

Verasys System Operation Overview

Technical Bulletin

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Introduction

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

The Verasys System supports Heating, Ventilating, and Air Conditioning (HVAC) applications through three types of systems: Variable Air Volume (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 Smart Building Hub (SBH) or Verasys Zone Coordinator and indicated in bold. 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	<i>Verasys™ System Product Bulletin</i>	<i>LIT-12012342</i>
Configuring Settings and Parameters within the Verasys System	<i>Verasys™ System User's Guide</i>	<i>LIT-12012371</i>
Configuring your Smart Building Hub settings	<i>Smart Building Hub Network and IT Guidance Technical Bulletin</i>	<i>LIT-12012015</i>

Zoning Systems

Variable Air Volume (VAV) System Components and Operating Modes

The VAV system consists of several components, which include:

- VAV Box Controllers
- Verasys Zone Coordinator (VZC)
- RTU, Heat Pump, or Split System Equipment with SMART Equipment Controls
- Verasys Equipment Controller (VEC)

The system uses either the Verasys Equipment controller (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 similar 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 of the unit.

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

Occupied

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, with the individual zones using their local heating first. The zone controllers use local heating if they are equipped with local supplemental and/or box heating.

VAV Box

The zone controller works in coordination with the VAV box to maintain the space temperature value within the cooling and heating setpoints using either hot water or electric box heat. If the VAV box uses hot water heat, hot water must be available from the building. 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 cubic feet per minute (cfm), the staged electric heating does not turn on if the flow drops below this value.

When the space temperature is above the cooling setpoint, the zone controller adjusts the space temperature to the occupied cooling setpoint using a pressure-independent strategy (cascaded flow loop). In this strategy, the VAV box adjusts the supply flow to meet a flow setpoint. The space temperature resets the flow setpoint.

When the space temperature drops below the heating setpoint, and if the zone damper is equipped with local supplemental and/or box reheat, the zone controller adjusts the space temperature to meet the occupied heating setpoint. This space temperature control is accomplished by staging the optional box reheat and/or supplemental heating as needed. Supplemental heat is used before box reheat if both are present. If the zone controller is using supplemental heat, the zone damper adjusts the supply flow to the cooling occupied minimum flow. 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 and/or box reheat, the control modulates box flow to the occupied cooling minimum flow position.

VAV boxes equipped with hot water reheat and a Supply Air Temperature sensor can also use a dual maximum control strategy. When the space temperature drops below the heating setpoint, the flow remains at the cooling minimum flow; and the zone controller resets the Supply Air Temperature from the current supply air temperature setpoint to a maximum Supply Air Temperature setpoint. Once the maximum Supply Air Temperature setpoint has been 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 occupancy sensor enables the controller to switch to standby mode from occupied mode when local activity is absent during a set time period in a normally occupied zone. 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 help save energy by reducing the demand for heating and cooling in an unoccupied zone. For VAV boxes, when 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 Smart Building Hub when you set the **Occupancy Mode** parameter to external. Set the occupancy sensitivity and time delay until standby locally from the sensor. Refer to Appendix B in the Verasys User's Guide for more information on each parameter.

Morning Warm-up

If the morning warm-up feature is enabled, the first hour of occupied operation is used to run morning warm-up. At the end of the first hour, the system enters occupied cooling mode, and the SAT is adjusted to meet the SAT setpoint.

RTU

The morning warm-up feature must be enabled for the RTU to use the morning warm-up strategy. Before energizing heat for morning warm-up, the system runs the fan for 5 minutes, then determines if morning warm-up is needed based upon the Return Air Temperature (RAT).

If the RAT indicates that morning warm-up is required for the space, 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 reenter the heating mode if the RAT drops 2 degrees below the morning warm-up RAT setpoint. If the morning warm-up RAT setpoint is not met by the scheduled occupied period, 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 duct static pressure current setpoint.

VAV Box

During morning warm-up, the Verasys Zone Coordinator (VZC) passes the Supply Air Temperature value from the RTU controller to the zone damper controller. The zone controller compares the Supply Air Temperature to the zone temperature and automatically determines, based on differential, when the system is in morning warm-up. If in morning warm-up, the zone controller adjusts the space temperature to meet the Occupied Heating setpoint. The space temperature is adjusted by commanding the damper to deliver the maximum primary heating (such as control damper to cooling maximum flow), and staging the optional box and/or supplemental heating as needed (supplemental heat is used before box heat if both heating strategies are present). 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

You can select a representative zone at the Verasys Zone Coordinator for the system to continuously monitor for a call for Unoccupied heating or cooling. This representative zone triggers the Unoccupied call for heating or cooling for the system when the representative zone space temperature drops below the Unoccupied heating setpoint, or when the representative zone temperature rises above the Unoccupied cooling setpoint. Once the call has been satisfied for a 30-second time period, the Unoccupied heating or cooling mode ends.

RTU

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

By default, while in Unoccupied mode, the economizer is closed. However, during a call for cooling, if free cooling is available, the economizer provides cooling. If free cooling is not available, the system requests cooling from the RTU, which then adjusts the Supply Air Temperature to its setpoint.

When the system is Unoccupied, and no call for Unoccupied cooling or heating is issued, the supply fan remains off. Cooling and heating is also off. The economizer is closed.

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 maximum flow (**Cooling Max Flow**) setpoint. Any zones that do not require Unoccupied heating (such as those zones with temperatures above the Unoccupied Heating setpoints) move to their cooling unoccupied minimum flow (**Unoccupied Cooling Min Flow**). Local supplemental and/or box heat stage adjust the zone temperature to meet the Unoccupied Heating setpoint, as needed. Supplemental heat is used before box heat if both heating strategies are present.

When the zone temperature of the representative zone rises above its Unoccupied Cooling setpoint, the zone controller requests Unoccupied Cooling and adjusts to its cooling maximum flow.

Any zones which do not require Unoccupied cooling (such as those zones with temperatures below the Unoccupied Cooling setpoint) move to the unoccupied cooling minimum flow. Any nonrepresentative zone calling for cooling or heating does not start the RTU. However, if heat is needed, the local fan operates when the local heat command rises above 5%.

Balancing

You can place the system into Balancing mode from the Zone Coordinator Commissioning section on the Smart Building Hub. When Balancing mode begins, the zone dampers move to their maximum cooling positions (**Cooling Max Flow**). The RTU waits 2 minutes, then runs the fan at full speed. Heating or cooling is turned off. The delay between opening the dampers and turning on the fan prevents the high static pressure protection from tripping.

When Balancing mode ends, the system returns the fan to static pressure control (if a call for the fan exists). After 2 minutes, the zone dampers are released to operate, and RTU heating and cooling are released to function as required. The delay between returning the fan to static pressure control and releasing the dampers prevents the high static pressure protection from tripping.

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 that the user forgets to disable balancing mode.

VAV System Strategies

Supply Air Temperature Setpoint Reset

The SAT setpoint reset helps improve control for the system zones, which 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 waits 30 minutes before adjusting the SAT setpoint again. The SAT setpoint is gradually reset back to its default value once heating or cooling is no longer at full capacity. This reset prevents the system from getting stuck at a setpoint once the representative zone is back in control. A user-set maximum SAT setpoint adjustment parameter limits the range of adjustment. The user has the option of disabling the SAT reset strategy if desired.

Duct Static Pressure Setpoint Reset

The system automatically adjusts the duct static pressure setpoint based upon the damper position of the zone that calls for 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. 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. An adjustable maximum duct static pressure setpoint adjustment parameter limits the range of adjustment (**Max Duct Static SP Adjust**). The user has the option of disabling the duct static pressure reset strategy.

Variable Frequency Drive (VFD) Economizer Minimum Position Reset

The 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 up to 100%, the economizer minimum position decreases to either user-specified **Economizer Minimum Position Setpoint** or DCV reset-adjusted economizer minimum position.

CO₂ Demand Controlled Ventilation (DCV) Operation

RTU

CO₂ DCV ensures indoor air quality in the zone by monitoring CO₂ levels. When an individual zone CO₂ level increases above its CO₂ setpoint, the zone coordinator increases the minimum position of the economizer damper by 5% every 30 minutes. Once 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 2 minutes when the **Title 24 Test Mode** parameter is set to True.

VAV Box

When **Demand Ventilation Mode of Operation** is set to CO₂ and a CO₂ sensor is reliable, the DCV minimum damper flows (**DCV Occupied Cooling Min Flow** and **DCV Occupied Heating Min Flow**) are proportionally reset based on a CO₂ setpoint and a CO₂ proportional band. The reset of the damper minimum flows does not exceed the user-set maximum value (**DCV Max Flow**). DCV supports up to four CO₂ sensors. The CO₂ sensor with the highest value is used to determine the reset. If all CO₂ sensors are unreliable, the system uses the **Occupied Cooling Min Flow** and **Occupied Heating Min Flow** parameter values.

Dehumidification Operation

RTU

Note: The Verasys Equipment Controller (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 UCB control board.

A call for dehumidification occurs when the humidity rises 5% above the dehumidification setpoint and persists until the humidity is 5% below the dehumidification setpoint. The call 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, a call for dehumidification and no cooling request turns on the first compressor (C1) and the hot gas reheat (HGR) coil. On a call for one stage of cooling (Y1), the mode is checked. If the mode is 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 UCB controller support three types of power exhaust: constant volume Exhaust Fan (EF), modulating exhaust damper, or Variable Frequency Drive (VFD) exhaust fan.

Note: The Verasys Equipment Controller does not support power exhaust control.

The constant volume exhaust fan turns on whenever the supply fan is running and the economizer is open more than the setpoint (**Economizer Damper Position for Exhaust Fan to Turn On**). The constant volume exhaust fan turns off when the supply fan is off or when the economizer is open less than the setpoint (**Economizer Damper Position for Exhaust Fan to Turn Off**) or 10% open, whichever value is greater.

The modulated exhaust damper modulates to maintain the building static pressure setpoint. 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 setpoint (**Exhaust Damper Position for Fan to Turn Off**), 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. 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. 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) initiates the load shed. All zones with load shed-enabled shift their setpoints by a user-specified amount. The user 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 system is shut down from the Smart Building Hub or Verasys Zone Coordinator.
- All zone controllers are offline.
- The system is shut down via BI-1 at the IOM selected from the Smart Building Hub when the Emergency Shutdown BI is enabled.

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

Changeover Bypass (COBP) System Components and Operating Modes

The following describes the supported features and modes for the COBP systems. The system consists of several components, which include:

- COBP Zone Damper Controllers
- Bypass Damper Controller
- Verasys Equipment Controller (VEC)
- Verasys Zone Coordinator (VZC)
- RTU, Heat Pump, or Split System Equipment with SMART Equipment Controls

The Verasys system uses the Verasys Equipment Controller (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 similar to that of an intelligent thermostat controller so the unit must have a thermostat interface.

Changeover Bypass systems operate based upon a zone voting logic. The following sections provide details on this logic.

Zone Voting

The Verasys Zone Coordinator 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 Verasys Zone Coordinator 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 Verasys Zone Coordinator continues to monitor the zones and change the operating mode of the RTU as needed to accommodate the zone needs.

Types of Votes

The zone can send five types of votes to the Verasys Zone Coordinator: Cool, Urgent Cool, Heat, Urgent Heat, and Satisfied. The following text describes these scenarios in detail.

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 Verasys Zone Coordinator. When the zone temperature decreases to within 0.5 degrees of the cooling setpoint, the zone vote changes to **Satisfied**.

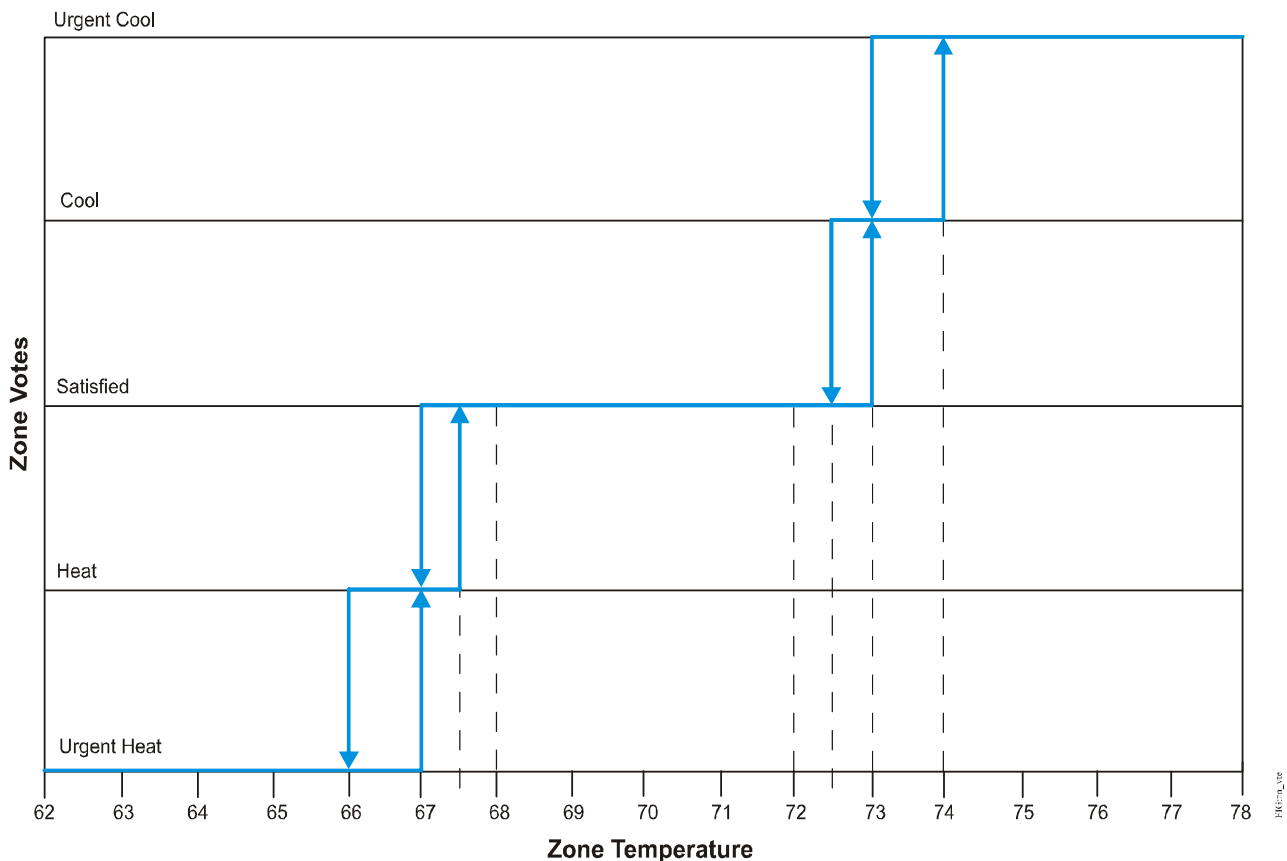
If the zone temperature is greater than 2 degrees above the cooling setpoint, the vote is **Urgent Cool**. When the zone temperature decreases to within 1 degree of the cooling setpoint, the vote returns to **Cool**.

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 Verasys Zone Coordinator. 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 Verasys Zone Coordinator uses zone votes to command the Verasys system into the appropriate operating mode. This system operating mode in return determines the COBP RTU state, the effective occupancy, and unit enable 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 Verasys Zone Coordinator 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 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 Changeover Bypass RTU state is determined by the system operating mode and the Occupancy Input. If the system is Occupied, the Changeover Bypass RTU state is Fan Only. If the system is Unoccupied, the Changeover Bypass RTU state is Off.

Changing Between Modes

Changeover Logic

The Verasys Zone Coordinator 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. Once 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 1 Heat and 2 Cool votes and the current system operating mode has just changed to Cool; if the 2 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 (default is 60 minutes). For zone controllers with local heat, the time period begins once the local heat is at the maximum level. **This situation only applies to Occupied operation.** In Unoccupied mode, the time period is reset.
- 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 it's 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 3 votes. The default is set to 1 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 supply air temperature 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 to 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 uses a pressure-dependent strategy to modulate to adjust the zone temperature to 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 zone temperature to meet the Unoccupied mode cooling and heating setpoints (**Occupied Heating Setpoint** and **Occupied 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 is modulated to adjust the zone temperature to meet the Occupied Cooling setpoint using a pressure independent strategy. 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 and/or box heat is used to control the zone temperature to the Occupied Heating setpoint. If the supplemental and/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, then the zone damper opens to maximum flow. If the system is in a Heating mode and if the system is providing heating, the damper is opened to maximum flow. If the system is providing Cooling (zone mode = Cooling), the zone damper adjusts to a heating minimum flow if local heat is present.

If the zone temperature is between the setpoints, the zone damper adjusts the flow to the Occupied Cooling Minimum Flow (**Occupied Cooling Min Flow**).

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

Off

The system may be commanded off in two different 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 prior to the equipment shutting down. These Minimum On times exist on the VEC controller. This instance applies even if Instant Shutdown or Control Mode was used to put the unit in Off.

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 to standby mode from occupied mode when local activity is absent during a set time period in a normally occupied zone. 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 help save energy by reducing the demand for heating and cooling in an unoccupied zone. For VAV boxes, when 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 Smart Building Hub. You can set occupancy sensitivity and time delay until standby locally at the sensor. Refer to the *Verasys User's Guide (LIT-120xxxx)* for more information.

COBP System Strategies

CO₂ Demand Controlled Ventilation (DCV) Operation

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

RTU

When an individual zone CO₂ level increases above its CO₂ setpoint, the Verasys Zone Coordinator increases the minimum position of the economizer damper by 5% every 30 minutes. Once 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 back down to the user-adjustable economizer minimum position. The 30-minute time period is reduced to 2 minutes with the **Title 24 Test Mode** parameter is set to True.

Zone Damper

When **Demand Ventilation Mode of Operation** is set to CO₂ and a CO₂ sensor is reliable, the DCV minimum damper positions (**DCV Cooling Min Value** and **DCV Heating Min Value**) are proportionally reset based on a CO₂ setpoint and a CO₂ proportional band. The damper minimum flow reset does not exceed the user-set maximum value (**Demand Ventilation Maximum Economizer Position**). If the CO₂ 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 Verasys Equipment Controller (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.

A call for dehumidification occurs when the humidity rises 5% above the dehumidification setpoint and persists until the humidity is 5% below the dehumidification setpoint. The call for dehumidification starts the fan, hot gas relay, and appropriate cooling stages based on the user-selectable mode.

The dehumidification sequence supports two modes: Normal and Alternate. In both modes, a call for dehumidification and no cooling request turns on the first compressor (C1) and the hot gas reheat (HGR) coil. On a call for one stage of cooling (Y1), the mode is checked. If the mode is 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 Verasys Equipment Controller (VEC) or split system equipment.

The Verasys COBP system controlled by SMART Equipment controllers support three types of power exhaust: constant volume Exhaust Fan (EF), modulating exhaust damper, or Variable Frequency Drive (VFD) exhaust fan.

The constant volume exhaust fan turns on whenever the supply fan is running and the economizer is open more than the setpoint (**Economizer Damper Position for Exhaust Fan to Turn On**). The constant volume exhaust fan turns off when the supply fan is off or when the economizer is open less than the setpoint (**Economizer Damper Position for Exhaust Fan to Turn Off**) or 10% open, whichever value is greater.

The modulated exhaust damper modulates to maintain the building static pressure setpoint. 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 setpoint (**Exhaust Damper Position for Fan to Turn Off**), 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. 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. 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 triggers the load shed. All zones with load shed enabled shift their setpoints by a user-set amount. The user 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

The system may be placed into a Balancing mode by changing the **Balancer Mode** from the Unit screen in the Zone Coordinator section from the Smart Building Hub. Immediately upon the start of the Balancing mode, 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.

Upon turning off Balancing mode, 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 Verasys Zone Coordinator.
- 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 Smart Building Hub when the Emergency Shutdown BI is enabled.

Maximum Bypass Damper Position

The maximum position setting (**Damper Max Position**) helps 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 such a scenario, RTU heating or cooling may still be desired 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 may 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 Verasys Zone Coordinator from the Smart Building Hub.

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 adjusts the SAT to meet the discharge cooling setpoint.
- In a Heat state, the RTU adjusts the SAT to meet the discharge heating setpoint.
- 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 3 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 requests (votes) displayed on the Details screen in the Zone Coordinator section on the Smart Building Hub.

Resetting Zone Lockouts

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

- 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

Constant Volume (CV) Systems

Constant Volume System Components and Operating Modes

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

- RTU Controller
- System Manager
- RTU, Heat Pump, or Split System Equipment

Verasys supports the TEC3000 thermostats or the SMART Equipment Controls to control Constant Volume 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 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. It 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

The system may be commanded Off in two different 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.

CO₂ Demand Controlled Ventilation (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 CO₂ sensor is reliable, the control modulates the economizer position to remain within ± 100 ppm of the CO₂ 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 a UCB or control board.

A call for dehumidification occurs when the humidity rises 5% above the dehumidification setpoint and persists until the humidity is 5% below the dehumidification setpoint. The call for dehumidification starts the fan, hot gas relay, and appropriate cooling stages based on the user-selectable mode.

The dehumidification sequence supports two modes: Normal and Alternate. In both modes, a call for dehumidification and no cooling request turns on the first compressor (C1) and the hot gas reheat (HGR) coil. On a call for one stage of cooling (Y1), the mode is checked. If the mode is 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 Exhaust Fan (EF), modulating exhaust damper, or Variable Frequency Drive (VFD) exhaust fan.

The constant volume exhaust fan turns on whenever the supply fan is running and the economizer is open more than the **Econ Damper Position for Exhaust Fan On** setpoint. The constant volume exhaust fan turns off when the supply fan is off or when the economizer is open less than the **Econ Damper Position for Exhaust Fan Off** setpoint or 10% open, whichever is greater.

The modulated exhaust damper modulates to maintain the building static pressure setpoint. When the exhaust damper opens more than the **Exhaust Damper Position for Fan On** setpoint, the power exhaust fan turns on. When the exhaust damper is open less than the **Exhaust Damper Position for Fan 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 is turned on when the supply fan is on. The exception is when the building static pressure is 0.02 in. W.C. or more below the setpoint and the VFD exhaust fan is at 0%. The power exhaust fan is turned back on when the building static pressure is 0.02 in. 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. The user 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 a Heat state, the RTU adjusts the zone temperature to meet the zone Heating setpoint.
- In a Cool state, the RTU adjusts the zone temperature to meet the zone Cooling setpoint.
- 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. 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.



Building Efficiency

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