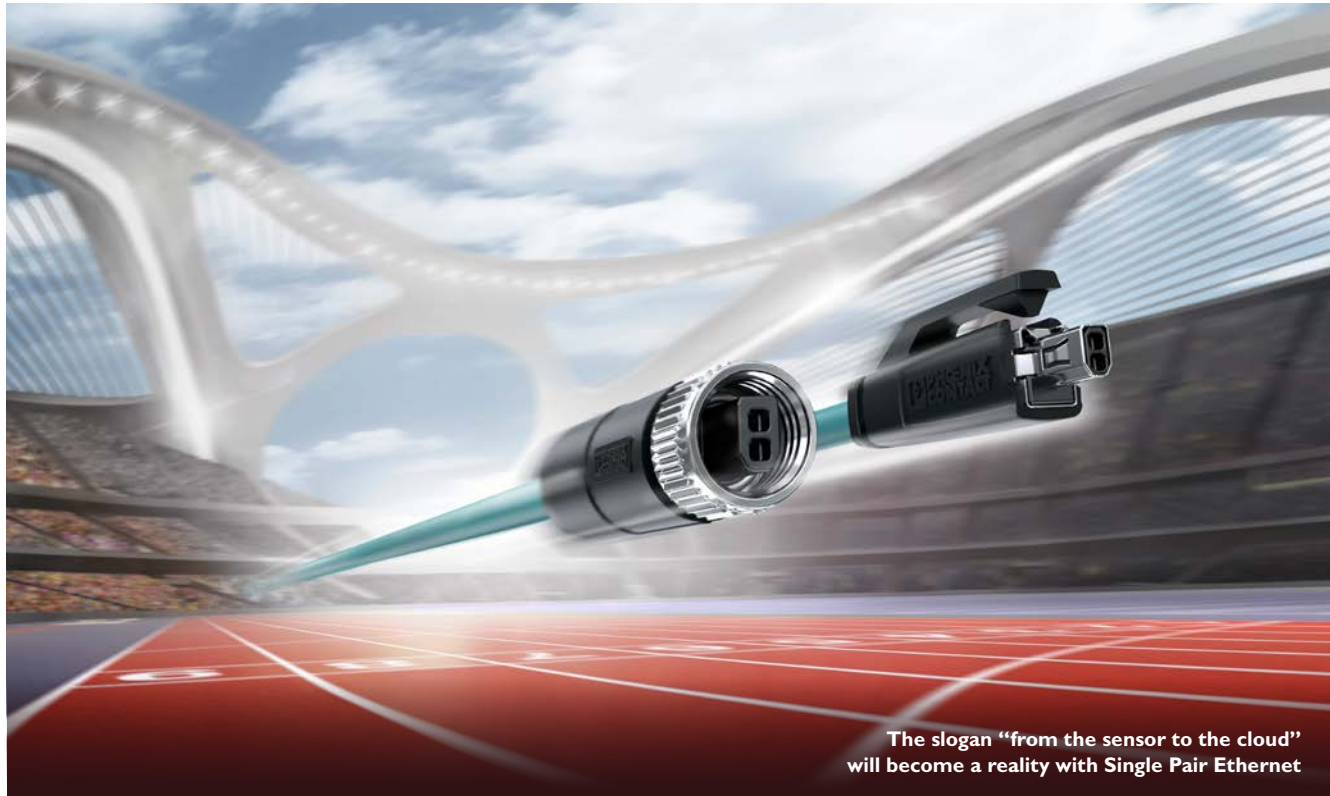




The slogan “from the sensor to the cloud”  
will become a reality with Single Pair Ethernet

## Single Pair Ethernet – when will it have its big breakthrough?

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### When will Single Pair Ethernet have its big breakthrough?

When it comes to modern industrial communication technologies, Single Pair Ethernet (SPE) tops the list of trending topics. Now that components, including connectors, cables, and PHYs, have been available for a few months, manufacturers can design first prototypes for end-to-end Ethernet devices and enable communications “from the sensor to the cloud.”

### Available components

IEC 61156 defines cabling requirements for multicore, symmetrical pairs. The cables for Single Pair Ethernet are described in standards IEC 61156-11/-12/-13 and -14 for both fixed and flexible installation. Currently, standards 61156-11 and 61156-12 are published and define the requirements for transmission frequencies up to 600 MHz over transmission distances up to 40 m and are suitable for 100BASE-T1 and 1000BASE-T1 deployments.

In 2020, Phoenix Contact launched its first line of connectors for end-to-end communications over Single Pair Ethernet. The portfolio includes compact IP20 connectors and IP-protected M8 connectors suitable for connecting sensors in the field. Both connector styles share a universal pin connector pattern that eliminates the need for adapters, optimizes cost, and fully satisfies the key objective of SPE: a compact, consistent interface (Figure 1).

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**Figure 1:** Phoenix Contact offers a consistent, compact, and robust range of SPE connectors standardized in accordance with IEC 63171-2 (IP20) and IEC 63171-5 (M8 connectors).

The IP20 connectors are standardized in accordance with IEC 63171-2 and feature the most compact pin connector pattern in the entire series of standards for SPE connectors. The IP20 portfolio includes preassembled patch cables in various lengths, as well as compact device connectors for reflow soldering in multiple configurations. The newest addition to the portfolio is an insulation-displacement connector for field assembly featuring a zinc, die-cast housing that is robust for all types of industrial applications and requires no tools during installation. The new SPE product line provides convenience and flexibility, offering field cabling and preassembled cabling solutions.

The IP67 M8 connector portfolio is standardized in accordance with IEC 63171-5 and includes preassembled patch cables with different cable types to support various applications, along with device connectors in the standard M8 housing. With standard M8 components, device manufacturers can benefit from easy design-in and maximum flexibility as the new SPE inserts can be incorporated into existing housing geometries and panel feedthroughs. The inserts are available as straight and angled versions that support SMD and THR soldering processes. Launched in the fall of 2020, the SPE IP20 and SPE M8 portfolios are available for mass production to support the manufacturing of compact SPE-enabled devices. (Figure 2).

## The SPE System Alliance

At the early development stages of the new SPE connector, it was clear that Single Pair Ethernet would influence the hardware ecosystem beyond connectors. SPE has influenced the development of all the infrastructure components involved:

from PHYs through cables to sensors. In 2020, Phoenix Contact and seven other manufacturers founded the SPE System Alliance. Leading technology companies from various industries and fields of application came together to form a registered association and bundle their expertise to ensure knowledge exchange. With a cross-industry and cross-application disposition, the SPE System Alliance is an exchange platform where companies from all areas of the SPE ecosystem can come together to develop products to support the SPE infrastructure. Today, the SPE System Alliance consists of 40 members who provide products, solutions, and services for smart industrial connectivity.

All the SPE System Alliance partners are pursuing a common goal: to drive the development of SPE to support the Industrial Internet of Things (IIoT). As a result, the SPE System Alliance does not champion a specific connector system or product. Regardless of the individual positions of its members, the System Alliance



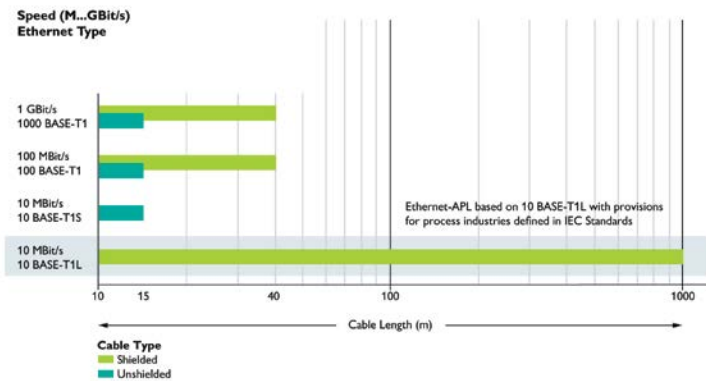
**Figure 2:** The M8 device connectors enable compact and standardized connection for SPE switches or sensors in the field, for example.

generally maintains a neutral and manufacturer-independent stance regarding products. The System Alliance's main objective is to promote the deployment of SPE technology.

The System Alliance focuses on the entire SPE ecosystem, and the members work together to resolve any open issues related to this topic. This encompasses far more than just physical components like cables, PHYs, connectors, sensors, or switches, as it also deals with questions regarding topologies, standardization proposals, and application scenarios for different areas of application. This broad approach is also reflected in different working groups within the System Alliance, which focus on different issues.

## New IEEE standards support higher speeds

The adopted IEEE 802.3 standards for Single Pair Ethernet cover data rates from 10 Mbps to 10 Gbps and distances up to 1,000 m. Driven by the automotive industry, the first standards covering shorter distances have been adopted. The 100BASE-T1 and



**Figure 3:** Overview of the different SPE standards from IEEE 802.3

1000BASE-T1 standards transmit data rates of 100 Mbps and 1 Gbps over distances of up to 40 m using shielded cable.

Users in the field of factory and building automation are eagerly awaiting the further availability of components for the 10BASE-T1L and 10BASE-T1S standards from the “cg” working group. These standards enable 10 Mbps transmission over distances up to 1,000 m for point-to-point communications (T1L) and 25 m for multidrop applications (T1S). While most of the current working groups are working on point-to-point communications, the “da” working group plans to expand upon the existing multidrop standard to expand the range of 10BASE-T1S beyond 25 m.

The most recently adopted standard is MultiGigBASE-T1 from the “ch” working group, which allows a data rate of 10 Gbps with a range of 15 m. Additionally, the Power over Data Line (PoDL) standard enables up to 50 W of additional power over a single data line for point-to-point applications but does not support multidrop topologies (Figure 3).

### When will the first devices emerge?

The prototype phase for SPE components that lasted a few years has culminated with the availability of PHYs, cables, and connectors for various applications. As a result, SPE development is now focused on coordinating deployment and translating the needs of the industrial market into requirements for optimized components. One of the challenges with SPE is the EMC behavior of the overall system, as conditions in industrial environments greatly differ from the conditions tested and validated with automotive Ethernet. While electromagnetic interference in automotive applications is limited to the confines of the automobile, its influence in industrial environments is unpredictable and often far more complex, depending on the application.

When it comes to connector standardization, there are currently six variants of IEC 63171 and one additional variant in preparation. However, there are questions related to connectivity infrastructure for industrial applications. Will there only be one

variant of the SPE connector in future? Which connector standards are best suited to certain applications? User organizations, such as the PI and the ODVA, are currently working on the topic of SPE and will have a large say in this. The influence of user organizations and the focus of companies like Phoenix Contact on supporting device manufacturers with implementation will certainly aid in SPE deployment, but it will take time for full adoption of the technology that will enable connectivity “from the sensor to the cloud.”

Overview of the IEEE standards for SPE:

#### IEEE 802.3da

10BASE-T1S – ~50 m (tbd) – 10 Mbps (multidrop)

#### IEEE 802.3cg

10BASE-T1S – 25 m – 10 Mbps (multidrop)  
10BASE-T1L – 1,000 m – 10 Mbps (point-to-point)

#### IEEE 802.3bw

100BASE-T1 – 40 m – 100 Mbps (point-to-point)

#### IEEE 802.3bv

1000BASE-T1 – 40 m – 1 Gbps (point-to-point)

#### IEEE 802.3ch

MultiGigBASE-T1 – 15 m – 2.5/5/10 Gbps

#### IEEE 802.3bu

Power over Data Line (PoDL) includes different performance classes up to 50 W (max. 48 V)

### ABOUT PHOENIX CONTACT

Phoenix Contact develops and manufactures industrial electrical and electronic technology products that power, protect, connect, and automate systems and equipment for a wide range of industries. Phoenix Contact GmbH & Co. KG, Blomberg, Germany, operates 50 international subsidiaries, including Phoenix Contact USA in Middletown, Pa.

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