SIEMENS

P1 TEC

VAV Series Fan with 3-Stage Electric Heat and Optional Occupancy Sensor

104296_2174p08
2013-3-19

Building Technologies

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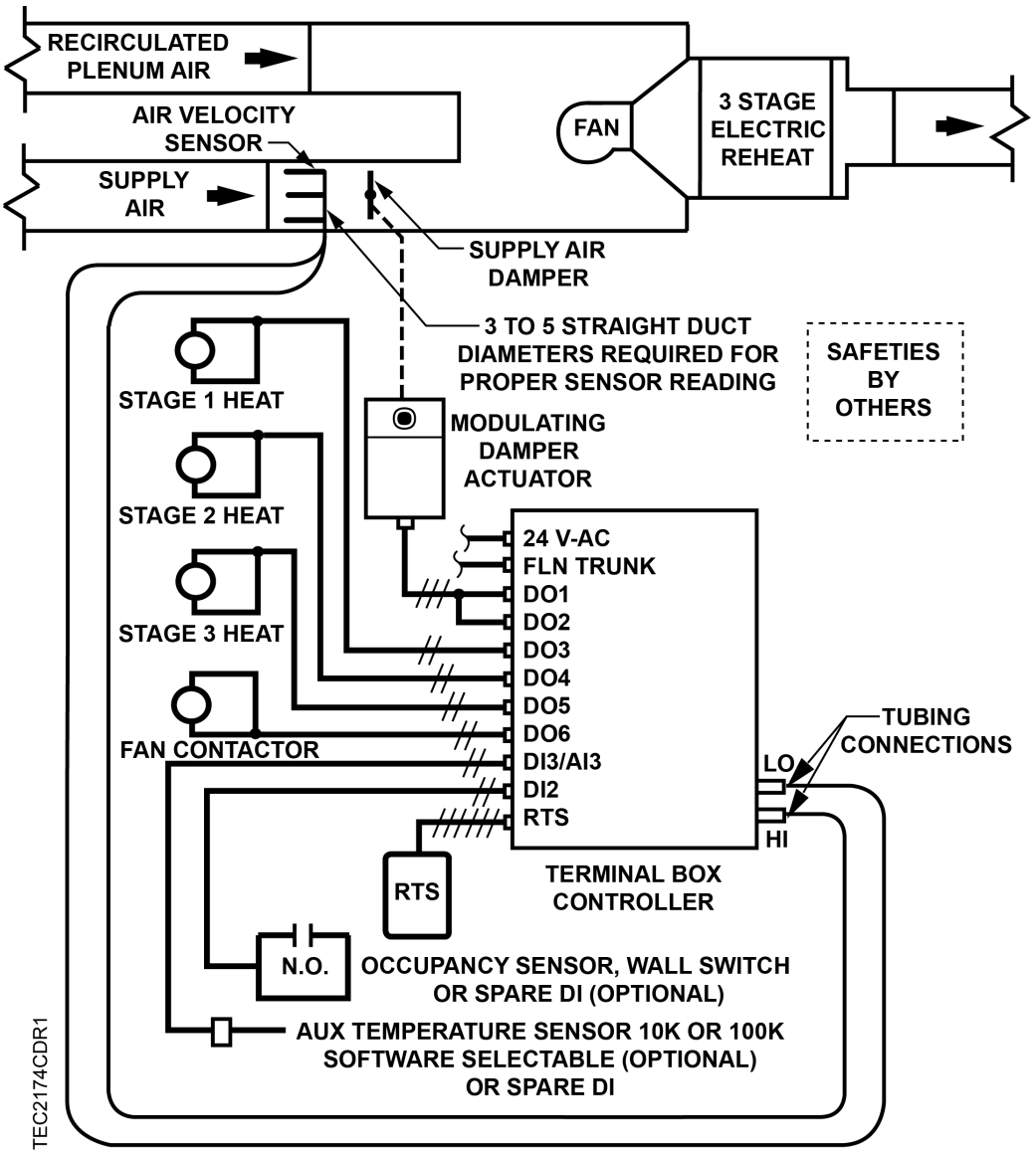
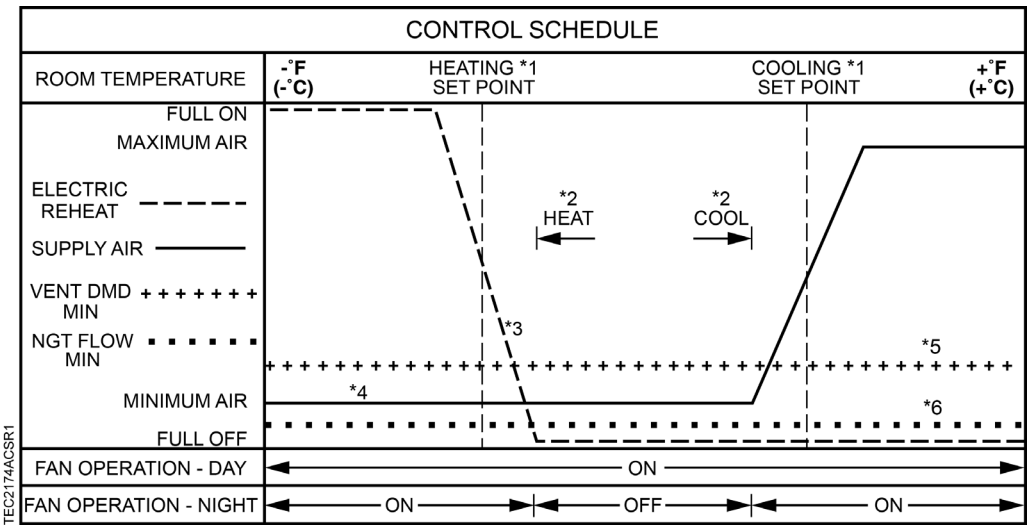
Overview

In Application 2174, 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. Application 2174 has a series fan for air circulation. In order for the terminal box to work properly, the central air-handling unit must provide supply air.



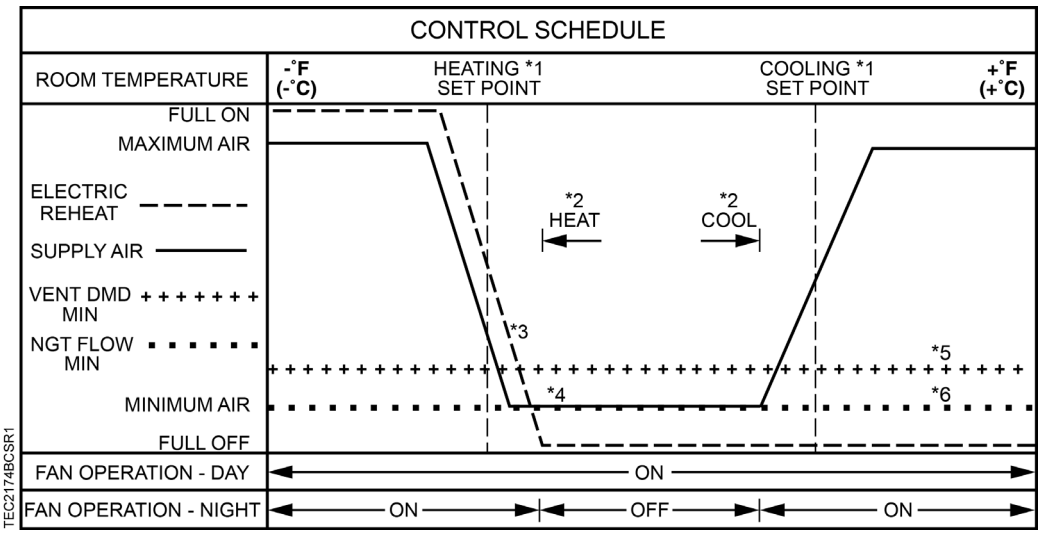
Application 2174 - VAV Series Fan with 3-Stage Electric Heat and Optional Occupancy Sensor.



Application 2174 Control Schedule – Fixed Air Flow in Heating

NOTES:

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 (default setting). The airflow can operate sequenced, parallel, or overlapping with the electric reheat (optional). See *Sequencing Logic*.
5. VENT DMD MIN can be set above, equal to, or below the minimum airflow setpoints (CLG FLOW MIN, HTG FLOW MIN) and can be controlled (reset) externally for ventilation demands. Minimum airflow will be the larger of temperature minimum airflow setpoint(s) and the ventilation demand flow setpoint VENT DMD MIN.
6. NGT FLOW MIN can be set equal or below the cooling minimum flow setpoints, or to zero, to be used for minimum flow during night modes.



Application 2174 Control Schedule – Modulating Heating Air Flow Control

NOTE:
The airflow is shown operating parallel with the electric reheat (optional). See Sequencing Logic [→ 17].

Hardware Inputs

Analog

- Airflow sensor
- Room temperature sensor
- Room temperature setpoint dial (optional)

Digital

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

Hardware Outputs

Analog

- None

Digital

- Damper actuator (DO 1/DO 2)
- Series Fan (DO 6)
- Stage 1 electric heat (optional) or Spare DO 3
- Stage 2 electric heat (optional) or Spare DO 4
- Stage 3 electric heat (optional) or Spare DO 5

Ordering Notes

540-100MD	Application 2170: VAV Cooling Only with Optional Occupancy Sensor Application 2174: VAV Series Fan with Electric Reheat and Optional Occupancy Sensor

Sequence of Operation

The following paragraphs present the sequence of operation for Application 2174, VAV Series Fan with Electric Reheat and Optional Occupancy Sensor.

Day and Night Modes

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

When a wall switch is physically connected to the controller at DI 2 and WALL SWITCH = YES, the controller monitors the status of DI 2. When DI 2 is ON (switch is closed), DAY.NGT will be set to DAY. When DI 2 is OFF (switch is open), DAY.NGT will be set to NIGHT.

When WALL SWITCH = NO, the controller will not monitor the status of a wall switch, even if one is connected at DI 2. 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 (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 the *APOGEE P2 ALN Field Panel User's Manual* (125-3020) for more information.

In addition to DAY.NGT, OCC STBY (occupied standby) will also affect control if an optional occupancy sensor is being used. OCC STBY works in conjunction with DAY.NGT to reduce airflow when no one is present in the zone during occupied times. See *Occupancy Sensor* for more information.

⚠ CAUTION

Do not turn a Wall Switch On and Off numerous times in rapid succession.

This can wear out the contactor of the 1st heating stage.

Occupancy Sensor

The occupancy sensor option provides a means to reduce airflow while using the occupied temperature setpoints. To enable this option, set WALL SWITCH = NO and OCC SWITCH = YES, and connect an occupancy sensor to the controller at DI 2.

When a zone is in a normal occupancy state (DAY.NGT = DAY) and people are present, the enabled occupancy sensor will keep OCC STBY equal to NO (space is occupied). If at some point people leave and the occupancy sensor senses no activity, OCC STBY will be set to YES. With OCC STBY set to YES, zone temperature setpoints will equal their occupied values (or an optional configurable offset of these) while airflow setpoints change to the unoccupied NGT FLOW MIN. If people return and the occupancy sensor senses activity, OCC STBY changes to NO and the zone returns to normal occupied control. See the table below for additional information.

Delay of activation and deactivation for detection of occupancy is not controlled by the application. If required, occupancy sensors should be selected to provide any of these delays.

Additional energy reduction can be achieved by changing the STBY OFFSET default of 0.0 deg to an offset that will be used to increase the cooling temperature setpoint and decrease the heating temperature setpoint. For example, with STBY OFFSET set to 1.0 deg, a cooling setpoint of 76 deg will be incremented to 77 deg and a heating setpoint of 70 deg will be decremented to 69 deg.

WALL SWITCH and OCC SWITCH Operation							
Conditions				Result			Comment
WALL SWITCH	OCC SWITCH	DAY.NGT	DI2	OCC STBY	Airflow minimum	Temp. control	
= NO **Note** WALL SWITCH must equal NO for occupancy sensor option.	= YES	DAY	OFF (no presence detected)	= YES	Minimum airflow setpoint changed from occupied calculation to NGT FLOW MIN	Remains at occupied temperature setpoints	Optional shift of temperature setpoints can be achieved by setting STBY OFFSET. For example, setting STBY OFFSET to 1.0 deg would raise a cooling setpoint of 76 deg to 77 deg (and lower a heating setpoint by 1.0 deg).
			ON (presence detected)	= NO	Minimum airflow setpoint, larger of VENT DMD MIN and minimum flow setpoint	Occupied temperature setpoints	
		NIGHT	Status of DI2 does not affect control	= NO	Minimum airflow set to NGT FLOW MIN	Unoccupied temperature setpoints	
	= NO	DAY	Status of DI2 does not affect control	= NO	Minimum airflow setpoint, larger of VENT DMD MIN and minimum flow setpoint	Occupied temperature setpoints	
		NIGHT	Status of DI2 does not affect control	= NO	Minimum airflow set to NGT FLOW MIN	Unoccupied temperature setpoints	
= YES	na (ignored)	DAY	ON	= NO	Minimum airflow setpoint, larger of VENT DMD MIN and minimum flow setpoint	Occupied temperature setpoints	Wall switch connected to DI2 sets DAY.NGT to DAY
		NIGHT	OFF	= NO	Minimum airflow set to NGT FLOW MIN	Unoccupied temperature setpoints	Wall switch connected to DI2 sets DAY.NGT to NIGHT

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.

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 several factors. These factors include override status of CTL STPT, time of day, the status of occupancy standby mode, and whether a temperature deadband (a zero energy band) has been configured for use with a room temperature setpoint dial.

CTL STPT Overridden – If CTL STPT is overridden, that value is used regardless of any other settings.

CTL STPT not Overridden – CTL STPT holds the value of one of the occupied, unoccupied, or standby cooling/heating setpoints, or it holds the value of the room setpoint dial calculation.

When STPT DIAL equals NO (default), CTL STPT holds the value of DAY CLG STPT or DAY HTG STPT (depending on HEAT.COOL) if:

- DAY.NGT equals DAY (or NGT OVRD = DAY)
- OCC STBY equals NO

In Night mode (DAY.NGT = NGT or NGT OVRD = NGT), 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.

Room Setpoint Dial

When the controller is in day mode and STPT DIAL = YES, cooling and heating day setpoints are based on the value of the setpoint dial and a calculated setpoint deadband. The setpoint deadband allows the controller to separate the heating and cooling temperature setpoints when the dial is enabled. The setpoint deadband is derived from the difference between the day cooling and heating setpoints. If desired, the deadband can be eliminated by setting DAY HTG STPT equal to DAY CLG STPT. See the illustration below.

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

- *Dial value* is the value of RM STPT DIAL, limited to the range between RM STPT MIN and RM STPT MAX.
- *Deadband* is the value difference between DAY CLG STPT and DAY HTG STPT: (DAY CLG STPT - DAY HTG STPT)

CTL STPT is calculated as follows:

With Deadband in Heat Mode:

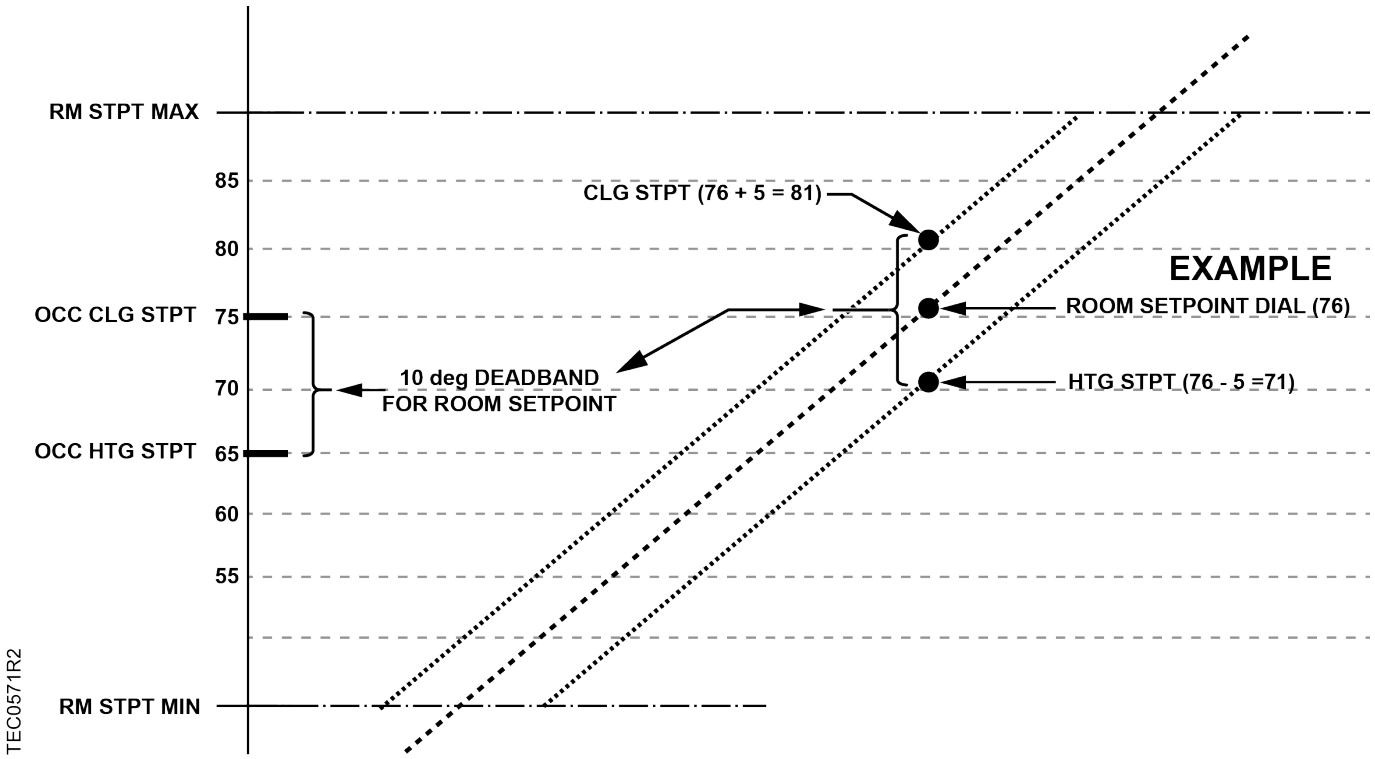
- CTL STPT = Dial value – (0.5 *Deadband)

With Deadband in Cool Mode:

- CTL STPT = Dial value + (0.5 *Deadband)

With Deadband Disabled (DAY HTG STPT = DAY CLG STPT):

- CTL STPT = Dial value



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

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

Optional Occupied Standby HTG / CLG Setpoints

When an occupancy sensor is present and enabled and no one is currently in the zone (OCC STBY = YES), the cooling and heating setpoints will be the day setpoints with the optional STBY OFFSET applied (cooling setpoint increased by the STBY OFFSET and heating setpoint decreased by the STBY OFFSET). For example, with STBY OFFSET set to 1.0 deg, a cooling setpoint of 76 deg will be incremented to 77 deg and the heating setpoint of 70 deg will be decremented to 69 deg.

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.

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 (defined in *Control Temperature Setpoints* section) 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 (defined in *Control Temperature Setpoints* section) heating setpoint plus SWITCH DBAND.

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*).

Ventilation Demand Minimum

For flexible ventilation control, a ventilation demand minimum setpoint (VENT DMD MIN) is provided. If used, VENT DMD MIN operates only during occupied modes.

VENT DMD MIN can be controlled externally using demand control ventilation (DCV) or an indoor air quality (IAQ) program (from a field panel or PPCL). The regular minimum airflow setpoint (CLG FLOW MIN) can be set lower than VENT DMD MIN or to zero, and VENT DMD MIN can modulate in response to CO_2 or other indoor air quality ventilation requirements.

Note that the control maximum flow setpoints are not affected by VENT DMD MIN.

NOTE:
If using optional occupancy sensor, the occupied minimum airflow is defined as above when OCC STBY = NO. When OCC STBY = YES (occupied mode but no one in the zone), the occupied minimum airflow will be set to NGT FLOW MIN.

Night Flow Minimum

Some applications do not provide a distinction between day/occupied and night/unoccupied modes for the minimum air flow setpoints. For day/occupied operation, the cooling or heating minimum flow setpoints were designed to be the air flow for minimum cooling and ventilation or for air flow across heating coils. At night the air handling unit was typically not running, making night/unoccupied airflow setpoints unnecessary.

The use of this additional flow setpoint, NGT FLOW MIN, in place of heating flow min and cooling flow min, addresses this limitation. As the flow at night/unoccupied times does not require the ventilation needs for personnel, it can be set below other minimums or at zero. The configured maximum heating and cooling flow setpoints will still be used when the zone temperature exceeds (goes out of bounds) the night cooling or heating setpoints.

Control Loops

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

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. See Control Temperature Setpoints.

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.

Cooling Loop – The cooling loop generates cooling loopout which is then used to generate FLOW STPT. FLOW STPT is the result of scaling the cooling loopout to the appropriate range of values determined by flow minimum and flow maximum (CLG FLOW MAX).

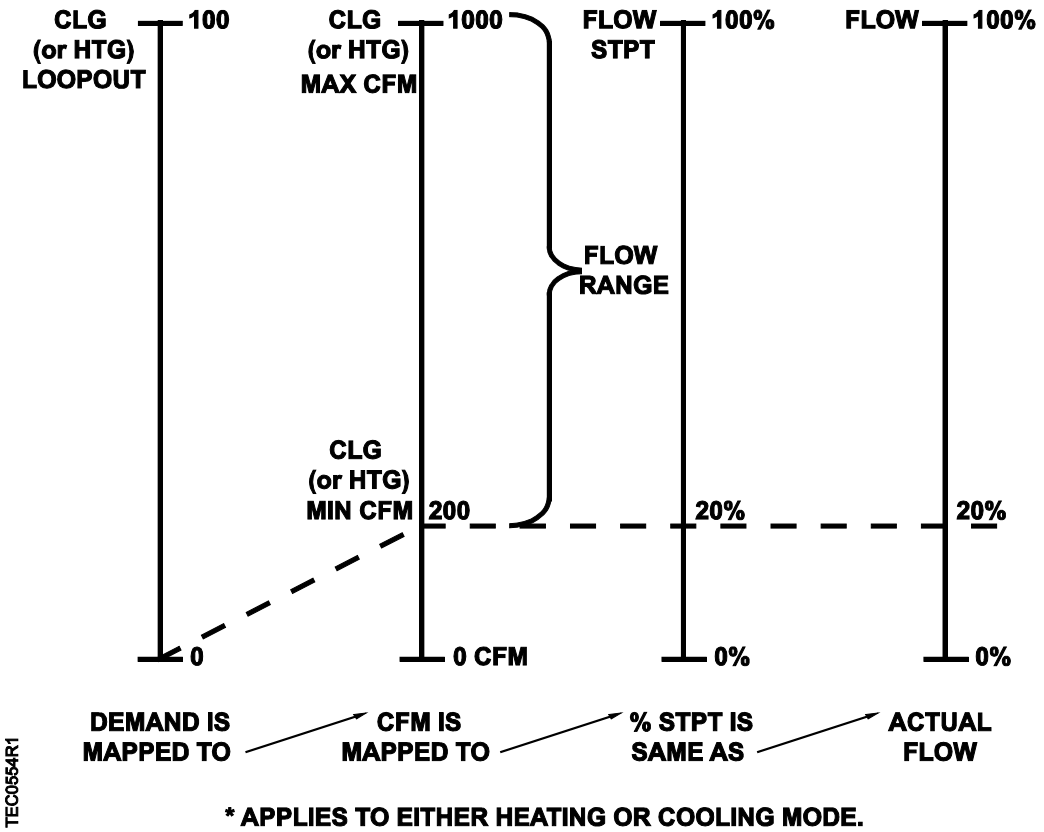
Flow minimum (CTL FLOW MIN) for Day cooling is set to the larger of CLG FLOW MIN and VENT DMD MIN. In Night cooling (or NGT OVRD = DAY), flow minimum is set to NGT FLOW MIN.

As described in the following figure, the flow setpoint is calculated by:

FLOW STPT = [CLG LOOPOUT × (100% – % minimum setpoint)] + % minimum setpoint.

Where percent minimum setpoint is:

% minimum setpoint = (CLG FLOW MIN / CLG FLOW MAX) x 100 %



FLOW STPT and FLOW % are relative to MIN and MAX STPTS of corresponding heating or cooling mode.

Example

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

When CLG LOOPOUT is 0%, FLOW STPT = 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 = 60% flow.
[50% × (100% – 20%)] + 20% = 60%

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

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

- Option 1: Constantly maintain airflow out of the terminal box equal to CTL FLOW MIN.
- Option 2: Operate in sequence with the reheat.
- Option 3: Operate parallel with the reheat.
- Option 4: Have its operation overlap with the operation of the electric reheat.

If the option 1 is chosen, HTG LOOPOUT will control the electric reheat in order to maintain the room temperature. If option 2, 3, or 4 is chosen, HTG LOOPOUT will control both the flow loop setpoint (FLOW STPT) and the electric reheat in order to maintain the room temperature. See Sequencing Logic [→ 17] 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 (CTL FLOW MIN/HTG FLOW MAX) × 100% flow or above 100% flow.

In heating mode, CTL FLOW MIN is determined as follows:
In Day heating, flow minimum (CTL FLOW MIN) is set to the larger of HTG FLOW MIN and VENT DMD MIN. In Night heating (or NGT OVRD = DAY), the flow minimum is set to NGT FLOW MIN.

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.

To enhance stable flow control, an advanced algorithm is used to calculate a controllable setpoint as the value approaches zero cfm (lps).

You can set CLG FLOW MIN equal to, but not greater than, CLG FLOW MAX, and set HTG FLOW MIN equal to, but not greater than, HTG FLOW MAX. If the minimum and maximum values are set equal, the flow loop becomes a constant volume loop and loses its ability to control temperature.

FLOW is the input value for the flow loop. It is calculated as a percentage based on where AIR VOLUME is between 0 cfm and CTL FLOW MAX. This percentage is referred to as % flow.

- If AIR VOLUME = 0 cfm, FLOW is 0% flow.
- If AIR VOLUME = CTL FLOW MAX, 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 will not be less than CTL FLOW MIN.

Example

If CTL FLOW MIN = 250 cfm, and CTL FLOW MAX = 1000 cfm,
the low limit of FLOW STPT = (250 cfm / 1000 cfm) × 100% flow
= 0.25 × 100% flow
= 25% flow.
Since 25% of 1000 cfm = 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 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 = 10 minutes), and the heating loop is calling for 60% of heating (HTG LOOPOUT = 60%) 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 electronic 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

Room Unit Operation

Stat Supervision

STAT SUPV is a configurable point (values are additive). Configuration will differ depending on the type of room unit (stat) being used. (Note: If the room unit is analog, STAT SUPV is used **only** to specify thermistor inputs as 10K or 100K.Therefore for analog room units the only values possible for STAT SUPV are 0, 8, or 16. See the table below.

If the room unit is digital, STAT SUPV defines the thermistors **and also** enables the room unit temperature, humidity and/or CO_2 points to be read by the controller. For digital room units, if a temperature, humidity, or CO_2 value (see table) is not included in the configured value for STAT SUPV, then the related point cannot be read (or ever display as failed). Conversely, if you enable supervision for a feature that the room unit does not support, then the related point will always display as failed.

Example: If you are using a digital room unit and need temperature and CO_2 sensing and a 100K thermistor on AI 5, you would set STAT SUPV = 13 (1 + 4 + 8 = 13). See the table below.

STAT SUPV Additive Values	
Value	**Description**
0 (default)	10K Ω thermistor(s)
1	Temperature sensing [1]
2	Relative Humidity (RH) sensing [1]
4	CO_2 sensing [1]
8	If short board: 100K Ω thermistor on AI 3 If long board: 100K Ω thermistor on AI 5
16	Long board only: 100K Ω thermistor on AI 4 (AI 4 must be a thermistor input, not a 0-10V/4-20 mA input.)

1) Additive values 1, 2, 4 **must not** be used with Series 1000 / 2000 analog room units.

See *Sensors and Transducers Configuration and Sizing* for part numbers and ordering information.

CO2 Monitoring

RM CO2 displays the CO_2 value in units of parts-per-million (PPM). RM CO2 can be unbundled for monitoring purposes.

Room RH

RM RH displays the relative humidity value in percent. RM RH can be unbundled for monitoring purposes.

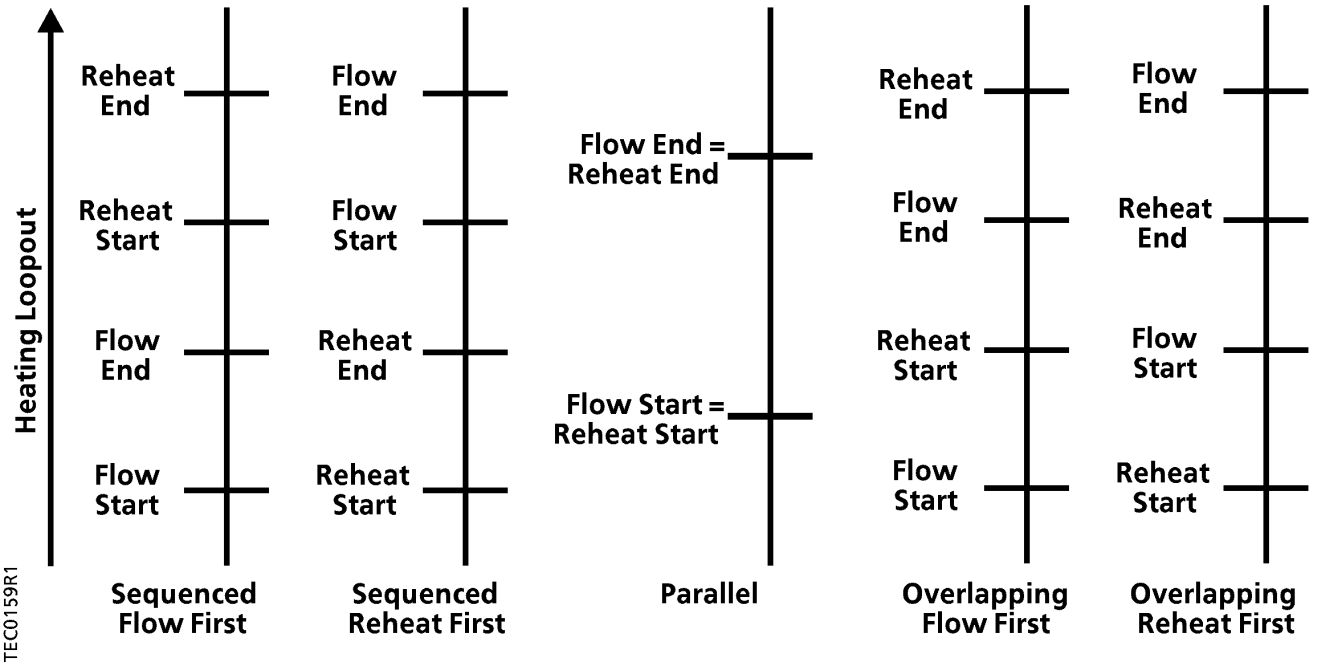
Sequencing Logic

NOTE:
Setting FLOW START = 0 and FLOW END = 100, will provide modulating supply airflow during heating mode (HTG FLOW MIN to HTG FLOW MAX).

NOTE:
The series fan will provide airflow across the terminal heating coils. In addition, supply air will modulate in the heating mode from HTG FLOW MIN to HTG FLOW MAX only when the setpoints for FLOW START and FLOW END are not equal (for example, 0 and 100 percent).

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%.

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.

Example 1 (Airflow Sequenced First)

Assume that your system has electric heat 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%, the electric heat will be off all the time.
- When HTG LOOPOUT = 75%, for every 10-minute period the electric heat will be on for 5 minutes and off for 5 minutes.
- When HTG LOOPOUT = 100%, the electric heat will be on all the time.

Example 2 (Airflow and Heat Sequenced Together)

Assume that your system has electric heat 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%, the electric heat will be off all the time.
- When HTG LOOPOUT = 50%, for every 10-minute period the electric heat will be on for 5 minutes and off for 5 minutes.
- When HTG LOOPOUT = 100%, the electric heat will be on all the time.

Example 3 (Airflow Sequenced First with Overlap for Heating)

Assume that your system has electric heat 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%, the electric heat will be off all the time.

- When HTG LOOPOUT = 62.5%, for every 10-minute period the electric heat will be on for 5 minutes and off for 5 minutes.
- When HTG LOOPOUT = 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 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 (Airflow Remains Fixed; Heating Modulates)

If the job requirement specifies that the supply airflow in heating will remain fixed, set HTG FLOW MIN = HTG FLOW MAX so that the fixed value in heating is indicated. An alternative setting, would be to set FLOW START = FLOW MIN = 0, which would fix the flow at HTG FLOW MIN.

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.

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

If:

- FLOW START=0%
- FLOW END=0% (or/and HTG FLOW MIN = HTG FLOW MAX)
- 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 an 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%, the electric heat will be off all the time.
- When HTG LOOPOUT = 50%, for every 10-minute period the electric heat will be on for 5 minutes and off for 5 minutes.
- When HTG LOOPOUT = 100%, the electric heat will be on all the time.

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.

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%.

Series Fan Operation

⚠ CAUTION

On series fan powered terminal boxes, the terminal box fan must be controlled/interlocked to start either before or at the same time as the central air handler.

Failure to do so may cause the terminal box fan to rotate backwards and cause consequent damage at start up.

Day Mode – FAN is ON all of the time.

Night Mode – The fan is controlled as follows:

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

- The first stage of electric heat, HEAT STAGE 1, turns ON.
- The airflow out of the supply duct, FLOW, is greater than 50% of NGT FLOW MIN (when NGT FLOW MIN is greater than zero).
- The airflow out of the supply duct, FLOW, is greater than the value stored in SERIES ON. This ensures that the series fan is on when supply air is provided, independent of the heating demand.

The fan will turn OFF only when the following conditions have been met:

- The first stage of electric heat is OFF for at least one full duty cycle: HEAT STAGE 1 is OFF longer than STAGE TIME.
- The airflow out of the supply duct is less than 50% of NGT FLOW MIN or NGT FLOW MIN = 0.
- The airflow out of the supply duct, FLOW, is less than the value stored in SERIES 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.

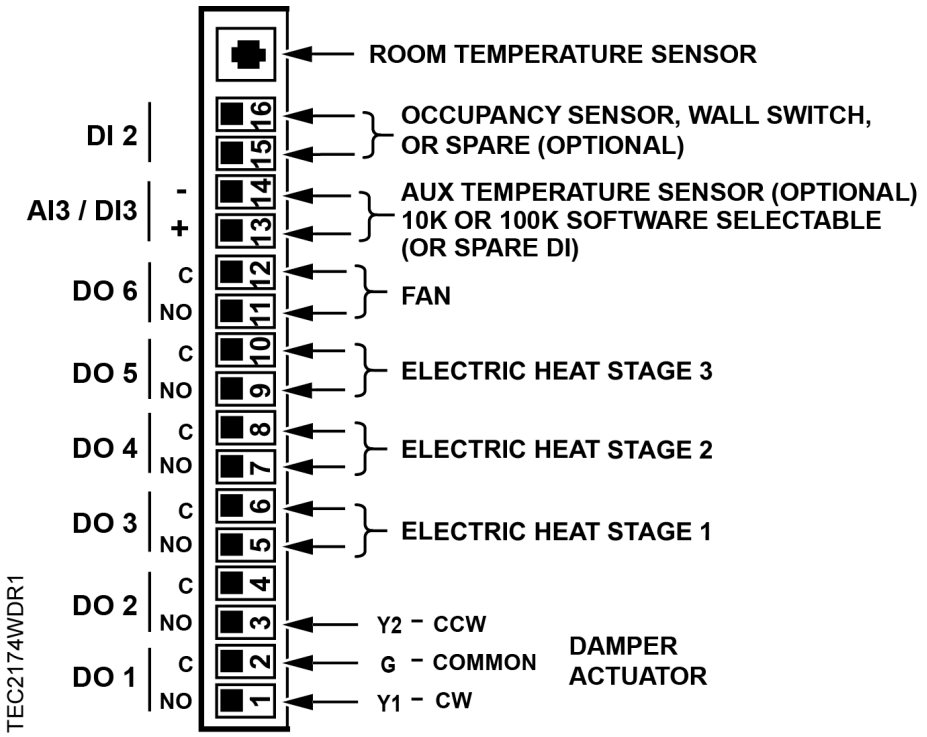
Application Notes

- 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.

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)



Application 2174 – Variable Air Volume Series Fan with Electric Reheat and Optional Occupancy Sensor.

Application 2174 Point Database

Point Number [1]	Descriptor	Factory Default (SI Units)[2]	Eng Units (SI Units)	Slope (SI Units)	Intercept (SI Units)	On Text	Off Text
01	CTLR ADDRESS	99	--	1	0	--	--
02	APPLICATION	2178	--	1	0	--	--
03	RMTMP OFFSET	0.0 (0.0)	DEG F (DEG C)	0.25 (0.14)	-31.75(-17.78)	--	--
{04} [3]	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 AI3	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	0.0	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
26	SERIES ON	20.0	PCT	0.4	0.0	--	--
27	SERIES OFF	10.0	PCT	0.4	0.0	--	--
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	--	--

Point Number [1]	Descriptor	Factory Default (SI Units)[2]	Eng Units (SI Units)	Slope (SI Units)	Intercept (SI Units)	On Text	Off Text
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	--	--
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	--	--
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	--	--
{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	--	--

Point Number [1]	Descriptor	Factory Default (SI Units)[2]	Eng Units (SI Units)	Slope (SI Units)	Intercept (SI Units)	On Text	Off Text
90	SWITCH DBAND	1.0 (0.56)	DEG F (DEG C)	0.25 (0.14)	0.0	--	--
{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	--	--
104	NGT FLOW MIN	0 (0.0)	CFM (LPS)	4 (1.8876)	0	--	--
{105}	VENT DMD MIN	220 (103.818)	CFM (LPS)	4 (1.8876)	0	--	--
106	OCC SWITCH	NO	--	--	--	YES	NO
{107}	OCC STBY	NO	--	--	--	YES	NO
108	STBY OFFSET	0.0 (0.0)	DEG F (DEG C)	0.25 (0.14)	0.0	--	--
124	STAT SUPV	0	--	1	0	--	--
{125}	RM CO2	1000	PPM	1	0	--	--
{126}	RM RH	50.0	PCT	0.4	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.

Issued by
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