Single Zone VAV - SZVAV

Mode Enable Sensor Options

The temperature of this sensor will determine if the unit is in heating, cooling or vent mode during occupied operation. The following options are available:

- Supply Air Temperature Sensor

Occupied Operation

There are several ways to initiate the occupied mode of operation:

- Internal week schedule
- Remote Forced Occupied contact closure
- Pushbutton Override button on a Space Sensor (Override length is user adjustable)
- Monitoring an external Orion scheduling device

Scheduling

- Has an internal clock that provides 7 day scheduling with 2 start/stops per day.
- Allows scheduling of up to 14 holiday periods per year.

Unoccupied Operation

- The space sensor uses Night Setback Setpoints for heating and cooling calls. If Night Setback Setpoints are left at the default 30°, no Night Setback operation will occur and the unit will be off.
- Uses normal dehumidification setpoint for unoccupied dehumidification calls if Night Humidity Control is configured.
- Outdoor air damper will be closed except if unit is in unoccupied economizer free cooling mode.
- If there is no call for heating, cooling or dehumidification the unit will be in the Off Mode

HVAC Modes of Operation

There are 6 possible HVAC Modes of Operation:

*Cooling
*Heating
*Ventilation
*Morning Warm-Up
*Off

Cooling Mode with Digital Scroll Compressor and Optional Fixed Capacity Scroll Compressors

- Cooling is enabled when the temperature at the Mode Enable Sensor rises one deadband above the Cooling Setpoint. Cooling is disabled when the Mode Enable temperature falls one deadband below the Cooling Setpoint. The setpoint and deadband are user adjustable.
- Under normal VAV operation (Supply Air Control), the unit is in Cooling Mode anytime it is in the Occupied Mode.
- In the cooling mode, as the Supply Air Temperature (SAT) rises above the Active Supply Air Cooling Setpoint (see Supply Air Temperature Setpoint Reset section for explanation), the Digital Compressor will stage on and modulate to control to the Active Supply Air Cooling Setpoint.
- If additional cooling is required, fixed compressor stages can be staged on while the Digital Compressor continues to modulate.
- To stage up the extra compressor(s), the SAT needs to be above the Active Supply Air Cooling Setpoint and the Digital Compressor needs to be at 100% for a period of time equal to the Stage Up Delay. Once a fixed compressor is enabled the digital compressor signal will go to 10% and modulate up as needed. This will repeat as additional fixed compressors are staged up.
- For compressors to stage on, Minimum Off Times (adj.) must be satisfied as well as Stage Up Delays (adj.).
- To stage down the extra compressor(s), the SAT needs to be below the Active Supply Air Cooling Setpoint minus the Cooling Stage Control Window and the Digital Compressor needs to be at 0% for a period of time equal to the Stage Down Delay. Once a fixed compressor stages off the digital compressor will go to 100% and modulate down as needed. This will repeat as additional fixed compressors stage off.
- For compressors to stage down, Minimum Run Times (adj.) must be satisfied as well as Stage Down Delays (adj.). The digital compressor is always the last compressor to be deactivated.
- Mechanical cooling is disabled if the outdoor air temperature (OAT) falls 1° below the Cooling Lockout Setpoint and will remain disabled until the OAT rises 1° above the Cooling Lockout

Setpoint. If the OAT disables mechanical cooling while it is currently operating, mechanical cooling will stage off as minimum run times and stage down delays are satisfied.
- If the economizer is enabled it will function as the first stage of cooling (see Economizer section).

Heating Mode:
- Available heating options are Staged Gas, Staged Electric, Modulating Gas (using MODGAS II controller with the VCM), On/Off Hot Water, Modulating Hot Water and Modulating SCR Electric.
- Heating is enabled when the temperature at the Mode Enable Sensor falls one deadband below the Heating Setpoint. Heating is disabled when the Mode Enable temperature rises one deadband above the Heating Setpoint.
- Once in the Heating Mode the unit will stage or modulate heating to maintain the Supply Air Temperature at the **Active Supply Air Heating Setpoint** (See Supply Air Temperature Setpoint Reset section for explanation).
- Multiple stages of heating can be configured subject to user adjustable minimum run times, minimum off times, staging up and staging down delays.
- Mechanical heating is disabled if the outdoor air temperature (OAT) rises 1° above the Heating Lockout Setpoint and will remain disabled until the OAT falls 1° below the Heating Lockout Setpoint. If the OAT disables mechanical heating while it is currently operating, mechanical heating will stage off as minimum run times and stage down delays are satisfied.
- This unit has dual heating capability (2 forms of heat). The following are the possible configurations for the 1st and 2nd forms of heat:
  - 1st -- Modulating SCR Electric or Modulating HW heat & 2nd -- MODGAS II (Allows fine tuning that ModGas alone cannot provide because of the 30% minimum turndown)
  - 1st -- Modulating SCR Electric or Modulating HW heat & 2nd -- Stages (Allows fine tuning)
  - 1st -- MODGAS II & 2nd -- Stages.(For supplemental heat)
- During stage up of these dual heating options the 1st form of heat (Modulating SCR Electric, Modulating HW heat or the ModGas has to be at 100% before the 2nd form can be activated. During stage down the 1st form of heat must be at 0% before the 2nd form can be de-activated.
- Modulating SCR heat and Modulating HW heat cannot be used together for dual heating.
- Modulating SCR or Modulating HW heating can be configured for 0 – 10 VDC or 2 – 10 VDC operation and also for reverse acting operation.
- If this is a PAC or DPAC unit, the Return Air Bypass Damper remains closed during heating.

Morning Warm-up Mode:
- Only available for VAV operation
- This mode occurs when the unit goes from the Unoccupied to the Occupied Mode and the return air temperature is below the Morning Warm-up Setpoint.
- In this mode the unit operates as if in the heating mode
- All the VAV boxes are driven either to full open or to a fixed CFM position
- This mode is in effect until the Return Air Temperature rises above the morning warm up target temperature or a user adjustable time period elapses.

Off Mode:
- Occurs in the Unoccupied Mode when there is no heating, cooling or dehumidification demand.
- Can only occur in the Occupied Mode if the fan is configured to cycle with heating and cooling and there is no call for heating, cooling or dehumidification.
- Supply fan is off and the outside air damper is closed.

Economizer Operation
- Enabled when Outdoor Air (OA) drybulb or wetbulb temperature falls below the Economizer Enable Setpoint by 1° and the OA temperature is at least 5° below the return air temperature (if a return air temperature sensor is being used).
- Economizer operation is disabled when the OA temperature rises 1° above the Economizer Enable Setpoint.
- Wetbulb operation requires an Outdoor Humidity Sensor.
- Economizer acts as 1st stage of cooling and controls to the Active Supply Air Cooling Setpoint. If the economizer reaches 100% and the supply air temperature is still above setpoint, mechanical cooling is allowed to stage up while the economizer is held at the full open position.
- An Economizer Minimum Position can be programmed into the controller.
- A CO2 sensor can be used to reset the Economizer Minimum Position for IAQ control.

- Economizer Damper is closed during Unoccupied Mode, except when unoccupied free cooling is used during night setback operation.

Single Zone VAV

- Hybrid CAV/VAV application where the supply fan VFD is modulated to maintain the Space Temperature Setpoint while heating or cooling is modulated to maintain the Leaving Air Setpoint.
- This sequence will only provide satisfactory performance when modulating heating and cooling are used. Staged heating and cooling will not provide stable performance.
- The Space Temperature Sensor determines the heating or cooling mode of operation. Heating and cooling are enabled and disabled as described above in the Heating and Cooling sections
- In the Cooling Mode the modulating cooling source will modulate to maintain the Cooling Leaving Air Setpoint. The supply fan VFD will begin operation at 30% and modulate between 30% and 100% as needed to maintain the space temperature within the Space Cooling Reset Window created by configuring a Space Cooling High and a Space Cooling Low Reset Source Setpoint.
- In the Heating Mode the modulating heating source will modulate to maintain the Heating Leaving Air Setpoint. The supply fan VFD will begin operation at 50% and modulate between 50% and 100% as needed to maintain the space temperature within the Space Heating Reset Window created by configuring a Space Heating High and a Space Heating Low Reset Source Setpoint.
- In the Vent Mode of operation the supply fan will operate at 30%.
- In Heat Pump Heating Mode of operation the supply fan will modulate between 75% and 100%.
- Dehumidification Mode will operate as described above in earlier Dehumidification sections. The VFD will operate as described above depending on if the space is calling for Cooling, Heating or Vent Mode operation.
- During CO2 override operation of the outdoor air damper, the supply fan will be forced to 75% and can modulate up from there as needed.

Space Sensor Operation

- Available as a Plain Sensor, Sensor with Override, Sensor with Setpoint Slide Adjust, and Sensor with Override and Setpoint Slide Adjust.
- Sensors with Setpoint Slide Adjust can be programmed to allow space setpoint adjustment of up to ± 10° F.
- The Setpoint Slide Adjust will adjust the setpoints of whichever sensor is the mode controlling sensor, even if that sensor is not installed Space Temperature Sensor.
- If Space Temperature is being used to reset the Supply Air Temperature Setpoint, then the Slide Adjust will adjust the HVAC Mode Enable setpoints and the SAT/Reset Source setpoints simultaneously.
- For MUA applications the Space Sensor can be used as a reset sensor to reset the Supply Air Setpoint based on space conditions.
- During Unoccupied hours the Override Button can be used to force the unit back into the Occupied Mode (by pressing the button for less than 3 seconds) for a user-defined override duration of up to 8.0 hours. Pressing the button between 3 and 10 seconds cancels the override.

Supply Fan Operation

- Occupied Mode – Supply fan can be configured to run continuously (default) or to cycle with heating, cooling or dehumidification.
- Unoccupied Mode – Supply fan will cycle on a call for heating, cooling or dehumidification.
- Anytime the Supply Fan is requested to start, a 1 minute minimum off timer must be satisfied. If the timer is satisfied the Supply Fan relay is activated while all other outputs are held off for a period of 1-2 minutes to purge stagnate air from the ductwork before heating or cooling occurs.
- In fan cycle mode or when going unoccupied the supply fan is held on for 2 minutes after the last stage of heating or cooling stages off.

Condenser Fan Control (Using a Condenser Head Pressure Module)

- The condenser fan is commanded on when the first compressor is enabled.
- Can monitor up to (4) head pressure transducers and control the condenser fan based on the highest of the (4) readings.
- In the Cooling Mode the speed of the condenser fan will be adjusted between 0% and 100% to maintain the desired Head Pressure Setpoint.
- In Heat Pump Heating Mode the condenser fan will operate at 100%.

- In units with (2) physically separate condenser sections, the highest reading of transducers 1 and 2 will control the fan output for the 1st section, while the highest reading of transducers 3 and 4 will control the fan of the 2nd condenser section.

Supply Air Temperature Setpoint Reset

- Various sources can be configured to reset the Supply Air Temperature (SAT) Setpoint. Since the Supply Air Temperature Setpoints are not fixed during reset, we refer to them as **"Active Supply Air Temperature Setpoints".** The following Reset Source options are available.
    - Space Temperature
    - Return Air Temperature
    - Outdoor Air Temperature
    - Remote Voltage Signal
    - Fan VFD Percentage
- For whatever option is selected, a High and a Low Reset Source Setpoint must be configured that will correspond to configured Low and High SAT Setpoints. This must be done separately for the Cooling Mode setpoints and for the Heating Mode setpoints.
- When the Reset Source is at its highest configured setpoint the SAT Setpoint will be reset to its lowest configured setpoint. When the Reset Source is at its lowest configured setpoint the SAT Setpoint will be reset to its highest configured setpoint.
- The only exception to the above rule would be if doing reset based on the Supply Fan VFD Signal Percentage during the heating mode. In that case at the High Reset Source Setpoint the supply air setpoint would be reset to the configured High SAT Setpoint, etc.
- In all cases as the Reset Source value moves within its range established by the configured High and Low Reset Setpoints, the Supply Air Setpoint will be proportionally reset within its range established by the configured Low and High SAT Setpoints.
- If Dehumidification Priority has been configured and the unit is in Cooling Dehumidification or the Heating Dehumidification Mode, the SAT reset will occur as described above.
- In the Vent Mode or the Vent Dehumidification Mode, the SAT Setpoint will be calculated to be halfway between the HVAC Mode Enable Setpoints.

Coil Suction Temperature Setpoint Reset

- During dehumidification the VCM will automatically reset the Coil Suction Temperature Setpoint within a ± 5° range based on the space or return air humidity sensor condition rising or falling with a ± 5 % range.

Airflow Monitoring

- Outdoor, Supply and Return Airflow can be monitored using specific Ebtron Airflow Stations.
- The Outdoor Air Damper can be controlled to maintain an Outdoor Air CFM Setpoint.

Proof of Flow Interlock

- This interlock prevents cooling and heating operation in the event of a fan failure.
- A Proof of Flow switch (by others) that provides a 24 VAC wet contact closure is required.

Dirty Filter Status

This input in uses a 24 VAC wet contact closure for Filter Status Indication. A differential pressure switch (by others) is required.

Duct Static Pressure Control for Filter Loading

- In order to maintain a constant CFM through the supply air ducts on MUA Unit or a mixed air CAV, PAC or DPAC Unit, a duct static pressure sensor can be used to monitor the discharge pressure.
- If the filters are getting dirty, the VCM-X will ramp up the VFD to compensate for the decrease in airflow.
- To utilize this feature the unit must be configured to use VFD fan control.
- This feature cannot be used if this is a VAV Unit with typical duct static pressure control.

Remote Forced Heating and Cooling

- These inputs (24 VAC wet contacts) allow another control system or a thermostat to force the unit into heating or cooling.
- To utilize these inputs, the heating and cooling setpoints in the VCM-X must be set to zero.

- Once in this force mode the unit will stage heating/cooling to maintain the appropriate heating/cooling leaving air setpoint until the force is removed.

Remote Forced Dehumidification

- This input (24 VAC wet contact) allows another control system or a humidistat to force the unit into dehumidification.
- To utilize this feature the humidity setpoint in the VCM-X must be set to 100%.
- Once in this force mode the unit will stage compressors to maintain the suction temperature setpoint until the force is removed.

Duct Static Pressure Control for VAV Units with VFD or CAV Units with Zoning Bypass Damper

- The VCM-X Controller will need to be configured for "VFD or Bypass Damper Control" and then will read and control Duct Static Pressure in the duct system anytime the fan is operating.
- The Duct Static Pressure Setpoint, Deadband Limits and Controlling Interval are user adjustable.
- A modulating output signal is used to control a Supply Fan VFD or a Zoning Bypass Damper.

Emergency Shutdown

- A 24 VAC wet contact input is available to be used with a N.C. Smoke Detector, Firestat, or other shutdown condition (all by others).
- If this contact opens it will initiate shutdown of the VCM-X and will generate an alarm condition. This contact closure does not produce an instantaneous shutdown.
- For instantaneous shutdown the device initiating the open condition on this contact should also be wired to cut the 24 V common to the VCM-X relay outputs.

Temperature Protection:

- Activated when the Supply Air Temperature (SAT) rises above the High Cutoff Temperature (immediate) or drops below the Low Cutoff Temperature (for 10 minutes) both of which are user adjustable. This mode shuts off the unit (with a 3 minute fan off delay) until the mode is cancelled.
- This mode is cancelled when the SAT drops 5 degrees below the High Cutoff Temperature Setpoint or rises 5 degrees above the Low Temp Cutoff Temperature Setpoint, or when the unit changes back into Occupied Operation.

Outdoor Air Lockouts

- Mechanical cooling is disabled when the Outdoor Air Temperature is below the Cooling Lockout Setpoint.
- Mechanical heating is disabled when the Outdoor Air Temperature is above the Heating Lockout Setpoint.
- For Air to Air Heat Pumps the Cooling Lockout also applies to Compressor Heating, so it will usually be a lower setting that on Cooling units that are not Air to Air Heat Pumps.

Relay Outputs

There are up to 20 output relays that that are configurable for the VCM-X controller (Relay #1 is reserved for the Supply Fan and is not configurable). The configuration options are as follows:

Cooling Stages	Reversing Valve for Heat Pump Operation
Heating Stages	Economizer (Outdoor Air Damper)*
Warm up Command for VAV Boxes	Occupied*
On/Off Hot Gas Reheat	Alarm*
Preheat	Override*
On/Off Exhaust Fan (See Bldg Pressure)	Heat Wheel (Described above)

*Relay Explanations Not Discussed Previously:

Economizer (Outdoor Air Damper) Relay

This relay will enable if any one of the following three conditions occurs:

- The unit is configured for Economizer control and the Economizer moves 5% above its Economizer Minimum Setpoint position.
- The unit is configured as a makeup air unit (MUA), with 100% outside air, and the unit goes occupied. This condition could not occur on a CAV configured unit.

- The Hood-On contact is made (See Exhaust Hood On Operation above).

Occupied, Alarm, Override Relays

- Occupied Relay – enabled anytime the unit goes into the Occupied Mode
- Alarm Relay – enabled anytime a VCM-X alarm is active
- Override Relay – enabled anytime a space sensor pushbutton override is active

System Broadcasts

- An Outdoor Air Temperature Sensor reading and an Outdoor Air Humidity Sensor reading can be broadcast from one VCM-X controller to all other controllers on the system.

Local Loop Broadcasts

The following broadcasts can be made from a VCM-X Controller to all VAV Boxes or Zone Controllers on its loop:

- Real Time Clock information
- Supply Air Temperature
- Occupied/Unoccupied Schedule
- Main fan and heat status

Alarm Detection and Reporting

- Continuously performs self-diagnostics during normal operations to determine if any operating failures have occurred.
- These failure (alarms) can be reported to a wall mounted System Manager (requires a MiniLink Polling Device), a hand-held Modular Service Tool, the Touch Screen System Manager, or to a computer running Prism II software.
- Diagnostic LEDs on the VCM-X controller will generate “blink codes” for certain alarm conditions.

The following are the available alarm designations for the VCM-X Controller:

No Supply Sensor	Dirty Filter Alarm
Bad outdoor Air Temp	Emergency Shutdown Alarm
Space Sensor Failure	Low Supply Air Alarm
Mechanical Cooling Failure	High Supply Air Alarm
Mechanical Heating Failure	Low Control Temp Alarm
Fan Proving Alarm	High Control Temp Alarm

Trend Logging

- Continuously maintains an Internal Trend Log in memory on the controller which records a fixed set of values at a user-defined interval.
- 120 log positions (timed retrievals) are available on the controller.
- Once these positions are full, it begins overwriting the oldest data.
- Values can be retrieved using the Prism II graphical front-end software program.
- With Prism running continuously, values can be saved to the computer hard drive at regular intervals to keep from losing data.

The following are the fixed items that can be logged:

Date	Indoor Air Humidity
Time	Duct Static Pressure
Mode	Building Static Pressure
Return Air Temperature	Economizer Signal Percentage
Outdoor Air Temperature	Supply Fan VFD/Bypass Damper Signal Percentage
Supply Air Temperature	Exhaust Fan VFD/Exhaust Damper Signal Percentage
Active Supply Air Setpoint	Modulating Heat Signal Percentage
Coil Suction Temperature	Modulating Cool Signal Percentage
Outdoor Air Dewpoint	On Board Relay Status
Space Temperature	Expansion Board Relay Status
Head Pressure	Condenser Fan Signal Percentage
Outdoor Air CFM	Return Air or Space CO2
Supply Air CFM	ModGas Module Signal Percentage
	Modulating Hot Gas Reheat Module Signal Percentage

VCM-X Controller and Expansion Boards I/O Map

I/O Map

VCM-X Controller			
	Analog Inputs	Analog Outputs	Relays
1	Space temperature	Economizer	Supply Fan
2	Supply Temperature	Supply Fan VFD	Configurable
3	Return Temperature		Configurable
4	Outdoor Temperature		Configurable
5	Coil Temperature		Configurable
6	Static Pressure		
7	Space Sensor Slide Offset or Remote BAS Reset of SAT Setpoint		
VCM-X Expansion Module			
	Analog Inputs	Analog Outputs	Binary Inputs
1	Outdoor Humidity	Building Pressure VFD	Emergency Shutdown
2	Space/RA Humidity	Modulating Heating	Dirty Filter
3	Not Used	Modulating Cooling	Proof of Flow
4	Building Pressure	Return Air Damper	Remote Forced Occupied
5		Return Air Bypass Damper	Remote Forced Heating
6			Remote Forced Cooling
7			Exhaust Hood On
8			Remote Forced Dehum.
4 Binary Input Expansion Module			
	Binary Inputs		
1	Emergency Shutdown		
2	Dirty Filter		
3	Proof of Flow		
4	Remote Forced Occupied		
12 Relay Output Expansion Module			
	Relay Outputs		
1-12	Configurable		