Optimized Products for 4PPoE. The *PowerSafe* Quality Seal

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R&M

Safe current transmission with high-end Power over Ethernet applications

Supplying power remotely using Power over Ethernet (PoE) is electrifying the network market. Now PoE can supply power for the LED lighting of entire concert halls and shopping malls – plus IP cameras, access control systems, WLAN antennas, checkouts, building sensors and lots more. The more PoE applications, the more current flows through the data cables. It is putting a strain on the individual cabling components more than ever before.

This white paper details the consequences of the high power, continuous use PoE applications paying particular attention to the technology of wire termination.

With *PowerSafe*, R&M is introducing a quality seal for products which are optimized for PoE.

Application	Remote Powering in Local Area Networks, powering of IP- and other data networks. Terminal equipment and LED lighting, permanent use of high streams
Technology	Power over Ethernet (PoE) and 4 Pair PoE (4PPoE)
Standard	IEEE 802.3bt
Topics	Planning and product evaluation for PoE installations, insulation displacement contact technology (IDC), limitation of contact resistance and temperature increase, *PowerSafe* quality seal
Objective	Expert information on the benefits of IDC when PoE is used, launch of the *PowerSafe* quality seal
Target group	Network planners, installers, R&M QPP partners
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Constant loads with extended PoE application

Supplying power remotely using Power over Ethernet has developed enormously over the last 15 years. Transmittable output has risen from a modest 15W with PoE to a probable 90W with 4PPoE. The standard for 4PPoE (IEEE 802.3bt) is likely to be ratified in September 2018. In an earlier white paper, R&M already investigated the effects of this increased current load on network cabling (see White Paper «4PPoE – Parameters for Network Planning» at www.rdm.com).

And now we are facing the next step in the evolution of PoE use. The conditions of use for end devices are changing. In the past, devices powered by PoE only rarely needed maximum output or it was only required for a relatively short time. Typical example: setting up and focusing an IP camera. Once it has attained the right position, it returns to pure transmission mode. This meant that, in the past, average power consumption was relatively low.

But more recent applications do require maximum electrical output long term. Around the clock, seven days a week (24/7 operation), high currents will be flowing continuously. Such applications include networked LED lighting systems (e.g. connected lighting) in modern office buildings (digital buildings) and digitally controlled LED advertising spaces and info screens (digital signage).

The question is whether the active and passive network components are equipped for this constant load.
What effect will the high currents have long term on the quality of the data network?
How can users counteract possible disadvantages from the start?

Manufacturers of network devices have already reacted to the changed requirements. A new switch generation can supply high power PoE on all ports simultaneously and continuously. One example is the Cisco Catalyst Digital Building CDB-8x series. These switches can supply up to 60W per port continuously without a fan being necessary for cooling.

These changes also increase the stress on the passive network components. For the cabling, distribution and connection technology this means what used to be tolerable for an occasional peak load is quickly going to become a handicap in continuous operation.

Decisive: the connection technique

The cable bundles will heat up due to the high currents. That is a very natural effect of PoE. Higher cable temperatures reduce the attenuation budget and thus, under certain circumstances, the maximum possible link length. But experts can cope with this aspect easily with foresighted planning. The PoE calculator from R&M can offer help. This tool for planners is also available at www.rdm.com.
Another aspect deserves a lot more attention: the connection technique with PoE installations.

Specifically, it is about the important area between cable and connector systems: the connections between the individual wires and contacts. Everybody who wants to guarantee sustainable building and operational safety using PoE applications as well as provide a highly available network, has to choose an appropriate connectivity.
Experience to date confirms R&M's opinion that the industry has created a sword of Damocles with the connection technique used. And that sword can strike at any time when using PoE at permanent maximum output.

Insulation piercing contacts, IPC, are often used to terminate wires in RJ45 connectors. But there is a considerable risk to this technique. With IPC, a rigid contact plate is pressed through the stranded wire. Hence the individual wires are on the outside of the contact. They create a good initial contact. Quality assurance measures of the manufacturers guarantee good finishing. But it is only the material properties of the wire that create the contact force. The insulation presses the outlying stranded wires onto the contact surface. This termination is expected to be permanent but there is no reliable mechanism which can ensure permanent stable contact.

In fact the contact is gradually lost due to:

- aging, creeping, relaxation and fatigue of the insulation and the copper
- mechanical loads of the wires
- thermal growth and shrinking processes of the conductors

As a result, the contact of a piercing connection resistance rises continuously and unpredictably. A current load from PoE increases the temperature at the contact junction. The higher temperature load further weakens the contact: The contact resistance grows exponentially. The connection then breaks up. The entire connector can overheat and destroy itself.

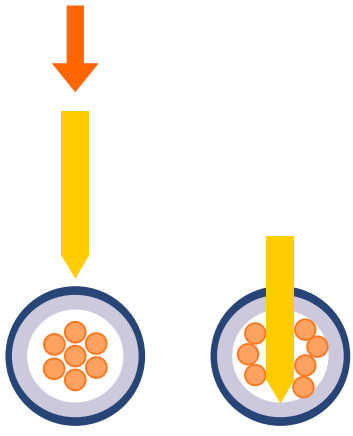


Figure 1: Functioning of IPC.

Advantageous: insulation displacement contact

The alternative to IPC is **insulation displacement contact, IDC.** With IDC, the wire is mechanically clamped between the two sides of a spring contact (Figure 2). The two contact halves cut through the conductor insulation and then elastically press the wire. Therefore, they ensure a safe, stable contact. It will work perfectly even if the stranded wire has to withstand external stress. The stranded wire cannot escape!

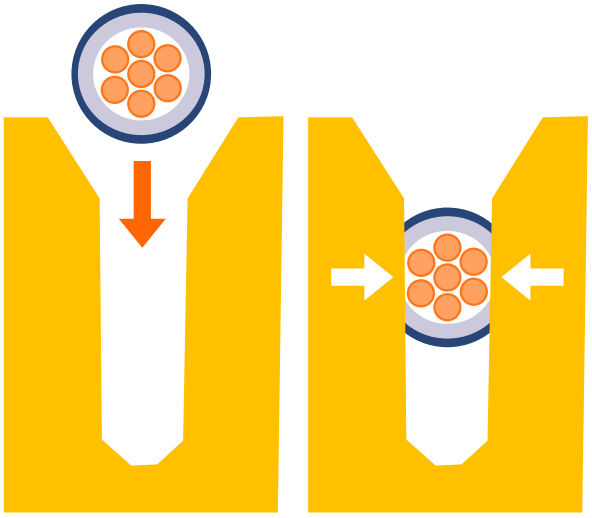


Figure 2: Functioning of IDC.

Furthermore, providing the IDC is designed by an expert, the IDC termination is vibration-resistant, moisture-resistant, dust- and gas-tight, and thus corrosion-protected. The contact resistance of an IDC connection changes only slightly over the course of time and then stabilizes. This is proved by test series and decades of experience of the R&M lab. An IDC connection thus promises a reliable connection long term. Figure 3 shows the resistance behavior of an insulation piercing and an insulation displacement contact during artificial aging tests in the climate chamber.

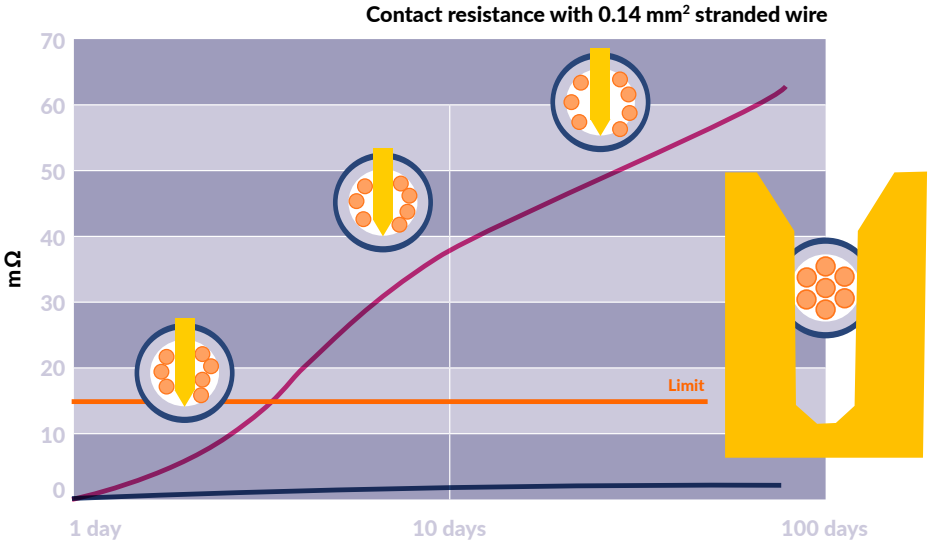


Figure 3: Resistance behavior of the piercing (IPC) and displacement (IDC) connection.
IPC, violet curve: The contact resistance increases continuously, no stabilization.
IDC, blue curve: The contact resistance increases just slightly and then stabilizes. Graphic: R&M

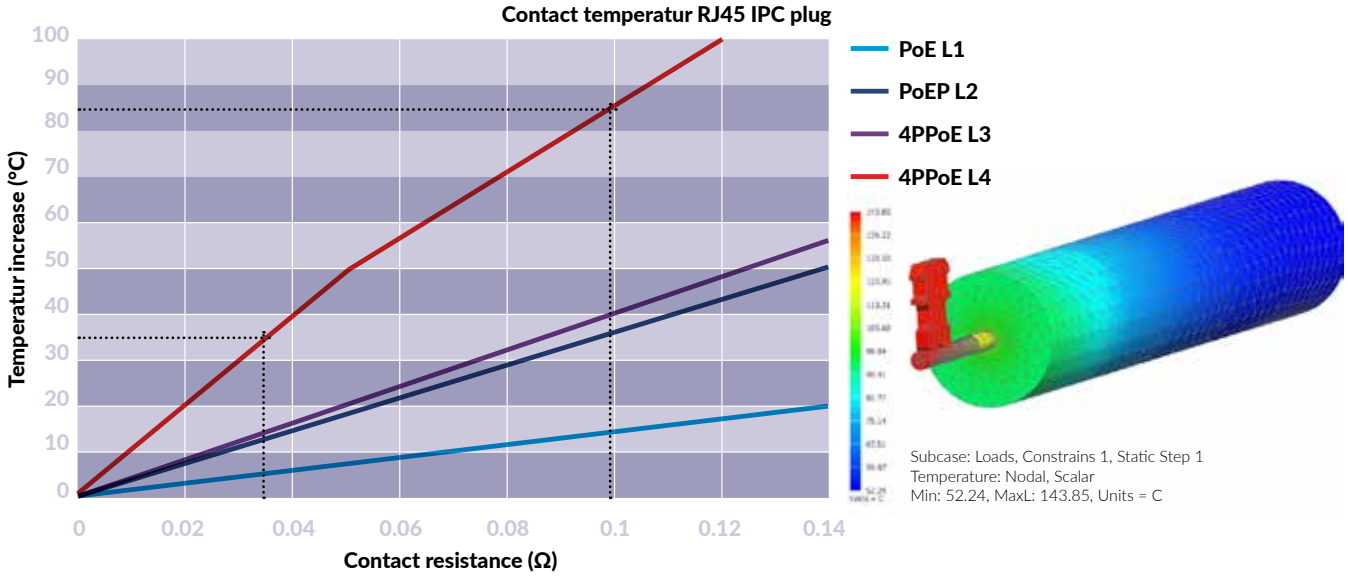
Temperature increase due to contact resistance

An electrical current flowing through a contact resistance will generate some loss in the form of heat production. This heat has to dissipate to the environment and results in an increased temperature. The R&M technical department has simulated with FEM tools what contact temperatures will have to be expected for different currents. Picture 5 shows the maximum temperature increase of a contact in a RJ45 plug in relation to the contact resistance for the different PoE power levels 1 to 4.

The plastic material used for insulation in a patch cord is typically PE-HD. It has a melting temperature of 125°C – 135°C and a maximum continuous use temperature of 80°C (short term 100°C).

If the patch cord is used for 4PPoE in a typical environment in a network cabinet, one has to calculate with an ambient temperature of around 40 – 50 °C. Therefore, an allowed temperature increase of 35 °C to the maximum continuous use limit and of 85 °C to the melting temperature can be assumed.

In a 4PPoE level 4 application, the melting temperature of the plastic materials involved are reached with a contact resistance of under 100mΩ. This is a contact resistance that would not show any negative effects in the transmission performance and would therefore remain unnoticed until used with 4PPoE.



Picture 5: FEM simulation of the contact temperature increase for different PoE applications

A standard complying IDC connection (with maximum 15 mΩ) assures, that the maximum continuous use temperature of the plastics is not reached even under the condition of the maximum operation temperature of the cable of 60 °C. In a piercing termination even a slight increase in contact resistance can lead to a contact temperature exceeding the melting temperature of the plastic materials used, triggering the thermal destruction of the plug.

Different handling of patch and installation cords

Usually insulation displacement contacts (IDC) are used in connection modules for installation cables forming the Permanent Link. With correct dimensioning by the manufacturer, these connections are reliable and safe for the foreseeable future. Top-quality cables and in particular shielded cables are especially suitable for PoE applications.

However, when it comes to patch cords you will mostly find piercing contacts. Since patch cords are easy to exchange, not as much attention is paid to their quality as they may deserve.

If patch cords are used for high-current PoE applications the termination technology can no longer be ignored. Any shortcomings could have critical consequences for the entire infrastructure of a building. In worst-case the destruction could be much bigger than just the patch cord. Exchanging a single patch cord could eventually not be enough to restore the operational reliability of a network.

Quality seal for PoE-suitable products from R&M

R&M has been using IDC technology for decades. Since 2000, it has also been used for the RJ45 plugs in the R&M patch cords. R&M is the only manufacturer using IDC technology in RJ45 plugs for commercial patch cord production. This makes these patch cords perfectly suited for use in PoE systems. The termination is characterized by a stable, reliable and low contact resistance. In addition, there is R&M's internationally benchmarked quality assurance every individual product has to go through. R&M ensures that there are no unpleasant surprises for the entire lifecycle of a patch cord.

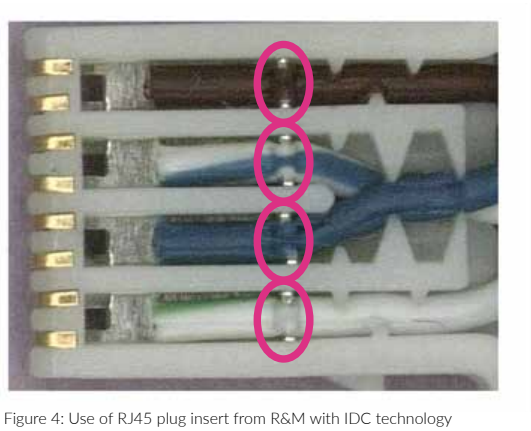


Figure 4: Use of RJ45 plug insert from R&M with IDC technology

To assist customers, partners, planners and installation companies towards selecting suitable PoE products, R&M launched a new quality seal in 2017. **Its name: *PowerSafe*.**

It is used to mark R&M products that have special characteristics optimized for PoE transmission. With *PowerSafe* products, PoE can be transmitted stably and reliably on levels 1–4 (15–90W) over the entire lifecycle.

The *PowerSafe* portfolio comprises:

- Patch cords
- Cable assemblies (CP and trunk cables)
- RJ45 connection modules
- Cable couplers
- Field-terminable FM45 connectors.

All products labeled *PowerSafe* are suitable for continuous transmission of Power over Ethernet at the highest level.
For further information on R&M products and solutions, go to **www.rdm.com.**