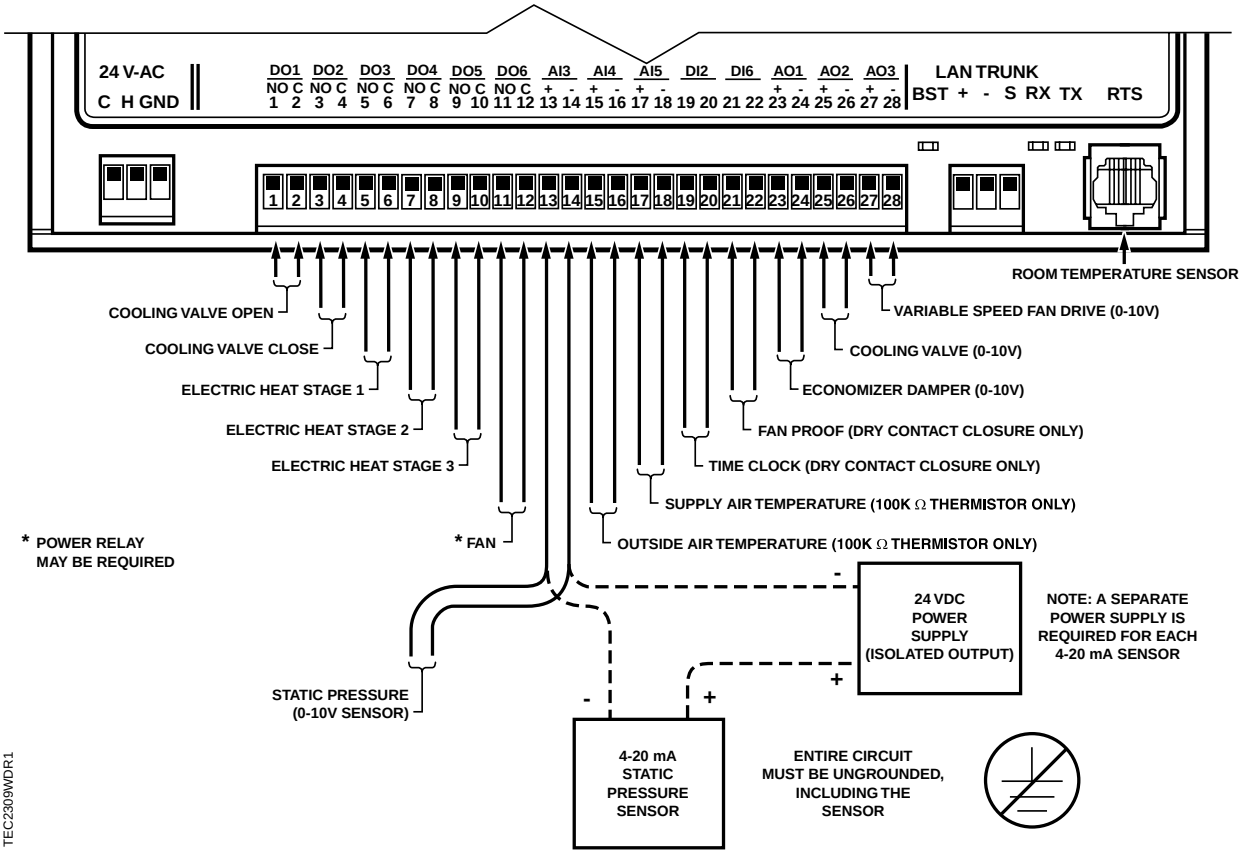
3. When the point TIME CLOCK (number 81) equals NO, the point MAX RM TEMP (number 21) must be set by PPCL in a field panel.

Wiring diagram

The point wiring for Application 2309 is shown in Figure 2309-13.

CAUTION:

The Australian Small Point Controller controls 24 Vac loads only. The maximum rating is 12 VA for each DO. For higher VA requirements, 110 or 220 Vac requirements, or DC power requirements, use an interposing 220 V 4-relay module.



NOTE: If AI 3 monitors a 0-10 V static pressure sensor, then dip-switch located behind AI 3 on controller's circuit board must be set to the left (*voltage* position). If AI 3 monitors a 4-20 mA SP sensor, then dip-switch must be set to the right (*current* position).

Figure 2309-13. Application 2309 Wiring Diagram.

Table 2309-2. Point Database for Application 2309.

Point Number	Descriptor	Factory Default (SI Units)	Engr Units (SI Units)	Slope (SI Units)	Intercept (SI Units)	On Text	Off Text
01	CTLR ADDRESS	99	--	1	0	--	--
02	APPLICATION	2393	--	1	0	--	--
{03}	VSD	0.0	PCT	0.4	0.0	--	--
{04}	RAT.RTS	74.0 (23.45)	DEG F (DEG C)	0.25 (0.14)	48.0(8.89)	--	--
05	CSTP HI	74.0 (23.496)	DEG F (DEG C)	0.5 (0.28)	37.5(3.056)	--	--
06	CSTP LO	57.0 (13.976)	DEG F (DEG C)	0.5 (0.28)	37.5(3.056)	--	--
07	CSTP HIO	71.5 (22.096)	DEG F (DEG C)	0.5 (0.28)	37.5(3.056)	--	--
08	CSTP LOO	57.0 (13.976)	DEG F (DEG C)	0.5 (0.28)	37.5(3.056)	--	--
{09}	CLG SAT STPT	74.0 (23.496)	DEG F (DEG C)	0.5 (0.28)	37.5(3.056)	--	--
{10}	HTG SAT STPT	70.0 (21.256)	DEG F (DEG C)	0.5 (0.28)	37.5(3.056)	--	--
11	HSTP HI	86.0 (30.216)	DEG F (DEG C)	0.5 (0.28)	37.5(3.056)	--	--
12	HSTP LO	74.0 (23.496)	DEG F (DEG C)	0.5 (0.28)	37.5(3.056)	--	--
13	HSTP HIO	86.0 (30.216)	DEG F (DEG C)	0.5 (0.28)	37.5(3.056)	--	--
14	HSTP LOO	74.0 (23.496)	DEG F (DEG C)	0.5 (0.28)	37.5(3.056)	--	--
{15}	STATIC PRES	0	PASCAL	1	0	--	--
16	RAT HIC	82.5 (28.21)	DEG F (DEG C)	0.25 (0.14)	48.0(8.89)	--	--
17	RAT LOC	74.0 (23.45)	DEG F (DEG C)	0.25 (0.14)	48.0(8.89)	--	--
18	RM HIC	72.5 (22.656)	DEG F (DEG C)	0.5 (0.28)	37.5(3.056)	--	--
19	RM LOC	68.0 (20.136)	DEG F (DEG C)	0.5 (0.28)	37.5(3.056)	--	--
{21}	MAX RM TEMP	85.0 (29.656)	DEG F (DEG C)	0.5 (0.28)	37.5(3.056)	--	--
{22}	OA TEMP	74.0 (23.496)	DEG F (DEG C)	0.5 (0.28)	37.5(3.056)	--	--
23	TOO HOT	72.0 (22.376)	DEG F (DEG C)	0.5 (0.28)	37.5(3.056)	--	--
{24}	TIME CLK DI2	OFF	--	--	--	ON	OFF
{25}	MODE	0	--	1	0	--	--
{26}	FAN PROOF	OFF	--	--	--	ON	OFF
27	PURGE START	80.0 (26.856)	DEG F (DEG C)	0.5 (0.28)	37.5(3.056)	--	--
28	PURGE END	75.0 (24.056)	DEG F (DEG C)	0.5 (0.28)	37.5(3.056)	--	--
30	HTG STG1 ON	32.0	PCT	0.4	0.0	--	--
31	HTG STG2 ON	64.0	PCT	0.4	0.0	--	--
{33}	SA HLO	0.0	PCT	0.4	0.0	--	--
{34}	SA CLO	0.0	PCT	0.4	0.0	--	--
35	SP P GAIN	0.0	--	0.025	0.0	--	--
36	SP I GAIN	0.001	--	0.0001	0.0	--	--
37	AO DIR.REV	0	--	1	0	--	--
{38}	AOV 1	0.0	VOLTS	0.01	0.0	--	--

1. Points not listed are not used in this application.
2. A single value in a column means that the value is the same in English units and in SI units.
3. Point numbers that appear in brackets {} may be unbundled at the field panel.

continued on the next page…

Table 2309-2. Point Database for Application 2309.

Point Number	Descriptor	Factory Default (SI Units)	Engr Units (SI Units)	Slope (SI Units)	Intercept (SI Units)	On Text	Off Text
{39}	AOV 2	0.0	VOLTS	0.01	0.0	--	--
{40}	AOV 3	0.0	VOLTS	0.01	0.0	--	--
{41}	DO 1	OFF	--	--	--	ON	OFF
{42}	DO 2	OFF	--	--	--	ON	OFF
{43}	DO 3	OFF	--	--	--	ON	OFF
{44}	DO 4	OFF	--	--	--	ON	OFF
{45}	DO 5	OFF	--	--	--	ON	OFF
{46}	FAN	OFF	--	--	--	ON	OFF
47	RAT HIH	74.0 (23.45)	DEG F (DEG C)	0.25 (0.14)	48.0(8.89)	--	--
48	RAT LOH	64.5 (18.13)	DEG F (DEG C)	0.25 (0.14)	48.0(8.89)	--	--
49	RM HIH	68.0 (20.136)	DEG F (DEG C)	0.5 (0.28)	37.5(3.056)	--	--
50	RM LOH	64.5 (18.176)	DEG F (DEG C)	0.5 (0.28)	37.5(3.056)	--	--
51	HTG NEEDED	64.5 (18.13)	DEG F (DEG C)	0.25 (0.14)	48.0(8.89)	--	--
52	CLG NEEDED	77.0 (25.13)	DEG F (DEG C)	0.25 (0.14)	48.0(8.89)	--	--
{56}	SUPPLY TEMP	74.0 (23.496)	DEG F (DEG C)	0.5 (0.28)	37.5(3.056)	--	--
{57}	SP STPT	250	PASCAL	1	0	--	--
59	DO DIR.REV	0	--	1	0	--	--
60	SHUTDN TIME	15	MIN	1	0	--	--
61	RECIRC TIME	15	MIN	1	0	--	--
62	OCC TIME	15	MIN	1	0	--	--
63	ALARM TIME	30	SEC	1	0	--	--
66	HTG P GAIN	10.0	--	0.5	0.0	--	--
67	HTG I GAIN	0.01	--	0.002	0.0	--	--
68	CLG P GAIN	10.0	--	0.5	0.0	--	--
69	CLG I GAIN	0.01	--	0.002	0.0	--	--
{70}	CLG VLV COMD	0.0	PCT	0.4	0.0	--	--
{71}	MTR1 POS	0.0	PCT	0.4	0.0	--	--
72	MTR1 TIMING	95	SEC	1	0	--	--
73	DPR1 ROT ANG	90	--	1	0	--	--
{74}	MTR2 COMD	0.0	PCT	0.4	0.0	--	--
{75}	MTR2 POS	0.0	PCT	0.4	0.0	--	--
76	MTR2 TIMING	95	SEC	1	0	--	--
77	DPR2 ROT ANG	90	--	1	0	--	--
78	MTR SETUP	0	--	1	0	--	--
79	SP RANGE	500	PASCAL	1	0	--	--

1. Points not listed are not used in this application.
2. A single value in a column means that the value is the same in English units and in SI units.
3. Point numbers that appear in brackets {} may be unbundled at the field panel.

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Table 2309-2. Point Database for Application 2309.

Point Number	Descriptor	Factory Default (SI Units)	Engr Units (SI Units)	Slope (SI Units)	Intercept (SI Units)	On Text	Off Text
81	TIME CLOCK	NO	--	--	--	YES	NO
{82}	PURGE OK	NO	--	--	--	YES	NO
{84}	OA DAMPER	0.0	PCT	0.4	0.0	--	--
85	HTG STAGES	0	--	1	0	--	--
89	VSD HI	100.0	PCT	0.4	0.0	--	--
90	VSD LO	40.0	PCT	0.4	0.0	--	--
91	OA DPR HI	25.2	PCT	0.4	0.0	--	--
92	OA DPR LO	10.0	PCT	0.4	0.0	--	--
{94}	CAL DPR	NO	--	--	--	YES	NO
{95}	RM STPT DIAL	74.0 (23.45)	DEG F (DEG C)	0.25 (0.14)	48.0(8.89)	--	--
96	CAL TIMER	12	HOURS	1	0	--	--
{99}	ERROR STATUS	0	--	1	0	--	--

1. Points not listed are not used in this application.
2. A single value in a column means that the value is the same in English units and in SI units.
3. Point numbers that appear in brackets {} may be unbundled at the field panel.