

PoE technology - Part 1: Introduction

WHITE PAPER

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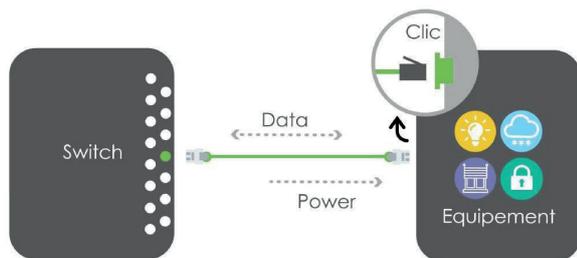
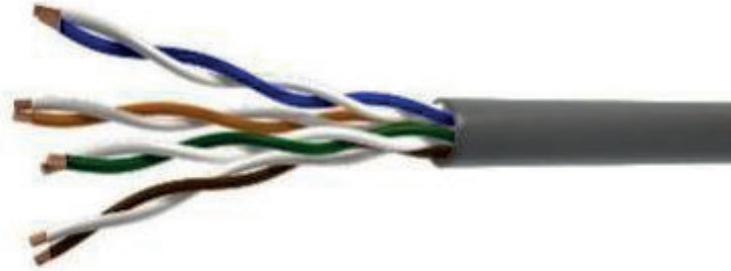


INTRODUCING THE POE TECHNOLOGY

An Ethernet cable can carry information (voice, data, images, etc.) at a rate up to 40Gbit/s depending on the type of cable and the active devices (router, switch) used. Since a few years, it is possible to inject electrical power on these same cables: we speak of PoE for "Power over Ethernet". In permanent evolution, the standard defined by the IEEE currently allows to inject up to 90W to power a remote device (camera, phone, wifi access point, etc.) with a maximum range of 100 meters.

PoE = POWER OVER ETHERNET

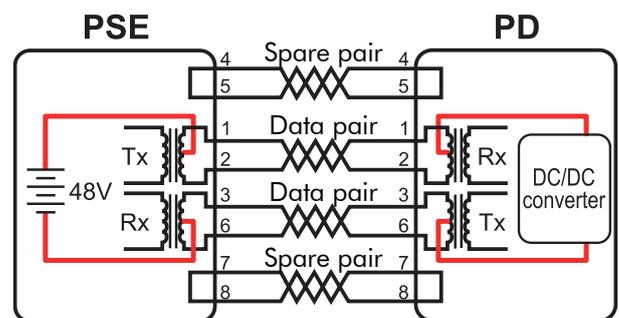
PoE technology is used to power remotely connected devices and simultaneously transmit information using an Ethernet cable support consisting of 4 pairs of twisted copper wire.



The principle of PoE power supply is based on the use of twisted copper pairs of the Ethernet cable to power from the source called PSE (Power Sourcing Equipment), the remote equipment called PD (Power Device).

The IEEE 802.3 standard sets the maximum distance of the Ethernet cable at 100 meters to take into account losses caused by the resistivity of the cable.

An Ethernet cable is made up of four pairs of wires. When the connection is 10 or 100 Mbps, the data travels on only two pairs, namely wires 1, 2, 3 and 6; the other two spare parts, namely the wires 4, 5, 7 and 8, can be used to convey the electric current (type A). It is however possible to use the wires 1, 2, 3 and 6 to convey the data and the power (type B), leaving the free pairs unused. When the connection is above 100 Mbps, the four pairs are used to carry the data. In this case, the power can be transmitted on the wires 1, 2, 3 and 6 or 4, 5, 7 and 8. The IEEE 802.3af (15 W) and 802.3at (30 W) PoE standards describe these two scenarios.



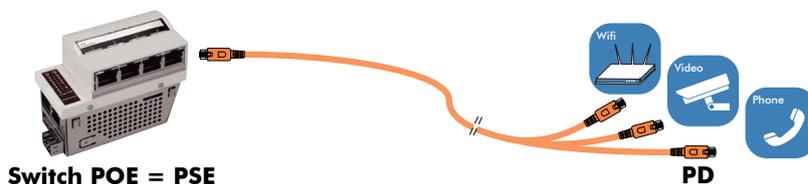
According to the standard, PDs must support power transmission capabilities in both types A and B. On power-up, the PSE needs to determine how much power it needs to supply the PD to avoid damaging it. For this there are two methods: either by a HW protocol (Physical Layer Classification) or by using the LLDP protocol (Link Layer Discovery Protocol) for data exchange between the two devices PSE and PD.

The data and the power supply pass in the same Ethernet cable, so there is only one cable to be pulled per connected device. Therefore, compared to an external power supply, the amount of connectors and adapters is reduced.

SOURCE (PSE) CONFIGURATIONS

"PSE END POINT" CONFIGURATION

The "End point" configuration is used to connect a PoE power supply, usually a switch, to a PoE-compatible PD remote device.



"PSE MIDSPAN" CONFIGURATION

The "Midspan" configuration is used to connect PoE-incompatible power equipment to PoE-compatible PD equipment via a PoE-compatible adapter.



IEEE 802.3 STANDARD HISTORY

The IEEE 802.3 Working Group has been working on the standardisation of the Ethernet cable feed since 1999. The first version of the standard, IEEE 802.3af, was ratified on 11 June 2003 and published on 11 July of the same year.

The main factor limiting the adoption of this technology has always been power. Indeed, the IEEE 802.3af version limited power to 15.4 W at the source (PSE).

Since then, the IEEE 802.3 Working Group has never stopped finding solutions to increase this power capacity at the source by first using the two pairs, then finally the 4 twisted pairs available, taking care to ensure each version of the standard backwards compatible with the previous version.

The IEEE 802.3at version, known as "PoE+", introduced Type 2 of the PSE/PD pair and allowed this type of equipment to inject 30 W at the source (PSE).

But this remains insufficient to cover all market needs. So, some manufacturers have come together in the HTBaseT Alliance to develop new components to achieve 60 W then 95 W (PoH standard) using the 4 twisted pairs available in the Ethernet cable and playing on the length of cable actually used.

The IEEE 802.3 Working Group continued its work in parallel and the IEEE 802.3bt version was ratified on 27 September 2018. It brings major changes to the increase in power delivered and the speed supported by PoE cables.

IEEE 802.3 and PoH standards published before 2018 about this technology:

Type	Standard	PSE Min. input power	PD Guaranteed min. power	Cable category	Max. cable length	Number of pairs
Type 1	IEEE 802.3af	15.4 W	12.95 W	Cat. 5e	100 m	2 pairs
Type 2	IEEE 802.3at	30 W	25.5 W	Cat. 5e	100 m	2 pairs
PoH	PoH	95 W	72 W–95 W*	Cat. 5e or 6	100 m	4 pairs
* Achieves power at the destination of 95 W if the cable length is known (<100m)						

IEEE 802.3BT VERSION: THE NEWS

The work of the IEEE 802.3bt version (also called "4PPOE" or "POE++") takes into account this need to increase the supplied electrical power, as well as increasing the bandwidth to reach 10 Gbit/s. It incorporates advances in technology during this period (cf. the work on PoH).

Main evolutions of the IEEE 802.3bt version of the standard:

- Introduction of Type 3 and Type 4 for the PSE/PD duo to reach respectively 60 W and 90 W at the source (PSE)
- Using the 4 twisted pairs available in an Ethernet cable
- Addition of new power classes: classes 5 to 8 and improvement of the process of mutual identification between the PSE and PD
- Addition of the "Automatic class" function
- Increase of power supply (Extended power capability) if the length of the cable used is known
- Improvement of consumption in idle mode
- Increase of bandwidth up to 10 Gbits/s (10G-BASE-T cables)

The table below summarizes the different types of IEEE 802.3 standards.

Type	Standard	PSE Min. input power	PD Guaranteed min. power	Cable category	Max. cable length	Number of pairs
Type 1	IEEE 802.3af	15.4 W	12.95 W	Cat. 5e	100 m	2 pairs
Type 2	IEEE 802.3at	30 W	25.5 W	Cat. 5e	100 m	2 pairs
Type 3	IEEE 802.3bt	60 W	51 W–60 W*	Cat. 5e and above	100 m	2 pairs class 0–4 4 pairs class 0–4 4 pairs class 5–6
Type 4	IEEE 802.3bt	90 W	71 W–90 W*	Cat. 5e and above	100 m	4 pairs class 7–8
* Provides power at the destination of 60 W for Type 3 and 90 W for Type 4, if the cable length is known (<100m)						

THE NEW PSE/PD TYPES

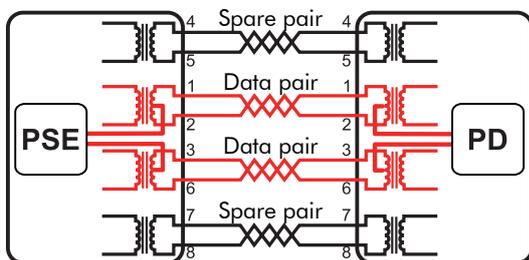
The IEEE 802.3bt standard introduces two new types of PSE/PD: types 3 and 4.

Capability	Type 1/Type 2	Type 3	Type 4
V_{PSE} (MIN)	44 V/50 V	50 V	52 V
PSE Polarity	Flexible	Flexible	Fixed
4P Capable	No	Class 0–4 : Optional Class 5–6 : Mandatory	Mandatory
Extended Power	No	Yes	Yes
Auto Class	No	Yes	Yes
Low MPS	No	Yes	Yes
P_{PSE} (MAX)	15 W/30 W	60 W	90 W–99 W
PD minimum input power	12,95 W/25,5 W	51 W*	71 W*
Supported PSE Classes	Class 0–4	Class 1–6	Class 8
Supported PD Classes	Class 0–4	Class 1–6	Class 7–8

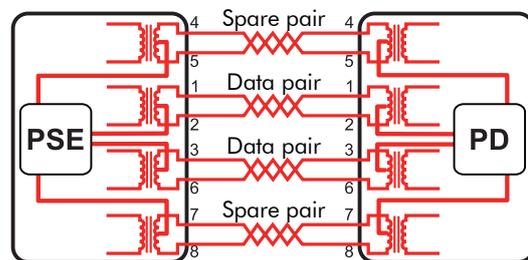
* The Extended wPower Capability function achieves a power output of 60W for Type 3 and 90W for Type 4, if the cable length is known (<100m)

The standard introduces the concept of "Assigned class" for the PSE system that is obtained as a result of the self-negotiation phase between the PSE and PD. The "Assigned class" value is determined by the lowest common denominator of power values that PSE and PD equipments can stand. For example if a PD requests to support a class 8 while a PSE can only support a class 6, the "Assigned class" value will be a class 6 for the PSE system.

THE DIFFERENT OPTIONS FOR USING THE 4 PAIRS



A first option is to use two pairs to power the PD and use the 4 pairs to convey the data.



A second option is to use the 4 pairs to both feed the PD and convey the data.

About Nexans

Nexans brings energy to life through an extensive range of advanced cabling systems, solutions and innovative services.

For over 120 years, Nexans has been providing customers with cutting-edge cabling infrastructure for power and data transmission. Today, beyond cables, the Group advises customers and designs solutions and services that maximize performance and efficiency of their projects in four main business areas: Building & Territories (including utilities, e-mobility), High Voltage & Projects (covering offshore wind farms, submarine interconnections, land high voltage), Telecom & Data (covering data transmission, telecom networks, hyperscale data centers, LAN), and Industry & Solutions (including renewables, transportation, Oil & Gas, automation, and others).

Corporate Social Responsibility is a guiding principle of Nexans' business activities and internal practices. In 2013 Nexans became the first cable provider to create a Foundation supporting sustainable initiatives bringing access to energy to disadvantaged communities worldwide. The Group's commitment to developing ethical, sustainable and high-quality cables also drives its active involvement within leading industry associations, including Europacable, the NEMA, ICF or CIGRE to mention a few.

Nexans employs nearly 27,000 people with industrial footprint in 34 countries and commercial activities worldwide. In 2018, the Group generated 6.5 billion euros in sales.

Nexans is listed on Euronext Paris, compartment A.

Nexans

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