Hitachi Cable America Inc.

Selecting Cables for Power over Ethernet

Factors to Consider when Selecting the Appropriate Cable

7/28/2016

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Power over Ethernet – Standards and applications

Increased energy efficiency has become a common consideration when developing just about any new electrical product. These technologies include lighting systems, access control, security systems with cameras, computers, access points for wireless networks and more. Where dozens, hundreds or even thousands of powered devices are active at a company site, reducing energy consumption (saving money) is typically a priority.

Power over Ethernet (PoE) allows devices to be powered over 4 pair category cables. Such cables are increasingly being installed to provide power and control to devices requiring up to 100 watts of power. Though it is extremely cost effective to utilize Category cables for powering devices, there are a number of factors that must be considered to ensure the cables will effectively and safely accommodate the type of PoE being utilized.

Type 1 and Type 2 PoE

The first two types of PoE were established in the standards IEEE 802.3.af and IEEE 802.3.at. The power sourcing equipment compliant to these standards deliver 15 watts and 30 watts of power respectively. Typical applications would be for lower power devices such as IP telephones, wireless access points and some cameras.

Type 3 and Type 4 PoE

The IEEE committee 802.3bt is currently developing the standards for higher levels of PoE power delivery. It is anticipated that Type 3 power will offer up to 60 watts of power, while Type 4 will deliver up to 100 watts. Type 4 PoE creates almost 80x the heat within the cable compared to Type 1 PoE, and managing this heat generation is a key industry concern. See Chart 1.

A critical point being addressed by the industry is that only some cable constructions will be able to safely support a higher power load in all installation configurations, specifically, cable bundles of various sizes . Some cables may be appropriate for small bundles, but not for larger ones.

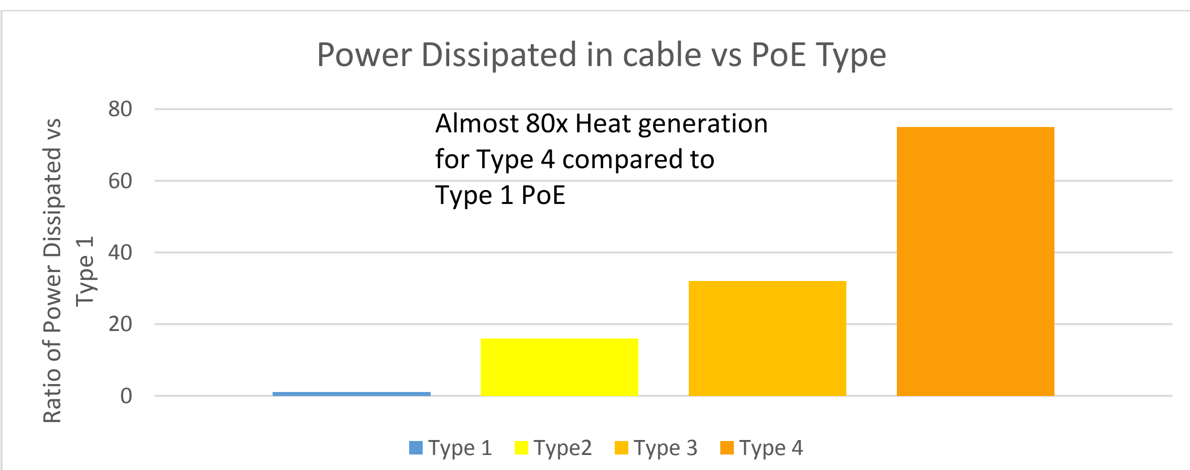


Chart 1

PoE Cable Safety Standards – The 2017 NEC Now Includes PoE

The National Fire Prevention Association (NFPA) has now adopted important new sections for the 2017 NFPA 70 – National Electrical Code (NEC), which include category cable ampacity tables. The proposed Ampacity table, a portion of which is shown below, will reside in section 725 and 800 of the NEC. The table clearly shows that that not all cables can support the higher power PoE types in all installation configurations.

	Number of 4-Pair Cables in a Bundle																				
	1			2-7			8-19			20-37			38-61			62-91			92-192		
	Temp Rating			Temp Rating			Temp Rating			Temp Rating			Temp Rating			Temp Rating			Temp Rating		
AWG	60°C	75°C	90°C	60°C	75°C	90°C	60°C	75°C	90°C	60°C	75°C	90°C	60°C	75°C	90°C	60°C	75°C	90°C	60°C	75°C	90°C
24	2.0	2.0	2.0	1.0	1.4	1.6	0.8	1.0	1.1	0.6	0.7	0.9	0.1	0.1	0.7	0.4	0.5	0.6	0.3	0.4	0.5
23	2.5	2.5	2.5	1.2	1.5	1.7	0.8	1.1	1.2	0.6	0.8	0.9	0.5	0.7	0.8	0.5	0.7	0.8	0.4	0.5	0.6
22	3.0	3.0	3.0	1.4	1.8	2.1	1.0	1.2	1.4	0.7	0.9	1.1	0.6	0.8	0.9	0.6	0.7	0.8	0.5	0.6	0.7

The table utilize specific cable characteristics, including conductor gauge and temperature rating, to establish a safe power rating (Ampacity) for the cable. For example, a cable with 23 AWG conductors and rated for 75°C, can accommodate .6 Amps in a bundle up to 193 cables.

The anticipated 2017 NEC also includes a provision for a limited power rating, or "LP" rating, which UL has developed as a standardized test to provide an alternate ampacity rating for specific cable designs. This "LP" rating is acknowledged in the NEC and can be used as an alternative to the values in the NEC ampacity tables. The ultimate goal of these efforts is to ensure that cable designs optimized for PoE can be properly identified regarding how much power they can safely handle.

Factors when selecting cables for PoE

Four key parameters for each cable type and application determine the ability of a cable to support PoE applications. See Figure 1. Each one of these characteristics is important to ensure safe PoE operation. Just as important as choosing the correct cable type, is choosing a cable known to be of high quality and high reliability. With the amount of delivered power increasing, great care should be given to picking the right cable, and by extension, the right cable manufacturer.

PoE capability is highly affected by substandard cables such as counterfeit cable with aluminum conductors or mislabeled cables. Mitigating those risks by choosing cables from a highly regarded manufacturer and one that is known to stand behind their products is highly recommended.

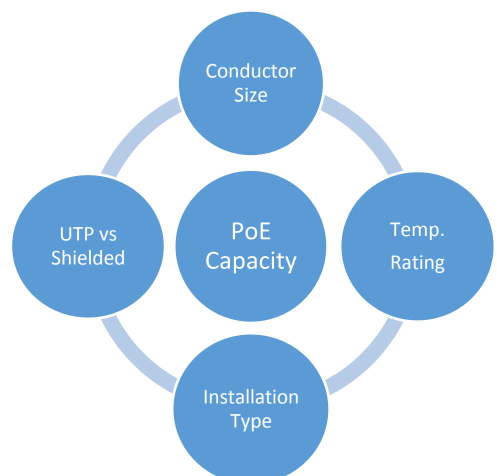


Figure 1

PoE Capacity and Heat Generation

Even small changes in one of these four parameters can affect the overall temperature rise in POE applications. Image 1 on the right taken by a thermal camera in the Hitachi lab shows the temperature of 6 different cables carrying identical currents. The image clearly demonstrates the significant differences in temperature rise among different cable designs. It is obvious that the higher category cables with the larger conductors bring additional power load capabilities.

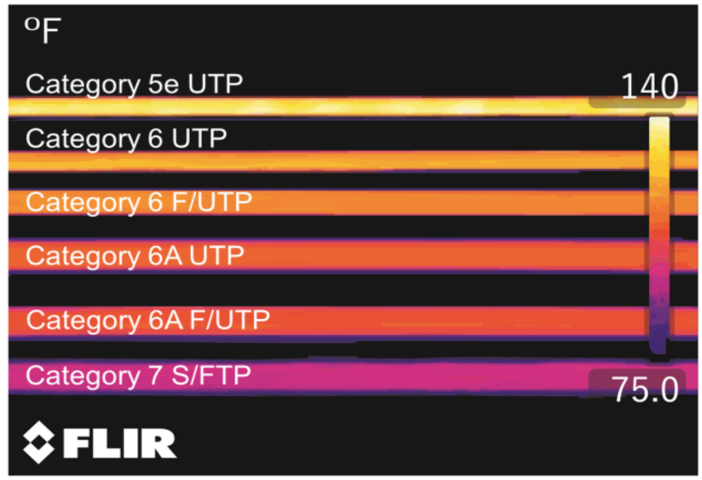


Image 1

Conductor Gauge Size

Conductor resistance (DCR) in POE applications drives the amount of heat generated in the cable. The larger conductor sizes in Category 6, 6A and 7A reduce the DC resistance, and thus the power lost (lost in the form of generated hear) within the cable itself. A typical change in conductor resistance across category cables is shown below in Chart 2. Every one percent reduction in conductor resistance results in the same ratio of reduction of dissipated power in the cable. Category 6 cables tend to have about 80% of the DCR of Category 5e, thus only about 80% of the heat generation.

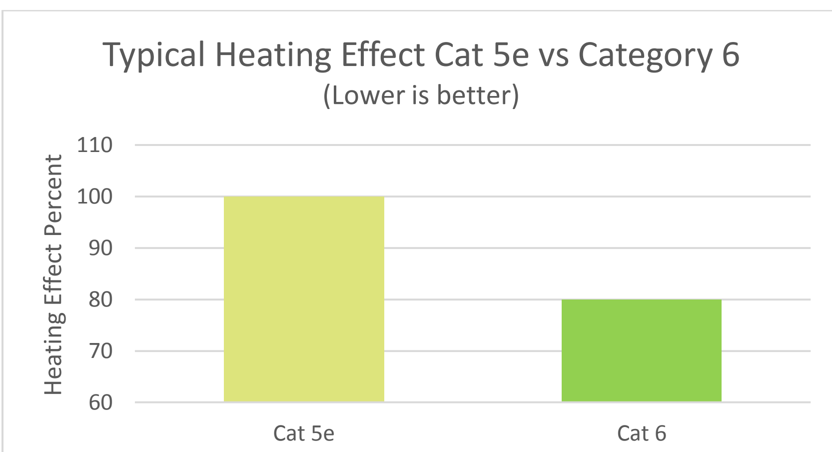
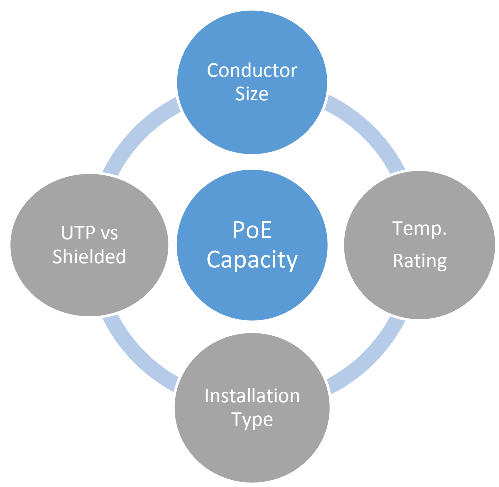
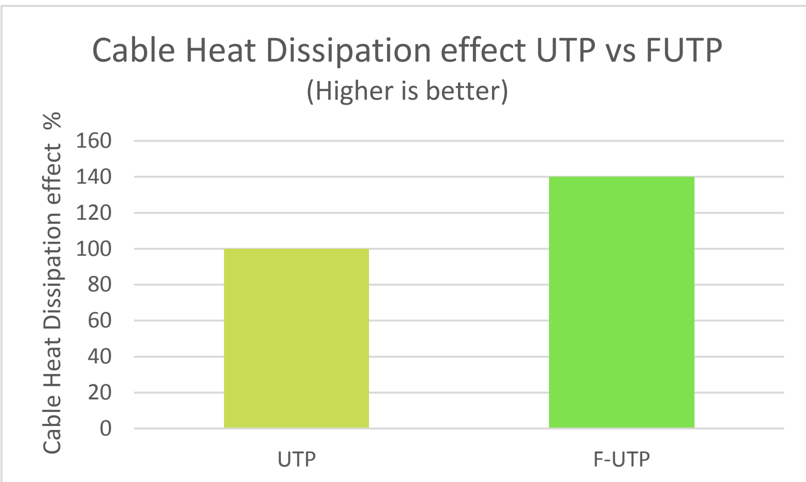


Chart 2



Cable Construction

The temperature rise of a cable in a PoE application also depends on the overall construction of the cable. In particular, cables with metallic shields have been shown to dissipate the heat better than UTP cables. Chart 3 below shows the reduction in temperature rise observed over several different test scenarios when using F/UTP Category 6 cables. Higher heat dissipation results in a cooler cable. It has been established that the presence of a metallic shield or foil helps dissipate heat. Category 7 S/FTP, which utilizes a foil shield around each pair delivered even better heat dissipating qualities than Category 6 and 6A F/UTP as shown in Image 1.



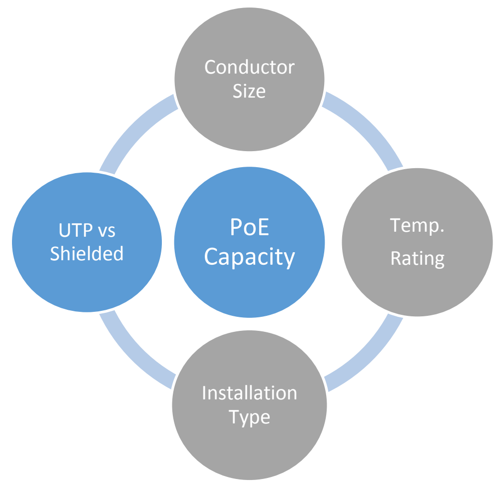


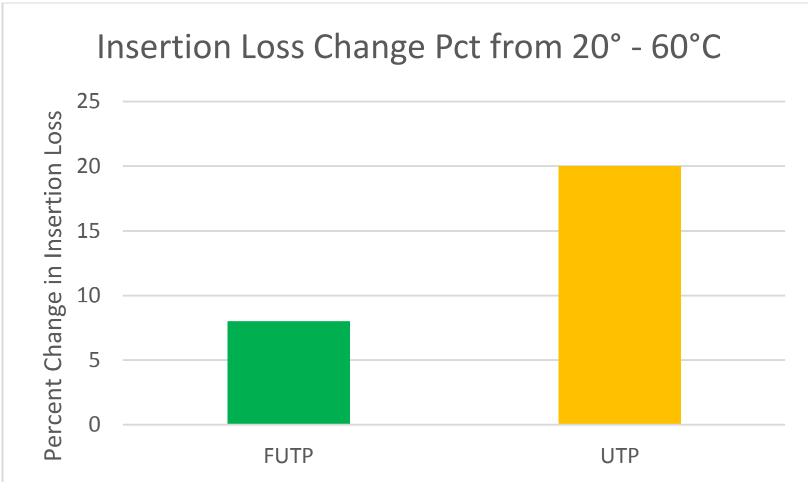
Chart 3

Cable Temperature Rating

Higher cable temperature ratings allow for a higher amount of power to be dissipated within the cable, and/or allow for an installation in environments that have higher ambient temperatures. Typical temperature ratings for the cables are 60°, 75°, and 90°C. For special applications, even higher ratings, 200C for example, can be obtained by using higher performing materials.

As the temperature of a cable rises, the electrical performance degrades. Also, excessive temperature rise in a cable can be detrimental to the cable's physical performance and longevity. Importantly, TIA standard 568-C.2 allows increases in insertion loss for shielded cables that is 2.5x greater than that for UTP cables. This allowance can have a significant impact on the reach and stability of installed systems at elevated temperatures.

Shielded constructions have been proven to be significantly less affected by temperature induced electrical degradation than UTP constructions, as demonstrated in Chart 4 on the next page.



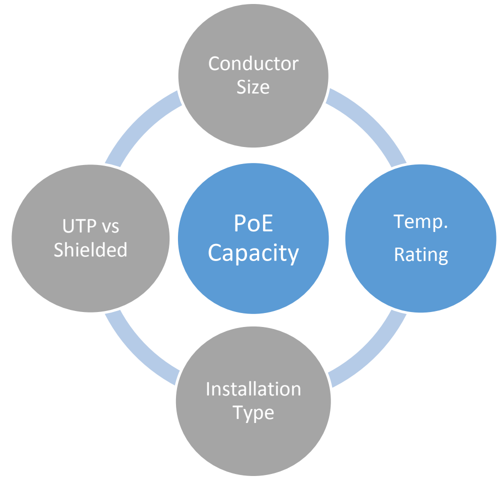
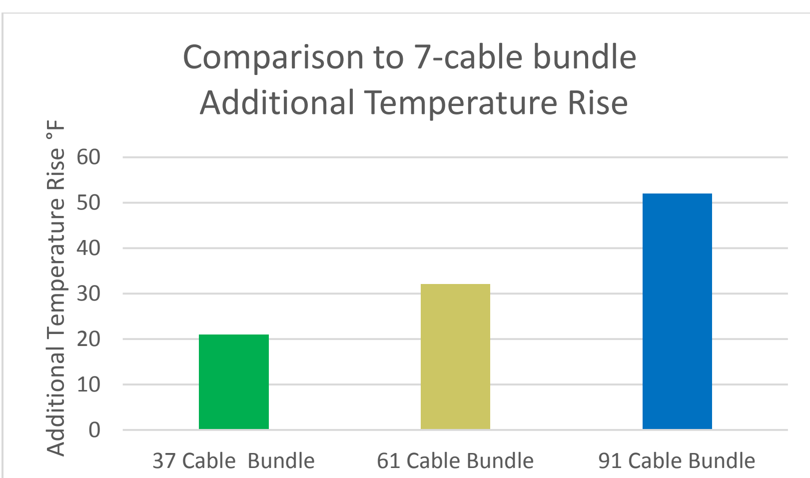


Chart 4

Installation Type

Last, but not least in this discussion of PoE capacity is the installation configuration of the cables. The installation affects the amount of thermal resistance that heat from the cable must dissipate through to the ambient environment and the cable configuration has a very large effect on the ability to dissipate the heat.

Higher thermal resistance and higher conductor temperatures occur with larger cable bundles, bundles in 'tight' or close proximity, fire stops in conduit, conduit effects, and other installation factors that tend to trap heat within the cable. The impact of bundle size and presence of conduit is very significant, which has standards organizations such as the NFPA including bundle sizes within the new NEC ampacity tables. Chart 5 below shows the incremental temperature increase due to an increase in bundle size regardless of cable category and construction.



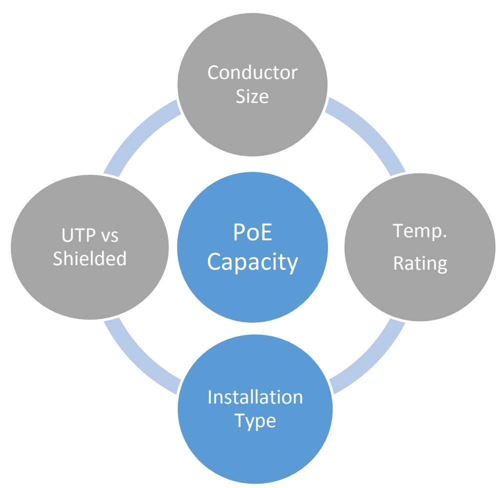
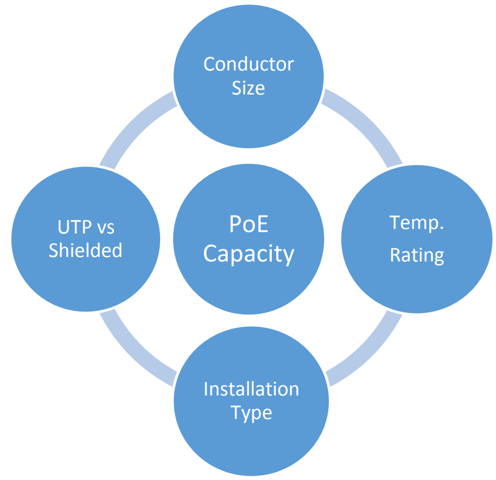


Chart 5

Summary

Power over Ethernet offers a wide range of options that provide flexibility for devices and applications.



Looking to the future of PoE, shielded Category cables, specifically Category 6 and 6A, offer some of the best ampacity performance and heat dissipation performance available. In addition to higher wattage PoE support, these cables also allow a wider range of application support, such as HDBaseT and the upcoming 2.5/5Gb Ethernet data rates.

For a premium solution, individually shielded pair Category 7 cables, as well as similarly designed Category 7A and the newest generation of data cables, Category 8, provide the best available performance ratings for PoE and deliver the most robust, stable channel for existing and proposed applications up to 25Gb.