Honeywell

Unitary

CONTROLLER

INSTALLATION INSTRUCTIONS

31-00614-01

GENERAL

Trademark Information

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

Product Description

Honeywell Unitary BACnet™ IP, BACnet™ MS/TP and BACnet™ T1L, controllers provide flexible, freely programmable, demand-led control that delivers tangible benefits to reduce energy spending while driving new levels of functionality and efficiency in today's buildings.

They offer performance-based engineering with Niagara 4 and enable Single-Tool-Engineering throughout the whole Building Management System with cost-effective installation.

These new generation controllers offer BACnet™ IP, T1L, or MS/TP as a backbone interface and Sylk™ and Modbus RTU as sub interface, flexible universal input/output (UIO) points, and solid-state relays (SSR) and normal relays.

These BACnet™ IP or BACnet™ MS/TP based Unitary controllers utilize smart engineering, commissioning tools, and Sylk™ bus technology. These controllers can achieve multiple flexible configurations to address specific applications with the Niagara Engineering tool.

The controllers can stand-alone operation; however, they can achieve optimum functional benefits when they use network communication capabilities.

MS/TP models of controller communicates via a TIA/EIA 485 BACnet™ MS/TP network communications network, capable of baud rates between 9.6 and 76.8 kb. BACnet™ IP models communicate over a wired standard network cable and BACnet™ T1L communicates via a 2-wire twisted pair cable.

Table 1 Part Numbers

Part Number	Housing	UIO	Relay	Solid State Relay (SSR)	Communication	Sylk™ BUS
UN-RS0844ES24NMC / D	Small	8	4	4	BACnet™ IP	Yes
UN-RS0844MS24NMC / D	Small	8	4	4	BACnet™ MS/TP	Yes
UN-RS0844TS24NMC / D	Small	8	4	4	BACnet™ T1L	Yes
UN-RL1644ES24NMC / D	Large	16	4	4	BACnet™ IP	Yes
UN-RL1644MS24NMC / D	Large	16	4	4	BACnet™ MS/TP	Yes
UN-RL1644TS24NMC / D	Large	16	4	4	BACnet™ T1L	Yes

Table 2 Accessories/Replacement Parts

Part Number	Comments
CW-Cov-L-Unitary	Terminal cover for the L-version of the unitary controller (sold in pack of 10)
CW-Cov-S-Unitary	Terminal cover for the S-version of the unitary controller (sold in pack of 10)
10BASE-T1L-ADAPT	IP-T1L single pair media adapter that allows converting 10BASE-T traffic to 10BASE-T1L
SCRW-TB-UNI-L	Set of removable terminal blocks covering all models of Unitary controllers
IO-JUMPER-4-10	4-pin relay output Jumper Bar to connect 4 relays IN terminals (sold in pack of 10)

Controller Part Numbers

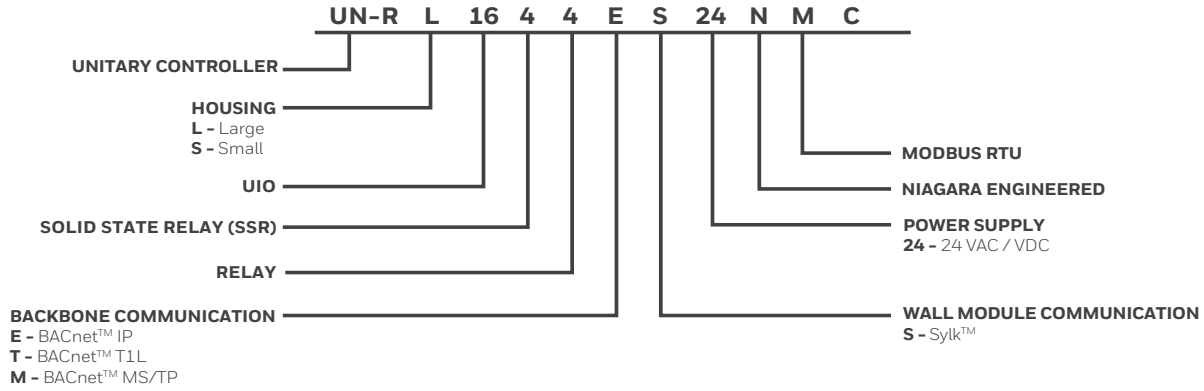


Fig. 1 Controller Part Numbers

Dimensions

Large Housing controller

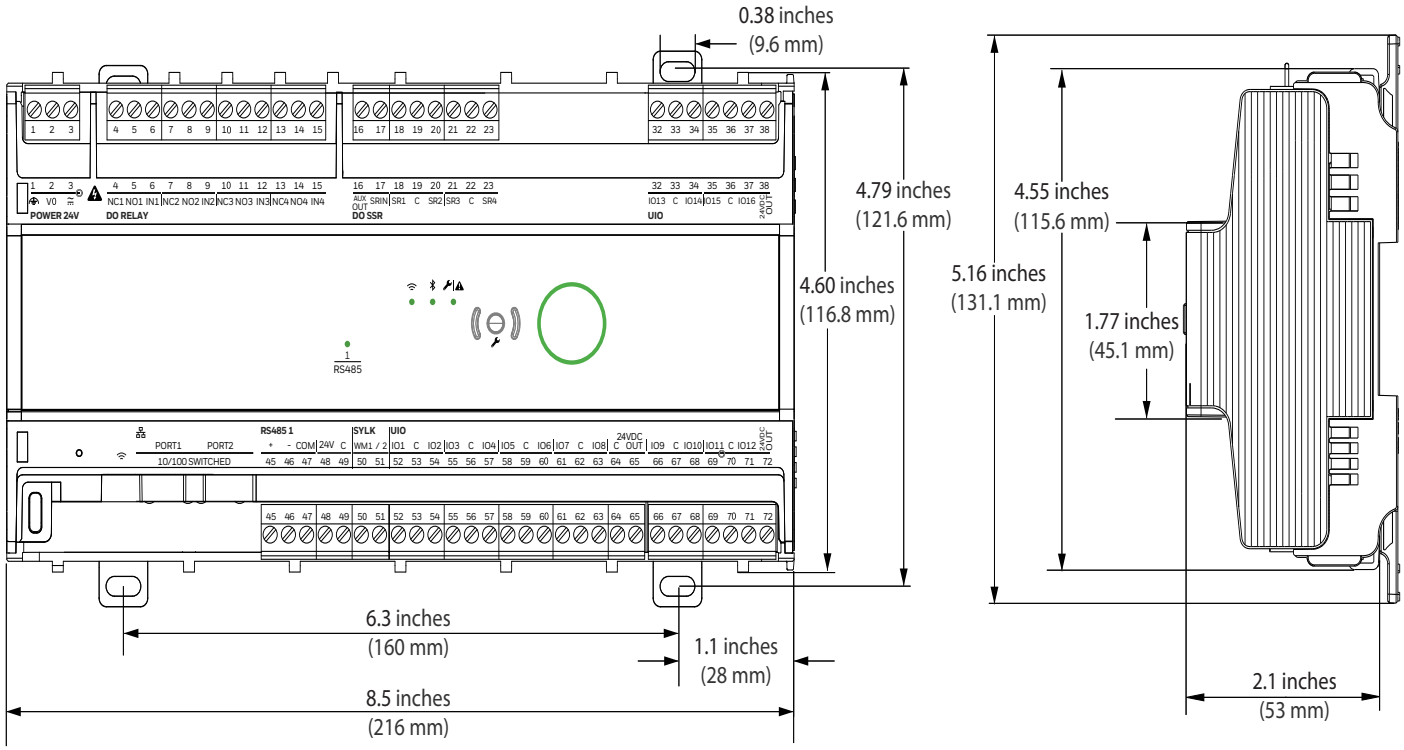


Fig. 2 Large Housing controller dimensions

Small Housing controller

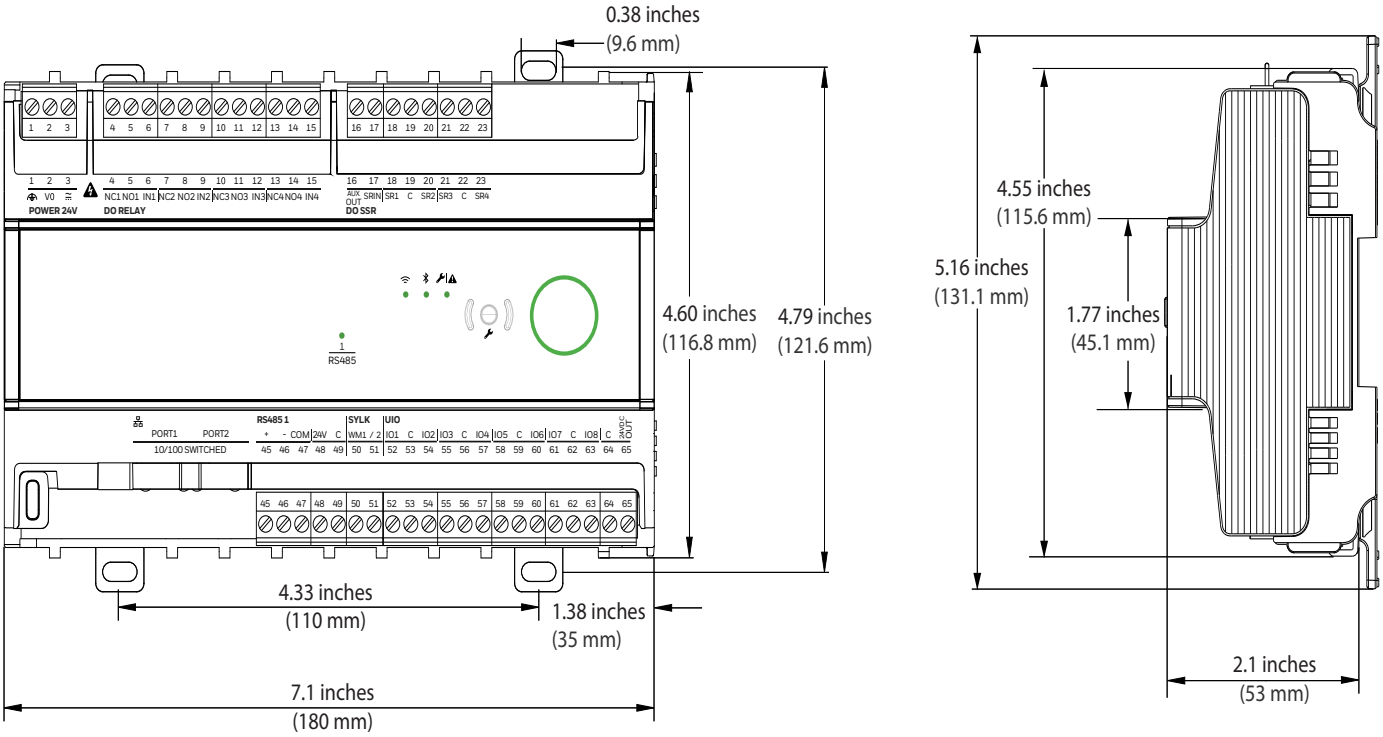


Fig. 3 Small Housing controller dimensions

NETWORK SECURITY

⚠ WARNING

Honeywell expressly states that Unitary BACnet™ IP, BACnet™ MS/TP and BACnet™ T1L controllers will not protect against all cyber security risks from the internet. Therefore, use the controllers in private and protected networks.

To ensure a safe and reliable operation, take necessary protective measures, such as locating BMS controls behind a firewall and using a VPN connection. Suitable VPN routers are available from third-party manufacturers.

GENERAL SAFETY INSTRUCTIONS

Follow the safety instructions provided by Honeywell in this manual while doing any operation such installation, mounting, or starting.

- The Honeywell Unitary controllers must be installed and mounted by authorized and trained personnel.
- In the case of any modification, except by Honeywell, the operation and safety warranties become void.
- Observe all applicable local standards and regulations.
- Use only Honeywell supplied or approved accessories.
- Before installing or dismantling the system, disconnect the power supply by either removing the power terminal block from the controller or through local isolation.

⚠ CAUTION

Disconnect the power before installing, removing, or replacing the Honeywell Unitary controller. Switch off the power before you install any jumpers.

SPECIFICATIONS

Electrical

Table 3 Electrical Specification

Parameter	Specification
Rated input voltage	20 - 30 VAC / 24 - 30 VDC
Nominal Power Consumption	• BACnet™ IP : 4 VA • BACnet™ MS/TP : 4 VA • BACnet™ T1L : 4 VA
Full Load Power Consumption (Maximum load including external loads, Sylk™, Communication, Universal IO output, and 24 VDC output, excluding the load on the SSRs and Relays). **Note:** For the current consumption of SSR, refer SSR section table.	• BACnet™ IP : 30 VA • BACnet™ MS/TP : 30 VA • BACnet™ T1L : 30 VA
Frequency Range	50 to 60 Hz
Auxiliary Output	1 x 24 VAC at 75 mA 1 x 24 VDC at 75 mA
Impulse Voltage	330 VAC

Operational Environment

Table 4 Operational Environment

Parameter	Specification
Storage Temperature	-40 °F to 150 °F (-40 °C to 66 °C)
Operation	-40 °F to 122 °F (-40 °C to 50 °C)
Humidity	5 % to 95 % RH, non-condensing
Protection	IP20, NEMA 1
Pollution Level	2

Hardware

Table 5 Hardware Specification

Parameter	Specification
CPU	Crossover processor NXP I.MRT, Cortex M7
Memory Capacity	16 MB QSPI Flash, 16 MB SDRAM
Ethernet	BACnet™ IP : 2 x RJ-45 Ethernet ports with a protection that allows loop topology to continue the communication with other controllers even if one node fails, when used with an RSTP supporting device.
Real Time Clock	24 hours backup after power failure. After 24 hours, the time will reset to factory default time until the user performs a BACnet™ Time Sync
Small LED	Transmission or reception of communication signal (green)
Large LED	Controller status (Green, Yellow, and Red)

Communications

Table 6 Communication Specification

Parameter	Specification
Protocol supported	• BACnet™ IP • BACnet™ MS/TP* • BACnet™ T1L • Modbus RTU (Modbus client only)
Ethernet Connection Speed	10/100 Mbps
Internet Protocol Version	IPv4
IP Addressing Modes	• Dynamic: DHCP and Link Local • Static: Assigned
Sylk™ bus	2-wire, polarity-insensitive
*Auto Baud rate detection is provided for the BACnet™ MS/TP controllers.	

T1L Communications

Table 7 T1L Specifications

Parameter	Specification
10BASE-T1L Standard	802.3cg-2019
Connection	Screw terminal, auto MDI-X
Cable Type	Single twisted pair, 18AWG, shielded or unshielded.
Distance	Maximum 984 ft. (300 m) to Honeywell T1L controller in daisy chain. Maximum 2,952 ft. (900 m) to any other T1L device without a daisy chain.
Transmission Mode	10 Mbps

Supported Devices*

Table 8 Supported Devices

Parameter	Specification
Sylk™ wall modules	TR40, TR40-H, TR40-CO2, TR40-H-CO2, TR42, TR42-H, TR42-CO2, TR42-H-CO2, TR50 (emulation mode only), TR71, TR71-H, TR75, TR75-H, TR75-HE, TR120 (TR75-E), and TR120-H (emulation mode only).
Sylk™ sensor	C7400S
Sylk™ Actuator	MS3103, MS3105, MS3110, and MS3120
Non Sylk™ Actuators	MS4103, MS4105, MS7403, MS7405, MS7503, MS7505, MS8103, and MS8105
Hardwired Wall Modules	T7460 A, B, C, D, E, F and T7770 A, B, C, D, E, F, G
Modbus Devices	Modbus RTU devices from any manufacturer (including Honeywell Modbus devices, for example DALI64MODPSUF/S, TR50, and TR80) can be used.

* Devices subject to local availability. Contact your local sales representative for information on available devices in your region.

Weight And Dimensions

Table 9 Weight And Dimensions

Parameter	Specification
Dimension (L x **W** x **H)**	Large - 8.5 x 4.79 x 2.1 inches (216 x 121.6 x 53 mm). Small - 7.1 x 4.7 x 2.1 inches (180 x 121.6 x 53 mm).
Weight	Large - 1.256 lbs. (570 grams) Small - 1.064 lbs. (483 grams)
Mounting	Mounting in fuse boxes (DIN43880), on DIN rails or surface mounted with optional protection covers.

Universal IO

Table 10 Universal IO Specification

Parameter	Specification
AI	• 16-bit A/D resolution
UI	• 0(2)...10 V direct/reverse or 0(4)...20 mA input. • Sensors: 10K Ohm NTC Type II, 10K Ohm NTC Type III, 10K3A1, 20K Ohm NTC, PT100, PT1000, NI1000TK5000, NI1000 Class B DIN43760, PT3000, 100 Ohm to 100K Ohm resistive (custom characteristic). • Hardwired wall modules*: space temperature, space temperature setpoint, fan speed override, occupancy mode override. • Dry contact binary input with direct/reverse. • Pulse input with maximum frequency 100 Hz, minimum pulse width 5 ms. Compatible with the S0* interface for pulse counters.
AO	• Voltage output with 0(2)...11 V direct/reverse with -3 mA ...+20 mA. • Current output with 0(4)...20 mA direct/reverse. • Hardwired wall modules*: LED Control.
DO	• Dry contact binary output with direct/reverse.

* Devices subject to local availability. Contact your local sales representative for information on available devices in your region.

Solid State Relay (SSR)

Table 11 Solid State Relay (SSR)

Specification
SSR works with maximum 24 VAC / VDC
1.5 A constant; 3.5 A inrush for 0.1 seconds per SSR output.
Factory installed jumper between 24 VAC or 24 VDC supply and SSR input shared by all SSRs.

Relays

Table 12 Relays

Specification
Up to 277 VAC / 230 VAC (+20 %)
3 contacts per relay (Normally open (NO), Normally closed (NC), Common (IN)).
10 A constant current on normally open contact and 100 A inrush for 100 ms.
Total current across all relays is limited to 12 A if all commons are connected via a relay jumper.

HARDWARE OVERVIEW

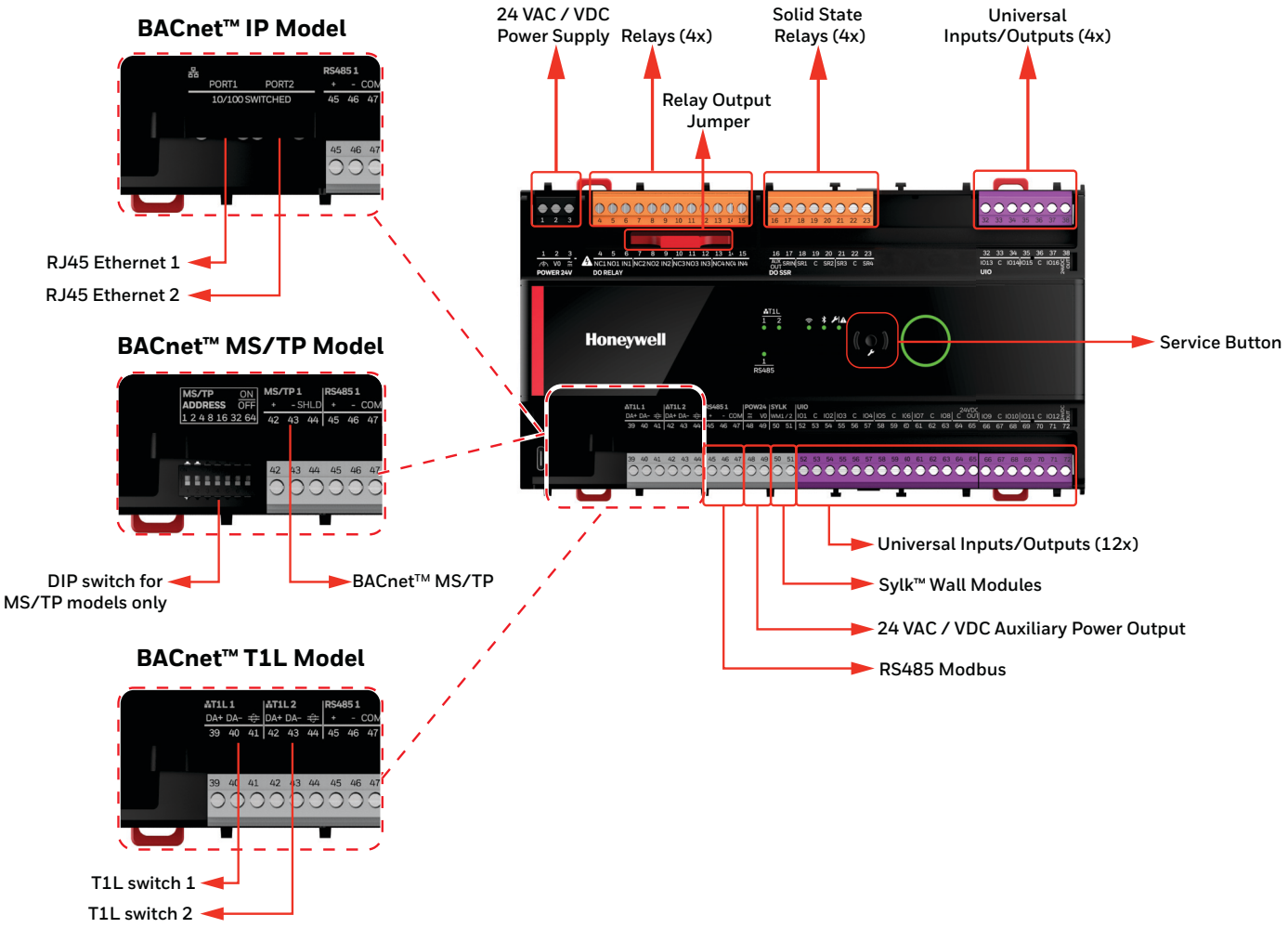


Fig. 4 Hardware Overview

System Overview

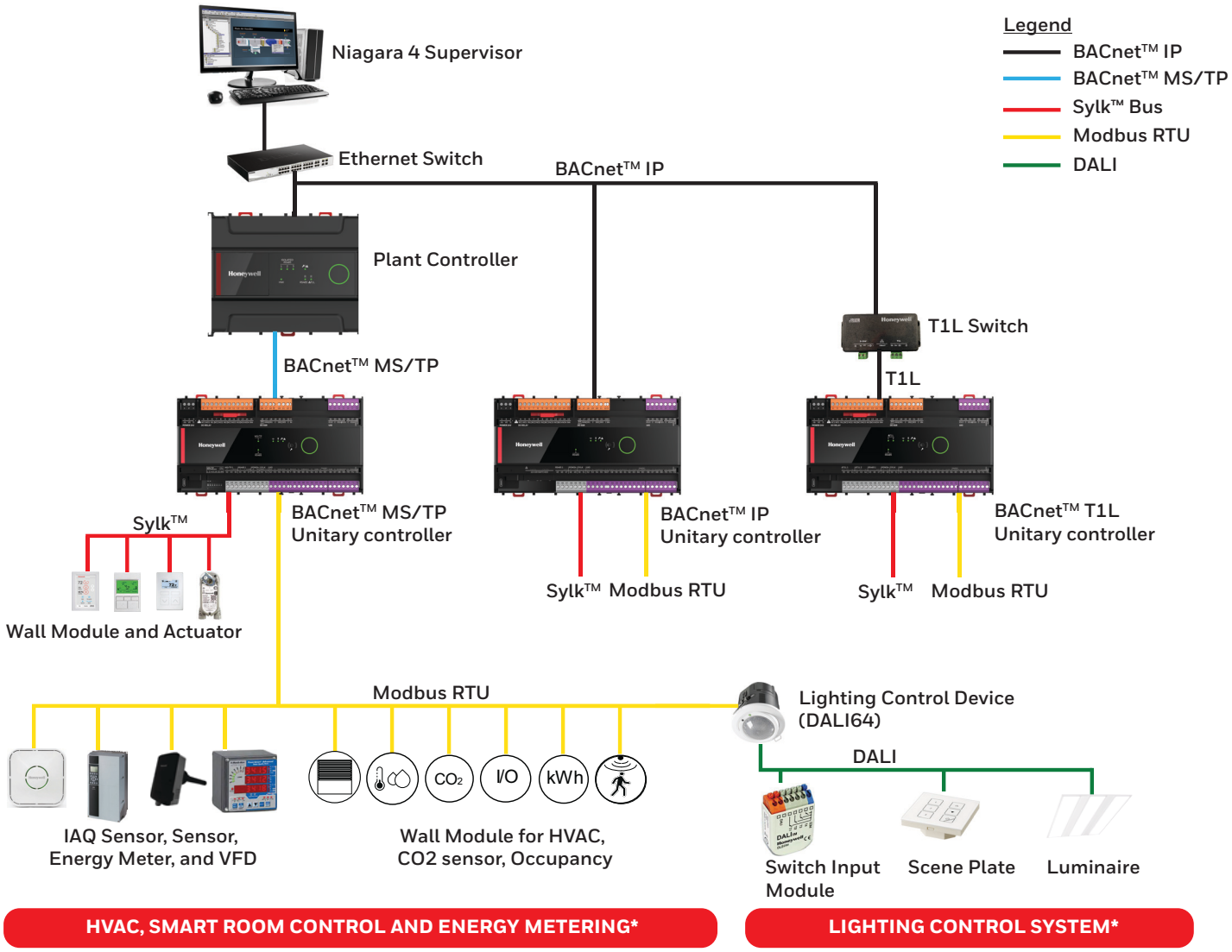


Fig. 5 System Overview

Service Button

The service button (refer Hardware Overview on page 9) 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 the controller 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 the controller is switched on (while the service pin is still pressed), a reset to factory delivery is performed. The service button must 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).
- The maxMaster setting will revert to its default value of 127.
- The max info frames will revert to 10.
- The device instance will revert to its default of 4194302.
- The device name will revert to [Model Name].
- The values of Auto MAC, Min MAC, and Max MAC will be reset to 1 and 127 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 button message (BACnet™ WhoAmI as a Private Transfer (SerialNo. = 130)) to be sent.

MOUNTING

Before Installation

IMPORTANT:
It is recommended that the unit be kept at room temperature for at least 24 hours before applying power. This is to allow the evaporation of any condensation resulting from low shipping / storage temperatures.

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

IMPORTANT:
US requirement, only: This device must be installed in a UL-listed enclosure offering adequate space to maintain the segregation of the line voltage field wiring and Class 2 field wiring.

CAUTION
To avoid electrical shock or equipment damage, you must switch OFF the power supply before attaching or removing connections to or from any terminals.

DIN Rail Mounting

1. Mount the DIN rail on the wall/surface by using screws.

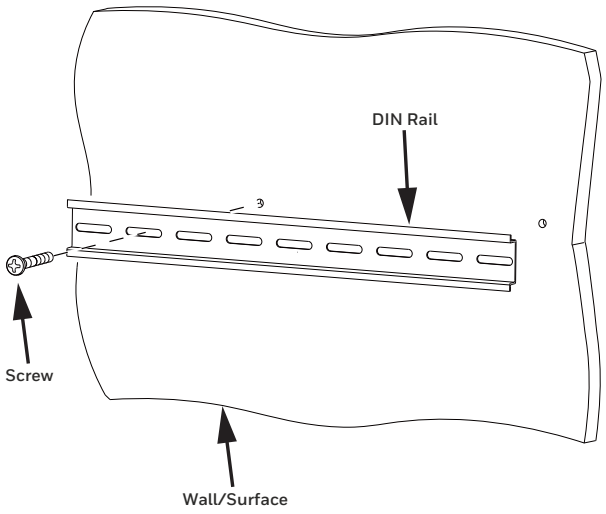


Fig. 6 DIN Rail Wall/Surface

2. Extend all red mounting clips to the unlock position as shown in figure 7.

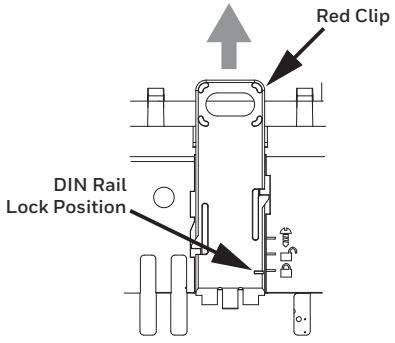


Fig. 7 Lock Position

3. Hold the controller as shown in below image and Mount the controller onto the DIN rail.

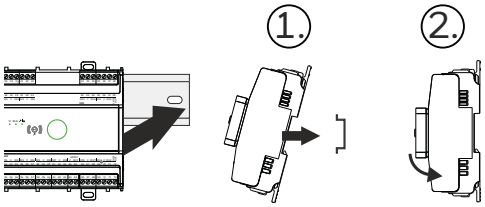


Fig. 8 Controller mounting on DIN Rail

Wall Mounting

1. Extend all red clips to the screw mounting position by inserting the flat blade screwdriver at a marked location and move up the nod from the lower slot to the upper slot as shown in figure 9.

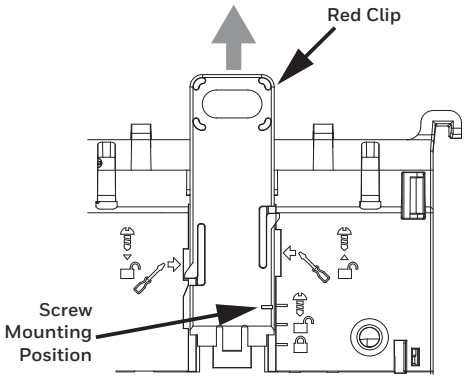


Fig. 9 Screw Mounting Position

2. Hold the controller along the wall and mark drilling locations through the screw red clip slots, as shown in figure 10.

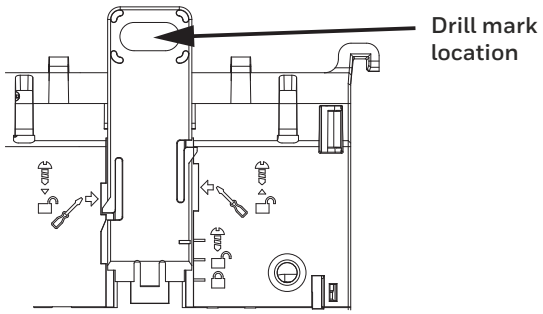


Fig. 10 Drill mark location

3. Remove the controller from the wall and drill four holes at the marked locations.

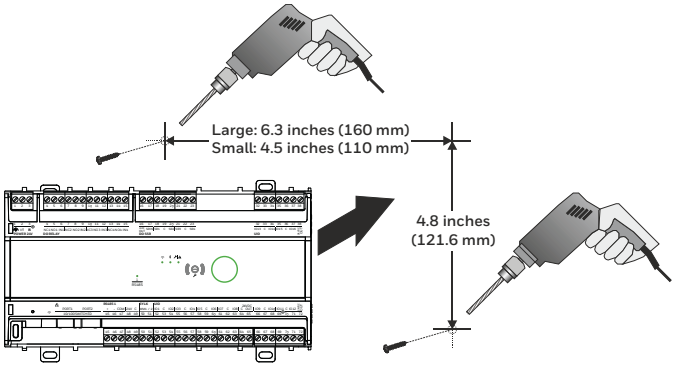


Fig. 11 Mounting and Dismounting

4. Insert anchors into the four mounting screw holes.
5. Place the controller on the wall/panel so that the holes are aligned. Insert the screws into the top-side holes first and fasten them with a screwdriver.
6. Insert the screws into the bottom hole and fasten them with a screwdriver.

NOTE:
It is recommended to use the 6/18 1-inch pan head Phillips tapping screws.

POWER SUPPLY

General Information

To prevent a risk of injury due to electrical shock and/or damage to the device due to short-circuiting, low voltage and high-voltage lines must be kept physically separate. To prevent a risk of short-circuiting and damage to your Honeywell Unitary controllers, do not reverse the polarity of the power connection cables and avoid ground loops (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 environmental conditions while selecting input and output devices.

Determine the location of controllers, sensors, actuators, other input and 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 the system as a whole. Usually, some variables must be passed between the controllers that are required for optimum system-wide operation. Typical examples are the TOD, occupied, unoccupied, outdoor air temperature, and demand limit control signal. Understanding these interrelationships early in the job engineering process is vital for proper implementation while configuring the controllers.

NOTE:

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

To comply with CE requirements, devices having a voltage of 50-1000 VAC or 75-1500 VDC, but lacking a supply cord, plug, or other means for disconnecting from the power supply must have the means of disconnect incorporated in the fixed wiring. This type of disconnect 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:

A single transformer can power more than one controller. The same side of the transformer secondary must be connected to the same power input terminal on each controller. Fig 12 shows the power wiring details for multiple controllers. Controller and configuration are not necessarily limited to three devices, but the total power draw, including accessories, cannot exceed 100 VA when powered by the same transformer (U.S. only).

NOTE:

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

Use the heaviest gauge wire available, up to 18 AWG (1 mm^2), with a minimum of 22 AWG (0.3 mm^2), for all power wiring.

CAUTION

To prevent a risk of short-circuiting and damage to your controller and external devices, do not reverse the polarity of the power supply connection cables.

IMPORTANT:

Power multiple controllers from a single transformer and connect the same transformer secondary side to each device same power input terminal. When connecting power, ensure that one leg of the 24 VAC / VDC secondary circuit and the grounded terminal on the device connects to known earth ground at the panel or enclosure. Limit the distance of the power wire running between the device and the transformer to 15 feet (4.5 meters) and restricted for same room installation. The transformer must be UL Listed for smoke control. The transformer also needs to be mounted and installed in an enclosure. Use a 15407287 series power supply.

Power Wiring Examples

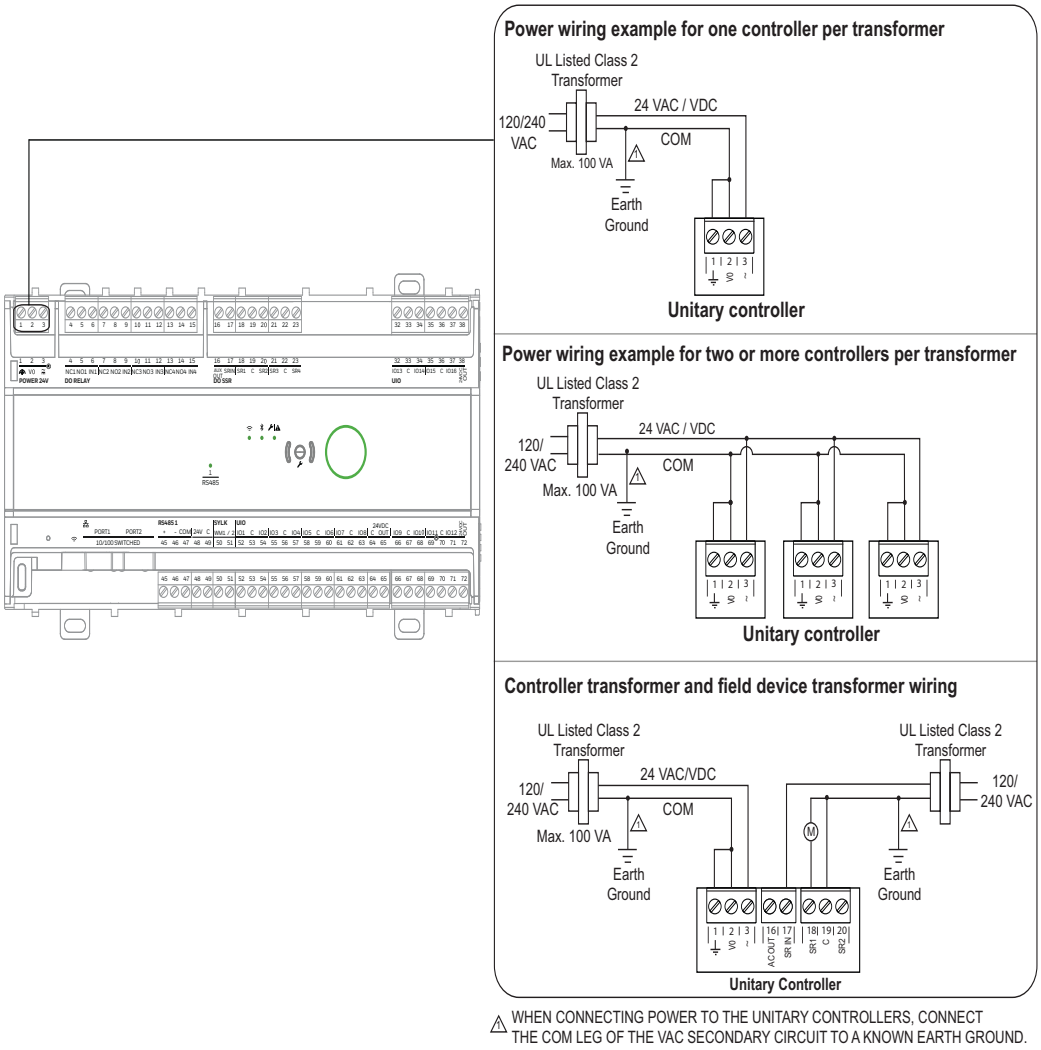


Fig. 12 Power Wiring Examples

Supply Voltage: 24 VAC/VDC. 50/60 Hz

⚠ CAUTION

Risk of Electric Shock: More than one disconnect switch may be required to de-energize the equipment before servicing. To Reduce the Risk of Fire or Electric Shock, Do Not Interconnect the Outputs of Different Class 2 Circuits.

Grounding

EGND is a functional grounding and it doesn't offer shock protection from a hazardous voltage. Connect the EGND terminal to the panel ground using the proper cable as shown above. Ensure that the panel ground connects to a known earth ground.

INPUT / OUTPUT WIRING

Wiring Requirements

NOTE:
When attaching two or more wires to the same terminal, other than 14 AWG (2.0 mm^2), be sure to twist them together. Deviation from this rule can result in improper electrical contact.

Each terminal can accommodate the following gauge of wire:

- **Single wire**: From 22 AWG (0.3 mm^2) to 18 AWG (1 mm^2) solid or stranded
- **Multiple wires**: Up to two 18 AWG (1 mm^2) 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 with a minimum of three turns before inserting them.
  - 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 to the terminal block. The maximum torque for the terminal screws is 4.4 in-lb (0.5 Nm).

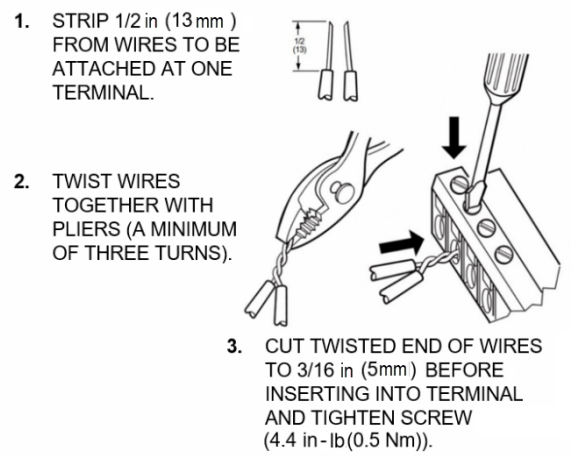


Fig. 13 Attaching Two or More Wires at Terminal Block

Internal Wiring Example

Internal Wiring Large controller

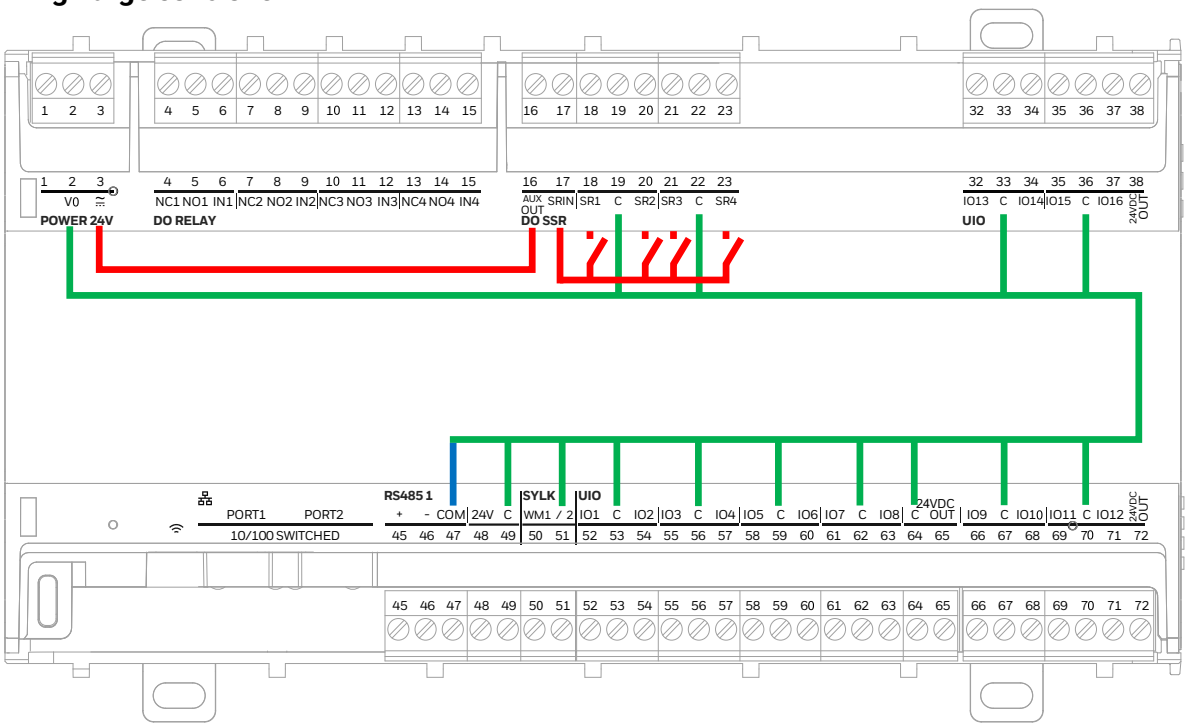


Fig. 14 Internal Wiring Large controller

Internal Wiring Small controller

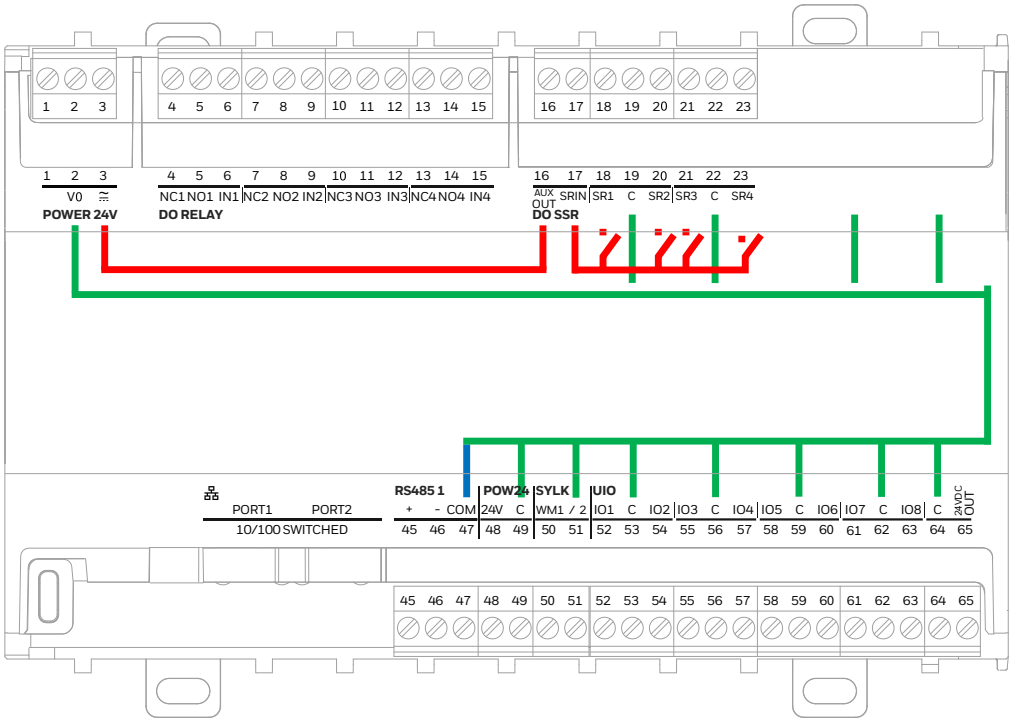


Fig. 15 Internal Wiring Small controller

Terminal Connections

All the terminals for this controller are removable.

Table 13 Terminal Connections

Terminal	Label	Description
Power 24V		
1		Earth ground (connected to building earth ground)
2	VO	Power supply voltage (connected to 24 V0)
3	~	Power supply voltage (connected to 24 VAC~)
DO Relay		
4	NC1	Normally Closed 1
5	NO1	Normally Open 1
6	IN1	Universal signal input / output 1
7	NC2	Normally Closed 2
8	NO2	Normally Open 2
9	IN2	Universal signal input / output 2
10	NC3	Normally Closed 3
11	NO3	Normally Open 3
12	IN3	Universal signal input / output 3
13	NC4	Normally Closed 4
14	NO4	Normally Open 4
15	IN4	Universal signal input / output 4
DO SSR		
16	AC OUT	24 VAC~ output
17	SRIN	SSR power input ((connected to AC OUT with a factory jumper)
18	SR1	SSR1 output
19	C	Common
20	SR2	SSR2 output
21	SR3	SSR3 output
22	C	Common
23	SR4	SSR4 output
UIO		
32	IO13	Universal signal input / output 13
33	C	Common
34	IO14	Universal signal input / output 14
35	IO15	Universal signal input / output 15
36	C	Common
37	IO16	Universal signal input / output 16
38	24 VDC OUT	Power Output
RS485 - 1		
45	+	RS-485 bus + (for Modbus only)
46	-	RS-485 bus - (for Modbus only)
47	COM	Common
Power 24		
48	~	Power supply voltage (connected to 24 VAC~)
49	VO	Power supply voltage (connected to 24 V0)

Table 13 Terminal Connections

Terminal	Label	Description
SYLK™		
50	+	Sylk™ Bus
51	-	Sylk™ Bus
UIO		
52	IO1	Universal signal input / output 1
53	C	Common
54	IO2	Universal signal input / output 2
55	IO3	Universal signal input / output 3
56	C	Common
57	IO4	Universal signal input / output 4
58	IO5	Universal signal input / output 5
59	C	Common
60	IO6	Universal signal input / output 6
61	IO7	Universal signal input / output 7
62	C	Common
63	IO8	Universal signal input / output 8
64	C	Common - 24 VDC
65	OUT	Power Output - 24 VDC
66	IO9	Universal signal input / output 9
67	C	Common
68	IO10	Universal signal input / output 10
69	IO11	Universal signal input / output 11
70	C	Common
71	IO12	Universal signal input / output 12
BACnet™ IP Model		
Port 1	Port 1	RJ45 Ethernet 1
Port 2	Port 2	RJ45 Ethernet 2
BACnet™ MS/TP Model		
42	+	Common
43	-	20 VDC power output
44	SHD	Shield
BACnet™ T1L Model		
39	DA+	T1L Switch 1 +
40	DA-	T1L Switch 1 -
41		T1L Switch 1 Common
42	DA+	T1L Switch 2 +
43	DA-	T1L Switch 2 -
44		T1L Switch 2 Common

UIO Wiring Examples

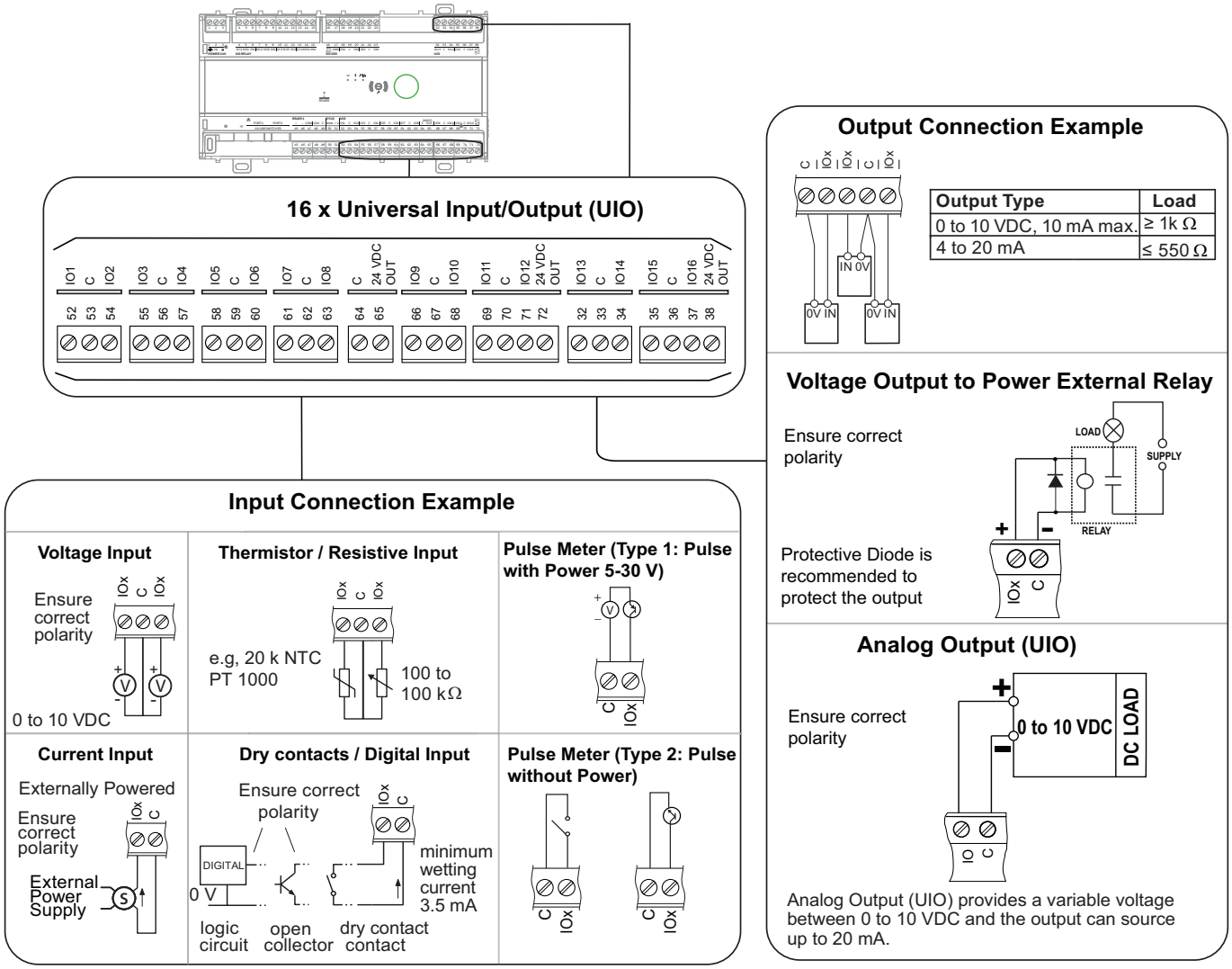


Fig. 16 Universal IO Wiring Examples

NOTE:

- UL Standards recommend all wiring connections for the IO, SSR, 24 VAC / VDC circuits are restricted to the same room.
- Use a protective diode for any circuit that allows the current to flow forward because the current will not flow in the reverse direction. The diode protects the components responsive to the current flow through them in the wrong direction.

SSR (DO) Wiring Examples

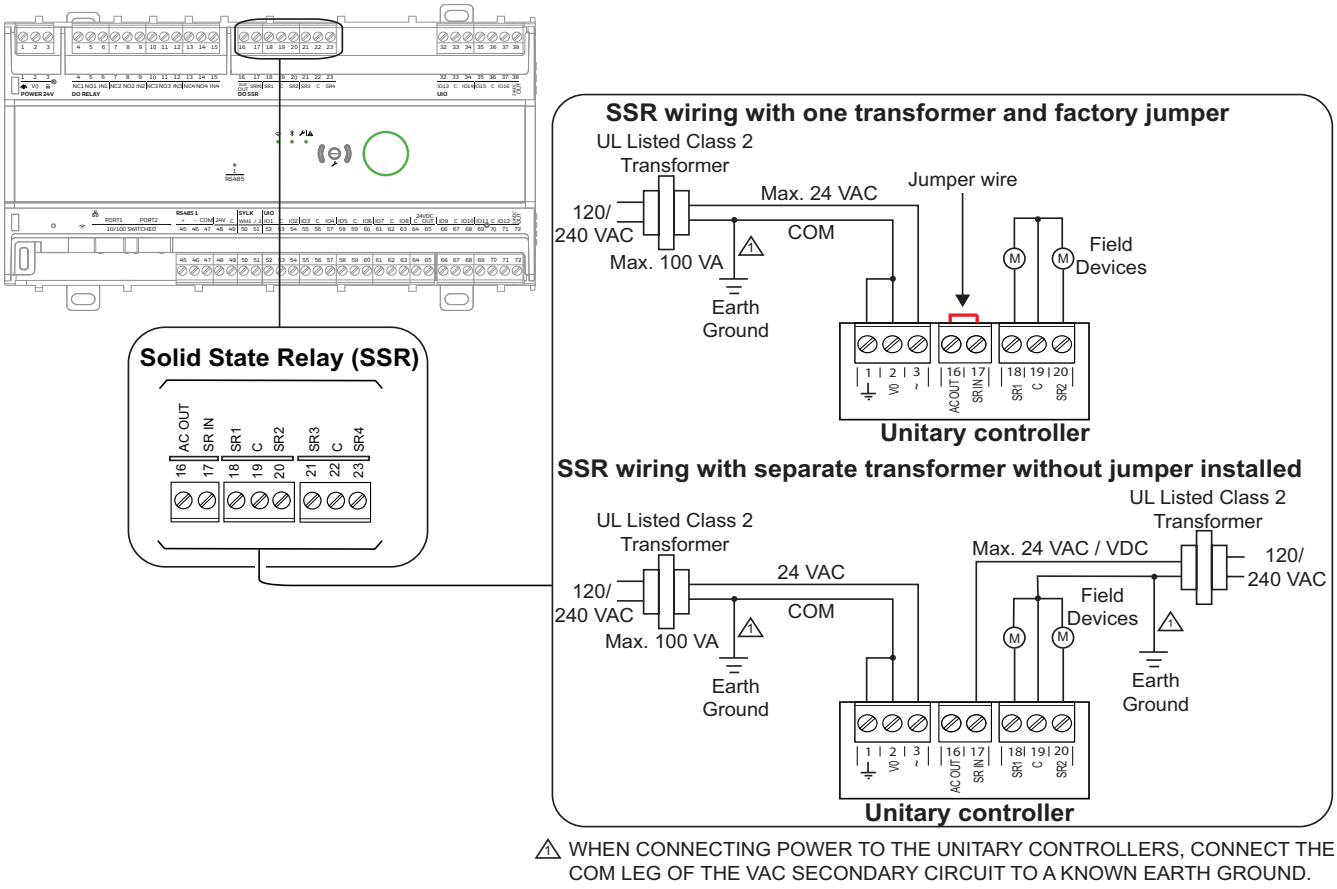


Fig. 17 SSR (DO) Wiring Examples

NOTE:

- SR IN (terminal 17, SSR power input) is connected to AC OUT (terminal 16, 24 VAC~ output) by a jumper wire provided by the factory.
- Remove the jumper if you want to power field devices with 24 VAC/VDC transformer or 20 VDC.
- All terminals are protected against short circuit and 24 VAC.
- Use copper conductor only.

CAUTION

Risk of Electric Shock: More than one disconnect switch may be required to de-energize the equipment before servicing.

Auxiliary Wiring Examples

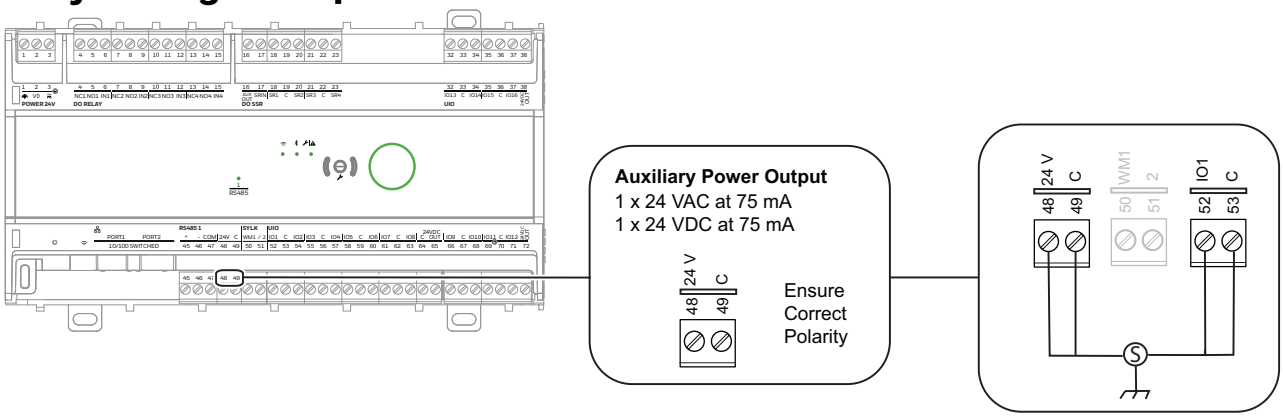


Fig. 18 Auxiliary Wiring Examples

NOTE:
The auxiliary power output (terminals 48, 49) is supplied from the controller input power supply (terminals 3, 2 respectively). The polarity of the external devices must be checked with the controller input power supply. If the polarity is reversed, external devices may be damaged.

DO Relay Wiring Examples

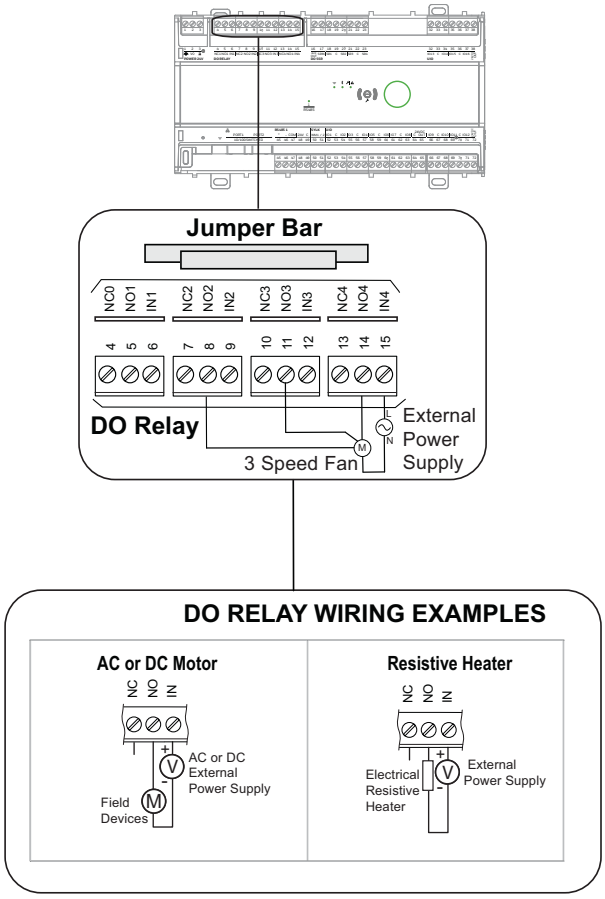


Fig. 19 DO Relay Wiring Examples

NETWORK CONCEPTS

The RS-485 Standard

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

BACnet™ connections to the RS-485 interfaces must comply with the RS-485 standard. Thus, it is recommended that each end of every bus be equipped with a termination resistor (not included in shipment) with a resistance equal to the cable impedance (120 Ω; the wattage should be in the range of 0.25 – 0.5 W).

RS-485 systems frequently lack a separate signal ground wire. However, the laws of physics still require that a solid ground connection be provided to ensure error-free communication between drivers and receivers unless all of the devices are electrically isolated and no earth grounding exists.

⚠ CAUTION

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 BACnet™ MS/TP EIA 485 buses.

Table 14. TIA/EIA 485 Cable Specifications

Maximum Length	3936 feet (1200 meters)
Cable Type	Twisted shielded pair (foil or braided shields are acceptable)
Characteristic Impedance	100-130 Ω
Distributed Capacitance Between Conductors	Less than 30 pF per foot (100 pF per meter)
Distributed Cap. Between Conductors and Shield	Less than 200 pF per foot (60 pF per meter)

The Honeywell tested and recommended MS/TP cable is Honeywell Cable 3322 (18 AWG, 1-Pair, Shielded, Plenum cable). Alternatively, Honeywell Cable 3251 (22 AWG, 1-Pair, Shielded, Plenum cable) is available and meets the BACnet™ Standard requirements.

IP Network Topologies

- Recommended cable: CAT5, CAT6.
- Maximum distance between two controllers or controller and switch should be less than 328 ft (100 m).

Fail-safe Daisy Chain Topology

In traditional daisy chain topologies, if any of the devices in the network fails, the devices that are connected after that device, also fail.

For example, if there are 10 devices in a network, device number 1 is the client device, which is connected to device 2, device 2 is connected to 3, and so on. If device 5 fails to function, then devices 6 through 10 also fail to communicate with the client device.

Our IP ports include a protection for these scenarios so that a device having a logic failure will not interrupt the communication of others, for as long as the Ethernet switch continues to be powered and running.

Maximum number of controllers that can be connected in a daisy chain is 100.

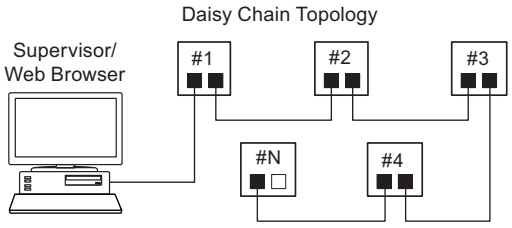


Fig. 20 Daisy Chain Topology

Ring Topology

If the Unitary controller are connected in a redundant ring. In that case, you must have one spanning tree protocol supported Ethernet switch as a part of the ring. Honeywell Unitary controllers supports an Ethernet switch for 10/100 Mbps IP connection.

The switch will connect Unitary Controller ring with the IP network. The loop-free topology ensures that there aren't any broadcast storms or duplicate frame transmissions. The maximum number of controllers connected in the STP loop is 40. A switch manages the connection of a loop.

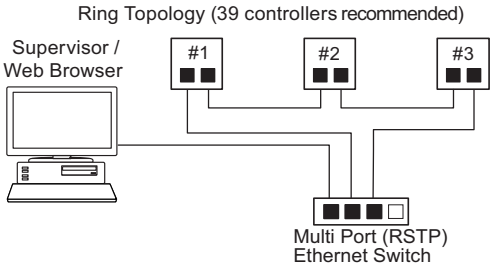


Fig. 21 Ring Topology

BACNET™ IP CONTROLLER

Table 15 Default Address

Gateway	0.0.0.0
Subnet Mask	255.255.0.0

Connecting to an IP network

Honeywell Unitary controllers communicates over wired IPv4 network using Ethernet connection via two RJ45 ports.

DHCP IP Configuration

A new controller from the factory has DHCP enabled by default.

- For the first 15 seconds after powering the controller, a search for a DHCP server will be performed to acquire an IP address.

Link-local addressing

- If a DHCP server is not found, the controller will switch to Auto IP mode, in which it follows link-local addressing for address resolution.
- It will acquire an IP address in the range 169.254.1.0 - 169.254.254.254. The controller will use the last two characters of its serial number as the last octet for starting address search. For example, if the serial ends with “36” (decimal value= 54), the IP address is set to 169.254.1.54).
- If the controller has link-local addressing, the controller will periodically (every 1 minute) search for the DHCP server. If a server is found, the controller will acquire a new IP address from the server and start using it immediately.

Static IP Configuration

Static IP address can be configured using Niagara-N4 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**.

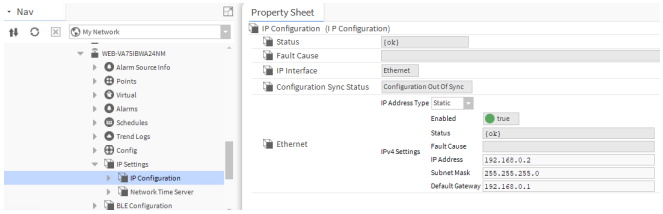


Fig. 22 Static IP Configuration

BACNET™ MS/TP WIRING

The MS/TP models of the Honeywell Unitary Controllers use the BACnet™ MS/TP communication protocol. The controller's data is presented to other controllers over a twisted-pair MS/TP network, using the TIA/EIA 485 signal standard capable of the following baud rates: 9.6, 19.2, 38.4, 57.6, and 76.8 kb/s. The Honeywell Unitary controller BACnet™ MS/TP are server devices on the MS/TP network. Each Honeywell Unitary controller BACnet™ controller uses a high-quality TIA/EIA 485 transceiver and exerts 1/8-unit load on the MS/TP network. The controller features a 2-wire non-isolated RS-485 interface (terminals 45, 46, and 47) suitable for BACnet™ MS/TP communication. The terminal block containing it is grey. The cable length affects the baud rate.

Table 16 Baud Rate vs Maximum Cable Length

Baud Rate	Maximum Cable Length (L)
9.6, 19.2, 38.4, 57.6, and 76.8 kbps	4000 ft (1200 m)

NOTE:
The maximum length of a BACnet™ MS/TP network bus segment with recommended wiring is 4,000 ft (1200 m). Repeaters must be used when making runs longer than 4,000 ft (1200 m). Between any two devices, a maximum of three repeaters can be used.

Auto Baud rate Functionality

Each time the supply voltage to the controller is switched on, the MS/TP network is listened up to 4 minutes to determine a baud rate. As soon as a correct baud rate has been determined, this is used and stored in the controller as a successful baud rate, and the auto baud detection is terminated.

If no baud rate is determined after 4 minutes, the controller will switch to the baud rate successfully used before the controller was powered up. However, if the controller is new from the factory and has yet to communicate successfully then a default baud rate is used but not stored as a successful baud rate in the controller. This causes the same process to start again next time the supply voltage is switched on.

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 = 130 Ω.

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 120 Ω, install a 120 Ω resistor.

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 higher voltage lines. If shielding is used, the shielding of each bus segment should be separately connected at one end to the earth.

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

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 considered.

- Maximum BACnet™ MS/TP bus length.
- Twisted-pair cable, for example,
  1. AWG 18 (1 mm^2)
  2. J-Y(ST)Y 4 x 2 x 0.8 mm2 or a special RS-485 cable.
  3. CAT 5,6,7 cable: use only one single pair for one bus.
  4. Belden 9842 or 9842NH
  5. Daisy chain topology.
  6. Must conform to TIA/EIA RS-485 cabling guidelines and ANSI/ASHRAE Standard 135-2010.

BACnet™ MS/TP Wiring Examples

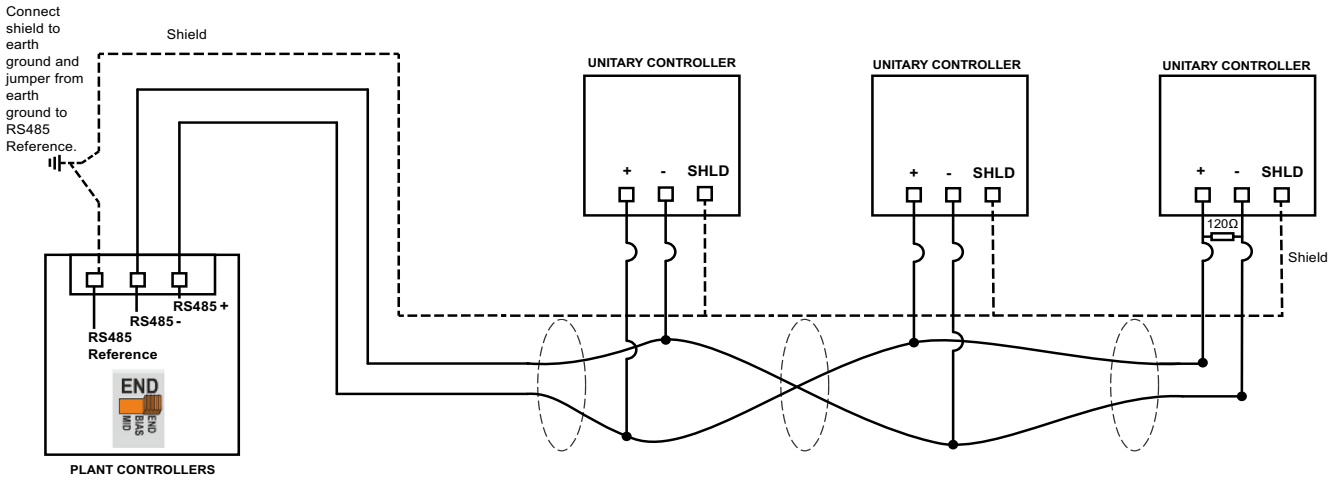


Fig. 23 Connection to a BACnet™ MS/TP Bus

NOTE:

- Suppose any of the devices are electrically isolated. It is recommended that those devices be connected to the ground terminal (SHLD), if available. See TIA/EIA 485 Cable Specifications.
- The 120 O termination resistor must be inserted directly into the terminals of both end devices.
- If shielding is used, the shielding of each individual bus segment should be separately connected at one end to earth.
- Always power each controller and the connected slaves via separate transformers.
- Between devices equipped with non-isolated RS-485 bus interfaces, potential differences of max. ±7 V are allowed. Further, this bus should not extend beyond a single building.

BACnet™ MS/TP connection with non-isolated RS485 Interfaces

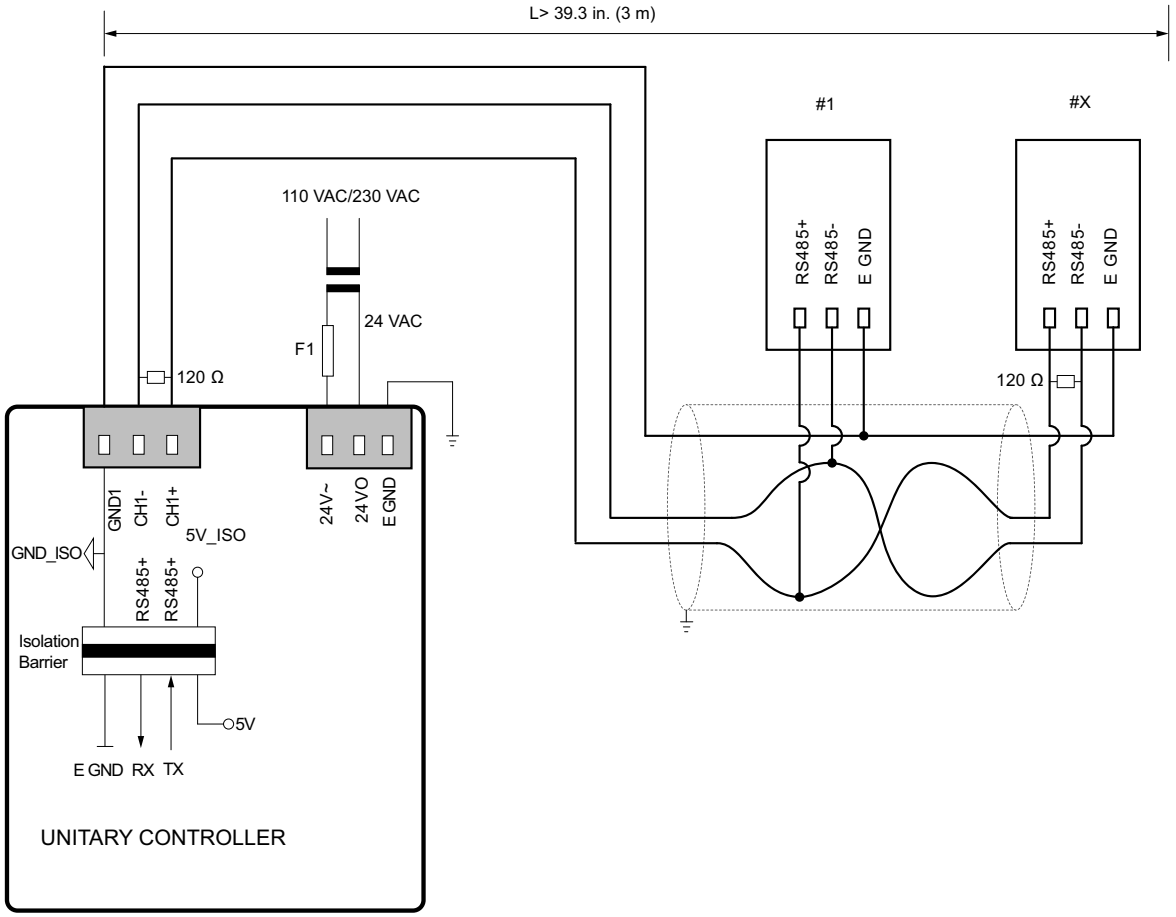


Fig. 24 Connection of RS485 interfaces 1, 2, or 3 (RS485 interface 1 shown) on a BACnet™ Bus

NOTE:

- Always power the Unitary controller with a separate transformer.
- X = max. 62 controllers.
- Single ground (single reference) connection is recommended if not all devices are electrically isolated.

BACNET™ MS/TP CONTROLLER

BACnet™ MS/TP Limitations

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

Physical Limitation

One Honeywell Unitary controller represents 1/8 load (32 loads per TIA/EIA-485 standard). The physical limitation is important if thrid party devices representing a full load are connected.

AutoMAC limitation

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

Table 17 Default Values

Default Max Master	Default MinMAC	Default MaxMAC	Default Baud Rate
127	1	127	38400

NOTE:
0 and 127 are special MAC address reserved for auto MAC addressing.

Depending on the actual performance needs and required communication rates, connecting a smaller number of BACnet™ MS/TP devices per network is recommended.

NOTE:
It is recommended not to have more than 62 controllers on single MS/TP channel.

Automatic MAC Addressing

In contrast to other controllers, the Honeywell Unitary controller features automatic MAC addressing.

The MAC addresses which the individual controllers in the BACnet™ MS/TP channel assign to themselves is not assigned in sequential order. Rather, they assign the MAC Addresses in the range of min MAC to max MAC (these are exposed as the proprietary properties ID 1028 (min MAC) and 1029 (max MAC) 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 Honeywell Unitary controllers are BACnet™ MS/TP clients. Every client performs periodic polling for the possible appearance of new clients. Each client “knows” the identity of the “next” client (for example, that Honeywell Unitary Controller with the next-highest MAC Address) on the BACnet™ MS/TP bus and to which it must therefore pass the token. The polling processes includes a search for new clients which might have MAC addresses lying between its own MAC address and that of the “next” client.

The property maxMaster specifies the highest allowable address for client nodes. The maxMaster is set to 127 by default, thus guaranteeing that, on a BACnet™ MS/TP bus. Following properties are writeable and can be changed:

- maxMaster
- min MAC
- max MAC
- MAC address

NOTE:
It would help if you did not attempt to program a MAC address outside the range of min MAC and max MAC.

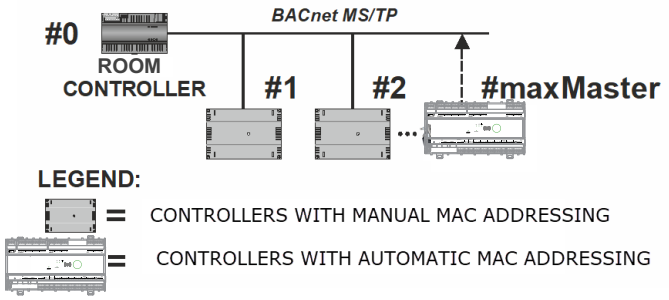


Fig. 25 Automatic MAC Addressing

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 1-126 on an MS/TP network segment (addresses 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 controller sets the controller's MAC address.

NOTE:
DIP setting of all-ON (Mac address will be 127) or all-OFF (Mac address will be 0) will enable the Auto MAC mode in the controller. The dip switches will not be used for MAC addressing.

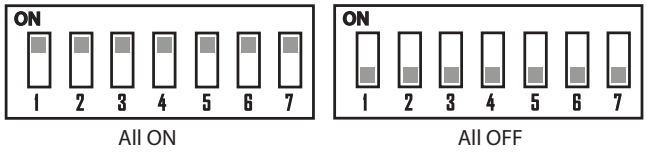


Fig. 26 MS/TP MAC Address Details

To set the MAC address of aBACnet™ MS/TP Honeywell Unitary controller:

1. Find an unused MAC address on the BACnet™ MS/TP network to which the Honeywell Unitary controller connects.
2. Locate the DIP switch bank on the Honeywell Unitary controller for addressing.
3. Power off the Honeywell Unitary controllers BACnet™ MS/TP and set the DIP switches for the MAC address you want.
4. Add the value of DIP switches set to ON to determine the MAC address. See Table 18.

Table 18 DIP Switch values for MSTP MAC Address

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

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

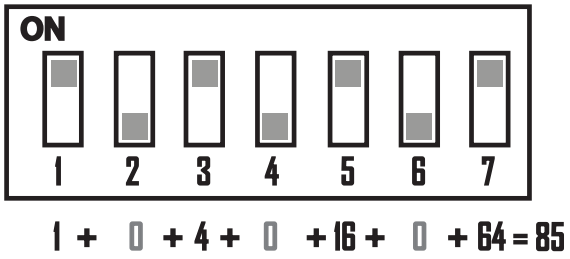


Fig. 27 Calculating the MAC Address

Setting the Device Instance Number

The Device Instance number must be unique across the entire BACnet™ MS/TP network because it is used to identify the BACnet™ devices uniquely. It may be used to identify the BACnet™ device from other devices during installation conveniently. The BACnet™ MS/TP Device Instance number is automatically set when added to a Niagara station. The user can change the Device Instance number.

T1L COMMUNICATION AND STANDARD

The standard Ethernet, 4-wire solution has evolved into a 2-wire solution known as 10BASE-T1L, consisting of a single pair of twisted cables or single-pair Ethernet (SPE).

10BASE-T1L offers the existing 2-wire infrastructure to realize line lengths of up to 1000 m at a transmission speed of 10 Mbps (see below table).

The T1L communication protocol allows devices to communicate on low-cost single twisted pair cable within an IP network. It reduces the cost of the installation of these devices. Through the Honeywell T1L media adaptor, T1L networks can be connected to main IP networks by converting one media type to another. An RJ-45 connector connects the 10BASE-T network cable to a switch or host device, and a three way screw terminal connects the downstream T1L devices with the twisted pair cable. The two ports exchange data packets in both directions. The adaptor does not require an IP or MAC address and works out of the box with no configuration.

Fail-safe Daisy Chain Topology

In traditional daisy chain topologies, if any of the devices in the network fails, the devices that are connected after that device, also fail.

For example, if there are 10 devices in a network, device number 1 is the client device, which is connected to device 2, device 2 is connected to 3, and so on. If device 5 fails to function, then devices 6 through 10 also fail to communicate with the client device.

Our IP ports include a protection for these scenarios so that a device having a logic failure will not interrupt the communication of others, for as long as the Ethernet switch continues to be powered and running.

The maximum number of T1L controllers which can be connected in a daisy chain is 100 with some limitations over few operations.

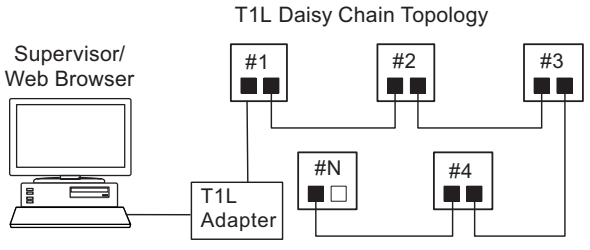


Fig. 28 T1L Fail-safe Daisy chain Topology

Ring Topology

If the Unitary controller are connected in a redundant ring. In that case, you must have one spanning tree protocol supported Ethernet switch as a part of the ring. Honeywell Unitary controller supports an Ethernet switch for 10/100 Mbps IP connection.

The switch will connect Unitary controller ring with the IP network. The loop-free topology ensures that there aren't any broadcast storms or duplicate frame transmissions.

The maximum number of T1L controllers which can be connected in the STP loop is 40 with some limitations.

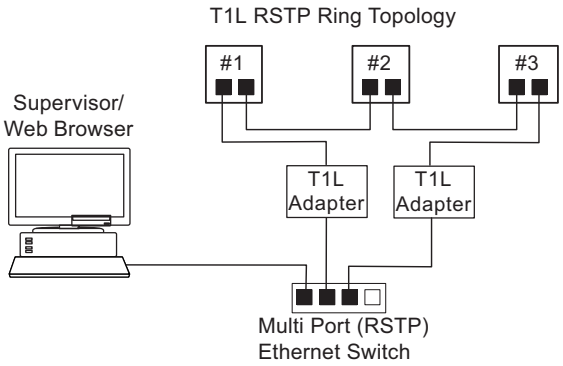


Fig. 29 T1L Ring Topology

Table 19 T1L Specifications

10BASE-T1L Standard	802.3cg-2019
Connection	Screw terminal, auto MDI-X
Cable Type	Single twisted pair, 18AWG, shielded or unshielded
Distance	Maximum 984 ft. (300 m) to Honeywell T1L controller in daisy chain. Maximum 2,952 ft. (900 m) to any other T1L device without a daisy chain.
Transmission speed	10 Mbs/s

MODBUS RTU

The controller features a removable 2-wire with shield, non-isolated, RS-485 interface suitable for Modbus communication (terminals 16, 17, and 18). The terminal block containing it is gray. The controller can function only as a Modbus server. In general, the TIA/EIA 485 wiring rules must be followed.

Wiring Topology

Only daisy chain wiring topology is allowed.

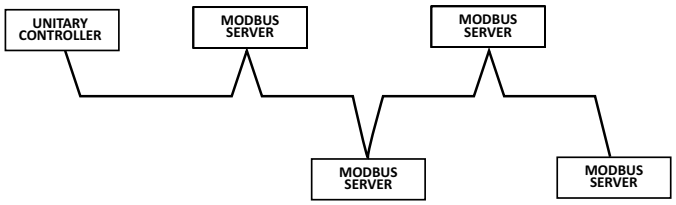


Fig. 30 Modbus Wiring Topology

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

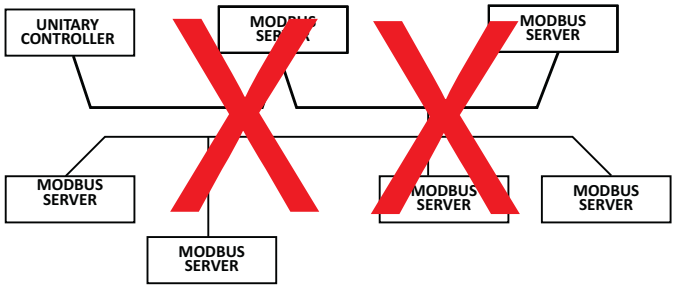


Fig. 31 Prohibited Wiring Topology (example)

Cables and Shielding

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 network).

Shielding is especially recommended when the Modbus cable is installed in areas with expected or actual electromagnetic noise. Prefer avoiding such areas.

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, CAT 5 cable may also be used.

Modbus RS-485 Repeaters

RS-485 repeaters are possible but have not been tested by Honeywell; therefore, it is the installing or commissioning person's responsibility to ensure proper operation.

NOTE:
Each Modbus segment will require its own line polarization and line termination (120 Ω; the wattage should be in the range of 0.25 – 0.5 W).

Modbus Client Specifications

Table 20 Modbus Client Specifications

Specification	Description
Physical Layer	2-wire serial line (TIA/EIA-485) (with additional common)
Communication rates	9.6, 19.2, 38.4, 57.6, and 76.8 kb/s supported.
Maximum numbers of devices	32, It is recommended to connect a smaller number of devices for better Modbus performance.
Cable and wiring specifications	Check cable and specifications in power wiring section.
Communication Mode	Modbus client only.
Transmission Mode	RTU (Remote Terminal Unit).
Address Range	Modbus client 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 Compliance

As per the Modbus standard, the Unitary 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 kb/s (because these communication rates are not market-relevant).

The baud rate (1200, 2400, 4800, 9600, 14400, 19200, 38400, 57600, 115200), parity (Even/Odd, None) and the number of stop bits (1 or 2) can be selected under Controller - IRM Program - Control Manager.

Modbus Considerations

The RS-485 interface suitable for Modbus communication is 2-wire with shield non-isolated, hence the following considerations apply:

- Maximum Modbus length (“L”):
  4000 feet (1200 meters) for 9.6 – 78.8 kbps or 2600 feet (790 meters) for 115.2 kbps. 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 common mode voltage limit.
- Must conform to TIA/EIA 485 cabling guidelines. Should not extend beyond a single building.

SYLK™ BUS

Sylk™ Bus compatible wall modules such as TR120 can be connected to the controller's Sylk™ (terminals 50 and 51).

- The Sylk™ bus is single pair and polarity insensitive.
- Maximum current provided at the Sylk™ bus interface: 96 mA.
- 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 software has a built-in resource calculator to calculate the number of Sylk™ wall modules.

Following are the Sylk™ devices and Sylk™ actuator supported by the Honeywell Unitary controller.

Supported Sylk™ bus devices

- **Sylk™ bus modules:** TR40, TR40-H, TR40-CO2, TR40-H-CO2, TR42, TR42-H, TR42-CO2, TR42-H CO_2, TR71, TR71-H, TR75, TR75-H, TR120 (TR120_TR75E), and TR120-H (TR120H_TR75E) emulation mode only.
- **Sylk™ actuator:** MS3103, MS3105, MS4103, MS4105, MS7403, MS7405, MS7503, MS7505, MS8103, MS8105 spring return direct-coupled actuators (DCA) are used within heating, ventilating, and air-conditioning (HVAC) systems. They can drive a variety of quarter-turn, final control elements requiring spring return fail-safe operation.
- **Sylk™ Sensors:** C7400S Sylk™ Sensor

NOTE:
- TR42x wall module must be firmware version 1.3 or higher.
- TR70 wall modules are not supported.

Table 21. Recommended maximum distances

Single Twisted Pair, Non-shielded, Stranded or Solid[a)]		Standard Non-twisted Thermostat Wire Shielded or Non-shielded, Stranded or Solid[b)]
18 - 22 AWG (0.048 - 0.028 in) (0.3 to 1 mm^2)	24 AWG (0.022 in) (0.2 mm^2)	18 - 24 AWG (0.048 - 0.022 in) (0.2 to 1 mm^2)
500 ft (150 m)	400 ft (120 m)	100 ft (30 m)

[a)] 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.

Table 21. Recommended maximum distances

Single Twisted Pair, Non-shielded, Stranded or Solid[a)]	Standard Non-twisted Thermostat Wire Shielded or Non-shielded, Stranded or Solid[b)]

[b)] 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.).

NOTE:
- Shielded cable is recommended if there is a need to reduce the effect of electrical noise.
- These distances also apply to shielded pair.

Sylk™ bus Wiring Example

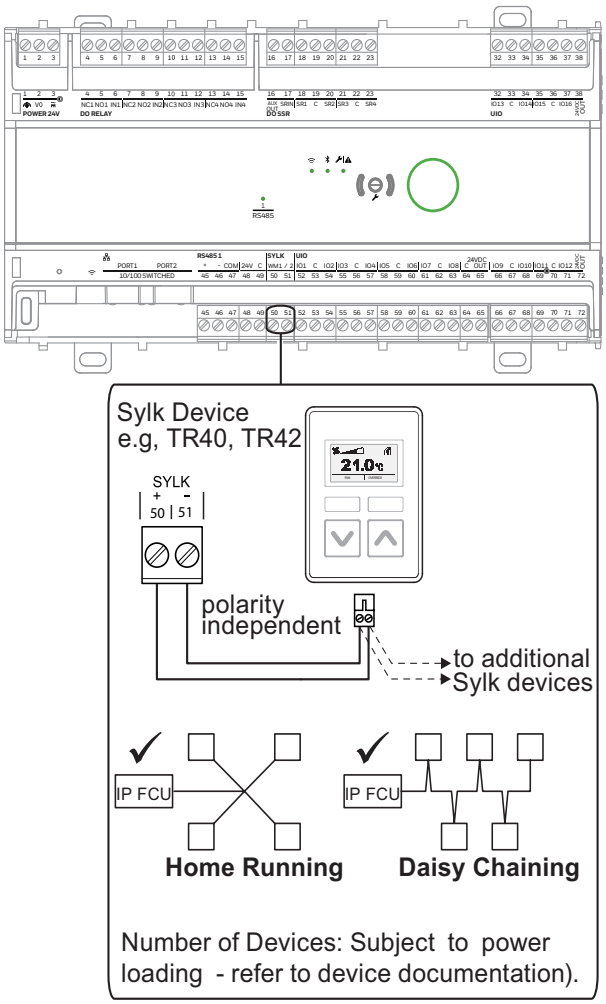


Fig. 32 Sylk™ Wiring Topologies

TROUBLESHOOTING

Honeywell Unitary controller feature a Service Button, Status LED, Power LED, and two additional LEDs (T1 and R1) for commissioning and troubleshooting.

Check if the Status LED's behavior is changed if you switch the power OFF/ON. If this does not solve the problem, contact your Reseller. If you purchased the product directly from Honeywell or have been instructed by your Reseller to contact Honeywell Safety and Productivity Solutions directly, call the Customer Service Department.

Further, the test function (online debugging) of Niagara Workbench can also be used to carry out a general application and wiring checks. Niagara Workbench also features a BACnet™ device manager who can prove very helpful in analyzing the controller's function and communication.

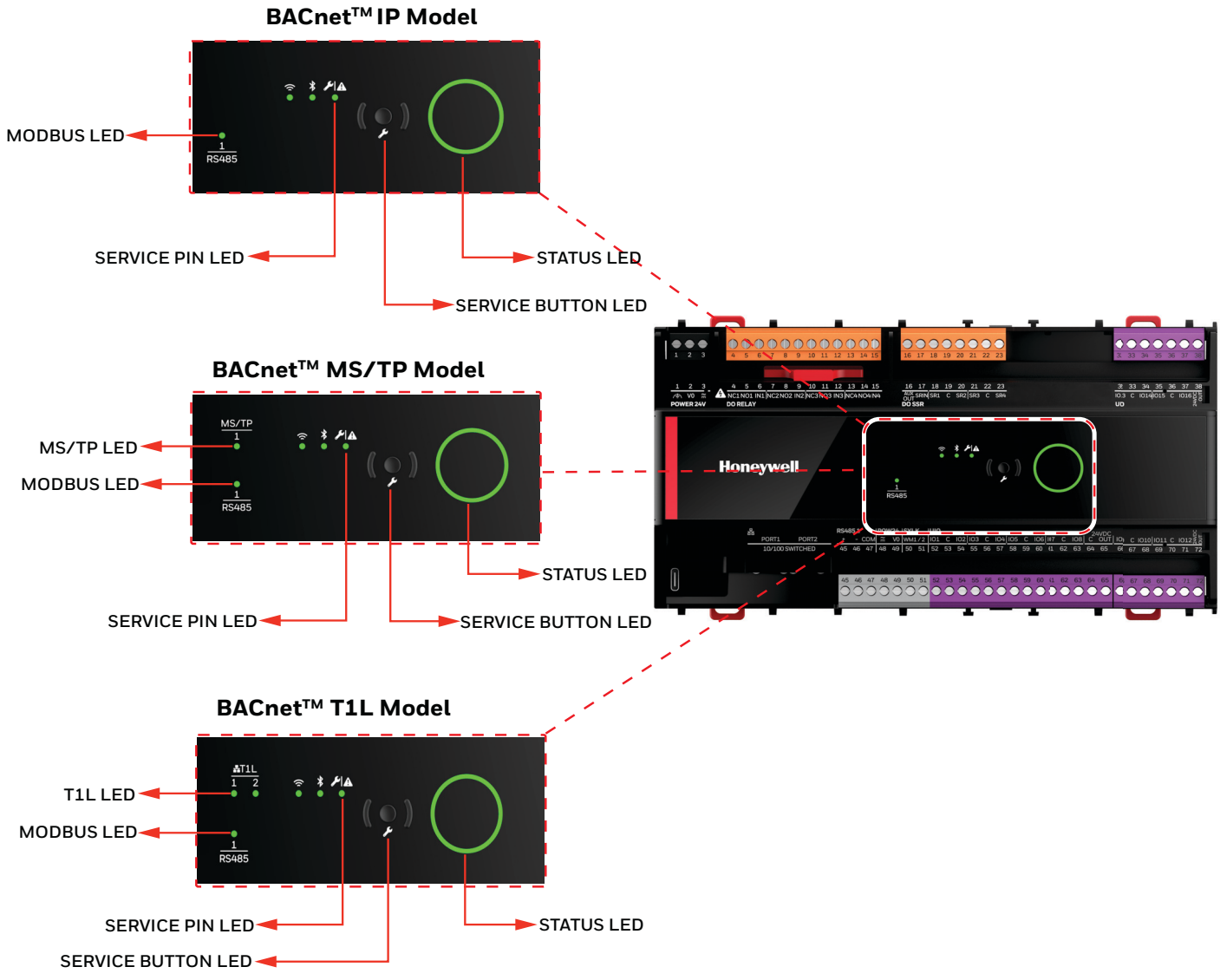


Fig. 33 LED Interface

Controller LED Status

Table 22 Controller LED Status

LED Status	Visual	Mode
Green LED permanent ON		Normal operation
Green LED blinks every 2 seconds		Auto MAC
Green LED blinks every 200 ms.		Firmware download
Yellow LED permanent ON		No Valid Mac
Yellow LED blinks every 2 seconds		Un Ack Alarm
Red LED permanent ON		Broken sensor Short circuit
Red LED blinks every 200 ms.		Communication error
Red, Green, Yellow LED blinks every 1 second		No application

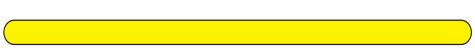
BACnet™ MS/TP LED Status

Table 23 BACnet™ MS/TP LED Status

LED Status	Visual	Mode
Green LED permanent ON		Controller MS/TP BACnet communication is normal.
Yellow LED permanent ON		Controller is sending MS/TP BACnet packets but not receiving any response.
Red LED permanent ON		No communication from MS/TP BACnet. The controller is not in the MS/TP network.

Modbus LED Status

Table 24 Modbus LED Status

LED Status	Visual	Mode
Green LED permanent ON		Modbus Communication is healthy - Successful to read/write all of Modbus registers configured in the application.
Yellow LED permanent ON		Modbus Communication is not healthy - failure to read/write some of Modbus registers configured in the application.

LED Status	Visual	Mode
Red LED permanent ON		Modbus Communication failure - failure to read/write all of Modbus registers configured in the application.
LED OFF		No Modbus Communication - Application don't have any Modbus read/write registers.

T1L LED Status

Table 25 T1L LED Status

LED Status	Visual	Mode
Green LED permanent OFF		Link is up, Valid IP address is configured. Communication is healthy.
Yellow LED permanent OFF		Link is up, No valid IP address is configured.
LED OFF		Link is down.

Service Pin LED Status

Table 26 Service Pin LED Status

LED Status	Visual	Mode
Green LED permanent ON		On Service PIN button Press
LED OFF		On release of Service PIN button

NOTE:
The communication error mode on the LED status reacts only on Modbus communication RS485-1.

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

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

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 or TV technician for help.

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

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 is listed in Table 2 on page 3.
- This device requires significant technology engineering expertise to understand the tools and relevant technology, which is not readily available to the average consumer. Only a person professionally trained in the technology is competent.
- This device is not directly marketed or sold to general public.

Wireless Connectivity (Future Release)

The BLE (Nordic) chip is used for the secure application of BLE communication and wiring verification. It works at a frequency of ~2400 MHZ. A mobile app is used to establish a secure BLE connection to the controller via BLE. After establishing a secure connection with the controller's mobile app, the controller will exchange cable verification data over BLE in an encrypted format.

Table 27 Connectivity Frequency Range

Parameter	Specification
Connectivity	Bluetooth
Frequency Range	2.4 GHz
E.I.R.P for CE (Effective Isotropic Radiated Power)	20 mW
E.I.R.P for FCC/IC (Effective Isotropic Radiated Power)	20 mW

CE Statement

The WLAN function for this device is restricted to indoor use only when operating in the 5150 to 5350 MHz frequency range.

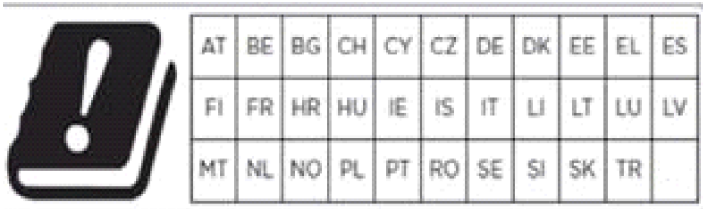


Fig. 34 CE Statement

EMF Statement

To comply with the RF exposure requirement, a separation distance of 20 cm between the device and the human should be maintained.

Déclaration EMF

Pour se conformer à l'exigence d'exposition RF, une distance de séparation de 20 cm entre l'appareil et l'humain doit être maintenue.

Restrictions in the 5 GHZ Band

Within the 5.15 to 5.25 GHz band, UNII devices will be restricted to indoor operations to reduce any potential for harmful interference to co-channel Mobile Satellite System (MSS) operations.

Detachable Antenna Warning (IC)

Transmitter Antenna (From Section 6.8 RSS-GEN, Issue 5, April 2018): This radio transmitter See Table 28 on page 38 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.

Table 28 BLE Certification Numbers

FCC ID	IC ID
2A8LT-24NM001	12252A-24NM001

Standards and Compliance

- CE mark
- UL916 Energy Management Equipment
- UL/ULC 60730-1
- FCC/IC Product Class B,
- UL2043
- BACnet™ BTL®-Listed

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;
- BACnet™ BTL®-Listed; BACnet™ Advanced Application Controller (B-AAC) certification pending, expected in 2023 as per ANSI/ASHRAE 135
- CE-approved
- FCC part 15B-compliant.
- RoHS conformity

WEEE Directive 2012/19/EC Waste Electrical and Electronic Equipment 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.

Table 29 Honeywell Unitary Controllers Containing Lead (Pb)

Product / Part Name	Substance Name
UN-RS0844ES24NMC / D UN-RS0844MS24NMC / D UN-RS0844TS24NMC / D UN-RL1644ES24NMC / D UN-RL1644MS24NMC / D UN-RL1644TS24NMC / D	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 10 K NTC Ω and 20 K NTC Ω sensors. The following table lists the typical minimum accuracies of the hardware and software for these temperature sensors.

Table 30 Sensor Accuracies

Range	Measurement Error (Excluding Sensor Characteristics)			
	10 kΩ NTC [a)]	**20 k NTC**	**PT3000**	**NI1000TK5000 [b)]**
-58 °F to -4 °F (-50 °C to -20 °C)	≤ 5.0 K	≤ 5.0 K	≤ 1.2 K	≤ 1.2 K
-4 °F to +32 °F (-20 °C to 0 °C)	≤ 1.0 K	≤ 1.0 K	≤ 0.7 K	≤ 0.7 K
32 °F to 86 °F (0 °C to 30 °C)	≤ 0.5 K	≤ 0.3 K	≤ 0.5 K	≤ 0.5 K
86 °F to 158 °F (30 °C to 70 °C)	≤ 0.5 K	≤ 0.5 K	≤ 0.7 K	≤ 0.7 K
158 °F to 212 °F (70 °C to 100 °C)	≤ 1.0 K	≤ 1.0 K	≤ 1.2 K	≤ 1.2 K
212 °F to 266 °F (100 °C to 130 °C)	--	≤ 3.0 K	≤ 1.2 K	≤ 1.2 K
266 °F to 302 °F (130 °C to 150 °C)	--	≤ 5.5 K	≤ 1.2 K	--
302 °F to 752 °F (150 °C to 400 °C)	--	--	--	--

a) 10 k NTC Ω specified for -22 °F to 212 °F (-30 °C to +100 °C) only.

b) NI1000TK5000 specified for -22 °F to +266 °F (-30 °C to +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 Sensor Characteristics on page 41.

Recognition of Sensor Failure of Sensor Inputs

The thresholds at which the sensor fails, that is, sensor breaks (SB) and short-circuits (SC), are recognized, depending upon the given sensor type. In the event of a recognized sensor failure, the sensor assumes the safety values configured in Table 30 on page 39. It lists the measurement ranges and the corresponding thresholds for the recognized sensor failure for the various types of sensor:

Table 31 Thresholds for Short-circuit (SC) and Sensor-break (SB) Recognition

I/O Configuration	Measurement Range	Recognition Thresholds
2 to 10 V	2 to 10 VDC 4 to 20 mA (without pull-up)	SC: < 1.5 VDC 3 mA; SB: no recognition
10 k NTC Ω (Type II)	-22 °F to +212 °F (-30 °C to +100 °C)	SC: < 20 Ω; SB: < -94 °F (-70 °C)
20 k NTC Ω	-58 °F to +302 °F (-50 °C to +150 °C)	SC: < 20 Ω; SB: < -94 °F (-70 °C)
PT1000	-58 °F to +752 °F (-50 °C to + 400 °C)	SC: < 775 Ω; SB: < -58 °F (-50 °C)
NI1000TK5000	-22 °F to +266 °F (-30 °C to +130 °C)	SC: < 850 Ω; SB: < -58 °F (-30 °C)
PT100	-58 °F to +752 °F (-50 °C to +400 °C)	-
PT3000	-58 °F to +302 °F (-50 °C to +150 °C)	-
10K3A1	-40 °F to +257 °F (-40 °C to +125 °C)	-
Nickel Class B DIN 43760 sensors	-76 °F to +752 °F (-60 °C to +169 °C)	-

NOTE:
In the case of temperatures lying outside the ranges, the lowest and highest value within the range, 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.

10 K NTC TYPE II Characteristics

Table 32 10 K NTC TYPE II Characteristics

Temp. [°F]	Temp. [°C]	Resistance [KΩ]	Terminal Voltage [V]
-22	-30	177	7.904
-20.2	-29	166.35	7.848
-18.4	-28	156.41	7.79
-16.6	-27	147.14	7.73
-14.8	-26	138.47	7.666
-13	-25	130.37	7.601
-11.2	-24	122.8	7.534
-9.4	-23	115.72	7.464
-7.6	-22	109.09	7.392
-5.8	-21	102.88	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
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
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

Table 32 10 K NTC TYPE II Characteristics (Continued)

Temp. [°F]	Temp. [°C]	Resistance [KΩ]	Terminal Voltage [V]
33.8	1	31.027	5.189
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
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
91.4	33	7.098	2.159
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
212	100	0.68	0.265

Table 32 10 K NTC TYPE II Characteristics (Continued)

Temp. [°F]	Temp. [°C]	Resistance [KΩ]	Terminal Voltage [V]
156.2	69	1.813	0.673
158	70	1.752	0.652

10 K NTC TYPE III Characteristics

Table 33 10 K NTC TYPE III Characteristics

Temp. [°F]	Temp. [°C]	Resistance [Ω]	Temp. [°F]	Temp. [°C]	Resistance [Ω]
-35	-37.2	203.6K	105	40.6	5479
-30	-34.4	173.6K	110	43.3	4947
-25	-31.7	148.3K	115	46.1	4472
-20	-28.9	127.1K	120	48.9	4049
-15	-26.1	109.2K	125	51.7	3671
-10	-23.3	94.07K	130	54.4	3333
-5	-20.6	81.23K	135	57.2	3031
0	-17.8	70.32K	140	60.0	2759
5	-15.0	61.02K	145	62.8	2515
10	-12.2	53.07K	150	65.6	2296
15	-9.4	46.27K	155	68.3	2098
20	-6.7	40.42K	160	71.1	1920
25	-3.9	35.39K	165	73.9	1759
30	-1.1	31.06K	170	76.7	1614
35	1.7	27.31K	175	79.4	1482
40	4.4	24.06K	180	82.2	1362
45	7.2	21.24K	185	85.0	1254
50	10.0	18.79K	190	87.8	1156
55	12.8	16.65K	195	90.6	1066
60	15.6	14.78K	200	93.3	984
65	18.3	13.15K	205	96.1	909.8
70	21.1	11.72K	210	98.9	841.9
75	23.9	10.46K	215	101.7	779.8
80	26.7	9354	220	104.4	723
85	29.4	8378	225	107.2	671
90	32.2	7516	230	110.0	623.3
95	35.0	6754	235	112.8	579.5
100	37.8	6078	240	115.6	539.4

10 K3A1 Characteristics

Table 34 10 K3A1 Characteristics

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

Temp. [°F]	Temp. [°C]	Resistance [Ω]
26.6	-3	38110
28.4	-2	36184
30.2	-1	34366
32	0	32651
33.8	1	31031
35.6	2	29500
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

Table 34 10 K3A1 Characteristics (Continued)

Temp. [°F]	Temp. [°C]	Resistance [Ω]
23	-5	42317
24.8	-4	40151
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
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

Temp. [°F]	Temp. [°C]	Resistance [Ω]
89.6	32	7402
91.4	33	7097
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
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

Table 34 10 K3A1 Characteristics (Continued)

Temp. [°F]	Temp. [°C]	Resistance [Ω]
156.2	69	1813
158	70	1752
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

Temp. [°F]	Temp. [°C]	Resistance [Ω]
222.8	106	571
224.6	107	555
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

20 K NTC Characteristics

Table 35 20 K NTC Characteristics

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

Temp. [°F]	Temp. [°C]	Resistance [KΩ]	Terminal Voltage [V]
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
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

Table 35 20 K NTC Characteristics (Continued)

Temp. [°F]	Temp. [°C]	Resistance [KΩ]	Terminal voltage [V]
-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
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

Temp. [°F]	Temp. [°C]	Resistance [KΩ]	Terminal Voltage [V]
42.8	6	51.1	6.2
44.6	7	48.5	6.1
44.4	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
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
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

Table 35 20 K NTC Characteristics (Continued)

Temp. [°F]	Temp. [°C]	Resistance [KΩ]	Terminal voltage [V]
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
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
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
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

Temp. [°F]	Temp. [°C]	Resistance [KΩ]	Terminal Voltage [V]
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
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

Table 35 20 K NTC Characteristics (Continued)

Temp. [°F]	Temp. [°C]	Resistance [KΩ]	Terminal voltage [V]
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

Temp. [°F]	Temp. [°C]	Resistance [KΩ]	Terminal Voltage [V]
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) = R0 (1+aT+bT2+cT4+dT6)

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)½ +d´R5+e´R7 dT < 0.12 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)

Table 36 Characteristic of the Nickel Temperature Sensor is Specified as per DIN 43760

Temp. [°F]	Temp. [°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

NI1000 TK5000 DIN B

R-T Characteristics of Ni1000 TK5000 DIN B.

Table 37 NI1000 TK5000 Sensor Specification

Sensor Type	Nominal Resistance	Sensitivity
Ni1000 TK5000 DIN B	R_0: 1000 Ω	TC: 5000 ppm/K

Table 38 R-T Characteristics (according to supplier's specifications and based on DIN 43760, resistance values in Ω)

Temp. [°F]	Temp. [°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
Temp. [°F]	**Temp. [°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									

PT100 Characteristics

Table 39 PT100 Characteristics

Temp. [°F]	Temp.[°C]	Resistance [Ω]
-30	-34.44	86
-20	-28.89	89

Table 39 PT100 Characteristics

Temp. [°F]	Temp.[°C]	Resistance [Ω]
-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

PT1000 Characteristics

Table 40 PT1000 Characteristics

Temp. [°F]	Temp. [°C]	Resistance [KΩ]	Terminal Voltage [V]	Temp. [°F]	Temp. [°C]	Resistance [KΩ]	Terminal Voltage [V]
-58	-50	803	0.312	8.6	-13	949	0.367
-56.2	-49	807	0.314	10.4	-12	953	0.369
-54.4	-48	811	0.315	12.2	-11	957	0.37
-52.6	-47	815	0.317	14	-10	961	0.372
-50.8	-46	819	0.318	15.8	-9	965	0.373
-49	-45	823	0.32	17.6	-8	969	0.375
-47.2	-44	827	0.321	19.4	-7	973	0.376
-45.4	-43	831	0.323	21.2	-6	977	0.378
-43.6	-42	835	0.324	23	-5	980	0.379
-41.8	-41	839	0.326	24.8	-4	984	0.38
-40	-40	843	0.327	26.6	-3	988	0.382
-38.2	-39	847	0.329	28.4	-2	992	0.383
-36.4	-38	851	0.33	30.2	-1	996	0.385
-34.6	-37	855	0.332	32	0	1000	0.386
-32.8	-36	859	0.333	33.8	1	1004	0.388
-31	-35	862	0.335	35.6	2	1008	0.389
-29.2	-34	866	0.336	37.4	3	1012	0.391
-27.4	-33	870	0.338	39.2	4	1016	0.392
-25.6	-32	874	0.339	41	5	1020	0.394
-23.8	-31	878	0.341	42.8	6	1023	0.395
-22	-30	882	0.342	44.6	7	1027	0.396
-20.2	-29	886	0.344	46.4	8	1031	0.398
-18.4	-28	890	0.345	48.2	9	1035	0.399
-16.6	-27	894	0.347	50	10	1039	0.401
-14.8	-26	898	0.348	51.8	11	1043	0.402
-13	-25	902	0.35	53.6	12	1047	0.404
-11.2	-24	906	0.351	55.4	13	1051	0.405
-9.4	-23	910	0.353	57.2	14	1055	0.406
-7.6	-22	914	0.354	59	15	1058	0.408
-5.8	-21	918	0.356	60.8	16	1062	0.409
-4	-20	922	0.357	62.6	17	1066	0.411
-2.2	-19	926	0.359	64.4	18	1070	0.412
-0.4	-18	929	0.36	66.2	19	1074	0.413
1.4	-17	933	0.361	68	20	1078	0.415
3.2	-16	937	0.363	69.8	21	1082	0.416
5	-15	941	0.364	71.6	22	1086	0.418
6.8	-14	945	0.366	73.4	23	1090	0.419

Table 40 PT1000 Characteristics (Continued)

Temp. [°F]	Temp. [°C]	Resistance [KΩ]	Terminal Voltage [V]
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
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

Temp. [°F]	Temp. [°C]	Resistance [KΩ]	Terminal Voltage [V]
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
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

Table 40 PT1000 Characteristics (Continued)

Temp. [°F]	Temp. [°C]	Resistance [KΩ]	Terminal Voltage [V]
143.6	62	1240	0.474
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
255.2	124	1476	0.56
257	125	1479	0.561
258.8	126	1483	0.562
260.6	127	1487	0.564
262.4	128	1491	0.565
264.2	129	1494	0.566
266	130	1498	0.567
267.8	131	1502	0.569
269.6	132	1506	0.57
271.4	133	1510	0.572
273.2	134	1513	0.573
275	135	1517	0.574
276.8	136	1521	0.576
278.6	137	1525	0.577
280.4	138	1528	0.578

Temp. [°F]	Temp. [°C]	Resistance [KΩ]	Terminal Voltage [V]
213.8	101	1389	0.528
284	140	1536	0.581
285.8	141	1539	0.582
287.6	142	1543	0.584
289.4	143	1547	0.585
291.2	144	1551	0.586
293	145	1554	0.587
294.8	146	1558	0.589
296.6	147	1562	0.59
298.4	148	1566	0.592
300.2	149	1569	0.593
302	150	1573	0.594
303.8	151	1577	0.596
305.6	152	1581	0.597
307.4	153	1584	0.598
309.2	154	1588	0.6
311	155	1592	0.601
312.8	156	1596	0.602
314.6	157	1599	0.603
316.4	158	1603	0.605
318.2	159	1607	0.606
320	160	1610	0.607
321.8	161	1614	0.609
323.6	162	1618	0.61
325.4	163	1622	0.612
327.2	164	1625	0.613
329	165	1629	0.614
330.8	166	1633	0.615
332.6	167	1636	0.617
334.4	168	1640	0.618
336.2	169	1644	0.619
338	170	1648	0.621
339.8	171	1651	0.622
341.6	172	1655	0.623
343.4	173	1659	0.625
345.2	174	1662	0.626
347	175	1666	0.627
348.8	176	1670	0.629

Table 40 PT1000 Characteristics (Continued)

Temp. [°F]	Temp. [°C]	Resistance [KΩ]	Terminal Voltage [V]
282.2	139	1532	0.58
352.4	178	1677	0.631
354.2	179	1681	0.632
356	180	1685	0.634
357.8	181	1688	0.635
359.6	182	1692	0.636
361.4	183	1696	0.638
363.2	184	1699	0.639
365	185	1703	0.64
366.8	186	1707	0.642
368.6	187	1711	0.643
370.4	188	1714	0.644
372.2	189	1718	0.645
374	190	1722	0.647
375.8	191	1725	0.648
377.6	192	1729	0.649
379.4	193	1733	0.651
381.2	194	1736	0.652
383	195	1740	0.653
384.8	196	1744	0.655
386.6	197	1747	0.656
388.4	198	1751	0.657
390.2	199	1755	0.658
392	200	1758	0.659
393.8	201	1762	0.661
395.6	202	1766	0.662
397.4	203	1769	0.663
399.2	204	1773	0.665
401	205	1777	0.666
402.8	206	1780	0.667
404.6	207	1784	0.669
406.4	208	1788	0.67
408.2	209	1791	0.671
410	210	1795	0.672
411.8	211	1799	0.674
413.6	212	1802	0.675
415.4	213	1806	0.676
417.2	214	1810	0.678

Temp. [°F]	Temp. [°C]	Resistance [KΩ]	Terminal Voltage [V]
350.6	177	1674	0.63
420.8	216	1817	0.68
422.6	217	1821	0.681
424.4	218	1824	0.683
426.2	219	1828	0.684
428	220	1832	0.685
429.8	221	1835	0.686
431.6	222	1839	0.688
433.4	223	1843	0.689
435.2	224	1846	0.69
437	225	1850	0.692
438.8	226	1854	0.693
440.6	227	1857	0.694
442.4	228	1861	0.695
444.2	229	1865	0.697
446	230	1868	0.698
447.8	231	1872	0.699
449.6	232	1875	0.7
451.4	233	1879	0.702
453.2	234	1883	0.703
455	235	1886	0.704
456.8	236	1890	0.705
458.6	237	1894	0.707
460.4	238	1897	0.708
462.2	239	1901	0.709
464	240	1905	0.711
465.8	241	1908	0.712
467.6	242	1912	0.713
469.4	243	1915	0.714
471.2	244	1919	0.716
473	245	1923	0.717
474.8	246	1926	0.718
476.6	247	1930	0.719
478.4	248	1934	0.721
480.2	249	1937	0.722
482	250	1941	0.723
483.8	251	1944	0.724
485.6	252	1948	0.726

Table 40 PT1000 Characteristics (Continued)

Temp. [°F]	Temp. [°C]	Resistance [KΩ]	Terminal Voltage [V]
419	215	1813	0.679
489.2	254	1955	0.728
491	255	1959	0.729
492.8	256	1962	0.73
494.6	257	1966	0.732
496.4	258	1970	0.733
498.2	259	1973	0.734
500	260	1977	0.736
501.8	261	1980	0.737
503.6	262	1984	0.738
505.4	263	1988	0.739
507.2	264	1991	0.74
509	265	1995	0.742
510.8	266	1998	0.743
512.6	267	2002	0.744
514.4	268	2006	0.746
516.2	269	2009	0.747
518	270	2013	0.748
519.8	271	2016	0.749
521.6	272	2020	0.75
523.4	273	2024	0.752
525.2	274	2027	0.753
527	275	2031	0.754
528.8	276	2034	0.755
530.6	277	2038	0.757
532.4	278	2042	0.758
534.2	279	2045	0.759
536	280	2049	0.76
537.8	281	2052	0.761
539.6	282	2056	0.763
541.4	283	2060	0.764
543.2	284	2063	0.765
545	285	2067	0.766
546.8	286	2070	0.768
548.6	287	2074	0.769
550.4	288	2077	0.77
552.2	289	2081	0.771
554	290	2085	0.773

Temp. [°F]	Temp. [°C]	Resistance [KΩ]	Terminal Voltage [V]
487.4	253	1952	0.727
557.6	292	2092	0.775
559.4	293	2095	0.776
561.2	294	2099	0.777
563	295	2102	0.778
564.8	296	2106	0.78
566.6	297	2110	0.781
568.4	298	2113	0.782
570.2	299	2117	0.784
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

Table 40 PT1000 Characteristics (Continued)

Temp. [°F]	Temp. [°C]	Resistance [KΩ]	Terminal Voltage [V]
555.8	291	2088	0.774
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
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

Temp. [°F]	Temp. [°C]	Resistance [KΩ]	Terminal Voltage [V]
624.2	329	2223	0.82
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
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

PT3000 Characteristics

Table 41 PT3000 Characteristics

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

ABBREVIATIONS

Table 42 Abbreviations

Abbreviation	Definition
SSR	Solid State Relay
MS/TP	Multiple Spanning Tree Protocol
IP	Internet Protocol
RTU	Remote Terminal Unit
BMS	Building Management Solutions
FCU	Fan Coil Unit
UIO	Universal IO
NEMA	National Electrical Manufacturers Association
SDRAM	Synchronous dynamic random-access memory
QSPI	Quad Serial Peripheral Interface
DHCP	Dynamic Host Configuration Protocol
EIRP	Effective Isotropic Radiated Power
SMA	Sub miniature push
CMOS	Complementary Metal Oxide Semiconductor
TTL	Transistor Transistor Logic

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31-00614-01 I Rev. 04-23

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