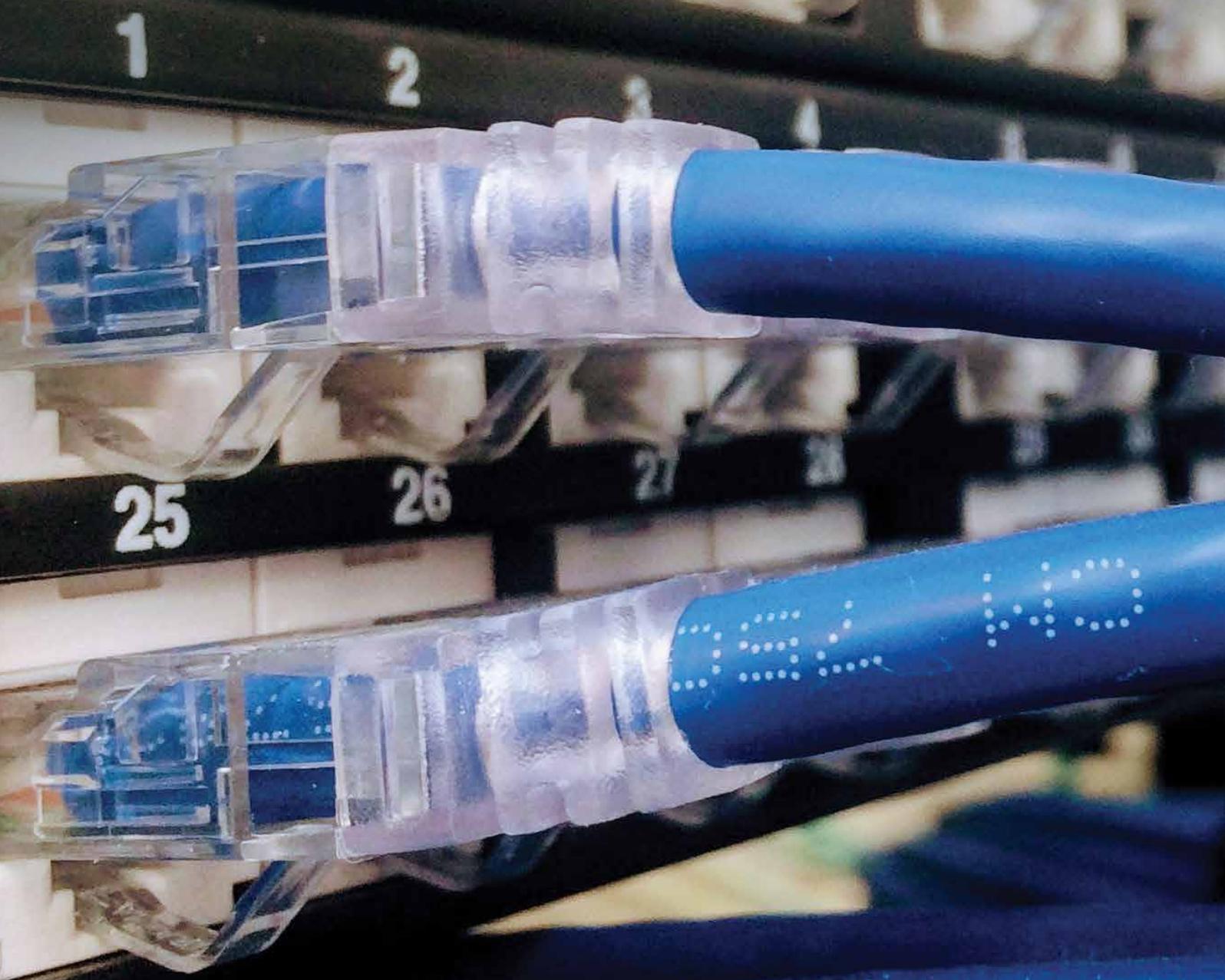


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# Power Over Ethernet with Panduit Copper Cabling

How To Create More Meaningful  
Connections With The Highest  
Performing Infrastructure



## Introduction

Power over Ethernet (PoE) represents one of the most meaningful changes to enterprise network infrastructure happening right now. This technology reduces installation costs and time by allowing power and data onto a single twisted-pair cable, installed by a single low-voltage contractor and eliminating the need for a separate electrical cable to each device.

As the ubiquitous nature of Ethernet has grown, an increasing number of items are being networked together. These new items, such as digital signage, next generation wireless access points, nurse call stations, and thin clients, have power needs beyond the existing PoE+ standards. The industry has recognized this need, and has begun to develop PoE++ equipment that will supply 51 to 71 watts.

This document provides information and guidance on installing Panduit cabling and connectivity with both the existing PoE+ and the new higher power PoE++ standards.

## Cable Standards and Power over Ethernet

It is important to understand that the cables and connectors, by themselves, can handle the 960 mA current and the 71 W of power. The concerns with running PoE in cables has to do with heat and temperature rise that occurs when the cables are bundled, and the concern with connectors is arcing that occurs when a plug is removed from a connector with live PoE. Concerns with these factors are:

- Some temperature rise will increase cable insertion loss and may create bit errors for your application
- Extreme temperature increase past the recommended cable operating range can damage the cable
- Arcing can damage plug and jack contacts, and make transmission through them impossible

## Temperature Rise Guidance from TIA TSB-184 and TSB-184-A

The Telecommunications Industry Association (TIA) TSB-184 is a technical service bulletin that provides guidance for installing cables that run PoE with currents up to 600 mA on 2 pairs. This TSB will soon be upgraded to TSB-184-A to provide guidance specific to POE++ which is up to 960 mA on 4 pairs. These documents recommend that a bundle of cables should not exceed a 15°C temperature rise within the center of the bundle. This temperature rise depends upon:

- Size of bundle
- Current running through the wire pairs and number of energized pairs
- Cable wire gauge and construction

## Arcing Test Method Standards; IEC 60512-9-3 and IEC 60512-99-001

An electrical arc (spark) naturally occurs most times when removing a plug from a jack with PoE running. The arc poses no danger to the user, and it is often difficult to notice. However, it can damage the points on the jack and plug contacts where it occurs. Connectors must be designed so the location damaged by the arc is not where the plug and jack mate. The IEC developed test methods IEC 60512-9-3 and IEC 60512-99-001 to address this particular issue.

## Maximum PoE Power Unlikely to Increase beyond 100W

It is unlikely that future PoE standards will be developed to exceed the 71 W proposed by the new PoE++ standard for many years. Next generation PoE standards have traditionally come to market within 6 to 8 year timeframes with double the power of the previous standard (see table 1). These standards are done in response to market needs. For a new standard to be developed, it will require a pervasive market need for about 200 W, as well as have a large installed base of cabling to run it. For PoE beyond 100 W, this installed base does not exist because much of today’s cabling will not support 200 W. 200 W will require next generation cabling with a higher operating temperature and improved thermal performance beyond typical Category 5E and 6. Therefore, PoE beyond 100 W is at least 10 to 15 years away.

## Existing and Future PoE Standards

Power over Ethernet will be able to provide the power and current as shown in Table 1.

Type	Standards	Maximum Current	Number of Energized Parts	Power at Device	Standard Ratified
PoE	IEEE 802.3af (802.3at Type 1)	350 mA	2	13 W	2003
PoE+	IEEE 802.3at Type 2	600mA	2	25.5 W	2009
PoE++	Proposed IEEE 802.3bt Type 3	600mA	4	51 W	Expected 2018
	Proposed IEEE 802.3bt Type 4	960mA		71 W	
Not PoE standards based	Cisco UPOE	600mA	4	60 W	Exists today – no official ratification
	HDBaseT (www.hdbaset.org)	1000mA		71 W	

Table 1: Power over Ethernet Existing and Future Standards

## Electrical arcs with Panduit Connectivity

All Panduit plugs and jacks are designed to pass the test methods of IEC 60512-9-3 and IEC 60512-99-001 to ensure that when arcing occurs, it will not damage the critical plug and jack mating point. Figure 1 highlights arcing on a Panduit connector showing how it occurs at a location (red) that does not affect the plug and jack mating location (green). It also shows the damage to the contacts on Panduit products is minimal.

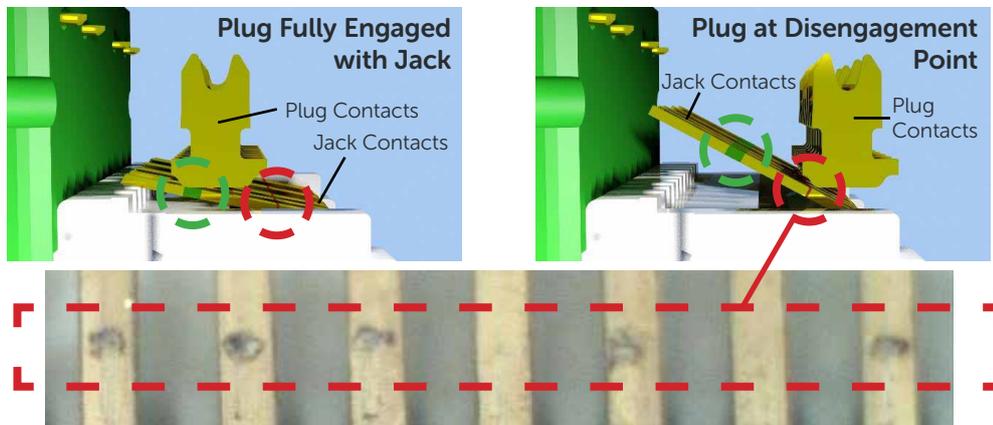


Figure 1: Minor arcing (red) does not occur in Panduit jack mating region (green). Non-Panduit jacks may see such damage in the critical mating area.

## Panduit Cabling Overview

Panduit is the industry leader in traditional standard gauge cables as well as small diameter solutions that have a length limitation below 100 meters. These small diameter solutions use wire gauges such as 26 or 28AWG in order to give customers the smallest diameter cables possible to allow for better cable management, improved air flow, and increased capacity in existing wire trays. The summary is shown in Figure 2.



Figure 2: Panduit Cabling Overview

## PoE Temperature Rise Testing Results

Panduit has done extensive testing across our entire cable line in order to provide guidance with TSB-184-A. These tests studied our diverse selection of cables and measured the temperature rise in varying bundle sizes having a variety of currents applied. An example of the testing done with 48 and 100 cable bundles is shown in Figure 3. Similar testing was done with bundle sizes of 61 and 24 cable bundles. 100 cables was chosen as the maximum bundles size as that was the maximum recommendation given in TSB-184-A.

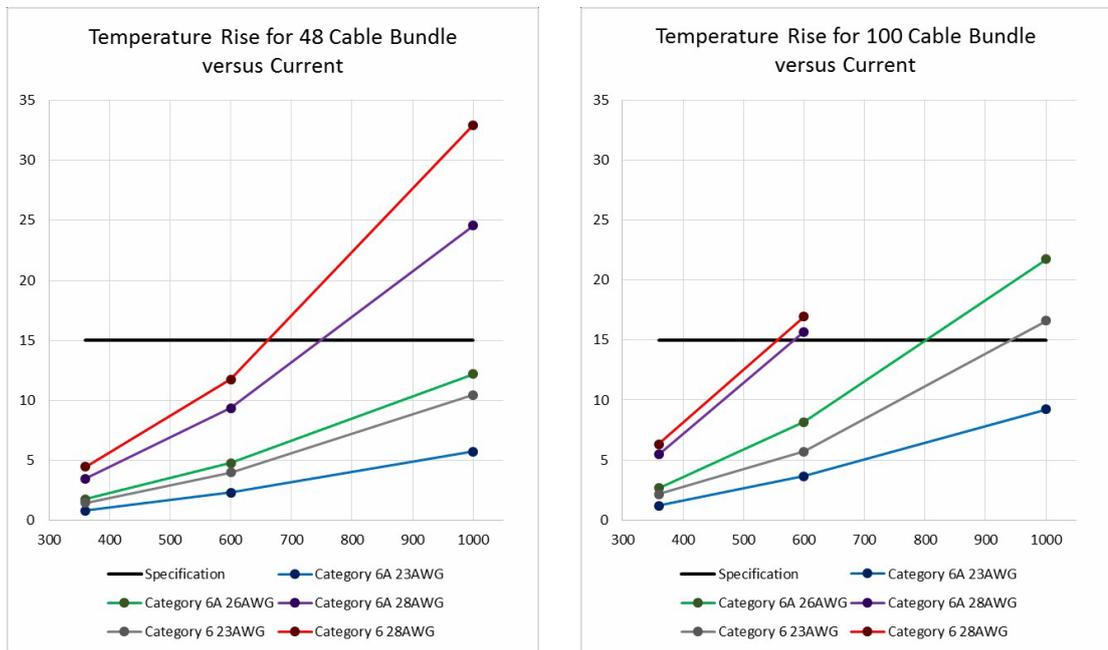


Figure 3: Bundle Temperature Rise over Time for 48 and 100 Cable Bundles

## Conclusion

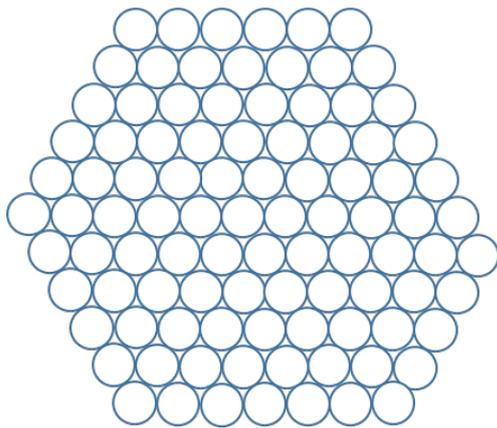
The recommendations for maximum bundle size are given below in Table 2. It is important to note that adjacent bundles are acceptable for installations. For example, running 48 cables of 960 mA 71 W PoE could require either 2 bundles of Cat 6 28 AWG or 1 bundle of Cat 6 24 AWG.

Cable Type	PoE / PoE + Maximum Bundle Size (2-pair, up to 600mA)	PoE++/HDBaseT Maximum Bundle Size (4-pair, up to 960 mA)
Cat 6 28 AWH	48	24
Cat 6A 28 AWG	48	24
Cat 5E 24 AWG	Tested up to 100 cables	61
Cat 6 23 AWG	Tested up to 100 cables	72
Cat 6A 26 AWG	Tested up to 100 cables	48
Cat 6A 23 AWG	Tested up to 100 cables	Tested up to 100 cables

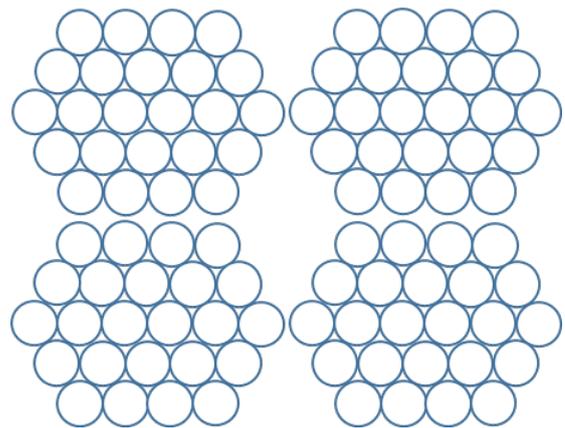
**Table 2: Recommended maximum bundle size for a given Panduit cable type to limit temperature rise to 15 degrees or less**

## Installation Instructions

The recommended bundle sizes refer to how many cables can be directly bundled together within groups. In other words, if 96 cables are needed to run between floors, it is possible to have a large bundle of 96 Category 6A cables for PoE++, or 4 smaller adjacent bundles of 24 Cat 6A 28 AWG as shown in Figure 4. Both are acceptable methods to run PoE and limit the temperature rise to only 15 degrees. These adjacent bundles can be placed as close as needed to each other.



Acceptable 96 cable bundle for 71 W / 960 mA over Category 6A 23 AWG



Acceptable deployment of 96 cables using four 24 cable bundles carrying 71 W / 960 mA over Category 6A 28 AWG

**Figure 4: Acceptable PoE++ Bundling for Cat 6A 23 AWG and Cat 6 28 AWG**

## The Importance of Cable Operating Temperature Rating

There is a simple equation to understand when deciding on a bundle size and cable type:

$$\text{Cable Temperature Rating} \geq \text{Ambient Temperature} + \text{Bundle Cable Temperature Rise}$$

Therefore, one must be aware of the ambient temperature of where the cable is being installed, what the expected cable temperature rise is for whatever cable type or bundle size is being used, and what the maximum cable operating temperature is. It should be noted that many Panduit cables allow for a cable operating temperature of 75°C, which is higher than the typical industry average of 60°C (all Panduit Category 6A MaTriX cables are rated up to 75°C). This gives more flexibility to the ambient temperature environment where they can be deployed.

## Deploying for PoE

Panduit recommends having a diversity of power delivery to have both redundant power sources, and to ensure there is room for future data and future power needs. This means:

- Running two Category 6A cables to each powered device
- Each run of Category 6A cable comes from a different zone distribution area

For example, wireless access point technology moves much faster than cabling technology. It is expected that wireless access point technology will double their speeds to 7 Gbps in conjunction with the adoption of IEEE 802.3bt. If these trends continue, wireless access points will need over 10 Gbps by 2020. By running two Category 6A cables that can each support 10GBASE-T and 71 W of power, it can be assured that the cabling infrastructure will be future proofed to support any future wireless technology data or power requirements for the foreseeable future.

## Recommendation

Not all PoE cabling and infrastructure is the same, and quality will make a meaningful difference to the performance of a network and its longevity.

Panduit recommends all new installations use Category 6A due to the fact it supports the highest data rate of 10GBASE-T, and has no bundle size limitations with any current or future Power over Ethernet application. If different cable types are used for PoE other than Category 6A, follow the guidelines in this document to reduce bundle size to allow the use of smaller gauge cables. These bundles can be grouped together so the total number of cables being routed remains the same.

For each PoE device deployed, Panduit recommends running two cables to that device.



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