RJ45 connection technology

Part 1: Power over Ethernet Plus (PoE+) sets high standards

The RJ45 has been around for over 40 years. Originally intended as a basic plug for telephony services, the humble plug has evolved over the course of time to become the dominant IT connector. Since Power over Ethernet was introduced at the beginning of the twenty-first century, the RJ45 has not only been transmitting data but has also been providing power to the end devices. Given the high electric currents which occur with the present Power over Ethernet Plus (PoE+), the contacts on the RJ45 jack can quickly be damaged. The RJ45 jacks must be designed for PoE+ in order to provide a reliable and safe service otherwise transmission errors can arise and, at worst, complete link failures.

Since the launch of Fast Ethernet with 100 Mbit/s, there have been repeated claims that the RJ45 jack is stretched to its limits. Yet it has continued to perform time and again – with both Gigabit Ethernet and 10 Gigabit Ethernet. 40 Gigabit Ethernet (40GBASE-T) also uses RJ45 interfaces and the cabling standards specify the RJ45 interface for the Category 8.1 connector, ensuring devices and installations are backwards compatible with the billions of existing RJ45 connections.

Remote powering for end devices

Back in the days of the classic analogue telephone network, end devices already received power and voice signals over the same cable. It is similar with Power over Ethernet (PoE) and the more recent variant Power over Ethernet Plus (PoE+) in that the end device is powered over the data cable which offers several advantages:

- There is no need for a separate power cable
- There is no need for a 230 V socket to power the end device
- There is no need for an electrician because the direct current voltage is below 60 V DC
- If the power sourcing equipment is connected to a UPS, all the end devices supplied by them will remain in operation even in the event of a power failure

With PoE+, end devices can be supplied with up to 25.5 W according to the IEEE 802.3at standard. This is not (yet) sufficient to run laptops or printers but it is certainly enough for WLAN access points, IP cameras, scanners on access control and time logging systems, and LCD displays on building automation systems. Even LED lighting systems, which are becoming more and more popular in offices, can run on PoE+. Power over Ethernet with higher power, such as 60 W or 100 W, is currently under discussion.

Telegärtner Karl Gärtner GmbH
Lerchenstr. 35
D-71144 Steinenbronn

Tel.: +49 (0) 7157 / 125 -100
Fax: +49 (0) 7157 / 125 -120
E-Mail: info@telegaertner.com

Geschäftsführer:
Dipl.-Wirtsch.Ing. (FH) Florian Gärtner
Dipl.-Kfm. Christian Harel

Amtsgericht Stuttgart HRB 243218
Steuernummer: 99010/01157
USt-IdNr. (VAT-No.): DE 147643868

DIN EN ISO 9001
DIN EN ISO 14001
www.telegaertner.com

Modern LED lighting systems can be powered by PoE+
Pictures: MICROSENS GmbH & Co. KG, Hamm

Power over Ethernet	Standard	Year of release	Power at the end device	Power per wire pair
PoE	IEEE 802.3af	2003	12.95 W	350 mA
PoE+	IEEE 802.3at	2009	25.5 W	600 mA
4PPoE	IEEE 802.3bt	Expected 2018	Expected 49 W; 96 W under discussion	Expected 600 mA; 1,000 mA under discussion

*Power over Ethernet according to IEEE 802.3 standards*

Sparks damage the contacts

Currents of up to 600 mA per wire pair already occur with PoE+, and there is serious discussion of up to 1000 mA with future versions. Sparks can arise when the plug is disconnected during operation before the end device has shut down completely. With PoE+ these sparks are harmless to the user but they will inevitably cause grave damage to the fine contacts of an RJ45 jack. It is usually time-consuming and expensive to exchange a jack in a patch panel or a junction box and it also causes inconvenient breakdowns. The relevant standards therefore dictate that devices shall always be switched off before they are unplugged. This is not really feasible in a world in which end devices are almost always used by non-IT-specialists.
A viable connector system must therefore be designed in such a way that the RJ45 jacks will still function reliably even if devices have been accidentally unplugged under load. With such jacks, the inevitable damage to the contacts arises at a point which is not used for the data transmission.
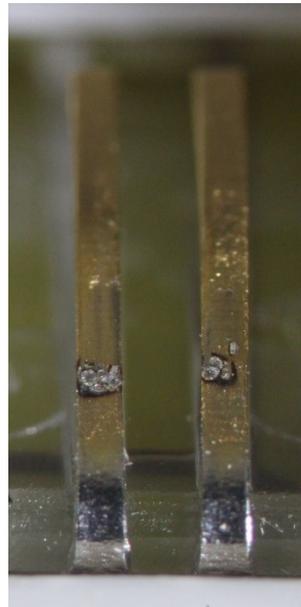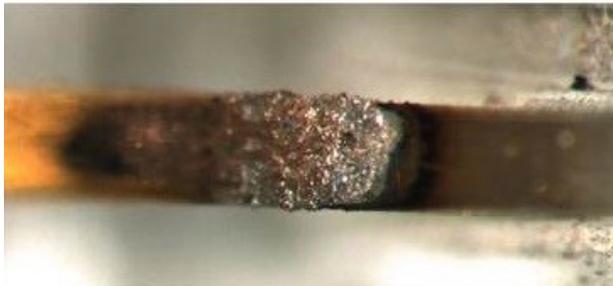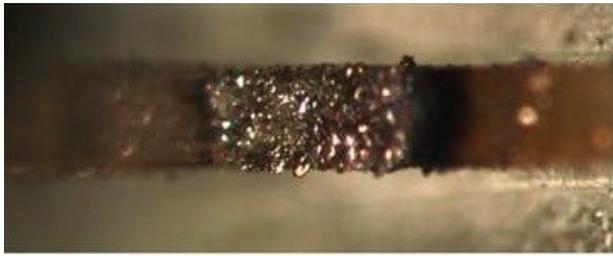
Unplugging devices while they are still being powerd by PoE+ will inevitably lead to sparks which will damage the fine contacts of the RJ45 jack.
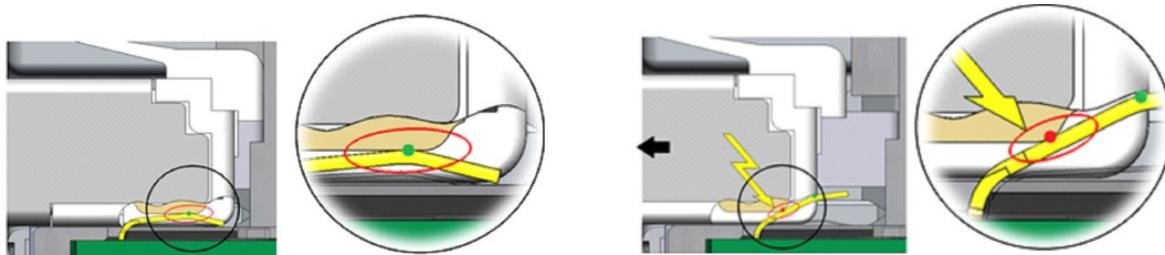
Sparks will occur when a plug is disconnected during PoE+ operation. The RJ45 jacks designed by Telegärtner are constructed with practicality in mind because the contact-breaking sparks will arise at a point (red) which is far from the point which is used for the data transmission (green). Even after being unplugged several times under load, the Telegärtner jack still offers full network performance.

Jack contacts designed for optimum safety

In jacks designed for improved safety, the top part of the contact which is further inside is used for the data transmission. If the plug slides out of the jack, the point at which the plug and jack contacts touch will move down towards the jack opening. With optimised contacts, the sparks arise in the lower outermost area of the jack contacts. The points damaged by sparks are therefore so far from the section used for the data transmission that they will not affect it. Even if the plug is repeatedly disconnected under load, the jack still offers the full data transfer rate of 10 Gbit/s with Category 6_A.

In addition to PoE+, powerful modern networks place yet more demands on RJ45 connections. These will be discussed in the second part of this article.