SIEMENS

LCM-OAVS

Room Pressurization with Slow-acting Supply Damper Actuation and Exhaust Venturi Air Valve, Hot Water Reheat and BTU Compensation, Application 2930

Application Note

140-1305
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Building Technologies

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Overview

Application 2930 controls pressurization, ventilation, and room temperature in a laboratory room served by one single-duct supply terminal with a reheat coil, one general exhaust terminal, and up to six fume hoods (multiple fume hood flow signals must be averaged using an averaging and scaling module. Pressurization is controlled by maintaining a selected difference between supply and exhaust airflows.

This version of the LCM uses conventional supply and exhaust actuation (rather than high speed actuation). Therefore, it should be used only where rapid room response to fume hood volume changes is not required. Fume hoods used in conjunction with these applications should be constant volume or slow actuation.

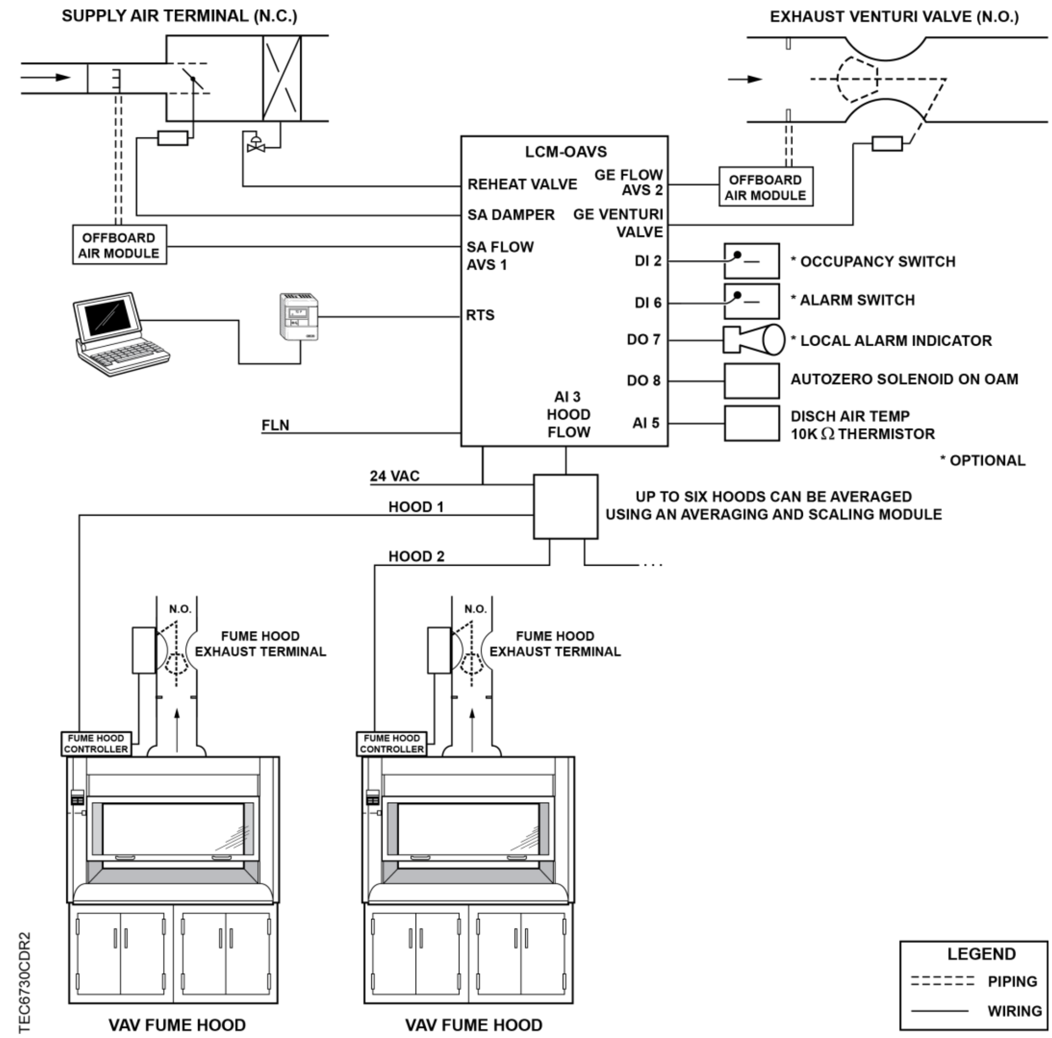
NOTE:
Application 2930 can be set up to operate without a supply box, or without a general exhaust box. See the *Application Notes* section for more information.

Application 2930 uses floating control electronic actuators for the supply control and a 0 to 10 Vdc signal to drive a Venturi Air Valve for exhaust control. A standard 0 to 10 Vdc actuator is used for the hot water valve.

NOTE:
The LCM controls pressure, ventilation, and temperature. When these functions conflict, the priorities are:

- Pressurization
- Ventilation (supply minimum may be overridden to maintain negative pressurization)
- Temperature

Temperature control is determined by input from the room temperature sensor. The discharge temperature setpoint is reset in sequence with the VAV flow to control the room temperature using a BTU Compensation algorithm. The discharge temperature is then controlled using the reheat coil.



Ventilation and Pressurization Control Drawing.

Hardware Inputs

Analog

- Air velocity sensor (s) – (one or two depending on setup)
- Fume hood controller input or FFM
- Room temperature sensor
- Discharge Temperature Sensor (10K Ω thermistor)

Digital

- Occupancy button (option on room temperature sensor)
- *(Optional)* Occupancy switch
- *(Optional)* Alarm switch

Hardware Outputs

Analog

- Reheat valve
- General exhaust Venturi Air Valve

Digital

- Autozero Solenoid in Offboard Air Module (DO 8)
- *(Optional)* Alarm
- Supply damper (two DOs)

Ordering Notes

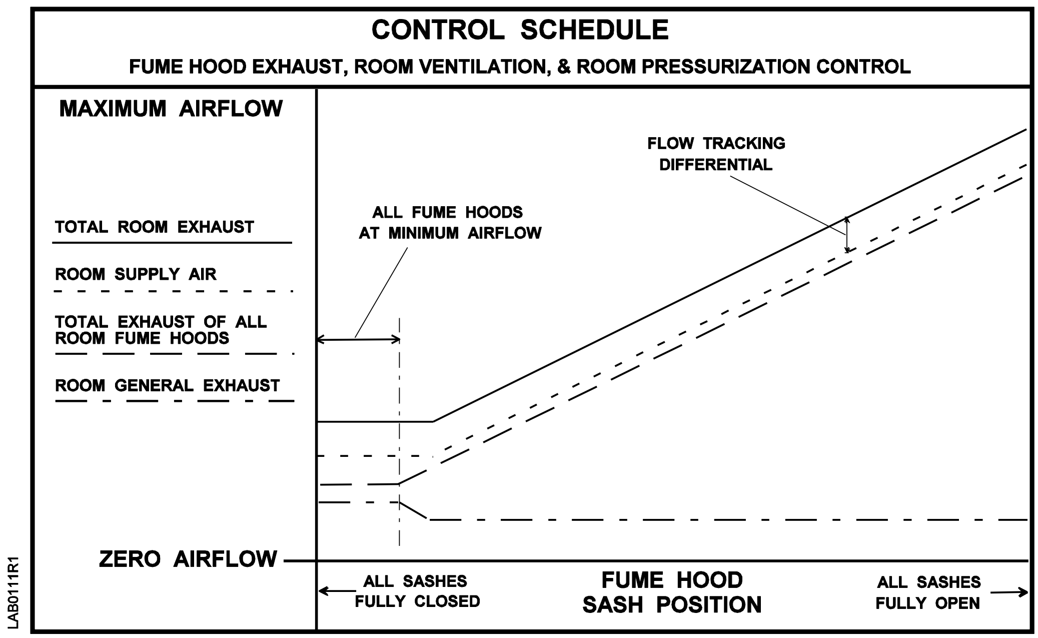
550-767GN	LCM-OAVS Room Pressurization with Slow-acting Supply Damper, Venturi Exhaust Actuation and Hot Water Reheat Requires Offboard Air Module(s) – order and ship separately
550-819B	Offboard Air Module (OAM) – order and ship separately

Sequence of Operation

The following paragraphs present the sequence of operation for LCM-OAVS VAV Room Pressurization with HW Reheat, BTU Compensation, Slow Supply Damper Actuation and Slow Exhaust Venturi Air Valve .

Pressurization Control

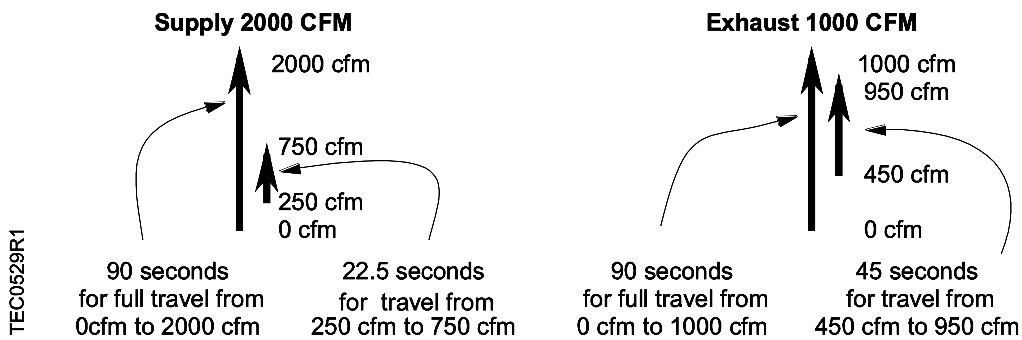
The goal of pressurization control is to maintain a fixed difference between the volumes of total supply air and total exhaust air (see the following figure). The controller selects supply and exhaust setpoints to balance flows while meeting supply air requirements, and the supply and exhaust flows are individually controlled by respective feed-forward table statements and feedback loops in order to meet the setpoints.



Optional Rate Limiting of Actuators

Under specific circumstances, such as when operating open loop with setpoint tracking and differently sized supply and exhaust, it may be necessary to adjust the actuator travel rates to improve pressurization control.

The example below illustrates when a rate limit might be needed, such as when equal travel times for the supply and exhaust actuators yield large differences in their respective flow rates.



To deal with the possibility of unequal flow rate changes, the application includes two new points which allow field adjustment to slow down actuators. SUP MAX RATE effectively limits the speed of the supply actuator; GEX MAX RATE effectively limits the speed of the exhaust actuator.

SUP MAX RATE and GEX MAX RATE should be changed to values other than 0 only after a thorough analysis has been made of the job specific scenarios. For example, slowing down a given supply actuator to match a general exhaust actuator may actually be detrimental overall if the installation includes faster acting fume hoods.

To limit the rate of the actuator (supply or exhaust depending on your setup) that controls the larger and faster changing flow rate, do the following: Take the max flow cfm value of the box you want to slow down and divide by its actuator runtime in seconds, then divide the result by 4 and round to the nearest integer. Enter this final value in either SUP MAX RATE or GEX MAX RATE depending on which box you want to slow down.

Here is the formula in its simplest terms, where "*max cfm*" represents the maximum flow value of the box that you want to slow down:

(max cfm ÷ runtime) ÷ 4 = SUP (or GEX) MAX RATE

NOTE:
This value is a good starting point. If necessary, you can raise it (must be an integer) to speed up the rate of flow change, or lower it to further slow down the rate of flow change, while observing the overall stability of your setup.

To accommodate the largest variety of room configurations and pressurization needs, the rate limit will ONLY be applied when the actuator is moving in the direction that, if left uncontrolled, could cause pressurization reversal. See the following table:

	SUPPLY	GENERAL EXHAUST
OCC DIF STPT (or UOC DIF STPT) <0 Maintain **positive** pressurization	The SUP MAX RATE is applied to supply closing, but not to supply opening.	The GEX MAX RATE is applied to general exhaust opening, but not to general exhaust closing.
OCC DIF STPT (or UOC DIF STPT) >=0 Maintain **negative** pressurization	The SUP MAX RATE is applied to supply opening, but not to supply closing.	The GEX MAX RATE is applied to general exhaust closing, but not to general exhaust opening.

Room Airflow Balance

The difference between total supply flow and total exhaust flow is the room airflow balance as shown in these calculations:

VOL DIFFRNC = TOTL EXHAUST – TOTL SUPPLY
-or-
VOL DIFFRNC = (HOOD VOL + GEX AIR VOL + OTHER EXH) – (SUP AIR VOL + OTHER SUP)

The controller uses these calculations to maintain VOL DIFFRNC at the VOL DIF STPT.

NOTE:
VOL DIFFRNC and VOL DIF STPT are positive numbers in a room that is negatively pressurized and negative in a positively pressurized room.

Application 2930 has the ability to maintain a different volume differential setpoint during occupied mode than during unoccupied mode. When OCC.UNOCC = OCC, VOL DIF STPT = OCC DIF STPT. When OCC.UNOCC = UNOCC, VOL DIF STPT = UOC DIF STPT.

Occupancy

The controller keeps track of the occupancy status of the room and uses that information for the following purposes:

- To select minimum and maximum flow rates for each air terminal.
- To select whether the controller is operating in the VAV or CV mode.
- To determine whether the controller is using Supply Tracks Exhaust (STE) or Exhaust Tracks Supply (ETS) flow tracking.
- To determine the value of VOL DIF STPT.
- To calculate the airflow level that triggers the ventilation alarm.

Occupancy status also affects the airflow level that triggers the ventilation alarm. The occupancy status of the room is indicated by OCC.UNOCC. A digital room thermostat can read OCC.UNOCC and display its value. This point cannot be overridden.

If the occupancy status of the room is set manually, it is necessary to work through the following command options.

The controller works in the occupied mode whenever **one or more** of the following occupancy signals indicates occupancy:

- Commands from a field panel, NET OCC CMD
- Dry contact switch in the room, OCC SWIT DI2
- Push button on the thermostat, OCC BUTTON

If **all** of these occupancy signals indicate vacancy, the controller works in the unoccupied mode.

NET OCC CMD – The NET OCC CMD may be set from a field panel by OCC and UNOCC commands to the LCTLR point. The commands may come from a time-of-day schedule, a PPCL program, or operator commands. These commands work on the LCTLR without unbundling.

NOTE:
The displayed OCC/UNOCC status of the LCTLR point does not always match the occupancy status of the controller. To get an actual indication of occupancy status, OCC.UNOCC must be used.

If network commands are not required and occupancy will be set by sources in the room, set NET OCC CMD to UNOCC. If set to OCC, the controller will stay in occupied mode.

OCC ENA is an analog point whose value determines whether or not OCC BUTN DI1, or OCC SWIT DI2, is enabled.

The following table shows what is enabled when OCC ENA is at a particular value.

OCC ENA Values.	
OCC ENA (value)	**Description**
0 (default)	Both OCC BUTN DI1 and OCC SWIT DI2 are disabled.
1	Only OCC BUTN DI1 is enabled.
2	Only OCC SWIT DI2 is enabled.

NOTE:
OCC ENA does not allow both OCC BUTN DI1 and OCC SWIT DI2 to be enabled at the same time. If OCC ENA is set greater than 2, it will default to 0.

OCC SWIT DI2 – The occupancy switch (dry contact switch in the room) can be any device that closes the switch when the room is occupied (occupancy sensor, extra contact on light switch, and so on). The controller uses this input for occupancy if the setup point OCC ENA is set to **2**. Otherwise, OCC SWIT DI2 does not affect occupancy.

OCC BUTTON – Some thermostats include a momentary switch with a push button. The controller can use this button as a source of occupancy commands if the setup point, OCC ENA, is set to **1**.

When the room sensor button is pushed, the controller interprets this as a request to change the occupancy status of the room. If the room is unoccupied, it changes to occupied. If it is occupied, it *may* switch to unoccupied, depending on the states of the other occupancy sources. The current request status of the room sensor button is indicated by BUTTON CMD. This point is used to investigate the room sensor button's effect on the occupancy status of a room.

OCC BUTTON does not provide that information because it is connected to a momentary switch.

Active Flow Minimums and Maximums

When OCC.UNOCC equals OCC:

- The active supply airflow minimum equals OCC SUP MIN.
- The active supply airflow maximum equals OCC SUP MAX.
- The active general exhaust airflow minimum equals OCC GEX MIN.
- The active general exhaust airflow maximum equals OCC GEN MAX.

When OCC.UNOCC equals UNOCC:

- The active supply airflow minimum equals UOC SUP MIN.
- The active supply airflow maximum equals UOC SUP MAX.
- The active general exhaust airflow minimum equals UOC GEX MIN.
- The active general exhaust airflow maximum equals UOC GEN MAX.

VAV versus CV Control

In Application 2930, VAV means that the supply airflow can be varied to provide cooling. CV means the supply airflow is not a source of cooling. However, the supply and general exhaust can still change in CV mode to keep the volume differential setpoint constant. This may be necessary if HOOD VOL is varying. Application 2930 can do either Variable Air Volume control (VAV) or Constant Air Volume Control (CV). It can also change the type of air volume control based on which mode it is operating in (OCC or UNOCC).

- When OCC.UNOCC equals **OCC**, Application 2930 will perform VAV control provided that VOLUME STATE equals **1** or **3**. It will perform constant volume (CV) control provided that VOLUME STATE equals **0** or **2**.
- When OCC.UNOCC equals **UNOCC**, Application 2930 will perform VAV control provided that VOLUME STATE equals **2** or **3**. It will perform constant volume control provided that VOLUME STATE equals **0** or **1**.

Depending on how VOLUME STATE is configured, Application 2930 can operate as either a Variable Air Volume (VAV) LCM or a constant volume (CV) LCM. Also, these operational modes can vary between the occupied and unoccupied periods, if desired.

The following table shows what the application does when VOLUME STATE is at a particular value.

VOLUME STATE Values.

VOLUME STATE (value)	Description
0	Always Constant Volume.
1 (default)	VAV during occupancy, Constant Volume during unoccupied period.
2	Constant Volume during occupancy, VAV during unoccupied period.
3	Always VAV.

NOTE:
If VOLUME STATE is set greater than 3, it will default to 0.

Fume Hood Flow Input

A signal of 1 to 10 Vdc at AI 3 represents the volume of air that is exhausted through the fume hood(s). By using a Fume Hood Flow Module (FFM), you can connect up to six fume hoods to AI 3. Multiple fume hood flows must be averaged using a Fume Hood Flow Module. The resulting airflow is displayed in point HOOD VOL.

MAX HOOD VOL is set during start-up to indicate the flow in cubic feet per minute (cfm) that corresponds to an input signal of 10 Vdc. A signal of 1 Vdc indicates 0 cfm. If the signal drops below 1 Vdc, TOTL EXHAUST will fail.

NOTE:
If desired, the LCM can be used without any fume hoods attached. In this case, MAX HOOD VOL should be set to 0 cfm to disable the alarming that would occur if the fume hood flow input drops below 1 Vdc.

Flow Tracking – Supply Tracks Exhaust vs. Exhaust Tracks Supply

The Supply Tracks Exhaust (STE) and Exhaust Tracks Supply (ETS) feature is configured by setting TRACK MODE to STE or ETS to help the controller meet the pressurization needs of the controlled space, such as for negative or positive pressure. TRACK METHOD is used to determine what is being tracked – a flow value or a setpoint value. Regardless of the mode (STE or ETS) in which the controller is operating, the application will change the value of TRACK METHOD from STPT to FLOW (that is, from setpoint tracking to flow tracking) if necessary to maintain proper pressurization. This is important in situations where a room may lack sufficient supply or general exhaust capacity. The following paragraphs explain this in greater detail.

Supply Tracks Exhaust mode is useful when trying to maintain negative pressurization. During Supply Tracks Exhaust, the supply air volume "tracks" or follows the exhaust air volume. If the exhaust air is "broken" (for instance, if the general exhaust airflow control device is stuck open or stuck closed), the supply air volume will be adjusted so that VOL DIF STPT is maintained as much as possible. (The supply air volume cannot go lower than zero and the application will not allow it to go higher than OCC SUP MAX during occupied periods, or UOC SUP MAX during unoccupied periods.)

Exhaust Tracks Supply mode is useful when trying to maintain positive pressurization. During Exhaust Tracks Supply, the general exhaust air volume "tracks" or follows the supply air volume. If the supply air is "broken" (for instance, if the supply airflow control device is stuck open or stuck closed), the general exhaust air volume will be adjusted so that VOL DIF STPT is maintained as much as possible. (The general exhaust air volume cannot go lower than zero and the application will not allow it to go higher than OCC GEX MAX during occupied periods, or UOC GEX MAX during unoccupied periods.)

The selected track mode is not affected by occupancy status (OCC or UNOCC), and is set by the value of TRACK MODE.

TRACK MODE Values.	
TRACK MODE (value)	**Description**
0 default	Always STE (Supply Tracks Exhaust), exhaust only.
1	STE during occupancy, ETS during the unoccupied period.
2	ETS during occupancy, STE during the unoccupied period.
3	Always ETS (Exhaust Tracks Supply), supply only.

NOTE:
If TRACK MODE is set greater than 3, it will default to 0.

TRACK METHOD
TRACK METHOD is a point associated with TRACK MODE. TRACK MODE determines which airflow (supply or general exhaust) gets tracked and which airflow does the tracking. TRACK METHOD determines how tracking is accomplished.

- If TRACK MODE is set to ETS and TRACK METHOD is set for FLOW tracking, the general exhaust flow setpoint is calculated according to the measured value, SUP AIR VOL.
- If TRACK METHOD is set for STPT tracking, the general exhaust flow setpoint is calculated according to the supply flow setpoint. However, this module changes over to FLOW tracking mode if the supply cannot reach the setpoint.

This feature prevents the incorrect pressurization of rooms that lack the required supply capacity. The changeover is based on the error of the supply flow loop. If the error is greater than FAIL LIMIT, and stays that way for a time longer than FAIL TIME, then the module changes from STPT tracking to FLOW tracking. It stays in that mode until the error comes back to zero, then switches back to the STPT tracking mode.

- If TRACK MODE is set to STE and TRACK METHOD is set for FLOW tracking, the supply flow setpoint is calculated according to the measured value, GEX AIR VOL.
- If TRACK METHOD is set for STPT tracking, the supply flow setpoint is calculated according to the general exhaust flow setpoint. However, this module changes over to FLOW tracking mode if the general exhaust cannot reach the setpoint.

This feature prevents the incorrect pressurization of rooms that lack the required general exhaust capacity. The changeover is based on the error of the general exhaust flow loop. If the error is greater than FAIL LIMIT, and stays that way for a time longer than FAIL TIME, then the module changes from STPT tracking to FLOW tracking. It stays in that mode until the error comes back to zero, then switches back to the STPT tracking mode.

Calculating Exhaust Flow Setpoint

When **Supply Tracks Exhaust** (STE) flow tracking is used, the general exhaust airflow setpoint is calculated as follows:

- During VAV operation, the controller calculates GEX FLO STPT by looking at the value of TEMP CTL VOL and determining the general exhaust flow needed to pressurize the room. If TEMP CTL VOL is less than the active supply minimum, the controller ignores TEMP CTL VOL and calculates GEX FLO STPT based on the value of the active supply flow minimum.
- During CV operation, the controller ignores TEMP CTL VOL. Instead, it calculates GEX FLO STPT based on the value of the active supply flow minimum and the amount of general exhaust airflow needed to pressurize the room.

NOTE:
When Supply Tracks Exhaust (STE) flow tracking is being used, the controller does not allow GEX FLO STPT (or the actual general exhaust flow) to rise above the active general exhaust airflow maximum. **However, the general exhaust airflow minimum can be overridden in situations where doing so is necessary to maintain desired room pressurization.**

When **Exhaust Tracks Supply** (ETS) flow tracking is used, the general exhaust airflow setpoint is calculated the same during both VAV and CV operation, as follows:

To calculate GEX FLO STPT, the controller determines the general exhaust airflow value that pressurizes the room based on the values of VOL DIF STPT, OTHER EXH, OTHER SUP and either SUP FLO STPT or SUP AIR VOL depending on the value of TRACK METHOD. GEX FLO STPT may not exceed the active general exhaust airflow maximum, but the currently active general exhaust airflow minimum (OCC GEX MIN or UOC GEX MIN) will be overridden if necessary to maintain the desired room pressurization.

Calculating Supply Flow Setpoint

When **Supply Tracks Exhaust (STE)** flow tracking is used, the supply airflow setpoint is calculated the same during both VAV and CV operation, as follows:

To calculate SUP FLO STPT, the controller determines the supply flow value that pressurizes the room based on the values of VOL DIF STPT, OTHER EXH, OTHER SUP, and either GEX FLO STPT or GEX AIR VOL depending on the value of TRACK METHOD. SUP FLO STPT may not exceed the currently active supply airflow maximum.

When **Exhaust Tracks Supply (ETS)** flow tracking is used, the supply airflow setpoint is calculated as follows:

- During VAV operation, the controller calculates SUP FLO STPT by looking at the value of TEMP CTL VOL and determining the supply flow needed to pressurize the room. If TEMP CTL VOL is less than the active supply minimum, the controller ignores TEMP CTL VOL and calculates SUP FLO STPT based on the value of the active supply flow minimum.
- During CV operation, the controller ignores TEMP CTL VOL. Instead, it calculates SUP FLO STPT based on the value of the active supply flow minimum and the amount of supply airflow needed to pressurize the room.

NOTE:
Regardless of the flow tracking method (STE or ETS) being used, the controller does not let the actual supply airflow rise above the currently active supply airflow maximum**. However, the currently active supply airflow minimum (OCC SUP MIN or UOC SUP MIN) will be overridden if necessary to achieve desired pressurization.**

External Flow Values

Airflows not connected to the controller must be taken into consideration when pressurizing the room, including snorkels, canopies, as well as other supplies, such as offices within the lab space controlled by constant volume controllers. Since these inputs are not connected to the controller, the combination of their values must be entered into OTHER SUP and OTHER EXH so the controller can properly control the lab space.

NOTE:
If these airflow values change slowly or predictably (for example, VAV temperature control and/or occ/unoc differences), steps can be taken using PPCL to have the changes sent over the network to update OTHER EXH and OTHER SUP with the new values

Ventilation – VAV Mode

During VAV operation, the ventilation works as follows:

OCC SUP MIN, the occupied supply minimum, is used to ensure that the room receives enough supply air for proper ventilation during the occupied mode. UOC SUP MIN is used to ensure that the room receives enough supply air for proper ventilation during the unoccupied mode. If necessary, the application raises the general exhaust flow to keep the supply flow from dropping below the minimum. See *Calculating Exhaust Flow Setpoint* for more information.

NOTE:
Since Application 2930 places a higher priority on pressurization than it does on ventilation, the currently active supply minimum (OCC SUP MIN or UNOCC SUP MIN) may be overridden to maintain negative pressurization.

Ventilation Setback in VAV Mode

Ventilation setback allows the minimum and maximum flows (air change rate) for each VAV terminal to vary based on occupancy mode (OCC.UNOCC). This allows several options for reducing the ventilation for unoccupied periods, including:

- Lowering the minimum supply flow, which allows a lower air change rate, but maintains cooling control.
- Lowering the maximum flow, which limits the air change rate and reduces cooling capacity.
- Closing the general exhaust, which lowers airflow and disables cooling completely.

Ventilation – Constant Volume Mode

During Constant Volume (CV) operation, the active supply airflow minimum is used to ensure that the room always receives enough supply air for proper ventilation. If necessary, the application raises the general exhaust flow to keep the supply flow from dropping below the minimum. See *Calculating Exhaust Flow Setpoint* for more information.

In CV mode the active supply minimum is the setpoint. The active supply airflow minimum is used to ensure that the room always receives enough supply air for proper ventilation.

During CV operation, the air volume out of the supply box will equal the active supply airflow minimum as long as this is sufficient to maintain proper room pressurization.

NOTE:
Regardless of the operation—VAV or CV temperature control—airflow out of both the supply and general exhaust box will vary as needed in order to maintain proper room pressurization whenever HOOD VOL changes.

AVS Calibration

Calibration of the air velocity transducer(s) is periodically required to maintain accurate air velocity readings. Depending on the value of CAL SETUP, calibration takes place either at fixed time intervals or whenever the application goes into unoccupied mode.

When calibration is in progress, CAL AIR equals YES. After calibration, CAL AIR returns to NO.

The application uses Autozero Modules connected to AUTOZERO DO8. This means that the supply and general exhaust flow control devices do not close during calibration of the transducers.

NOTE:
The LCM does not monitor Fume Hood flow changes for 3 seconds during AVS calibration.

Airflow Control

The supply flow is controlled with a feedback loop to operate the floating control damper motor so that the measured air velocity is maintained at setpoint. To enhance stable flow control, an advanced algorithm is used to calculate a controllable setpoint as the value approaches zero cfm (lps). This feedback loops works as follows:

When the flow is slightly below the setpoint, the LCM opens the floating control damper motor slowly, more and more until the airflow reaches the setpoint, at which time the air damper's position remains constant. If the flow is far below the setpoint, the LCM opens the floating control damper rapidly, more and more until the airflow reaches the setpoint, at which time the air damper's position remains constant. The feedback gain SUP P GAIN is adjusted to tune the flow loop. The sample loop time for the flow loops is fixed at 2.0 seconds. I and D gain are inherent in the system and do not need adjustment.

The application contains logic that prevents the feedback loops from trying to move the damper motors faster than they can actually go. This helps minimize airflow overshoots and undershoots whenever there is a large airflow setpoint change. The greatest amount of position change that the supply damper motor will be allowed to undergo during each execution of the supply airflow feedback loop is ± (100% * flow loop execution speed)/MTR1 TIMING. The flow loop execution speed is fixed in this application at 2.0 seconds.

NOTES:
1. Open the door to the controlled space and set VOL DIF STPT to zero while the flow loops are being tuned.
2. The damper motor command point for supply is SUP DMP CMD The supply damper motor may be set up for normally open or normally closed operation depending on the value of MTR SETUP. See the *Damper Configuration section of the Start-up document* for more information on motor setup.

Damper Status

When an Autozero solenoid from an Offboard Air Module is wired to D08, the physical damper position may vary from what the application's position point is indicating. A Damper Status firmware algorithm will detect and correct situations where airflow velocity is greater than 200 fpm and the following is true:

- SUP DMP POS = 100% and SUP VOL < SUP STPT

OR

- SUP DMP POS = 0% and SUP VOL > SUP STPT

When initiated, the firmware module sets DMPR STATUS from CAL to RECAL and decrements/increments the damper position (in a reiterative sequence up to four cycles in length) until sensed airflow matches setpoint.

NOTE:
It is important to realize that while the Damper Status module runs, the damper position point (SUP DMP POS will change in value but the flow point (SUP VOL) might not.

To change DMPR STATUS from RECAL back to CAL, set DMPR STATUS to CAL and then release it. (A status of RECAL will not prevent the recalibration sequence from running if needed.)

Venturi Operational Modes

The general exhaust Venturi Air Valve can operate in one of three modes:

- Mode 1 – Operates with both a PID loop and a Venturi table.
  This mode provides the best control and is the most commonly used mode for these applications. In this mode, the embedded Venturi table statements works together with a PID feedback loop to operate the Venturi Air Valve so that the measured air velocity is maintained at setpoint. The following several sections describe this mode.
- Mode 2 - Operates with a PID loop, but no Venturi table.
  In this mode, the controller operates with PID control based on a flow sensor input, but the Venturi table is not used. See the *PID Only Mode* section, later in this document, for specific information on this mode.
- Mode 3 - Operates with Venturi table, but no PID loop
  In this mode, the controller operates open loop (without a flow sensor). There is no PID control. Positioning of the actuator is based solely on a Venturi table consisting of command voltages and their resultant corresponding airflows. See the *Open Loop Mode* section, later in this document, for specific information on how this mode differs from the normal Mode 1 above.

Feedback Loop Operation

When the flow is slightly below the setpoint, the LCM gradually opens the Venturi Air Valve slowly, until the airflow reaches the setpoint, at which time the air valve’s position remains constant. If the flow is far below the setpoint, the LCM opens the Venturi Air Valve rapidly, and rapidly increases until the airflow reaches the setpoint, at which time the air valve’s position remains constant. The feedback gain GEX P GAIN is adjusted to tune the flow loop. The sample loop time for the flow loops is fixed at 2 seconds. I and D gain are inherent in the system and do not need adjustment.

NOTES:
1. VOL DIF STPT must be set to 0 while the flow loops are being tuned.
2. The Venturi Air Valve command point, GEX DMPR AO3, indicates Venturi Air Valve position. The Venturi Air Valve may be set up for normally open or normally closed operation.
3. Adjusting P gain to a value greater than 0.1 may cause system instability.

Table Statement and Feedback Loop Interaction

General exhaust Air Velocity Control – A table statement and the general exhaust air velocity feedback control loop work together to control the general exhaust air velocity. (The table statement values are generated automatically during calibration of the general exhaust Venturi Air Valve.) The table statement and the control loop work together as follows:

When general exhaust velocity is lower than the first element in the Venturi table (such as 300 or 350 cfm), the feedback control loop suspends operation and the table statement performs all general exhaust air velocity control. (The application uses GEX AIR VOL/GEXDUCT AREA as the value for general air velocity.)

When general exhaust velocity is greater than the first element in the Venturi table, but GEX AIR VOL is less than GEX FLO STPT × LO LIMIT, the table statement and the air velocity feedback loop work together to control the general exhaust air velocity. Once GEX AIR VOL becomes greater than GEX FLO STPT, the air velocity feedback loop suspends operation and the table statement takes over all general exhaust air velocity control.

When GEX AIR VOL is greater than GEX FLO STPT × HI LIMIT, the table statement and the air velocity feedback loop work to control the general exhaust air velocity. Once GEX AIR VOL becomes less than GEX FLO STPT, the air velocity feedback loop suspends operation and the table statement takes over all general exhaust air velocity control.

NOTE:
If HI and LO LIMIT are set equal, then the feedback loop will always be active as long as the general exhaust airflow is greater than first element in the Venturi table (such as 350 cfm).

The interaction between the table statement and the general exhaust air velocity feedback loop can be summarized as follows:

- When the general exhaust air volume is near setpoint, the table statement controls it.
- When the general exhaust air volume is not near its setpoint (either too high or too low) both the table statement and the general exhaust air velocity feedback loop work together to bring the general exhaust air velocity close to its setpoint as quickly as possible.
- When the general exhaust air velocity is so low that it cannot be accurately read by the general exhaust AVS, the table statement controls it.

Floating Control Actuation Auto-correct

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%.

Venturi Air Valve Calibration (Mode 1, 3)

The calibration table for Venturi Air Valve(s) determines the relationship between airflow and the voltage curve of the actuator. The calibration table initially contains all zeros by default, that is, it contains no calibration information. This section describes how the user initiates a calibration sequence that populates the calibration table with values of flow at given control voltages.

NOTE:
This automatic calibration sequence relies on values from an associated flow sensor. If running open loop (without a flow sensor), see the *Open Loop Mode* section.

Prerequisites for calibrating Venturi Air Valves:

- Fully operational supply and general exhaust airflow systems.
- Supply and general exhaust Air Velocity Sensors are calibrated and working normally (SUP AIR VOL and GEX AIR VOL cannot be Failed).

When calibration is complete, the EEPROM automatically stores a table statement of voltages (no loss of values upon power failure) that will be output to the AO point, SUP DMPR AO2 or GEX DMPR AO3, to drive the actuator.

Table values are the result of the application's analysis of the voltages that drove the actuator during calibration and the resulting airflow values in cfm. To hedge against airflow accuracy slippage, the supply (or general exhaust) air velocity feedback loop is used along with the table statement to maintain correct airflow out of the Venturi.

Table Access Feature (Mode 1, 3)

In Application 2930, an embedded table statement and a feedback loop work together to operate the supply or general exhaust Venturi Air Valve.

The table contains 16 pairs of "active" voltage/flow values, and 16 pairs of "inactive" voltage/flow values.

The active values are used to operate the Venturi Air Valve at desired airflows. For example, when the controller is given a flow setpoint value of 500 cfm, it goes to the active portion of the table statement and looks up what the voltage output to the actuator should be in order to achieve 500 cfm. The inactive values are used to edit the active values as explained later in this section.

The Table *Venturi Table Statement Example* shows an example of active values in a Venturi table statement after the Venturi Air Valves have been calibrated (note reverse acting exhaust voltage). Table statement values will vary per system.

Venturi Table Statement Example (active values).	
Exhaust Venturi Air Valve	
cfm	volts
0 [a)]	10 [a)]
180	5.48
216	5.08
244	4.68
340	3.88

Venturi Table Statement Example (active values).	
Exhaust Venturi Air Valve	
cfm	volts
368	3.48
452	2.98
476	2.73
504	2.48
572	1.98
604	1.73
618	1.48
712	0.98
760	0.73
800	0.48
904	0

a) These voltage/flow values constitute the "low flow" element (or "point") for the Exhaust Venturi Air Valves. They are shown here with factory default values. They are not altered during calibration—they must be set manually. However, they only need to be set if the Venturi Air Valve is going go be operating at low flow settings of less than 350 fpm. Otherwise, they can be left at default and ignored.

NOTE:
The first pair (or "point") of flow/voltage values in the table statement is the low flow point. It is provided for low flow situations where airflow through the Venturi Air Valve must be controlled at velocities less than 350 fpm. Otherwise, this point can be left at factory default of 0 cfm and 0V (10V if exhaust) and ignored, as is the case in the example table statement in the Table *Venturi Table Statement Example*. See the Table *Venturi Air Valve Table Statement* for how to manually set this point.

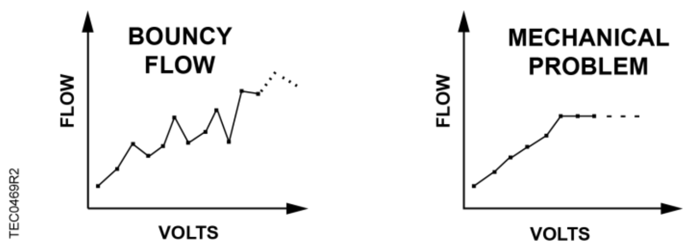
If there is a low flow cfm value, it is taken either from the room schedule or the Venturi Air Valve housing. Cubic feet per minute (cfm) flows in this range (where velocity equals less than 350 fpm) and related voltages must be determined and/or confirmed with help from a balancer. See the Table *Venturi Airflow @ 350 fpm* for cfm flows equal to 350 fpm. The following equation associates airflow to air velocity:
Airflow (cfm) = Velocity (fpm) × Duct Area (sq ft) × Flow Coefficient.

Venturi Airflow @ 350 fpm.	
Valve Size in Inches	cfm
5	48
6	69
8	122
10	191

Venturi Airflow @ 350 fpm.	
Valve Size in Inches	cfm
12	275
Dual 10	380
Dual 12	550
Triple 12	825

During calibration, voltage/flow values are automatically generated. Typically there are 8 or 9 pairs. The first pair of voltage/flow values—the low flow point—is not generated; it must be set manually. The Venturi Valve actuator is then fed the voltages and the application reads the resulting airflows. At the end of calibration, the airflow readings are analyzed and the calibration is either given a PASS or a FAIL (GEX VLV STAT is set to CAL OK or NOTCAL). To obtain a CAL OK, the airflow readings must increment correctly (the points in the table increase as the voltage increases). For example, if one point on the voltage/flow curve shows 5V and 500 cfm and the next point shows 6V and 450 cfm, the second point (6V, 450 cfm) would fail. But 6V at 550 cfm would pass. (This example assumes the actuator is direct acting, where more volts equal more flow. Exhaust devices are usually reverse acting and have an inverse voltage/flow relationship.) Too many failed airflow points along the voltage/flow curve will result in a NOTCAL status for the calibration.

This application has a table statement edit feature that allows you to view and edit the voltage/flow values in the table. This is useful for fine tuning the air valve to meet precise room flow setpoints and for diagnosing/editing problematic voltage/flow curves (see the Table *Venturi Air Valve Table Statement*).



Problematic Venturi Air Valve Voltage/Flow Curves.

NOTE:
Bouncy flow means that airflow through the air valve's flow orifice is too turbulent to be read consistently.

Venturi Table Evaluation and Editing (Mode 1, 3)

A Venturi Air Valve table statement consists of two sets of voltage/flow values—one set is active and the other inactive. When you run the calibration, the first thing that happens is that the inactive table values are filled in with new values generated by the calibration. Then the application checks these new values to make sure they are good. If they pass (that is, if enough increment correctly), these new values become the active values, and the old active values become inactive. However, if the new values don't pass, then the old active values remain active.

Running a successful calibration sequence is one way of changing/updating the active values. You can also edit the table manually. Normally this is not necessary, but if you are having flow control problems you may need to edit the table.

In order to manually edit the table statement, you must first know which points in the active table need adjusting. This is done by setting V TABLE PT to the appropriate active point values found in the Table *Venturi Air Valve Table Statement* in order to gather and view the active voltage/flow curve for the Venturi Air Valve and its actuator. By gathering and analyzing the active voltage/flow values (for example, you can plot them on a graph as in the figure *Problematic Venturi Air Valve Voltage/Flow Curves*), you can decide which one(s) need adjusting. The flow curve should be smooth and incremental.

You can change the active values using the following steps:

1. Set V TABLE PT to a "swap" value that tells the application to exchange active table values with inactive table values (see the Table *Venturi Air Valve Table Statement* for swap value).

   ⇨ This step is necessary because the application does not allow active values to be manually overridden.

NOTE:
An exception to this rule is when active values cannot be manually overridden. The first element in the active portion of the table—the low flow point—can be edited directly. The Table *Venturi Air Valve Table Statement* explains this in more detail.

2. Edit the inactive table values.

   ⇨ Since you have just switched the active and inactive portions of the table in Step 1, the inactive values are now identical to what the active values were moments ago. You can now edit these new inactive values by using V TABLE PT to reference them in TABLE FLOW and TABLE VOLTS. The Table *Venturi Air Valve Table Statement* explains this in more detail.

3. Set V TABLE PT once again to the swap value. This places the newly edited inactive values back into the active portion of the table statement (again, the active and inactive portions of the table are simply swapped). However, before the swap is finalized, the application analyzes your proposed values using the same logic as in a regular calibration sequence.

   ⇨ If your proposed values are good, then the swap is made and the edited values are accepted into the active portion of the table. GEX VLV STAT is set to CAL OK for exhaust calibration and SUP VLV STAT is set to CAL OK for supply calibration and control of the Venturi Air Valve resumes.

⇨ However, if either point is set to NOTCAL, you must gather and view the voltage/flow values to see where the problem lies.

NOTES:
1. If **SUP FLO COEF** is 0, the table edit feature uses a supply flow coefficient of 1.
2. If **SUPDUCT AREA** is 0, the table edit feature uses a supply duct area of 1 square foot.
3. If **GEX FLO COEF** is 0, the table edit feature uses a general exhaust flow coefficient of 1.
4. If **GEXDUCT AREA** is 0, the table edit feature uses a general exhaust duct area of 1 square foot.

The following table lists all values for V TABLE PT and describes their use. Any range of points not specifically mentioned (such as 47 through 60) is unused.

Venturi Air Valve Table Statement		
	V TABLE PT	**Description**
	0	Default value for **V TABLE PT**. When **V TABLE PT** equals 0, changes to **TABLE FLOW** or **TABLE VOLTS** are ignored. Setting **V TABLE PT** to 0 cancels an edit session.
Active Exhaust	31	Setting **V TABLE PT** to 31 takes the flow (cfm) and voltage values from the first element of the active exhaust table and displays them in **TABLE FLOW** and **TABLE VOLTS** where they can be edited. (This is the only active exhaust element (or "point") that can be directly edited.) Flow and voltage values are not allowed to exceed those in active exhaust point 32. To operate in the range below minimum readable flow (less than 350 fpm), a low flow value in cfm from either the room schedule or the general-exhaust Venturi Air Valve housing is entered into **TABLE FLOW**, with the correct corresponding actuator voltage determined/confirmed by the balancer and entered into **TABLE VOLTS**. **NOTE:** This point is only necessary for general-exhaust Venturi Air Valve operation in the range below minimum readable flow (below 350 fpm). Otherwise it can be ignored. This low flow point must be entered only after other non-zero points exist in the table as a result of manual edits, or as the result of a prior Venturi auto calibration sequence.
	32 - 46	This portion of the table (32 through 46) can be viewed but not edited directly. When a point is selected (that is, when **V TABLE PT** is set to a value 32 through 46), the corresponding flow and voltage values are displayed in **TABLE FLOW** and **TABLE VOLTS**. Setting **V TABLE PT** to 32 will result in the smallest readable flow and associated voltage for the exhaust Venturi Air Valve to be displayed in **TABLE FLOW** and **TABLE VOLTS.** Setting **V TABLE PT** to 46 will result in the maximum flow and associated voltage for the exhaust Venturi Air Valve to be displayed in **TABLE FLOW** and **TABLE VOLTS**. The in between values (33 through 45) are for the range of flow between min and max. **NOTE:** The table swap will fail if valid flow and voltage values are not entered in Point 46. Table entries marked as failed display FAIL for both flow and voltage.
Inactive Exhaust	91 – 106	This portion of the table can be viewed and edited. By entering a point (any value 91 through 106) into **V TABLE PT**, the corresponding cfm and voltage values display in **TABLE FLOW** and **TABLE VOLTS** where they can be edited.

Venturi Air Valve Table Statement		
	V TABLE PT	Description
Exhaust Swap	121	Setting **V TABLE PT** to 121 instructs the controller to evaluate the values in the inactive exhaust portion of the table using standard calibration pass/fail logic. If they pass, they are exchanged with those in the active exhaust portion of the table.

NOTE:
The factory default value for GEX VLV STAT is NOTCAL which indicates a failure of the calibration or that calibration has not yet been done. The value is set whenever a calibration or table transfer is performed as the last step of the calibration/table transfer. GEX VLV STAT is never used for active control decisions.

NOTE:
The calibration table initially contains all zeros by default, that is, it contains no calibration information. When the application detects all zeros, the application operates, but runs with only PID control. If PID only control is satisfactory for a given job, there is no need to populate the table. Should it be necessary, a populated table can later be edited back to all zeroes to force PID only control.

PID Only (Mode 2)

NOTE:
The default P gain value is intended for PID operation in conjunction with the Venturi table. The P gain and Venturi table work together to provide an appropriate response to setpoint changes. When operating without the Venturi table in PID Only mode, the application is slower to respond. Therefore, you should adjust the P gain as needed when operating in PID Only mode to ensure acceptable performance.

The Venturi calibration table initially contains all zeros by default, that is, it contains no calibration information. When the application detects a zero flow for the sixteenth entry (the table entry with the highest flow), the application does operate, but runs with only PID control. If PID only control is satisfactory for a given job, there is no need to populate the Venturi tables.

Open Loop (Mode 3)

This application can operate in open loop mode. In open loop control, there is no airflow sensor to provide an actual airflow measurement. Instead, operation is based completely on the values in the Venturi table. For example, if the actuator's setpoint is 600 cfm, the application will use the Venturi table to derive the voltage setting that generates a flow of 600 cfm and then set the actuator to that voltage to generate the desired flow. Assuming the table has accurate entries, the flow (if it were to be measured) would be at setpoint.

Internally within the application, with open loop control, the flow is always assumed to be at setpoint As a result there is virtually no difference between flow tracking and setpoint tracking when the actuator being tracked is operating open loop.

Set **G OPEN LOOP** to **YES** to indicate that the general exhaust actuator is to operate open loop. Setting this enable point to **YES** will suppress the AVS failure indication that otherwise would occur when no airflow sensor is connected.

When operating open loop, there is no flow sensor for use in the calibration sequence. Instead, the Venturi table values are directly input by the user. If the Venturi Valve has end points for calibration such as 1200 cfm at end voltage, and an implied lower range of 0 cfm at its other end of the voltage range, you should enter this information into Point 16, as shown in Example 1 and 2 below.

The direction of actuation, Normally Open or Normally Closed is determined by VENTRUI ACT.

Point	Flow	Volt
1	0	0.0
2	0	0.0
15	0	0.0
16	1200	10.0

Example 1 - Table with CFM End Limit – direct acting

It may not be necessary to enter 0 values since 0 values are initially in the table by default when direct acting is selected.

Point	Flow	Volt
1	0	10.0
2	0	10.0
15	0	10.0
16	1200	0.0

Example 2 - Table with CFM End Limits – reverse acting

It may not be necessary to enter 10.0 values since 10.0 values are initially in the table by default when reverse acting is selected.

If specific information about the voltage at low flow is known, that would be entered into Point 1 which is reserved for information about low flow. See Examples 3 and 4 below.

Point	Flow	Volt
1	300	3.0
2	0	0.0
15	0	0.0
16	1200	10.0

Example 3 - Table with Voltage End Limits and Low Flow Value – direct acting

Point	Flow	Volt
1	300	7.0
2	0	10.0
3	0	10.0
15	0	10.0
16	1200	0.0

Example 4 - Table with Voltage End Limits and Low Flow Value – reverse acting

You can also manually populate the table with additional values as shown in Example 5 below. In this case, the table becomes indistinguishable from a table generated using the calibration process.

Point	Flow	Volt
1	300	3.0
2	0	0
7	0	0
8	340	3.2
9	390	3.5
10	521	3.8
11	531	4.1
12	598	4.9
13	691	5.8
14	798	7.0
15	0	0
16	1200	10

Example 5 - Multi-point Table

The point values above are for the exhaust table. Open loop supply operation is similar, but the points used are 1 through 16; not 30 through 46.

Since the actual airflow being measured is 0, the heating safety requirement for minimum airflow is not met and heating will not occur. To re-enable heating, the FLO value must be set to 0, but only after a thorough safety review that the electric heating mechanism has sufficient internal safeguards (that is, resettable shutoffs) that would operate in the event that the system at some time actually did have insufficient flow.

NOTE:
Since **PID Only Mode** uses PID without a Venturi table and **Open Loop Mode** uses Venturi table without PID, these two modes cannot be used at the same time.

Operating Without a Supply or Exhaust

It is possible to run this application without the supply or exhaust if the corresponding flow coefficient is set to zero. When the flow coefficient is zero and the offboard air module is not connected the air velocity sensor will not display a FAIL status and the flow loop will be allowed to run with a flow value of zero. See the *Application Notes* section for more information.

Heating Safety

NOTE:
As a safety feature, these applications include MODHTG FLO to ensure that adequate airflow is present before heating coils are energized. When the supply airflow (in fpm as derived from the supply air velocity sensor) is greater than MODHTG FLO, then the internal point “ok_to_mod” is set to Yes and the modulating heating device is allowed to modulate.

The default value is 300, which means that the airflow over the heating coil must be at least 300 fpm.

Since CFM = FPM x Duct Area x Flow Coefficient, the default value of 300 fpm equates to the following cfms:

In a 12-inch diameter duct and a typical flow coefficient of .7, 300 fpm equates to 158 cfm.

12 inch diameter = .75 sq ft **.75 sq ft * 300 fpm * .7 = 158 cfm**

In an 8-inch diameter duct and a typical flow coefficient of .7, 300 fpm equates to 74 cfm.

8 inch diameter = .35 sq ft **.35 sq ft * 300 fpm * .7 = 74 cfm**

If the application uses hot water heat rather than electric heat, then MODHTG FLO may be set lower than the default value of 300. This allows reheating to occur even if the box is operating below its designated minimum flow setting.

In the open loop mode, the measured airflow is always 0. To re-enable heating, the MODHTG FLO value must be set to 0. When used with an electric reheat, the 0 should be set only after a thorough safety review that shows the electric heating mechanism has sufficient internal safeguards (that is, resettable shutoffs) that would operate if the system actually did have insufficient flow.

Using fpm flow rather than cfm makes the feature less dependent on duct size.

There is hysteresis (deadband) around the flow threshold. The heating turns off below a flow of MODHTG FLO, and does not turn back on until the measured flow rises to a level of 50 fpm more than MODHTG FLO. Between MODHTG FLO and MODHTG FLO + 50, the internal point “ok_to_mod” will not change value.

Room Temperature and Setpoint

The application uses the CTL STPT as the setpoint for the Room Temperature PID Loop. When CTL STPT is not overridden and not being controlled by a field panel, then ROOM STPT and CTL STPT are related to each other as follows:

- If ROOM STPT is greater than RM STPT MAX, then CTL STPT is set equal to RM STPT MAX.
- If ROOM STPT is less than RM STPT MIN, then CTL STPT is set equal to RM STPT MIN.
- If ROOM STPT is less than or equal to RM STPT MAX and greater than or equal to RM STPT MIN, then CTL STPT is set equal to ROOM STPT.

If CTL STPT is overridden or being controlled by a field panel, then RM STPT MIN and/or RM STPT MAX have no effect on CTL STPT.

The application also uses CTL TEMP as the temperature input for the Room Temperature PID Loop. When CTL TEMP is not overridden, then:

CTL TEMP = ROOM TEMP + TEMP OFFSET.

Room Temperature Offset

NOTE:
The Room Temperature Offset feature is optional.

TEMP OFFSET is a user-adjustable offset that will compensate for deviations between the value of ROOM TEMP and the actual room temperature. This corrected value is displayed in CTL TEMP.

CTL TEMP = ROOM TEMP + TEMP OFFSET

Example

If the actual room temperature is 72.0°F, and the value of ROOM TEMP is 73.0°F, then the value entered into TEMP OFFSET is **-1.0**. In this case, the value of ROOM TEMP would read 73.0°F, but the value of CTL TEMP would read 72.0°F.

Room Unit Identification

- For Analog Room Units (Series 1000) – The revision number is visually identified by its case.
- For Digital Room Units (Series 200/2300 Firmware Revision 25 or earlier) – The revision number displays for 5 seconds when the room unit is first powered up. These room units will display `laptop` when a laptop is connected and will no longer update room temperature sensor values.
- For Digital Room Units (Series 2200/2300 Firmware Revision 26 and later) – The revision number displays for 5 seconds when the room unit is first powered up or when a laptop is disconnected. These room units will continue to display and update the room temperature sensor values when a laptop is connected.

Room Unit Operation

Sensor Select

SENSOR SEL is a configurable, enumerated point (values are additive). This point tells the controller what type of room unit is being used and how to handle loss of communication, for more information see Fail Mode Operation [→ 38]. It also provides the ability to enable the optional RH and CO2 sensors and indicates which thermistor type is connected.

Room Temperature, Setpoint, RH and CO2

- When the digital room unit (Series 2200/2300) is used, SENSOR SEL selects the source for temperature and setpoint and enables a loss of communications indication:
  - 1 = enables supervision (from the room unit) for fail communications for temperature and setpoint.
  - 2 = enables supervision (from the room unit) for fail communications for relative humidity.
  - 4 = enables supervision (from the room unit) for fail communications for CO2.
- When the analog room unit (Series 1000/2000) is used, SENSOR SEL values for temperature/setpoint, relative humidity and CO2 should be left at their default values (0).

Thermistor Inputs

- Default for input is 10K.
- To enable 100K Ω thermistor on input, see the following table for additive values.

SENSOR SEL Value *	Description
0	Analog Room Unit, 10K
1	Select Digital Room Unit (for temperature sensing and setpoint dial), 10K
2	Relative Humidity (RH) sensing, 10K
3	Digital Room Unit, RH, 10K
4	CO_2 sensing, 10K
5	Digital Room Unit, CO2, 10K
7	Digital Room Unit, RH, CO2, 10K
8	Analog Room Unit, 100K
9	Digital Room Unit, 100K
11	Digital Room Unit, RH, 100K
13	Digital Room Unit, CO2, 100K
15	Digital Room Unit, RH, CO2, 100k
16	(Not used)

Example 1: Digital Room Unit with temperature, RH, CO2 and 10K thermistor. 1+2+4+0 = 7

Example 2: Analog Room unit with 100K thermistor. 0+0+0+8 = 8

Room CO2

RM CO2 displays the CO_2 value in units of parts-per-million (PPM). RM CO2 (from the digital 2200/2300 room units) can be used with PPCL in the PTEC/ATEC controller or unbundled for control or monitoring purposes.

Room RH

RM RH displays the relative humidity value in percent. RM RH can be used for PPCL in the PTEC or unbundled for control or monitoring purposes.

RM RH displays the relative humidity value in percent.

Temperature Control Loops

Room Temperature Loop

The room temperature loop operates in both heating and cooling modes. This loop reads the room temperature control point, CTL TEMP, and then controls the room temperature to the value of CTL STPT by generating TEMP LOOPOUT. TEMP LOOPOUT is then used in the BTU calculations in order to determine the value of the DISCH STPT and, during VAV operation, to determine the value of TEMP CTL VOL. See *BTU Calculations – VAV Mode* and *BTU Calculations – Constant Volume Mode*.

Supply Temperature Loop

The supply temperature loop is a heating loop which operates at all times. The heating loop generates the point VALVE CMD which drives the heating valve in order to maintain the discharge temperature set in DISCH STPT. See *BTU Calculations – VAV Mode* and *BTU Calculations – Constant Volume Mode*.

BTU Calculations

NOTE:
BTU Compensation vs. Room Temperature Sensor (RTS) Control – In applications that do not include BTU Compensation, the heating loop modulates the heating valve directly using RTS control.

In applications that do include BTU Compensation, the heating valve is controlled indirectly in that the BTU Compensator raises or lowers the discharge air temperature setpoint based on the temperature requirements of the room and supply/exhaust airflow quantities, followed by the modulation of the heating valve to meet the discharge setpoint. Although this may seem a slower and more involved method of temperature control, it can actually provide faster and more accurate response because it is a feedforward system instead of a feedback system. With BTU Compensation, some temperature error can be anticipated and corrected in advance.

BTU Calculations – VAV Mode

During VAV operation, the controller adjusts the supply airflow and the supply air temperature setpoint as necessary to maintain CTL TEMP at CTL STPT. The room temperature PID loop calculates the value of TEMP LOOPOUT. The Figure Temperature Control Sequence [→ 33] shows how this value is used to sequence the cooling flow and the supply air temperature setpoint. The loop is tuned by adjusting the values of the feedback gain points that are visible in the database (ROOM P GAIN; ROOM I GAIN), and the sample interval point, LOOP TIME.

The output of the room temperature loop, TEMP LOOPOUT, reflects the load requirements. The value of TEMP LOOPOUT is a supply air temperature expressed as “degrees above or below the room temperature setpoint if the supply flow is at 100%”. If the supply flow is less than 100% of the currently active air supply airflow maximum, DISCH STPT is adjusted to an amount greater than TEMP LOOPOUT by a corresponding percentage.

Example

CTL STPT = 70°F: OCC.UNOCC = OCC

If TEMP LOOPOUT =	and SUP AIR VOL =	then DISCH STPT =	Formula for DISCH STPT: CTL STPT + (TEMP LOOPOUT x 100% ÷ SUP AIR VOL)
10°F	OCC SUP MAX	80°F	70° + (10° x 100% ÷ 100%)
10°F	0.5 ´ OCC SUP MAX	90°F	70° + (10° x 100% ÷ 50%)
–5°F	0.25 ´ OCC SUP MAX	50°F	70° + (–5° x 100% ÷ 25%)
0°F	any flow	70°F	70° + (0° x 100% ÷ x%)

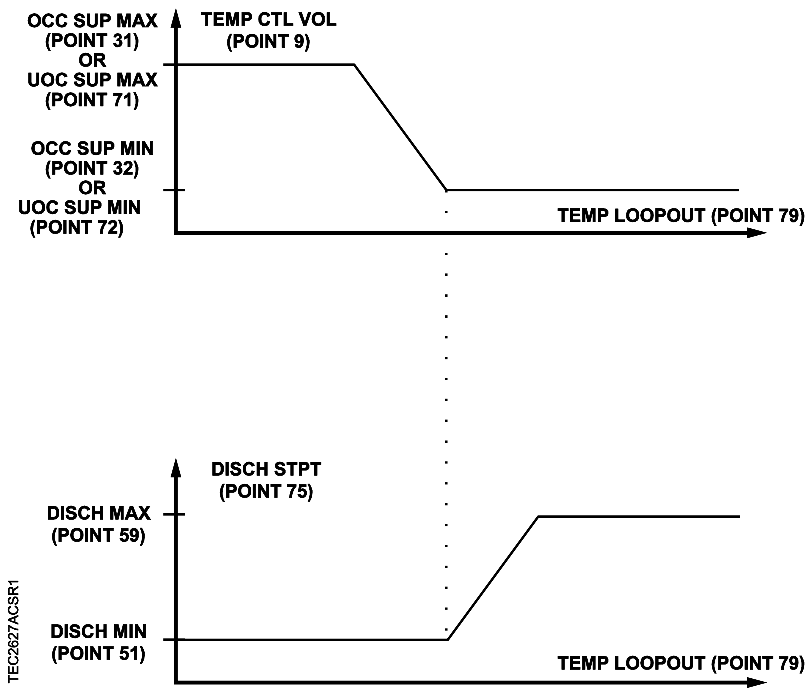
CTL STPT = 70°F: OCC.UNOCC = UNOCC

If TEMP LOOPOUT =	and SUP AIR VOL =	then DISCH STPT =	Formula for DISCH STPT: CTL STPT + (TEMP LOOPOUT x 100% ÷ SUP AIR VOL)
10°F	UOC SUP MAX	80°F	70° + (10° x 100% ÷ 100%)
10°F	0.5 ´ UOC SUP MAX	90°F	70° + (10° x 100% ÷ 50%)
–5°F	0.25 ´ UOC SUP MAX	50°F	70° + (–5° x 100% ÷ 25%)
0°F	any flow	70°F	70° + (0° x 100% ÷ x%)

While the actual number of BTUs is not explicitly calculated, DISCH STPT varies as the supply flow varies in order to maintain a constant quantity of heat entering the room.

This module also limits TEMP LOOPOUT to values that generate supply air temperature setpoints that are less than DISCH MAX.

As the demand for heating decreases (TEMP LOOPOUT drops), DISCH STPT eventually reaches DISCH MIN. If TEMP LOOPOUT drops further, then the value of TEMP CTL VOL begins to rise from the currently active supply airflow minimum to the currently active supply airflow maximum to provide more cool air to the space. If this value is compatible with correct room pressurization, then it is used as the supply flow setpoint, SUP FLOW STPT. If not, the actual setpoint may be higher or lower than TEMP CTL VOL.



Temperature Control Sequence.

BTU Calculations – Constant Volume Mode

During the Constant Volume Mode, the BTU Compensator operates as follows:

During Constant Volume operation, the controller adjusts the supply air temperature set point as necessary to maintain CTL TEMP at CTL STPT. The room temperature PID loop calculates the value of TEMP LOOPOUT. This value is used to adjust the value of the supply air temperature set point. The loop is tuned by adjusting the values of the feedback gain points, ROOM P GAIN and ROOM I GAIN and the sample interval point, LOOP TIME.

The output of the room temperature loop, TEMP LOOPOUT, reflects the load requirements. The value of TEMP LOOPOUT is a supply air temperature expressed as “degrees above or below the room temperature set point if the supply flow is at 100%”. If the supply flow is less than 100% of the currently active air supply airflow maximum, DISCH STPT is adjusted to an amount greater than TEMP LOOPOUT by a corresponding percentage.

Example

CTL STPT = 70°F: OCC.UNOCC = OCC

If TEMP LOOPOUT =	and SUP AIR VOL =	then DISCH STPT =	Formula for DISCH STPT: CTL STPT + (TEMP LOOPOUT x 100% ÷ SUP AIR VOL)
10°F	OCC SUP MAX	80°F	70° + (10° x 100% ÷ 100%)
10°F	0.5 ´ OCC SUP MAX	90°F	70° + (10° x 100% ÷ 50%)
–5°F	0.25 ´ OCC SUP MAX	50°F	70° + (–5° x 100% ÷ 25%)
0°F	any flow	70°F	70° + (0° x 100% ÷ x%)

CTL STPT = 70°F: OCC.UNOCC = UNOCC

If TEMP LOOPOUT =	and SUP AIR VOL =	then DISCH STPT =	Formula for DISCH STPT: CTL STPT + (TEMP LOOPOUT x 100% ÷ SUP AIR VOL)
10°F	UOC SUP MAX	80°F	70° + (10° x 100% ÷ 100%)
10°F	0.5 ´ UOC SUP MAX	90°F	70° + (10° x 100% ÷ 50%)
–5°F	0.25 ´ UOC SUP MAX	50°F	70° + (–5° x 100% ÷ 25%)
0°F	any flow	70°F	70° + (0° x 100% ÷ x%)

While the actual number of BTUs is not explicitly calculated, DISCH STPT varies as the supply flow varies in order to maintain a constant quantity of heat entering the room. (An example of when the supply flow can vary during CV mode is when it varies in order to maintain proper room pressurization when the fume hood sash position changes.)

This module also limits TEMP LOOPOUT to values that generate supply air temperature set points that are less than DISCH MAX and greater than DISCH MIN.

Alarms

The controller is equipped with ventilation and pressurization alarms. It does not contain temperature alarms. The controller’s alarms are designed to:

- Inform room occupants of hazards.
- Inform building operation personnel that the system is not functioning correctly.
- Supply data for documenting laboratory safety records through trending.

These alarms can be annunciated locally and/or broadcast across a network.

Ventilation Alarm

The alarm level depends on whether the room is occupied or vacant. When the OCC.UNOCC point indicates occupancy, the OC V ALM LVL is used. When the OCC.UNOCC point indicates vacancy, the UC V ALM LVL is used.

NOTE:
In the following discussion, the currently active supply flow minimum is OCC SUP MIN during occupancy and UOC SUP MIN during the unoccupied period. Likewise, the currently active general exhaust box minimum is OCC GEX MIN during occupancy and UOC GEX MIN during the unoccupied period.

The ventilation alarm, VENT ALM, indicates that there is something wrong with the ventilation to the room. VENT ALM has an adjustable alarm level that can vary with the occupancy status of the room. An adjustable delay timer, VENT ALM DEL, prevents nuisance alarms.

VENT ALM is turned on when at least one of the following conditions is true:

- The supply flow to the room, TOTL SUPPLY, stays below the alarm level, for a time at least equal to VENT ALM DEL.
- SUP AIR VOL stays below the currently active supply minimum, for a time at least equal to VENT ALM DEL.

- GEX AIR VOL stays below the currently active general exhaust box minimum, for a time at least equal to VENT ALM DEL.

It is turned off only when all of the following conditions are true:

- The TOTL SUPPLY stays above the alarm level, for a time at least equal to the alarm delay.
- SUP AIR VOL stays above the currently active supply minimum, for a time at least equal to VENT ALM DEL.
- GEX AIR VOL stays above the currently active general exhaust box minimum, for a time at least equal to VENT ALM DEL.

If the current conditions will neither turn on the ventilation alarm nor shut off the alarm, then VENT ALM will keep its current value.

Setting the alarm level to zero means the ventilation alarm will not turn on just because of a low value for TOTL SUPPLY.

Even if the alarm level is set to zero, the ventilation alarm will still turn on if:

- SUP AIR VOL stays below the currently active supply minimum, for a time at least equal to VENT ALM DEL.

and/or

- GEX AIR VOL stays below the currently active general exhaust box minimum, for a time at least equal to VENT ALM DEL.

Pressurization Alarm

The pressurization alarm, VOL DIF ALM indicates that the difference between supply and exhaust flow is not what it should be, or that the controller can't calculate the flow difference, VOL DIFFRNC, because it has lost a flow signal. The Figure *Failure Mode Sequence* lists reasons why VOL DIFFRNC may fail.

The pressurization alarm point is turned on when at least one of the following conditions occurs:

- VOL DIFFRNC has a status of Failed.
- VOL DIFFRNC stays below VOL DIF STPT – DIF ALM DBD for a time at least equal to DIF ALM DEL.
- VOL DIFFRNC stays above VOL DIF STPT + DIF ALM DBD for a time at least equal to DIF ALM DEL.

WARNING

To ensure that VOL DIF ALM turns on before the pressure in the room changes sign, DIF ALM DBD must be less than the absolute value of VOL DIF STPT.

For example, if negative pressure is desired and VOL DIF STPT equals 70 cfm and DIF ALM DBD is 200 cfm, then the room could go positive by almost 130 cfm without the pressure alarm turning on. In this case, if you want the alarm to turn on before the room changes sign, then you must set DIF ALM DBD to be less than 70 cfm.

The pressurization alarm point is turned off when all of the following conditions occur:

- VOL DIFFRNC has a status of Normal.
- VOL DIFFRNC stays above VOL DIF STPT – DIF ALM DBD for a time at least equal to DIF ALM DEL.
- VOL DIFFRNC stays below VOL DIF STPT + DIF ALM DBD, for a time at least equal to DIF ALM DEL.
- DIF ALM DBD and DIF ALM DEL can be configured to prevent nuisance alarms.

Local Annunciation

ALARM ENA is an analog point whose value determines whether or not a particular alarm activates ALARM DO7.

For ALARM ENA, the terms enabled and not enabled do not mean that a particular alarm is enabled or not. It means whether or not a particular alarm will or will not activate ALARM DO7. For example, if ALARM ENA is set to **1** (Vent Alarm Enabled) and a ventilation alarm occurs, then both VENT ALM and ALARM DO7 will turn on. However, if ALARM ENA is not Vent Alarm Enabled and a ventilation alarm occurs, VENT ALM will turn on, but ALARM DO7 will not.

ALARM ENA Values.	
	ALARM ENA
0 default	No alarms are enabled.
1	Vent Alarm is enabled.
2	Alarm Switch is enabled.
4	Dif Alarm is enabled.
5	Vent Alarm and Dif Alarm are enabled.
6	Alarm Switch and Dif Alarm are enabled.
7	Vent Alarm, Alarm Switch, and Dif Alarm are all enabled.

NOTE:
If ALARM ENA is set greater than 7, it will default to 0.

ALM ENA is additive. For example, if ALM ENA equals 5, then either a ventilation or a pressurization alarm will activate ALARM DO7, but the alarm switch will not.

ALARM DO7 is used to operate a local alarm annunciation device such as a light or horn in or near the room. Inputs can be set up to annunciate alarms from any combination of the following sources:

- Pressurization alarm point, VOL DIF ALM
  (To connect VOL DIF ALM to DO 7, set ALM ENA to a value that enables the pressure alarm (4, 5, 6 or 7)).
- Ventilation alarm point, VENT ALM
  (To connect VENT ALM to DO 7, set ALM ENA to a value that enables the ventilation alarm (1, 3, 5 or 7)).
- DI connected to a switch in the room, ALM SWIT DI6
  (To connect ALM SWIT DI6 to DO 7, set ALM ENA to a value that enables the Alarm Switch (2, 3, 6 or 7)).
- Network alarm point, NET ALM CMD
  (NET ALM CMD is always enabled for local annunciation.)

ALARM DO7 turns ON if any of the enabled alarm sources indicate an alarm. ALARM DO7 cannot be overridden.

NET ALM CMD can be commanded with the workstation software or PPCL to send an alarm state from the field panel. This makes it possible to program unique alarm criteria and annunciate alarms in specific rooms.

Network Annunciation

If the LCM is connected to a field panel, alarms can be reported using the workstation software, or by using a printer that is set up in a building manager's office to receive alarms. Points in the controller must be entered in the field panel's point database (referred to as unbundling) and defined as alarmable. For example, if the room pressurization alarm (VOL DIF ALM) is unbundled in a field panel and a pressurization alarm is triggered, an alarm will be annunciated across the network.

Alarms in Open Loop Mode

When operating a Venturi valve in open loop mode, there is no sensor to measure actual flow. Instead, flow estimates are based on the current commanded valve position.

Actuator Position on Return from Power Failure

Supply Damper

On a return from power failure, the damper-command DOs (DOs1 through 2) remain OFF for 5 seconds prior to resuming control. Because of this it is recommended that the Supply Damper Motor Setup be set to Enabled (normally closed) for rooms where negative or neutral pressurization is required and Enabled and Reversed (normally open, where the actuator is retracted) for positively pressurized rooms.

Additive Values that Determine the Value of MTR SETUP			
	Not Used	Enabled	Enabled and Reversed
Motor 1 (supply damper – DO 1 and DO 2)	0	1	3

GEX Valve

On a return from power failure, the AOs remain OFF for 5 seconds prior to resuming control. Because of this it is recommended that the General Exhaust Valve be set to Normally Opened for rooms where negative or neutral pressurization is required and Normally Closed for positively pressurized rooms. Setting of the Venturi direction is via VENTURI ACT.

	VENTURI ACT
0	Exhaust Venturi Valve is Normally Closed (Direct Acting)
1 (default)	Exhaust Venturi Valve is Normally Opened (Reverse Acting)

Operation of AVS FAILMODE

AVS FAILMODE is an enumerated point that describes how the supply Damper and the general exhaust Venturi Air Valve will respond if one or both Air Velocity Sensors (AVS) fail. It can handle both positively pressurized rooms and negatively pressurized rooms.

The default value of AVS FAILMODE is **0**. This default causes both the supply and general exhaust to hold their current position when an AVS fails. Open Supply, Open Exhaust and Close Supply, Close Exhaust are not defined AVS FAILMODE states.

AVS Failure and AVS FAILMODE Table Values.	
	AVS FAILMODE
0 (default)	Hold Supply, Hold General Exhaust
1	Hold Supply, Open General Exhaust
2	Hold Supply, Close General Exhaust
3	Open Supply, Hold General Exhaust
4	Close Supply, Hold General Exhaust
5	Close Supply, Open General Exhaust
6	Open Supply, Close General Exhaust
7	VENTILATION
8	PRESSURE

AVS FAILMODE values are not additive. For example, if AVS FAILMODE equals **3**, this means to open the supply Damper and hold the general exhaust Venturi Air Valve if an AVS fails.

The first seven values of AVS FAILMODE (0 through 6) describe specific actions taken when an AVS fails. For example, if AVS FAILMODE equals **5**, then whenever an AVS fails, the supply Damper will always close and the general exhaust Venturi Air Valve will always open.

The last two values of AVS FAILMODE do not describe specific actions; that is, when an AVS fails, the supply and general exhaust will react differently depending on the circumstances.

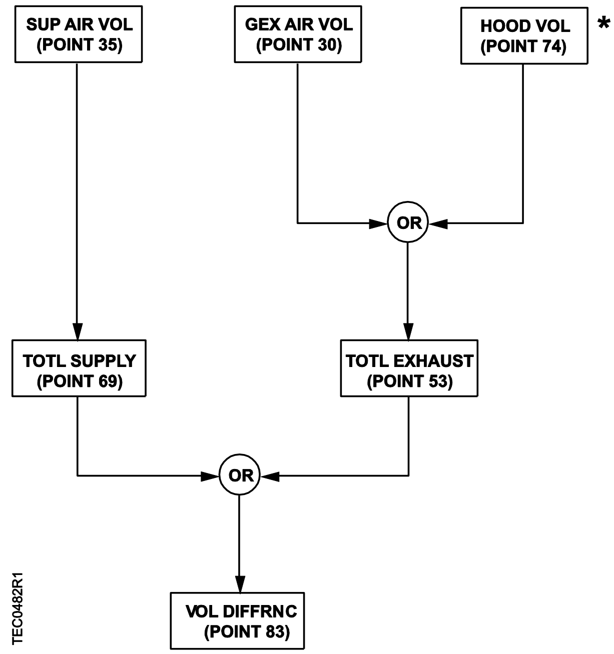
If AVS FAILMODE equals **7**, the supply Damper will hold. The general exhaust Venturi Air Valve will also hold if a fume hood is present (that is, if MAX HOOD VOL > 0). If a fume hood is absent, then the general exhaust Venturi Air Valve will close if the room is being positively pressurized and open if the room is neutral or negatively pressurized (that is if VOL DIF STPT is equal to or greater than 0).

If AVS FAILMODE equals **8**, the supply Damper will open if the room is being positively pressurized and close if the room is neutral or negatively pressurized. The general exhaust Venturi Air Valvewill hold if a fume hood is present. If a fume hood is absent, the general exhaust Venturi Air Valve will close if the room is being positively pressurized and open if the room is neutral or negatively pressurized.

NOTE:
If AVS FAILMODE is set greater than 8, it will default to 0.

Fail Mode Operation

If one of the controller's accessories (inputs) fails, a failure mode sequence is initiated that leads to the failure of VOL DIFFRNC. The following figure shows the order in which points will fail.



* If MAX HOOD VOL is set to 0, a "Failed" status of HOOD VOL will not initiate a failure in TOTL EXHAUST or VOL DIFFRNC. See *Fume Hood Flow Input*.

Air Velocity Sensors – If one or both of the LCM air sensor signals (SUP AIR VOL, GEX AIR VOL) are out of range (for example, improper wiring to/from the Offboard Air Module(s), tubing not connected or connected backward), then the actions of the supply and general exhaust Venturi Air Valves will depend on the value of AVS FAILMODE. Once GEX AIR VOL and SUP AIR VOL are normal, the supply and general exhaust Venturi Air Valves return to normal operation.

See *Operation of AVS FAILMODE* for more information.

Fume Hood Flow – If MINHOODVOLTS is 1 Volt or higher, HOOD VOL will fail when the LCM receives an invalid (less than .4 Vdc) fume hood flow signal or when the fume hood controller (FHC) loses power or when it loses its flow sensor. If HOOD VOL fails and if VOL DIF STPT is greater than or equal to 0 (negative or neutral pressurization required), the supply and exhaust loops assume a hood exhaust value of 0 cfm and continue to maintain user-defined pressurization. If HOOD VOL fails and VOL DIF STPT is less than 0 (positive pressurization required), the supply and exhaust loops assume the hood's exhaust value is equal to MAX HOOD VOL and continue to maintain user-defined pressurization. When the LCM is being used with fume hoods, and MAX HOOD VOL is set above its default of 0 cfm, a failure of HOOD VOL causes TOTL EXHAUST and VOL DIFFRNC to fail in succession. When VOL DIFFRNC fails, the pressurization alarm point, VOL DIF ALM, turns on automatically. If any of these points have been defined as alarmable and unbundled at the field panel, an alarm will be annunciated across the network.

If MINHOODVOLTS is set to a value less than 1 (including 0), the fail voltage sensing at .4 Vdc as described above is disabled. However, if there is a break (open circuit) in the wiring, both the AI 3 point and HOOD VOL point will indicate failure.

NOTE:
If desired, the LCM can be used without any fume hoods attached. In this case, MAX HOOD VOL should be set to 0 cfm to disable the alarming that would occur if the fume hood flow input drops below 1 Vdc.

Laboratory Room Controller – If the LCM power fails, all actuators default to their user-defined fail-safe states. Since there is no power to the controller, no LEDs are available.

Room Temperature Sensor – If the room temperature sensor fails while CTL TEMP is not overridden or is not being adjusted by a field panel, then ROOM TEMP and CTL TEMP both display as “Failed” and temperature control is suspended at the current value of TEMP LOOPOUT. If ROOM TEMP is unbundled in a field panel and defined as alarmable, an alarm will be annunciated across the network.

If the room temperature sensor fails while CTL TEMP is overridden or is being adjusted by a field panel, then ROOM TEMP displays as “Failed”. CTL TEMP will continue to be overridden or adjusted by the field panel and room temperature control proceeds as normal. CTL TEMP will continue to have a status of NORMAL. If ROOM TEMP is unbundled in a field panel and defined as alarmable, an alarm will be annunciated across the network.

Room Temperature Setpoint Dial – If the room temperature setpoint dial fails while CTL STPT is not overridden or is not being adjusted by a field panel, then ROOM STPT and CTL STPT both display as “Failed” and the last known good value of ROOM STPT is used to determine the current value of CTL STPT. The rest of the room temperature PID loop is unaffected by the setpoint dial failure. If ROOM STPT is unbundled in a field panel and defined as alarmable, an alarm will be annunciated across the network.

If the room temperature sensor fails while CTL STPT is overridden or is being adjusted by a field panel, then ROOM STPT displays as “Failed”. CTL STPT will continue to be overridden or adjusted by the field panel and room temperature control proceeds as normal. CTL STPT will continue to have a status of NORMAL. If ROOM STPT is unbundled in a field panel and defined as alarmable, an alarm will be annunciated across the network.

Discharge Temperature Sensor – Temperature control is lost and BTU calculations cease if the discharge temperature analog input point, DISCH TEMP fails. This is because the temperature loop stops updating and the discharge loop stops operating.

Application Notes

Supply Only - Operating Without a General Exhaust Box

This application can operate without a general exhaust box. If a general exhaust box is not being controlled, set TRACK METHOD to FLOW and set the following points:

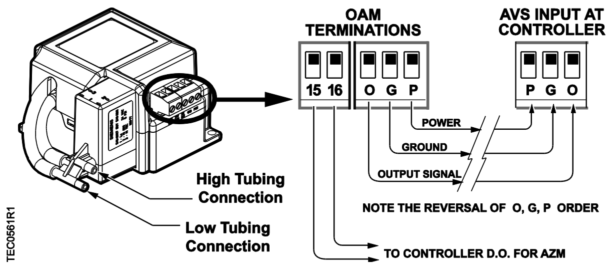
- TRACK MODE to 3.
  - Without a fume hood attached, use a value of 3 = ETS (exhaust tracks supply) Flow Tracking, should be used for both the occupied and unoccupied modes.
  - With a fume hood attached, use a value of 0 = STE (supply tracks exhaust) Flow Tracking, should be used for both the occupied and unoccupied modes.
- GEX FLO COEF to 0.
  When GEX FLO COEF equals 0, GEX AIR VOL will always read 0, but will never display as Failed.
- OCC GEX MIN and UOC GEX MIN to 0.
  If these two points are not set to 0, GEX AIR VOL— will read 0 since GEX FLO COEF was set to 0—will be less than the general exhaust box minimum, resulting in a false ventilation alarm.
- OCC GEX MAX and UOC GEX MAX left at default or a higher value.
  These two points should be set to the highest value: 1) default or 2) OCC SUP MAX / UOC SUP MAX – small values will result in the supply box not being able to reach higher flow setpoints.

The application varies the supply airflow as the fume hood flow changes, in order to maintain the proper room pressurization. The supply airflow is not varied for cooling purposes; all temperature control is done by the reheat valve.

General Exhaust Only - Operating Without a Supply Box

BTU compensation in Application 2930 will not function without supply airflow. Use Application 2924.

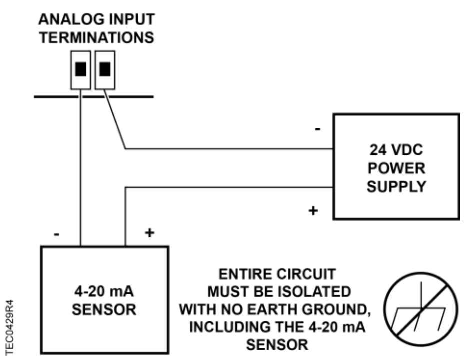
Wiring Diagrams



Offboard Air Module Wiring.

⚠	⚠ CAUTION
	The LCM-OAVS has two terminal blocks with terminations numbered identically (terminations 1 through 16). DO NOT mix these up with each other. If the LCM-OAVS is not connected as shown, it is not resistant to electrical surges. It is also susceptible to interference from other equipment.

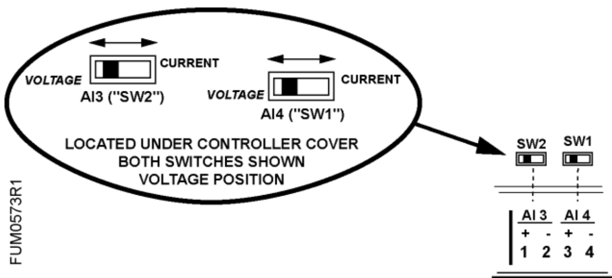
⚠	⚠ CAUTION
	A separate power supply is required if a 4-20 mA sensor is used. Failure to follow wiring precautions will result in equipment damage.



Wiring for AI with a 4 to 20 mA Sensor.

	CAUTION
	Each 4-20 mA sensor requires a SEPARATE dedicated power limited 24 Vdc power supply. DO NOT use the same transformer to power both the sensor and the controller.

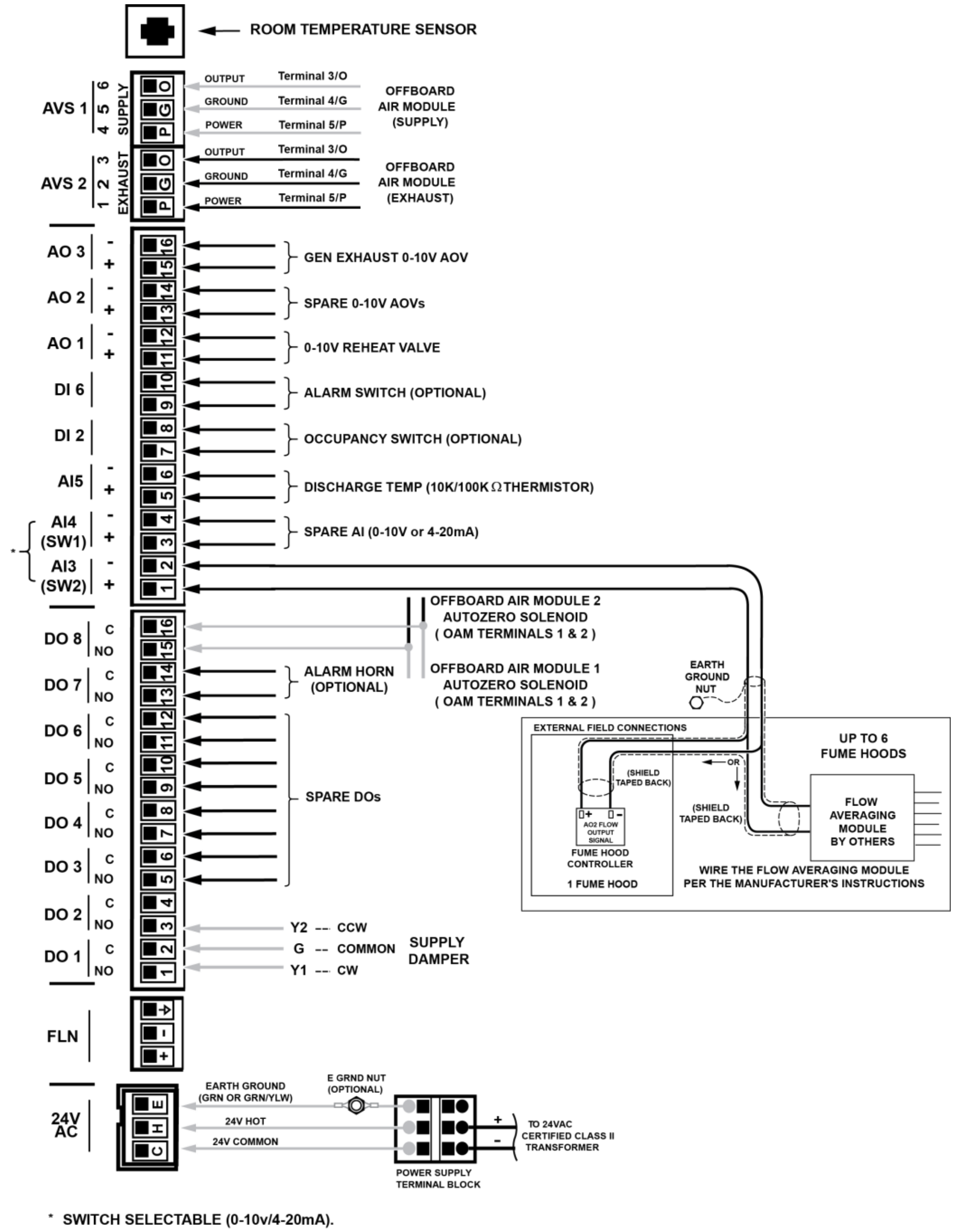
NOTE:
If the voltage/current switch is set to current and a 4 to 20 mA sensor is connected to an AI, then special wiring requirements must be followed.



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)

NOTE:
Thermistor inputs are 10K (default) or 100K software selectable (AI X).



BACnet LCM-OAVS Slow Actuation Damper Supply/Venturi Exhaust with BTU Compensation - Application 2930 Wiring Diagram.

Point Database Application 2930

Point Number	Descriptor	Factory Default (SI Units)	Eng Units (SI Units)	Slope (SI Units)	Intercept (SI Units)	On Text	Off Text
1	CTLR ADDRESS	99	--	1	0	--	--
2	APPLICATION	2997	--	1	0	--	--
3	TEMP OFFSET	0.0 (0.0)	DEG F (DEG C)	0.25 (0.14)	-31.75 (-17.78)	--	--
{04}	ROOM TEMP	74.0 (23.44888)	DEG F (DEG C)	0.25 (0.14)	48.0 (8.88888)	--	--
5	OCC DIF STPT	400 (188.7599)	CFM (LPS)	4 (1.8876)	-8000 (-3775.2)	--	--
6	UOC DIF STPT	400 (188.7599)	CFM (LPS)	4 (1.8876)	-8000 (-3775.2)	--	--
7	RM STPT MIN	55.0 (12.80888)	DEG F (DEG C)	0.25 (0.14)	48.0 (8.88888)	--	--
8	RM STPT MAX	90.0 (32.40888)	DEG F (DEG C)	0.25 (0.14)	48.0 (8.88888)	--	--
{09}	TEMP CTL VOL	0 (0.0)	CFM (LPS)	4 (1.8876)	0	--	--
{10}	TABLE FLOW	0 (0.0)	CFM (LPS)	4 (1.8876)	0	--	--
12	OCC ENA	0	--	1	0	--	--
{13}	ROOM STPT	74.0 (23.44888)	DEG F (DEG C)	0.25 (0.14)	48.0 (8.88888)	--	--
{14}	AI 4	0	PCT	0.1	0	--	--
{15}	HOOD SIG AI3	0	VOLTS	0.01	0	--	--
16	VENT ALM DEL	30	SEC	1	0	--	--
17	ALARM ENA	0	--	1	0	--	--
{19}	OCC BUTTON	OFF	--	--	--	ON	OFF
{21}	OCC.UNOCC	OCC	--	--	--	UNOCC	OCC
{22}	VOL DIF ALM	OFF	--	--	--	ON	OFF
{23}	NET ALM CMD	OFF	--	--	--	ON	OFF
{24}	OCC SWIT DI2	OFF	--	--	--	ON	OFF
{25}	BUTTON CMD	OCC	--	--	--	UNOCC	OCC
26	GEX P GAIN	0.015	--	0.001	0	--	--
{27}	ALM SWIT DI6	OFF	--	--	--	ON	OFF
28	TRACK MODE	0	--	1	0	--	--
{29}	NET OCC CMD	OCC	--	--	--	UNOCC	OCC
{30}	GEX AIR VOL	0 (0.0)	CFM (LPS)	4 (1.8876)	0	--	--
{31}	OCC SUP MAX	3400 (1604.46)	CFM (LPS)	4 (1.8876)	0	--	--

Point Number	Descriptor	Factory Default (SI Units)	Eng Units (SI Units)	Slope (SI Units)	Intercept (SI Units)	On Text	Off Text
{32}	OCC SUP MIN	340 (160.446)	CFM (LPS)	4 (1.8876)	0	--	--
{33}	OCC GEX MAX	1100 (519.09)	CFM (LPS)	4 (1.8876)	0	--	--
{34}	OCC GEX MIN	600 (283.14)	CFM (LPS)	4 (1.8876)	0	--	--
{35}	SUP AIR VOL	0 (0.0)	CFM (LPS)	4 (1.8876)	0	--	--
36	SUP FLO COEF	0.73	--	0.01	0	--	--
{37}	REHEAT AO1	0	VOLTS	0.01	0	--	--
38	DIF ALM DBD	100 (47.19)	CFM (LPS)	4 (1.8876)	0	--	--
39	DIF ALM DEL	30	SEC	1	0	--	--
40	AVS FAILMODE	0	--	1	0	--	--
{41}	DO 1	OFF	--	--	--	ON	OFF
{42}	DO 2	OFF	--	--	--	ON	OFF
{43}	DO 3	OFF	--	--	--	ON	OFF
{44}	DO 4	OFF	--	--	--	ON	OFF
45	TRACK METHOD	FLOW	--	--	--	FLOW	STPT
{46}	DO 5	OFF	--	--	--	ON	OFF
{47}	ALARM DO7	OFF	--	--	--	ON	OFF
{48}	AUTOZERO DO8	OFF	--	--	--	ON	OFF
{49}	VALVE CMD	0	PCT	0.4	0	--	--
50	GEX VLV STAT	NOTCAL	--	--	--	NOTCAL	CAL OK
51	DISCH MIN	55.0 (12.856)	DEG F (DEG C)	0.5 (0.28)	37.5 (3.056)	--	--
52	MAX HOOD VOL	0 (0.0)	CFM (LPS)	4 (1.8876)	0	--	--
{53}	TOTL EXHAUST	0 (0.0)	CFM (LPS)	4 (1.8876)	0	--	--
54	GEX FLO COEF	0.73	--	0.01	0	--	--
{55}	AO2	0	VOLTS	0.01	0	--	--
{56}	GEX DMPR AO3	0	VOLTS	0.01	0	--	--
57	VALVE CLOSED	10	VOLTS	0.01	0	--	--
58	VALVE OPEN	0	VOLTS	0.01	0	--	--
59	DISCH MAX	120.0 (49.256)	DEG F (DEG C)	0.5 (0.28)	37.5 (3.056)	--	--
60	GEXDUCT AREA	1.0 (0.09292)	SQ. FT (SQ M)	0.025 (0.002323)	0	--	--
{61}	OTHER SUP	0 (0.0)	CFM (LPS)	4 (1.8876)	0	--	--
{62}	SUP DMP CMD	0	PCT	0.4	0	--	--
63	ROOM P GAIN	2	--	0.05	0	--	--
64	ROOM I GAIN	0.001	--	0.0001	0	--	--

Point Number	Descriptor	Factory Default (SI Units)	Eng Units (SI Units)	Slope (SI Units)	Intercept (SI Units)	On Text	Off Text
{67}	UOC GEX MAX	1000 (471.9)	CFM (LPS)	4 (1.8876)	0	--	--
{68}	UOC GEX MIN	500 (235.95)	CFM (LPS)	4 (1.8876)	0	--	--
{69}	TOTL SUPPLY	0 (0.0)	CFM (LPS)	4 (1.8876)	0	--	--
70	SUP P GAIN	0.015	--	0.001	0	--	--
{71}	UOC SUP MAX	2200 (1038.18)	CFM (LPS)	4 (1.8876)	0	--	--
{72}	UOC SUP MIN	220 (103.818)	CFM (LPS)	4 (1.8876)	0	--	--
{73}	CTL STPT	74.0 (23.44888)	DEG F (DEG C)	0.25 (0.14)	48.0 (8.88888)	--	--
{74}	HOOD VOL	0 (0.0)	CFM (LPS)	4 (1.8876)	0	--	--
{75}	DISCH STPT	60.0 (15.656)	DEG F (DEG C)	0.5 (0.28)	37.5 (3.056)	--	--
76	VOLUME STATE	1	--	1	0	--	--
{77}	DO 6	OFF	--	--	--	ON	OFF
{78}	CTL TEMP	74.0 (23.44888)	DEG F (DEG C)	0.25 (0.14)	48.0 (8.88888)	--	--
{79}	TEMP LOOPOUT	0.0 (0.0)	DEG F (DEG C)	0.1 (0.0556)	-100.0 (-55.6)	--	--
80	DISCH P GAIN	2.0 (3.6)	--	0.05 (0.09)	0	--	--
81	DISCH I GAIN	0.02 (0.036)	--	0.0002 (0.00036)	0	--	--
{83}	VOL DIFFRNC	0 (-0.0001)	CFM (LPS)	4 (1.8876)	-8000 (-3775.2)	--	--
{84}	DISCH TEMP	74.0 (23.496)	DEG F (DEG C)	0.5 (0.28)	37.5 (3.056)	--	--
{85}	GEX FLO STPT	0 (0.0)	CFM (LPS)	4 (1.8876)	0	--	--
86	FAIL LIMIT	40 (18.876)	CFM (LPS)	4 (1.8876)	0	--	--
{87}	CAL GEX VLV	NO	--	--	--	YES	NO
{88}	VOL DIF STPT	400 (188.7599)	CFM (LPS)	4 (1.8876)	-8000 (-3775.2)	--	--
{89}	OTHER EXH	0 (0.0)	CFM (LPS)	4 (1.8876)	0	--	--
90	OC V ALM LVL	0 (0.0)	CFM (LPS)	4 (1.8876)	0	--	--
91	UC V ALM LVL	0 (0.0)	CFM (LPS)	4 (1.8876)	0	--	--
{92}	VENT ALM	OFF	--	--	--	ON	OFF
{93}	SUP FLO STPT	0 (0.0)	CFM (LPS)	4 (1.8876)	0	--	--
{94}	CAL AIR	NO	--	--	--	YES	NO
95	CAL SETUP	4	--	1	0	--	--
96	CAL TIMER	12	HRS	1	0	--	--

Point Number	Descriptor	Factory Default (SI Units)	Eng Units (SI Units)	Slope (SI Units)	Intercept (SI Units)	On Text	Off Text
97	SUPDUCT 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	--	--
104	SENSOR SEL	8	--	1	0	--	--
105	VENTURI ACT	1	--	1	0	--	--
106	MODHTG FLO	300 (1.524)	FPM (MPS)	1 (0.00508)	0	--	--
107	DO DIR.REV	0	--	1	0	--	--
{108}	RM RH	50	PCT	0.4	0	--	--
109	FAIL TIME	60	SEC	2	0	--	--
110	MTR SETUP	0	--	1	0	--	--
{111}	SUP DMP POS	0	PCT	0.4	0	--	--
112	MTR1 TIMING	95	SEC	1	0	--	--
113	MTR1 ROT ANG	90	--	1	0	--	--
117	MINHOODVOLTS	1	VOLTS	0.01	0	--	--
{118}	RM CO2	1000	PPM	1	0	--	--
{119}	TABLE VOLTS	0	VOLTS	0.01	0	--	--
{120}	V TABLE PT	0	--	1	0	--	--
121	HI LIMIT	1	--	0.01	0	--	--
122	LO LIMIT	1	--	0.01	0	--	--
124	G OPEN LOOP	NO	--	--	--	YES	NO
125	SUP MAX RATE	0 (0.0)	FPM (MPS)	1 (0.00508)	0	--	--
126	GEX MAX RATE	0 (0.0)	FPM (MPS)	1 (0.00508)	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.

Point Database (Slave Mode) Application 2997

Point Number	Descriptor	Factory Default (SI Units)	Eng Units (SI Units)	Slope (SI Units)	Intercept (SI Units)	On Text	Off Text
1	CTLR ADDRESS	99	--	1	0	--	--
2	APPLICATION	2997	--	1	0	--	--
3	TEMP OFFSET	0.0 (0.0)	DEG F (DEG C)	0.25 (0.14)	-31.75(-17.78)	--	--
{04}	ROOM TEMP	74.0 (23.44888)	DEG F (DEG C)	0.25 (0.14)	48.0 (8.88888)	--	--
{13}	ROOM STPT	74.0 (23.44888)	DEG F (DEG C)	0.25 (0.14)	48.0 (8.88888)	--	--
{14}	AI 4	0	PCT	0.1	0	--	--
{15}	AI 3	0	VOLTS	0.01	0	--	--
{19}	OCC BUTTON	OFF	--	--	--	ON	OFF
{21}	OCC.UNOCC	OCC	--	--	--	UNOCC	OCC
{23}	NET ALM CMD	OFF	--	--	--	ON	OFF
{24}	DI 2	OFF	--	--	--	ON	OFF
{25}	BUTTON CMD	OCC	--	--	--	UNOCC	OCC
{27}	DI 6	OFF	--	--	--	ON	OFF
{30}	AIR VOLUME 2	0 (0.0)	CFM (LPS)	4 (1.8876)	0	--	--
{35}	AIR VOLUME 1	0 (0.0)	CFM (LPS)	4 (1.8876)	0	--	--
36	FLOW COEF 1	0.73	--	0.01	0	--	--
{37}	AO1	0	VOLTS	0.01	0	--	--
{41}	DO 1	OFF	--	--	--	ON	OFF
{42}	DO 2	OFF	--	--	--	ON	OFF
{43}	DO 3	OFF	--	--	--	ON	OFF
{44}	DO 4	OFF	--	--	--	ON	OFF
{46}	DO 5	OFF	--	--	--	ON	OFF
{47}	DO 7	OFF	--	--	--	ON	OFF
{48}	DO 8	OFF	--	--	--	ON	OFF
54	FLOW COEF 2	0.73	--	0.01	0	--	--
{55}	AO2	0	VOLTS	0.01	0	--	--
{56}	AO3	0	VOLTS	0.01	0	--	--
60	DUCT AREA 2	1.0 (0.09292)	SQ. FT (SQ M)	0.025 (0.002323)	0	--	--
{77}	DO 6	OFF	--	--	--	ON	OFF
{78}	CTL TEMP	74.0 (23.44888)	DEG F (DEG C)	0.25 (0.14)	48.0 (8.88888)	--	--

Point Number	Descriptor	Factory Default (SI Units)	Eng Units (SI Units)	Slope (SI Units)	Intercept (SI Units)	On Text	Off Text
{84}	AI 5	74.0 (23.496)	DEG F (DEG C)	0.5 (0.28)	37.5(3.056)	--	--
{94}	CAL AIR	NO	--	--	--	YES	NO
95	CAL SETUP	4	--	1	0	--	--
96	CAL TIMER	12	HRS	1	0	--	--
97	DUCT AREA 1	1.0 (0.09292)	SQ. FT (SQ M)	0.025 (0.002323)	0	--	--
{99}	ERROR STATUS	0	--	1	0	--	--
104	SENSOR SEL	8	--	1	0	--	--
107	DO DIR.REV	0	--	1	0	--	--
{108}	RM RH	50	PCT	0.4	0	--	--
{118}	RM CO2	1000	PPM	1	0	--	--

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