



BACnet IP/MSTP VAV Controller

Prelim Draft - Brand Neutral

INSTALLATION INSTRUCTIONS

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GENERAL

Trademark Information

Sylk™ is a trademark of Honeywell International Inc.
 BACnet® is a registered trademark of ASHRAE Inc

Product Description

The BACnet IP/MSTP VAV configurable, direct digital controllers are used for either pressure-independent or pressure single duct VAV terminal unit control solutions. VAV controllers feature pre-programmed heat/cooling or reheat algorithms for VAV box control applications and can be configured to match a wide range of VAV applications. The BACnet IP/MSTP VAV controllers use BACnet MSTP and IP (different order numbers) network for great installation flexibility.

The BACnet IP/MSTP VAV unitary controllers provides flexible, freely programmable, demand-led control that delivers tangible benefits to reduce energy spends while driving new levels of functionality and efficiency in today's buildings. These scalable and freely programmable BACnet MSTP and IP based unitary

controllers utilize smart engineering and commissioning tools and Sylk™ bus technology. Multiple flexible configurations can be achieved to address specific applications using Niagara workbench.

All models contain an integral, field-replacable, polarity-free differential pressure sensor that provides flow measurement for pressure independent applications.

The controllers are capable of stand-alone operation; however, optimum functional benefits are achieved when the network communication capabilities are used.

MSTP variant of controller communicates via an TIA/EIA 485 BACnet MSTP network communications network, capable of baud rates between 9.6 and 115.2 kilobits.

Table 1. Ordering Part Numbers

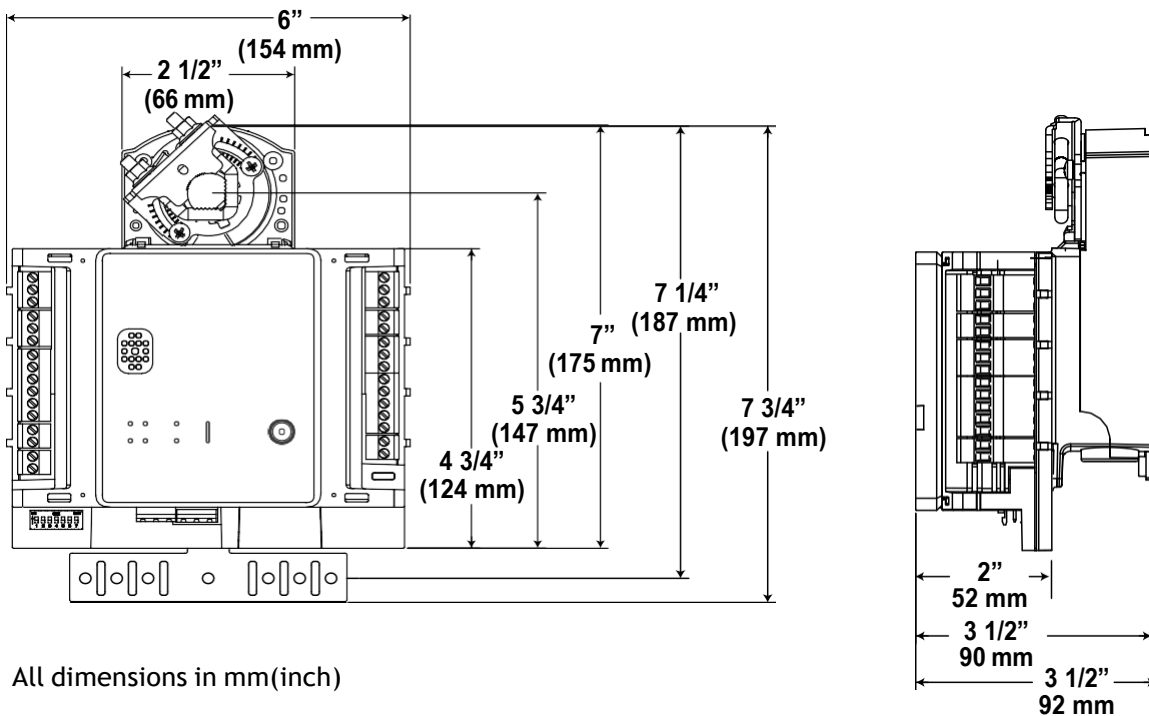
Controller Model	Power supply	UIOs	Solid State	Sum IO	Backbone Communication	DIP switches	BLE	Wi-Fi USA	Wi-Fi EU	Modbus Master/ Slave
WEB-VA00IB24NM CPO-VA00IB24NM CLMEVA00IB24NM	24 VAC	0	0	0	IP	No	Yes	No	No	M
WEB-VA75IB24NM CPO-VA75IB24NM CLMEVA75IB24NM	24 VAC	7	5	12	IP	No	Yes	No	No	M
WEB-VA75MB24NM CPO-VA75MB24NM CLMEVA75MB24NM	24 VAC	7	5	12	MSTP	Yes	Yes	No	No	M
WEB-VA00MB24NM CPO-VA00MB24NM CLMEVA00MB24NM	24 VAC	0	0	0	MSTP	Yes	Yes	No	No	M

HW version: RevA ; SW version:1.0.0.0

Table 2. Remote Antenna Part Numbers

Antennae Part Number	Vendor Name	Type	Gain
ANT-DB1-LCD-SMA	LINX	External	2.4 GHz: 2.8 dbi
ARY113-0012-006-00	Wieson	External	2.4 GHz: -0.31dbi

DIMENSION



All dimensions in mm(inch)

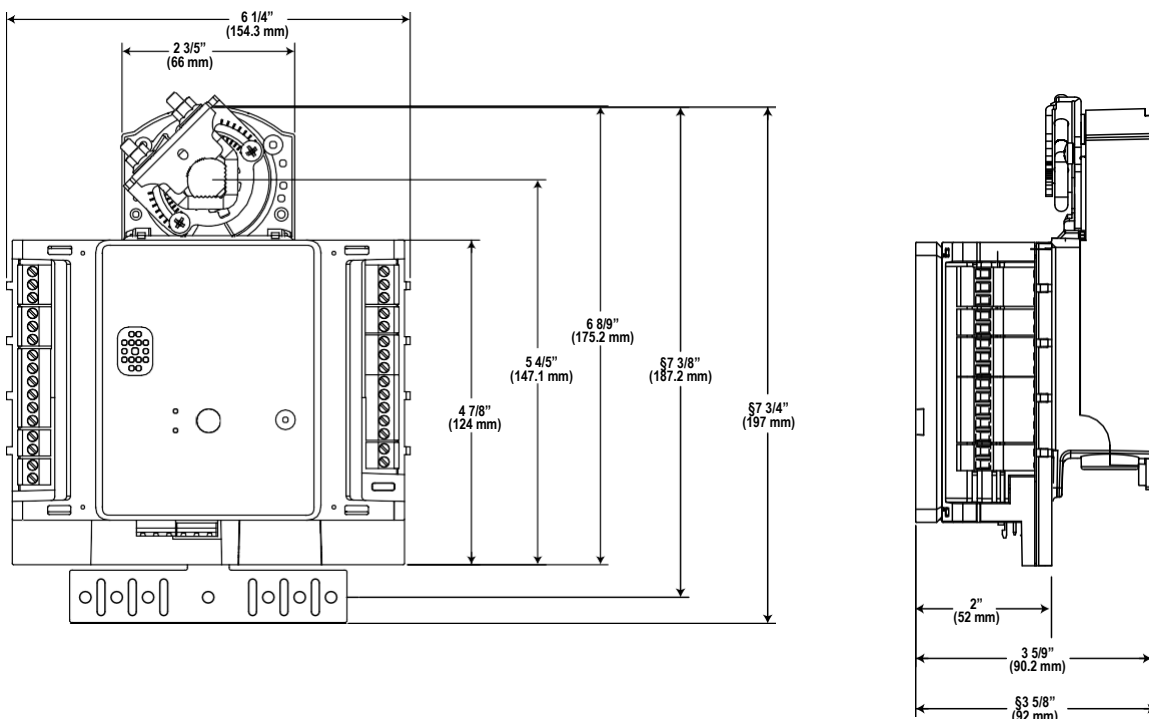


Figure 1. Dimensions

NETWORK SECURITY

WARNING

Honeywell hereby expressly states that the BACnet IP/MSTP VAV controller is not inherently protected against cyber-attacks from the Internet and that it is therefore intended solely for use in private, protected networks.

Unprotected Internet connections can expose the BACnet IP/MSTP VAV controller to cyber-attacks from third parties who can then damage it and connected facility components or cause them to malfunction, or who can misuse it for illegal purposes for which the operator may then be held liable. When directly connected to the Internet, the BACnet IP/MSTP VAV controller automatically becomes a potential target for cyber-attacks. To ensure safe and reliable operation take necessary protective measures. If it is not necessary for the BACnet IP/MSTP VAV controller to be accessible from the Internet, it should be isolated from the Internet via a suitable firewall.

If it is necessary for the BACnet IP/MSTP VAV controller to be accessible from the Internet (e.g., to perform a remote maintenance), the use of a coded VPN connection is indispensable. Suitable VPN routers are available from numerous third-party manufacturers in a wide variety of designs, for operation at 230 V or 24 V.

GENERAL SAFETY INSTRUCTIONS

While performing any work (installation, mounting, startup), follow all instructions given by the manufacturer and the safety instructions provided in this document.

- The BACnet IP/MSTP VAV controller must be installed and mounted by authorized and trained personnel.
- If the unit is modified in any way, except by the manufacturer, all warranties concerning operation and safety become invalid.
- Make sure that applicable local standards and regulations are always observed.
- Use only Honeywell supplied or approved accessories.
- Before dismantling the system, disconnect the power supply by either removing the power terminal block from the controller or by means of local isolation. Read the following caution note carefully.

CAUTION

Disconnect the power supply before installing the BACnet IP/MSTP VAV controller. Do not reconnect the power supply until you have completed the installation.

Switch off the power before you plug / un-plug the jumper.

SPECIFICATIONS

Electrical

Voltage Range: 20-30 VAC; Class 2 transformer **Nominal**

Power Consumption:

- **IP variant:** 8VA; Controller and actuator load (nothing connected to IO's and COM)
- **MSTP variant:** 6VA; Controller and actuator load (nothing connected to IO's and COM)

Full Load Power Consumption:

- **IP variant:** 30VA; Maximum load including external loads (including SYLK™, communication, BLE, UIO output, 20V output)
- **MSTP variant:** 22VA; Maximum load including external loads (including SYLK™, communication, BLE, UIO output, 20V output)
- If SSR is used it should consider real VA needed.

Frequency Range: 50 to 60Hz

Auxiliary Output: 20 VDC @ 75 mA

Hardware

CPU: Crossover processor NXP I.MRT, Cortex M7

Memory capacity: 16MB QSPI Flash, 16MB SDRAM

Ethernet: 2 X RJ-45 Ethernet ports with integrated fail-safe for daisy-chaining

Real Time Clock: 24-hr backup after power failure. The controller includes a supercapacitor to power the built-in real time clock for 24 hours. In case of power failure, the super capacitor retains the time set in controller for 24 hours. After 24 hours, the time will reset to default factory time until user perform BACnetTime Sync.

Communication

Protocol supported: BACnet IP (IP variants), BACnet MSTP (MSTP variants), Sylk™, Modbus Master / Slave (different order numbers).

Ethernet Connection Speed: 10/100 Mbps

Addressing: IPv4

BACnet Profile: B-AAC

Sylk™ Bus: 2-wire, polarity-insensitive

Bluetooth: BLE, optional external antenna

Airflow Sensor

Range: ±2.0 in. H₂O (±500 Pa)

Accuracy: ±3% of full range

Dimension (LXWXH): 175.2 X 154.3 X 90.2 mm (6 8/9 X 6 1/4 X 3 5/7 inch)

Weight: 1.5 Kg

Operational Environment

Storage: -40 °F to 150 °F (-40 °C to 66 °C)

Operation: 32 °F to 122 °F (0 °C to 50 °C)

Humidity: 5% to 95% RH., non-condensing

protection: IP20, NEMA -1

Pollution: Level2

Sylk™ Devices Supported

Wall Modules Sensors: TR40, TR40-H, TR40-CO₂, TR40-H-CO₂, TR42, TR42-H, TR42-CO₂, TR42-H-CO₂, TR71, TR71-H, TR75, TR75-H, TR120, TR120-H

Sensors: C7400S Sylk™ Sensor

Universal Input Types and Characteristics

AO: 0(2)...10V direct/reverse with -3mA ...+20mA (negative current needed for light dimming) or current output with 0(4)...20mA

- UI: 0(2)...10V direct/reverse or 0(4)...20 mA input
- **Sensors:** NTC10k (Type 2), NTC10K3, 10K3A1, NTC20k, PT100, PT1000, NI1000TK5000, NI1000 Class B DIN43760, PT3000, JOHNSON A99, 100 Ohm to 100k Ohm resistive (custom characteristic).
- Hardwired wall modules: set point, fan speed, override
- Dry contact binary input with direct/reverse
- Counter (S0) with 100Hz (min. pulse width 5 ms; e.g. used to measure fan speed).

Common terminal shared by 2 UIO, protected against 24VAC mis-wiring and short circuit

Analog Outputs

Output Resolution: 16-bit digital to analog converter

Voltage Output: 0-10 VDC

Current Output: 10-20 mA DC

Solid State Relay

SSR does switch supply voltage, works with AC and DC, however in case of DC no support of synchronous motor.

- 1.5A constant; 3.5A inrush for 0.1 sec per SSR output
- Optional bridge between 24 VAVC supply and SSR input shared by all SSRs

Standards and Compliances

CE, UL916 Energy Management Equipment, FCC Part15; Class A verified, BTL B-BC, EN 55022; Class A, EN 61000-3-2, 61000, UL 864 UUKL; Listed Smoke Control system, UL2043, AMEV AS-A, AMEV AS-B

Wireless Connectivity

Table 3. Connectivity Frequency Range

Connectivity Medium	Frequency range	E.I.R.P for CE	E.I.R.P for FCC/IC
Bluetooth	2400 MHz- 2483.5 MHz	20 mW	20 mW

MOUNTING

To mount the BACnet IP/MSTP VAV refer the mounting instructions (XX-XXXX) provided with the controller.

Before mounting the controller on damper shaft, review the power, inputs and output specifications.

See "Specifications" on page 5.

Hardware driven by the analog current outputs must have a maximum resistance of 550 Ohms.



IMPORTANT:

Avoid mounting in areas where acid fumes or other deteriorating vapors can harm the metal parts of the controller, or in areas where escaping gas or other explosive vapors are present.

Before Mounting Actuator onto the Damper Shaft

BACnet IP/MSTP VAV controller includes a direct coupled actuator with Declutch mechanism, which is shipped hard-wired to the controller.

1. Determine the direction in which the damper shaft rotates to open the damper. Typically, there is an etched line on the end of the damper shaft that indicates the position of the damper.

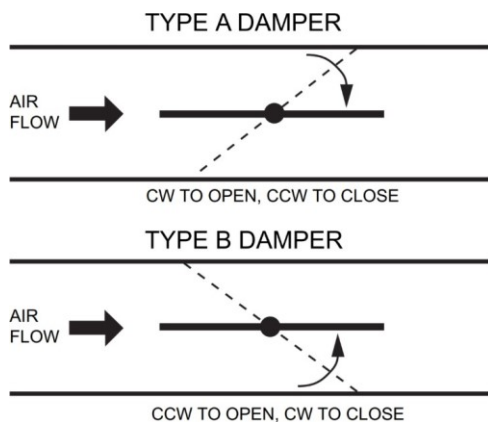


Figure 2. Determining the rotation direction (CW or CCW)

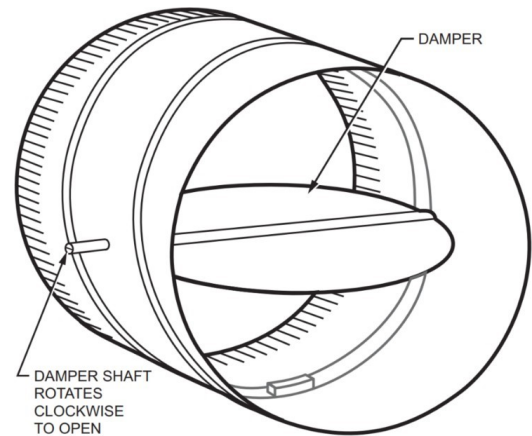


Figure 3. Damper with 90 degree CW rotation to open



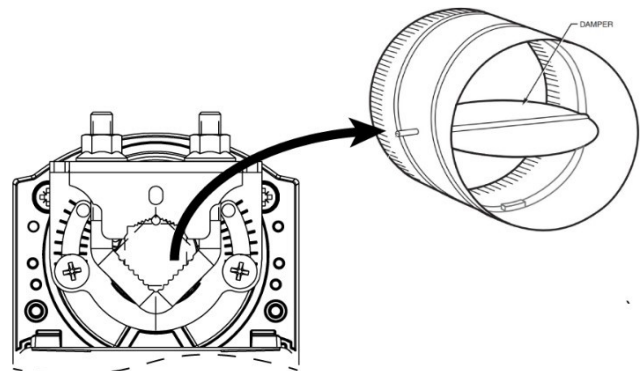
IMPORTANT:

Mount the actuator flush with damper housing or add a spacer between the actuator mounting surface and damper box housing.

2. Determine the damper 'full opening angle' (45, 60, or 90 degrees). In Figure 3 above, the damper is open to its fully open position of 90 degrees.

Mounting Actuator onto Damper Shaft

BACnet IP/MSTP VAV controller can be mounted in any orientation. However, ensure it is mounted in a position that allows clearance for wiring, servicing, removal, connection of the BACnet connector and access to the service button.



* The Controller can be mounted in any position, depending on VAV boxes and position of the damper shaft.

Figure 4. Mounting Actuator on Damper Shaft

**IMPORTANT:**

The controller is not position sensitive and can be mounted sideways or upside down. Use the drilling template provided in box.

The BACnet IP/MSTP VAV controller's integral actuator does not float inside the housing therefore it should be installed with a floating mount to allow for non-concentric travel, which can occur with damper shaft that are out-of-round and/or have asymmetrical damper shaft mounts.

If the actuator does not allow any wobble, then it is likely to bind. To prevent this, when installing the BACnet IP/MSTP VAV controller, install it over the damper shaft and then slide the anti-rotation bracket underneath and into the mounting slot but not at the very end of the slot (leave a little wiggle room).

Screw the anti-rotation bracket using two screws on the sides of the controller. The anti-rotation bracket is designed to be bent as needed (it has built-in bend-it-easy slots) to accommodate difficult installation locations

Tools Required:

- Phillips #2 screwdriver for end-limit set screw adjustment
- 8 mm wrench for centering clamp

The actuator mounts directly onto the VAV box damper shaft and has up to 44 in.-lb. (5 Nm) torque, 90-degree stroke, and 108 second timing at 50 Hz and 90 second timing at 60 Hz.

The actuator is shipped with two mechanical end limit set screws to control the amount of rotation from 12° to 95°. These set screws must be securely fastened in place. To ensure tight closing of the damper, the shaft adapter has a total rotation stroke of 95°.

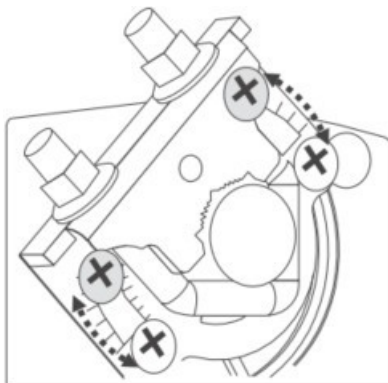


Figure 5. Setting the mechanical end limits

**NOTE:**

The actuator is shipped with the mechanical end-limit set screws set to 95 degrees of rotation.

Adjust the two set screws closer together to reduce the rotation travel. Each "hash mark" indicator on the bracket represents approximately 6.5° of rotation per side.

The Declutch button, when pressed, allows you to rotate the universal shaft adapter.

The unit is shipped with the actuator set to rotate open in the clockwise (CW) direction to a full 95 degrees. The extra 5 degrees ensures a full opening range for a 90° damper. The installation procedure varies depending on the damper opening direction and angle:

1. **If the damper rotates clockwise (CW) to open, and the angle of the damper open-to-closed is 90 degrees:**
 - a. Manually open the damper fully (rotate clockwise).
 - b. Using the Declutch button, rotate the universal shaft adapter fully clockwise.
 - c. Mount the actuator to the VAV damper box and shaft.
 - d. Tighten the two bolts on the centering clamp (8 mm wrench; 70 lb.-in. [8 Nm] torque). When the actuator closes, the damper rotates CCW 90 degrees to fully close.
2. **If the damper rotates clockwise (CW) to open, and the angle of the damper open-to-closed is 45 or 60 degrees:**
 - a. Manually open the damper fully (rotate clockwise).
 - b. The actuator is shipped with the mechanical end limits set at 95 degrees. Adjust the two mechanical end-limit set screws to provide the desired amount of rotation. Adjust the two set screws closer together to reduce the rotation travel.
 - c. Tighten the two mechanical end-limit screws (Phillips #2 screwdriver; (26.5-31 lb.-in. [3.0-3.5 Nm] torque).
 - d. Using the Declutch button, rotate the universal shaft adapter fully clockwise.
 - e. Mount the actuator to the VAV damper box and shaft.
 - f. Tighten the two bolts on the centering clamp (8 mm wrench; 70 lb. in. [8-10 Nm] torque).
 - g. When the actuator closes, the damper rotates CCW either 45 or 60 degrees to fully close.
3. **If the damper rotates counterclockwise (CCW) to open, and the angle of the damper open-to-closed is 90 degrees:**
 - a. Manually open the damper fully (rotate counterclockwise).
 - b. Using the Declutch button, rotate the universal shaft adapter fully counterclockwise.
 - c. Mount the actuator to the damper box and shaft.
 - d. Tighten the two bolts on the centering clamp (8 mm wrench; 70 lb.-in. [8 Nm] torque). When the actuator closes, the damper rotates CW 90 degrees to fully close.

4. If the damper rotates counterclockwise (CCW) to open, and the angle of the damper open-to-closed is 45 or 60 degrees:
 - a. Manually open the damper fully (rotate counterclockwise).
 - b. The actuator is shipped with the mechanical end limits set at 95 degrees. Adjust the two mechanical end-limit set screws to provide the desired amount of rotation. Adjust the two set screws closer together to reduce the rotation travel.
 - c. Tighten the two mechanical end-limit screws (Phil-lips #2 screwdriver; 26.5-31 lb.-in. [3.0-3.5 Nm] torque).
 - d. Using the Declutch button, rotate the universal shaftadapter fully counterclockwise.
 - e. Mount the actuator to the VAV damper box and shaft.
 - f. Tighten the two bolts on the centering clamp (8 mm wrench; 70 lb.-in. [8Nm] torque).
 - g. When the actuator closes, the damper rotates CW either 45 or 60 degrees to fully close.

When twin tubing is used from the pickup, split the pickup tubing a short length to accommodate the connections.

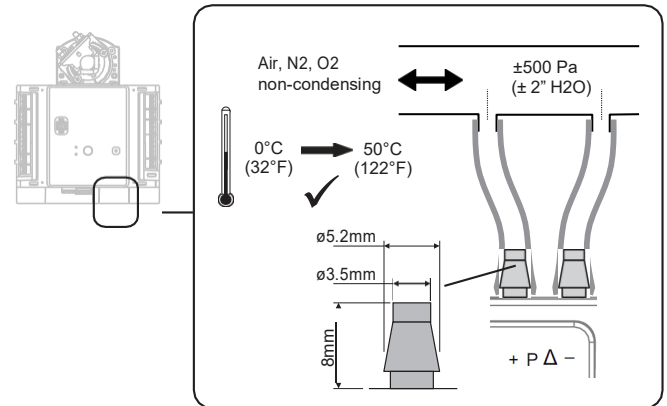


Figure 6. Airflow pickup connections

Differential Pressure Sensor

Connect the air flow pickup to the two restrictor ports on the controller.



NOTE:

Use 1/4 in. (6 mm) outside diameter, with a 3/64 in. (1 mm) wall thickness, plenum-rated 1219 FR (94V-2) tubing.

Always use a fresh cut on the end of the tubing that connects to the air flow pickups and the restrictor ports on the controller.

Connect the high pressure or upstream tube and the low pressure or downstream tube to the restrictor port on the controller.



IMPORTANT:

The pressure sensor is polarity insensitive. Pickup tubes can be connected to either restrictor port irrespective of marking on the sensor.



NOTE:

The controller must be powered up for a minimum of 1 hour before performing the zero calibration for the air flow sensor.

If controllers are mounted in unusually dusty or dirty environments, an inline, 5-micron disposable air filter (use 5-micron filters compatible with pneumatic controls) is recommended for the high-pressure line connected to the air flow pickup.

The tubing from the air flow pickup to the controller should not exceed three feet (1 m). Any length greater than this will degrade the flow sensing accuracy.

Use caution when removing tubing from a connector. Always pull straight away from the connector or use diagonal cutters to cut the edge of the tubing attached to the connector. Never remove by pulling at an angle.

NOTICE

Dust particle contamination may be present in some applications. Ensure appropriate measures are taken to minimize the effect of particulate contamination.

The sense element is in parallel to the airstream and tends to direct the dust particles in the airflow stream past the sense element away from the sense bridge. The sense element is a microstructure-based device and the bridge portion of the sense element structure is made up of two platinum sense elements and a heater. The heater tends to repel dust particles via a thermophoretic

effect past the heater and tends to keep most dust off the bridge structure. The heat affect, along with a simple filter, can help to keep the dust from causing output shifts in the output of the device. Although the sensor naturally repels dust, some dust and contamination can still collect on the microstructure. Dust adherence to chip edges and channel surfaces can be prevented by using a simple filter. A disposable five micron filter used in series on the upstream side of the airflow divide will provide adequate filtering in most applications. See [Table 4](#) for recommended filter suppliers.

Table 4. Recommended Filter Suppliers

Pall Corporation www.pall.com	
Acro 50	The filter may be used at a common mode pressure of 0.17 MPa (24.6 psi) at a temperature of 80 °C [176 °F] May be used with swag lock compression fittings Approximate pressure drop is 5 kPa at 1 SLPM of flow.
Acro cap	May be used at an operating temperature of 55 °C [131 °F] and common mode pressure of 30 psi Sensors connections are 1/4 barb fittings General Gas filter Pressure drop is 1psi with a flow of 15 SLPM Fittings are 1/8 barbed tubing.
Parker Balston www.balstonfilters.com	
Model 9933-05	US and EMEA only sales offices. May be used at common mode pressures up to 125 psi and operating temperature to 135 °C [275] °F Sensor connections are 1/4 tube.
MAHLE: https://catalog.mahleaftermarket.com/eu/product.xhtml?eid=184	
MAHLE KL13	Automotive filter

Airflow Sensor Replacement

Procedure to replace the airflow sensor is as follows:

1. Gently pull the sensor cover outward and rotate it by 75 degree.

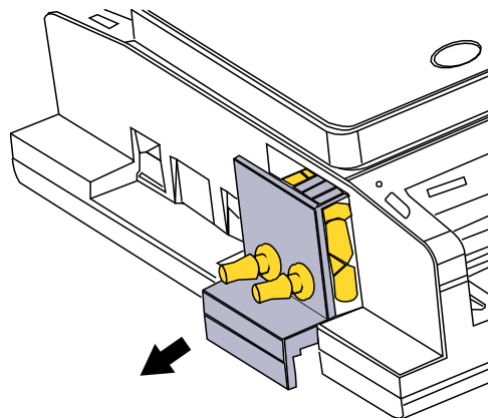


Figure 7. Removing the sensor cover

2. Disconnect the electrical connector by gently pulling it away from the differential pressure sensor.
3. Replace the airflow sensor.

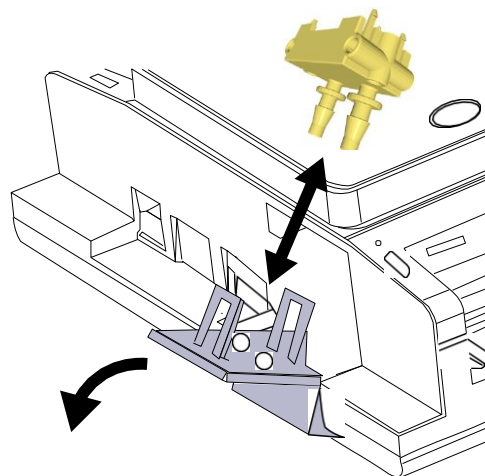
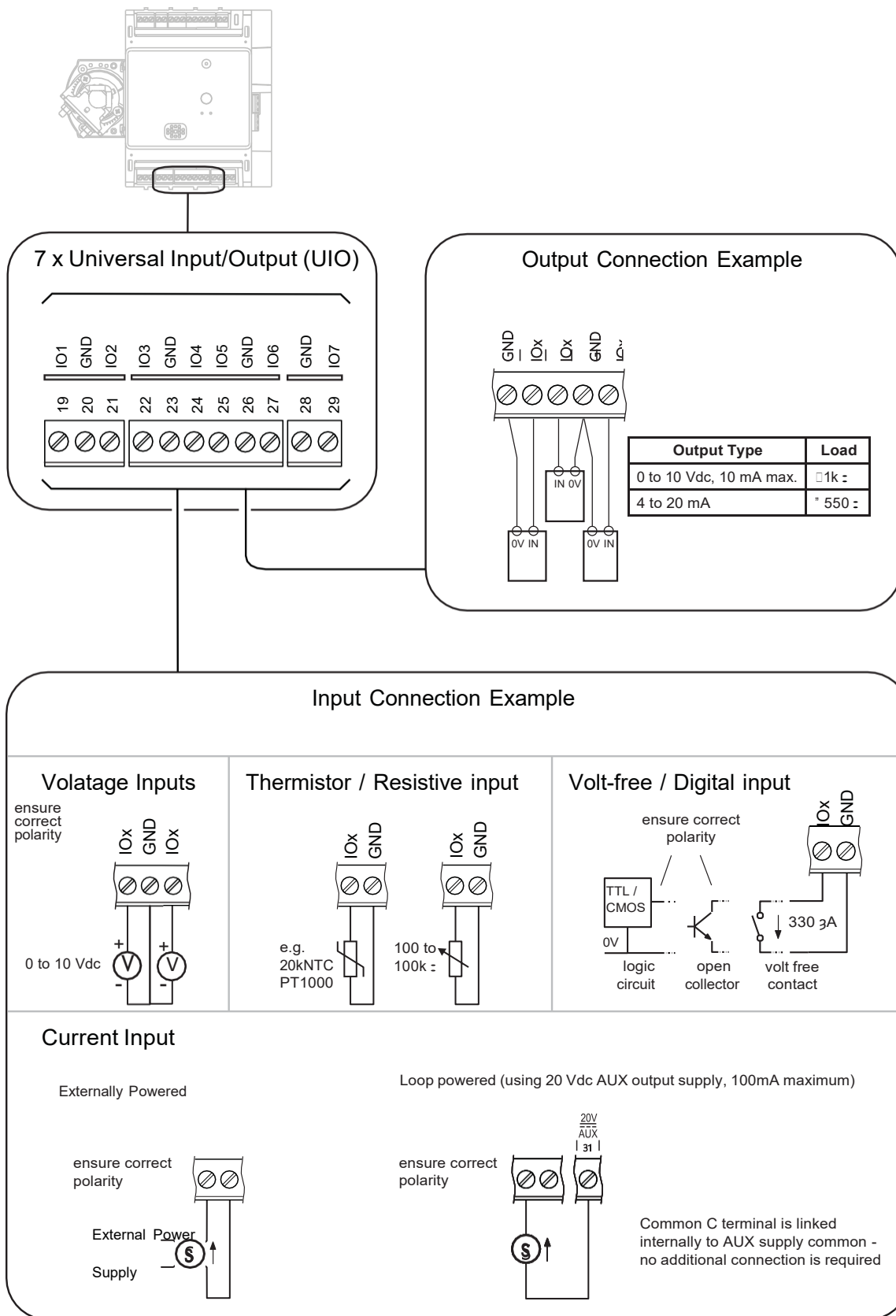


Figure 8. Replace the sensor

4. Attach the electrical connector.
5. Close the cover.

WIRING



POWER SUPPLY

General Information

To prevent a risk of injury due to electrical shock and/or damage to device due to short-circuiting, low-voltage and high-voltage lines must be kept physically separate from one another. Further, to prevent a risk of short-circuiting and damage to your unit, do not reverse the polarity of the power connection cables, and avoid ground loops (i.e., avoid connecting one field device to several controllers).

Before wiring the controller, determine the input and output device requirements for each controller used in the system. Select input and output devices compatible with the controller and the application. Consider the operating range, wiring requirements, and the environment conditions when selecting input/output devices.

Determine the location of controllers, sensors, actuators and other input/output devices and create wiring diagrams for illustrations of typical controller wiring for various configurations.

The application engineer must review the control job requirements. This includes the sequences of operation for the controller, and for the system as a whole. Usually, there are variables that must be passed between the controllers that are required for optimum system wide operation. Typical examples are the TOD, Occ/Unocc signal, the outdoor air temperature, the demand limit control signal, and the smoke control mode signal.

It is important to understand these interrelationships early in the job engineering process, to ensure proper implementation when configuring the controllers.



NOTE:

All wiring must comply with applicable electrical codes and ordinances. Refer to job or manufacturers' drawings for details. Local wiring guidelines (for example, IEC 364-6-61 or VDE 0100) may take precedence over recommendations provided in these installation instructions.

To comply with CE requirements, devices having a voltage of 50-1000 VAC or 75-1500 VDC but lack-

ing a supply cord, plug, or other means for disconnecting from the power supply must have the means of disconnection incorporated in the fixed wiring. This type of disconnection must have a contact separation of at least 1/8 in. (3 mm) at all poles.

Power Wiring

All wiring must comply with applicable electrical codes and ordinances, or as specified on installation wiring diagrams. Controller wiring is terminated to the screw terminal blocks located on the device.



NOTE:

For multiple controllers operating from a single transformer, the same side of the transformer secondary must be connected to the same power input terminal in each controller.

All loads on the controller must be powered by the same transformer that powers the controller itself. A controller can use separate transformers for controller power and output power.

The 24 VAC power from an energy limited Class II power source must be provided to the controller. To conform to Class II restrictions (U.S. only), the transformer must not be larger than 100 VA. *Figure 9 on pg 13* depicts a single controller using one transformer.



IMPORTANT:

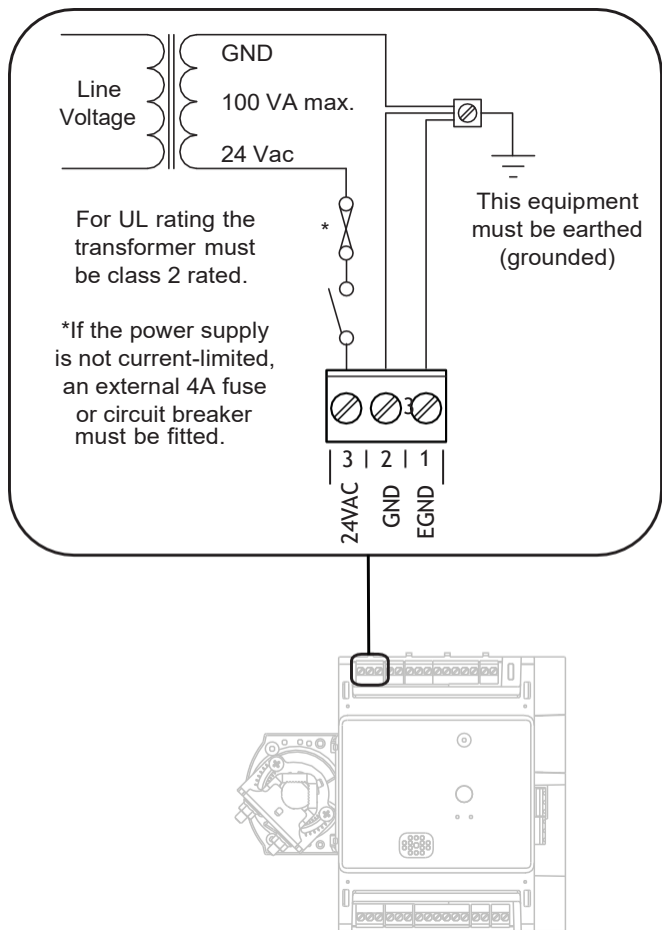
Power must be off prior to connecting to or removing connections from the 24 VAC power (24V~/24 V0), and 20 VDC power (20 VDC) terminals.

Use the heaviest gauge wire available, up to 18 AWG (0.8 mm²), with a minimum of 22 AWG (0.3mm²), for all power wiring.



CAUTION

Where multiple devices are powered from a single transformer, the same side of the transformer secondary must be connected to the same power input terminal in each device.



Supply voltage: 24 Vac (20 to 30 Vac) 50/60 Hz



Important: Where multiple devices are powered from a single transformer, the same side of the transformer secondary must be connected to the same power input terminal in each device.

Figure 9. Power wiring

The RS485 Standard

According to the RS485 standard (TIA/EIA 485: “Electrical Characteristics of Generators and Receivers for Use in Balanced Digital Multipoint Systems”), only one driver communicating via an RS485 interface may transmit data at a time. Further, according to U.L. requirements, each RS485 interface may be loaded with a max. of 32 unit loads. For example, if a controller utilizes as little as 1/8 unit load each, up to 256 devices can be connected.

BACnet connections to the RS485 interfaces must comply with the RS485 standard. Thus, it is recommended that each end of every bus should be equipped with a termination resistor (not included in shipment) having a resistance equal to the cable impedance (120 Ω; the wattage should be in the range of 0.25 – 0.5 W).

RS485 systems frequently lack a separate signal ground wire. However, the laws of physics still require that a solid ground connection be provided for in order to ensure error-free communication between drivers and receivers – unless all of the devices are electrically isolated, and no earth grounding exists.

IMPORTANT:

A separate signal ground wire must be used. Failing to obey this requirement can lead to unpredictable behavior if other electrically non-isolated devices are connected and the potential difference is too high.

TIA/EIA 485 Cable Specifications

The following cable specification is valid for BACnetMS/TP EIA 485 buses.

Table 5. TIA/EIA 485 cable specifications

Maximum length	4000 ft (9.6–78.8 kbps) or 2600 ft (115.2 kbps).
Cable type	Twisted pair shielded (foil or braided shields are acceptable)
Characteristic impedance	100-130 Ω
Distributed capacitance between conductors	Less than 100 pF per meter (30 pF per foot)
Distributed cap. between conductors and shield	Less than 200 pF per meter (60 pF per foot)

The following cables fulfill this requirement:

- AWG 18
- Shielded, twisted pair cable J-Y-(St)-Y 4 x 2 x 0.8 mm2.
- CAT 5,6,7 cable - use only one single pair for one bus
- Belden 9842 or 9842NH.

Wiring Method



NOTE:

When attaching two or more wires to the same terminal, other than 14 AWG (2.0 mm²), be sure to twist them together. Deviation from this rule can result in improper electrical contact, see [Figure. 10](#) below.

Each terminal can accommodate the following gauges of wire:

- Single wire: from 22 AWG to 18 AWG solid or stranded
- Multiple wires: up to two 18 AWG stranded, with 1/4 watt wire-wound resistor
 - Prepare wiring for the terminal blocks, as follows:
 - Strip 1/2 in. (13 mm) insulation from the conductor.
 - Cut a single wire to 3/16 in. (5 mm). Insert the wire in the required terminal location and tighten the screw.
 - If two or more wires are being inserted into one terminal location, twist the wires together a minimum of three turns before inserting them, see [Figure. 10](#) below.
 - Cut the twisted end of the wires to 3/16 in. (5 mm) before inserting them into the terminal and tightening the screw.
 - Pull on each wire in all terminals to check for good mechanical connection.



NOTE:

Do not over-tighten the terminal screws to avoid deformation and damage of the terminal block. The maximum torque for the terminal screws 4.4lb.-in. (0.5 Nm).

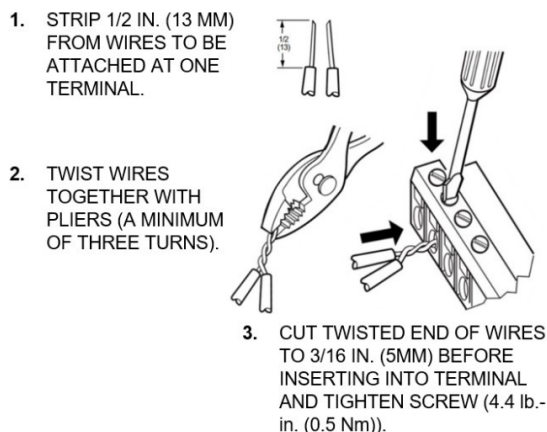


Figure 10. Attaching two or more wires at terminal block

COMMUNICATION

BACNET MS/TP

Each controller uses a BACnet MS/TP communications port. The controller's data is presented to other controllers over a twisted-pair MS/TP network, which uses the TIA/EIA 485 signaling standard capable of the following baud rates: 9.6, 19.2, 38.4, 76.8, 57.6 or 115.2 Kilobits per second. The BACnet controllers are master devices on the MS/TP network. Each BACnet controller uses a high-quality TIA/EIA 485 transceiver and exerts 1/8 unit load on the MS/TP network.

The controller features an isolated RS485 interface (terminals 32, 33, and 34) suitable for BACnet MS/TP communication. The terminal block containing it is Grey. The cable length affects the baud rate, see [Table 6](#) below..

Table 6. Baud rate vs. Maximum cable length

Baud rate	Maximum cable length (L)
9.6, 19.2, 38.4, 57.6, 76.8 and 115.2 kbps	4000 ft (1200 m)

NOTE:

The maximum BACnet MS/TP network Bus segment length is 4,000 ft. (1200 m) using recommended wiring. Repeaters must be used when making runs longer than 4,000 ft. (1200 m). A maximum of three repeaters can be used between any two devices.

Setting the MS/TP MAC Address

The MS/TP MAC address for each device must be set to a unique value in the range of 1-127 on an MS/TP network segment (address 0, 1, 2, & 3 should be avoided as they are commonly used for the router, diagnostic tools, and as spare addresses). A seven position DIP switch on the BACnet MS/TP BACnet controller is used to set the controller's MAC address.

NOTE:

DIP setting of all-ON or all-OFF will enable the Auto MAC mode in controller and the dip switches will not be used for MAC addressing.

See ["Automatic MAC Addressing" on page 22.](#)



To set the MS/TP MAC address of a BACNET BACnetMSTP VAV controller:

1. Find an unused MAC address on the MS/TP network to which the BACnet MS/TP VAV controller connects.
2. Locate the DIP switch bank on the BACNET MS/TP VAV controller BACnet for addressing.
3. Powered off the BACNET MS/TP BACnet Controller and set the DIP switches for the MAC Address you want. Add the value of DIP switches set to ON to determine the MAC address. See [Table 7](#) below.

Table 7. DIP Switch Values For MS/TP MAC Address

DIP	7	6	5	4	3	2	1
VALUE	64	32	16	8	4	2	1

For example, if only DIP switches 1, 3, 5, and 7 are enabled the MAC address would be 85 (1 + 4 + 16 + 64 = 85).

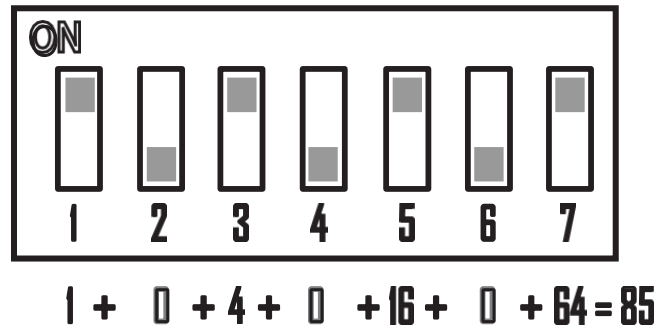


Figure 11. Calculating MAC address

Setting the Device Instance Number

The Device Instance Number must be unique across the entire BACnet system network because it is used to uniquely identify the BACnet devices. It may be used to conveniently identify the BACnet device from other devices during installation. The BACnet MS/TP BACnet Controllers Device Instance Number is automatically set when it is added to a WEBStation-NX project. The Device Instance Number can be changed by the user, which may be necessary when integrating with a third party or when attempting to replace an existing controller and it is desired to maintain the existing Device Instance Number.

IMPORTANT:

This controller is insensitive to bias voltages because of failsafe chip-set inside and can share the BACnet bus with other devices with or without bias voltages.

Termination Resistors

Matched terminating resistors are required at each end of a segment bus wired across (+) and (-). Use matched precision resistors rated ¼ W ±1% / 80 - 130Ω.

Ideally, the value of the terminating resistors should match the rated characteristic impedance of the installed cable. For example, if the installed MS/TP cable has a listed characteristic impedance of 120Ω, install 120 Ω matched precision resistors.

Shield Termination

Following proper MS/TP cabling shield grounding procedures is important to minimize the risk of communication problems and equipment damage caused by capacitive coupling. Capacitive coupling is caused by placing MS/TP cabling close to lines carrying higher voltage. If shielding is used, the shielding of each individual bus segment should be separately connected at one end to earth.

NOTE:
If any of the devices are electrically isolated, it is recommended that those devices be connected to signal ground.

Connecting to BACnet MS/TP Buses

The controller communicates via its BACnet MS/TP interface with other BACnet MS/TP-capable devices (for example, other room controllers or MS/TP controllers). In doing so, the following considerations should be taken into account.

- Maximum BACnet MS/TP bus length (= "L" on [Figure 12](#). See [Table 6, "Baud rate vs. Maximum cable length,"](#) on [page 15](#).
- Twisted-pair cable, for example,
 - AWG 18
 - J-Y(ST)Y 4 x 2 x 0.8 mm² or a special RS485 cable.
 - CAT 5,6,7 cable – use only one single pair for one bus

- Belden 9842 or 9842NH and
- Daisy-chain topology.
- Must conform to TIA/EIA RS485 cabling guidelines and ANSI/ASHRAE Standard 135-2010.

BACnet MS/TP Limitations

There are two limitations regarding the number of controllers per BACnet MS/TP channel:

PHYSICAL LIMITATION:

32 loads as per TIA/EIA-485 standard. One BACnet MSTPVAV controller represents 1/8 load. The physical limitation is important in case 3rd party devices representing a full load are connected.

AUTOMAC LIMITATION:

See [Table 8, "MAC Address,"](#) on [page 16](#) for default maxmaster value. It can be modified by the user. Refer *IRM Engineering Tool User Guide - 31-00282* for more information on how to do this.

A maxMaster of 127 means we can support a maximum of 125 BACnet MSTP VAV controllers, one supervisor, and one BACnet client (tool) per BACnet MS/TP channel.

Thus, depending upon the actual performance needs and required communication rates, it is recommended to connect a smaller number of BACnet MS/TP devices per channel. The recommendation is not to have more than 62 controllers on single MSTP channel.

Table 8. MAC Address

Brand	Default maxmaster	Default MinMAC	Default MaxMAC	Default Baud rate
Centraline	64	1	60	38400
Webs	127	1	127	76800
HBS	35	1	30	38400

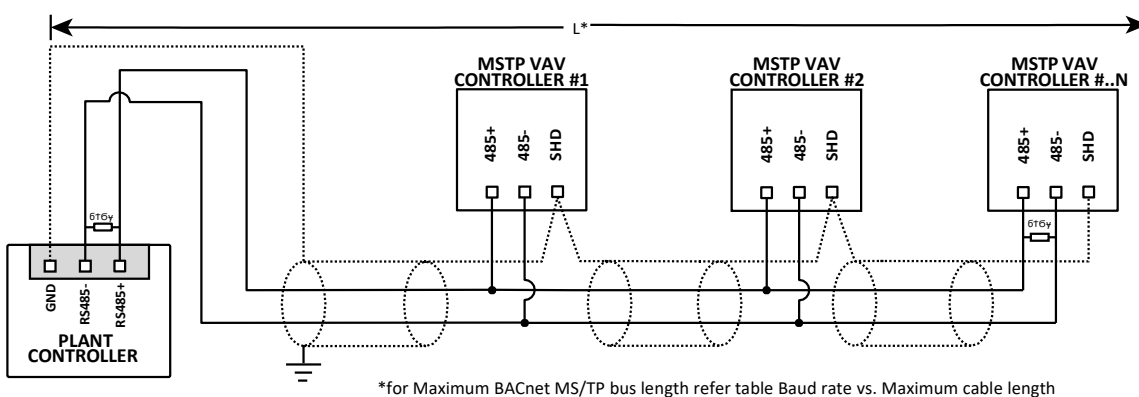


Figure 12. Connection to a BACnet MS/TP Bus

BACNET IP

Table 9. Default IP Address

Static IP Address	0.0.0.0
Subnet Mask	0.0.0.0
Default Gateway	0.0.0.0

Connecting to a IP network

BACnet IP VAV controller communicates over IP V4 network using:

1. Wired - Using Ethernet connection via either port.
2. Wireless* - Using integrated Wi-Fi support and optional external antennae.
* Wireless functionality is for future use.

Controller will search for a DHCP server to acquire an IP address for 15 seconds after powering ON. If DHCP server is not found, controller will switch to Auto IP mode. In Auto IP mode controller will follow Link Local Addressing for Address Resolution and will acquire an IP address in range 169.254.1.0 - 169.254.254.254.

NOTE:

Controller will use last 2 characters of its Serial Number as last octet for starting address search.

Static IP Configuration

Static IP address can be configured using Niagara workbench.

1. Navigate to IP configuration under IP settings.
2. Select the IP address as **Static**.
3. Select **Enabled** as True.
4. Configure a valid **IP address**.

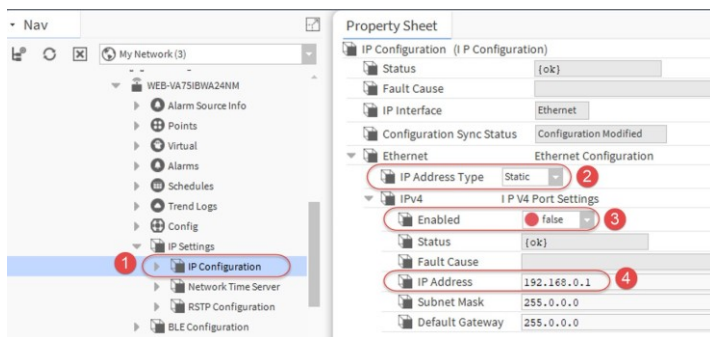


Figure 13. Static IP Configuration

Refer *IRM Engineering Tool User Guide - 31-00282* for more information on how to do this.

Network Topologies

- Recommended cable: Cat5/Cat6
- Maximum distance between 2 controllers or controller and switch should be less than 328 ft. (100 meters)

Non-Failover (Daisy Chain)

In non-failover, that is daisy chain connection type, if any of the device in the network fails, the devices next to the failed device also fail.

For example, there are 10 devices in a network and device number 1 is the master device, which is connected to device 2, and device 2 is connected to 3, and so on. If device 5 fails to function, the device after 5, that is 6, 7, 8, 9, and 10 also fail to communicate with master device.

Maximum number of controller that can be connected in a daisy chain is 200.

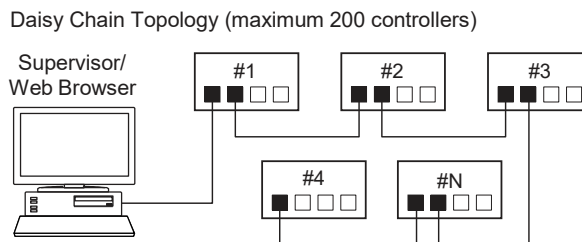


Figure 14. Daisy chain topology

Spanning Tree Protocol (RSTP)

If the BACnet IP VAV controllers are to be connected in a redundant ring, then you must have one spanning tree protocol supported Ethernet switch as a part of the ring. BACNET IP VAV supports Ethernet switch for 10/100 Mbps IP connection.

The switch will connect BACnet IP VAV ring with the backbone network. The loop-free topology ensures that there is no broadcast storms and duplicate frame transmission. Maximum number of controllers that can be connected in STP loop is 40. The connection of a loop managed by a switch.

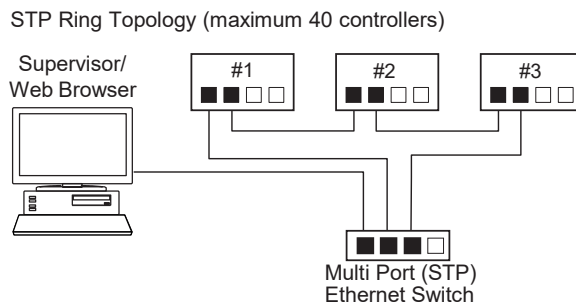


Figure 15. STP wiring

Antenna

IP and MSTP VAV controller has a local rubber antenna included in the kit. The antenna facilitates wireless communication via Wi-Fi and Bluetooth with other devices. If the IP VAV controller is mounted inside a cabinet/enclosure and you are using the local antenna, use an enclosure that is made of a nonmetallic material to achieve a reliable wireless signal.

Replace the local antenna with the Remote antenna when an extended range is needed or when the IP VAV controller is mounted in a metal cabinet/enclosure. The Remote antenna has a cable that connects to the IP and MSTP VAV controller, and the antenna is mounted outside the cabinet/enclosure. When the IP or MSTP VAV controller are mounted inside a metal cabinet/enclosure, the Remote Antenna is required to achieve a reliable wireless signal.

Installing the Local Antenna

5. Insert local antenna terminal nut into the SMA connector.
6. Tighten by turning the base of the antenna clockwise.

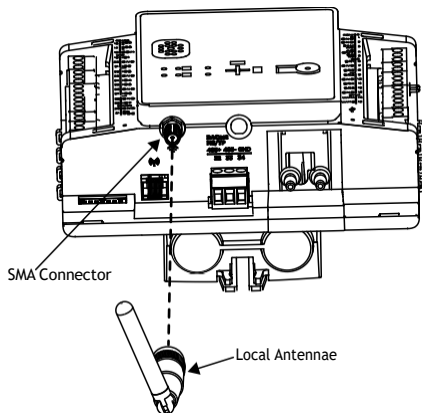


Figure 16. Installing a Local Antenna

Installing the Remote Antenna

1. Uninstall the Local antenna by turning the base of the antenna counter-clockwise.
2. Place the Remote antenna where the signal reception is good.
3. Safely route the Remote antenna wire terminal nut to the IP VAV controller.
4. Insert the wire terminal nut into the SMA connector.
5. Tighten the wire terminal nut by turning the nut clock-wise. Do not over-tighten.

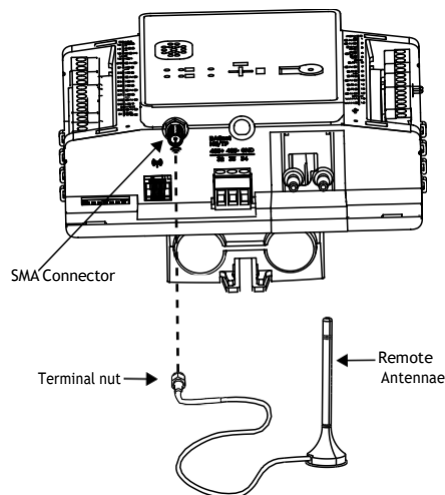


Figure 17. Installing a Remote Antenna

Remote Antenna Placement

Table 10. types of building materials and range reduction

Wall Material	Range Reduction
Wood, drywall, glass	0-10%
Brick, Particle board	5-25%
metal, steel-reinforced concrete wall	10-90%

- The antenna has a strong signal transmission and reception from the side. See figure below. Position the sides of the antenna towards the device it is communicating with

- Do not install the antenna close to the floor.

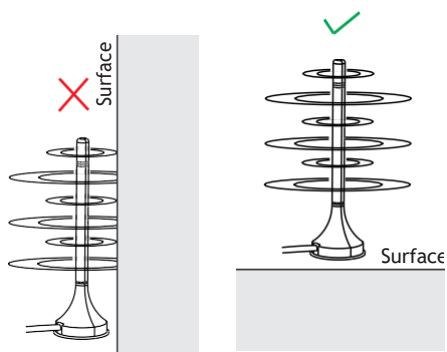


Figure 19. Remote Antennae Placement

- The Local antenna can be used when the IP and MSTP VAV controller is installed in a plastic cabinet/enclosure.

SYLK BUS™

Sylk™ Bus capable wall modules such as TR40x / T42x can be connected to the controller's Sylk™ Interface (terminals 14 and 15).

- The Sylk™ Bus is single pair, and polarity-insensitive.
- Maximum current provided at the Sylk™ Bus interface: 96mA.
- The maximum number of wall modules depends on the following wall module specific information:
 - Sylk™ bus power consumption
 - Number of parameters used
 - Total config file size

The Niagara tool has an inbuilt resource calculator to calculate the number of Sylk™ wall modules. The Sylk™ devices supported by the WEB-VA423B24N are;

- TR40, TR40-H, TR40-CO2, TR40-H-CO2
- TR42, TR42-H, TR42-CO2, TR42-H-CO2,
- TR71, TR71-H,
- TR75, TR75-H,
- TR120, TR120H and
- C7400S Sylk™ sensor.



NOTE:

The TR42x Wall Module must be version 1.00.3 or higher. TR70 Wall Modules are not supported.

Table 11. Recommended max. distances from controller to TR40x/T42x wall modules

Single twisted pair, Non-Shielded, Stranded or Solid ^{c)}		Standard non-twisted thermostat wire shielded or Non- Shielded, Stranded or Solid ^{d)}
18 - 22 AWG (0.33 to 0.82mm ²)	24 AWG (0.20 mm ²)	18 - 24 AWG (0.20 to 0.82 mm ²)

Table 11. Recommended max. distances from controller to TR40x/T42x wall modules (Continued)

Single twisted pair, Non-Shielded, Stranded or Solid ^{c)}		Standard non-twisted thermostat wire shielded or Non- Shielded, Stranded or Solid ^{d)}
500 ft (150 m)	400 ft (120 m)	100 ft (30 m)

^{c)} As a rule of thumb, single twisted pair (two wires per cable, only), thicker gauge, non-shielded cable yields the best results for longer runs.

^{d)} The 100 ft (30 m) distance for standard thermostat wire is conservative but is meant to reduce the impact of any sources of electrical noise (incl. but not limited to VFDs, electronic ballasts, etc.). Shielded cable recommended only if there is a need to reduce the effect of electrical noise. These distances apply also for shielded twisted pair.

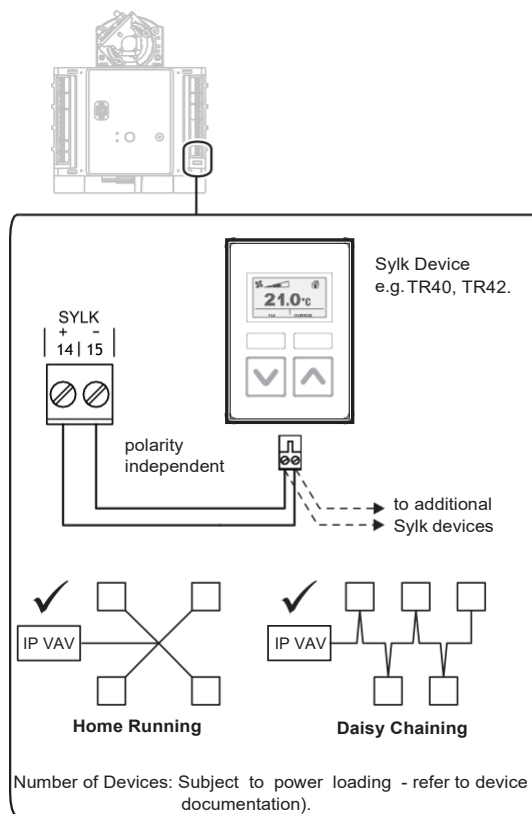


Figure 20. Sylk™ Wiring Topologies

MODBUS

The controller features a removable non-isolated RS485 interface suitable for Modbus communication (terminal 16, 17, and 18). The terminal block containing it is grey. The controller can function only as a Modbus Master. In general, the TIA/EIA 485 wiring rules must be followed.

Wiring Topology

Only daisy-chain wiring topology is allowed.

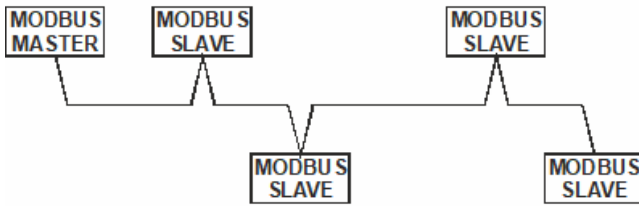


Figure 1. Allowed Modbus Wiring Topology

Other wiring topologies (such as, star wiring, mixed star wiring, and daisy chain wiring) are prohibited. This is to avoid communication problems of the physical layer.

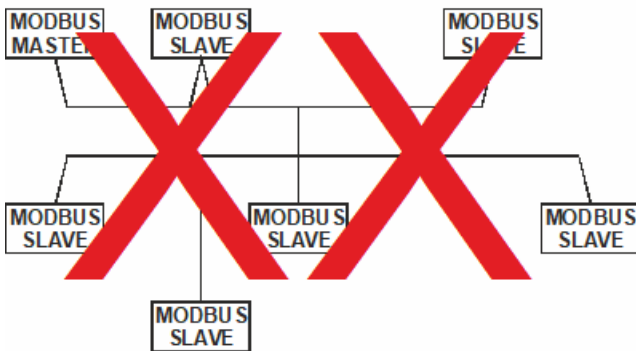


Figure 2. Prohibited Modbus wiring topology (example)

Cables and Shielding

See [“TIA/EIA 485 Cable Specifications” on page 14.](#)

Use shielded twisted pair cable J-Y-(St)-Y 4 x 2 x 0.8 and connect the Modbus shield to a noise-free earth ground - only once per Modbus connection.

Shielding is especially recommended when the Modbus cable is installed in areas with expected or actual electromagnetic noise. Avoiding such areas is to be preferred.

You must use three wires:

- One wire for Modbus +
- One wire for Modbus -
- One wire for the signal common

When using one pair for Modbus (+) and Modbus (-) and

one wire of another pair for the signal common, CAT5 cable may also be used.

RS485 Repeaters

RS485 repeaters are possible but have not been tested by Honeywell. Therefore it is the responsibility of the installing / commissioning person to ensure proper function.



NOTE:

Each Modbus segment will require its own line polarization and line termination.

Modbus Master Specifications

Modbus Compliance

As per the Modbus standard, the controller is a conditionally compliant “regular” Modbus device.

The controller differs from an unconditionally compliant “regular” Modbus device in that, it does not support communication rates of 1.2, 2.4, and 4.8 kbps (because these communication rates are not market-relevant).

Physical Layer	2-wire serial line (TIA/EIA-485) (with additional common)
Communication rates:	9.6, 19.2, 38.4, 57.6, 76.8, and 115.2 kbps supported.
Maximum number of devices:	32 It is recommended to connect a smaller number of devices for better Modbus performance.
Cable and wiring specifications:	See section TIA-EIA 485 Cable Specifications on pg. 13
Communication Mode	Always Modbus Master.
Transmission Mode	RTU (Remote Terminal Unit).
Address Range	Modbus slaves can have an address between 1 and 247. Discrete Inputs, Coils, Input Registers and Holding Registers can have an address between 1 and 65534.

Modbus Considerations

The RS485 interface suitable for Modbus communication is non-isolated, hence the following considerations apply:

- Maximum Modbus length (“L”): 4000 ft (9.6 – 78.8 kbps) or 2600 ft (115.2 kbps) See [“TIA/EIA 485 Cable Specifications” on page 14.](#) It is recommended that you select a low baud rate (for example, 19.2 kbps) for reliable operation.
- Use only shielded, twisted-pair of cables and daisy-chain topology.
- Ground noise should not exceed the EIA-485 commonmode voltage limit.

- Must conform to TIA/EIA 485 cabling guidelines. See [“TIA/EIA 485 Cable Specifications” on page 14.](#)
- Should not extend beyond a single building.
- It is recommended that you select a low baud rate (for example, 19.2 kbps) for reliable operation.

With regards to [Figure 3](#) above, note the following:



NOTE:

1. If any of the devices are electrically isolated, it is recommended that those devices be connected to the ground terminal (GND), if available. See [“TIA/EIA 485 Cable Specifications” on page 14.](#)
2. The 120-Ohm termination resistor must be inserted directly into the terminals of both end devices.
3. If shielding is used, the shielding of each individual bus segment should be separately connected at one end to earth.
4. Always power each controller and the connected slaves via separate transformers.
5. Between devices equipped with non-isolated RS485 bus interfaces, potential differences of max. ± 7 V are allowed. Further, this bus should not extend beyond a single building.

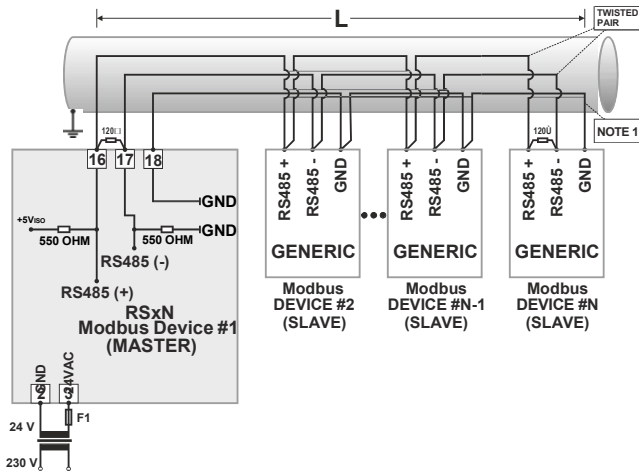


Figure 3. Modbus Master Controller and Connected Modbus Slaves (with inserted termination resistors)

COMMISSIONING

Automatic MAC Addressing

NOTE: Automatic MAC addressing will be enabled only if dip switches are all-on or all-off.

In contrast to other controllers, the BACNET MSTP controllers features automatic MAC addressing.

The MAC addresses which the individual BACNET MSTP VAV controller in the BACnet MS/TP channel assign to themselves are not assigned in sequential order.

Rather, they assign the MAC Address in the range of minMAC to max MAC (these are exposed as the proprietary properties id 1028 (min MAC) and 1029 (maxMAC) under device object) currently not in use by another device in the BACnet MS/TP channel (the MAC Address of "0" is reserved by default for the router / plant controller, itself).

All BACNET MSTP VAV controllers are BACnet MS/TP masters. Every master performs periodic polling for the possible appearance of new masters. Each master "knows" the identity of the "next" master (i.e., that BACNET MSTP VAV controller with the next-highest MACAddress) on the BACnet MS/TP bus and to which it must therefore pass the token. The polling process includes a search for new masters which might have MAC addresses lying between its own MAC address and that of the "next" master.

The property maxMaster specifies the highest- allowable address for master nodes. The maxMaster is set to 127/64/35 by default, thus guaranteeing that, on a BACnet MS/TP bus with, for example, 35 BACnet MSTP VAV controllers, all of the other BACnet MSTP VAV controllers will be found. Following properties are writeable and can be changed:

- maxMaster
- min MAC
- max MAC
- MAC address.

NOTE: You should not attempt to program a MAC Address outside the range of min MAC and maxMAC (1 to 127).

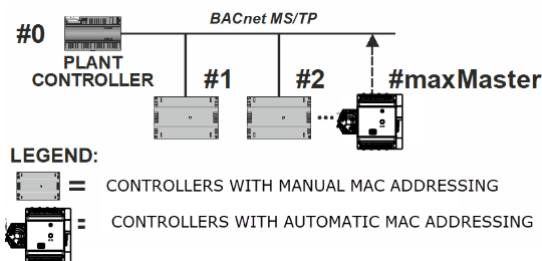


Figure 21. Automatic MAC addressing

In the scenario depicted in Figure 21 above, some of the controllers in the BACnet MS/TP channel do not feature automatic MAC addressing; rather, their MAC addresses were assigned manually. Thus, when a new BACNET MSTP VAV is added to the channel, and its automatic MAC addressing function is triggered, it will assign itself an available (unused) MAC address within the range of min MAC and max MAC values.

Operator interface LEDs

The controller features the following LEDs:

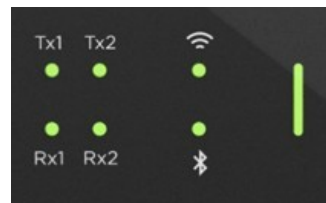


Table 12. Status LED

Legend	Colour	Function
TX1	Green*	The IP VAV controller is equipped with two Tx LEDs and two corresponding Rx LEDs. These LEDs indicate the transmission and reception of data by the two RS485 interfaces
RX1		
RX1		
RX2		
Bluetooth	Green	Indicates that the Bluetooth is working properly
Vertical Bar	Green Breathe	Indicates that the device is working properly.
	Yellow Blink	Indicates that the device is having minor issues such as connection failure.
	Red Blink	Indicates that the device is having severe issue such as CPU failure.
*In case of no communication LED will not glow.		

Table 13. Status LED and power LED behaviors

Mode	
Power failure	inputs required
Device error ^(a)	
Firmware Download	
No application	
Broken sensor	
Short-circuiting	
Auto-MAC	
Unacknowledged alarm	
Normal operation	

^(a)Return the controller for repair. Contact HoneywellWEBs Customer Care for assistance.

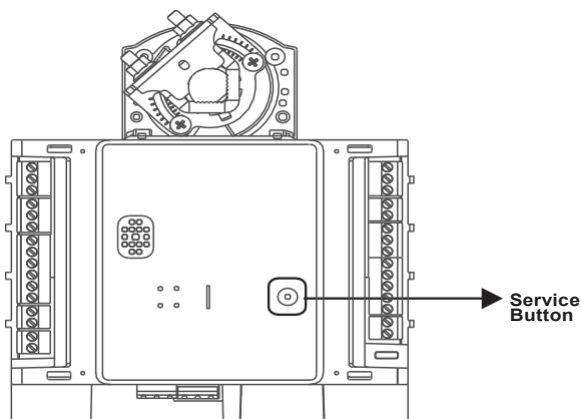
The ON/OFF frequencies listed in Table above can beconverted from "Hz" (i.e., "ON/OFF per second") to "ON/OFF per minute" by multiplying them by 60.

- The maxMaster setting will revert to its default value of127.
- The Max info frames will revert to 10.
- The device instance will revert to its default of 4194302.
- The device name will revert to WEB-[ModelName].
- The values of Auto MAC, Min MAC and Max MAC will bereset to 1 and 127/64/35, respectively.

Pressing Service Button during Normal Operation

During normal operation of the controller, a short press (< 1 sec) of the Service Button will cause a Service Pin Message (BACnet WhoAmI as a PrivateTransfer (SerialNo. = 130)) to be sent.

Service Button



The Service Button is used to trigger dedicated events. It is important to distinguish different controller behaviors which are elicited depending upon whether the Service Button is pressed when thecontroller is powering up or when it is in normal operation.

See the following dedicated events.

Pressing Service Button during Power-Up

If the service pin is pressed and then the controller isswitched on (while the service pin is still pressed), a reset to factory delivery is performed. **The service button has to be pressed until the green power LED goes out at least twice and is switched on again.**

Factory defaults are as follows:

- The application is cleared from the controller.
- The MAC address will be set to 0xFF, meaning that the controller will now search for a new mac address (Auto-MAC will be automatically triggered after controller power-up).

REGULATORY INFORMATION

FCC Regulation

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:

(1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation.

This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications.

However, there is no guarantee that interference will not occur in a particular installation.

If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

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



IMPORTANT:

Changes or modifications to this unit not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

Canadian Regulatory Statement

This device complies with Industry Canada license-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes : (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

EMF Statement: To maintain compliance with the RF exposure requirement, a separation distance of 20 cm between the device and the human should be maintained.

Déclaration d'exposition Attention: Cet émetteur doit être installé pour fournir une distance de séparation d'au moins 20 cm de toute personne.

Professional Installation Warning

- This device must be professionally installed, this should be noted on grantee.
- To maintain compliance, only the antenna types that have been tested shall be used, which listed in [Table 2, "Remote Antenna Part Numbers," on page 3](#).
- This device requires a significant technology engineering expertise towards understanding of the tools and relevant technology, not readily available to average consumer. Only a person professionally trained in the technology is competent. This device is not directly marketed or sold to general public.

Detachable Antennae Warning (IC)

Transmitter Antenna (From Section 6.8 RSS-GEN, Issue 5, April 2018):

— This radio transmitter 24552-00005 has been approved by Innovation, Science and Economic Development Canada to operate with the antenna types listed below, with the maximum permissible gain indicated. Antenna types not included in this list that have a gain greater than the maximum gain indicated for any type listed are strictly prohibited for use with this device.

— Le présent émetteur radio [24552-00005] a été approuvé par Innovation, Sciences et Développement économique Canada pour fonctionner avec les types d'antenne énumérés ci-dessous et ayant un gain admissible maximal. Les types d'antenne non inclus dans cette liste, et dont le gain est supérieur au gain maximal indiqué pour tout type figurant sur la liste, sont strictement interdits pour l'exploitation de l'émetteur.

CERTIFICATIONS, ETC.

Approvals and Certifications

- UL 60730-1, Standard for Automatic Electric Controls for Household and Similar Use, Part 1: General Requirements;
- CAN/CSA-E60730-1:02, Standard for Automatic Electrical Controls for Household and Similar Use, Part 1: General Requirements;
- Complementary listing for UL916, CSA C22.2 No. 205;
- BTL-listed, BACnet AAC profile;
- CE-approved;
- FCC part 15B-compliant.
- RoHS Conformity



WEEE DIRECTIVE

At the end of the product life, dispose of the packaging and product in an appropriate recycling center.

Do not dispose of the device with the usual domestic refuse.

Do not burn the device.

Article 33 Communication

REGULATION (EC) No 1907/2006 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 18 December 2006

Concerning the Registration, Evaluation, Authorization and Restriction of Chemicals (REACH)

Honeywell takes compliance with REACH very seriously.

According to Article 33 “Duty to communicate information on substances in articles”:

- Any supplier of an article containing a substance meeting the criteria in Article 57 and identified in accordance with Article 59(1) in a concentration above 0,1% weight by weight (w/w) shall provide the recipient of the article with sufficient information, available to the supplier, to allow safe use of the article including, as a minimum, the name of that substance.
- On request by a consumer any supplier of an article containing a substance meeting the criteria in Article 57 and identified in accordance with Article 59(1) in a concentration above 0,1% weight by weight (w/w) shall provide the consumer with sufficient information, available to the supplier, to allow safe use of the article including, as a minimum, the name of that substance. Our duty is to inform you that the substance(s) listed below may be contained in these products above the threshold level of 0.1% by weight of the listed article.

Product / Part Name	Substance Name
WEB-VA75MB24NM / PWBA	Lead (Pb)

We confirm that our products do not use any other REACH restricted materials during the manufacturing, storage or handling process.

APPENDIX

Sensor Input Accuracy

The controller's internal sensor inputs support both NTC10KΩ and NTC20 kΩ sensors. The following table lists the typical minimum accuracies of the hardware and software for these temperature sensors.

Table 15. Accuracies of internal NTC10kΩ and NTC20kΩ sensor inputs of the controller

Range	Measurement error (excluding sensor characteristics)				
	NTC10kΩ ^(a)	NTC20k	Johnson A99 ^(b)	PT3000	NI1000TK5000 ^(c)
-58 to -4 °F (-50 to -20 °C)	≤ 5.0 K	≤ 5.0 K	≤ 1.2 K	≤ 1.2 K	≤ 1.2 K
-4 to +32 °F (-20 to 0 °C)	≤ 1.0 K	≤ 1.0 K	≤ 0.7 K	≤ 0.7 K	≤ 0.7 K
32 to 86 °F (0 to 30 °C)	≤ 0.5 K	≤ 0.3 K	≤ 0.5 K	≤ 0.5 K	≤ 0.5 K
86 to 158 °F (30 to 70 °C)	≤ 0.5 K	≤ 0.5 K	≤ 0.7 K	≤ 0.7 K	≤ 0.7 K
158 to 212 °F (70 to 100 °C)	≤ 1.0 K	≤ 1.0 K	≤ 1.2 K	≤ 1.2 K	≤ 1.2 K
212 to 266 °F (100 to 130 °C)	--	≤ 3.0 K	≤ 1.2 K	≤ 1.2 K	≤ 1.2 K
266 to 302 °F (130 to 150 °C)	--	≤ 5.5 K	≤ 1.2 K	≤ 1.2 K	--
302 to 752 °F (150 to 400 °C)	--	--	--	--	--

^(a) NTC10kΩ specified for -22 to 212 °F (-30 to +100 °C) only.
^(b) Johnson A99 specified for -40 to +248 °F (-40 to +120 °C) only.
^(c) NI1000TK5000 specified for -22 to +266 °F (-30...+130 °C) only.



NOTE:

This is the accuracy of the internal sensor input (hardware + software [linearization]), only. This table does not include the characteristics of the sensors, themselves (see section “Sensor Characteristics below). If a different sensor or sensor accuracy is required, one may instead use the inputs of, such as a connected Panel I/O module.

Recognition of Sensor Failure of Sensor Inputs

The thresholds at which sensor failures – i.e., sensor breaks (SB) and short-circuits (SC) – are recognized depends upon the given sensor type. In the event of a recognized sensor failure, the sensor assume the safety values configured in CARE. *Table 16, “Thresholds for short-circuit (SC) and sensor-break (SB) recognition,” on page 26* lists the measurement ranges and the corresponding thresholds for the recognition of sensor failure for the various different sensor types:

Table 16. Thresholds for short-circuit (SC) and sensor-break (SB) recognition

I/O configuration	Measurement range	Recognition thresholds
2to10 V	2to10 V / 4to20 mA (without pull-up)	SC: < 1.5 V / 3 mA; SB: no recognition
NTC10kΩ (TypeII)	-22 to +212 °F (-30 to +100 °C)	SC: < 20 Ω; SB: < -94 °F (-70 °C)
NTC20kΩ	-58 to +302 °F (-50 to +150 °C)	SC: < 20 Ω; SB: < -94 °F (-70 °C)
PT1000	-58 to +752 °F (-50 to +400 °C)	SC: < 775 Ω; SB: < -58 °F (-50 °C)
Ni1000TK5000	-22 to +266 °F (-30 to +130 °C)	SC: < 850 Ω; SB: < -58 °F (-30 °C)
PT100	-58 to +752 °F (-50 to +400 °C)	Inputs required
PT3000	-58 to +302 °F (-50 to +150 °C)	Inputs required
10K3A1	-40 to +257 °F (-40 to +125 °C)	Inputs required
Nickel Class B DIN 43760 sensors	-76 to +752 °F (-60 to +169 °C)	Inputs required
JOHNSON A99	-40 to +248 °F (-40 to +120 °C)	Inputs required



NOTE:

In the case of temperatures lying outside the aforementioned ranges, the lowest/highest value within the range, instead, will be communicated. Thus, a temperature of -51 °F will be communicated as “-50 °F.”

SENSOR CHARACTERISTICS

The characteristics (resistance in relation to temperature) of the sensors and the resultant voltage are listed on the following pages. The stated values do not include failures due to sensor failures; wiring resistance or wiring failures; misreadings due to a meter connected to measure resistance or voltage at the input.

NTC10K TYPE II

Temp. [°F]	Temp. [°C]	Resistance [KΩ]	Terminal voltage [V]
-22	-30	177	7.904
-20.2	-29	166.35	7.848
-18.4	-28	156.413	7.79
-16.6	-27	147.136	7.73
-14.8	-26	138.47	7.666
-13	-25	130.372	7.601
-11.2	-24	122.8	7.534
-9.4	-23	115.718	7.464
-7.6	-22	109.089	7.392
-5.8	-21	102.883	7.318
-4	-20	97.073	7.241
-2.2	-19	91.597	7.161
-0.4	-18	86.471	7.08
1.4	-17	81.667	6.996
3.2	-16	77.161	6.91
5	-15	72.932	6.821
6.8	-14	68.962	6.731
8.6	-13	65.231	6.639
10.4	-12	61.723	6.545
12.2	-11	58.424	6.448
14	-10	55.321	6.351
15.8	-9	52.399	6.251
17.6	-8	49.648	6.15
19.4	-7	47.058	6.047
21.2	-6	44.617	5.943
23	-5	42.317	5.838
24.8	-4	40.15	5.732
26.6	-3	38.106	5.624
28.4	-2	36.18	5.516
30.2	-1	34.363	5.408
32	0	32.65	5.299
33.8	1	31.027	5.189
35.6	2	29.494	5.079
37.4	3	28.047	4.969
39.2	4	26.68	4.859
41	5	25.388	4.75
42.8	6	24.166	4.641
44.6	7	23.01	4.532
46.4	8	21.916	4.423
48.2	9	20.88	4.316
50	10	19.898	4.209
51.8	11	18.968	4.103

Temp. [°F]	Temp. [°C]	Resistance [KΩ]	Terminal voltage [V]
53.6	12	18.087	3.998
55.4	13	17.252	3.894
57.2	14	16.46	3.792
59	15	15.708	3.69
60.8	16	14.995	3.591
62.6	17	14.319	3.492
64.4	18	13.678	3.396
66.2	19	13.068	3.3
68	20	12.49	3.207
69.8	21	11.94	3.115
71.6	22	11.418	3.025
73.4	23	10.921	2.937
75.2	24	10.449	2.85
77	25	10	2.767
78.8	26	9.572	2.684
80.6	27	9.165	2.603
82.4	28	8.777	2.524
84.2	29	8.408	2.447
86	30	8.057	2.372
87.8	31	7.722	2.299
89.6	32	7.402	2.228
91.4	33	7.098	2.159
93.2	34	6.808	2.091
95	35	6.531	2.025
96.8	36	6.267	1.962
98.6	37	6.015	1.9
100.4	38	5.775	1.84
102.2	39	5.546	1.781
104	40	5.327	1.724
105.8	41	5.117	1.669
107.6	42	4.917	1.616
109.4	43	4.726	1.564
111.2	44	4.543	1.514
113	45	4.369	1.465
114.8	46	4.202	1.418
116.6	47	4.042	1.373
118.4	48	3.889	1.329
120.2	49	3.743	1.286
122	50	3.603	1.244
123.8	51	3.469	1.204
125.6	52	3.34	1.166
127.4	53	3.217	1.128
129.2	54	3.099	1.092
131	55	2.986	1.057

Temp. [°F]	Temp. [°C]	Resistance [KΩ]	Terminal voltage [V]
132.8	56	2.878	1.023
134.6	57	2.774	0.99
136.4	58	2.675	0.959
138.2	59	2.579	0.928
140	60	2.488	0.898
141.8	61	2.4	0.87
143.6	62	2.316	0.842
145.4	63	2.235	0.815
147.2	64	2.158	0.79
149	65	2.083	0.765
150.8	66	2.011	0.74
152.6	67	1.943	0.718
154.4	68	1.877	0.695
156.2	69	1.813	0.673
158	70	1.752	0.652
159.8	71	1.694	0.632
161.6	72	1.637	0.612
163.4	73	1.583	0.593
165.2	74	1.531	0.575
167	75	1.481	0.557
168.8	76	1.433	0.541
170.6	77	1.387	0.524
172.4	78	1.342	0.508
174.2	79	1.299	0.493
176	80	1.258	0.478
177.8	81	1.218	0.464
179.6	82	1.179	0.45
181.4	83	1.142	0.436
183.2	84	1.107	0.423
185	85	1.072	0.411
186.8	86	1.039	0.399
188.6	87	1.007	0.387
190.4	88	0.976	0.375
192.2	89	0.947	0.365
194	90	0.918	0.354
195.8	91	0.89	0.344
197.6	92	0.863	0.334
199.4	93	0.838	0.324
201.2	94	0.813	0.315
203	95	0.789	0.306
204.8	96	0.765	0.297
206.6	97	0.743	0.289
208.4	98	0.721	0.28
210.2	99	0.7	0.276

Temp. [°F]	Temp. [°C]	Resistance [KΩ]	Terminal voltage [V]
212	100	0.68	0.265

NTC10K TYPE III

Temp. [°F]	Temp.[°C]	Resistance [Ω]
-35	-37.2	203.6K
-30	-34.4	173.6K
-25	-31.7	148.3K
-20	-28.9	127.1K
-15	-26.1	109.2K
-10	-23.3	94.07K
-5	-20.6	81.23K
0	-17.8	70.32K
5	-15.0	61.02K
10	-12.2	53.07K
15	-9.4	46.27K
20	-6.7	40.42K
25	-3.9	35.39K
30	-1.1	31.06K
35	1.7	27.31K
40	4.4	24.06K
45	7.2	21.24K
50	10.0	18.79K
55	12.8	16.65K
60	15.6	14.78K
65	18.3	13.15K
70	21.1	11.72K
75	23.9	10.46K
80	26.7	9354
85	29.4	8378
90	32.2	7516
95	35.0	6754
100	37.8	6078
105	40.6	5479
110	43.3	4947
115	46.1	4472
120	48.9	4049
125	51.7	3671
130	54.4	3333
135	57.2	3031
140	60.0	2759
145	62.8	2515
150	65.6	2296
155	68.3	2098
160	71.1	1920
165	73.9	1759
170	76.7	1614
175	79.4	1482

Temp. [°F]	Temp.[°C]	Resistance [Ω]
180	82.2	1362
185	85.0	1254
190	87.8	1156
195	90.6	1066
200	93.3	984
205	96.1	909.8
210	98.9	841.9
215	101.7	779.8
220	104.4	723
225	107.2	671
230	110.0	623.3
235	112.8	579.5
240	115.6	539.4

PT100

Temp. [°F]	Temp.[°C]	Resistance [Ω]
-30	-34.44	86
-20	-28.89	89
-10	-23.33	91
0	-17.78	93
10	-12.22	95
20	-6.67	97
30	-1.11	100
32	0.00	100
40	4.44	102
50	10.00	104
60	15.56	106
70	21.11	108
77	25.00	110
80	26.67	110
90	32.22	113
100	37.78	115
110	43.33	117
120	48.89	119
130	54.44	121
140	60.00	123
150	65.56	125
160	71.11	127
170	76.67	130
180	82.22	132
190	87.78	134
200	93.33	136
210	98.89	138
220	104.44	140

JOHNSON A99

Temp. [°F]	Temp.[°C]	Resistance [Ω]
-40	(-40)	613
-31	(-35)	640
-22	(-30)	668
-13	(-25)	697
-4	(-20)	727
5	(-15)	758
14	(-10)	789
23	(-5)	822
32	0	855
41	5	889
50	10	924
59	15	960
68	20	997
77	25	1035
86	30	1074
95	35	1113
104	40	1153
113	45	1195
122	50	1237
131	55	1279
140	60	1323
149	65	1368
158	70	1413
167	75	1459
176	80	1506
185	85	1554
194	90	1602
203	95	1652
212	100	1702
221	105	1753
230	110	1804
239	115	1856
248	120	1908

NTC20K

Temp. [°F]	Temp. [°C]	Resistance [KΩ]	Terminal voltage [V]
-58	-50	1659	8.78
-56.2	-49	1541	8.77
-54.4	-48	1432	8.76
-52.6	-47	1331	8.75
-50.8	-46	1239	8.74
-49	-45	1153	8.72
-47.2	-44	1073	8.71
-45.4	-43	1000	8.7
-43.6	-42	932	8.69
-41.8	-41	869	8.67
-40	-40	811	8.66
-38.2	-39	757	8.64
-36.4	-38	706	8.62
-34.6	-37	660	8.6
-32.8	-36	617	8.58
-31	-35	577	8.56
-29.2	-34	539	8.54
-27.4	-33	505	8.52
-25.6	-32	473	8.49
-23.8	-31	443	8.47
-22	-30	415	8.44
-20.2	-29	389	8.41
-18.4	-28	364	8.38
-16.6	-27	342	8.35
-14.8	-26	321	8.32
-13	-25	301	8.28
-11.2	-24	283	8.25
-9.4	-23	266	8.21
-7.6	-22	250	8.17
-5.8	-21	235	8.13
-4	-20	221	8.08
-2.2	-19	208	8.04
-0.4	-18	196	7.99
1.4	-17	184	7.94
3.2	-16	174	7.89
5	-15	164	7.83
6.8	-14	154	7.78
8.6	-13	146	7.72
10.4	-12	137	7.66
12.2	-11	130	7.6
14	-10	122	7.53
15.8	-9	116	7.46
17.6	-8	109	7.39
19.4	-7	103	7.32
21.2	-6	97.6	7.25
23	-5	92.3	7.17
24.8	-4	87.3	7.09
26.6	-3	82.6	7.01
28.4	-2	78.2	6.93
30.2	-1	74.1	6.85

Temp. [°F]	Temp. [°C]	Resistance [KΩ]	Terminal voltage [V]
32	0	70.2	6.76
33.8	1	66.5	6.67
35.6	2	63	6.58
37.4	3	59.8	6.49
39.2	4	56.7	6.4
41	5	53.8	6.3
42.8	6	51.1	6.2
44.6	7	48.5	6.1
46.4	8	46	6
48.2	9	43.7	5.9
50	10	41.6	5.8
51.8	11	39.5	5.7
53.6	12	37.6	5.59
55.4	13	35.7	5.49
57.2	14	34	5.38
59	15	32.3	5.28
60.8	16	30.8	5.17
62.6	17	29.3	5.07
64.4	18	27.9	4.96
66.2	19	26.6	4.85
68	20	25.3	4.75
69.8	21	24.2	4.64
71.6	22	23	4.53
73.4	23	22	4.43
75.2	24	21	4.32
77	25	20	4.22
78.8	26	19.1	4.12
80.6	27	18.2	4.01
82.4	28	17.4	3.91
84.2	29	16.6	3.81
86	30	15.9	3.71
87.8	31	15.2	3.62
89.6	32	14.5	3.52
91.4	33	13.9	3.43
93.2	34	13.3	3.33
95	35	12.7	3.24
96.8	36	12.1	3.15
98.6	37	11.6	3.06
100.4	38	11.1	2.97
102.2	39	10.7	2.89
104	40	10.2	2.81
105.8	41	9.78	2.72
107.6	42	9.37	2.64
109.4	43	8.98	2.57
111.2	44	8.61	2.49
113	45	8.26	2.42
114.8	46	7.92	2.34
116.6	47	7.6	2.27
118.4	48	7.29	2.2
120.2	49	7	2.14
122	50	6.72	2.07
123.8	51	6.45	2.01

Temp. [°F]	Temp. [°C]	Resistance [KΩ]	Terminal voltage [V]
125.6	52	6.19	1.94
127.4	53	5.95	1.88
129.2	54	5.72	1.82
131	55	5.49	1.77
132.8	56	5.28	1.71
134.6	57	5.08	1.66
136.4	58	4.88	1.61
138.2	59	4.69	1.56
140	60	4.52	1.51
141.8	61	4.35	1.46
143.6	62	4.18	1.41
145.4	63	4.03	1.37
147.2	64	3.88	1.32
149	65	3.73	1.28
150.8	66	3.59	1.24
152.6	67	3.46	1.2
154.4	68	3.34	1.16
156.2	69	3.21	1.13
158	70	3.1	1.09
159.8	71	2.99	1.06
161.6	72	2.88	1.02
163.4	73	2.78	0.991
165.2	74	2.68	0.96
167	75	2.58	0.929
168.8	76	2.49	0.9
170.6	77	2.41	0.872
172.4	78	2.32	0.844
174.2	79	2.24	0.818
176	80	2.17	0.792
177.8	81	2.09	0.767
179.6	82	2.02	0.744
181.4	83	1.95	0.72
183.2	84	1.89	0.698
185	85	1.82	0.676
186.8	86	1.76	0.655
188.6	87	1.7	0.635
190.4	88	1.65	0.616
192.2	89	1.59	0.597
194	90	1.54	0.578
195.8	91	1.49	0.561
197.6	92	1.44	0.544
199.4	93	1.4	0.527
201.2	94	1.35	0.511
203	95	1.31	0.496
204.8	96	1.27	0.481
206.6	97	1.23	0.466
208.4	98	1.19	0.452
210.2	99	1.15	0.439
212	100	1.11	0.425
213.8	101	1.08	0.413
215.6	102	1.05	0.401
217.4	103	1.01	0.389

Temp. [°F]	Temp. [°C]	Resistance [KΩ]	Terminal voltage [V]
219.2	104	0.98	0.378
221	105	0.95	0.367
222.8	106	0.92	0.356
224.6	107	0.9	0.346
226.4	108	0.87	0.336
228.2	109	0.84	0.326
230	110	0.82	0.317
231.8	111	0.79	0.308
233.6	112	0.77	0.299
235.4	113	0.75	0.29
237.2	114	0.73	0.282
239	115	0.7	0.274
240.8	116	0.68	0.266
242.6	117	0.66	0.259
244.4	118	0.64	0.252
246.2	119	0.63	0.245
248	120	0.61	0.238
249.8	121	0.59	0.231
251.6	122	0.57	0.225
253.4	123	0.56	0.219
255.2	124	0.54	0.213
257	125	0.53	0.207
258.8	126	0.51	0.201
260.6	127	0.5	0.196
262.4	128	0.49	0.191
264.2	129	0.47	0.186
266	130	0.46	0.181
267.8	131	0.45	0.176
269.6	132	0.43	0.171
271.4	133	0.42	0.167
273.2	134	0.41	0.162
275	135	0.4	0.158
276.8	136	0.39	0.154
278.6	137	0.38	0.15
280.4	138	0.37	0.146
282.2	139	0.36	0.142
284	140	0.35	0.139
285.8	141	0.34	0.135
287.6	142	0.33	0.132
289.4	143	0.32	0.128
291.2	144	0.32	0.125
293	145	0.31	0.122
294.8	146	0.3	0.119
296.6	147	0.29	0.116
298.4	148	0.29	0.113
300.2	149	0.28	0.11
302	150	0.27	0.107

Nickel Class B DIN 43760 sensors

The characteristic of the nickel temperature sensor is specified as per DIN 43760. The large Temperature Coefficient of Resistance (TCR) of the Ni-RTD, 6178 ppm/K, offers greater sensitivity than other types of RTD's. The electrical characteristic can be described by the following equation:

$$R(T) = R_0 (1 + aT + bT^2 + cT^4 + dT^6)$$

Coefficients:

- a = 5.485 x 10⁻³
- b = 6.650 x 10⁻⁶
- c = 2.805 x 10⁻¹¹
- d = -2.000 x 10⁻¹⁷

$$T(R) = a' + b'(1 + c'R)^{1/2} + d'R^5 + e'R^7 \quad dT < 0.12 \text{ K (higher order equations on request)}$$

Coefficients:

- a' = - 412.6
- b' = 140.41
- c' = 0.00764
- d' = - 6.25 x 10⁻¹⁷
- e' = -1.25 x 10⁻²⁴

Tolerances:

- Class B (0.4+0.007 x |T|) in range from 32 °F (0 °C) to 320 °F (+160 °C)
- (0.4+0.028 x |T|) in range from -67 °F (-55 °C) to 32 °F (0 °C)

T/°F	T/°C	0	1	2	3	4	5	6	7	8	9
-76	-60	695.2	699.9	704.6	709.3	714	718.7	723.4	728.2	733	737.8
-58	-50	742.6	747.4	752.2	757	761.9	766.8	771.6	776.5	781.4	786.4
-40	-40	791.3	796.3	801.2	806.2	811.2	816.2	821.2	826.3	831.3	836.4
-22	-30	841.5	846.5	851.7	856.8	861.9	867	872.2	877.4	882.6	887.8
-4	-20	893	898.2	903.4	908.7	913.9	919.2	924.5	929.8	935.1	940.5
14	-10	945.8	951.2	956.5	961.9	967.3	972.7	978.2	983.6	989.1	994.5
32	0	1000	1005.5	1011	1016.5	1022	1027.6	1033.1	1038.7	1044.3	1049.9
50	10	1055.5	1061.1	1066.8	1072.4	1078.1	1083.8	1089.5	1095.2	1100.9	1106.6
68	20	1112.4	1118.1	1123.9	1129.7	1135.5	1141.3	1147.1	1153	1158.8	1164.7
86	30	1170.6	1176.5	1182.4	1188.3	1194.2	1200.2	1206.1	1212.1	1218.1	1224.1
104	40	1230.1	1236.1	1242.2	1248.2	1254.3	1260.4	1266.5	1272.6	1278.8	1284.9
122	50	1291.1	1297.2	1303.4	1309.6	1315.8	1322	1328.3	1334.5	1340.8	1347.1
140	60	1353.4	1359.7	1366	1372.4	1378.7	1385.1	1391.5	1397.9	1404.3	1410.8
158	70	1417.2	1423.7	1430.1	1436.6	1443.1	1449.7	1456.2	1462.8	1469.3	1475.9
176	80	1482.5	1489.1	1495.7	1502.4	1509.1	1515.7	1522.4	1529.1	1535.9	1542.6
194	90	1549.3	1556.1	1562.9	1569.7	1576.5	1583.4	1590.2	1597.1	1604	1610.9
212	100	1617.8	1624.7	1631.7	1638.6	1645.6	1652.6	1659.6	1666.7	1673.7	1680.8
230	110	1687.9	1695	1702.1	1709.3	1716.4	1723.6	1730.8	1738	1745.2	1752.5
248	120	1759.7	1767	1774.3	1781.6	1788.9	1796.3	1803.7	1811.1	1818.5	1825.9
266	130	1833.3	1840.8	1848.3	1855.8	1863.3	1870.9	1878.4	1886	1893.6	1901.2
284	140	1908.9	1916.5	1924.2	1931.9	1939.6	1947.4	1955.1	1962.9	1970.7	1978.5
302	150	1986.3	1994.2	2002.1	2010	2017.9	2025.9	2033.8	2041.8	2049.8	2057.8
320	160	2065.9	2074	2082.1	2090.2	2098.3	2106.5	2114.6	2122.8	2131.1	2139.3

10K3A1

Temp. [°F]	Temp.[°C]	Resistance [Ω]
-40	-40	336098
-38.2	-39	314553
-36.4	-38	294524
-34.6	-37	275897
-32.8	-36	258563
-31	-35	242427
-29.2	-34	227398
-27.4	-33	213394
-25.6	-32	200339
-23.8	-31	188163
-22	-30	176803
-20.2	-29	166198
-18.4	-28	156294
-16.6	-27	147042
-14.8	-26	138393
-13	-25	130306
-11.2	-24	122741
-9.4	-23	115661
-7.6	-22	109032
-5.8	-21	102824
-4	-20	97006
-2.2	-19	91553
-0.4	-18	86439
1.4	-17	81641
3.2	-16	77138
5	-15	72911
6.8	-14	68940
8.6	-13	65209
10.4	-12	61703
12.2	-11	58405
14	-10	55304
15.8	-9	52385
17.6	-8	49638
19.4	-7	47050
21.2	-6	44613
23	-5	42317
24.8	-4	40151
26.6	-3	38110
28.4	-2	36184
30.2	-1	34366
32	0	32651
33.8	1	31031
35.6	2	29500

Temp. [°F]	Temp.[°C]	Resistance [Ω]
37.4	3	28054
39.2	4	26687
41	5	25395
42.8	6	24172
44.6	7	23016
46.4	8	21921
48.2	9	20885
50	10	19903
51.8	11	18973
53.6	12	18092
55.4	13	17257
57.2	14	16465
59	15	15714
60.8	16	15001
62.6	17	14324
64.4	18	13682
66.2	19	13073
68	20	12493
69.8	21	11943
71.6	22	11420
73.4	23	10923
75.2	24	10450
77	25	10000
78.8	26	9572
80.6	27	9165
82.4	28	8777
84.2	29	8408
86	30	8056
87.8	31	7721
89.6	32	7402
91.4	33	7097
93.2	34	6807
95	35	6530
96.8	36	6266
98.6	37	6014
100.4	38	5774
102.2	39	5544
104	40	5325
105.8	41	5116
107.6	42	4916
109.4	43	4724
111.2	44	4542
113	45	4367
114.8	46	4200

Temp. [°F]	Temp.[°C]	Resistance [Ω]
116.6	47	4040
118.4	48	3887
120.2	49	3741
122	50	3601
123.8	51	3467
125.6	52	3339
127.4	53	3216
129.2	54	3098
131	55	2985
132.8	56	2877
134.6	57	2773
136.4	58	2674
138.2	59	2579
140	60	2487
141.8	61	2399
143.6	62	2315
145.4	63	2234
147.2	64	2157
149	65	2082
150.8	66	2011
152.6	67	1942
154.4	68	1876
156.2	69	1813
158	70	1752
159.8	71	1693
161.6	72	1637
163.4	73	1582
165.2	74	1530
167	75	1480
168.8	76	1432
170.6	77	1385
172.4	78	1341
174.2	79	1298
176	80	1256
177.8	81	1216
179.6	82	1178
181.4	83	1141
183.2	84	1105
185	85	1070
186.8	86	1037
188.6	87	1005
190.4	88	974
192.2	89	945
194	90	916

Temp. [°F]	Temp.[°C]	Resistance [Ω]
195.8	91	888
197.6	92	862
199.4	93	836
201.2	94	811
203	95	787
204.8	96	764
206.6	97	741
208.4	98	720
210.2	99	699
212	100	678
213.8	101	659
215.6	102	640
217.4	103	622
219.2	104	604
221	105	587
222.8	106	571
224.6	107	555
226.4	108	539
228.2	109	524
230	110	510
231.8	111	496
233.6	112	482
235.4	113	469
237.2	114	457
239	115	444
240.8	116	432
242.6	117	421
244.4	118	410
246.2	119	399
248	120	388
249.8	121	378
251.6	122	368
253.4	123	359
255.2	124	350
257	125	341

NI1000TK5000

Sensor Type	Nominal Resistance	Sensitivity
Ni1000 TK5000 DIN B	R ₀ : 1000 Ω	TC: 5000 ppm/K

°F	°C	0	-1	-2	-3	-4	-5	-6	-7	-8	-9
-58	-50	790.88									
-40	-40	830.84	826.8	822.78	818.76	814.75	810.75	806.76	802.78	798.8	794.84
-22	-30	871.69	867.57	863.45	859.34	855.24	851.15	847.07	843	838.94	834.88
-4	-20	913.48	909.26	905.05	900.85	896.65	892.47	888.3	884.13	879.98	875.83
14	-10	956.24	951.92	947.61	943.31	939.02	934.74	930.47	926.21	921.96	917.72
32	0	1000	995.58	991.17	986.77	982.37	977.99	973.62	969.26	964.91	960.57
°F	°C	0	1	2	3	4	5	6	7	8	9
32	0	1000	1004.4	1008.9	1013.3	1017.8	1022.3	1026.8	1031.2	1035.8	1040.3
50	10	1044.8	1049.3	1053.9	1058.4	1063	1067.6	1072.2	1076.8	1081.4	1086
68	20	1090.7	1095.3	1100	1104.6	1109.3	1114	1118.7	1123.4	1128.1	1132.9
86	30	1137.6	1142.4	1147.1	1151.9	1156.7	1161.5	1166.3	1171.2	1176	1180.9
104	40	1185.7	1190.6	1195.5	1200.4	1205.3	1210.2	1215.1	1220.1	1225	1230
122	50	1235	1240	1245	1250	1255	1260.1	1265.1	1270.2	1275.3	1280.3
140	60	1285.5	1290.6	1295.7	1300.8	1306	1311.1	1316.3	1321.5	1326.7	1331.9
158	70	1337.2	1342.4	1347.6	1352.9	1358.2	1363.5	1368.8	1374.1	1379.4	1384.8
176	80	1390.1	1395.5	1400.9	1406.3	1411.7	1417.1	1422.5	1428	1433.4	1438.9
194	90	1444.4	1449.9	1455.4	1460.9	1466.5	1472	1477.6	1483.2	1488.8	1494.4
212	100	1500	1505.6	1511.3	1517	1522.6	1528.3	1534	1539.8	1545.5	1551.2
230	110	1557	1562.8	1568.6	1574.4	1580.2	1586	1591.8	1597.7	1603.6	1609.5
248	120	1615.4	1621.3	1627.2	1633.2	1639.1	1645.1	1651.1	1657.1	1663.1	1669.1
266	130	1675.2	1681.3	1687.3	1693.4	1699.5	1705.7	1711.8	1717.9	1724.1	1730.3
284	140	1736.5	1742.7	1748.9	1755.2	1761.4	1767.7	1774	1780.3	1786.6	1792.9
302	150	1799.3									

PT1000

Temp. [°F]	Temp. [°C]	Resistance [KΩ]	Terminal voltage [V]
-58	-50	803	0.312
-56.2	-49	807	0.314
-54.4	-48	811	0.315
-52.6	-47	815	0.317
-50.8	-46	819	0.318
-49	-45	823	0.32
-47.2	-44	827	0.321
-45.4	-43	831	0.323
-43.6	-42	835	0.324
-41.8	-41	839	0.326
-40	-40	843	0.327
-38.2	-39	847	0.329
-36.4	-38	851	0.33
-34.6	-37	855	0.332
-32.8	-36	859	0.333
-31	-35	862	0.335
-29.2	-34	866	0.336
-27.4	-33	870	0.338
-25.6	-32	874	0.339
-23.8	-31	878	0.341
-22	-30	882	0.342
-20.2	-29	886	0.344
-18.4	-28	890	0.345
-16.6	-27	894	0.347
-14.8	-26	898	0.348
-13	-25	902	0.35
-11.2	-24	906	0.351
-9.4	-23	910	0.353
-7.6	-22	914	0.354
-5.8	-21	918	0.356
-4	-20	922	0.357
-2.2	-19	926	0.359
-0.4	-18	929	0.36
1.4	-17	933	0.361
3.2	-16	937	0.363
5	-15	941	0.364
6.8	-14	945	0.366
8.6	-13	949	0.367
10.4	-12	953	0.369
12.2	-11	957	0.37
14	-10	961	0.372
15.8	-9	965	0.373

Temp. [°F]	Temp. [°C]	Resistance [KΩ]	Terminal voltage [V]
17.6	-8	969	0.375
19.4	-7	973	0.376
21.2	-6	977	0.378
23	-5	980	0.379
24.8	-4	984	0.38
26.6	-3	988	0.382
28.4	-2	992	0.383
30.2	-1	996	0.385
32	0	1000	0.386
33.8	1	1004	0.388
35.6	2	1008	0.389
37.4	3	1012	0.391
39.2	4	1016	0.392
41	5	1020	0.394
42.8	6	1023	0.395
44.6	7	1027	0.396
46.4	8	1031	0.398
48.2	9	1035	0.399
50	10	1039	0.401
51.8	11	1043	0.402
53.6	12	1047	0.404
55.4	13	1051	0.405
57.2	14	1055	0.406
59	15	1058	0.408
60.8	16	1062	0.409
62.6	17	1066	0.411
64.4	18	1070	0.412
66.2	19	1074	0.413
68	20	1078	0.415
69.8	21	1082	0.416
71.6	22	1086	0.418
73.4	23	1090	0.419
75.2	24	1093	0.42
77	25	1097	0.422
78.8	26	1101	0.423
80.6	27	1105	0.425
82.4	28	1109	0.426
84.2	29	1113	0.428
86	30	1117	0.429
87.8	31	1121	0.431
89.6	32	1124	0.432
91.4	33	1128	0.433
93.2	34	1132	0.435
95	35	1136	0.436

Temp. [°F]	Temp. [°C]	Resistance [KΩ]	Terminal voltage [V]
96.8	36	1140	0.438
98.6	37	1144	0.439
100.4	38	1148	0.441
102.2	39	1152	0.442
104	40	1155	0.443
105.8	41	1159	0.445
107.6	42	1163	0.446
109.4	43	1167	0.448
111.2	44	1171	0.449
113	45	1175	0.451
114.8	46	1179	0.452
116.6	47	1182	0.453
118.4	48	1186	0.455
120.2	49	1190	0.456
122	50	1194	0.458
123.8	51	1198	0.459
125.6	52	1202	0.461
127.4	53	1205	0.462
129.2	54	1209	0.463
131	55	1213	0.465
132.8	56	1217	0.466
134.6	57	1221	0.467
136.4	58	1225	0.469
138.2	59	1229	0.47
140	60	1232	0.471
141.8	61	1236	0.473
143.6	62	1240	0.474
145.4	63	1244	0.476
147.2	64	1248	0.477
149	65	1252	0.479
150.8	66	1255	0.48
152.6	67	1259	0.481
154.4	68	1263	0.483
156.2	69	1267	0.484
158	70	1271	0.486
159.8	71	1275	0.487
161.6	72	1278	0.488
163.4	73	1282	0.49
165.2	74	1286	0.491
167	75	1290	0.493
168.8	76	1294	0.494
170.6	77	1297	0.495
172.4	78	1301	0.497
174.2	79	1305	0.498

Temp. [°F]	Temp. [°C]	Resistance [KΩ]	Terminal voltage [V]
176	80	1309	0.499
177.8	81	1313	0.501
179.6	82	1317	0.502
181.4	83	1320	0.503
183.2	84	1324	0.505
185	85	1328	0.506
186.8	86	1332	0.508
188.6	87	1336	0.509
190.4	88	1339	0.51
192.2	89	1343	0.512
194	90	1347	0.513
195.8	91	1351	0.515
197.6	92	1355	0.516
199.4	93	1358	0.517
201.2	94	1362	0.519
203	95	1366	0.52
204.8	96	1370	0.522
206.6	97	1374	0.523
208.4	98	1377	0.524
210.2	99	1381	0.525
212	100	1385	0.527
213.8	101	1389	0.528
215.6	102	1393	0.53
217.4	103	1396	0.531
219.2	104	1400	0.532
221	105	1404	0.534
222.8	106	1408	0.535
224.6	107	1412	0.537
226.4	108	1415	0.538
228.2	109	1419	0.539
230	110	1423	0.541
231.8	111	1427	0.542
233.6	112	1430	0.543
235.4	113	1434	0.545
237.2	114	1438	0.546
239	115	1442	0.547
240.8	116	1446	0.549
242.6	117	1449	0.55
244.4	118	1453	0.551
246.2	119	1457	0.553
248	120	1461	0.554
249.8	121	1464	0.555
251.6	122	1468	0.557
253.4	123	1472	0.558

BACnet IP/MSTP VAV Controller - INSTALLATION

Temp. [°F]	Temp. [°C]	Resistance [KΩ]	Terminal voltage [V]	Temp. [°F]	Temp. [°C]	Resistance [KΩ]	Terminal voltage [V]	Temp. [°F]	Temp. [°C]	Resistance [KΩ]	Terminal voltage [V]	Temp. [°F]	Temp. [°C]	Resistance [KΩ]	Terminal voltage [V]
255.2	124	1476	0.56	334.4	168	1640	0.618	413.6	212	1802	0.675	492.8	256	1962	0.73
257	125	1479	0.561	336.2	169	1644	0.619	415.4	213	1806	0.676	494.6	257	1966	0.732
258.8	126	1483	0.562	338	170	1648	0.621	417.2	214	1810	0.678	496.4	258	1970	0.733
260.6	127	1487	0.564	339.8	171	1651	0.622	419	215	1813	0.679	498.2	259	1973	0.734
262.4	128	1491	0.565	341.6	172	1655	0.623	420.8	216	1817	0.68	500	260	1977	0.736
264.2	129	1494	0.566	343.4	173	1659	0.625	422.6	217	1821	0.681	501.8	261	1980	0.737
266	130	1498	0.567	345.2	174	1662	0.626	424.4	218	1824	0.683	503.6	262	1984	0.738
267.8	131	1502	0.569	347	175	1666	0.627	426.2	219	1828	0.684	505.4	263	1988	0.739
269.6	132	1506	0.57	348.8	176	1670	0.629	428	220	1832	0.685	507.2	264	1991	0.74
271.4	133	1510	0.572	350.6	177	1674	0.63	429.8	221	1835	0.686	509	265	1995	0.742
273.2	134	1513	0.573	352.4	178	1677	0.631	431.6	222	1839	0.688	510.8	266	1998	0.743
275	135	1517	0.574	354.2	179	1681	0.632	433.4	223	1843	0.689	512.6	267	2002	0.744
276.8	136	1521	0.576	356	180	1685	0.634	435.2	224	1846	0.69	514.4	268	2006	0.746
278.6	137	1525	0.577	357.8	181	1688	0.635	437	225	1850	0.692	516.2	269	2009	0.747
280.4	138	1528	0.578	359.6	182	1692	0.636	438.8	226	1854	0.693	518	270	2013	0.748
282.2	139	1532	0.58	361.4	183	1696	0.638	440.6	227	1857	0.694	519.8	271	2016	0.749
284	140	1536	0.581	363.2	184	1699	0.639	442.4	228	1861	0.695	521.6	272	2020	0.75
285.8	141	1539	0.582	365	185	1703	0.64	444.2	229	1865	0.697	523.4	273	2024	0.752
287.6	142	1543	0.584	366.8	186	1707	0.642	446	230	1868	0.698	525.2	274	2027	0.753
289.4	143	1547	0.585	368.6	187	1711	0.643	447.8	231	1872	0.699	527	275	2031	0.754
291.2	144	1551	0.586	370.4	188	1714	0.644	449.6	232	1875	0.7	528.8	276	2034	0.755
293	145	1554	0.587	372.2	189	1718	0.645	451.4	233	1879	0.702	530.6	277	2038	0.757
294.8	146	1558	0.589	374	190	1722	0.647	453.2	234	1883	0.703	532.4	278	2042	0.758
296.6	147	1562	0.59	375.8	191	1725	0.648	455	235	1886	0.704	534.2	279	2045	0.759
298.4	148	1566	0.592	377.6	192	1729	0.649	456.8	236	1890	0.705	536	280	2049	0.76
300.2	149	1569	0.593	379.4	193	1733	0.651	458.6	237	1894	0.707	537.8	281	2052	0.761
302	150	1573	0.594	381.2	194	1736	0.652	460.4	238	1897	0.708	539.6	282	2056	0.763
303.8	151	1577	0.596	383	195	1740	0.653	462.2	239	1901	0.709	541.4	283	2060	0.764
305.6	152	1581	0.597	384.8	196	1744	0.655	464	240	1905	0.711	543.2	284	2063	0.765
307.4	153	1584	0.598	386.6	197	1747	0.656	465.8	241	1908	0.712	545	285	2067	0.766
309.2	154	1588	0.6	388.4	198	1751	0.657	467.6	242	1912	0.713	546.8	286	2070	0.768
311	155	1592	0.601	390.2	199	1755	0.658	469.4	243	1915	0.714	548.6	287	2074	0.769
312.8	156	1596	0.602	392	200	1758	0.659	471.2	244	1919	0.716	550.4	288	2077	0.77
314.6	157	1599	0.603	393.8	201	1762	0.661	473	245	1923	0.717	552.2	289	2081	0.771
316.4	158	1603	0.605	395.6	202	1766	0.662	474.8	246	1926	0.718	554	290	2085	0.773
318.2	159	1607	0.606	397.4	203	1769	0.663	476.6	247	1930	0.719	555.8	291	2088	0.774
320	160	1610	0.607	399.2	204	1773	0.665	478.4	248	1934	0.721	557.6	292	2092	0.775
321.8	161	1614	0.609	401	205	1777	0.666	480.2	249	1937	0.722	559.4	293	2095	0.776
323.6	162	1618	0.61	402.8	206	1780	0.667	482	250	1941	0.723	561.2	294	2099	0.777
325.4	163	1622	0.612	404.6	207	1784	0.669	483.8	251	1944	0.724	563	295	2102	0.778
327.2	164	1625	0.613	406.4	208	1788	0.67	485.6	252	1948	0.726	564.8	296	2106	0.78
329	165	1629	0.614	408.2	209	1791	0.671	487.4	253	1952	0.727	566.6	297	2110	0.781
330.8	166	1633	0.615	410	210	1795	0.672	489.2	254	1955	0.728	568.4	298	2113	0.782
332.6	167	1636	0.617	411.8	211	1799	0.674	491	255	1959	0.729	570.2	299	2117	0.784

Temp. [°F]	Temp. [°C]	Resistance [KΩ]	Terminal voltage [V]
572	300	2120	0.785
573.8	301	2124	0.786
575.6	302	2127	0.787
577.4	303	2131	0.788
579.2	304	2134	0.789
581	305	2138	0.791
582.8	306	2142	0.792
584.6	307	2145	0.793
586.4	308	2149	0.794
588.2	309	2152	0.796
590	310	2156	0.797
591.8	311	2159	0.798
593.6	312	2163	0.799
595.4	313	2166	0.8
597.2	314	2170	0.802
599	315	2173	0.803
600.8	316	2177	0.804
602.6	317	2181	0.805
604.4	318	2184	0.806
606.2	319	2188	0.808
608	320	2191	0.809
609.8	321	2195	0.81
611.6	322	2198	0.811
613.4	323	2202	0.812
615.2	324	2205	0.814
617	325	2209	0.815
618.8	326	2212	0.816
620.6	327	2216	0.817
622.4	328	2219	0.818
624.2	329	2223	0.82
626	330	2226	0.821
627.8	331	2230	0.822
629.6	332	2234	0.823
631.4	333	2237	0.824
633.2	334	2241	0.826
635	335	2244	0.827
636.8	336	2248	0.828
638.6	337	2251	0.829
640.4	338	2255	0.83
642.2	339	2258	0.831
644	340	2262	0.833
645.8	341	2265	0.834
647.6	342	2269	0.835
649.4	343	2272	0.836

Temp. [°F]	Temp. [°C]	Resistance [KΩ]	Terminal voltage [V]
651.2	344	2276	0.838
653	345	2279	0.839
654.8	346	2283	0.84
656.6	347	2286	0.841
658.4	348	2290	0.842
660.2	349	2293	0.843
662	350	2297	0.845
663.8	351	2300	0.846
665.6	352	2304	0.847
667.4	353	2307	0.848
669.2	354	2311	0.849
671	355	2314	0.85
672.8	356	2318	0.852
674.6	357	2321	0.853
676.4	358	2325	0.854
678.2	359	2328	0.855
680	360	2332	0.856
681.8	361	2335	0.857
683.6	362	2339	0.859
685.4	363	2342	0.86
687.2	364	2346	0.861
689	365	2349	0.862
690.8	366	2353	0.863
692.6	367	2356	0.864
694.4	368	2360	0.866
696.2	369	2363	0.867
698	370	2367	0.868
699.8	371	2370	0.869
701.6	372	2373	0.87
703.4	373	2377	0.871
705.2	374	2380	0.872
707	375	2384	0.874
708.8	376	2387	0.875
710.6	377	2391	0.876
712.4	378	2394	0.877
714.2	379	2398	0.878
716	380	2401	0.879
717.8	381	2405	0.881
719.6	382	2408	0.882
721.4	383	2412	0.883
723.2	384	2415	0.884
725	385	2419	0.885
726.8	386	2422	0.886
728.6	387	2426	0.888

Temp. [°F]	Temp. [°C]	Resistance [KΩ]	Terminal voltage [V]
730.4	388	2429	0.889
732.2	389	2432	0.89
734	390	2436	0.891
735.8	391	2439	0.892
737.6	392	2443	0.893
739.4	393	2446	0.894
741.2	394	2450	0.896
743	395	2453	0.897
744.8	396	2457	0.898
746.6	397	2460	0.899
748.4	398	2463	0.9
750.2	399	2467	0.901
752	400	2470	0.902

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Temp. [°F]	Temp. [°C]	Resistance [KΩ]	Terminal voltage [V]
-58	-50	2.82	1.02
-49	-45	2.87	1.03
-40	-40	2.91	1.05
-31	-35	2.96	1.06
-22	-30	3	1.08
-13	-25	3.05	1.09
-4	-20	3.09	1.1
5	-15	3.13	1.12
14	-10	3.18	1.13
23	-5	3.22	1.15
32	0	3.27	1.16
41	5	3.31	1.17
50	10	3.35	1.19
59	15	3.4	1.2
68	20	3.44	1.21
77	25	3.48	1.23
86	30	3.53	1.24
95	35	3.57	1.25
104	40	3.61	1.27
113	45	3.66	1.28
122	50	3.7	1.29
131	55	3.74	1.31
140	60	3.78	1.32
149	65	3.83	1.33
158	70	3.87	1.35
167	75	3.91	1.36
176	80	3.95	1.37
185	85	4	1.38
194	90	4.04	1.4
203	95	4.08	1.41
212	100	4.12	1.42
221	105	4.16	1.43
230	110	4.21	1.45
239	115	4.25	1.46
248	120	4.29	1.47
257	125	4.33	1.48
266	130	4.37	1.49
275	135	4.41	1.51
284	140	4.45	1.52
293	145	4.5	1.53
302	150	4.54	1.54

RELATED TECHNICAL LITERATURE

Table 17. Related Technical Literature

Title	Reference
Spyder Model 5 & 7 – Engineering Tool User Guide	31-00282
Spyder Model 5 & 7 – Function Block User Guide	31-00364
Spyder Model 7 - Mounting Instructions	31-00473
Spyder Model 7 IP VAV - Product Data	31-00472
Spyder Model 7 MSTP VAV - Product Data	31-00471
TR40x/TR42x – Specification Data	63-1389
TR40x/TR42x – Installation Instructions	62-0467
TR40x/TR42x – Operating Guide	63-2741
TR2x Series – Specification Data	63-1321
TR2x Series – Installation Instructions	62-0267
TR120 – Specification Data	31-00312
TR120 – Installation Instructions	31-00275
TR120 – Operating Guide	63-2719
TR71, TR75 – Specification Data	63-1322
TR71, TR75 – Installation Instructions	62-0271
TR71, TR75 – Operating Guide	63-2719
C7400S – Specification Data	63-1365
C7400S – Installation Instructions	62-0332

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