Verasys System Operation Overview Technical Bulletin

Johnson Controls
www.johnsoncontrols.com
2019-06-14

LIT-12012370

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Introduction

This document provides an overview of the Verasys® System types, system components, and the supported features and operating modes particular to each system. This document does not describe how to set operating modes and related parameters, how to set up your Verasys network, or how to troubleshoot the system. For information on these topics, refer to the *Verasys User's Guide (LIT-12012371)*.

The Verasys System supports HVAC applications through three types of systems: VAV, change over bypass (COBP), and constant volume (CV). Verasys also enables the creation of a fourth option by combining the functions of a COBP and VAV system.

This document addresses each system within its primary behavior as a zoning system or single-zone (constant volume) system.

ⓘ **Note:** Verasys parameters in this document are indicated in bold as they appear in the Verasys Smart Building Hub (SBH) or Verasys Zone Coordinator. For example, the minimum position set for the economizer is referred to as **Economizer Min Position**.

Related documentation

Table 1 includes documentation related to Verasys System operation.

Table 1: Commercial Comfort System Operation Related Documentation

For Information On	See Document	LIT Number
Features, Benefits, and Applications of the Verasys System	*Verasys® System Product Bulletin*	*LIT-12012342*
Configuring Settings and Parameters within the Verasys System	*Verasys® System User's Guide*	*LIT-12012371*
Configuring your Smart Building Hub settings	*Smart Building Hub Network and IT Guidance Technical Bulletin*	*LIT-1202324*

Zoning systems

VAV system components and operating modes

The VAV system consists of several components, which include the following:

- VAV Box Controllers
- Verasys Zone Coordinator (VZC)
- Rooftop unit (RTU), heat pump, or split system equipment with SMART Equipment controls
- Verasys Equipment Controller (VEC)

The system uses either the VEC or the RTU, heat pump, or split system equipment with SMART Equipment controls. The VEC controller communicates with non-smart equipment RTUs on a VAV System. The VEC controller communicates in a similar manner to a thermostat controller. Therefore, the unit must have a thermostat interface for the controller to control. The controller also has outputs to directly control the variable frequency drive (VFD) of the unit.

The following sections provide a description of VAV system behavior in the various operating modes.

Occupied mode

RTU

In occupied mode, the RTU controls and adjusts the supply air temperature (SAT) to meet the SAT setpoint. The supply fan controls and adjusts the duct static pressure (SP) to meet the current duct SP setpoint.

The Verasys system supports an RTU-based occupied heating operation, in which the individual zones use their local heating first. The zone controllers use local heating if they are equipped with local supplemental or box heating.

VAV box

The zone controller uses hot water or electric box heat to maintain the zone temperature value within the cooling and heating setpoints. The zone controller does this with the VAV box. If the VAV box uses hot water heat, the building must provide hot water. If the VAV box uses electric box heat, the system initiates a user-set flow-based heating lockout according to the flow (Staged Reheat Min Flow). For example, if the user-set heating lockout flow is set to 200 cfm, the staged electric heating does not turn on if the flow drops below this value. When the zone temperature is above the cooling setpoint, the zone controller uses a pressure-independent strategy, or cascaded flow loop to adjust the zone temperature. When this strategy is used, the VAV box adjusts the supply flow to meet a flow setpoint. The zone temperature resets the flow setpoint. When the zone temperature drops below the occupied heating setpoint, the zone controller adjusts to meet the setpoint. This occurs when the zone damper is equipped with local supplemental or box reheat. Stage the optional box reheat or supplemental heating as needed to accomplish the zone temperature control. Supplemental heat is used before box reheat when both are present, unless the dual maximum strategy is used. The zone damper adjusts the supply flow to the occupied cooling minimum flow, when the zone controller uses supplemental heat. If the box heat is on, or if both box reheat and supplemental heat are on, the zone damper adjusts the supply flow to the occupied heating minimum flow. If the zone controller is not equipped with either supplemental or box reheat, the control modulates box flow to the occupied cooling minimum flow position. VAV boxes equipped with hot water reheat and a SAT sensor, use a dual maximum control strategy. When the zone temperature drops below the heating setpoint, the flow remains at the cooling minimum flow. The zone controller then resets the SAT from the current setpoint to the maximum setpoint. When the maximum SAT setpoint is reached, the flow setpoint resets from the cooling minimum flow to a heating maximum flow. On boxes equipped with both supplemental and box reheat, supplemental heat is used after box reheat.

Standby mode

All zone controllers support an occupancy sensor. The controller can switch from occupied to standby mode due to the occupancy sensor. This occurs after a set period of time, when local activity is absent. When in standby mode, the zone controller uses standby temperature setpoints that are higher and lower than the occupied cooling and occupied heating temperature setpoints. The standby setpoints reduce the demand for heating and cooling in an unoccupied zone and save energy as a result. When VAV boxes are in standby mode, the application uses unoccupied flow setpoints in addition to standby temperature setpoints. To enable the occupancy sensor, set the **Occupancy Mode** parameter to external in the **Control Setup** screen in the **Zone View** of the SBH. Use the sensor to set the occupancy sensitivity and time delay to standby. Refer to Appendix B in the *Verasys User's Guide* for more information on each parameter.

VAV occupied heating

Make sure the control is in occupied mode and not in morning warm-up mode. Enable the VAV occupied heating feature. If the return air temperature drops below the VAV occupied heating setpoint, all cooling stages de-energize after all compressor minimum run times have expired. After the two minute cool to heat changeover delay has expired, all heat stages energize with approximately 30 seconds of delay between stages. Heat remains energized until the return air temperature exceeds the VAV occupied heating setpoint.

Morning warm-up

The morning warm-up feature runs during the first hour of occupied operation. The system enters cooling mode at the end of the hour and the SAT adjusts to meet the SAT setpoint. Morning warm-up functionality is available on RTUs with SMART Equipment controllers.

RTU

Enable the morning warm-up feature so that the RTU can use the morning warm-up strategy. Before energizing heat for morning warm-up, the system runs the fan for five minutes, then determines if morning warm-up is needed based on the Return Air Temperature (RAT).

If the RAT indicates that morning warm-up is required for the zone, the system operates all stages of heating simultaneously at the RTU. If the morning warm-up RAT setpoint is met before the one hour morning warm-up period ends, the system waits until the one hour time period expires before entering the occupied cooling mode. The system continues to operate the fan and monitor the RAT until the scheduled occupied period begins. The system may re-enter the heating mode if the RAT drops two degrees below the morning warm-up RAT setpoint. If the scheduled occupied period does not meet the morning warm-up RAT setpoint, the system enters occupied cooling mode. The economizer remains closed until the occupied period begins.

During the morning warm-up operation, the supply fan adjusts the duct static pressure to meet the current setpoint of the duct static pressure.

VAV box

During morning warm-up or VAV occupied heating, the VZC passes the SAT value from the RTU controller to the zone damper controller. The zone controller compares the SAT to the zone temperature and automatically determines when the system is in morning warm-up or VAV occupied heating based on the difference. In morning warm-up mode, the zone controller adjusts the zone temperature to meet the occupied heating setpoint.To adjust the zone temperature, configure the damper to deliver the maximum primary heating, such as control damper to cooling maximum flow, and stage the optional box or supplemental heating as needed. Supplemental heat is used before box heat if both heating strategies are present. In the zones that do not require heating control the supply flow to the warm-up minimum flow. For example, if the zone temperature is higher than the occupied heating setpoint.

Unoccupied mode

The system monitors calls for unoccupied heating or cooling when you select a representative zone at the VZC. When the representative zone temperature drops below the unoccupied heating setpoint, or rises above the unoccupied cooling setpoint, it triggers the unoccupied call for heating or cooling. The unoccupied heating or cooling mode ends when the call is satisfied for a 30-second time period.

RTU

The RTU turns on all heating stages after a call for unoccupied heating. During the unoccupied heating operation, the supply fan adjusts the duct static pressure to meet the current setpoint for the duct static pressure. The economizer is closed.

While in unoccupied mode, the economizer is closed by default. However, during a call for cooling, the economizer provides cooling if free cooling is available. If free cooling is not available, the system requests cooling from the RTU. This adjusts the SAT to its setpoint.

The supply fan remains off when the system is unoccupied. Cooling and heating also remain off when no call for unoccupied cooling or heating is issued. The economizer closes.

VAV box

When the zone temperature of the representative zone drops below its unoccupied heating setpoint, the zone controller requests unoccupied heating and adjusts it to the **Cooling Max Flow** setpoint. Zones that do not require unoccupied heating move to their **Unoccupied Cooling Min Flow**. For example, zones with temperatures above the unoccupied heating setpoints and local

supplemental or box heat stage, adjust the zone temperature to meet the unoccupied heating setpoint. Supplemental heat is used before box heat if both heating strategies are present.

The zone controller requests unoccupied cooling and adjusts to its cooling maximum flow when the zone temperature of the representative zone rises above its unoccupied cooling setpoint. Zones that do not require unoccupied cooling move to the unoccupied cooling minimum flow. For example, zones with temperatures below the unoccupied cooling setpoint. Non-representative zones that call for cooling or heating, do not start the RTU. When heat is needed, the local fan operates when the local heat command rises above 5%.

Balancing mode

Balancing mode places the VAV system in a state where the balancing contractor determines if the system can deliver rated flow to all of the VAV boxes at full system flow. To determine this, the balancing mode places the RTU and the VAV Boxes in the proper operating modes. You can place the system into balancing mode from the **Commissioning** section of the zone coordinator on the SBH.

When the system is placed in balancer mode, the following occurs:

1. The VAV boxes command to **Cooling Max Flow**.
2. After a two minute time delay, the RTU runs the fan at full speed.
3. The heating and cooling of the RTU turns off.
4. The economizer closes.

When the system exits balancer mode, the following occurs:

1. The RTU returns to static pressure control mode.
2. After a two minute time delay, the VAV boxes are released to normal control.
3. The heating and cooling of the RTU is enabled.
4. The economizer returns to its minimum position.

ⓘ **Note:** The system automatically returns to normal operation if balancing mode is left to operate for eight hours. This automatic expiration safeguards the system from constantly running with dampers fully open if the user forgets to disable balancing mode.

VAV system strategies

SAT setpoint reset

The SAT setpoint reset helps improve control for the system zones that may have a tendency to overcool or overheat. By monitoring the operation of those zones, the system may adjust the SAT setpoint accordingly to move the zone back to its user-set occupied or unoccupied setpoints.

You can select a representative zone at the Zone Coordinator. The system monitors the status of the cooling and heating for the selected zone and determines if heating or cooling is at full capacity. If the cooling capacity of the zone is fully used, the SAT setpoint is lowered by 1°F. If the heating capacity of the zone is fully used, the SAT setpoint is raised by 1°F. The system then adjusts the SAT setpoint after 30 minutes. The SAT setpoint is gradually reset to its default value when heating or cooling is no longer at full capacity. This reset prevents the system from getting stuck at a setpoint when the representative zone is readjusted. A user-set maximum SAT setpoint adjustment parameter limits the range of adjustment. The user can disable the SAT reset strategy if desired.

Duct static pressure setpoint reset

The system automatically adjusts the duct static pressure setpoint based on the damper position of the zone that needs the most cooling. It increments or decrements the duct static pressure setpoint so that the damper position of this zone is maintained between 85% and 95% open. If the damper position rises above 95%, it increases the duct static pressure setpoint by 0.1 in. (2.54 mm) Water Column (W.C.). If the damper position drops below 85%, it decrements the duct static pressure setpoint by 0.1 in. W.C. The system waits 10 minutes between setpoint adjustments. No adjustment occurs if the damper position is between 85% and 95% open. A maximum duct static pressure setpoint adjustment parameter limits the range of adjustment (**Max Duct Static SP Adjust**). The user can disable the duct static pressure reset strategy.

VFD economizer minimum position reset

The variable frequency drive (VFD) economizer minimum position reset strategy (**VFD Econ Min Pos Reset**) adjusts the economizer minimum position proportional to the supply fan speed to maintain the outdoor ventilation rate. When the supply fan is at 0%, the economizer minimum position is set to **Economizer Damper Minimum Position Low Speed Fan**. As the supply fan increases to 100%, the economizer minimum position decreases to either the user-specified **Economizer Minimum Position Setpoint** or the DCV reset-adjusted economizer minimum position.

CO_2 DCV operation

RTU

The CO_2 demand controlled ventilation (DCV) operation improves indoor air quality in the zone by monitoring CO_2 levels. When the CO_2 level in an individual exceeds its CO_2 setpoint, the zone coordinator increases the minimum position of the economizer damper by 5% every 30 minutes. After the zone has fallen below the setpoint for 5 minutes, the coordinator decreases the economizer minimum position by 5% every 30 minutes. The economizer minimum position does not exceed the user-set maximum ventilation damper position (**Demand Ventilation Maximum Damper Position**) but returns to the user-set **Economizer Minimum Position Setpoint**. The 30-minute time period is reduced to two minutes when the **Title 24 Test Mode** parameter is set to **True**.

VAV box

When **Demand Ventilation Mode of Operation** is set to CO_2 and a CO_2 sensor is operational, the DCV minimum damper flows (**DCV Occupied Cooling Min Flow** and **DCV Occupied Heating Min Flow**) are proportionally reset based on a CO_2 setpoint and a CO_2 proportional band. The value that the damper minimum flows are reset to do not exceed the user-set minimum value (**DCV Max Flow**). DCV supports up to four CO_2 sensors. The CO_2 sensor with the highest value is used to determine the reset value. If all CO_2 sensors are unreliable, the system uses the **Occupied Cooling Min Flow and Occupied Heating Min Flow** parameter values.

Dehumidification operation

RTU

ⓘ **Note:** The VEC does not support dehumidification control.

The Verasys system supports dehumidification operation on RTUs equipped with a factory-installed Hot Gas Reheat (HGR) coil and a SMART Equipment control board.

Dehumidification is initiated when the humidity rises 5% above the dehumidification setpoint and continues until the humidity is 5% below the dehumidification setpoint. The request for dehumidification starts the fan, hot gas relay, and appropriate cooling stages based on the user-set mode.

The dehumidification sequence supports two modes: normal and alternate. In both modes, requests for dehumidification with no cooling turns on the first compressor (C1) and the HGR coil. When one stage of cooling (Y1) is requested, the mode is checked. If the mode is set to normal, the HGR coil is turned off or remains off. The request for cooling is then satisfied by the economizer, if present, or the first compressor. If the mode is alternate, the first compressor, HGR coil, and the second compressor (C2) are turned on. For both normal and alternate modes, a call for two stages of cooling (Y2) turns off the HGR and turns on the first and second compressors.

See Table 2 for a summary of the dehumidification sequence in both modes.

Table 2: Dehumidification Sequence in Normal and Alternate Modes

Request	Normal Mode			Alternate Mode		
	HGR	**C1**	**C2**	**HGR**	**C1**	**C2**
Dehumidification	On	On	Off	On	On	Off
One Stage of Cooling (Y1)	Off	On	Off	On	On	On
Two Stages of Cooling (Y2)	Off	On	On	Off	On	On

Power exhaust control

The Verasys VAV system with RTUs featuring power exhaust and a SMART Equipment controller, support three types of power exhaust: constant volume exhaust fan (EF), modulating exhaust damper, or Variable Frequency Drive (VFD) exhaust fan.

ⓘ **Note:** The VEC does not support power exhaust control.

Economizer Damper Position for Exhaust Fan to Turn On: The constant volume exhaust fan turns on when the supply fan is running and the economizer is open more than the setpoint.

Economizer Damper Position for Exhaust Fan to Turn Off: The constant volume exhaust fan turns off when the supply fan is off or when the economizer is open less than the setpoint or 10% open, whichever value is greater.

The exhaust damper modulates to maintain the static pressure setpoint for the building. When the exhaust damper opens more than the **Exhaust Damper Position for Fan to Turn On** setpoint, the power exhaust fan turns on. When the exhaust damper is open less than the **Exhaust Damper Position for Fan to Turn Off** setpoint, the power exhaust fan is turned off or 10% open, whichever is greater.

The VFD exhaust fan modulates to maintain the building static pressure setpoint. The power exhaust fan turns on when the supply fan is on. The exception is when the building static pressure is 0.02 in. (0.508 mm) W.C. or more below the setpoint and the VFD exhaust fan is at 0%. The power exhaust fan turns on again when the building static pressure is 0.02 in. (0.508 mm) W.C. or more above the setpoint.

Load shed

The Verasys system supports a centralized demand shed for user-specified zones. A predefined binary input (BI) on an input output module (IOM) is used to trigger the load shed. All zones that have load shed enabled, shift their setpoints by a user-specified amount. You can also set an adjustable rate limit which controls how quickly the setpoint changes from its current setpoint to its shed setpoint in either direction. The setpoint shift occurs during occupied and standby modes.

Shutdown

The system shuts down if one of the following is true:

- The SBH or VZC shut down the system.
- All zone controllers are offline.

- The system is shut down via BI-1 at the IOM selected from the SBH when the Emergency Shutdown BI is enabled.

When the system shuts down, the RTU turns off the heating and cooling. The supply fan is turned off and the zone dampers close. The system restarts when the above conditions are returned to normal operation.

COBP system components and operating modes

The following describes the supported features and modes for the changeover bypass (COBP) systems. The system consists of the following components:

- COBP zone damper controllers
- Bypass damper controller
- VEC
- VZC
- RTU, heat pump, or split system equipment with SMART Equipment controls

The Verasys system uses the VEC or the RTU, heat pump, or split system with SMART Equipment controls. The VEC board interfaces with non-smart equipment RTUs on a zoning system. The VEC controller communicates in the same way as an intelligent thermostat controller so the unit must have a thermostat interface.

COBP systems use a zone voting logic. The following sections provide details about this logic.

Zone voting

The VZC monitors the status of the individual zones. These zones vote for either heating or cooling based on how the current zone temperature deviates from the current zone temperature setpoint. The VZC processes the votes, determines whether the RTU should provide heating or cooling to the zones, and commands the RTU to the appropriate mode based on this decision. The VZC continues to use the appropriate zones and change the operating mode of the RTU as needed to accommodate the zone's needs.

Types of votes

The zone can send five types of votes to the VZC: Cool, Urgent Cool, Heat, Urgent Heat, and Satisfied. The following sections describe these votes.

When the zone temperature is greater than 1 degree above the Cooling setpoint but less than 2 degrees above it, a zone sends a **Cool** vote to the VZC When the zone temperature decreases to within 0.5 degrees of the cooling setpoint, the zone vote changes to **Satisfied**.

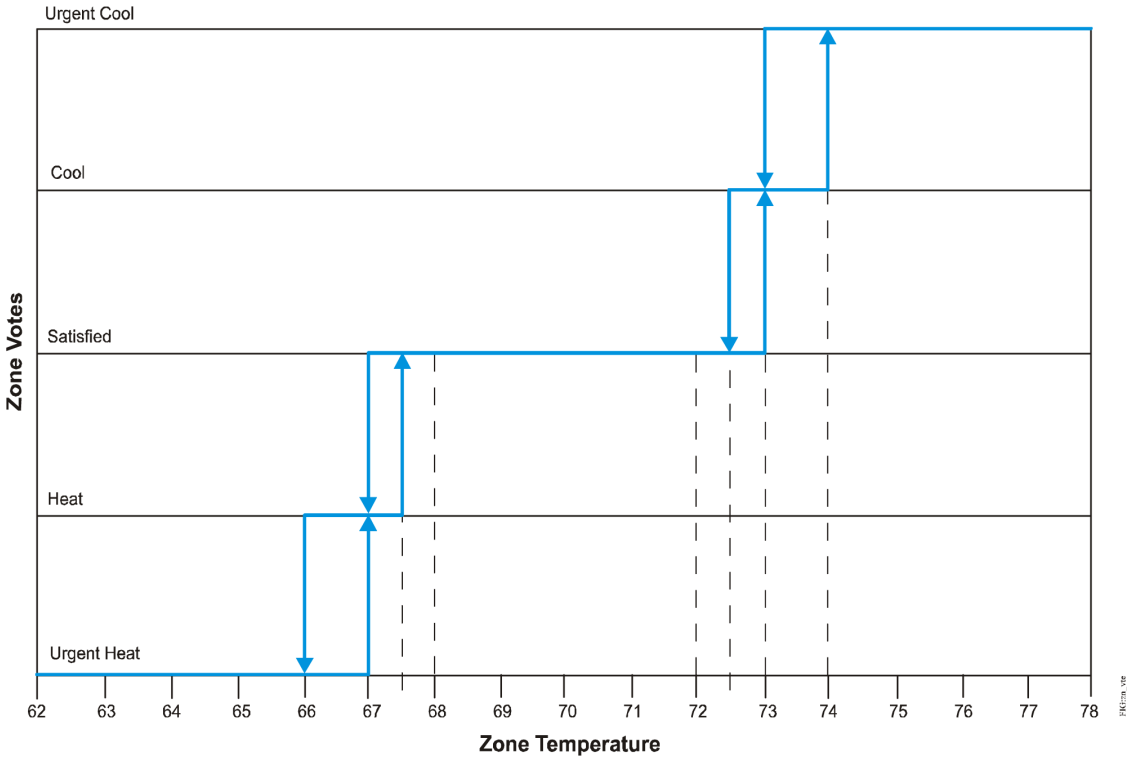
If the zone temperature is greater than 2 degrees above the cooling setpoint, the vote is **Urgent Cool**. When the zone temperature decreases to within 1 degree of the cooling setpoint, the vote returns to **Cool**.

When the zone temperature is greater than 1 degree below the heating setpoint but less than 2 degrees below it, a zone sends a vote of **Heat** to the VZC. When the zone temperature rises to within 0.5 degrees of the heating setpoint, the zone vote changes to **Satisfied**.

If the zone temperature is greater than 2 degrees below the heating setpoint, the vote is **Urgent Heat**. When the zone temperature rises to within 1 degree of the heating setpoint, the zone vote returns to **Heat**.

If the zone temperature is between the heating and cooling setpoints, the vote is **Satisfied**. See Figure 1.

Figure 1: Zone Votes



Unit status determination

The VZC uses zone votes to direct the Verasys system to use the appropriate operating mode. This system operating mode determines the COBP RTU state, the effective occupancy, and unit-enabled attributes.

The RTU can be in one of the following states:

- Idle
- SD Alarm
- Purge Command
- Self Test
- Morning Warm-Up
- Air Tempering
- Dehumidification
- Heating
- Cooling
- Economizer
- Fan Only
- Comfort Ventilation
- Startup Delay

Locate the **Unit Status Parameter** on the VZC homepage or on the **Circle of Comfort** on the RTU Homepage. This parameter displays the current state of the RTU.

All heat or all cool modes

The following are conditions that determine the RTU operating mode:

- If at least one zone vote is **Heat** and all of the other zone votes are **Satisfied**, the operating mode is **Heat**.
- If at least one zone vote is **Cool** and all of the other zone votes are **Satisfied**, the operating mode is **Cool**.
- If all of the zone votes are **Satisfied**, the COBP RTU state is determined by the system operating mode and the occupancy input. If the system is occupied, the COBP RTU state is **Fan Only**. If the system is unoccupied, the COBP RTU state is **Off**.

Changing between modes

Changeover logic

The VZC changeover logic requires the following conditions to switch the system operating mode between Heat and Cool. In all scenarios, the timer for minimum time before changeover must be expired (**Changeover Min Time**).

- The system changes from heat to cool when:
    - The number of urgent cooling requests exceeds the minimum number of urgent requests to change modes (**Min Urgent Requests to Change**) or the number of cooling requests, including urgent requests, exceeds the minimum number of requests to change modes (**Min Requests to Change**) and all heating requests have been satisfied.
- The system changes from cool to heat when:
    - The number of urgent heating requests exceeds the minimum number of urgent requests to change modes (**Min Urgent Requests to Change**) or the number of heating requests, including urgent requests, exceeds the minimum number of requests to change modes (**Min Requests to Change**) and all cooling requests have been satisfied.

The logic for cooling requests ignores one heating request when determining if all the current heating requests have been satisfied. By ignoring one heating request, the cooling request logic prevents a single zone from forcing the system to remain in heat mode when the current cooling requests exceed the minimum number of change modes. The heating request logic also ignores one cooling request for the same purpose.

Urgent requests do not require that all zones are satisfied before changing modes. The system changes modes even if requests or urgent requests of the opposite mode occur.

Changeover timer

A user-set timer (**Changeover Min Time**) prevents cycling between the heat and cool modes. The timer begins running when it enters either the heat or cool mode. When it expires, the system may change modes if the other conditions are met (see Changeover logic). The timer restarts when the mode changes.

The timer may be bypassed if no opposing votes occur. For example, if the system has one heat and two cool votes and the current system operating mode has just changed to cool and if the two cool votes are removed, the system immediately switches to heat, thereby bypassing the timer.

Nonvoting conditions

The following scenarios represent nonvoting conditions:

- The zone temperature is unreliable.
- The zone temperature remains more than 3 degrees from setpoint for more than the user-set time period, the default is 60 minutes. For zone controllers with local heat, the time period begins when the local heat is at the maximum level. In unoccupied mode, the time period is reset.

  ⓘ **Note:** This situation only applies to occupied operation.
- The zone controller is currently offline.
- The zone vote is not allowed via the user setup; this restriction is set by the **Zone Vote Allowed** parameter in the **Control Setup** screen under the zone.
- The zone weight of a zone is set to zero.

On zones containing local heat, local heat must be at the maximum level before the zone votes for heat.

Zone vote weighting

You can configure each zone to add weight so that its vote is more important than other zones. Adjust the **Zone Weight** parameter from the **Control Setup** section of the **Zone View**. Votes can be adjusted from 0 to 3. Zero implies it does not vote. Three implies the vote is worth three votes. The default is set to one vote.

Cooling

RTU

The RTU adjusts the supply air temperature to meet its discharge cooling setpoint. When the unit is in occupied mode, the supply fan runs continuously. In unoccupied mode, the fan does not run unless a call for cooling occurs.

Heating

RTU

The RTU adjusts the SAT to its discharge heating setpoint. When the unit is occupied, the supply fan runs continuously. In unoccupied mode, the fan does not run unless a call for heating occurs.

Damper operation (heating and cooling)

COBP zone dampers

In occupied mode, if the zone temperature rises above the occupied mode cooling setpoint (**Occupied Cooling Setpoint**) and the system requests cooling, the zone damper uses a pressure-dependent strategy to modulate to adjust the zone temperature and meet the occupied cooling setpoint. If the system is providing heat, the zone damper remains at its cooling minimum position.

If the zone temperature drops below the occupied mode heating setpoint (**Occupied Heating Setpoint**), the zone damper remains at minimum position and uses supplemental heat to satisfy the zone if supplemental heat is installed. If the box does not have supplemental heat or the supplemental heat is fully saturated, this means that the supplemental heating command is at 100% for more than five minutes, the zone damper uses a pressure-dependent strategy to modulate to adjust the zone temperature and meet the occupied heating setpoint. If the system is providing cooling, the zone damper remains at its heating minimum position. If the zone temperature is between the setpoints, the zone damper is at its cooling minimum position.

Unoccupied mode operation is identical to occupied mode operation except that the unit adjusts the zone temperature to meet the unoccupied mode cooling and heating setpoints (**Unoccupied Heating Setpoint** and **Unoccupied Cooling Setpoint**).

VAV box

In occupied mode, if the zone temperature rises above the occupied cooling setpoint and the system is in a cooling mode, the zone damper uses a pressure independent strategy to adjust the zone temperature to meet the occupied cooling setpoint. If the system is providing Heating (zone mode = Heating), the zone damper controls the flow to meet the occupied cooling Minimum Flow (**Occupied Cooling Min Flow**).

If the zone temperature drops below the occupied heating setpoint, the optional supplemental heat or box heat is used to adjust the zone temperature to the Occupied Heating setpoint. If the supplemental or box heat is at maximum capacity but cannot maintain the zone temperature, the zone remains at the heating minimum until the system is in a heating mode. If the system is in a heating mode and if the system is providing heating, the damper is opened to maximum flow. If the zone mode is set to cooling, the zone damper adjusts to a heating minimum flow if local heat is present.

The zone damper adjusts the flow to the occupied cooling minimum flow (**Occupied Cooling Min Flow**) when the zone temperature is between the setpoints.

For unoccupied operation, if the temperature rises above or below the cooling and unoccupied heating setpoints (**Unoccupied Heating Setpoint and Unoccupied Cooling Setpoint**), and the system provides the desired air, the zone damper adjusts to a maximum. For example, the system provides cold air when the zone needs cooling. If the system is not providing the desired air, the zone damper adjusts the flow to the appropriate minimum flow.

Off

Shut down the system in the following two ways:

- **Instant Shutdown:** The application performs an Instant Shutdown on all heating or cooling stages and the fan when the input is set to Shutdown. Minimum On timers are ignored in this mode.
- **Control Mode:** The application performs a shutdown on all heating and cooling stages and the fan when the Control Mode input is Off. Minimum On timers are observed in this mode. Table 3 provides minimum on and off times for each stage.

  ⓘ **Note:** The SMART Equipment board may have additional Minimum On timers for the compressors that must expire before the equipment shuts down. These Minimum On times exist on the VEC controller. This instance applies even if instant shutdown or control mode was used to shut off the unit.

Table 3: Minimum On and Off Times for RTU Stages

RTU Stage	Minimum On Time	Minimum Off Time
Heating	2 min	2 min
Cooling	3 min	5 min

RTU

All Heating and Cooling stages are off. The supply fan is off.

Zone Damper

The zone dampers are set to 100% open.

Bypass damper

The bypass damper is set to 50% open. This value is **not** overridden by the value set for the maximum bypass damper position parameter.

Fan only

RTU

When the system is in fan only mode, the supply fan runs continuously regardless of scheduled occupancy. No cooling or heating is staged regardless of heating or cooling votes.

Zone Damper

The zone dampers adjust the zone temperature to meet the setpoints based on the temperature of the supply air being delivered during fan only mode.

Bypass damper

The bypass damper adjusts the duct static pressure to meet its setpoint. The bypass damper does not open to a value larger than the maximum bypass damper position.

Standby mode

All zone controllers support an occupancy sensor. The occupancy sensor enables the controller to switch from occupied to standby mode. This occurs after a set period of time, when local activity is absent. When in standby mode, the zone controller uses standby temperature setpoints that are higher and lower than the occupied cooling and occupied heating temperature setpoints. These standby setpoints save energy by reducing the demand for heating and cooling in an unoccupied zone. When VAV boxes are in standby mode, the application uses unoccupied flow setpoints in addition to standby temperature setpoints.

You can enable the occupancy sensor in the **Control Setup** screen in the **Zone View** of the SBH. You can set occupancy sensitivity and set the time that the unit goes into standby mode, at the sensor. Refer to the Verasys User's Guide (*LIT-12012371*) for more information.

COBP system strategies

CO_2 DCV Operation

ⓘ **Note:** DCV operation is not supported on split-system equipment.

RTU

When the CO_2 level in an individual zone exceeds above its CO_2 setpoint, the VZC increases the minimum position of the economizer damper by 5% every 30 minutes. When the zone has fallen below the setpoint for 5 minutes, the coordinator decreases the economizer minimum position by 5% every 30 minutes. The economizer minimum position is never increased beyond the user-adjustable maximum ventilation damper position and is only decreased to the user-adjustable economizer minimum position. The 30-minute time period is reduced to two minutes when the **Title 24 Test Mode** parameter is set to True.

Zone Damper

When **Demand Ventilation Mode of Operation** is set to CO_2 and a CO_2 sensor is reliable, the DCV minimum damper positions (**DCV Cooling Min Value** and **DCV Heating Min Value**) are proportionally reset based on a CO_2 setpoint and a CO_2 proportional band. The damper minimum flow reset does not exceed the user-set maximum value (**Demand Ventilation Maximum Economizer Position**). If the CO_2 sensor is unreliable, the system uses the **Damper Cooling Min Position and Damper Heating Min Position**.

Dehumidification operation

Note: Dehumidification operation is not supported on VEC, heat pump, or split system equipment.

RTU

The Verasys system supports dehumidification operation on RTUs equipped with a factory installed HGR coil and a SMART Equipment control board.

Dehumidification is initiated when the humidity rises 5% above the dehumidification setpoint and continues until the humidity is 5% below the dehumidification setpoint. The request for dehumidification starts the fan, hot gas relay, and appropriate cooling stages based on the user-set mode.

The dehumidification sequence supports two modes: normal and alternate. In both modes, requests for dehumidification with no cooling turns on the first compressor (C1) and the HGR coil. When one stage of cooling (Y1) is requested, the mode is checked. If the mode is set to normal, the HGR coil is turned off or remains off. The request for cooling is then satisfied by the economizer, if present, or the first compressor. If the mode is alternate, the first compressor, HGR coil, and the second compressor (C2) are turned on. For both normal and alternate modes, a call for two stages of cooling (Y2) turns off the HGR and turns on the first and second compressors.

See Table 4 for a summary of the dehumidification sequence in both modes.

Table 4: Dehumidification Sequence in Normal and Alternate Modes

Request	Normal Mode			Alternate Mode		
	HGR	**C1**	**C2**	**HGR**	**C1**	**C2**
Dehumidification	On	On	Off	On	On	Off
One Stage of Cooling (Y1)	Off	On	Off	On	On	On
Two Stages of Cooling (Y2)	Off	On	On	Off	On	On

Power exhaust control

Note: Power exhaust control is not supported on VEC or split system equipment.

The Verasys COBP system controlled by SMART Equipment controllers support three types of power exhaust: constant volume EF, modulating exhaust damper, or VFD exhaust fan.

Economizer Damper Position for Exhaust Fan to Turn On: The constant volume exhaust fan turns on when the supply fan is running and the economizer is open more than the setpoint.

Economizer Damper Position for Exhaust Fan to Turn Off: The constant volume exhaust fan turns off when the supply fan is off or when the economizer is open less than the setpoint or 10% open, whichever value is greater.

The exhaust damper modulates to maintain the static pressure setpoint for the building. When the exhaust damper opens more than the **Exhaust Damper Position for Fan to Turn On** setpoint, the power exhaust fan turns on. When the exhaust damper is open less than the **Exhaust Damper Position for Fan to Turn Off** setpoint, the power exhaust fan is turned off or 10% open, whichever is greater.

The VFD exhaust fan modulates to maintain the building static pressure setpoint. The power exhaust fan turns on when the supply fan is on. The exception is when the building static pressure is 0.02 in. (0.508 mm) W.C. or more below the setpoint and the VFD exhaust fan is at 0%. The power exhaust fan turns on again when the building static pressure is 0.02 in. (0.508 mm) W.C. or more above the setpoint.

Load shed

The Verasys system supports a centralized demand shed for user-specified zones. A predefined BI on an IOM is used to trigger the load shed. All zones with load shed enabled shift their setpoints by a user-specified amount. You can also set an adjustable rate limit which controls how quickly the setpoint changes from its current setpoint to its shed setpoint in either direction. The setpoint shift occurs during occupied and standby modes.

Balancing

You can place the system into balancing mode through the **Commissioning** section of the zone coordinator on the SBH. When the balancing mode starts, the zone dampers fully open and the bypass damper is closed. The supply fan continues to run regardless of occupancy and any heating or cooling is turned off.

When balancing mode is turned off, the system returns the bypass damper to static pressure control. The zone dampers are released to operate and RTU heating and cooling are released to operate as required.

ⓘ **Note:** The system automatically returns to normal operation if balancing mode is left to operate for 8 hours. This automatic expiration safeguards the system from constantly running with dampers fully open in the event the user forgets to disable balancing mode.

Shutdown

The system shuts down if one of the following is true:

- The system is shutdown from the System Manager or VZC.
- All zone controllers are offline.
- The SAT sensor is unreliable.
- No voting zones are on the system.
- The system is shut down via BI-1 at the IOM selected from the SBH when the Emergency Shutdown BI is enabled.

Maximum bypass damper position

The maximum position setting (**Damper Max Position**) helps to limit the amount of air bypassed on systems with oversized bypass dampers. The maximum bypass damper position only affects the limits when the bypass damper is performing duct static pressure control. When the system is off, the bypass damper is set to 50% open regardless of the maximum bypass damper position setting.

Construction mode

During the construction phase of a project, the zone dampers may not be fully functional or installed. Under normal operation, the system shuts down the RTU if zone controllers are offline or if the bypass damper is offline. In this case, you can request RTU heating or cooling even though the system is not yet fully installed. Construction mode ignores offline conditions and allows the RTU to run heating or cooling.

ⓘ **Note:** There may be no duct static pressure control in construction mode if the bypass damper is offline.

The system can be placed in **Heat, Cool, Fan Only,** or **Not In Use** operating states.

- In a Heat state, the RTU adjusts the SAT to meet the discharge heating setpoint. The economizer remains at the minimum position.
- In a Cool state, the RTU adjusts the SAT to meet the discharge cooling setpoint. The economizer modulates if conditions allow.

- In a Fan Only state, the supply fan runs and no Heating or Cooling is staged. The economizer remains at the minimum position.
- In a Not In Use state, the Verasys system and economizer operate normally.

When the system is in construction mode, it ignores the following conditions that typically initiate a system shutdown:

- All zone controllers are offline.
- The bypass controller is offline.
- No voting zones are on the system.

The system still enters shutdown mode during construction mode if the SAT is unreliable or if the system is shut down via the VZC from the SBH.

Construction mode does not depend on occupancy. The operation is identical when the system is occupied or unoccupied.

Control mode

Control mode states include **Heat, Cool, Fan Only, Off**, or **Auto.** Unlike Construction mode, Control mode does **not** override any conditions, which would normally shut down the system. If any of these conditions occur, the system is shut down regardless of the Control mode setting. In addition, if set by Control mode, the Cool and Heat modes operate in the same manner in occupied and unoccupied modes.

The following are descriptions of Control mode states:

- In a **Cool** state, the RTU responds to votes of Cool, Urgent Cool, or Satisfied only, and ignores Heat and Urgent Heat.
- In a **Heat** state, the RTU responds to votes of Heat, Urgent Heat, or Satisfied only, and will ignore Cool and Urgent Cool.
- In a **Fan Only** state, the supply fan runs and no heating or cooling is staged.
- In an **Off** state, the system shuts down heating and cooling and turns off the supply fan. The **Off** state is not an instant shutdown; therefore, all minimum times are observed.
- In an **Auto** state, the system operates normally based on the zone votes.

Zoning system lockouts

Lockout logic

If the zone temperature for a given zone remains more than three degrees from setpoint for more than a user-set time period (default is 60 minutes), the zone no longer votes. For zone controllers with local heat, the time period starts once the local heat is at a maximum. This scenario only applies to occupied operation. In unoccupied mode, the time period is reset. Locked out zones are not counted and therefore do **not** show up in the current number of Cooling and Heating votes displayed on the **Details** screen in the **Zone Coordinator** section on the SBH.

Resetting zone lockouts

The lockout is cleared and the zone returns to voting if the following occurs:

- The system becomes unoccupied
- The zone temperature moves within 1 degree of the setpoint
- The system is shut down.

- The zone controller is power cycled.

CV Systems

CV System components and operating modes

The following describes the supported features and modes for the CV systems. The system consists of several components that include the following:

- RTU Controller
- System Manager
- RTU, heat pump, or split system equipment

Verasys supports the TEC3000 Thermostats or the SMART Equipment Controls to control CV units. The TEC3000 Thermostat is the only supported thermostat for the Verasys system. The TEC3000 Thermostat communicates to third-party RTUs.

The following sections provide a description of system behavior in the various operating modes.

Cooling

When the unit is in occupied mode, the supply fan runs based on the parameters selected. It either cycles with a call for cooling or it continuously runs. When the zone temperature is below the occupied cooling setpoint, all cooling is off. When in unoccupied mode, the economizer is closed unless there is a call for free cooling, and free cooling is available.

If the zone temperature rises above the occupied cooling setpoint and if the outside air conditions are suitable, the mixed air dampers modulate to maintain the setpoint. If the outside air conditions are not suitable and the zone temperature rises above the occupied cooling setpoint, the first stage (Y1) of cooling is energized. A further rise in zone temperature initiates additional cooling stages (Y2 to Y4), if equipped. Cooling stages operate with minimum OFF and ON times. As the zone temperature falls below the occupied cooling setpoint, stages of cooling de-energize in reverse order.

When the unit is in unoccupied mode, cooling turns on when the zone temperature rises above the unoccupied cooling setpoint. It remains on until the zone temperature is below the unoccupied cooling setpoint for 30 seconds.

The fan does not run unless a call for cooling occurs. The economizer remains closed unless a call for free cooling occurs and free cooling is available.

Heating

When zone temperature is above the occupied heating setpoint, all heating is off. As zone temperature drops below the occupied heating setpoint, the first stage (W1) of heating is energized. A further drop in zone temperature initiates additional heating stages (W2 and W3), if equipped. Heating stages operate with minimum off and on times. As the zone temperature rises above the occupied heating setpoint, stages of heating de-energize in reverse order.

When the unit is in unoccupied mode, heating turns on when the zone temperature drops below the unoccupied heating setpoint. Heating remains on until the zone temperature is above the unoccupied heating setpoint for 30 seconds.

The fan does not run unless a call for heating occurs.

Off

Shut down the system in the following two ways:

Instant Shutdown: The application performs an instant shutdown on all heating or cooling stages and the fan when the input is set to **Shutdown**. Minimum on times are ignored in this mode.

Control Mode: The application performs a shutdown on all heating and cooling stages and the fan when the Control mode input is Off. Minimum on times are observed in this mode. Table 5 provides minimum on and off times for each stage.

ⓘ **Note:** The SMART Equipment board may have additional minimum on timers for the compressors that must expire prior to the equipment shutting down. These minimum on times exist on the VEC. This instance applies even if instant shutdown or control mode was used to put the unit in **Off**.

Table 5: Minimum On and Off Times for RTU Stages

RTU Stage	Minimum On Time	Minimum Off Time
Heating	2 min	2 min
Cooling	3 min	5 min

RTU

All heating and cooling stages are off. The supply fan is off.

Fan only

When the system is in fan only, the supply fan runs continuously regardless of occupancy. No cooling or heating is staged.

CO_2 DCV operation

ⓘ **Note:** DCV operation is not supported on split system equipment. The TEC3000 Thermostat does not support dehumidification control.

RTU

When **DCV Enabled** is set to True and a CO_2 sensor is reliable, the control modulates the economizer position to remain within ±100 ppm of the CO_2 setpoint. The DCV control of the economizer position does not exceed the user-set maximum value (**Demand Ventilation Maximum Economizer Position**).

Dehumidification operation

ⓘ **Note:** Dehumidification operation is not supported on heat pump or split system equipment. The TEC3000 Thermostat does not support dehumidification control.

RTU

The Verasys system supports dehumidification operation on RTUs equipped with a factory installed HGR coil and SMART Equipment or control board.

Dehumidification is initiated when the humidity rises 5% above the dehumidification setpoint and continues until the humidity is 5% below the dehumidification setpoint. The request for dehumidification starts the fan, hot gas relay, and appropriate cooling stages based on the user-set mode.

The dehumidification sequence supports two modes: normal and alternate. In both modes, requests for dehumidification with no cooling turns on the first compressor (C1) and the HGR coil. When one stage of cooling (Y1) is requested, the mode is checked. If the mode is set to normal, the HGR coil is turned off or remains off. The request for cooling is then satisfied by the economizer, if present, or the first compressor. If the mode is alternate, the first compressor, HGR coil, and the second compressor (C2) are turned on. For both normal and alternate modes, a call for two stages of cooling (Y2) turns off the HGR and turns on the first and second compressors.

See Table 6 for a summary of the dehumidification sequence in both modes.

Table 6: Dehumidification Sequence in Normal and Alternate Modes

Request	Normal Mode			Alternate Mode		
	HGR	**C1**	**C2**	**HGR**	**C1**	**C2**
Dehumidification	On	On	Off	On	On	Off
One Stage of Cooling (Y1)	Off	On	Off	On	On	On
Two Stages of Cooling (Y2)	Off	On	On	Off	On	On

Power exhaust control

Note: Power exhaust control is not supported on split system equipment.

The Verasys system supports three types of power exhaust: constant volume EF, modulating exhaust damper, or VFD exhaust fan.

Economizer Damper Position for Exhaust Fan to Turn On: The constant volume exhaust fan turns on when the supply fan is running and the economizer is open more than the setpoint.

Economizer Damper Position for Exhaust Fan to Turn Off: The constant volume exhaust fan turns off when the supply fan is off or when the economizer is open less than the setpoint or 10% open, whichever value is greater.

The exhaust damper modulates to maintain the static pressure setpoint for the building. When the exhaust damper opens more than the **Exhaust Damper Position for Fan to Turn On** setpoint, the power exhaust fan turns on. When the exhaust damper is open less than the **Exhaust Damper Position for Fan to Turn Off** setpoint, the power exhaust fan is turned off or 10% open, whichever is greater.

The VFD exhaust fan modulates to maintain the building static pressure setpoint. The power exhaust fan turns on when the supply fan is on. The exception is when the building static pressure is 0.02 in. (0.508 mm) W.C. or more below the setpoint and the VFD exhaust fan is at 0%. The power exhaust fan turns on again when the building static pressure is 0.02 in. (0.508 mm) W.C. or more above the setpoint.

Load shed

The Verasys system supports a centralized demand shed for user-specified zones. A predefined BI on an IOM is used to trigger the load shed. All zones with load shed enabled shift their setpoints by a user-specified amount. You can also set an adjustable rate limit which controls how quickly the setpoint changes from its current setpoint to its shed setpoint in either direction. The setpoint shift occurs during occupied and standby modes.

CV system strategies

Shutdown

The **System Manager** can shut down the system.

Control mode

Control mode allows the user to place the system into the following operating states: **Heat, Cool, Fan Only, Off**, or **Auto**.

- In **Heat** state, the RTU adjusts the zone temperature to meet the zone heating setpoint.
- In **Cool** state, the RTU adjusts the zone temperature to meet the zone cooling setpoint.
- In **Fan Only** state, the supply fan runs and no heating or cooling is staged.
- In **Off** state, the system shuts down heating and cooling and turns off the supply fan. **Off** mode is not an instant shutdown so minimum times are observed.
- In an **Auto** state, the system operates normally based on the zone temperature.

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