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Introduction

Delta Controls has written *Wiring and Installation Guidelines* to provide its Partners with a primary source of recommended practices for wiring power, inputs and outputs and networks for Delta Controls products.

*This symbol identifies a note about a situation where damage to a device will occur if the instructions are not followed carefully. To protect the equipment you are using, please read and follow the instructions in these notes.*

What this document contains

Chapter 1 - Power Installation Guidelines – covers power wiring practices for all Delta Controls Class 2 (24 VAC) products.

Chapter 2 - Inputs and Outputs Guidelines – covers the recommended wiring practices for inputs and outputs on Delta Controls HVAC products.

Chapter 3 - RS-485 Network Installation Guidelines – covers the Delta Controls recommended design and installation specifications for a RS-485 network and aids the installer in building robust networks.

Chapter 4 - Ethernet Network Installation Guidelines – provides a synopsis of Ethernet network wiring specifications and practices that are applicable to Delta Controls products.

Chapter 5 – RS-232 Information – provides wiring information about RS-232 connections used with Delta Controls products.

Chapter 6 – enteliBUS Network Installation Guidelines – covers recommended design and installation specifications for the enteliBUS network, known as the eBUS network, which connects components of the enteliBUS family.

Chapter 7 – O3BUS Network Installation Guidelines – covers recommended design and installation specifications for the O3BUS network, which connects components of the O3 family.

Glossary of Terms - defines important terms used in this document.
Chapter 1 - Power Installation Guidelines

This chapter describes the power wiring practices for all Delta Controls Class 2 (24 VAC) products. Follow these guidelines to ensure optimum performance of your Delta Controls products.

This document does not describe line voltage wiring practices.

For details about a specific product, see the product installation guide, which can be found on the product page on Delta Controls’ technical support site.

Review Glossary of Terms to be sure you understand terms used in this chapter.

Power Supply Specifications

Table 1: Power Supply Specifications

<table>
<thead>
<tr>
<th>Category</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage</td>
<td>20–28 VAC</td>
</tr>
<tr>
<td>Electrical Class</td>
<td>Class 2 100 VA Max</td>
</tr>
<tr>
<td>Fuse Rating</td>
<td>See Table 4 for correct fuse size</td>
</tr>
</tbody>
</table>

Power Wire

Delta Controls requires that device power for its products must use a dedicated 2-conductor stranded wire. Wire gauge depends on the VA rating for the device and the length of the wire used, as shown in Table 2.

Table 2 does not take into account multiple devices powered by the same transformer. If multiple devices use the same transformer, add the VA ratings of all devices together, then use the wire length to the furthest device to determine wire selection.
Table 2: Power Wire Selection

<table>
<thead>
<tr>
<th>Description</th>
<th>Device VA Rating</th>
<th>Max Wire Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>16 AWG stranded</td>
<td></td>
<td></td>
</tr>
<tr>
<td>100</td>
<td>100 ft (30 m)</td>
<td></td>
</tr>
<tr>
<td>75</td>
<td>150 ft (45 m)</td>
<td></td>
</tr>
<tr>
<td>50</td>
<td>250 ft (75 m)</td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>500 ft (150 m)</td>
<td></td>
</tr>
<tr>
<td>18 AWG stranded</td>
<td></td>
<td></td>
</tr>
<tr>
<td>50</td>
<td>150 ft (45 m)</td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>300 ft (90 m)</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>500 ft (150 m)</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>1000 ft (300 m)</td>
<td></td>
</tr>
</tbody>
</table>

Transformer Specifications

Transformers must be UL Listed, 24 VAC and rated to Class 2. Delta Controls recommends the transformers listed in Table 3.

A 1-hub transformer has all wires coming out the same side. A 2-hub transformer has primary wires coming out the primary side and secondary wires coming out the secondary side.

Table 3: Recommended Transformers

<table>
<thead>
<tr>
<th>Delta Part #</th>
<th>Primary Voltage</th>
<th>VA Rating</th>
<th>Hubs</th>
<th>Circuit Breaker</th>
<th>Agency Approvals and Listings</th>
</tr>
</thead>
<tbody>
<tr>
<td>440000</td>
<td>120 VAC</td>
<td>40 VA</td>
<td>2</td>
<td>No</td>
<td>UL Listed CSA Approved Class 2</td>
</tr>
<tr>
<td>440001</td>
<td>120 VAC</td>
<td>40 VA</td>
<td>1</td>
<td>No</td>
<td>UL Recognized Class 2</td>
</tr>
<tr>
<td>440002</td>
<td>120 VAC</td>
<td>50 VA</td>
<td>2</td>
<td>No</td>
<td>UL Listed CSA Approved Class 2</td>
</tr>
<tr>
<td>440003</td>
<td>120 VAC</td>
<td>50 VA</td>
<td>1</td>
<td>No</td>
<td>UL Recognized Class 2</td>
</tr>
</tbody>
</table>
## Delta Part # Overview

<table>
<thead>
<tr>
<th>Delta Part #</th>
<th>Primary Voltage</th>
<th>VA Rating</th>
<th>Hubs</th>
<th>Circuit Breaker</th>
<th>Agency Approvals and Listings</th>
</tr>
</thead>
<tbody>
<tr>
<td>440004</td>
<td>277 VAC</td>
<td>50 VA</td>
<td>2</td>
<td>No</td>
<td>UL Listed, CSA Approved, Class 2</td>
</tr>
<tr>
<td>440005</td>
<td>277 VAC</td>
<td>50 VA</td>
<td>1</td>
<td>No</td>
<td>UL Recognized, Class 2</td>
</tr>
<tr>
<td>440006</td>
<td>120 VAC</td>
<td>75 VA</td>
<td>2</td>
<td>Yes</td>
<td>UL Listed, CSA Approved, Class 2</td>
</tr>
<tr>
<td>440007</td>
<td>120 VAC</td>
<td>75 VA</td>
<td>1</td>
<td>Yes</td>
<td>UL Recognized, Class 2</td>
</tr>
<tr>
<td>440008</td>
<td>120 VAC</td>
<td>96 VA</td>
<td>2</td>
<td>Yes</td>
<td>UL Listed, CSA Approved, Class 2</td>
</tr>
<tr>
<td>440009</td>
<td>120 VAC</td>
<td>96 VA</td>
<td>1</td>
<td>Yes</td>
<td>UL Recognized, Class 2</td>
</tr>
<tr>
<td>440010</td>
<td>120 VAC</td>
<td>150 VA</td>
<td>1</td>
<td>Yes</td>
<td>UL Listed, CSA Approved, Class 2</td>
</tr>
<tr>
<td>440011</td>
<td>120, 208, 240, 480 VAC</td>
<td>50 VA</td>
<td>1</td>
<td>Yes</td>
<td>UL Listed, CSA Approved, Class 2</td>
</tr>
<tr>
<td>440012</td>
<td>120, 208, 240, 480 VAC</td>
<td>75 VA</td>
<td>1</td>
<td>Yes</td>
<td>UL Listed, CSA Approved, Class 2</td>
</tr>
<tr>
<td>440013</td>
<td>120, 208, 240, 480 VAC</td>
<td>96 VA</td>
<td>1</td>
<td>Yes</td>
<td>UL Listed, CSA Approved, Class 2</td>
</tr>
</tbody>
</table>
Power Supply Types

The type of power supply used on a device affects the way you wire power to the device. Delta Controls products use three types of power supply: full- and half-wave rectified power supplies, and direct current power supply.

Half-Wave Rectification

A half-wave rectified signal draws current from the positive voltage cycle only. Because of this, devices that use half-wave rectification have ground-referenced power circuitry; all half-wave devices share a common ground.

Full-Wave Rectification

Also known as bridge rectified, a full-wave rectified signal draws current from both the positive and negative voltage cycles. Full-wave devices have floating power supplies and are not referenced to ground.

Identify the type of power supply used in a device carefully; failing to do so can damage the device and the transformer.

Identifying the Type of Power Supply

It is essential to identify whether the device’s power supply is direct current, half-wave rectified or full-wave rectified before wiring power to it. Identifying the type of power supply correctly can prevent many potential problems.

To identify the type of power supply that a Delta Controls device uses, see the device’s installation guide. Figure 1 shows typical power ports and controller labeling.

*Figure 1: Typical Full-Wave and Half-Wave Rectified, Direct Current Power Ports as Labeled on Controller*
Wiring Half-Wave Rectified Devices

Multiple half-wave devices can be wired from the same transformer, providing that wire polarity is observed. Crossing wires between panels can quickly damage both devices and transformers.

Wire the transformer’s X1 lead to the device power port’s 24 VAC terminal and wire the transformer’s X2 lead to the device power port’s GND terminal, as shown in Figure 2.

Figure 2: Wiring Half-Wave Rectified Devices

Wiring Full-Wave Rectified Devices

Full-wave devices must not be wired to the same transformer to which a half-wave device is connected. Wiring devices in this manner creates a ground loop and damages both the device and the transformer.

Each full-wave device must use a dedicated transformer. Do not wire other devices to the same transformer. Doing so damages both the device and the transformer.

Do not ground the transformer of a full-wave device. Connect the transformer directly to the power port as shown in Figure 3.
Figure 3: Wiring Full-Wave Rectified Devices

Correct

Wrong

Wrong

Each full-wave device must have a dedicated transformer

Do not ground power terminals

Wiring Direct Current Devices

Ground all devices in the same circuit in one place only at the direct current power supply.

Figure 4: Wiring Direct Current Devices

Correct

Correct

Wrong

Wrong

Wrong

Grounding

Regardless of power supply, all terminals labeled GND must be connected to earth ground. Proper grounding prevents many potential problems that can occur in a network of devices. Common symptoms of a poorly grounded network include inconsistent RS-485 communications and damage from voltage spikes.

This section describes the acceptable methods to use to ground Delta devices.
Preferred Method for Grounding a Version 3 Device

To ensure proper grounding for Version 3 devices, ground each device.

When the device contains a ground lug, then connect the ground lug to earth ground.

If the device does not contain a ground lug, then connect any one of the terminals labeled GND to earth ground.

*Figure 5: Correct Device Grounding - Version 3 Devices*

Each device must be grounded securely to earth ground.

*Figure 6: Wrong Device Grounding*

Never ground RS-485 network or 24 VAC ports of full-wave devices.

*Never ground one of the transformer’s secondary wires when connected to a full-wave device. Doing so will damage both the device and the transformer.*
Alternate Method for Grounding a Version 3 Device

The preferred method is not always practical for some installations. There may be instances where grounding each device is difficult, for example a network of BACstats. In this case, the alternate method may be used.

If grounding each device is impractical, then a single ground point may be used. The most common place to ground in this manner is one of the secondary wires of the power transformer.

*Figure 7: Single Ground Point – Version 3 LINKnet Devices*

An alternate grounding method: single ground point on transformer secondary. The ground is passed internally through the properly grounded Delta controller to all devices in the network.
Grounding enteliBUS Components in the Same Enclosure

When all enteliBUS components are in the same enclosure connect the power port GND on the automation engine and on each expander to the same earth ground, as shown in Figure 8. This recommendation applies when the components are connected by their integrated eBUS network connectors and when connected by eBUS network cable.

I/O modules are grounded properly via the backplane they are plugged into.

*Figure 8: Grounding enteliBUS Components in the Same Enclosure*

![Grounding enteliBUS Components in the Same Enclosure](image)

Grounding Distributed enteliBUS Components

When enteliBUS components are distributed (within the limitations of the eBUS network) and not in the same enclosure, connect the power port GND on the automation engine and on each expander to a local earth ground, as shown in Figure 9.

I/O modules are grounded properly via the backplane they are plugged into.

*Power and ground must comply with following rules:*

*Power for all components must be supplied from the same electrical service.*

*All local earth grounds must be supplied from the same electrical service.*
Figure 9: Grounding Distributed enteliBUS Components

Power and ground for all components must be supplied from the same electrical service.
Grounding O3-DIN Devices

Connect the power port PWR IN GND on the O3-DIN-CPU controller to earth ground, as shown in Figure 10.

The O3-DIN modules attached to the O3-DIN-CPU controller are grounded properly when connected to the O3-DIN-CPU controller.

*Figure 10: Grounding O3-DIN Devices*

```
24VDC

GND 24V
PWR IN

O3-DIN-CPU

O3-DIN Module

O3-DIN Module
```

Fusing

When a transformer does not have a built-in circuit breaker, Delta Controls recommends using a slow-blow fuse on the secondary side of the transformer. The fuse size is determined by the VA ratings of the devices. Use Table 4 to determine the correct fuse size. A fuse not only provides protection for the transformer, but can also help with troubleshooting.

*Table 4: Correct Fuse Sizes*

<table>
<thead>
<tr>
<th>Transformer Rating</th>
<th>Fuse Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 VA</td>
<td>4 A</td>
</tr>
<tr>
<td>75 VA</td>
<td>3 A</td>
</tr>
<tr>
<td>50 VA</td>
<td>2 A</td>
</tr>
<tr>
<td>25 VA</td>
<td>1 A</td>
</tr>
</tbody>
</table>

Without a fuse, the only protection a Class 2 circuit has is the primary circuit breaker (normally 15 A or 20 A). If a device were to fail, this circuit breaker is not sufficient protection to prevent damage to the transformer. A fuse on the transformer’s secondary prevents damage to the device.
Delta Controls Class 2 products have a maximum rating of 100 VA. This means that the maximum allowable fuse size is 4 A.

Fuse one secondary transformer wire only. For half-wave devices, fuse the wire connected to the device’s 24~ pin. For full-wave devices, either wire can be fused.

*Figure 11: Using 4 A Slow-Blow Fuse*

![Diagram of 4 A Slow-Blow Fuse for half-wave and full-wave devices]

**Multiple Service Entrances**

A service entrance is a location where the electrical service enters the building. Multiple services are common in large installations or installations where multiple buildings are on the same network.

**Identifying Multiple Service Entrances**

To identify whether or not the location uses multiple services, check for the following:

- If there is more than one electrical room that contains a primary transformer, then there are multiple service entrances.

- If the building has had a large addition to the original structure, then it likely has another service entrance.

If there is any question as to whether or not there are multiple service entrances, obtain and check a wiring diagram for the building.

**Ground Isolation**

Never tie grounds from multiple services together. Ground voltage differences across multiple services can be quite high. During lightning storms, potential differences can reach hundreds, even thousands, of volts.
Treat multiple services as separate sites. Never connect power, I/O or network wiring directly across multiple services.

Never connect power, I/O, or network wiring directly across multiple services.

See Chapter 3, section Running RS-485 between Buildings, for more information about network and power isolation.

Power over Ethernet

Delta’s Power over Ethernet (PoE) devices are 802.3af-2003 (“PoE”) and 802.3at-2009 (“PoE+”) compliant devices receive power from PSE (power sourcing equipment), which can be either a PoE network switch or a midspan power injector. Power is delivered over the same Cat5e/Cat6 cable that is used for Ethernet communications. No external control transformer is required. Do not apply 24 VAC these devices.

Delta’s PoE devices have an on board power supply that converts the PoE power to 24 VDC, which powers the device and provides a limited amount of 24 VDC power for external field devices.

For an installation to be compliant with the 802.3af and 802.3at standards, there are specifications on the PSE output voltage, power, cable type and cable length. The following table show the electrical specifications for each of the PoE standards that the Delta PoE devices comply with.

**Table 5: PoE Electrical Specifications**

<table>
<thead>
<tr>
<th>Specification</th>
<th>802.3af (802.3at Type 1) “PoE”</th>
<th>802.3at Type 2 “PoE+”</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power available at device</td>
<td>12.95 W</td>
<td>25.50 W</td>
</tr>
<tr>
<td>Maximum power delivered by PSE</td>
<td>15.40 W</td>
<td>30.0 W</td>
</tr>
<tr>
<td>Voltage range at PSE</td>
<td>44.0–57.0 VDC</td>
<td>50.0–57.0 VDC</td>
</tr>
<tr>
<td>Voltage range at device</td>
<td>37.0–57.0 VDC</td>
<td>42.5–57.0 VDC</td>
</tr>
<tr>
<td>Maximum cable length</td>
<td>100 m [328 ft]</td>
<td>100 m [328 ft]</td>
</tr>
<tr>
<td>Maximum cable resistance</td>
<td>20 Ω</td>
<td>12.5 Ω</td>
</tr>
</tbody>
</table>

Delta’s PoE devices work with all PSEs that comply with the electrical specifications in Table 5.

For details about PoE power for a specific product, see the product installation guide, which can be found on the product page on Delta Controls’ technical support site.
Chapter 2 - Inputs and Outputs Guidelines

This chapter describes the recommended wiring practices for inputs and outputs on Delta Controls HVAC products. Follow these guidelines to ensure optimum performance of your Delta Controls products.

For detailed information about specific controller’s inputs and outputs see the controller’s installation guide.

Review Glossary of Terms to be sure you understand terms used in this chapter.

Inputs

Delta Controls controllers provide six types of industry-standard inputs, compatible with most sensors available on the market:

- A universal input that can be configured for:
  - 10 kΩ / dry contact;
  - 5 V;
  - 10 V; or
  - 4–20 mA.
- A digital-only input
- A RTD (Resistance Temperature Detector) input.

Input Wiring Practices and Precautions

Although Delta Controls controllers’ inputs are very robust, by following the wiring practices and precautions described in this document you can further improve input accuracy and reliability.

The following sections describe in detail how to wire each of these input types.
Powering Sensors

Some sensors need to receive power for proper operation. This power can be supplied from a 24 VAC Class 2 transformer or from a power supply that converts the transformer voltage into a more usable 24 VDC.

Delta recommends that sensor power be supplied from a source that is separate from the controller’s power source for two important reasons:

1. When 24 VDC is required, you don’t need to be concerned whether the DC converter is half-wave or full-wave rectified to match the controller’s power requirement.
2. Controller power is not affected by electrical problems associated with the sensor; you may lose a sensor but the controller continues to function.

Further, Delta recommends you wire the sensor power supply input power according to the manufacturer’s instructions.

In this document, all sensor wiring figures reflect these recommendations.

10 kΩ / Dry Contact Input

Delta Controls 10 kΩ inputs are typically used for a 10 kΩ thermistor or a dry contact such as a push button or switch. Internally to the controller, the input is connected to a 10 kΩ pull-up resistor. A resistance value of 10 kΩ wired to the input translates to a reading of 50% in the Analog Input object. An open circuit reads 100% and a short circuit reads 0%.

Table 6: 10 kΩ / Dry Contact Input – Specifications

<table>
<thead>
<tr>
<th>Category</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full Scale Value</td>
<td>Open circuit ($\infty$ ohm) = 100%</td>
</tr>
<tr>
<td>Half Scale Value</td>
<td>10 kΩ = 50%</td>
</tr>
<tr>
<td>Input Impedance</td>
<td>10 kΩ</td>
</tr>
<tr>
<td>Cable Type</td>
<td>2 conductor 18 AWG (Belden 8461NH)</td>
</tr>
<tr>
<td></td>
<td>2 conductor 22 AWG (Belden 88442)</td>
</tr>
<tr>
<td>Max Cable Length</td>
<td>1500 ft (450 m) max using 22 AWG</td>
</tr>
<tr>
<td></td>
<td>3900 ft (1200 m) max using 18 AWG</td>
</tr>
<tr>
<td>Wiring Precautions</td>
<td>Ground only at controller input GND terminal</td>
</tr>
</tbody>
</table>
Proper grounding increases sensor reliability and accuracy. Proper grounding eliminates any ground noise effect and any potential differences that could develop during electrical storms. Figure 12 illustrates this.

*Figure 12: Wiring 10 kΩ / Dry Contact Inputs*

5 V Input

The 5 volt input on Delta Controls controllers is a high input impedance input. Use a 5 V input with active devices that generate their signal source. The 5 V input’s high input impedance makes it suitable for current transformers and other sensors that have high output impedance.
Table 7: 5 V Input – Specifications

<table>
<thead>
<tr>
<th>Category</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full Scale Voltage</td>
<td>5 VDC</td>
</tr>
<tr>
<td>Maximum Voltage</td>
<td>20 VDC; higher voltages damage input circuit</td>
</tr>
<tr>
<td>Input Impedance</td>
<td>&gt; 1 MΩ</td>
</tr>
<tr>
<td>Cable Types</td>
<td>2 conductor 22 AWG shielded (Belden 83552)</td>
</tr>
<tr>
<td></td>
<td>2 conductor 20 AWG shielded (Belden 83602)</td>
</tr>
<tr>
<td></td>
<td>3 conductor 20 AWG shielded (Belden 8772)</td>
</tr>
<tr>
<td>Max Cable Length</td>
<td>100 ft (30 m)</td>
</tr>
<tr>
<td></td>
<td>330 ft (100 m) with 20 kΩ load resistor</td>
</tr>
<tr>
<td>Wiring Precautions</td>
<td>Keep cable short</td>
</tr>
<tr>
<td></td>
<td>Use dedicated shielded cable</td>
</tr>
</tbody>
</table>

While the input’s high impedance characteristics can be advantageous for monitoring some sensors, the current flow from the sensor to the controller is low, making the signal very susceptible to noise.

Delta Controls strongly recommends using shielded wire for all 5 V inputs. Delta Controls also recommends using a dedicated cable because adjacent wires in the same cable can induce noise into the signal. A dedicated shielded cable protects the signal from outside noise sources.

When using shielded wire, earth ground the controller end of the shield only. When you ground both ends, difference in ground potentials can induce noise into the signal.

When the sensor has low output impedance (less than 200 Ω), Delta Controls recommends wiring a 20 kΩ resistor in parallel with the input. The 20 kΩ input impedance acts as a load for the sensor, increasing the current flow into the controller. The higher the current flow, the less susceptible the sensor is to external noise.

Keep the cable length as short as possible. Delta Controls recommends a maximum shielded cable length of 100 ft (30 m) for all 5 V inputs. The addition of a 20 kΩ resistor at the controller allows for increased cable lengths of up to 330 ft (100 m). Signal quality degrades quickly with
long cable runs. Ensure that the addition of the 20 kΩ does not significantly affect the signal level generated at the input device.

Figure 13: Wiring a 5 V Current Sensor

[Diagram of wiring a 5 V Current Sensor]

Figure 14: Wiring a 5 V Position Feedback Potentiometer

[Diagram of wiring a 5 V Position Feedback Potentiometer]
10 V Input

Delta Controls 10 volt inputs have a wide variety of applications including humidity and pressure sensors. 10 V inputs have moderate input impedance, making them less susceptible to noise than 5 V inputs.

Table 8: 10 V Input – Specifications

<table>
<thead>
<tr>
<th>Category</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full Scale Voltage</td>
<td>10 VDC</td>
</tr>
<tr>
<td>Input Impedance</td>
<td>20 kΩ</td>
</tr>
<tr>
<td>Cable Type</td>
<td>3-conductor 18 AWG unshielded [Belden 88870]</td>
</tr>
<tr>
<td>Max Cable Length</td>
<td>330 ft (100 m)</td>
</tr>
</tbody>
</table>

Figure 15: Wiring a 10 V Sensor

* Most 24VAC to DC power supplies are full-wave rectified and require a dedicated transformer

See the controller installation guide for input point configuration instructions
4–20 mA Input

4–20 mA inputs are used for a variety of sensors such as pressure sensors. 4–20 mA inputs are preferred over other input types because of the high current. The higher the current through a wire, the less susceptible it is to noise.

Table 9: 4–20 mA Input – Specifications

<table>
<thead>
<tr>
<th>Category</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full Scale Current</td>
<td>20 mA</td>
</tr>
<tr>
<td>Input Impedance</td>
<td>250 Ω</td>
</tr>
<tr>
<td>Cable Type</td>
<td>2-conductor 18 AWG unshielded (Belden 8461NH)</td>
</tr>
<tr>
<td></td>
<td>4-conductor 18 AWG unshielded (Belden 88489)</td>
</tr>
<tr>
<td>Max Cable Length</td>
<td>3300 ft (1000 m)</td>
</tr>
</tbody>
</table>

Figure 16: Wiring a 2-Wire 4–20 mA Sensor

* Most 24VAC to DC power supplies are full-wave rectified and require a dedicated transformer

See the controller installation guide for input point configuration instructions
Digital-Only Input

Digital-only inputs are used to monitor dry contacts, push buttons and switches. The digital input described here is available on the enteliBUS modules.

Digital inputs can use either 24 VAC or 24 VDC. When a digital input is configured in software as direct acting, it switches off when voltage drops below a threshold of 5 VDC or 5 VAC and switches on when voltage rises above the threshold of 11 VDC or 18 VAC. When the voltage is between these thresholds, the input maintains its current state.

A 24 VDC-powered digital input satisfies the switching requirements for IEC 61131-2 Type 1 and Type 3 switches. IEC 61131-2 Type 2 is not supported.

The digital input circuit includes hysteresis that provides noise immunity to minimize the detection of false transitions.

Table 10: Digital Input – Specifications

<table>
<thead>
<tr>
<th>Category</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output current supplied</td>
<td>40 mA</td>
</tr>
<tr>
<td>Cable Type</td>
<td>2 conductor 18 AWG (Belden 8461NH)</td>
</tr>
<tr>
<td></td>
<td>2 conductor 22 AWG (Belden 88442)</td>
</tr>
<tr>
<td>Max Cable Length</td>
<td>1500 ft (450 m) max using 22 AWG</td>
</tr>
<tr>
<td></td>
<td>3900 ft (1200 m) max using 18 AWG</td>
</tr>
</tbody>
</table>
Figure 18: Wiring a Digital Input Dry Contact (Typical)

See the controller installation guide for input point configuration instructions.

Figure 19: Wiring a Digital Input Dry Contact (Alternate Method)

See the controller installation guide for input point configuration instructions.
RTD Input

RTD (Resistance Temperature Detector) inputs are used to measure temperature over a wide range. The RTD input described here is available on the enteliBUS modules.

RTD inputs need to be calibrated to take into account the non-linearity of the sensor and the resistance of the connecting wire between the sensor and the controller.

See the eBM-R800-1K Installation Guide for details about supported sensors and calibration procedures.

Table 11: RTD Input – Specifications

<table>
<thead>
<tr>
<th>Category</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resistance Range</td>
<td>750 to 2210 Ω</td>
</tr>
<tr>
<td>Types</td>
<td>Ni1000, Ni1000 DIN, Pt1000</td>
</tr>
<tr>
<td></td>
<td>2-wire only</td>
</tr>
<tr>
<td>Cable Type</td>
<td>2 conductor 18 AWG (Belden 8461NH)</td>
</tr>
<tr>
<td></td>
<td>2 conductor 22 AWG (Belden 88442)</td>
</tr>
<tr>
<td>Max Cable Length</td>
<td>No practical limit</td>
</tr>
<tr>
<td>Wiring Precautions</td>
<td>Ground only at controller input GND terminal</td>
</tr>
</tbody>
</table>

Proper grounding increases sensor reliability and accuracy. Proper grounding eliminates ground noise effect and potential differences that could develop during an electrical storm.

Figure 20: Wiring a RTD Input
## Outputs

Delta Controls controllers provide five types of industry-standard outputs, compatible with most actuators and relays available on the market:

- Analog: 0–10 VDC
- Analog: 0–20 mA
- Binary: TRIAC
- Binary: FET
- Binary: Relay

### Analog 0–10 VDC Output

Delta Controls 0–10 VDC analog outputs can be used for a variety of DC voltage applications, including actuators, relays and heat units.

*Table 12: 0–10 VDC Analog Output – Specifications*

<table>
<thead>
<tr>
<th>Category</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full Scale Voltage</td>
<td>10 VDC</td>
</tr>
<tr>
<td>Max Output Current</td>
<td>20 mA (resistance greater than 500 Ω)</td>
</tr>
<tr>
<td></td>
<td>5 mA for eZ-440R4-230, eZP-440R4-230, eZV-440 and eZVP-440</td>
</tr>
<tr>
<td></td>
<td>(resistance greater than 2000 Ω)</td>
</tr>
<tr>
<td>Cable Type</td>
<td>2-conductor 18 AWG unshielded (Belden 8461NH)</td>
</tr>
<tr>
<td>Max Cable Length</td>
<td>330 ft (100 m)</td>
</tr>
</tbody>
</table>

0–10 VDC analog outputs can also be used as binary outputs to provide 0 V or 10 V signals. This signal is useful for driving solid state and low power DC relays. Figure 22 shows an example of this application.
Figure 21: Wiring a 0–10 VDC Analog Output to 0–10 V Actuator

Figure 22: Wiring a 0–10 VDC Analog Output to Low Power Relay

See the controller installation guide for output point configuration instructions.
Analog 0–20 mA Output

Delta Controls 0–20 mA analog outputs can be used for a variety of two-wire current loop control applications, including actuators and transducers.

The 0–20 mA analog output is configurable for 4–20 mA analog output to control a loop-powered device.

The 0–20 mA analog output described here is available on the enteliBUS modules.

Table 13: 0–20 mA Analog Output – Specifications

<table>
<thead>
<tr>
<th>Category</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full Scale Current</td>
<td>20 mA</td>
</tr>
<tr>
<td>Max Load Range</td>
<td>250–500 Ω at the end device</td>
</tr>
<tr>
<td>Cable Type</td>
<td>2-conductor 18 AWG unshielded (Belden 8461NH)</td>
</tr>
<tr>
<td>Max Cable Length</td>
<td>Maximum cable length depends on the impedance of the end device. Use the following formula to calculate the maximum cable length for 2-conductor 18 AWG cable where 1000 ft = 12.8 Ω (1000 m = 42 Ω), for both conductors. Feet: 1000(500 – end device impedance)/12.8 Meters: 1000(500 – end device impedance)/42</td>
</tr>
</tbody>
</table>
Binary TRIAC Output

Binary TRIAC (Triode for Alternating Current) outputs are used to provide switched 24 VAC at up to 500 mA to an output device. On some controllers, the AC power source for the outputs is jumper selectable for internal or external power. When using the external power setting, the maximum voltage that can be applied is 28 VAC. Never connect line voltage to a binary output.

enteliBUS modules with TRIAC or relay outputs include a PTC (Positive Temperature Coefficient) fuse on the internal power that supplies each pair of outputs. When too much
current is drawn by the device connected to an output, the fuse opens and power is removed from that pair of outputs.

Table 14: Binary TRIAC Output – Specification

<table>
<thead>
<tr>
<th>Category</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max External Voltage</td>
<td>28 VAC</td>
</tr>
<tr>
<td>Max Output Current</td>
<td>Version 3 controllers: 500 mA enteliBUS I/O Modules: 500 mA when switching external power; 250 mA when switching internal controller-supplied power</td>
</tr>
<tr>
<td>Max Leakage Current</td>
<td>160 µA</td>
</tr>
<tr>
<td>Cable Type</td>
<td>2-conductor 18 AWG unshielded (Belden 8461NH)</td>
</tr>
<tr>
<td>Max Cable Length</td>
<td>330 ft (100 m)</td>
</tr>
<tr>
<td>Minimum Turn-On Current</td>
<td>25 mA</td>
</tr>
</tbody>
</table>

Binary outputs are not meant to switch line voltage. Never connect line voltage to a binary output. Doing so will damage the controller.

When using the external power setting, apply AC power only. A TRIAC is an AC device; it doesn’t turn off when DC voltage is applied. Never connect a DC voltage to the external power of a TRIAC output. This also applies to a Delta Controls controller that is being powered from a DC source. Binary TRIAC outputs cannot be used on a device that is powered from a DC source.

Never connect a DC voltage to the external power pin of a TRIAC output. Similarly, never power a controller with binary outputs with a DC power source.
Figure 25: Wiring an Internally-Powered Binary TRIAC Output

24VAC

Controller

24VAC

GND

OP1

COM

OP2

See the controller installation guide for output point configuration instructions

1 kOhm supplemental load resistor as required

Figure 26: Wiring an Externally-Powered Binary TRIAC Output

24VAC

Controller

24VAC

GND

OP1

COM

OP2

See the controller installation guide for output point configuration instructions

1 kOhm supplemental load resistor as required
Figure 27: Wiring Tri-State Valve with an Internally-Powered Binary TRIAC Output

See the controller installation guide for output point configuration instructions

Tri-State Valve Actuator
2+ Float Valve

TRIAC Leakage and Load Current Considerations

All TRIACs have a specified leakage current when in the off state. Delta Controls TRIAC outputs have a maximum leakage current of 100 µA. This amount of leakage is not normally high enough to cause concern; however, there are conditions when it could be enough to trigger a device.

For devices that trigger on the leakage current, wire a 1 kΩ, 1 W resistor in parallel with the output to provide a path for the leakage current.

TRIACs require a minimum 25 mA current draw to turn on and off properly. When an AC solid-state relay load current is less than 25 mA, wire a 1 kΩ, 1 W resistor in parallel with the output to provide the additional current required to power the device, as shown in Figure 25 and Figure 26.

Wire a 1 kΩ, 1 W resistor in parallel with the output when:

- The load is an AC solid-state relay that draws less than 25 mA.
- The device being power requires less than 100 µA to turn on.
Binary SSR Output

Binary SSR (Solid State Relay) outputs are used to provide switched 24 VAC or 24 VDC at up to 500 mA to an output device. On some controllers, the power source for the outputs is jumper selectable for internal or external power. When using the external power setting, the maximum voltage that can be applied is 28 VAC. Never connect line voltage to a binary output.

Table 15: Binary SSR Output – Specification

<table>
<thead>
<tr>
<th>Category</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max External Voltage</td>
<td>28 VAC</td>
</tr>
<tr>
<td></td>
<td>28 VDC</td>
</tr>
<tr>
<td>Max Output Current</td>
<td>Version 3 controllers:</td>
</tr>
<tr>
<td></td>
<td>700 mA DC for PoE products using internal power</td>
</tr>
<tr>
<td></td>
<td>500 mA AC/DC for PoE products using external power</td>
</tr>
<tr>
<td>Max Leakage Current</td>
<td>100 µA for AC power</td>
</tr>
<tr>
<td></td>
<td>10 µA DC for DC power</td>
</tr>
<tr>
<td>Cable Type</td>
<td>2-conductor 18 AWG unshielded (Belden 8461NH)</td>
</tr>
<tr>
<td>Max Cable Length</td>
<td>330 ft (100 m)</td>
</tr>
<tr>
<td>Minimum Turn-On Current</td>
<td>Not applicable for SSR outputs</td>
</tr>
</tbody>
</table>

*Binary outputs are not meant to switch line voltage. Never connect line voltage to a binary output. Doing so will damage the controller.*
Figure 28: Wiring an Internally—DC-Powered Binary SSR Output

See the controller installation guide for output point configuration instructions.

Figure 29: Wiring an Externally—AC-Powered Binary SSR Output

1 kΩm supplemental load resistor required to prevent false turning on of load due to leakage.
**Figure 30: Wiring a Tri-State Valve with an Internally-DC-Powered Binary SSR Output**

See the controller installation guide for output point configuration instructions.
Binary FET Output

Binary FET (Field Effect Transistor) outputs are used to provide switched 24 VAC or 24 VDC at up to 500 mA to an output device. On some devices, the power source for the outputs is jumper selectable for internal or external power. When using the external power setting, the maximum voltage that can be applied is 28 VAC. Never connect line voltage to a binary output.

Table 16: Binary FET Output – Specification

<table>
<thead>
<tr>
<th>Category</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max External Voltage</td>
<td>28 VAC</td>
</tr>
<tr>
<td></td>
<td>28 VDC</td>
</tr>
<tr>
<td>Max Output Current</td>
<td>500 mA</td>
</tr>
<tr>
<td>Cable Type</td>
<td>2-conductor 18 AWG unshielded (Belden 8461NH)</td>
</tr>
<tr>
<td>Max Cable Length</td>
<td>330 ft (100 m)</td>
</tr>
<tr>
<td>Minimum Turn-On Current</td>
<td>Not applicable for FET outputs</td>
</tr>
</tbody>
</table>

*Binary outputs are not meant to switch line voltage. Never connect line voltage to a binary output. Doing so will damage the device.*
Figure 31: Wiring an Internally Powered Binary FET Output (eZNT)

![Diagram of Internally Powered FET Output]

Figure 32: Wiring an Externally Powered Binary FET Output (eZNT)

![Diagram of Externally Powered FET Output]
Figure 33: Wiring an O3-DIN-4F4xP Module for a Single Output Device

- Power Supply: 24 VDC or 24 VAC
- GND
- PWR
- OP1, OP2, OP3, OP4
- COM
- O3-DIN-4F4xP Module
- Output Device

GND
24

PWR

OP1
COM
OP2
COM
OP3
OP4

Power Supply

GND
PWR

O3-DIN-4F4xP
Binary Relay Output

Binary relay outputs are used to provide switched 24 VAC or VDC at up to 0.5 A to an output device. The power source for the relay output is jumper-selectable for internal or for external power source. Never connect line voltage to a binary output.

enteliBUS modules with TRIAC or relay outputs include a PTC (Positive Temperature Coefficient) fuse on the power circuit that supplies each pair of outputs. When too much current is drawn by the device connected to an output, the fuse opens and power is removed from that pair of outputs.
### Table 17: Binary Relay Output – Specification

<table>
<thead>
<tr>
<th>Category</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max External Voltage</td>
<td>28 VAC</td>
</tr>
<tr>
<td></td>
<td>28 VDC</td>
</tr>
<tr>
<td>Max Output Current per Relay</td>
<td>enteliBUS I/O Modules:</td>
</tr>
<tr>
<td></td>
<td>500 mA when switching external power;</td>
</tr>
<tr>
<td></td>
<td>250 mA when switching internal controller-supplied power</td>
</tr>
<tr>
<td>Cable Type</td>
<td>2-conductor 18 AWG unshielded (Belden 8461NH)</td>
</tr>
<tr>
<td>Max Cable Length</td>
<td>330 ft (100 m)</td>
</tr>
</tbody>
</table>

> **Binary outputs are not meant to switch line voltage. Never connect line voltage to a binary output. Doing so will damage the controller.**

### Figure 35: Wiring an Internally-Powered Binary Relay Output

See the controller installation guide for output point configuration instructions.
Figure 36: Wiring an Externally-Powered Binary Relay Output

Wiring Internal/External Power Jumpers for Binary Outputs

Figure 37 and Figure 38 detail the jumpers for internally-powered and for externally-powered TRIAC and relay binary outputs.

Figure 39 and Figure 40 detail the jumpers for internally-powered and for externally-powered SSR binary outputs.

Figure 37 Internally-powered TRIAC and Relay Binary Output, Jumpers Details
Figure 38: Externally-powered TRIAC and Relay Binary Output, Jumpers Details

![Diagram of externally-powered TRIAC and Relay Binary Output]

Figure 39: Internally-powered SSR Binary Output, Jumpers Details

![Diagram of internally-powered SSR Binary Output]

Figure 40: Externally-powered SSR Binary Output, Jumpers Details

![Diagram of externally-powered SSR Binary Output]
Chapter 3 - RS-485 Network Installation Guidelines

This chapter describes the Delta Controls recommended design and installation specifications for a RS-485 network.

Delta Controls uses RS-485 as the physical network between devices in BACnet MS/TP, LINKnet and V2 Subnet networks.

Review Glossary of Terms to be sure you understand terms used in this chapter.

Cable Type

Delta Controls RS-485 networks require cable that meets all of the following specifications:

Twisted Pair Cable

- 22–24 AWG twisted pair, shielded jacketed communication cable
- Characteristic impedance of 100–120 Ω
- Capacitance of 17 pF/ft conductor-to-conductor or less.
  18 AWG cable doesn’t meet this specification.
- Braided or aluminum foil shield
- Velocity of propagation of 66% or higher

Example compatible cable products are Belden 9841, Belden 82841 and Windy City Wire 42002-S.

For details about UL864 cable specifications, see the product installation guide, which can be found on the product page on Delta Controls’ technical support site.

Cat5e/Cat6 Cable

- Industry-standard Cat5e/Cat6 straight-through unshielded twisted pair communication cable when used with applicable Delta products such as the DZNT-VAV.
Network Configuration

Delta Controls requires that RS-485 networks use a daisy chain configuration. No other RS-485 network wiring configuration is acceptable.

Daisy chain means that there is one cable with only two ends and every network device is connected directly along its path.

Figure 41 illustrates two unacceptable network configurations and the required daisy chain configuration.

*Figure 41: Daisy Chain Network Configuration*

Only the daisy chain configuration is acceptable for a RS-485 network.

Maximum RS-485 Network Cable Length

Twisted Pair Cable

Using proper cable, the maximum length of an RS-485 twisted-pair network segment is 4000 ft (1220 m). A segment of this length works reliably for data rates up to Delta Controls’ maximum data rate of 76,800 bps.

Cat5e/Cat6 Cable

The maximum length of Delta’s Cat5e/Cat6 RS-485 network segment is 2000 ft (610 m). A segment of this length works reliably for data rates up to Delta Controls’ maximum data rate of 76,800 bps when used with applicable products such as the DZNT-VAV.
Maximum Number of Nodes

A maximum of 64 nodes are allowed on a network segment. For the example in Figure 42 there are five nodes: one node for the system controller plus four for the other controllers.

A maximum of 99 nodes are allowed on a network. When you have more than 64 nodes a repeater is required to drive the network. See Figure 50 for an example using a repeater.

Figure 42: Five Node Network Example

Shield Continuity and Termination

When properly installed, shielded twisted pair cable improves the protection of the network and equipment against harmful electromagnetic interference (EMI) and transient voltage spikes.

Delta Controls does not support unshielded cable in twisted pair networks except when using the Delta Cat5e/Cat6 wiring technique.

Proper installation of the cable’s shield involves two steps:

1. **Ensuring shield continuity** by tying the shield through at each node
2. **Terminating the shield**

When the network shield is connected to different ground potentials, current flows through the shield and induces noise into the network. This causes unreliable network communications and could damage the controllers.
Ensuring Shield Continuity

The cable’s shield must be tied through at each node to make a continuous shield that runs the entire length of the RS-485 segment, as shown in Figure 43 and Figure 44. Do not connect the shield to ground at the node.

Figure 43: Shield Continuity at Node – V3 Devices

As shown in Figure 44, enteliBUS automation controllers come with a three-terminal RS-485 port. The SHD terminal is connected via a capacitive path to ground similar to the Shield terminal on the Delta TRM-768 Network Terminator.

Figure 44: Shield Continuity at Node – Built-In Shield Termination

Terminating the Shield

In a typical RS-485 network segment, the shield, along with the data wires are terminated with a TRM-768 terminator at both ends of the segment, as shown in Figure 45.

While the recommendation for terminating the shield at both ends may seem to contradict the RS-485 standard, RC circuitry components in the TRM-768 provide a transient path to ground while preventing ground loops. By always terminating the shield at both ends with a TRM-768, the installer doesn’t inadvertently ground the shield incorrectly.

Some Delta devices provide the built-in equivalent to the TRM-768 for terminating the shield, as shown in Figure 44.
Network Data Wires End-of-Line Termination

The data wires at both ends of an RS-485 network segment must be terminated to ensure reliable operation. Proper termination ensures network stability and helps to prevent damage to controllers during high electrical activity.

*Termination is effective only when proper RS-485 network cable is used (see Cable Type). Otherwise, termination may provide unpredictable results.*

Two methods can be used to terminate network data wires:

- Using two TRM-768s
- Using one TRM-768 and a device’s built-in termination

Using Two TRM-768s

Using a TRM-768 at each end for terminating a RS-485 network provides the most reliable results by providing proper transient protection and proper protection against electromagnetic interference. Whenever possible use this method.

After the last node on each end of an RS-485 network, install a TRM-768. The TRM-768 provides the correct termination impedance not only for the network data wires but also for the network cable shield.

The stub cable from the last node to the TRM-768 must be kept as short as possible and be no longer than 12 inches (30 cm). A long stub causes a significant impedance mismatch and thus reflections. The RS-485 specification doesn’t specify maximum stub length.

The TRM-768 provides a capacitive path for the shield to ground and additional protection through a 180 V MOV.

Connect the TRM-768 network terminators to earth ground, as shown in Figure 45.
Using one TRM-768 and Built-In Termination

Delta Controls manufactures several products that provide built-in jumper-selectable termination for the data wires. However, most of Delta’s controllers don’t include built-in termination; review the product installation guide to confirm.

The Delta Controls DZNR-768 repeater includes built-in termination, as shown in Figure 50.

Although products with built-in termination provide proper termination for the data wires, they don’t provide termination for the shield.

In this case, the network cable shield is terminated at the TRM-768 end of the network and left unconnected at the controller end, as shown in Figure 46.

Never connect the shield directly to the ground. Differences in ground potentials in large buildings can cause current to flow. When the shield is connected to two different ground potentials, the resulting current induces noise into the network.
Twisted Pair and Three-Wire Isolated Devices

Some MS/TP RS-485 devices, from manufacturers other than Delta Controls, provide a third-wire reference connection for the network data wires. To meet RS-485 requirements, the third-wire reference must be connected to the same earth ground reference as the two-wire non-isolated devices such as the Delta devices.

The following three scenarios apply.

- **Twisted Pair Cable in building**
- **Three Conductor Cable in building**
- **Extending Twisted Pair Cable with Three Conductor Cable**

> Do not confuse the term “third wire reference” with the cable shield. Regardless of whether the network cable is twisted pair only or twisted pair with a third wire reference conductor, the shield is separate and is installed as described in Shield Continuity and Termination.

Twisted Pair Cable

When the RS-485 cable is two-wire twisted pair, that is, cable with no third conductor for common reference, and a three-wire isolated device is present, connect the device’s third-wire reference to earth ground using one of the following methods for the earth connection:

- connect via 100 Ω resistor to cable shield
- connect via 100 Ω resistor to the device’s earth ground point such as the device enclosure

*Figure 47: Twisted Pair Cable with Mixed Devices*
Three Conductor Cable

When the RS-485 cable is three conductor cable, that is, a two-wire twisted pair with a third conductor for common reference, and the installation includes both two-wire non-isolated devices such as the Delta devices and three-wire isolated devices, then the following guidelines apply:

- Install the two-wire non-isolated devices such as the Delta devices, according to the guidelines in this chapter
- Connect the third-wire reference connectors on the three-wire isolated devices to the third conductor in the cable
- Connect the third conductor in the cable through a single 100 Ω resistor to earth ground in a low-noise area, preferable near the supervisory controller. This earth ground must be the same earth ground that the two-wire non-isolated devices, such as the Delta devices, are connected to.

*The third wire reference conductor must be connected to earth ground in only one place for the entire network.*

*Figure 48: Three Conductor Cable with Mixed Devices*
Extending Twisted Pair Cable with Three Conductor Cable

When the RS-485 cable is two-wire twisted pair and you need to extend the installation with three-wire isolated devices and three conductor cable, then the following guidelines apply:

- Install the two-wire twisted pair and the cable shield in the three conductor cable according to the guidelines in this chapter

- Connect the third-wire reference connectors on the three-wire isolated devices to the third conductor in the cable

- Connect the third conductor in the cable through a single 100 Ω resistor to earth ground in a low-noise area, preferable near the supervisory controller. This earth ground must be the same earth ground that the two-wire non-isolated devices, such as the Delta devices, are connected to.

*The third wire reference conductor must be connected to earth ground in only one place for the entire network.*

*Figure 49: Extending Twisted Pair Cable with Three Conductor Cable*
Repeaters

A repeater strengthens the RS-485 signals to allow a network to be extended to accommodate more than 64 nodes.

The DZNR-768 multi-port repeater accommodates both twisted pair and Cat5e/Cat6 wiring methods for Delta RS-485 networks. Each of the repeater’s four ports divides the network into a separate segment.

No more than 64 nodes are allowed on an RS-485 segment and no more than 99 nodes are allowed per network. All standards in this document for wire length, shielding, and grounding must be followed for each wiring segment.

The network’s system controller is normally placed on DZNR-768 port 1. Ports 2, 3 and 4 are used to interconnect the remaining nodes.

Differences between Rev 1.1 and Rev 1.2 DZNR-768 Repeater

The DZNR-768 Rev. 1.2 hardware was released in 2013 to replace the DZNR-768 Rev. 1.1 hardware. Rev 1.2 changed the enclosure and added twisted pair terminals to ports 3 and 4.

Otherwise, both revisions perform the same functions.

Using the Ports on Rev 1.1 DZNR-768 Repeater

On ports 1 and 2, select either twisted pair or Cat5e/Cat6 cable. Use only one or the other wiring method on each port. Do not connect both the twisted pair and Cat5e/Cat6 types to the same port.

On ports 3 and 4 the DZNR-768 Rev 1.1 is built for Delta Cat5e/Cat6 MS/TP cabling technique only. This approach allows quick, error-free connections across the controllers on the segment.

Using the Ports on Rev 1.2 DZNR-768 Repeater

On all ports, select either twisted pair or Cat5e/Cat6 cable. Use only one or the other wiring method on each port. Do not connect both the twisted pair and Cat5e/Cat6 types to the same port.
Using a DZNR-768 Rev 1.1 Repeater with Twisted Pair Network

Figure 50 illustrates the recommended use of the DZNR-768 Rev 1.1 repeater, Cat5e/Cat6 adapters and terminators in a twisted pair RS-485 network.

Notice that a Delta Controls ADP45-MSTP-TB-Y adapter is required to convert between twisted pair and Cat5e/Cat6 type RS-485 configuration on ports 3 and 4. Nothing must be connected to the second Cat5e/Cat6 port on the ADP45-MSTP-TB-Y.

*Figure 50: Twisted Pair Segments and DZNR-768 Rev 1.1 Repeater*
Using a DZNR-768 Rev 1.2 Repeater with Twisted Pair Network

Figure 51 illustrates the recommended use of the DZNR-768 Rev 1.2 repeater and terminators in a twisted pair RS-485 network.

*Figure 51: Twisted Pair Segments and DZNR-768 Rev 1.2 Repeater*
Using Repeaters Incorrectly

Do not install repeaters in series or use more than one repeater to extend a network. This results in network reliability problems. Figure 52 demonstrates an incorrect use of a repeater in an RS-485 network.

*Figure 52: Repeaters – Incorrect Usage*

The second repeater in series may result in an unreliable network.
Using a DZNR-768 Repeater with Delta’s Cat5e/Cat6 Network

Each of the four ports of the DZNR-768 repeater has an RJ-45 jack for straight through unshielded twisted pair Cat5e/Cat6 cables.

Accessory adapters are available to split the line, provide end-of-loop termination, convert between types of wiring media and temporarily bypass missing or defective controllers, while maintaining a strict daisy-chain configuration.

Calculating Cat5e/Cat6 Network Segment Length

The total length of each network segment can’t exceed 2000 ft (610 m). This length is determined by the sum of all cable lengths including runs between termination boards, controllers and sensors, as shown in Figure 53.

Figure 53: Cat5e/Cat6 Network Segment Length Calculation

Cat5e/Cat6 Network Segment Length Calculation

\[
(2 \times 50) + (8 \times 25) + (4 \times 100) + 250 + 300 + 700 = 1950
\]

1950 ft < 2000 ft therefore network length is acceptable
Network Configuration for DZNR-768 Repeater

Figure 54 shows a typical installation using a combination of twisted pair cable and Cat5e/Cat6 cable.

*Figure 54: DZNR-768 Multi-Segment Configuration*
Accessories for Wiring a Cat5e/Cat6 RS-485 Network

The following accessories are available to aid in Cat5e/Cat6 RS-485 network wiring and maintenance.

**ADP45-MSTP-BYPASS** - an adaptor that allows a DZNT stat to be disconnected from service for troubleshooting purposes while maintaining the integrity of the network.

**ADP45-MSTP-EOL** - an end-of-line loopback adaptor in the form of an RJ-45 plug that completes the network at the first and last devices in the Cat5e/Cat6 RS-485 network.

**ADP45-MSTP-TB-Y** - allows for one 2-wire RS-485 conventional device to be added to the Cat5e/Cat6 RS-485 network. You must use the short 2-wire RS-485 cable included with the adaptor.

**ADP45-MSTP-Y** - an adaptor that allows a branch expansion to the Cat5e/Cat6 RS-485 network while maintaining the daisy chain connection requirements of the basic RS-485 network.

Running RS-485 between Buildings

Although running RS-485 communications between buildings may be an installation requirement, doing so greatly increases the network’s exposure to communication problems and/or damage to equipment.

Using Fiber Optic Repeaters

The most reliable method of running RS-485 between buildings is by using RS-485-to-fiber optic repeaters. By utilizing a fiber link, you eliminate the electrical connection and dramatically reduce exposure to damage due to inherent voltage transients and to lightning.

Delta Controls does not manufacture a RS-485-to-fiber optic repeater. However, the Telebyte Model 276A Optoverter - 2 Wire, RS-485 to Fiber Optic Line Driver/Converter has been used.
effectively in a number of installations. Because this device is a third-party product, Delta Controls cannot guarantee its future compatibility with Delta products.

*Figure 55: Using RS-485-to-Fiber Optic Repeaters between Buildings*
Using a RPT-768 Repeater

An alternative is to use the Delta Controls RPT-768 repeater. While it can’t provide the same level of protection against transient voltages as a fiber optic repeater, it provides 24 VAC separation as well as ensuring correct network topology and termination.

*Figure 56: Using RPT-768 Repeater between Buildings*

Wiring Power to the RPT-768 Repeater

The RPT-768 can be powered using one or two transformers. When one transformer is used, as shown in Figure 57, the RPT-768 provides 50 V isolation. When two transformers are used, as shown in Figure 58, the RPT-768 provides 500 V isolation.

Power the RPT-768 with two transformers whenever wiring RS-485 between buildings.

*When wiring RS-485 networks between buildings, use the two-transformer method of powering the RPT-768 for 500 V isolation.*
Chapter 3 - RS-485 Network Installation Guidelines

Figure 57: Wiring RPT-768 with One Transformer for 50 V Isolation

Figure 58: Wiring RPT-768 with Two Transformers for 500 V Isolation
Transients and RS-485 Transceiver Failure

High voltage transients are the primary cause of RS-485 transceiver failure. Although there is no way to completely eliminate voltage transients, their harmful effects can be reduced by using the techniques previously described in this document.

A rapid drop in line voltage at one controller on a network results in a voltage transient. The parasitic capacitance of electronic devices allows this transient to pass over the RS-485 network as it tries to equalize the voltage difference between devices.

*Figure 59: Example of a Voltage Transient*

In Figure 59, if the line voltage at TR2 (Transformer 2) drops rapidly and other line voltages (TR1 and TR3) remain constant, the rapid drop results in a voltage transient that may cause damage to the RS-485 communication chips.

Using a dedicated line voltage source for all control device power, for example 120 VAC: 24 VAC transformers, significantly improves your chances of completing a project successfully.
LINKnet Networks

LINKnet is an RS-485 network, therefore all guidelines described in this chapter apply.

For a LINKnet network, Delta recommends a maximum network length of 1000 ft (305 m).

Limited LINKnet Network

In a limited LINKnet network, termination of the network data wires is not required when both of the following conditions are present:

- the number of nodes is three or less, including the LINKnet master controller, and
- the cable length is less than 100 ft (30 m).

For example, two DNS-24s on a limited LINKnet network, as shown in Figure 60. Since there are only three nodes on this network and the overall network length is 100 ft (30 m), it is not necessary to install network terminators.

In this case, connect the shield to the LINKnet master controller’s ground lug and leave it unconnected at the other end of the LINKnet network.

Figure 60: Example of a Limited LINKnet Network
Chapter 4 - Ethernet Network Installation Guidelines

This chapter provides a summary of Ethernet network wiring specifications and practices that are applicable to Delta Controls products.

The installer should be familiar with the IEEE 802.3 standard before installing any Ethernet network. This standard can be found at [http://standards.ieee.org/getieee802/802.3.html](http://standards.ieee.org/getieee802/802.3.html). See also [http://www.ethermanage.com/](http://www.ethermanage.com/)

Many Delta Controls products use Ethernet as a mode of communication. Ethernet’s much higher bandwidth provides many advantages over RS-485.

Review Glossary of Terms to be sure you understand terms used in this chapter.

Communications Devices

Ethernet communications devices such as switches, hubs and routers provide flexibility and solve many network problems.

Switch

Switches improve network speeds compared to hubs because they allow full port speed to be used for every pair of devices connected to the switch and they allow simultaneous communications paths to be established between devices.

10BaseT Ethernet networks that use switches are called switched networks and have no limitation as to number of segments or switches.

A switch also provides a central point of connection used in networks that are arranged in a star topology.

Delta Controls recommends using switches in all BACnet Ethernet networks.

Hub

A hub has no way of distinguishing which port the data should be sent to. Broadcasting the data to every port ensures that it will reach its intended destination. This places a lot of traffic on the network and can lead to poor network response times due to collisions.

A hub also provides a central point of connection used in networks that are arranged in a star topology.
10BaseT Ethernet networks that use hubs are called shared access networks and must adhere to the IEEE 5-4-3 rule. This rule limits the number of hubs and segments in the network. Switches, which do not have this limitation, have replaced hubs because the cost difference is essentially nil. See the Specifications section below for a definition of the IEEE 5-4-3 rule.

Delta Controls recommends using switches rather than hubs in all BACnet Ethernet networks.

A repeater is essentially a two-port hub.

**Router**

As an OSI Layer 3 device, a router moves packets (unlike switches which route frames) from one network to another until that packet ultimately reaches its destination. A packet not only contains data, but also the destination address of where it’s going.

**Interfacing to High Speed Ethernet Networks**

Many Delta Controls devices provide fixed 10 Mbps Ethernet that can’t adjust automatically to higher speeds such as 100 Mbps.

To interface to a high speed Ethernet segment, insert a 10/100 Mbps switch between the high speed segment and the Delta Controls’ segment. The switch senses and adjusts automatically to both segments’ speeds.

Delta Controls’ enteliTOUCH and enteliBUS devices operate at either 10 Mbps or 100 Mbps Ethernet.

Because the enteliTOUCH includes two Ethernet ports it can function as a 10/100 Mbps switch.

**10/100BaseT Specifications**

10/100BaseT is 10 Mbps Ethernet running over unshielded, twisted-pair (UTP) cabling. UTP cabling for Ethernet comes in different grades, with higher grade numbers called Category numbers, indicating better quality and bandwidth.

10/100BaseT requires Cat5e/Cat6 cabling. The UTP cable connection at either end is made by an RJ45 connector. These connectors are attached to the cable using a tool made specifically for this task.

<table>
<thead>
<tr>
<th>Category</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum length of segment (port-to-port length)</td>
<td>330 ft (100 m)</td>
</tr>
</tbody>
</table>
The IEEE rule for shared access networks states: there shall be no more than five repeated segments or more than four hubs between any two Ethernet interfaces and of the five cable segments, only three may be populated.

This rule is referred to as the “5-4-3” rule: 5 segments, 4 hubs/repeaters, 3 populated segments. The IEEE rule doesn’t apply to switched networks.

### 10BaseT/100BaseT Cable Wiring

Two types of cable connections are used in 10/100BaseT: straight-through and crossover cables. Both use RJ45 connectors.

#### Straight-Through Data Cable

To connect multiple devices such as computers and controllers, by a switch, the cable required is referred to as a straight-through connection, meaning that Pin 1 on one end is connected to Pin 1 on the other end, and so on, for all 8 conductors.

See pinouts in Table 19.
Table 19: Wiring Pinout for Straight-Through Data Cable

<table>
<thead>
<tr>
<th>Pinout at End 1</th>
<th>Pinout at End 2</th>
<th>Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pin 1 (TD+)</td>
<td>Pin 1 (TD+)</td>
<td>White/orange stripe</td>
</tr>
<tr>
<td>Pin 2 (TD-)</td>
<td>Pin 2 (TD-)</td>
<td>Orange solid</td>
</tr>
<tr>
<td>Pin 3 (RD+)</td>
<td>Pin 3 (RD+)</td>
<td>White/green stripe</td>
</tr>
<tr>
<td>Pin 4 (not used)</td>
<td>Pin 4 (not used)</td>
<td>Blue solid</td>
</tr>
<tr>
<td>Pin 5 (not used)</td>
<td>Pin 5 (not used)</td>
<td>White/blue stripe</td>
</tr>
<tr>
<td>Pin 6 (RD-)</td>
<td>Pin 6 (RD-)</td>
<td>Green solid</td>
</tr>
<tr>
<td>Pin 7 (not used)</td>
<td>Pin 7 (not used)</td>
<td>White/brown stripe</td>
</tr>
<tr>
<td>Pin 8 (not used)</td>
<td>Pin 8 (not used)</td>
<td>Brown solid</td>
</tr>
</tbody>
</table>

Crossover Data Cable

Two devices can be connected together without using a switch by using a cable called a crossover or flip cable. A crossover cable crosses some of the conductors between the two ends of the cable. For example, to connect a DSC-1212E directly to a computer, a crossover cable could be used; this would not require a switch. See pinouts in Table 20.

Table 20: Wiring Pinout for Crossover Data Cable

<table>
<thead>
<tr>
<th>Pinout at End 1</th>
<th>Pinout at End 2</th>
<th>Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pin 1 (TD+)</td>
<td>Pin 3 (RD+)</td>
<td>White/orange stripe</td>
</tr>
<tr>
<td>Pin 2 (TD-)</td>
<td>Pin 6 (RD-)</td>
<td>Orange solid</td>
</tr>
<tr>
<td>Pin 3 (RD+)</td>
<td>Pin 1 (TD+)</td>
<td>White/green stripe</td>
</tr>
<tr>
<td>Pin 4 (not used)</td>
<td>Pin 4 (not used)</td>
<td>Blue solid</td>
</tr>
<tr>
<td>Pin 5 (not used)</td>
<td>Pin 5 (not used)</td>
<td>White/blue stripe</td>
</tr>
<tr>
<td>Pin 6 (RD-)</td>
<td>Pin 2 (TD-)</td>
<td>Green solid</td>
</tr>
<tr>
<td>Pin 7 (not used)</td>
<td>Pin 7 (not used)</td>
<td>White/brown stripe</td>
</tr>
<tr>
<td>Pin 8 (not used)</td>
<td>Pin 8 (not used)</td>
<td>Brown solid</td>
</tr>
</tbody>
</table>

Power over Ethernet (PoE)

For detailed information about wiring and powering a PoE controller, see the installation guide on Delta Controls’ technical support site for the Delta PoE controller you are installing.
Chapter 5 – RS-232 Information

This chapter provides wiring information about RS-232 connections used with Delta Controls products.

Factory-Built RS-232 Cables

An RS-232 cable may be used to connect a controller to your PC or modem. Delta manufactures ready-made cables you can order, as shown in the following tables.

Table 21: Factory-Built Direct Connection RS-232 Cables

<table>
<thead>
<tr>
<th>Product Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CBL930-2</td>
<td>Female DB9 connector, 3 pin direct to panel connector, DSC/DSM, 10 ft (3 m)</td>
</tr>
<tr>
<td>CBL930-4</td>
<td>Female DB9 connector, AMP connector, direct to room controller, 10 ft (3 m)</td>
</tr>
</tbody>
</table>

Table 22: Factory-Built Modem RS-232 Cables

<table>
<thead>
<tr>
<th>Product Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CBL931-1</td>
<td>Male DB25 connector, 5 pin connector, DSC modem cable, 10 ft (3 m)</td>
</tr>
<tr>
<td>CBL931-2</td>
<td>Male DB25 connector, 7 pin connector, DSM modem cable, 10 ft (3 m)</td>
</tr>
<tr>
<td>CBL931-3</td>
<td>Male DB25 connector, AMP connector, room controller modem cable, 10 ft (3 m)</td>
</tr>
</tbody>
</table>
Delta Controller Serial Port Pinouts

DSC Serial Port

Table 23: DSC Serial Port Pinouts

<table>
<thead>
<tr>
<th>Signal</th>
<th>DB9</th>
<th>DB25</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) DCD*</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>(2) DTR*</td>
<td>4</td>
<td>20</td>
</tr>
<tr>
<td>(3) RX</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>(4) GND</td>
<td>5</td>
<td>7</td>
</tr>
<tr>
<td>(5) TX</td>
<td>3</td>
<td>2</td>
</tr>
</tbody>
</table>

*required for modem cables only

Figure 62: (Left) Direct Connection to a Female DB9 Connector. (Right) Modem Connection to a Female DB25 Connector
DCU-050/DSM-050 Serial Port

Table 24: DCU-050/DSM-050 Serial Port Pinouts

<table>
<thead>
<tr>
<th>Signal</th>
<th>DB9</th>
<th>DB25</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) DTR*</td>
<td>4</td>
<td>20</td>
</tr>
<tr>
<td>(2) CTS*</td>
<td>8</td>
<td>5</td>
</tr>
<tr>
<td>(3) DCD*</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>(4) RTS*</td>
<td>7</td>
<td>4</td>
</tr>
<tr>
<td>(5) RX</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>(6) GND</td>
<td>5</td>
<td>7</td>
</tr>
<tr>
<td>(7) TX</td>
<td>3</td>
<td>2</td>
</tr>
</tbody>
</table>

*required for modem cables only
Figure 63: (Top) Direct Connection to a Female DB9 Connector. (Bottom) Modem Connection to a Female DB25 Connector

Room Controller Serial Port
The RS-232 port of the Room Controller uses a MTA-156 5 pin connector.

Table 25: Room Controller Serial Port Pinouts

<table>
<thead>
<tr>
<th>Signal</th>
<th>DB9</th>
<th>DB25</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) DTR</td>
<td>4</td>
<td>20</td>
</tr>
<tr>
<td>(2) TX</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>(3) RX</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>(4) DCD</td>
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<td>8</td>
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<tr>
<td>(5) GND</td>
<td>5</td>
<td>7</td>
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* required for modem cables only

Figure 64: (Left) Direct Connection to a Female DB9 Connector. (Right) Modem Connection to a Female DB25 Connector
Chapter 6 – enteliBUS Network Installation Guidelines

This chapter describes the Delta Controls recommended design and installation specifications for the enteliBUS network. The enteliBUS network, also known as the eBUS network, connects components of the enteliBUS family.

The eBUS network is an implementation of the ISO-standard Controller Area Network (CAN or CAN-bus).

Review Glossary of Terms to be sure you understand terms used in this chapter.

Cable Type

The eBUS network can be extended with cable that meets all of the following specifications:

- 22–24 AWG twisted pair, shielded jacketed communication cable
- Characteristic impedance of 100–120 Ω
- Capacitance of 17 pF/ft conductor-to-conductor or less. 18 AWG cable doesn’t meet this specification.
- Braided or aluminum foil shield
- Velocity of propagation of 66% or higher

Suggested compatible cable products are Belden 9841, Belden 82841 and Windy City Wire 42002-S.

Network Configuration

The eBUS network uses a daisy chain configuration. The eBUS network has two ends joined by a single path comprising one enteliBUS controller backplane and multiple enteliBUS expander backplanes.

The backplanes are connected to each other by plugging them together by the connectors at each end of the backplanes or by wiring network cable between the backplane connectors. Any combination of plugging backplanes together and wiring them with network cabling is acceptable as long as the daisy chain configuration is maintained.

Figure 65 shows an example eBUS network.
Maximum Network Length

The maximum end-to-end length for an eBUS network is 330 ft (100 m).

End-to-end means from the automation engine on the controller backplane at one end of the network to the eBB-TERM terminator at the other end taking into account all enteliBUS expander backplane boards and network cable in between them.
Maximum Number of enteliBUS Backplanes

The eBUS network allows one controller backplane and up to eight expander backplanes for a total maximum of nine backplanes.

Shield Continuity and Termination

When properly installed, shielded twisted pair cable can improve the protection of the network and equipment against harmful electromagnetic interference (EMI) and transient voltage spikes.

Ensuring Shield Continuity

The eBUS network cable’s shield must be tied through at each expander backplane to make a continuous shield that runs the entire length of the eBUS network, as shown in Figure 65.

Terminating the Shield

Do not ground the shield at any point in the eBUS network.

The shield is not terminated or grounded on the last expander backplane at the eBB-TERM-terminated end of the eBUS network. Leave the shield unconnected.

At the automation engine end, shield termination is built-in, providing a transient path to ground; do not otherwise terminate or ground the shield at the automation engine.

Network Data Wires Termination

Both ends of the eBUS network data wires must be terminated properly to ensure reliable operation and network stability.

Terminating the eBUS Network Data Wires

As shown in Figure 65, the eBUS network data wires must be terminated on the last expander backplane using the Delta eBUS terminator, eBB-TERM. Do not use a TRM-768.

At the automation engine end, termination is built-in. No additional termination is required.

Repeaters

Repeaters are not used or required in an eBUS network.
Running the eBUS Network between Buildings

Do not run the eBUS network between buildings or between areas of a building with different electrical services.

Running the eBUS Network between Electrical Services

Do not run the eBUS network between electrical services. All expander backplane modules must be powered by the same electrical service.
Chapter 7 – O3BUS Network Installation Guidelines

This chapter describes the Delta Controls recommended design and installation specifications for the O3BUS network. The O3BUS network connects components of the O3 family.

Review Glossary of Terms to be sure you understand terms used in this chapter.

Cable Type

The O3BUS network can be extended with cable that meets all of the following specifications:

- 22–24 AWG twisted pair, shielded jacketed communication cable
- Characteristic impedance of 100–120 Ω
- Capacitance of 17 pF/ft conductor-to-conductor or less. 18 AWG cable doesn’t meet this specification.
- Braided or aluminum foil shield

Suggested compatible cable products are Belden 9841, Belden 82841 and Windy City Wire 42002-S.

Network Configuration

The O3BUS network connects the O3-DIN-CPU room controller using its NET3 port to O3 devices with O3BUS ports in the O3 system. The O3BUS network uses a daisy chain configuration. Stars or stub configurations are not supported.

Examples of O3 devices with O3BUS ports include the O3 sensor hub and the O3-DIN-PWRINJ module.
**Maximum Network Length**

The maximum end-to-end length for an O3BUS network is 230 ft (70 m).

**Maximum Number of Nodes**

A maximum of 9 nodes are allowed on an O3BUS network; one node for the O3-DIN-CPU room controller plus 8 for O3-DIN-PWRINJ power injector modules and O3 sensor hubs.

**Shield Continuity and Termination**

When properly installed, shielded twisted pair cable can improve the protection of the network and equipment against harmful electromagnetic interference (EMI) and transient voltage spikes.

**Ensuring Shield Continuity**

The O3BUS network cable’s shield must be tied at each node on the O3BUS network to make a continuous shield that runs the entire length of the O3BUS network.
Chapter 7 – O3BUS Network Installation Guidelines

Terminating the Shield
Do not ground the shield at any point in the O3BUS network.

Connect the shield to the Shield pin of the O3BUS port connector of each O3 device on the O3BUS network.

Network Data Wires Termination
Both ends of the O3BUS network data wires must be terminated properly to ensure reliable operation and network stability.

Terminating the O3BUS Network Data Wires
As shown in Figure 66, the O3BUS network data wires are terminated on the O3-DIN-CPU room controller using a 120 Ω resistor. The O3BUS network data wires are terminated at the sensor hub using the sensor hub’s built-in termination switch. Termination at the O3-DIN-PWRINJ module utilizes the module’s built-in termination switch.

Terminating the O3BUS Network at the O3-DIN-CPU Room Controller
If an O3-DIN-CPU room controller is placed at either end of the O3BUS daisy chain, a 120 Ω termination resistor must be used across the NET3 port pins.

Figure 67 shows how to terminate at the O3-DIN-CPU NET3 port pins.
Terminating the O3BUS Network at the O3 Sensor Hub

The sensor hub includes built-in termination through a switch setting. The switch is factory set to no termination as indicated by the OPEN label. To terminate, move the switch to the position indicated by the TERM label.
Terminating the 03BUS Network at the 03-DIN-PWRINJ Module

If an 03-DIN-PWRINJ module is installed at either end of the 03BUS network, the 03BUS network can be terminated at the 03-DIN-PWRINJ module using the module’s built-in termination. Like the 03 sensor hub, the built-in termination is achieved through a switch setting. The switch is factory set to no termination as indicated by the OFF label. To terminate, move the switch to the position closest to the TERM label.
Glossary of Terms

Daisy chain – a network topology in which there is one cable with only two ends and every network device is connected directly along its path.

Earth ground - provides metallic continuity to the Earth; sometimes referred to as conduit ground. In this document, earth ground is indicated by $\mathcal{G}$.

Electrical service - the wiring that connects the electric utility’s cables in the street to the building. Specifically, electrical service is the wiring from the street, through the meter and up to the panel board, but no farther.

Grounding or ground - provides metallic continuity to a common return path for current from many different components in an electrical circuit. The terms ground and grounding are used in North American electrical practice. In the UK the equivalent terms are earth and earthing.

Hub - an OSI Layer 1 device used in an Ethernet network that repeats data frames received at any of its ports to all ports in the device.

Line voltage - voltage provided by a power line at the point of use, usually a general-purpose alternating current (AC) electric power supply. Also known as mains.

Node - any device with an active RS-485 network connection including system controllers, VAV controllers, application controllers, BACstats, enteliBUS automation engines, repeaters and so on. A node is also used for a device on an O3BUS network with an O3BUS network connection.

PoE – Power over Ethernet describes a system which passes electrical power along with data on Ethernet cabling. This allows a single cable to provide both the data connection and the electrical power to Delta PoE-enabled controllers.

Repeater - a node that joins two RS-485 segments. A repeater strengthens the RS-485 signals to allow a network to be extended.

Router - An OSI Layer 3 device used in an Ethernet network that move packets (unlike switches which route frames) from one network to another until that packet ultimately reaches its destination.

Segment – in an RS-485 network, the network cable between terminators or between a terminator and a repeater. In an Ethernet network, the network cable between switches.
Glossary of Terms

**Switch** - As an OSI Layer 2 device used in an Ethernet network, a switch uses the MAC address in each data frame to send it only to the port connecting the device the data is intended for. A switch extends the reach of each segment and allows traffic to pass selectively between two network segments.

**Terminating or terminate RS-485 data wires** - providing a path with correct impedance between the RS-485 data wires.

**Terminating or terminate shield** - providing an isolating path to ground using resistive and/or capacitive components.
# Document Revision History

<table>
<thead>
<tr>
<th>Document Edition Number</th>
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<th>Author</th>
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<td>Added wire colors to wiring diagrams.</td>
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<td>J. Halliday</td>
<td>Chapter 3: added CAT5 wiring and DZNK-768, reorganized flow, changed 50 nodes/segment to 64 nodes/segment. Chapter 4: updated. Chapter 5 moved Transients section to end of Chapter 3. Removed Quick Reference section.</td>
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<td>J. Halliday</td>
<td>Added Chapter 6 enteliBUS Network</td>
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<td>Updated figures in Chapters 1 through 4 to be more generic; instructed reader to see the specific controller installation guide on George Support site for details such as jumpers.</td>
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<td>J. Halliday</td>
<td>Added section <em>Twisted Pair and Three Wire Isolated Devices</em>, in Chapter 3</td>
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<td>Added a note about UL864 cable specs in Chapter 3 Cable Type section</td>
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<td>J. Halliday</td>
<td>Added section <em>Power Over Ethernet</em>, in Chapter 1</td>
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<td>Updated Max Output Current specification in table 12 for eZ-440R4-230, eZP-440R4-</td>
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