



Installation and Operation

Tracer™ ZN521 Zone Controller



SAFETY WARNING

Only qualified personnel should install and service the equipment. The installation, starting up, and servicing of heating, ventilating, and air-conditioning equipment can be hazardous and requires specific knowledge and training. Improperly installed, adjusted or altered equipment by an unqualified person could result in death or serious injury. When working on the equipment, observe all precautions in the literature and on the tags, stickers, and labels that are attached to the equipment.



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Warnings, Cautions, and Notices

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

⚠ WARNING

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

⚠ CAUTION

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

NOTICE:

Indicates a situation that could result in equipment or property-damage only accidents.

Revision Summary

CNT-SVX07F-EN (30 May 2012)

Cost Savings: Update to mount plate and metal enclosure to remove metal screw/nut and use plastic PEM nut. Change to figure illustrations.

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Overview and Specifications

This guide provides installation and configuration information for the Tracer™ ZN521 zone controller, as well as a description of its operations. The overview includes a product description, specifications, and descriptions of ancillary products that may be necessary.

Product Description

The ZN521 is an application-specific controller that provides direct-digital zone temperature control. The controller can operate as a stand-alone device or as part of a building automation system (BAS). Communication between the controller and a BAS occurs by means of a LonTalk communication link, which complies with the LonTalk protocol.

The ZN521 supports the following equipment:

- Fan coils
- Unit ventilators
- Blower coils

The ZN521 can be configured to control:

- Tri-state modulating or two-position valves
- Tri-state modulating dampers; outdoor/return air, and face-and-bypass
- DX cooling (single stage)
- Electric heat (two stages)

It is designed to be field-installed and is sent from the factory un-configured. Use the Rover™ service tool to configure the controller for specific applications.

Note: For information about using the Rover service tool, see the current version of the Rover Installation/Operation/Programming guide (EMTX-SVX01).

Storage Environment

If a ZN521 is stored for a substantial amount of time, store it in an indoor environment that meets the following requirements:

- Temperature: -40° to 185°F (-40° to 85°C)
- Relative humidity: 5–95%, non-condensing

Dimensions

Plastic Cover Model

- Height: 5.375 in. (137 mm)
- Width: 6.875 in. (175 mm)
- Depth: 2 in. (51 mm)

Metal Cover Model

- Height: 9.0 in (25 mm)
- Width: 10.37in. (263 mm)
- Depth: 2.25 in. (58 mm)

Clearances

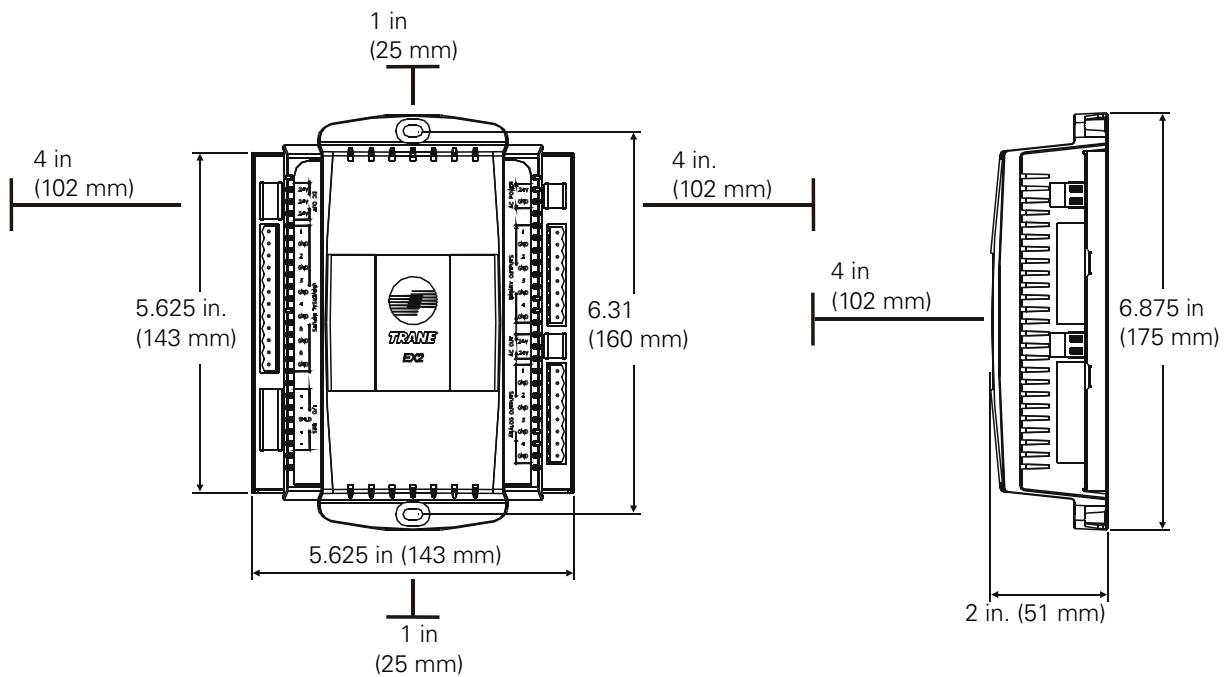
Plastic Cover Model

- Front: 4.0 in. (102 mm)
- Each side: 1.0 in. (25 mm)
- Top and bottom: 4.0 in. (102 mm)

Metal Cover Model

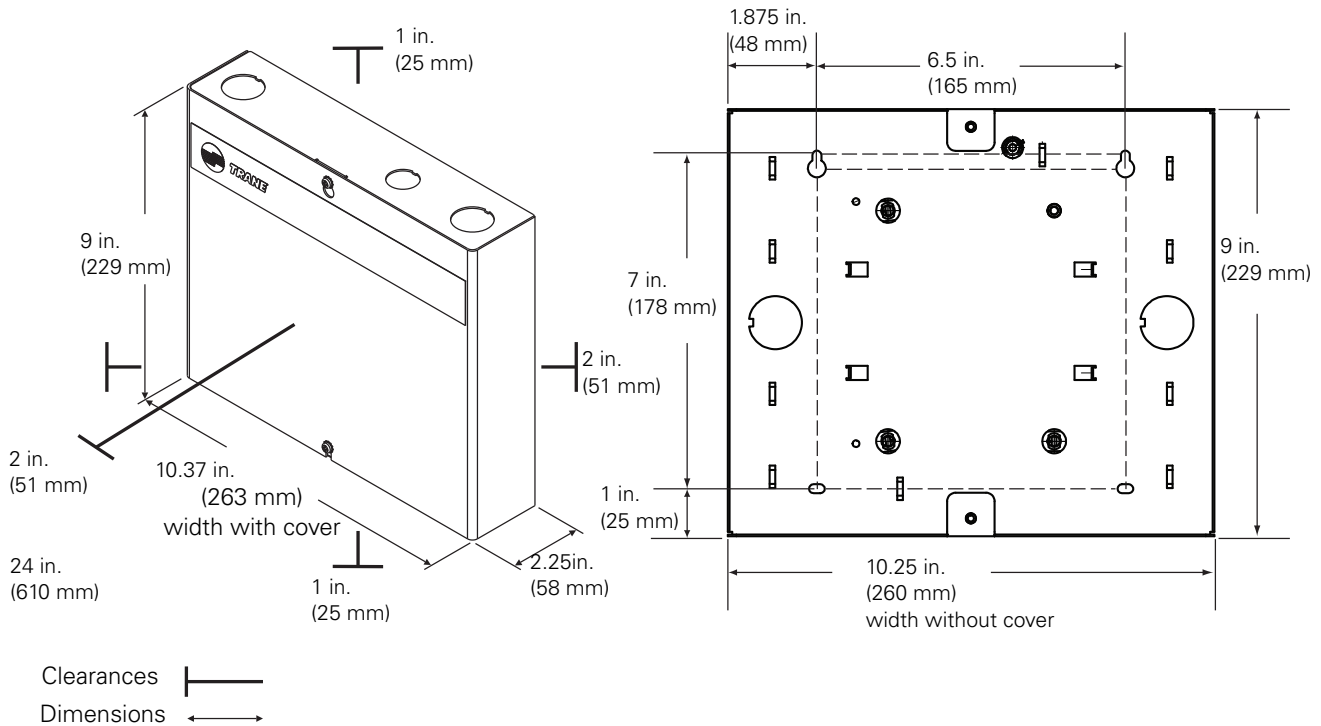
- Front: 24.0 in. (610 mm)
- Each side: 2.0 in. (51 mm)
- Top and bottom: 1.0 in. (25 mm)

Figure 1. Plastic cover model dimensions and clearances



Overview and Specifications

Figure 2. Metal cover model dimensions and clearances



Agency Listing/Compliance

- CE—Immunity: EN 50082-1:1997; EN 50082-2:1995
- CE—Emissions: EN 50081-1:1992 (CISPR 22) Class B
- UL and C-UL 916 listed: Energy management system
- UL 94-5V (UL flammability rating for plenum use)
- FCC Part 15, Class A
- ASHRAE Cycle 1 & Cycle 2 control sequences

Additional Components

The ZN521 requires the use of additional components for monitoring and proper control of the associated equipment. The use of specific components depends on the application. These components are not included with the ZN521.

Power Transformer

Use a UL-listed Class 2 power transformer supplying a nominal 24 Vac (19–30 Vac) to power both the ZN521 (14 VA) and its associated output devices, including relays and actuators, to a maximum of 12 VA per output utilized.

Water, Duct, and Outdoor Air Temperature Sensors

Temperature sensors must be Trane 10 k Ω (at 25°C) thermistors. Entering water and discharge air inputs may use a sealed temperature sensor (part number 4190 1100).

Binary Input Switching Devices

Occupancy, condensate overflow, low-coil-temperature, and fan status inputs accept switching devices that may have normally open or normally closed dry contacts.

Output Devices

Output devices connected to the ZN521 binary outputs cannot exceed 12 VA (0.5 A) current draw at 24 Vac.

Zone Temperature Sensors

Table 1 shows the Trane zone temperature sensors that are supported by the ZN521.

Table 1. Tracer zone temperature sensor options

BAS Order Number	Use	Fan					Zone		Timed Override Buttons		Comm Jack
		High	Med	Low	Auto	Off	Setpoint Thumb-wheel	Temperature Sensor	On	Cancel	
4190 1087	Any							x			
4190 1088	Any							x	x	x	x
4190 1090	Any						x	x	x	x	x
4190 1094	Any						x	x			x
4190 1095	Unit ventilator	x		x		x	x	x	x	x	x
4190 1115	Fan coil	x	x	x	x	x	x	x	x	x	x
4190 1116	Unit ventilator	x		x	x	x	x	x	x	x	x
4190 1117	Any				x	x	x	x	x	x	x

Valve Actuators

Valve actuators cannot exceed 12 VA draw at 24 Vac. For two-position valves, use actuators with on/off action, and with a spring action that returns the valve to normally open or closed (dependent on the desired default position). For modulating valve control, use tri-state modulating actuators with or without a spring return, as required by the application.

Damper Actuators

Damper actuators cannot exceed 12 VA draw at 24 Vac. For control of outdoor/return air dampers, use tri-state modulating actuators that incorporate a spring return.

Zone Humidity sensor

For measurement of relative humidity (RH), the ZN521 requires a zone humidity sensor with a 4–20 mA output, where 4 mA is 0% RH and 20 mA is 100% RH. The controller provides 20 Vdc to power the zone humidity sensor.

CO₂ Sensor

For CO₂ measurement, the ZN521 requires a CO₂ sensor with a 4–20 mA output, where 4 mA = 0 ppm and 20 mA = 2000 ppm.



General Wiring Information

This section provides specifications and general information about the following:

- Input/output terminal Wiring
- AC power wiring
- Communication link wiring and addressing

Input/Output Terminal Wiring

All input/output terminal wiring for the ZN521 is application specific and dependent on the configuration of the controller. Input/output terminal wiring must meet the following requirements:

- All wiring must comply with the National Electrical Code™ (NEC) and local codes.
- Use only 18 AWG, twisted-pair wire with stranded, tinned-copper conductors (shielded wire is recommended).
- Binary input and output wiring must not exceed 1000 ft (300 m).
- Analog input wiring must not exceed 300 ft (100 m).
- Do not run input/output wires in the same wire bundle with any ac power wires.

For application-specific wiring information and diagrams, refer to the section, [“Input/Output Functions And Wiring For Typical Applications,” p. 13.](#)

AC Power Wiring

⚠ CAUTION

Proper Grounding Required!

Ensure that the 24 Vac transformer is properly grounded. Failure to do so may result in personal injury or equipment damage.

⚠ WARNING

Hazardous Voltage!

Before making line voltage electrical connections, lock open the supply-power disconnect switch. Failure to do so may cause death or serious injury.

NOTICE:

Avoid Equipment Damage!

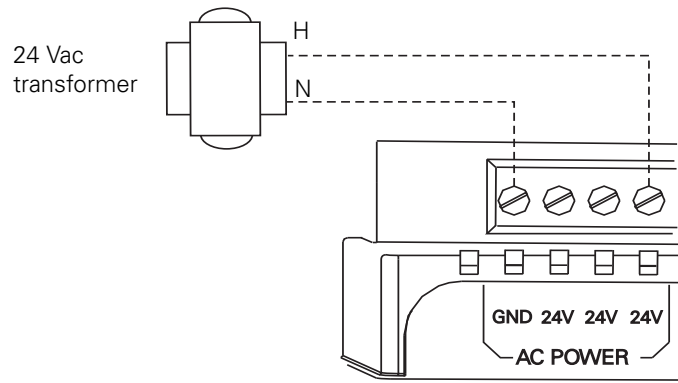
Complete input/output wiring before applying power to the Tracer ZN521 zone controller. Failure to do so may cause damage to the controller or power transformer due to inadvertent connections to power circuits.



Important: Do not share 24 Vac between controllers.

The ac power connections are in the top left corner of the ZN521 (refer to [Figure 3](#)).


Figure 3. Connecting ac power wires to the controller



The ZN521 can be powered by an existing transformer integral to the controlled equipment, provided the transformer has adequate power available and proper grounding is observed. If providing a new transformer for power, use a UL-listed Class 2 power transformer supplying a nominal 24 Vac (19–30 Vac). The transformer must be sized to provide adequate power to both the Tracer ZN521 zone controller (14 VA) and its associated output devices, including relays and actuators, to a maximum of 12 VA per output utilized.

Communication Link Wiring And Addressing

The ZN521 communicates with the BAS and with other LonTalk® controllers by means of a LonTalk communication link.

 **Important:** For important instructions on network wiring, refer to the *Tracer Summit™ Hardware and Software Installation guide (BMTX-SVN01)*.

Wiring for the communication link must meet the following requirements:

- All wiring must comply with the National Electrical Code and local codes.
- 22 AWG Level 4 un-shielded communications wire recommended for most Comm5 installations.
- Termination resistors are required for wiring LonTalk devices communicating on a network. For specific information about using termination resistors for LonTalk applications, refer to the *Tracer Summit Hardware and Software Installation Guide (BMTX-SVN01)*.

Each ZN521 has a unique 12-character alphanumeric device address for communicating on a BAS network. This address, referred to as a *Neuron ID*, is assigned in the factory before the product is shipped and cannot be changed. Each controller can be identified by viewing its unique Neuron ID, which is on a printed label attached to the circuit board of the controller. Additional adhesive-backed, peel-off Neuron ID labels are tethered to the controller for placing on mechanical prints or unit location worksheets. The Neuron ID will appear when communication is established with the Rover service tool or a BAS. An example Neuron ID is 00-01-64-1C-2B-00.



Mounting the Controller

This section provides recommendations and requirements for mounting the ZN521.

Location Recommendations

Trane recommends locating the ZN521:

- Near the controlled piece of equipment to reduce wiring costs.
- Where it is easily accessible for service personnel.
- Where public access is restricted to minimize the possibility of tampering or vandalism.
- The controller can often be mounted inside the wiring enclosure of the associated mechanical equipment.

Operating Environment Requirements

Operate a ZN521 in an indoor environment that meets the following requirements:

- Temperature: from 32°F to 140°F (from 0°C to 60°C)
- Relative humidity: 5–95%, non-condensing

Mounting Recommendations

Mounting recommendations are as follows:

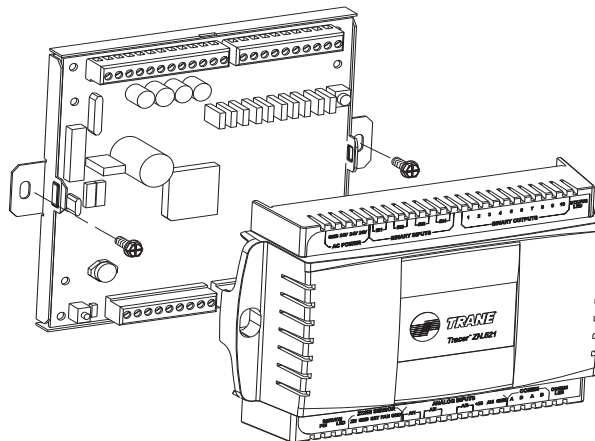
NOTICE:

Avoid Equipment Damage!

Mount the ZN521 with the cover on to avoid the possibility of damaging the circuit board during installation.

- Mount the controller in any position, other than with the front of the cover facing downward.
- Mount using the two $\frac{3}{16}$ in. (4.8 mm) radius mounting holes provided (see Figure 4). Mounting fasteners are not included.
- Attach the controller securely so it can withstand vibrations of associated HVAC equipment.
- When the controller is mounted in a small enclosed compartment, complete all wiring connections before securing the controller in the compartment.

Figure 4. Mounting the ZN521



Input/Output Functions And Wiring For Typical Applications

This section provides information about the function of inputs and outputs and examples of wiring for typical applications. Applications supported by the ZN521 are shown in [Table 2](#).

Table 2. Typical applications for the ZN521

Application	Multiple Fan Speed	Dehum	Auto Min Damper Adj	Face/ Bypass Damper	Valve Control	Econ	Aux (Base Board) Heat	Elec Heat
2-pipe hydronic cooling only	x		x		x	x	x	x
2-pipe hydronic heating only	x		x	x	x	x	x	
2-pipe changeover	x	x	x	x	x	x	x	x
2-pipe steam only	x		x	x	x	x	x	
4-pipe hydronic heating and cooling	x	x	x	x	x	x	x	
4-pipe changeover	x	x	x	x	x	x	x	
4-pipe steam/chilled water	x		x		x	x	x	
Electric heat only (single- and two-stage)						x	x	x
DX/hydronic heating	x		x		x	x	x	
DX/steam heating	x		x		x	x	x	
DX cooling only						x	x	x

Figures [Figure 7, p. 21](#) through [Figure 17, p. 31](#) show typical wiring diagrams that include all required and all optional components for typical applications.

Binary Inputs

The ZN521 includes four (4) binary inputs. Each binary input associates an input signal of 0 Vac with open contacts and 24 Vac with closed contacts. Use the Rover service tool to configure each of the inputs as normally open or normally closed. If an application does not warrant the use of a particular input, configure the input as Not Used. This will disable the generation of diagnostics for this function.

[Table 3](#) gives the function of each binary input.

Table 3. Binary inputs

Binary Input Terminal Label	Function
BI1	Low-coil temperature detection
BI2	Condensate overflow
BI3	Occupancy or generic binary input
BI4	Fan status

Each function is explained in the following paragraphs. For an explanation of the diagnostics generated by each binary input, see [“Diagnostics,” p. 49](#). For more information about how the controller operates, see [“Sequence of Operations,” p. 32](#)

BI1: Low-coil Temperature Detection

Note: BI1 applies to hydronic/steam coils only.

The function of low-coil-temperature detection is to protect the coil from freezing. If BI1 is wired to a binary low-coil-temperature detection device (freeze-protection switch) and a low-coil-temperature condition exists, the ZN521 will detect the condition and generate a **Low Coil Temp Detection** diagnostic.

BI2: Condensate Overflow

The function of condensate overflow is to prevent the condensate drain pan from overflowing and causing water damage to the building. If BI2 is wired to a condensate overflow switch and the level of condensate reaches the trip point, the ZN521 will detect the condition and generate a **Condensate Overflow** diagnostic.

BI3: Occupancy or Generic Binary Input

The BI3 binary input can function as either:

- The occupancy input
- A generic binary input

The function of occupancy is to save energy by spreading zone setpoints when the zone is unoccupied. As the occupancy input, BI3 can be used for two related functions. For stand-alone controllers, BI3 can be hard-wired to a binary switch or time clock to determine the occupancy mode—either occupied or unoccupied. For controllers receiving a BAS-communicated occupancy request, the function of BI3 is to change the mode from occupied to occupied standby. (For more information on occupancy-related functions, see [“Occupancy Modes,” p. 32.](#))

BI3 is the only binary input that can be configured as generic. If configured as a generic binary input, it can be monitored by a BAS and has no direct effect on the operation of the ZN521.

BI4: Fan Status

The fan status input provides feedback to the controller regarding the fan operating status. If BI4 is wired to a fan status switch and the input indicates that the fan is not operating when the controller has the fan controlled to on, the controller will generate a **Low AirFlow—Fan Failure** diagnostic. (For more information, see [“Fan Status,” p. 42.](#))

Analog Inputs

The ZN521 includes seven (7) analog inputs. [Table 4](#) describes their functions. Each function is explained in the following paragraphs. For an explanation of the diagnostics generated by each analog input, see “[Diagnostics](#),” p. 49. For more information about how the controller operates, see “[Sequence of Operations](#),” p. 32

Table 4. Analog inputs

Analog Input Terminal Label	Function
ZN	Zone temperature
GND	Zone sensor common ground
SET	Local setpoint
FAN	Fan mode input
GND	Auxiliary ground
AI1	Entering water temperature
AI2	Discharge air temperature
AI3	Outdoor air temperature or generic temperature
AI4	Universal 4–20 mA

GND: Ground Terminals

Use a GND terminal as the common ground for all zone sensor analog inputs.

ZN: Zone Temperature

The ZN analog input functions as the local (hardwired) zone temperature input. The controller receives the temperature as a resistance signal from a 10 kΩ thermistor in a standard Trane zone sensor wired to analog input ZN. A zone temperature value communicated by means of a LonTalk link can also be used for controllers operating on a BAS. When both hardwired and communicated zone temperature values are present, the controller uses the communicated value. If neither a hardwired nor a communicated zone temperature value is present, the controller generates a **Zone Temp Failure** diagnostic.

The ZN analog input is also used to communicate timed override requests and cancel requests to the controller for applications using a Trane zone sensor with **ON** and **CANCEL** buttons.

SET: Local Setpoint

The SET analog input functions as the local (hardwired) temperature setpoint input for applications utilizing a Trane zone sensor with a temperature setpoint thumbwheel. The local setpoint input is configurable (as enabled or disabled) using the Rover service tool. A setpoint value communicated by means of a LonTalk link can also be used for controllers operating on a BAS. If both hardwired and communicated setpoint values are present, the controller uses the communicated value. If neither a hardwired nor a communicated setpoint value is present, the controller uses the stored default setpoints (configurable using the Rover service tool). If a valid hardwired or communicated setpoint value is established, and then is no longer present, the controller generates a **Setpoint Failure** diagnostic.

Input/Output Functions And Wiring For Typical Applications

FAN: Fan Mode Input

The FAN analog input functions as the local (hardwired) fan mode switch input for applications using the Trane zone sensor with a fan mode switch option. The various fan mode switch positions (off, low, medium, high, auto) provide different resistances that are interpreted by the ZN521. The local fan mode switch input is configurable (as enabled or disabled) using the Rover service tool. A communicated fan mode request via the LonTalk communications link can be used for controllers operating on a BAS. If both hardwired and communicated fan mode values are present, the controller uses the communicated value. If neither a hardwired nor a communicated fan mode value is present, the controller recognizes the fan mode value as auto and operates according to the default configuration. If a valid hardwired or communicated fan mode value is established and then is no longer present, the controller generates a **Fan Mode Failure** diagnostic.

AI1: Entering Water Temperature

The AI1 analog input functions as the local (hardwired) entering water temperature input. An entering water temperature communicated via the LonTalk communications link can be used for controllers operating on a BAS. If both hardwired and communicated entering water temperature values are present, the controller uses the communicated value. If a valid hardwired or communicated entering water temperature value is established, and then is no longer present, the controller generates an **Entering Water Temp Failure** diagnostic.

For units configured as 2-pipe or 4-pipe changeover units, the entering water temperature is used to make heating/cooling operation decisions. If neither hardwired nor a communicated entering water temperature values are present on changeover units, the controller will always operate in heating mode.

For units not configured as changeover units, the entering water temperature value is used for information and troubleshooting only and does not affect the operation of the controller.

Note: AI1 is not polarity sensitive. Connect either terminal to either sensor lead.

AI2: Discharge Air Temperature

The AI2 analog input functions as the local discharge air temperature input.

Important: The ZN521 cannot operate without a valid discharge air temperature value.

The controller receives the temperature as a resistance signal from a 10 k Ω thermistor wired to analog input AI2. The thermistor is typically located downstream from all unit heating and cooling coils at the unit discharge area.

If a discharge air temperature value is invalid or is not present, the controller generates a **Discharge Air Temp Failure** diagnostic and shuts down the equipment. When the thermistor returns to a valid temperature, the controller automatically allows the equipment to resume normal operation.

Note: AI2 is not polarity sensitive. Connect either terminal to either sensor lead.

AI3: Outdoor Air Temperature or Generic Temperature

The AI3 analog input can function as either:

- An outdoor air temperature input
- A generic temperature input

If AI3 is configured as the local (hardwired) outdoor air temperature input, the controller receives the temperature as a resistance signal from a 10 k Ω thermistor wired to analog input AI3. An outdoor air temperature value communicated by means of a LonTalk link can be used for controllers operating on a BAS. If both hardwired and communicated outdoor air temperature values are present, the controller uses the communicated value. If a valid hardwired or communicated outdoor air temperature value is established, and then is no longer present, the controller generates an **Outdoor Air Temp Failure** diagnostic.

Input/Output Functions And Wiring For Typical Applications

Economizing (*free cooling*) is a function, whereby, outdoor air is used as a source of cooling before hydronic or DX cooling is used. The ZN521 uses the outdoor air temperature value to determine whether economizing is feasible. Economizing is not possible without a valid outdoor air temperature. (For more information, see “[Economizing \(Free Cooling\)](#),” p. 40.)

The outdoor air temperature value is also used for the freeze avoidance function. This function is used for low-coil temperature protection when the fan is off. The controller enters the freeze avoidance mode when the outdoor air temperature is below the freeze avoidance setpoint (configurable using the Rover service tool). [For more information, see “[Freeze Avoidance](#),” p. 43.]

If AI3 is configured as a generic temperature input, it can be monitored by a BAS. The controller receives the temperature as a resistance signal from a 10 kΩ thermistor wired to analog input AI3. The generic temperature input can be used with any Trane 10 kΩ thermistor. The thermistor can be placed in any location and has no effect on the operation of the controller. The controller will generate a **Generic Temperature Failure** diagnostic if the input becomes invalid or goes out of range.

Note: AI3 is not polarity sensitive. Connect either terminal to either sensor lead.

AI4: Universal 4–20 mA

The AI4 analog input can be configured in one of the three ways as shown in [Table 5](#).

Table 5. AI4 configuration options and associated measurement ranges

Configuration	Measurement range
Generic 4–20 mA input	0–100% (4 mA=0%; 20 mA=100%)
CO ₂ measurement	0–2000 ppm (4 mA=0 ppm; 20 mA=2000 ppm)
Relative humidity (RH) measurement	0–100% (4 mA=0% RH; 20 mA=100% RH)

If this input is not needed for an application, configure it as Not Used. This will disable the generation of diagnostics.

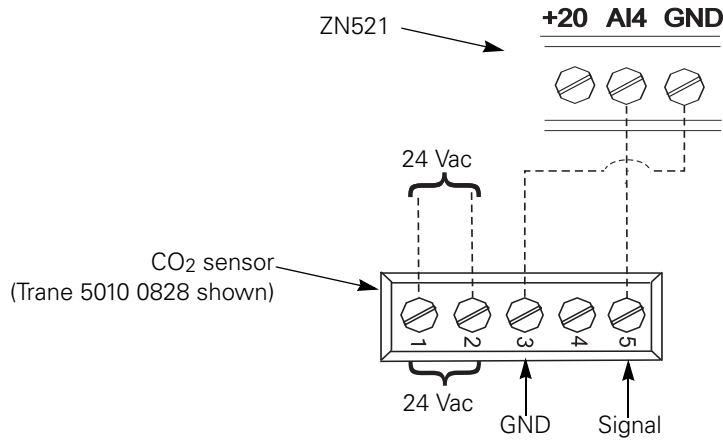
Note: AI4 is polarity sensitive.

For the generic input configuration, a 4–20 mA sensor must be hardwired to the AI4 terminal. (Wiring is dependent on the specific application.) The sensor communicates a value of 0–100% to the BAS. This configuration has no direct effect on ZN521 operation. If a valid value is established, and then is no longer present, the controller generates a **Generic AIP Failure** diagnostic.

For the CO₂ measurement configuration, a 4–20 mA sensor must be hardwired to the AI4 terminal as shown in [Figure 5](#). The sensor will transmit a 0–2000 ppm value to the BAS. This configuration has no direct effect on the operation of the ZN521. If a valid value is established, and then is no longer present, the controller generates a **CO₂ Sensor Failure** diagnostic.

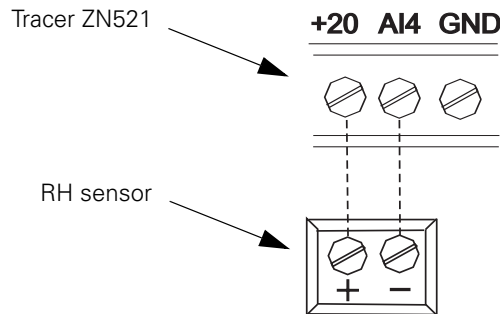
Input/Output Functions And Wiring For Typical Applications

Figure 5. AI4 terminal wiring: CO₂ measurement



For the RH measurement configuration, either a hardwired 4–20 mA zone humidity sensor (refer to [Figure 6](#)) must provide a value to the controller or a BAS communicates a value to the controller. The controller uses this value to support the dehumidification function. (For more information, see “[Dehumidification](#),” p. 41.) If a valid hardwired or communicated relative humidity value is established, and then is no longer present, the controller generates a **Humidity Input Failure** diagnostic and disables the dehumidification function.

Figure 6. AI4 terminal wiring: RH measurement



Binary Outputs

The ZN521 supports fan coil, blower coil, and unit ventilator applications that may include the following components:

- Supply fan with up to three speeds
- Hydronic cooling and/or heating coils with two-position or tri-state modulating control valve
- DX cooling (single stage)
- Electric heat (single stage or two stage)
- Baseboard heat (single stage)
- Tri-state modulating outdoor/return air damper
- Tri-state modulating face-and-bypass damper

The ZN521 includes ten (10) binary outputs. Each binary output is a triac with a rating of 12 VA at 24 Vac. [Table 6](#) describes the function of each output.

Table 6. Binary output functions

Binary Output	Functions
1	• Fan high
2	• Fan medium • Exhaust fan or damper
3	• Fan low
4	• Modulating cooling/changeover valve, open • Two-position cooling/changeover valve • DX cooling
5	• Modulating cooling/changeover valve, close • Face-and-bypass damper, open to face
6	• Modulating heating valve, open • Two-position heating valve • Electric heat, stage 1
7	• Modulating heating valve, close • Face-and-bypass damper, close (bypass) • Electric heat, stage 2
8	• Outdoor air damper, open (return air damper, close)
9	• Outdoor air damper, close (return air damper, open)
10	• Baseboard heat • Generic

Generic Binary Output

Binary output 10 is the only output that can be configured as a generic binary output. When configured as a generic binary output, it can be controlled only by a BAS, and has no direct effect on the operation of the ZN521.

Overriding Binary Outputs

The ZN521 includes a manual output test and a water valve override feature. Use the manual output test to manually control the outputs in a defined sequence. For information, see [“Manual Output Test,” p. 43](#).

The water valve override feature is a procedure used for water balancing. Using the Rover service tool or a BAS, the user can specify a ZN521 to override the state of water valves to:

- Open all valves
- Close all valves

Note: *The controller resets itself to normal operation after two hours.*

Wiring Requirements and Options

Table 7 shows required controller inputs for minimal proper operation of all applications.

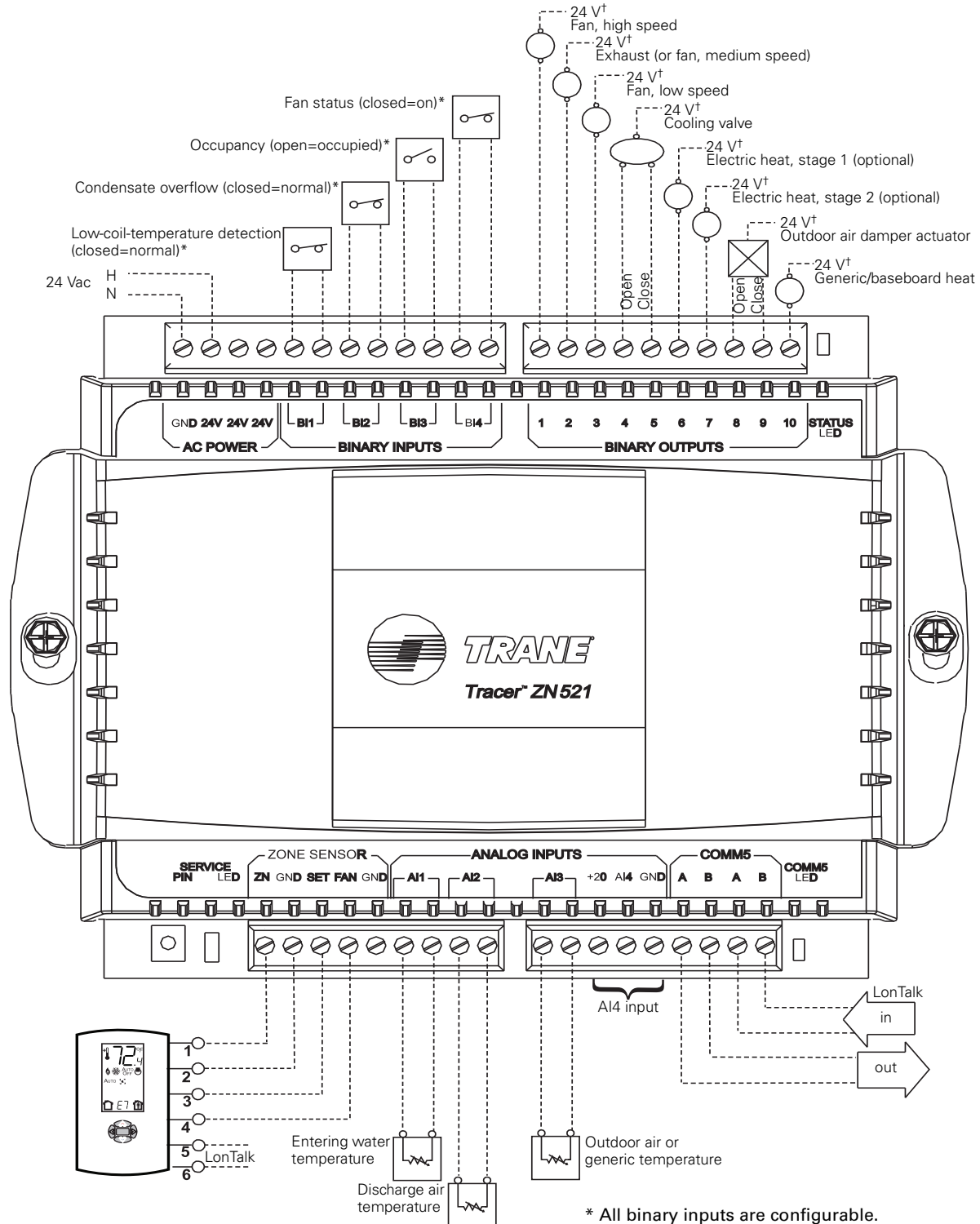
Table 7. Required controller inputs for proper operation

Function	Input source
24 Vac power	Terminals: GND, 24 V (refer to the section, "AC Power Wiring," p. 10).
Zone temperature	Terminals: ZN, GND or communicated (refer to the section, "ZN: Zone Temperature," p. 15).
Discharge air temperature	Terminals: AI2 (refer to the section, "AI2: Discharge Air Temperature," p. 16).
Entering water temperature—required only for units with auto changeover	Terminal: AI1 or communicated (refer to the section, "AI1: Entering Water Temperature," p. 16).
Outdoor air temperature—required only for economizing	Terminals: AI3 or communicated (refer to the section, "AI3: Outdoor Air Temperature or Generic Temperature," p. 16).
Relative humidity—required only for dehumidification	Terminals: AI4 (refer to the section, "AI4: Universal 4–20 mA," p. 17).

Figure 7, p. 21 through Figure 17, p. 31 show typical applications that include all required and all optional components.

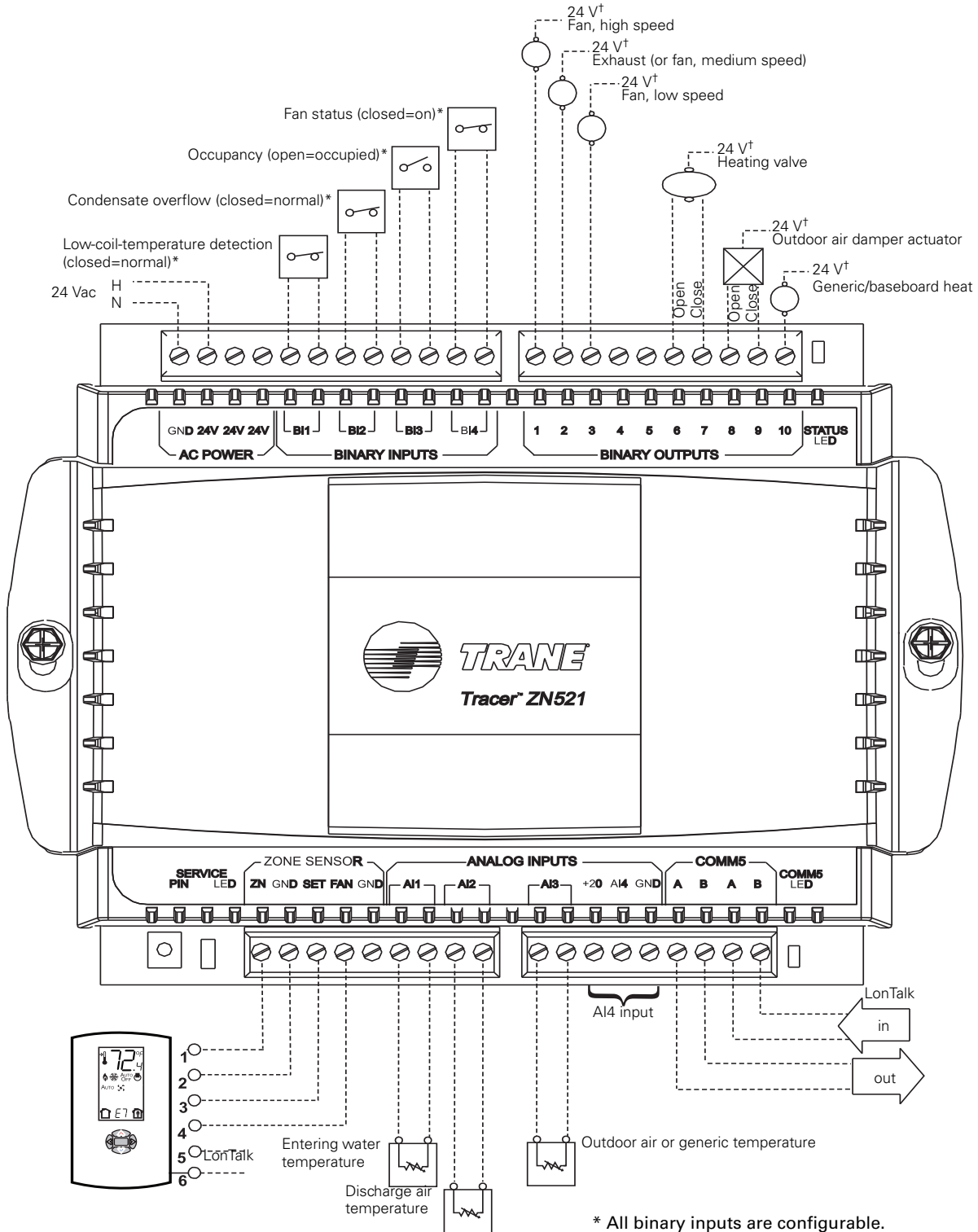
Input/Output Functions And Wiring For Typical Applications

Figure 7. Two-pipe hydronic-cooling unit



Input/Output Functions And Wiring For Typical Applications

Figure 8. Two-pipe hydronic-heating unit

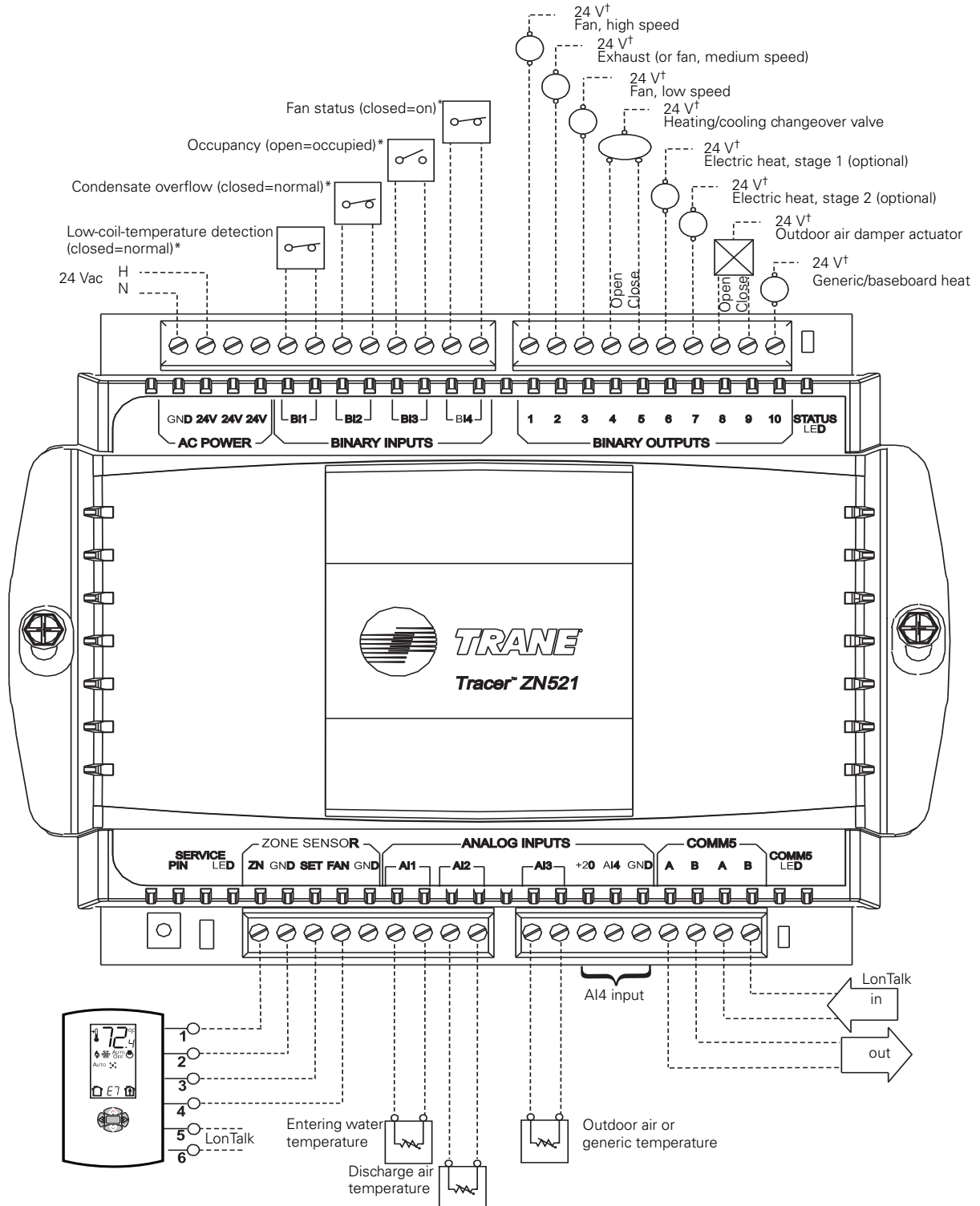


* All binary inputs are configurable.

† Connect 24 V to an AC POWER (24V) terminal.

Input/Output Functions And Wiring For Typical Applications

Figure 9. Two-pipe hydronic heating/cooling unit with auto changeover

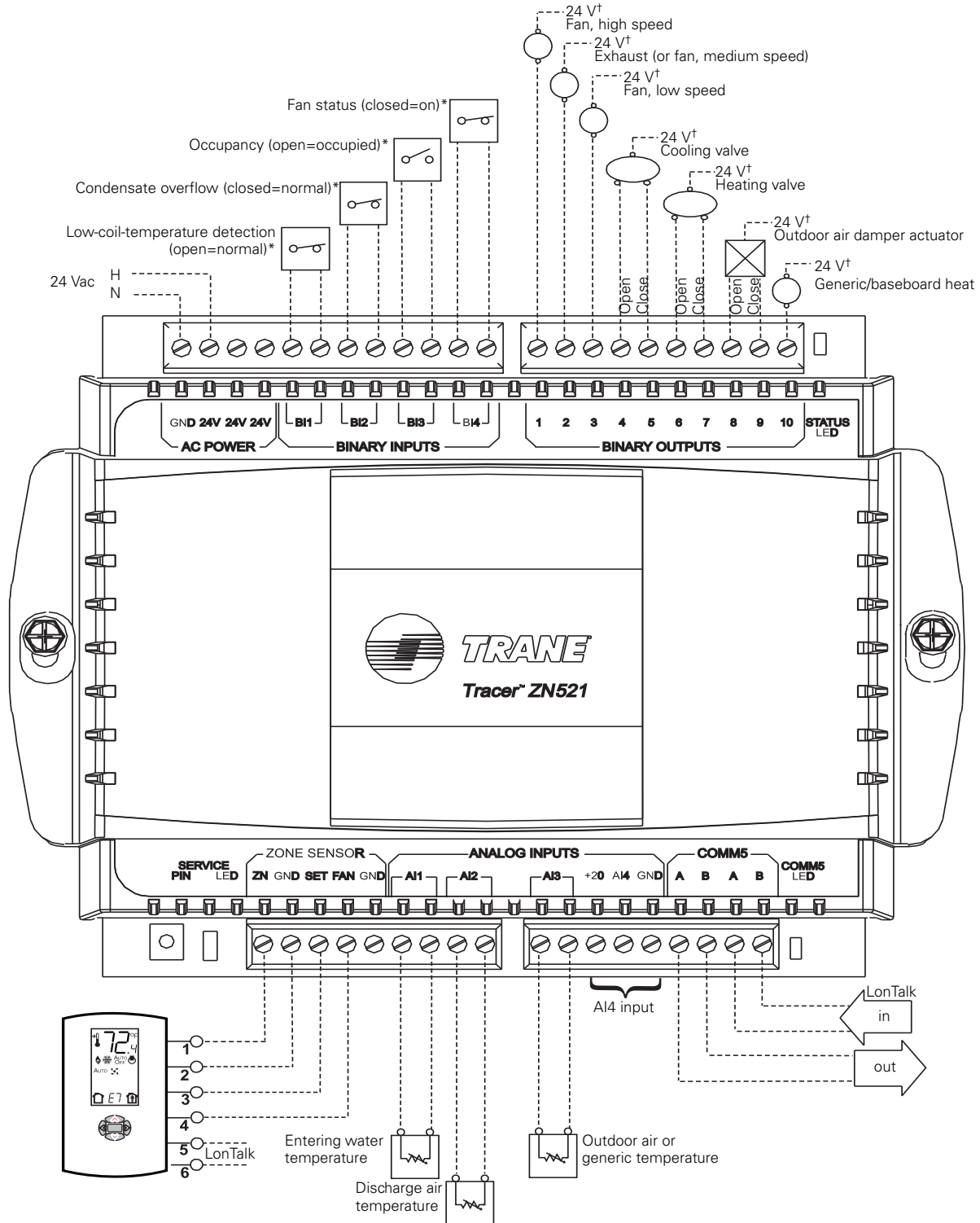


* All binary inputs are configurable.

† Connect 24 V to an AC POWER (24V) terminal.

Input/Output Functions And Wiring For Typical Applications

Figure 10. Four-pipe hydronic heating/cooling unit

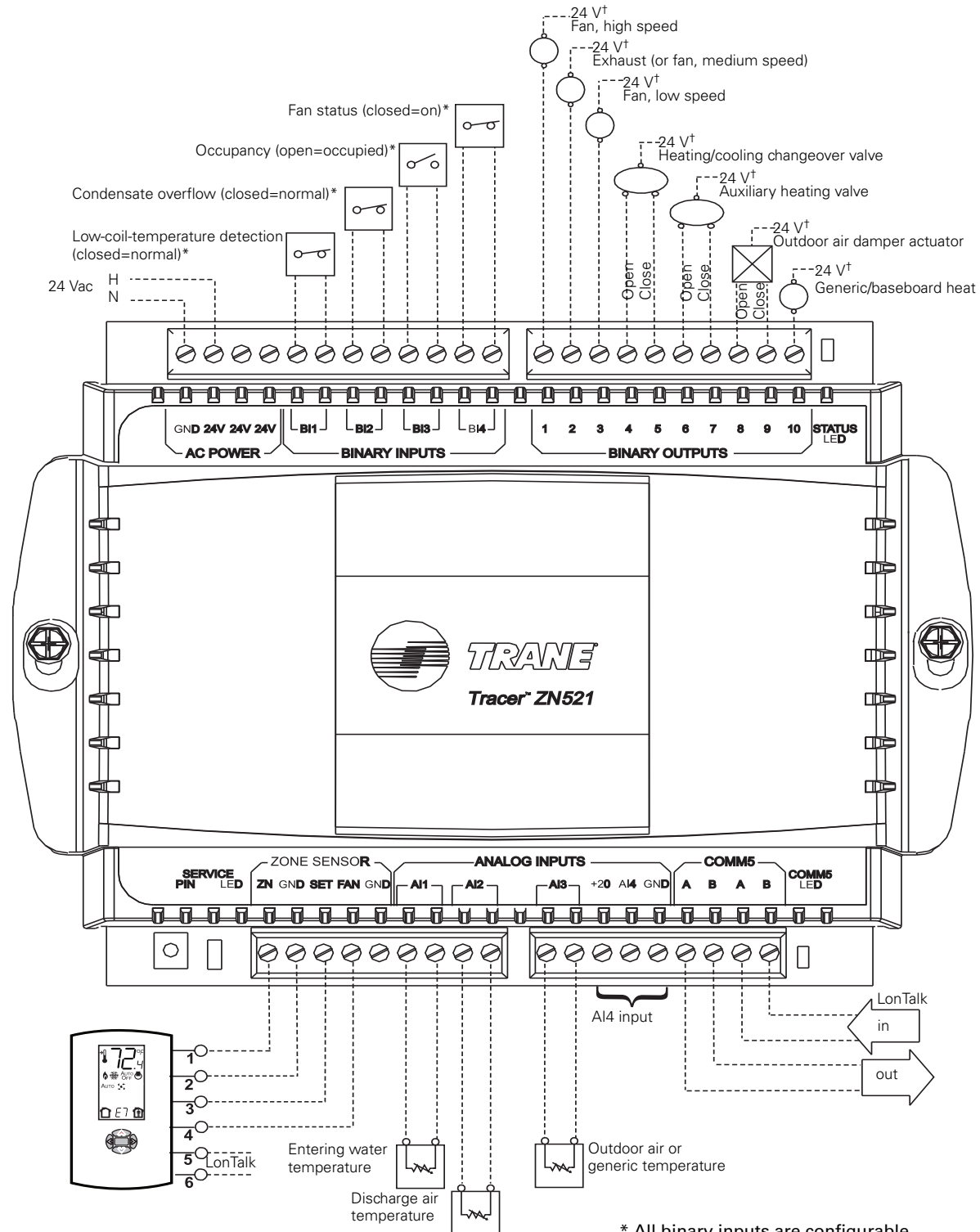


* All binary inputs are configurable.

† Connect 24 V to an AC POWER (24V) terminal.

Input/Output Functions And Wiring For Typical Applications

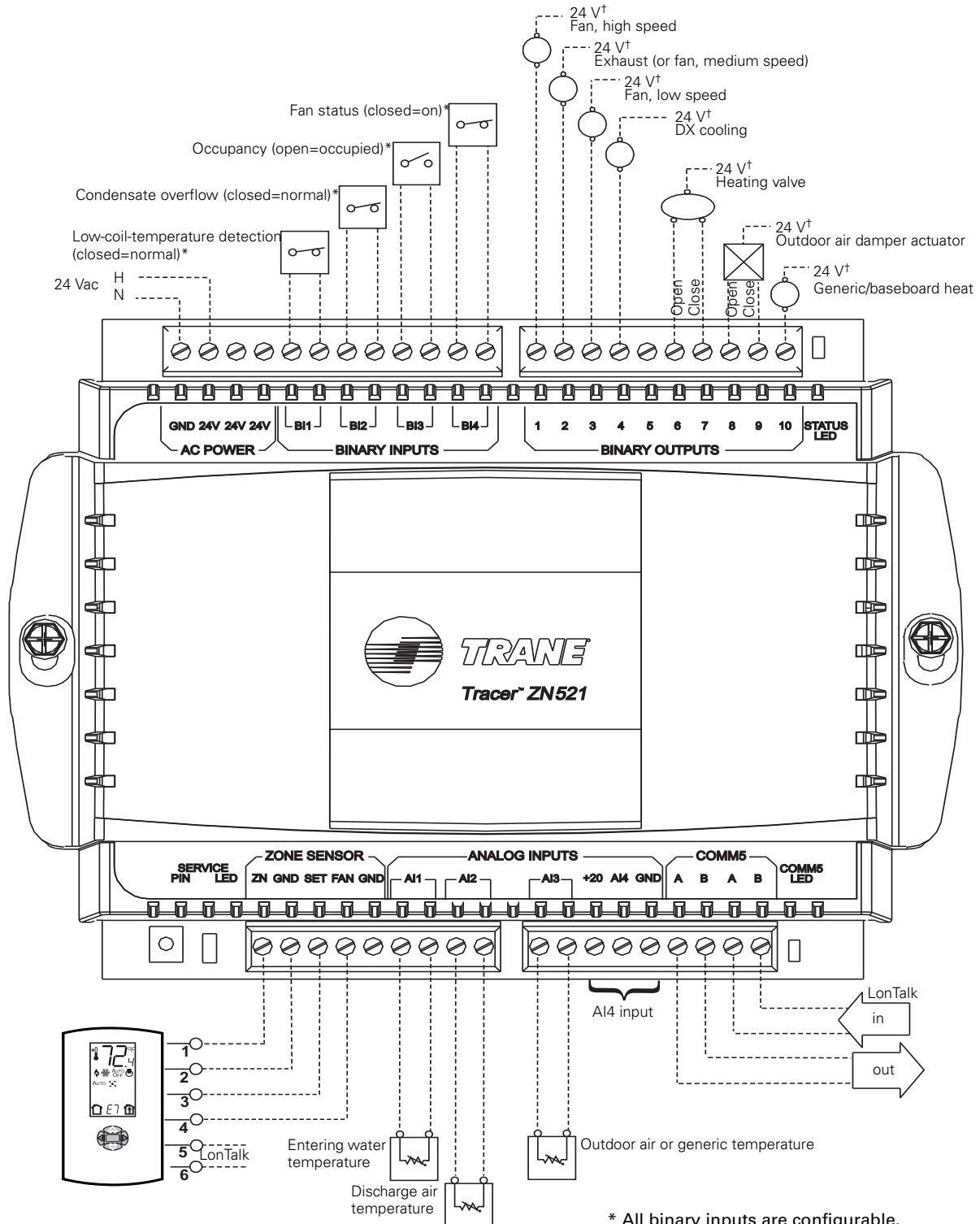
Figure 11. Four-pipe heating/cooling unit with auto changeover



* All binary inputs are configurable.
 † Connect 24 V to an AC POWER (24V) terminal.

Input/Output Functions And Wiring For Typical Applications

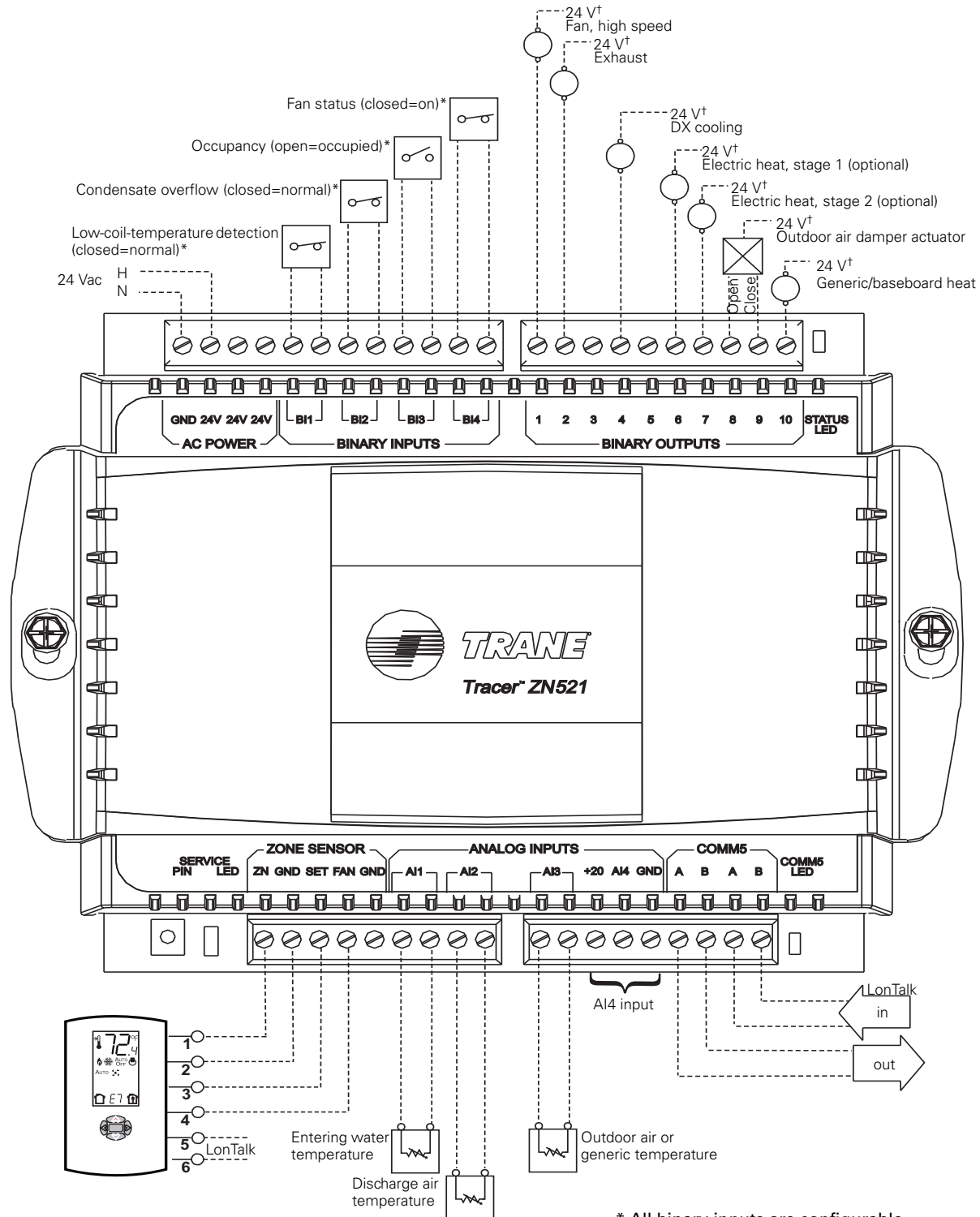
Figure 12. Two-pipe heating unit with DX cooling



* All binary inputs are configurable.
 † Connect 24 V to an AC POWER (24V) terminal.

Input/Output Functions And Wiring For Typical Applications

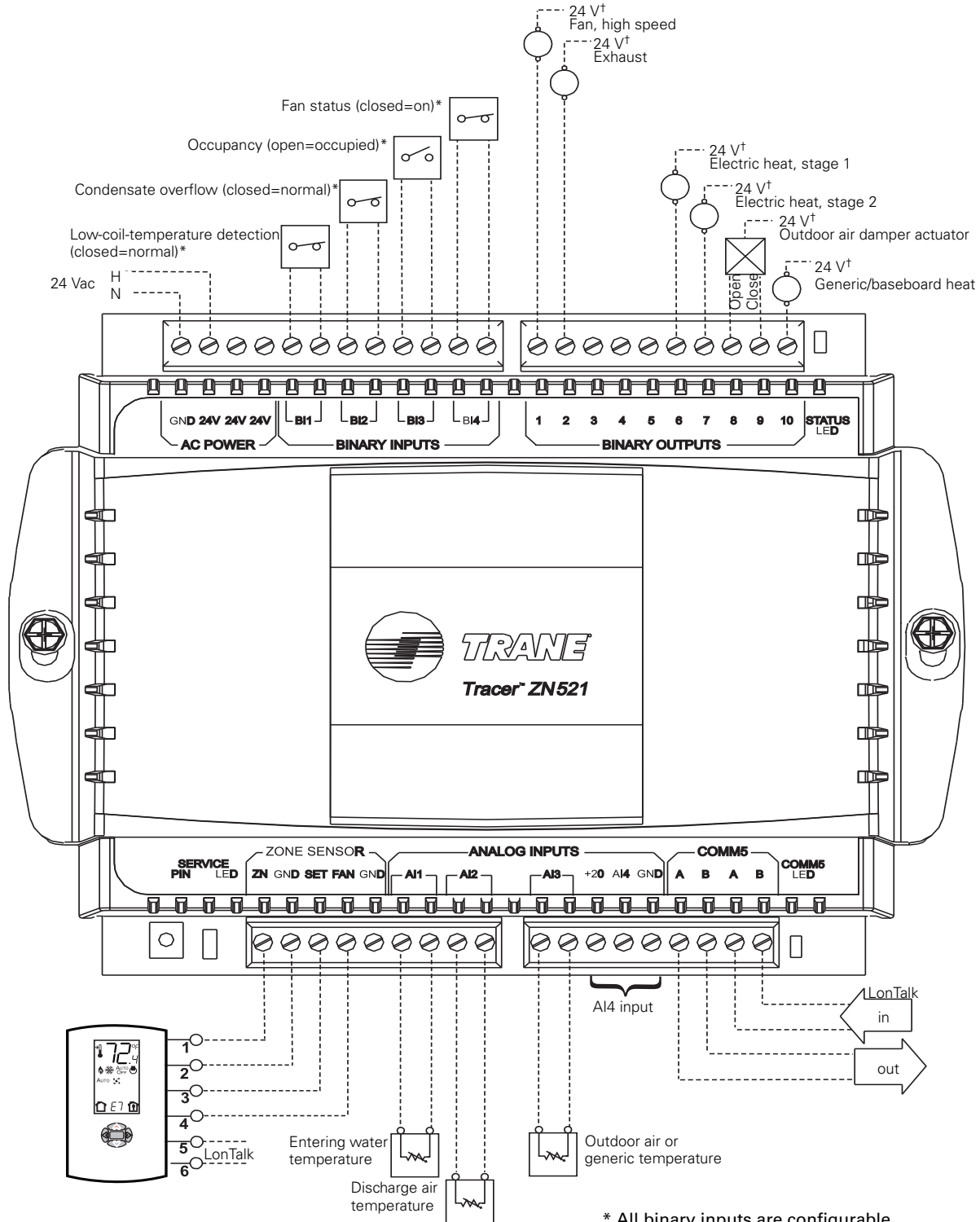
Figure 13. Electric heat unit with DX cooling



* All binary inputs are configurable.
 † Connect 24 V to an AC POWER (24V) terminal.

Input/Output Functions And Wiring For Typical Applications

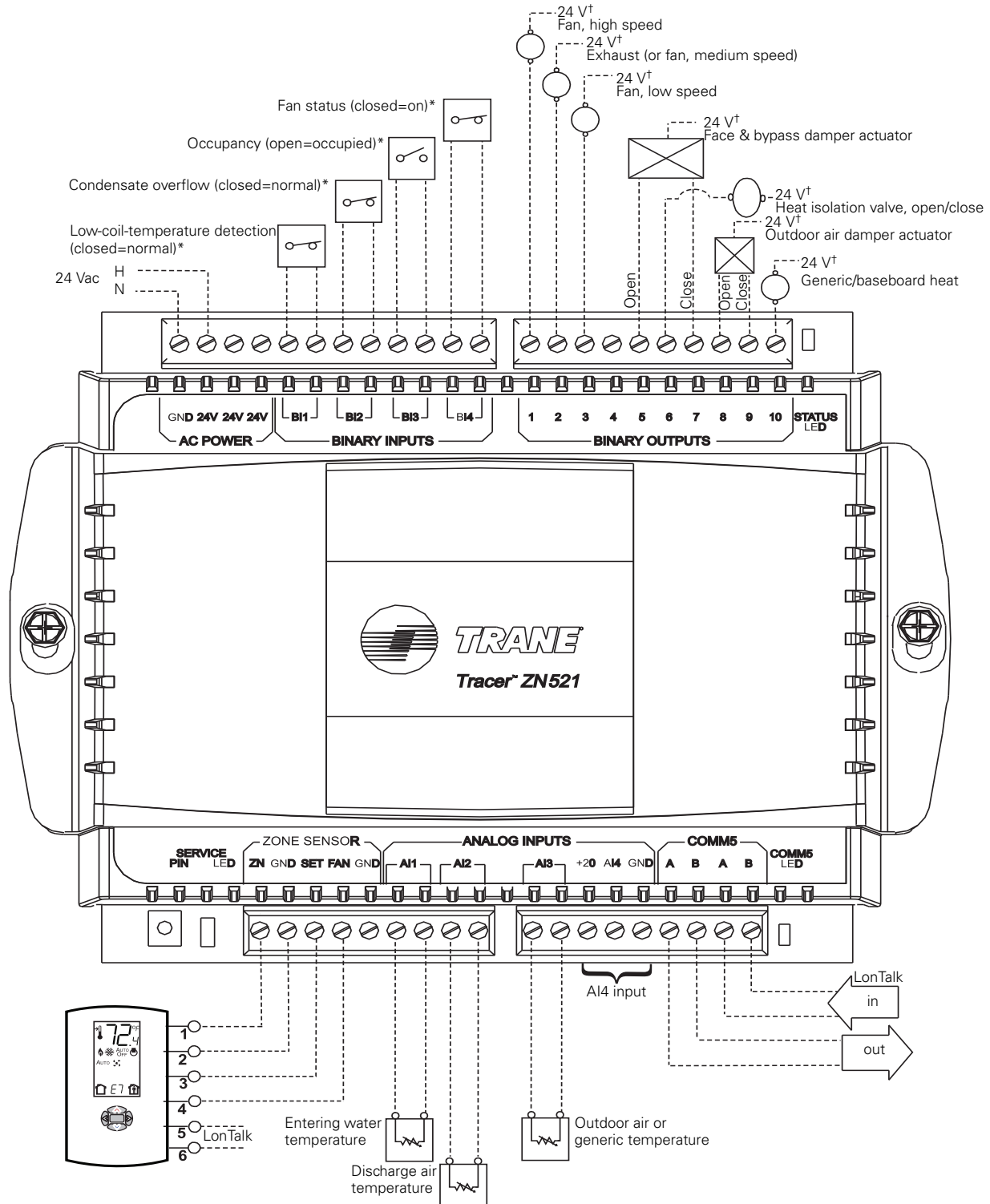
Figure 14. Electric heat unit



* All binary inputs are configurable.
[†] Connect 24 V to an AC POWER (24V) terminal.

Input/Output Functions And Wiring For Typical Applications

Figure 15. Two-pipe heating unit with face-and-bypass damper

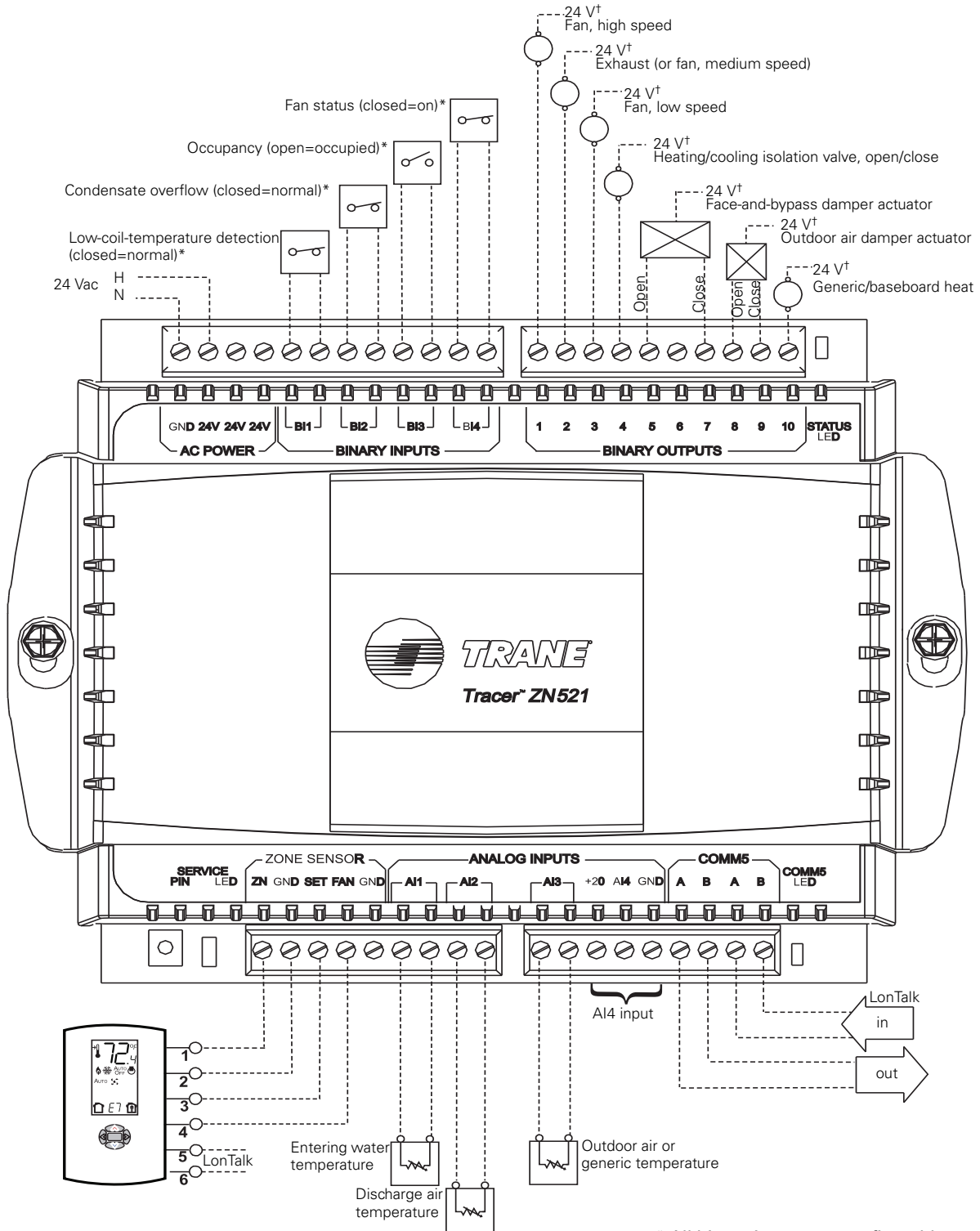


* All binary inputs are configurable.

† Connect 24 V to an AC POWER (24V) terminal.

Input/Output Functions And Wiring For Typical Applications

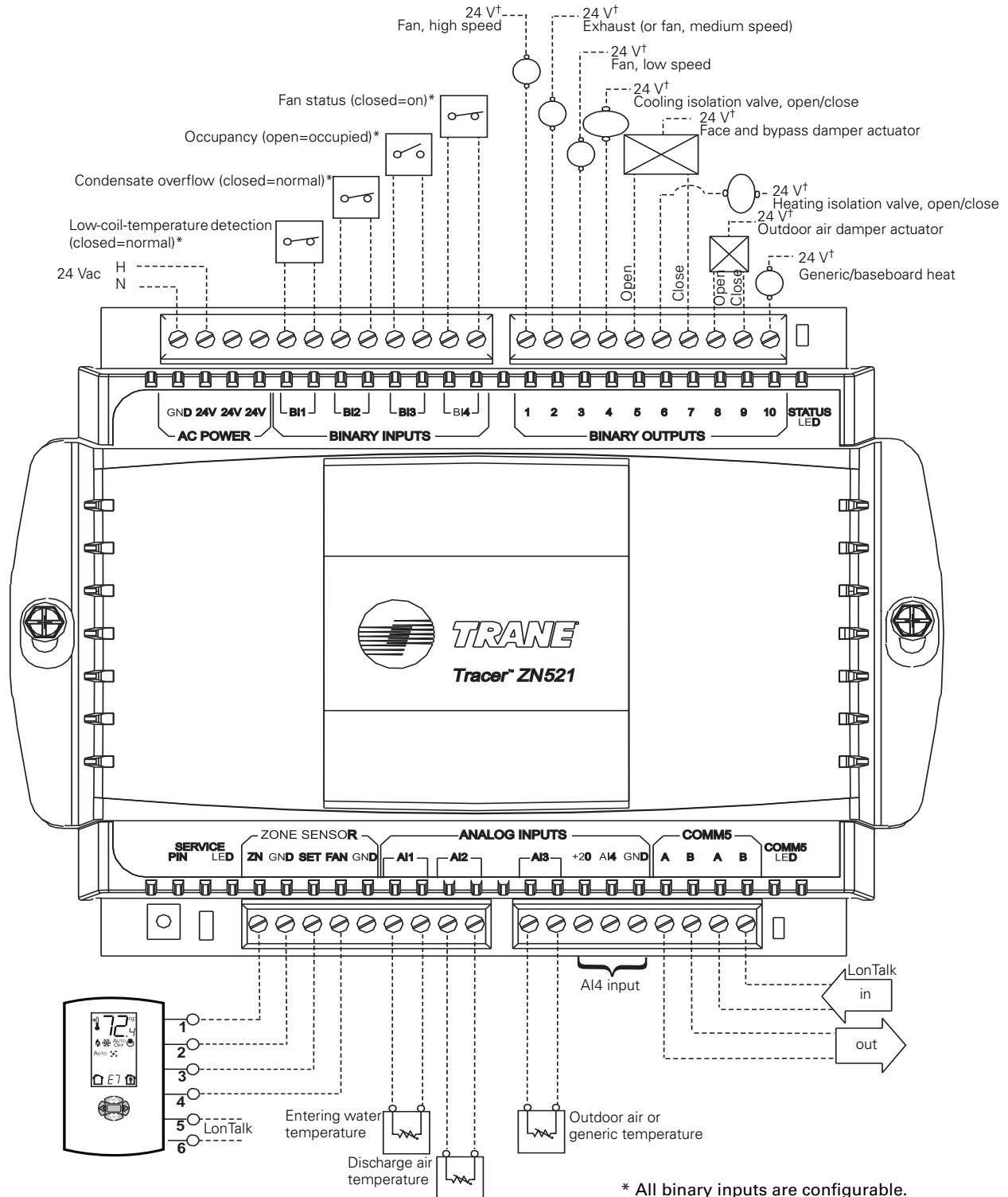
Figure 16. Two-pipe heating/cooling unit with face-and-bypass damper



* All binary inputs are configurable.
 † Connect 24 V to an AC POWER (24V) terminal.

Input/Output Functions And Wiring For Typical Applications

Figure 17. Four-pipe heating/cooling unit with face-and-bypass damper



* All binary inputs are configurable.

† Connect 24 V to an AC POWER (24V) terminal.



Sequence of Operations

The ZN521 operates to maintain the zone temperature setpoint. This section provides information about operational sequences used by the controller to maintain the zone temperature setpoint.

Power-up Sequence

When 24 Vac power is initially applied to the ZN521, the following sequence occurs:

1. The green status indicator LED turns on (see [“Interpreting LEDs,”](#) p. 48).
2. All outputs are controlled off, all modulating valves and dampers close, and the face-and-bypass damper calibrates to bypass (when present).
3. The controller reads all input local values to determine initial values.
4. The random-start timer begins (see [“Random Start,”](#) p. 32).
5. If a hardwired zone temperature value is not detected, the controller begins to wait for a communicated value. (This can take several minutes [15-minute default] and occurs concurrently with the remainder of the power-up sequence.)
6. The random-start timer expires.
7. The power-up control wait function begins automatically if the configured power-up control wait time is greater than 0 seconds. When this function is enabled, the controller waits for the configured amount of time (from 0 to 120 seconds) to allow a communicated occupancy request to arrive. If a communicated occupancy request arrives, normal operation can begin. If a communicated occupancy request does not arrive, the controller assumes stand-alone operation.
8. Normal operation begins assuming no diagnostics have been generated.

Random Start

Random start is intended to prevent all units in a building from energizing at the same time. The random-start timer delays the fan and any heating or cooling start-up from 5 to 30 seconds. If neither heating nor cooling is initiated, or if fan operation is not required during the delay, the random-start timer will time out.

Occupancy Modes

Occupancy modes can be controlled by any of the following:

- The state of the local (hardwired) occupancy binary input BI3 (see [“BI3: Occupancy or Generic Binary Input,”](#) p. 14)
- A timed override request from a Trane zone sensor (see [“Timed Override Control,”](#) p. 33)
- A communicated signal from a peer device (see [“Peer-to-peer Communication,”](#) p. 41)
- A communicated signal from a BAS

A communicated request, either from a BAS or a peer controller, takes precedence over local requests. If a communicated occupancy request has been established and is no longer present, the controller reverts to the default (occupied) occupancy mode after 15 minutes (if no hardwired occupancy request exists). The ZN521 has the following occupancy mode options:

- Occupied
- Unoccupied
- Occupied standby
- Occupied bypass

Occupied Mode

In occupied mode, the controller maintains the zone temperature based on the occupied heating or cooling setpoints. The controller uses the occupied mode as a default mode when other forms of occupancy request are not present. The fan runs continuously. The outdoor air damper closes when the fan is off. The temperature setpoints can be local (hardwired), communicated, or stored default values (configurable using the Rover service tool).

Unoccupied Mode

In unoccupied mode, the controller attempts to maintain the zone temperature based on the unoccupied heating or cooling setpoint. The fan cycles between high speed and off. The outdoor air damper remains closed, unless economizing. The controller always uses the stored default setpoint values (configurable using the Rover service tool), regardless of the presence of a hardwired or communicated setpoint value.

Occupied Standby Mode

The controller is placed in occupied standby mode only when a communicated occupied request is combined with an unoccupied request from occupancy binary input BI3. In occupied standby mode, the controller maintains the zone temperature based on the occupied standby heating or cooling setpoints. Because the occupied standby setpoints are typically spread 2°F (1.1°C) in either direction, and the outdoor air damper is closed, this mode reduces the demand for heating and cooling the space. The fan runs as configured (continuously) for occupied mode. The controller always uses the stored default setpoint values (configurable using the Rover service tool), regardless of hardwired or communicated setpoint values. In addition, the outdoor air damper uses the **Economizer Occupied Standby Minimum Position** setpoint to reduce the ventilation rate.

Occupied Bypass Mode

The controller is placed in occupied bypass mode when the controller is operating in the unoccupied mode and either the timed override **ON** button on the Trane zone sensor is pressed or the controller receives a communicated occupied bypass signal from a BAS. In occupied bypass mode, the controller maintains the zone temperature based on the occupied heating or cooling setpoints. The fan runs as configured (continuous or cycling). The outdoor air damper closes when the fan is off. The controller remains in occupied bypass mode until either the **CANCEL** button is pressed on the Trane zone sensor or the occupied bypass time (configurable using the Rover service tool) expires. The temperature setpoints can be local (hardwired), communicated, or stored default values (also configurable using the Rover service tool).

Timed Override Control

If the zone sensor has a timed override option (**ON/CANCEL** buttons), pushing the **ON** button initiates a timed override on request. A timed override on request changes the occupancy mode from unoccupied mode to occupied bypass mode. In occupied bypass mode, the controller controls the zone temperature based on the occupied heating or cooling setpoints. The occupied bypass time, which resides in the ZN521 and defines the duration of the override, is configurable from 0 to 240 minutes (default value of 120 minutes). When the occupied bypass time expires, the unit transitions from occupied bypass mode to unoccupied mode. Pushing the **CANCEL** button cancels the timed override request. A timed override cancel request will end the timed override before the occupied bypass time has expired and will transition the unit from occupied bypass mode to unoccupied mode.

If the controller is in any mode other than unoccupied when the **ON** button is pressed, the controller still starts the occupied bypass timer without changing the mode to occupied bypass. If the controller is placed in unoccupied mode before the occupied bypass timer expires, the controller is placed in occupied bypass mode and remain in that mode until either the **CANCEL** button is pressed on the Trane zone sensor or the occupied bypass time expires.

Zone Temperature Control

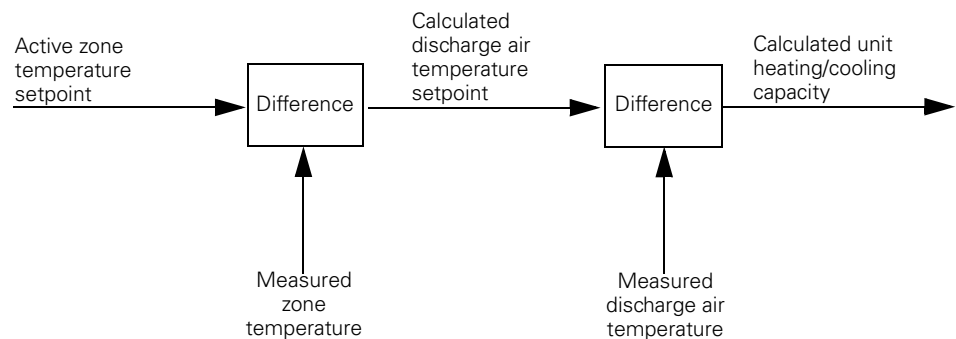
The ZN521 uses two methods of zone temperature control:

- Cascade zone control—used in the occupied, occupied bypass, and occupied standby modes
- Simplified zone control—used in the unoccupied mode

Cascade Zone Control

Cascade zone control maintains zone temperature by controlling the discharge air temperature to control the zone temperature. The controller uses the difference between the measured zone temperature and the active zone temperature setpoint to produce a discharge air temperature setpoint. The controller compares the discharge air temperature setpoint with the discharge air temperature and calculates a unit heating/cooling capacity accordingly (see [Figure 18](#)). The end devices (outdoor air damper, valves, etc.) operate in sequence based on the unit heating/cooling capacity (0–100%).

Figure 18. Cascade zone control



If the discharge air temperature falls below the **Discharge Air Control Point Low Limit** (configurable using the Rover service tool) and cooling capacity is at a minimum, available heating capacity will be used to raise the discharge air temperature to the low limit (see [“Discharge Air Tempering,”](#) p. 35).

Simplified Zone Control

In the unoccupied mode, the controller maintains the zone temperature by calculating the required heating or cooling capacity (0–100%) according to the measured zone temperature and the active zone temperature setpoint. The active zone temperature setpoint is determined by the current operating modes, which include occupancy and heat/cool modes.

Discharge Air Tempering

If the controller is in cooling mode, cascade zone control initiates a discharge air tempering function when the discharge air temperature falls below the **Discharge Air Control Point Low Limit** (configurable using the Rover service tool) and all cooling capacity is at a minimum. The discharge air tempering function allows the controller to provide heating capacity (if available) to raise the discharge air temperature to the **Discharge Air Control Point Low Limit**.

The discharge air tempering function is often initiated under the following circumstances: Cold outdoor air is brought in through the outdoor air damper when the damper is at (a high) minimum position, causing the discharge air temperature to fall below the **Discharge Air Control Point Low Limit**.

Morning Warm-up

Morning warm-up can occur any time the controller is in the occupied mode. The controller supply fan always runs in the occupied mode.

Morning warm-up is initiated when the zone temperature is more than 2°F (1.1°C) below the occupied heating setpoint. Morning warm-up is terminated when the zone temperature is less than 2°F (1.1°C) below the occupied heating setpoint.

When morning warm-up is terminated, the ZN520 runs in occupied heat mode. The outdoor air damper will be closed when the zone temperature is 3°F (1.7°C) or more below the occupied heating setpoint. The outdoor air damper will be at the minimum position when the zone temperature is 2°F (1.1°C) or less below the occupied heating setpoint. The outdoor air damper modulates between the minimum position and closed as the zone temperature goes from 2°F (1.1°C) below the occupied heating setpoint to 3°F (1.7°C) below the occupied heating setpoint.

Morning Cool-down

Morning cool-down is initiated when the controller transitions from unoccupied to occupied and the zone temperature is 3°F (1.7°C) above the occupied cooling setpoint. The fan will turn on and the outdoor air damper will remain closed. The damper modulates between closed and the minimum position as the zone temperature cools down toward the occupied cooling setpoint.

The damper will be closed when the zone temperature is more than 3°F (1.7°C) above the occupied cooling setpoint. The damper will be at the minimum position when the zone temperature is less than 2°F (1.1°C) above the occupied cooling setpoint. If economizing is possible, the damper will open up above the minimum position. Cool down can only happen once.

When the outdoor air damper gets to its minimum position, morning cool-down is over and cannot happen again until the next transition from unoccupied to occupied.

The controller will be in the occupied cooling mode when morning cool-down is over.

Heating or Cooling Mode

The heating or cooling mode can be determined in one of two ways:

- By a communicated signal from a BAS or a peer controller
- Automatically, as determined by the controller

A communicated heating signal permits the controller to heat only. A communicated cooling signal permits the controller to cool only. A communicated auto signal allows the controller to automatically change from heating to cooling and vice versa.

In heating and cooling mode, the controller maintains the zone temperature based on the active heating setpoint and the active cooling setpoint, respectively. The active heating and cooling setpoints are determined by the occupancy mode of the controller.

Sequence of Operations

For two-pipe and four-pipe changeover units, normal heat/cool operation will not begin until the ability to conduct the desired heating or cooling operation is verified. This is done using the entering water temperature sampling function, for which a valid entering water temperature is required. When neither a hard-wired nor a communicated entering water temperature value is present on changeover units, the controller will operate in heating mode only and assume the coil water is hot. The sampling function is not used.

The entering water temperature sampling function is used only for changeover applications. It is used for information and troubleshooting only and does not affect the operation of the controller. (For more information, see [“Entering Water Temperature Sampling Function,”](#) p. 36.)

Entering Water Temperature Sampling Function

The entering water temperature sampling function is used with two-pipe and four-pipe changeover units and requires a valid entering water temperature value. If the entering water temperature value is less than 5°F (2.8°C) above a valid zone temperature value for hydronic heating and greater than 5°F (2.8°C) below a valid zone temperature value for hydronic cooling, the sampling function is enabled. When the sampling function is enabled, the controller opens the main hydronic valve to allow the water temperature to stabilize. After 3 minutes, the controller again compares the entering water temperature value to the zone temperature value to determine if the desired heating or cooling function can be accomplished. If the entering water temperature value remains out of range to accomplish the desired heating/cooling function, the controller closes the main hydronic valve and waits 60 minutes to attempt another sampling. If the entering water temperature value falls within the required range, it resumes normal heating/cooling operation and disables the sampling function.

Fan Operation

The ZN521 supports up to three fan speeds. Every time the fan is enabled, the fan will begin operation and run on high speed for a period of time (0.5 seconds for fan coils and 3 seconds for unit ventilators and blower coils) before changing to any other speed. This is done to provide adequate torque to start the fan motor from the off position. The fan always operates continuously while either heating or cooling during occupied, occupied standby, and occupied bypass operation. During unoccupied operation, the fan cycles between off and high regardless of the fan configuration. The controller can be configured to auto, to a specific fan speed, or to off. If both communicated and hardwired values (fan-speed switch) are present, the communicated value has priority.

Note: *In occupied mode, the ZN521 requires continuous fan operation because of cascade zone control. In unoccupied mode, the fan cycles.*

When the controller receives a communicated auto signal (or the associated fan-speed switch is set to AUTO with no communicated value present), the fan operates in the auto mode. In the auto mode, the fan operates according to the fan default (configurable using the Rover service tool). The fan speed can be configured to default to auto, a specific speed, or off for both heating and cooling operation.

Configured as auto and with multiple speeds available, the fan automatically switch speeds depending on the difference between the zone temperature and the active zone temperature setpoint. The fan speed increases as the difference increases and decrease as the difference decreases.

When the controller receives a communicated fan-speed signal (high, medium, low) or the associated fan-speed switch is set to a specific fan speed, the fan runs continuously at the desired fan speed during occupied, occupied standby, and occupied bypass operation. During unoccupied operation, the fan cycles between off and high regardless of the communicated fan-speed signal or fan-speed switch setting (unless either of these is off, which will control the fan off).

The fan turns off when the controller receives a communicated off signal, when the fan-speed switch is set to **OFF**, when specific diagnostics are generated, or when the default fan speed is set to off and the fan is operating in the auto mode.

The ability to enable or disable the controller fan speed switch is configurable.

Exhaust Control

Exhaust control is accomplished by a single-speed exhaust fan or a two-position exhaust damper. BOP2 controls this function. To enable exhaust control, configure the controller by selecting **Exhaust Fan/Damper Present** and by selecting the number of fan speeds as either *One* or *Two*.

The exhaust function is coordinated with the supply fan and outdoor/return air dampers as follows:

- The exhaust output is energized only when the supply fan is operating and the outdoor air damper position (%) is greater than or equal to the **Exhaust Fan/Damper Enable Setpoint** (configurable using the Rover service tool).
- The exhaust output is de-energized if the outdoor air damper position drops 10% below the **Exhaust Fan/Damper Enable Setpoint**.
- If the **Exhaust Fan/Damper Enable Setpoint** is less than 10%, the exhaust output is energized if the outdoor air damper position is at the setpoint and de-energized at 0.

Valve Operation

The ZN521 supports one or two tri-state modulating or two-position valves, depending on the application (see [Table 8](#)). The controller opens and closes the appropriate valve(s) to maintain the active zone temperature setpoint at the heating setpoint in heating mode or the cooling setpoint in cooling mode (see "[Cascade Zone Control](#)," p. 34). For face-and-bypass applications, one or two isolation valves are controlled.

Table 8. Valve control options

Application	Tri-state modulating	Two-position	Isolation (Two-position)
Hydronic/steam fan coils and blower coils	x	x	
Unit ventilators with valve control	x		
Face-and-bypass unit ventilators			x

Modulating Valve Operation

The ZN521 supports tri-state modulating valve control. Two binary outputs control each valve: one to drive the valve open and one to drive the valve closed. The stroke time for each valve is configurable using the Rover Service tool. The controller supports heating, cooling, or heat/cool changeover with a single valve/coil for two-pipe applications. The controller supports cooling or heat/cool changeover with the main valve/coil and heating only with the auxiliary valve/coil for four-pipe applications. The controller moves the modulating valve to the desired positions based on heating or cooling requirements.

Modulating Valve Calibration

Calibration of modulating valves is done automatically. During normal operation, the controller overdrives the actuator (135% of the stroke time) whenever a position of 0% or 100% is requested, as part of ZN521 normal operation. At power-up or after a power outage, the controller first drives all modulating valves (and dampers) to the closed position. The controller calibrates to the fully closed position by over driving the actuator (135% of the stroke time). Then, the controller resumes normal operation.

Sequence of Operations

Two-position Valve Operation

The ZN521 supports two-position valves with a single binary output for each valve. Controllers used for two-pipe applications support heating, cooling, or heat/cool changeover with a single valve/coil. Controller used for four-pipe applications support cooling or heat/cool changeover with a main valve/coil, and heating only with an auxiliary valve/coil.

Isolation-valve Operation

See [“Face-and-bypass Damper Operation,” p. 40.](#)

Two-pipe Operation

For two-pipe applications, the ZN521 can be configured as heating only, cooling only, or heat/cool changeover. The coil can be used as the primary heating source and/or the primary cooling source. If present, an electric heating element can be used only as the primary heating source (instead of hydronic or steam heating). A changeover unit requires a valid entering water temperature value—either communicated or hard-wired—to operate properly (see [“AI1: Entering Water Temperature,” p. 16](#) and [“Entering Water Temperature Sampling Function,” p. 36](#)).

Four-pipe Operation

For four-pipe applications, the ZN521 can be configured as heat/cool or heat/cool changeover. The main coil can be used as the primary cooling source or the primary heating/cooling source. The auxiliary coil can be used only as the primary heating source, not as a second stage of heating. During normal operation, the controller never uses the main coil and auxiliary coil simultaneously. A changeover unit requires a valid entering water temperature value—either communicated or hard-wired—to operate properly (see [“AI1: Entering Water Temperature,” p. 16](#) and [“Entering Water Temperature Sampling Function,” p. 36](#)). Electric heat control is not available on four-pipe applications.

Modulating Outdoor/Return Air Damper

The ZN521 operates the modulating outdoor/return air dampers according to the following factors:

- Occupancy mode
- Outdoor air temperature (communicated or hard-wired sensor)
- Zone temperature
- Setpoint
- Discharge air temperature
- Discharge air temperature setpoint

The minimum position for an outdoor air damper is configurable using the Rover service tool for occupied and occupied standby modes and for low-speed fan operation. A controller can also receive a BAS-communicated outdoor air damper minimum position.

A BAS-communicated minimum position setpoint has priority over all locally configured setpoints. When a communicated minimum position setpoint is not present, the controller uses the configured minimum position for low fan speed whenever the fan is running at low speed,

regardless of the occupancy state. See [Table 9](#) and [Table 10](#) for more information about how the controller determines the position of the modulating outdoor air damper.

Table 9. Modulating outdoor air damper position setpoint determination

Occupancy	BAS-communicated Setpoint	Fan Speed	Active Minimum Setpoint
Unoccupied	Any value	Any value	0% (closed)
Occupied Occupied bypass Occupied standby	Valid	Any value	BAS-communicated
Occupied Occupied bypass Occupied standby	Invalid	Low	Occupied low fan minimum
Occupied Occupied bypass	Invalid	Medium/high	Occupied minimum
Occupied standby	Invalid	Medium/high	Occupied standby minimum

Table 10. Relationship between outdoor temperature sensors and damper position

Outdoor Air Temperature	Modulating Outdoor Air Damper Position		
	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 present and economizing possible ^(a)	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 possible ^(a)	Open to occupied minimum position	Open to occupied standby minimum position	Closed

(a) For an explanation of the economizing feature, refer to the section, "[Economizing \(Free Cooling\)](#)," p. 40

ASHRAE Cycle 1 Conformance

ZN521 applications with an outside air damper support ASHRAE Cycle 1 conformance. ASHRAE Cycle 1 operation admits 100% outdoor air at all times except during a warm-up cycle. A tri-state modulating damper actuator is re

minimum position of the economizer setpoint to 100% open during occupied periods. If the zone temperature drops 3°F (1.7°C) below the active zone temperature setpoint, the ZN521 closes the outdoor air damper regardless of the minimum position setpoint.

ASHRAE Cycle 2 Conformance

ZN521 controller applications with modulating outside air damper support ASHRAE Cycle 2 conformance. ASHRAE Cycle 2 operation allows the modulating outdoor air damper to completely close when the zone temperature drops 3°F (1.7°C) or more below the active zone temperature setpoint. If the zone temperature rises to within 2°F (1.2°C) of the active setpoint, the damper opens to the occupied or occupied standby minimum damper positions. If the zone temperature is between 2°F and 3°F (1.2°C and 1.7°C) below the active zone temperature setpoint, the damper modulates between the minimum position and closed.

If the discharge air temperature is between the discharge air temperature low limit and the discharge air temperature low setpoint, the damper modulates between the minimum position and closed. If this situation is concurrent with ASHRAE Cycle 2 operation, the lesser of the two setpoints will determine the actual damper position.

Economizing (Free Cooling)

Cooling with outdoor air, when the temperature is low enough to make this possible, is referred to as *economizing* or *free cooling*. ZN521 applications with modulating outdoor air damper support economizing. The modulating outdoor air damper provides the first source of cooling for the ZN521. The controller initiates economizing if the outdoor air temperature is below the economizer enable point (configurable using the Rover service tool). If economizing is initiated, 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 (2.8°C) 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 outdoor air damper position. If an outdoor air temperature value is not present, economizing is disabled.

Two-position Control of a Modulating Outdoor Air Damper

The ZN521 does not support a two-position outdoor air damper actuator. However, a modulating outdoor/return air damper actuator can be used for two-position control. Two-position control can be accomplished by not providing an outdoor air temperature (neither hard-wired nor communicated) to the controller, and by setting the damper minimum position (using the Rover service tool) to the desired value (typically, 100%).

Face-and-bypass Damper Operation

The ZN521 can control a face-and-bypass damper to modulate a percentage of air to the face of the coil(s) and around (bypass) the coil(s) to maintain zone comfort. For two-pipe changeover applications, if the controller requests heating and hot water is available, the face-and-bypass damper modulates to the face position. If the controller requests heating and hot water is not available, the face-and-bypass damper remains in the bypass position, and water sampling may be initiated (see [“Entering Water Temperature Sampling Function,” p. 36](#)). For four-pipe changeover applications, both heat and cool capacity are assumed to be available.

Face-and-bypass, Isolation-valve Operation

A ZN521 with a face-and-bypass damper controls on/off isolation valve(s) to prevent unwanted water flow through the coil(s) when no airflow is passing over the coil (100% bypass). In two-pipe applications, the isolation valve stops water flow, preventing radiant heat (heating mode) and excessive condensate (cooling mode) from the coil. In four-pipe applications, the isolation valves are used to prevent simultaneous heating and cooling.

The heating or cooling isolation valve opens whenever capacity is requested (>0%) as the face-and-bypass damper begins to modulate toward the coil face. The isolation valve closes when capacity returns to 0%.

DX Cooling Operation

The ZN521 supports one stage of direct expansion (DX) compressor operation for cooling only.

Note: *The controller does not use the DX compressor and economizing simultaneously. Not doing so prevents short cycling from occurring if the entering air temperature is too low for the evaporator coil to operate as designed.*

Electric Heat Operation

The ZN521 supports both single-stage and two-stage electric heat. Electric heat is cycled on and off to maintain the discharge air temperature at the active heating setpoint. Two-pipe changeover units with electric heat use the electric heat only when hot water is not available. The use of both electric and hydronic heat is not supported.

Baseboard Heat Operation

When configured for baseboard heat output, the controller turns on baseboard heat at 2.2°F (1.2°C) below the active heating setpoint, and turns off baseboard heat at 0.8°F (0.4°C) below the active heating setpoint. The range for activating the baseboard heat cannot be adjusted; however, the heating setpoint is configurable using the Rover service tool.

Baseboard heating is used most effectively when the discharge air temperature control high limit is set below 100°F (56°C). If this is done, the unit heat will maintain the temperature on light load days and the baseboard heat will be enabled to maintain the temperature on heavier load days.

Dehumidification

The ZN521 supports a dehumidification feature. Dehumidification is possible if the following are present:

- Mechanical cooling is available
- The heating capacity is located in the reheat position
- A zone humidity sensor is connected at AI4, or a relative humidity (RH) value is transmitted to the controller by a BAS.
- The Space RH Setpoint is valid (configurable using the Rover service tool)
- Dehumidification is enabled using the Rover service tool

The controller initiates dehumidification if the zone humidity exceeds the humidity setpoint. The controller continues to dehumidify until the sensed humidity falls below the setpoint minus the relative humidity offset.

The controller uses cooling and heating capacities simultaneously to dehumidify the space. While dehumidifying, the controller maintains the zone temperature at the active setpoint.

Note: *Dehumidification is not available for face-and-bypass applications, and cannot be used if the unit is in the unoccupied mode. Dehumidification disables the economizing function.*

Peer-to-peer Communication

The ZN521 has the ability to share data with other LonTalk-based controllers. Multiple controllers can be bound as peers, using the Rover service tool, to share:

- Setpoint
- Zone temperature
- Heating/cooling mode
- Fan status
- Unit capacity control

Shared data is communicated from one controller to any other controller that is bound to it as a peer. Applications having more than one unit serving a single zone can benefit by using this feature; it allows multiple units to share a single zone temperature sensor and prevents multiple units from simultaneously heating and cooling.

Unit Protection Strategies

The following strategies are initiated when specific conditions exist in order to protect the unit or building from damage:

- Smart reset
- Low-coil-temperature protection
- Condensate overflow
- Fan status
- Fan off delay
- Filter-maintenance timer
- Freeze avoidance
- Freeze protection (discharge air temperature low limit)

Smart Reset

The ZN521 automatically restarts a unit that is locked-out as a result of a **Low Coil Temp Detection** (BI1) diagnostic. Referred to as *smart reset*, this automatic restart occurs 30 minutes after the diagnostic occurs. If the unit is successfully restarted, the diagnostic is cleared. If the unit undergoes another **Low Coil Temp Detection** diagnostic within a 24-hour period, the unit will be locked out until it is manually reset. (For more information on manual resetting, refer to the section, "[Manual \(Latching\) Diagnostics](#)," p. 49).

Low-coil Temperature Protection

Refer to the sections, "[BI1: Low-coil Temperature Detection](#)," p. 14 and "[Smart Reset](#)" above.

Condensate Overflow

Refer to the section, "[BI2: Condensate Overflow](#)," p. 14.

Fan Status

The fan status is based on the status of the binary output(s) dedicated to fan control. The fan status is reported as high, medium, or low whenever the corresponding binary output is energized. The fan status is reported as off whenever none of the fan binary outputs are energized.

Additionally, a fan status switch can be connected to BI4 to monitor the status of the fan for belt-driven or direct-driven units. The fan status switch provides feedback to the controller. If the fan is not operating when the controller has the fan controlled to on, the controller will generate a **Low AirFlow—Fan Failure** diagnostic.

If the controller energizes the fan output for 1 minute, and the fan status switch indicates no fan operation, the controller performs a unit shutdown and generates a **Low AirFlow—Fan Failure** diagnostic. If the fan has been operating normally for one minute, but the fan status switch indicates no fan operation, the same diagnostic is generated. This manual diagnostic discontinues unit operation until the diagnostic has been cleared from the controller. If a diagnostic reset is sent to the controller and the fan condition still exists, the controller attempts to run the fan for 1 minutes before generating another diagnostic and performing a unit shutdown.

Fan Off Delay

After heating has been controlled off, the ZN521 keeps the fan energized for an additional 30 seconds. The purpose of this feature is to remove residual heat from the heating source.

Filter Maintenance Timer

The filter maintenance timer tracks the amount of time (in hours) that the fan is enabled. The **Maintenance Required Timer Setpoint** (configurable using the Rover service tool) is used to set the amount of time until maintenance (typically, a filter change) is needed. If the setpoint is configured to zero, the filter maintenance timer is disabled.

The controller compares the fan runtime to **Maintenance Required Timer Setpoint**. Once the setpoint is reached, the controller generates a **Maintenance Required** diagnostic. When the diagnostic is cleared, the controller resets the filter maintenance timer to zero, and the timer begins accumulating fan runtime again.

Freeze Avoidance

Freeze avoidance is used for low ambient temperature protection. It is initiated only when the fan is off. The controller enters the freeze avoidance mode when the outdoor air temperature is below the **Freeze Avoidance Setpoint** (configurable using the Rover service tool). The controller disables freeze avoidance when the outdoor air temperature rises 3°F (1.7°C) above the **Freeze Avoidance Setpoint**.

When the controller is in freeze-avoidance mode:

- Valves are driven open to allow water to flow through the coil
- Fan is off
- Face-and-bypass damper (when present) is at full bypass
- Economizing is disabled
- The outdoor/return air damper is closed
- DX cooling is off
- Electric heat stages are off

Freeze Protection (Discharge Air Temperature Low Limit)

The controller monitors the discharge air temperature with a 10 kΩ thermistor wired to analog input AI2. The freeze protection operation is initiated whenever the discharge air temperature falls below the **Discharge Air Temperature Low Limit**. The **Discharge Air Temperature Low Limit** is configurable using the Rover service tool. During freeze protection, the controller increases the heating capacity or decreases the cooling capacity in order to raise the discharge air temperature above the low limit. If the discharge air temperature remains below the low limit for 3 minutes, the controller generates a **Discharge Air Temp Limit** diagnostic. Refer to [Table 16, p. 50](#) for the effects of this diagnostic on outputs.

Status Indicators For Operation And Communication

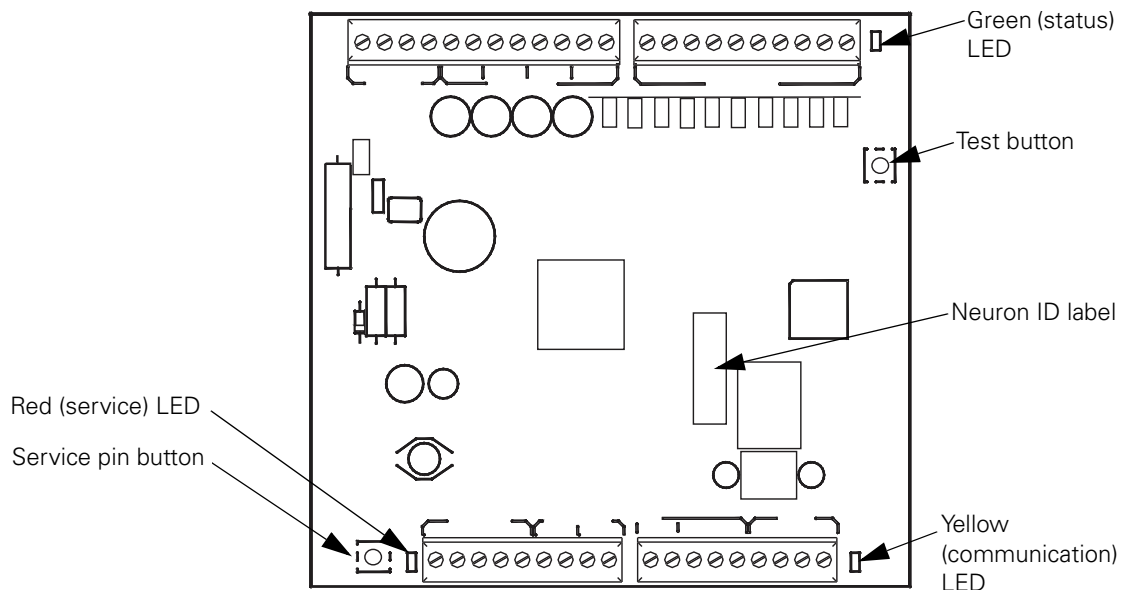
This section provides information about the operation and communication status indicators on the ZN521, including:

- A description of the location and function of the Test button and Service pin button and the light-emitting diodes (LEDs) located on the controller
- A complete list of the diagnostics that can occur, their effect on controller outputs, and an explanation of how diagnostics are cleared and the device restored to normal operation

Test Button

The Test button is used to perform the manual output test which verifies that the controller output devices are operating properly (refer to the section, “Manual Output Test,” p. 44). It is located on the ZN521 circuit board as shown in Figure 19. You must remove the cover to access the Test button.

Figure 19. ZN521 zone controller circuit board



Manual Output Test

The manual output test sequentially turns on and off all binary outputs to verify their operation. The test overrides normal operation of the controller, which is suspended while the test is being performed.

Use the manual output test to:

- Verify output wiring and operation
- Force the water valve(s) open to balance the hydronic system
- Clear diagnostics and restore normal operation (although not a primary function of the manual output test)

The manual output test is performed either by repeatedly pressing the Test button to proceed through the test sequence or by using the Rover service tool. [Table 11, p. 46](#) lists the outputs for non-face-and-bypass unit configurations in the sequence in which they are verified; [Table 12, p. 47](#) lists the outputs for face-and-bypass unit configurations in the sequence in which they are verified.

Status Indicators For Operation And Communication

The procedure is as follows:

1. Press and hold the Test button for 3 to 4 seconds, then release it to start the test mode. The green (status) LED goes off when you press the Test button, and then it blinks (refer to [Table 14, p. 48](#)) when the Test button is released to indicate that the controller is in manual test mode.
2. Press the Test button (no more than once per second) to advance through the test sequence. [Table 11, p. 46](#) and [Table 12, p. 47](#) show the resulting activities of the binary outputs.

Note: *The outputs are not subject to minimum on or off times during the test sequence.*

Status Indicators For Operation And Communication

Table 11. Manual output test sequence for non-face-and-bypass configurations

Step	Result	BOP1	BOP2	BOP3	BOP4	BOP5	BOP6	BOP7	BOP8	BOP9	BOP10
Number of times Test button is pressed (in sequence)		Fan high	1) Fan medium 2) Exhaust	Fan low	1) Cooling/changeover valve, open 2) Two-position cooling/ changeover valve 3) DX compressor	Cooling/changeover valve, close	1) Heating valve, open 2) Two-position heat valve 3) Electric heat, stage 1	1) Heating valve, close 2) Electric heat, stage 2	Outdoor air damper, open	Outdoor air damper, close	1) Generic 2) Baseboard heat
1	Begins test mode.(a)	Off	Off	Off	Off	On/Close	Off	1) On/Close 2) Off	Off	On/Close	Off
2	Fan high.(b)	On/High	Off	Off	Off	Off	Off	Off	Off	Off	Off
3	Fan medium.(c)	Off	1) On/Med 2) Off	Off	Off	Off	Off	Off	Off	Off	Off
4	Fan low.(d)	Off	Off	On/Low	Off	Off	Off	Off	Off	Off	Off
5	Main open, DX on	On/High	Off	Off	On/Open	Off	Off	Off	Off	Off	Off
6	Main close, DX off, aux open, EH1 on	On/High	Off	Off	Off	On/Close	On/Open	Off	Off	Off	Off
7	Aux open, EH1 on, exhaust fan.(e)	On/High	1) Off 2) On	Off	Off	Off	On/Open	Off	Off	Off	Off
8	Aux close, EH1 off, EH2 on, damper open	On/High	Off	Off	Off	Off	Off	On/Close	On/Open	Off	Off
9	Damper close	On/High	Off	Off	Off	Off	Off	Off	Off	On/Close	Off
10	Generic/baseboard heat energized (f)	On/High	Off	Off	Off	Off	Off	Off	Off	Off	On
1.1: Exit.(e)											

(a) The controller turns off all fan and electric heat outputs and drives all dampers and valves closed.

(b) The controller attempts to clear all diagnostics.

(c) If configured for 3-speed fan, the medium fan speed output energizes at step 3. If configured for 2-speed fan, the fan remains on high speed at step 3.

(d) If configured for 3-speed fan, the medium fan speed output energizes at step 4. If configured for 2-speed fan, the low fan speed output energized at step 4. If configured for 1-speed fan, the fan remains on high speed at step 4.

(e) If configured for 1- or 2-speed fan, the exhaust fan output energizes at step 7. The exhaust fan output is shared with medium fan speed.

(f) After step 10, the manual output test performs an exit, which initiates a reset to restore the controller to normal operation.

Status Indicators For Operation And Communication

Table 12. Manual output test sequence for face-and-bypass configurations (two-position isolation valves only)

Step	Result	BOP1	BOP2	BOP3	BOP4	BOP5	BOP6	BOP7	BOP8	BOP9	BOP10
1	Begins test mode ^(a)	Off	Off	Off	Off	Off	Off	On/Close	Off	On/Close	Off
2	Fan high ^(b)	On/High	Off	Off	Off	On/Open	Off	Off	Off	Off	Off
3	Fan medium ^(c)	Off	1) On/Med 2) Off	Off	Off	On/Open	Off	Off	Off	Off	Off
4	Fan low ^(d)	Off	Off	On/Low	Off	On/Open	Off	Off	Off	Off	Off
5	Main open, DX on	On/High	Off	Off	On/Open	On/Open	Off	Off	Off	Off	Off
6	Main close, DX off, aux open	On/High	Off	Off	Off	On/Open	On/Open	Off	Off	Off	Off
7	Aux open, EH1 on, exhaust fan ^(e)	On/High	1) Off 2) On	Off	Off	On/Open	On/Open	Off	Off	Off	Off
8	Aux close, damper open	On/High	Off	Off	Off	Off	Off	On/Close	On/Open	Off	Off
9	Outdoorair damper close	On/High	Off	Off	Off	Off	Off	On/Close	Off	On/Close	Off
10	Generic/baseboard heat energized ^(f)	On/High	Off	Off	Off	Off	Off	On/Close	Off	Off	On
11: Exit ^(e)											

(a) The controller turns off all fan and electric heat outputs and drives all dampers and valves closed.

(b) The controller attempts to clear all diagnostics.

(c) If configured for 3-speed fan, the medium fan speed output energizes at step 3. If configured for 2-speed fan, the fan remains on high speed at step 3.

(d) If configured for 3-speed fan, the medium fan speed output energizes at step 4. If configured for 2-speed fan, the low fan speed output energized at step 4. If configured for 1-speed fan, the fan remains on high speed at step 4.

(e) If configured for 1- or 2-speed fan, the exhaust fan output energizes at step 7. The exhaust fan output is shared with medium fan speed.

(f) After step 10, the manual output test performs an exit, which initiates a reset to restore the controller to normal operation.

Service Pin Button

The Service pin button is located as shown in [Figure 19, p. 44](#). The Service pin button is used to:

- Identify a device
- Add a device to the active group
- Verify PCMCIA communications
- Make the green (status) LED *wink* to verify that the controller is communicating on the link

Note: Refer to the *Rover Installation, Operation, and Programming Guide (EMTX-SVX01)*.

Interpreting LEDs

Red Service LED

The red (service) LED on the ZN521 controller (see [Figure 19, p. 44](#)) indicates whether the controller is capable of operating normally (see [Table 13](#)).

Table 13. Red LED: Service indicator

LED Activity	Explanation
LED is off continuously when power is applied to the controller.	The controller is operating normally.
LED is on continuously when power is applied to the controller.	The controller is not working properly, or someone is pressing the Service pin button.
LED flashes once every second.	The controller is not executing the application software because the network connections and addressing have been removed. ^(a)

(a) Restore the controller to normal operation using the Rover service tool.

Green Status LED

The green (status) LED on the ZN521 controller (see [Figure 19, p. 44](#)) indicates whether the controller has power applied to it and if the controller is in manual test mode (see [Table 14](#)).

Table 14. Green LED: Status indicator

LED Activity	Explanation
LED is on continuously.	Power is on (normal operation).
LED blinks (one recurring blink).	Manual output test mode is being performed and no diagnostics are present.
LED blinks (blinks twice as a recurring sequence).	Manual output test mode is being performed and one or more diagnostics are present.
LED blinks (1/4 second on, 1/4 second off for 10 seconds).	The Auto-wink option is activated, and the controller is communicating. ^(a)
LED is off continuously.	Either the power is off, the controller has malfunctioned, or the Test button is being pressed.

(a) Sending a request from the Rover service tool will request the green LED to blink (wink) and a notification that the controller received the signal and is communicating.

Status Indicators For Operation And Communication

Yellow LED

The yellow (communications) LED on the ZN521 controller (see [Figure 19, p. 44](#)) indicate the controller's communication status (see [Table 15](#)).

Table 15. Yellow LED: Communications indicator

LED Activity	Explanation
LED is off continuously	The controller is not detecting any communication (normal for stand-alone applications).
LED blinks.	The controller detects communication (normal for communicating applications, including data sharing).
LED is on continuously.	Problem with communication link wiring (possible need for termination resistor), or controller failure (caused by power surge, lightning strike, etc.)

Diagnostics

Diagnostics are informational messages that indicate the operational status of the controller. In response to most diagnostics, the controller attempts to protect the equipment by enabling or disabling, or opening or closing, specific outputs. Other diagnostics provide information about the status of the controller, but have no effect on outputs. Diagnostics are reported in the order in which they occur. Multiple diagnostics can be present simultaneously. Diagnostic messages are viewed using the Rover service tool or through a BAS.

Types of Diagnostics

Diagnostics are categorized according to the type of clearing method each uses and the type of information each provides.

The four categories are:

- Manual (latching)
- Automatic (non-latching)
- Smart reset
- Informational

Note: *Clearing diagnostics refers to deleting diagnostics from the software; it does not affect the problem that generated the message. For help with diagnosing a problem, see "Troubleshooting," p. 52.*

Manual (Latching) Diagnostics

Manual diagnostics (also referred to as *latching*) cause the unit to shut down. Manual diagnostics can be cleared from the controller in one of the following ways:

- By using the Rover service tool (refer to the *Rover Installation, Operation, and Programming Guide* (EMTX-SVX01A-EN))
- Through a building automation system (refer to product literature)
- By initiating a manual output test at the controller (see "Manual Output Test" on page 43)
- By cycling power to the controller. When the 24 Vac power to the controller is cycled off and then on again, a power-up sequence occurs.
- By turning the zone sensor fan switch to OFF and then back to any other setting. (This feature will be available beginning with controller software version 2.10.)

Automatic (Non-latching) Diagnostics

Automatic diagnostics clear automatically when the problem that generated the diagnostic is solved.

Status Indicators For Operation And Communication

Smart Reset Diagnostics

After the controller detects the first smart reset diagnostic, the unit waits 30 minutes before initiating the smart reset function. If another diagnostic of this type occurs again within 24 hours after an automatic clearing, it is important to clear the diagnostic manually by using any of the ways listed in the section, “[Manual \(Latching\) Diagnostics](#),” p. 49.

Informational Diagnostics

Informational diagnostics provide information about the status of the controller. They do not affect machine operation. They can be cleared from the controller using any of the ways listed in the section, “[Manual \(Latching\) Diagnostics](#),” p. 49.

Table of Diagnostics

Table 16 presents each diagnostic that can be generated by the ZN521, its effect on outputs (consequences), and its type.

Note: The generic binary output is unaffected by diagnostics.

Table 16. Diagnostics

Diagnostic	Probable Cause	Consequences	Diagnostic Type
Maintenance Required	Fan run hours exceed the time set to indicate filter change	Fan unaffected Valves unaffected Electric heat unaffected Face and bypass damper unaffected	Informational
Condensate Overflow	The drain pan is full of water	Fan off Valves closed Outdoor air damper closed Face and bypass damper bypass DX/electric heat off Baseboard heat off	Manual
Low Coil Temp Detection	The leaving fluid temperature may be close to freezing	Fan off Valves open Outdoor air damper closed Face and bypass damper bypass DX/electric heat off Baseboard heat off	Smart reset/ Manual
Low Airflow—Fan Failure	The fan drive belt, contactor, or motor has failed.	Fan off Valves closed Outdoor air damper closed Face and bypass damper bypass DX/electric heat off Baseboard heat off	Manual
Space Temperature Failure	Invalid or missing value for zone temperature	Fan off Valves closed Outdoor air damper closed Face and bypass damper bypass DX/electric heat off Baseboard heat off	Automatic
Entering Water Temp Failure	Invalid or missing value for zone temperature	Fan unaffected (enabled) Valves unaffected Outdoor air damper unaffected Face and bypass damper unaffected DX/electric heat unaffected Baseboard heat off	Automatic
Discharge Air Temp Limit	Discharge air temperature has fallen below the Discharge Air Temperature Low Limit	Fan off Valves open Outdoor air damper closed Face and bypass damper bypass DX/electric heat off Baseboard heat off	Automatic

Status Indicators For Operation And Communication

Table 16. Diagnostics (continued)

Diagnostic	Probable Cause	Consequences	Diagnostic Type
Discharge Air Temp Failure	Invalid or missing value for discharge air temperature	Fan off Valves closed Outdoor air damper closed Face and bypass damper bypass DX cooling/electric heat off Baseboard heat off	Automatic
Outdoor Air Temp Failure	Invalid or missing value for outdoor air temperature	Fan unaffected Valved unaffected Outdoor air damper minimum position Face and bypass damper unaffected DX cooling/electric heat unaffected Baseboard heat unaffected	Automatic
Humidity Input Failure	Invalid or missing value for relative humidity	Fan unaffected Valves unaffected Outdoor air damper unaffected Face and bypass damper unaffected DX cooling/electric heat unaffected Baseboard heat unaffected Dehumidification sequence off	Automatic
CO ₂ Sensor Failure	Invalid or missing value for CO ₂	Fan unaffected Valves unaffected Outdoor air damper unaffected Face and bypass damper unaffected DX cooling/electric heat unaffected Baseboard heat unaffected	Informational
Generic AIP Failure	Invalid or missing value for generic analog input	Fan unaffected Valves unaffected Outdoor air damper unaffected Face and bypass damper unaffected DX cooling/electric heat unaffected Baseboard heat unaffected	Informational
Local Fan Mode Failure	Invalid or missing fan-speed switch (reverts to default fan speed)	Fan unaffected Valves unaffected Outdoor air damper unaffected Face and bypass damper unaffected DX cooling/electric heat unaffected Baseboard heat unaffected	Automatic
Local Setpoint Failure	Invalid or missing value for zone temperature setpoint (reverts to default setpoint)	Fan unaffected Valves unaffected Outdoor air damper unaffected Face and bypass damper unaffected DX cooling/electric heat unaffected Baseboard heat unaffected	Automatic
Generic Temperature Failure	Invalid or missing generic temperature value	Fan unaffected Valves unaffected Outdoor air damper unaffected Face and bypass damper unaffected DX cooling/electric heat unaffected Baseboard heat unaffected	Informational
Invalid Unit Configuration	Software is configured improperly	Fan off Valves off Outdoor air damper closed Face and bypass damper closed DX cooling/electric heat off Baseboard heat off	Manual
Normal	On start-up	Fan unaffected Valves unaffected Electric heat unaffected Compressors unaffected Damper unaffected	Automatic

Troubleshooting

Use section provides information for diagnosing the following:

- Fan does not energize ([Table 17](#))
- Valves remain closed ([Table 18, p. 52](#))
- Valves remain open ([Table 19, p. 53](#))
- Compressors are not running ([Table 20, p. 53](#))
- Electric heat does not energize ([Table 20, p. 53](#))
- An outdoor air damper stays closed ([Table 21, p. 54](#))
- An outdoor air damper stays open ([Table 22, p. 54](#))

Table 17. Fan does not energize

Probable Cause	Explanation
Unit wiring	The wiring between the controller outputs and the fan relays and contacts must be present and correct for normal fan operation. Refer to applicable wiring diagram.
Failed end device	The fan motor and relay must be checked to ensure proper operation.
Normal operation	The fan will turn off when the controller receives a communicated off signal, when the fan-speed switch is set to OFF, when specific diagnostics are generated, or when the default fan speed is set to Off and the fan is operating in the Auto mode. If the controller is in unoccupied mode, the fan cycles between off and the highest fan speed.
No power to the controller	If the controller does not have power, the unit fan does not operate. For the ZN521 to operate normally, it must have an input voltage of 24 Vac. If the green LED is off continuously, the controller does not have sufficient power or has failed.
Power-up control-wait	If power-up control-wait is enabled (non-zero time), the controller remains off until one of two conditions occurs: <ul style="list-style-type: none"> • The controller exits power-up control-wait after it receives communicated information. • The controller exits power-up control-wait after the power-up control-wait time expires.
Diagnostic present	Several diagnostics affect fan operation. For information about these diagnostics, see Table 16, p. 50 .
Unit configuration	The controller must be properly configured based on the actual installed end devices and application. If the unit configuration does not match the actual end device, the fans 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. Refer to the “ Manual Output Test ,” p. 44.
Random start observed	After power-up, the controller always observes a random start from 5 to 30 seconds. The controller remains off until the random start time expires.
Cycling fan operation/continuous	The controller operates the fan continuously when in the occupied, occupied standby, or occupied bypass mode. When the controller is in the unoccupied mode, the fan is cycled between high speed and off with capacity.
Unoccupied operation	Even if the controller is configured for continuous fan operation, the fan normally cycles with capacity during unoccupied mode. While unoccupied, the fan cycles on or off with heating/cooling to provide varying amounts of heating or cooling to the space.
Fan mode off	If a local fan mode switch determines the fan operation, the off position controls the fan off.
Requested mode off	You can communicate a desired operating mode (such as off, heat, and cool) to the controller. If off is communicated to the controller, the unit controls the fan off. There is no heating or cooling.

Table 18. Valves remain closed

Probable Cause	Explanation
Unit wiring	The wiring between the controller outputs and the valve(s) must be present and correct for normal valve operation. Refer to applicable wiring diagram.
Failed end device	The valves must be checked to ensure proper operation.
No power to the controller	If the controller does not have power, the unit valve(s) will not operate. For the ZN521 to operate normally, you must apply an input voltage of 24 Vac. If the green LED is off continuously, the controller does not have sufficient power or has failed.
Power-up control-wait	If power-up control-wait is enabled (non-zero time), the controller remains off until one of two conditions occurs: <ul style="list-style-type: none"> • The controller exits power-up control-wait after it receives communicated information. • The controller exits power-up control-wait after the power-up control-wait time expires.
Diagnostic present	Several diagnostics affect valve operation. For information about these diagnostics, see Table 16, p. 50 .
Normal operation	The controller opens and closes the valves to meet the unit capacity requirements.

Table 18. Valves remain closed (continued)

Probable Cause	Explanation
Unit configuration	The controller must be properly configured based on the actual installed end devices and application. If the unit configuration does not match the actual end device, the valves 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 valves may not be open. Refer to the "Manual Output Test," p. 44.
Random start observed	After power-up, the controller always observes a random start from 5 to 30 seconds. The controller remains off until the random start time expires.
Requested mode off	You can communicate a desired operating mode (such as off, heat, and cool) to the controller. If off is communicated to the controller, the unit controls the fan off. There is no heating or cooling.
Entering water temperature sampling logic	The controller includes entering water temperature sampling logic, which is automatically initiated during 2-pipe and 4-pipe changeover if the entering water temperature is either too cool or too hot for the desired heating or cooling. (See "A11: Entering Water Temperature," p. 16.)
Valve configuration	Make sure the valves are correctly configured, using the Rover service tool, as normally open or normally closed as dictated by the application.

Table 19. Valves remain open

Probable Cause	Explanation
Unit wiring	The wiring between the controller outputs and the valve(s) must be present and correct for normal valve operation. Refer to applicable wiring diagram.
Failed end device	The valves must be checked to ensure proper operations.
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 valves may not be open. Refer to the "Manual Output Test," p. 44.
Diagnostic present	Several diagnostics affect valve operation. For information about these diagnostics, see Table 16, p. 50.
Unit configuration	The controller must be properly configured based on the actual installed end devices and application. If the unit configuration does not match the actual end device, the valves may not work correctly.
Entering water temperature sampling logic	The controller includes entering water temperature sampling logic, which is automatically initiated during 2-pipe and 4-pipe changeover if the entering water temperature is either too cool or too hot for the desired heating or cooling. (See "A11: Entering Water Temperature," p. 16.)
Valve configuration	Make sure the valves are correctly configured, using the Rover service tool, as normally open or normally closed as dictated by the application.
Freeze avoidance	When the fan is off with no demand for capacity (0%) and the outdoor air temperature is below the freeze avoidance setpoint, the controller opens the water valves (100%) to prevent coil freezing. This includes unoccupied mode when there is no call for capacity or any other time the fan is off.

Table 20. DX or electric heat does not energize

Probable Cause	Explanation
Unit wiring	The wiring between the controller outputs and the end devices must be present and correct for normal operation. Refer to applicable wiring diagram.
Failed end device	Check the control contactors or the electric heat element, including any auxiliary safety interlocks, to ensure proper operation.
No power to the controller	If the controller does not have power, heat outputs do not operate. For the ZN521 to operate normally, you must apply an input voltage of 24 Vac. If the green LED is off continuously, the controller does not have sufficient power or has failed.
Diagnostic present	Several diagnostics affect DX and electric heat operation. For information about these diagnostics, see Table 16, p. 50.
Normal operation	The controller controls compressor or electric heat outputs as needed to meet the unit capacity requirements.
Unit configuration	The controller must be properly configured based on the actual installed end devices and application. If the unit configuration does not match the actual end device, DX or electric heat may not operate 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 DX or electric heat outputs may be off. Refer to the "Manual Output Test," p. 44.

Troubleshooting

Table 20. DX or electric heat does not energize (continued)

Probable Cause	Explanation
Requested mode off	You can communicate a desired operating mode (such as off, heat, and cool) to the controller. If off is communicated to the controller, the unit shuts off the compressor or electric heat.
Freeze avoidance	When the fan is off with no demand for capacity (0%) and the outdoor air temperature is below the freeze avoidance setpoint, the controller disables compressors and electric heat outputs (100%) to prevent coil freezing. This includes unoccupied mode when there is no call for capacity or any other time the fan is off.

Table 21. Outdoor air damper remains closed

Probable Cause	Explanation
Unit wiring	The wiring between the controller outputs and the outdoor air damper must be present and correct for normal outdoor air damper operation. Refer to applicable wiring diagram.
Failed end device	Check damper actuator to ensure proper operation.
No power to the controller	If the controller does not have power, the outdoor air damper does not operate. For the ZN521 to operate normally, you must apply an input voltage of 24 Vac. If the green LED is off continuously, the controller does not have sufficient power or has failed.
Diagnostic present	Several diagnostics affect outdoor air damper operation. For information about these diagnostics, see Table 16, p. 50 .
Normal operation	The controller opens and closes the outdoor air damper based on the controller's occupancy mode and fan status. Normally, the outdoor air damper is open during occupied mode when the fan is running and closed during unoccupied mode.
Unit configuration	The controller must be properly configured based on the actual installed end devices and application. If the unit configuration does not match the actual end device, the outdoor air damper 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 outdoor air damper may not be open. Refer to the "Manual Output Test," p. 44 .
Warm-up and cool-down sequence	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 is an attempt to bring the space under control as quickly as possible.
Requested mode off	You can communicate a desired operating mode (such as off, heat, or cool) to the controller. If off is communicated to the controller, the unit closes the outdoor air damper.

Table 22. Outdoor air damper remains open

Probable Cause	Explanation
Unit wiring	The wiring between the controller outputs and the outdoor air damper must be present and correct for normal outdoor air damper operation. Refer to applicable wiring diagram.
Failed end device	Check damper actuator to ensure proper operation.
Normal operation	The controller opens and closes the outdoor air damper based on the controller's occupancy mode and fan status. Normally, the outdoor air damper is open during occupied mode when the fan is running and closed during unoccupied mode. (See "Modulating Outdoor/Return Air Damper," p. 38 .)
Unit configuration	The controller must be properly configured based on the actual installed end devices and application. If the unit configuration does not match the actual end device, the outdoor air damper 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 outdoor air damper may be open. Refer to the "Manual Output Test," p. 44 .

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