SINGLE ZONE VARIABLE AIR VOLUME SEQUENCE (WATTMASTER CONTROLS)

Mode Enable Sensor
- In a standard VAV application the Supply Air Temperature (SAT) sensor is configured as the Mode Enable Sensor during the Occupied Mode.
- In this configuration, upon entering the Occupied Mode (after a Morning Warm-Up cycle) the unit operates in the Cooling Mode and controls to the SAT Cooling Setpoint.

Occupied Operation
There are several ways to initiate the Occupied mode of operation for the VCM-X:
- 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 7 day schedule with 2 start/stops per day.
- Allows scheduling of up to 14 holiday periods per year.

HVAC Modes of Operation
In a standard VAV configuration there are 6 possible HVAC Modes of Operation:
- Cooling
- Cooling with Supply Air Tempering Heating
- Morning Warm-Up
- Heating (Night Setback Heating)
- Dehumidification
- Off

Cooling Mode with Digital Scroll Compressor:
- 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 50% and modulate 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 30% 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).

Cooling Mode with Supply Air Tempering Heating
- Applicable for VAV units being used in cold climates where very cold outdoor air being introduced into the unit prevents it from maintaining the Supply Air Temperature (SAT) at the SAT Cooling Setpoint. When this happens the VAV Box heat may not be able to adequately heat the colder supply air.
- In this configuration, unit heat is allowed to operate if the following conditions are met:
  - The Outdoor Air Temperature must fall below the Low Ambient Protection Setpoint (which must be below the Compressor Lockout Setpoint)
  - The SAT must fall below a special SAT Heating Setpoint (used only in this sequence) that is hard-coded to be 2° below the SAT Cooling Setpoint.
  - The economizer must be at its minimum position.
  - The supply fan VFD must be operating above the Heating Minimum VFD Setpoint.
- If these conditions are met unit heat will activate and operate to maintain the SAT at the special 2° offset Heating Setpoint.
- If a stage of heat or ModGas at its minimum turndown position overshoots this Heating Setpoint, the outdoor air damper will be allowed to modulate open to bring the SAT back down. There is a Maximum Heat Economizer Setpoint (adj.) that will limit the amount the outdoor air damper can open during this operation.
- If, after the Heat Stage Minimum Run Time has been satisfied, the economizer has not been able to bring the SAT down within the Heat Control Staging Window, the controller will stage down/off the heat.

Heating Mode:
- For normal VAV applications the Heating Mode can be initiated during Morning Warm-Up or Night Setback Heating. Heating can also be used in the special Supply Air Tempering Heating sequence (described above in that section). For other VAV configurations requiring unit heat, consult factory.
- Modulating SCR electric shall be provided.
- Multiple stages of heating can be configured subject to user adjustable minimum run times, minimum off times, staging up and staging down delays.
- 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).
- 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.

Dehumidification Mode with Digital Scroll:
- Dehumidification is enabled based on an Indoor Humidity Setpoint and requires a Space or Return Air Humidity Sensor.
- Dehumidification shall be selected as a priority mode to operate since the unit is always in the Cooling Mode during Occupied operation.
- Once in dehumidification, the unit will maintain the Evaporator Coil Suction Temperature at the Coil Suction Temperature Setpoint by modulating the Digital Compressor.
- A Coil Suction Pressure Sensor shall be factory installed.
- Dehumidification Reheat is always controlled to the appropriate Active Supply Air Temperature Setpoint which will be dependent on whether you are in Heating Dehumidification or Cooling Dehumidification.
- Reheat shall be modulating.
- Heating may also be used to supplement hot gas reheat if necessary. In this case, SCR Electric used.

Off Mode
- Occurs in the Unoccupied Mode when no heating, cooling or dehumidification demands exist.
- Supply fan is off and the outside air damper is closed.

Economizer Operation
- Available when outdoor air (OA) drybulb or wetbulb temperature is below the Economizer Enable Setpoint by 1° and the OA temperature is at least 5° below the return air temperature.
- 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.
- Closed during Unoccupied Mode, except when Unoccupied free cooling is required.
- A CO2 override of the Economizer can be configured (see next section).

Supply Fan Operation
- Occupied Mode - Supply fan will run continuously.
- 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.
- In a VAV application, anytime the Supply Fan is running, the VCM-X is controlling the speed of the VFD to maintain the Duct Static Pressure Setpoint.

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.

Coil Suction Temperature Setpoint Reset
During dehumidification the VCM-X will automatically reset the **Coil Suction Temperature Setpoint** within a ± 5° range based on the space or return air humidity sensor condition changing ± 5 % from the humidity setpoint.

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

Building Pressure Control
This can be used to maintain a user adjustable Building Pressure Setpoint (requires a Building Pressure Sensor). Available controlling output options are:
- A relay output for On/Off operation
- A 0-10VDC modulating output

There are 2 possible methods of control:
- **Direct Acting**, meaning that on an **increase** in building static pressure, an on/off exhaust fan can be activated or a VFD exhaust fan can be ramped up.
- **Reverse Acting,** meaning that on a **decrease** in building static pressure, the outside air damper can be modulated open. When this option is selected, no economizer free cooling or IAQ operation will be available.

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
- A 24 VAC wet contact closure on this input will create a Dirty Filter Alarm.
- A differential pressure switch (by others) is required.

Emergency Shutdown
- A 24 VAC wet contact closure is available that will initiate shutdown of the VCM-X and will generate an alarm condition. This contact closure does not produce an instantaneous shutdown.
- This contact closure can be generated from a smoke detector, fire alarm, or other device based on a condition that needs to shut the unit down.
- For instantaneous shutdown the device initiating the contact closure should also be wired to cut the 24 V common to the VCM-X relay outputs.

Remote Forced Heating and Cooling
- These inputs (24 VAC wet contacts) allow another control system 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 "1" and the mode enable sensor must be configured as Supply Air.

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%.

VAV Box Compatibility
When the VCM-X Controller is configured for VAV operation and is used in conjunction with WattMaster's Orion Controls VAV/Zone Controllers the following features are available:
- Can respond to Unoccupied overrides and Unoccupied heating and cooling calls from box controllers.
- Broadcasts the Supply Air Temperature to the boxes so they can use that information to determine Warm-Up Mode or Heating/Cooling/Vent Mode of operation.

Zoning Capability
When the VCM-X Controller is configured for zoning operation (zone voting) with heating and cooling capability, and is used in conjunction with WattMaster's Orion Controls VAV/Zone Controllers the following features are available:
- Broadcasts the Supply Air Temperature to all zones on its loop so they can use that information to determine Heating/Cooling/Vent Mode of operation.
- Broadcasts the Occupied/Unoccupied Schedule, Main Fan Status and Heat Status to all zones on the loop.
- Can respond to Unoccupied overrides and Unoccupied heating and cooling calls from zone controllers.
- Requires a MiniLink Polling Device to be installed on each zoned loop to calculate the heating and cooling requirements for the unit based on voting information received from each zone.
- The MiniLink Polling Device then directs the VCM Controller to provide the appropriate amount of heating, cooling and ventilation to satisfy each zone's requirements.

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 than on Cooling units that are not Air to Air Heat Pumps.

Relay Outputs
There are up to 20 output relays 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, 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, Heat Wheel (Described Above)

Economizer (Outdoor Air Damper) Relay
On a VAV unit this relay will enable if the unit is configured for Economizer control and the Economizer moves 5% above its Economizer Minimum Setpoint position.

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

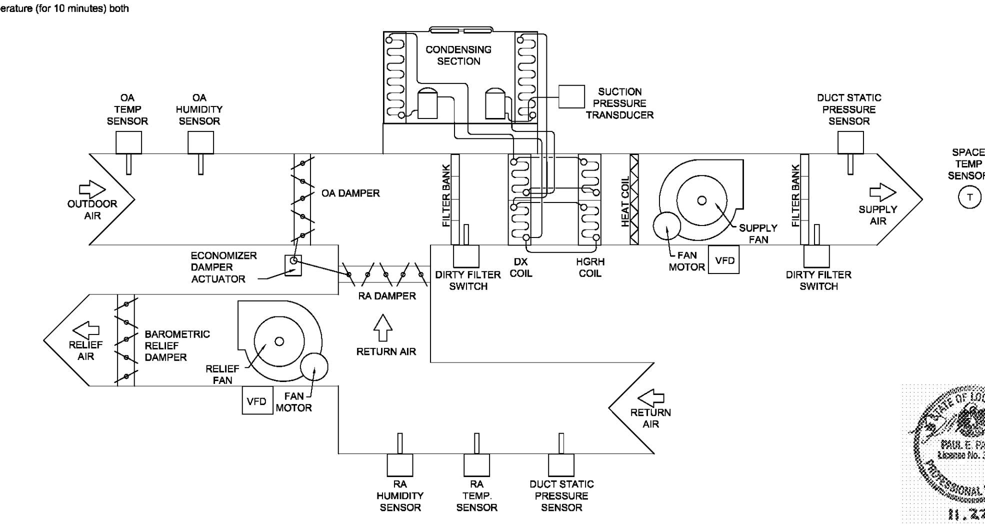
Alarm Detection and Reporting
- Continuously performs self diagnostics during normal operation to determine if any operating failures have occurred.
- Failure (alarms) shall be reported to Touch Screen System Manager.
- Diagnostic LEDs on the VCM controller will generate "blink codes" for certain alarm conditions.

The following alarms shall be reported:

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 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, Supply Air CFM, ModGas Module Signal Percentage, Modulating Hot Gas Reheat Module Signal Percentage



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MECHANICAL CONTROLS