SIEMENS

TEC Controller

VAV 0-10V Fan Control with Hot Water Heat, Application 2236

Application Note

140-1228
2015-06-04

Building Technologies

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Overview

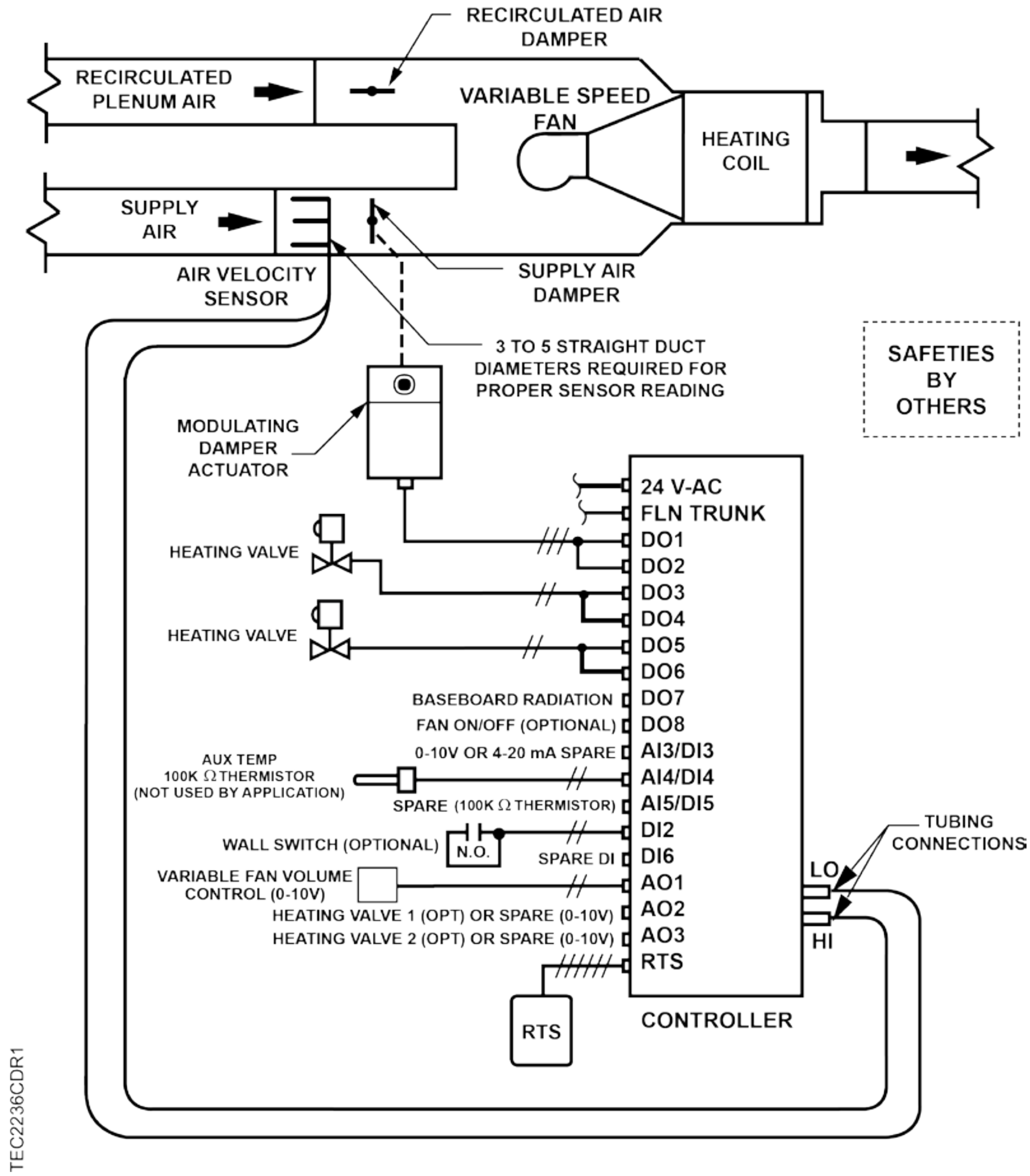
NOTE:
For information on applications with Firmware Revision B*x*40 or earlier, see InfoLink and/or Asset Portal for documentation.

In Application 2236, the supply air damper of the terminal box is modulated for cooling, and up to two heating valves are controlled for heating. When in heating, the terminal box will typically be setup to maintain a minimum airflow out of the supply air duct or can be configured to provide modulating supply air flow. The terminal box also has a variable air volume series fan for air circulation (an option exists to run this series fan at constant volume). For the terminal box to work properly, the central air handling unit must provide supply air.

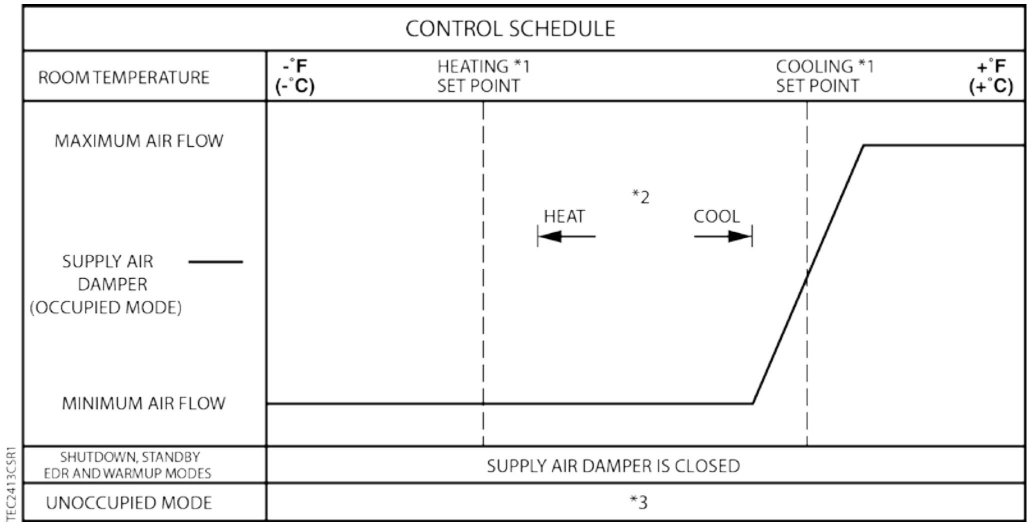
Certain control features of Application 2236 depend on whether the central air handling unit is ON or OFF. Application 2236 monitors VAV AHU for this information. This application does not command VAV AHU — it only responds to it. To command VAV AHU, it must be unbundled at the field panel and commanded by PPCL.

FAN MODE has two possible settings, CONST or VARI (constant or variable; the default = VARI). It is configurable during controller start-up and can also be overwritten by the customer during operation.

One (or both) of the hot water valves can be configured to be controlled either by floating control outputs (DO pairs) or with analog outputs (AO 2 and AO 3).

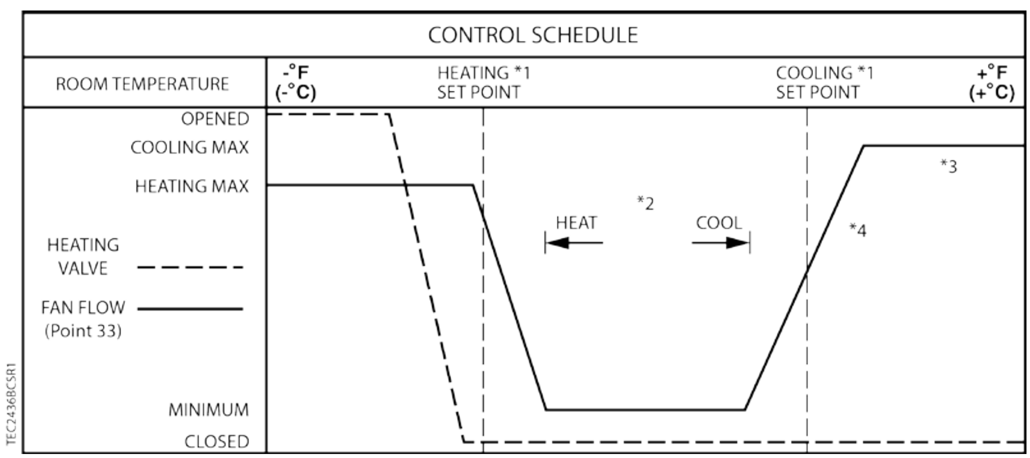


Application 2236 Control Diagram.



Application 2236 Supply Air Damper Control Schedule.

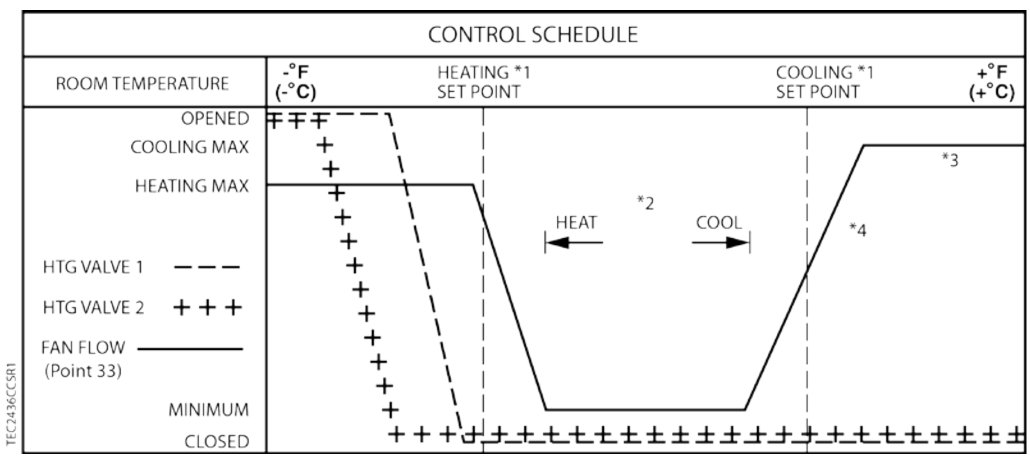
NOTES:
1. See *Control Temperature Setpoints*.
2. See *Heating/Cooling Switchover*.
3. The supply damper remains closed in the unoccupied mode as long as HEAT.COOL equals HEAT. The supply damper also remains closed in the unoccupied mode if HEAT.COOL equals COOL and the room temperature remains less than TEMP HLIMIT. Once the room temperature rises above TEMP HLIMIT while VAV AHU = ON, the supply damper is controlled as in the occupied cooling mode for as long as HEAT.COOL stays equal to COOL and VAV AHU remains ON. (See *Note 4* in the *Application Notes* section for more information on VAV AHU.)



Application 2236 FAN FLOW Control and One Hot Water Valve Heat Operation in Occupied Mode.

Heating Option 1: The application has been set up so that no stage of hot water heat can turn ON until the airflow out of the fan is at FAN FLO HMAX.

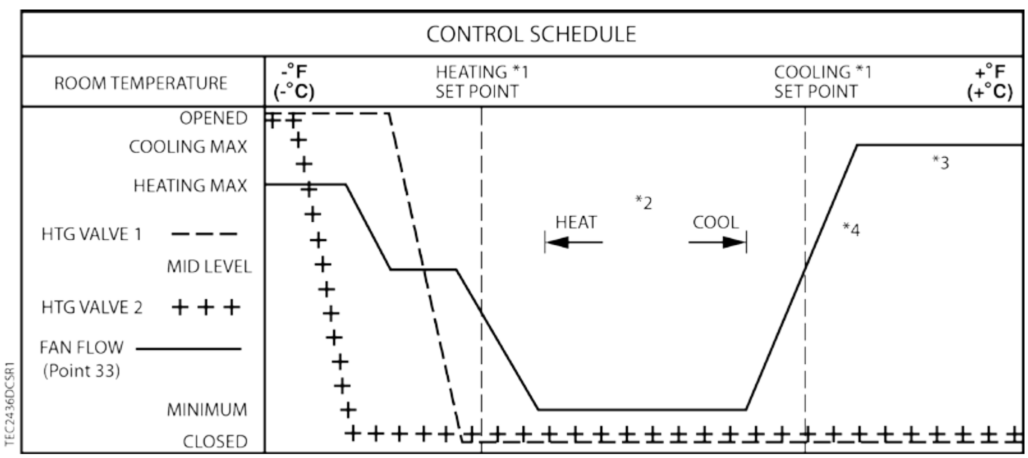
NOTES:
1. See *Control Temperature Setpoints*.
2. See *Heating/Cooling Switchover*.
3. **Occupied Mode** - If FAN MODE = CONST, FAN FLOW remains at the highest possible maximum flow (FAN FLO CMAX) throughout the entire occupied mode.
4. To regulate fan speed, this application uses FAN FLOW and embedded table statements to modulate the voltage of FAN AOV1. The particular table statement used depends on the box size or custom configuration. The following describes the operation of the fan and one heating valve during the controller's other modes (see *Definition of MODE Point*):
Shutdown Mode — The fan (see *Note 5*) and the heating valve is closed.
Unoccupied Mode — See *Note 6* for fan operation. See *Note 7* for operation of heating valve operation.
Electrical Demand Reduction (EDR) Mode — The fan is controlled as in the occupied heating mode. The heating valve is closed.
Standby Mode — The single heating valve and the fan are controlled the same as in the occupied heating mode.
Warm-up Mode — The single heating valve and the fan are controlled the same as in the occupied heating mode.
5. FAN FLOW is set to 0 in shutdown mode and FAN is set to OFF. Not all motor controllers will use FAN. When this is the case, setting FAN FLOW = 0 shuts OFF the fan.
6. During unoccupied mode the fan stays OFF if the room temperature remains between TEMP LLIMIT and TEMP HLIMIT. If the room temperature drops below TEMP LLIMIT while the fan is OFF, the fan will be controlled like it is during occupied heating for the remainder of the unoccupied mode. If the room temperature rises above TEMP HLIMIT while the fan is OFF — and VAV AHU is ON — the fan will be controlled like it is during occupied cooling for the remainder of the unoccupied mode. (See *Note 4* in the *Application Notes* section for more information on VAV AHU.)
7. In the unoccupied mode, the heating valve stays closed unless the room temperature drops below TEMP LLIMIT. If this occurs, the heating valve is controlled like it is during occupied heating for the remainder of the unoccupied mode.



Application 2236 Fan and Two Hot Water Valve Heat Operation in Occupied Mode.

Heating Option 2: The application has been set up so that neither heating valve can modulate open until the airflow out of the fan is at FAN FLO HMAX.

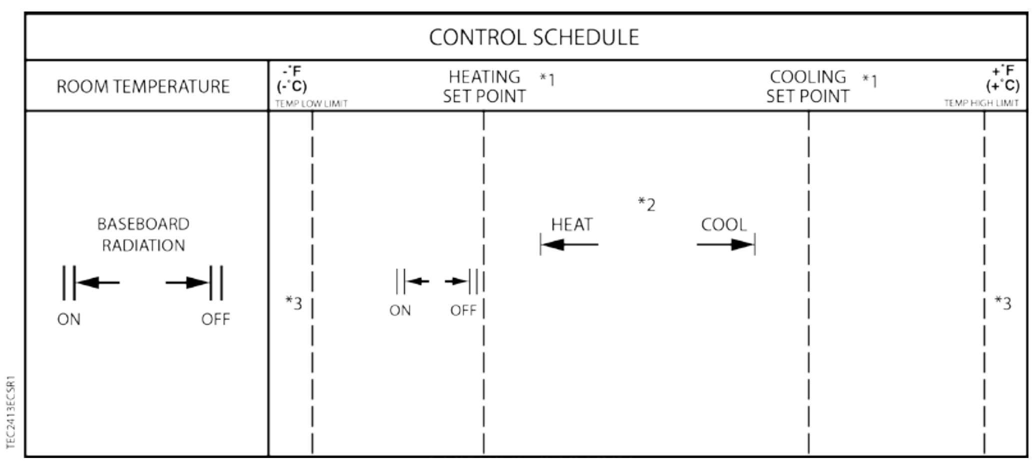
NOTES:
1. See *Control Temperature Setpoints*.
2. See *Heating/Cooling Switchover*.
3. **Occupied Mode** - If FAN MODE = CONST, FAN FLOW remains at the highest possible maximum flow (FAN FLO CMAX) throughout the entire occupied mode.
4. To regulate fan speed, this application uses FAN FLOW and embedded table statements to modulate the voltage of FAN AOV1. The particular table statement used depends on the box size or custom configuration. The following describes the operation of the fan and one heating valve during the controller's other modes (see *Definition of MODE Point*):
Shutdown Mode — The fan (see *Note 5*) and the heating valves are closed.
Unoccupied Mode — See *Note 6* for fan operation. See *Note 7* for operation of heating valves.
Electrical Demand Reduction (EDR) Mode — The fan is controlled as in the occupied heating mode. The heating valves are closed.
Standby Mode — Both the fan and first heating valve are controlled as in the occupied heating mode. The second heating valve remains closed.
Warm-up Mode — Both the fan and the heating valves are controlled as in the occupied heating mode.
5. FAN FLOW is set to 0 in shutdown mode and FAN is set to OFF. Not all motor controllers will use FAN. When this is the case, setting FAN FLOW = 0 shuts OFF the fan.
6. During unoccupied mode the fan stays OFF if the room temperature remains between TEMP LLIMIT and TEMP HLIMIT. If the room temperature drops below TEMP LLIMIT while the fan is OFF, the fan will be controlled like it is during occupied heating for the remainder of the unoccupied mode. If the room temperature rises above TEMP HLIMIT while the fan is OFF — and VAV AHU is ON — the fan will be controlled like it is during occupied cooling for the remainder of the unoccupied mode. (See *Note 4* in the *Application Notes* section for more information on VAV AHU.)
7. In the unoccupied mode, the heating valves remain closed unless the room temperature drops below TEMP LLIMIT. If this occurs, the heating valves are controlled like they are during occupied heating for the remainder of the unoccupied mode.



Application 2236 Fan and One or Two Hot Water Valve Heat Option in Occupied Mode.

Heating Option 3: The application has been set up so that the first stage cannot start until the fan flow is at the mid level setpoint (FAN FLOW MID) The application has been set up so that the first stage cannot start until the fan flow is at the mid level setpoint (FAN FLOW MID), and the remaining stages cannot start until the fan flow is at FAN FLO HMAX and the remaining stages cannot start until the fan flow is at FAN FLO HMAX.

NOTES:
1. See *Control Temperature Setpoints*.
2. See *Heating/Cooling Switchover*.
3. **Occupied Mode** - If FAN MODE = CONST, FAN FLOW remains at the highest possible maximum flow (FAN FLO CMAX) throughout the entire occupied mode.
4. To regulate fan speed, this application uses FAN FLOW and embedded table statements to modulate the voltage of FAN AOV1. The particular table statement used depends on the box size or custom configuration. The following describes the operation of the fan and one heating valve during the controller's other modes (see *Definition of MODE Point*):
Shutdown Mode — The fan (see *Note 5*) and the heating valves are closed.
Unoccupied Mode — See *Note 6* for fan operation. See *Note 7* for operation of heating valves.
Electrical Demand Reduction (EDR) Mode — The fan is controlled as in the occupied heating mode. The heating valves are closed.
Standby Mode — Both the fan and first heating valve are controlled as in the occupied heating mode. The second heating valve remains closed.
Warm-up Mode — Both the fan and the heating valves are controlled as in the occupied heating mode.
5. FAN FLOW is set to 0 in shutdown mode and FAN is set to OFF. Not all motor controllers will use FAN. When this is the case, setting FAN FLOW = 0 shuts OFF the fan.
6. During unoccupied mode the fan stays OFF if the room temperature remains between TEMP LLIMIT and TEMP HLIMIT. If the room temperature drops below TEMP LLIMIT while the fan is OFF, the fan will be controlled like it is during occupied heating for the remainder of the unoccupied mode. If the room temperature rises above TEMP HLIMIT while the fan is OFF — and VAV AHU is ON — the fan will be controlled like it is during occupied cooling for the remainder of the unoccupied mode. (See *Note 4* in the *Application Notes* section for more information on VAV AHU.)
7. In the unoccupied mode, the heating valves remain closed unless the room temperature drops below TEMP LLIMIT. If this occurs, the heating valves are controlled like they are during occupied heating for the remainder of the unoccupied mode.



Application 2236 Baseboard Radiation Operation in Unoccupied Mode.

NOTES:
1. See *Control Temperature Setpoints*.
2. See *Heating/Cooling Switchover*.
3. The baseboard radiation remains OFF for the remainder of the unoccupied period if the room temperature drops below TEMP LLIMIT or rises above TEMP HLIMIT. (If the room temperature drops below TEMP LLIMIT, the regular heating stage(s) are then controlled in order to maintain room temperature.)
4. Baseboard radiation is allowed ON only during unoccupied mode. (See *Baseboard Radiation* for more information.)

Hardware Inputs

Analog

- Air velocity sensor
- Room temperature sensor
- *(Optional)* Room temperature setpoint dial
- *(Optional)* Auxiliary temperature sensor (100K Ω thermistor)
- *(Optional)* Spare temperature sensor (100K Ω thermistor)
- *(Optional)* Spare 0-10V or 4-20 mA

Digital

- *(Optional)* Night/Unoccupied mode override
- *(Optional)* Wall switch

Hardware Outputs

Analog

- Fan AOV
- *(Optional)* Hot water valve 1 (0-10 Vdc)
- *(Optional)* Hot water valve 2 (0-10 Vdc)

Digital

- Damper actuator (DO 1/DO 2)
- Hot water valve 1 (DO 3/DO 4)
- Hot water valve 2 (DO 5/DO 6)
- Baseboard radiation (DO 7)
- Series fan enable (DO 8)

Ordering Notes

540-511AN	TEC VAV 0-10V Fan Control with Hot Water Heat

Sequence of Operation

The following paragraphs present the sequence of operation for Application 2236, TEC VAV 0-10V Fan Control with Hot Water Heat and one or two hot water valves (with floating control actuators or analog actuators).

Definition of MODE Point

The DAY.NGT point is not used. A virtual AO point (MODE) is used instead.

The *MODE Point* table shows the values that MODE can have, as well as the names of the modes that correspond to these different values.

MODE Point	
Value of MODE point	**Corresponding Mode**
0	Shutdown Mode
10	Unoccupied Mode
20	Electric Demand Reduction Mode (EDR)
30	Standby Mode
60	Occupied Mode

NOTE:
For the rest of this document, the names of modes will be used instead of numeric values (for example, MODE = Standby instead of MODE = 30). This should make the application easier to understand.

Summary of Equipment Action During Different Optional Modes

The following table provides a brief summary of equipment actions during the different operational modes. Full descriptions of detailed interactions between equipment pieces are provided in the related sections of the text.

Summary of Equipment Action During Different Operational Modes.					
Operational Modes	**Fan constant volume configuration**	**Fan variable volume configuration**	**Supply Damper**	**Reheat Valves See Note 1**	**Baseboard Radiation**
Shutdown	OFF See *Note 2*	OFF See *Note 2*	Closed	OFF	OFF
Unoccupied. See *Note 1*. Room temp stays between TEMP LLIMIT and TEMP HLIMIT	OFF See *Note 2*	OFF See *Note 2*	Closed	CLOSED	Cycles See *Note 4*
Unoccupied	Maximum flow at	Modulates from	Closed	See *Note 5*	OFF

Summary of Equipment Action During Different Operational Modes.					
Operational Modes	**Fan constant volume configuration**	**Fan variable volume configuration**	**Supply Damper**	**Reheat Valves See Note 1**	**Baseboard Radiation**
Heating See *Note 4* Room temp has dropped below TEMP LLIMIT	FAN FLO CMAX	min to max flow based on heating demand			
Unoccupied Cooling See *Note 7* Room temp has risen above TEMP HLIMIT	At max flow if VAV AHU is ON. (OFF if VAV AHU is OFF) See *Note 2*	See *Note 6*	See *Note 7*	CLOSED	OFF
Electrical Demand Reduction (EDR)	Maximum flow at FAN FLO CMAX	Modulates from min to max flow based on heating demand	Closed	CLOSED	OFF
Standby	Maximum flow at FAN FLO CMAX	Modulates from min to max flow based on heating demand	Closed	1st heating valve is modulated on heating demand. 2nd heating valve (if used) remains closed.	OFF
Warm-up Occurs, if needed, at start of occupied mode	Maximum flow at FAN FLO CMAX	Modulates from min to max flow based on heating demand	Closed	See *Note 5*	OFF
Occupied Heating	Maximum flow at FAN FLO CMAX	Modulates from min to max flow based on heating demand	Provides minimum airflow for ventilation	See *Note 5*	OFF
Occupied Cooling		Modulates from min to max flow based on cooling demand	Modulates from min to max flow based on cooling demand and minimum airflow for ventilation	CLOSED	

1. The unoccupied mode is more complex than the other modes, so 3 separate table rows are used to make it easier to under-stand. Unoccupied,. as described in this table, means that the room temperature never goes outside the range of TEMP LLIMIT to TEMP HLIMIT. Notes 2 and 3 (for Unoccupied Heating and Cooling, respectively) summarize what happens if it does leave this range.
2. Once the room temperature drops below TEMP LLIMIT, this sequence of operation will remain in effect for the remainder of the entire unoccupied period so long as the room temperature never rises as high as TEMP HLIMIT.
3. Once the room temperature rises above TEMP HLIMIT, this sequence of operation will remain in effect for the remainder of the entire unoccupied period so long as the room temperature never falls all the way down to TEMP LLIMIT.
4. Baseboard radiation is OFF in the unoccupied mode if HEAT.COOL equals COOL. If HEAT.COOL equals HEAT, the baseboard radiation cycles to maintain the room temperature at CTL STPT.
5. During all heating modes (warm-up, occupied heating, and unoccupied heating), the 1st heating valve is modulated based on heating demand. The 2nd heating valve (if used) is also modulated based on heating demand.
6. If VAV AHU is ON during unoccupied cooling, the fan . when configured for variable volume operation . modulates

from minimum to maximum flow based on cooling demand. The fan is OFF during unoccupied cooling if VAV AHU is OFF.

7. If VAV AHU is ON during unoccupied cooling, the supply damper modulates from minimum to maximum flow based on cooling demand. The supply damper is closed during unoccupied cooling if VAV AHU is OFF.

8. The second valve modulates when fan = VARI and if FAN FLO MID => FAN FLO HMAX and FAN FLOW is greater than 98% of FAN FLO HMAX. OR FAN FLOW MID <= FAN FLO HMAX.

Unoccupied 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, then by pressing the override switch, a room occupant can reset the controller to occupied mode for the length of time set in OVRD TIME. The status of UNOCC OVRD changes to OCC and remains there until OVRD TIME elapses, at which point UNOCC OVRD changes back to UNOCC and the controller returns to unoccupied mode.

NOTE:
Only during unoccupied mode (MODE = Unoccupied) can a room sensor's override switch set the controller to occupied mode; if MODE equals anything other than Unoccupied, UNOCC OVRD will equal UNOCC.

NOTE:
For the following sections, this application utilizes temperature control setpoints that are named: OCC CLG STPT, OCC HTG STPT, UOC CLG STPT and UOC HTG STPT, in lieu of DAY or NGT CLG/HTG STPT.

Control Temperature Setpoints

NOTE:
For this application, the point names for cooling and heating temperature setpoints are: OCC CLG STPT, OCC HTG STPT, UOC CLG STPT and UOC HTG STPT.

This application has a number of different room temperature setpoints (DAY HTG STPT, NGT CLG STPT, RM STPT DIAL, and so on.). The application actually controls using the 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.

Depending on certain conditions, CTL STPT holds either the value of one of the occupied or unoccupied cooling/heating setpoints, or the value of the room setpoint dial. See the following:

Occupied CLG/HTG Setpoints – When STPT DIAL equals NO (default), CTL STPT holds the value of OCC CLG STPT or OCC HTG STPT if:

- MODE equals Occupied, EDR, or Standby.
- MODE equals Unoccupied, but UNOCC OVRD equals OCC.

Unoccupied CLG/HTG Setpoints – CTL STPT holds the value of UOC CLG STPT or UOC HTG STPT if:

- MODE equals Shutdown or Unoccupied, and UNOCC OVRD equals UNOCC.

Room Setpoint Dial –When STPT DIAL is set to YES, CTL STPT holds the value of RM STPT DIAL if:

- MODE equals Occupied, EDR, or Standby.
- MODE equals Unoccupied, but UNOCC OVRD equals OCC.

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

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*

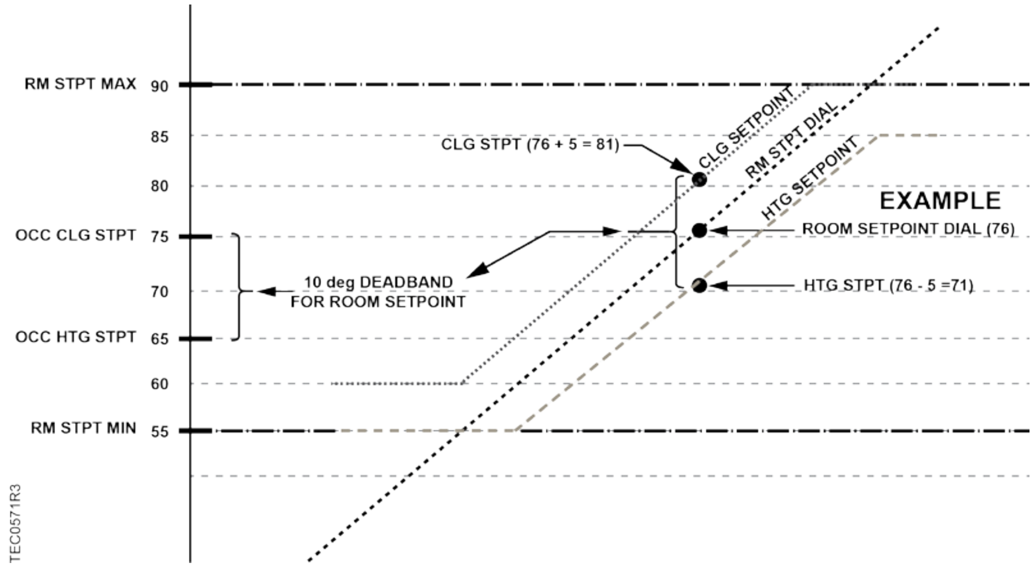
With Deadband enabled in Heat Mode:

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 and CTL TEMP

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

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 the control setpoint.

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 CTL TEMP is overridden then:

- ROOM TEMP has 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 all of the following conditions are met for the length of time set in SWITCH TIME, the controller switches from heating to cooling by setting HEAT.COOL to COOL:

- HTG LOOPOUT is less than 5%.
- CTL TEMP is above CTL STPT by at least the value set in SWITCH DBAND.
- CTL TEMP is greater than the appropriate cooling setpoint minus SWITCH DBAND.

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

- CLG LOOPOUT is less than 5%.
- CTL TEMP is below CTL STPT by at least the value set in SWITCH DBAND.
- CTL TEMP is less than the appropriate heating setpoint 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 based on the supply air temperature, you must command it through PPCL. (This is required if the flow loop is used as a source of cooling in cooling mode and as a source of heating in heating mode.)

If the flow loop is used during heating mode just to meet minimum air requirements, then the heating/cooling switchover mechanism operates as previously described in this section.

Control Loops

The terminal box 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*.

The cooling loop generates CLG LOOPOUT which is used to calculate FLOW STPT during the cooling mode. FLOW STPT is the result of scaling the cooling loopout to the appropriate range of values as determined by CLG FLOW MAX and CTL FLOW MIN, and as shown in the following equation:

$$\frac{[\text{CLG LOOPOUT} \times (\text{CLG FLOW MAX} - \text{CTL FLOW MIN})] + \text{CTL FLOW MIN}}{\text{CLG FLOW MAX}} \times 100\% = \text{FLOW STPT}$$

FLOW STPT Examples

If CTL FLOW MIN = 200 cfm and CLG FLOW MAX = 1000 cfm then, when CLG LOOPOUT is 0%, FLOW STPT equals 20% flow.

$$\frac{[0\% \times (1000 - 200)] + 200}{1000} \times 100\% = 20\%$$

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.

$$\frac{[50\% \times (1000 - 200)] + 200}{1000} \times 100\% = 60\%$$

When CLG LOOPOUT is 100%, FLOW STPT = 100% flow.

$$\frac{[100\% \times (1000 - 200)] + 200}{1000} \times 100\% = 100\%$$

In addition to being used to set FLOW STPT, CLG LOOPOUT is also used to control FAN FLOW during the cooling mode (FAN FLOW is then used to control FAN AOV1). See the *Fan Operation* section for more information about FAN FLOW and FAN AOV1 control.

The Cooling Loop is operational under either of the following situations:

- The application is in the occupied mode, WARMUP is OFF, and HEAT.COOL equals COOL.
- The application is in the unoccupied mode, and
  – CTL TEMP is above TEMP HLIMIT.
  – HEAT.COOL equals COOL.
  – VAV AHU is ON. (See *Note 4* of Application Notes for more information on VAV AHU.)
  (Once these conditions are met, the cooling loop will remain enabled for the rest of the entire unoccupied period as long as HEAT.COOL and VAV AHU do not change status and CTL TEMP does not fall to TEMP LLIMIT.)

If the controller is in heating mode, the flow loop maintains airflow out of the terminal box equal to CTL FLOW MIN, and HTG LOOPOUT controls the hot water heat and FAN FLOW in order to maintain the room temperature. (FAN FLOW is used to control FAN AOV1; see the *Fan Operation* section for more information about FAN FLOW and FAN AOV1.)

The heating loop is operational under any of the following conditions:

- The application is in the occupied mode and WARMUP is ON.
- The application is in the occupied mode, WARMUP is OFF, and HEAT.COOL equals HEAT.
- The application is in the EDR (electric demand reduction) mode or in standby mode.
- The application is in the unoccupied mode, CTL TEMP is below TEMP LLIMT, and HEAT.COOL equals HEAT. (Once these conditions are met, the heating loop remains enabled for the rest of the entire unoccupied period as long as HEAT.COOL does not change status and CTL TEMP never reaches TEMP HLIMIT.)

Flow Loop – Maintains minimum airflow and maximum airflow through CTL FLOW MIN and CTL FLOW MAX. CTL FLOW MAX holds different heating and cooling flow maximums. When HEAT.COOL equals HEAT, CTL FLOW MAX equals HTG FLOW MAX. When HEAT.COOL equals COOL, CTL FLOW MAX equals CLG FLOW MAX.

Separate flow minimums for heating and cooling modes are not used — CTL FLOW MIN is used for both. In the cooling mode, CTL FLOW MIN is the larger of CLG FLOW MIN and VENT DMD MIN. Either can be set equal to, but not greater than CTL 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.

The flow loop maintains FLOW STPT by modulating the supply air damper point, DMPR COMD to keep airflow between CTL FLOW MIN and CTL FLOW MAX.

FLOW is the input value for the flow loop. It is a percentage derived from the value of AIR VOLUME—that is, a value in the range of 0 cfm to CTL FLOW MAX. In the following text, 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 is 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 volume 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.

The flow loop is operational under either of the following situations:

- The application is in the occupied mode and WARMUP is OFF.
- The application is in the unoccupied mode, and
  - CTL TEMP is above TEMP HLIMIT.
  - HEAT.COOL equals COOL.
  - VAV AHU is ON. (See note 4 in the Application Notes section for more information on VAV AHU.)
    Once these conditions are met, the flow loop will remain active for the rest of the entire unoccupied period as long as HEAT.COOL and VAV AHU do not change status and CTL TEMP does not fall to TEMP LLIMIT.

Hot Water Reheat

The hot water reheat is operational when any of the following conditions occur:

- The application is in the occupied mode and WARMUP is ON
- The application is in the occupied mode, WARMUP is OFF, and HEAT.COOL equals HEAT.
- The application is in the standby mode. (When in standby, the 2nd reheat valve, if it exists, is not available.)
- The application is in the unoccupied mode, CTL TEMP is below TEMP LLIMT, and HEAT.COOL equals HEAT. (Note: Once CTL TEMP is less than TEMP LLIMIT, the heating valves remain under the control of HTG LOOPOUT for the remainder of the entire unoccupied period as long as HEAT.COOL does not change and CTL TEMP never reaches TEMP HLIMIT.)

NOTE:
The reheat valve(s) are closed at all times during the cooling mode.

When FAN MODE equals VARI, the reheat valve control depends on the amount of airflow coming from the series fan, as follows:

- The second heating valve (if used) will not be allowed to modulate open until FAN FLOW is equal to or greater than 98% of FAN FLO HMAX.
- The first heating valve (if used) will not be allowed to modulate open until FAN FLOW is equal to or greater than 98% of FAN FLO HMAX under the following circumstances:
  - –Only one heating valve is being used (that is, VALVE COUNT = 1).
  - –Two heating valves are being used and FAN FLO MID has been configured to be greater than or equal to FAN FLO HMAX.
- If VALVE COUNT equals 2, and FAN FLO MID has been configured to be less than FAN FLO HMAX, the first heating valve will modulate open when FAN FLOW becomes equal to or greater than 98% of FAN FLO MID.

When FAN MODE equals CONST, airflow from the series fan will equal FAN FLO CMAX whenever the fan is running. Since this is considered more than enough airflow for safe operation of the heating coil(s), the heating valves(s) can modulate whenever needed without the application having to calculate and verify a minimum airflow.

NOTE:
If FAN MODE equals CONST, the heating valve(s) will work best if FLOW END equals 0 and FAN FLO MID is set equal to or greater than FAN FLO HMAX.

If there are two heating valves (VALVE COUNT = 2), the second heating valve is not allowed to modulate open until after the first heating valve has been at least 98% opened for the length of time in VLV 1 TIME. Conversely, the first heating valve is not allowed to modulate closed until after the second heating valve has been less than 2% opened for the length of time in VLV 2 TIME.

HTG LOOPOUT does not control the heating valves directly. Instead, it is used to fill out an embedded Table Statement that generates an internal control signal (this was done to properly sequence the heating valves with the VAV series fan). The control signal is then used to modulate the heating valve(s).

As the following paragraphs explain, control of the heating valve(s) differs depending on whether one or two valves are operational and whether the first valve is allowed to modulate at a lower FAN FLOW value than the second valve, as when FAN FLOW MID is less than FAN FLO HMAX.

(Regardless of these differences, this application's heating valves(s) are always controlled by an internal control signal that is generated by an embedded Table Statement driven by HTG LOOPOUT.)

FAN FLOW MID ≥ FAN FLO HMAX

When FAN FLOW MID ≥ FAN FLO HMAX, the relationship between HTG LOOPOOUT and the

internal control signal is as follows:

- When HTG LOOPOUT is less than FLOW END, the control signal is set to 0.
- When HTG LOOPOUT equals 100, the control signal equals 100.
- When HTG LOOPOUT is between FLOW END and 100, linear interpolation is used to scale the control signal to a value between 0 and 100.

NOTE:
As HTG LOOPOUT goes from 0 to FLOW END, FAN FLOW goes from FAN FLOW MIN to FAN FLO HMAX.

FAN FLOW MID < FAN FLO HMAX

When FAN FLOW MID < FAN FLO HMAX, the relationship between HTG LOOPOOUT and the internal control signal is as follows:

- When HTG LOOPOUT is less than FLOW 1 END, the control signal is set to 0.
- As HTG LOOPOUT goes from FLOW 1 END to FLOW 2 START, the control signal goes from 0 to 50.
- As HTG LOOPOUT goes from FLOW 2 START to FLOW END, the control signal remains at 50.
- When HTG LOOPOUT is between FLOW END and 100, the control signal goes from 50 to 100.

NOTE:
As HTG LOOPOUT goes from 0 to FLOW 1 END, FAN FLOW goes from FAN FLOW MIN to FAN FLOW MID. As HTG LOOPOUT goes from FLOW 2 START to FLOW END, FAN FLOW goes from FAN FLOW MID to FAN FLO HMAX.

Hot Water Heat Actuator Operation

One, or both, hot water heat actuators can be configured to be controlled by floating control (digital outputs) or by analog outputs (0-10 Vdc). When configured to be controlled by analog outputs, the voltages representing full closed and full open can be configured to provide for normally open or normally closed valves (AOV 2 CLOSED, AOV 2 OPEN, AOV 3 CLOSED, AOV 3 OPEN). In addition, when the actuator timing is entered (MTR2 TIMING and MTR3 TIMING), HTG VLV1 POS and HTG VLV2 POS will increment as the actuator opens and closes. These positions also reflect the valve open/closed percentage when the corresponding analog output is overridden (taking into account the OPEN/CLOSED configurations for each analog output).

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.

In Application 2236, the two points most directly related to the fan’s operation are FAN FLOW and FAN AOV1. FAN AOV1 is the analog output that controls the fan’s airflow, and FAN FLOW is the desired airflow for the fan. The rest of this section describes how these points are determined and their operation.

NOTE:
FAN FLOW is set to 0 in shutdown mode and FAN is set to OFF. Not all fan motor controllers will use the FAN digital output point, but if it's necessary, setting FAN FLOW = 0 shuts the fan OFF.

Fan Flow

For the fan to be OFF, FAN FLOW must = 0 and all of the stages of heat must be OFF for at least 30 seconds. Even after all of the heating stages have been OFF for at least 30 seconds, FAN FLOW is assured of equaling 0 only in 4 specific circumstances. These are:

1. The application is in the shutdown mode.
2. The application is in the unoccupied mode, CTL TEMP is below TEMP LLIMIT, and HEAT.COOL equals COOL. (FAN FLOW will remain at 0 (and the fan will be OFF) for the rest of the entire unoccupied period as long as HEAT.COOL does not change and CTL TEMP never reaches TEMP HLIMIT.

3. The application is in the unoccupied mode, and
   – CTL TEMP is above TEMP HLIMIT.
   – VAV AHU is OFF and/or HEAT.COOL equals HEAT. (See note 4 in the Application Notes section for more information on VAV AHU.)
     (Once these conditions are met, FAN FLOW will remain at 0 (and the fan will be OFF) for the rest of the unoccupied mode as long as HEAT.COOL and/or VAV AHU do not change in status and CTL TEMP does not fall to TEMP LLIMIT.)
4. The application is in the unoccupied mode and CTL TEMP has remained between TEMP LLIMIT and TEMP HLIMIT throughout the entire unoccupied mode.

In the above four cases, if all of the heating stages have not been OFF for at least 30 seconds, then FAN FLOW will remain where it was before that case was entered. For instance, if the application goes into the shutdown mode and all of the heating stages have not been OFF for at least 30 seconds, then FAN FLOW will remain where it was before the shutdown mode was entered.

In any condition other than the four above, FAN FLOW will not equal 0 and the series fan will be running. In this case, the value of FAN MODE makes a big difference in the fan's operation. FAN MODE can equal VARI or CONST (variable or constant). If FAN MODE = CONST, FAN FLOW runs steadily at the rate indicated by FAN FLO CMAX. If FAN MODE = VARI, FAN FLOW is controlled by either the cooling loop or the heating loop as described in the following paragraphs.

FAN FLOW Controlled by CLG LOOPOUT – When FAN MODE = VARI, CLG LOOPUT controls FAN FLOW under either of the following conditions:

1. The application is in the occupied mode, WARMUP equals OFF, and HEAT.COOL is set to COOL.
2. The application is in the unoccupied mode, and
   – CTL TEMP is above TEMP HLIMIT.
   – HEAT.COOL equals COOL.
   – VAV AHU is ON. (See *Note 4* in the *Application Notes* section for more information on VAV AHU.)
     (Once these conditions are met, FAN FLOW will remain under the control of CLG LOOPOUT for the rest of the entire unoccupied period as long as HEAT.COOL and VAV AHU do not change status and CTL TEMP does not fall to TEMP LLIMIT.)

CLG LOOPOUT controls FAN FLOW via an embedded Table Statement as follows:

- When CLG LOOPOUT is zero, FAN FLOW is set to FAN FLOW MIN.
- When CLG LOOPOUT is 100, FAN FLOW is set to FAN FLO CMAX.
- When CLG LOOPOUT is between 0 and 100, linear interpolation is used to scale FAN FLOW to a value between FAN FLOW MIN and FAN FLO CMAX.

FAN FLOW Controlled by HTG LOOPOUT – When FAN MODE = VARI, HTG LOOPUT controls FAN FLOW under any of the following conditions:

- The application is in occupied mode and WARMUP is ON.
- The application is in occupied mode, WARMUP is OFF, and HEAT.COOL equals HEAT.
- The application is in the unoccupied mode, CTL TEMP is below TEMP LLIMT, and HEAT.COOL equals HEAT.
  (Once these conditions are met, FAN FLOW will remain under the control of HTG LOOPOUT for the rest of the entire unoccupied period as long as HEAT.COOL does not change and CTL TEMP never reaches TEMP HLIMIT.)
- The application is in the EDR (electric demand reduction) mode or in standby mode.

Because the operation of the series fan must be coordinated with the heating stage(s), controlling FAN FLOW with HTG LOOPOUT is more complicated than controlling it with CLG LOOPOUT. Whereas CLG LOOPOUT uses only one embedded Table Statement to adjust the value of FAN FLOW, HTG LOOPOUT will use one of several embedded Table Statements to control FAN FLOW depending on the circumstances.

FAN FLOW Control and One Heating Valve – When VALVE COUNT equals 1 and the heating valve is 2% opened or greater (this means that HTG VLV1 CMD is equal to or greater than 2), FAN FLOW will be set to FAN FLO HMAX. Once this occurs, FAN FLOW is not allowed to change in value until HTG VLV1 CMD is less than 2% opened and remains so for longer than the amount of time set in CLOSE TIME.

Whenever HTG VLV1 CMD remains less than 2% opened for longer than CLOSE TIME, a speed limit in addition to the Table Statements control signal is used to control FAN FLOW. However, for the speed limit to be used, HTG LOOPOUT must be changing rapidly. If HTG LOOPOUT is constant or changing slowly, the Table Statement works as follows:

- When HTG LOOPOUT is 0, FAN FLOW is set equal to FAN FLOW MIN.
- When HTG LOOPOUT is equal to or greater than FLOW END, FAN FLOW is set equal to FAN FLO HMAX.
- When HTG LOOPOUT is between 0 and FLOW END, linear interpolation is used to scale FAN FLOW to a value between FAN FLOW MIN and FAN FLO HMAX.

When HTG LOOPOUT changes rapidly, the speed limit works as follows:

Regardless of how rapidly HTG LOOPOUT changes, FAN FLOW cannot change faster than (LOOP TIME ÷ FAN TIME) × FLOW END. Even if HTG LOOPOUT changes suddenly from 0 to 100, the amount of time stored in FAN TIME must still elapse before FAN FLOW may change from FAN FLOW MIN to FAN FLO HMAX. (If FAN TIME is less than LOOP TIME, the speed limit is disabled and FAN FLOW can change as fast as HTG LOOPOUT changes.)

FAN FLOW Control when Two Heating Valves are Used and FAN FLOW MID ≥ FAN FLOW HMAX

If FAN FLOW MID is equal to or greater than FAN FLO HMAX, and VALVE COUNT equals 2, FAN FLOW will be set to FAN FLO HMAX when HTG VLV2 CMD is either equal to or greater than 2% Open or has been less than 2% opened for less than CLOSE TIME. Other than this, the control of FAN FLOW is identical to when VALVE COUNT equals 1.

FAN FLOW Control when Two Heating Valves are Used and FAN FLOW MID < FAN FLOW HMAX

If FAN FLOW MID is less than FAN FLO HMAX, and VALVE COUNT equals 2, FAN FLOW will be set to FAN FLO HMAX when HTG VLV2 CMD is either equal to or greater than 2% open or has been less than 2% opened for less than CLOSE TIME. When HTG VLV2 CMD has been less than 2% opened for longer than CLOSE TIME, but HTG VLV1 CMD has not been less than 2% opened for longer than CLOSE TIME, FAN FLOW is controlled by a Table Statement and a speed limit. (This is the difference between having FAN FLOW MID be less than FAN FLO HMAX, and having it be equal to or greater than FAN FLO HMAX (FAN FLOW MID is configurable during controller start-up): If FAN FLOW MID is equal or greater than FAN FLO HMAX, both heating valves are alike in terms of how their OPENED/CLOSED status influences the control of FAN FLOW (see Figure 4). But if FAN FLOW MID is less than FAN FLO HMAX, then FAN FLOWs relationship to the heating valves specifically, the values FAN FLOW gets set to differs for each heating valve. See Figure 5.)

Whenever the 2nd heating valve has been closed (less than 2% Opened) for longer than CLOSE TIME, but the 1st heating valve has not been closed for longer than CLOSE TIME, a speed limit in addition to the Table Statements control signal is used to control FAN FLOW.

However, for the speed limit to be used, HTG LOOPOUT must be changing rapidly. If HTG LOOPOUT is constant or changing slowly, the Table Statement works as follows: When HTG LOOPOUT is equal to or less than FLOW 2 START, FAN FLOW is set equal to FAN FLOW MID.

- When HTG LOOPOUT is equal to or greater than FLOW END, FAN FLOW is set equal to FAN FLO HMAX.
- When HTG LOOPOUT is between FLOW 2 START and FLOW END, linear interpolation is used to scale FAN FLOW to a value between FAN FLOW MID and FAN FLO HMAX.

When HTG LOOPOUT changes rapidly, the speed limit works as follows:

Regardless of how rapidly HTG LOOPOUT changes, FAN FLOW is not allowed to change faster than (LOOP TIME ÷ FAN TIME) × (FLOW END − FLOW 2 START). Even if HTG LOOPOUT changes suddenly from FLOW 2 START to FLOW END, the amount of time stored in FAN TIME must still elapse before FAN FLOW may change from FAN FLOW MID to FAN FLO HMAX. (If FAN TIME is less than LOOP TIME, the speed limit is disabled and FAN FLOW can change as fast as HTG LOOPOUT changes.)

When both heating valves have been closed for longer than CLOSE TIME, FAN FLOW is controlled by two speed limits and the Table Statements control signal. However, for the speed limits to be used, HTG LOOPOUT must be changing rapidly. If HTG LOOPOUT is constant or changing slowly, the Table Statement works as follows:

When HTG LOOPOUT equals 0, FAN FLOW is set equal to FAN FLOW MIN.

- When HTG LOOPOUT is between 0 and FLOW 1 END, linear interpolation is used to scale FAN FLOW to a value between FAN FLOW MIN and FAN FLO MID.
- When HTG LOOPOUT equals FLOW 1 END, FAN FLOW is set equal to FAN FLOW MID. (If HTG LOOPOUT rises above FLOW 1 END but stays below FLOW 2 START, FAN FLOW remains equal to FAN FLO MID while the 1st heating valve modulates open.)
- When HTG LOOPOUT is between FLOW 2 START and FLOW END, linear interpolation is used to scale FAN FLOW to a value between FAN FLOW MID and FAN FLO HMAX.
- When HTG LOOPOUT is equal to or greater than FLOW END, FAN FLOW is set equal to FAN FLO HMAX. (Note: when HTG LOOPOUT is greater than FLOW END, the 2nd heating valve will modulate open.)

When HTG LOOPOUT changes rapidly, the speed limits work as follows:

If HTG LOOPOUT is less than or equal to FLOW 2 START, FAN FLOW will not be allowed to change faster than (LOOP TIME ÷ FAN TIME) × FLOW 1 END, no matter how quickly HTG LOOPOUT changes. If HTG LOOPOUT is greater than FLOW 2 START, FAN FLOW cannot change faster than (LOOP TIME ÷ FAN TIME) × (FLOW END − FLOW 2 START).

Since FLOW 1 END, FLOW 2 END –FLOW 2 START and FLOW END–FLOW 3 START are all likely to be different, three different speed limits are used even though the value of FAN TIME remains the same. The speed limit being used at any given time depends on the value of HTG LOOPOUT (as explained in the previous paragraph). If FAN TIME is less than LOOP TIME, the speed limits are disabled and FAN FLOW can change as quickly as HTG LOOPOUT changes.

FAN AOV1

Once a value for FAN FLOW (the fan's desired airflow) has been determined, a Table Statement in the firmware calculates the proper value for FAN AOV1 (FAN AOV1 is the analog output that controls the fan's airflow). This application actually contains 4 such Table Statements, but only one will be used. Which one gets used depends on the value of BOX SIZE. Refer to the following:

BOX SIZE = 3, 5 or 7 – When BOX SIZE is set to 3, 5 or 7, the application uses 1 of 3 pre-coded Table Statements with pre-determined FAN AOV1 voltage levels. The voltage values are fixed and cannot be changed by the user.

NOTE:
BOX SIZE should be set to 3, 5, or 7 only if you have a Nailor box of size 3, 5, or 7.

BOX SIZE = 0 – When BOX SIZE is set to 0, the application uses a general purpose Table Statement to adjust the value of FAN AOV1.

NOTE:
BOX SIZE should be set to 0 if the box being used is either a Nailor box with a size other than 3, 5, or 7, or any box made by a manufacturer other than Nailor.

The flow and voltage values of the general purpose table statement are not pre-coded and must be entered by the user as follows:

- FLO LO – The lowest flow the fan can produce. (FLO LO must be less than or equal to FAN FLOW MIN, and may be set to 0 cfm, if desired.)
- FLO LO VOLTS – The voltage used by FAN AOV1 that tells the fan to produce an airflow equal to FLO LO.
- FLO HI – The highest flow that the fan can produce. (FLO HI must be greater than or equal to both FAN FLO HMAX and FAN FLO CMAX).
- FLO HI VOLTS – The voltage used by FAN AOV1 that tells the fan to produce an airflow equal to FLO HI.

Once properly set up, the Table Statement works as follows:

- When FAN FLOW is less than or equal to FLO LO, FAN AOV1 will be set to FAN LO VOLTS.
- When FAN FLOW is greater than or equal to FAN HI, FAN AOV1 will be set to FAN HI VOLTS.
- When FAN FLOW is between FLO LO and FLO HI, linear interpolation is used to scale FAN AOV1 to a value that is between FAN LO VOLTS and FAN HI VOLTS.

Once FAN AOV1 is set to a particular voltage, the signal is sent to an intelligent motor controller that controls the fan. This intelligent motor controller is provided by others. It must be set up to know what the fan's airflow should be for a given value of FAN AOV1 voltage. Consult the operating instructions provided by the manufacturer for information on how to do this.

NOTES:
1. FAN FLOW is a calculated value, not a measured value. The application does not measure the airflow coming out of the fan.
2. This application does not have a DO that turns the fan ON and OFF. To turn the fan OFF, FAN FLOW must be set equal to 0.

Warm-Up Mode

Warm-up mode is only allowed to operate during occupied heating. At no other time may the application enter warm-up mode.

WARMUP is turned ON only if all of the following circumstances are true:

- MODE has just changed from Unoccupied to Occupied (MODE currently equals occupied but equaled unoccupied one LOOP TIME ago).
- HEAT.COOL equals HEAT.
- The room temperature is not warm enough. CTL TEMP < (CTL STPT – MORN DBAND).

The warm-up mode remains in effect until CTL TEMP becomes equal to or greater than (CTL STPT – MORN DBAND). Once this occurs, WARMUP is set to OFF. Once OFF, WARMUP cannot be turned back ON for the rest of the Occupied period.

Baseboard Radiation

For baseboard radiation (BASE DO7) to turn ON, the application must be in unoccupied heating (MODE = UNOCC, UNOCC OVRD = UNOCC, and HEAT.COOL = HEAT), and both of the following must be true:

- CTL TEMP is between TEMP LLIMIT and TEMP HLIMIT.
- The room temperature is not warm enough: CTL TEMP < (CTL STPT – HTG DBAND).

At all other times, BASE DO7 will be OFF.

Once ON, baseboard radiation remains ON until CTL TEMP becomes equal to or greater than CTL STPT. When CTL TEMP is between CTL STPT and (CTL STPT – HTG DBAND), the baseboard radiation remains in its last commanded state: If ON, it remains ON; if OFF, it remains OFF.

If CTL TEMP becomes less than TEMP LLIMIT or greater than TEMP HLIMIT, BASE DO7 is shut OFF and not allowed to turn back ON for the remainder of the unoccupied heating mode.

Flow Temperature Alarm

The status of FLOW TEMP indicates whether the supply airflow is properly cooling down the control temperature (CTL TEMP). Basically, this feature checks whether the supply airflow is both great enough and cool enough to cool down the space.

FLOW TEMP is sent to ALARM only when all of the following are true:

- HEAT.COOL equals COOL.
- MODE equals occupied, or UNOCC OVRD equals OCC while MODE equals unoccupied.
- FLOW < FLOW STPT, and CTL TEMP > CTL STPT, both of these being true for at least the amount of time stored in ALARM TIME.

At all other times FLOW TEMP = NORMAL.

NOTE:
During occupied cooling, FLOW TEMP equals NORMAL when: FLOW > (FLOW STPT – LOW FLOW) and/or CTL TEMP < CTL STPT.

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.

Calibration of the first and second water valve can be calibrated at the same time.

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.

Additional calibration is provided by driving the floating control valves or damper fully closed or open, whenever they are commanded to 0 or 100 percent.

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

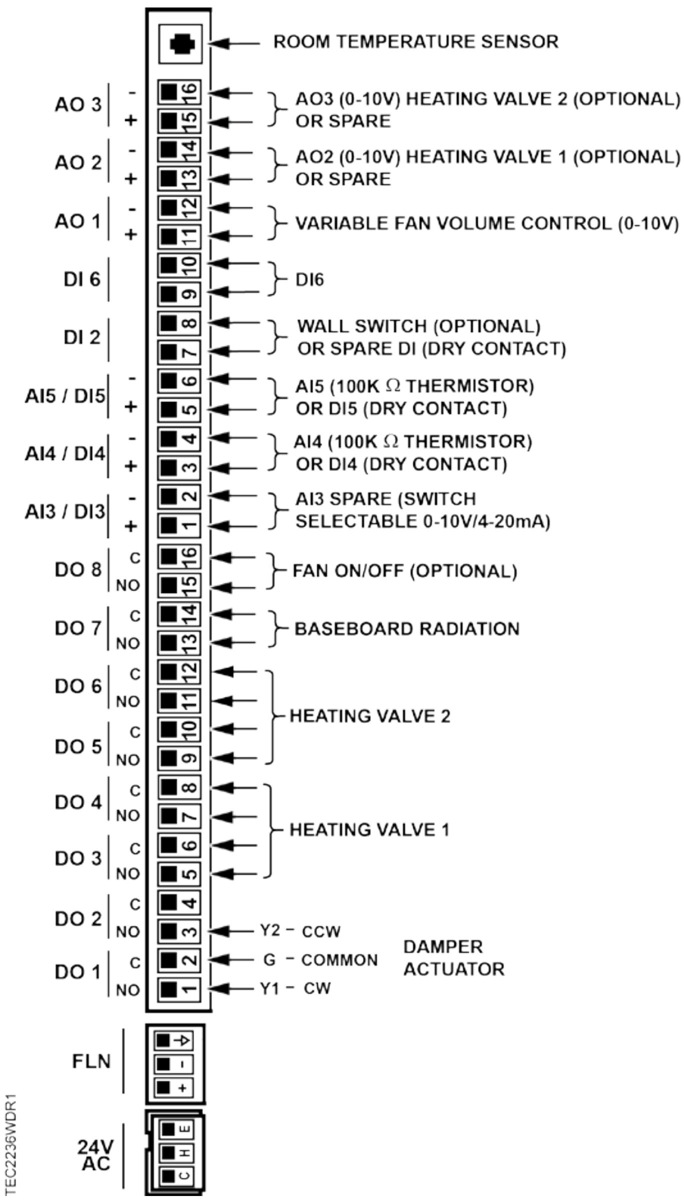
1. If the temperature swings in the room are excessive or there is trouble maintaining the setpoint, then either the cooling loop, the heating loop, or both need to be tuned. If FLOW is oscillating while FLOW STPT is constant, then the flow loop requires tuning.
2. Unless overridden, the value of CTL TEMP equals ROOM TEMP plus RMTMP OFFSET.
3. The controller, as shipped from the factory, keeps all associated equipment OFF and the heating valve(s) closed.
4. Certain control features depend on whether the central air handling unit is ON or OFF. Application 2236 monitors VAV AHU for this information. This application does not command VAV AHU -- it only reacts to it. To command VAV AHU, it must be unbundled at the field panel and PPCL must be written for it.
5. To turn the fan off without using the fan DO (FAN - DO 8), FAN FLOW must be set to 0. FAN FLOW should also be set to 0 even in situations where the fan is turned off using a DO.
6. Spare DOs can be used as auxiliary points that are controlled by the field panel after being defined in the field panel's database. If the 1st heating valve is not being controlled by the application (VALVE COUNT = 0), then DO 3 and DO 4 may be used as auxiliary motor points. If the 2nd heating valve is not being controlled by the application (VALVE COUNT = 0 or 1), then 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 make sure that the motor setup and motor timing are enabled correctly before you unbundle the point HTG VLV1 CMD for DOs 3 and 4 and/or HTG VLV2 CMD for DOs 5 and 6. Also, if less than two heating valves are being controlled by the application, then the DOs that are not used will be spare.
7. Setting VALVE COUNT to 1 (or 2) and not enabling the associated MTR SETUP values for floating control prevents the use of the digital outputs from being controlled as floating control spare, but the digital outputs may be individually controlled as spare DOs.

For more information, contact your local Siemens Industry representative.

Wiring Diagram

NOTE:
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 2236 VAV 0-10V Fan Control with Hot Water Heat Controller.

Application 2236 Point Database

Point Number	Descriptor	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	2236	--	1	0	--	--
{03}	MODE	0	--	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
6	OCC CLG STPT	74.0 (23.44888)	DEG F (DEG C)	0.25 (0.14)	48.0(8.88888)	--	--
7	OCC HTG STPT	70.0 (21.20888)	DEG F (DEG C)	0.25 (0.14)	48.0(8.88888)	--	--
8	UOC CLG STPT	82.0 (27.92888)	DEG F (DEG C)	0.25 (0.14)	48.0(8.88888)	--	--
9	UOC HTG STPT	65.0 (18.40888)	DEG F (DEG C)	0.25 (0.14)	48.0(8.88888)	--	--
10	MTR3 TIMING	130	SEC	1	0	--	--
11	RM STPT MIN	52.5 (11.40888)	DEG F (DEG C)	0.25 (0.14)	48.0(8.88888)	--	--
12	RM STPT MAX	74.25 (23.58888)	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}	FAN MODE	VARI	--	--	--	CONST	VARI
17	FLOW END	75.2	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}	UNOCC OVRD	UNOCC	--	--	--	UNOCC	OCC
22	FLOW 2 START	50	PCT	0.4	0	--	--
23	FLOW 1 END	25.2	PCT	0.4	0	--	--
{24}	DI 2	OFF	--	--	--	ON	OFF
{25}	DI 5	OFF	--	--	--	ON	OFF
26	ALARM TIME	5	MIN	1	0	--	--
27	VLV 1 TIME	120	SEC	1	0	--	--
28	VLV 2 TIME	120	SEC	1	0	--	--

Point Number	Descriptor	Factory Default (SI Units)[2]	Eng Units (SI Units)	Slope (SI Units)	Intercept (SI Units)	On Text	Off Text
30	LOW FLOW	5	PCT	0.25	0	--	--
31	BOX SIZE	3	--	1	0	--	--
32	CLG FLOW MAX	2200 (1038.18)	CFM (LPS)	4 (1.8876)	0	--	--
{33}	FAN FLOW	0 (0.0)	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}	FLO LO VOLTS	0	VOLTS	0.01	0	--	--
{38}	FLO HI VOLTS	10	VOLTS	0.01	0	--	--
{39}	FLO LO	0 (0.0)	CFM (LPS)	4 (1.8876)	0	--	--
{40}	DI 6	OFF	--	--	--	ON	OFF
{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}	DO 6	OFF	--	--	--	ON	OFF
{47}	BASE DO7	OFF	--	--	--	ON	OFF
{48}	DMPR COMD	0	PCT	0.4	0	--	--
{49}	DMPR POS	0	PCT	0.4	0	--	--
{50}	FAN	OFF	--	--	--	ON	OFF
51	MTR1 TIMING	95	SEC	1	0	--	--
{52}	HTG VLV1 CMD	0	PCT	0.4	0	--	--
{53}	HTG VLV1 POS	0	PCT	0.4	0	--	--
{54}	HTG VLV2 CMD	0	PCT	0.4	0	--	--
55	MTR2 TIMING	130	SEC	1	0	--	--
56	DMPR ROT ANG	90	--	1	0	--	--
{57}	HTG VLV2 POS	0	PCT	0.4	0	--	--
58	MTR SETUP	0	--	1	0	--	--
59	DO DIR. REV	0	--	1	0	--	--
{60}	WARMUP	OFF	--	--	--	ON	OFF
{61}	VAV AHU	OFF	--	--	--	ON	OFF
{62}	FLOW TEMP	NORMAL	--	--	--	ALARM	NORMAL
{63}	AI 3	0	PCT	0.4	0	--	--
{64}	DI 3	OFF	--	--	--	ON	OFF

Point Number	Descriptor	Factory Default (SI Units)[2]	Eng Units (SI Units)	Slope (SI Units)	Intercept (SI Units)	On Text	Off Text
65	TEMP LLIMIT	55.0 (12.80888)	DEG F (DEG C)	0.25 (0.14)	48.0(8.8888 8)	--	--
{66}	FAN AOV1	0	VOLTS	0.01	0	--	--
{67}	AI 4	74.0 (23.495556)	DEG F (DEG C)	0.5 (0.28)	37.5(3.0555 56)	--	--
{68}	DI 4	OFF	--	--	--	ON	OFF
69	TEMP HLIMIT	85.0 (29.60888)	DEG F (DEG C)	0.25 (0.14)	48.0(8.8888 8)	--	--
{70}	AOV 2	0	VOLTS	0.01	0	--	--
71	FAN TIME	60	SEC	1	0	--	--
72	FLOW I GAIN	0.02	--	0.001	0	--	--
73	HTG DBAND	2.0 (1.12)	DEG F (DEG C)	0.25 (0.14)	0.5(0.28)	--	--
74	MORN DBAND	2.0 (1.12)	DEG F (DEG C)	0.25 (0.14)	0	--	--
{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)	DEG F (DEG C)	0.25 (0.14)	48.0(8.8888 8)	--	--
{79}	CLG LOOPOUT	0	PCT	0.4	0	--	--
{80}	HTG LOOPOUT	0	PCT	0.4	0	--	--
{81}	VLV CONTROL	0	PCT	0.4	0	--	--
82	FAN FLOW MIN	220 (103.818)	CFM (LPS)	4 (1.8876)	0	--	--
83	FAN FLOW MID	2500 (1179.75)	CFM (LPS)	4 (1.8876)	0	--	--
84	FAN FLO HMAX	2200 (1038.18)	CFM (LPS)	4 (1.8876)	0	--	--
85	FAN FLO CMAX	2200 (1038.18)	CFM (LPS)	4 (1.8876)	0	--	--
86	SWITCH TIME	10	MIN	1	0	--	--
{87}	FLO HI	2200 (1038.18)	CFM (LPS)	4 (1.8876)	0	--	--
88	VALVE COUNT	2	--	1	0	--	--
89	CLOSE TIME	3	MIN	1	1	--	--
90	SWITCH DBAND	1.0 (0.56)	DEG F (DEG C)	0.25 (0.14)	0	--	--
{91}	AOV 3	0	VOLTS	0.01	0	--	--
{92}	CTL STPT	74.0	DEG F	0.25 (0.14)	48.0(8.8888	--	--

Point Number	Descriptor	Factory Default (SI Units)[2]	Eng Units (SI Units)	Slope (SI Units)	Intercept (SI Units)	On Text	Off Text
		(23.44888)	(DEG C)		8)		
{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	--	--
101	CLG P GAIN	20.0 (36.0)	--	0.25 (0.45)	0	--	--
102	CLG I GAIN	0.01 (0.018)	--	0.001 (0.0018)	0	--	--
103	HTG P GAIN	10.0 (18.0)	--	0.25 (0.45)	0	--	--
104	HTG I GAIN	0.01 (0.018)	--	0.001 (0.0018)	0	--	--
{105}	AOV 2 CLOSE	0	VOLTS	0.01	0	--	--
{106}	AOV 2 OPEN	10	VOLTS	0.01	0	--	--
{107}	AOV 3 CLOSE	0	VOLTS	0.01	0	--	--
{108}	AOV 3 OPEN	10	VOLTS	0.01	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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