SIEMENS

TEC Custom Solutions Application 2452

VAV with Modified Parallel Fan Sequence and Electric Reheat

TEC-0168.08

This document contains the following topics:

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Overview

In Application 2452, the controller modulates the supply air damper of the terminal box for cooling and controls stages of electric reheat for heating. When in heating, the terminal box either maintains minimum airflow or modulates the supply air damper. The terminal box also has a parallel fan which recirculates the room air.

Application 2452 is based on Application 2026 (*VAV Parallel Fan Powered with Electric Reheat*). The only difference is the modified parallel fan sequence in Application 2452, where the fan can be configured to operate as the first stage of heat to take advantage of free heating opportunities. Otherwise, there is no difference between the applications.

In order for the terminal box to work properly, the central air handling unit must provide supply air. See Figures 2452-1 through 2452-5.

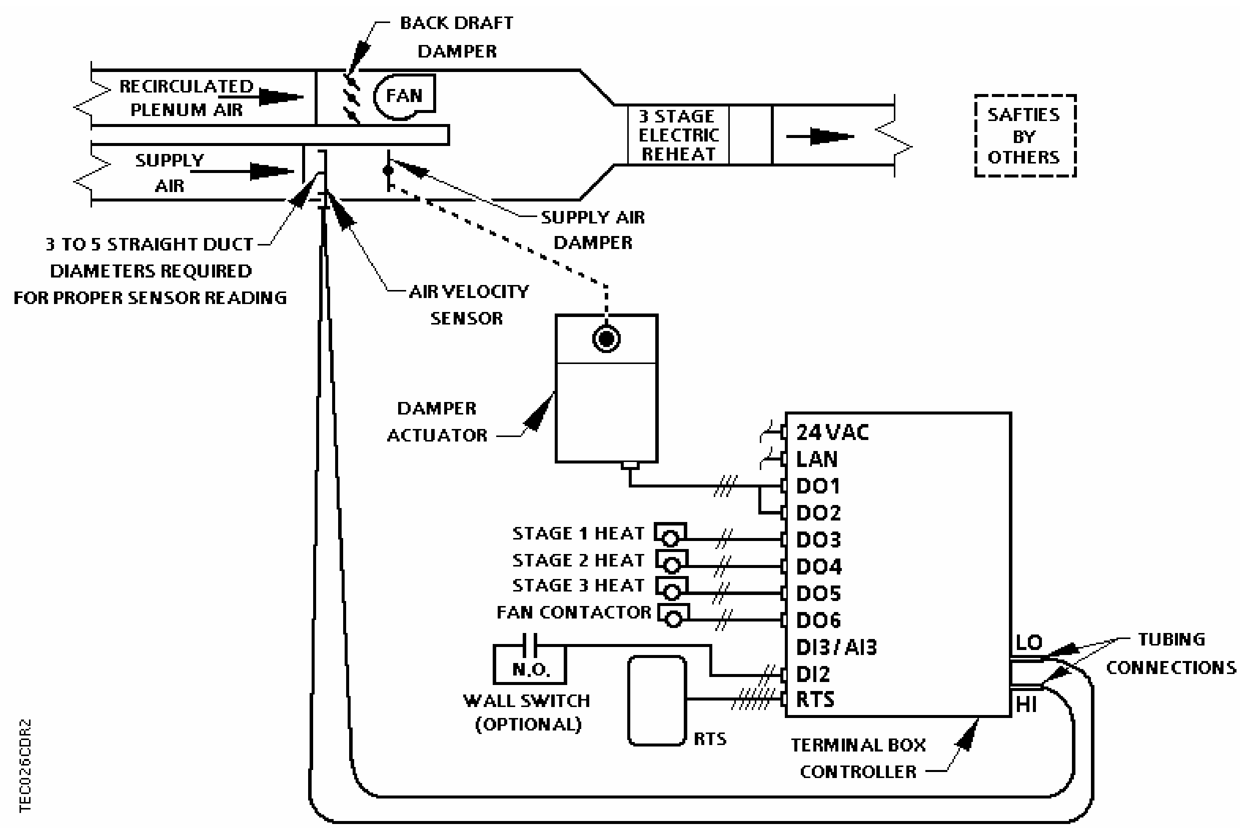
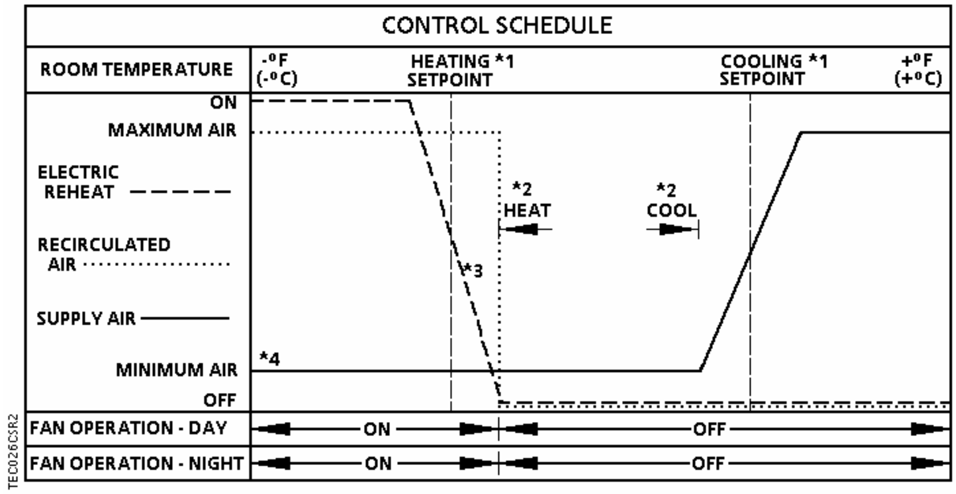
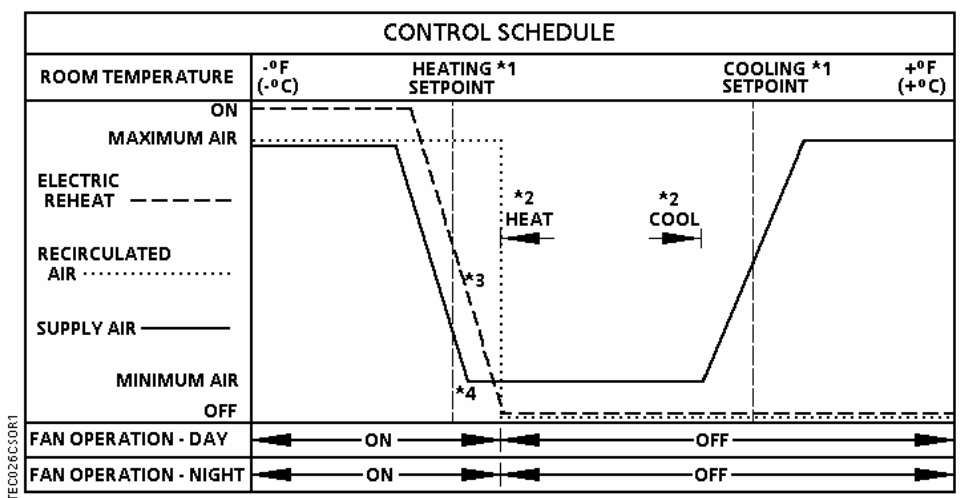


Figure 2452-1. Application 2452 Control Drawing.



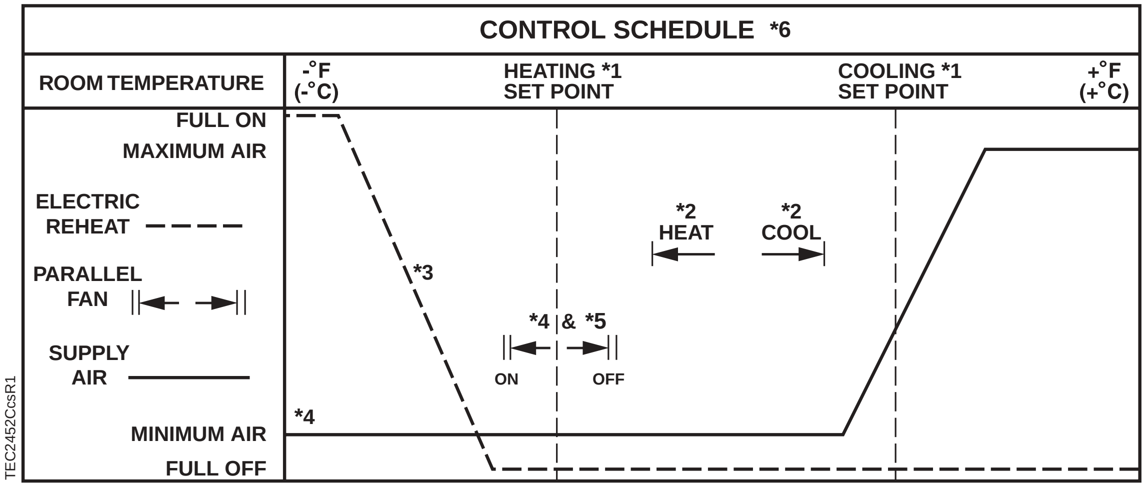
1. See *Control Temperature Setpoints.*
2. See *Heating/Cooling Switchover*.
3. The electric reheat is time modulated. This allows it to be controlled proportionally rather than with deadbands.
4. The airflow is shown at minimum flow throughout the entire heating mode. The airflow can also operate sequenced, parallel, or overlapping with the electric reheat (optional). See *Sequencing Logic—Fan Operation as in 2026*.
5. See *Fan Operation.*

Figure 2452-2. Control Schedule—Fan Operation as in Application 2026.



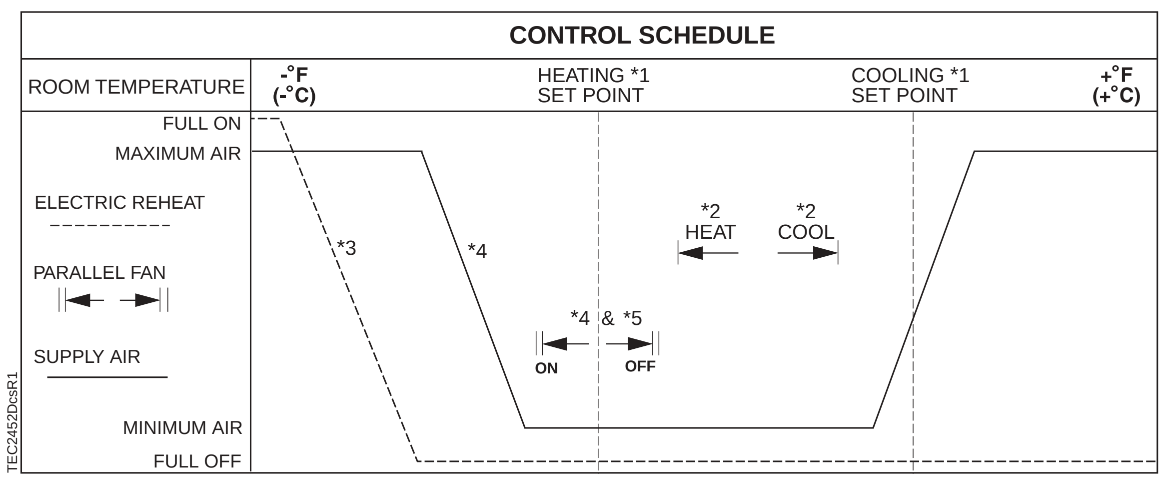
1. See *Control Temperature Setpoints*.
2. See *Heating/Cooling Switchover*.
3. The electric reheat is time modulated. This allows it to be controlled proportionally rather than with deadbands.
4. The airflow is shown operating parallel with the electric reheat (optional). The airflow can also operate at minimum flow throughout the entire heating mode, in series with the electric reheat or overlapping with the electric reheat. See *Sequencing Logic—Fan Operation as in 2026*.
5. See *Fan Operation.*

Figure 2452-3. Application 2452 Control Schedule with Modulating Damper in Heating Mode—Fan Operation as in Application 2026.



1. See *Control Temperature Setpoints*.
2. See *Heating/Cooling Switchover*.
3. The electric reheat is time modulated. This allows it to be controlled proportionally rather than with deadbands.
4. The airflow is shown at minimum flow throughout the entire heating mode, with the parallel fan operating as the first heating stage. The airflow can also operate sequenced, parallel, or overlapping with the electric reheat (optional), with the parallel fan operating as the first heating stage. See *Sequencing Logic—Fan Operating as a Stage of Heating*.
5. See *Fan Operation.*
6. This Control Schedule is the default method of control for Application 2452.

Figure 2452-4. Application 2452 Control Schedule—Fan Operating as 1st Heating Stage.



1. See *Control Temperature Setpoints*.
2. See *Heating/Cooling Switchover*.
3. The electric reheat is time modulated. This allows it to be controlled proportionally rather than with deadbands.
4. The airflow is shown operating in series with the electric reheat (optional). The airflow can also operate at minimum flow throughout the entire heating mode or overlapping with the electric reheat, with the parallel fan operating as the first heating stage. See *Sequencing Logic—Fan Operating as a Stage of Heating*.
5. See *Fan Operation.*

Figure 2452-5. Application 2452 Control Schedule with Modulating Damper in Heating Mode—Fan Operating as 1st Heating Stage.

Hardware Inputs

Analog

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

Digital

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

Hardware Outputs

Analog

- None

Digital

- Damper actuator
- Fan
- Stage 1 electric reheat
- Stage 2 electric reheat (optional)
- Stage 3 electric reheat (optional)

Ordering Notes

Order the controller from the Custom Solutions website as P/N 550-504C.
http://iknow.us.abatos.com/customsolutions

Sequence of Operation

The following paragraphs present the sequence of operation for Application 2452, *VAV with Modified Parallel Fan Sequence and Electric Reheat*.

Control Temperature Setpoints

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

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

If the setpoint dial is used and the value of RM STPT DIAL is less than the value of RM STPT MIN (Point 11), then CTL STPT holds the value of RM STPT MIN. If the value of RM STPT DIAL is greater than the value of RM STPT MAX (Point 12), then CTL STPT holds the value of RM STPT MAX.

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

NOTE: The value of CTL TEMP (Point 78) is the same as the value of ROOM TEMP (Point 4), unless CTL TEMP is overridden.

Day and Night Modes

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

When a wall switch is physically connected to the termination strip on the controller at DI 2 and WALL SWITCH (Point 18) equals YES, the controller monitors the status of DI 2. When the status of DI 2 (Point 24) is ON (the switch is closed), DAY.NGT will be set to DAY indicating that the controller is in day mode. When the status of DI 2 is OFF (the switch is open), DAY.NGT will be set to NIGHT indicating that the controller is in night mode.

When WALL SWITCH equals NO, the controller does not monitor the status of the wall switch, even if one is connected to it.If this is the case, and the controller is operating stand-alone, then the controller stays in day 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 DAY.NGT. See *Powers Process Control Language (*PPCL*) User's Manual* (125-1896) and *Field Panel User's Manual* (125-1895) for more information.

Night Mode Override Switch

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

It is only when the controller is in night mode that the override switch on the room sensor has any effect on the controller.

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), then the controller switches from heating to cooling mode by setting HEAT.COOL (Point 5) to COOL:

- HTG LOOPOUT (Point 80) is less than SWITCH LIMIT (Point 85).
- 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, then the controller switches from cooling to heating mode by setting HEAT.COOL to HEAT:

- CLG LOOPOUT (Point 79) is less than SWITCH LIMIT.
- 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.

Modulate damper during heating mode (optional)

CAUTION:

This heating/cooling switchover mechanism is not affected by the air temperature in the supply duct.

To change the value of HEAT.COOL (Point 5) based on the supply air temperature, you must command HEAT.COOL through PPCL. This is required when the flow loop will be used as a source of cooling in cooling mode and a source of heat in heating mode. (See Examples 1 through 3 in either *Sequencing Logic* sections.) If the flow loop is used in heating mode just to meet minimum air requirements, then the heating/cooling switchover mechanism operates as described in this section to control HEAT.COOL. (See Example 4 in *Sequencing Logic* sections.)

Control Loops

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

The cooling temperature loop generates cooling loopout which is then used to generate FLOW STPT (Point 93). FLOW STPT is the result of scaling the cooling loopout to the appropriate range of values determined by the points CLG FLOW MIN (Point 31) and CLG FLOW MAX (Point 32). In order to scale it, the loopout is multiplied by the range (MAX–MIN) and then added to the minimum setpoint.

When CLG FLOW MIN does not equal 0 cfm, then FLOW STPT does not equal CLG LOOPOUT (Point 79). The minimum flow setpoint is (CLG FLOW MIN ÷ CLG FLOW MAX) × 100% flow. And FLOW STPT is [CLG LOOPOUT × (100% – minimum setpoint)] + minimum setpoint.

Example

If CLG FLOW MIN = 200 cfm, and CLG FLOW MAX = 1000 cfm,
then, the minimum flow setpoint is:
(200 cfm, ÷ 1000 cfm,) × 100% flow = 20%

When CLG LOOPOUT is 0%, FLOW STPT equals 20% flow.
[0% × (100% – 20%)] + 20% = 20%
This ensures that the airflow out of the terminal box is no less than CLG FLOW MIN.

When CLG LOOPOUT is 50%, FLOW STPT equals 60% flow.
[50% × (100% – 20%)] + 20% = 60%

When CLG LOOPOUT is 100%, FLOW STPT equals 100% flow.
[100% × (100% – 20%)] + 20% = 100%

If the controller is in heating mode, then the operation of the flow loop is flexible. It can be set up to do one of the following:

- Constantly maintain an airflow out of the terminal box equal to HTG FLOW MIN (Point 33). If this option is chosen, then HTG LOOPOUT (Point 80) will control the electric reheat in order to maintain the room temperature.

If any of the following three options are chosen, then HTG LOOPOUT will control both the flow loop setpoint (FLOW STPT) and the electric reheat in order to maintain the room temperature.

- Operate in sequence with the electric reheat.
- Operate parallel with the electric reheat.
- Have its operation overlap with the operation of the electric reheat. See the *Sequencing Logic* sections for more information.

See the *Sequencing Logic* sections for more information.

HTG LOOPOUT will adjust the value of FLOW STPT differently depending on which flow loop setup is chosen. However, the following rule applies no matter what setup is chosen:

- In heating mode, FLOW STPT is never set below
  (HTG FLOW MIN ÷ HTG FLOW MAX) × 100% flow or above 100% flow.

Flow Loop – The flow loop maintains minimum and maximum airflows via CTL FLOW MIN (Point 76) and CTL FLOW MAX (Point 77).

When the controller is in cooling mode, CTL FLOW MIN equals CLG FLOW MIN and CTL FLOW MAX equals CLG FLOW MAX.

When the controller is in heating mode, CTL FLOW MIN equals HTG FLOW MIN and CTL FLOW MAX equals HTG FLOW MAX.

In Application 2452, you can set CLG FLOW MIN equal to, but not greater than, CLG FLOW MAX, and you can set HTG FLOW MIN equal to, but not greater than, HTG FLOW MAX. If the minimum and maximum values are set equal, then the flow loop becomes a constant volume loop and its ability to control temperature is lost.

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

FLOW (Point 75) is the input value for the flow loop. It is calculated as a percentage based on where AIR VOLUME (Point 35) is between 0 cfm and CTL FLOW MAX. In the following text, this percentage is referred to as *% flow*.

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

The low limit of FLOW STPT will be the percentage that corresponds to the volume given in CLG FLOW MIN. This percentage can be calculated as:

(CTL FLOW MIN ÷ CTL FLOW MAX) × 100% flow.

The flow loop ensures that the supply air will not be less than CTL FLOW MIN.

For 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 will be 250 cfm.

Electric Reheat

CAUTION:
Verify that the equipment is supplied with safeties by others to ensure that there is airflow across the heating coils when they are to be energized.

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

Example

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

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

Sequencing Logic (optional) Fan Operation as in Application 2026

Whenever PARALLEL OFF (Point 30) is greater than PARALLEL ON (Point 28), the parallel fan operates exactly as it does in Application 2026. In this case, the sequencing for Application 2452 is identical to the sequencing logic of Application 2026 (reprinted here for your convenience). If you are operating the fan like a heating stage (that is, if you have PARALLEL OFF set less than PARALLEL ON) you can skip the rest of this section.

NOTE: The default setups for FLOW START (Point 16) and FLOW END (Point 17) are 0. This provides minimum airflow during heating mode.

In heating mode, this application includes logic that allows the flow loop to operate either in sequence, parallel, or overlapping with the electric reheat. This algorithm is similar to the spring range sequencing of valves and dampers. Portions of the output of the heating loop (HTG LOOPOUT, Point 80) drive both the flow loop and the electric reheat from 0 to 100%. See Examples 1 to 4 that follow Figure 2452-6. For simplicity, assume that in these examples HTG FLOW MIN (Point 33) equals 0 cfm, that there is one stage of electric heat (STAGE COUNT, Point 88 equals 1), and that the cycle time of the electric heat is 10 minutes (STAGE TIME, Point 89 equals 10). (When this is done, FLOW STPT (Point 93) equals 0 when HTG LOOPOUT equals 0). The ladder diagrams in Figure 2452-6 show sequenced, parallel, and overlapping flow loop operations with electric reheat. The vertical bars show the output of heating loopout from 0 to 100%. The horizontal bars (reheat start, flow start, etc.) show the action that occurs when the loop output rises above the horizontal bar. The relative positions shown on the graphs are for illustration purposes only and may differ from the examples.

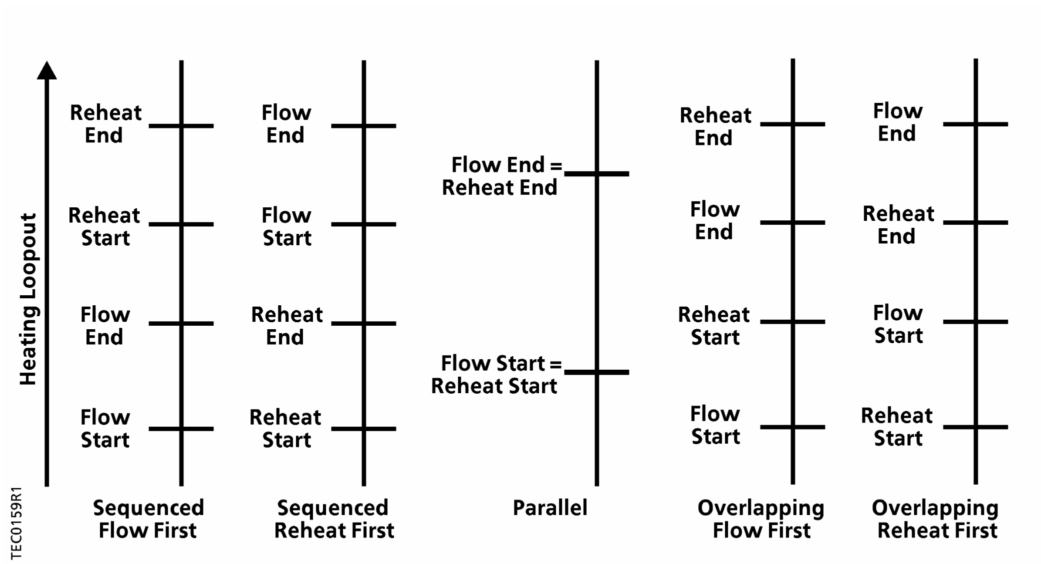


Figure 2452-6. Sequenced, Parallel, and Overlapping Flow Loop Operations with Electric Reheat.

Example 1

Assume that your system has electric heat that is to operate in *sequence* with the flow loop. If,

- FLOW START (Point 16) equals 0%
- FLOW END (Point 17) equals 50%
- REHEAT START (Point 22) equals 50%
- REHEAT END (Point 23) equals 100%

then,

- When HTG LOOPOUT equals 0%, FLOW STPT will equal 0% flow.
- When HTG LOOPOUT equals 25%, FLOW STPT will equal 50% flow.

- When HTG LOOPOUT is greater than or equal to 50%, FLOW STPT will equal 100% flow.
- When HTG LOOPOUT is less than or equal to 50%, the electric heat will be off all the time.
- When HTG LOOPOUT equals 75%, then for every 10 minute period the electric heat will be on for 5 minutes and off for 5 minutes.
- When HTG LOOPOUT equals 100%, then the electric heat will be on all the time.

Example 2

Assume that your system has electric heat that is to operate in *parallel* with the flow loop. If,

- FLOW START (Point 16) equals 0%
- FLOW END (Point 17) equals 100%
- REHEAT START (Point 22) equals 0%
- REHEAT END (Point 23) equals 100%

then,

- When HTG LOOPOUT equals 0%, FLOW STPT will equal 0% flow.
- When HTG LOOPOUT equals 50%, FLOW STPT will equal 50% flow.
- When HTG LOOPOUT equals 100%, FLOW STPT will equal 100% flow.
- When HTG LOOPOUT equals 0%, then the electric heat will be off all the time.
- When HTG LOOPOUT equals 50%, then for every 10 minute period the electric heat will be on for 5 minutes and off for 5 minutes.
- When HTG LOOPOUT equals 100%, then the electric heat will be on all the time.

Example 3

Assume that your system has electric heat that is to operate *overlapping* with the flow loop. If,

- FLOW START (Point 16) equals 0%
- FLOW END (Point 17) equals 75%
- REHEAT START (Point 22) equals 25%
- REHEAT END (Point 23) equals 100%

then,

- When HTG LOOPOUT equals 0%, FLOW STPT will equal 0% flow.
- When HTG LOOPOUT equals 37.5%, FLOW STPT will equal 50% flow.

- When HTG LOOPOUT is greater than or equal to 75%, FLOW STPT will equal 100% flow.
- When HTG LOOPOUT is less than or equal to 25%, the electric heat will be off.
- When HTG LOOPOUT equals 62.5%, then for every 10 minute period the electric heat will be on for 5 minutes and off for 5 minutes.
- When HTG LOOPOUT equals 100%, the electric heat will be on all the time.

Another option that the sequencing logic provides is to have the flow loop provide an airflow equal to HTG FLOW MIN throughout the heating mode with all of the temperature control being done by the electric heat. The airflow minimum will be maintained by setting the FLOW START and FLOW END to 0% which will cause FLOW STPT to hold the value corresponding to minimum flow throughout the entire heating mode, regardless of the value of HTG LOOPOUT. Example 4 clarifies this:

Example 4

Assume that your system has electric heat that provides the temperature control in the heating mode, while the flow loop provides for the minimum air requirements. Assume,

- HTG FLOW MIN equals 170 cfm
- HTG FLOW MAX equals 1000 cfm
- STAGE COUNT equals 1
- STAGE TIME equals 10 minutes

If,

- FLOW START (Point 16) equals 0%
- FLOW END (Point 17) equals 0%
- REHEAT START (Point 22) equals 0%
- REHEAT END (Point 23) equals 100%

then,

- When HTG LOOPOUT equals 0%, FLOW STPT will equal
  (170 cfm ÷ 1000 cfm) × 100% flow = 17% flow. This will cause the flow loop to maintain an airflow of 170 cfm out of the terminal box.
- When HTG LOOPOUT equals 50%, FLOW STPT will equal 17% flow.
- When HTG LOOPOUT equals 100%, FLOW STPT will equal 17% flow.
- When HTG LOOPOUT equals 0%, then the electric heat will be off all the time.
- When HTG LOOPOUT equals 50%, then for every 10 minute period the electric heat will be on for 5 minutes and off for 5 minutes.

- When HTG LOOPOUT equals 100%, then the electric heat will be on all the time.

Sequencing Logic (optional) Fan Operating as a Heating Stage

The above examples work exactly as when the parallel fan operates like it does in Application 2026. This is the case whenever PARALLEL ON (Point 28) is less than PARALLEL OFF (Point 30). When the reverse is true, with PARALLEL ON greater than PARALLEL OFF, the parallel fan will operate like a heating stage. In this case the fan will be another item that needs to be sequenced.

NOTE: The default setups for the points FLOW START (Point 16) and FLOW END (Point 17) are 0. This provides minimum airflow during heating mode.

In heating mode, this application includes logic that allows the flow loop to operate either in sequence, parallel, or overlapping with the parallel fan and the electric reheat. This algorithm is very similar to the spring range sequencing of valves and dampers. Portions of the output of the heating loop, HTG LOOPOUT (Point 80), will drive both the flow loop and electric reheat from 0 to 100% and will turn the parallel fan ON and OFF. See Examples 5, 6, and 7. For simplicity, assume that in these examples HTG FLOW MIN (Point 33) equals 0 cfm, there is one stage of electric heat (STAGE COUNT (Point 88) equals 1), and the cycle time of the electric heat is 10 minutes (STAGE TIME (Point 89) equals 10). (When this is done, FLOW STPT (Point 93) will equal 0 when HTG LOOPOUT equals 0). The ladder diagrams in Figure 2452-7 show sequenced, parallel, and overlapping flow loop operations with electric reheat and the fan acting as a heating stage. The vertical bars show the output of heating loopout from 0 to 100%. The horizontal bars (reheat start, flow start, etc.) show the action that occurs when the loop output rises above the horizontal bar. The relative positions shown on the graphs are for illustration purposes only and may differ from the examples that follow.

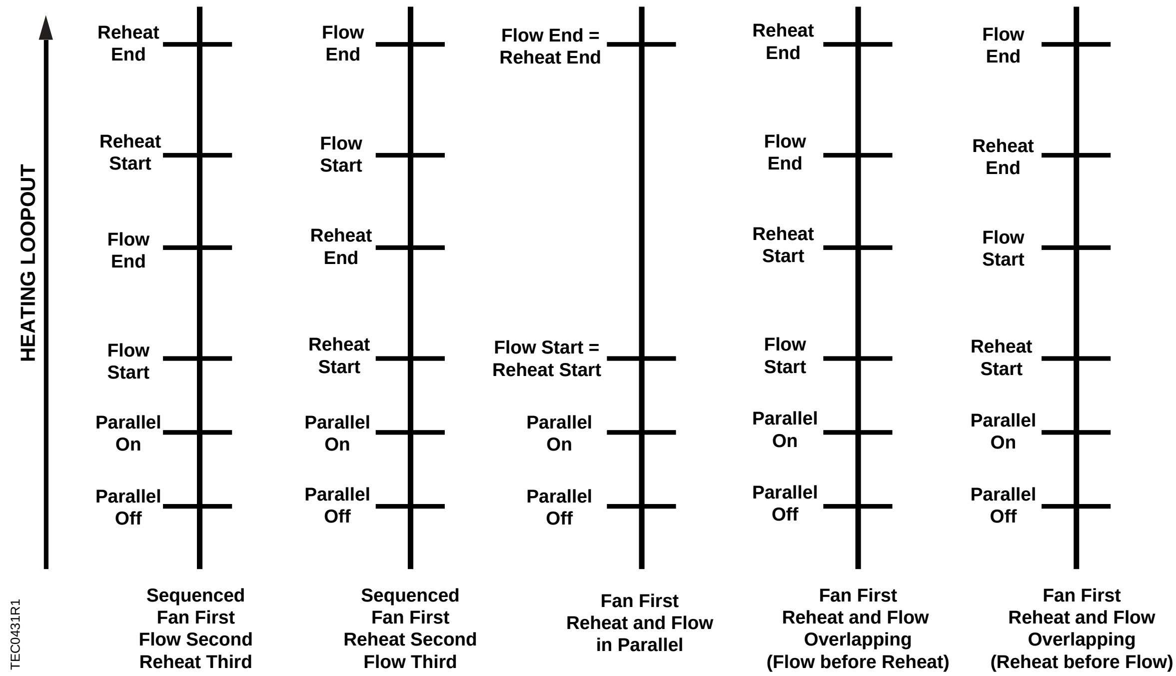


Figure 2452-7. Sequenced, Parallel, and Overlapping Flow Loop Operations with Electric Reheat—Fan operating as 1st Heating Stage.

Example 1

Assume that your system has electric heat that is to operate in sequence with the flow loop. Also assume that the fan will turn on before the flow loop starts increasing the supply airflow. If,

- PARALLELL OFF (Point 30) equals 10%
- PARALLEL ON (Point 28) equals 20%
- FLOW START (Point 16) equals 25%
- FLOW END (Point 17) equals 50%
- REHEAT START (Point 22) equals 50%
- REHEAT END (Point 23) equals 100%

then,

- When HTG LOOPOUT is greater than 20%, FAN (Point46) will be ON. Once ON, the fan only shuts off when the following 2 conditions are satisfied:
  - HTG LOOPOUT drops below 10%.
  - The electric heat has been OFF for longer than STAGE TIME.

If the electric heat has been OFF for longer than STAGE TIME and HTG LOOPOUT is between 10% and 20%, then the fan will remain in its last commanded state (if ON it will remain ON, if OFF it will remain OFF).

- When HTG LOOPOUT is less than 25%, FLOW STPT will equal 0% flow.
- When HTG LOOPOUT equals 37.5%, FLOW STPT will equal 50% flow.
- When HTG LOOPOUT is greater than or equal to 50%,FLOW STPT will equal 100% flow.
- When HTG LOOPOUT is less than or equal to 50%, the electric heat will be OFF.
- When HTG LOOPOUT equals 75%, then for every 10 minute period the electric heat will be on for 5 minutes and off for 5 minutes.
- When HTG LOOPOUT equals 100%, then the electric heat will be on all the time.

Example 2

Assume that in your system that the fan is to turn on before the electric heat is used. Also assume that the flow loop is to operate in *parallel* with the fan and electric heat. If,

- FLOW START (Point 16) equals 0%
- FLOW END (Point 17) equals 100%
- PARALLELL OFF (Point 30) equals 10%
- PARALLEL ON (Point 28) equals 20%
- REHEAT START (Point 22) equals 30%
- REHEAT END (Point 23) equals 100%

then,

- When HTG LOOPOUT is greater than 20%, FAN (Point46) will be ON. Once ON, the fan will only shut off when the following 2 conditions are satisfied:
  - HTG LOOPOUT drops below 10%.
  - The electric heat has been OFF for longer than STAGE TIME.

If the electric heat has been OFF for longer than STAGE TIME and HTG LOOPOUT is between 10% and 20%, then the fan will remain in its last commanded state (if ON it will remain ON, if OFF it will remain OFF).

- When HTG LOOPOUT equals 0%, FLOW STPT will equal 0% flow.
- When HTG LOOPOUT equals 50%, FLOW STPT will equal 50% flow.
- When HTG LOOPOUT equals 100%, FLOW STPT will equal 100% flow.
- When HTG LOOPOUT is less than 30%, the electric heat will be off all the time.

- when HTG LOOPOUT equals 65%, then for every 10 minute period the Electric heat will be on for 5 minutes and off for 5 minutes.
- When HTG LOOPOUT equals 100%, then the electric heat will be on all the time.

Example 3

Assume that your system has electric heat that is to operate overlapping with the flow loop. Also assume that the parallel fan is to turn ON before the electric heat comes ON. If,

- FLOW START (Point 16) equals 0%
- FLOW END (Point 17) equals 75%
- PARALLELL OFF (Point 30) equals 20%
- PARALLEL ON (Point 28) equals 30%
- REHEAT START (Point 22) equals 40%
- REHEAT END (Point 23) equals 100%

then,

- When HTG LOOPOUT is greater than 30%, FAN (Point 46) will be ON. Once ON, the fan will only shut off when the following two conditions are satisfied:
  - HTG LOOPOUT drops below 20%.
  - The electric heat has been OFF for longer than STAGE TIME.

  If the electric heat has been OFF for longer than STAGE TIME and HTG LOOPOUT is between 20% and 30%, then the fan remains in its last commanded state (if ON, it remains ON; if OFF, it remains OFF).
- When HTG LOOPOUT equals 0%, FLOW STPT will equal 0% flow.
- When HTG LOOPOUT equals 37.5%, FLOW STPT will equal 50% flow.
- When HTG LOOPOUT is greater than or equal to 75%, FLOW STPT will equal 100% flow.
- When HTG LOOPOUT is less than or equal to 40%, then the electric heat will be off all the time.
- When HTG LOOPOUT equals 70%, then for every 10 minute period the electric heat will be on for 5 minutes and off for 5 minutes.
- When HTG LOOPOUT equals 100%, then the electric heat will be on all the time.

Another option that the sequencing logic provides is to have the flow loop provide an airflow equal to HTG FLOW MIN throughout the heating mode with all of the temperature control being done by the parallel fan and the electric heat. The airflow minimum will be maintained by setting the FLOW START and FLOW END to 0% which will cause FLOW STPT to hold the value corresponding to minimum flow throughout the entire heating mode, regardless of the value of HTG LOOPOUT. Example 8 clarifies this:

Example 4

Assume that in the heating mode your system has the parallel fan operating as the first heating stage, the electric heat provides any additional heat need for temperature control Assume,

- HTG FLOW MIN equals 170 cfm
- HTG FLOW MAX equals 1000 cfm
- STAGE COUNT equals 1
- STAGE TIME equals 10 minutes

If,

- FLOW START (Point 16) equals 0%
- FLOW END (Point 17) equals 0%
- PARALLELL OFF (Point 30) equals 10%
- PARALLEL ON (Point 28) equals 20%
- REHEAT START (Point 22) equals 30%
- REHEAT END (Point 23) equals 100%

then,

- When HTG LOOPOUT equals 0%, FLOW STPT will equal
  (170 cfm ÷ 1000 cfm) × 100% flow = 17% flow. This will cause the flow loop to maintain an airflow of 170 cfm out of the terminal box.
- When HTG LOOPOUT equals 50%, FLOW STPT will equal 17% flow.
- When HTG LOOPOUT equals 100%, FLOW STPT will equal 17% flow.
- When HTG LOOPOUT is greater than 20%, FAN (Point46) will be ON. Once ON, the fan will only shut off when the following two conditions are satisfied:
  - HTG LOOPOUT drops below 10%.
  - The electric heat has been OFF for longer than STAGE TIME.

  If the electric heat has been OFF for longer than STAGE TIME and HTG LOOPOUT is between 10% and 20%, then the fan will remain in its last commanded state (if ON, it remains ON; if OFF, it remains OFF).

- When HTG LOOPOUT is less than 30%, the electric heat will be off all the time.
- When HTG LOOPOUT equals 65%, then for every 10 minute period the electric heat will be on for 5 minutes and off for 5 minutes.
- When HTG LOOPOUT equals 100%, then the electric heat will be on all the time.

Calibration

Calibration of the controller's internal air velocity transducers is periodically required to maintain accurate air velocity readings. The damper is commanded closed to get a zero airflow reading during calibration. CAL SETUP (Point 95) is set with the desired calibration option during controller startup. Depending upon the value of CAL SETUP, calibration may be set to take place automatically or manually. If the status of CAL AIR (Point 94) is YES, then calibration is in progress.

At the end of a calibration sequence, CAL AIR returns to NO automatically. A status of NO indicates that the controller is not in a calibration sequence.

Fan Operation

Fan Operation as in Application 2026

When PARALLEL OFF (Point 30) is greater than PARALLEL ON (Point 28), the fan is controlled the same as it is in Application 2026.

FAN (Point 46) will turn ON only when the following two conditions have been met:

1. The first stage of electric heat, point HEAT STAGE 1 (Point 43), turns ON.
2. The airflow out of the supply duct (FLOW, Point 75) is less than the value stored in PARALLEL ON (Point 28). (This means that there is not enough airflow out of the supply duct to allow for safe operation of the electric heat.)

The fan will turn OFF when at least one of the following two conditions has been met:

1. The first stage of electric heat is OFF for at least one full duty cycle. (HEAT STAGE 1 (Point 43) is OFF longer than STAGE TIME (Point 89).)
2. The airflow out of the supply duct, FLOW, is greater than the value stored in PARALLEL OFF (Point 30). (This means that there is enough airflow out of the supply duct to allow for safe operation of the electric heat.)

If the conditions have not been satisfied to turn the fan either ON or OFF, then the state of the fan remains unchanged (if ON it remains ON; if OFF, it remains OFF).

Fan Operating as First Heating Stage

NOTE: For the fan to be used as a stage of heat, PARALLEL ON (Point 28) must be greater than PARALLEL OFF (Point 30), as in the default setting.

The ON/OFF status of the fan is determined mainly by the following two conditions: the status of HEAT STAGE 1 (Point 43) and the value of HTG LOOPOUT (Point 80).

The fan is ON whenever HEAT STAGE 1 is ON. If HEAT STAGE 1 has been OFF for longer than STAGE TIME, then the ON/OFF status of the fan depends on the value of HTG LOOPOUT. If HEAT STAGE 1 has been OFF for longer than STAGE TIME, and:

- HTG LOOPOUT is less than or equal to PARALLEL OFF, the fan is OFF.
- HTG LOOPOUT is greater than or equal to PARALLEL ON, the fan is ON.
- HTG LOOPOUT is between PARALLEL ON and PARALLEL OFF, the fan remains in its last commanded state.

Fail-Safe Operation

If the air velocity sensor fails, then the controller uses pressure dependent control, with the temperature loop controlling the operation of the damper. If the room temperature sensor fails, the controller uses the last known temperature value.

Application Notes

1. If the temperature swings in the room are excessive or if there is trouble in maintaining the setpoint, then the cooling loop and/or the heating loop need to be tuned. If FLOW (Point 75) is oscillating while FLOW STPT (Point 93) is constant, then the flow loop requires tuning. See the *APOGEE® Automation Service Procedures* on InfoLink for more information.

2. The controller as shipped from the factory keeps all associated equipment OFF. See the *APOGEE® Automation Startup Procedures* on InfoLink for information on how to release the controller and its equipment to application control.

Wiring Diagram

CAUTION:
The Controller controls 24 Vac loads only. The maximum rating is 12 VA for each DO. Use an interposing 220 V 4-relay module (P/N 550-054) for any of the following:

VA requirements higher than maximum

110 or 220 Vac requirements

DC power requirements

Separate transformers used to power the load

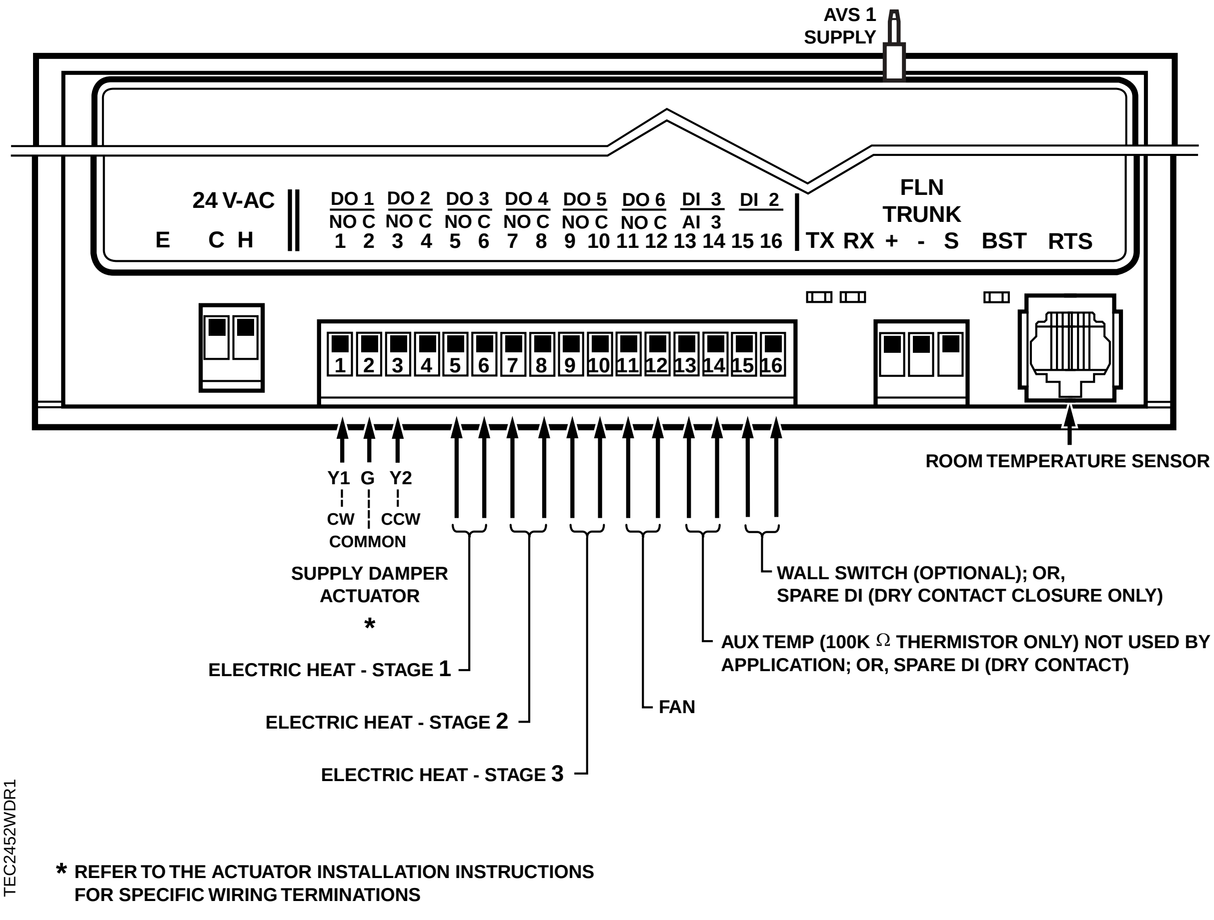


Figure 2452-8. Application 2452 Wiring Diagram.

Point Database

Table 2452-1. Point Database for Application 2452.

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	2091	--	1	0	--	--
{04}	ROOM TEMP	74.0 (23.44888)	DEG F (DEG C)	0.25 (0.14)	48.0(8.88888)	--	--
{05}	HEAT.COOL	COOL	--	--	--	HEAT	COOL
06	DAY CLG STPT	74.0 (23.44888)	DEG F (DEG C)	0.25 (0.14)	48.0(8.88888)	--	--
07	DAY HTG STPT	70.0 (21.20888)	DEG F (DEG C)	0.25 (0.14)	48.0(8.88888)	--	--
08	NGT CLG STPT	82.0 (27.92888)	DEG F (DEG C)	0.25 (0.14)	48.0(8.88888)	--	--
09	NGT HTG STPT	65.0 (18.40888)	DEG F (DEG C)	0.25 (0.14)	48.0(8.88888)	--	--
11	RM STPT MIN	55.0 (12.80888)	DEG F (DEG C)	0.25 (0.14)	48.0(8.88888)	--	--
12	RM STPT MAX	90.0 (32.40888)	DEG F (DEG C)	0.25 (0.14)	48.0(8.88888)	--	--
{13}	RM STPT DIAL	74.0 (23.44888)	DEG F (DEG C)	0.25 (0.14)	48.0(8.88888)	--	--
14	STPT DIAL	NO	--	--	--	YES	NO
{15}	AUX TEMP	74.0 (23.495556)	DEG F (DEG C)	0.5 (0.28)	37.5(3.055556)	--	--
16	FLOW START	0.0	PCT	0.4	0.0	--	--
17	FLOW END	0.0	PCT	0.4	0.0	--	--
18	WALL SWITCH	NO	--	--	--	YES	NO
{19}	DI OVRD SW	OFF	--	--	--	ON	OFF
20	OVRD TIME	0	HRS	1	0	--	--
{21}	NGT OVRD	NIGHT	--	--	--	NIGHT	DAY
22	REHEAT START	30.0	PCT	0.4	0.0	--	--
23	REHEAT END	100.0	PCT	0.4	0.0	--	--
{24}	DI 2	OFF	--	--	--	ON	OFF
{25}	DI 3	OFF	--	--	--	ON	OFF
28	PARALLEL ON	20.0	PCT	0.4	0.0	--	--
{29}	DAY.NGT	DAY	--	--	--	NIGHT	DAY
30	PARALLEL OFF	10.0	PCT	0.4	0.0	--	--
31	CLG FLOW MIN	220 (103.818)	CFM (LPS)	4 (1.8876)	0	--	--
32	CLG FLOW MAX	2200 (1038.18)	CFM (LPS)	4 (1.8876)	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 2452-1. Point Database for Application 2452.

Point Number	Descriptor	Factory Default (SI Units)	Engr Units (SI Units)	Slope (SI Units)	Intercept (SI Units)	On Text	Off Text
33	HTG FLOW MIN	220 (103.818)	CFM (LPS)	4 (1.8876)	0	--	--
34	HTG FLOW MAX	2200 (1038.18)	CFM (LPS)	4 (1.8876)	0	--	--
{35}	AIR VOLUME	0 (0.0)	CFM (LPS)	4 (1.8876)	0	--	--
36	FLOW COEFF	1.0	--	0.01	0.0	--	--
{41}	DO 1	OFF	--	--	--	ON	OFF
{42}	DO 2	OFF	--	--	--	ON	OFF
{43}	HEAT STAGE 1	OFF	--	--	--	ON	OFF
{44}	HEAT STAGE 2	OFF	--	--	--	ON	OFF
{45}	HEAT STAGE 3	OFF	--	--	--	ON	OFF
{46}	FAN	OFF	--	--	--	ON	OFF
{48}	DMPR COMD	0.0	PCT	0.4	0.0	--	--
{49}	DMPR POS	0.0	PCT	0.4	0.0	--	--
51	MTR1 TIMING	95	SEC	1	0	--	--
56	DMPR ROT ANG	90	--	1	0	--	--
58	MTR SETUP	0	--	1	0	--	--
59	DO DIR. REV	0	--	1	0	--	--
63	CLG P GAIN	20.0 (36.0)	--	0.25 (0.45)	0.0	--	--
64	CLG I GAIN	0.01 (0.018)	--	0.001 (0.0018)	0.0	--	--
65	CLG D GAIN	0 (0.0)	--	2 (3.6)	0	--	--
66	CLG BIAS	0.0	PCT	0.4	0.0	--	--
67	HTG P GAIN	10.0 (18.0)	--	0.25 (0.45)	0.0	--	--
68	HTG I GAIN	0.01 (0.018)	--	0.001 (0.0018)	0.0	--	--
69	HTG D GAIN	0 (0.0)	--	2 (3.6)	0	--	--
70	HTG BIAS	0.0	PCT	0.4	0.0	--	--
71	FLOW P GAIN	0.0	--	0.05	0.0	--	--
72	FLOW I GAIN	0.01	--	0.001	0.0	--	--
73	FLOW D GAIN	0	--	2	0	--	--
74	FLOW BIAS	50.0	PCT	0.4	0.0	--	--
{75}	FLOW	0.0	PCT	0.25	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.

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Table 2452-1. Point Database for Application 2452.

Point Number	Descriptor	Factory Default (SI Units)	Engr Units (SI Units)	Slope (SI Units)	Intercept (SI Units)	On Text	Off Text
{76}	CTL FLOW MIN	220 (103.818)	CFM (LPS)	4 (1.8876)	0	--	--
{77}	CTL FLOW MAX	2200 (1038.18)	CFM (LPS)	4 (1.8876)	0	--	--
{78}	CTL TEMP	74.0 (23.44888)	DEG F (DEG C)	0.25 (0.14)	48.0(8.88888)	--	--
{79}	CLG LOOPOUT	0.0	PCT	0.4	0.0	--	--
{80}	HTG LOOPOUT	0.0	PCT	0.4	0.0	--	--
{81}	AVG HEAT OUT	0.0	PCT	0.4	0.0	--	--
82	STAGE MAX	90.0	PCT	0.4	0.0	--	--
83	STAGE MIN	10.0	PCT	0.4	0.0	--	--
85	SWITCH LIMIT	5.2	PCT	0.4	0.0	--	--
86	SWITCH TIME	10	MIN	1	0	--	--
88	STAGE COUNT	1	--	1	0	--	--
89	STAGE TIME	10	MIN	1	0	--	--
90	SWITCH DBAND	1.0 (0.56)	DEG F (DEG C)	0.25 (0.14)	0.0	--	--
{91}	TOTAL VOLUME	0 (0)	CF (L)	4 (113)	0	--	--
{92}	CTL STPT	74.0 (23.44888)	DEG F (DEG C)	0.25 (0.14)	48.0(8.88888)	--	--
{93}	FLOW STPT	0.0	PCT	0.25	0.0	--	--
{94}	CAL AIR	NO	--	--	--	YES	NO
95	CAL SETUP	4	--	1	0	--	--
96	CAL TIMER	12	HRS	1	0	--	--
97	DUCT AREA	1.0 (0.09292)	SQ. FT (SQ M)	0.025 (0.002323)	0.0	--	--
98	LOOP TIME	5	SEC	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.