SIEMENS

TEC

VAV Parallel Fan with 0-10V AO Heat Modulation and CO2 Monitoring, Application 2847

Application Note

Building Technologies

140-1093

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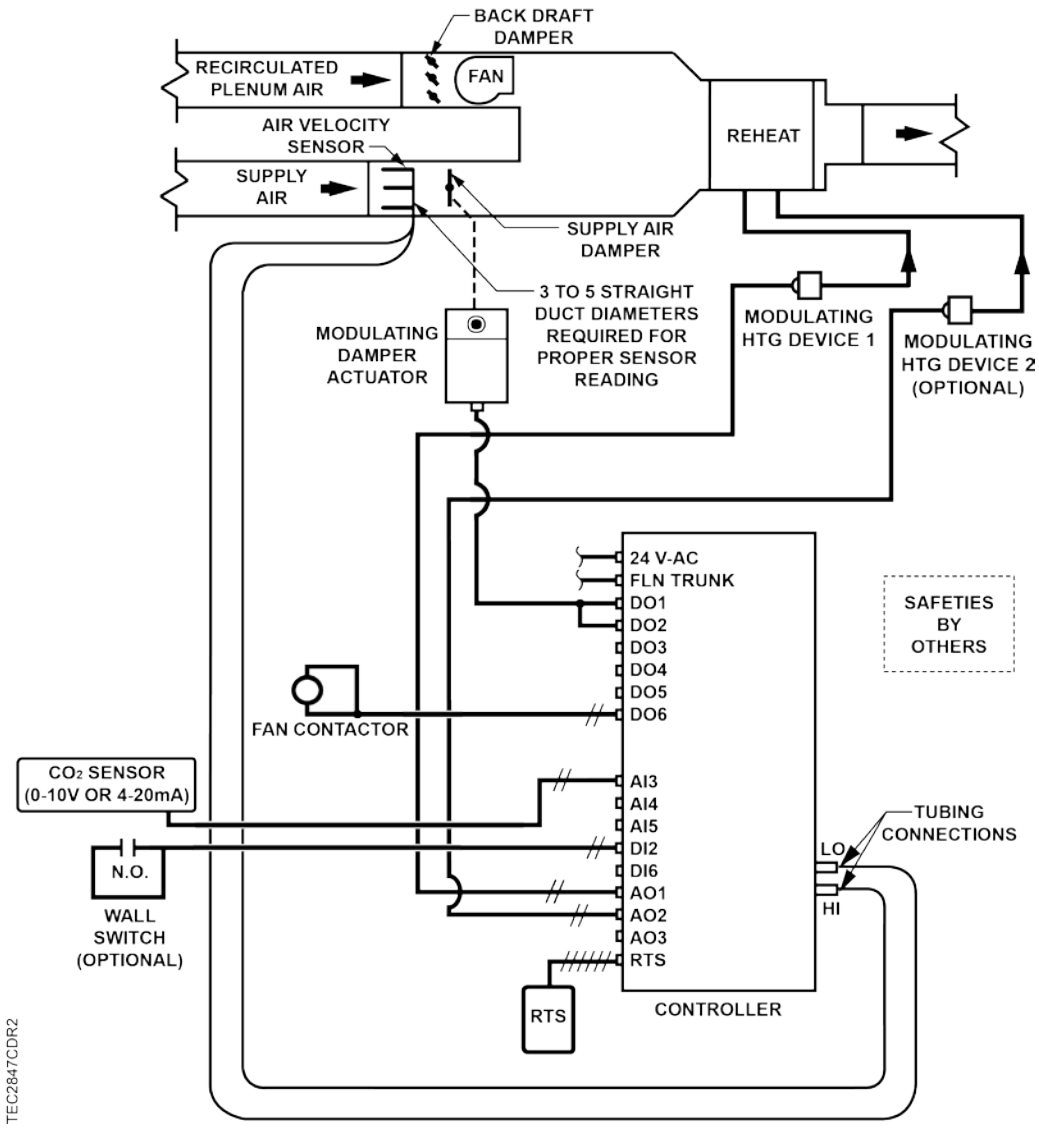
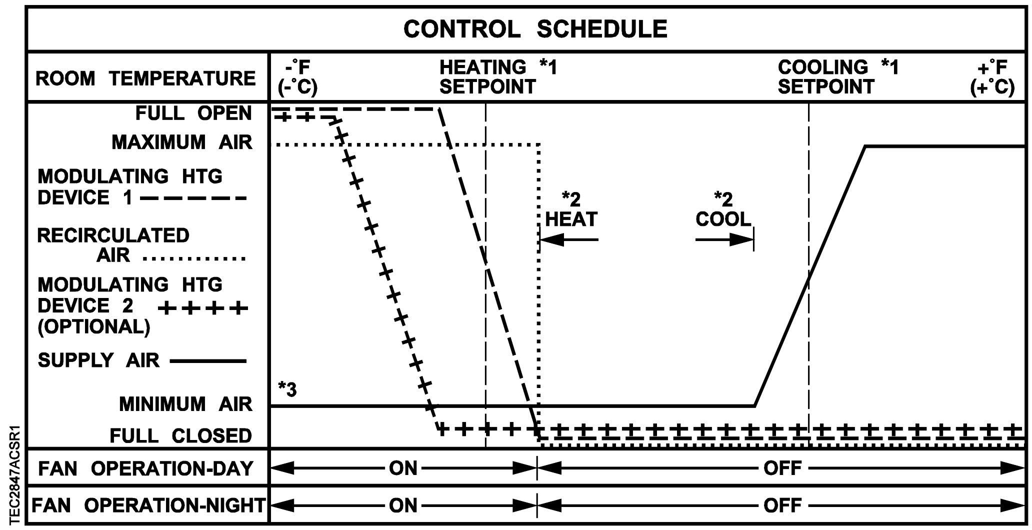
Overview

In Application 2847, the controller modulates the supply air damper of the terminal box for cooling and modulates a heating device(s) for heating. When in heating, the VAV box either maintains minimum air flow or modulates the VAV box air flow based on the heating needs of the space. If the VAV box air flow is to be modulated in heating mode, the flow loop and the heating devices can be sequenced as desired (series, parallel and overlapping sequencing are all supported.) This application can also monitor CO_2 and Supply Air Temperature (Aux Temp). In order for the terminal box to work properly, the central air handling unit must provide supply air.

Application 2847 controls a parallel fan that recirculates the room air.

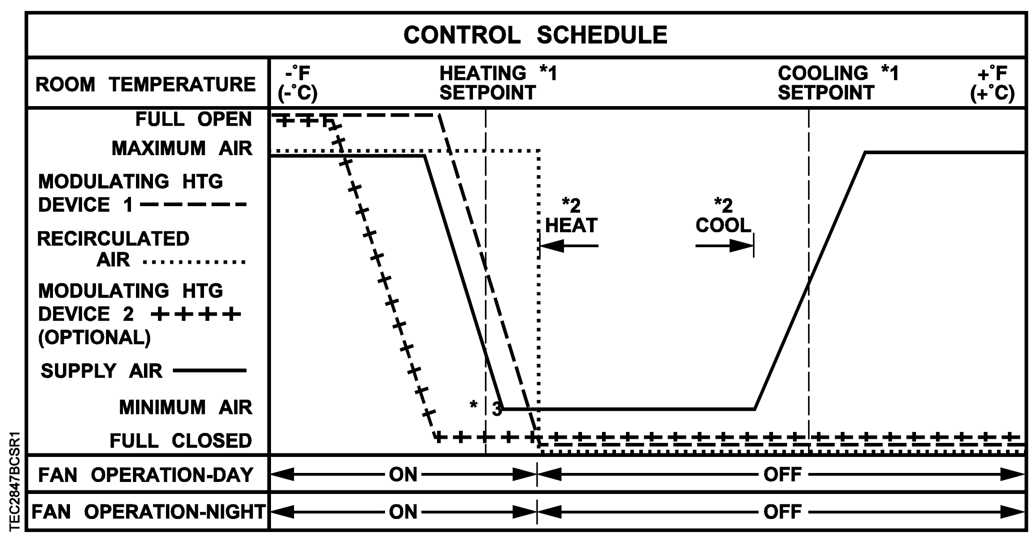


Application 2847 -- VAV Parallel Fan with 0-10V AO Heat Modulation and CO2 Monitoring.



Application 2847 Control Schedule with Fixed Flow in Heating Mode.

NOTES:
1. See *Control Temperature Setpoints*.
2. See *Heating/Cooling Switchover*.
3. 1 or 2 stages modulating heating coil.
4. The airflow is shown at minimum flow throughout the entire heating mode (default setting). The airflow can operate sequenced, parallel, or overlapping with the electric reheat (optional). See *Sequencing Logic*.



Application 2847 Control Schedule with Modulating Damper in Heating Mode.

NOTES:
1. See *Control Temperature Setpoints*.
2. See *Heating/Cooling Switchover*.
3. 1 or 2 stages modulating heating coil.
4. The airflow is shown at minimum flow throughout the entire heating mode (default setting). The airflow can operate sequenced, parallel, or overlapping with the electric reheat (optional). See *Sequencing Logic*.

Hardware Inputs

Analog

- Airflow sensor
- Room temperature sensor
- Room temperature setpoint dial (optional)
- Auxiliary temperature sensor (100K thermistor, optional)
- Spare temperature sensor (100K thermistor, optional)
- CO_2 sensor (0-10V or 4-20mA)

Digital

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

Hardware Outputs

Analog

- First modulating heating device actuator (required)
- Second modulating heating device actuator (optional)
- Spare AO 3

Digital

- Damper actuator (DO 1/DO 2)
- Parallel fan
- Spare DOs (DO 3, DO 4, DO 5)

Ordering Notes

540-865EN	Siemens TEC VAV with 0-10V AO Heat Modulation and CO2 Monitoring

Sequence of Operation

The following paragraphs present the sequence of operation for Application 2847, VAV Parallel Fan with 0-10V AO Heat Modulation and CO2 Monitoring.

Control Temperature Setpoints

This application has a number of different room temperature setpoints (DAY HTG STPT, NGT CLG STPT, RM STPT DIAL, etc.). The application actually controls to CTL STPT. CTL STPT is set to different values depending on its override status, the time of day, whether or not a temperature deadband (zero energy band) has been configured, and the type of RTS used.

CTL STPT is Overridden:

If CTL STPT is overridden, that value is used regardless of any other settings. This disables the setpoint deadband feature.

CTL STPT in Night Mode:

The controller is in Night Mode if DAY.NGT = NGT and NGT OVRD = NGT.

When the controller is in night mode, CTL STPT holds the value of NGT CLG STPT or NGT HTG STPT depending on the value of HEAT.COOL. When the controller is in night mode the value of RM STPT DIAL is ignored.

CTL STPT in Day Mode:

The controller is in Day Mode if DAY.NGT = DAY or NGT OVRD = DAY.

Without setpoint dial:

When the controller is in day mode and STPT DIAL = NO, CTL STPT holds the value of DAY CLG STPT or DAY HTG STPT depending on the value of HEAT.COOL.

With setpoint dial:

When the controller is in day mode and STPT DIAL = YES. CTL STPT is set based on the value of the setpoint dial and the setpoint deadband. The setpoint deadband exists to allow the controller to provide a separation of the heating and cooling temperature setpoints when a setpoint dial is enabled. The setpoint deadband is the difference between the cooling and heating day setpoints (DAY CLG STPT - DAY HTG STPT). The setpoint deadband can be disabled by setting DAY HTG STPT equal to DAY CLG STPT. When DAY HTG STPT does not equal DAY CLG STPT, a setpoint deadband (or zero energy band) is used.

The following values are used in the calculation of CTL STPT:

- *Dial value* is the value of RM STPT DIAL limited between the value of RM STPT MIN and RM STPT MAX.
- *Deadband* is the value of the difference between DAY CLG STPT and DAY HTG STPT, half of which is applied to establish the current heating and cooling setpoints.
  - *Deadband* = (DAY CLG STPT – DAY HTG STPT)

CTL STPT is calculated as follows:

With Deadband Disabled:

CTL STPT = *Dial value*

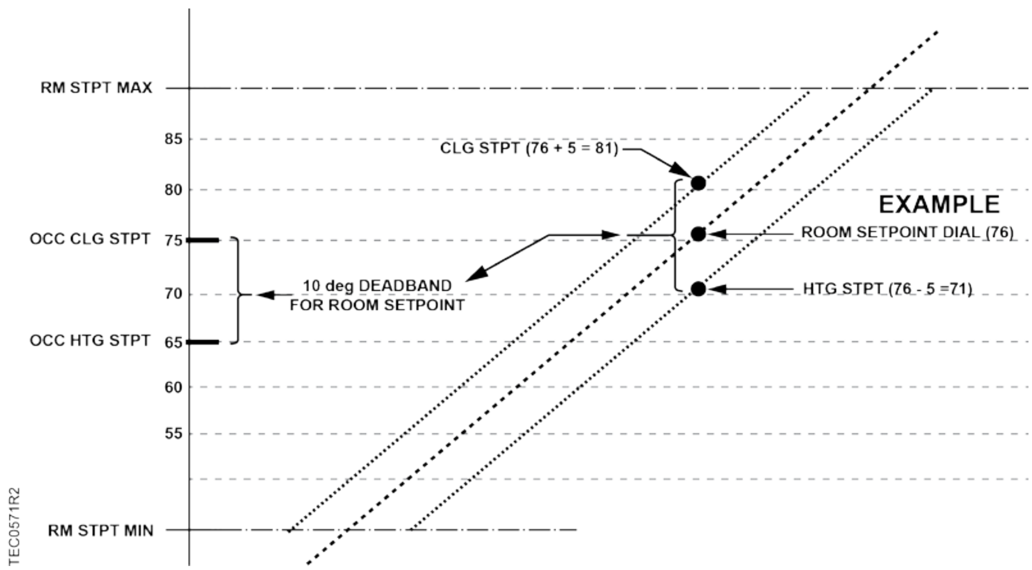
With Deadband enabled in Heat Mode:

CTL STPT = *Dial value* – 0.5 * *Deadband* (limited between the value of RM STPT MIN and RM STPT MAX)

With Deadband enabled in Cool Mode:

CTL STPT = *Dial value* + 0.5 * *Deadband* (limited between the value of RM STPT MIN and RM STPT MAX).

NOTE:
If RM STPT DIAL is failed, it maintains the last known value.



Room Temperature, Room Temperature Offset and CTL TEMP

ROOM TEMP is the temperature that is being sensed by the room temperature sensor (the RTS).

RMTMP OFFSET (or TEMP OFFSET) is a user-adjustable offset that will compensate for deviations between the value of ROOM TEMP and the actual room temperature.

CTL TEMP is the room temperature that is used for control purposes. In other words, what the application is trying to do is to maintain CTL TEMP at CTL STPT.

When CTL TEMP is not overridden, CTL TEMP and ROOM TEMP are related by the following equation:

CTL TEMP = ROOM TEMP + RMTMP OFFSET (or TEMP OFFSET)

If CTL TEMP is not overridden, then:

- The current value of ROOM TEMP (normal or overridden) will be used to determine the value of CTL TEMP.
- If ROOM TEMP has a status of Failed the last known good value of ROOM TEMP will be used to determine the value of CTL TEMP.

If CTL TEMP is overridden then:

- CTL TEMP equals its overridden value and the points ROOM TEMP and TEMP (RMTMP) OFFSET have no effect on the value of CTL TEMP.

Day and Night Modes

The day/night status of the space is determined by the status of DAY.NGT. 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 DI 2 (see the Control Diagram(s), and WALL SWITCH = YES, the controller monitors the status of DI 2.) When the status of DI 2 is ON (the switch is closed), then 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), then DAY.NGT will be set to NIGHT indicating that the controller is in night mode.

When WALL SWITCH = NO, the controller does not monitor the status of the wall switch, even if one is connected to it. In this case, if 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* (125-3019 or 125-3020) 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, pressing the override switch will reset the controller to DAY operational mode for the time period that is set in OVRD TIME. The status of NGT OVRD changes to DAY. After the override time elapses, the controller returns to night mode and the status of NGT OVRD changes back to NIGHT.

The override switch on the room sensor will only affect the controller when in night mode.

Heating/Cooling Switchover

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

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

- HTG LOOPOUT < SWITCH LIMIT.
- CTL TEMP > CTL STPT by at least the value set in SWITCH DBAND.
- CTL TEMP > the appropriate cooling setpoint minus SWITCH DBAND.

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

- CLG LOOPOUT < SWITCH LIMIT.
- CTL TEMP < CTL STPT by at least the value set SWITCH DBAND.
- CTL TEMP < the appropriate heating setpoint plus SWITCH DBAND.

Application 2847 performs heating/cooling switchover based on room load. To perform heating/cooling switchover based on some other criteria, such as time of year, outside air temperature or supply air temperature, unbundle the HEAT.COOL point at a field panel and use PPCL to control it.

- Heating only, set HC.ENDIS = 1.
- Cooling only, set HC.ENDIS = 2.
- Heating or Cooling (auto switchover), set HC.ENDIS = 3.

Modulating Damper During Heating Mode (Optional)

CAUTION

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

To change the value of HEAT.COOL based on the supply air temperature, you must command 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 *Sequencing Logic*). If the flow loop is used in heating mode just to meet minimum air requirements, the heating/cooling switchover mechanism operates as described in this section to control HEAT.COOL (see Example 4 in *Sequencing Logic*).

Control Loops

Advanced PID algorithm for the temperature control loops is employed to provide stability and to reduce unnecessary changes in the Flow setpoint when the room temperature is at or near the room temperature setpoint.

Flow Loop – The flow loop maintains FLOW STPT by modulating the supply air damper, DMPR COMD. The flow loop maintains the airflow between CTL FLOW MIN and CTL FLOW MAX.

Modulating Heat

CAUTION

As a safety feature, MODHTG FLOW ensures that adequate airflow is present before an electric heating element is energized. Since the application has a default of one heating valve (MODHTG COUNT = 1), MODHTG FLOW has the default of 20 pct (of HTG FLOW MAX). If flow safety is not required, set MODHTG FLOW = 0 to eliminate the dependency.

The default value is 20, which means that the airflow must be at least 20% of HTG FLOW MAX before heating outputs are enabled. (Note that if CTL FLOW MAX is overridden, MODHTG FLOW becomes the minimum required percentage of CTL FLOW MAX rather than the minimum required percentage of HTG FLOW MAX.) If hot water heat is used rather than electric heat, then, using WCIS you can set the value of MODHTG FLOW to a lower value to allow heating at lower airflows.
For installations that include radiant heating panels (either ceiling or wall mounted), MODHTG FLOW should b set to zero.

The heating loop modulates the heating device(s) in order to warm up the space as follows:

- If MODHTG COUNT = 1, when the heating command varies from 0 to 100% open of the reheat output range, MODHTG1 COMD varies from 0 to 100% open, and MODHTG2 COMD is not used in the application.
- If MODHTG COUNT = 2, when the heating command varies from 0 to 50% of the reheat output range, MODHTG1 COMD varies from 0 to 100% open. When the heating command varies from 50 to 100% of the reheat output range, MODHTG2 COMD varies from 0 to 100% open.

When the controller is in cooling mode, the heating device(s) is closed.

- If MODHTG COUNT is set to a value greater than 2, then the MODHTG COUNT will display a 0 when viewed on the screen and the application will treat MODHTG COUNT as though it was set to 0.

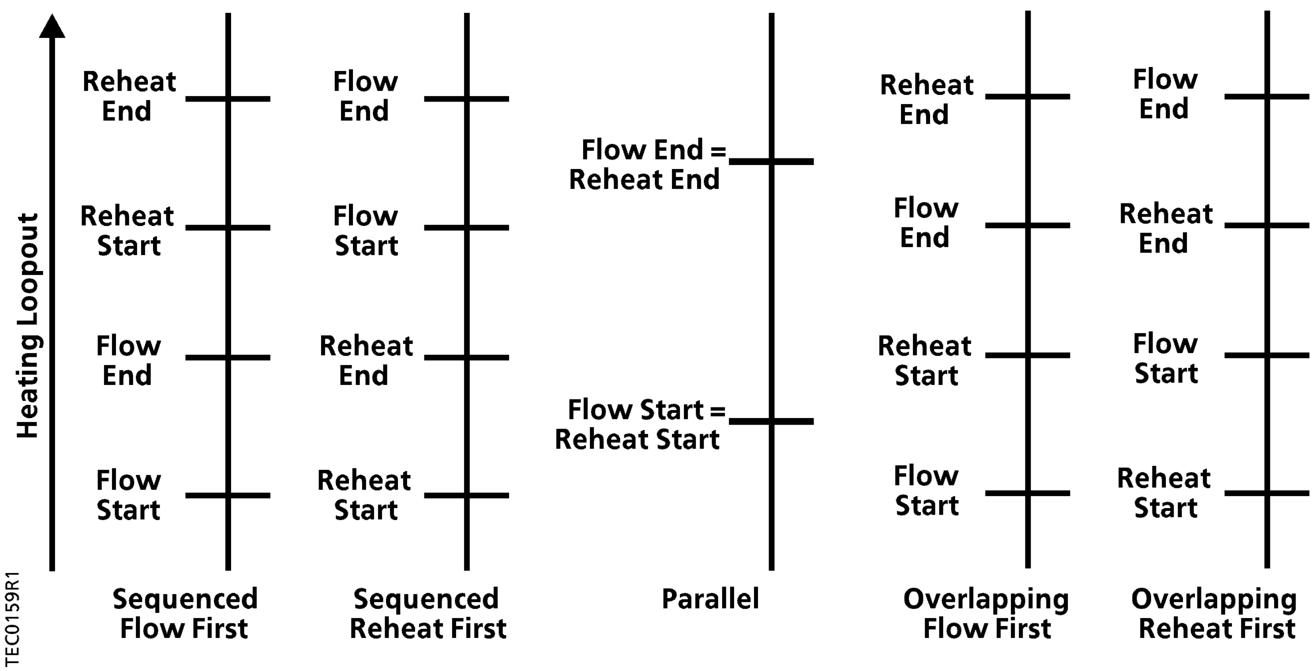
NOTE:
In this application, MODHTG1 COMD drives AOV1. When MODHTG1 COMD = 0, AOV1 will be set equal to AOV1 CLOSE. When MODHTG1 COMD = 100, AOV1 will be set equal to AOV1 OPEN.
In a similar fashion, MODHTG2 COMD drives AOV2. When MODHTG2 COMD = 0, AOV2 will be set equal to AOV2 CLOSE. When MODHTG2 COMD =100, AOV2 will be set equal to AOV2 OPEN.

Sequencing Logic

NOTE:
The default setpoints, FLOW START = 0 and FLOW END = 0, will provide minimum modulating supply airflow during heating mode.

In heating mode, this application includes logic that allows the flow loop to operate in sequence, parallel, or overlapping with the heating device. Selected portions of the output of the heating loop, HTG LOOPOUT, will drive both the flow loop and the heating from 0 to 100%. See the *Examples* section.

The ladder diagram shows sequenced, parallel, and overlapping flow loop operations with the heating device(s). 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.



For simplicity, assume that in these examples:

- HTG FLOW MIN = 0 cfm.
- There is only one modulating heating device (MODHTG COUNT = 1).
- When this is done, FLOW STPT = 0 when HTG LOOPOUT = 0.

Example 1

Assume that your system has a modulating heating device that is to operate in sequence with the flow loop. If:

- FLOW START = 0%
- FLOW END = 50%

- REHEAT START = 50%
- REHEAT END = 100%

then,

- When HTG LOOPOUT = 0%, FLOW STPT will equal 0% flow.
- When HTG LOOPOUT = 25%, FLOW STPT will equal 50% flow.
- When HTG LOOPOUT ≥ 50%, FLOW STPT will equal 100% flow.
- When HTG LOOPOUT ≤ 50%, MODHTG1 COMD will equal 0% open.
- When HTG LOOPOUT = 75%, MODHTG1 COMD will equal 50% open.
- When HTG LOOPOUT = 100%, MODHTG1 COMD will equal 100% open.

Example 2

Assume that your system has a modulating heating device that is to operate in parallel with the flow loop. If:

- FLOW START = 0%
- FLOW END = 100%
- REHEAT START = 0%
- REHEAT END = 100%

then,

- When HTG LOOPOUT = 0%, FLOW STPT will equal 0% flow.
- When HTG LOOPOUT = 50%, FLOW STPT will equal 50% flow.
- When HTG LOOPOUT = 100%, FLOW STPT will equal 100% flow.
- When HTG LOOPOUT = 0%, MODHTG1 COMD will equal 0% open.
- When HTG LOOPOUT = 50%, MODHTG1 COMD will equal 50% open.
- When HTG LOOPOUT = 100%, MODHTG1 COMD will equal 100% open.

Example 3

Assume that your system has a modulating heating device that is to operate overlapping with the flow loop. If:

- FLOW START = 0%
- FLOW END = 75%
- REHEAT START = 25%
- REHEAT END = 100%

then,

- When HTG LOOPOUT = 0%, FLOW STPT will equal 0% flow.
- When HTG LOOPOUT = 37.5%, FLOW STPT will equal 50% flow.
- When HTG LOOPOUT ≥ 75%, FLOW STPT will equal 100% flow.
- When HTG LOOPOUT ≤ 25%, MODHTG1 COMD will equal 0% open.
- When HTG LOOPOUT = 62.5%, MODHTG1 COMD will equal 50% open.
- When HTG LOOPOUT = 100%, MODHTG1 COMD will equal 100% open.

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 modulating heating device(s). The airflow minimum will be maintained by setting the FLOW START and FLOW END to a value of

0%, resulting in the corresponding 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 a modulating heating device that provides the temperature control in the heating mode, while the flow loop provides for the minimum air requirements. Assume:

- HTG FLOW MIN=170 cfm
- HTG FLOW MAX = 1000 cfm

If:

- FLOW START = 0%
- FLOW END = 0%
- REHEAT START = 0%
- REHEAT END = 100%

then,

- When HTG LOOPOUT = 0%,

FLOW STPT will equal (170 cfm / 1000 cfm) × 100% flow = 17% flow. This will cause the flow loop to maintain airflow of 170 cfm out of the terminal box.

- When HTG LOOPOUT = 50%, FLOW STPT will equal 17% flow.
- When HTG LOOPOUT = 100%, FLOW STPT will equal 17% flow.
- When HTG LOOPOUT = 0%, MODHTG1 COMD will equal 0% open.
- When HTG LOOPOUT = 50%, MODHTG1 COMD will equal 50% open.
- When HTG LOOPOUT = 100%, MODHTG1 COMD will equal 100% open.

As a safety feature, this application includes MODHTG FLOW to ensure that adequate airflow is present before heating coils are energized. The default value is 20, which means that the airflow must be at least 20% of HTG FLOW MAX before heating outputs are enabled.

NOTE:
In Example 4, the airflow is fixed at HTG FLOW MIN which may or may not be sufficient to satisfy the safeties. If electric heat is used, HTG FLOW MIN must be raised to a value high enough to satisfy the safeties—that is, higher than 20% of HTG FLOW MAX. If non-electric heating is used, then, using WCIS, the value of MODHTG FLOW may be lowered to allow heating operation at lower airflows.
If CTL FLOW MAX is overridden, MODHTG FLOW becomes the minimum required percentage of CTL FLOW MAX rather than the minimum required percentage of HTG FLOW MAX.

Sequencing Logic, FAN MODE = VARIED (Optional)

When FAN MODE equals VARIED, the sequencing logic in Application 2847 is more complex than it is when FAN MODE equals FIXED. This is because the parallel fan can now be sequenced along with the modulating heating device(s) 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, modulating heating device(s), and flow loop. For simplicity, assume that in these examples HTG FLOW MIN equals 0 cfm.

The modulating heating device(s) 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. If FLOW gets too high the parallel fan shuts OFF. The following examples illustrate this. (**Note:** In these examples, it is assumed that MODHTG COUNT equals 1.)

Example 1

Assume that your system has a modulating heating device operating in sequence with the flow loop and parallel fan, the sequence order being fan, modulating heating device, 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 equals 5%
- FAN ON equals 20%
- PARALLEL ON equals 30%
- PARALLEL OFF equals 50%
- REHEAT START equals 35%
- REHEAT END equals 65%
- FLOW START equals 70%
- FLOW END equals 100%

then,

- When HTG LOOPOUT is greater than or equal to 20%, the FAN will turn ON (because the heating load is large enough).
- When HTG LOOPOUT is less than or equal to 35%, MODHTG1 COMD will equal 0% open.
- When HTG LOOPOUT equals 50%, MODHTG1 COMD will equal 50% open.
- When HTG LOOPOUT is equal to or greater than 65%, MODHTG1 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) 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 modulating heating device operating in sequence with the flow loop and parallel fan, the sequence order being modulating heating device, 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 equals 40%
- FAN ON equals 60%
- PARALLEL ON equals 30%
- PARALLEL OFF equals 50%
- REHEAT START equals 0%
- REHEAT END equals 30%
- FLOW START equals 70%
- FLOW END equals 100%

then,

- When HTG LOOPOUT is equal to 0%, MODHTG1 COMD will equal 0% open.
- When HTG LOOPOUT equals 15%, MODHTG1 COMD will equal 50% open.
- When HTG LOOPOUT is equal to or greater than 30%, MODHTG1 COMD will equal 100% open.
- When HTG LOOPOUT is greater than 60%, the FAN 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) 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 modulating heating device operating parallel with the flow loop, and that the fan turns ON before either the modulating heating device 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 equals 5%
- FAN ON equals 30%
- PARALLEL ON equals 50%
- PARALLEL OFF equals 60%
- FLOW START equals 30%
- FLOW END equals 100%

- REHEAT START equals 30%
- REHEAT END equals 100%

then,

- When HTG LOOPOUT is greater than or equal to 30%, FAN will turn ON (because the heating load is large enough).
- When HTG LOOPOUT is equal to or less than 30%, MODHTG1 COMD will equal 0% open.
- When HTG LOOPOUT equals 65%, MODHTG1 COMD will equal 50% open.
- When HTG LOOPOUT equals 100%, MODHTG1 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) 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 modulating heating device 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. See *Example 4*.

Example 4

Assume that the fan turns ON before the heating device 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 equals 5%
- FAN ON equals 30%
- PARALLEL ON equals 50%
- PARALLEL OFF equals 60%
- FLOW START equals 0%
- FLOW END equals 0%
- REHEAT START equals 30%
- REHEAT END 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%, MODHTG1 COMD will equal 0% open.
- When HTG LOOPOUT equals 65%, MODHTG1 COMD will equal 50% open.
- When HTG LOOPOUT equals 100%, MODHTG1 COMD will equal 100% open.
- When HTG LOOPOUT is greater than 30%, the FAN 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.

CO2 Monitoring

CO2 displays the CO_2 value in units of parts-per-million (PPM). This value takes the sensor input (0-100%) and scales it using CO2 SCALE. CO2 can be unbundled for monitoring purposes.

Floating Control Actuation Auto-correct

In addition to the existing options for floating control actuator full stroke actions; all floating control actuators are provided with additional logic to fully drive open or closed when commanded to 100% or 0%.

Calibration

Calibration of the controller's internal air velocity sensor(s) is periodically required to maintain accurate air velocity readings. CAL SETUP is set with the desired calibration option during controller startup.

Depending on the value of CAL SETUP, calibration may be set to take place automatically or manually. If CAL AIR = YES, calibration is in progress.

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

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

During normal operation: To ensure that the damper opens and closes fully, the controller will provide additional opening or closing time when commanded DMPR POS = 100% and 0%.

Parallel Fan Operation

⚠	⚠ CAUTION
	It is strongly recommended that PARALLEL OFF be set greater than PARALLEL ON. If this is not done, the fan could shut off prematurely. This could cause the air flow across the heating coil to be insufficient to dissipate heat. (The point database has PARALLEL OFF greater than PARALLEL ON by default.

When HEAT.COOL equals COOL, FAN is OFF. In heating mode, the type of fan control depends on the value of FAN MODE.

When HEAT.COOL equals HEAT and FAN MODE equals FIXED the fan will turn ON only when both of the following two conditions have been met:

- Any modulating heating device controlled by this application is at least partially opened (greater than 0% opened) or has been completely closed for less than MODHTG TIME. (The number of modulating heating devices controlled by this application is determined by the value of MODHTG COUNT.
- The airflow out of the supply duct, FLOW, is less than the value stored in PARALLEL ON. (This means that there is not enough airflow out of the supply duct to transfer heat supplied by the modulating heating device(s) into the room.)

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

• All modulating heating devices controlled by this application have been completely closed for at least the amount of time stored in MODHTG TIME.

• The airflow out of the supply duct, FLOW is greater than the value stored in PARALLEL OFF. (This means that there is enough airflow out of the supply duct to transfer heat supplied by the modulating heating device 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, FAN will be OFF.
- If HTG LOOPOUT is greater than FAN ON, FAN will be ON.

If HTG LOOPOUT is between FAN OFF and FAN ON, the state of FAN remains unchanged.

NOTE:
It is possible for the fan to be ON in the cooling mode. If HEAT.COOL equals COOL but a modulating heating device used by this application has been closed for less than MODHTG TIME (Point 83), then the Fan will be controlled as though HEAT.COOL equals HEAT and FAN MODE equals FIXED. This could cause the fan to turn on.
This is a rare situation and will most likely only occur after the HEAT.COOL point has just changed from HEAT to COOL. This is an added safety to ensure that heat has dissipated from the heating coils when the modulating heating devices have recently turned off.

Fail Mode Operation

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

If the room temperature sensor fails, the controller operates using the last known temperature value.

Application Notes

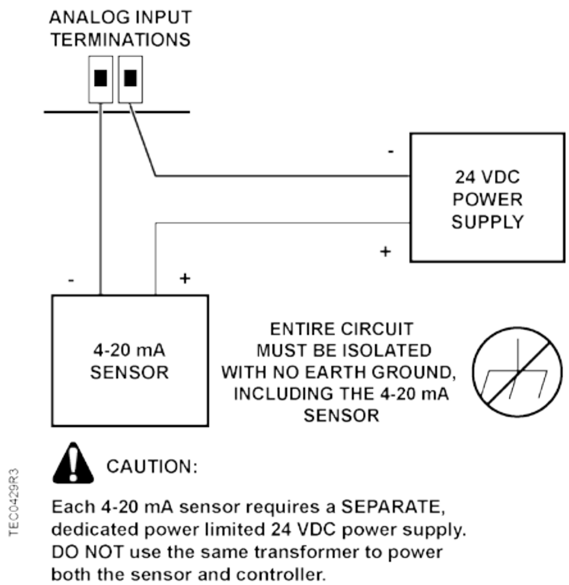
- If temperature swings in the room are excessive or there is trouble maintaining the setpoint, the cooling loop needs to be tuned. If FLOW is oscillating while FLOW STPT is constant, the flow loop requires tuning.
- The controller, as shipped from the factory, keeps all associated equipment OFF. See the appropriate *Start-up Procedures* for information on how to release the controller and its equipment to application control.
- In order for the heating loopout to work, use the correct setting for MODHTG COUNT.
- Spare DOs can be used as auxiliary points that are controlled by the field panel after being defined in the field panel's database.
- The heating device(s) controlled by this application are connected to AOV1 and AOV2. This application is not restricted to controlling valves from AOV1 and AOV2; it can control SCRs from AOV1 and AOV2 as well. In order to do this, the SCR must have its own controller that will modulate the SCR based on the value of a 0 to 10 V input. In this case, the TEC can control the SCR by connecting either AOV1 or AOV2 on the TEC to the 0 to 10 V input on the SCR.

Wiring Diagram

CAUTION

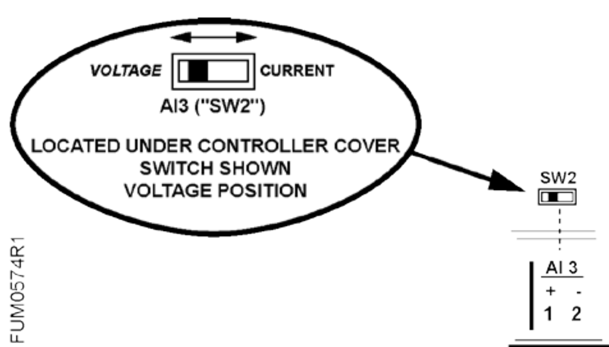
The controller's DOs control 24 Vac loads only. The maximum rating is 12 VA for each DO. An external interposing relay is required for any of the following:

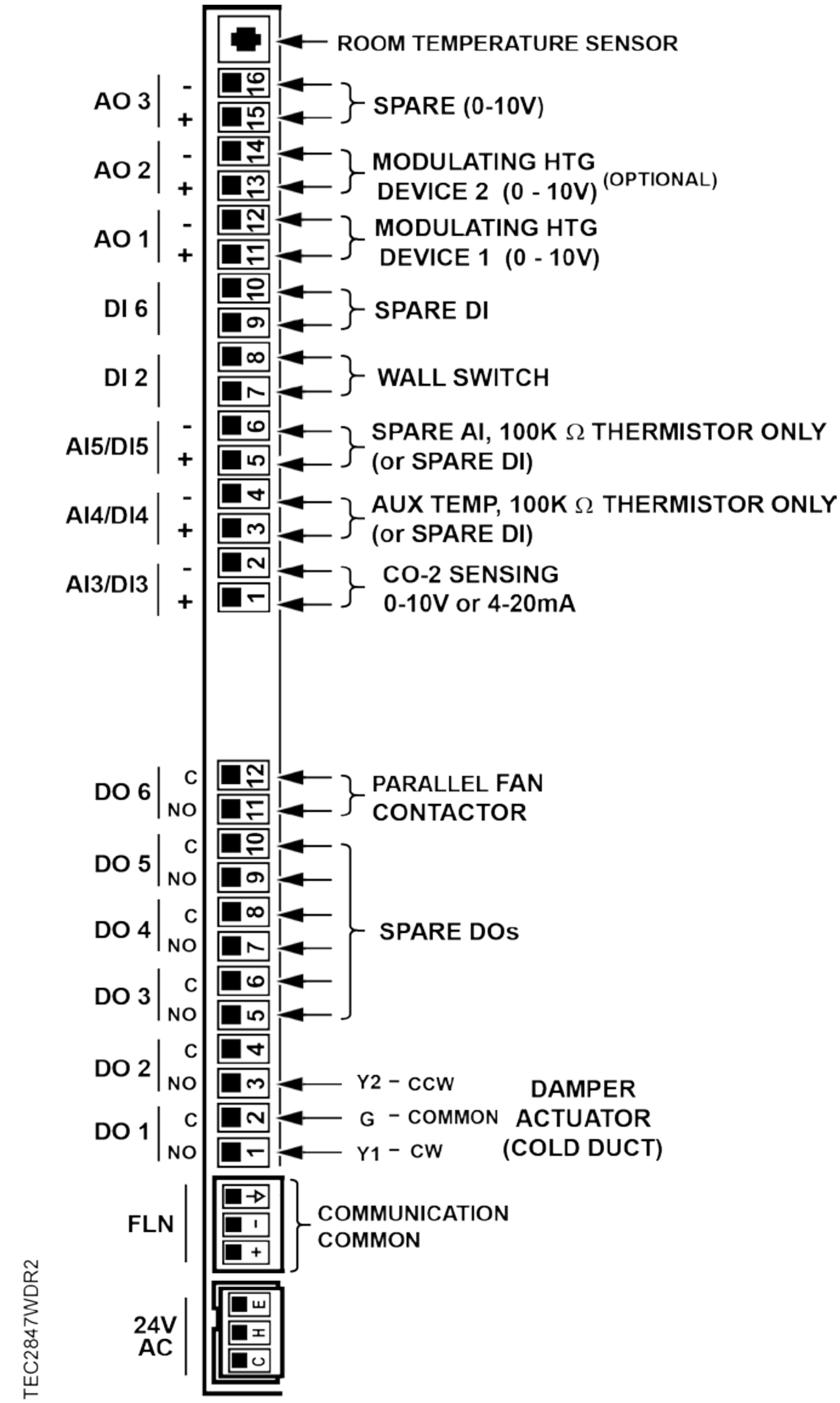
- VA requirements higher than the maximum
- 110 or 220 Vac requirements
- DC power requirements
- Separate transformers used to power the load
(for example part number 540-147, Terminal Equipment Controller Relay Module)



Wiring for AI with a 4 to 20 mA Sensor.

NOTE:
If the voltage/current switch is set to current and a 4 to 20 mA sensor is connected to an AI, then special wiring requirements must be followed.





Application 2847 -- VAV Parallel Fan with 0-10V AO Heat Modulation and CO2 Monitoring.

* AI 3 is switch selectable for voltage or current (on controller board under cover).

Application 2847 Point Database

Point Number[1]	Description	Factory Default (SI Units)[2]	Eng. Units (SI Units)	Slope (SI Units_	Intercept (SI Units)	On Text	Off Text
1	CTLR ADDRESS	99	–	1	0	–	–
2	APPLICATION	2899	–	1	0	–	–
{03}	CO2	2000	PPM	1	0	–	–
{04}[3]	ROOM TEMP	74.0 (23.44888)	DEGF(DEG C)	0.25 (0.14)	48.0 (8.88888)	–	–
{05}	HEAT.COOL	COOL	–	–	–	HEAT	COOL
6	DAY CLG STPT	74.0 (23.44888)	DEGF(DEG C)	0.25 (0.14)	48.0 (8.88888)	–	–
7	DAY HTG STPT	70.0 (21.20888)	DEGF(DEG C)	0.25 (0.14)	48.0 (8.88888)	–	–
8	NGT CLG STPT	82.0 (27.92888)	DEGF(DEG C)	0.25 (0.14)	48.0 (8.88888)	–	–
9	NGT HTG STPT	65.0 (18.40888)	DEGF(DEG C)	0.25 (0.14)	48.0 (8.88888)	–	–
{10}	CO2 SCALE	5000	PPM	1	0	–	–
11	RM STPT MIN	55.0 (12.80888)	DEGF(DEG C)	0.25 (0.14)	48.0 (8.88888)	–	–
12	RM STPT MAX	90.0 (32.40888)	DEGF(DEG C)	0.25 (0.14)	48.0 (8.88888)	–	–
{13}	RM STPT DIAL	74.0 (23.44888)	DEGF(DEG C)	0.25 (0.14)	48.0 (8.88888)	–	–
14	STPT DIAL	NO	–	–	–	YES	NO
{15}	AI 3	100	PCT	0.4	0	–	–
16	FLOW START	0	PCT	0.4	0	–	–
17	FLOW END	0	PCT	0.4	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	0	PCT	0.4	0	–	–
23	REHEAT END	100	PCT	0.4	0	–	–
{24}	DI 2	OFF	–	–	–	ON	OFF
{25}	DI 3	OFF	–	–	–	ON	OFF
{26}	DI 4	OFF	–	–	–	ON	OFF
{27}	DI 5	OFF	–	–	–	ON	OFF
{28}	DI 6	OFF	–	–	–	ON	OFF

Point Number[1]	Description	Factory Default (SI Units)[2]	Eng. Units (SI Units)	Slope (SI Units_	Intercept (SI Units)	On Text	Off Text
{29}	DAY.NGT	DAY	–	–	–	NIGHT	DAY
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	–	0.01	0	–	–
{37}	MODHTG2 COMD	0	PCT	0.4	0	–	–
{38}	AOV2	0	VOLTS	0.01	0	–	–
39	AOV2 OPEN	0	VOLTS	0.01	0	–	–
40	AOV2 CLOSE	10	VOLTS	0.01	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}	AUX TEMP AI4	74.0 (23.495556)	DEGF(DEG C)	0.5 (0.28)	37.5 (3.055556)	–	–
{48}	DMPR COMD	0	PCT	0.4	0	–	–
{49}	DMPR POS	0	PCT	0.4	0	–	–
51	MTR1 TIMING	95	SEC	1	0	–	–
{52}	MODHTG1 COMD	0	PCT	0.4	0	–	–
{54}	AOV3	0	VOLTS	0.01	0	–	–
55	PARALLEL ON	20	PCT	0.4	0	–	–
56	DMPR ROT ANG	90	–	1	0	–	–
57	PARALLEL OFF	30	PCT	0.4	0	–	–
58	MTR SETUP	0	–	1	0	–	–
59	DO DIR. REV	0	–	1	0	–	–
{60}	AOV1	0	VOLTS	0.01	0	–	–
61	AOV1 OPEN	0	VOLTS	0.01	0	–	–
62	AOV1 CLOSE	10	VOLTS	0.01	0	–	–
63	CLG P GAIN	20.0 (36.0)	–	0.25 (0.45)	0	–	–
64	CLG I GAIN	0.01 (0.018)	–	0.001 (0.0018)	0	–	–

Point Number[1]	Description	Factory Default (SI Units)[2]	Eng. Units (SI Units)	Slope (SI Units_	Intercept (SI Units)	On Text	Off Text
65	CLG D GAIN	0 (0.0)	–	2 (3.6)	0	–	–
66	TEMP OFFSET	0.0 (0.0)	DEG F(DEG C)	0.25 (0.14)	-31.75 (-17.78)	–	–
67	HTG P GAIN	10.0 (18.0)	–	0.25 (0.45)	0	–	–
68	HTG I GAIN	0.01 (0.018)	–	0.001 (0.0018)	0	–	–
69	HTG D GAIN	0 (0.0)	–	2 (3.6)	0	–	–
70	FAN ON	20	PCT	0.4	0	–	–
71	FAN OFF	10	PCT	0.4	0	–	–
72	FLOW I GAIN	0.01	–	0.001	0	–	–
73	FAN MODE	FIXED	–	–	–	VARIED	FIXED
74	MODHTG SAFE	NO	–	–	–	YES	NO
{75}	FLOW	0	PCT	0.25	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	–	–
{78}	CTL TEMP	74.0 (23.44888)	DEGF(DEG C)	0.25 (0.14)	48.0 (8.88888)	–	–
{79}	CLG LOOPOUT	0	PCT	0.4	0	–	–
{80}	HTG LOOPOUT	0	PCT	0.4	0	–	–
{82}	AUX TEMP AI5	74.0 (23.495556)	DEGF(DEG C)	0.5 (0.28)	37.5 (3.055556)	–	–
83	MODHTG TIME	120	SEC	1	0	–	–
85	SWITCH LIMIT	5.2	PCT	0.4	0	–	–
86	SWITCH TIME	10	MIN	1	0	–	–
88	MODHTG COUNT	1	–	1	0	–	–
90	SWITCH DBAND	1.0 (0.56)	DEG F(DEG C)	0.25 (0.14)	0	–	–
91	HC.ENDIS	3	–	1	1	–	–
{92}	CTL STPT	74.0 (23.44888)	DEGF(DEG C)	0.25 (0.14)	48.0 (8.88888)	–	–
{93}	FLOW STPT	0	PCT	0.25	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	–	–
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.

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Siemens Industry, Inc.
Building Technologies Division
1000 Deerfield Pkwy
Buffalo Grove IL 60089
Tel. +1 847-215-1000