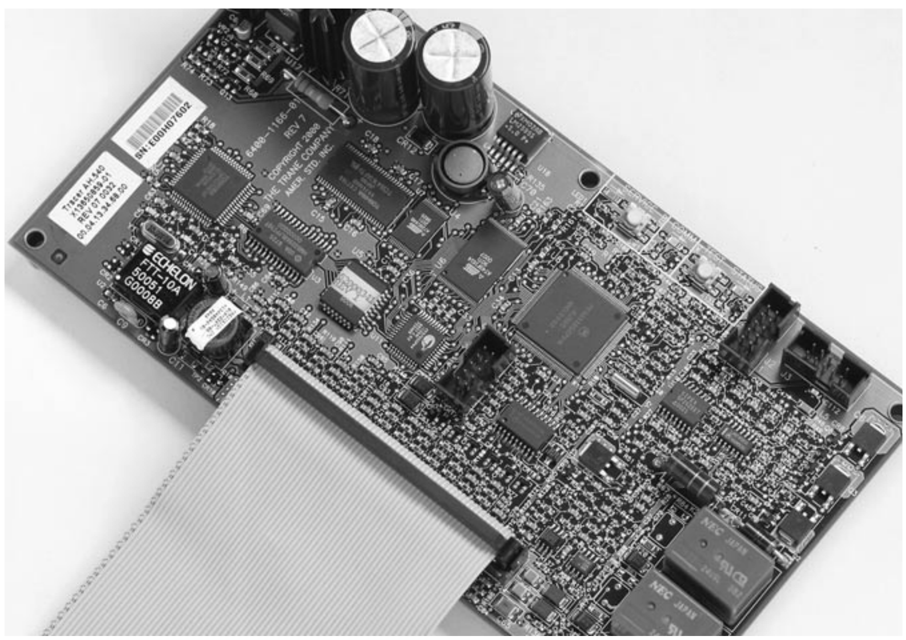
# Installation
# Owner
# Diagnostics

## Tracer™ AH.540
## Tracer™ AH.541
### Configurable Air Handling Unit Controller



CNT-SVX05A-EN

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# Introduction

This installation and operation document includes information about the Tracer™ AH.540 configurable air handling unit (AHU) controller. Version 1.0 of the controller works in both the standalone mode and when connected to a Tracer Summit™ automation system. This document details:

- Controller features
- Sequence of operation
- Inputs and outputs required for each feature

The controller is applied to air handling product configurations supporting analog modulating valves, economizer damper, and face and bypass damper. The controller also supports a constant volume or variable air volume supply fan.

The configurable air handling unit controller is also available as the Tracer AH.541 field-installed air handling unit controller (St. Paul, Minnesota). The features and functions of the Tracer AH.541 are identical to those of the Tracer AH.540 described in this manual.

# Supported Products

The configurable air handling unit controller is available installed, pre-wired, and tested with the following Trane air handling equipment:

**Packaged Climate Changer**™ Air Handling Units
LPC A Horizontal/Front Top
LPC B Horizontal/Top Front
LPC C Vertical/Front Top
LPC D Vertical/Top Front
LPC E Vertical/Top Back
LPC F Vertical/Back Top
Manufacturing Location: Macon, Georgia

**Modular Climate Changer**™ Air Handling Units
The Tracer™ AH.540 controller availability on the Modular Climate Changer air handler is limited to the features and functions provided by the controller. See the *Features* section for more information.
Manufacturing Location: Lexington, Kentucky

**T-Series Climate Changer**™ Air Handling Units
The Tracer AH.540 controller availability on the T-Series Climate Changer air handlers is limited to the features and functions provided by the controller. See the *Features* section for more information.
Manufacturing Location: Lexington, Kentucky

# Features

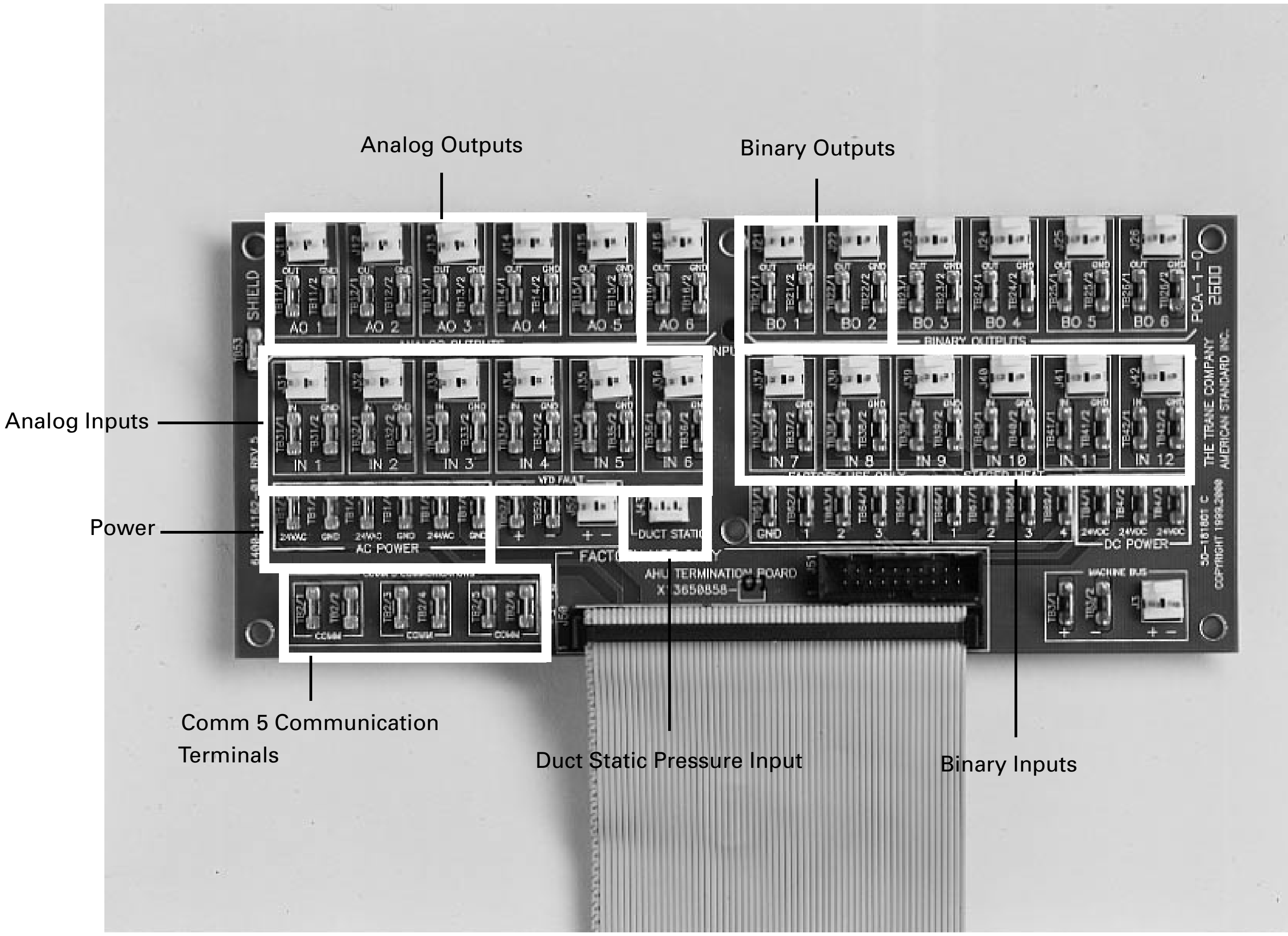
***Table 1 — Tracer™ AH.540 features and control modes***

| | Constant volume space temperature control | Constant volume discharge air control | Variable air volume control |
|---|---|---|---|
| Fan control | On/Off | On/Off | Variable |
| Duct static pressure control | | | X |
| Hydronic cooling | X | X | X |
| Hydronic heating | X | X | X |
| Steam heat | X | X | X |
| Face and bypass heating | X | X | X |
| Ventilation control | X | X | X |
| Economizer damper | X | X | X |
| Warm-up functions | X | X | X |
| Mixed air temperature control | X | X | X |
| Exhaust fan (on/off) | X | X | X |

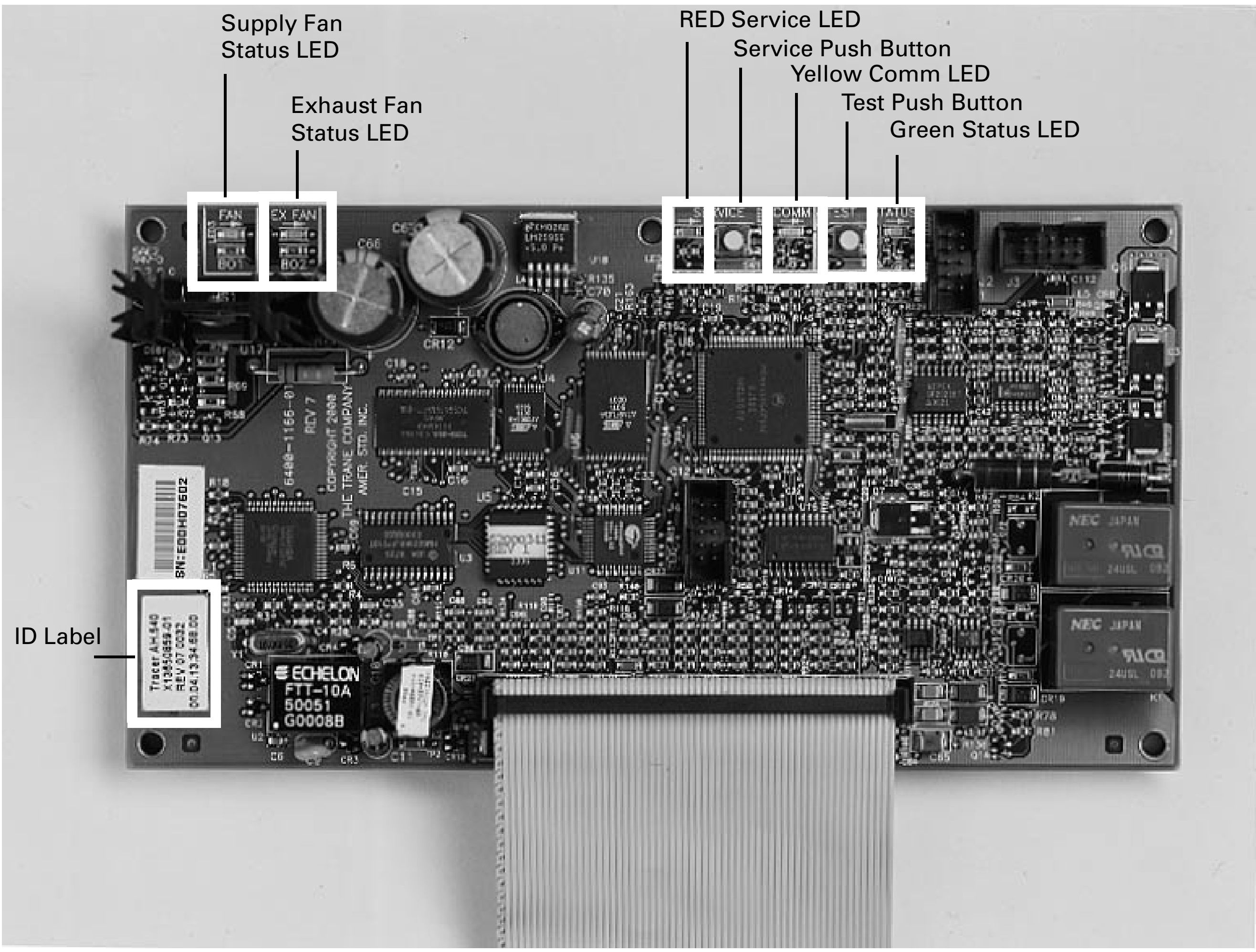
**Fan control options are:**
- Constant volume with space temperature control
- Constant volume with discharge air temperature control
- Variable air volume with discharge air temperature control

**Features available for any of the above fan control options include:**
- Hydronic cooling valve
- Hydronic heating valve
- Steam heat valve
- Face and bypass damper (heating only)
- Economizer cooling

# Termination board



# Controller board



TRANE

# Physical specifications

## Board dimensions

Termination board

Height: 3.5 inches (88.9 mm)

Width: 8.0 inches (203.2 mm)

Depth: 1.0 inch (25.4 mm)

Controller board

Height: 4.3 inches (109.2 mm)

Width: 8.0 inches (203.2 mm)

Depth: 2.0 inches (50.8 mm)

## Operating environment

-40° to 70°C (-40° to 158°F)

5% to 95% relative humidity non-condensing

## Storage environment

-40° to 85°C (-40° to 185°F)

5% to 95% relative humidity non-condensing

## Agency Conformance

(See Appendix for use limitations)

## UL

UL unlisted component

UL 873 Temperature Indicating and Regulating Equipment

CUL C22.2 No. 24-93 Temperature Indicating and Regulating Equipment

## CE

| | |
|---|---|
| Conducted Emissions | EN55022 Class A |
| | EN55022 Class B |
| | EN 61000-3-2 |
| | EN 61000-3-3 |
| Radiated Emissions | EN55022 Class A |
| Immunity | EN 50082-2 Industrial |

## FCC

CFR 47, Part 15, Subpart A, Class A

CFR 47, Part 15, Subpart A, Class B

## Power requirements

Low voltage class 2, non-safety device

18 to 32VAC (24VAC nominal)

Maximum VA = 13VA (control board)

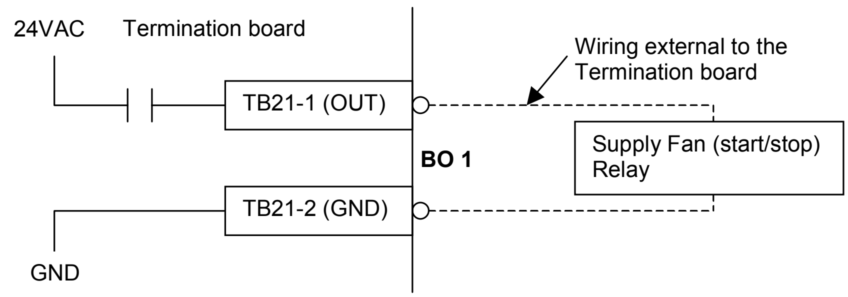
50 or 60 HZ

# Physical specifications

## Binary outputs

The binary outputs are normally-open, form A relays. The relays act as a switch, either making or breaking the circuit between the load (device) and 24VAC. When binary output 1 is energized, 24VAC is supplied to terminal TB21-1 (OUT), energizing the supply fan start/stop relay.

Example:




Each binary output has a green status LED on the Tracer AH.540 control board. The LED is off when the relay contacts are open. The LED is on when the relay contacts are closed.

When the binary output relay is off (contact is open), a multimeter should measure 0VAC across the output terminals. When the binary output relay is on (contacts are closed), a multimeter should measure 24VAC across the output terminals.

***Table 2 — Binary outputs***

| Description | Function | Factory Terminals | Field Terminals | Label | Terminal Function | Maximum Output Rating |
|---|---|---|---|---|---|---|
| BO 1 | Supply fan start/stop | J21 | TB21-1<br>TB21-2 | OUT<br>GND | 24VAC<br>Ground | 24VA |
| BO 2 | Exhaust fan start/stop | J22 | TB22-1<br>TB22-2 | OUT<br>GND | 24VAC<br>Ground | 24VA |
| BO 3 | Not used (Note 1) | J23 | TB23-1<br>TB23-2 | OUT<br>GND | Not used | Not used |
| BO 4 | Not used (Note 1) | J24 | TB24-1<br>TB24-2 | OUT<br>GND | Not used | Not used |
| BO 5 | Not used (Note 1) | J25 | TB25-1<br>TB25-2 | OUT<br>GND | Not used | Not used |
| BO 6 | Not used (Note 1) | J26 | TB26-1<br>TB26-2 | OUT<br>GND | Not used | Not used |

**Note 1:** Terminals BO 3, BO 4, BO 5, and BO 6 do not serve any function of the Tracer AH.540 controller and are not used.

# Physical specifications

## Analog outputs

The analog outputs are 0 to 10VDC.

***Table 3 — Analog outputs***

| Description | Function | Factory terminals | Field terminals | Label | Terminal function | Maximum output rating |
|---|---|---|---|---|---|---|
| AO 1 | Supply fan speed | J11 | TB11-1<br>TB11-2 | OUT<br>GND | 0 to 10VDC<br>Ground | 20mA |
| AO 2 | Cool output | J12 | TB12-1<br>TB12-2 | OUT<br>GND | 0 to 10VDC<br>Ground | 20mA |
| AO 3 | Heat output | J13 | TB13-1<br>TB13-2 | OUT<br>GND | 0 to 10VDC<br>Ground | 20mA |
| AO 4 | Face and bypass damper | J14 | TB14-1<br>TB14-2 | OUT<br>GND | 0 to 10VDC<br>Ground | 20mA |
| AO 5 | Outdoor air damper | J15 | TB15-1<br>TB15-2 | OUT<br>GND | 0 to 10VDC<br>Ground | 20mA |
| AO 6 | Not used | — | — | — | — | — |

## Analog inputs

***Table 4 — Analog inputs***

| Description | Function | Sensor type (Note 3) | Factory terminals | Field terminals | Label | Range |
|---|---|---|---|---|---|---|
| IN 1 | Space temp | 10KΩ thermistor | J31 | TB31-1<br>TB31-2 | IN<br>GND | -15° to 50°C<br>5° to 122°F |
| IN 2 | Space setpoint | 1KΩ potentiome-ter | J32 | TB32-1<br>TB32-2 | IN<br>GND | 10° to 29.4°C<br>50° to 85°F |
| IN 3 | Fan mode switch (Note 1) | Switched resistance | J33 | TB33-1<br>TB33-2 | IN<br>GND | Off (4870 Ω +/-5%)<br>Auto (2320 Ω +/-5%) |
| IN 4 | Discharge air temp | 10KΩ thermistor | J34 | TB34-1<br>TB34-2 | IN<br>GND | -40° to 100°C<br>–40° to 212°F |
| IN 5 | Outdoor air temp | 10KΩ thermistor | J35 | TB35-1<br>TB35-2 | IN<br>GND | -40° to 100°C<br>-40° to 212°F |
| IN 6 | Mixed air temp | RTD (Note 2) | J36 | TB36-1<br>TB36-2 | IN<br>GND | -40° to 100°C<br>-40° to 212°F |
| J43 | Duct static pres-sure | Specialized pressure transducer | J43-1 GND<br>J43-2 Signal<br>J43-3 5VDC | NA | Duct static | 0 to 1250 Pascals<br>0 to 5.02 in. water |

**Note 1:** Sensor type: Switched resistance fan auto = 2320Ω +/-5%, fan off = 4870Ω +/-5%.

**Note 2:** Sensor type RTD averaging sensor, 1000Ω at 0°C, platinum 385 curve.

**Note 3:** See Appendix for analog input sensor curves, **Table 65 on page 76** and **Table 66 on page 77.**

# Physical specifications

## Binary inputs

Each binary input associates an input signal of 0VDC with closed contacts and 24VDC with open contacts. If the wired binary device has closed contacts, a multimeter should measure less than 1.0VDC across the binary input terminals. If the binary input has opened, a multimeter should measure greater than 20VDC across the binary input terminals.

***Table 5 — Binary inputs***

| Description | Function | Factory terminals | Field terminals | Label | Terminal function |
|---|---|---|---|---|---|
| IN 7 | Low temp detect | J37 | TB37-1<br>TB37-2 | IN<br>GND | 24VDC<br>Ground |
| IN 8 | Run/stop | J38 | TB38-1<br>TB38-2 | IN<br>GND | 24VDC<br>Ground |
| IN 9 | Occupancy or generic | J39 | TB39-1<br>TB39-2 | IN<br>GND | 24VDC<br>Ground |
| IN 10 | Supply fan status | J40 | TB40-1<br>TB40-2 | IN<br>GND | 24VDC<br>Ground |
| IN 11 | Filter status | J41 | TB41-1<br>TB41-2 | IN<br>GND | 24VDC<br>Ground |
| IN 12 | Exhaust fan status | J42 | TB42-1<br>TB42-2 | IN<br>GND | 24VDC<br>Ground |

# Analog and binary outputs

The Tracer AH.540 is configured at the factory per unit configuration and order information. The controller is applied to air handling product configurations supporting analog modulating valves, economizer damper, and face and bypass damper. The controller supports a constant volume or variable air volume supply fan.

## General description

The configuration of analog and binary outputs is largely based on the unit configuration. Each of the five analog outputs and two binary outputs is assigned a specific function:

***Table 6 — Analog outputs***

| | |
|---|---|
| AO 1 | Supply fan speed (VAV units only) |
| AO 2 | Cooling valve output (water) |
| AO 3 | Heating valve output (water or steam) |
| AO 4 | Face and bypass damper output |
| AO 5 | Outdoor air damper output |
| AO 6 | Not used |

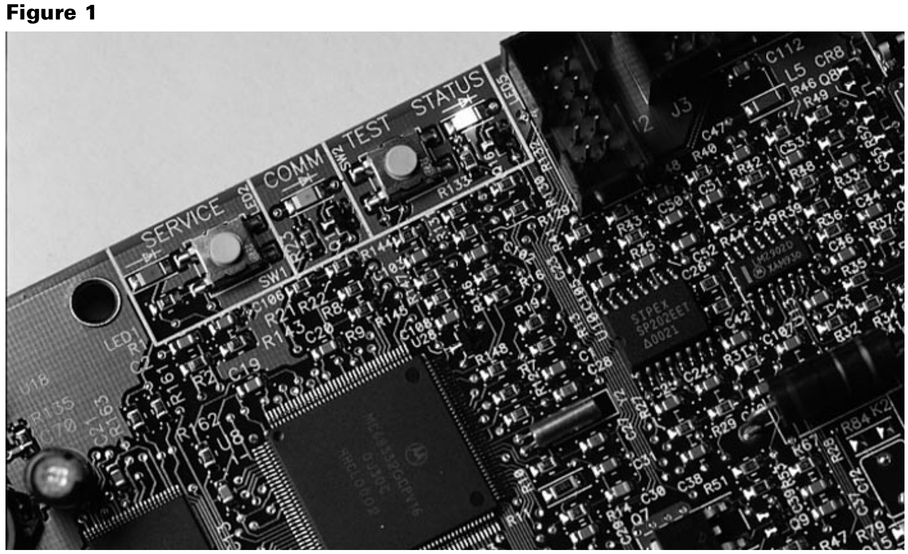
***Table 7 — Binary outputs***

| | |
|---|---|
| BO 1 | Supply fan start/stop output |
| BO 2 | Exhaust fan start/stop output |

## Output overrides

The Tracer AH.540 controller includes a manual output test function. This function can be initiated by depressing the Test push button on the controller. Use this feature to manually exercise the outputs in a defined sequence. For more information about the manual output test function, see the *Troubleshooting* section.

**Figure 1**




The Tracer AH.540 controller includes a water balancing function, which can be controlled by Rover™ or another communicating device to selectively drive open or closed the water valve outputs. For more information about the water balancing function see the *Sequence of operation* section.

# Binary inputs

The default configuration for each binary input (including normally open/closed) of the Tracer™ AH.540 is set at the factory. For field-installed AH.541 controllers, the configuration of the binary inputs must be set with Trane Rover™ service software.

Configure any binary input not in use (an input to which no device is physically connected) as Not Used.

The Tracer AH.540 controller has six available binary inputs. The binary inputs are connected to the Tracer AH.540 terminal board on inputs IN 7 through IN 12. Normally these inputs are factory-configured for the following functions.

## Binary inputs

- IN 7: Low temperature detection (freezestat)
- IN 8: Run/stop
- IN 9: Occupancy or generic
- IN 10: Supply fan status
- IN 11: Filter status
- IN 12: Exhaust fan status

Configure IN 9 either as Occupancy or as a Generic binary input. When configured as a generic binary input, IN 9 does not affect controller operation.

***Table 8 — Table Binary input controller operation***

| Binary input | Description | Configuration | Contact closed | Contact open |
|---|---|---|---|---|
| IN 7 | Low temp detect (Note 1) | Normally closed | Normal | Latching diagnostic (Note 2) |
| IN 8 | Run/stop (Note 1) | Normally open | Latching diagnostic (Note 2) | Normal |
| IN 9 | Occupancy | Normally open | Unoccupied | Occupied |
| IN 10 | Supply fan status (Note 1) | Normally open | Normal | Latching diagnostic (Note 2) |
| IN 11 | Filter status | Normally open | Dirty | Clean |
| IN 12 | Exhaust fan status | Normally closed | Exhaust fan diagnostic (Note 2) | Normal |

**Note 1:** During low temp detect, run/stop, and supply fan status diagnostics, the controller disables all normal unit operation of the fans, valves, and dampers.

**Note 2:** The table below shows the controller's response to low temp detect, run/stop, supply fan status, and exhaust fan status latching diagnostics.

***Table 9 — Control response to binary input latching diagnostics***

| Binary input | Latching diagnostic | Supply fan | Cool output | Face and bypass damper | Heat output | Outdoor air damper | Exhaust fan |
|---|---|---|---|---|---|---|---|
| IN 7 | Low temp detect | Off | Open | Face | Open (Note 1) | Closed | Off |
| IN 8 | Run/stop | Off | Closed | Bypass | Closed | Closed | Off |
| IN 10 | Supply fan status | Off | Closed | Bypass | Closed | Closed | Off |
| IN 12 | Exhaust fan status | Normal Operation | Normal Operation | Normal Operation | Normal Operation | Normal Operation | Off |

**Note 1:** When steam is the source of heat, the heat output is cycled open and closed when the controller is shut down on a *Low Temp Detect* latching diagnostic. See *Steam valve cycling* in the *Sequence of operation* section for further details.

# Binary inputs

## Low temperature detection

The low temperature detection device can be automatically or manually reset. However, you must manually reset the Tracer™ AH.540 controller *Low Temperature Detect* diagnostic to clear the diagnostic and restart the unit.

Low temperature detection protects the coils of hydronic units. A low temperature detection device (freezestat) connected to binary input IN 7 detects the low temperature. The Tracer AH.540 controller can protect the coil using one binary input. When the controller detects the low temperature detection signal, the controller generates a diagnostic which disables the fan, opens all unit water or steam valves, and closes the outdoor air damper (when present).

**Note**: *Even if the low temperature detection device automatically resets when the coil/heat exchanger temperature returns to a normal value, you must clear the Low Temperature Detect diagnostic from the controller to restart the air handling unit. See the Resetting Diagnostics section for instructions to clear controller diagnostics.*

***Table 10 — Low temperature detection controller operation***

| Diagnostic | Fan operation | Cool output | Heat output | Face and bypass | Outdoor air damper operation |
|---|---|---|---|---|---|
| Low temperature detection | Off | Open | Open (Note 1) | Face | Closed |

**Note 1:** When steam is the source of heat, the heat valve is cycled open and closed when the controller is shut down on a *Low Temp Detect* latching diagnostic. Cycling the steam valve helps prevent excessive cabinet temperatures. See *Steam valve cycling* in the *Sequence of operation* section for further details.

## Run/stop

This hardwired binary input IN 8 can be used for a variety of functions to shut down the unit. The Tracer AH.540 controller systematically shuts down unit operation and reports a *Unit Shutdown* diagnostic upon detecting a stop input. For example, a condensate overflow sensor or a smoke detector can be connected to the run/stop input to shut down unit operation.

The run/stop input creates a latching *Unit Shutdown* diagnostic. The run/stop input must first be returned to the run condition and the diagnostic must be reset in the controller before the unit is allowed to run.

***Table 11 — Run/stop IN 8 binary input configuration***

| Configuration | Contact closed | Contact open |
|---|---|---|
| Not used | Run | Run |
| Normally closed | Run | Stop |
| Normally open | Stop | Run |

# Binary inputs

## Occupancy

The Tracer AH.540 controller uses the occupancy binary input IN 9 for two occupancy-related functions.

**Standalone**

For standalone controllers (any unit not receiving a communicated occupancy request, typically from a building automation system), the occupancy binary input determines the unit's occupancy based on the hardwired signal. Normally, the signal is hardwired to a binary switch or clock.

When a hardwired occupancy signal on binary input IN 9 is open, the unit switches to occupied mode if the occupancy input is configured as normally open. When a hardwired occupancy signal is closed, the controller switches to unoccupied mode (only if the occupied bypass timer = 0). See *Occupied bypass* in the *Sequence of operation* section.

**Communicated request**

For controllers that receive a communicated occupancy request (typically from a building automation system), the hardwired occupancy binary input, along with the communicated occupancy request, place the controller in either occupied, unoccupied, or occupied standby mode.

In occupied mode, the controller operates according to the occupied setpoints. In occupied standby mode, the unit controller operates according to the occupied standby setpoints. When the controller receives a communicated unoccupied request, the controller operates according to the unoccupied setpoints regardless of the state of the hardwired occupancy input (only if the occupied bypass timer = 0).

When neither an occupancy device is wired to binary input IN 9 nor a communicated input is used to select the occupancy mode, the controller defaults to occupied mode because the occupancy binary input IN 9 typically is configured as normally open and no occupancy device is connected.

***Table 12 — Normally open hardwired input configuration***

| Tracer AH.540 status | Communicated request from BAS (nviOccSchedule) | Hardwired state of binary input IN 9 | Result |
|---|---|---|---|
| Standalone | N/A | Open = Occupied | Occupied |
| Standalone | N/A | Closed = Unoccupied | Unoccupied |
| Communicating | Occupied | Open = Occupied | Occupied |
| Communicating | Unoccupied | Open = Occupied | Unoccupied |
| Communicating | Occupied standby | Open = Occupied | Occupied standby |
| Communicating | Occupied | Closed = Unoccupied | Occupied standby |
| Communicating | Unoccupied | Closed = Unoccupied | Unoccupied |
| Communicating | Occupied standby | Closed = Unoccupied | Occupied standby |

***Table 13 — Normally closed hardwired input configuration***

| Tracer AH.540 status | Communicated request from BAS | Hardwired state of binary input IN 9 | Result |
|---|---|---|---|
| Standalone | N/A | Closed = Occupied | Occupied |
| Standalone | N/A | Open = Unoccupied | Unoccupied |
| Communicating | Occupied | Closed = Occupied | Occupied |
| Communicating | Unoccupied | Closed = Occupied | Unoccupied |
| Communicating | Occupied standby | Closed = Occupied | Occupied standby |
| Communicating | Occupied | Open = Unoccupied | Occupied standby |
| Communicating | Unoccupied | Open = Unoccupied | Unoccupied |
| Communicating | Occupied standby | Open = Unoccupied | Occupied standby |

# Binary inputs

## Generic binary input

Binary input IN 9 can be configured as a generic binary input for a variety of applications with Trane Tracer Summit™ only. The binary input does **not** affect controller operation. Binary input IN 9 can be configured as Occupancy or Generic. A generic binary input can be monitored only from Tracer Summit.

## Supply fan status

The fan status binary input IN 10 indicates the presence of air flow through the supply fan of an air handling unit. For Tracer™ AH.540 applications, a differential pressure switch detects fan status, with the high side of the differential being supplied at the unit outlet and the low side supplied inside the unit. During fan operation, differential pressure closes the normally open switch and confirms that the fan is operating properly.

**A *Low Supply Fan Air Flow* diagnostic is detected during the following two conditions:**

- The controller is commanding the fan On and the fan status switch is not in the closed position
- The fan status switch does not close the binary input within the configurable fan On delay time limit of the controller commanding the fan On

This is a latching diagnostic and discontinues unit operation until the diagnostic is cleared from the controller. Additional details can be found in the *Troubleshooting* section.

***Table 14 — Fan status binary input IN 10 configuration***

| IN 10 configuration | Contact closed | Contact open |
|---|---|---|
| Not used | Normal | Normal |
| Normally closed | Latching diagnostic (Note 1) | Normal |
| Normally open | Normal | Latching diagnostic (Note 1) |

**Note 1:** A *Low Supply Fan Air Flow* diagnostic is generated when the controller turns on the supply fan output, but the supply fan status binary input indicates the supply fan is not running after the configurable fan delay time.

## Filter status

The filter status switch connected to binary input IN 11 detects a dirty air filter and indicates a need for maintenance. For Tracer AH.540 applications, a differential pressure switch detects filter status, with the high side of the differential being supplied at the filter inlet and the low side supplied at the filter outlet. During fan operation, filter differential pressure increases as the filter becomes increasingly dirty.

A normally open filter status switch closes when the differential pressure reaches a set threshold. This is a non-latching, informational diagnostic and the controller will continue normal unit operation.

***Table 15 — Filter status configuration***

| IN 11 configuration | Contact closed | Contact open |
|---|---|---|
| Not used | Clean | Clean |
| Normally closed | Clean | Dirty |
| Normally open | Dirty | Clean |

# Binary inputs

## Exhaust fan status

The exhaust fan status binary input IN 12 indicates the presence of air flow through an exhaust fan associated with the controlled air handling unit. For Tracer™ AH.540 applications, a differential pressure switch detects exhaust fan status, with the high side of the differential being supplied at the outlet. During exhaust fan operation, differential pressure closes the normally open switch and confirms that the fan is operating properly.

**A *Low Exhaust Fan Air Flow* diagnostic is detected during the following two conditions:**

- The controller is commanding the exhaust fan On and the status switch is not in the closed position
- The fan status switch does not close the binary input within two minutes of the controller commanding the exhaust fan On

This is a latching diagnostic but does not affect controller operation of the air handling unit. Refer to the *Troubleshooting* section for additional details.

***Table 16 — Exhaust fan status binary input IN 12 configuration***

| IN 12 configuration | Contact closed | Contact open |
|---|---|---|
| Not used | Normal | Normal |
| Normally closed | Exhaust fan diagnostic (Note 1) | Normal |
| Normally open | Normal | Exhaust fan diagnostic (Note 1) |

**Note 1:** A *Low Exhaust Fan Air Flow* diagnostic is generated when the controller turns on the exhaust fan output, but the exhaust fan status binary input indicates the exhaust fan is not running after a two-minute delay time.

# Analog inputs

The analog inputs are connected to the Tracer AH.540 termination board on inputs IN 1 through IN 6. A special connector (J43) on the termination board is used for the duct static pressure input, analog input J43.

## Analog inputs

- IN 1: Space temperature
- IN 2: Local setpoint
- IN 3: Fan mode input
- IN 4: Discharge air temperature
- IN 5: Outdoor air temperature
- IN 6: Mixed air temperature
- Terminal J43 Duct static pressure

A communicated variable input like setpoint, space temperature, or outdoor air temperature has priority over a locally wired input to the controller. For example, if the Tracer™ AH.540 controller has a wired outdoor air temperature sensor, and Tracer Summit™ or another Comm5 controller sends it a communicated outdoor air temperature, the communicated value is used by the Tracer AH.540 controller.

## Space temperature

The space temperature analog input IN 1 measures space temperature only. The space temperature is measured with a 10kΩ thermistor included with Trane zone sensors. The Tracer AH.540 controller receives the space temperature from either a wired zone sensor or as a communicated value. A communicated value has precedence over a locally wired sensor input. Therefore, the communicated value, when present, is automatically used by the controller.

If the Tracer AH.540 controller is operating in constant volume space temperature control mode and the space temperature fails or does not receive a communicated value, the controller generates a *Space Temperature Failure* diagnostic.

The space temperature input may also be used to generate timed override On/Cancel requests to the controller. If a momentary short of the space temperature signal occurs, the Tracer AH.540 interprets the signal as a timed override On request.

The Tracer AH.540 uses the timed override On request (while the zone is unoccupied) as a request to go to the occupied bypass mode (occupied bypass). The occupied bypass mode lasts for the duration of the occupied bypass time, typically 120 minutes. The occupied bypass time can be changed using the Trane Rover™ service tool.

Press the Cancel button on the zone sensor to cancel the override request and return the controller to unoccupied mode. This creates a momentary fixed resistance (1.5kΩ), which sends a cancel request to the space temperature input.

# Analog inputs

## Local setpoint

The local setpoint input is a hardwired setpoint connected on analog input IN 2. The local setpoint is a resistive input for use with Trane zone sensors. If neither a hardwired nor communicated setpoint is present, the controller uses the stored default configured heating and cooling setpoints:

- Occupied setpoints
- Occupied standby setpoints
- Unoccupied setpoints

Once a valid setpoint is established through the hardwired input IN 2 or through communication, and when neither a local setpoint nor communicated setpoint is present, the controller generates a *setpoint Failure* diagnostic.

Rover™, Trane's service tool communication software package, allows you to monitor, configure, and test Tracer™ AH.540 unit controllers via a connection to the communication link.

When a *setpoint Failure* diagnostic occurs, the controller operates using the default heating and cooling setpoints. These setpoints are factory-configured, but you can change them using the Rover service tool.

**The Tracer AH.540 controller uses the following steps to determine the space temperature setpoint:**

1. Check for a communicated setpoint. If present, validate this setpoint.
2. Check for a hardwired setpoint and validate the setpoint.
3. Use the default setpoints if neither the hardwired setpoint nor the communicated setpoint is available.

| Tracer AH.540 status | Communicated setpoint input - nviSetpoint (Note 1) | Local, wired setpoint input - IN 2 | Result |
|---|---|---|---|
| Standalone | N/A | Not present | Configured default setpoints are used |
| Standalone | N/A | Present - local zone sensor thumb wheel | Local setpoint input |
| Communicating | Communicated setpoint input | Not present | Communicated setpoint |
| Communicating | Communicated setpoint input | Present - local zone sensor thumb wheel | Communicated setpoint |

**Note 1**: Communicated inputs to the Tracer AH.540 controller have precedence over locally wired inputs.

## Fan mode switch

The fan mode analog input IN 3 responds to specific resistances corresponding to a fan mode switch provided with certain Trane zone sensors. The fan mode switch on a Trane zone sensor generates the fan mode signal.

The Tracer AH.540 controller detects the unique resistance corresponding to each position of the fan mode switch. By measuring this resistance, the controller determines the requested fan mode.

If the Tracer AH.540 controller does not receive a hardwired or communicated request for fan mode, the unit recognizes the fan input as Auto.

***Table 17 — Tracer AH.540 fan modes***

| Fan modes | Tracer AH.540 operation |
|---|---|
| Off | Fan off (4870 ohms +/-1%) |
| Auto | In occupied mode, the fan runs. In unoccupied mode, the fan cycles Off when no heating or cooling is required. (2320 ohms +/-5%) |

# Analog inputs

## Discharge air temperature

The Tracer™ AH.540 controller cannot operate if the controller does not sense a valid discharge air temperature input. If the sensor returns to a valid input, the controller automatically allows the unit to resume operation.

The Tracer AH.540 controller uses analog input 4 (IN 4) as the discharge air temperature input with a 10kΩ thermistor only. This sensor is hardwired and located downstream from all unit heating/cooling capacity at the unit discharge area. The discharge air temperature is used as a control input to the controller which is used for all control modes of operation: constant volume space temperature control, constant volume discharge air temperature control, and variable air volume control.

Any time the discharge air temperature signal is not present, the controller generates a *Discharge Temperature Failure* diagnostic and performs a unit shutdown. If the sensor returns to a valid input, the controller automatically clears the diagnostic and allows the unit to resume operation.

## Outdoor air temperature

Analog input IN 5 is used for outdoor air temperature (10kΩ thermistor only). When a valid outdoor air temperature (either hardwired or communicated) and an economizer outdoor air damper exist, the controller uses this value to determine if economizing (free cooling) is feasible and (only if economizing is enabled) if the controller should enter freeze avoidance when the supply fan is off.

If the outdoor air temperature is below the economizer enable point (default 60°F, adjustable), then economizing is allowed. When the outdoor air temperature is not present, then economizing is not allowed. If both the hardwired and communicated outdoor air temperatures are present, the controller uses the communicated value for control decisions.

When an outdoor air temperature is established (either hardwired or communicated), the controller generates an *Outdoor Air Temp Failure* diagnostic if the signal is no longer valid, and the unit disallows economizing. If the sensor returns to a valid input, the controller automatically clears the diagnostic and allows economizer operation.

## Mixed air temperature

The Tracer AH.540 controller uses analog input IN 6 as the mixed air temperature input with an averaging, 1000Ω (at 0°C, 32°F) RTD sensor only. The controller's mixed air temperature input is used for mixed air tempering and outdoor air economizing operations.

The Tracer AH.540 controller disallows economizing if the controller does not sense a valid mixed air temperature input. If the sensor returns to a valid input, the controller automatically checks to see if economizer operation is possible.

If a valid mixed air temperature signal has been established by the RTD sensor, but then the value is no longer present, the controller generates a *Mixed Air Temperature Failure* diagnostic and disallows economizer operation. When the sensor returns to a valid input, the controller automatically clears the diagnostic and checks to see if economizer operation is possible.

## Duct static pressure

The duct static pressure input (terminal J43) interfaces with a specialized pressure transducer only. When a valid duct static pressure value (either hardwired or communicated) exists and a variable air volume supply fan is present, the controller uses this value for duct static pressure control.

# Analog inputs

When a duct static pressure is established, the controller generates a *Duct Static Pressure* diagnostic if the signal is no longer valid, and shuts down the unit. When the sensor returns to a valid input, the controller automatically clears the diagnostic and allows the unit to resume operation.

The Tracer™ AH.540 controller, when configured for variable air volume control, cannot operate without a valid duct static pressure input. When the sensor returns to a valid input, the controller resumes unit operation. The controller is not required to have a duct static pressure input for constant volume space temperature or constant volume discharge air temperature control.

## On/cancel buttons

Momentarily pressing the On button during unoccupied mode places the controller in occupied bypass mode for 120 minutes. You can adjust the number of minutes the Tracer AH.540 is placed in the occupied bypass mode using Rover™ service tool. The controller remains in occupied bypass mode until the override time expires or until you press the Cancel button.

If Tracer Summit™ sends an unoccupied mode command to the controller and someone presses the On button on the zone sensor, the controller goes to occupied bypass and communicates back to Tracer that its effective occupancy mode is occupied bypass.

If the controller is in the unoccupied mode, regardless of the source (Tracer Summit or hardwired occupancy binary input), pressing the On button causes the controller to go into the occupied bypass mode for the duration of the configured occupied bypass time.

# Zone sensor

**The controller accepts the following zone sensor inputs:**

- Space temperature measurement (10kΩ thermistor)
- Zone sensor setpoint adjustment (either internal or external on the zone sensor module)
- Fan mode switch
- Timed override On request
- Timed override Cancel request
- Communication jack
- Service pin message request

## Space temperature measurement

Trane zone sensors use a 10kΩ thermistor to measure the space temperature. Typically, zone sensors are wall-mounted in the room and include a space temperature thermistor. A valid space temperature input is required for the controller to operate in constant volume space temperature control.

If both a hardwired and communicated space temperature value exist, the controller ignores the hardwired space temperature input and uses the communicated value.

## Zone sensor setpoint adjustment

Zone sensors with an internal or external setpoint adjustment (1kΩ) provide the Tracer™ AH.540 controller with a local setpoint (50° to 85°F, 10° to 29.4°C). An internal setpoint adjustment is concealed under the zone sensor's cover. To access the adjustable setpoint wheel, remove the zone sensor cover. An external setpoint (when present) is accessible from the zone sensor's front cover.

There is only one hardwired setpoint input (IN 2) associated with the Tracer AH.540 controller. When the hardwired setpoint adjustment is used to determine the setpoints, all unit setpoints are calculated based on the hardwired setpoint value, the configured/default setpoints, and the active mode of the controller.

**Example:** Assume the controller is configured with the following default setpoints:

| | |
|---|---|
| Unoccupied cooling setpoint | 85°F |
| Occupied standby cooling setpoint | 76°F |
| Occupied cooling setpoint | 74°F |
| Occupied heating setpoint | 70°F |
| Occupied standby heating setpoint | 66°F |
| Unoccupied heating setpoint | 60°F |

Absolute setpoint Offset = setpoint Input - Mean setpoint

*From the default setpoints in this example, the mean of the occupied cooling and heating setpoints is 72°F [(74+70) / 2]. The absolute setpoint offset is the difference between the setpoint input and the mean setpoint. For this example, assume a setpoint input of 73°F, resulting in an absolute setpoint offset of one degree (73 –72=1).*

The hardwired setpoint is used with the controller's occupancy mode (occupied, occupied standby, or unoccupied), the heating or cooling mode, the temperature deadband values, and the heating and cooling setpoints (high and low limits) to determine the controller's active setpoint.

# Zone sensor

The controller adds the absolute setpoint offset to occupied and occupied standby default setpoints to derive the effective setpoints as follows:

| | |
|---|---|
| Unoccupied cooling setpoint | 85°F (same as default) |
| Occupied standby cooling setpoint | 77°F (default+1=77) |
| Occupied cooling setpoint | 75°F (default+1=75) |
| Occupied heating setpoint | 71°F (default+1=71) |
| Occupied standby heating setpoint | 67°F (default+1=67) |
| Unoccupied heating setpoint: | 60°F (same as default) |

**The Tracer™ AH.540 controller determines the effective setpoint based on the following:**

- Hardwired setpoint input
- setpoint calibration
- Local setpoint enable/disable
- Communicated setpoint input
- Communicated setpoint offset
- Communicated setpoint shift
- Default setpoints
- Occupancy mode
- Heating or cooling mode
- setpoint high and low limits

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 in the unoccupied mode, when the controller always uses the stored default unoccupied setpoints; a communicated setpoint shift can move the default unoccupied setpoints.

After the controller completes all setpoint calculations based on the requested setpoint, the occupancy mode, the heating and cooling mode, and other factors, the calculated setpoint is validated against the following setpoint limits:

- Heating setpoint high limit
- Heating setpoint low limit
- Cooling setpoint high limit
- Cooling setpoint low limit

These setpoint limits only apply to the occupied and occupied standby heating and cooling setpoints. These setpoint limits do not apply to the unoccupied heating and cooling setpoints stored in the controller's configuration.

When the controller is in unoccupied mode, it uses the stored unoccupied heating and cooling setpoints.

The unit can also be configured to enable or disable 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 (which determines the occupied and occupied standby temperature deadbands) and the controller's occupancy mode.

# Zone sensor

## Fan mode switch

The zone sensor fan mode switch provides the controller with a fan request signal (Off, Auto). If the fan control request is communicated to the controller, the controller ignores the hardwired fan mode switch input and uses the communicated value.

The zone sensor fan mode switch input can be enabled or disabled through configuration using the Rover™ service tool. If the zone sensor switch is disabled, the controller resorts to the *Auto* fan mode.

When the fan mode switch is placed in the Off position, the controller does not control any unit capacity. The unit remains powered and all outputs are driven Closed or Off.

Upon a loss of signal on the fan speed input, the controller reports a diagnostic and reverts to using the *Auto* fan mode of operation.

## On/cancel buttons

Some Trane zone sensor modules include timed override On and Cancel buttons. Use the timed override On and Cancel buttons to place the controller in override (occupied bypass mode) and to cancel the override request.

The controller always recognizes the timed override On button. If someone presses the zone sensor's timed override On button, the controller initializes the bypass timer to 120 minutes (adjustable).

If the controller is unoccupied when someone presses the On button for two seconds, the controller immediately changes to occupied bypass mode and remains in the mode until either the timer expires or someone presses the zone sensor's timed override Cancel button. If the On button is pressed during occupied bypass mode before the timer expires, the controller re-initializes the bypass timer to 120 minutes.

If the controller is in any mode other than unoccupied when someone presses the On button, the controller initializes the bypass time to 120 minutes. As time expires, the bypass timer continues to decrement. During this time, if the controller changes from its current mode to unoccupied (perhaps due to a change based on the system's time of day schedule), the controller switches to occupied bypass mode for the remainder of the bypass time or until someone presses the zone sensor's timed override Cancel button.

## Zone sensor communication jack

Use the RJ-11 communication jack (present on some zone sensor modules) as the connection point from Rover service tool to the communication link, when the communication jack is wired to the communication link at the controller. By accessing the communication jack via Rover, you gain communication access to any controller on the link.

## Service pin message request

At any time, pressing the zone sensor On button for ten seconds, then releasing it, causes the controller to transmit a service pin message. The service pin message can be useful for installing the controller in a communication network. See Trane Rover service tool literature for more information.

# Zone sensor

## Zone sensor wiring connections

***Table 18 — Typical Trane zone sensor wiring connections with a fan mode switch***

| TB1 | Description |
|---|---|
| 1 | Space temperature |
| 2 | Common |
| 3 | setpoint |
| 4 | Fan mode |
| 5 | Communications |
| 6 | Communications |

***Table 19 — Typical Trane zone sensor wiring connections without a fan mode switch***

| TB1 | Description |
|---|---|
| 1 | Space temperature |
| 2 | Common |
| 3 | setpoint |
| 5 | Communications |
| 6 | Communications |

# Communications

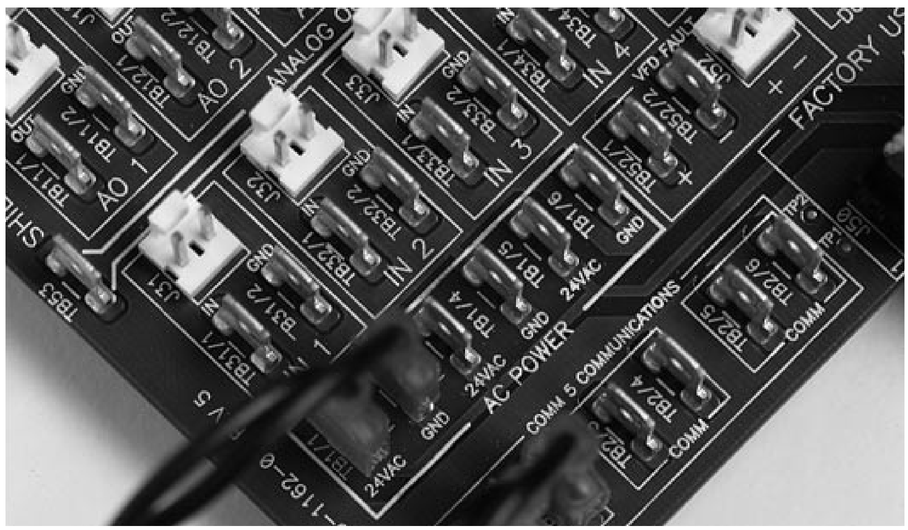
The Tracer™ AH.540 controller communicates via Trane's Comm5 protocol. Typically, a communication link is applied between unit controllers and a building automation system. Communication also is possible via Rover service tool. Peer-to-peer communication across controllers is possible even when a building automation system is not present.

You do not need to observe polarity for Comm5 communication links.

**The controller provides six terminals for the Comm5 communication link connections, as follows:**

- Two terminals for communication to the board
- Two terminals for communication from the board to the next unit (daisy chain)
- Two terminals for a connection from the zone sensor back to the controller

**Figure 2 — Communication wiring**




The Comm5 communications protocol allows peer-to-peer communications between controllers, which allows controllers to share information or data. A communicated variable input such as setpoint, space temperature, or outdoor air temperature has priority over a locally wired input to the controller.

For example: If the Tracer AH.540 controller has a wired outdoor air temperature sensor and Tracer Summit or another Comm5 controller sends it a communicated outdoor air temperature, the communicated value is used by the Tracer AH.540 controller. If a communicated input value is lost, the Tracer AH.540 controller reverts to using the locally wired sensor input.

## Device addressing

Comm5 devices are given a unique address by the manufacturer. This address is called a Neuron ID. Each Tracer AH.540 controller can be identified by its unique Neuron ID, which is printed on a label on the controller's logic board. The Neuron ID is also displayed when communication is established using Tracer Summit or Rover service tool. The Neuron ID format is 00-01-64-1C-2B-00.

# Communications

## Wire characteristics

UCM communication-link wiring must be low capacitance, 18-gauge, shielded, twisted pair with stranded, tinned-copper conductors. For daisy chain configurations, limit the wire run length to 5,000 ft (1524 m). Trunk and branch configurations are significantly shorter (see Figure 3). Comm5 wire length limitations can be extended through the use of a link repeater.

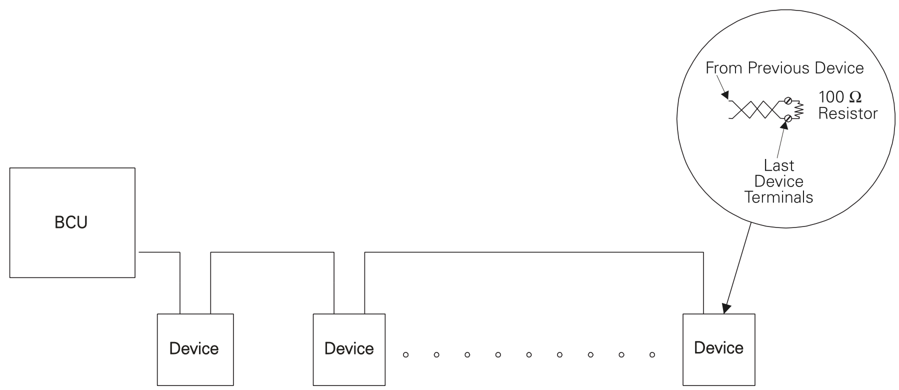
Wire capacitance (measured in picofarads/foot [pF/ft] or picofarads/meter [pF/m]) between conductors must be 23+/-2 pF/ft (72+/-6 pF/m).

## Link configuration and termination

**Communication-link wiring must use one of the following configurations:**

- Daisy chain configuration (preferred), shown in Figure 3
- Trunk and branch configuration, shown in Figure 4

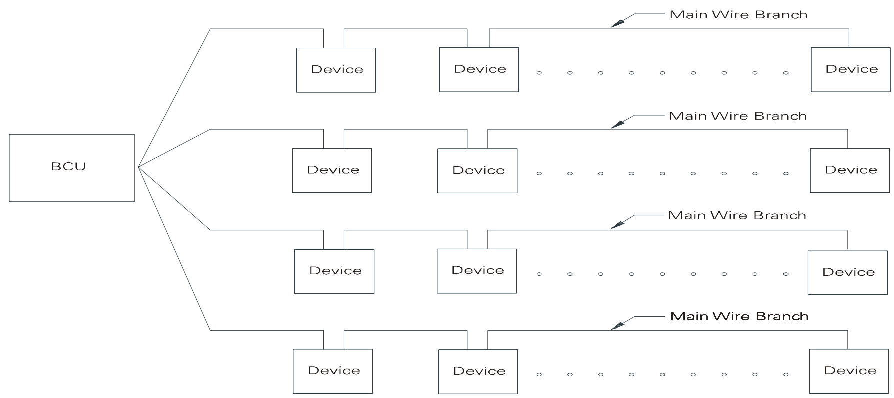
**Figure 3 — Daisy chain configuration for communication-link wiring (preferred configuration)**




- Limit total wire length to 5,000 ft (1,524 m). (Comm5 wire length limitations can be extended through the use of a link repeater)
- See the following section on *Termination resistance placement for Comm5 links*

# Communications

**Figure 4 — Trunk and branch configuration for communication link wiring**




- Total wire length for all branches is limited to 1,600 ft (500 m). (Comm5 wire length limitations can be extended through the use of a link repeater)
- The maximum number of branches is ten
- See the following section on *Termination resistance placement for Comm5 links*

## Termination resistance placement for Comm5 links

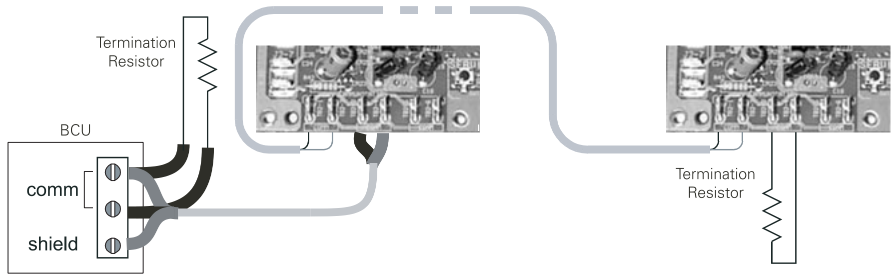
To correctly install a Comm5 link, termination resistors are required. For daisy chain configurations, the termination resistance (measured in ohms) must be 100 ohms at each end. For trunk and branch configurations, the termination resistance must be 50 ohms (use two termination resistors in parallel).

**For correct termination placement, follow the guidelines below:**

- Terminate the daisy chain configuration with a resistor at the extreme end of each wire
- Terminate a trunk and branch configuration with a resistor or resistors placed at one point on the link. The termination resistance for trunk and branch configuration can be achieved by using two terminating resistors in parallel. While it is not necessary that the termination resistance be placed at the controller, it may be the most convenient
- When terminating a trunk and branch configuration, it is best to terminate at the point where the branching occurs or at a point very close to it
- If the link contains more than one type of wire, the link will probably have to be manually tuned. Trane recommends that only one type of wire be used for the Comm5 communication link
- A set of as-built drawings or a map of the communication wire layout should be made during installation. Any sketch of the communication layout should feature the terminating resistor placement

# Communications

**Figure 5 — Daisy chain resistor placement**




## Recommended wiring practices

The following guidelines should be followed while installing communication wire.

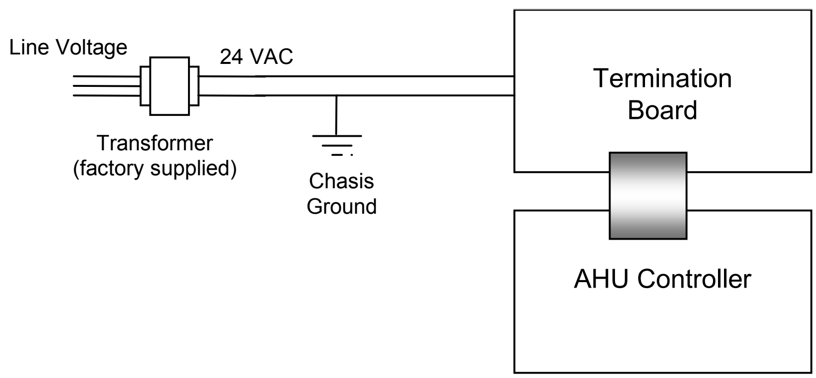
- Comm5 is not polarity sensitive. Trane recommends that the installer keep polarity consistent throughout the site
- Only strip away 2" maximum of the outer conductor of shielded cable
- Make sure that the 24VAC power supplies are consistent in how they are grounded. Avoid sharing 24VAC between Comm5 UCMs
- Avoid over-tightening cable ties and other forms of cable wraps. A tight tie or wrap could damage the wires inside the cable
- Do not run Comm5 cable alongside or in the same conduit as 24VAC power
- In an open plenum, avoid lighting ballasts, especially those using 277VAC
- Do not use a trunk and branch configuration, if possible. Trunk and branch configurations shorten the distance cable can be run

# Power

The Tracer™ AH.540 controller is powered by 24VAC. Three pairs of two terminals are provided for 24VAC connection to the board.

| | | |
|---|---|---|
| TB1-1 | 24VAC | Power input from control box 24VAC transformer |
| TB1-2 | GND | |
| TB1-3 | 24VAC | Accessory 24VAC power to other devices |
| TB1-4 | GND | |
| TB1-5 | 24VAC | Accessory 24VAC power to other devices |
| TB1-6 | GND | |

**Figure 6 — Tracer AH.540 power requirement**



# Input/output summary

## The controller includes the following input and output points:

### Power

24VAC NEC Class 2

### Two binary outputs

Supply fan start/stop (BO 1)
Exhaust fan start/stop (BO 2)

### Five analog outputs

Supply fan speed (AO 1)
Cool output (AO 2)
Heat output (AO 3)
Face and bypass damper (AO 4)
Outdoor air damper (AO 5)

### Seven analog inputs

Space temperature (IN 1)
Local setpoint (IN 2)
Fan mode switch (IN 3)
Discharge air temperature (IN 4)
Outdoor air temperature (IN 5)
Mixed air temperature (IN 6)
Duct static pressure (J43)

### Six binary inputs

Low temp detect (IN 7)
Run/stop (IN 8)
Occupancy or generic (IN 9)
Supply fan status (IN 10)
Filter status (IN 11)
Exhaust fan status (IN 12)

### Timed override On and Cancel inputs

### Comm5 communication

# Sequence of operation

The Tracer™ AH.540 is a configurable controller. All of the controller's sequences of operation are predefined with no need for programming the controller. Configurable parameters are provided to allow user adjustments to the controller’s operation. For example, the minimum occupied outdoor air damper position can be changed.

All configuration parameters are set to defaults predetermined through extensive air handling unit testing in several different operating conditions. The factory default settings are also based on the air handling unit configuration and order information.

**The Tracer AH.540 controller is configurable to operate in one of three air handling modes of operation:**

- Constant volume space temperature control
- Constant volume discharge air temperature control
- Variable air volume (VAV) control

The Tracer AH.540 controller requires both a space temperature and discharge air temperature sensor to be present for **constant volume space temperature control** operation (also called cascade control). In this control mode, the controller compares the space temperature to the space heat/cool setpoint to generate a discharge air temperature setpoint. The controller modulates its heating or cooling outputs to control the discharge air temperature to the discharge air temperature setpoint. This calculated discharge air temperature setpoint is the desired discharge air temperature (supply air temperature) that the unit must deliver to maintain space temperature at the space heating or cooling setpoint.

The space temperature can be hardwired to analog input 1 (IN 1) on the termination board (10kΩ thermistor only) or can be communicated to the controller via Comm5. Similarly, a setpoint can be provided with either a hardwired setpoint adjustment to analog input 2 (IN 2) on the controller, with a communicated value, or by using the stored default setpoints in the controller.

The discharge air temperature must be a hardwired analog input (IN 4) to the termination board (10kΩ thermistor only).

The Tracer AH.540 controller can be configured to operate in **a constant volume discharge air temperature control** mode. The controller only requires a discharge air sensor (10kΩ thermistor only) to operate in this mode. Constant volume discharge air temperature control modulates the heating or cooling outputs to maintain the discharge air temperature at the discharge air temperature setpoint.

When the Tracer AH.540 controller is configured for **variable air volume (VAV) control**, the controller maintains a discharge air temperature according to the cool/heat discharge air setpoint, and duct static pressure at the duct static pressure setpoint. The controller maintains duct static pressure by modulating the fan analog output (AO 1) which is wired to the fan’s variable frequency drive.

The duct static pressure input can either be hardwired or communicated to the controller via Comm5. If both a communicated value and a hardwired duct static pressure value exists, the communicated value has precedence. Similarly, the duct static pressure setpoint can either be configured (default) or communicated. If a communicated value is present, the communicated value has precedence.

# Sequence of operation

If a space temperature input is provided to the controller when configured as constant volume discharge air control or variable air volume control, the controller uses the space temperature to perform morning warm-up and daytime warm-up functions. Morning or daytime warm-up functions allow the controller to automatically change to heating if space temperature is less than the heating setpoint. Morning or daytime warm-up functions can also be initiated through a communicated request.

Other temperature inputs, such as mixed air temperature or outdoor air temperature, aid the controller's ability to maintain comfort and protect the air handling unit.

Economizer cooling requires a mixed air temperature sensor and outdoor air temperature value to be present. If an outdoor temperature is not available, a communicated request from Tracer Summit™ can enable economizer cooling.

Economizer cooling is possible when the air handling unit is equipped with a mixing box. The mixed air sensor is used as a low temperature limit, to keep mixed air temperatures above freezing.

Active heating and cooling setpoints are affected by the controller's occupancy mode. Valid occupancy modes for the three different control modes are shown in the following table.

***Table 20 — Tracer™ AH.540 occupancy modes of operation***

| | |
|---|---|
| Constant volume space temperature control | Occupied (default)<br>Unoccupied<br>Occupied standby<br>Occupied bypass |
| Constant volume discharge air temperature control | Occupied (default)<br>Unoccupied<br>Occupied bypass |
| Variable air volume control | Occupied (default)<br>Unoccupied<br>Occupied bypass |

The controller's occupancy mode is determined by either a binary input to the controller (IN 9) or via a communicated request (from a system-level controller or another peer controller).

## Power up sequence

**When 24VAC power is initially applied to the controller, the following sequence occurs:**

- Green Status LED turns on
- All binary outputs are controlled to their de-energized state, and analog outputs are set to the normally closed output voltage
- The controller reads the inputs to determine initial values
- *Power-up control wait* feature is applied.The controller waits 300 seconds to allow ample time for the communicated control data to arrive. If after 300 seconds, the controller has not received any communicated control data, the unit assumes standalone operation
- Normal operation begins

Manual output test can be initiated at any time in the power up sequence or during normal operation. Refer to the *Manual output test* section.

# Sequence of operation

## Space temperature setpoint operation

**The controller has three sets of possible heating and cooling setpoints:**

- Occupied
- Occupied standby
- Unoccupied

In unoccupied mode, the controller always uses locally stored default unoccupied heating and cooling setpoints. These setpoints are configured at the factory prior to shipment. Use Rover™ service tool to modify these default unoccupied setpoints.

***Table 21 — Setpoint operation***

| Method | Used in these situations: |
|---|---|
| Zone sensor (with an adjustable, hardwired setpoint) | A hardwired, adjustable setpoint is connected to the controller on IN 2. Local setpoints are enabled in the unit configuration. No communicated setpoint is present. |
| Communicated source | A setpoint is communicated to the controller, typically from a building automation system or a peer controller. If both a hardwired setpoint and a communicated setpoint exist, the controller uses the communicated value. The configuration feature for enabling/disabling the local setpoint does not affect the setpoint handling when communicated setpoints are used. The communicated setpoint always takes priority over the set-pointhardwired setpoint, even when the local setpoint is enabled. |
| Stored default setpoints | The controller uses the locally stored default heating and cooling setpoints when neither a local hardwired setpoint nor communicated setpoint is present. When a building automation system is present, the controller uses the default setpoints when no setpoint is communicated to the controller and no hardwired setpoint exists. 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. |

## Space temperature setpoint selection

**Internal and external setpoint adjustment**

Zone sensors with an internal or external setpoint adjustment (1kΩ) provide the Tracer™ AH.540 controller with a local setpoint (50° to 85°F or 10° to 29.4°C). An internal setpoint adjustment is concealed under the zone sensor's cover. To access the adjustable setpoint wheel, remove the zone sensor cover. An external setpoint (when present) is accessible from the zone sensor's 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.

**Example:** Assume the controller is configured with the following default setpoints:

| | |
|---|---|
| Unoccupied cooling setpoint | 85°F |
| Occupied standby cooling setpoint | 76°F |
| Occupied cooling setpoint | 74°F |
| Occupied heating setpoint | 70°F |
| Occupied standby heating setpoint | 66°F |
| Unoccupied heating setpoint | 60°F |

Absolute Setpoint Offset = Setpoint Input – Mean Setpoint

*From the default setpoints in this example, the mean setpoint is the mean of the occupied cooling and heating setpoints, which is 72°F [(74+70) / 2]. The absolute setpoint offset is the difference between the setpoint input and the mean setpoint.*

# Sequence of operation

The hardwired setpoint is used with the controller's occupancy mode (occupied, occupied standby, or unoccupied), the heating or cooling mode, the temperature deadband values, and the heating and cooling setpoints (high and low limits) to determine the controller's active setpoint

*<u>Example continued</u>: Assume a thumbwheel setpoint input of 73°F, resulting in an absolute setpoint offset of 1°F (73–72=1). The controller adds the absolute setpoint offset (1*°F) to occupied and occupied standby default setpoints to derive the effective setpoints, as follows.

| | |
|---|---|
| Unoccupied cooling setpoint | 85°F (same as default) |
| Occupied standby cooling setpoint | 77°F (default+1=77) |
| Occupied cooling setpoint | 75°F (default+1=75) |
| Occupied heating setpoint | 71°F (default+1=71) |
| Occupied standby heating setpoint | 67°F (default+1=67) |
| Unoccupied heating setpoint | 60°F (same as default) |

**The Tracer™ AH.540 controller determines the effective setpoint based on the following sequence:**

1. Hardwired setpoint input
2. Setpoint calibration
3. Thumbwheel enabled or disabled? (Use default setpoints if thumbwheel is disabled)
4. Communicated or local setpoint available?
5. Communicated setpoint input (nvisetpoint)
6. Communicated setpoint offset (nviSetptOffset)
7. Communicated setpoint shift (nviSetptShift)
8. Setpoint high and low limits (configurable)
9. Occupancy mode
10. Heating or cooling mode

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 the unoccupied mode, when the controller always uses the stored default unoccupied setpoints.

After the controller completes all setpoint calculations based on the requested setpoint, the occupancy mode, the heating and cooling mode, and other factors, the calculated setpoint is validated against the following setpoint limits:

- Heating setpoint high limit
- Heating setpoint low limit
- Cooling setpoint high limit
- Cooling setpoint low limit

These setpoint limits only apply to the occupied and occupied standby heating and cooling setpoints. These setpoint limits do not apply to the unoccupied heating and cooling setpoints stored in the controller's configuration.

Unit configuration also exists to enable or disable the local (hardwired) setpoint at the zone sensor module. This parameter provides additional flexibility to allow you to apply communicated, hardwired, or default setpoints without having to make physical wiring changes to the controller.

# Sequence of operation

## Occupied and unoccupied operation

**The valid occupancy modes of the Tracer™ AH.540 controller are:**

- **Occupied—**Normal operating mode for occupied spaces or daytime operation.
- **Unoccupied—**Normal operating mode for unoccupied spaces or nighttime operation.
- **Occupied Standby—**Constant volume mode used to reduce the heating and cooling demands during the occupied hours when the space is vacant or unoccupied. For example, the controller may use occupied standby mode for a classroom while the students are out of the room.
- **Occupied Bypass—**Mode used for timed override conditions. For example, if the controller is in unoccupied mode and someone presses the On button on the zone sensor, the controller is placed in occupied bypass mode for 120 minutes (adjustable) or until someone presses the Cancel button on the zone sensor.

The occupancy mode can be hardwired to the controller via the occupancy binary input or communicated to the controller.

## Occupied mode

**The Tracer AH.540 controller operates according to the configured control mode:**

- Constant volume space temperature control
- Constant volume discharge air temperature control
- Variable air volume control

When the controller is configured for constant volume space temperature control, the unit attempts to maintain the space temperature at the active occupied heating or cooling space setpoint, based on the measured space temperature, the discharge air temperature, the active setpoint, and the proportional/integral control algorithm. The modulating control algorithm used when occupied or in occupied standby is described in the following sections. Additional information related to the handling of the controller setpoints can be found in the previous *Setpoint operation* section.

The Tracer AH.540 controller, when configured for constant volume discharge air temperature control, maintains the discharge air temperature at the configured discharge air temperature heating or cooling setpoint. The default occupied mode of the controller is cooling. In the occupied mode, the controller's communicated application mode input (nviAppicMode) and heat/cool mode input (nviHeatCool) determine the controller's heating and cooling setpoint. Refer to the Appendix for heating and cooling control modes of operation.

When the controller is configured for variable air volume control, the duct static pressure is always maintained at the configured or communicated duct static pressure setpoint. The air volume is controlled by the supply fan speed analog output to the variable frequency drive (VFD).

Variable air volume control also maintains the discharge air temperature at the discharge air heating or cooling setpoint. The discharge air temperature and supply fan speed are both modulated to maintain the duct static pressure at the duct static setpoint and the discharge air at the discharge air temperature setpoint.

Economizing is possible during any of the configured control types if a mixed air sensor and outdoor air temperature sensor exist.

# Sequence of operation

## Unoccupied mode

When the controller is in the unoccupied mode, the controller attempts to maintain the space temperature between the configured unoccupied heating and cooling setpoints, based on the measured space temperature. Similar to other configuration properties of the controller, the locally stored unoccupied setpoints can be modified using Rover™ service tool.

**Constant volume space temperature control**

In unoccupied mode the supply fan is off whenever the space temperature is between the unoccupied heating and cooling setpoints. If the space temperature rises above the unoccupied cooling setpoint the Tracer™ AH.540 turns on the supply fan and provides cooling at the discharge air temperature setpoint low limit.

If the space temperature drops below the unoccupied heating setpoint the controller turns on the supply fan and provides heating at the discharge air temperature setpoint high limit. See Table 40 *Discharge air setpoint limits for constant volume space temperature control* in the Configuration section of this manual.

**Constant volume discharge air or variable air volume control**

For unoccupied heating or cooling operation the controller must have a space temperature input either hardwired or communicated from Tracer Summit™. In unoccupied mode the supply fan is off whenever the space temperature is between the unoccupied heating and cooling setpoints. If the space temperature rises above the unoccupied cooling setpoint the Tracer AH.540 turns on the supply fan and provides cooling at the discharge air cooling setpoint.

If the space temperature drops below the unoccupied heating setpoint the controller turns on the supply fan and provides heating at the discharge air heating setpoint. See Table 41 *Discharge air temperature control setpoints and setpoint limits* in the Configuration section of this manual.

If configured for variable air volume control, supply fan will control duct static pressure at the duct static pressure setpoint.

Note that primary heating or cooling capacity is defined by unit type and whether heating or cooling is enabled or disabled. For example, if the economizer is enabled and possible, it will be the primary cooling capacity. If hydronic heating is possible, it will be the primary heating capacity.

## Occupied standby mode

In the occupied standby mode, the controller uses the occupied standby cooling and heating setpoints. Because the occupied standby setpoints typically cover a wider range than the occupied setpoints, the Tracer AH.540 controller reduces the demand for heating and cooling the space. Also, the outdoor air economizer damper uses the economizer standby minimum position to reduce the heating and cooling demands.

Occupied standby is a mode in which the controller has received an occupied request from Tracer Summit™, but has also received a local unoccupied binary input IN 9 signal. For example, an unoccupied conference room (as sensed by a local occupancy sensor) in an occupied building (as commanded by Tracer Summit) is in occupied standby mode. When the conference room becomes occupied with people, the local occupancy sensor changes the controller mode to occupied.

The controller can be placed into the occupied standby mode when a communicated occupancy request is combined with the local (hardwired) occupancy binary input signal. When the communicated occupancy request is unoccupied, the occupancy binary input (if present) does not affect the controller's occupancy. When the communicated occupancy request is occupied, the controller uses the local occupancy binary input to switch between the occupied and occupied standby modes.

During occupied standby mode, the controller's economizer damper position goes to the economizer standby minimum position. The economizer standby minimum position can be changed using Rover service tool.

When no occupancy request is communicated, the occupancy binary input switches the controller’s operating mode between occupied and unoccupied. When no communicated occupancy request exists, the unit cannot switch to occupied standby mode.

## Occupied bypass mode

The controller can be placed in occupied bypass mode by either communicating an occupancy request of Bypass to the controller or by using the timed override On button on the Trane zone sensor.

When the controller is in unoccupied mode, you can press the On button on the zone sensor to place the controller into occupied bypass mode for the duration of the bypass time (typically 120 minutes).

If the controller is in the occupied standby mode, you can press the On button on the zone sensor to place the controller into occupied bypass mode for the duration of the configured bypass time. Typically occupied and occupied standby are controlled from the local binary occupancy input.

## Occupancy sources

**There are four ways to control the occupancy mode:**

- Communicated request (usually provided by the building automation system or peer device)
- By pressing the zone sensor's timed override On button (or Cancel button)
- Occupancy binary input
- Default operation of the controller (occupied mode)

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

**Determining the occupancy mode**

The occupancy of the controller is determined by evaluating the combination of three potential communicating inputs, as well as the hardwired occupancy input and the occupied bypass timer. Three different communicating inputs affect the controller's occupancy mode:

- Occupancy—manual command
- Occupancy—schedule
- Occupancy—sensor

These inputs provide maximum flexibility, but the number of inputs you decide to use varies with the application and the features available in your building automation system.

**Occupancy—manual command**

Some communicating devices may request occupancy based on the information communicated in the network variable *nvoOccManCmd*. Trane systems and zone sensors do not communicate this information to the controller, but the Tracer™ AH.540 controller accepts this network variable as communicated input *nviOccManCmd*.

**Occupancy—schedule**

# Sequence of operation

Building automation systems normally communicate an occupancy request using the occupancy—schedule input. The Tracer AH.540 controller accepts communicated occupancy schedule as a network variable input *nviOccSchedule*.

**Occupancy—sensor**

Some occupancy sensors may be equipped with the ability to communicate an occupancy mode to the controller. In such devices, network variable input *nviOccSensor* is used to communicate occupancy to the controller. Trane systems and zone sensors do not currently send this variable. The hardwired occupancy input of this controller is handled as if it is a communicated occupancy sensor input. When both a hardwired input and a communicated input exist, the communicated input is used.

***Table 22 — Effect of occupancy commands on the controller***

| Occupancy—manual command | Occupancy—schedule | Occupancy—sensor (Note 2) | Controller's Effective Occupancy |
|---|---|---|---|
| Occupied | Any state | Occupied (Note 3) | Occupied |
| | | Unoccupied | Occupied |
| Unoccupied | Any state | Any state | Unoccupied (Note 4) |
| Occupied bypass (Note 1) | Occupied | Any state | Occupied |
| | Unoccupied | Any state | Occupied bypass |
| | Occupied standby | Any state | Occupied bypass (Note 1) |
| | Invalid or not present | Occupied (Note 3) | Occupied |
| | | Unoccupied | Occupied bypass (Note 1) |
| Occupied standby | Any state | Any state | Occupied standby (Note 4) |
| Invalid or not present | Occupied | Occupied (Note 3) | Occupied |
| | | Unoccupied | Occupied standby (Note 4) |
| | Unoccupied | Any state | Unoccupied (Note 4) |
| | Occupied standby | Any state | Occupied standby (Note 4) |
| | Invalid or not present | Occupied (Note 3) | Occupied |
| | | Unoccupied | Unoccupied (Note 4) |

***Note 1:*** Occupied bypass is initiated by either a communicated request or by pressing the local zone sensor On button. The effective occupancy is occupied bypass.

***Note 2:*** The occupancy sensor can be either a local input or a communicated input. If a valid value for the network input is present, it has precedence over the local input.

***Note 3:*** If the occupancy sensor communicated input is invalid or not present, and no local input exists, the controller's mode is occupied.

***Note 4:*** If the occupied bypass timer is not equal to zero, the effective occupancy will be occupied bypass.

## On and Cancel buttons on the zone sensor

Some Trane zone sensor modules include timed override On and Cancel buttons. Use the timed override On and Cancel buttons to place the controller in override (occupied bypass mode) and to cancel the override request.

The controller always recognizes the timed override On button. If someone presses the zone sensor's timed override On button, the controller initializes the bypass timer to 120 minutes (adjustable).

If the controller is unoccupied when someone presses the On button, the controller immediately changes to occupied bypass mode and remains in the mode until either the timer expires or someone presses the zone sensor's timed override Cancel button. If the On button is pressed during occupied bypass mode before the timer expires, the controller initializes the bypass timer to 120 minutes.

If the controller is in any mode other than unoccupied when someone presses the On button, the controller initializes the bypass time to 120 minutes. As time expires, the bypass timer continues to decrement. During this time, if the controller changes from

# Sequence of operation

its current mode to unoccupied (perhaps due to a change based on the system's time of day schedule), the controller switches
to occupied bypass mode for the remainder of the bypass time or until someone presses the zone sensor's timed override Cancel button.

## Occupancy binary input

You can configure input 9 (IN 9) as an occupancy binary input. The Tracer™ AH.540 controller uses the occupancy binary input for two occupancy-related functions. For standalone controllers (any unit not receiving a communicated occupancy request, typically from a building automation system), the occupancy binary input determines the occupancy of the unit based on the hardwired signal. Normally, the signal is hardwired to a binary switch or time clock.

When a hardwired occupancy signal is open, the unit switches to occupied mode (if the occupancy input is configured as normally open). When a hardwired occupancy signal is closed, the controller switches to unoccupied mode.

For controllers that receive a communicated occupancy request from a building automation system, the hardwired occupancy binary input is used with a communicated occupancy request to place the controller in either occupied mode or occupied standby mode.

In occupied mode, the controller operates according to the occupied setpoints. In occupied standby mode, the unit controller operates according to the occupied standby setpoints. When the controller receives a communicated unoccupied request, the controller operates according to the unoccupied setpoints regardless of the hardwired occupancy input state.

If neither the hardwired binary input nor a communicated request is used to select the occupancy mode, the controller defaults to occupied mode because the occupancy binary input (if present) typically is configured as normally open and no occupancy device is connected.

## Constant volume space temperature control

The controller uses the space temperature and the measured discharge air temperature to maintain the space temperature at the active space cooling setpoint or the active space heating setpoint.

The controller's 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 active space setpoint and the active space temperature and decides if the space needs heating or cooling.

The Tracer AH.540 controller must have a valid space temperature and discharge air temperature input to operate constant volume space temperature control.

When the controller is configured for a constant volume supply fan and space temperature control, the controller will not operate the unit if the space temperature or discharge air temperature sensors are missing or have failed.

The controller's space temperature control algorithm uses two control loops: a space temperature loop and a discharge air temperature loop. The space temperature control loop compares the active heat/cool space setpoint and the space temperature and calculates a discharge air temperature setpoint. The calculated discharge air temperature setpoint range is bound by configurable heating (maximum) and cooling (minimum) limits.

The discharge air temperature loop compares the discharge air temperature to the calculated discharge air temperature setpoint (calculated by the space temperature loop), and calculates a heat or cool capacity to respond to discharge air temperature setpoint.

# Sequence of operation

The capacity calculation, as a result of the discharge air control loop, is used to drive the air handling unit's actuators to maintain space temperature at the space temperature setpoint.

**Figure 7 — Space temperature control block diagram**

| | | |
|---|---|---|
| Space temperature | → | |
| Space temperature setpoint | → | |
| | | Space temperature control loop |
| Space temperature control gains | → | |
| Discharge air temperature setpoint limits | → | |
| | | ↓ |
| | | Discharge air temperature setpoint |
| | | ↓ |
| Discharge air temperature | → | Discharge air control loop |
| | | ↓ |
| Discharge air control gains | → | |
| | | Calculate heat/cool capacity |
| | | ↓ |
| | | Use capacity to drive actuators |

**Control gains**

Figure 7 above illustrates the separate control for the space temperature control loop and discharge air control loop. The gain parameter values that control the different loops have been determined through extensive testing of different types of heating or cooling capacities and at operating conditions of the air handling unit.

**Heating or cooling control mode operation**

The heating or cooling control mode of the controller can be determined two ways:

- Communicated request
- Automatically by the controller

**Communicated request**

A building automation system or peer controller may communicate the heating or cooling mode to the controller via network variables nviHeatCool and/or nviApplicMode. Heating mode commands the controller to heat only. Cooling mode commands the controller to cool only. The Auto mode allows the controller to automatically change from heating to cooling or cooling to heating. Refer to the Appendix, Table 63 *Constant volume space temperature control operation based on the effective heat/cool output*.

# Sequence of operation

*Table 23 — Constant volume unit operation allowed based on communicated request*

| Request (Note 1) | Supply fan | Mechanical heating | Mechanical cooling | Outdoor air damper | Exhaust fan |
|---|---|---|---|---|---|
| Auto | Enabled | Enabled | Enabled | Enabled | Enabled |
| Heat | Enabled | Enabled | Disabled | Enabled | Enabled |
| Morning warm-up | Enabled | Enabled | Disabled | Closed | Disabled |
| Cool | Enabled | Disabled | Enabled | Enabled | Enabled |
| Night purge | Enabled | Disabled | Disabled | Ventilation disabled Economizer enabled | Enabled |
| Pre-cool | Enabled | Disabled | Enabled | Ventilation disabled Economizer enabled | Disabled |
| Off | Disabled | Disabled | Disabled | Disabled | Disabled |
| Test | Enabled | Enabled | Enabled | Enabled | Enabled |
| Emergency heat (Note 2) | Enabled | Enabled | Enabled | Enabled | Enabled |
| Fan only | Enabled | Disabled | Disabled | Disabled | Enabled |

***Note 1:*** Enabled means normal operation.
Disabled means that the controller **cannot** use it.

***Note 2:*** The Tracer™ AH.540 controller does not support Emergency heat. Emergency heat will be treated as Auto.

### Automatically by the controller

A communicated request of Auto or the controller's default operation (Auto) can place the unit into heating or cooling mode. When the controller automatically determines the heating or cooling mode while in Auto mode, the unit switches to the desired mode based on the control algorithm.

If the Tracer AH.540 controller is operating space temperature control, it uses the space temperature and space temperature setpoint to automatically determine heat or cool mode of operation. When the controller first powers up or after a reset, it makes an initial determination if the heat/cool mode should be heat or cool. If the controller is configured as heating and cooling, the controller determines the appropriate mode.

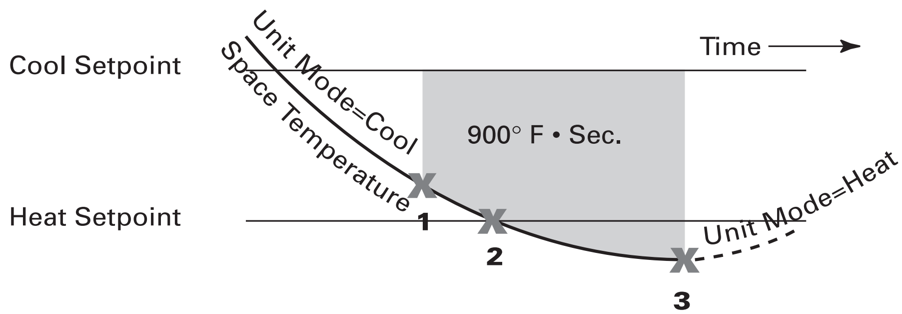
***Example:*** *If the initial space temperature is less than the occupied space heat setpoint then the initial heat/cool mode is heating. The heat/cool mode for a cool-only unit is always cool. The heat/cool mode for a heat-only unit is always heat.*

When the controller is allowed to automatically determine its space heating and cooling mode, the unit changes from cool to heat or from heat to cool, when the integrated error between the active space setpoint and the active space temperature is 900° F • seconds or greater. The integrated error is calculated once every ten seconds.

See Figure 8 below for an example of the controller changing from space cooling (Unit Mode = cool) to space heating (Unit Mode = heat). In this example the controller's initial unit mode is cool because the space temperature is above the cool setpoint, and the controller's cooling capacity is greater than 0%. Following the curve from left to right, the space temperature falls below the cool setpoint and the controller reacts by lessening its cooling capacity.
When the space temperature reaches 1, the controller's capacity is 0%.
The rate at which the controller reaches 0% capacity depends on the space temperature rate of change.

# Sequence of operation

**Figure 8 — Automatic heat/cool changeover logic example**




**1** This is the point at which the cooling capacity equals 0%, space temperature is less than 0.5° F below the cooling setpoint, and the error integrator starts to add up. Error integration does not begin until the capacity is 0%. See the *Error integration example* below.

**2** The space temperature must fall below the active space heat setpoint before the controller can change to heating. Conversely, the space temperature must rise above the active space heat +0.5° F setpoint before the controller can change to cooling.

**3** The controller switches to heat (from cool) after the error integrator exceeds 900° F • seconds.

**4** The controller must be able to heat before it will switch to heat. A unit that cannot heat will not switch to heat. A unit that cannot cool will not switch to cool.

***Error integration example:*** *If the active space temperature is 66.5 °F, the current mode is cooling, and the space cooling setpoint is 70 °F. The error calculation is 70 - 0.5 - 66.5 = 3° F. If the same error exists for 60 seconds, the error integration term is*
*(3 °F x 60 seconds = 180 °F seconds). Therefore, after five minutes*
*(3 °F x 300 seconds = 900 °F seconds), the controller will switch from cooling to heating mode.*

**Cooling operation**

The heating and cooling space setpoint high and low limits are always applied to the occupied and occupied standby setpoints.

During the cooling mode, the Tracer™ AH.540 controller attempts to maintain the active space temperature at the active space cooling setpoint. Based on the controller's occupancy mode, the active space cooling setpoint is one of the following:

- Occupied cooling setpoint
- Occupied standby cooling setpoint
- Unoccupied cooling setpoint

# Sequence of operation

The cooling outputs are controlled based on the unit configuration and the required machine cooling capacity. At 0% machine cooling capacity, the cooling valve is closed and the outdoor air damper is at its minimum position. As the required machine cooling capacity increases, the cooling valve and/or the outdoor air damper opens above their minimum positions.

The constant volume control algorithm calculates a desired discharge air temperature to maintain the space cooling setpoint. Cool capacity is controlled to achieve the desired discharge air setpoint. Heat capacity can also be used to temper cold outdoor air conditions to maintain ventilation and the discharge air setpoint.

The outdoor air damper is used for cooling whenever economizing is possible and there is a need for cooling. If economizing is not possible, it will not be used in cooling. If economizing is possible, it is always the first stage of cooling. See the *Outdoor air damper* section for more information.

**Heating operation**
In the heating mode, the Tracer™ AH.540 controller attempts to maintain the space temperature at the active heating setpoint. Based on the controller's occupancy mode, the active space heating setpoint is one of the following:

- Occupied heating setpoint
- Occupied standby heating setpoint
- Unoccupied heating setpoint

The outputs are controlled based on the unit configuration and the required machine heating capacity. At 0% machine heating capacity, the heating capacity is at its minimum position. As the required machine heating capacity increases, the heating capacity is opened above its minimum position. At 100% machine heating capacity, the heating capacity is open to its maximum position.

The economizer outdoor air damper is never used as a source of heating. The economizer damper is only used for ventilation when the unit is heating. For more information about outdoor air damper operation, see the *Outdoor air damper operation* section.

## Constant volume discharge air temperature control

Constant volume discharge air temperature control maintains a discharge air temperature at a desired discharge air temperature setpoint regardless of the entering air conditions of the air handling unit.

Figure 9 shows the steps the Tracer AH.540 controller takes to control discharge air. First the controller determines if a communicated discharge air heating setpoint and discharge air cooling setpoint are present. The communicated setpoint has precedence over the configured (default) setpoint. If no communicated value is present, the controller uses the configured discharge air temperature setpoint.

Discharge air temperature setpoint minimum and maximum limits are placed on the discharge air setpoint depending on the effective heat or cool mode. If the effective heat/cool mode is cool, the maximum discharge air cooling setpoint limit and minimum discharge air cooling setpoint limit the discharge air cooling setpoint. See the *Configuration* section for more information about discharge air heating and cooling setpoint limits.

# Sequence of operation

The effective discharge air temperature setpoint is determined from:

- communicated or configured discharge air setpoint value
- minimum and maximum heat/cool setpoint limits
- the effective heat/cool mode

**Example**:

***Table 24 — Configuration parameters***

| | |
|---|---|
| Discharge air cooling setpoint | 55°F |
| Maximum discharge air cooling setpoint | 68°F |
| Minimum discharge air cooling setpoint | 53°F |
| Discharge air heating setpoint | 100°F |
| Maximum discharge air heating setpoint (Note 1) | 104°F |
| Minimum discharge air heating setpoint | 86°F |

***Note 1:*** When the controller is applied to an air handling unit with a draw-through supply fan, the maximum discharge air heating setpoint should be set to 104°F (default setpoint). This prevents the discharge air temperature from exceeding the high temperature limit of the supply fan motor. Exceeding the motor's temperature limit can cause premature failures.

***Table 25 — Communicated values***

| | |
|---|---|
| Discharge air cooling setpoint input | 50°F |
| Discharge air heating setpoint input | none |
| Effective heat cool mode | Cool |

Since the effective heat cool mode is *Cool* and the communicated value has precedence over the local configuration value, the discharge air cooling setpoint is *50 °F*. The maximum and minimum discharge air cooling setpoint limits are then applied to determine an effective discharge air temperature setpoint of *53 °F*, from Table 23.

In this example, if the effective heat cool mode is *Heat*, the effective discharge air temperature setpoint would be 100°F.

The discharge air temperature control loop uses the effective discharge air temperature setpoint, discharge air temperature (from the wired sensor), and the configured control gains to calculate an output capacity for the end devices.

**TRANE**

# Sequence of operation

**Figure 9 — Discharge air temperature control flow diagram**

| | | | |
|---|---|---|---|
| Configured value:<br>discharge air heating setpoint<br>discharge air cooling setpoint | → | The communicated heat/cool setpoint value has precedence over the configured discharge air temperature heat/cool setpoint | |
| Communicated value:<br>discharge air heating setpoint<br>discharge air cooling setpoint | → | Discharge air heating setpoint | Discharge air cooling setpoint |
| | | ↓ | ↓ |
| | | Discharge air<br>heat setpoint limits | Discharge air<br>cool setpoint limits |
| | | ↓ | ↓ |
| Effective heat/cool mode | → | Effective discharge air temperature setpoint | |
| | | ↓ | |
| Discharge air temperature<br>(wired sensor) | → | Discharge air temperature control loop | |
| | | ↓ | |
| Discharge air control gains | → | Calculate heat/cool capacity | |
| | | ↓ | |
| | | Use capacity to drive actuators | |

### Heating or cooling control mode operation

The heating or cooling control mode of the controller can be determined in two ways:

- Communicated request
- Automatically by the controller

### Communicated request

A building automation system or peer controller may communicate the heating or cooling mode to the controller via network variable nviApplicMode. Heating mode commands the controller to heat only. Cooling mode commands the controller to cool only. The Auto mode allows the controller to automatically change from heating to cooling or cooling to heating. See Appendix Table 63 *Constant volume discharge air temperature control and variable air volume operation based on the effective heat/cool output*.

### Automatically by the controller

A communicated request of Auto or the controller's default operation (Auto) can place the unit into cooling mode. A zone temperature input is required for constant volume discharge air control when auto heat/cool changeover is desired. When the controller automatically determines the heating or cooling mode using auto mode, the unit switches to the desired mode based on the control algorithm and the relationship between zone temperature to the configured daytime warm up start and stop setpoints. See daytime warm up in configuration section of this manual.

When the controller first powers up or after a reset, it makes an initial determination if the discharge air control mode should be heating or cooling. The discharge demand for a cooling-only unit is always cooling. The discharge demand for a heating only unit is always heating. A unit that can heat or cool initially starts in cooling mode.

# Sequence of operation

## Variable air volume control

The Tracer™ AH.540 controller that is operating with variable air volume control uses both a discharge air temperature control routine and a duct static pressure control routine. The unit's discharge air temperature is controlled using the discharge air temperature control sequence. The air handling unit's duct static pressure is maintained by a duct static pressure control sequence.

### Duct static pressure control

The supply fan variable frequency drive, in a variable air volume system, is controlled to maintain the duct static pressure setpoint. When the fan is On, the controller reads and compares the duct static pressure input to the duct static pressure setpoint and adjusts the supply fan speed analog output signal (AO 1) to the variable frequency drive.

The duct static pressure signal can be from a wired sensor or communicated via a network variable. If the controller does not have a valid duct static pressure from a wired sensor or communicated, the controller generates a *Duct static press failure* diagnostic and shuts down the unit. The controller does not operate duct static pressure control without a valid duct static pressure input.

If the controller has both a hardwired and communicated duct static pressure input, the communicated value is used for duct static pressure control. The greater of the two values, hardwired or communicated, is used for duct static pressure high limit shutdown.

The Tracer AH.540 controller has a configurable duct static pressure high limit setpoint. If the duct static pressure exceeds the duct static pressure high limit setpoint, the controller shuts down the unit and generates a *Duct static pressure high limit* diagnostic. This latching diagnostic must be cleared from the controller before unit is allowed to operate.

## Supply fan operation

The Tracer AH.540 controller determines fan operation based on the selected control mode. If the Tracer AH.540 controller is configured for constant volume space temperature control or constant volume discharge air control, the controller turns the supply fan binary output (BO 1) on continuously during occupied, occupied standby, and occupied bypass modes.

When a supply fan status binary input sensor is wired to the controller (IN 10) it is used to verify fan operation before heating and cooling start. Upon energizing the supply fan output (BO 1) the Tracer AH.540 controller waits a configurable time period (fan status delay) to allow the fan time to reach a desired air flow. Then the controller verifies fan operation (fan status).

A *Low Supply Fan Air Flow* diagnostic is detected when the controller is commanding the fan On and the fan status switch is not in the closed position, or if the fan status switch does not close the binary input within the configured time limit after the controller commanding the fan On. This is a latching diagnostic and discontinues unit operation until the diagnostic is cleared from the controller.

# Sequence of operation

Certain diagnostic conditions can cause the controller to shut down the unit, which affects fan operation. See the *Diagnostics* section for details.

If the controller is configured for variable air volume control, variable speed fan operation is assumed by the controller. The supply fan analog output (AO 1) and binary output (BO 1) are used to control a variable frequency drive.

**Constant volume operation**

The Tracer™ AH.540 controller turns on the supply fan continuously during occupied, occupied standby, and occupied bypass modes of operation. During unoccupied periods, the supply fan binary output (BO 1) controls the supply fan off and on depending on heating or cooling requirements.

If the controller is wired to a Trane zone sensor, the user can change the supply fan operation through the fan mode switch (when present). When the fan mode switch is in the Off position, the controller shuts down the unit. If the fan mode switch is moved to the Auto position, the controller operates the fan on and off according to heat and cool demands and the active occupancy mode.

**Variable air volume operation**

For variable air volume supply fan operation, the Tracer AH.540 controller must be configured for variable air volume control and have a duct static pressure and discharge air temperature sensor available. The controller's supply fan binary output (BO 1) controls the fan's run/stop input, and the controller's supply fan analog output (AO 1) controls the supply fan speed.

The supply fan speed is controlled to maintain the air handling unit's duct static pressure to the desired duct static pressure setpoint.

The Tracer AH.540 controller has a configurable duct static pressure high limit. Fan operation is controlled to actively avoid exceeding this high pressure limit. If the duct static pressure exceeds the duct static pressure high limit point, the controller shuts down the unit and generates *a Duct static press high limit* diagnostic. This latching diagnostic must be cleared from the controller before unit operation is allowed.

## Valve operation

The controller uses analog modulating (0-10VDC or 2-10VDC) valves for heating or cooling operation. The controller supports one or two modulating valves for hydronic heating, steam heat, and hydronic cooling operation. The Tracer AH.540 controller supports both one- and two-valve unit configurations. See the *Configuration* section for further details regarding heating and cooling configurations.

A one-valve unit can be either cooling only or heating only. A two-valve unit supports preheat (heating coil before the cooling coil) or reheat coil-valve configurations (heating coil after the cooling coil).

If the cooling output is configured for cooling and the heating valve is configured for preheat (or reheat), the controller always assumes hot water (or steam) is available for the heating valve and cold water is available for the cooling valve.

The Tracer AH.540 controller operates to either normally open or normally closed valves. The normal state of the valve is the position of the valve when power is not applied. When power is applied, the controller has full control of the valve. For example, if the fan mode switch on the zone sensor is in the Off position, the controller closes the valve, regardless if it is configured normally open or normally closed.

# Sequence of operation

### Steam valve cycling

During low temp detect or freeze avoidance diagnostic conditions, which causes a unit shutdown, the controller opens all heating and cooling valves 100% to prevent the coil from freezing. When steam heat is present, the controller cycles the steam heat valve output on, then off over a period of five minutes (configurable) to prevent excessive unit cabinet temperatures. The heat valve output Open position is configurable 0 to 100%.

**For example:** *If steam heat cycling is configured for 25% (default), the controller opens the steam valve for 75 seconds (25% of 5 minutes) and closes it for 225 seconds.*

**Caution!** An air handling unit with greater than 15 psig of steam could create excessive cabinet temperatures with the valve 100% open.

## Face and bypass damper operation

The face and bypass damper modulates a percentage of air to the face of the heat coil and around the coil (bypass) to maintain the supply air temperature setpoint. The air passing through the hot water coil is mixed with the air bypassing the coil to produce a desired discharge air temperature.

The Tracer™ AH.540 controller supports face and bypass operation for low outdoor temperature heating modes of operation only. During low outdoor temperatures, when the outdoor air temperature is lower than the face and bypass heat modulation setpoint, the heating valve is fully opened and the face and bypass damper is used for heating to prevent the coil from freezing. During economizer cooling operation, when outdoor temperature is less than the face and bypass heat modulation setpoint, the face and bypass damper is full bypass.

The face and bypass heat modulation setpoint is the outdoor air temperature (40°F default) at which the controller changes over to face and bypass heating operation. The face and bypass heat modulation setpoint can be changed using the Trane Rover™ service tool.

When the outdoor air temperature is greater than 3°F above the face and bypass heating modulation setpoint, the hydronic heating valve is modulated to maintain discharge air temperature. The face and bypass damper is positioned for full face air flow. When the outdoor air temperature is less than the face and bypass heating modulation setpoint, the controller fully opens the heating valve and uses the heat face and bypass damper to modulate heating capacity to maintain the desired discharge air temperature.

***Table 26 — Face and bypass damper operation based upon outdoor air temperature***

| Outdoor air temperature | Hydronic heating valve | Face and bypass damper |
|---|---|---|
| Outdoor air temperature is greater than face and bypassheat modulation setpoint (Note 1) | Modulated to maintain desired setpoint | Full coil face (operation disabled) |
| Outdoor air temperature is less than face and bypass heat modulation setpoint | 100% open | Modulated to maintain desired setpoint (operation enabled) |

***Note 1:*** The outdoor air temperature must rise 3°F above the face and bypass heating enable point before face and bypass heating operation is disabled.

During diagnostic and fan off conditions, when the controller shuts down unit operation, the face and bypass damper is in the full bypass position. During freeze avoidance operation or a *Low Temp Detect* diagnostic, the face and bypass damper is driven to full face.

# Sequence of operation

## Outdoor air damper operation

The controller operates the modulating outdoor air damper according to the effective occupancy, outdoor air temperature (communicated or hardwired sensor), space temperature, effective space temperature setpoint, discharge air temperature, and discharge air temperature setpoint. Default minimum damper positions are provided and can be changed using Trane's Rover service tool for occupied and occupied standby ventilation.

The controller can also receive a communicated outdoor air damper minimum position from Tracer Summit™. A communicated minimum position from Tracer Summit has priority over all configured minimum setpoints. When a communicated minimum position is not present, the controller uses the configured minimum setpoints.

***Table 27 — Determining the economizer damper minimum position setpoint***

| Occupancy | Tracer Summit setpoint | Active minimum damper setpoint |
|---|---|---|
| Unoccupied | Valid or Invalid | Closed |
| Occupied<br>Occupied bypass<br>Occupied standby | Valid | Tracer Summit |
| Occupied<br>Occupied bypass | Invalid | Occupied minimum |
| Occupied standby | Invalid | Occupied standby minimum |

During occupied modes, the damper remains at a minimum damper position, whether a configured minimum position or communicated from Tracer Summit.

**Mixed air temperature control**

The Tracer™ AH.540 controller provides minimum ventilation requirements according to the effective occupancy mode. Ventilation requirements are maintained by mixed air control depending on available heating and cooling sources, unit configuration, and mixed air control type (configurable). Low mixed air temperatures can be a concern for units with hydronic heating and cooling.

Mixed air control is used to maintain the mixed air temperature above the mixed air low limit setpoint (configurable). See Table 27 below. If the air handling unit does not have a mixing box section, then mixed air control is not required.

Heat only, cool only, or cool reheat air handling configurations with a mixing box can be configured for mixed air control. If cold outdoor air conditions exist, depending on ventilation requirements, the mixed air temperature can create freezing conditions. *Mixed air control* reduces the outdoor air damper below the minimum position to maintain mixed air temperature above the mixed air temperature low limit.

Air handling units with preheat can use *mixed air preheat control* to maintain mixed air temperature before reducing ventilation. Cold entering air conditions from the mixing box can be heated with the preheat capacity to maintain the mixed air temperature above the mixed air temperature low limit. *Mixed air preheat control* attempts to use preheat until it has reached 100% capacity. At 100% preheat capacity, if mixed air temperature is below the low limit temperature, the *mixed air preheat control* then lowers the outdoor air damper below the minimum position to maintain mixed air above the mixed air temperature low limit.

# Sequence of operation

If ventilation is not a concern, the Tracer™ AH.540 controller can be configured for *mixed air control* when preheat capacity is available. *Mixed air preheat control* is the best choice for preheat air handling units with ventilation requirements.

***Table 28 — Mixed air temperature control***

| Air handling unit configuration | Mixed air control type (configurable) | Controller action |
| --- | --- | --- |
| No mixing box present | None | None |
| Heat only unit<br>Cool only unit<br>Cool reheat unit | Mixed air control | Reduce ventilation. Mixed air temperature is maintained above the mixed air low limit setpoint (50°F default, configurable) by reducing the outdoor air ventilation below minimum position. The lower percent of outdoor air raises the mixed air temperature. |
| Preheat cool unit | Mixed air preheat control | Preheat before reducing ventilation. Preheat capacity is used to maintain the mixed air temperature above the mixed air temperature low limit setpoint (50°F default, configurable). If 100% preheat capacity does not maintain the mixed air temperature above the mixed air temperature low limit, outdoor air ventilation is reduced below minimum position. |

**Economizer operation**

Economizing is a mode in which outdoor air is used as a source of cooling capacity before hydronic cooling. With a valid outdoor air temperature (either hardwired or communicated) or a communicated Enable command from Tracer Summit™, the Tracer AH.540 controller uses the modulating economizer damper as the highest priority source of free cooling.

Economizing is possible during the occupied, occupied standby, unoccupied, and occupied bypass modes.

The controller initiates the economizer function if the outdoor air temperature is cold enough to be used as free cooling capacity. If the outdoor air temperature is less than the economizer enable setpoint (absolute dry bulb), the controller modulates the outdoor air damper (between the active minimum damper position and 100%) to control the amount of outdoor air cooling capacity. When the outdoor air temperature rises 5°F above the economizer enable point, the controller disables economizing and moves the outdoor air damper back to its predetermined minimum position based on the current occupancy mode or communicated minimum damper position.

# Sequence of operation

*Table 29 — Relationship between outdoor temperature sensors and damper position*

| | Outdoor air damper | | |
|---|---|---|---|
| Outdoor air temperature | Occupied or Occupied bypass | Occupied standby | Unoccupied |
| No or invalid outdoor air temperature | Open to occupied minimum position | Open to occupied standby minimum position | Closed |
| Failed outdoor air sensor | Open to occupied minimum position | Open to occupied standby minimum position | Closed |
| Outdoor air temperature less than the low ambient damper lockout setpoint (Note 1) | Closed | Closed | Closed |
| Outdoor air temperature present and economizing feasible | Economizing, damper controlled between occupied minimum position and 100% | Economizing, damper controlled between occupied standby minimum position and 100% | Open and economizing during unit operation, otherwise closed |
| Outdoor air temperature present and economizing not feasible (Note 2) | Open to occupied minimum position | Open to occupied standby minimum position | Closed |

***Note 1:*** The low ambient damper lockout setpoint is a configurable temperature setpoint used to close the outdoor air damper, regardless of occupancy, when extreme outdoor air temperatures are present.

***Note 2:*** The Tracer™ AH.540 controller disables economizing if the mixed air temperature sensor is not present or is not valid.

**Low ambient damper lockout**

The controller closes the outdoor air damper during any heating, cooling, or economizer mode of operation or occupancy when extreme outdoor air temperatures exist. This condition disables outdoor air damper ventilation and economizing functions, but low ambient damper lockout does not affect other unit operations.

The outdoor air temperature must rise 5°C (9°F) above the low ambient damper lockout setpoint before economizing and ventilation become possible again.

## Exhaust fan operation

The exhaust fan/damper is coordinated with the unit supply fan and outdoor damper operation. The exhaust output is energized only when the unit supply fan is operating and the outdoor damper position is greater than or equal to the configurable exhaust fan start setpoint. The exhaust fan output is disabled when the outdoor air damper position drops 10% (configurable) below the exhaust fan start setpoint. If the enable point is less than 10% (configurable), the unit turns on at the start setpoint and off at zero.

The controller logic commands the exhaust fan to be energized/de-energized based on the target position of the economizing damper. Because of device stroke time, the state of the exhaust fan may change before the economizing damper reaches its target position.

If the exhaust fan start setpoint is set at or lower than the outdoor air damper minimum position, the exhaust fan will be on continuously when the outdoor air damper is at minimum position.

If the exhaust fan start setpoint is set higher than the outdoor air damper minimum position (minimum ventilation) the exhaust fan will be off during periods of minimum ventilation. During economizer cooling operation the exhaust fan start setpoint can be selected to compensate for the increased outdoor ventilation.

The exhaust fan status binary input is present to detect operation of a belt-driven exhaust fan. An *Exhaust Fan Air Flow* diagnostic is detected when the control starts the exhaust fan and the exhaust fan status binary input does not indicate operation after two minutes. This is an exhaust fan latching

# Sequence of operation

diagnostic and discontinues exhaust operation until the diagnostic is reset. All other control functions continue to operate normally.

## Electric heat operation

The Tracer™ AH.540 controller does not support electric heat. Use of the controller's heat output to control electric heat elements for heating purposes is highly discouraged. Using the heat output to control electric heat could cause dangerously high cabinet temperature conditions when the supply fan is off or when low airflows exist.

## Morning warm-up

The morning warm-up function initiates a special heating sequence to raise space temperature to occupied conditions. This sequence is especially useful for a building occupancy transition from unoccupied to occupied.

The Tracer AH.540 controller performs morning warm-up differently for constant volume space temperature control than constant volume discharge air control or variable air volume control.

**Constant volume space temperature control**
The controller keeps the outdoor air damper closed (when a mixing box is present) anytime during a occupied, occupied bypass, or occupied standby mode when the space temperature is 3ºF or more below the heating setpoint. The damper remains closed indefinitely (no time limit) during morning warm-up until the space temperature is within 2ºF of the effective heating setpoint.

The outdoor air damper normally is open to a minimum position during the occupied mode when the controller turns on the supply fan. The damper normally is closed during:

- warm-up/cooldown mode
- unoccupied mode
- certain diagnostic conditions
- low ambient damper lockout
- anytime the supply fan is off.

Morning warm-up can also be a communicated request from a Trane Tracer Summit™ building automation system. When the Tracer AH.540 controller receives a communicated morning warm-up request, heating mode is enabled and the outdoor air damper closes. The controller remains in morning warm-up until a different request is communicated.

**Constant volume discharge air control or variable air volume control**
In these modes, the Tracer AH.540 controller requires a space temperature input (hardwired or communicated) and setpoint input (hardwired, communicated, or default value) to initiate the morning warm-up sequence of operation.

On a transition from unoccupied to occupied (occupied bypass or occupied standby) the controller compares the space temperature to the heating setpoint. If the space temperature is 1.5° F below the heating setpoint, morning warm-up is initiated. The outdoor air damper closes (or remains closed) and the controller's heat/cool mode is heating.

The morning warm-up control sequence has no time limit upon a transition from unoccupied to occupied, when the controller is configured for constant volume discharge air control or variable air volume control modes.

Morning warm-up can also be a communicated request from a Trane Tracer Summit™ building automation system. When the Tracer™ AH.540 controller receives a communicated morning warm-up request, heating mode is enabled and the outdoor air damper closes. The controller remains in morning warm-up until a different request is communicated.

# Sequence of operation

## Daytime warm-up

The daytime warm-up sequence is only available when the air handling unit has heating capacity (hydronic or steam) and Tracer AH.540 is configured for:

- constant volume discharge air temperature control
- variable air volume control.

A communicated or wired space temperature is required for the Tracer AH.540 to initiate daytime warm-up.

Daytime warm-up forces the controller into heating when the space temperature is below the effective heating setpoint by a temperature that is more than the configured daytime warm-up enable differential. This initiated sequence of operation coordinates the controller's heat/cool to heating, as well as communicating the controller's application mode of operation to the duct system for changeover.

*Daytime warm-up start setpoint* is a configurable temperature below the effective space heating setpoint. When the space temperature drops below the start setpoint the daytime warm-up function is initiated by the controller.

*Daytime warm-up stop setpoint* is a configurable temperature above the start setpoint. When the space temperature rises above the stop setpoint, the warm-up function is terminated by the controller.

Unlike morning warm-up, the outdoor air damper is at the configured minimum position or at the communicated minimum damper position according to the effective occupancy.

## Cooldown

The controller configured for constant volume space temperature control closes the outdoor air damper (when present) at every transition from unoccupied to occupied mode when the space temperature is 3ºF or more above the cooling setpoint.

The damper remains closed during cooldown until the space temperature is within 2ºF of the effective cooling setpoint. The damper normally is closed during:

- anytime the supply fan is off
- warm-up/cooldown mode
- unoccupied mode
- certain diagnostic conditions
- low ambient damper lockout.

## Filter status

The controller’s filter status is based on the supply fan’s cumulative run hours. The controller compares the fan run time against an adjustable fan run hours limit (maintenance required setpoint time, stored in the controller) and recommends unit maintenance as required. The *Maintenance Required* diagnostic is informational only. Its state does not affect unit operation.

Use the Rover™ service tool to edit the Maintenance Required setpoint time. When the setpoint limit is exceeded, the controller generates a *Maintenance Required* diagnostic. To disable the diagnostic feature, set the maintenance required setpoint time to zero.

You can use Rover service tool or Tracer Summit™ to clear the *Maintenance Required* diagnostic. When the diagnostic is cleared, the controller resets the fan run time to zero and resumes accumulating fan run hours.

## Freeze avoidance

Freeze avoidance is used as low ambient temperature protection and is only initiated when the supply fan is off. The controller enters the freeze avoidance mode when the outdoor air temperature is below the freeze avoidance setpoint (configurable). The controller disables freeze avoidance when the outdoor air temperature rises 3°F above the freeze avoidance setpoint. When the controller is in freeze avoidance mode:

- all water valves are driven open to allow water to flow through the coil
- steam valves are cycled open and closed to prevent excessive cabinet temperatures
- supply fan is off
- face and bypass damper (when present) is at full bypass
- freeze avoidance protects the air handling unit's hydronic heating and cooling coils from freezing when cold outdoor air temperatures are present and the supply fan is off.

***Example:*** *The Tracer AH.540 is not able to run the air handling unit because the run/stop input is set to stop (supply fan is off). If the outdoor air temperature is below the freeze avoidance setpoint, the Tracer AH.540 opens all water valves.*

## Tracer Summit™ and Rover™ output overrides

The controller includes the capability to override both analog and binary outputs (typically for test and commissioning) through Trane's Tracer Summit building automation system or from Rover service tool. For more information on the output overrides, refer to the product-specific literature for the building automation system and the service tool.

The controller includes a Manual Output Test function which allows the user to manually exercise the outputs in a predefined sequence. For more information, refer to the *Manual output test* section.

### Service override mode

The controller includes a Manual Output Test function which allows the user to manually exercise the outputs in a predefined sequence from the Test push button. The service override mode allows you to step through the Manual Output Test remotely via Rover.

The Rover service tool communicates through the Comm5 link to place the Tracer™ AH.540 in service override mode. From the Rover computer screen you can step the Tracer AH.540 controller through Manual Output Test sequence. For more information, refer to the *Manual output test* section.

### Emergency override

The Tracer AH.540 controller can be placed into emergency override via the communication link. Emergency override allows a building automation system such as Trane Tracer Summit to pressurize, depressurize, or purge the air from a building space. It can also be used to shut down the controller’s operation of the unit.

The emergency override command influences the controller's supply fan, outdoor air damper, and exhaust fan to create the desired condition, as shown in the following table.

***Table 30 — Emergency override commands***

| Command | Supply fan | Outdoor air damper | Exhaust fan |
|---|---|---|---|
| Pressurize | On | Open | Off |
| Depressurize | Off | Close | On |
| Purge | On | Open | On |
| Shutdown | Off | Close | Off |

# Sequence of operation

Duct static pressure (when present) is always controlled when the supply fan is running. Freeze avoidance in emergency override can force the heating and cooling valves open.

**Water valve override**
To support water balancing, the controller includes a communication variable (nviValveOverride) that allows a user to specify the desired state of all water valves. The states supported are:

- Open all valves
- Close all valves

Water valve override remains active until the override is removed. The controller resets itself if the variable is not refreshed within ten hours or any other value except open or closed is written to it.

The Rover service tool or another communicating device is required to access this feature.

# Calibration

With Rover™ service tool, you can calibrate two of the controller's analog inputs: space temperature, and setpoint. For each input, the calibration value is added to the measured value to determine the effective value.

# Configuration

## Configurable parameters

The Tracer™ AH.540 controller is factory configured and commissioned with fixed sequences of operation. All of the controller's configuration parameters are predefined and loaded based upon the air handling unit configuration. The Trane Rover™ service tool provides access to these parameters to make adjustments to the controller's operation.

The Tracer AH.540 contains configuration parameters for the air handling unit type to select the type of control mode, cooling source, heating source, face and bypass damper, and outdoor air damper. Refer to Table 30. The control mode selects the desired unit operation: constant volume space temperature control, constant volume discharge air temperature control, or variable air volume control.

***Table 31 — Tracer AH.540 unit type configuration parameters***

| Control mode | Temperature control |
|---|---|
| • Constant volume<br>• Variable air volume | • Space temperature<br>• Discharge air |

***Table 32 — Heating and cooling source***

| Cooling source | Heat type (Note 1) | Heat source | Face and bypass damper | Outdoor air damper |
|---|---|---|---|---|
| None<br>Hydronic | • Preheat<br>• Reheat | • Hot water<br>• Steam | • None<br>• Face and bypass damper | • None<br>• Outdoor air damper |

***Note 1:*** In a preheat unit configuration, the heating coil is located in the air stream before the cooling coil (when present). In a reheat unit configuration, the heating coiling is located in the air stream after the cooling coil.

***Table 33 — Analog outputs***

| Analog output (Note 1) | Function | Output voltage range | Valid range (Note 2) | Default value |
|---|---|---|---|---|
| AO 1 | Supply fan speed | 0 to 10VDC or 2 to 10VDC | Normally slow or Normally fast | 0 to 10VDC Normally open |
| AO 2 | Cool output | 0 to 10VDC or 2 to 10VDC | Normally open or Normally closed | 2 to 10VDC Normally closed |
| AO 3 | Heat output | 0 to 10VDC or 2 to 10VDC | Normally open or Normally closed | 2 to 10VDC Normally open |
| AO 4 | Face and bypass damper | 0 to 10VDC or 2 to 10VDC | Normally face or Normally bypass (Note 3) | 2 to 10VDC Normally face |
| AO 5 | Outdoor air damper | 0 to 10VDC or 2 to 10VDC | Normally open or Normally closed | 2 to 10VDC Normally closed |

***Note 1:*** Trane's Rover service tool uses the unit type to determine and download the proper default analog output configuration. For example, if you configure the controller's control mode to be constant volume space temperature control, Rover will not allow AO 1 to be configured for a supply fan speed output. Analog output 1 (AO 1) is only used when the controller is configured for variable air volume control.

***Note 2:*** The normally open/closed configuration item refers to the inactive state of the end device, such as a cooling valve. If the device is a normally open valve, the configuration for analog output 2 (AO 2) must be normally open.

***Note 3:*** A normally face damper is positioned full coil face, and a normally bypass damper is full coil bypass when the analog output is at oVDC.

# Configuration

## *Table 34 — Analog inputs*

| Analog input (Note 1) | Function | Calibration range | Default value |
|---|---|---|---|
| IN 1 | Space temperature sensor | +/-10.0°F (+/-5.7°C) (0.1°F resolution) | 0°F |
| IN 2 | Hardwired setpoint | +/-10.0°F (+/-5.7°C) (0.1°F resolution) | 0°F |
| IN 3 | Fan mode switch | NA | NA |
| IN 4 | Discharge air temp | NA | NA |
| IN 5 | Outdoor air temp | NA | NA |
| IN 6 | Mixed air temp | NA | NA |
| Duct static | Duct static pressure | NA | NA |

***Note 1:*** Trane's Rover service tool uses the unit type to determine and download the proper default analog input configuration.

## *Table 35 — Binary inputs*

| Binary input (Note 1) | Function | Valid range | Default Configuration |
|---|---|---|---|
| IN 7 | Low temp detect or Not used | Normally open or Normally closed | Dependent on air handling unit type |
| IN 8 | Run/stop or Not used | Normally open or Normally closed | Run/stop Normally open |
| IN 9 | Occupancy, generic or Not used | Normally open or Normally closed | Occupancy Normally open |
| IN 10 | Supply fan status or Not used | Normally open (Note 2) or Normally closed (Note 2) | Sales order dependent |
| IN 11 | Filter status or Not used | Normally open (Note 3) or Normally closed (Note 3) | Sales order dependent |
| IN 12 | Exhaust fan status or Not used | Normally open or Normally closed | Sales order dependent |

***Note 1:*** Trane's Rover service tool uses the unit type to determine and download the proper default binary input configuration.

***Note 2:*** When the supply fan is off, the state of the fan status device is its normal state. For example, if the fan status switch (end device) is normally open when the fan is off, the controller should be configured for a normally open fan status input.

***Note 3:*** When the supply fan is off, the state of the filter status device is its normal state. For example, if the filter status switch (end device) is normally closed when the fan is off, the controller should be configured for a normally closed filter status input.

## *Table 36 — Outdoor air damper*

| Parameter | Valid range | Default value |
|---|---|---|
| Occupied outdoor damper minimum position | 0 to 100% | 15% |
| Occupied standby damper minimum position (Note 1) | 0 to 100% | 0% |
| Economizer enable temperature (dry bulb) | 32°F to 122°F (0°C to 50°C) | 60°F (15.6°C) |
| Low ambient damper lock out temperature (Note 2) | -40 to 32°F (-40°C to 0°C) | -20°F (-28.9°C) |
| Outdoor air damper open time (Note 3) | 0 to 30 minutes | 5 minutes |

***Note 1:*** Occupied standby minimum damper position only applies to space temperature control operation.

***Note 2:*** This is the outdoor air temperature below which the outdoor air damper will always be closed.

***Note 3:*** Adjustable open time for the outdoor air damper to open from 0% to minimum position.

## *Table 37 — Exhaust fan or damper*

| Parameter | Valid range | Default value |
|---|---|---|
| Exhaust fan start setpoint (Note 1) | 0 to 100% | 26% |
| Exhaust fan stop differential (Note 1) | 0 to 100% | 10% |

***Note 1:*** The exhaust fan is energized when the outdoor air damper is equal to or greater than the exhaust fan start setpoint. The exhaust fan is turned off when the outdoor air damper is less than the exhaust fan start setpoint minus the exhaust fan stop differential.

# Configuration

*Table 38 — Local zone sensor fan switch*

| Parameter | Valid range | Default |
|---|---|---|
| Local fan switch | Enable or disable | Enable |

*Table 39 — Space temperature setpoints*

| Default setpoint | Valid range | Default value |
|---|---|---|
| Occupied heating setpoint | 40 to 115°F (4.44 to 46.1°C) | 71°F (21.7°C) |
| Occupied cooling setpoint | 40 to 115°F (4.44 to 46.1°C) | 74°F (23.3°C) |
| Occupied standby heating setpoint | 40 to 115°F (4.44 to 46.1°C) | 67°F (19.4°C) |
| Occupied standby cooling setpoint | 40 to 115°F (4.44 to 46.1°C) | 78°F (25.6°C) |
| Unoccupied heating setpoint | 40 to 115°F (4.44 to 46.1°C) | 60°F (15.6°C) |
| Unoccupied cooling setpoint | 40 to 115°F (4.44 to 46.1°C) | 85°F (29.4°C) |
| Heating setpoint low limit (Note 1) | 40 to 115°F (4.44 to 46.1°C) | 40°F (4.4°C) |
| Cooling setpoint low limit (Note 1) | 40 to 115°F (4.44 to 46.1°C) | 40°F (4.4°C) |
| Heating setpoint high limit (Note 1) | 40 to 115°F (4.44 to 46.1°C) | 104°F (40°C) |
| Cooling setpoint high limit (Note 1) | 40 to 115°F (4.44 to 46.1°C) | 104°F (40°C) |
| Thumbwheel setpoint | Disable or enable | Enable |

***Note 1:*** The heating and cooling setpoint high and low limits only apply to the occupied and occupied standby setpoints and are never applied to the unoccupied setpoints.

*Table 40 — Discharge air setpoint limits for constant volume space temperature control*

| Limit | Valid range | Default value |
|---|---|---|
| Disharge temperature setpoint high limit (Note 1) | 38 to 150°F (3.3 to 65.6°C) | 104°F (40°C) |
| Disharge temperature setpoint low limit (Note 1) | 35 to 150°F (1.7 to 65.6°C) | 45°F (7.2°C) |

***Note 1:*** When the Tracer AH.540 controller is configured for constant volume space temperature control (control mode), the control algorithm is limited to calculating this high and low discharge air temperature setpoint.

*Table 41 — Discharge air temperature control setpoints and setpoint limits*

| Setpoint | Valid range | Default value |
|---|---|---|
| Discharge air cooling setpoint | 32°F to 86°F (0°C to 30°C) | 55°F (12.8°C) |
| Discharge air heating setpoint | 50 to 158°F (10°C to 70°C) | 100°F (37.8°C) |
| Maximum discharge air cooling setpoint | 32°F to 86°F (0°C to 30°C) | 68°F (20°C) |
| Minimum discharge air cooling setpoint | 32°F to 86°F (0°C to 30°C) | 44.6°F (7°C) |
| Maximum discharge air heating setpoint | 32°F to 158°F (0°C to 70°C) | 104°F (40°C) |
| Minimum discharge air heating setpoint | 32°F to 158°F (0°C to 70°C) | 86°F (30°C) |

*Table 42 — Daytime warm-up*

| Parameter | Valid range | Default value |
|---|---|---|
| Daytime warm-up start setpoint (Note 1) | 40 to 87.0°F (4.4 to 30.6°C) | 62°F (16.7°C) |
| Daytime warm-up stop setpoint (Note 2) | 43 to 90°F (6.1 to 32.2°C) | 71°F (21.7°C) |

***Note 1:*** When the space temperature is below the daytime warm-up start setpoint, the daytime warm-up sequence is initiated.

***Note 2:*** When the space temperature is above the daytime warm-up stop setpoint, the daytime warm-up sequence is terminated.

# Configuration

***Table 43 — Duct static pressure***

| Parameter | Valid range | Default value |
|---|---|---|
| Duct static pressure high limit (Note 1) | 0 to 5 inches WC (0 to 1250 Pa) | 4 inches WC (1000 Pa) |
| Duct static pressure setpoint | 0 to 5 inches WC (0 to 1250 Pa) | 1.5 inches WC (375 Pa) |
| Maximum duct static pressure setpoint | 0 to 5 inches WC (0 to 1250 Pa) | 3 inches WC (750 Pa) |
| Minimum duct static pressure setpoint | 0 to 5 inches WC (0 to 1250 Pa) | 0.5 inches WC (125 Pa) |

***Note 1:*** This is the pressure at which the controller shuts down the unit to prevent duct damage.

***Table 44 — Mixed air temperature control low limit***

| Parameter | Valid range | Default value |
|---|---|---|
| Mixed air low limit setpoint (Note 1) | -4°F to 104°F (-20°C to 40°C) | 50°F (10°C) |
| Mixed air control sequence (Note 2) | • None<br>• Mixed air control<br>• Mixed air preheat control | Dependent on air handler unit type |

***Note 1:*** If the mixed air temperature reaches this low limit setpoint, the controller uses the configured mixed air control sequence to maintain mixed air temperature above the configured mixed air low limit setpoint.

***Note 2:*** The Tracer™ AH.540 controller can be configured three different ways to control mixed air temperature above the mixed air low limit temperature. If *none* is selected, the controller does not attempt to prevent low mixed air temperature conditions. Low temperature detect provides unit freeze protection from a binary input freezestat (IN 7). *Mixed air* control reduces the outdoor air damper minimum position to maintain mixed air temperature. The *mixed air preheat* control sequence first attempts to use preheat (if available) to maintain mixed air temperature above the low limit temperature. If preheat capacity cannot maintain the air handling unit's mixed air temperature above the configured mixed air low limit temperature, the controller lowers the outdoor air damper below its minimum ventilation position.

***Table 45 — Supply fan status ignore time***

| Parameter | Valid range | Default value |
|---|---|---|
| Supply fan status ignore time (Note 1) | 0.0 to 6,553 seconds | 30 seconds |

***Note 1:*** This configuration property defines the maximum period of time the supply fan status binary input is ignored after the control has started the supply fan.

***Table 46 — Face and bypass heat modulation***

| Parameter | Valid range | Default value |
|---|---|---|
| Face and bypass heat modulation setpoint (Note 1) | 14 to 122°F (-10 to 50°C) | 40°F (4.4°C) |

***Note 1:*** This parameter is only used when a face and bypass damper is present. When the outdoor air temperature is below this outdoor air temperature setpoint, the face and bypass damper is used to modulate the hydronic heat capacity. When the outdoor air temperature rises to 3°F (1.67°C) above this setpoint, the heat valve is used to modulate the hydronic heat capacity.

***Table 47 — Freeze avoidance***

| Parameter | Valid range (Note 2) | Default value |
|---|---|---|
| Freeze avoidance setpoint (Note 1) | 32 to 122°F (0 to 50°C) | 35°F (1.67°C) |

***Note 1:*** This setpoint defines the outdoor air temperature below which the controller starts the freeze avoidance sequence.

***Note 2:*** A freeze avoidance setpoint value outside the valid range disables the freeze avoidance function.

# Configuration

*Table 48 — Steam valve cycling*

| Parameter | Valid range | Default value |
|---|---|---|
| Time period | 0 to 10 minutes | 5 minutes |
| Duty cycle (Note 1) | 0 to 100% | 25% |
| Valve open position (Note 2) | 0 to 100% | 25% |

***Note 1:*** Duty cycle is the percentage of the time period the steam valve is open.

***Note 2:*** The steam valve open position can be set to a partially open position to prevent excessive steam coil temperatures.

*Table 49 — Timers*

| Parameter | Valid range | Default value |
|---|---|---|
| Power up control wait | 0 to 1,000 seconds | 300 seconds |
| Maintenance required time setpoint (based on fan run hours) | 0 to 10,000 hours | 600 hours |
| Occupancy bypass timer (Note 1) Space temperature control | 0 to 240 minutes (1 minute resolution) | 120 minutes |
| Occupancy bypass timer (Note 1) Discharge air control | 0 to 24 minutes (1 minute resolution) | 0 minutes |

***Note 1:*** The occupied bypass time is used for timed override applications when a building automation system is not present or when the building automation system does not send the occupied (override) request. The timed override timer is maintained in the unit controller. When the timed override is applicable, the controller reports Occupied Bypass as its effective occupancy mode.

*Table 50 — Diagnostic alarm level*

| Parameter | Valid range | Default value |
|---|---|---|
| Diagnostic alarm level (Note 1) | • Service required<br>• Critical alarm | Service required |

***Note 1:*** Duct Static Pressure Failure, Duct Static Pressure High Limit, Space Temperature Failure, Discharge Air Temperature Failure, Unit Shutdown, Low Temperature Detect, and Low Supply Fan Air Flow diagnostics can all be configured as service required or critical alarm diagnostics. The diagnostics cannot be individually configured.

### Location identifier

The Tracer™ AH.540 includes unit configuration for a location identifier. The maximum length of the location identifier is 30 characters. You can use Rover™ service tool to download this identifier and easily identify the unit based on its physical location.

# Application information

## Standalone

**Occupied/unoccupied**

You can configure the controller's binary input (IN 9) as an occupancy input to switch between occupied and unoccupied modes of operation. When IN 9 is configured as a normally open occupancy input, the standalone controller switches to occupied mode when IN 9 contacts are open.

**Timed override**

The range for the timed override bypass time is 0 to 240 minutes (configurable). The default value for the bypass time is 120 minutes.

The controller's space temperature analog input generates timed override On and Cancel requests in the following manner. The controller interprets a momentary short of the space temperature analog input as a timed override On request. The controller always accepts this timed override On request and resets the bypass time. The controller only changes to occupied bypass if the controller is in either the unoccupied or occupied standby mode. The controller stays in the occupied bypass mode for the occupied bypass time or until someone presses the zone sensor's Cancel button.

The controller interprets a momentary fixed resistance of 1.5KΩ on the space temperature analog input as a timed override Cancel request. The controller always accepts the Cancel request and sets the bypass time to zero. The controller only acts on a Cancel request during occupied bypass.

**Morning warm-up and daytime warm-up**

If the Tracer™ AH.540 controller is configured for constant volume discharge air temperature control or variable air volume control, a space temperature sensor can be wired to the controller to provide the morning warm-up and daytime warm-up sequence of operation. The space temperature and setpoint inputs are used by the controller to determine if heating or cooling air should be supplied to the space.

In heating, the controller creates a supply air temperature according to the configured discharge air heating setpoint or communicated discharge air heating setpoint input. In cooling, the controller maintains a supply air temperature according to the configured discharge air cooling setpoint or communicated discharge air cooling setpoint input. If a valid communicated discharge air setpoint exists, the controller uses the communicated value.

**Configuration**

Use Rover™ service tool to modify any of the controller's configuration parameters. Refer to the literature supplied with the Rover service tool for more information.

**Setpoint operation**

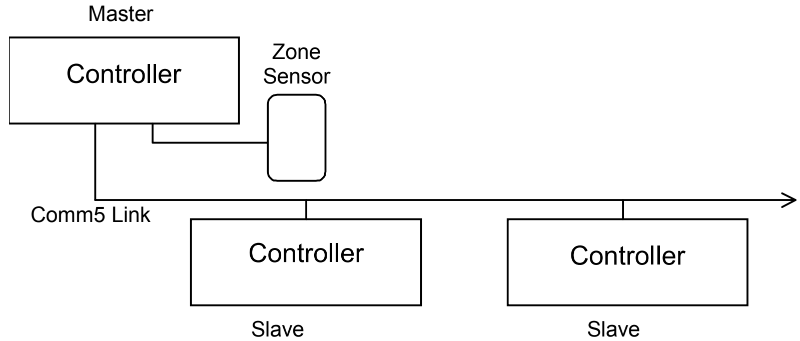
Standalone unit controllers can use two different stipend sources, the local hardwired thumbwheel setpoint input or the default setpoints (nciSetpoints). Use the thumbwheel setpoint input to provide the controller with a single setpoint from which all other heating and cooling setpoints are derived.

# Application information

## Standalone peer-to-peer

Tracer™ AH.540 controllers allow peer-to-peer (also referred to as master/slave) data communication. Data such as space temperature, setpoint, and occupancy can be shared from a master control to a peer control with or without the presence of Tracer Summit™.

**Figure 10 — *Simple data sharing application***




**Occupied/unoccupied**

The controller's occupancy generic binary input can be an occupancy input. As an occupancy input, the standalone controller uses the binary input to switch between occupied and unoccupied.

The *master* controller (the unit controller with the hardwired occupancy input) in peer-to-peer communication can send its occupancy mode to one or more *slave* controllers (so they all track each other's occupancy mode). For these applications, you must use Rover™service tool to set up the controller. Refer to the Rover service tool product literature for more information.

**Timed override**

Peer-to-peer timed override requires at least two controllers. The first controller, commonly referred to as the *master*, passes occupancy information to other controllers, commonly referred to as *slaves*.

The master controller's space temperature analog input generates timed override On and Cancel requests in the following manner. The master controller interprets a momentary short (0.4 to 5 seconds) on the space temperature input as a timed override On request. During unoccupied mode, the On request places the master controller in occupied bypass mode until the occupied timer expires or until someone presses the zone sensor Cancel button. When the master controller's occupancy mode is communicated to one or more slave controllers, the slave controllers echo the master's occupancy mode, including both On and Cancel requests.

The controller interprets a momentary fixed resistance (0.4 to 25 seconds) of 1.5KΩ by the space temperature input as a timed override Cancel request. During occupied bypass mode, the controller uses a Cancel request to return the controller to unoccupied mode.

# Application information

**Setpoint operation**

Controllers sharing information peer-to-peer, also referred to as *master/slave*, can share a variety of data, including the heating/cooling setpoint (communicated from a master to a slave).

Each controller derives its effective setpoint and default setpoints (including deadbands between setpoints) from the setpoint input (hardwired or communicated). To make sure the peer-to-peer setpoint application results in identical setpoints for each communicating controller, each controller must have exactly the same default setpoints.

The standalone master controller derives its setpoint from either the local hardwired setpoint input (if present) or from its default setpoints. Peer-to-peer applications often require the use of one hardwired setpoint to be shared across two or more controllers. You can achieve this by wiring the adjustable setpoint (typically included as a part of the Trane zone sensor module) to one controller—defined as the master. Next, use Rover™ to set up the master and one or more slaves to share that setpoint. For this application, each communicating controller uses the same setpoint.

# Troubleshooting

### Red Service LED

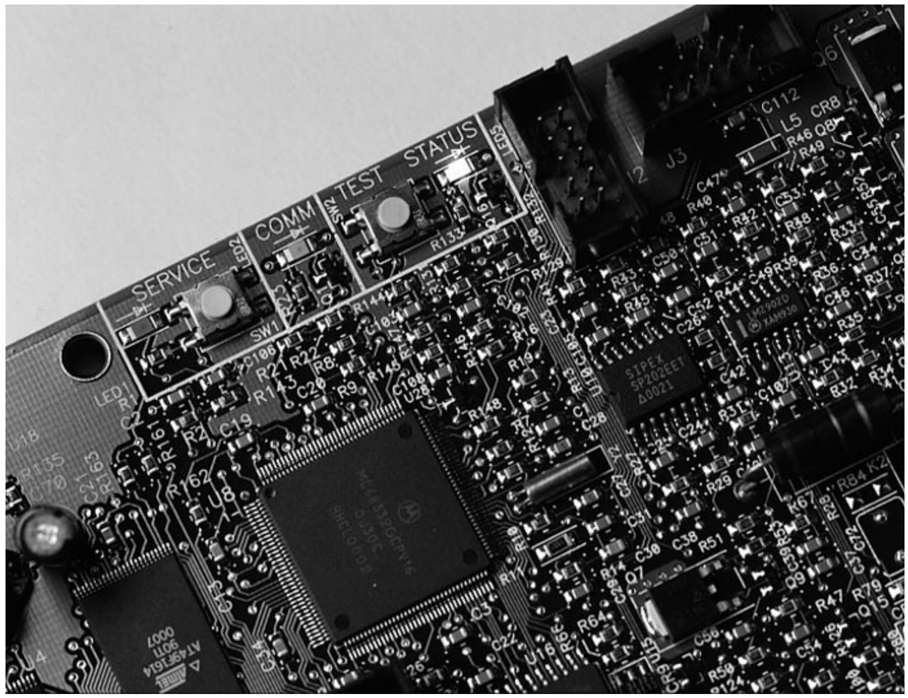



*Table 51 — Red Service LED activity*

| Red 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 has failed. |
| LED flashes approximately once every second. | Uninstall (normal controller mode). Use Rover™ service tool to restore the unit to normal operation. Refer to the Rover product literature for more information. |

### Test push button

The Test push button is located on the top right board edge of the Tracer™ AH.540 controller. It is used to initiate and advance the controller through the manual output test sequence. The manual output test sequence can be useful to verify unit operation and wiring. See *Manual output test* in this manual for details.

### Service push button

The Service push button is located on the top right board edge of the Tracer AH.540 controller. It can be used to install the controller in a communication network. Refer to the Rover service tool product literature for more information.

**Warning!** If the Service push button is held down for more than 15 seconds, the controller will uninstall itself from the ICS communication network. This mode is indicated by the red Service LED flashing once every second. Refer to the previous section on *Red Service LED* for more information. Use the Rover service tool to restore the unit to normal operation. Refer to the Rover product literature for more information.

# Troubleshooting

### Green Status LED

The green Status LED is normally used to indicate whether or not the controller is powered On (24VAC).

***Table 52 — Green Status LED activity***

| Green LED activity | Description |
|---|---|
| LED is on continuously. | Power on (normal operation). |
| LED blinks (one blink). | The controller is in manual output test mode. No diagnostic present. |
| LED blinks (two blinks). | The controller is in manual output test mode.<br>One or more diagnostics is present (Note 1). |
| LED blinks (1/4 second on,<br>1/4 second off for ten seconds). | Wink mode (Note 2). |
| LED off. | Power is off.<br>Controller failure.<br>Test button is pressed. |

***Note 1:*** During manual output test, certain diagnostics make the status LED light in a two-blink pattern. Refer to the diagnostics table for a list of two-blink diagnostics. If a two-blink pattern remains after an attempt to clear diagnostics, the diagnostic condition is still present and may affect the manual output test. The diagnostic must then be cleared using another method. Refer to the section on *Resetting diagnostics*.

***Note 2:*** The Wink feature allows you to identify a controller. By sending a request from Rover service tool, you can request the controller to wink (blink on and off as a notification that the controller received the signal). The green LED blinks (1/4 second on, 1/4 second off for ten seconds) during Wink mode.

### Yellow Comm LED

The yellow Comm LED blinks at the rate the controller receives communication. The yellow LED does not blink when the controller is transmitting communication data.

***Table 53 — Yellow Comm LED activity***

| Yellow LED activity | Description |
|---|---|
| LED off continuously. | The controller is not detecting any communication<br>(normal for standalone 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

The manual output test sequence (Table 53) verifies output and end device operation. The manual output test can be conducted to verify output wiring and actuator operation without using the Rover™service tool.

Many service calls are initiated due to unit diagnostics, so the test sequence attempts to clear unit diagnostics and restore normal unit operation prior to testing the outputs. If the diagnostics remain after an attempt to clear diagnostics, the status LED lights in a two-blink pattern, indicating the diagnostic condition is still present and may affect the manual output test. See the *Diagnostics* section for information on which diagnostics cause a two-blink pattern.

Manual output test can also be useful for air balancing or water balancing. As shown in Table 53, Step 4 of the manual output test opens the cool valve and Step 5 opens the heat valve for water balancing. Step 4 can also be used for air balancing. This step opens the cool valve, opens the outdoor air damper to the minimum occupied position, and controls the duct static pressure at the duct static pressure setpoint.

Manual output test can be terminated by advancing completely through the test sequence. The controller will time out if the unit remains in a single step for ten hours.

# Troubleshooting

**Manual output test can be overridden by the following sequences:**

- Power up sequence
- Manufacturing test
- Emergency override

**Test sequence**
The procedure for testing is:

- Press and hold the Test push button for at least two seconds. The green Status LED turns off, confirming the Test button has been pressed. The Test push button is located on the right top board edge of the Tracer™ AH.540 controller
- Release the Test button to start the manual output test mode. The manual output test is then in Step 1. The green Status LED blinks in one of two patterns. If the Status LED blinks once, no diagnostics are present. If the Status LED blinks twice, diagnostics are present
- Press the Test button (no more than once per second) to advance through the test sequence

The manual output test can also be controlled over the communications network using Rover. When conducting the manual output test via the communications network, the sequence must start with Step 1 (Off), as shown in Table 53. However, subsequent steps may be conducted in any order.

***Table 54 — Manual output test sequence***

| Step (Note 1) | Supply fan | Cool output | Heat output | Face and bypass damper | Outdoor air damper | Exhaust fan |
|---|---|---|---|---|---|---|
| 1: Off (Note 2) | Off, 0% | Close | Close | Bypass | Close | Off |
| 2: Supply fan on, slowest speed (Note 3) Face and bypass full face | On, 0% | Close | Close | Face | Close | Off |
| 3: Supply fan on, duct static pressure control | On, DSP (Note 5) | Close | Close | Face | Close | Off |
| 4: Cool output open Outdoor air damper open to occupied minimum position | On, DSP (Note 5) | Open | Close | Face | Occupied minimum position | Off |
| 5: Heat output open Face and bypass full face Outdoor air damper open to occupied minimum position | On, DSP (Note 5) | Close | Open | Face | Occupied minimum position | Off |
| 6: Exhaust fan on Outdoor air damper full open Face and bypass full bypass | On, DSP (Note 5) | Close | Close | Bypass | Open | On (Note 6) |
| 7: Exit (Note 4) | | | | | | |

***Note 1:*** The following diagnostics cause the Tracer AH.540 to exit manual output test:

- Duct Static Pressure High Limit
- Low Supply Fan Air Flow
- Low Temp Detect
- Unit Shutdown

***Note 2:*** Upon entering manual output test mode, all outputs are turned off or closed. The Status LED blinks in a one-blink pattern in the manual output test, or the Status LED blinks in a two-blink pattern if in the manual output test and a diagnostic is present.

***Note 3:*** At the beginning of Step 2, the controller attempts to reset all present diagnostics. If the controller is unsuccessful clearing all diagnostics, the controller exits manual output test.

***Note 4:*** After the last step, the test sequence performs an exit. This initiates a reset and attempts to return the controller to normal operation.

***Note 5:*** If the controller is configured to operate in variable air volume control, the controller runs duct static pressure (DSP) control during Steps 3-6.

***Note 6:*** If an exhaust fan status diagnostic occurs, the controller turns off the exhaust fan on this step.

# Troubleshooting

### Minimum timers

The controller automatically exits the manual test mode after ten hours and reverts back to normal operation. 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.

## Required inputs for unit operation

The following locally wired sensor or communicated inputs are required for each listed control function. If any one of the sensors does not exist, the controller operates the control function.

***Table 55 — Required sensors***

| Control function | Sensor(s) required to be present - wired sensor or communicated value | Controller operation if input is not present |
|---|---|---|
| Variable air volume control | Duct static pressure<br>Discharge air temperature | Diagnostic shutdown<br>Diagnostic shutdown |
| Discharge air temperature control | Discharge air temperature | Diagnostic shutdown |
| Space temperature control | Space temperature<br>Discharge air temperature | Diagnostic shutdown<br>Diagnostic shutdown |
| Economizer operation | Outdoor air temperature<br>Mixed air temperature | Economizer disabled<br>Economizer disabled |

## Diagnostics

Three different types of diagnostics are generated by the Tracer™ AH.540 controller to help you troubleshoot abnormal unit operation.

***Table 56 — Diagnostic types***

| | |
|---|---|
| Critical alarm | The controller shuts down the unit to protect the air handling unit and avert possible damage, or the controller cannot operate until the diagnostic condition is corrected. |
| Service required | The controller disables certain sequences of operation only and attempts to maintain unit operation. For example, if the mixed air temperature sensor fails or is not wired, the Tracer AH.540 controller disables (does not allow) economizer operation. |
| Informational | This type of diagnostic does not affect controller operation. |

***Table 57 — Controller diagnostics***

| Diagnostic or Condition | Control type configuration | Supply fan | Other outputs (Enabled = Normal Operation) |
|---|---|---|---|
| Low Temp Detect (Notes 1, 6) | CV Space temp control<br>CV Discharge air control<br>Variable air volume control | Off | Valves **Open** (hydronic)<br>Valves **Cycled** (steam)<br>Outdoor air damper **Closed**<br>Face and bypass damper **Face**<br>Exhaust fan **Off** |
| Duct Static Press High Limit (Note 6) | Variable air volume control | Off | Valves **Closed**<br>Outdoor air damper **Closed**<br>Face and bypass damper **Bypass**<br>Exhaust fan **Off** |
| Unit Shutdown (Note 6) | CV Space temp control<br>CV Discharge air control<br>Variable air volume control | Off | Valves **Closed**<br>Outdoor air damper **Closed**<br>Face and bypass damper **Bypass**<br>Exhaust fan **Off** |
| Low Supply Fan Air Flow (Note 6) | CV Space temp control<br>CV Discharge air control<br>Variable air volume control | Off | Valves **Closed**<br>Outdoor air damper **Closed**<br>Face and bypass damper **Bypass**<br>Exhaust fan **Off** |
| Dirty Filter (informational) | CV Space temp control<br>CV Discharge air control<br>Variable air volume control | Enabled | Valves **Enabled**<br>Outdoor air damper **Enabled**<br>Face and bypass damper **Enabled**<br>Exhaust fan **Enabled** |

# Troubleshooting

***Table 56 – (continued) Controller diagnostics***

| Diagnostic or Condition | Control type configuration | Supply fan | Other outputs (Enabled = Normal Operation) |
|---|---|---|---|
| Low Exhaust Fan Air Flow (service required) | CV Space temp control<br>CV Discharge air control<br>Variable air volume control | Enabled | Valves **Enabled**<br>Outdoor air damper **Enabled**<br>Face and bypass damper **Enabled**<br>Exhaust fan **Off** |
| Discharge Air Temp Failure (Notes 2, 6) | CV Space temp control<br>CV Discharge air control<br>Variable air volume control | Off | Valves **Closed**<br>Outdoor air damper **Closed**<br>Face and bypass damper **Bypass**<br>Exhaust fan **Off** |
| Space Temperature Failure<br>(Notes 2, 6) | CV Space temp control | Off | Valves **Closed**<br>Outdoor air damper **Closed**<br>Face and bypass damper **Bypass**<br>Exhaust fan **Off** |
| Space Temperature Failure<br>(service required)<br>(Notes 2, 5) | CV Discharge air control<br>Variable air volume control | Enabled | Valves **Enabled**<br>Outdoor air damper **Enabled**<br>Face and bypass damper **Enabled**<br>Exhaust fan **Enabled** |
| Outdoor Air Temp Failure<br>(service required)<br>(Notes 2, 5) | CV Space temp control<br>CV Discharge air control<br>Variable air volume control | Enabled | Valves **Enabled**<br>Outdoor air damper **Minimum position** (Note 3)<br>Face and bypass damper **Enabled**<br>Exhaust fan **Enabled** |
| Mixed Air Temp Failure<br>(service required)<br>(Note 2) | CV Space temp control<br>CV Discharge air control<br>Variable air volume control | Enabled | Valves **Enabled**<br>Outdoor air damper **Minimum position** (Note 4)<br>Face and bypass damper **Enabled**<br>Exhaust fan **Enabled** |
| Maintenance Required<br>(informational) | CV Space temp control<br>CV Discharge air control<br>Variable air volume control | Enabled | Valves **Enabled**<br>Outdoor air damper **Enabled**<br>Face and bypass damper **Enabled**<br>Exhaust fan **Enabled** |
| Local Fan Switch Failure<br>(informational)<br>(Note 2) | CV Space temp control<br>CV Discharge air control<br>Variable air volume control | Enabled | Valves **Enabled**<br>Outdoor air damper **Enabled**<br>Face and bypass damper **Enabled**<br>Exhaust fan **Enabled** |
| Local Space setpoint Failure<br>(service required)<br>(Note 2) | CV Space temp control<br>CV Discharge air control<br>Variable air volume control | Enabled | Valves **Enabled**<br>Outdoor air damper **Enabled**<br>Face and bypass damper **Enabled**<br>Exhaust fan **Enabled** |
| Duct Static Press Failure<br><br>(Notes 2, 6) | Variable air volume control | Off | Valves **Closed**<br>Outdoor air damper **Closed**<br>Face and bypass damper **Bypass**<br>Exhaust fan **Off** |
| Duct Static Press Failure<br>(informational)<br>(Note 2) | CV Space temp control<br>CV Discharge air control | Enabled | Valves **Enabled**<br>Outdoor air damper **Enabled**<br>Face and bypass damper **Enabled**<br>Exhaust fan **Enabled** |
| Invalid Unit Configuration<br>(service required)<br>(Note 6) | CV Space temp control<br>CV Discharge air control<br>Variable air volume control | Off | Valves **Closed**<br>Outdoor air damper **Closed**<br>Face and bypass damper **Bypass**<br>Exhaust fan **Off** |
| Normal<br>(informational) | CV Space temp control<br>CV Discharge air control<br>Variable air volume control | Enabled | Valves **Enabled**<br>Outdoor air damper **Enabled**<br>Face and bypass damper **Enabled**<br>Exhaust fan **Enabled** |

***Note 1:*** If the low temp detect device requires manual reset, reset the freezestat device first before resetting the controller.

***Note 2:*** When a local temperature, setpoint, or pressure sensor has failed after being valid, the controller generates a diagnostic to indicate the sensor loss condition. The controller automatically clears the diagnostic once a valid sensor value is present (non-latching diagnostic).

***Note 3:*** If the local outdoor air temperature sensor fails and a communicated value is not present, the outdoor air damper is opened to minimum position and economizer operation is disabled.

***Note 4:*** If the air handling unit's mixed air sensor fails or is not present, economizer operation is disabled and the outdoor air damper is opened to minimum position.

***Note 5:*** A space temperature failure diagnostic disables morning and daytime warm-up sequence of operation when the controller is configured for constant volume discharge air control or variable air volume control.

***Note 6:*** This diagnostic message can be configured as a service required or critical alarm.

# Troubleshooting

**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. Each diagnostic has a priority. When two diagnostic conditions exist, one diagnostic has priority over the other.

**Example:** *If a freezestat condition occurs (IN 7), the controller communicates a Low Temp Detect diagnostic message, shuts down the air handling unit, and opens all valves. If a stop input condition occurs (IN 8), the controller communicates a Unit Shutdown diagnostic message but does not close the valves. Since low temp detect is a higher priority diagnostic, a unit shutdown diagnostic does not override the output conditions.*

**Priority of each diagnostic:**

1. Low Temp Detect
2. Unit Shutdown
3. Low Supply Fan Air Flow
4. Low Exhaust Fan Air Flow
5. Space Temperature Failure *
6. Duct Static Press Failure *
7. Duct Static Press High Limit
8. Discharge Air Temp Failure *
9. Local Space setpoint Failure *
10. Local Fan Switch Failure *
11. Outdoor Air Temp Failure *
12. Mixed Air Temp Failure *
13. Dirty Filter *
14. Maintenance Required
15. Invalid Unit Configuration

* Non-latching diagnostics automatically reset when the input is present and valid.

# Troubleshooting

## Resetting diagnostics

A reset clears any latching diagnostics and allows the controller to try to run the air handling unit normally. If the latching condition is still present, the controller immediately shuts down the air handling unit. A reset will restart a unit that is running normally. A reset is similar to cycling power to the unit.

**There are many ways to reset unit diagnostics:**

- Manual output test at the controller
- Cycling power to the controller
- Building automation system
- Rover™ service tool
- Any communicating device able to access the controller's diagnostic reset input
- Zone sensor fan mode switch

**Manual output test**

You can use the Test button on the controller either during installation to verify proper end device operation or during troubleshooting. When you press the Test button, the controller exercises all outputs in a predefined sequence. The first and last outputs of the sequence reset the controller diagnostics. Refer to the *Manual output test* section.

**Cycling power**

When the controller's 24VAC power is turned off, then on, the unit cycles through a power up sequence. By default, 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 the previous Diagnostics table).

**Building automation system**

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

**Rover™ service tool**

Rover service tool can reset diagnostics in the controller. For more complete information, refer to the Rover product literature.

**Diagnostic reset input**

Any device that can communicate the network variable *nviRequest* (enumeration “clear_alarm") can reset diagnostics in the controller.

**Zone sensor fan mode switch**

When the zone sensor fan mode switch is changed from off to auto, the controller attempts to reset all diagnostics. If the zone sensor fan mode switch has been disabled by configuration, then the zone sensor fan mode switch is ignored and it cannot be used to reset diagnostics.

# Troubleshooting

## Questionable unit operation

### *Table 58 — Fan 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:<br>The controller exits power up control wait when it receives communicated information.<br>The controller exits power up control wait when the power up control wait time expires. |
| Unoccupied operation | When the controller is in the unoccupied mode, the fan is cycled between high speed and off with capacity to maintain zone temperature control. |
| Fan mode off | When a local fan mode switch (provided on the Trane zone sensor) determines the fan operation, the off position controls the unit off. |
| 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 | Specific diagnostics affect fan operation. For more information, see the *Diagnostics* section. |
| 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 24VAC. When the green LED is off continuously, the controller does not have sufficient power or has failed. |
| 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 sequence 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.<br>Refer to the *Manual output test* section. |
| Unit wiring | The wiring between the controller outputs and the fan relays and contacts must be present and correct for normal fan operation. |

### *Table 59 — Valves 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 sequence 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.<br>Refer to the *Manual output test* section. |
| Freeze avoidance | When the controller is in the unoccupied mode with no demand for capacity (0%) and the outdoor air temperature is below the freeze avoidance setpoint, the controller opens the water valves (100%) and the face and bypass damper to prevent coil freezing. |
| Diagnostic present | Specific diagnostics affect valve operation. For more information, see the *Diagnostics* section. |
| No power to the controller | If the controller does not have power, a normally open valve remains open. For the controller or valve to operate normally, it must have an input voltage of 24VAC. When the green LED is off continuously, the controller does not have sufficient power or has failed. |
| No power to the valves | If the valve does not have power, a normally open valve remains open.<br>The valves are powered separately from the controller's output signal.<br>If the valves do not have 24VAC, the controller cannot operate the 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. |

# Troubleshooting

*Table 60 — Valves 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 until one of two conditions occurs:<br>The controller exits power up control wait when it receives communicated information.<br>The controller exits power up control wait when the power up control wait time expires. |
| Manual output test | The controller includes a manual output test sequence 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.<br>Refer to the *Manual output test* section. |
| Fan mode off | When a local fan mode switch (provided on the Trane zone sensor) determines the fan operation, the Off position controls the unit off and closes the valves. |
| Diagnostic present | Specific diagnostics affect valve operation. For more information, see the *Diagnostics* section. |
| No power to the controller | If the controller does not have power, a normally open valve remains closed. For the controller or valve to operate normally, it must have an input voltage of 24VAC. When the green LED is off continuously, the controller does not have sufficient power or has failed. |
| No power to the valves | If the valve does not have power, a normally open valve remains closed. The valves are powered separately from the controller's output signal. If the valves do not have 24VAC, the controller cannot operate the 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. |

*Table 61 — Outdoor air damper stays open*

| Probable Cause | Explanation |
|---|---|
| Normal operation | The controller opens and closes the outdoor air damper based on the controller's occupancy mode and fan operation. Normally, the outdoor air damper is open during occupied, occupied standby, and occupied bypass mode when the fan is running and closed during unoccupied mode unless the controller is economizing. Refer to the *Outdoor air damper* section for more information. |
| Manual output test | The controller includes a manual output test sequence you can use to verify output operation and associated output wiring. However, based on the current step in the test sequence, the outdoor air damper may be open.<br>Refer to the *Manual output test* section. |
| 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 outdoor air damper may not work correctly. |
| Unit wiring | The wiring between the controller outputs and the outdoor air damper must be present and correct for normal outdoor air damper operation. |

# Troubleshooting

***Table 62 — Outdoor air damper stays closed***

| Probable cause | Explanation |
|---|---|
| Normal operation | The controller opens and closes the outdoor air damper based on the controller's occupancy mode and fan operation. Normally, the outdoor air damper is open during occupied, occupied standby, and occupied bypass mode when the fan is running and closed during unoccupied mode unless the controller is economizing. Refer to the *Outdoor air damper* section for more information. |
| Warm-up and cool down | The controller includes both a morning warm-up and cool down sequence to keep the outdoor air damper closed during the transition from unoccupied to occupied. This sequence is an attempt to bring the space under control as quickly as possible. |
| Unoccupied mode | When the controller is in the unoccupied mode, the outdoor air damper remains closed unless economizing is enabled. |
| Low ambient damper lock out | When the outdoor air temperature is less than the low ambient damper lockout setpoint (which can be changed with the Rover™ service tool), the outdoor air damper is closed. |
| 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). The outdoor air damper is closed. |
| 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 when it receives communicated information. The controller exits power up control wait when the power up control wait time expires. |
| Manual output test | The controller includes a manual output test sequence you can use to verify output operation and associated output wiring. However, based on the current step in the test sequence, the outdoor air damper may not be open. Refer to the *Manual output test* section. |
| Fan mode off | When a zone sensor fan mode switch determines the fan operation, the Off position controls the unit off and closes the outdoor air damper. |
| 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 24VAC. When the green status LED is off continuously, the controller does not have sufficient power or has failed. |
| Diagnostic present | Specific diagnostics affect outdoor air operation. For more information, see the *Diagnostics* section in the manual. |
| 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 outdoor air damper may not work correctly. |
| Unit wiring | The wiring between the controller outputs and the outdoor air damper must be present and correct for normal damper operation. |

# Appendix

***Table 63 — Constant volume space temperature control operation based on the effective heat/cool output***

| Application mode input (nviApplicMode) | Heat/cool mode input (nviHeatCool) | Effective heat cool mode output (nvoHeatCool) | Unit Operation |
|---|---|---|---|
| Auto | Auto | Determined by controller | Fan Enabled<br>Heating Enabled<br>Cooling Enabled<br>Damper Enabled |
| | Heat | Heat | Fan Enabled<br>Heating Enabled<br>Cooling Disabled<br>Damper Ventilation enabled<br>Economizer disabled |
| | Morning warm-up | Morning warm-up | Fan Enabled<br>Heating Enabled (Note 1)<br>Cooling Disabled<br>Damper Closed |
| | Cool | Cool | Fan Enabled<br>Heating Disabled<br>Cooling Enabled<br>Damper Enabled |
| | Night purge | Night purge | Fan Enabled<br>Heating Disabled<br>Cooling Disabled<br>Damper Ventilation disabled<br>Economizer enabled |
| | Pre-cool | Pre-cool | Fan Enabled<br>Heating Disabled<br>Cooling Enabled<br>Damper Ventilation disabled<br>Economizer enabled |
| | Off | Off | Fan Disabled<br>Heating Disabled<br>Cooling Disabled<br>Damper Disabled |
| | Test | Determined by controller | Fan Enabled<br>Heating Enabled<br>Cooling Enabled<br>Damper Enabled |
| | Emergency heat | Determined by controller | Fan Enabled<br>Heating Enabled<br>Cooling Disabled<br>Damper Enabled |
| | Fan only | Fan only | Fan Enabled<br>Heating Disabled<br>Cooling Disabled<br>Damper Disabled |

***Note 1:*** Heating capacity can be used to control the discharge air temperature to the discharge air setpoint.

# Appendix

***Table 62 — (continued) Constant volume space temperature control operation based on the effective heat/cool output***

| Application mode input (nviApplicMode) | Heat/cool mode input (nviHeatCool) | Effective heat cool mode output (nvoHeatCool) | Unit Operation |
|---|---|---|---|
| Auto | Not present | Determined by controller | Fan Enabled<br>Heating Enabled<br>Cooling Enabled<br>Damper Enabled |
| Heat | Any state | Heat | Fan Enabled<br>Heating Enabled (Note 1)<br>Cooling Disabled<br>Damper Ventilation enabled<br>Economizer disabled |
| Morning warm-up | Any state | Morning warm-up | Fan Enabled<br>Heating Enabled<br>Cooling Disabled<br>Damper Closed |
| Cool | Any state | Cool | Fan Enabled<br>Heating Disabled (Note 1)<br>Cooling Enabled<br>Damper Enabled |
| Night purge | Any state | Night purge | Fan Enabled<br>Heating Disabled<br>Cooling Disabled<br>Damper Ventilation disabled<br>Economizer enabled |
| Pre-cool | Any state | Pre-cool | Fan Enabled<br>Heating Disabled<br>Cooling Enabled<br>Damper Ventilation disabled<br>Economizer enabled |
| Off | Any state | Off | Fan Disabled<br>Heating Disabled<br>Cooling Disabled<br>Damper Disabled |
| Test | Any state | Determined by controller | Fan Enabled<br>Heating Enabled<br>Cooling Enabled<br>Damper Enabled |
| Emergency heat | Any state | Determined by controller | Fan Enabled<br>Heating Enabled<br>Cooling Enabled<br>Damper Enabled |
| Fan only | Any state | Fan only | Fan Enabled<br>Heating Disabled<br>Cooling Disabled<br>Damper Disabled |

***Note 1:*** Heating capacity can be used to control the discharge air temperature to the discharge air setpoint.

# Appendix

*Table 64 — Constant volume discharge air temperature control and variable air volume operation based on the effective heat/cool output*

| Application mode input (nviApplicMode) | Effective heat cool mode output (nvoHeatCool) | Application mode output (nvoApplicMode) | Unit Operation |
|---|---|---|---|
| Auto | Determined by controller | Determined by controller | Fan Enabled<br>Heating Enabled<br>Cooling Enabled<br>Damper Enabled |
| Heat | Heat | Heat | Fan Enabled<br>Heating Enabled<br>Cooling Disabled<br>Damper Ventilation enabled<br>Economizer disabled |
| Morning warm-up | Morning warm-up | Heat | Fan Enabled<br>Heating Enabled<br>Cooling Disabled<br>Damper Disabled |
| Cool | Cool | Auto | Fan Enabled<br>Heating Disabled (Note 1)<br>Cooling Enabled<br>Damper Enabled |
| Night purge | Night purge | Cool | Fan Enabled<br>Heating Disabled<br>Cooling Disabled<br>Damper Ventilation disabled<br>Economizer enabled |
| Pre-cool | Pre-cool | Cool | Fan Enabled<br>Heating Disabled<br>Cooling Enabled<br>Damper Ventilation disabled<br>Economizer enabled |
| Off | Off | Auto | Fan Disabled<br>Heating Disabled<br>Cooling Disabled<br>Damper Disabled |
| Test | Determined by controller | Determined by controller | Fan Enabled<br>Heating Enabled<br>Cooling Enabled<br>Damper Enabled |
| Fan only | Fan only | Cool | Fan Enabled<br>Heating Disabled<br>Cooling Disabled<br>Damper Disabled |
| Maximum flow heating | Determined by controller | Determined by controller | Fan Enabled<br>Heating Enabled<br>Cooling Disabled<br>Damper Enabled |

***Note 1:*** Heating capacity can be used to control the discharge air temperature to the discharge air cooling setpoint.

*Table 65 — Trane zone sensor module hardwired setpoint adjustment*

| Resistance | setpoint |
|---|---|
| 889.4Ω | 50°F |
| 733.6Ω | 58°F |
| 577.9Ω | 66°F |
| 500.0Ω | 70°F |
| 422.1Ω | 74°F |
| 344.2Ω | 78°F |
| 266.4Ω | 82°F |
| 188.5Ω | 86°F |
| 110.6Ω | 90°F |

## Appendix

*Table 66 — Hardwired 10kΩ thermistor values*

| Resistance | Temperature | Resistance | Temperature |
|---|---|---|---|
| 87.5kΩ | 0°F | 10.0kΩ | 77°F |
| 74.6kΩ | 5°F | 9.3kΩ | 80°F |
| 63.8kΩ | 10°F | 8.2kΩ | 85°F |
| 54.6kΩ | 15°F | 7.3kΩ | 90°F |
| 46.9kΩ | 20°F | 6.5kΩ | 95°F |
| 40.4kΩ | 25°F | 5.8kΩ | 100°F |
| 34.8kΩ | 30°F | 5.2kΩ | 105°F |
| 30.2kΩ | 35°F | 4.7kΩ | 110°F |
| 26.2kΩ | 40°F | 4.2kΩ | 115°F |
| 22.8kΩ | 45°F | 3.8kΩ | 120°F |
| 20.0kΩ | 50°F | 3.4kΩ | 125°F |
| 17.5kΩ | 55°F | 3.1kΩ | 130°F |
| 15.3kΩ | 60°F | 2.8kΩ | 135°F |
| 13.5kΩ | 65°F | 2.5kΩ | 140°F |
| 11.9kΩ | 70°F | 2.3kΩ | 145°F |
| 10.5kΩ | 75°F | 2.1kΩ | 150°F |

*Table 67 — Hardwired 1kΩ mixed air sensor RTD values*

| Resistance (ohms) | Temperature | Resistance (ohms) | Temperature |
|---|---|---|---|
| 930.3 | 0°F | 1097.3 | 77°F |
| 941.2 | 5°F | 1103.8 | 80°F |
| 952.1 | 10°F | 1114.6 | 85°F |
| 963.0 | 15°F | 1125.3 | 90°F |
| 973.9 | 20°F | 1136.1 | 95°F |
| 984.8 | 25°F | 1146.8 | 100°F |
| 995.7 | 30°F | 1157.5 | 105°F |
| 1000.0 | 32°F | 1168.3 | 110°F |
| 1006.5 | 35°F | 1179.0 | 115°F |
| 1017.4 | 40°F | 1189.7 | 120°F |
| 1028.2 | 45°F | 1200.4 | 125°F |
| 1039.0 | 50°F | 1211.0 | 130°F |
| 1049.8 | 55°F | 1221.7 | 135°F |
| 1060.7 | 60°F | 1232.4 | 140°F |
| 1071.5 | 65°F | 1243.0 | 145°F |
| 1082.2 | 70°F | 1253.7 | 150°F |
| 1093.0 | 75°F | | |

# Appendix

## FCC

CFR 47, Part 15, Subpart A, Class A

Note: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

CFR 47, Part 15, Subpart A, Class B

Note: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna
- Increase the separation between the equipment and receiver
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected
- Consult the dealer or an experienced radio/TV technician for help

## CE radiated emissions

## EN55022 Class A

**Warning**: This is a Class A product. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

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