SIEMENS

TEC Custom Solutions Application 2369 VAV Parallel Fan with Hot Water Reheat — Electronic Output

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Overview

In Application 2369, the controller modulates the supply air damper of the terminal box to provide cooling. A hot water valve is modulated for heating. During heating operation, the supply air damper is set to a minimum position, or it can be modulated as a source of heating. The terminal box also has a parallel fan which recirculates the room air. If desired, the fan can be sequenced with the valve and supply air during heating mode to provide an inexpensive source of heat before more expensive forms of heat are used. In order for the terminal box to work properly, the central air handling unit must provide supply air. Refer to Figures 2369-1 through 2369-5.

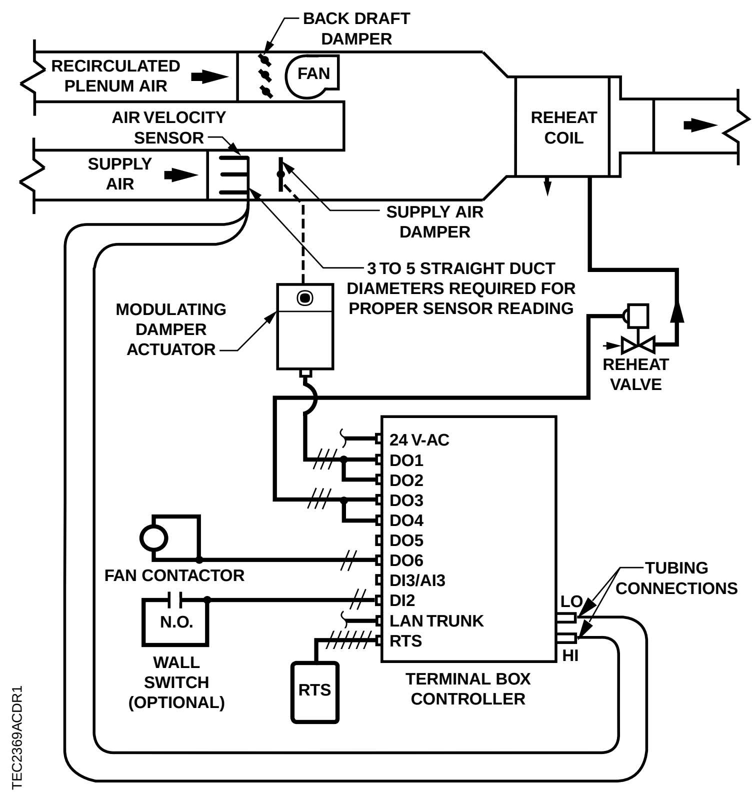


Figure 2369-1. Application 2369 Control Drawing – Reheat Coil in Discharge Duct.

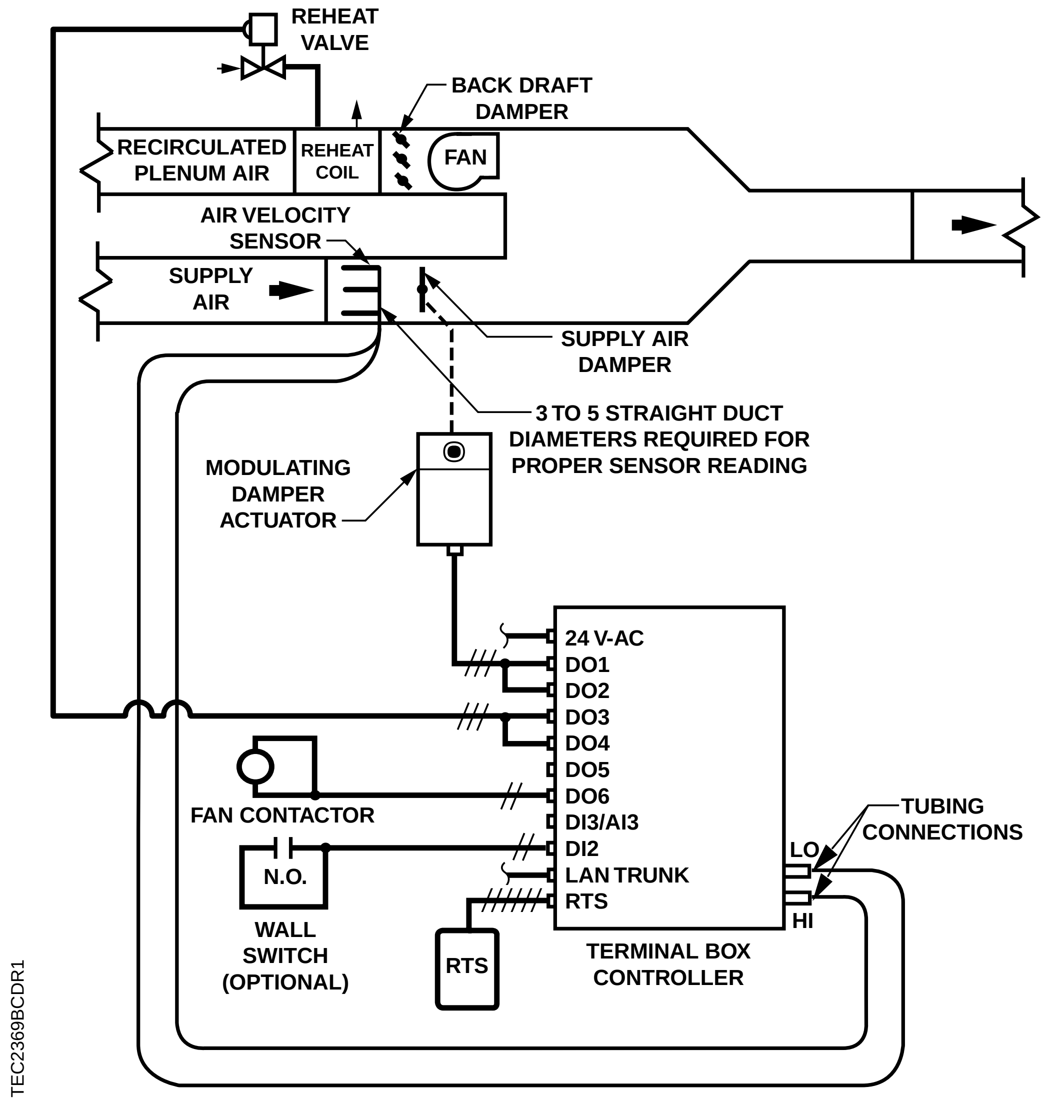
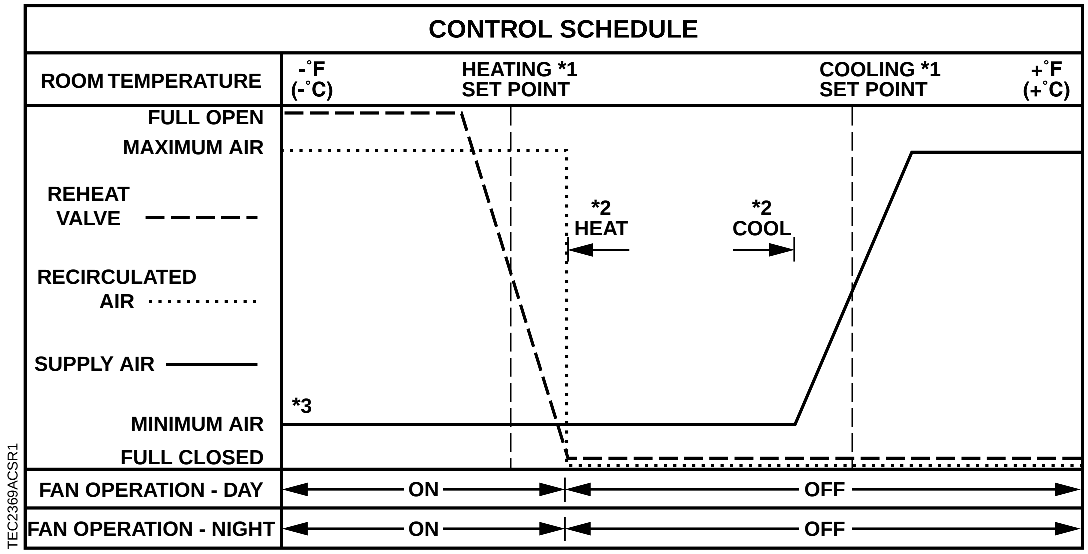
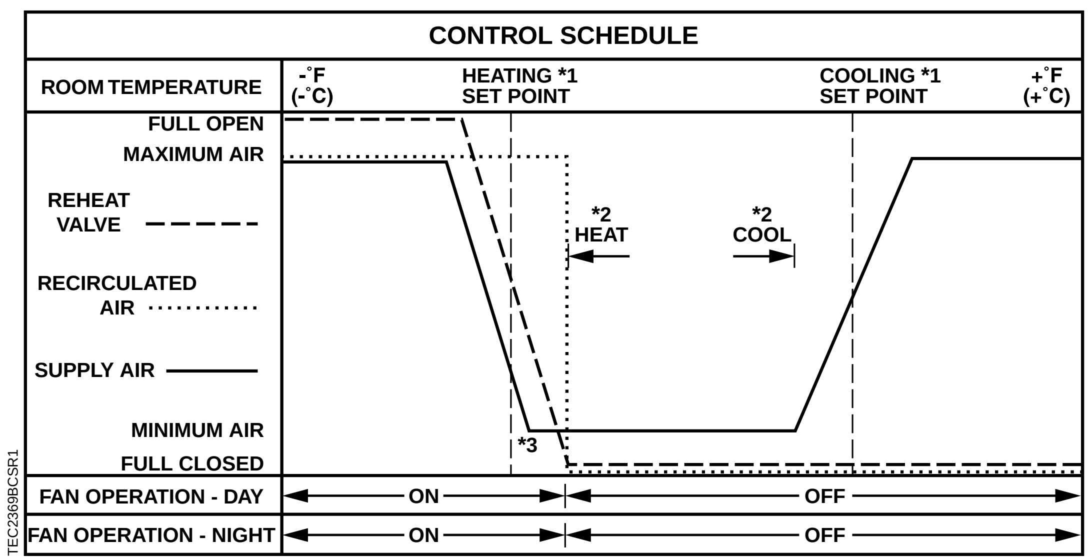


Figure 2369-2. Application 2369 Control Drawing – Reheat Coil in Recirculated Plenum Air Duct.



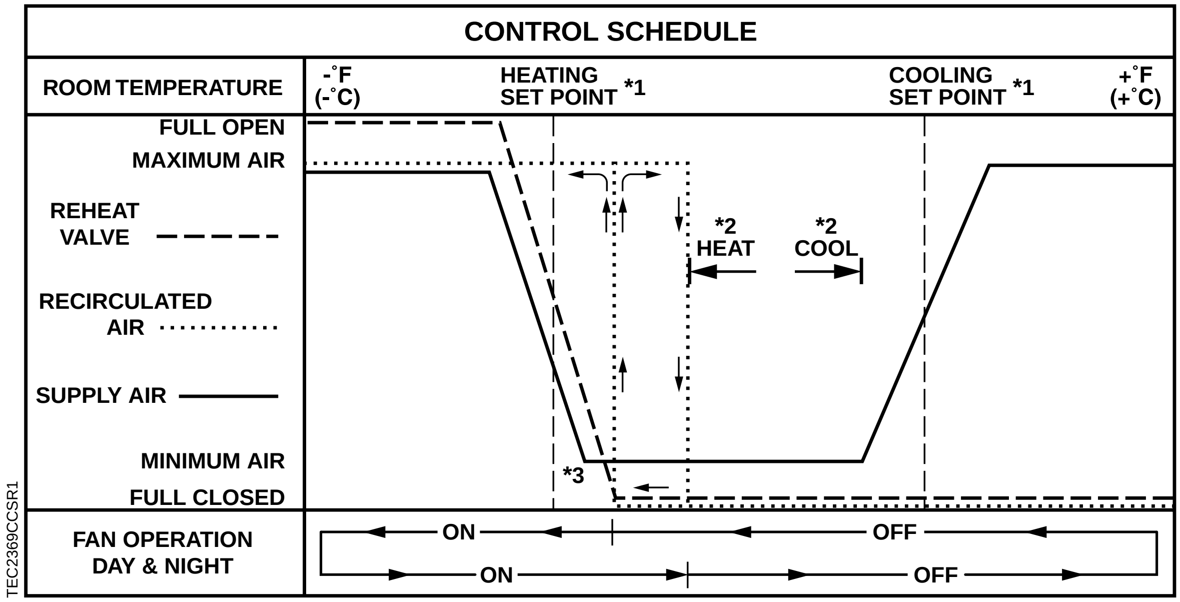
1. Refer to the *Control Temperature Set Points* section.
2. Refer to the *Heating/Cooling Switchover* section.
3. The airflow is shown at minimum flow throughout the entire heating mode (default setting). The airflow can operate sequenced, parallel, or overlapping with the reheat valve (optional). Also, the fan is shown operating as it does in Application 2027. Refer to the *Sequencing Logic, FAN MODE = FIXED* section.

Figure 2369-3. Application 2369 Control Schedule with Minimum Supply Air in Heating Mode.



1. Refer to the *Control Temperature Set Points* section.
2. Refer to the *Heating/Cooling Switchover* section.
3. The airflow is shown operating parallel with the reheat valve (optional). The airflow can operate at minimum flow throughout the entire heating mode (default setting). Also, the fan is shown operating as it does in Application 2027. Refer to the *Sequencing Logic, FAN MODE = FIXED* section.

Figure 2369-4. Application 2369 Control Schedule with Modulating Damper in Heating Mode.



1. Refer to the *Control Temperature Set Points* section.
2. Refer to the *Heating/Cooling Switchover* section.
3. The airflow is shown operating parallel with the reheat valve (optional). The fan turns ON before the valve and damper start to modulate. Refer to the *Sequencing Logic, FAN MODE = VARIED* section.

Figure 2369-5. Application 2369 Control Schedule with Modulating Damper in Heating Mode – the Fan Turns ON before the Valve and Damper Modulate.

Hardware Inputs

Analog

- Air velocity sensor
- Room temperature sensor
- Room temperature set point dial (optional)

Digital

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

Hardware Outputs

Analog

- None

Digital

- Damper actuator
- Fan
- Valve actuator

Ordering Notes

TEC Custom Solution number 244.

Controller Part Number 540-874.

Point Database

The point database information is in Table 2369-1 at the end of this document.

Sequence of Operation

The following paragraphs present the sequence of operation for Application 2369, "VAV Parallel Fan with Hot Water Reheat."

Control Temperature Set Points

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

Day Mode – In day mode, CTL STPT holds the value of DAY CLG STPT (Point 06) or DAY HTG STPT (Point 07). If the room temperature sensor has a set point dial and STPT DIAL (Point 14) is set to YES, then CTL STPT holds the value of RM STPT DIAL (Point 13).

If the set point 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 08) or NGT HTG STPT (Point 09).

NOTE: The value of CTL TEMP (Point 78) is the same as the value of the point ROOM TEMP (Point 04), 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 (Figures 2369-1, 2369-2, and 2369-7), 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 is 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 is set to NIGHT, indicating 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. In this case, and if the controller is operating stand-alone (not connected to a field panel), then the controller stays in day mode all the time. If the controller is operating with centralized control (connected to a field panel), then the field panel can send an operator or PPCL command to override the status of DAY.NGT. Refer to *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 operational mode for the amount of time set in OVRD TIME. The status of NGT OVRD (Point 21) changes to DAY and remains there until override time elapses, at which time 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

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

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 05) 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 set point 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 in SWITCH DBAND.
- CTL TEMP is less than the appropriate heating set point 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 (Point 05) based on the supply air temperature, HEAT.COOL must be commanded through PPCL. This is required when the flow loop is used to control cooling in cooling mode and heat in heating mode. Refer to Examples 1 through 3 in both *Sequencing Logic* sections that follow (*FAN MODE = FIXED* and *FAN MODE = VARIED*). 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. (Refer to Example 4 in both *Sequencing Logic* sections.)

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). Refer to the *Control Temperature Set Points* section for more information.

The cooling temperature loop generates a 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 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 set point.

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

For example:

If CLG FLOW MIN = 200 CFM, and CLG FLOW MAX = 1000 CFM,

then,

the minimum flow set point 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).
- Operate in sequence with the hot water valve.
- Operate parallel with the hot water valve.
- Operate overlapping with the hot water valve.

If the first option is chosen, then HTG LOOPOUT (Point 80) controls the hot water valve in order to maintain the room temperature. If any of the remaining three options is chosen, then HTG LOOPOUT controls both the flow loop set point (FLOW STPT) and the hot water valve in order to maintain the room temperature. Refer to the *Sequencing Logic* section(s) for more information.

HTG LOOPOUT adjusts 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 airflow and maximum airflow through 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.

CLG FLOW MIN can be set equal to but not greater than CLG FLOW MAX, and HTG FLOW MIN can be set 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 CTL FLOW MIN and CTL 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 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 is not 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 is 250 CFM.

Hot Water Reheat

In cooling mode, the heating valve is closed. The valve is also closed in heating mode if **all** of the flowing three conditions are met:

- FAN MODE (Point 40) = VARIED.
- VALVE SAFETY (Point 54) = YES.
- FAN (Point 46) = OFF.

In heating mode, the heating loop modulates the heating valve to warm up the room under **any** of the following conditions:

- FAN MODE = FIXED.
- FAN MODE = VARIED and VALVE SAFETY = NO.
- FAN MODE = VARIED, VALVE SAFETY = YES and FAN = ON.

Sequencing Logic, FAN MODE = FIXED (optional)

There is a point in this application called FAN MODE (Point 40). FAN MODE is a digital point that can have either the value FIXED or VARIED. FIXED refers to a fixed sequence between the valve and the parallel fan (the valve and fan operate exactly as they do in Application 2027). When FAN MODE equals VARIED, the sequence between the valve and the fan can be varied. This section of text explains the FIXED sequence of operation. (The VARIED sequence is explained in the following section.)

In heating mode, this application includes logic that allows the flow loop to operate in sequence, parallel, or overlapping with the hot water valve. 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 the hot water valve from 0 to 100%.

This concept is illustrated in the following three examples. (For simplicity, assume that in these examples HTG FLOW MIN (Point 33) equals 0 CFM. When this is done, FLOW STPT (Point 93) equals 0 when HTG LOOPOUT equals 0. The ladder diagrams in Figure 2369-6 show sequenced, parallel, and overlapping flow loop operations with 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.)

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

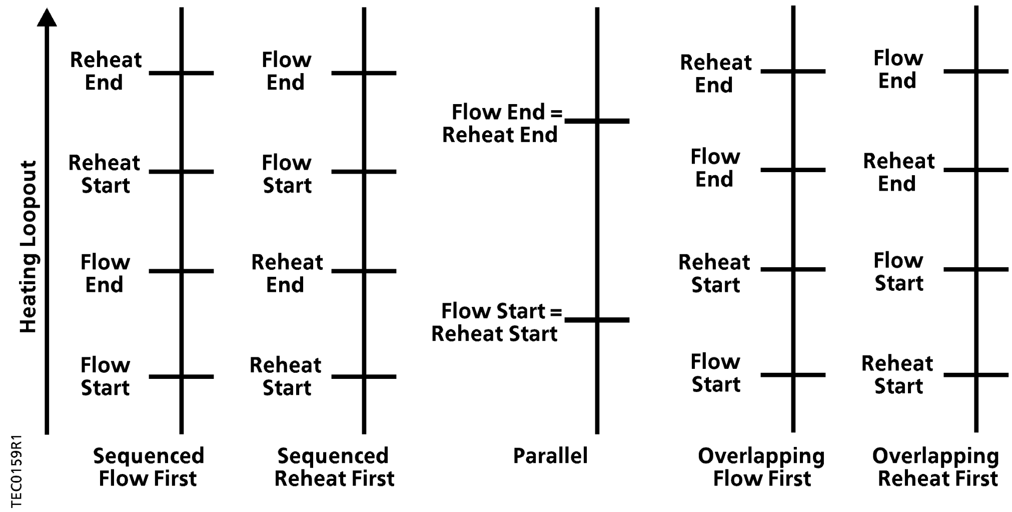


Figure 2369-6. Sequenced, Parallel, and Overlapping Flow Loop Operations with Hot Water Reheat.

Example 1*:* Assume that your system has a hot water valve operating *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 (Point 80) 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%, VLV COMD (Point 52) will equal 0% open.
- When HTG LOOPOUT equals 75%, VLV COMD will equal 50% open.
- When HTG LOOPOUT equals 100%, VLV COMD will equal 100% open.

Example 2*:* Assume that your system has a hot water valve operating *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%, VLV COMD will equal 0% open.
- When HTG LOOPOUT equals 50%, VLV COMD will equal 50% open.
- When HTG LOOPOUT equals 100%, VLV COMD will equal 100% open.

***Example 3**:* Assume that your system has a hot water valve 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%, VLV COMD will equal 0% open.
- When HTG LOOPOUT equals 62.5%, VLV COMD will equal 50% open.
- When HTG LOOPOUT equals 100%, VLV COMD will equal 100% open.

Another option the sequencing logic provides is to have the flow loop provide an airflow equal to HTG FLOW MIN throughout the heating mode, with all temperature control being done by the hot water valve. This is accomplished by setting FLOW START and FLOW END to zero. Example 4 clarifies this:

***Example 4**:* Assume that your system has a hot water valve that provides temperature control in heating mode, while the flow loop controls the minimum air requirements. Also, assume that HTG FLOW MIN equals 170 CFM and that HTG FLOW MAX equals 1000 CFM.

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%, VLV COMD will equal 0% open.
- When HTG LOOPOUT equals 50%, VLV COMD will equal 50% open.
- When HTG LOOPOUT equals 100%, VLV COMD will equal 100% open.

Sequencing Logic, FAN MODE = VARIED (optional)

When FAN MODE (Point 40) equals VARIED, the sequencing logic in Application 2369 is more complex than the sequencing logic in Application 2027. This is because the parallel fan can now be sequenced along with the valve and the flow loop. This provides many sequencing combinations. It is not the purpose of this section to provide an example for every type of sequencing possible. Instead, examples are provided that will help you understand how to sequence the parallel fan, hot water valve, and flow loop. For simplicity, assume that in these examples HTG FLOW MIN (Point 33) equals 0 CFM.

The hot water valve and the supply air damper are sequenced off of HTG LOOPOUT. The parallel fan is a bit more complicated. Not only is it controlled by HTG LOOPOUT, but it is also controlled by FLOW (Point 75). If FLOW gets too high the parallel fan shuts OFF to prevent the common duct from rupturing. The following examples illustrate this.

Example 1*:* Assume that your system has a hot water valve operating *in sequence* with the flow loop and parallel fan, the sequence order being fan, valve, and flow loop. Assume also that the parallel fan will shut OFF when the flow out of the supply duct is greater than 50% of HTG FLOW MAX and that the parallel fan will be allowed to turn back ON once the supply duct airflow drops to less than 30% of HTG FLOW MAX.

If,

- FAN OFF (Point 50) equals 5%
- FAN ON (Point 47) equals 20%
- PARALLEL ON (Point 28) equals 30%

- PARALLEL OFF (Point 30) equals 50%
- REHEAT START (Point 22) equals 35%
- REHEAT END (Point 23) equals 65%
- FLOW START (Point 16) equals 70%
- FLOW END (Point 17) equals 100%

then,

- When HTG LOOPOUT is greater than or equal to 20%, the FAN (Point 46) will turn ON (because the heating load is large enough).
- When HTG LOOPOUT is less than or equal to 35%, VLV COMD (Point 52) will equal 0% open.
- When HTG LOOPOUT equals 50%, VLV COMD will equal 50% open.
- When HTG LOOPOUT is equal to or greater than 65%, VLV COMD will equal 100% open.
- When HTG LOOPOUT is equal to or less than 70%, FLOW STPT will equal 0% flow.
- When HTG LOOPOUT is greater than 85%, FLOW STPT will equal 50% flow. Since this will cause the flow in the supply duct (FLOW, Point 75) to rise above 50% of HTG FLOW MAX, the FAN will shut OFF (to prevent the common duct from rupturing).
- When HTG LOOPOUT is equal to 100%, FLOW STPT will equal 100% flow.
- When HTG LOOPOUT is less than 79%, FLOW will be less than 30% of HTG FLOW MAX and the parallel fan will turn back ON.
- When HTG LOOPOUT is less than or equal to 5%, the parallel fan will turn OFF (because the heating load is so small that the fan no longer needs to be ON).

Example 2*:* Assume that your system has a hot water valve operating *in sequence* with the flow loop and parallel fan, the sequence order being valve, fan, and flow loop. Assume also that the parallel fan will shut OFF when the flow out of the supply duct is greater than 50% of HTG FLOW MAX, and that the parallel fan will be allowed to turn back ON once the supply duct airflow drops to less than 30% of HTG FLOW MAX.

If,

- FAN OFF (Point 50) equals 40%
- FAN ON (Point 47) equals 60%
- PARALLEL ON (Point 28) equals 30%
- PARALLEL OFF (Point 30) equals 50%
- REHEAT START (Point 22) equals 0%
- REHEAT END (Point 23) equals 30%

- FLOW START (Point 16) equals 70%
- FLOW END (Point 17) equals 100%

then,

- When HTG LOOPOUT is equal to 0%, VLV COMD (Point 52) will equal 0% open.
- When HTG LOOPOUT equals 15%, VLV COMD will equal 50% open.
- When HTG LOOPOUT is equal to or greater than 30%, VLV COMD will equal 100% open.
- When HTG LOOPOUT is greater than 60%, the FAN (Point 46) will turn ON (because the heating load is large enough).
- When HTG LOOPOUT is equal to or less than 70%, FLOW STPT will equal 0% flow.
- When HTG LOOPOUT is greater than 85%, FLOW STPT will be greater than 50% flow. Since this will cause the flow in the supply duct (FLOW, Point 75) to rise above 50% of HTG FLOW MAX, the FAN will shut OFF (to prevent the common duct from rupturing).
- When HTG LOOPOUT is equal to 100%, FLOW STPT will equal 100% flow.
- When HTG LOOPOUT is less than 79%, FLOW will be less than 30% of HTG FLOW MAX and the parallel fan will turn back ON.
- When HTG LOOPOUT is less than 40%, the parallel fan will turn OFF (because the heating load is so small that the fan no longer needs to be ON).

Example 3*:* Assume that your system has a hot water valve operating *parallel* with the flow loop, and that the fan turns ON before either the valve or the flow loop modulates. Assume also that the parallel fan will shut OFF when the flow out of the supply duct is greater than 60% of HTG FLOW MAX, and that the parallel fan will be allowed to turn back ON once the supply duct airflow drops to less than 50% of HTG FLOW MAX.

If,

- FAN OFF (Point 50) equals 5%
- FAN ON (Point 47) equals 30%
- PARALLEL ON (Point 28) equals 50%
- PARALLEL OFF (Point 30) equals 60%
- FLOW START (Point 16) equals 30%
- FLOW END (Point 17) equals 100%
- REHEAT START (Point 22) equals 30%
- REHEAT END (Point 23) equals 100%

then,

- When HTG LOOPOUT is greater than or equal to 30%, FAN (Point 46) will turn ON (because the heating load is large enough).
- When HTG LOOPOUT is equal to or less than 30%, VLV COMD will equal 0% open.
- When HTG LOOPOUT equals 65%, VLV COMD will equal 50% open.
- When HTG LOOPOUT equals 100%, VLV COMD will equal 100% open.
- When HTG LOOPOUT is equal to or less than 30%, FLOW STPT will equal 0% flow.
- When HTG LOOPOUT is equal to 65%, FLOW STPT will equal 50% flow.
- When HTG LOOPOUT is greater than 72%, FLOW STPT will be greater than 60% flow. Since this will cause the flow in the supply duct (FLOW, Point 75) to rise above 60% of HTG FLOW MAX, the fan will shut OFF (to prevent the common duct from rupturing).
- When HTG LOOPOUT equals 100%, FLOW STPT will equal 100% flow.
- When HTG LOOPOUT is less than 65%, FLOW will be less than 50% of HTG FLOW MAX and the parallel fan will turn back ON.
- When HTG LOOPOUT is less than or equal to 5%, the parallel fan will turn OFF (because the heating load is so small that the fan no longer needs to be ON).

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 hot water valve and the parallel fan. When FLOW START and FLOW END are both set equal to 0%, the minimum flow will be maintained throughout the entire heating mode, regardless of the value of HTG LOOPOUT. Example 4 clarifies this:

Example 4*:* Assume that the fan turns ON before the valve modulates. Assume also that the parallel fan will shut OFF when the flow out of the supply duct is greater than 60% of HTG FLOW MAX, and that the parallel fan will be allowed to turn back ON once the supply duct airflow drops to less than 50% of HTG FLOW MAX. Finally, assume that HTG FLOW MIN equals 170 CFM and that HTG FLOW MAX equals 1000 CFM.

If,

- FAN OFF (Point 50) equals 5%
- FAN ON (Point 47) equals 30%
- PARALLEL ON (Point 28) equals 50%
- PARALLEL OFF (Point 30) equals 60%
- FLOW START (Point 16) equals 0%
- FLOW END (Point 17) equals 0%
- 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 equal to or less than 30%, VLV COMD will equal 0% open.
- When HTG LOOPOUT equals 65%, VLV COMD will equal 50% open.
- When HTG LOOPOUT equals 100%, VLV COMD will equal 100% open.
- When HTG LOOPOUT is greater than 30%, the FAN (Point 46) will turn ON (because the heating load is large enough).
- When HTG LOOPOUT is less than or equal to 5%, the parallel fan will turn OFF (because the heating load is so small that the fan no longer needs to be ON).

NOTE: In this example the fan never turned OFF due to high supply airflow, because the supply airflow never rose above HTG FLOW MIN.

Calibration

Air Velocity Transducer – Calibration of the controller's internal air velocity transducers is periodically required to maintain accurate air velocity readings. CAL SETUP (Point 95) is set with the desired calibration option during controller startup. Depending upon the value of CAL SETUP, calibration can be set to take place automatically or manually. If the status of CAL AIR (Point 94) is YES, then calibration is in progress.

- The damper is commanded closed to get a zero airflow reading during calibration.

Hot Water Valve – Calibration of a hot water valve is done by commanding the valve to fully closed.

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

When HEAT.COOL (Point 05) equals COOL, FAN (Point 46) is OFF. In heating mode, the type of fan control depends on the value of FAN MODE (Point 40).

When HEAT.COOL equals HEAT and FAN MODE equals FIXED, the fan is controlled as it is in application 2027. This means the fan will turn ON only when both of the following two conditions have been met:

- The hot water valve, VLV COMD (Point 52) is open greater than the value stored in STAGE FAN (Point 83).

- 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 transfer heat supplied by the hot water valve into the room.)

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

- The hot water valve, VLV COMD, is open less than the value stored in SWITCH LIMIT (Point 85).
- The airflow out of the supply duct, FLOW (Point 75) is greater than the value stored in PARALLEL OFF (Point 30). (This means that there is enough airflow out of the supply duct to transfer heat supplied by the hot water valve into the room.)

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

When HEAT.COOL equals HEAT and FAN MODE equals VARIED, the fan is controlled as follows:

Whenever the flow out of the supply duct (FLOW) is greater than the value in PARALLEL OFF, the parallel fan will shut OFF. (This is to prevent the common duct from rupturing.)

If the flow out of the supply duct (FLOW) is less than the value in PARALLEL OFF, but greater than the value in PARALLEL ON, the state of the parallel fan remains unchanged. (If it is ON, it remains ON; if OFF, it remains OFF.)

If the flow out of the supply duct (FLOW) is less than the value in PARALLEL ON, then HTG LOOPOUT will control the fan as follows:

- If HTG LOOPOUT is less than FAN OFF (Point 50), FAN (Point 46) will be OFF.
- If HTG LOOPOUT is greater than FAN ON (Point 47), FAN will be ON.
- If HTG LOOPOUT is between FAN OFF and FAN ON, the state of FAN remains unchanged.

Fail-safe Operation

If the air velocity sensor fails, then the controller uses pressure dependent control. The temperature loop controls the operation of the damper.

If the room temperature sensor fails, then the controller operates using 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 set point, 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. Refer to *APOGEE Automation Service and Procedures* in InfoLink for more information.

2. The Terminal Box Controller – Electronic Output, as shipped from the factory, keeps all associated equipment OFF. Refer to the Equipment Controllers tab in the *APOGEE Automation Start-up Procedures* in InfoLink for information on how to release the controller and its equipment to application control.

3. Spare DOs can be used as auxiliary points that are controlled by the field panel after being defined in the field panel's database. DO 3 and DO 4 or DO 5 and DO 6 may be used as auxiliary motor points. If using a pair of spare DOs to control a motor, you must unbundle the corresponding motor command point.

Wiring Diagram

The point wiring for Application 2369 is shown in Figure 2369-7.

CAUTION:

The Controller's D Os control 24 Vac loads only. The maximum rating is 12 VA for each DO. Use an interposing 220 V 4-relay module for any of the following:

- VA requirements higher than the maximum
- 110 or 220 Vac
- DC power

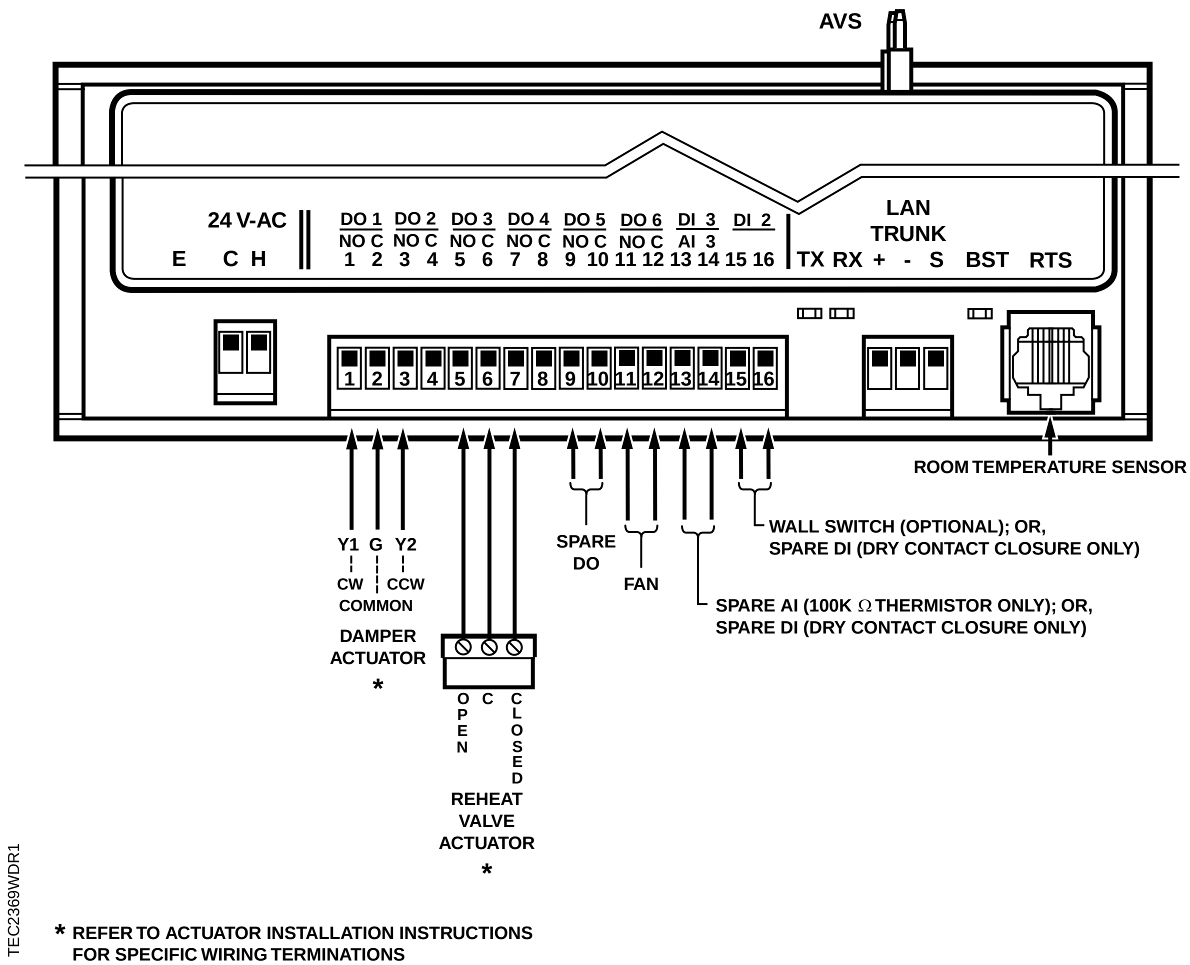


Figure 2369-7. Application 2369 Wiring Diagram.

Table 2369-1. Point Database for Application 2369.

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	30.0	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	--	--
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	--	--
40	FAN MODE	VARIED	--	--	--	VARIED	FIXED

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 2369-1. Point Database for Application 2369.

Point Number	Descriptor	Factory Default (SI Units)	Engr Units (SI Units)	Slope (SI Units)	Intercept (SI Units)	On Text	Off Text
{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	FAN ON	20.0	PCT	0.4	0.0	--	--
{48}	DMPR COMD	0.0	PCT	0.4	0.0	--	--
{49}	DMPR POS	0.0	PCT	0.4	0.0	--	--
50	FAN OFF	10.0	PCT	0.4	0.0	--	--
51	MTR1 TIMING	95	SEC	1	0	--	--
{52}	VLV COMD	0.0	PCT	0.4	0.0	--	--
{53}	VLV POS	0.0	PCT	0.4	0.0	--	--
54	VALVE SAFETY	YES	--	--	--	YES	NO
55	MTR2 TIMING	130	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	--	--
{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	--	--

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 2369-1. Point Database for Application 2369.

Point Number	Descriptor	Factory Default (SI Units)	Engr Units (SI Units)	Slope (SI Units)	Intercept (SI Units)	On Text	Off Text
{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	--	--
83	STAGE FAN	10.0	PCT	0.4	0.0	--	--
85	SWITCH LIMIT	5.2	PCT	0.4	0.0	--	--
86	SWITCH 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.