

LEONI *technicalbulletin*

Data communication technology 03/2020



PoE (Power over Ethernet) on the advance

- › Category 7_A data cables tolerate higher power loads
- › The connection technology must meet and be certified for all of the requirements made by 4PPoE (100 W).

With our product solutions from the LEONI MegaLine® range, these new challenges can be met easily.

- › **MegaLine® Connect100**
- › **MegaLine® Connect45**
- › **MegaLine® Connect45 Pro**

Find out everything you need to know about the latest technical standards. Learn about new developments and applications in the pipeline. If you want to know about the data cables and connectors used for power transmission in the future – LEONI has the answers.

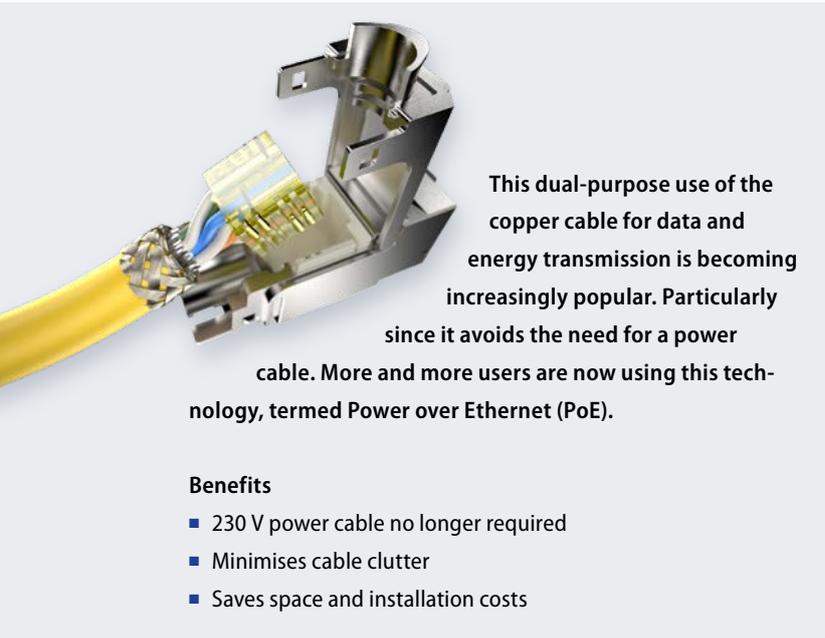
Data Communication & Networks

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PoE (Power over Ethernet)

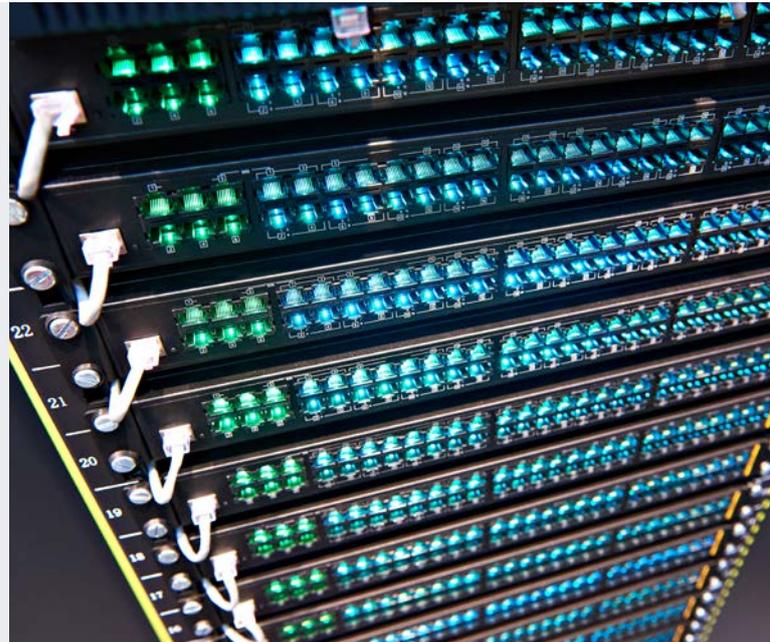
Power distribution to many kinds of network-ready devices via the LAN cable



This dual-purpose use of the copper cable for data and energy transmission is becoming increasingly popular. Particularly since it avoids the need for a power cable. More and more users are now using this technology, termed Power over Ethernet (PoE).

Benefits

- 230 V power cable no longer required
- Minimises cable clutter
- Saves space and installation costs



Current IEEE standards

> from 2003

IEEE 802.3af-2003

Power over Ethernet (PoE)

This is the first standard to specify power distribution over the data cable for Ethernet devices, with a nominal power of 15.4 W. Maximum amperage is 175 mA per conductor or 350 mA per pair.

> from 2009

IEEE 802.at-2009

Power over Ethernet-Plus (PoE+ / PoE Plus)

With this standard from 2009, the power rating is as much as 30 W and is fed in using an amperage of 600 mA per pair.

> from 2018

IEEE 802.3bt-2018

Four-Pair Power over Ethernet (PoE++ / 4PPoE)

Issued in 2018, the most recent standard provides a much higher rate of power distribution to Ethernet devices. Here, there are four levels from 40 to 72 W. This improvement provides for larger output ratings for power distribution, with a maximum of 55 W (level 3) and 100 W (level 4). This results in a usable power output of 40 to 72 W directly at the consumer.

A wide range of application scenarios

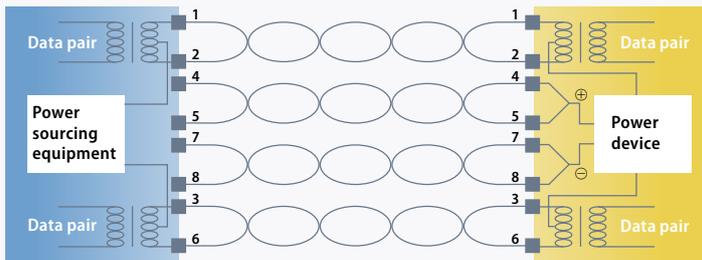
For personal use (e.g. smart home), for office equipment (e.g. smart office) or for industrial installations (e.g. sensors, meters, controllers). Including VoIP phones, IP cameras, WLAN access points, network routers, VoIP phones, network switches or IP cameras.

A power class can be selected to match the specific application. A quick overview:

	PoE	PoE+	PoE++ / 4PPoE	PoE++ / 4PPoE
PoE standard	IEEE 802.3af-2003	IEEE802.3at-2009	IEEE802.3bt-2018	IEEE802.3bt-2018
Type	Type 1	Type 2	Type 3	Type 4
Useful power for the PD	3.84 – 6.5 W	12.95 – 25.5 W	40 – 51 W	62 – 72 W
Output power of the power supply	4 – 7 W	15 – 30 W	40 – 51 W	75 – 90 W
Supply adjustment	44 V	50 V	50 V	52 V
Max. power consumption per pair	350 mA	600 mA	600 mA	720 – 860 mA
No. of pairs	2	2	4	4

Benefits of PoE

The PoE-capable switch used (Power Sourcing Equipment – PSE) offers enormous benefits in conjunction with PoE-capable end devices (Powered Devices – PD):



Core block diagram for PoE (from IEC 62652)

- **Saves 230 V energy supply**
(cable and socket)
- **Internationally secured compatibility**
(based on international standardisation)
- **Comprehensive management and monitoring options**
- **Reduced energy costs**
due to needs-oriented routing of energy and deactivation of unused ports
- **Fail-safe**
due to central, uninterrupted power supply (UPS).

New requirements for PoE

PoE was originally developed for conventional telephony, in order to provide phones with power via their connection cables. New deployment options have now arisen, however, thanks to the improved performance offered by PoE+ and PoE++. The new megatrends – with an endless stream of new user devices and applications – are also powerful drivers for improvements

» These include **IoT (Internet of Things), Smart Grid, Smart Home, building automation and control systems and Industry 4.0.**

PoE (15 W)

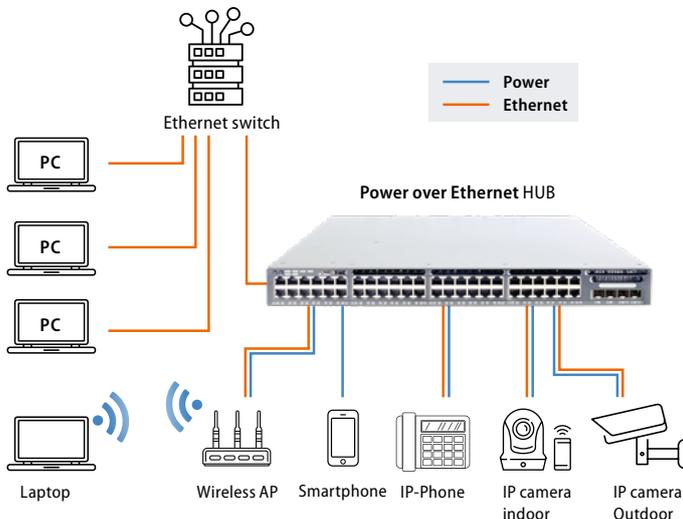
- IP telephones
- IP cameras
- Wireless LAN access points
- Bluetooth access points

PoE (30 W)

- Devices for the high-speed WLAN standard IEEE 802.11n
- Outdoor IP camera with heat, pan, tilt and zoom function
- Access control systems with controller, reading devices and lock system
- Video IP telephone

4PPoE Four-Pair Power over Ethernet (up to 100 W)

- Nursing call system in the healthcare sector
- Credit card reading devices and printers, e.g. in retail
- Laptops, thin-client computers
- Lighting (LED)
 - Sensors for measuring temperature and humidity
 - Camera surveillance
 - Safety systems
- Industrial applications



Application examples for PoE

Energy feed-in variants

There are two options for transferring current between the power sourcing equipment (PSE) and the powered device (PD):

› Spare pairs method

With this variant, only the unused conductor pairs (4/5 and 7/8) are used for delivering power from the PSE to the PD.

› Phantom power

This variant uses all data-carrying conductors to supply power (according to the IEEE 802.3bt-2018 (4PPoE) standard).

This means a voltage modulation occurs simultaneously with data transfer. Power levels can now be as high as 90 W with a maximum amperage of 860 mA.

What to note when wiring?

Data cabling was not originally designed for energy transmission at all. Nonetheless, dual use as desired is possible if the defined framework conditions are taken into account and suitable components selected.

The following points must be taken into account, however:

›› Overheating of the data cable

The increased power levels involved with the use of PoE, combined with cable accumulation in the installation duct and poor heat dissipation, can lead to perceptible increases in temperature in the data cables, potentially rising to dangerous levels in extreme cases.

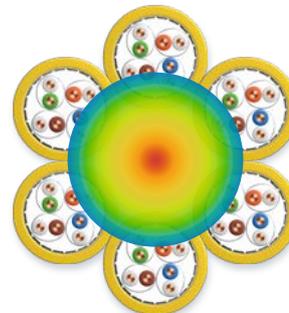
Cable warming depends on the following factors:

- Current load (depending on the PoE standard used)
- Cable design (in particular conductor cross-section)
- Number of cable bundles in the installation channel
- Installation environment (heat release)
- Ambient temperature

The higher the category, the larger the conductor cross-section, the less the direct current resistance and therefore the less heat loss, too.

In the example shown from ISO/IEC TR 29125, Category 7_A cables exhibit 36 per cent lower heating as compared to Category 5 data cables.

The correct cable design makes a crucial contribution in minimising cable warming.



Cable heating from the inside outwards

The rule of thumb is:
the higher the category, the less the warming!

Cable warming based on cable category (from ISO/IEC TR 29125)

Size of cable cluster (no. of cables)	Temperature increase in C°				
	CAT 5	CAT 6	CAT 6 _A	CAT 7	CAT 7 _A
1	0.8	0.6	0.6	0.6	0.6
7	1.4	1.1	1.0	1.0	0.9
19	2.6	2.1	1.8	1.8	1.6
37	4.7	3.7	3.2	3.2	2.9
61	6.9	5.5	4.8	4.8	4.4
91	9.7	7.7	6.7	6.7	6.2
127	13.1	10.4	9.0	9.0	8.3
169	16.9	13.5	11.7	11.7	10.8

-36%

» Overheating of the data cable

Another generally neglected effect is the increase in attenuation – caused by the rise in temperature and the reduction in range which this derives from. This can lead to incorrect transmission and in extreme cases result in system failure.

Here, shielded data cables offer clear benefits over unshielded data cables due to the lower temperature coefficient.

Example 1 – unshielded

Class D(a) at 60 °C with Cat.5 cable UTP

$$H_{60^{\circ}\text{C}} = (109 \text{ m} - 10 \times 1.5 \text{ m}) - (0.4 / 100 \times 20 \times 94 \text{ m}) - (0.6 / 100 \times 20 \times 94 \text{ m}) = 75 \text{ m}$$

Example 2 – shielded

Class D(a) at 60 °C with Cat. 5 cable STP

$$H_{60^{\circ}\text{C}} = (109 \text{ m} - 10 \times 1.5 \text{ m}) - (0.2 / 100 \times 40 \times 94) = 86 \text{ m (+15 %)}$$

Equation for horizontal transmission links

Increase in attenuation and reduction in reach depending on temperature and the cable design (from EN 50173)

Model	Model equation		
	Class D	Class E and E _A	Class F and F _A
a) Through connection TO	$H = 109 - F \times X$	$H = 107 - 3 - FX$	$H = 107 - 2 - F \times X$
b) Marshalling TO	$H = 107 - F \times X$	$H = 106 - 3 - FX$	$H = 106 - 2 - F \times X$
c) Through-connection SP – TO	$H = 107 - F \times X - C \times Y$	$H = 106 - 3 - F \times X - C \times Y$	$H = 106 - 2 - F \times X - C \times Y$
d) Marshalling SP – TO	$H = 105 - F \times X - C \times Y$	$H = 105 - 3 - F \times X - C \times Y$	$H = 105 - 2 - F \times X - C \times Y$

H = max. length of tertiary cable (m)

F = total length of marshalling cords, marshalling pairs, device connection and device connector cords (m)

C = length of collection point cable (m)

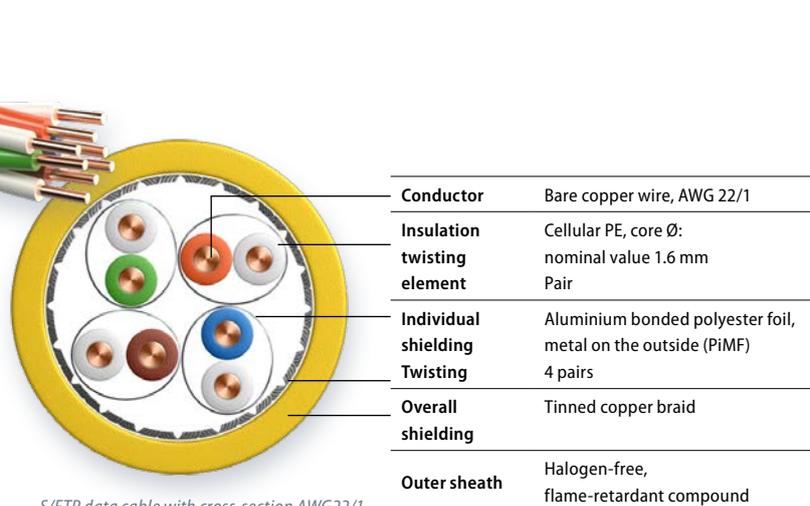
X = relation between the insertion loss of the flexible cable (dB/m) and the insertion loss of the tertiary cable (dB/m)

Y = relation between the insertion loss of the collection point cable (dB/m) and the insertion loss of the tertiary cable (dB/m)

At temperatures above +20 °C H should be reduced in shielded cables by 0.2 % per 1 °C and in unshielded cables by 0.4 % per °C (+20 °C to +40 °C) and by 0.6 % per 1 °C (> +40 °C to +60 °C).

Our recommendation for the right data cable

- Shielded cable with the highest possible category: e.g. Category 7_A
- Large conduction cross-section (AWG 22)
- If required – special designs with permitted operating temperature > 60 °C



S/FTP data cable with cross-section AWG22/1
e.g. MegaLine® F10-130 S/F

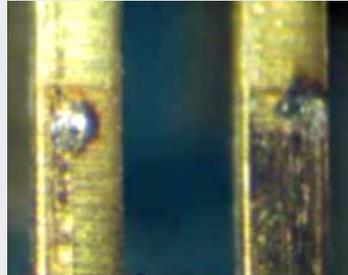
Conductor	Bare copper wire, AWG 22/1
Insulation twisting element	Cellular PE, core Ø: nominal value 1.6 mm Pair
Individual shielding Twisting	Aluminium bonded polyester foil, metal on the outside (PiMF) 4 pairs
Overall shielding	Tinned copper braid
Outer sheath	Halogen-free, flame-retardant compound

Contact burn in connectors

In connection technology, removing a plug under load can cause damage – so-called contact burn – due to the occurrence of an electric arc or sparking. An irreversible impairment of the contacts is caused, possibly even failure.

A potential remedy here is to use the appropriate port power management – i.e. first switch off the power supply, then remove the plug.

However, intentional or unintentional removal of the plug under load cannot be entirely avoided.



Contact burns in connection technology – shown here: a RJ45 socket (from IEC 62652)

Our recommendation for your choice of connection technology: **use staggered contact and insulation zones – over and above the relevant connector standards.**

Certified safety

MegaLine® Connect100 and MegaLine® Connect45

For this reason, LEONI had the product families MegaLine® Connect100 and MegaLine® Connect45 independently tested according to IEC 60512-99-001 and IEC 60512-9-3.

For this purpose, the socket/plug combinations were exposed to frequent insertion cycles under load. The permitted deviation of transition resistances (max. 20 MΩ) is easily maintained – **which means certified safety!**



MegaLine® Connect100 with staggered contact and insulation zones

Summary and outlook

Thanks to Power Ethernet, numerous IT devices are now able to do without a 230 V power supply. This technology enables buildings and offices to be planned and operated more intelligently and with greater energy efficiency.

Our contribution to green IT in buildings.



Not least due to the increase in power levels to be expected, LEONI recommends the use of shielded data cables of Category 7_A with conductor dimension AWG 22 and connection technology with staggered contact and insulation zones.