

LEONI *productreport*

Possible uses of LEONI Ethernet cables for PoE (Power over Ethernet) 01/2020



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Ethernet cables are increasingly being used not only to transfer data, but additionally also to supply power to connected devices. This technology is called Power over Ethernet – abbreviated PoE.

The aim here is to present some of the technical conditions for facilitating optimum use of LEONI Ethernet cables.

The key advantage of PoE technology is that it dispenses with the need to lay a power supply cable alongside the Ethernet cable. Depending which cables and what devices are used, output of 15 W (PoE) or 30 W (PoE+) is possible via 4-pair data wiring; in the case of 4PPoE power supply of even up to 100 W (PoE++). This makes it easier to fit and run, for example, IP cameras, Bluetooth devices, IP phones, small servers or hubs.

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Technical background

The IEEE 802.3 standard is the basic document for using PoE.

The IEEE 802.3af (PoE) standard permits power supply of Ethernet devices with output of 15 W via the data wiring. The permitted current is 175 mA per conductor (350 mA per pair). 2 conductor pairs of the 4-pair Ethernet cable are used for the outgoing and return feeds. In the case of the IEEE 802.3at (PoE+) standard, the output even comes to 30 W. The permitted current here is 300 mA per conductor (600 mA per pair). Likewise, 2 conductor pairs of the 4-pair Ethernet cable are used for the outgoing and return feeds.

The IEEE 802.3bt (PoE++) standard is also described as four-pair Power-over-Ethernet (4PPoE). Whereas PoE hitherto used only two of the four core pairs of a data cable, this uses all 4 pairs to transmit power (two each for outgoing and return) of up to 100 W at a permissible current.

	PoE	PoE+	PoE++
Standard	IEEE 802.3af-2003	IEEE802.3at-2009	IEEE802.3bt-2018
Effective output	13 W	25 W	60 – 100 W
Effective voltage	37 – 57 V	42.5 – 57 V	44 – 57 V
Max. power consumption per pair	350 mA	600 mA	1000 mA
Conductors of the 4-pair cable used	2	2	4

Installation of Ethernet cables

Ethernet wiring was originally not devised for power transmission. That is why only the typical problems of data security, such as the radiation and interference of electromagnetic fields, had to be considered. In principle, laying cables in larger bundles was not a problem.

When using PoE, however, other physical effects must be considered for installation and use of the Ethernet cables.

Above all, these include:

- Heating of the individual data cable and of a data cable bundle
- Connector contact melting

Heating of the individual data cable

PoE substantially increases the current carried via the electrical conductors and pairs and thereby the electrical output. Because of the electrical resistance of the conductors, this also increases the heat generated in the cable. This must be discharged by the electrical conductors. In the case of unshielded Ethernet cables, the heat thereby generated is higher by a factor of 5 over the structurally identical cable serves only to transfer data. Thanks to the better heat dissipation, shielded Ethernet cables only heat up by a factor of 2.5 to 3 above the electrical shield.

Key determinants for cable heating are:

- Power load
(depending on the PoE standard used)
- Conductor cross section
- Cable construction and choice of materials used
- Length of cable used
- Voltage used as well as voltage drop considered

Heating of the data cable bundle

Alongside heating and heat dissipation of the individual Ethernet cable, the way the cable bundle is laid is also crucial because the heat dissipation of a cable bundle requires additional ratings. The draft standards ISO/IEC TR 29125 and Cenelec EN 50174-99-1 provide instruction on rating the specific thermal load in the cable bundle. In addition to the determinants already mentioned with respect to the individual cable, particularly the following must be considered in this case:

- Number of cables in the bundle
- Installation environment (heat dissipation)
- Ambient temperature
- Conditions for heat dissipation

The right cable design makes a crucial contribution to minimising heating of the cable.



Example of application for an Ethernet cable bundle with PoE use with resulting heat generation

1. The first rule of thumb that applies is:
The greater the conductor cross section, the less the PoE heating.

Even if it is technically possible for all Ethernet cables of transmission categories 5e, 6, 6A and 7 (7A) to use the following conductor cross sections (AWG = American Wire Gauge):

- AWG 26 (equates to a conductor cross-sectional area of approx. 0.14 mm²)
- AWG 24 (equates to a conductor cross-sectional area of approx. 0.21 mm²)
- AWG 23 (equates to a conductor cross-sectional area of approx. 0.26 mm²)
- AWG 22 (equates to a conductor cross-sectional area of approx. 0.34 mm²)

principally the following conductor cross sections are used in the individual transmission categories:

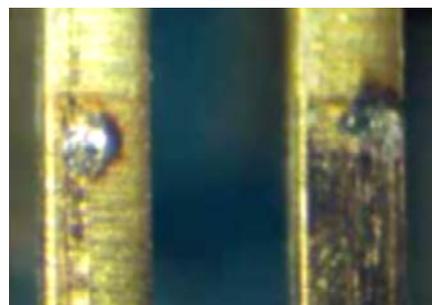
- Cat 5e: AWG 24
- Cat 6/6A: AWG 23
- Cat 7/7A: AWG 22

2. The second rule of thumb is:
The higher the transmission category, the less the probable PoE heating.

Connector contact melting

In connection technology, pulling the plug under load can result in damage - known as contact melting - due to triggering an electric arc or sparks. This leads to irreversible deterioration or even failure of the contacts.

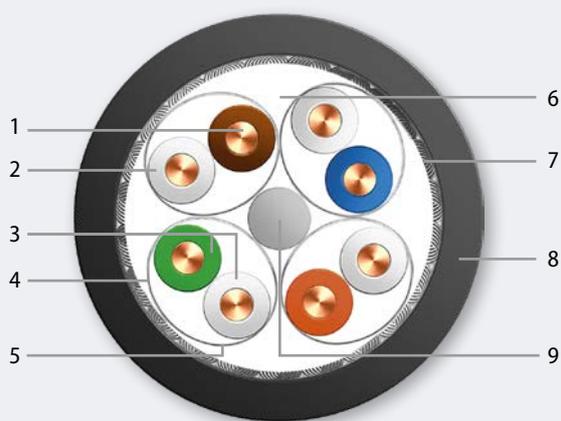
Corresponding port power management can remedy this - i.e. first switching off the power supply, then pulling the plug. However, intentional or unintentional pulling of the connector under load cannot be entirely prevented.



Contact melting in connection technology – here an RJ45 terminal (IEC 62652)

Recommendation for choosing the right data cable for PoE use

- Shielded cable of the highest possible category
- Large conductor cross section (e.g. AWG 22)
- Solid conductor preferable to stranded conductor
- If required – use special designs with an allowable operating temperature of > 60 °C
- Considering the way the cable is later laid
- Considering the cable's installation length
- Considering the cable's later type of contact



Ethernet data cable with solid conductor

Cable structure:

1. Metallic conductor
2. Dielectric
3. Twisted data pair
4. Electrical shield
5. Filler compound in the twisted data pair
6. "Clearance", gusset
7. Overall electric shield
8. Cable jacket
9. Central member

LEONI offers the following Ethernet cable design options that are suitable for PoE use:

- Standard category 5e, 6, 6A, 7 and some Type 7A cables
- Cables with system integrity in the event of a fire for up to 180 minutes in various transmission categories
- Cables with reduced gas flow suitable for installation in areas at risk of explosion in various transmission categories
- Hybrid cables with Ethernet components in various transmission categories