TC-9102 Terminal Unit Controller

Introduction

Description

The TC-9102 Controller is a microprocessor-based Direct Digital Controller (DDC). It is designed for use with Fan Coil Units (FCUs) to control fan speed and heating and cooling valves. Fan coil units are defined as containing only a fan and a heating and/or cooling coil. If the controller is intended for use with direct expansion mechanical cooling, time delay relays must be supplied to provide minimum on/off timers. The controller has heating and cooling setpoints for comfort, standby, and night modes. The TM-9100 Room Command Module allows for mode selection and setpoint adjustment. Window contact override and low limit protection are also included.

Full stand-alone operation is a standard feature. The controller is configured using HVAC PRO, which assigns default operating parameters. The controller is factory configured to control with default operating parameters and may be modified using HVAC PRO. Minimal setup is required.

All TC-9102 controllers may be connected to an N2 Bus to provide operating data to a supervisory system and allow modification of operating parameters. You can start up and commission controllers via the N2 Bus or from the Metasys® Operator Workstation (Release 7.01) using HVAC PRO (Release 8.04) software, a component of configuration tools. The TC-9102 is also supported under Companion Version 6.02 or later.

Figure 1: TC-9102 Controller

Figure 2: TM-9160 Room Command Module

Winter and summer compensation (setpoint reset) may be enabled when the controller receives outside air temperature data via the N2 Bus. Modes of operation may be set by weekly scheduling or control logic processes in the supervisory system.

The TC-9102 Controller is available in four different hardware model types according to the type of outputs you need for your application. A list of the controller hardware follows.

Table 1: Available TC-9102 Models

Model	Fan Control	Htg/Clg Control
TC-9102-0221	On/Off (Relay)	0 to 10 VDC Proportional
TC-9102-0330	0 to 10 VDC	2-stage, PAT, DAT*
TC-9102-0331	ON/OFF (Relay)	2-stage, PAT, DAT*
TC-9102-0332	3-speed (Relays)	2-stage, PAT, DAT*

PAT = Position Adjust Type (Incremental)
DAT = Duration Adjust Type

* These models may only use one of these choices for heating and cooling. Both heating and cooling must be of the same type.

Table 2: TC-9102 Controller Hardware Characteristics

Function	Characteristics
N2 Bus	Opto-isolated
N2 Terminations	Removable screw terminal block
24 VAC Power	Screw terminal block
Operating Environment Rating	32 to 122°F (0 to 50°C), 10 to 90% RH noncondensing
I/O Terminations	Screw terminal block
AI Zone Temperature	Passive, Negative Temperature Coefficient (NTC), 32 to 105°F (0 to 40°C)*
AI Remote Setpoint	Active 3-wire, Pot, 0 to 10 K ohms
AI Fan Override Control	Active 3-wire, Pot, 0 to 10 K ohms
BI Window Contact	Closed = window closed, <1 K ohms
BI Occupancy Button	Momentary contact, <1 K ohms
BI Occupancy Sensor	Closed = occupied, <1 K ohms
BO Heating/Cooling Control	Triac, 0.5 A at 24 VAC
BO Fan Control	Relay, 3 A at 125/250 VAC, 1/8 hp maximum
AO Heating/Cooling and Fan Control	0 to 10 VDC, 10 mA

* The TC-9102s require a TM-9100 Series thermostat sensor.

Standards Compliance

The TC-9102 controller complies with the following standards:

- FCC Part 15, Subpart B, Class A - North American Radio Emissions
- IEEE 472 - Surge Withstand Capability (SWC)
- IEEE 587, Categories A - Surge Voltages in Low-Voltage AC Power Circuits
- UL 916 - Energy Management Equipment
- IEEE 446 - Industrial Power/Brownouts

Terminology Equivalents

Table 3: European and North American Terminology

European Modes	North American Modes
Comfort	Occupied
Comfort Setpoint Cooling	Occupied Cooling Setpoint
Comfort Setpoint Heating	Occupied Heating Setpoint
Earth	Earth Ground
N2 COM	N2 REF
Night*	Unoccupied
Night Cooling Setpoint Bias*	Unoccupied Cooling Setpoint Bias
Night Heating Setpoint Bias*	Unoccupied Heating Setpoint Bias
Off	Shutdown
Standby	Economy**
Standby Cooling Setpoint Bias	Economy Cooling Setpoint Bias**
Standby Heating Setpoint Bias	Economy Heating Setpoint Bias**
Winter/Summer Compensation	Compensation

* Not available for the TC-9100s in stand-alone mode; must use standby mode.
** Provides intermediate setpoints for energy savings.

Table 4: Acronym Definitions

Acronym	Term
0 to 10 VDC	Proportional
DAT	Duration Adjust Type
NTC	Negative Temperature Co-efficient
PAT	Position Adjust Type (Incremental)
PWM	Pulse Width Modulated (Europe only)
WSP	Working Setpoints
WSP Cooling	Working Setpoint Cooling
WSP Heating	Working Setpoint Heating

Auxiliary Access

For auxiliary access application information, see the *Controller Access Technical Bulletin (LIT-6364013).*

N2 Dialer Module (NDM)

When the controller is connected to a remote N2 Bus and monitored by a Metasys N2 Dialer Module (NU-NDM101-0), the following alarm conditions in the controller initiate the automatic dial feature:

- Window Open
- Low Limit Mode
- High or low alarm limit violation of room temperature when alarm limits have been set by the supervisory system or by HVAC PRO

When any one of these alarm conditions occurs, the N2 Dialer detects the alarm and connects the remote N2 Bus to the Metasys or Companion Network. When the telephone line connection is established and the Metasys or Companion network communicates to the controller, the controller alarm status is automatically reset. The controller is then ready to report further alarm conditions as they occur. The TC-9102 does **not** initiate a dial-out when any of the listed points return to their normal condition. Refer to the *N2 Dialer Module (NDM) Technical Bulletin (LIT-6363065)* for further information.

Application Example

The following example is created by answering configuration questions using HVAC PRO to identify terminal locations of the inputs and outputs.

Fan Coil Application

Table 5: Fan Coil Parameters and Configuration Selections

HVAC PRO Parameters	Configuration Selections
Heating/Cooling Type	Incremental Heating/Cooling (PAT)
Fan Type	3-speed

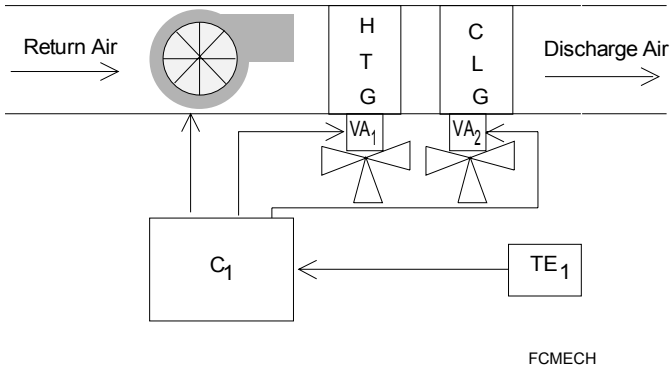


Figure 3: Fan Coil Mechanical Flow Diagram

Bill of Materials

Table 6: Fan Coil Bill of Materials

Component	Part Number
C1 Digital Controller	TC-9102-0332
TE1 Zone Temperature Sensor	TM-9160-5002
VA_1 VA_2 Valve Actuator	VA-7150 Valve Actuator Assembly
XFR Power Transformer	Y65 or XFR 50

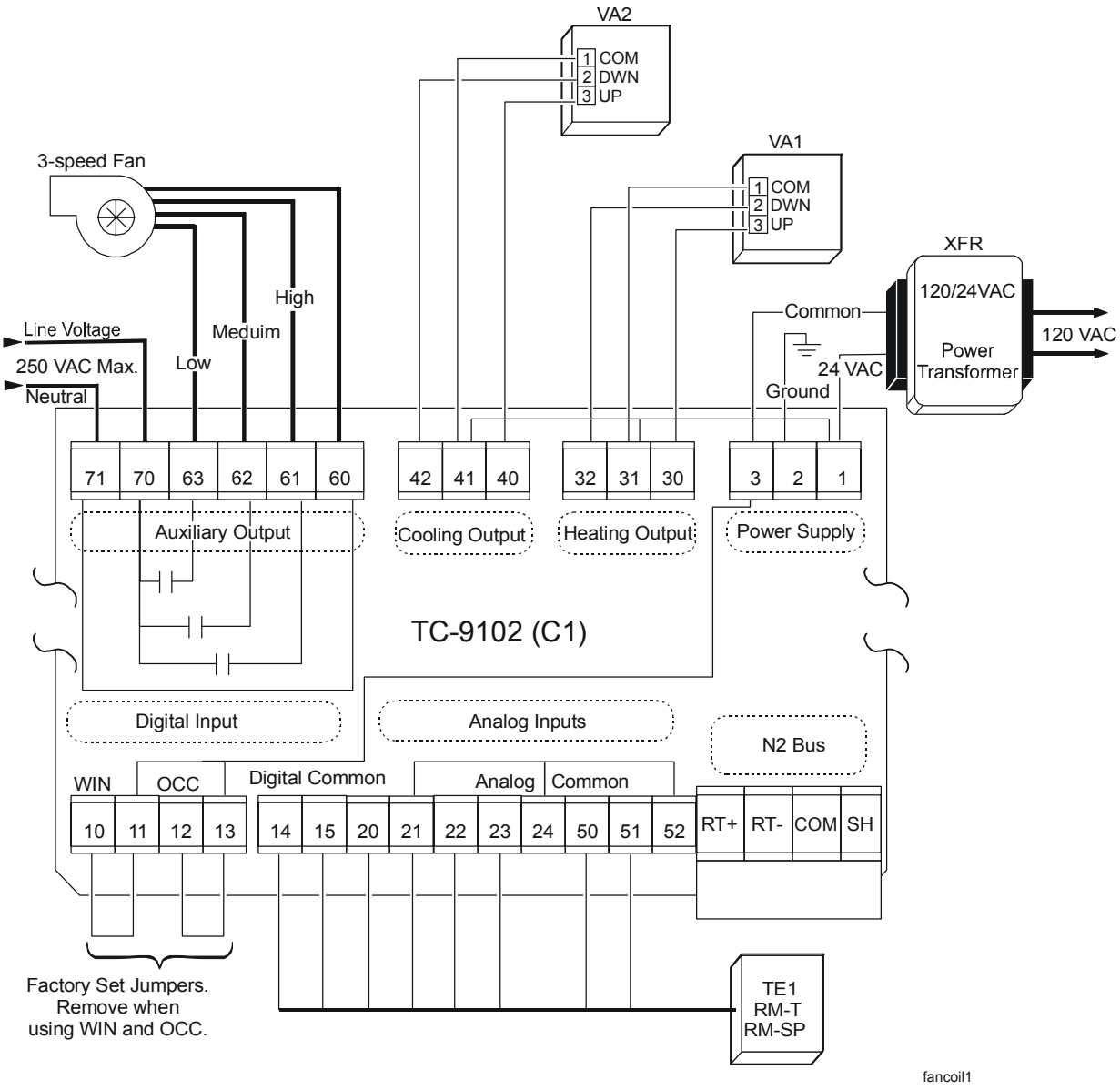


Figure 4: Fan Coil Wiring Example

Installation Procedures

Design Considerations

The TC-9102 Series controller is designed to be mounted within the fan coil unit housing or within a control cabinet. Access is required for installation and maintenance workers. The mounting location must be clean and dry and not subject to extreme heat or cold. The installation and electrical wiring must conform to local codes and should be performed only by authorized personnel. Line voltage wiring must be separated from low voltage (30 VAC or less) by 25 mm (one inch). See *Wiring Details* in this bulletin for more information. Consider the existence of power sources and communication lines. Users must ensure that all Johnson Controls products are used safely and without risk to health or property.

CAUTION: Risk of Property Damage. Mount the TC-9102 controller at least 1 in. (25 mm) away from high-voltage wiring and inductive loads, or any other sources of electrical noise. Mounting the TC-9102 closer than 1 in. (25 mm) may cause control malfunction and damage to other equipment or property.

Note: Installation instructions for the TC-9102 Controller and its accessory devices are detailed in this section. The types and numbers of components (sensors and actuators) selected for use with the TC-9102 vary according to application. Analyze the proposed installation for logical locations to place these devices, and draw an inventory based on that study.

Information on types of accessory devices available is in the *Ordering Information* section of this document.

Tools Needed

For a typical installation, you will need the following:

- HVAC PRO software, Release 8.04 or later
- MM-CVT101-0 converter (for N2 downloading, uploading, and commissioning)
- null modem cable (for Companion or NDM, downloading, uploading and commissioning)
- laptop computer
- two screwdrivers (1/8 inch and 1/4 inch flat-head)
- drill

Environmental Information

The installation site of the TC-9102 Controller must meet the following environmental standards:

- The atmosphere must be free of explosive vapors and gases.
- The atmosphere must be free of exposure to corrosive chemical or salt vapors that might damage electrical equipment.
- The temperature must be maintained between 0°C (32°F) to 50°C (122°F) with the relative humidity (noncondensing) maintained between 10 and 90 percent.

Mounting the Controller

For surface mounting, slide the two mounting brackets included with the TC-9102 (see Figure 5) into the slots at opposite corners of the controller base behind the terminals. Attach to the surface using No. 8 self-tapping screws provided.

For DIN rail mounting, place the controller on the upper edge of the rail and press the controller firmly against the rail until the spring-loaded clip engages the lower edge of the rail. To remove the controller, insert a screwdriver into the clip at the base of the controller pulling the clip downward to release. Then pull the controller up and off the DIN rail.

When not mounted within the control panel of the unit casing, a common package for the TC-9102 Controller must be provided. You can use the following enclosures:

- AS-ENC100-0
- EN-EWC10-0 (without transformer)
- EN-EWC15-0 (with 50 VA transformer)

The controller requires a flat mounting surface area to match its dimensions.

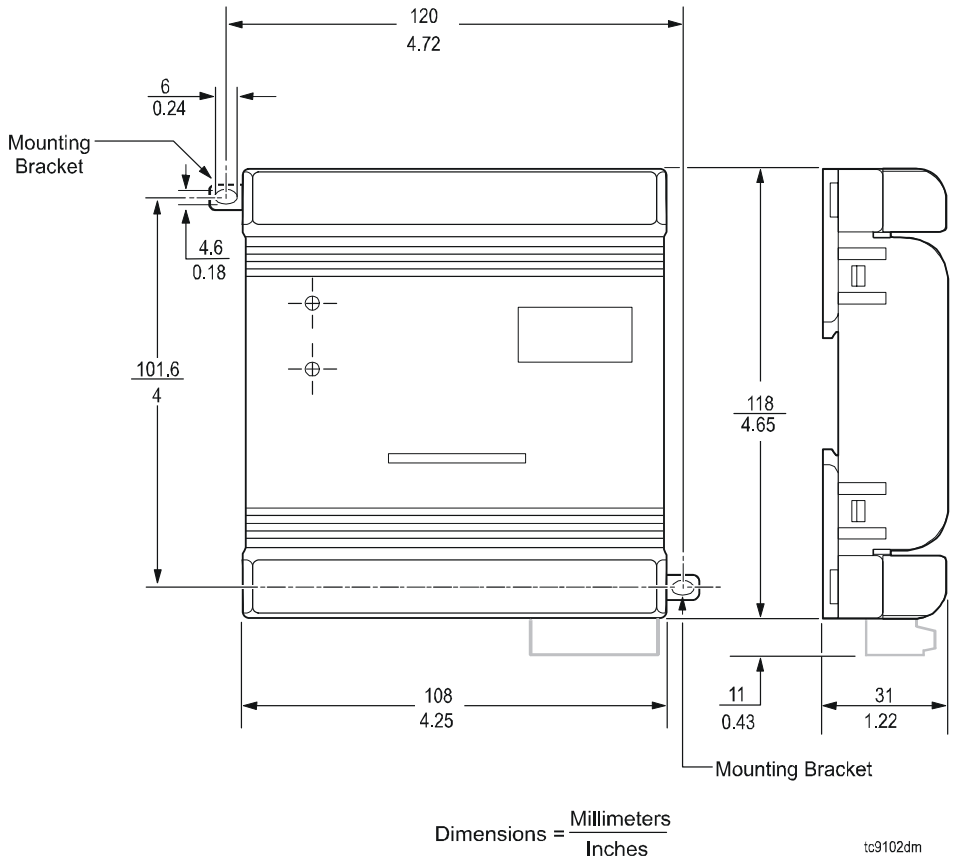


Figure 5: TC-9102 Controller Dimensions, millimeters (in.)

The TC-9102 overall dimensions are:

- 118 x 108 x 31 mm (4.65 x 4.25 x 1.25 in.)
- 173 x 185 x 119 mm (6.8 x 7.3 x 4.7 in.) with the AS-ENC100-0 enclosure
- 230 x 410 x 190 mm (9 x 16 x 7.5 in.) with the EN-EWC10-0 enclosure

Make sure you allow enough room to install the enclosure and conduit for wiring terminations to the controller.

Note: A minimum of 25 mm (one inch) of space is required above and below the controller for the removal of separable terminals (N2 Bus only in North America).

Power Line Wiring Transient Noise Precautions

The standard TC-9102 Controller, when powered by any typical UL or National Electrical Code (NEC) Class 2 separate isolation transformer or step-down transformer, operates reliably in an electrical environment defined as Location Category A by the IEEE 587 Standard Light Equipment Room.

Surge Levels

In addition, the TC-9102 Controller meets the following surge level specifications:

IEEE-587 style Common Mode:	3.0 kv
IEEE-587 style Normal Mode:	1.5 kv
IEEE-472 style Power Line:	1.0 kv
IEEE-472 style I/O:	0.5 kv

Note: The AS-XFR050 or the AS-XFR100 split bobbin transformer provides additional surge/noise immunity along with a resettable breaker. Order separately or within an EN-EWC15 enclosure panel that contains the transformer.

Wiring Details

WARNING: Risk of Electrical Shock. Disconnect each of multiple power sources before making electrical connections. More than one disconnect may be required to completely de-energize equipment. Contact with components carrying hazardous voltage can cause electrical shock and may result in severe personal injury or death.

IMPORTANT: Observe proper Electrostatic Discharge (ESD) precautions when installing or servicing the TC-9102 controller. Failure to observe proper ESD precautions may result in damage to the electronic circuits in the controller.

Power Source and Loads

Before connecting or disconnecting any wires, ensure that all power supplies have been switched off to prevent equipment damage and avoid electrical shock.

Terminations are made on the terminal blocks at each end of the controller. The low voltage terminal blocks accept up to 16 AWG wires, and the fan control terminals accept up to 14 AWG wires.

Separate the low voltage wiring from the line voltage wiring by a minimum of 25 mm (one inch). Keep all cables as short as possible and tie in position. To avoid induced noise, do not run cables close to transformers or inductive loads.

The 24 VAC supply Terminals 1 and 3 must be stable and not shared with other switched inductive loads. An earth ground (Terminal 2) is provided on the TC-9102 to add additional noise suppression on the power source, and should be grounded.

Complete and verify all wiring connections before continuing with the installation procedure.

The TC-9102 Controller has an isolated transformer on board, allowing the user to share a single UL or NEC Class 2 power transformer among multiple TC-9102 Controllers by running a power trunk from the single transformer to several devices. Class 2 implies no more than 100 VA loading per transformer.

Note: If you use one low voltage power trunk for multiple controllers, follow these precautions:

- Ensure that polarity is maintained at each 24 VAC connection.
- Consider that some local electrical codes require that the secondary common of the stepdown transformer be connected to earth ground (typically on units that are greater than 150 VAC). This ground must be at only the transformer secondary.
- Determine the total system load by adding all the actual loads to the basic load of the controller.

Use Table 7 to determine the total 24 VAC power draw of your system.

Table 7: TC-9102 Power and Load Specifications

System Loads	Power Consumption
TC-9102 Controller with Sensors/Transmitters/AOs (without BO loads)	3 VA (150 mA)
BO Load (Heating/Cooling Triacs) **Minimum required load for each BO (triac) used is 1.2 VA (50 mA at 24 VAC).** **Note: Relay loads less than 50 mA may cause triac/relay chattering. If necessary, use a 360 ohm, 5 watt resistor across the relay coil.**	0.5 A at 24 VAC
AO Load	Maximum allowable load for each AO is 10 mA @ 10 VDC with a minimum load resistance of 1,000 ohms.

Use Table 8 to determine transformer and power trunk wire size from the transformer to the most distant controller.

Table 8: Distance of Power Trunk (Wire Gauge vs. Transformer Size)

Wire – Transformer	40 VA		50 VA		100 VA	
	Feet	Meters	Feet	Meters	Feet	Meters
8 AWG	975	297	780	238	390	119
10 AWG	614	187	490	149	245	75
12 AWG	386	118	308	94	154	47
14 AWG	243	74	194	59	97	30
16 AWG	153	47	122	37	61	19
18 AWG	96	29	76	23	38	12

Table 9: Actuator VA Requirements

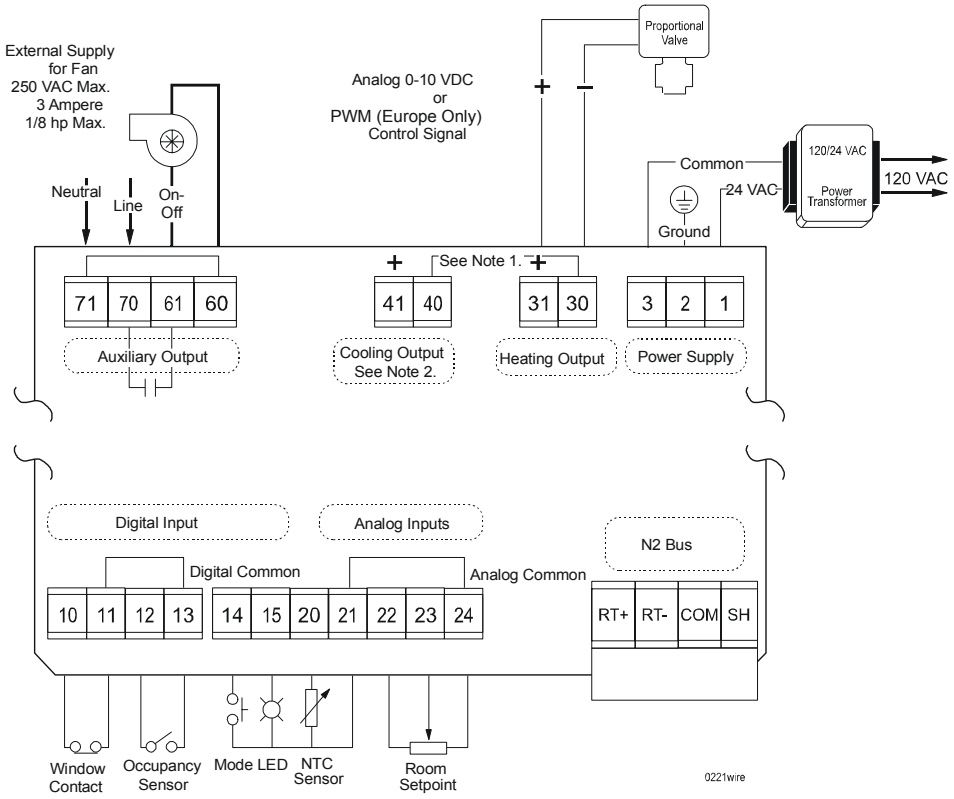
Actuator	Type	Power Requirements
J-Series Electric Zone Valve	On-Off	7 VA
M9100-A	24 VDC or 24 VAC Triac/Incremental	6.5 VA
M9100-G	Proportional - Voltage or Current	6.5 VA
VA-7150	Electric 2-position Zone Valve/Incremental	2.7 VA
VA-7152	0 to 10 VDC	4.7 VA
VA-7200	Electric 2-position Zone Valve/Incremental	5.5 VA
VA-7202	0 to 10 VDC	7.5 VA
VA-8020	24 VAC Triac/Incremental	4 VA
VA-8022	0 to 10 VDC	4 VA
VA-8050	24 VAC Triac/Incremental	6 VA
VA-8052	0 to 10 VDC	6 VA

Follow these wiring precautions:

- Make all wiring connections in accordance with the NEC, as well as in accordance with local regulations.
- Locate equipment and route the wiring so that low voltage wiring is a twisted pair and is separated from power wiring by a minimum of 25 mm (one inch).
- Make all wiring connections to the TC-9102 Controller using only copper conductors.
- The N2 Bus must be daisy-chained. The use of **Y** or **T** bus topologies without a repeater installed in the **T** may cause loss of communications. Do not use wire smaller than 22 gauge.
- N2 Bus, Analog Input (AI), Binary Input (BI), Analog Output (AO), and Binary Output (BO) wiring are low voltage wiring (30 VAC and below). Do not run low voltage wiring in the same conduit as line voltage wiring (>30 VAC) or wiring that switches power to highly inductive loads such as contactors, coils, motors, or generators.
- You may run **shielded** N2 Bus wiring in the same conduit or bundle as 24 VAC power wiring.
- You may run AI, AO, and BI wiring in the same bundle or conduit as 24 VAC, where convenient. If the BO wiring is not wired through other switches or contacts, you may also bundle it with the other Input/Output (I/O) wiring.

- You may have either no earth ground connection (preferred), or one earth ground connection that must be at the transformer secondary common, whether one or multiple controllers are powered by the same UL or NEC Class 2 transformer.
- To meet the requirement for a UL installation, the following installation practices are required:
  - The TC-9102 must be mounted into an enclosure when it is mounted remote from the FCU.
  - The TC-9102 can be mounted directly into an FCU without the use of an additional enclosure.
  - In either case, the Class I high voltage fan control wiring from the TC-9102 must be routed away from all other 24 VAC power or communication (Class II) wiring. High voltage (>30 VAC) Class I and low voltage (30 VAC or less) Class II wiring must be separated by at least one inch. In addition, the heating/cooling outputs must be routed separately even though they are Class II.

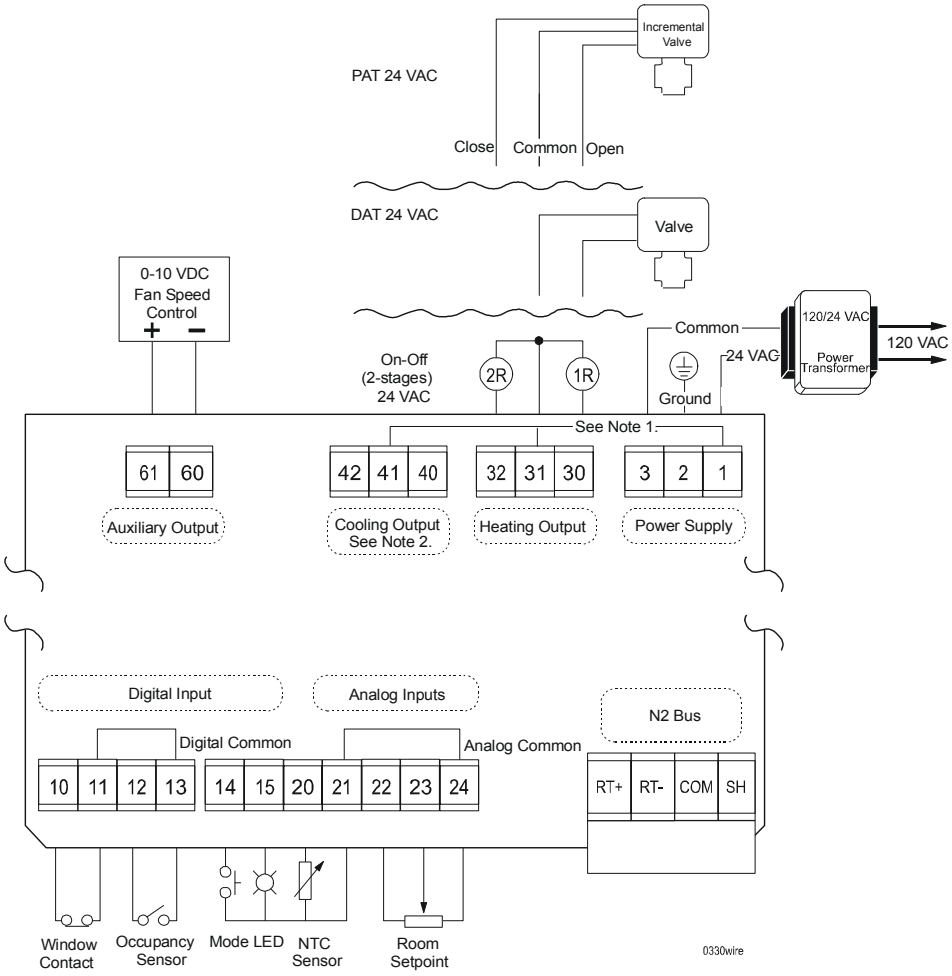
Terminal Designations



Note 1: For 0 to 10 VDC and PWM (only available in Europe) output, terminals 30 and 40 are internally connected.

Note 2: Wiring for Cooling Output is the same as that shown for Heating Output.

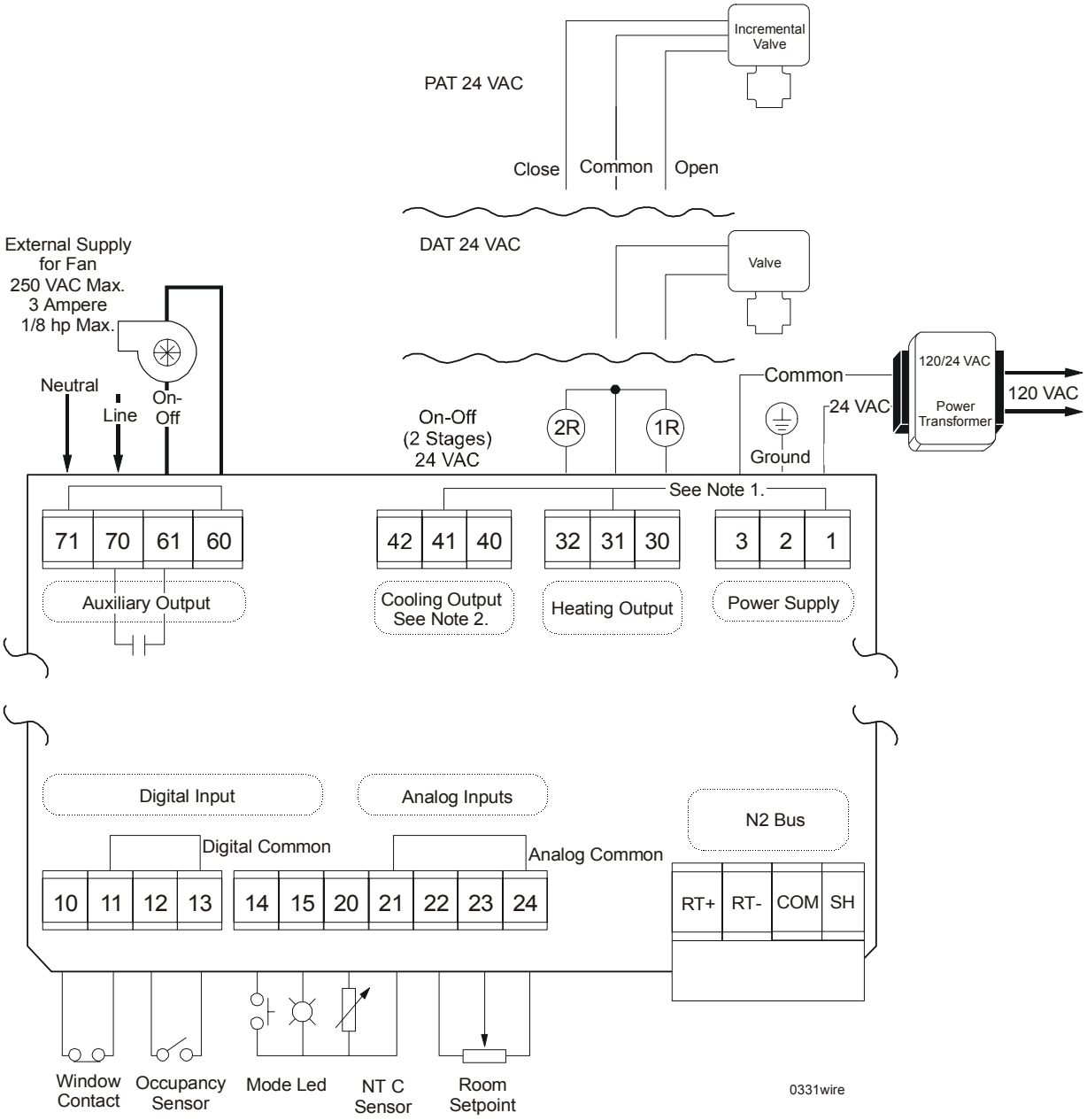
Figure 6: TC-9102-0221 Controller Wiring - On/Off Fan Control



Note 1: For PAT, DAT, and On-Off outputs, terminals 1, 31, and 41 are internally connected.

Note 2: Wiring for Cooling Output is the same as that shown for Heating Output.

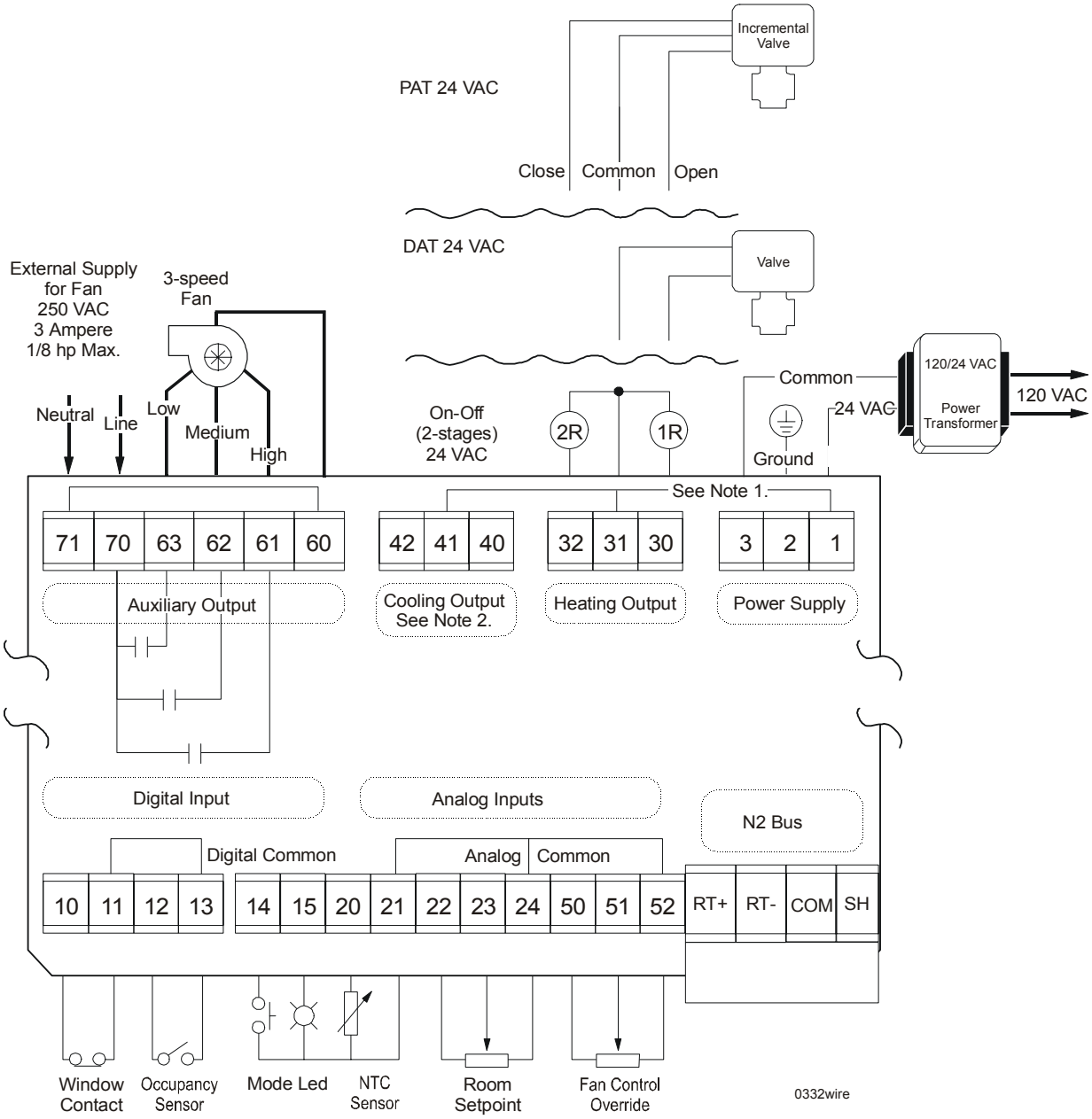
Figure 7: TC-9102-0330 Controller Wiring - 0 to 10 VDC Fan Control



Note 1: For PAT, DAT, and ON-OFF outputs, terminals 1, 31, and 41 are internally connected.

Note 2: Wiring for Cooling Output is the same as that shown for Heating Output.

Figure 8: TC-9102-0331 Controller Wiring - On/Off Fan Control



Note 1: For PAT, DAT, and On-Off outputs, terminals 1, 31, and 41 are internally connected.

Note 2: Wiring for Cooling Output is the same as that shown for Heating Output.

Figure 9: TC-9102-0332 Controller Wiring - 3-Speed Fan Control

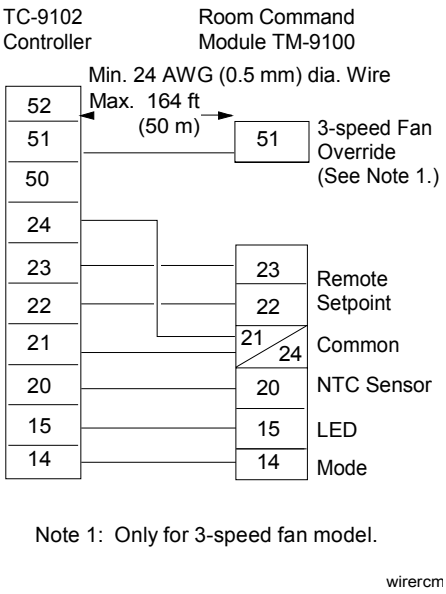


Figure 10: TC-9102 Controller Wiring to Room Command Module TM-9100

Fan Output Types

Fan On/Off

The output Terminals 61 and 70, for single speed fans, are normally open relay contacts, which close when the fan runs. Terminals 70 and 71 connect the fan supply voltage to the controller to facilitate the wiring to the fan motor. The line voltage is used only to power the fan. See Figure 6 and Figure 8 for the TC-9102-0221 and -0331 models.

3-Speed Fan Control

The output is a set of interlocked relay contacts. There is one contact (Terminals 61 to 63 and 70) for each speed, and the contact closes when that speed is selected to run. Terminals 70 and 71 are provided to connect the fan supply voltage to the controller in order to facilitate the wiring to the fan motor. The line voltage is used only to power the fan. See Figure 9 for the TC-9102-0332 model.

0 to 10 VDC Control Signal

The output is a control signal for driving a fan speed controller with a 0 to 10 VDC input. See Figure 7 for the TC-9102-0330 model.

Htg/Clg Output Types

0 to 10 VDC

The output is an analog voltage between 0 and 10 VDC in direct proportion to the controller output from 0 to 100%.

PAT - Position Adjust Type

The PAT (incremental) output is a pair of triacs that is switched on to open or close an incrementally driven heating or cooling valve. The duration of the output pulse is equal to the change in the controller output command multiplied by the full stroke time of the actuator.

DAT - Duration Adjust Type

The DAT output is a triac that is switched on for a duration within the set heating or cooling valve cycle time.

2-Stage On/Off

The outputs are two separate triacs that are switched on in sequence as the controller output increases.

CAUTION: Risk of Property Damage. Protect mechanical equipment, such as refrigeration equipment, that requires a minimum run time or minimum off time with an appropriate time delay relay. Failure to incorporate such protection may result in damage to the mechanical equipment.

Wiring Sensors and Actuators

Use 18 to 24 AWG twisted pair wire for all sensor and output wiring depending on line length (see Table 11). If shielding is used, it should be earth grounded at the controller end.

CAUTION: Risk of Property Damage. Do not run low-voltage cables or wires in the same conduit or wiring troughs with high-voltage wires. Running low and high voltage wires in the same conduit or wiring troughs may damage the equipment or cause system malfunction.

Table 10: Input and Output Load Impedances

Function	Range	DC Input Impedance	Sensor or Load Impedance
Inputs			
AI Temp	NTC 2252 ohm at 25°C (77°F)	10 K ohms	7400 to 1200 ohms
AI Set Point Pot	0 to 5 VDC	600 K	10 K ohm
BI Opto-isolated - DC	<1 K ohms closed >100 K ohms open	4.4 K ohms	0 to 10 M ohm
Outputs			
AO Voltage	0 to 10 VDC @ 10 mA max.	N/A	1 K to 10 M ohm
BO VAC Triac	24 VAC @ 50 to 500 mA	N/A	48 to 480 ohm

Table 11: Sensor Wire Sizes and Lengths

Sensor Type	18 AWG Wire Size Run Length in Meters (Feet)	24 AWG Wire Size Run Length in Meters (Feet)
AI Temperature (Resistive)	152.4 (500)	50 (164)
AI Voltage	152.4 (500)	30.5 (100)
BI Voltage/Contact	152.4 (500)	152.4 (500)
Single BO at 0.1 ampere	152.4 (500)	30.5 (100)
Single BO at 0.5 ampere	30.5 (100)	6.1 (20)

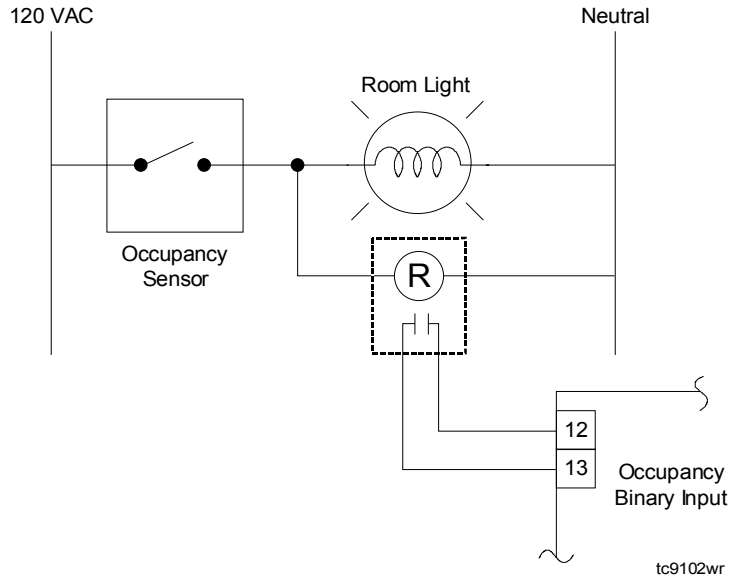


Figure 11: Example of Occupancy Sensor Being Used with a TC-9102 Controller

Networking the Controller

N2 Bus Overview

If you are familiar with the N2 Bus, skip this section and go to the *Installing the N2 Bus* section of this technical bulletin.

N2 Bus Characteristics

When installed in a Metasys Network, the TC-9102 Controller receives commands from the Network Control Module (NCM) or Companion on the N2 Bus and transmits status reports in return.

The N2 Bus connections are electrically isolated from other TC-9102 circuitry to 500 V by optical and magnetic coupling.

For runs up to 5,000 feet, use 22 AWG or heavier twisted pair wire (electrically, 26 AWG wire works, but it is fragile and prone to nicks and breaks). Runs longer than 5,000 feet require use of a bus repeater. An N2 network may be extended to a maximum length of 15,000 feet using two repeaters.

The N2 Bus is a **daisy-chain** communications line. Essentially, it consists of three wires which carry three signals: RT+, RT- (N2+/-), and COM (REF). The RT+ and RT- lines carry the actual data signals. The COM line provides a common reference so that each connected device is capable of electrically receiving and transmitting data by creating a common voltage reference among all the devices connected by the N2 lines. Three lines are required for optimum reliability.

The TC-9102 database can be configured and commissioned using HVAC PRO Release 8.04 or later in one of the following three methods:

- Metasys Operator Workstation (Rev. 7.01 or later)
- Companion (Rel. 6.02 or later)
- Directly over the N2 Bus using a laptop and an MM-CVT101-0

Upon loss of N2 communication, the TC-9102 waits 2 hours before reverting to stand-alone control. Refer to Figure 12 for networking examples.

Notes: When exiting HVAC PRO commissioning, HVAC PRO resets the controller supervisory bit, leaving it in stand-alone mode.

IMPORTANT: All N2 Bus cables **must be twisted-pair cable**. Failure to use twisted-pair cable may result in loss of communication and possible TC-9102 controller malfunction.

Do not run N2 Bus wiring in the same conduits as line voltage wiring (30 VAC or above) or wiring that switches power to highly inductive loads (such as contactors, coils, motors, or generators).

For more N2 Bus overview information, refer to the *ASC and N2 Bus Networking and Troubleshooting Guide Technical Bulletin (LIT-6363003)*.

Note: Do not use address **0** when setting the N2 Address. The N2 Address 0 is invalid for the TC-9102.

Installing the N2 Bus

A hardwire connection between the N2 Bus and the Network Control Module (NCM) of the Network Control Unit (NCU) is required if the NCM is to communicate with N2 devices. Refer to the *N2 Communications Bus Technical Bulletin (LIT-636018)* for information specific to wiring the N2.

N2 Wiring to an NCU

N2 Wiring to Companion

A hardwire connection between the N2 Bus and the Companion PC/Panel/*LTD* is required to communicate with N2 devices (see Figure 12).

Setting the N2 Address Switches

You need to set the N2 address and test for N2 voltage, polarity, and isolation before actually wiring the TC-9102 for operation.

If the controller is connected to a communications bus, a unique network address must be set for each N2 device. Refer to the project documentation for the address setting for each controller. Addresses 0 to 63 can be set on the address switches. The zone jumpers allow addressing up to 255 according to Table 12.

Table 12: Setting Network Addresses

Zone 1 Jumper	Zone 2 Jumper	Address Switch	Network Address
Out	Out	0 to 63	0 to 63
In	Out	0 to 63	64 to 127
Out	In	0 to 63	128 to 191
In	In	0 to 63	192 to 255

The setting on the Address Switches is in binary format according to Table 13. Table 14 shows an example of an address.

Table 13: Addresses Format

Switch Number	1	2	3	4	5	6	Zone 1 Jumper	Zone 2 Jumper
Decimal Equivalent	1	2	4	8	16	32	64	128

Table 14: Example (Address 43)

Switch Number	1	2	3	4	5	6	Zone 1 Jumper	Zone 2 Jumper
Switch Position	On	On	Off	On	Off	On	Out	Out
Decimal Equivalent 43 =	1 +	2 +	0 +	8 +	0 +	32 +	0	0
Note: The Metasys system uses this address for polling and commanding.								

Refer to the *Configuring the Controller* section of this technical bulletin for information on the other jumpers (Figure 13).

Configuring the Controller

Jumper Positions

To reach the jumpers and switches, open the controller by gripping the cover with thumb and finger on both sides above center, and pull the cover off using the lower edge as a hinge. Replace the cover by resting the lower edge of the cover against the base and then pressing the cover firmly to engage all four retaining lugs.

Remove the JP2 **Gain Jumper (Red)** to reduce the proportional band to half of the factory setting or value entered in the HVAC PRO configuration (gain x 2).

Remove the JP2 **Integral Time Jumper (Blue)** to perform proportional heating/cooling control only.

For a more detailed explanation of the effect of these tuning values, see the *TC-9102 Applications Application Note (LIT-6375130).*

JP1, JP3, and JP4 are factory set.

Refer to the *Networking the Controller* section of this technical bulletin for information on address jumpers and switches.

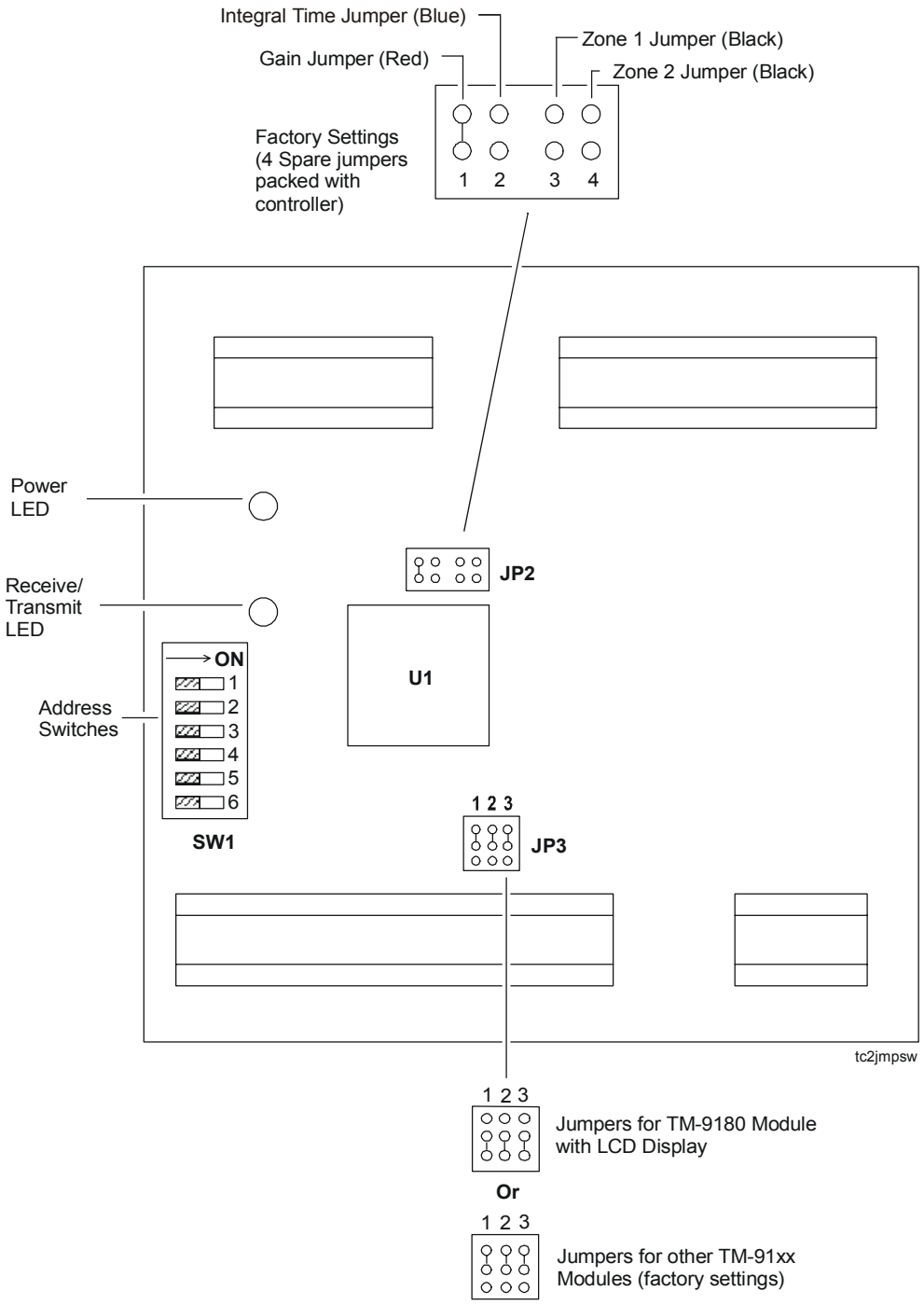


Figure 12: TC-9102 Controller Jumpers and Switches

Startup

When all jumpers and address switches have been set, and all connections have been made and verified, 24 VAC power may be applied. The Power LED should be lit. If the communications bus is active, the R/T LED flashes. If the Power LED is not lit, check the 24 VAC supply.

Using HVAC PRO Configuration Tool

Configure the TC-9102 Controller with the software program, HVAC PRO (Release 8.04 or later). This easy-to-use software tool configures, commissions, uploads, and downloads the TC-9102 Controller database. Refer to the *TC-9102 Applications Application Note (LIT-6375130)* for details.

Defining a TC-9100 Control Device in a Metasys Network

Using a Metasys Network System, define a TC-9100 Controller device the same way you define any object in the Metasys network. Refer to the *Operator Workstation User's Guide* for additional information on general procedures for defining and modifying objects.

Downloading/Commissioning

Commissioning Procedures via the N2 Bus

Commissioning a TC-9102 begins after the unit is mounted, wired, and the control and hardware/software features have been defined through HVAC PRO. Refer to the *HVAC PRO User's Manual* for complete controller configuration and commissioning information.

The TC-9102 database can be configured and commissioned using HVAC PRO Release 8.04 or later in one of the following three methods:

- Metasys OWS (Rev. 7.01 or later)
- Companion (Rel. 6.02 or later)
- Directly over the N2 Bus using a laptop and an MM-CVT101-0

Upon loss of N2 communication, the TC-9102 waits 2 hours before reverting to stand-alone control. Refer to Figure 12 for networking examples.

Additional information about the commissioning procedures is in the *Controller Access Technical Bulletin (LIT-6364013)*.

Hardware Installation Inspection

Upon product delivery of the TC-9102 Controller, test a sample of the shipment by loading a job configuration prior to installation at the job site.

Troubleshooting

Troubleshooting Tools

Tools needed for typical troubleshooting include:

- Digital Multimeter (DMM)
- 1/8 in. blade flat-head screwdriver

Installation Checkout

Review the mounted TC-9102 to ensure proper installation. Refer to the appropriate illustrations under *Installation Procedures* earlier in this guide. Also, refer to the engineering drawings supplied for the individual site.

1. Check that the mounting screws holding the subassembly onto the base frame are secure.
2. Verify that accessory equipment is connected and labeled correctly.
3. Ensure that the controller terminal connections are secure by pulling on each wire.
4. Verify that the N2 connections are secure and labeled correctly.
5. Verify that the TC-9102 switches are appropriately positioned. (Refer to *Networking the Controller* and *Configuring the Controller* sections in this technical bulletin.)

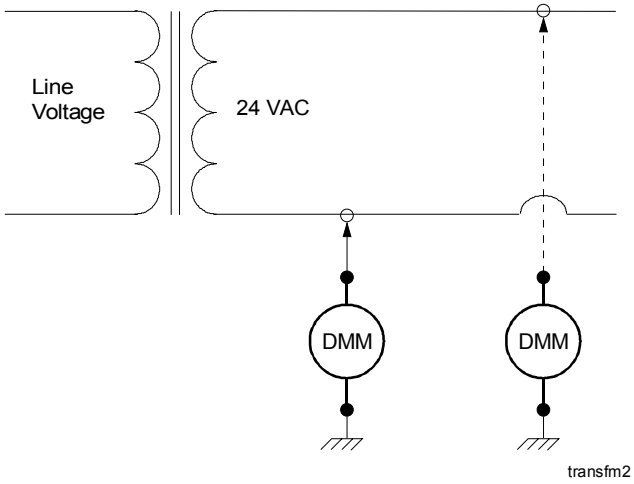


Figure 13: Testing the Transformer

Power Transformer Polarization

Before connecting the transformer to the TC-9102, make sure the secondary is isolated. Then connect the input power to the primary leads of the 24 VAC transformer.

Measure the voltage of each secondary transformer lead to earth ground with the DMM.

Determine the polarity of the transformer's leads by using a DMM referenced to earth ground (Figure 13). Connect the transformer's secondary lead with the higher voltage potential to the 24 VAC terminal on the TC-9102. Connect the transformer's secondary lead with the lower potential to the 24 VAC common terminal on the TC-9102.

Troubleshooting the TC-9102 Controller with HVAC PRO

Table 15 indicates symptoms and corrections for possible controller malfunctions. We recommend the use of HVAC PRO Commissioning mode during all troubleshooting procedures.

Note: While in the commissioning program, you are actively viewing the controller's inputs and outputs. The screens automatically refresh the data values when the controller senses a change in value.

Table 15: Troubleshooting with HVAC PRO

Symptom	Possible Cause	Corrective Action
Indoor Fan Does Not Run	Unit not in Comfort mode.	Use the Commissioning mode to force the controller into Comfort mode.
	Occupancy sensor is not closed.	Close the occupancy sensor or insert a jumper across the defined occupancy BI.
	Window contact is not closed.	Close the window, or insert a jumper across the defined, window BI.
	In override, fan is Off.	Check the Command Module (Thermostat) fan override condition.
	Zone does not require heating or cooling.	Compare the temperature and setpoint to make sure there is a call for heating or cooling.
Heating or Cooling Will Not Turn On Automatically	Zone sensor not connected.	Ensure the zone sensor is properly wired to the terminal block.
	Zone temperature not above or below setpoint.	Simulate a load by changing the set point using HVAC PRO.

Note: Analog inputs cannot be overridden using HVAC PRO.

For more information on HVAC PRO, refer to the *HVAC PRO User's Guide*.

Troubleshooting the N2 Bus

You need to troubleshoot the N2 Bus if the supervisory system is not properly communicating with the TC-9102 Controllers.

Specific troubleshooting tests are given in the following documents:

- *ASC and N2 Bus Networking and Troubleshooting Guide Technical Bulletin (LIT-6363003)*
- *N2 Communications Bus Technical Bulletin (LIT-636018)*

Before trying one of these tests, you may be able to determine the cause of the problem by asking yourself the following questions:

- Are the N2 Bus wires securely terminated to each TC-9102?
- Is the N2 polarity correct?
- Is the TC-9102 powered and ready to respond?
- Are the TC-9102s configured properly using HVAC PRO Release 8.04 or later?
- Are two or more TC-9102s configured with the same address?

Note: The firmware version of the TC-9102 was changed from Version 3 to Version 4 starting in May 2002. You need HVAC PRO Release 8.04 (M-Tool Release 5.1) or later to download a TC-9102 Version 4 Controller.

WARNING: Risk of Electrical Shock. Do not touch any metal parts with anything other than properly insulated tools or insulated probes of a digital voltage meter. Failure to use properly insulated tools and probes may result in severe personal injury or death.

Table 16: Troubleshooting the N2 Bus

Symptom	Possible Cause	Action
N2 Bus is Offline	End-of-Line (EOL) jumpers and/or W3 jumper on MM-CVT101, Companion Panel/*LTD,* or NCM are not installed.	Install EOL jumpers and W3 jumper properly.
	MM-CVT101 is not plugged into Personal Computer (PC).	Plug MM-CVT101 into PC.
	N2 Bus polarity is incorrect.	Rewire N2 Bus wires for proper polarity.
	A device has an address of zero.	Change address to something other than zero.

Note: For NCM troubleshooting information, refer to the *Network Control Module 300 Series Technical Bulletin (LIT-6360251)*.

Ordering Information

Johnson Controls Code Numbers

Controllers

Table 17 lists code numbers and descriptions for the TC-9102 Controllers and accessory equipment.

Table 17: TC-9102 Controllers

Ordering Code	Htg/Clg Outputs	Fan Output
TC-9102-0221	Two 0 to 10 VDC	On/Off Fan Control
TC-9102-0330	Two DAT, PAT, or 2 Stage On/Off*	0 to 10 VDC Fan Control
TC-9102-0331	Two DAT, PAT, or 2 Stage On/Off*	On/Off Fan Control
TC-9102-0332	Two DAT, PAT, or 2 Stage On/Off*	3-speed Fan Control
* These models may use only one of these choices for heating and cooling. Both heating and cooling must be of the same type.		

Table 18: Room Command Module and Accessories

Ordering Code	Setpoint	Fan Switch
TM-9151-0000	w/o Setpoint Dial	None
TM-9161-0000	12 to 28°C	
TM-9161-4005	+/- 3°C	
TM-9161-5000	55 to 85°F	
TM-9161-5005	+/- 5°F	
TM-9161-0002	12 to 28°C	3-speed Fan Override
TM-9161-4007	+/- 3°C	
TM-9161-5002	55 to 85°F	
TM-9161-5007	+/- 5°F	
T-4000-119	Stat Adjustment Tool (to open module)	
TE-6300-607	3-inch Thermistor Probe for remote NTC temperature sensing (Refer to the *TE-6300 Series Temperature Sensors Product Bulletin [LIT-216320]* for more information.)	
Note: All TM-9100 Series models are available with an NTC sensor and momentary override button, and include a U.S. Wallbox Mounting Kit.		

Valve Actuators

Table 19: TC-9102 Valve Actuators

Code Number	Description	Type
J-Series Electric Zone Valve	Valve Actuator Assemblies 1/2 in. to 1 in.	On/off
M9100-A Series or M9200-A with Spring Return	Direct Mount Actuators, Valve linkage kit required	24 VDC or 24 VAC Triac/Incremental
M9100-G, -H Series or M9200-G, -H with Spring Return	Direct Mount Actuators, Valve linkage kit required	Proportional - Voltage or Current
VA-7150 Series	Valve Actuator Assemblies 1/2 in. to 2 in.	24 VAC, 50/60 Hz
VA-7152 Series	Valve Actuator Assemblies 1/2 in. to 2 in.	0 to 10 VDC
VA-7200 Series	Valve Actuator Assemblies 1-1/2 in., 2 in.	24 VAC, 50/60 Hz
VA-7202 Series	Valve Actuator Assemblies 1-1/2 in., 2 in.	0 to 10 VDC
VA-8020 Series	Valve Actuator Assemblies 1/2 in.	24 VAC Triac/Incremental
VA-8022 Series	Valve Actuator Assemblies 1/2 in.	0 to 10 VDC
VA-8050 Series	Valve Actuator Assemblies 1/2 in., 3/4 in., 1 in., and 1-1/2 in.	24 VAC Triac/Incremental
VA-8052 Series	Valve Actuator Assemblies 1/2 in., 3/4 in., 1 in., and 1-1/2 in.	0 to 10 VDC

Accessories

Table 20: TC-9102 Accessories

Code Number	Description	Type
AS-ENC100-0	Generic Enclosure Kit	Sheet Metal
AS-XFR050-1	50 VA Transformer	Split Bobbin
AS-XFR100-1	Transformer Kit, 120/240 VAC w/ Power Switch	100 VA, Split Bobbin
EN-EWC10-0	Single Enclosure	Plastic Universal Packaging Module
EN-EWC15-0	Single Enclosure with PWR	Plastic Universal Packaging Module with 50 VA Transformer
MM-CVT101-0	RS-232/RS-485 Converter for N2, PC version only	Download/Commissioning with HVAC PRO
MW-MTOOL-0	M-Tool Software (includes HVAC PRO)	N/A
MW-MTOOL-6	M-Tool Update	N/A
Y65XX-X Series	Transformer	24/120/220/277/480 VAC to 24 VAC

Technical Specifications

Table 21: Technical Specifications

Supply Voltage	24 VAC, -15% to +10%, 50-60 Hz	
Power Consumption	3 VA Controller and Room Command Module	
Ambient Operating Conditions	0 to 50°C (32 to 122°F) 10 to 90% RH noncondensing	
Ambient Storage Conditions	-40 to 70°C (-40 to 158°F) 10 to 90% RH	
Terminations	Terminal block for 1 x 1.5 mm^2/16 AWG (maximum) cable and 14 AWG for fan terminal block. Rated for 4 lb·in maximum torque.	
Serial Interfaces	Optically isolated RS-485 interface for N2 Bus connection; 9600 baud	
Controller Addressing	1 to 255 selectable on DIP switches (6) and jumpers (2)	
Room Command Module TM-9100 Inputs	Room Temperature Sensor	NTC Thermistor 0 to 40°C (32 to 105°F)
	Remote Setpoint	10 K ohm potentiometer
	3-speed Fan Override	10 K ohm potentiometer
	Occupancy Button	Momentary Contact
	Window Contact	Closed (<1 K ohm) = window closed
	Occupancy Sensor	Closed (<1 K ohm) = occupied
Heating/Cooling Control Outputs	Analog	0 to 10 VDC, maximum 10 mA
	2 DAT	Triacs rated at 24 VAC, maximum 0.5 A*
	2 PAT	Triacs rated at 24 VAC, maximum 0.5 A*
	2-stage	On/Off Triacs rated at 24 VAC, maximum 0.5 A* (Maximum 1 mA leakage current)
Fan Control Outputs	On/Off	Relay contact rated at 125/250 VAC, maximum 3 A, maximum 1/8 hp
	3-speed	Relay contact rated at 125/250 VAC, maximum 3 A maximum 1/8 hp
	Proportional	0 to 10 VDC, maximum 10 mA
Mounting	DIN rail or surface (two brackets supplied with controller)	
Housing	Material	ABS + polycarbonate, self-extinguishing UL94 V0
	Protection	IP30 (IEC529)
Dimensions (H x W x D)	118 x 108 x 31 mm (4.65 x 4.25 x 1.22 in.) Standard Terminals Allow an extra 0.43 in. for Communications terminal.	
Shipping Weight	0.3 kg (0.66 lb)	
Processor	ST 72334N	
Memory	256 Bytes Random Access Memory (RAM), 8 K Bytes Read-only Memory (ROM), 256 Bytes Electrically Erasable Programmable Read-only Memory (EEPROM)	
Standards Compliance	FCC Part 15, Subpart B, Class A IEEE 446, IEEE 472, IEEE 587 Category A UL 916	
Agency Listings	UL Listed and CSA Certified as part of the Metasys Network.	

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