

RS



SPE CONNECTION

Components for Single Pair Ethernet

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Image: Analogue devices

SPE CONNECTION

Components for the use of Single Pair Ethernet

According to many experts, 'single-pair cabling' via Single Pair Ethernet has the potential to revolutionise Ethernet in industrial applications. Cables and connectors have several advantages due to their simplicity and size. Ethernet as a protocol offers a variety of transmission speeds, bridges long distances in its SPE version and also supports the remote power supply of devices.

With a single Ethernet network from sensor to cloud, Single Pair Ethernet provides control over every network component (see the RS White Paper ["World on a Wire"](#)). This technology also aims to reduce investment costs by up to 80% while achieving long-term savings. Going more in-depth, the following advantages are mentioned:

- Cables up to 50% lighter and requiring less space than conventional fieldbus cables.
- Faster and easier to install. Field devices, sensors and actuators can be integrated into the existing Ethernet environment without additional gateways and interfaces.
- Greater range – e.g. 10Mbit/s can bridge a distance of 1,000 metres, at a transmission performance 10 times higher with future options for 1Gbit/s and multi-gigabit.
- Bus topologies without additional power lines (PoDL, Power over Data Line).
- Standardised cables and connectors with interchangeable M8 and M12 connectors.

THE DATA CARRIER

Single Pair Ethernet cables are subject to the same cable classifications as were set out for Profinet:

- Type A: Solid wire cables for fixed installation
- Type B: Stranded wire cables for flexible applications or vibrations
- Type C: Cables with stranded conductors for highly dynamic applications (e.g. drag chains)
- Type R: Torsion-capable cables with stranded conductors for robotics applications

Robot and drag chain cables differ mainly in their shielding, which is particularly suitable for systems where bending or torsional load capacity is required.

THE MICE CLASSIFICATION

In addition to electrical specifications and mechanical requirements, environmental conditions play an important role when selecting a suitable cable (as well as connectors). The MICE classes can help us here.

MICE stands for four basic types of environmental influences on cabling.

Each of the four letters is assigned an index that specifies the level of the property. For example, a full MICE classification looks like this:

M2I2C1E3.

The four environments that make up the abbreviation MICE include:

- **M:** Mechanical (shock, vibration, impact, pushing, pulling, bending)
- **I:** Ingress (e.g. of water and dust)
- **C:** Climatic/Chemical (temperature, UV exposure, humidity, contact with impurities such as oil or gas)
- **E:** Electromagnetic (voltage spikes, EMI/RFI interference, magnetic fields, transients)

The number after each letter of the acronym represents the degree of impact of the environmental factors:

- **1:** Low severity (e.g. office environment)
- **2:** Moderate severity (e.g. light industrial environment)
- **3:** High severity (e.g. extreme industrial environment)

DM1I1C1E1 denotes an environment in an office building and M3I3C3E3 is an environment typical of industry or outdoors.

REMOTE POWER SUPPLY AS A 'RANGE KILLER'

PoDL can convey electrical energy in 10 voltage/current classes with powers between 0.5W and 52W (consumer power, supply power = 63.3W) in addition to the working signal on the two lines of the SPE. This type of power supply requires two-wire cables in accordance with IEC 61156.

It should be noted that when using PoDL, the transmission distance specified in the standard may not be reached. Depending on the cable diameter, you can expect significant reductions in the distance, especially in the higher power classes. A 10Base-T1L connection, which has a transmission distance of 1000m with an AWG-18 cable without power supply, is reduced to a distance of 170m when using PoDL class 15 (52W). With an AWG-22 cable, the transmission distance is reduced from 620m without PoDL to 70m with PoDL class 15 (reported by Reichle & De-Massari AG).

For longer transmission distances, IEC 61156-13 will be used in the future for fixed installations and IEC 61156-14 for type B applications (see above). These standards form the basis for a 10Mbit/s transmission up to 1000m for 10BASE-T1L (IEEE802.3cg).

CONNECTORS

In relation to application areas and performance standards of Single Pair Ethernet in the industrial sector, two pole connectors have also been standardised, which eliminates the disadvantages of Industrial Ethernet RJ45 connectors – such as the unreliable locking or the poor protection from dirt and moisture.

Current standards specify the connector. Providing defined standards for the connector guarantees the connection compatibility and the subsequent use of products from different manufacturers. There are versions of connectors in protection classes IP20 to IP65/67.



Fig. 1. Harting T1 Industrial SPE connector which meets IEC 63171-6. (Image: Harting)

For industrial applications, for example, [Harting](#) has developed a connector that meets IEC 63171-6 (Fig. 1). This T1 SPE connector can provide both 1Gbps connections for shorter distances and a 10Mbps connection for long distances. The Harting connecting element comes in IP65/67 and IP20 versions.



Fig. 2. M8 hybrid connector system from Harting. (Image: Harting)

In a two-wire SPE installation, devices with an output of up to 52W can be supplied at 48V using PoDL, as long as the cable cross-sections are compatible (see above). Cable and connector hybrid solutions require an additional pair of cables for the power supply to meet the high performance requirements of end devices. The plugs used in these applications are the popular M8 or M12 designs (M8 Hybrid IEC 63171-6, M12 Hybrid IEC 63171-7). A hybrid system like this can carry up to 200W at 24V or up to 400W at 48V. Another advantage over PoDL is the galvanic isolation of the signal and power supply.

MEASUREMENT AND TESTING

With the further development of Ethernet in industry, certification and signal testing are becoming increasingly important in industrial applications – be it for initial installations, migrations, extensions or changes of cabling.

With the K58 option for its R&S RTO and R&S RTP oscilloscopes, Rohde & Schwarz offers what it claims to be the world's first trigger and decoding solution for 1000BASE-T1 Single Pair Ethernet. The decoded data can be displayed both as a table and a honeycomb chart. Important parameters such as idle, MAC or error frames can be identified via defined colour codes.



Fig. 3. With the K58 option for the R&S RTO and R&S RTP oscilloscopes, tests can be carried out for 1000BASE-T1 Single Pair Ethernet. (Image: Rohde & Schwarz)

With the R&S RT-ZF7 test equipment, both the forward and reverse data streams can be decoded simultaneously. In addition, the oscilloscopes support the simultaneous decoding of up to four serial buses. Search functions are designed to simplify the analysis of long signal sequences. All detected events are displayed in a table with timestamps. The user can examine them in a zoom window with the correct time correlation and navigate between events.

1000BASE-T1 ERROR SIMULATION

The 1000Base-T1 fault simulation modules from Pickering Interfaces come with different channel numbers and with two fault buses. Modules 40-203 (PXI) and 42-203 (PXIe) allow you to simulate fault conditions on up to six 2-wire channels, while the 40-204 (PXI) and 42-204 (PXIe) dual-multiplexers use two fault buses to simulate faults on one or more both lines of the 2-wire connection. Both card models offer signal paths with a line impedance designed for 100Ω.



Fig. 4. 1-slot PXI and PXIe 1000Base-T1 fault simulation modules from Pickering Interfaces.
(Image: Pickering Interfaces)

For smaller test applications, both card models are available as partially populated versions; the 40/42-203 module offering three channels and the 40/42-204 module as a single-channel version. Although there is no differential version, both series use an MMCX connector interface, which accommodates a high number of channels on a small front panel area.

The fault simulation allows the user to simulate cable breaks in one or both wires of the cable pair. The two fault buses also allow a connection to supply potentials such as earthing or battery units and it can feed other signals or a short-circuit simulation on the differential conductor pair.

PROCUREMENT

Our experts at [RS](#) have a good insight into the availability of individual networking components for SPE. Single Pair Ethernet user organisations are another great point of contact for obtaining information:

SINGLE PAIR ETHERNET INDUSTRIAL PARTNER NETWORK



The SPE Industrial Partner Network is based in Rahden, Germany. This user organisation goes back to the 2019 Hanover Trade Fair, when an SPE cooperation was announced between Harting, TE Connectivity and Hirose. In October 2019, it became the Single Pair Ethernet Industrial Partner Network, and has since grown into a network of more than 55 member companies.

<http://www.single-pair-ethernet.com>

SINGLE PAIR ETHERNET SYSTEM ALLIANCE



The Single Pair Ethernet System Alliance began at the 2019 Hanover Trade Fair, when Phoenix Contact, Weidmüller Interface, Reichle & Massari (R&M), Belden and Fluke Networks announced a technology partnership for Single Pair Ethernet. In April 2020, the association officially emerged as the Single Pair Ethernet System Alliance. Officially founded on August 18, 2020, the Alliance became an association and now has 40 member companies. In October 2021, TIA's Single Pair Ethernet Consortium (SPEC) merged with the SPE System Alliance.

<https://singlepairethernet.com>

SINGLE PAIR ETHERNET CONSORTIUM



The Single Pair Ethernet Consortium (SPEC) belongs to the American TIA. TIA is the Telecommunications Industry Association, representing over 400 companies worldwide. It is accredited by the American National Standards Institute (ANSI). The organisation was initiated in September 2019 by founding members, Belden, CommScope, Panduit and Siemon Company.

<https://spec.tiaonline.org>

Based on documentation from: Helukabel, Belden, Harting, Panduit, Single Pair Ethernet Industrial Partner Network, Single Pair Ethernet System Alliance