Installation and Operation

Tracer™ VV550/551 VAV Controller

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Warnings and Cautions

Warnings and cautions are provided in appropriate places throughout this document:

⚠ WARNING: **Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.**

⚠CAUTION: **Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury. It may also be used to alert against unsafe practices.**

CAUTION: **Indicates a situation that may result in equipment or property-damage only accidents.**

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Introduction

The Tracer™ VV550 and Tracer VV551 are variable air volume (VAV) controllers. The Tracer VV550 is the factory-installed version of the controller and the Tracer VV551 is the field-installed version of the controller. Both versions have the same capabilities.

The Tracer VV550/VV551 controllers conform to the LonMark® Space Comfort Controller (SCC) Functional Profile (see "Appendix A: Properties, Data Lists Points, and Network Variables," p. 99). They communicate using Comm5 protocol, which is the Trane implementation of LonTalk® protocol.

This guide provides information about the Tracer VV550/VV551 controllers and describes their features. However, certain features and options may not be available on all systems due to design constraints. Refer to specific equipment literature for available features and options.

Topics in this introduction are:

- Supported products
- Non-supported products
- Features
- Specifications

Supported and Non-supported Equipment

Supported Equipment

The Tracer VV550/VV551 VAV controller is compatible with both Trane VAV equipment and non-Trane VAV units.

Trane VAV Equipment

Trane manufactures VariTrane™ VAV equipment in its Rushville, Indiana location. VariTrane VAV equipment includes:

- VCxF Single duct
- VSxF Fan-powered series
- VPxF Fan-powered parallel
- LSxF Low-height fan-powered series
- LSxF Low-height fan-powered parallel

Note: VDDF Dual duct is possible with two controllers and higher level coordination.

Non-Trane VAV Equipment

Non-Trane VAV units are supported as generic configurations.

Non-supported Equipment

The Tracer™ VV550/VV551 controllers do not support the following sequences:

- Dual duct in space temperature control
- Dual duct with dedicated ventilation
- Generic binary output
- Fan-pulse-width modulation
- VariTrac® bypass air valve

Features and Specifications

Features

Table 1 compares the features of the Tracer VV550/551 controller with the features of the VAV 4.2 controller.

Table 1. Comparison of the Tracer VV550/551 controller and the VAV 4.2 controller

Tracer VV550/VV551	VAV 4.2
Supports Comm5.	Supports only Comm4 or Comm3 (VariTrac or VariTrane).
No local CO_2 sensor input. Uses only a communicated value.	Local CO_2 sensor input is available.
Single star (*) initiates cool minimum airflow override.	Single star (*) initiates maximum flow override after pressing the ON button. Override is held until you move the thumbwheel.
Double star (**) initiates cool maximum airflow override.	Double star (**) initiates unoccupied override after pressing the ON button. Override is held until you move the thumbwheel.
Does not support VariTrac central control panel (CCP2 and CCP3).	Does not support VariTrac CCP2 and CCP3.
Supports ventilation flow control.	Does not support ventilation flow control.
Supports flow tracking control.	Does not support flow tracking control.
Supports enhanced ventilation control sequences.	Does not support enhanced ventilation control sequences.
Supports auto-commissioning sequence.	Does not support auto-commissioning sequence.
Supports zone sensor air balance sequence.	Does not support zone sensor air balance sequence.

Specifications

Table 2 provides the engineering and agency specifications of the Tracer™ VV550/VV551 controllers.

Table 2. Tracer VV550/VV551 specifications

Specification	Description
Power requirements	Low voltage NEC Class 2, non-safety device 18 to 32 Vac (24 Vac nominal) Control board, 4 VA Four outputs, 48 VA maximum 50 or 60 Hz **Note:** Trane recommends a separate transformer, fuse, and switch for each controller.
Board dimensions	• Height: 5.5 inches (13.97 cm) • Width: 2 inches (5.08 cm) • Depth: 4.5 inches (11.43 cm)
Operating environment	0°C to 60°C (32°F to 140°F) 5% to 95% relative humidity noncondensing
Storage environment	–40°C to 85°C (–40°F to 185°F) 5% to 95% relative humidity noncondensing
Engineering and agency requirements	The following documents specify procedures, ratings, and test levels to demonstrate compliance to product requirements and C-UL agency requirements.
Agency	This controller is a low-voltage class 2, non-safety device. For factory mounting, the controller is a C-UL unlisted component under UL873.
Agency compliance	UL 873/CSA C22.2 No. 24, Temperature Indicating and Regulating Equipment Tested to IEC standards and Trane engineering standards.
Tracer VV551 field mount controller agency requirements	U and C-UL Listing: UL-916-PAZX—energy management CUL-C22.2—signal devices—Canada Flammability Rating: Plenum rated per UL 94-5V FCC: FCC Part 15 Class A emissions compliant CE: CE-EN61326:1998 Industrial Certified: LonMark®

Inputs and Outputs

The inputs and outputs associated with the Tracer™ VV550/551 controller are shown in Table 3 and discussed in this section.

Table 3. Input and output summary

Input or output	Description
Comm5	• Communication link; • Rover™ service tool.
Binary input	One input configured as one of the following: • Occupancy; • Generic; • Not used.
Analog inputs	Four inputs: • Space temperature; • Space setpoint; • Primary air temperature/discharge air temperature; • Primary airflow (differential pressure).
Zone sensor inputs	The controller accepts these inputs from the zone sensor: • Zone sensor ON and CANCEL buttons; • 10kΩ thermistor; • Internal and external space setpoint adjustment; • Single star and double star thumbwheel settings.
Binary outputs	Five outputs: • Primary air valve 1 close; • Primary air valve 1 open; • Heat 1; • Heat 2; • Heat 3 or Fan On/Off.
Analog output	None

Comm5 Communications

Typically, a Comm5 communication link connects unit controllers to the building automation system. However, peer-to-peer communication between controllers is possible over any Comm5 link, whether or not a building automation system is present. The Rover™ service tool also communicates with the controllers over a Comm5 link.

Comm5 Communications Link

The controller provides a total of six terminals for connection to the Comm5 communication link. It is not necessary to observe polarity for Comm5 communication links. The terminal descriptions follow:

- Two terminals for communication to the board (In Comm);
- Two terminals for communication from the board (daisy chain) (Out Comm);
- Two terminals for a connection from the zone sensor back to the controller or for the Rover service tool (Tool Comm).

Table 4. Comm5 communication link description and wiring

Link	Terminals	Label
Comm 5	TB2_1	Tool Comm
Comm 5	TB2_2	Tool Comm
Comm 5	TB2_3	In Comm
Comm 5	TB2_4	In Comm
Comm 5	TB2_5	Out Comm
Comm 5	TB2_6	Out Comm

Data Sharing

Since the controller uses LonWorks® technology, the controller can send or receive data (for example, setpoint, heat/cool mode, fan request, and space temperature) to and from other controllers on the communication link, with or without a building automation system.

Wink

For more information on the wink capability, refer to "Green Status LED" on page 90.

Rover Service Tool

An RJ-11 communication jack (present on some zone sensor modules) is the connection point between the Rover service tool and the communication link. The jack must be wired to the communication link at the controller. Accessing the communication jack with the Rover service tool gains access to all controllers on the link.

The Rover™ service tool can be used to change the controller configuration properties and update the application by downloading new code for both the Neuron and the mega32 processors.

Binary Input

Each Tracer™ VV550/VV551 controller provides one binary input. The binary input can be configured as occupancy or generic (see Table 5) or not used. The input associates 0 Vac with open contacts and 24 Vac with closed contacts. It is activated by a dry contact switch closure.

Table 5. Binary input description and wiring

Binary input	Terminals	Label	Terminal function
Occupancy or Generic	TB4-1, TB4-2	BI 1	Input

On the Tracer VV550 factory-installed controller, the binary input configuration is set up at the factory. The controller is correctly set up for each factory-supplied binary input end device.

On the Tracer VV551 field-installed controller the binary input has to be configured with the Rover service tool for the connected end device. The binary input is looking for a dry contact switch closure.

Occupancy Binary Input

The occupancy binary input can be configured as NO or NC. Occupied is the normal state. It is also the initial state at power-up and after a reset. Unoccupied is the other state. If the binary input is configured as generic, the default occupancy mode is occupied.

Generic Binary Input

The generic binary input can be configured as NO or NC. Normal state is inactive and is also the initial state at power-up and after a reset. Active is the other state.

Not Used Input

When no device is connected to the input, configure the controller input as not used.

Occupancy and Generic Binary Input Configuration

Table 6 shows the occupancy and generic binary input configuration.

Table 6. Occupancy and generic binary input configuration

Binary input type configuration	Binary input state configuration	Contact	Occupancy mode	Generic
Occupancy	NO	Open	Occupied	Not valid
Occupancy	NO	Closed	Unoccupied	Not valid
Occupancy	NC	Open	Unoccupied	Not valid
Occupancy	NC	Closed	Occupied	Not valid
Generic	NO	Open	Occupied	Inactive
Generic	NO	Closed	Occupied	Active
Generic	NC	Open	Occupied	Active
Generic	NC	Closed	Occupied	Inactive
None	Any state	Any state	Occupied	Not valid

Analog Inputs

Each Tracer™ VV550/VV551 controller provides four analog inputs (see Table 7). There is no local CO_2 input as there is on the 4.2 VAV controllers.

Table 7. Analog input descriptions and wiring

Analog input	Terminal(s)	Label	Range	Resolution	Sensor type
Space temperature	TB3-1	ZONE	14°F to 50°F (–10°C to 10°C)	0.25°F (0.14°C)	10KΩ at 77°F (25°C) Thermistor
			51°F to 95°F (10.56°C to 35°C)	0.125°F (0.07°C)	
			96°F to 122°F (35.56°C to 50°C)	0.25°F (0.14°C)	
Ground	TB3-2	GND			
Space setpoint	TB3-3	SET	50°F to 90°F (10°C to 32.2°C)	0.5°F (0.28°C)	1KΩ Potentiometer
Primary air temperature or Discharge air temperature	TB3-5	AUX	–40°F to 160°F (–40°C to 71.11°C)	1°F (0.56°C)	10KΩ at 77°F (25°C) Thermistor
			161°F to 212°F (71.67°C to 100°C)	2.5°F (1.39°C)	
Ground	TB3-6	GND			
Primary airflow (differential pressure)	J2-3 5VDC J2-2 signal J2-1 Ground	FLOW	0 to 2 inches water (0 to 498 Pascals) 0% to 120%	Less than 1%	Kavlico® differential pressure sensor(a)

(a) The controller uses a Kavlico differential pressure sensor to calculate the airflow.

Space Temperature Analog Input

The space (zone) temperature analog input can only be used for space temperature. Space temperature is measured with a 10kΩ thermistor in the Trane® zone sensor. The controller receives the space temperature either from a local analog input, as measured by the zone sensor, or as a remote communicated value. If both are present, the controller uses the communicated value. The controller uses the network variable output space temperature to report the space temperature value that it is using.

Construction Mode

On reset, if the space temperature input is not present (open circuit) and no valid communicated space temperature is available, the controller provides temporary heat for construction if configured as a space temperature controller. In construction mode the controller provides heat by driving the air valve to the configured maximum heating airflow (see Table 8 below).

Space Temperature Failure Diagnostic

If a valid space temperature is present, either locally or communicated, and then disappears, the controller generates a space temperature failure diagnostic. If both the local analog input and the communicated value are present, both have to disappear before the controller generates a space temperature failure diagnostic.

Table 8. Controller operation with no space temperature analog input

Failure type	Control type	Unit operation	Air valve operation	Fan operation	Reheat operation
Space temperature open on reset	Space temperature control	Construction temporary heat	Occupied: configured maximum heating airflow Unoccupied: closed	Series fan enabled; parallel fan Off	Off
	Ventilation flow control	Normal operation	Normal	Do not care	Normal
	Flow control	Normal operation	Normal	Do not care	Do not care

Table 8. Controller operation with no space temperature analog input

Failure type	Control type	Unit operation	Air valve operation	Fan operation	Reheat operation
Space temperature either: • Open (after normal on reset); • Short (anytime for 25 seconds).	Space temperature control	Space temperature failure; space temperature failure diagnostic	Occupied: configured minimum airflow Unoccupied: closed	Series fan enabled; parallel fan Off	Off
	Ventilation flow control	Normal operation; space temperature failure diagnostic	Normal	Do not care	Normal
	Flow tracking	Normal operation; space temperature failure diagnostic	Normal	Do not care	Do not care

This sequence is ignored by and can be overridden by the following seven sequences listed in priority from highest to lowest. For more information on control sequence descriptions, refer to "Control Sequences" on page 31.

1. Power-Up/reset sequence (highest priority)
2. Manufacturing test
3. Unit shutdown
4. Emergency override
5. Manual output test
6. Auto commission
7. Water valve override

Space Setpoint Analog Input

The controller can operate without a valid space setpoint input value (either hardwired or communicated).

The local setpoint input (SET) is designed as the local (hardwired) setpoint input. You cannot use the input for other functions. The local setpoint is a resistive input intended for use with Trane zone sensors.

The controller generates a setpoint failure diagnostic when a valid setpoint is established (through the hardwired input or through communications) and neither the local setpoint nor the communicated setpoint is present. When a setpoint failure diagnostic occurs, the controller operates using the configured heating and cooling setpoints. The heating and cooling setpoints are factory configured, but can be changed with the Rover™ service tool.

The local hardwired setpoint is available on the communications network. The effective setpoint used by the controller is available on the communications network.

Primary Air Temperature/Discharge Air temperature Analog Input

The controller senses the primary or discharge air temperature input with a hardwired 10kΩ thermistor. The primary/discharge air temperature analog input can be configured as either primary air temperature or discharge air temperature and applied as:

- Primary supply air temperature input for stand-alone changeover control and local reheat lockout. The 10kΩ thermistor is upstream from the VAV heating and cooling capacity;
- Discharge air temperature input for reheat control (preconditioning outdoor air in a ventilation flow control job). The discharge air temperature is used as feedback to the control algorithm that is influencing the discharge air temperature. This is discharge air control for units configured as ventilation flow control units. The 10kΩ thermistor is downstream of the VAV reheat capacity.

Either configuration also provides monitoring and diagnostics.

The controller can receive the primary air temperature as either a local analog input or as a communicated value. If both are present, the controller uses the communicated source temperature. If neither is present, the controller uses configuration to assume a primary air condition, either hot or cold.

The space temp controller or a flow-tracking controller can operate without a valid discharge air temperature analog input. Table 9 shows that the impact of discharge air temperature loss depends on the control algorithm configuration. If a valid discharge air temperature is present, then disappears, then returns to the valid range, the controller automatically resets and attempts to run normally.

Table 9. Discharge air temperature loss impact and control algorithm configuration

Discharge air temperature failure	Type of control	Unit operation	Air valve	Fan	Reheat
Open or short after being valid	Space temperature controller	Normal operation; discharge air temperature failure diagnostic	Normal	Normal	Normal
	Ventilation flow controller with reheat	Shutdown; discharge air temperature failure diagnostic	Closed	Do not care	Off
	Ventilation flow controller without reheat	Normal operation; discharge air temperature failure diagnostic	Normal	Do not care	Do not care
	Flow tracking controller	Normal operation; discharge air temperature failure diagnostic	Normal	Do not care	Do not care

This sequence is ignored by and can be overridden by the following sequences listed in priority from highest to lowest. For more information on control sequence descriptions, refer to "Control Sequences" on page 31.

1. Power up and reset sequence (highest priority)
2. Manufacturing test
3. Unit shutdown
4. Emergency override

5. Manual output test
6. Autocommission
7. Water valve override

Primary Airflow (Differential Pressure) Analog Input

The controller can operate with or without a valid flow value (either hardwired or communicated). It operates under pressure-dependent control or pressure-independent control.

Pressure-dependent Control

When a valid flow value is not present, the controller operates under pressure-dependent control (position control). Pressure-dependent control substitutes the air valve position for the flow measurement for all control actions.

During space-temperature control or ventilation-flow control

During space-temperature control or ventilation-flow control, pressure-dependent control activates when the air valve position is above 75% and the airflow value is below 5% of the configured nominal airflow. Pressure-dependent control also activates when the airflow setpoint is less than 10% of the configured nominal airflow.

During flow-tracking control

During flow-tracking control, if the airflow setpoint plus the configured airflow tracking offset is less than 10% of the configured nominal airflow and if the configured airflow tracking offset is negative, the air valve is closed, otherwise the air valve goes to the configured minimum airflow. These conditions do not generate an alarm message.

If the airflow sensor fails (Table 10), the controller closes the air valve if the configured airflow tracking offset is negative. If the configured airflow tracking offset is positive the controller controls the air valve to the configured minimum airflow.

Pressure-independent Control

When a valid flow value is present, the controller operates under pressure- independent control. The airflow is the calculated airflow needed to control the zone temperature +/-2% of the configured nominal airflow. If after an airflow sensor failure, the airflow returns to the valid range (airflow value greater than 10% of configured nominal airflow), the controller automatically resumes pressure-independent control.

Table 10. Flow sensor loss impact depends on control algorithm configuration

Airflow sensor failure	Type of control	Unit operation	Air valve operation	Fan	Reheat
• Open or shorted after being valid; • Cannot calibrate; • Measured airflow more than 120%.	Space temperature control	Pressure dependent mode; airflow sensor failure diagnostic	Normal	Normal	Normal
	Ventilation flow control	Pressure dependent mode; airflow sensor failure diagnostic	Normal	Do not care	Normal
	Flow tracking	Airflow failure mode; airflow sensor failure diagnostic	If the configured airflow tracking offset is negative, close the air valve. If the configured airflow tracking is offset is positive, move the air valve to the configured minimum airflow.	Do not care	Do not care

When the communicated airflow setpoint is invalid, either the flow sensor has failed or calibration has failed, and the controller closes the air valve if the configured airflow tracking offset is negative. If the configured airflow tracking offset is positive, the controller opens the air valve to the configured maximum airflow.

Once a valid differential pressure is established through the local hardwired input and then is no longer present, the controller generates a flow sensor failure diagnostic.

This sequence is ignored by and can be overridden by the following sequences listed in priority from highest to lowest. For control sequence descriptions, refer to “Control Sequences” on page 31.

1. Power-up/reset sequence (highest priority);
2. Manufacturing test;
3. Unit shutdown;
4. Emergency override;
5. Manual output test;
6. Auto commission;
7. Water valve override.

Zone Sensor Inputs

The Tracer™ VV550/551 controller receives inputs from the zone sensor. Typical zone sensor wiring connections are shown in Table 11.

Table 11. Typical Trane® zone sensor description and wiring

TB1	Description
1	Space temperature (ZONE)
2	Common
3	Setpoint (SET)
4	Communications (COMM)
5	Communications (COMM)

The controller accepts inputs from the following zone sensor components:

- Zone sensor *ON* and *CANCEL* buttons;
- 10kΩ thermistor;
- Internal and external space setpoint thumbwheel setting;
- Single- (*) and double-star (**) thumbwheel settings.

Zone Sensor ON and CANCEL Buttons

The *ON* and *CANCEL* buttons can be used to generate requests to the controller. The following five request types are available even when the communicated space temperature is valid and the local space temperature analog input is not used to read the space temperature.

Note: The ON and CANCEL buttons cannot be read by the controller if the 10kΩ thermistor is not physically present.

Timed Override On Request

To generate a timed override *ON* request, press the zone sensor *ON* button for one second and release. When the zone sensor *ON* button is released, the *ON* request is generated. This request is available even when the communicated space temperature is valid and the local space temperature analog input is not used to read the space temperature.

A timed override *ON* request sets the occupied bypass timer to the configured occupied bypass time (default is 120 minutes). If the controller is currently in unoccupied or occupied standby, the controller goes to occupied bypass. The controller remains in occupied bypass until the occupied bypass timer expires or until the *CANCEL* button is pressed.

Timed Override Cancel Request

To cancel a timed override *ON* request, press the zone sensor *CANCEL* button for one second and release. When the zone sensor *CANCEL* button is released, the cancel request is generated. This request is available even when the communicated space temperature is valid and the local space temperature analog input is not used to read the space temperature.

A timed override cancel request clears the occupied bypass timer. Setting the configured occupied bypass time to zero disables the timed override function. The controller is still informed of timed override *ON* requests and timed override cancel requests when the configured occupied bypass time is set to zero.

Zone Sensor Air Balance Request

To enter the zone sensor air balance mode, position the zone sensor thumbwheel to either the single star or double star, then press the *CANCEL* button on the zone sensor for 10 seconds. Both the local setpoint and the single star and double star functions must be enabled in configuration.

Zone sensor air balancing takes priority over occupied bypass. When the controller is in the zone sensor air balance mode, pressing the *ON* button for one second increases the configured airflow measurement gain. No timed override requests are generated when the controller is in the zone sensor air balance mode. From more information of zone sensor air balance function, refer to "Zone Sensor Air Balance Function" on page 78.

Service Pin Message Request

To generate a service pin message request, press the zone sensor *ON* button for 10 seconds and release. When the zone sensor *ON* button is released, the service pin message request is generated. This function is available even when the communicated space temperature is valid and the local space temperature analog input is not used to read the space temperature. The request does not change the current value of the occupied bypass timer.

Space Temperature Failure Diagnostic Request

To generate a space temperature failure diagnostic, press either the *ON* or the *CANCEL* button and hold for more than 25 seconds. This diagnostic automatically resets when the button is released.

10kΩ Thermistor

Trane® wall-mounted zone sensors use a 10kΩ thermistor to measure the space temperature. The sensors communicate over a hardwired connection. However, if both a hardwired and communicated space temperature value are available, the controller ignores the hardwired space temperature input and uses the communicated value.

Internal and External Space Setpoint Adjustment

Zone sensors with an internal or external setpoint adjustment (1kΩ) provide the controller with a local setpoint (50°F to 85°F or 10°C to 29.4°C). The internal setpoint adjustment is concealed under the zone sensor cover. To access the adjustable setpoint wheel, remove the zone sensor cover. The external setpoint (when present) is displayed on the digital display zone sensor front cover.

When the hardwired setpoint adjustment is used to determine the setpoints, all unit setpoints are calculated based on the hardwired setpoint value, the configured setpoints, and the active mode of the controller.

For example, Table 12 shows the derivation of effective setpoints from default values and a setpoint input.

Table 12. Example effective setpoints

Configured setpoints	Default value	Effective setpoint
Unoccupied cooling setpoint	85°F	85°F (same as default)
Occupied standby cooling setpoint	76°F	77°F (default + 1°F = 77°F)
Occupied cooling setpoint	74°F	75°F (default + 1°F = 75°F)
Occupied heating setpoint	70°F	71°F (default + 1°F = 71°F)
Occupied standby heating setpoint	66°F	67°F (default + 1°F = 67°F)
Unoccupied heating setpoint	60°F	60°F (same as default)

Steps to calculate default values to effective setpoints:
1. Mean setpoint = (Occupied cooling setpoint + Occupied heating setpoint) / 2.
2. Absolute setpoint offset = Setpoint input (73°F) – Mean setpoint.
3. Effective occupied setpoint = Absolute setpoint offset + Default setpoint.
4. Effective unoccupied setpoints are the same as the defaults.

The controller determines the effective space setpoint based on the following:

- Hardwired thumbwheel setpoint input (SET);
- The hardwired setpoint calibration (configured);
- Whether or not the local hardwired thumbwheel can be used or not (configured);
- Communicated setpoint input;
- Default setpoints (configured);
- Occupancy mode;
- Heating or cooling mode (space demand);
- Space setpoint high and low limits (configured).

The controller reports the setpoint it is using in the network variable output effective setpoint. The controller reports the calibrated hardwired thumbwheel setpoint using the network variable output setpoint.

When a building automation system or other controller communicates a setpoint to the controller, the controller ignores the hardwired setpoint input and uses the communicated value. The exception is when the system is in unoccupied mode and the controller always uses the stored default unoccupied setpoints.

After the controller completes all setpoint calculations, the calculated occupied setpoint is validated against the following configured space setpoint limits:

- Heating setpoint high limit;
- Heating setpoint low limit;
- Cooling setpoint high limit;
- Cooling setpoint low limit.

These setpoint limits apply only to the occupied and occupied standby, heating, and cooling setpoints. They do not apply to the unoccupied heating and cooling setpoints. When the controller is in the unoccupied mode, it always uses the unoccupied heating and cooling setpoints.

Unit configuration enables or disables the local (hardwired) setpoint. This parameter provides additional flexibility to allow you to apply communicated, hardwired, or default setpoints without making physical changes to the unit.

Similar to hardwired setpoints, the effective setpoint value for a communicated setpoint is determined based on the stored default setpoints, configuration values, and the controller occupancy mode.

Single-Star (*) and Double-Star (**) Thumbwheel settings

Positioning the thumbwheel at the single star (*) setting generates an override to cooling minimum flow. The override is enabled when the setpoint is greater than 88°F (31.11°C) and disabled when the setpoint is less than 87.7°F (30.94°C).

Positioning the thumbwheel at the double star (**) setting generates an override to cooling maximum flow. The double-star function is enabled when the setpoint is less than 48.5°F (9.17°C) and disabled when the setpoint is greater than 50°F (10°C).

Note: The maximum flow and the minimum flow overrides generated by using the thumbwheel have priority over the communicated flow override network variable.

Positioning the thumbwheel past the single star or double star sometimes generates a Local Setpoint failure diagnostic.

Consider the following:

- If the thumbwheel is not enabled, locally generated overrides (maximum flow or minimum flow) are not possible.;
- Single star and double star airflow override capability can be disabled through configuration, while leaving the thumbwheel local setpoint enabled;
- The controller communicates an active override by setting the mode field in the reported unit status and the reported heat/cool mode to *TEST*;
- There is no effect on the fan and the reheat operation during the single star and double star thumbwheel airflow overrides. When the single star and double star thumbwheel airflow overrides are active, the default space setpoints are used, the reported local setpoint reports the invalid value. Setpoint values outside of the valid setpoint range (50°F to 85°F [10.0°C to 29.44°C]) are not used.

Binary Outputs

Each Tracer™ VV550/VV551 controller provides five binary outputs (see Table 13). The binary outputs are load side-switching triacs. Each triac acts as a switch that either makes or breaks the circuit between the load and ground.

Table 13. Binary output descriptions and wiring

Binary output	Terminals	Label	Maximum output rating
Primary air valve close	J1-3	Actuator	12 VA
Primary air valve open	J1-4	Actuator	12 VA

Table 13. Binary output descriptions and wiring

Binary output	Terminals	Label	Maximum output rating
Heat 1	J9	Heat 1	12 VA
Heat 2	J10	Heat 2	12 VA
Heat 3 or Fan On/Off	J11	Heat 3	12 VA

Binary outputs controlling electric heat are always *NO*. Binary water valve outputs can be configured as *NO* or *NC*. The factory-installed controller is correctly set up for each factory-supplied binary output end device. When no device is connected to the output, configure the controller output as not used.

Primary Air Valve Binary Outputs

The *primary air valve close and open* binary output control the modulating primary air valve. The default minimum actuation drive time for the air valve is 0.5 seconds and the minimum actuation time for the water valve is 0.5 seconds. The airflow is the calculated airflow needed to control the zone temperature +/-2% of the configured nominal airflow.

Heat and Fan Binary Outputs

The heat outputs (Heat 1, Heat 2, and Heat 3) control reheat. Output Heat 3 may be configured for heat or a fan (Fan *ON/OFF*). The heat outputs may be configured as:

- Hot water *ON/OFF* control (*NO or NC*);
- Hot water modulating (three-wire) valve control (open and close outputs are predetermined);
- Electric heat pulse width modulation (PWM) control (always NO).

The fan output can be configured as:

- Parallel *ON/OFF* control;
- Series *ON/OFF* control.

Binary Output Overrides

The controller includes a manual output test. The test overrides and manually exercises all binary outputs in a defined sequence. For more information on manual output test, refer to "Manual Output Test" on page 33.

The controller also includes overrides for the fan, auxiliary heat (reheat), water valve, airflow, and emergency override. For more information on overrides, see "Sequence of Operations" on page 29.

Analog Output

The Tracer™ VV550/VV551 controllers do not provide an analog output capability.

Sequence of Operations

This chapter provides information concerning the sequence of operation of the Tracer™ VV550/VV551 controllers. Topics consist of:

- Control modes;
- Control sequences;
- Occupancy;
- Space temperature control;
- Ventilation flow control;
- Flow tracking control;
- Stand-alone control;
- Air balance functions.

Control Modes

The Tracer VV550/VV551 controllers are factory configured for a variety of VAV unit types. The controller supports three control modes: two temperature controls and one pressure control. Table 14 shows the basic unit type and control mode combinations, Table 15 describes the occupancy modes for each control mode, and Table 16 shows the possible heat options.

Table 14. Options available depending on configured unit type and control algorithm

VAV unit type	Control mode	Air valve	Fan	Local heat	Remote heat
Single duct	Space temperature control (STC) (space temperature sensor required for normal operation, but will run in construction mode without a space temperature sensor)	Required	Optional	Optional	Optional
Single duct	Ventilation flow control (VFC) (discharge air temperature sensor required if reheat present)	Required	None	Optional	None
Single duct	Flow tracking (pressure) (FT)	Required	None	None	None

Table 15. Algorithm type and control sequence descriptions

Control mode	Occupancy mode	Description
Space temperature control	Occupied	Controller modulates the heating and cooling capacity to keep the space temperature at the active space temperature setpoint. Applicable ventilation and airflow setpoints are enforced. A space temperature sensor is required.
	Unoccupied	Controller enables or disables control to keep the active space temperature between the unoccupied heating and cooling setpoints. Ventilation requirements are assumed to be zero. Minimum airflow setpoints are enforced when actively cooling or heating, otherwise the air valve is closed. A space temperature sensor is required.

Table 15. Algorithm type and control sequence descriptions

Control mode	Occupancy mode	Description
Ventilation flow control	Occupied	Controller controls to the active airflow setpoint and modulates the heating capacity to keep the discharge air temperature at the active discharge air temperature setpoint. A discharge air temperature sensor is required if reheat is present. A space temperature sensor is not required. A diagnostic is generated on a failure of the space temperature sensor input if it was ever valid.
	Unoccupied	Controller closes the air valve. All local heating capacity is disabled.
Airflow tracking control	Occupied and unoccupied	Controller supports one airflow tracking control algorithm. The controller modulates the air valve to keep airflow at the calculated airflow setpoint. Neither a space temperature nor a discharge air temperature sensor is required.

Table 16. Possible heat options

	Local heat	Remote heat	Heat1 J9	Heat2 J10	Heat3 J11
1	No local heat [a]	No remote heat			
2	PWM electric (1 or 2 stages)	No remote heat	Local 1	Local 2	Fan [b]
3	PWM electric (3 stages)	No remote heat	Local 1	Local 2	Local 3
4	Staged electric (1 or 2 stages) [a]	No remote heat	Local 1	Local 2	Fan [b]
5	Staged electric (3 stages) [a]	No remote heat	Local 1	Local 2	Local 3
6	On/Off hot water (1 stage) [a]	No remote heat	Local 1		Fan [b]
7	Modulating hot water [a, c]	No remote heat	Close	Open	Fan [b]
8	No local heat	Electric (1 stage)	Remote 1		Fan [b]
9	No local heat	On/Off hot water (1 stage)	Remote 1		Fan [b]
10	No local heat	Modulating hot water [c]	Close	Open	Fan [b]
11	PWM electric (1 stage)	Electric (1 stage)	Local 1	Remote 1	Fan [b]
12	PWM electric (2 stages)	Electric (1 stage)	Local 1	Local 2	Remote 1
13	Staged electric (1 stage)	Electric (1 stage)	Local 1	Remote 1	Fan [b]
14	Staged electric (2 stages)	Electric (1 stage)	Local 1	Local 2	Remote 1
15	On/Off hot water (1 stage)	On/Off hot water (1 stage)	Local 1	Remote 1	Fan [b]
16	On/Off hot water (1 stage)	Modulating hot water [c]	Close	Open	Local 1
17	Modulating hot water [c]	On/Off hot water (1 stage)	Close	Open	Remote 1

a. Ventilation flow control only supports these types of heat.
b. The fan is optional, none, serial, or parallel.
c. Modulating hot water, local or remote, is always on HEAT1 (J9 closed) and HEAT2 (J10 open).

Control Sequences

The following, in order of priority, are the Tracer™ VV550/VV551 controller sequences. Higher priority sequences ignore inputs that affect lower priority sequences. The power-up/reset sequence has the highest priority; no other sequence can override it. The normal operation sequence has the lowest priority; all other sequences can override it. All sequences can override normal operation.The following are the control sequences described in this topic:

- Power-up/reset (highest priority);
- Manufacturing test;
- Unit shutdown;
- Emergency override;
- Manual output test;
- Auto commissioning;
- Calibrate;
- Water valve override, flow override, fan override;
- Normal operation (lowest priority).

Power-up/reset Sequence

The power-up/reset sequence is the highest priority sequence. After the configuration is defined, the manual output test can be initiated. When 24Vac power is initially applied to the Tracer VV550/551 controller or a reset occurs, the following sequence occurs:

1. Green status LED turns *ON*.
2. All outputs are controlled to their normal or de-energized state.
3. Configuration is read out of the non-volatile memory.
4. The controller reads input values to determine initial values.
5. Stand-alone control is assumed until communicated control data is received.
6. Power-up control wait timer is started. The controller waits the configured number of seconds to allow time for the communicated control data to arrive.

Note: If, after the power-up control wait timer expires and the controller has not received communicated control data, the unit assumes stand-alone operation.

a. Receiving a control data network variable drives the power-up control wait timer to zero and the controller immediately transitions to normal operation. The following are the communicated control data network variables:
   i. Communicated application mode;
   ii. Communicated auto commission command;
   iii. Communicated emergency override;
   iv. Communicated flow override;
   v. Communicated heat/cool mode;
   vi. Communicated occupancy schedule;
   vii. Communicated occupancy override;
   viii. Communicated occupancy sensor;

ix. Communicated source temperature;
x. Communicated field override;
xi. Communicated valve override.

7. Normal operation begins (assume modulating valves/valve are closed at power up).
8. Calibration occurs if autocalibration is enabled.
9. Normal operation resumes.

Manufacturing Test

Manufacturing test is the sequence the controller uses when factory testing is being conducted. This sequence is not for field use.

Unit Shutdown

The unit shutdown sequence follows the generation of either the invalid unit configuration diagnostic or the controller failure diagnostic. The controller is still communicating: the green status LED is *ON* and the Red status LED is *OFF*.

Emergency Override

The communicated emergency override request enables the controller to start driving the outputs within five seconds of its receipt. The actuators are driven as quickly as possible to the correct position. All the control inputs are ignored and the associated sequences are not run during emergency override.

A reset or receipt of a communicated emergency override normal request resets the controller and returns the controller to normal operation, if normal operation is possible.

Table 17 and Table 18 show the supported emergency override requests for control modes.

Table 17. Space temperature and ventilation flow controller emergency override operation

Communicated emergency override No heartbeat	Fan	Reheat output	Air valve
Normal or not valid [a]	Normal	Normal	Normal
Pressurize	Series On; Parallel Off	Off	Open [a]
Depressurize	All Off	Off	Closed
Purge	Series On; Parallel Off	Off	Open [a]
Shutdown	Off	Off	Closed
Fire	Off	Off	Closed

a. Open to configured maximum airflow setpoint.

Table 18. Flow tracking emergency override operation

Communicated emergency override No heartbeat	Fan	Reheat output	Air valve
Normal or not valid [a]	Don't care	Don't care	Normal
Pressurize	Don't care	Don't care	Closed
Depressurize	Don't care	Don't care	Open [a]
Purge	Don't care	Don't care	Open [a]
Shutdown	Don't care	Don't care	Closed
Fire	Don't care	Don't care	Closed

a. Open to configured maximum airflow setpoint.

Manual Output Test

The manual output test sequence verifies output and end device operation and can be conducted to verify output wiring and actuator operation without using the Rover® service tool. It can also be used during air balancing or water balancing.

Many service calls are initiated due to unit diagnostics. This manual output test sequence (see Table 19) attempts to clear unit diagnostics and restore normal unit operation prior to testing the outputs.

If the diagnostics remain after an attempt to clear them, the status LED flashes in a *two-blink* pattern. The two-blink pattern indicates that the diagnostic condition is still present and may affect or disallow the manual output test. For information on which diagnostics cause a two-blink pattern, refer to "Green status LED blink pattern during manual test" on page 93 and Table 48 on page 90.

The manual output test terminates when it has advanced completely through the test sequence or when the controller times out as a result of remaining in a single step for one hour. The outputs are not subject to minimum times during the test sequence. However, the test sequence only permits one step per second, which enforces a minimum output time.

All diagnostics other than the following are ignored during manual test:

- Ventilation flow control, freeze protection (low discharge air temperature);
- Low airflow diagnostic will prevent local electric reheat.

Table 19. Manual output test sequence

Step [a]	Air valve close	Air valve open	Heat 1 or water valve close	Heat 2 or water valve open	Heat 3 or fan On / Off
1. Off [b]	Off	Off	Off	Off	Off/Off
2. Air valve opens [c]	Off	On	Off	Off	Off/Off
3. Air valve stops opening; fan turns On	Off	Off	Off	Off	Off/On
4. Heat 1 turns On/water valve closes	Off	Off	On	Off	Off/On

Table 19. Manual output test sequence

Step [a]	Air valve close	Air valve open	Heat 1 or water valve close	Heat 2 or water valve open	Heat 3 or fan On / Off
5. Heat 1 turns Off; Heat 2 turns On/water valve opens	Off	Off	Off	On	Off/On
6. Heat 2 turns Off; Heat 3 turns On/water valve closes	Off	Off	Off/On	Off	On/On
7. Heat 3 turns Off; air valve 1 closes; fan turns Off	On	Off	Off	Off	Off/Off [d]
8. Exit [e]					

a. The invalid unit configuration diagnostic causes the controller to exit manual output test.
b. On activating the manual output test function, all outputs are turned Off or closed. The green status LED blinks in a one-blink pattern during the manual output test if no diagnostics are present. The green status LED blinks in a two-blink pattern during the manual output test if a diagnostic is present.
c. At the beginning of step 2, the controller attempts to reset all diagnostics. The low airflow diagnostic prevents local electric reheat from energizing. A ventilation flow controller with a freeze protection active diagnostic will not run the manual output test.
d. A series fan stays On until the air valve is closed.
e. After the last step, the test sequence performs an exit. This initiates a reset and attempts to return the controller to normal operation.

To perform manual output testing:

1. Press and hold the *TEST* push button for at least three seconds. The green status LED turns Off, confirming the Test button was pressed.
2. Release the *Test* button to start the manual output test. The manual output test is in step one. The green status LED is blinking in one of two patterns. If the green status LED blinks once, no diagnostics are present. If the green status LED blinks twice, diagnostics are present.
3. Press the *TEST* button (no more than once per second) to advance through the test sequence. Test steps are not skipped. For example, if the unit does not have Heat 3, advancing to step 6 has no effect, but you still must advance to step 6 before advancing to step 7.

Alternatively, the service override mode enables the Rover™ service tool to override all outputs over the communications network. This mode is useful for water balancing, air balancing, test, and commissioning. The implementation mimics the manual output test.

The mode field of reported unit status and reported heat/cool mode reports *TEST* during the manual output test.

A manual override timer is used to limit the length of the override request. This timer is set to 60 minutes at the start of the manual output test, and reset to 60 minutes each time the manual output test is advanced to the next step either by pressing the *Manual Test* button or on receipt of a communicated value.

Auto-commissioning Test Sequence

The controller auto-commissioning test sequence (see Table 20 below) validates both the proper operation of all outputs and the capability to measure all inputs. The purpose of the test sequence is to minimize the labor required to commission the unit in the field.

The auto-commissioning test does not require a flow sensor or an auxiliary temperature sensor. If there is no flow sensor, the controller runs in pressure-dependent mode. An auxiliary temperature sensor in the discharge air stream is required for testing of the fan and the reheat. The fan and the reheat are not tested if the discharge air temperature sensor is not present. The fan is not tested if there is no fan. Local reheat is tested, if it is present. Remote reheat is not tested.

The sequence starts on receipt of an auto-commission command from the Tracer Summit™ BAS or the Rover™ service tool. The auto-commission command contains a time/date stamp. No third party tool can start the auto-commissioning sequence. The user then chooses to commission all VAV boxes or one VAV box.

The results of auto-commissioning are contained in a structured network variable called reported auto commissioning report. The controller places the time/date stamp in the report. The structure is loaded with the default values for all of the fields when the auto-commissioning test sequence starts. The the fields are updated with the results as the sequence progresses. The data is held until the next auto-commissioning test.

If an auto-commission command is received in the middle of an auto-commissioning cycle the auto-commissioning sequence restarts. If an auto-commission command is received during calibration, calibration aborts and restarts after auto-commissioning finishes. If an abort auto-commission command is received during the calibration portion of the primary air valve test, it is honored after the air valve calibration finishes.

The mode field of reported unit status reports *TEST* when the controller is in the auto-commissioning sequence.

Table 20. Auto-commissioning test sequence

Item	Test action	Reported data
Primary air valve and airflow [a]	1. Turn Off fan and reheat. 2. Close air valve and modulating water valve (if present). 3. Calibrate the airflow sensor. 4. Open the air valve to 40% of the configured maximum airflow. Record the position of the air valve. 5. Open the air valve to 100% of the configured maximum airflow. Record the position of the air valve.	Primary air valve position at 40% and 100% flow
Fan flow [b]	1. Record the auxiliary temperature at the configured maximum airflow. 2. Close the primary air valve. 3. Turn On the fan (if present). 4. Monitor auxiliary temperature for 3 minutes or until it changes by 10°F. 5. Record the auxiliary temperature.	Starting and ending auxiliary temperature
Local reheat hydronic [b]	1. If no fan is present, open the air valve to the configured minimum local heating airflow. 2. If the fan is present, close the air valve and turn On the fan. 3. Record the auxiliary temperature. 4. Open the water valve to 100% open. 5. Monitor the auxiliary temperature for 10 minutes or until it changes by 10°F.	Starting and ending auxiliary temperature

Table 20. Auto-commissioning test sequence

Item	Test action	Reported data
Local reheat electric [b]	1. If no fan is present, open the air valve to the configured minimum local heating airflow. 2. If the fan is present, close the air valve and turn On the fan. 3. Record the auxiliary temperature. 4. Progressively turn On each local stage 30 seconds after the previous stage until all stages are energized. 5. Record the auxiliary temperature 30 seconds after each stage is energized.	Starting auxiliary temperature and the auxiliary temperature for each local stage of electric heat energized

a. If there is no flow sensor, the controller runs in pressure dependent mode and record 40% and 100% during this auto-commissioning step.
b. Requires a functional auxiliary sensor in the discharge air stream. The auxiliary sensor must be configured for discharge air temperature.

Calibration Sequence

The calibration sequence enables the controller to calibrate the air valve position and the water valve position. Calibration takes place if autocalibration is enabled and either a power cycle or a transition from occupied to unoccupied has occurred.

Note: Whether or not autocalibration is enabled, the controller initiates calibration on a communicated application mode command.

The building automation system is responsible for the staggering of the calibration sequence that is needed between units.

When autocalibration is enabled and a transition from occupied to unoccupied occurs, the calibration sequence starts after a fixed delay of three minutes. The controller effective occupancy mode is unoccupied, but runs like it is occupied during this three-minute period.

The *mode field of reported unit status* reports calibration when the controller is in the calibration sequence. If autocalibration is disabled, the air valve and water valve are not driven closed and the flow sensor zero flow voltage reading is not recorded. Refer to Table 21 for calibration actions.

Table 21. Calibration actions

I/O device	Calibration action taken	Result after calibration
Air valve	Drive the air valve closed to the stroke time plus 20 seconds.	Initialize the air valve position as closed when the air valve is over-driven.
Flow sensor	Record the flow reading when the air valve is fully closed.	Subtract the zero flow reading from all subsequent readings.
Modulating hot water reheat	Drive the water valve closed for the stroke time plus 20 seconds.	Initialize the water valve position as closed when the water valve is over-driven.
Fan	Enabled	Enabled
Electric or On/Off hot water	Disabled	Enabled

Overrides: Water Valve, Flow, Fan

These three overrides have the same priority in the control sequences:

Water Valve Override

When the controller responds by driving the outputs within five seconds of receiving the communicated valve override network variable. The actuators are driven as quickly as possible to the correct position.

Water valve override has many enumerations. See the LonMark® Space Comfort Controller (SCC) functional profile for a complete list of all the water valve override enumerations. Table 22 shows the three supported water valve override requests. Other enumerations are treated as not valid.

Table 22. Water valve override controller operation

Communicated valve override	Local reheat	Air valve	Fan
0 = Off, normal, or not valid	Normal	Normal	Normal
4 = Open, fully open all valves	Open	Normal	Normal
5 = Close, fully close all valves	Closed	Normal	Normal
Other enumeration	Normal	Normal	Normal

There is no impact on the air valve or fan operation during water valve override.

Receiving the communicated valve override *OFF* request releases the water valves back to the controller for normal operation. The controller automatically exits the water valve override mode, changes the communicated valve override to *OFF*, and reverts back to normal operation, if the configured manual override time (default = 600 minutes, [10 hours]) elapses since the last valid receipt of a communicated valve override.

Flow Override

The controller responds by driving the outputs within 5 seconds of receiving the communicated flow override network variable. The actuators are driven as quickly as possible to the correct position. The local zone sensor module flow overrides (single star and double star) have priority over the communicated flow override.

The airflow override network variable (communicated flow override) has many enumerations. See the LonMark® Space Comfort Controller functional profile for a complete list of all the airflow override enumerations. Table 23 shows the supported airflow override requests. Other enumerations are treated as not valid.

Table 23. Airflow override controller operation

Communicated flow override	Local or remote reheat	Air valve	Fan
0 = Off Normal or not valid	Normal	Normal	Normal
3 = Flow percent	Normal	Control airflow to the requested percentage of the configured maximum airflow	Normal
4 = Open Fully open all air valves	Normal	Open	Series normal Parallel Off
5 = Close Fully close all air valves	Normal	Close	Normal
6 = Minimum	Normal	Control airflow to the configured minimum airflow	Normal
7 = Maximum	Normal	Control airflow to the configured maximum airflow	Series normal Parallel Off
Other enumeration	Normal	Normal	Normal

Note: Local electric reheat is turned Off when the primary airflow rate falls below the configured minimum local heating airflow minus 3% of the configured nominal airflow.

There is no impact on the reheat operation during airflow override. Parallel fans are turned Off during the drive to configured maximum airflow or open to prevent physical damage to the back-draft door.

Receiving the communicated flow override *OFF* request releases the air valve back to the controller for normal operation. The controller automatically exits the airflow override mode, changes communicated flow override to *OFF*, and reverts back to normal operation if the configured manual override time (default = 600 minutes [10 hours]) elapses since the last valid reception of communicated flow override.

Fan Override

The fan can be remotely controlled by the use of the communicated fan speed command. This variable can be used to request modulating speeds from 0% to 100% in 0.5% increments. Table 24 shows the affect of the variable on controller operation.

Table 24. Fan override controller operation

Communicated fan speed command No heartbeat	On / Off fans series or parallel	Air valve	Reheat
Off	Off	Normal	Local electric: Off; Other: normal
On, 100%	On	Normal	Normal
On 0.5% to 99.5%	On	Normal	Normal

Normal Operation

Normal operation is the lowest priority sequence. The controller is functioning normally when it is operating in one of the three control modes (space temperature control, ventilation control, or flow tracking control) and in one of four occupancy modes (occupied mode, unoccupied mode, occupied standby mode, or occupied bypass mode).

Occupancy

This section provides information that relates to the operation of the Tracer™ VV550/551 controller and includes the topics of:

- Occupancy modes;
- Space setpoint operation;
- Occupancy mode sources;
- Determining the occupancy mode;
- Overriding occupancy;
- Occupancy arbitration.

Occupancy Modes

Tracer VV550/551 controllers have four valid occupancy modes.

Occupied Mode

Occupied mode is the normal (default) operating mode for occupied spaces or daytime operation. When the controller is in the occupied mode, it uses occupied setpoints and runs in:

- Occupied temperature control;
- Ventilation flow control or space temperature control;
- Flow tracking control.

Unoccupied Mode

Unoccupied mode (also known as *night setback*) is the normal operating mode for unoccupied spaces or nighttime operation. Unoccupied setpoints enable or disable occupied space temperature control.

When the controller is in the unoccupied mode and configured for space temperature control, the controller attempts to keep the space temperature between the active unoccupied heating setpoint and the active unoccupied cooling setpoint.

When the controller is in the unoccupied mode and configured for ventilation flow control, it will not run in unoccupied mode, the air valve is closed, and local heat is disabled. A flow tracking controller runs the same as when it is occupied.

When the controller is in the unoccupied mode and configured for flow tracking control, it runs the same as it does in occupied mode.

Occupied Standby Mode

Occupied standby mode is used to reduce the heating and cooling demands during the occupied hours when the space is unoccupied. It can be activated for a classroom currently not in use.

The controller can be placed in the occupied standby mode when a communicated occupancy mode request (from a communicated occupancy override, occupancy schedule, or occupancy sensor) is combined with an occupancy request from the local (hardwired) occupancy binary input. Once in occupied standby mode, the controller uses the occupied standby cooling and heating setpoints, which typically cover a wider range than the occupied setpoints. The wider range reduces the demand for heating and cooling in the space.

When the communicated occupancy mode request is unoccupied, the occupancy binary input signal (if present) does not affect the controller occupancy mode. When the communicated occupancy mode request (communicated occupancy override not valid, communicated occupancy schedule occupied, or communicated occupancy sensor not valid) is occupied, the controller uses the local occupancy binary input to switch between the occupied and occupied standby modes.

When the controller is in the occupied standby mode, it uses occupied standby setpoints and runs in:

- Occupied temperature control;
- Ventilation flow control or space temperature control;
- Flow tracking control.

Occupied Bypass Mode

Occupied bypass mode is used for timed overrides. For example, if the controller is in unoccupied mode or occupied standby mode, pressing the zone sensor *ON* button places the controller in occupied bypass mode for 120 minutes (default configured occupied bypass time) or until someone presses the zone sensor *CANCEL* button.

The controller can be placed in occupied bypass mode by either communicating an occupancy mode request of bypass mode (communicated occupancy override) to the controller or by using the zone sensor timed override *ON* button. The occupied bypass mode and the occupied mode operate similarly.

When the controller is in the unoccupied mode, pressing the zone sensor *ON* button places the controller in the occupied bypass mode for the duration of the configured occupied bypass time.

When the controller is in the occupied standby mode, pressing the zone sensor *ON* button places the controller in the occupied bypass mode for the duration of the configured occupied bypass time.

When the controller is in the occupied bypass mode, it uses occupied setpoints and runs in:

- Occupied temperature control;

- Ventilation flow control or space temperature control;
- Flow tracking control.

Space Setpoint Operation

Space setpoints provide temperature boundaries for each of the occupancy modes of the Tracer™ VV550/VV551 controllers. There are three sets of possible heating and cooling setpoints available:

- Occupied (also used by occupied bypass);
- Occupied standby;
- Unoccupied.

Table 25 shows the space setpoint operation. In unoccupied mode, the controller uses the locally stored default unoccupied heating and cooling setpoints. These local setpoints are configured during factory download and unit verification. Use the Rover™ service tool or the Tracer Summit™ BAS to modify these default unoccupied setpoints.

Table 25. Space setpoint operation

Method	When used
Zone sensor (with an adjustable hardwired setpoint, SET)	A hardwired, adjustable setpoint is connected to the controller. Local setpoints are enabled in the unit configuration. No communicated setpoint is present.
Communicated Source	A communicated setpoint to the unit controller comes from a building automation system or a peer controller. If both a hardwired setpoint and a communicated setpoint are available, the controller uses the communicated value. The configuration feature for enabling and disabling the local setpoint does not affect the setpoint handling when a communicated setpoint is used. The communicated setpoint always takes priority over the hardwired setpoint, even when the local setpoint is enabled.
Stored default space setpoints	The controller uses the locally stored default heating and cooling setpoints when neither a local hardwired setpoint nor communicated setpoint is present. The controller uses stored default setpoints when only a local setpoint exists, but the local setpoint is disabled in the configuration of the controller. The controller always uses the stored default (unoccupied) setpoints in unoccupied mode.

Occupancy Mode Sources

There are various ways to control the controller occupancy mode. The first two bullet points are the more common and separately addressed below:

- Communicated request (Comm5 network variable inputs);
  - Communicated occupancy override (occupied, unoccupied, standby, bypass);
  - Communicated occupancy schedule (occupied, unoccupied, standby);
  - Communicated occupancy sensor (occupied, unoccupied).
- Occupancy binary input (occupied, unoccupied);
- Zone sensor timed override *ON* button;
- Zone sensor timed override *CANCEL* button;
- Default operation of the controller (occupied mode).

Communicated Request

A communicated request from a building automation system or another peer controller can change the controller occupancy mode. However, if communication is lost, the controller reverts to the default operating mode (occupied) after 15 minutes (the configured receive heartbeat time), if no local hardwired occupancy mode signal exists.

A communicated request can be provided to control the occupancy mode of the controller. Typically, the occupancy mode of the controller is determined by using time-of-day scheduling in the building automation system. The result of the time-of-day schedule can then be communicated to the unit controller (communicated occupancy schedule). If the communicated occupancy schedule receives heartbeat times out, the controller reverts back to occupied.

To view the present values chart for Tracer Summit™ BAS SCC, refer to Table 61 on page 105. For complete information about the setup for Tracer Summit building automation system (BAS) applications of this controller, see the Tracer Summit product literature. For more information on the setup of another building automation system, refer to product-specific literature from its manufacturer.

Occupancy Binary Input

The binary input can be configured as an occupancy input. The controller uses the occupancy binary input and the presence of a communicated occupancy schedule to determine the occupancy mode of the unit.

If a controller does not receive a communicated occupancy schedule, usually from a building automation system (stand-alone controller), the occupancy binary input determines the occupancy mode of the unit based on the hardwired signal. Typically, the signal is hardwired to a binary switch or to a time clock.

If a controller receives a communicated occupancy schedule from a building automation system, the hardwired occupancy binary input is used with a communicated occupancy schedule to determine the occupancy mode of the controller: either occupied mode or occupied standby mode.

If neither a hardwired binary input nor a communicated schedule is used to select the occupancy mode, the controller defaults to occupied mode.

Determining the Occupancy Mode

The occupancy mode of the controller is determined by evaluating a combination of three communicating inputs, the hardwired occupancy input, and the timed override *ON* and *CANCEL* buttons on the Trane zone sensor. Three communicating inputs affect the controller occupancy mode:

- Occupancy determined by manual command;
- Occupancy determined by schedule;
- Occupancy determined by sensor.

These three network variables provide maximum flexibility, but the number of inputs used varies with the application and the features available in the building automation system.

Occupancy Determined by Manual Command

Some communicating devices may request an occupancy mode based on the information communicated in the communicated occupancy override network variable. Trane® systems and zone sensors do not communicate this information to the controller, but the controller accepts this network variable.

Note: The receipt of communicated occupancy override with a value other than bypass causes the occupied bypass timer to be set to zero.

Occupancy Determined by Schedule

Building automation systems typically communicate an occupancy mode request using the occupancy schedule input. The controller accepts communicated occupancy schedule in the communicated occupancy schedule network variable input.

Occupancy Determined by Sensor

Some occupancy sensors may have the capability to communicate an occupancy mode to the controller. In such devices, the communicated occupancy sensor variable is used to communicate the occupancy mode to the controller. Trane systems and zone sensors do not currently send this variable. The hardwired occupancy input of the controller is handled as if it is a communicated occupancy sensor input. When both a hardwired input and a communicated input are available, the communicated input is used.

Overriding Occupancy

Some Trane zone sensors include timed override buttons labeled *ON* and *CANCEL*. The controller always recognizes the timed override *ON* button. Use the timed override *ON* button to place the controller in override (occupied bypass mode). Use the timed override *CANCEL* button to cancel the override request. Table 26 shows bypass timer actions and Table 27 shows the result of using the *ON* button in each of the four occupancy modes.

Table 26. Bypass timer action

Zone sensor buttons	Bypass timer action
None	Timer counts down to zero and stops
ON	Set bypass timer to the configured occupied bypass time [a]
CANCEL	Set bypass timer to zero
Both ON and CANCEL [b]	Set bypass timer to the configured occupied bypass time [a]

a. When an update of the communicated occupancy mode override indicates bypass, the bypass timer is set to the configured occupied bypass time.
b. If both the ON and CANCEL buttons are pressed simultaneously, it is interpreted as ON.

Table 27. Result of pressing the ON button in each occupancy mode

Controller mode	Action	Result
Occupied	ON button pressed for one second then released	Controller sets bypass timer to 120 minutes (default configured occupied bypass time). The bypass timer starts to count down to zero. Concurrently, the controller may change its current mode to unoccupied or occupied standby (possibly due to a change based on the system time of day schedule). If it does, the controller switches to occupied bypass mode for the remainder of the bypass time or until the zone sensor CANCEL button is pressed. If the bypass timer counts down to zero, the timed override is disabled.
Unoccupied mode	ON button pressed for one second then released	Controller changes to occupied bypass mode. It sets the bypass timer to 120 minutes (default configured occupied bypass time). The timed override is disabled either if the bypass timer counts down to zero or if the zone sensor CANCEL button is pressed for one second then released.
Occupied standby mode	ON button pressed for one second then released	Controller changes to occupied bypass mode. It sets the bypass timer to 120 minutes (default configured occupied bypass time). The timed override is disabled either if the bypass timer counts down to zero or if the zone sensor CANCEL button is pressed for one second then released.
Occupied bypass mode (timer not expired)	ON button pressed for one second then released	Bypass timer set to 120 minutes (default configured occupied bypass time). When the bypass timer counts down to zero, the timed override is disabled.

Occupancy Arbitration

Table 28 shows occupancy arbitration for Trane® Comm5 devices.

Table 28. Effective occupancy arbitration for Trane Comm5 devices

Communicated occupancy mode override [a]	Communicated occupancy mode schedule (heartbeat)	Communicated occupancy mode sensor (heartbeat)	Occupancy binary input	Bypass timer	Reported effective occupancy mode
Occupied [b]	X [c]	X [c]	X [c]	X [c]	Occupied
Unoccupied [b]	X [c]	X [c]	X [c]	Zero	Unoccupied
				Not zero	Bypass
Bypass [b]	Occupied	X [c]	X [c]	X [c]	Occupied
	Unoccupied	X [c]	X [c]	Zero	Unoccupied
				Not zero	Bypass
	Standby	X [c]	X [c]	Zero	Standby
				Not zero	Bypass
	Not present	Occupied	X [c]	X [c]	Occupied
		Unoccupied	X [c]	Zero	Unoccupied
				Not zero	Bypass
		Not present	Occupied	X [c]	Occupied
			Unoccupied	Zero	Unoccupied
				Not zero	Bypass
			Not present	X [c]	Occupied
Standby [b]	X [c]	X [c]	X [c]	Zero	Standby

Table 28. Effective occupancy arbitration for Trane Comm5 devices (continued)

Communicated occupancy mode override [a]	Communicated occupancy mode schedule (heartbeat)	Communicated occupancy mode sensor (heartbeat)	Occupancy binary input	Bypass timer	Reported effective occupancy mode
				Not zero	Bypass
Not present [b]	Occupied	Occupied	X [c]	X [c]	Occupied
		Unoccupied	X [c]	Zero	Standby
				Not zero	Bypass
		Not present	Occupied	X [c]	Occupied
			Unoccupied	Zero	Standby
				Not zero	Bypass
			Not present	X [c]	Occupied
	Unoccupied	X [c]	X [c]	Zero	Unoccupied
				Not zero	Bypass
	Standby	X [c]	X [c]	Zero	Standby
				Not zero	Bypass
	Not present	Occupied	X [c]	X [c]	Occupied
		Unoccupied	X [c]	Zero	Unoccupied
				Not zero	Bypass
		Not present	Occupied	X [c]	Occupied
			Unoccupied	Zero	Unoccupied
				Not zero	Bypass
			Not present	X [c]	Occupied

a. The communicated occupancy override enumerations of unoccupied and standby can be bypassed.
b. The bypass timer is set to the value in the configured occupied bypass time each time one of the following occurs:
- Receive communicated occupancy mode override of bypass
- Receive timed override On request from the local zone sensor module (zone sensor ON button is pressed for one second then released)

After the bypass timer is set to the configured occupied bypass time, it counts down to zero.
The bypass timer is cleared to zero each time one of the following occurs:
- Receive communicated occupancy mode override of: occupied, unoccupied, standby, or not present
- Receive timed override cancel request from the local zone sensor module (zone sensor cancel button is pressed for one second then released)

To disable the bypass timer, set the configured occupied bypass time to zero. This effectively disables the zone sensor module timed override On function, and the communicated occupancy mode override bypass request.
c. An upper case X means “do not care”.

Note: The shaded area of the table is where most jobs operate

Space Temperature Control Mode

Space temperature control (STC) is one of three supported control algorithms. Space temperature control requires a valid space temperature. If there is no valid space temperature (communicated or local), the space temperature control algorithm does not run; the unit either shuts down or goes to construction mode.

Tracer™ VV550/VV551 controllers use the active space temperature to maintain the space temperature at the active space cooling setpoint or the active space heating setpoint. The space temperature control algorithm runs once every 10 seconds.

The controller heat/cool mode is determined by either a communicated request or by the controller itself, when the heat/cool mode is auto. When the heat/cool mode is auto, the controller compares the primary air temperature with the configured auto-changeover setpoint to determine if the primary air is *hot* or *cold*. This is called autochangeover. This determination may differ from the reported heat/cool mode, which matches the zone demand.

The control compares the active space setpoint and the active space temperature and calculates the desired capacity. The control positions the modulating air valve to deliver the desired airflow (cooling or heating capacity).

Heating or Cooling Control Mode Operation

Heating or cooling control mode of the controller can be determined by either a communicated request (via communicated heat/cool mode or communicated application mode) or automatically by the controller.

Communicated Request

A building automation system or peer controller may communicate the heating or cooling mode to the controller using the following network variables:

- Communicated heat/cool mode;
- Communicated application mode.

Heating mode commands the controller to heat only (implies primary air temperature is hot). Cooling mode commands the controller to cool only (implies primary air temperature is cold). During cooling mode the use of reheat is possible. The communicated application mode enables the controller to automatically change from heating to cooling or cooling to heating.

Automatically by the Controller

A communicated request of auto or the controller default operation (auto) can place the unit in heating or cooling mode. When the controller automatically determines the heating or cooling mode, the unit switches to the desired mode based on the primary air temperature.

Initial Space Demand Determination for Space Temperature Control

When the controller powers up or after it resets, it makes an initial determination of what the space demand should be: heat or cool. If the initial space temperature is less than the occupied heating setpoint, the initial space demand is heat; if not, the initial space demand is cool. The space demand is what is reported in reported heat/cool mode and the mode field of reported unit status.

Heating and Cooling Changeover Logic

The controller can receive communicated requests for heating or cooling operation. Two communicated variables (communicated application mode and communicated heat/cool mode) are used to communicate the requests to the controller (see Table 29). For more information on the relationship between these two variables, refer to Table 62 on page 107.

Table 29. Heating and cooling changeover logic

System command, communicated application mode, communicated heat/cool mode	Primary air temp, communicated source temp or local input [g]	Local zone demand [f]	Reported heat/cool mode or reported unit status mode [a, b]	Air valve action [c]	Air valve position	Active minimum [h]
Heat	Hot	Don't care	Heat	Heat	Modulation	Refer to Table 40 on page p. 65 for Active Minimums
	Cold	Don't care	Heat	Cool	Refer to Table 40 on page p. 65 for Active Minimums	Refer to Table 40 on page p. 65 for Active Minimums
	Invalid	Don't care	Heat	Heat [d]	Modulation	Refer to Table 40 on page p. 65 for Active Minimums
Cool	Hot	Don't care	Cool	Heat	Refer to Table 40 on page p. 65 for Active Minimums	Refer to Table 40 on page p. 65 for Active Minimums
	Cold	Don't care	Cool	Cool	Modulation	Refer to Table 40 on page p. 65 for Active Minimums
	Invalid	Don't care	Cool	Cool [d]	Modulation	Refer to Table 40 on page p. 65 for Active Minimums
Auto	Hot	Heat	Heat	Heat	Modulation	Refer to Table 40 on page p. 65 for Active Minimums
		Cool	Cool	Heat	Refer to Table 40 on page p. 65 for Active Minimums	Refer to Table 40 on page p. 65 for Active Minimums
	Cold	Heat	Heat	Cool	Refer to Table 40 on page p. 65 for Active Minimums	Refer to Table 40 on page p. 65 for Active Minimums
		Cool	Cool	Cool	Modulation	Refer to Table 40 on page p. 65 for Active Minimums
	Invalid	Heat	Heat	Heat/Cool [e]	Note e	Note e

Table 29. Heating and cooling changeover logic (continued)

System command, communicated application mode, communicated heat/cool mode	Primary air temp, communicated source temp or local input [g]	Local zone demand [f]	Reported heat/cool mode or reported unit status mode [a, b]	Air valve action [c]	Air valve position	Active minimum [h]
		Cool	Cool	Heat/ Cool[e]	Note e	Note e

a. The active heat/cool mode matches the system command if the command is anything other than auto.
b. If the system command is auto, the active heat/cool mode matches the zone demand.
c. If the system command is anything other than auto, zone demand is not considered.
d. If the system command is heat or cool and the primary air temperature is invalid, the primary air temperature is assumed to match the system mode. This will result in problem operation.
e. Based on the configured default primary air temperature (heating or cooling). An assumption is made about the primary air temperature. This will result in problem operation.
f. If the space temperature < heat setpoint, then zone demand is heat and reported heat/cool mode is heat. If the space temperature > cool setpoint and space temperature > heat setpoint + 0.5°F (0.28°C), then zone demand is cool and reported heat/cool mode is cool.
g. If primary air temperature > configured reheat enable setpoint, then primary air temperature is hot. (Primary air is hot enough for heating and too hot for reheat) If primary air temperature > configured auto changeover setpoint, then primary air temperature is warm (hot in table above). (Primary air is hot enough for heating and reheat can be used.) If primary air temperature < configured auto changeover setpoint – 10°F (5.56°C), then primary air temperature is cold. (Primary air is cold enough for cooling and reheat can be used.) No change in hysteresis region.
h. Refer to Table 40 on p. 65.

General Notes:

- Controller state is based on either system command (if heat or cool) or primary air temperature.
- Valve action is based on primary air temperature or configured default primary air temperature.
- Active minimum is based on valve action.

Cooling Operation

Under space temperature control during the cooling mode (communicated heat/cool mode is cool), the controller attempts to maintain the active space temperature at the active space cooling setpoint. Based on the controller occupancy mode, the active space cooling setpoint is either the occupied cooling setpoint, the occupied standby cooling setpoint, or the unoccupied cooling setpoint.

The outputs are controlled based on the unit configuration and the required cooling capacity. At 0% required cooling capacity, the air valve is closed or at the active minimum flow setpoint. As the required cooling capacity increases, the air valve opens above the minimum position. At 100% required cooling capacity, the air valve opens to the maximum position or to the active maximum flow setpoint.

All units have a modulating air valve. The modulating air valve is used to control the volume of air flowing through the diffusers and into the space. Modulating the volume of air modulates the unit cooling capacity.

Also, units may have local or remote reheat. The reheat may be hydronic or electric. Reheat is allowed to turn On when the space temperature is below the heating setpoint. Refer to “Reheat Control” on page 50.

Heating Operation

Under space temperature control, during the heating mode (communicated heat/cool mode is heat), the controller attempts to maintain the space temperature at the active heating setpoint. Based on the controller occupancy mode, the active space heating setpoint is either the occupied heating setpoint, the occupied standby heating setpoint, or the unoccupied heat setpoint. Reference Table 30 for information on controller operation during occupied heating and cooling. All ventilation requirements are in force during occupied heating and cooling.

The outputs are controlled based on the unit configuration and the required heating capacity. At 0% required heating capacity, the air valve is at its minimum flow setpoint. As the required heating capacity increases, the air valve opens above its minimum position. At 100% required heating capacity, the air valve opens to its maximum position.

All units have a modulating air valve. The modulating air valve is used to control how much air is flowing through the diffusers and into the space. By modulating the volume of air flowing, the unit heating capacity is modulated.

Units may also have local or remote reheat. This reheat may be hydronic or electric. Reheat is used to maintain the space temperature at the heating setpoint. For more information on reheat, refer to "Reheat Control" on page 50).

Table 30. Controller operation during occupied heating and cooling

PAT [a]	Space Temperature	Primary airflow control active minimum airflow setpoints	Fan control	Reheat control
Cold	≤ Active Heat Stpt	At the highest min position: • Local heat min airflow • Min airflow • Effective ventilation setpoint	Series On Parallel On	Reheat On
	HSP < ZT < HSP + 2	At the highest min position: • Min airflow • Effective ventilation setpoint	Series On Parallel On	Reheat Off
	> Active Cool Stpt	Modulate from cool max to highest min: • Min airflow • Effective ventilation setpoint	Series On Parallel Off	Reheat Off
Warm	≤ Active Heat Stpt	Modulate from heat max to highest min: • Local heat min airflow • Heating min airflow • Effective ventilation setpoint	Series On Parallel Off	Reheat Not Present
	≤ Active Heat Stpt	Modulate from heat max to highest min: • Local heat min airflow • Heating min airflow • Effective ventilation setpoint	Series On Parallel On (w/ reheat)	Reheat On
	HSP < ZT < HSP + 2	At the highest min position: • Heating min airflow • Effective ventilation setpoint	Series On Parallel Off	Reheat Off
	> Active Cool Stpt	At the highest min position: • Heating min airflow • Effective ventilation setpoint	Series On Parallel Off	Reheat Off

Table 30. Controller operation during occupied heating and cooling

PAT [(a)]	Space Temperature	Primary airflow control active minimum airflow setpoints	Fan control	Reheat control
Hot	≤ Active Heat Stpt	Modulate from heat max to highest min: • Local heat min airflow • Heating min airflow • Effective ventilation setpoint	Series On Parallel Off	Reheat Off
	HSP < ZT < HSP + 2	At the highest min position: • Heating min airflow • Effective ventilation setpoint	Series On Parallel Off	Reheat Off
	> Active Cool Stpt	At the highest min position: • Heating min airflow • Effective ventilation setpoint	Series On Parallel Off	Reheat Off

a. Primary air temperature is derived from either the communicated source temperature or the primary/discharge air temperature sensor when configured for primary air temperature. Cold; PAT< configured auto-changeover setpoint minus 10°F. Warm; configured auto-changeover setpoint < PAT < configured reheat enable setpoint minus 5°F. Hot; configured reheat enable setpoint < PAT. Rover ™will check the range of the configured reheat enable setpoint, 70°F to 100°F (21.11°C to 37.78°C) for electric heat and 70°F to 200°F (21.11°C to 93.33°C) for hot water heat.

Air Valve Control in Space Temperature Control Operation

The Tracer™ VV550/VV551 controllers support one modulating air valve for heating and cooling operation. Air delivered to the space is controlled with a three-wire floating-point actuator that modulates the air valve. The controller positions the modulating air valve to deliver the desired airflow (cooling or heating capacity). The desired airflow is called the active-flow setpoint. The controller positions the modulating air valve to deliver the desired airflow (cooling and heating capacity) to within +/-2% of nominal airflow.

The airflow control algorithm compares the active airflow setpoint with the measured airflow and calculates the necessary air valve movement to minimize error. The airflow setpoint is limited by applicable minimum and maximum flow setpoints.

Reheat Control

There are two types of reheat control: hydronic heat and electric heat. Reheat is allowed to turn On if the zone temperature is below the heating setpoint. Space temperature control can use reheat if the following conditions are all true:

- The unit is not calibrating;
- Reheat is enabled (communicated auxiliary heat enable);
- For local reheat only, the fan, if present, is not being overridden to Off (communicated fan speed command);
- The primary air temperature is less than the configured reheat enable setpoint (5°F [2.78°C]);
- Local heat minimum airflow is used for both local and remote reheat.

Hydronic Heat

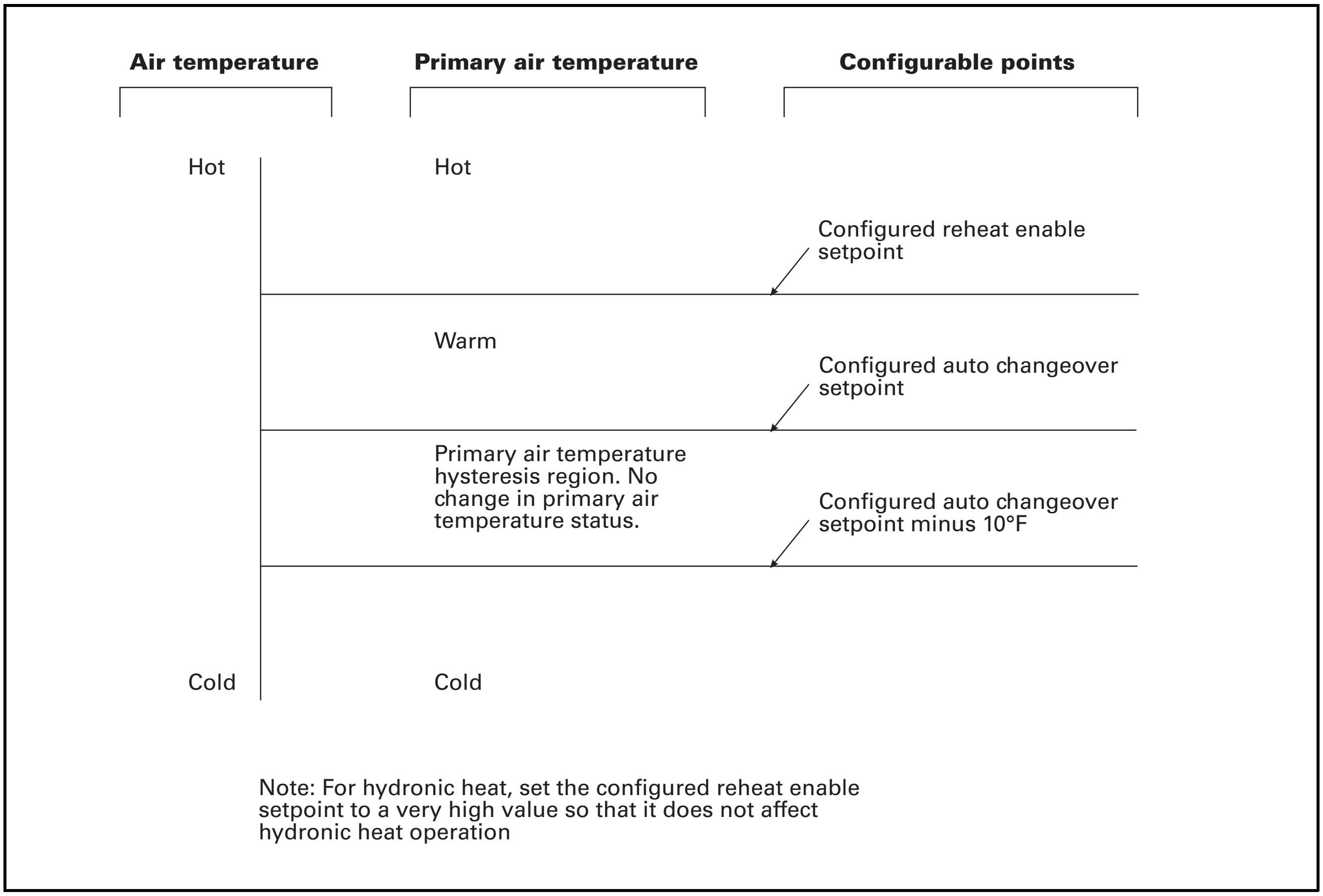
Two types of control of hydronic heat are supported: On/Off and modulating.

Note: Steam is not supported.

Hydronic heat is enabled if there is no valid primary air temperature. Hydronic heat is disabled if the primary air temperature is greater than the configured reheat enable setpoint.

Figure 1 shows the primary air temperature status determination.

Figure 1. Primary air temperature status determination



For hydronic heat, the reheat enable setpoint is able to be configured. The hydronic heat range is 70°F to 200°F (21.11°C to 93.33°C). When the primary air temperature is greater than the configured reheat enable setpoint, reheat is turned *OFF* until the primary air temperature drops 5°F (2.78°C) below the configured reheat enable setpoint. When no primary air temperature is available, the controller checks the configured default primary air temperature to determine if reheat can operate.

On/Off hydronic heat

The controller supports up to three stages of *ON*/*OFF* hydronic heat with no fan and two stages with a fan (series or parallel). For more information on actuation, refer to Appendix D, "Appendix D: Reheat Actuation Schedule Tables" on page 111.

Modulating (three-wire) hydronic heat

The amount of modulating hot water reheat required is determined by a control algorithm. The algorithm determines the percentage of available reheat capacity needed to satisfy zone heating requests. The modulating valve then is driven to the calculated position.

It is difficult for the modulating types of reheat to control to the heating setpoint. The proportional integral algorithm would normally overshoot slightly and settle in at the correct amount of heat. However, this overshoot is not allowed for reasons relating to energy consumption. When the zone temperature reaches the heating setpoint plus 0.5°F (0.28°C), the reheat is turned Off. This causes the operation with modulating heat to oscillate over a long time period and not control at the setpoint.

The modulating hot water valve is over driven closed (by 20 seconds) whenever reheat is no longer required. This maintains position calibration of the hot water valve.

Electric Heat

Thermostat control and pulse width modulation (PWM) control of electric heat are supported. The controller supports up to three stages of electric heat without a fan and two stages with a fan. For electric heat, the reheat enable setpoint is able to be configured. The electric heat range is 70°F to 100°F [21.11°C to 37.78°C]).

Local electric heat is enabled when there is no valid primary air temperature and the configured default primary air temperature is cooling. Local electric heat is disabled:

- When there is no valid primary air temperature and the configured default primary air temperature is heating;
- If the primary air temperature is greater than the configured reheat enable setpoint. It remains disabled until the primary air temperature drops 5°F (2.78°C) below the configured reheat enable setpoint;
- When the derived primary air temperature is warm or hot. If the configured reheat enable setpoint is invalid, the local electric heat is disabled.

Local electric heat is only allowed when a valid primary air temperature is available. If a valid primary air temperature is not available, the controller uses a derived primary air temperature. The derived primary air temperature is warm or hot when the system is heating, or in morning warm-up, or in auto with a configured default primary air temperature indicating heat.

Local electric reheat is allowed to run for 30 seconds prior to the airflow being at the local reheat minimum airflow setpoint. If the airflow never reaches that point, electric reheat is turned off until the airflow is at least at the local reheat minimum airflow setpoint. Once the reheat is on, it is allowed to run as long as the airflow is greater than the local reheat minimum -3% of the normal airflow. If the reheat is turned off because the airflow falls below the local reheat minimum -3%, the airflow has to rise above the local reheat minimum before the reheat is turned back on.

The factory-installed local electric heater provides two mechanical safeties. The two safeties are independent of the controller. The controller provides no indication of the state of the safeties. One safety is an automatic thermal cutout that trips when the temperature is 140°F (60°C). It resets automatically when the temperature drops. The other safety is a manual reset cutout that trips when the temperature reaches 160°F (71.11°C). It requires a manual reset.

Thermostatically controlled electric heat

The controller supports up to three stages of On/Off electric heat with no fan and two stages with a fan. For more information on actuation, refer to Appendix D, "Appendix D: Reheat Actuation Schedule Tables" on page 111.

PWM electric heat (local stages only)

The amount of PWM electric heat required is calculated by a control algorithm identical to the algorithm that calculates the desired airflow for the air valve. It acts like the air valve control.

It is difficult for the modulating types of reheat to control to the heating setpoint. The proportional integral algorithm would normally overshoot slightly and settle in at the correct amount of heat. However, this overshoot is not allowed for reasons relating to energy consumption. When the zone temperature reaches the heating setpoint plus 0.5°F (0.28°C), the reheat is turned Off. This causes the operation with modulating heat to oscillate over a long time period and not control at the setpoint.

PWM electric heat modulates one, two, or three local stages. PWM electric heat uses a hard coded three-minute period and 10-second minimum *ON* and *OFF* times. These values cannot be configured. Each stage of PWM electric heat is an equal percentage of the total reheat capacity.

Reheat Actuation Schedule with No Fan Present

All types of reheat can be limited by the communicated auxiliary heat enable.

The effect of communicated auxiliary heat enable on reheat is described in the following table:

- Table 64 on page 112. Effect of communicated auxiliary heat enable on reheat

The methods of control for the reheat actuation schedule with no fan present are described in the following tables:

- Table 65 on page 117. Local heat only with no fan present
- Table 66 on page 118. Remote heat only with no fan present
- Table 67 on page 119. Local and remote heat with local priority and no fan present
- Table 68 on page 120. Local and remote heat with remote priority and no fan present

Reheat Actuation Schedule with a Parallel Fan Present

Fan-powered units have two outputs available for reheat and one output available for the fan. The parallel fan runs intermittently and is the first stage of reheat. The parallel fan is not limited by the value in the communicated auxiliary heat enable. All other types of reheat are limited by the communicated auxiliary heat enable. The methods of control for the reheat actuation schedule with a parallel fan present are described in the following tables:

- Table 69 on page 121. Local heat only with parallel fan present
- Table 70 on page 122. Local and remote heat with local heat priority and parallel fan present
- Table 71 on page 123. Local and remote heat with remote heat priority and parallel fan present

Reheat Override

All reheat is subject to being remotely enabled or disabled by the communicated auxiliary heat enable network variable. When the variable enables less than 100% of controller capacity, the controller limits the use of reheat to the percentage enabled. Reheat may be enabled in 0.5% increments. For heat stages that cannot support such fine increments, the range 0% to 100% is divided into equal sections and each stage is successively enabled. Table 31 shows an example for a three-stage hot water reheat unit.

Table 31. Example for a three-stage hot water reheat unit

Communicated auxiliary heat enable value	Number of stages enabled
0%	No stages enabled
0.5% to 33%	Stage 1 enabled
33.5% to 66.5%	Stages 1 and 2 enabled
67% to 100%	Stages 1, 2, and 3 enabled

Morning warm-up

The controller enters morning warm-up on receipt of a communicated command. This is the only way morning warm-up can be activated. The controller remains in morning warm-up until the command is changed.

Morning warm-up uses the occupied heating setpoint regardless of the occupancy mode. All ventilation requirements are waived during morning warm-up. Table 32 shows controller operation during morning warm-up.

Table 32. Controller operation during morning warm-up

Primary air temperature	Space temperature	Primary airflow control	Fan control	Reheat control
Cold air in duct: Primary air temperature [a] less than configured auto-changeover setpoint minus 10°F	≤ Active heating setpoint	Local reheat min	Series On Parallel On	Reheat On (All stages on)
	> Active heating setpoint plus 0.5°F	Cool min	Series On Parallel Off	Reheat Off

Table 32. Controller operation during morning warm-up

Primary air temperature	Space temperature	Primary airflow control	Fan control	Reheat control
Warm air in duct: Configured auto-changeover setpoint < primary air temperature [a] < configured reheat enable setpoint minus 5°F [b]	≤ Active heating setpoint	Normal control, modulate from heat min to max	Series On Parallel Off	Reheat Not Present
	≤ Active heating setpoint	Normal control, modulate from heat min to max	Series On Parallel On (w/ reheat)	Reheat On (All stages on)
	> Active heating setpoint plus 0.5°F	Heat min	Series On Parallel Off	Reheat Off
Hot air in duct: Primary air temperature [a] greater than configured reheat enable setpoint [b]	≤ Active heating setpoint	Normal control, modulate from heat min to max	Series On Parallel Off	Reheat Off
	> Active heating setpoint plus 0.5°F	Heat min	Series On Parallel Off	Reheat Off

a. Primary air temperature is derived from either communicated Source Temperature, or the Primary/Discharge air temperature sensor when this input is configured for primary air temperature.

b. The Rover™ service tool checks the range of the configured reheat enable setpoint: 70°F to 100°F (21.11°C to 37.78°C) for electric heat; and 70°F to 200°F (21.11°C to 93.33°C) for hot water heat.

Pre-cool (Morning Cool Down)

The controller enters pre-cool on receipt of a communicated command. This is the only way morning pre-cool can be activated. The controller remains in pre-cool until the command is changed. This operational sequence is also used for night purge.

Pre-cool uses the occupied cooling setpoint regardless of the occupancy mode. All ventilation requirements are waived during pre-cool. Table 33 shows controller operation during pre-cool.

Table 33. Controller operation during pre-cool

Primary air temperature [a]	Space temperature	Primary airflow control	Fan control	Reheat control
Cold air in duct: Primary air temperature less than configured auto-changeover setpoint minus 10°F	≤ Active cooling setpoint minus 2°F	Cool min	Series On Parallel Off	Reheat Off
	> Active cooling setpoint	Normal control, modulate cool min to max	Series On Parallel Off	Reheat Off
Warm air in duct: Configured auto-changeover setpoint < primary air temperature	Do not care	Heat min	Series On Parallel Off	Reheat Off
Hot air in duct: Configured reheat enable setpoint < primary air temperature	Do not care	Heat min	Series On Parallel Off	Reheat Off

a. Primary air temperature is derived from either communicated source temperature, or the primary/discharge air temperature sensor when configured for primary air temperature.

Maximum Flow Heat

The controller enters maximum flow heat on receipt of a communicated command and remains in maximum flow heat until the command changes.

The controller maintains the flow rate at the heating maximum flow setpoint. Table 34 shows controller operation during maximum flow heat.

Table 34. Controller operation during maximum flow

Primary air temperature [a]	Space temperature	Primary airflow control	Fan control	Reheat control
Cold air in duct; Primary air temperature < configured auto-changeover setpoint minus 10°F	≤ active heating setpoint	Heating max flow setpoint	Series On Parallel On	Reheat On
	> active heating setpoint plus 0.5°F	Heating max flow setpoint	Series On Parallel Off	Reheat Off
Warm air in duct; Configured auto-changeover setpoint < primary air temperature < configured reheat enable setpoint minus 5°F	≤ active heating setpoint	Heating max flow setpoint	Series On Parallel Off	Reheat Not Present
	≤ active heating setpoint	Heating max flow setpoint	Series On Parallel On (w/ reheat)	Reheat On
	> active heating setpoint plus 0.5°F	Heating max flow setpoint	Series On Parallel Off	Reheat Off
Hot air in duct; Configured reheat enable setpoint < primary air temperature	≤ active heating setpoint	Heating max flow setpoint	Series On Parallel Off	Reheat Off
	> active heating setpoint plus 0.5°F	Heating max flow setpoint	Series On Parallel Off	Reheat Off

a. Primary Air Temperature is derived from either the communicated Source Temperature, or the Primary/Discharge Air Temperature sensor when configured for Primary Air Temperature. A communicated Application Mode of Max Heat forces the controller to assume the primary is hot if neither the communicated Source Temperature or the local Primary Air Temperature sensor is present. The default Primary Air Temperature does not come into play during Max Heat.

Night Purge

The controller enters night purge on receipt of a communicated command and remains in night purge until this command is changed.

Night purge uses the occupied cooling setpoint regardless of the occupancy mode. All ventilation requirements are waived during night purge. This operational sequence is identical to pre-cool.

Construction (Temporary Heat)

The controller controls the air valve at the maximum heating flow setpoint when no valid space temperature is detected on reset. All local and remote reheat is locked out. Fan operation remains unaffected.

Ventilation Control

Ventilation is in effect whenever the space temperature controller is in one of the following modes:

- Occupied heating;
- Occupied cooling;
- Occupied standby heating;
- Occupied standby cooling.

Ventilation is allowed as long as the space temperature remains in control. If the space temperature gets too cold or too hot, limiting ventilation can help get the space temperature back under control.

Note: Ventilation flow controllers and flow tracking controllers do not do ventilation flow control as described in this topic.

The Tracer Summit™ BAS uses the effective ventilation setpoint from all the VAV boxes to calculate how much outdoor air (OA) the system needs. The Tracer Summit BAS uses the communicated ventilation ratio limit to tell the controllers how much outdoor air is in the primary air. However, the air handler may not be able to provide as much outdoor air as the system requires due, for example, to a low outdoor air temperature. If the communicated ventilation ratio limit is not sufficient, the controller can raise its minimum airflow setpoint as long as the space temperature remains under control.

This topic provides information concerning:

- Methods of ventilation control;
- Arbitration of ventilation requirements;
- Ventilation control actions;
- Active minimum flow setpoint selection arbitration.

Methods of Ventilation Control

Two methods of ventilation control are possible: the CO_2-based demand controlled ventilation (DCV) procedure and the prescribed ASHRAE rate procedure. Both methods achieve the same results, only the procedure is different. Each method calculates an effective ventilation setpoint that can be used locally, or by the system, to maintain ventilation. Table 35 shows the data required for each method of ventilation control.

Table 35. Data required for each method of ventilation control

		Method	
Variable	**Description**	**CO_2-based DCV setpoint**	**Prescribed ASHRAE rate**
Communicated space CO_2	Space CO_2 concentration	Mandatory	Do not care
Communicated ventilation ratio limit	Ventilation ratio limit: *System limit on the amount of outdoor air (OA) that can be present in the primary air stream.*	Optional	Optional
Communicated ventilation setpoint	Dynamic ventilation setpoint: *Input sent to the controller to schedule ventilation.*	Optional	Optional

Table 35. Data required for each method of ventilation control

Variable	Description		Method	
			CO_2-based DCV setpoint	Prescribed ASHRAE rate
Reported airflow	Measured primary airflow		Mandatory	Mandatory
Reported space CO_2	Space CO_2 concentration: *Not used for control, but passed to the system for monitoring.*		Mandatory	Do not care
Reported ventilation status	Ventilation ratio	Required ratio of OA to primary air to meet zone ventilation needs	Mandatory	Mandatory
	Effective ventilation setpoint	Arbitrated final value of the zone ventilation requirement		
	Active minimum flow setpoint			
	Minimum flow setpoint source			
Configured space CO_2 high limit	CO_2 high limit: *CO_2 concentration in the space at which modulation of the ventilation setpoint ends.*		Mandatory	Do not care
Configured space CO_2 low limit	CO_2 low limit: *CO_2 concentration in the space at which modulation of the ventilation setpoint begins.*		Mandatory	Do not care
Configured ventilation setpoint	Occupied ventilation setpoint: *Maximum OA required to ventilate the zone during occupied periods and the high OA limit for CO_2 DCV control. Default is zero, which disables ventilation.*		Mandatory	Mandatory
Configured standby ventilation setpoint	Standby ventilation setpoint: *OA required to ventilate the zone during periods of occupied standby and the low OA limit for CO_2 DCV control. Default is zero, which disables ventilation.*		Mandatory	Mandatory

CO2-based demand-control ventilation procedure

CO_2-based demand-control ventilation uses the communicated space CO_2 value. The controller cannot monitor CO_2 from a local CO_2 sensor. The controller compares the space CO_2 concentration to the configured band of CO_2 values and determines the demand ventilation rate of the zone. The resulting ventilation rate is called the *effective ventilation setpoint*. The effective ventilation setpoint is the outdoor airflow required to provide ventilation. It is used to calculate the ventilation ratio of the zone. Table 36 outlines the derivation of the outdoor air requirement.

Table 36. Calculation of reported effective ventilation setpoint for CO_2-based DCV zones

Communicated space CO_2	Reported effective ventilation setpoint	Description
Less than configured space CO_2 low limit	Configured standby-ventilation setpoint	Zone CO_2 concentration is low. Zone is most likely unoccupied. Contaminants come from the zone itself (carpet, furniture, paint, etc.). A minimum of ventilation air is required to ventilate the zone.
More than configured space CO_2 high limit	Communicated ventilation setpoint limited by configuration [a]	Zone CO_2 concentration is high. Zone is most likely at maximum designed occupancy. Contaminants come from people and building sources. A maximum of ventilation air is required to ventilate the zone.
Configured space CO_2 low limit ≤ communicated space CO_2 ≤ configured space CO_2 high limit	Linear modulation between configured standby-ventilation setpoint and communicated ventilation setpoint limited by configuration [a]	Zone CO_2 concentration is mid-range. Zone is most likely at partial occupancy. Contaminants come from people and building sources. However, zone is not at maximum design occupancy and does not need maximum design ventilation. [b]

a. If the value of the communicated ventilation setpoint is valid, it is used but it is limited by the configuration: Configured standby-ventilation setpoint ≤ Communicated ventilation setpoint ≤ Configured ventilation setpoint.
b. Reported effective ventilation setpoint = Configured standby-ventilation setpoint + (Communicated space CO_2 – Configured space CO_2 low limit) * Communicated ventilation setpoint limited by configuration: Configured standby-ventilation setpoint ÷ (Configured space CO_2 high limit – configured space CO_2 low limit).

The communicated space CO_2 value must fall between the configured space CO_2 high limit and the configured space CO_2 low limit. The reported effective ventilation setpoint must fall between the configured ventilation setpoint and the configured standby-ventilation setpoint. If the configured space CO_2 high limit is less than or equal to the configured space CO_2 low limit, the reported effective ventilation setpoint is equal to the configured standby-ventilation setpoint.

ASHRAE rate procedure

If no communicated CO_2 value is present, the prescribed ASHRAE rate procedure is used. For zones performing ventilation control without CO_2 sensors, the ventilation requirement is based on either the occupancy mode of the zone, as prescribed in ASHRAE 62-2001, or on the communicated ventilation setpoint. The prescribed ASHRAE rate procedure uses one of three values for the effective ventilation setpoint (see Table 37):

- Configured ventilation setpoint;
- Configured standby-ventilation setpoint;
- Communicated ventilation setpoint.

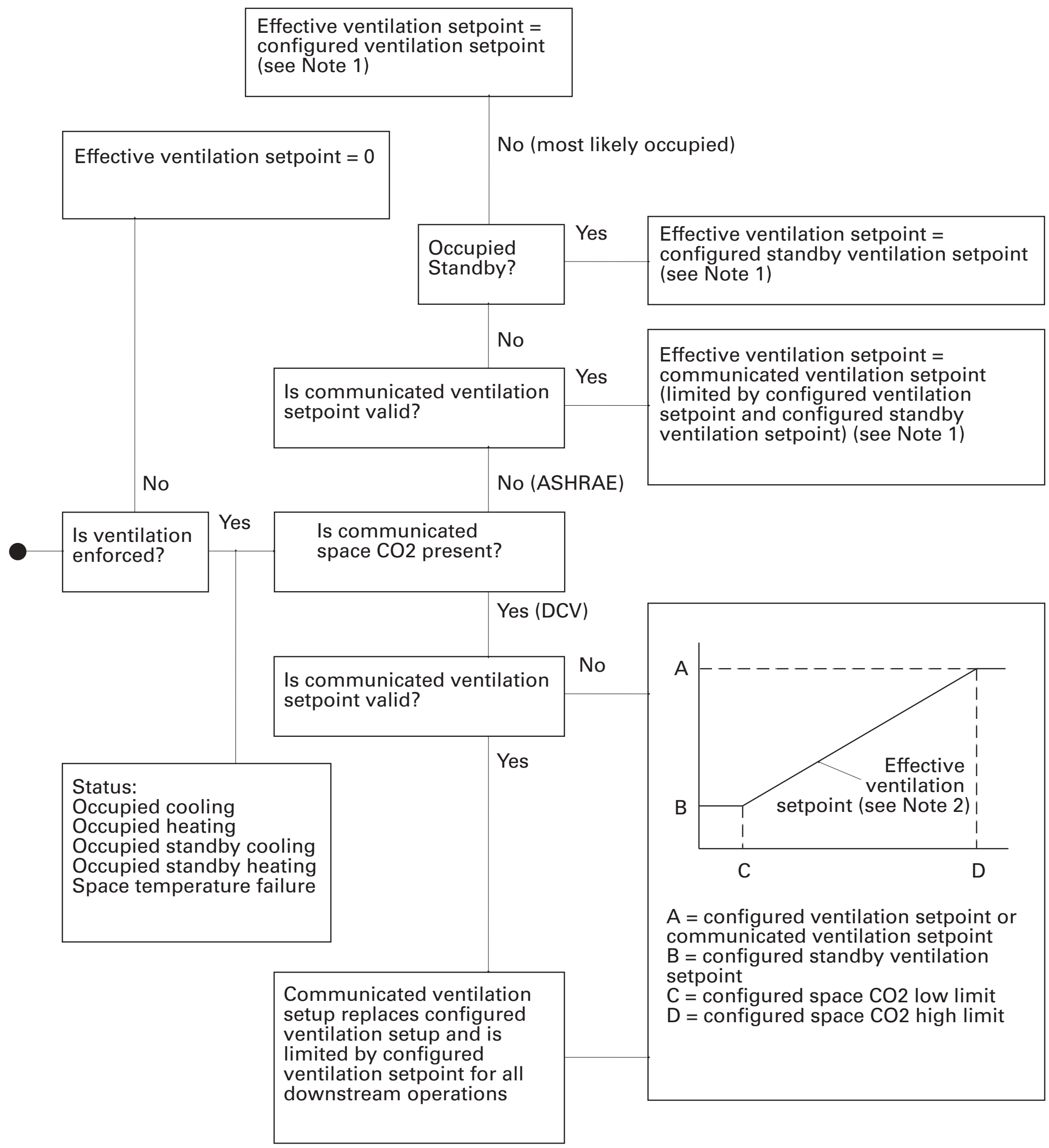
Table 37. Calculation of reported effective ventilation setpoint for zones without CO_2 inputs

Occupancy mode	Communicated ventilation setpoint	Reported effective ventilation setpoint	Description
Occupied	Invalid	Equal configured ventilation setpoint	Zone is occupied. The amount of outdoor air (OA) required for ventilation should be equal to the design maximum occupancy rate.
Occupied standby	Invalid	Equal configured standby-ventilation setpoint	Zone is probably between occupied periods. The amount of OA for ventilation should be less than the design maximum occupancy rate.
Any	Valid	Equal communicated ventilation setpoint (limited, configured ventilation setpoint ≥ communicated ventilation setpoint ≥ configured standby-ventilation setpoint)	The Tracer Summit™ BAS keeps track of occupancy and delivers the outdoor air required for ventilation based on a schedule.

Arbitration of ventilation requirements

Figure 2 shows the arbitration of reported effective ventilation setpoints.

Figure 2. Arbitration of reported effective ventilation setpoint



Note 1: If the unit enters pressure dependent (PD) mode, the value of the effective ventilation setpoint remains at its current value, regardless of other inputs, until pressure independent (PI) mode is re-established. This will lower the impact of system disturbance, since the box cannot play an active role in ventilation without an accurate airflow reading.

Note 2: If C ≥ D, the effective ventilation setpoint = B.

Ventilation Control actions

The controller uses the reported effective ventilation setpoint to find the reported ventilation ratio.

Reported ventilation ratio = reported effective ventilation setpoint ÷ reported airflow

Tracer Summit™ ventilation control

The values of reported effective ventilation setpoint, reported ventilation ratio, and reported airflow are sent to the Tracer Summit BAS for use in system ventilation control functions. Once the system receives these values from all the zones, it determines the required outdoor airflow setpoint by implementing Equation 6-1 from ANSI/ASHREA 62-2001.

The communicated ventilation ratio limit tells the controllers how much outdoor air is in the primary airflow.

Local ventilation control

If the capability of the system to deliver outdoor air is limited, local action must be taken at the zone level to achieve proper ventilation. Since no more outdoor air is available, the zone must provide more air into the zone to ventilate it. To do this, the zone calculates a new increased minimum flow setpoint:

Zone required minimum flow setpoint =
Reported effective ventilation setpoint ÷ Communicated ventilation ratio limit

Ventilation is allowed to adjust the local minimum flow setpoint upward as much as needed until one of the following conditions is met:

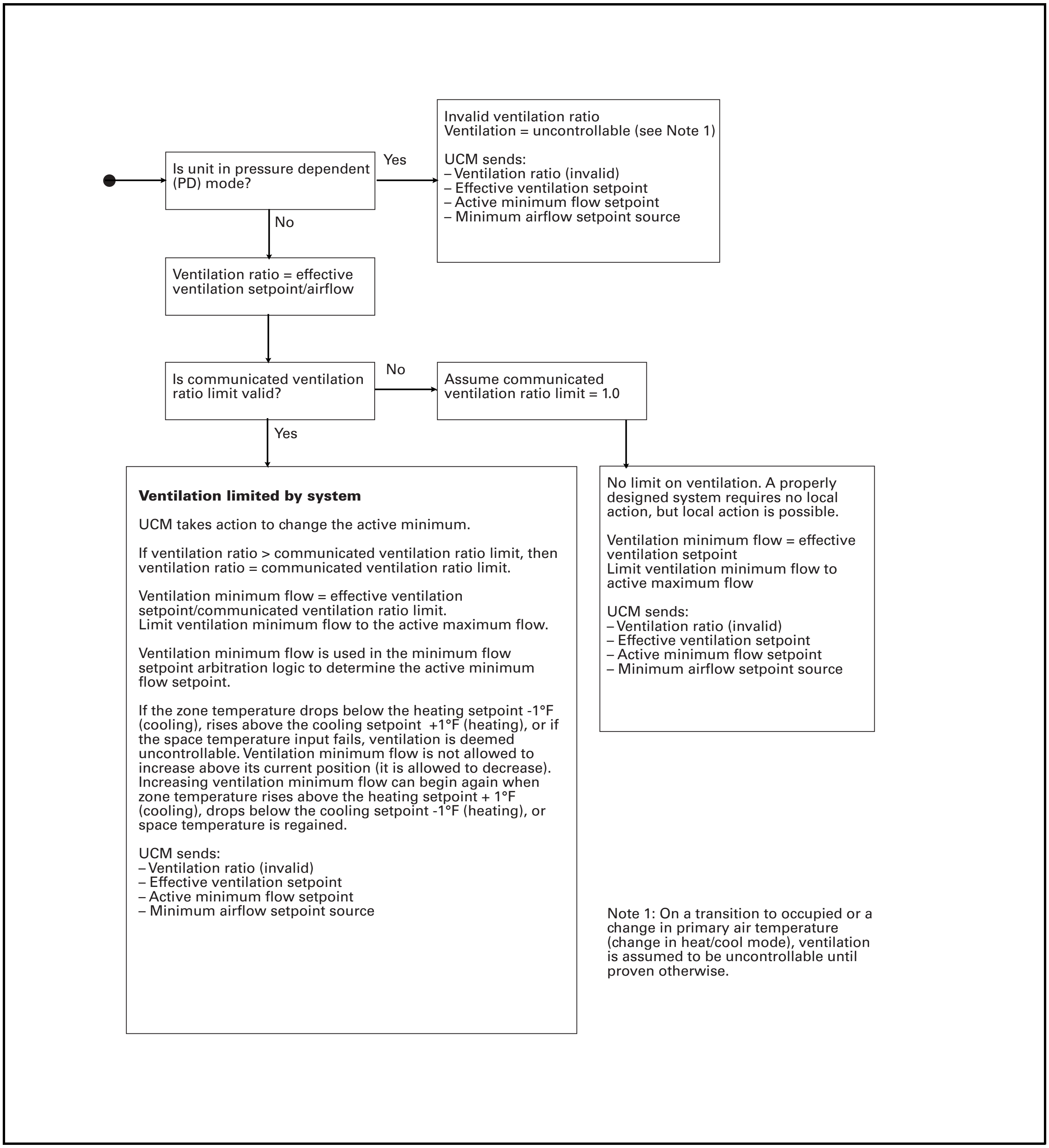
- Zone temperature drops below the heating setpoint minus 1°F (for cooling);
- Zone temperature rises above the cooling setpoint plus 1°F (for heating);
- Space temperature input fails.

The minimum can be adjusted up again when one of the following conditions is met:

- Zone temperature rises to the heating setpoint plus 1°F (for cooling);
- Zone temperature falls to the cooling setpoint minus 1°F (for heating;)
- Space temperature input is regained.

The minimum can be adjusted down at anytime, but only as far as the configured minimum airflow. Figure 3 provides a flow diagram of local ventilation actions.

Figure 3. UCM local ventilation operations



Active Minimum Flow Setpoint Selection Arbitration

The controller selects the active minimum flow setpoint based on the occupancy mode, the use of reheat, and the control mode. Table 38 shows the minimum airflow setpoints. Ventilation reset may raise the active minimum flow setpoint when ventilation reset is being performed at the system level. Table 39 shows space temperature control modes and minimum ventilation requirements.

Table 38. Minimum airflow setpoints

Setpoint name	Rover field label	Location in Rover
Cooling minimum	Minimum airflow	Configuration setup tab
Heating minimum	Minimum heating airflow	Configuration setup tab
Unit heating minimum	Minimum local heating airflow	Configuration setup tab
Cooling standby minimum	Standby minimum airflow	Configuration setup tab
Heating standby minimum	Standby heating minimum air flow	Configuration setup tab
Pressure dependent mode minimum	Minimum position setpoint	Configuration setup tab
Ventilation minimum airflow setpoint	Active minimum flow setpoint [1]	Ventilation tab

Note: Note: Reported active minimum flow setpoint = Reported effective ventilation setpoint ÷ Communicated ventilation ratio limit

Table 39. Space temperature control modes and minimum ventilation requirement

Mode	Minimum ventilation requirement	Use active minimum flow setpoint
Occupied heat	Enforced	Yes
Standby heat	Enforced	Yes
Occupied cool	Enforced	Yes
Standby cool	Enforced	Yes
Off or stop	No minimum ventilation requirement	No
Construction	Maximum heating airflow	No
Unoccupied heat	No minimum ventilation requirement	Yes
Unoccupied cool	No minimum ventilation requirement	Yes
Morning warm-up	No minimum ventilation requirement	Yes, occupied minimum
Pre-cool	No minimum ventilation requirement	Yes, occupied minimum
Night purge	No minimum ventilation requirement	Yes, occupied minimum
Maximum heat	Maximum heating airflow	No

Note: Ventilation flow control and flow tracking have no minimum ventilation requirements. Flow tracking does not use the active minimum airflow setpoint.

A ventilation flow controller in the occupied mode uses the communicated ventilation setpoint or the configured ventilation setpoint for the airflow setpoint. A ventilation flow controller in the unoccupied mode uses zero for the airflow setpoint.

The ventilation flow control uses *nviVentSetpt* if it is valid. If *nviVentSetpt* is not valid, the ventilation flow control uses one of the following two airflow setpoints:

- If *no reheat* being used, it uses the configured *Ventilation Setup Occupied Setpoint;*
- If *reheat* being used, it uses the configured *Local Heat Minimum Airflow.*

Pressure dependent (PD) mode uses the configured minimum position setpoint to position the air valve unless the air valve should be closed.

If the controller is cooling, the active maximum airflow setpoint is the configured maximum airflow. Otherwise, the active maximum airflow setpoint is the configured maximum heating airflow.

The active minimum airflow setpoint must be less than the active maximum airflow setpoint. The active minimum airflow setpoint and the active maximum airflow setpoint are limited to 1.2 times the configured nominal airflow. Table 40 below shows space temperature controller active minimum airflow setpoint selection.

Table 40. Space temperature controller active minimum airflow setpoint selection

PD [a]	STC mode	Effective occupancy mode	Control action (PAT) [b]	Local reheat state	Active minimum setpoint (the greatest of the following)
Do not care	Off	Do not care	Do not care	Do not care	0
No	Occupied cool Occupied heat	Occupied	Cooling	Off	• Configured minimum airflow • Ventilation minimum airflow
				On	• Configured minimum local heating airflow • Configured minimum airflow • Ventilation minimum airflow
			Heating	Off	• Configured minimum heating airflow • Ventilation minimum airflow
				On	• Configured minimum local heating airflow • Configured minimum heating airflow • Ventilation minimum airflow
		Standby	Cooling	Off	• Configured standby minimum airflow • Ventilation minimum airflow
				On	• Configured minimum local heating airflow • Configured standby minimum airflow • Ventilation minimum airflow
			Heating	Off	• Configured standby heating minimum airflow • Ventilation minimum airflow
				On	• Configured minimum local heating airflow • Configured standby heating minimum airflow • Ventilation minimum airflow

Table 40. Space temperature controller active minimum airflow setpoint selection

PD [a]	STC mode	Effective occupancy mode	Control action (PAT) [b]	Local reheat state	Active minimum setpoint (the greatest of the following)
	Unoccupied cool Unoccupied heat	Unoccupied	Cooling	Off	• Zero (air valve closed)
				On	• Configured minimum local heating airflow
			Heating	Off	• Zero (air valve closed)
				On	• Configured minimum local heating airflow
	MWU pre-cool night purge	Do not care	Cooling	Off	• Configured minimum airflow
				On	• Configured minimum local heating airflow • Configured minimum airflow
			Heating	Off	• Configured minimum heating airflow
				On	• Configured minimum local heating airflow • Configured minimum heating airflow
Yes	Occupied cool Occupied heat	Occupied	Cooling	Off	• Configured minimum airflow • Ventilation minimum airflow = 0 • Configured minimum position setpoint
				On	• Configured minimum local heating airflow • Configured minimum airflow • Ventilation minimum airflow = 0 • Configured minimum position setpoint
			Heating	Off	• Configured minimum heating airflow • Ventilation minimum airflow = 0 • Configured minimum position setpoint
				On	• Configured minimum local heating airflow • Configured minimum heating airflow • Ventilation minimum airflow = 0 • Configured minimum position setpoint
		Standby	Cooling	Off	• Configured standby minimum airflow • Ventilation minimum airflow = 0 • Configured minimum position setpoint
				On	• Configured minimum local heating airflow • Configured standby minimum airflow • Ventilation minimum airflow = 0 • Configured minimum position setpoint
			Heating	Off	• Configured standby heating minimum airflow • Ventilation minimum airflow = 0 • Configured minimum position setpoint
				On	• Configured minimum local heating airflow • Configured standby heating minimum airflow • Ventilation minimum airflow = 0 • Configured minimum position setpoint

Table 40. Space temperature controller active minimum airflow setpoint selection

PD [a]	STC mode	Effective occupancy mode	Control action (PAT) [b]	Local reheat state	Active minimum setpoint (the greatest of the following)
	Unoccupied cool Unoccupied heat	Unoccupied	Cooling	Off	• Zero (air valve closed)
				On	• Configured minimum local heating airflow • Configured minimum position setpoint
			Heating	Off	• Zero (air valve closed)
				On	• Configured minimum local heating airflow • Configured minimum position setpoint
	MWU Pre-cool Night purge	Don't care	Cooling	Off	• Configured minimum airflow • Configured minimum position setpoint
				On	• Configured minimum local heating airflow • Configured minimum airflow • Configured minimum position setpoint
			Heating	Off	• Configured minimum heating airflow • Configured minimum position setpoint
				On	• Configured minimum local heating airflow • Configured minimum heating airflow • Configured minimum position setpoint

a. PD is the acronym for pressure dependent.
b. PAT is the acronym for primary air temperature.

Air Valve Control in Ventilation Flow Control Operation

The Tracer™ VV550/VV551 controllers support one modulating air valve for heating and cooling operation. Air delivered to the space is controlled with a three-wire floating-point actuator that modulates the air valve. The controller positions the modulating air valve to deliver the desired airflow (cooling or heating capacity). The desired airflow is called the active flow setpoint.

The active flow setpoint is set to the communicated ventilation setpoint, if valid. If the communicated ventilation setpoint is not valid, the configured ventilation setpoint is used.

Unoccupied Space Temperature Control

When no space temperature is present, the controller does not run heating or cooling capacity in unoccupied. Ventilation requirements are assumed to be zero. The controller enters this mode from a communicated command or from a local occupancy sensor. Table 41 shows unoccupied space temperature control.

Table 41. Unoccupied space temperature control

Primary air temperature	Space temperature	Primary airflow control	Fan control	Reheat control
Cold air in duct: Primary air temperature < configured auto changeover setpoint minus 10°F	≤ than or equal to active heating setpoint minus 1.5°F	Close air valve	Series On Parallel On	Reheat On 100%
		Close air valve	Series Off Parallel Off	Not present
		Local heat min	Not present	Reheat On 100%
	> Active heating setpoint plus 1.5°F	Close air valve	Series Off Parallel Off	Reheat Off
	≤ Active cooling setpoint minus 1.5°F	Close air valve	Series Off Parallel Off	Reheat Off
	> Active cooling setpoint plus 1.5°F	Max flow setpoint	Series On Parallel Off	Reheat Off
Warm air in duct: Configured auto changeover setpoint < primary air temperature < configured reheat enable setpoint minus 5°F	≤ Active heating setpoint minus 1.5°F	Max heat flow setpoint	Series On Parallel On	Reheat On 100%
	≤ Active heating setpoint minus 1.5°F	Max heat flow setpoint	Series On Parallel Off	Not present
	> Active heating setpoint plus 1.5°F	Close air valve	Series Off Parallel Off	Reheat Off
	≤ Active cooling setpoint minus 1.5°F	Close air valve	Series Off Parallel Off	Reheat Off
	> Active cooling setpoint plus 1.5°F	Close air valve	Series Off Parallel Off	Reheat Off
Hot air in duct: Primary air temperature > configured reheat enable setpoint	≤ Active heating setpoint minus 1.5°F	Max heat flow setpoint	Series On Parallel Off	Reheat Off
	> Active heating setpoint plus 1.5°F	Close air valve	Series Off Parallel Off	Reheat Off
	≤ Active cooling setpoint minus 1.5°F	Close air valve	Series Off Parallel Off	Reheat Off
	> Active cooling setpoint plus 1.5°F	Close air valve	Series Off Parallel Off	Reheat Off

A VAV unit turns the series fan to *ON*, if present, when capacity is being run. A parallel fan turns *ON* only if reheat is *ON*. The air valve is closed when the space temperature is between the unoccupied setpoints. When there is no more need for heat capacity, the heat capacity is turned *OFF*. There is a 15-second fan *OFf* delay. See the fan *OFF* delay section in this specification for more details.

Note: The nvoUnitStatus.mode and nvoHeatCool both report Cool when nvoSpaceTemp is 0.01°C above the configured unoccupied cooling setpoint. The nvoUnit Status.mode and nvoHeatCool both report Heat when nvoSpaceTemp is 0.01°C less than the configured unoccupied heating setpoint. Otherwise, there is no change in nvoUnitStatus.mode and nvoHeatCool. There is no change on the transition from occupied to unoccupied.

Fan Control

The Tracer™ VV550/VV551 controllers provide three fan options when in space temperature control mode:

- None;
- One-speed *ON*/*OFF* series fan;
- One-speed *ON*/*OFF* parallel fan.

This Comm5 controller supports an electronically commutated motor (ECM) fan similar to the way that the Comm4 VAV controller does. The controller turns the ECM fan On and Off. It does not change the ECM fan airflow. To assist with flow balancing the fan flow rate is stored as a configuration item.

Series Fan

The series fan is always controlled as a one-speed *ON*/*OFF* fan. The fan operates continuously in the occupied or occupied standby mode. The fan cycles *ON* and *OFF* with calls for heating or cooling in the unoccupied mode.

Operation to prevent reverse rotation of fan

The series fan operates in a manner that prevents reverse rotational operation. The series fan is turned *ON* whenever one of the following occurs:

- Target airflow control point is greater than zero;
- Target air valve position is not closed;
- Actual air valve position is not closed.

Series fan operation during calibration

During calibration, the series fan is *OFF* unless the power-up control wait timer reaches zero. When the power-up control wait timer reaches zero, the controller uses the normal series fan control logic. The series fan is turned *OFF* for 10 seconds during calibration after the air valve closes all the way. And, it remains *OFF* after the 10 seconds expires if:

- Power-up control wait time is still active;
- System mode (communicated application mode or communicated heat/cool mode) is *ON*;
- Effective occupancy mode is unoccupied.

Otherwise the series fan is turned *ON* when the 10-second period expires.

Parallel Fan

The parallel fan is the first stage of heat. When the primary air temperature is cold, the parallel fan:

- Cycles *ON* as the first stage of heat during occupied mode or occupied standby mode;
- Cycles *ON* with a call for heat during unoccupied mode.

When the primary air temperature is warm or hot, the parallel fan is *OFF* unless the local reheat is *ON*. Two methods of control are supported for energizing the parallel fan. One method is based on space temperature; the other method is based on primary airflow. The parallel fan start points for each method of control are able to be configured.

Parallel fan start based on space temperature

The parallel fan turns *ON* when the space temperature falls below the heat setpoint plus the configured parallel fan delta temperature enable setpoint. It turns *OFF* when the space temperature rises above the heat setpoint plus the configured parallel fan delta temperature enable setpoint by 0.5°F (0.28°C).

Parallel fan start based on primary airflow

The parallel fan turns *ON* when the primary airflow falls below the configured parallel fan airflow enable setpoint or the primary airflow is less than the active minimum flow setpoint plus 2% of the configured nominal airflow. The parallel fan turns *OFF* when the primary airflow rises above the configured parallel fan airflow enable setpoint plus 5% of the configured nominal airflow and the primary airflow is greater than the active minimum flow setpoint plus 5% of the configured nominal airflow. In pressure dependent mode, the air valve position is substituted for the primary airflow.

Parallel fan operation during calibration

During calibration, the parallel fan is in the same state (*ON* or *OFF*) as it was before calibration started. It remains in that state until one minute after calibration ends. One minute after calibration ends, normal control of the parallel fan resumes. The one-minute period is ignored if reheat is active or if the parallel fan is overridden.

Fan Off Delay

There is a 15-second fan *OFF* delay. When reheat is turned *OFF*, the controller turns the fan *OFF* 15 seconds later.

Ventilation Flow Control Mode

Ventilation flow control (VFC) is one of three supported control algorithms. It is applied to a VAV terminal and used to temper cold outdoor air (OA) that is brought into a building for ventilation purposes. The tempered air is intended to supply an air-handling unit (AHU), which provides comfort control to the zones it is serving. The VAV terminal supplies the correct amount of ventilation air and, when possible, tempers the ventilation air to reduce the load on the air handler. Table 42 provides the ventilation flow control outputs. For more information on ventilation flow control operation, refer to Table 63 on page 110.

Table 42. Ventilation flow control outputs

Occupancy mode	Source temperature	Air valve control	Reheat control	
Occupy standby bypass	Any	Constant volume (if valid, communicated ventilation setpoint; if not valid, configured ventilation setpoint)	Electric	VFC staged reheat control
			Staged hot water	VFC staged reheat control
			Modulating hot water	VFC modulating reheat control (same as STC capacity control)
Unoccupied	Communicated source temperature (if valid; if not valid, discharge air temperature) greater than configured OA low limit	Closed, 0%	Electric	Off
			Staged hot water	Off
			Modulating hot water	Off
	Communicated source temperature (if valid; if not valid, discharge air temperature) less than configured OA low limit	Closed, 0%	Electric	Off
			Staged hot water	On, 100% freeze protection
			Modulating hot water	On, 100% freeze protection

The ventilation flow control process is a constant volume, variable temperature process. Single duct VAV units with either electric or hot water reheat are used. Fan-powered units are not used for ventilation flow control.

Ventilation flow control must have an auxiliary temperature sensor that is located and configured as a discharge air temperature (DAT) sensor. The required range of discharge air temperature setpoints is 45°F to 70°F (7.22°C to 21.11°C).

Ventilation flow control staged reheat control (electric or hot water) achieves a 30-minute average discharge air temperature to within ±5°F (±2.78°C) of the discharge air temperature setpoint when the inlet temperature is within the control range.

Ventilation flow control modulating reheat control (hot water only) achieves a discharge air temperature to within ±5°F (±2.78°C) of the discharge air temperature setpoint when the inlet temperature is within the control range.

The ventilation flow control uses *nviVentSetpt* if it is valid. If *nviVentSetpt* is not valid, the ventilation flow control uses one of the following two airflow setpoints:

- If *no reheat* being used, it uses the configured *Ventilation Setup Occupied Setpoint;*
- If *reheat* being used, it uses the configured *Local Heat Minimum Airflow.*

Air Valve Control

Ventilation flow control uses the air valve as a constant volume device. The unit is given a constant flow setpoint for air valve control (configured ventilation setpoint); the air valve only repositions itself in response to changes in inlet static pressure. By using pressure independent control for ventilation purposes, a constant volume of fresh air can be maintained, regardless of small fluctuations in inlet static pressure. Ventilation flow control unit uses nviVentSetpt if it is valid. The ventilation flow control uses *nviVentSetpt* if it is valid. If *nviVentSetpt* is not valid, the ventilation flow control uses one of the following two airflow setpoints:

- If *no reheat* being used, it uses the configured *Ventilation Setup Occupied Setpoint;*
- If *reheat* being used, it uses the configured *Local Heat Minimum Airflow.*

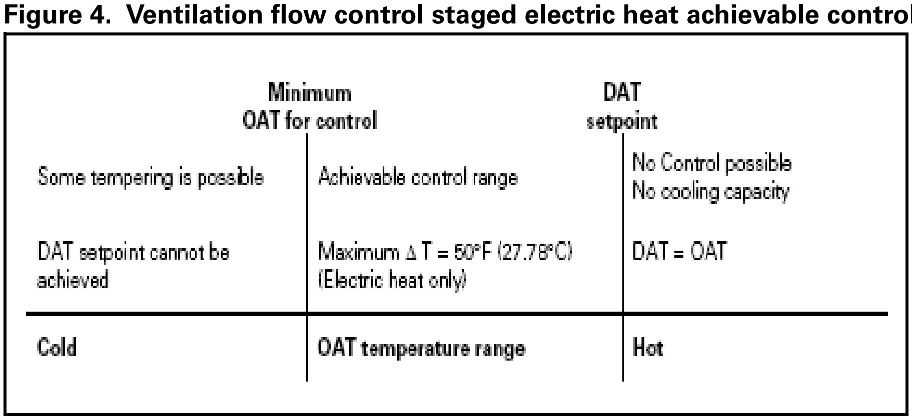
Staged Reheat Control (Electric and Hot Water)

The heat outputs of the controller are binary. Only discrete levels of discharge air temperature are possible. Since discrete discharge air temperature levels do not always provide an instantaneous temperature within the required band, staged reheat controls to a 30-minute average discharge air temperature. The discharge air temperature setpoint is limited from 20°F to 70°F.

Staged Electric Reheat Control

Units that are equipped with electric reheat should be sized so that the maximum temperature rise across the heating elements is 40°F to 48°F (22.22°C to 26.67°C); it should never exceed 50°F (27.78°C) for safety reasons. These values were selected to allow the largest control range without damage to the heater elements. Figure 4 shows the achievable control range for ventilation flow control staged electric heat.

Figure 4. Ventilation flow control staged electric heat achievable control range



For staged electric ventilation flow control, the number of installed stages can range from one to three. Three stages are recommended, since finer control is available with more stages. In cases where the outdoor air temperature is more than 48°F (26.67°C) below the discharge air temperature setpoint, the controller cannot provide the requested control performance.

The controller provides no cooling capacity. If the outdoor air temperature (OAT) is above the discharge air temperature setpoint, the discharge air temperature cannot be controlled and the discharge air temperature is equal to the OAT.

Staged Hot Water Reheat Control

Units equipped with hot water coils should be sized so the maximum temperature of air leaving the coil does not exceed 140°F (60°C F). Since only one stage of hot water reheat is available, staged hot water does not allow tight control of the discharge air temperature. Although the controller operates in this configuration, it is not recommended.

Staged Reheat Control Algorithm (Integral Only)

An incremental form of the integral PID algorithm computes the desired level of reheat capacity. The algorithm is run once every 10 seconds.

Modulating Reheat Control (Hot Water Only)

Units equipped with hot water coils should be sized so the maximum temperature of air leaving the coil does not exceed 140°F (60°C). If hot water reheat is installed, the preferred method of control is with a modulating valve. The modulating valve enables an instantaneous discharge air temperature within the dead band of the discharge air temperature setpoint. The reheat capacity algorithm for modulating hot water discharge air temperature control is the same algorithm used to control modulating hot water valves for a space temperature controller.

Modulating Reheat Control Algorithm (Proportional-Integral)

An incremental form of the proportional integral algorithm runs once every 10 seconds and calculates the reheat capacity required to meet the discharge air temperature setpoint. The required capacity is equal to valve position.

Freeze Protection (Hot Water Only)

Units with hot water coils installed are susceptible to freezing. It is important to prevent the water coils from freezing. Freeze protection occurs only when the controller is in the Off state or during the unoccupied period when the primary air valve is closed and the reheat is disabled. During occupied operation, the control algorithm indirectly provides freeze protection.

Network Controller Freeze Protection

Controllers that are connected to a LonTalk® network use the communicated source temperature. If the value of the communicated source temperature drops below the value of the configured outdoor air low limit, the hot water valve is fully opened. The hot water valve remains open until the communicated source temperature is 10°F (5.56°C) above the configured outdoor air low limit or occupied operation begins.

Stand-alone Controller Freeze Protection

Controllers operating without communications do not have the source temperature available to them. In these cases, the discharge air temperature sensor is assumed to provide a reasonable representation of the coil temperature at conditions with no airflow if the sensor is close to the coil. If the discharge air temperature, at no airflow, falls below the configured outdoor air low limit, the hot water valve is fully opened. The hot water valve remains open until the discharge air temperature is 10°F (5.56°C) above the configured outdoor air low limit or occupied operation begins.

If the communicated source temperature is invalid and the local discharge air temperature sensor has failed, freeze protection is active and the water valve is open.

Morning Warm-up

Morning warm-up in ventilation flow control acts like auto.

Pre-cool (Morning Cool Down)

Pre-cool in ventilation flow control acts like auto.

Maximum Flow Heat

Maximum flow heat in ventilation flow control acts like auto.

Night Purge

Night purge in ventilation flow control acts like auto.

Construction (Temporary Heat)

Construction applies only to the space temperature control mode.

Humidity Control Functions

The controller is not capable of monitoring relative humidity either locally or over the communication network.

Unoccupied Ventilation Flow Control

The controller closes the air valve. Local electric heat and hot water heat are disabled. The hot water valves open if needed for freeze protection. The operation of freeze protection for local hot water heat depends on whether the controller is operating as a network controller or a stand-alone controller. Table 43 shows unoccupied VFC control freeze protection for hot water reheat.

Table 43. Unoccupied VFC control, freeze protection for hot water reheat

Controller operation	Air valve position	Condition	Hot water valve position
Networked and valid communicated source temperature	Closed no flow	Communicated source temperature greater than configured outdoor air low limit	Closed
		Communicated source temperature less than or equal to configured outdoor air low limit, freeze protection active diagnostic (with 10°F hysteresis)	Open to 100%
Stand-alone coil temperature sensed at discharge air temperature [a]	Closed no flow	Discharge air temperature greater than configured outdoor air low limit	Closed
		Discharge air temperature less than or equal to configured outdoor air low limit, freeze protection active diagnostic (with 10°F hysteresis)	Open to 100%

a. Place the discharge temperature sensor in close proximity to the hot water coil discharge. The sensor effectively reports coil temperature when there is no airflow through the coil. Therefore, the coil can be freeze protected by the discharge air temperature sensor.

Fan Control

Ventilation control does not use the fan.

Flow Tracking Control Mode

Flow tracking control (FTC) is one of three supported control algorithms. Two Tracer™ VV550/VV551 controllers work together to provide flow tracking control (see Table 44). The space temperature controller outputs the airflow (reported airflow). The space temperature controller airflow output (reported airflow) is bound to the flow tracking controller airflow setpoint input (communicated airflow setpoint). The flow tracking controller adds the configured airflow tracking offset (positive or negative) to the airflow setpoint (communicated airflow setpoint) and controls the airflow to this setpoint. The flow tracking controller does not require a space temperature sensor or a discharge air temperature sensor. For more information on flow tracking control and flow tracking operation, refer to Table 63 on page 110.

Table 44. Flow tracking control required inputs

Communicated airflow setpoint	Calibration	Airflow sensor	Configured airflow tracking offset	Air valve position
Invalid	Do not care	Do not care	< 0	Closed
			≥ 0	Configured maximum airflow
Do not care	Failed	Do not care	< 0	Closed
			≥ 0	Configured maximum airflow
Do not care	Do not care	Failed	< 0	Closed

Table 44. Flow tracking control required inputs

Communicated airflow setpoint	Calibration	Airflow sensor	Configured airflow tracking offset	Air valve position
			≥ 0	Configured maximum airflow
Valid	Not failed	Not failed	< 0	Modulated between closed and the configured maximum airflow
			≥ 0	Modulated between the configured minimum airflow and the configured maximum airflow

If the calculated airflow setpoint is less than 10% of the configured nominal airflow and the configured airflow tracking offset is less than zero, the air valve is closed. If the calculated airflow setpoint is less than 10% of the configured nominal airflow and the configured airflow tracking offset is greater than or equal to zero, the air valve is positioned at the configured minimum airflow. The maximum airflow setpoint is limited by the configured maximum airflow.

Air Valve Control in Flow Tracking Control Operation

The Tracer™ VV550/VV551 controllers support one modulating air valve for heating and cooling operation. Air delivered to the space is controlled with a three-wire floating-point actuator that modulates the air valve. The controller positions the modulating air valve to deliver the desired airflow (cooling or heating capacity). The desired airflow is called the active flow setpoint.

Flow tracking control is provided by two controllers working together: space temperature controller and flow tracking controller. The space temperature controller outputs the airflow as reported airflow. The airflow is determined by the airflow setpoint input (communicated airflow setpoint) of the flow tracking controller. The flow tracking controller adds a configured airflow tracking offset (positive or negative) to the communicated airflow setpoint and controls its airflow to this new airflow setpoint.

Reheat Control in Flow Tracking Control Operation

Reheat is not an option on a flow tracking controller.

Unoccupied Flow Tracking Control

In unoccupied control mode, the controller operates the air valve the same as it does in occupied control mode. The controller enters this mode from a communicated command or from a local occupancy sensor.

Morning Warm-up

Morning warm-up in ventilation flow control acts like auto.

Pre-cool (Morning Cool Down)

Pre-cool in ventilation flow control acts like auto.

Maximum Flow Heat

Maximum flow heat in ventilation flow control acts like auto.

Night Purge

Night purge in ventilation flow control acts like auto.

Construction (Temporary Heat)

Construction applies only to the space temperature control mode.

Humidity Control Functions

The controller is not capable of monitoring relative humidity either locally or over the communication network.

Fan Control

Flow tracking control does not use the fan.

Stand-alone Control

The controller uses both communicated and hardwired inputs to derive information required to control the space. Since communicated values can arrive independently, the controller uses whatever data is available to make decisions on control actions.

With two exceptions, communicated values take precedence over hardwired inputs. It is when:

- Local flow overrides to minimum flow (single star);
- Maximum flow (double star) has precedence over the communicated flow override.

As heartbeat communication variables are no longer valid, the controller relies more on the hardwired inputs. Communication variables that are not heartbeat are always valid until written not valid or power is cycled on the controller.

Modes and operations affected by communicated inputs include:

- Occupancy;
- Heat/cool;
- Space temperature and setpoint selection;
- Ventilation overrides (accurate ventilation requires communications).

Air Balance Functions

There are two functions which enable air balancing: zone sensor air balance function and communicating air balance function.

Zone Sensor Air Balance Function

A single point air balance function can be initiated at the zone sensor. Place the thumbwheel at either the maximum (double star [**]) or the minimum (single star [*]) flow override position and press the CANCEL button for 10 seconds. If single point air balancing is used, it should be done at the maximum flow override position, since the airflow measurement is more accurate.

Note: Both the enable thumbwheel setpoint and the enable thumbwheel single star (*) and double star (**) function boxes must be checked in configuration.

When the zone sensor air balance sequence initiates, the configured airflow measurement offset is set to zero and the configured airflow measurement gain does not change. When the zone sensor air balance sequence is active, the zone sensor ON and CANCEL buttons do not generate timed override requests.

The controller controls the primary airflow to the configured maximum airflow (double star) or the configured minimum airflow (single star) for the duration of the flow balance operation.

Once in flow balance operation, each momentary (one second) press of the zone sensor *ON* button or *CANCEL* button increases (*ON*) or decreases (*CANCEL*) the configured airflow measurement gain by 0.005 (configured nominal airflow divided by configured minimum airflow or configured maximum airflow). The user can use either the configured maximum airflow or the configured minimum airflow as the calibration point (single point calibration).

To exit this sequence, turn the thumbwheel away from the single star or double star positions and toward the normal operation region. Once initiated, there is a 60-minute time out. On exiting the flow balance operation, the controller permanently stores the new value of the configured airflow measurement gain.

A dual point calibration method is available through the communicating air balance function. Dual point calibration data present in the controller is overwritten when the zone sensor is used for single point calibration.

The configured airflow measurement gain in the controller is the same as the cooling flow correction factor in the VAV 4.2 controller.

Zone sensor air balancing has priority over the communicated flow overrides. This is the only time local has precedence over communicated.

Communicating Air Balance Function

The controller supports a comprehensive two-point air balance function only over communications. An optional feature in the Rover service tool is used to do two-point air balancing, which gives greater accuracy in box calibration for the controller. This function uses the configured airflow measurement gain and the configured airflow measurement offset to correct for slope and offset errors. Two-point balancing is recommended over single-point balancing, but is not required.

The two-point air balance function adjusts the output of the controller flow measurements to match independent measurements taken by a flow hood. The independent measurements are taken at two points, minimum flow and maximum flow, using the controller flow override commands. The goal is to make the controller flow measurement match the independent flow measurement as closely as possible. It does not matter if the flow measurements are done in cubic feet per minute (CFM) or liters per second. The configured airflow measurement gain and the configured airflow measurement offset are referenced to the configured nominal airflow.

Analog Input Calibration

With the Rover™ service tool, you can calibrate three controller analog inputs:

- Space temperature
- Space setpoint
- Flow sensor

For each input, the calibration value is added to the measured value to determine the effective value.

Space temperature:

±10.0°F at 0.1°F resolution

Space setpoint:

±10.0°F at 0.1°F resolution

Flow:

Calibrated airflow reading = (gain * actual airflow reading) + offset

Gain = configured airflow measurement gain, 0 to 2, at 0.001 resolution

Offset = configured airflow measurement offset, ±50%, at 0.005% resolution

Configuration

Trane configures the Tracer™ VV550/VV551 controllers at the factory. Controller configuration parameters can be modified in the field, as necessary, using the Rover™ service tool. Topics in this chapter consist of:

- Configuration considerations;
- Parameter configurations;
- Operation without configuration.

Configuration Considerations

Table 45 lists details that must be considered when configuring a Tracer VV550/VV551 system.

Table 45. Configuration considerations

Category	Detail to consider
Unit types	• Single duct • Series fan powered • Parallel fan powered • Electric reheat (local and/or remote) • Hot water reheat (local or remote)
Unit type configuration notes	Feature that is always present: • Modulating air valve - single duct Optional features that may or may not be present: • Binary input (normally open, normally closed, or not present) • Space temperature • Space setpoint • Primary/discharge air temperature • Occupancy/generic binary input • Fan • Local or remote reheat
Applications	• Space temperature control (STC)/single duct • Ventilation flow control (VFC)/single duct • If reheat is present, a discharge air temperature sensor is required • Flow tracking (FT)/single duct • Does not support the bypass air valve on VariTrac® system • Dual duct boxes are not supported directly. Two controllers and supporting logic are required to coordinate controller operation

Parameter Configurations

The control will not run normally without a complete set of all configuration data. However, there is a small set of functions that do not require configuration. All other functions require the complete set of valid configuration data. An invalid set of configuration data generates a configuration diagnostic with a reported alarm message of invalid unit configuration.

Location Identifier

The controller includes a configured name/location ID location identifier. The maximum length of the location identifier is 30 characters. You can use the Rover service tool to download this identifier and easily identify the unit based on its physical location.

Operation Without Configuration

If the major and/or minor software version number in non-volatile memory does not match the value stored in the program memory, the configuration data in the non-volatile memory is set to default values. This causes the board to go into shutdown mode, since the default configuration does not have a valid checksum.

The unit will not run without valid configuration data. Table 46 shows invalid unit configuration controller operation. Comm5 communications do not require valid configuration data. All other functions require a complete set of valid configuration data.

Table 46. Example invalid unit configuration controller operation

Latching diagnostic	Air valve	Reheat outputs	Fan outputs
Invalid unit configuration	Both outputs Off	Off	Off

This sequence can be overridden by and is ignored by the following sequences, listed highest to lowest priority. For more information on control sequence descriptions, refer to “Control Sequences” on page 31.

1. Power-up/reset sequence (highest priority)
2. Manufacturing test

LonMark® configuration properties are public and may be changed at anytime by any device. Changes to LonMark configuration properties are handled on the fly and do not require the controller to be reset. The controller is responsible for range checking the incoming values and taking the appropriate action if the valid ranges are violated. The Rover service tool is required to setup Trane configuration properties.

Application Information

Use the Rover™ service tool to set up peer-to-peer applications. Refer to the *Operation and Programming, Rover Version 5.0* user guide for more information on setting up applications.

Troubleshooting

Topics in this chapter consist of:

- LED operation;
- Manual output test;
- Diagnostics;
- Resetting diagnostics;
- Questionable unit operation.

LED Operation

Red Service LED

Table 47 shows and describes red service LED activity.

Table 47. Red service LED activity

Red service LED activity	Description
LED is Off continuously after power is applied to the controller.	Normal operation
LED is On continuously, even when power is first applied to the controller.	Someone is pressing the Service push button or the controller failed.
LED flashes approximately once every two seconds.	Uninstalled (normal controller mode). Use the Rover™ service tool to restore the unit to normal operation. Refer to the Rover product literature for more information.

Service Push Button

The Service push button can be used, as one of several methods, to install the controller in a communication network. Refer to the Rover service tool product literature for more information.

Caution

If the Service button is held down for more than 15 seconds, the controller will uninstall itself from the Comm5 network. The red service LED flashing approximately once two every seconds indicates this mode (see Red service LED above). Use the Rover service tool to restore the unit to normal operation. Refer the Rover product literature for more information.

Green Status LED

The green status LED is typically used to indicate whether or not the controller is powered On (24 Vac). This is the only LED under direct software control. The green status LED is Off when you press the Test button. The green status LED blinks during manual output testing. Table 48 shows and describes the green status LED activity.

Table 48. Green status LED activity

Green status LED activity	Description
On	Power On, normal operation
Off	One of the following: • Power Off • Controller failure • Test button pressed
Blinking for 10 seconds, 0.25 seconds Off; 0.25 seconds On	Wink mode [a]
One blink continuously, 0.25 seconds Off; 2.25 seconds On	The controller is in the manual output test mode and no output-override unit diagnostic[b] conditions
Two blinks continuously, 0.25 seconds Off; 0.25 seconds On 0.25 seconds Off; 1.75 seconds On	The controller is in the manual output test mode and one or more output-override unit diagnostic [b] conditions exist

a. The wink feature enables you to identify a controller. By sending a request from the Rover™ service tool, you can request the controller to wink.
b. See the diagnostic topic in this guide for a complete list of output override diagnostics.

Yellow Comm LED

The yellow Comm5 LED blinks whenever another controller is transmitting. However, the yellow Comm5 LED does not blink when the controller is transmitting data. The yellow Comm5 LED cannot distinguish between messages meant for the controller and messages that the controller ignores. Table 49 shows and describes the yellow Comm LED activity.

Table 49. Yellow Comm LED activity

Yellow Comm LED activity	Description
LED Off continuously	The controller is not detecting communication. (Normal for stand-alone applications.)
LED blinks or flickers	The controller detects communication. (Normal for communicating applications, including data sharing.)
LED On continuously	Abnormal condition or extremely high traffic on the link.

Manual Output Test

See “Manual Output Test” on page 33 for a description of the manual output test and how to perform this test step by step as reference when reading this section.

Diagnostics

Table 50 shows the Tracer® VV550/551 controller diagnostics.

Table 50. Controller diagnostics

Diagnostic	Air valve	Fan	Reheat
Invalid unit configuration [b]	0 VDC	0 VDC	0 VDC
Controller failure	Closed	Off	Off
Discharge air temperature failure (space temperature control)	Normal	Normal	Normal
Discharge air temperature failure (ventilation flow control without reheat)	Normal	Do not care	Do not care
Discharge air temperature failure (ventilation flow control with reheat)	Closed	Do not care	Off
Discharge air temperature failure (flow tracking control)	Normal	Do not care	Do not care
Low airflow (space temperature control)	Normal	Normal	Local electric heat is Off; local hydronic and all remote heat is normal
Low airflow (ventilation flow control)	Normal	Do not care	Local electric heat is Off; local hydronic is normal; remote is Don’t care
Primary air temperature failure (space temperature control)	Normal	Normal	Local electric heat is Off [c]; local hydronic and all remote heat is normal
Primary air temperature failure (ventilation flow control)	Normal	Do not care	Normal
Primary air temperature failure (flow tracking control)	Normal	Do not care	Do not care
Space temperature fail (space temperature control) [a]	Occupied: cool minimum flow setpoint Unoccupied: closed	Series fan enabled; parallel fan Off	Off
Space temperature fail (ventilation flow control) [a]	Normal	Do not care	Normal
Space temperature fail (flow tracking control) [a]	Normal	Do not care	Do not care
Local setpoint failure	Normal	Normal	Normal
Flow sensor failure or flow sensor calibration failure (space temperature control	Normal pressure dependent control	Normal	Normal
Flow sensor failure or flow sensor calibration failure (ventilation flow control)	Normal pressure dependent control	Do not care	Normal

Table 50. Controller diagnostics (continued)

Diagnostic	Air valve	Fan	Reheat
Flow sensor failure or flow sensor calibration failure (flow tracking control)	If the configured airflow tracking offset is positive, configure maximum airflow If the configured airflow tracking offset is negative, configure minimum airflow	Do not care	Do not care
Freeze protection active (ventilation flow control)	Closed	Off	Off
Thumbwheel in */** position (single star position)	Minimum airflow	Normal	Normal
Thumbwheel in */** position (double star position)	Maximum airflow	Normal	Normal
Normal	Normal	Normal	Normal

a.When a temperature sensor fails after being valid, the controller generates a diagnostic to indicate the sensor loss condition. The controller automatically clears the diagnostic once a valid sensor temperature value is present (non-latching diagnostic).

b.When the unit configuration is invalid, all outputs are de-energized (0 VDC) so that they return to their normal state.

c.If system mode is heat or auto with a warm or hot primary air temperature.

Translating Multiple Diagnostics

The controller senses and records each diagnostic independently of other diagnostics. It is possible to have multiple diagnostics present simultaneously. The diagnostics are reported in the order they occur. The reported alarm message is made up of two parts. The first part is the Trane alarm level. The second part is the alarm message text. The level and the text are separated by one space. The total length must be equal to or less than 30 characters. Table 51 through Table 55 describe alarm levels and reported alarm message text.

Table 51. Trane alarm levels

Level	Description
P	Normal; occurs immediately following a power-up reset
0	Normal
1	Informational message
2	Service required
3	Critical alarm

Table 52. Latching diagnostics, reset required

Level	Reported alarm message text	Description
2	Invalid unit configuration	Cannot use current configuration
2	Controller failure	Controller self test failure

Table 53. Automatically resetting diagnostics

Level	Reported alarm message text	Description
2	Discharge air temperature failure (ventilation flow control with reheat)	No valid discharge air temperature
2	Discharge air temperature failure (ventilation flow control without reheat)	Discharge air temperature valid, then not valid
2	Discharge air temperature failure (space temperature control or flow tracking)	Discharge air temperature valid, then not valid
2	Primary air temperature failure [a, b]	Primary air temperature valid, then not valid
2	Local space setpoint failure [b]	Local space setpoint input valid, then not valid
2	Space temperature failure [a, b]	Space temperature valid, then not valid
2	Flow sensor failure	Flow signal not valid. Sensor open or shorted
2	Flow sensor calibration failure	Flow did not calibrate successfully (*The Kavlico® pressure sensor input voltage has to be 0.25 +/-0.06 volts during calibration. If it is outside this range, the diagnostic is generated*.)
1	Freeze protection active	Ventilation flow control unit opened the water valve(s) due to low source temperature
1	Low airflow	Low primary airflow preventing electric reheat from turning On
1	Thumbwheel in */** position	The thumbwheel setpoint and the thumbwheel star and double star function are enabled in configuration. The thumbwheel setpoint is cranked all the way to the single star or the double star position.

a. Losing the network variable input does not generate a diagnostic if the local sensor is present and vice versa.
b. Do not send a diagnostic message if the input (local or network variable input) is never present.

Table 54. No diagnostics present

Level	Reported alarm message text	Description
P	Power-up reset	No diagnostic occurred since the last reset
0	Normal	Diagnostics that automatically reset are cleared

Table 55. Green status LED blink pattern during manual test

Reported alarm message text	Blink pattern during manual test
Invalid unit configuration	Twice (output override diagnostic)
Controller failure	Twice (output override diagnostic)

Table 55. Green status LED blink pattern during manual test

Reported alarm message text	Blink pattern during manual test
Discharge air temperature failure (ventilation flow control with reheat)	Twice (output override diagnostic)
Dichroic air temperature failure (ventilation flow control without reheat)	Once
Discharge air temperature failure (space temperature control or flow tracking	Once
Primary air temperature failure	Once
Local space setpoint failure	Once
Space temperature failure	Twice (output override diagnostic)
Flow sensor failure	Twice (output override diagnostic)
Flow sensor calibration failure	Twice (output override diagnostic)
Freeze protection active	Once

Resetting Diagnostics

A reset clears latching diagnostics and enables the controller to try to run normally. If the latching condition is still present after the reset, the controller shuts down. A reset resets a unit that is running normally. There are five ways to reset unit diagnostics:

- Manual output test at the controller
- Cycling power to the controller
- BAS (communicated status request, clear alarm)
- Rover™ service tool (communicated status request, clear alarm)
- A communicating device able to access the controller diagnostic reset input (communicated status request, clear alarm)

Manual Output Test

You can use the Test button on the controller during installation or troubleshooting to verify proper end device operation. When you press the Test button, the controller exercises all outputs in a predefined sequence. The last step of the sequence resets the controller. See topic "Manual Output Test" on page 33 for more information on the manual output test function and how to perform this test step by step.

Cycling Power

When power to the controller cycles (24Vac turns *OFF* then *ON*), the controller initiates its power-up/reset sequence. The controller attempts to reset all diagnostics at power-up. Diagnostics present at power-up and those that occur after power-up are handled according to the defined unit diagnostics sequences (see Table 50 on page 91).

Building Automation System

Some building automation systems can reset diagnostics in the controller. For more complete information, refer to the building automation system product literature.

Rover™ Service Tool

The Rover service tool can reset diagnostics in the controller. For more complete information, refer to the *Operation and Programming, Rover Version 5.0* user guide.

Diagnostic Reset

Devices that can communicate a network variable communicated status request ("clear_alarm" request) can reset diagnostics in the controller.

Questionable Unit Operation

Table 56 on page 95 through Table 59 on page 97 provide probable causes and explanation for symptoms that indicate problems:

- Reheat outputs do not energize
- Fan output does not energize
- Air valve and/or water valves stay open
- Air valve and/or water valves stay closed

Table 56. Reheat outputs do not energize

Probable cause	Explanation
Power-up control wait	When power-up control wait is enabled (non-zero time), the controller remains Off until one of two conditions occurs: • The controller exits power-up control wait once it receives communicated information. • The controller exits power-up control wait once the power-up control wait time expires.
Requested mode Off	You can communicate a desired operating mode (such as Off, heat, and cool) to the controller. When Off is communicated to the controller, the unit controls the reheat Off. There is no heating or cooling.
Diagnostic present	A specific list of diagnostics affects reheat operation. For more information on controller diagnostics, refer to Table 50 on page 91.
No power to the controller	If the controller does not have power, the reheat does not operate. For the controller to operate normally, it must have an input voltage of 24 Vac. When the green LED is Off continuously, the controller does not have sufficient power or has failed. For more information on green LED, refer to "Green Status LED" on page 90.
Unit configuration	The controller must be properly configured based on the actual installed end devices and application. When the unit configuration does not match the actual end devices, the reheat may not work correctly. Local stages of reheat should start with Heat 1 output. Remote heat must be placed adjacent to the last local reheat stage. One stage of local and remote heat, Heat 1 is local, Heat 2 is remote.
Manual output test	The controller includes a manual output test function you can use to verify output operation and associated output wiring. However, based on the current step in the test sequence, the unit reheat may not be on. For more information on manual output test, refer to sections "Manual Output Test" on page 90 and "Manual Output Test" on page 33.
Unit wiring	The wiring between the controller outputs and the fan relays and contacts must be present and correct for normal reheat operation.
Low primary airflow	The unit must have sufficient primary airflow to energize the local electric reheat outputs. If the airflow never reaches this level or falls below this level, the reheat is not energized. For more information on reheat control, refer to "Reheat Control" on page 50.
Primary air temperature above reheat enable setpoint	The primary air temperature must be below the reheat enable setpoint before the reheat can be energized. This prevents damage to the reheat coils due to excessive heat.

Table 56. Reheat outputs do not energize (continued)

Probable cause	Explanation
Invalid reheat enable setpoint	Invalid reheat enable setpoint disables local electric heat.
Invalid primary air temperature	Disables local electric heat when the system mode is heat or if system mode is auto with warm default primary air temperature.
Fan override active	Fan override Off with a fan present disables local electric reheat.
Auxiliary heat enable	Communicated auxiliary heat enable is limiting reheat unit capacity or disabling reheat completely.
Water valve override	Water valve override, when in effect, controls outputs.

Table 57. Fan output does not energize

Probable cause	Explanation
Power-up control wait	When power-up control wait is enabled (non-zero time), the controller remains Off until one of two conditions occurs: • The controller exits power-up control wait once it receives communicated information. • The controller exits power-up control wait once the power-up control wait time expires.
Unoccupied operation	When the controller is in the unoccupied mode, the fan is cycled between On and Off with capacity to maintain zone temperature control.
Requested mode Off	You can communicate a desired operating mode (such as Off, heat, and cool) to the controller. When Off is communicated to the controller, the unit controls the fan Off. There is no heating or cooling.
Diagnostic present	A specific list of diagnostics affects fan operation. For more information on controller diagnostics, refer to Table 50 on page 91.
No power to the controller	If the controller does not have power, the unit fan does not operate. For the controller to operate normally, it must have an input voltage of 24 Vac. When the green LED is Off continuously, the controller does not have sufficient power or has failed. For more information on green LED, refer to “Green Status LED” on page 90.
Unit configuration	The controller must be properly configured based on the actual installed end devices and application. When the unit configuration does not match the actual end devices, the fan may not work correctly.
Manual output test	The controller includes a manual output test function you can use to verify output operation and associated output wiring. However, based on the current step in the test sequence, the unit fan may not be On. For more information on manual output test, refer to sections “Manual Output Test” on page 90 and “Manual Output Test” on page 33.
Unit wiring	The wiring between the controller outputs and the fan relays and contacts must be present and correct for normal fan operation.
Fan override	Fan is overridden via communicated fan speed command.

Table 58. Air valve and/or water valve stay open

Probable cause	Explanation
Normal operation	The controller opens and closes the valves to meet the unit capacity requirements.
Manual output test	The controller includes a manual output test function you can use to verify output operation and associated output wiring. However, based on the current step in the test sequence, the valve(s) may be open. For more information on manual output test, refer to sections “Manual Output Test” on page 90 and “Manual Output Test” on page 33.

Table 58. Air valve and/or water valve stay open

Probable cause	Explanation
Diagnostic present	A specific list of controller diagnostics affects valve operation. For more information on controller diagnostics, refer to Table 50 on page 91. Freeze protection for a ventilation flow control unit opens the water valve or valves.
Unit configuration	The controller must be properly configured based on the actual installed end devices and application. When the unit configuration does not match the actual end devices, the valves may not work correctly.
Unit wiring	The wiring between the controller outputs and the valve(s) must be present and correct for normal valve operation.
Actuator failure	Device failed or setscrew loosened.
Water valve override	Control of the water valve is overridden by the communicated valve override.
Flow override	Control of the air valve is overridden by the communicated flow override

Table 59. Air valve and/or water valve stay closed

Probable cause	Explanation
Requested mode Off	You can communicate a desired operating mode (such as Off, heat, and cool) to the controller. When Off is communicated to the controller, the unit controls the fan Off. There is no heating or cooling (valves are closed).
Power-up control wait	When power-up control wait is enabled (non-zero time), the controller remains Off (calibration occurs during power-up control wait if auto-calibration is enabled) until one of two conditions occurs: • The controller exits power-up control wait once it receives communicated information. • The controller exits power-up control wait once the power-up control wait time expires.
Manual output test	The controller includes a manual output test function you can use to verify output operation and associated output wiring. However, based on the current step in the test sequence, the valve(s) may not be open. For more information on these sections, refer to "Manual Output Test" on page 90 and "Manual Output Test" on page 33.
Diagnostic present	A specific list of diagnostics affects valve operation. For more information on controller diagnostics, refer to Table 50 on page 91.
Unit configuration	The controller must be properly configured based on the actual installed end devices and application. When the unit configuration does not match the actual end devices, the valves may not work correctly.
Unit wiring	The wiring between the controller outputs and the valve(s) must be present and correct for normal valve operation.
Actuator failure	Device failed or setscrew loosened.
Valve override	Water valve is overridden by the communicated valve override.
Flow override	Control of the air valve is overridden by the communicated flow override.

Appendix A: Properties, Data Lists Points, and Network Variables

The Tracer™ VV550/551 controller uses the Space Comfort Controller (SCC) profile. Twenty-two properties were added to the space comfort controller object for the Tracer VV550/551 controller:

- Air Flow Override: Tracer
- Air Flow Stpnt: Active Min
- Air Flow Stpnt: Active Min Source
- Air Flow Stpnt: Min Local Heat
- Air Flow Stpnt: Min Standby Heat
- Air Flow Stpnt: Tracer
- Air Valve Position
- Auto-commissioning Air Valve Pos (1-2)
- Auto-commissioning Cmd: Tracer
- Auto-commissioning Disch Air Temp (1-7)
- Auto-commissioning State
- Auto-commissioning Time Stamp
- Space CO_2 Concentration: Tracer
- Space CO_2 Low Limit
- Ventilation Ratio Calc
- Ventilation Ratio Limit: Tracer
- Ventilation Setpoint: Active
- Ventilation Setpoint: Max
- Ventilation Setpoint: Min
- Ventilation Setpoint: Ref
- Ventilation Setpoint: Tracer
- Water Valve Override: Tracer

Table 60 describes the SCC profile for the Tracer™ VV550/551 controller.

Table 60. SCC profile for the Tracer™ VV550/551 controller

SCC profile	SCC	Network variable	Standard network variable type (SNVT)	Tracer VV550 /551	Tracer Summit® BAS property [a]
Space temperature	Mandatory	nviSpaceTemp	SNVT_temp_p	Note [b]	Space Temperature: Tracer
Clear alarms diagnostics	Mandatory [c]	nviRequest	SNVT_obj_request	Note [b]	Node Request or Alarm Reset
Setpoint	Optional	nviSetpoint	SNVT_temp_p	Note [b]	Space Temperature: Tracer
Setpoint offset	Optional	nviSetptOffset	SNVT_temp_p		Setpoint Offset: Tracer
Setpoint shift	Optional	nviSetptShift	SNVT_temp_setpt		Cooling and Heating Setpoint Shift: Tracer [d]
Occupancy, schedule	Optional	nviOccSchedule	SNVT_tod_event	Note [b]	Occupancy: Tracer
Occupancy, manual command	Optional	nviOccManCmd	SNVT_occupancy	Note [b]	No property
Occupancy, sensor	Optional	nviOccSensor	SNVT_occupancy	Note [b]	No property
Application mode	Optional	nviApplicMode	SNVT_hvac_mode	Note [b]	Application Mode: Tracer
Heat/cool mode	Optional	nviHeatCool	SNVT_hvac_mode	Note [b]	No property
Fan speed command	Optional	nviFanSpeedCmd	SNVT_switch	Note [b]	No property
Compressor enable	Optional	nviComprEnable	SNVT_switch		Compressor Control: Tracer
Auxiliary heat enable	Optional	nviAuxHeatEnable	SNVT_switch	Note [b]	Auxiliary Heat Control: Tracer
Economizer enable	Optional	nviEconEnable	SNVT_switch		Economizer Control: Tracer
Valve override	Optional	nviValveOverride	SNVT_hvac_overid	Note [b]	Water Valve Override: Tracer
Flow override	Optional	nviFlowOverride	SNVT_hvac_overid	Note [b]	Air Flow Override: Tracer
Emergency override	Optional	nviEmergOverride	SNVT_hvac_emerg	Note [b]	Emergency Override: Tracer
Source temperature	Optional	nviSourceTemp	SNVT_temp_p	Note [b]	Entering Water Temperature: Tracer or Source Temperature: Tracer
Outdoor air temperature	Optional	nviOutdoorTemp	SNVT_temp_p		Outdoor air temperature: Tracer
Space relative humidity	Optional	nviSpaceRH	SNVT_lev_percent		No property
Space CO_2	Optional	nviSpaceCO_2	SNVT_ppm	Note [b]	Space CO_2 Concentration: Tracer
Airflow setpoint	Optional	nviAirFlowSetpt	SNVT_flow	Note [b]	Air Flow Stpnt: Tracer
Binary output request	Proprietary	Proprietary	Proprietary		Generic Binary Output: Tracer

Table 60. SCC profile for the Tracer™ VV550/551 controller (continued)

SCC profile	SCC	Network variable	Standard network variable type (SNVT)	Tracer VV550 /551	Tracer Summit® BAS property [a]
Outdoor air damper minimum position setpoint	Proprietary	Proprietary	Proprietary		Economizer Min Position: Tracer
Master slave [e]	Proprietary	Proprietary	Proprietary		No property
Auto commission command	Proprietary	Proprietary	Proprietary	Trane [f]	Auto-commissioning Cmd: Tracer
Discharge air temperature setpoint	Proprietary	nviDischAirStpt	SNVT_temp_p	Note [b]	No property
Ventilation ratio limit	Proprietary	nviVentRatioLim	SNVT_lev_percent	Note [b]	Ventilation Ratio Limit: Tracer
Ventilation rate for the zone	Proprietary	nviVentSetpt	SNVT_flow	Note [b]	Ventilation Setpoint: Tracer
Space temperature	Mandatory	nvoSpaceTemp	SNVT_temp_p	Note [b]	Space Temperature: Active
Unit status, mode	Mandatory [g]	nvoUnitStatus mode	SNVT_hvac_status	Note [b]	Mode: Active
Unit status, heat output primary	Mandatory [g]	nvoUnitStatus heat output primary	SNVT_hvac_status	Notes [b, h]	Heat Output or Air Valve Position
Unit status, heat output secondary	Mandatory [g]	nvoUnitStatus heat output secondary	SNVT_hvac_status	Notes [b, i]	Heat Output Secondary
Unit status, cool output	Mandatory [g]	nvoUnitStatus cool output	SNVT_hvac_status	Notes [b, j]	Cool Output or Air Valve Position
Unit status, economizer output	Mandatory [g]	nvoUnitStatus econ output	SNVT_hvac_status		Economizer Damper Position
Unit status, fan output	Mandatory [g]	nvoUnitStatus fan output	SNVT_hvac_status	Note [b]	Supply Fan Speed or Supply Fan Status
Unit status, alarm present	Mandatory [g]	nvoUnitStatus in alarm	SNVT_hvac_status	Note [b]	Alarm Present
Effective setpoint	Optional	nvoEffectSetpt	SNVT_temp_p	Note [b]	Space Temperature Setpoint: Active
Effective occupancy	Optional	nvoEffectOccup	SNVT_occupancy	Note [b]	Occupancy: Active or Mode: Occupancy or Occupied Bypass: Active
Heat/cool mode	Optional	nvoHeatCool	SNVT_hvac_mode	Note [b]	Mode: Heat/Cool or Heat/Cool Mode: Active
Setpoint	Optional	nvoSetpoint	SNVT_temp_p	Note [b]	Space Temperature Setpoint: Local
Fan speed	Optional	nvoFanSpeed	SNVT_switch		No property
Discharge air temperature	Optional	nvoDischAirTemp	SNVT_temp_p	Note [b]	Discharge Air Temp
Load, absolute	Optional	nvoLoadAbsK	SNVT_power_kilo		Load: Absolute
Terminal load	Optional	nvoTerminalLoad	SNVT_lev_percent	Present but always invalid	Load: Terminal

Table 60. SCC profile for the Tracer™ VV550/551 controller (continued)

SCC profile	SCC	Network variable	Standard network variable type (SNVT)	Tracer VV550 /551	Tracer Summit® BAS property [a]
Heat output, primary	Optional	nvoHeatPrimary	SNVT_lev_percent		No property
Cool output, primary	Optional	nvoCoolPrimary	SNVT_lev_percent		No property
Outdoor air damper position	Optional	nvoOADamper	SNVT_lev_percent		Outdoor Air Damper Position
Space relative humidity	Optional	nvoSpaceRH	SNVT_lev_percent		Space Humidity: Input
Outdoor relative humidity	Optional	nvoOutdoorRH	SNVT_lev_percent		Outdoor Air Humidity: Input
Outdoor air temperature	Optional	nvoOutdoorTemp	SNVT_temp_p		Outdoor Air Temperature: Active
Space CO_2	Optional	nvoSpaceCO_2	SNVT_ppm	Note [b]	Space CO_2 Concentration: Input
Effective airflow setpoint	Optional	nvoEffectFlowSP	SNVT_flow	Note [b]	Flow Setpoint: Active
Airflow	Optional	nvoAirFlow	SNVT_flow	Note [b]	Airflow: Active
Alarm message	Proprietary	nvoAlarmMessage	SNVT_str_asc	Note [b]	Diagnostic Alarm Status
Entering water temperature	Proprietary	nvoEnterWaterTmp	SNVT_temp_p		Entering Water Temperature: Active
Face and bypass damper position	Proprietary	nvoFBDamper	SNVT_lev_percent		Face And Bypass: Active
Leaving water temperature	Proprietary	nvoLeaveWaterTmp	SNVT_temp_p		Leaving Water Temperature: Active
Mixed air temperature	Proprietary	nvoMATemp	SNVT_temp_p		Mixed Air Temperature
Fan run hours	Proprietary	Proprietary	Proprietary		Supply Fan Run Time
Generic analog input	Proprietary	Proprietary	Proprietary		No property
Reheat heating capacity	Proprietary	Proprietary	Proprietary		No property
Dehumidification status	Proprietary	Proprietary	Proprietary		No property
Generic binary input status	Proprietary	Proprietary	Proprietary	Trane [f]	Generic Binary Input (1-1)
Generic binary output status	Proprietary	Proprietary	Proprietary		Generic Binary Output (1-1)
Heat stages	Proprietary	Proprietary	Proprietary		Heat Stage Status (1-8)
Cool stages	Proprietary	Proprietary	Proprietary		Cool Stage Status (1-8)
Reversing valve status	Proprietary	Proprietary	Proprietary		Reversing Valve
Economizer enabled	Proprietary	Proprietary	Proprietary		Economizer Enable: Active
Exhaust status	Proprietary	Proprietary	Proprietary		Exhaust Status

Table 60. SCC profile for the Tracer™ VV550/551 controller (continued)

SCC profile	SCC	Network variable	Standard network variable type (SNVT)	Tracer VV550 /551	Tracer Summit® BAS property [a]
Generic temperature	Proprietary	Proprietary	Proprietary	Trane [f, k]	Generic Temperature
Economizing active	Proprietary	Proprietary	Proprietary		Economizing Active
Timed override request	Proprietary	Proprietary	Proprietary	Trane [f]	Timed Override Request
Timed override cancel	Proprietary	Proprietary	Proprietary	Trane [f]	Timed Override Request: Cancel
Position dependent operation status	Proprietary	Proprietary	Proprietary	Trane [f]	No property
Master slave [h]	Proprietary	Proprietary	Proprietary		No property
Auto-commissioning report, damper position at 40% flow and 100% flow	Proprietary	Proprietary	Proprietary	Trane [f]	Auto-commissioning Air Valve Pos (1-2)
Auto-commissioning report, discharge air temperature at each step	Proprietary	Proprietary	Proprietary	Trane [f]	Auto-commissioning Disch Air Temp (1-7)
Auto-commissioning report, test status	Proprietary	Proprietary	Proprietary	Trane [f]	Auto-commissioning State
Auto-commissioning report, time stamp	Proprietary	Proprietary	Proprietary	Trane [f]	Auto-commissioning Time Stamp
Ventilation ratio	Proprietary	Proprietary	Proprietary	Trane [f]	Ventilation Ratio Calc
Effective ventilation setpoint	Proprietary	Proprietary	Proprietary	Trane [f]	Ventilation Setpoint: Active
Active minimum flow setpoint	Proprietary	Proprietary	Proprietary	Trane [f]	Air Flow Stpnt: Active Min
Minimum airflow setpoint source	Proprietary	Proprietary	Proprietary	Trane [f]	Air Flow Stpnt: Active Min Source
Send heartbeat	Mandatory	nciSndHrtBt	SNVT_time_sec	Note [b]	
Setpoints	Mandatory	nciSetpoints	SNVT_temp_setpt	Note [b]	(Six properties)
Minimum send time	Optional	nciMinOutTm	SNVT_time_sec	Note [b]	
Receive heartbeat	Optional	nciRecHrtBt	SNVT_time_sec	Note [b]	
Location label	Optional	nciLocation	SNVT_str_asc	Note [b]	Location Label
Bypass time	Optional	nciBypassTime	SNVT_time_min	Note [b]	Occupied Bypass Time (in minutes)
Manual time	Optional	nciManualTime	SNVT_time_min		
Outdoor air damper minimum position	Optional	nciOAMinPos	SNVT_lev_percent		Economizer Minimum Position
Space CO_2 limit	Optional	nciSpaceCO2Lim	SNVT_ppm	Note [b]	Space CO_2 Limit
Space reheat setpoint	Optional	nciSpaceRHSetup	SNVT_lev_percent		

Table 60. SCC profile for the Tracer™ VV550/551 controller (continued)

SCC profile	SCC	Network variable	Standard network variable type (SNVT)	Tracer VV550 /551	Tracer Summit® BAS property [a]
Minimum local heating airflow	Optional	nciMinFlowUnitHt	SNVT_flow	Note [b]	Air Flow Stpnt: Min Local Heat
Standby heating minimum airflow	Optional	nciMnFlowStbyHt	SNVT_flow	Note [b]	Air Flow Stpnt: Min Standby Heat
Space CO_2 low limit	Proprietary	nciSpaceCO2LowLm	SNVT_ppm	Note [b]	Space CO_2 Low Limit
Ventilation setpoint	Proprietary	nciVentSetpt	SNVT_flow	Note [b]	Ventilation Setpoint: Max
Standby ventilation setpoint	Proprietary	nciVentSetptStby	SNVT_flow	Note [b]	Ventilation Setpoint: Min
Setpoint limits	Proprietary	Proprietary	Proprietary	Note [b]	(Four properties)

a. The ":Tracer" property is used to view the sent data. The ":Ref" property (same prefix) is used for referencing.
b. Non-proprietary. Network variable and Tracer Summit property are supported.
c. The variable is mandatory, but each of the elements of the variable are optional.
d. Two separate properties: one for cooling, one for heating.
e. Implemented in a proprietary manner but is available to others through public nvi/nvo.
f. Trane is proprietary. Trane® only.
g. Unit Status is mandatory, but not all elements of the structure are required.
h. Air valve position during heat mode.
i. Total reheat capacity, discrete values for staged reheat capacity.
j. Air valve position during cool mode.
k. Used by Tracer™ VV550/551 controller to report the primary air temperature. Could be either nviSourceTemp or the auxiliary temperature when configured to measure the primary air temperature.

Appendix B: Tracer Summit™ BAS Present Value Chart

The Tracer Summit BAS present value chart is contained in Table 61:

Table 61. Tracer Summit BAS SCC present value chart

Tracer Summit BAS present value		What the Tracer Summit BAS sends to the SCC		
		nviApplicMode heart beat	nviOccSchedule heartbeat	nviEmergOverride no heartbeat
Unoccupied		Auto Heat Cool	Unoccupied	Normal
Optimal start up	(Space temperature cold) (Space temperature hot)	MWU Pre-cool	Occupied	Normal
Occupied		Auto Heat Cool	Occupied	Normal
Duty cycle		Auto Heat Cool	Standby	Normal
Demand limit		Auto Heat Cool	Standby	Normal
Coast down		Auto Heat Cool	Standby	Normal
Priority shutdown		Auto Heat Cool	No change	Shutdown
Night heat/cool	(Space temperature cold) (Space temperature hot)	MWU Pre-cool	Occupied	Normal
Night economizer		Night purge	Unoccupied	Normal
Communication loss (receive heartbeat times out). This happens at different times for nviApplicMode and nviOccSchedule. This would not happen for nviEmergOverride.		Auto after receive heartbeat times out	Occupied after receive heartbeat times out	Stays at the last value sent, no receive heartbeat

Appendix C: Mode Control Operation

Mode control operation is described in these tables:

- Table 62; Space temperature control VAV unit operation
- Table 63; Ventilation flow control and flow tracking VAV unit operation

Table 62. Space temperature control VAV unit operation

nvi Applic Mode	nvi Heat Cool	nvoHeatCool [a, c] nvoUnitStatus. mode	nvoEffect Occup	Output [b]	Operation	Temp control sequence
Auto, test, not valid (any enumeration not listed)	Auto, test, not valid (any enumeration not listed)	Determined by controller [a] or Test [c]	Unoccupied Occupied Bypass Standby	Air valve Reheat Fan Vent req	Enabled Enabled Enabled Enabled	See appropriate row below
	Heat	Heat	Unoccupied	Air valve Reheat Fan Vent req	Enabled Enabled Enabled Disabled	STC Unoccupied heating
			Occupied Bypass Standby	Air valve Reheat Fan Vent req	Enabled Enabled Enabled Enabled	STC Occupied heating
	Morning warm-up	Morning warm-up	Unoccupied Occupied Bypass Standby	Air valve Reheat Fan Vent req	Enabled Enabled Enabled Disabled	STC Morning warm-up
	Cool	Cool	Unoccupied	Air valve Reheat Fan Vent req	Enabled Enabled Enabled Disabled	STC Unoccupied cooling
			Occupied Bypass Standby	Air valve Reheat Fan Vent req	Enabled Enabled Enabled Enabled	STC Occupied cooling
	Night purge	Night purge	Unoccupied Occupied Bypass Standby	Air valve Reheat Series fan Parallel fan Vent req	Enabled Disabled Enabled Disabled Disabled	STC Pre-cool
	Pre-cool	Pre-cool	Unoccupied Occupied Bypass Standby	Air valve Reheat Series fan Parallel fan Vent req	Enabled Disabled Enabled Disabled Disabled	STC Pre-cool
	Off	Off	Unoccupied Occupied Bypass Standby	Air valve Reheat Fan Vent req	Disabled Disabled Disabled Disabled	Off
	Maximum heat	Maximum heat	Unoccupied Occupied Bypass Standby	Air valve Reheat Fan Vent req	Enabled Enabled Enabled Disabled	STC Maximum heat

Table 62. Space temperature control VAV unit operation

nvi Applic Mode	nvi Heat Cool	nvoHeatCool [a, c] nvoUnitStatus. mode	nvoEffect Occup	Output [b]	Operation	Temp control sequence
Heat	Don't care	Heat	Unoccupied	Air valve Reheat Fan Vent req	Enabled Enabled Enabled Disabled	STC Unoccupied heating
			Occupied Bypass Standby	Air valve Reheat Fan Vent req	Enabled Enabled Enabled Enabled	STC Occupied heating
Morning warm-up	Don't care	Morning warm-up	Unoccupied Occupied Bypass Standby	Air valve Reheat Fan Vent req	Enabled Enabled Enabled Disabled	STC Morning warm-up
Cool	Don't care	Cool	Unoccupied	Air valve Reheat Fan Vent req	Enabled Enabled Enabled Disabled	STC Unoccupied cooling
			Occupied Bypass Standby	Air valve Reheat Fan Vent req	Enabled Enabled Enabled Enabled	STC Occupied cooling
Night purge	Don't care	Night purge	Unoccupied Occupied Bypass Standby	Air valve Reheat Series fan Parallel fan Vent req	Enabled Disabled Enabled Disabled Disabled	STC Pre-cool
Pre-cool	Don't care	Pre-cool	Unoccupied Occupied Bypass Standby	Air valve Reheat Series fan Parallel fan Vent req	Enabled Disabled Enabled Disabled Disabled	STC Pre-cool
Off	Don't care	Off	Unoccupied Occupied Bypass Standby	Air valve Reheat Fan Vent req	Disabled Disabled Disabled Disabled	Off
Maximum heat	Don't care	Maximum heat	Unoccupied Occupied Bypass Standby	Air valve Reheat Fan Vent req	Enabled Enabled Enabled Disabled	STC Maximum heat
Calibrate	Don't care	Calibrate	Unoccupied Occupied Bypass Standby	Air valve Reheat Fan Vent req	Enabled Disabled Enabled Disabled	Calibrate

a. nvoHeatCool/reported unit status mode determined by the controller.

Controller state	Sub state	nvoHeat Cool	Reported unit status. mode
Manual output test	Step 1 through 8	Test	Test
Flow override (via nvi or */**) [f]		Test	Test

Table 62. Space temperature control VAV unit operation

nvi Applic Mode	nvi Heat Cool	nvoHeatCool [a, c] nvoUnitStatus. mode	nvoEffect Occup	Output [b]	Operatio n	Temp control sequence
	Water valve override			Test	Test	
	Auto-commissioning			Test	Test	
	Stand-alone air balancing			Test	Test	
	Calibration			Calibrate	Calibrate	
	STC: construction			Heat	Heat	
	STC: space temperature fails			Cool	Cool	
	Emergency override			Don't care [e]	Don't care [e]	
	Unit shutdown			Off	Off	
	Off			Off	Off	
	Power-up		Zone demand is cool [d]	Cool	Cool	
	STC occupied/unoccupied cool STC occupied/unoccupied heat		Zone demand is heat [d]	Heat	Heat	
	VFC (occupied or unoccupied)			Cool	Cool	
	Flow tracking			Cool	Cool	

b.

Output	Enabled meaning	Disabled meaning
Air valve	Control can use air valve	Air valve is closed
Reheat	Control can use reheat	Reheat is Off
Fan	Control can run fan	Fan is Off
Ventilation Requirements (Vent req)	Ventilation requirements are enforced	Ventilation requirements are waived (air valve may close)

c. When communicated application mode is equal to HVAC_TEST, or communicated application mode is equal to HVAC_AUTO and communicated heat/cool mode is equal to HVAC_TEST, nvoUnitStatus.mode reports HVAC_TEST. The controller otherwise treats HVAC_TEST the same as HVAC_AUTO for communicated application mode and communicated heat/cool mode.

d. Zone demand is heat when the space temperature < heat setpoint. Zone demand is cool when the space temperature > cool setpoint AND space temperature > heat setpoint + 0.5°F.

e. Emergency override leaves nvoHeatCool and nvoUnitStatus.mode as is. Just likeTracer™ZN510/520.

f. A flow override whether initiated by nviFlowOverride or by star or double star on the zone sensor thumbwheel reports test.

Table 63. Ventilation flow control and flow tracking VAV unit operation

nviApplicMode	nviHeatCool	nvoHeatCool nvoUnitStatus. mode	nvoEffectOccup	Outputs [a]	Operation
Auto not valid (any enumeration not listed)	Auto not valid (any enumeration not listed)	Cool	Unoccupied Occupied Bypass Standby	Air valve Reheat Fan	Enabled Enabled [b] Not present
	Off	Off	Unoccupied Occupied Bypass Standby	Air valve Reheat Fan	Disabled Disabled [b] Not present
Off	Don’t care	Off	Unoccupied Occupied Bypass Standby	Air valve Reheat Fan	Disabled Disabled [b] Not present

a.

Output	Enabled meaning	Disabled meaning
Air valve	Control can use air valve	Air valve is closed
Reheat	Control can use reheat	Reheat is Off
Fan	Control can run fan	Fan is Off
Ventilation Requirements (Vent req)	Ventilation requirements are enforced	Ventilation requirements are waived (air valve may close)

b.Ventilation flow control VAV boxes can have reheat. Flow tracking VAV boxes never have reheat.

Appendix D: Reheat Actuation Schedule Tables

The purpose of this appendix is to provide greater detail regarding the reheat output stages. Reheat can be controlled either by responding directly to a zone temperature error or by running a proportional integral derivative (PID) loop that provides a modulating capacity output, a modulating duty cycle, or a binary output. The terms used to describe these temperature control functions are as follows and are further differentiated by their control to local reheat or remote reheat (for example, baseboard heating valve):

- Local thermostatic:

  Local output control is based on the temperature error.
- Remote thermostatic:

  Remote output control is based on the temperature error.
- Local proportional integral (PI) capacity loop:

  Local capacity or duty cycle output control is based on the response to a PID control loop.
- Remote PI capacity loop:

  Remote capacity or duty cycle output control is based on the response to a PID control loop.
- Local capacity:

  Local binary output control is based on the response to a PID control loop output and a threshold value.
- Remote capacity:

  Remote binary output control is based on the response to a PID control loop output and a threshold value

Effect of Communicated Auxiliary Heat Enable on Reheat

The Effect of communicated auxiliary heat enable value on heat outputs is described in Table 64.

Table 64. Effect of communicated auxiliary heat enable value on heat outputs

Configuration		Total number of heat stages	Communicated auxiliary heat enable value [a]	Stage 1	Stage 2	Stage 3	Unit status, heat_output_secondary
Local	Remote						
None	None	0	Any	Not applicable	Not applicable	Not applicable	0
None	On/Off Electric (1 stage)	1	0.5 to 100	Enabled. On/Off	Not applicable	Not applicable	0 or 100
			0	Disabled	Not applicable	Not applicable	0
None	On/Off hot water (1 stage)	1	0.5 to 100	Enabled. On/Off	Not applicable	Not applicable	0 or 100
			0	Disabled	Not applicable	Not applicable	0
None	Modulating hot water	1	100	Enabled. No limit	Not applicable	Not applicable	0 or 100 (PI capacity)
			0.5 to 99.5	Enabled. Limited by communicated auxiliary heat enable	Not applicable	Not applicable	0 to Communicated auxiliary heat enable value (PI capacity)
			0	Disabled	Not applicable	Not applicable	0
PWM electric (1 to 3 stages)	None	1	100	Enabled. No limit	Not applicable	Not applicable	0 or 100
			0.5 to 99.5	Enabled. Limited by communicated auxiliary heat enable	Not applicable	Not applicable	0 or Communicated auxiliary heat enable value
			0	Disabled	Not applicable	Not applicable	0
		2	100	Enabled. No limit	Enabled. No limit	Not applicable	0, 50, Or 100
			50.5 to 99.5	Enabled. No limit	Enabled: Limited by communicated auxiliary heat enable	Not applicable	0, 50, or Communicated auxiliary heat enable value
			50	Enabled. No limit	Disabled	Not applicable	0 or 50
			0.5 to 49.5	Enabled: Limited by communicated auxiliary heat enable	Disabled	Not applicable	0 or Communicated auxiliary heat enable value
			0	Disabled	Disabled	Not applicable	0
		3	100	Enabled. No limit	Enabled. No limit	Enabled. No limit	0, 33, 67, or 100

Table 64. Effect of communicated auxiliary heat enable value on heat outputs (continued)

Configuration		Total number of heat stages	Communicated auxiliary heat enable value [a]	Stage 1	Stage 2	Stage 3	Unit status, heat_output_ secondary
Local	Remote						
			67.5 to 99.5	Enabled. No limit	Enabled. No limit	Enabled: Limited by communicated auxiliary heat enable	0, 33, 67, or Communicated auxiliary heat enable value
			67	Enabled. No limit	Enabled. No limit	Disabled	0, 33, or 67
			34 to 66.5	Enabled. No limit	Enabled. Limited by communicated auxiliary heat enable	Disabled	0, 33, or Communicated auxiliary heat enable value
			33.5	Enabled. No limit	Disabled	Disabled	0 or 33
			0.5 to 33	Enabled: Limited by communicated auxiliary heat enable	Disabled	Disabled	0 or Communicated auxiliary heat enable value
			0	Disabled	Disabled	Disabled	0
On/Off electric (1 to 3 stages)	None	1	0.5 to 100	Enabled. On/Off	Not applicable	Not applicable	0 or 100
			0	Disabled	Not applicable	Not applicable	0
		2	50 to 100	Enabled. On/Off	Enabled. On/Off	Not applicable	0, 50, or 100
			0.5 to 49.5	Enabled. On/Off	Disabled	Not applicable	0 or 50
			0	Disabled	Disabled	Not applicable	0
		3	67.5 to 100	Enabled. On/Off	Enabled. On/Off	Enabled. On/Off	0, 33, 67, or 100
			34 to 67	Enabled. On/Off	Enabled. On/Off	Disabled	0, 33, or 67
			0.5 to 33.5	Enabled. On/Off	Disabled	Disabled	0 or 33
			0	Disabled	Disabled	Disabled	0
Modulating hot water	None	1	100	Enabled. No limit	Not applicable	Not applicable	0 to 100 (PI capacity
			0.5 to 99.5	Enabled. Limited by communicated auxiliary heat enable	Not applicable	Not applicable	0 to Communicated auxiliary heat enable value (PI capacity)
			0	Disabled	Not applicable	Not applicable	0
On/Off hot water (1 stage)	None	1	0.5 to 100	Enabled. On/Off	Not applicable	Not applicable	0 to 100
			0	Disabled	Not applicable	Not applicable	0

Table 64. Effect of communicated auxiliary heat enable value on heat outputs (continued)

Configuration		Total number of heat stages	Communicated auxiliary heat enable value [a]	Stage 1	Stage 2	Stage 3	Unit status, heat_output_ secondary
Local	Remote						
Local heat priority							
PWM electric (1 to 2 stages)	On/Off electric (1 stage)	2	50.5 to 100	Enabled. No limit	Enabled. On/Off	Not applicable	0, 50, or 100
			50	Enabled. No limit	Disabled	Not applicable	0 or 50
			0.5 to 49.5	Enabled. Limited by communicated auxiliary heat enable	Disabled	Not applicable	0 or Communicated auxiliary heat enable value
			0	Disabled	Disabled	Not applicable	0
		3	67.5 to 100	Enabled. No limit	Enabled. No limit	Enabled. On/Off	0, 33, 67, or 100
			67	Enabled. No limit	Enabled. No limit	Disabled	0, 33, or 67
			34 to 66.5	Enabled. No limit	Enabled. Limited by communicated auxiliary heat enable	Disabled	0, 33 or Communicated auxiliary heat enable value
			33.5	Enabled. No limit	Disabled	Disabled	0 or 33
			0.5 to 33	Enabled. Limited by communicated auxiliary heat enable	Disabled	Disabled	0 or Communicated auxiliary heat enable value
			0	Disabled	Disabled	Disabled	0
On/Off electric (1 to 2 stages) priority	On/Off electric (1 stage)	2	50.5 to 100	Enabled. On/Off	Enabled. On/Off	Not applicable	0, 50, or 100
			0.5 to 50	Enabled. On/Off	Disabled	Not applicable	0 or 50
			0	Disabled	Disabled	Not applicable	0
		3	67.5 to 100	Enabled. On/Off	Enabled. On/Off	Enabled. On/Off	0, 33, 67, or 100
			34 to 67	Enabled. On/Off	Enabled. On/Off	Disabled	0, 33, or 67
			0.5 to 33.5	Enabled. On/Off	Disabled	Disabled	0 or 33
			0	Disabled	Disabled	Disabled	0
On/Off hot water (1 stage) priority	On/Off hot water (1 stage)	2	50.5 to 100	Enabled. On/Off	Enabled. On/Off	Not applicable	0, 50, or 100
			0.5 to 50	Enabled. On/Off	Disabled	Not applicable	0 or 50
			0	Disabled	Disabled	Not applicable	0

Table 64. Effect of communicated auxiliary heat enable value on heat outputs (continued)

Configuration		Total number of heat stages	Communicated auxiliary heat enable value [a]	Stage 1	Stage 2	Stage 3	Unit status, heat_output_ secondary
Local	Remote						
On/Off hot water (1 stage) priority	Modulating hot water	2	100	Enabled. On/Off	Enabled. No limit	Not applicable	0 or 50 to 100 (PI capacity)
			50.5 to 99.5	Enabled. On/Off	Enabled. Limited by communicated auxiliary heat enable	Not applicable	0 or 50 to Communicated auxiliary heat enable value (PI capacity)
			0.5 to 50	Enabled. On/Off	Disabled	Not applicable	0 or 50
			0	Disabled	Disabled	Not applicable	0
Modulating hot water priority	On/Off hot water (1 stage)	2	50.5 to 100	Enabled. No limit	Enabled. On/Off	Not applicable	0 to 50 or 100 (PI capacity)
			50	Enabled. No limit	Disabled	Not applicable	0 to 50 (PI capacity)
			0.5 to 49.5	Enabled. Limited by communicated auxiliary heat enable	Disabled	Not applicable	0 to Communicated auxiliary heat enable value (PI capacity)
			0	Disabled	Disabled	Not applicable	0
Remote heat priority							
PWM electric (1 to 2 stages	On/Off electric (1 stage) priority	2	100	Enabled. On/Off	Enabled. No limit	Not applicable	0 to 50 or 100
			50.5 to 99.5	Enabled. On/Off	Enabled. Limited by communicated auxiliary heat enable	Not applicable	0, 50 or Communicated auxiliary heat enable value
			0.5 to 50	Enabled. On/Off	Disabled	Not applicable	0 or 50
			0	Disabled	Disabled	Not applicable	0
		3	100	Enabled. On/Off	Enabled. No limit	Enabled. No limit	0, 33, 67, or 100
			67.5 to 99.5	Enabled. On/Off	Enabled. No limit	Enabled. Limited by communicated auxiliary heat enable	0, 33, 67, or Communicated auxiliary heat enable value
			67	Enabled. On/Off	Enabled. No limit	Disabled	0, 33, or 67
			34 to 66.5	Enabled. On/Off	Enabled. Limited by communicated auxiliary heat enable	Disabled	0, 33, or Communicated auxiliary heat enable value
			0.5 to 33.5	Enabled. On/Off	Disabled	Disabled	0 or 33

Table 64. Effect of communicated auxiliary heat enable value on heat outputs (continued)

Configuration		Total number of heat stages	Communicated auxiliary heat enable value [a]	Stage 1	Stage 2	Stage 3	Unit status, heat_output_ secondary
Local	Remote						
			0	Disabled	Disabled	Disabled	0
On/Off electric (1 to 2 stages)	On/Off electric (1 stage) priority	2	50.5 to 100	Enabled. On/Off	Enabled. On/Off	Not applicable	0, 50, or 100
			0.5 to 50	Enabled. On/Off	Disabled	Not applicable	0 or 50
			0	Disabled	Disabled	Not applicable	0
		3	67.5 to 100	Enabled. On/Off	Enabled. On/Off	Enabled. On/Off	0, 33, 67, or 100
			34 to 67	Enabled. On/Off	Enabled. On/Off	Disabled	0, 33, or 67
			0.5 to 33.5	Enabled. On/Off	Disabled	Disabled	0 or 33
			0	Disabled	Disabled	Disabled	0
On/Off hot water (1 stage)	On/Off hot water (1 stage) priority	2	50.5 to 100	Enabled. On/Off	Enabled. On/Off	Not applicable	0, 50, or 100
			0.5 to 50	Enabled. On/Off	Disabled	Not applicable	0 or 50
			0	Disabled	Disabled	Not applicable	0
On/Off hot water (1 stage)	Modulating hot water priority	2	50.5 to 100	Enabled. No limit	Enabled. On/Off	Not applicable	0 to 50 or 100 (PI capacity)
			50	Enabled. No limit	Disabled	Not applicable	0 to 50 (PI capacity)
			0.5 to 49.5	Enabled. Limited by communicated auxiliary heat enable	Disabled	Not applicable	0 to Communicated auxiliary heat enable value (PI capacity)
			0	Disabled	Disabled	Not applicable	0
Modulating hot water	On/Off hot water (1 stage) priority	2	100	Enabled. On/Off	Enabled. No limit	Not applicable	0 or 50 to 100 (PI capacity)
			50.5 to 99.5	Enabled. On/Off	Enabled. Limited by communicated auxiliary heat enable	Not applicable	0 or 50 to Communicated auxiliary heat enable value (PI capacity)
			0.5 to 50	Enabled. On/Off	Disabled	Not applicable	0 or 50
			0	Disabled	Disabled	Not applicable	0

a. The value of the PI capacity loop (total unit capacity) is limited by communicated auxiliary heat enable

Reheat Actuation Schedule With No Fan Present

The reheat actuation operation with no fan present is described in the following tables:

- Table 65; Local heat only with no fan present
- Table 66; Remote heat only with no fan present
- Table 67; Local and remote heat with local priority and no fan present
- Table 68; Local and remote heat with remote priority and no fan present

Table 65. Local heat only with no fan present

Configuration		Method of control		
Local	**Remote**	**Stage 1**	**Stage 2**	**Stage 3**
PWM electric (1 to 3 stages)	Not applicable	Local PI capacity loop Each stage represents an equal percentage of total capacity PWM Output (one stage = 100%; two stages = 50% each; three stages = 33.33% each). Total capacity is limited by communicated auxiliary heat enable.		
On/Off electric (1 to 3 stages)	Not applicable	Local thermostatic On: Zt < HSP Off: Zt ≥ HSP + 0.5°F (0.28°C)	Local thermostatic On: Zt < HSP – 1°F (0.56°C) Off: Zt ≥ HSP – 0.5°F (0.28°C)	Local thermostatic On: Zt < HSP – 2°F Off: Zt ≥ HSP – 1.5°F
		Each stage represents an equal percentage of total capacity. Total capacity is limited by communicated auxiliary heat enable.		
ON/Off hot water (1 stage)	Not applicable	Local thermostatic On: Zt < HSP Off: Zt ≥ HSP + 0.5°F (0.28°C)	Not applicable	Not applicable
		Total capacity is limited by communicated auxiliary heat enable.	Not applicable	Not applicable
Modulating hot water	Not applicable	Local PI capacity loop Modulating valve capacity = Total capacity Valve drive Incrementally open/closed Total capacity limited by communicated auxiliary heat enable		Not applicable
Abbreviations: Zt = Zone temperature; HSP = Heating setpoint				

Table 66. Remote heat only with no fan present

Configuration		Method of control		
Local	**Remote**	**Stage 1**	**Stage 2**	**Stage 3**
Not applicable	On/Off electric (1 stage)	Remote thermostatic On: Zt < HSP Off: Zt ≥ HSP + 0.5°F (0.28°C) Limited by communicated auxiliary heat enable.	Not applicable	Not applicable
Not applicable	ON/Off hot water (1 stage)	Remote thermostatic On: Zt < HSP Off: Zt ≥ HSP + 0.5°F (0.28°C) Limited by communicated auxiliary heat enable.	Not applicable	Not applicable
Not applicable	Modulating hot water	Remote PI capacity loop Modulating valve capacity = Total capacity Valve drive Incrementally open/closed Total capacity limited by communicated auxiliary heat enable		Not applicable
Abbreviations: Zt = Zone temperature; HSP = Heating setpoint				

Table 67. Local and remote heat with local priority and no fan present

Configuration		Method of control		
Local	**Remote**	**Stage 1**	**Stage 2**	**Stage 3**
PWM electric (1 to 2 stages) priority	On/Off electric (1 stage)	Local PI capacity loop Local heat capacity = 1/2 or 2/3 of total capacity Local heat controls total capacity from 0% to 50% or 0% to 67% PWM Output		Remote capacity Remote heat capacity = 1/2 or 1/3 of total capacity On: total capacity ≥ 100% Off: total capacity ≤ 50% (or 67%)
		Total capacity is limited by communicated auxiliary heat enable.		
On/Off electric (1 to 2 stages) priority	On/Off electric (1 stage)	Local thermostatic On: Zt < HSP Off: Zt ≥ HSP + 0.5°F	Local thermostatic On: Zt < HSP – 1°F Off: Zt ≥ HSP – 0.5°F	Remote thermostatic On: Zt < HSP – 2°F Off: Zt ≥ HSP – 1.5°F
		Each stage represents an equal percentage of total capacity. Total capacity is limited by communicated auxiliary heat enable.		
On/Off hot water (1 stage) priority	On/Off hot water (1 stage)	Local thermostatic On: Zt < HSP Off: Zt ≥ HSP + 0.5°F	Remote thermostatic On: Zt < HSP – 1°F Off: Zt ≥ HSP – 0.5°F	Not applicable
		Each stage represents an equal percentage of total capacity. Total capacity is limited by communicated auxiliary heat enable.		Not applicable
On/Off hot water (1 stage) priority	Modulating hot water	Local capacity or thermostatic Local On/Off valve capacity = 1/2 total capacity On: total capacity > 50% or Zt < HSP – 0.5°F Off: total capacity ≤ 0% or Zt ≥ HSP + 0.5°F	Remote PI capacity loop Remote modulating calve capacity = 1/2 total capacity Remote valve controls total capacity from 51% to 100% Valve drive incrementally open/closed	
		Total capacity is limited by communicated auxiliary heat enable.		
Modulating hot water priority	On/Off hot water (1 stage)	Local PI capacity loop Local modulating valve capacity = 1/2 total capacity Local valve controls total capacity from 0% to 50% Valve drive incrementally open/closed		Remote capacity Remote On/Off valve capacity = 1/2 total capacity On: total capacity > 100% Off: total capacity ≤ 50%
		Total capacity is limited by communicated auxiliary heat enable.		
Note: This remote stage is On, Zt < HSP – 1°F / Off, Zt ≥ HSP – 0.5°F if only one stage of local heat is present. Abbreviations: Zt = Zone temperature; HSP = Heating setpoint				

Appendix D: Reheat Actuation Schedule Tables

Table 68. Local and remote heat with remote priority and no fan present

Configuration		Method of control		
Local	**Remote**	**Stage 1**	**Stage 2**	**Stage 3**
PWM electric (1 to 2 stages)	On/Off electric (1 stage) priority	Remote capacity or thermostatic Remote heat capacity = 1/2 or 1/3 of total capacity On: total capacity ≥ 50% (or 33%) or Zt < HSP – 0.5°F Off: total capacity ≤ 0% or Zt ≥ HSP + 0.5°F	Local PI capacity loop Local heat capacity = 1/2 or 2/3 of total capacity Local heat controls total capacity from 51% to 100% or 34% to 100% PWM Output	
		Total capacity is limited by communicated auxiliary heat enable.		
On/Off electric (1 to 2 stages)	On/Off electric (1 stage) priority	Remote thermostatic On: Zt < HSP Off: Zt ≥ HSP + 0.5°F	Local thermostatic On: Zt < HSP – 1°F Off: Zt ≥ HSP – 0.5°F	Local thermostatic On: Zt < HSP – 2°F Off: Zt ≥ HSP – 1.5°F
		Each stage represents an equal percentage of total capacity. Total capacity is limited by communicated auxiliary heat enable.		
On/Off hot water (1 stage)	On/Off hot water (1 stage) priority	Remote thermostatic On: Zt < HSP Off: Zt ≥ HSP + 0.5°F	Local thermostatic On: Zt < HSP – 1°F Off: Zt ≥ HSP – 0.5°F	Not applicable
		Each stage represents an equal percentage of total capacity. Total capacity is limited by communicated auxiliary heat enable.		Not applicable
On/Off hot water (1 stage)	Modulating hot water priority	Remote PI capacity loop Remote modulating calve capacity = 1/2 total capacity Remote valve controls total capacity from 0% to 50% Valve drive incrementally open/closed		Local capacity Local On/Off valve capacity = 1/2 total capacity On: total capacity > 100% Off: total capacity ≤ 50%
		Total capacity is limited by communicated auxiliary heat enable.		
Modulating hot water	On/Off hot water (1 stage) priority	Remote capacity or thermostatic Remote On/Off valve capacity = 1/2 total capacity On: total capacity > 50% or Zt < HSP – 0.5°F Off: total capacity ≤ 0% or Zt ≥ HSP + 0.5°F	Local PI capacity loop Local modulating valve capacity = 1/2 total capacity Local valve controls total capacity from 51% to 100% Valve drive incrementally open/closed	
		Total capacity is limited by communicated auxiliary heat enable.		
Abbreviations: Zt = Zone temperature; HSP = Heating setpoint				

Reheat Actuation Schedule With Parallel Fan Present

Fan powered units only have two outputs available for reheat, the third output is occupied by the fan output. The series fan runs whenever the airflow is greater than zero. The parallel fan runs intermittently, as the first stage of reheat. The parallel fan is the first stage of reheat. Its operation is not limited by the value in communicated auxiliary heat enable. The reheat actuation operation with parallel fan present is described in the following tables:

- Table 69; Local heat only with parallel fan present
- Table 70; Local and remote heat with local heat priority and parallel fan present
- Table 71; Local and remote heat with remote heat priority and parallel fan present

Table 69. Local heat only with parallel fan present

Configuration		Method of control		
Local	**Remote**	**Stage 1 [a]**	**Stage 2**	**Stage 3**
Fan	Not applicable	Parallel Fan	Not applicable	Not applicable
Fan + PWM electric (1 to 2 stages)	Not applicable	Parallel Fan	Local PI capacity loop Each stage represents an equal percent of total capacity (1-stage = 100%, 2 stages = 50% each) PWM output	
			Total capacity is limited by communicated auxiliary heat enable.	
Fan + On/Off electric (1 to 2 stages)	Not applicable	Parallel Fan	Local thermostatic On: Zt < HSP – 1°F (0.56°C) Off: Zt ≥ HSP – 0.5°F (0.28°C)	Local thermostatic On: Zt < HSP – 2°F (1.11°C) Off: Zt ≥ HSP – 1.5°F (0.83°C)
			Each stage represents an equal percentage of total capacity. Total capacity is limited by communicated auxiliary heat enable.	
Fan + On/Off hot water (1 to 2 stages)	Not applicable	Parallel Fan	Local thermostatic On: Zt < HSP – 1°F (0.56°C) Off: Zt ≥ HSP – 0.5°F (0.28°C)	Not applicable
			Total capacity is limited by communicated auxiliary heat enable.	Not applicable
Fan + Modulating hot water	Not applicable	Parallel Fan	Local PI capacity loop Modulating valve capacity = Total capacity Valve drive incrementally open/closed Total capacity limited by communicated auxiliary heat enable	

a. For more information on fan operation, see “Fan Control” on page 71.
Abbreviations: Zt = Zone temperature; HSP = Heating setpoint

Table 70. Local and remote heat with local heat priority and parallel fan present

<table>
<tr><th colspan="2">Configuration</th><th colspan="3">Method of control</th></tr>
<tr><th>Local</th><th>Remote</th><th>Stage 1 [a]</th><th>Stage 2</th><th>Stage 3</th></tr>
<tr><td rowspan="2">Fan priority</td><td rowspan="2">On/Off electric
(1 stage)</td><td rowspan="2">Parallel fan</td><td>Remote thermostatic
100% of total capacity
On: Zt < HSP
Off: Zt ≥ HSP + 0.5°F</td><td rowspan="2">Not applicable</td></tr>
<tr><td>Total capacity is limited by communicated auxiliary heat enable.</td></tr>
<tr><td rowspan="2">Fan priority</td><td rowspan="2">On/Off hot water
(1 stage)</td><td rowspan="2">Parallel fan</td><td>Remote thermostatic
100% of total capacity
On: Zt < HSP
Off: Zt ≥ HSP + 0.5°F</td><td rowspan="2">Not applicable</td></tr>
<tr><td>Total capacity is limited by communicated auxiliary heat enable.</td></tr>
<tr><td rowspan="2">Fan priority</td><td rowspan="2">Modulating hot water</td><td rowspan="2">Parallel fan</td><td colspan="2">Remote PI capacity loop
Remote modulating valve capacity = Total capacity
Remote valve controls total capacity from 0% to 100%
Valve drive incrementally open/closed</td></tr>
<tr><td colspan="2">Total capacity is limited by communicated auxiliary heat enable.</td></tr>
<tr><td rowspan="2">Fan +
PWM Electric
(one-stage)
priority</td><td rowspan="2">On/Off electric
(1 stage)</td><td rowspan="2">Parallel fan</td><td>Local PI capacity loop
Local heat capacity = 1/2 total capacity
Local heat controls capacity from 0% to 50%
PWM output</td><td>Remote capacity
Remote heat capacity = 1/2 total capacity
On: total capacity ≥ 100%
Off: total capacity ≤ 50%</td></tr>
<tr><td colspan="2">Total capacity is limited by communicated auxiliary heat enable.</td></tr>
<tr><td rowspan="2">Fan +
On/Off Electric
(one-stage)
priority</td><td rowspan="2">On/Off electric
(1 stage)</td><td rowspan="2">Parallel fan</td><td>Local thermostatic
On: Zt < HSP – 1°F (0.56°C)
Off: Zt ≥ HSP – 0.5°F (0.28°C)</td><td>Remote thermostatic
On: Zt < HSP – 2°F (1.11°C)
Off: Zt ≥ HSP – 1.5°F (0.83°C)</td></tr>
<tr><td colspan="2">Each stage represents an equal percentage of total capacity. Total capacity is limited by communicated auxiliary heat enable.</td></tr>
<tr><td rowspan="2">Fan +
On/Off hot water
(one-stage)
priority</td><td rowspan="2">On/Off hot water
(1 stage)</td><td rowspan="2">Parallel fan</td><td>Local thermostatic
On: Zt < HSP – 1°F (0.56°C)
Off: Zt ≥ HSP – 0.5°F (0.28°C)</td><td>Remote thermostatic
On: Zt < HSP – 2°F (1.11°C)
Off: Zt ≥ HSP – 1.5°F (0.83°C)</td></tr>
<tr><td colspan="2">Each stage represents an equal percentage of total capacity. Total capacity is limited by communicated auxiliary heat enable.</td></tr>
<tr><td colspan="5">a. For more information on fan operation, see “Fan Control” on page 80.
Abbreviations: Zt = Zone temperature; HSP = Heating setpoint</td></tr>
</table>

Table 71. Local and remote heat with remote heat priority and parallel fan present

Configuration		Method of control		
Local	**Remote**	**Stage 1 [a]**	**Stage 2**	**Stage 3**
Fan + PWM Electric (one-stage)	On/Off Electric (one-stage) priority	Fan	Remote capacity or thermostatic Remote heat capacity = 1/2 total capacity On: total capacity ≥ 50% or Zt < HSP – 0.5°F Off: total capacity ≤ 0% or Zt ≥ HSP + 0.5°F	Local PI capacity loop Local heat capacity = 1/2 total capacity Local heat controls capacity from 50% to 100% PWM output
			Total capacity is limited by communicated auxiliary heat enable.	
Fan + On/Off Electric (one-stage)	On/Off Electric (one-stage) priority	Fan	Remote thermostatic On: Zt < HSP – 1°F (0.56°C) Off: Zt ≥ HSP – 0.5°F (0.28°C)	Local thermostatic On: Zt < HSP – 2°F (1.11°C) Off: Zt ≥ HSP – 1.5°F (0.83°C)
			Each stage represents an equal percentage of total capacity. Total capacity is limited by communicated auxiliary heat enable.	
Fan + On/Off hot water (one-stage)	On/Off hot water (one-stage) priority	Fan	Remote thermostatic On: Zt < HSP – 1°F (0.56°C) Off: Zt ≥ HSP – 0.5°F (0.28°C)	Local thermostatic On: Zt < HSP – 2°F (1.11°C) Off: Zt ≥ HSP – 1.5°F (0.83°C)
			Total capacity is limited by communicated auxiliary heat enable.	

a. For more information on fan operation, see “Fan Control” on page 71.
Abbreviations: Zt = Zone temperature; HSP = Heating setpoint

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