



IEEE802.3at Power over Ethernet Plus (PoE+)

Answering challenges
to structured cabling in buildings

Overview

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Overview

Power over Ethernet (PoE, IEEE 802.3an), which combines power and data transmission within a single cable, has made great advances since 2003.

The original PoE standards supported delivered power of up to 12.95 watts, but with the introduction in 2009 of IEEE 802.3at PoE+, equipment that requires up to 25.5 watts can now be supported. However, higher power transmission using the data cable means more heating in the conductors. This is both a risk factor and a cost factor, as is the associated increase in attenuation that occurs as the temperature rises. The increase of attenuation could harm the performance and could even cause network downtime in worst case. Hence, when planning applications that utilise PoE+, great care must be taken in choosing the optimal cabling system; and in certain situations it may be necessary to impose limitations.

When correctly implemented the problems of heating and increased attenuation can be managed. By paying strict attention to current standards, data-transmission is not impacted and costs do not spiral.

One further risk factor that needs to be considered is the effect of spark discharge caused by the unmating of live connections causing damage to the contacts. Only high-quality, robust and approved plugs and sockets offer long-term contact quality and trouble-free and economic operation.

1. Introduction

Power over Ethernet (PoE) permits transmission of data and DC current via the 8-wire Ethernet cable (Cat. 5e or higher), thus providing a universal and remotely controllable power supply and data connection. In PoE, the power sourcing equipment (PSE) supplies power only to designated users, and it monitors and limits the maximum power that can be taken by each one. PoE is implemented as an integral power feature of the network switch, or via peripheral devices (referred to as midspans) that are installed between the switch and the network physical devices (PDs).

The transmission medium for data and electrical power consists of cables that support the IEEE802.3af standard. A major application for communication cabling is the remote powering of terminal devices with operating ratings up to 12.95 watts, such as wireless access points (WAPs), voice-over-IP (VoIP) telephones and internet protocol (IP) cameras. The use of PoE for these applications avoids the need for traditional power adapters.

The rapid growth of PoE quickly led to a desire to provide power supplies for higher powered terminal devices requiring more than 12.95 watts. As a result, the PoE+ working group developed the IEEE802.3at standard, which was introduced in 2009.

2. Advantages of PoE+ compared with PoE

The IEEE802.3at standard defines the requirements for increasing the power to the consumers (PDs) to 25.5 watts via two Ethernet cable pairs and can be drawn at a distance of up to 100 metres. This is of importance for such items as pan-tilt-zoom (PTZ) cameras, which require higher powers to operate internal motors which control the camera position. In addition to PTZ cameras, other types of equipment also obtain their full required power of 12 to 24 watts over PoE+, such as:

- safety systems for buildings and surface/underground railway carriages
- VOIP video telephones
- POS terminals
- Multiband wireless access points (IEEE 802.11n)
- RFID readers (radio-frequency identification)
- PoE computers

Many companies are already benefiting from the advantages offered by using a single network to handle voice, data and power, and their number is constantly growing.

The trend to PoE continues

According to research by Dell'Oro, in 2011 approximately 20 % of all users were using PoE via Ethernet switch ports. Internet telephony is increasingly being equipped with cameras for transmission of video telephony – and many companies such as Brocade, Cisco and D-Link concur in forecasting a spread of PoE+ in 2012. 25.5 watts can be delivered over PoE+, which is two times as much as with the previous PoE standard. The growing sales figures clearly illustrate the trend towards PoE+, which can also support a greater number of terminal devices.

Assured compatibility

The IEEE standards group, which includes experts from Nexans, has defined precise limitations. PoE+ extends the previous 802.3af standard, and it will operate within this defined framework. The target infrastructures for PoE+ are systems in accordance with ISO/IEC 11801 Class D / ANSI/TIA/EIA-568.C.2 Cat.5e (or higher). Further features are:

- PoE+ energy sources (PSE) operate in modes that are compatible with the requirements of IEEE STD 802.3af.
- PoE+ provides the energy consumer (PD) with a maximum of 25.5 W
- Support for midspan PSEs running over 1000Base-T.
- Trouble-free operation of PoE+ PDs together with 802.3af PSEs in the power range covered by 802.3af.

New power categories were also defined for “consumers” (PDs) and power modules (PSEs), paying special attention to backward compatibility, and to providing support for conventional PoE devices or devices with low power consumption

2a. Impact on the cabling infrastructure – challenges

The doubling in usable current with PoE+ (by comparison with conventional PoE) also leads to increased requirements for the cabling system that is used.

Differences between PoE and PoE+:

	PoE	PoE+
PSE current (A)	0.35 A	Type 1: 0.35 A Type 2: 0.6 A
PSE voltage (Vdc)	44-57 V	Type 1: 44-57 Vdc Type 2: 50-57 Vdc
PD current (A)	0.35 A	Type 1: 0.35 A Type 2: 0.6 A
PD voltage (Vdc)	37-57 V	Type 1: 37-57 Vdc Type 1: 47-57 Vdc
Power	12.95 W	25.5 W
Cable requirement	Cat. 3 or higher	Cat. 5 or higher

Type 1 devices with low power consumption / Type 2 devices with high power consumption

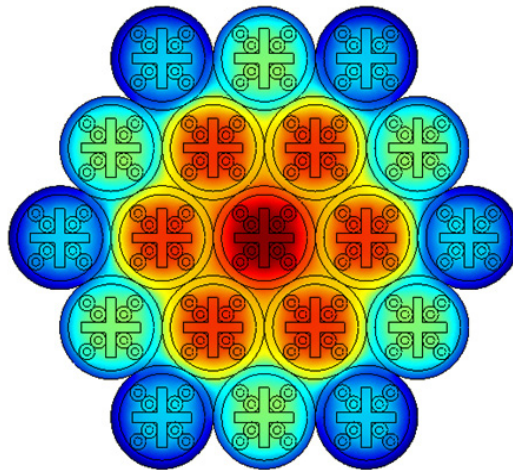
The PD classes in IEEE standard P802.3at are classified as follows:

Class	PD Class	Electrical power of PD
0	Standard, Type 1	0.44 W to 12.95 W
1	Type 1	0.44 W to 3.84 W
2	Type 1	3.84 W to 6.49 W
3	Type 1	6.49 W to 12.95 W
4	Type 2	12.95 W to 25.5 W

2b. Generation of heat in cable bundles

Transmission of energy over a generic communications cabling system leads to rising temperature levels within the cables. The temperature increase depends on the amount of energy transmitted, the conductor cross-section and the thermal insulation around the bundle.

A cable located in the centre of a bundle will naturally heat up more because no heat can be conducted away. As the operating temperature (ambient + temperature rise) increases in the cable bundle the insertion loss also increases, which may restrict the maximum permissible cable length. The values of attenuation quoted in the standard and in the manufacturers' data are based on an ambient temperature of 20 C°. For screened cables, the maximum range is reduced by approx. 0.2% per C°, and for unscreened cables the figures are 0.4 %/C° from 20 C° to 40 C° and 0.6 %/C° from 40 C° to 60 C°. For this reason, the maximum operating temperature defined by the IEEE standard P802.3at is limited to 60 C°. Since the heat generation in the cable increases with higher current flow, it is recommended to use cables of a higher category in order to minimize this effect. The "Finite Element 3D Model" produced by Nexans was of considerable help to the IEEE when defining the PoE+ standard. Using this model, it was possible to simulate effects caused by a variety of energy levels and currents.

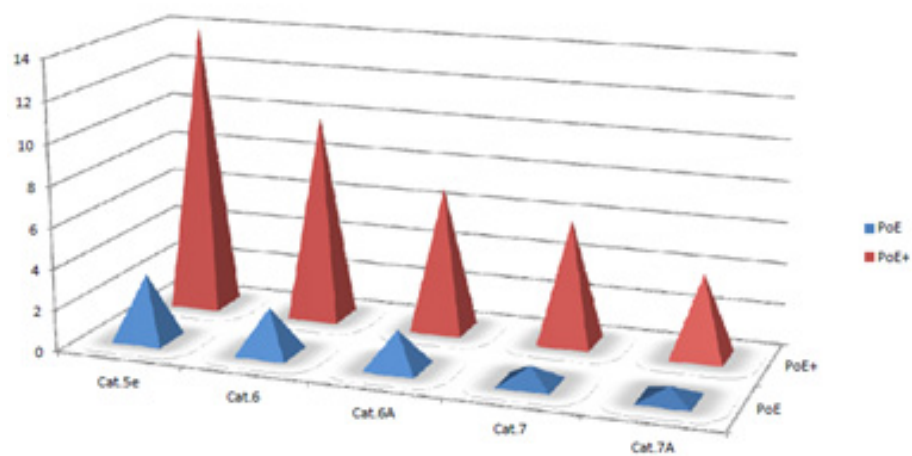


Cables in the centre of a bundle heat up

The modelling carried out by Nexans gave the following results for a bundle of >100 cables:

Cable type	Conductor cross-section	Temperature rise
Cat. 5e / U/UTP*	AWG 24	14° C
Cat. 6 / F/UTP**	AWG 24	10° C
Cat. 6A / F/UTP**	AWG 23	7° C
Cat. 7***	AWG 23	6° C
Cat. 7A***	AWG 23	4° C

(* unscreened / ** screened / ***screened with individually shielded pairs =PiMF)



Heating in bundles of 100 cables. PoE vs PoE+

In the end, the results of Nexans' modelling contributed to the IEEE to specify a maximum current level of 0.35 A, in order to limit the temperature rise in the bundles to a maximum of 10 °C.

2c. Spark formation when connections are separated

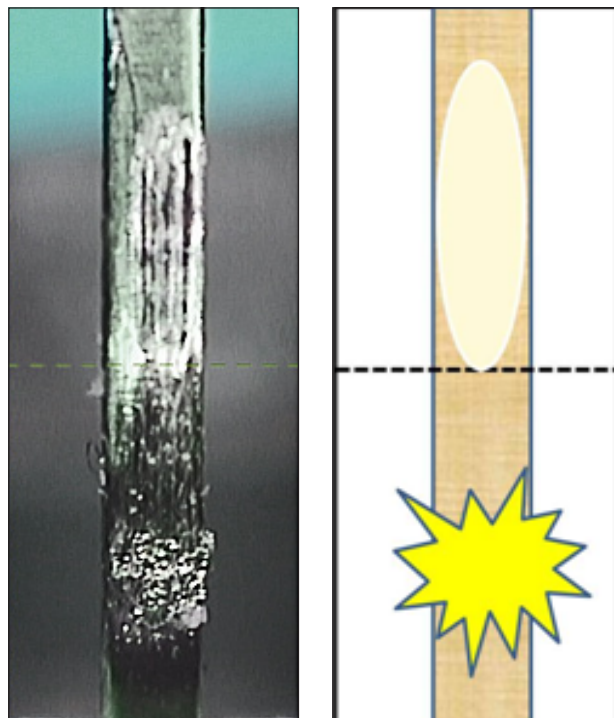
Another difference between PoE+ and “normal” PoE is that, due to the higher current, a larger spark may be generated when a connection is broken under load. These arcs, which are not generally apparent to the user, pose no hazard to people, but over the course of time they cause visible damage to the contacts in the RJ45 socket.

A socket may meet the criteria of the IEC 60603 standard, but it does not automatically follow the damage caused by sparking will have no effect on the data transmission. Where the contacts are poorly designed, the area where the plug and socket make contact with each other under normal operation may be damaged by the arcing caused by connecting and disconnecting the plug from the socket while current is still being supplied.

In the case of PoE+, this will occur if the patch cord is unplugged while the device is still operating.

Damage to the contacts due to arcing cannot be avoided in the long term, but the RJ45 socket can be constructed in such a way that this unavoidable damage does not occur in the critical part of the contact zone between the plug and the socket.

As a result of this, the IEC developed the IEC 60512-9-3(Ed2) and IEC 60512-99-001 standards for testing components suitable for POE+. When purchasing a structured cabling network, customers should convince themselves the connectors are compliant with this component standard.



RJ45 contact from a LANmark-6A connector showing the undamaged operational area of the contact at the top of the picture. The lower half of the picture shows the damage caused by unmating under load which due to the design of the connector will not affect transmission performance. A short video showing this is available at www.nexans.com/lansystems

3. Summary

In the tests carried out for the IEEE, it was evident that the additional increase in temperature due to the higher current level with PoE+ had a greater effect on bundles with a higher number of conductors. The tests clearly showed that the greater the size of the cable bundle and the smaller the conductor cross-section, the higher was the temperature rise. In addition, cables with bigger wire diameters, which usually correspond with higher categories, performed distinctly better. Although an unscreened Cat.6A system would be an advantage compared with a Cat.5e solution, the recommendation is to use a screened system. If only minimally compliant components according to Cat.5e U/UTP are used, significant limitations must be imposed. Moreover, the system will lose its future sustainability, in that it will not be able to cope with future requirements to transmit more power. Many manufacturers are already offering devices that inject more power than is defined in IEEE802.3at and many industry experts are predicted that an IEEE project for an even higher power level is on the horizon. Depending on the bundle sizes and cable lengths, Nexans recommends that higher grade shielded cabling represents the optimal infrastructure for PoE+.

Customers should also ensure they only use PoE+ compatible connectors. LANmark connectors are designed so as to be fully compatible with PoE+ Nexans gives corresponding guarantees in its data-sheets.



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