



**Single Pair Ethernet
System Alliance**



Two years of SPE System Alliance: standards and strategies for IIoT

So much achieved, so much more to come

With Single Pair Ethernet, the field level with sensors and actuators can be integrated into smart factories and smart buildings in a simple, space-saving and cost-effective way that enables the continuous flow of data from the edge to the cloud.

The SPE System Alliance is advancing the development of this technology. Several of its many members have contributed their expertise to the standardisation of connectors, among other things. The internationally standardised mating faces according to IEC 63171-2 and IEC 63171-5 are based on this. These consist of a uniform, compact mating face that allows new, space-saving device designs. The first products and solutions have already been realised and will be presented at the SPS in Nuremberg by some of the System Alliance members.



Fieldbuses have been used successfully for communication in automation applications since the end of the 1990s. They are still the most widely used bus system at the sensor/actuator level in the manufacturing and process industry: they are easy to install, easy to maintain and cost-effective. However, they have now reached their limits in smart factories: they are not suitable for the requirements of the Industrial Internet of Things (IIoT), i.e. fast, continuous communication without interfaces from the sensor to the cloud.

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This is why, according to the experts, Single Pair Ethernet (SPE) will become established in the sensor/actuator level as a feeder to IP high-speed networks. The impetus for this development came from the automotive industry, where the first SPE solutions were introduced in 2008. However, the technology also offers major advantages in factory automation, the process industry and building automation. In contrast to the classic Ethernet, which requires up to eight cores due to the higher data transmission rates, SPE only requires one pair of cores. Instead of increasing transmission rates, however, what is required at the field level in industry are long cable runs and miniaturisation. And with 10 Mbit/s at a transmission length of up to 1,000 m and up to 1 Gbit/s at a transmission length of 40 m, SPE is perfectly adequate even for demanding sensor technologies.

To establish SPE in the markets, an alliance of interests was founded at the Hannover Messe in 2019. The **Single Pair System Alliance** emerged from this alliance in April 2020. The association currently includes 33 companies. The organisation deals with the entire SPE ecosystem and open questions arising in this context. This includes not only physical components such as cables, PHYs, connectors, sensors and switches, but also topologies, standardisation projects, tests and use cases.

From theory to practice

Since coming together, the member companies have been extremely active: in one of the first steps, they played a major role in the development of the internationally standardised mating faces according to IEC 63171-2 for protection class IP20 and IEC 63171-5 for M8 and M12 (protection class IP67). The IP20 and IP65/67 connectors have a uniform mating face: for example, an IP20 patch cable fits into an M8 or M12 connection without an adapter. "The mating face according to IEC 63171-2 is the most compact of the entire series of standards and thus absolutely meets the demand for miniaturisation," explains Verena Neuhaus, Manager Product Marketing at Phoenix Contact. "Compared to the RJ45, it is possible to double the port density, which means that significantly more compact device designs can be realised."

Phoenix Contact has now also developed corresponding **device and cable connectors for single-pair Ethernet** for factory automation, process automation and building automation. The standardised interfaces according to IEC 63171-2 and IEC 63171-5 are ideal for office and industrial environments. The portfolio includes both pre-assembled patch cables and compact device connectors for the reflow soldering process in a variety of design types.

The portfolio in the M8 design type also includes pre-assembled patch cables with different cable types for various applications. The use of standard M8 components offers the device manufacturer the advantage of simple design and flexibility in cabling. Existing enclosure geometries and panel feed-throughs can be adopted and assembled with new SPE inserts. The inserts are available in straight and angled variations and for different soldering processes (THR and SMD).

Verena Neuhaus: "In addition to the SPE connectors already available, Phoenix Contact is developing new components in the M12 and M12 Hybrid design types. We will present the first prototypes of the SPE M12 connectors **at the SPS.**"

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SPE also offers advantages in the field of building automation, as Matthias Gerber, Market Manager LAN Cabling at **Reichle & De Massari AG (R&M)** explains: "SPE is ideal for connecting a wide range of applications in building automation to the data network." Especially in "digital ceiling zones" between the service outlet (SO) and small IoT applications, SPE offers a variety of new possibilities. Gerber: "The ISO/IEC 11801-6 standard already allows the use of application-specific cabling after the service outlet. This lays the foundation for network connectivity solutions for light, temperature, smoke or air sensors or controls for windows and blinds."

With SPE, Ethernet / IP communication in building automation and in industrial environments can be extended to the sensor-actuator level, replacing many fieldbus applications. Matthias Gerber: "Countless end devices can then be integrated directly into the Internet of Things (IoT) without costly gateways and controlled via an IP-based, digitalised building management system."

To this end, R&M has developed a complete cabling system based on two SPE connector types: **LC-Cu (IEC 63171-1) and MSP (IEC 63171-2)**. R&M uses insulation-displacement connectors (IDC) in both SPE connector systems. Operated with the 10BASE-T1L protocol, the R&M cabling system can reach transmission distances of up to 600 meters.

SPE: transmitting data and power

Single Pair Ethernet has its origins in the automotive industry. Thomas Keller, Project Management Medical & Industries at Rosenberger and Board Member of the Alliance: "Today's vehicles are microcosms of connectivity in which electronic devices are connected to in-vehicle networks. Only in this way can autonomous driving be realised in the future." For this reason, the automotive industry has been using Rosenberger's MTD and H-MTD connector series for years. "It's similar in industrial automation," says Thomas Keller: "Extreme conditions such as large temperature ranges that need to be covered, shock and vibration, IPx protection against dust and moisture and miniaturisation play an important role in the design of the connection system." Rosenberger supports future automation solutions for industrial Ethernet applications with the RoSPE-HMTD and RoSPE-Industrial (IEC 63171-2 and -5) connector series, **which will also be showcased at the SPS.**

Marcel Leonhard, Head of the ICT & DCF business units at Telegärtner Karl Gärtner GmbH, is also looking forward to the trade fair in Nuremberg: "After presenting ourselves as an alliance for the first time two years ago at the 2019 SPS trade fair in Nuremberg, we now finally have the opportunity at this year's SPS to present to the general public what we have achieved in the meantime." On the technical side, Telegärtner, like the other Alliance partners, has developed SPE connectors for both the IP20 and IP67 ranges, which will be presented at the SPS.

But at the same time, as Marcel Leonhard points out, the System Alliance has also further developed the SPE system as a whole: "After all, the cables of course play just as important a role in the system as the connectors. But before you can connect cables and connectors, you have to test whether they are compatible and function properly – especially with SPE."

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This is because the market offers a wide range of cables such as AWG 22/1 to AWG 26/7, all of which comply with the SPE cable standard IEC 61156, but which have to be matched with the connectors. Marcel Leonhard: "This is why, in the Alliance, the connector and cable manufacturers worked together, matched the suitable products and conducted round-robin tests. After all, our goal as SPE System Alliance is to advance not only individual products, but the complete system."

In addition to reducing space and weight, another advantage lies in the installation of the components. Marcel Leonhard: "The field-terminable connectors are particularly suitable when the length of the cable route cannot be defined in advance and the cable length has to be determined flexibly on-site. Likewise, not only stranded conductor cables but also solid conductor cables can be connected – without special tools."

Simon Seereiner, Head of Product Management SAI & IE at **Weidmüller**, explains another major advantage of SPE technology: "In addition to data, power can also be transmitted via the two-core cables." Power over Data Line (PoDL) makes it possible to guide up to 60 W to an interface during simultaneous data transmission (100 Mbit). Seereiner: "That's adequate for most sensor applications. As a result, sensor systems can be easily and cheaply set up in industrial applications with a high density, which in turn helps to increase levels of automation and networking while also implementing processes with an ever-increasing degree of automation."

With a clear focus on industry, Weidmüller has realised IEC 63171-2 variation connectors for the IP20 environment and the IEC 63171-5 variation for the IP67 environment. With a focus on cross-sections in the AWG 26 to AWG 22 range, particularly user-friendly connectors have been developed that can be used both as patch cables and freely configurable variations **and will be presented at the SPS**.

With a pitch of 7.62 mm, the compact connector is only half the size of an RJ45 connector, so that ten SPE connectors can now be connected to machines that previously had five RJ45 connectors.

The space-saving design of the connectors is a big advantage but, as Simon Seereiner points out: "A much bigger advantage of SPE is that thanks to the transparent architecture, the machines can be controlled and operated much more efficiently. This saves a huge amount of money in parametrisation, as well as during commissioning and when carrying out work. In one of the simulations we carried out, operating costs were reduced by 18% when using SPE technology."

Thus, the SPE System Alliance does not stand for a specific connector system or product. Instead, its activities are directed towards the entire future SPE ecosystem. The successful work of the Alliance has led to the **Single Pair Ethernet Consortium (SPEC) of the TIA** and the **Single Pair Ethernet System Alliance** recently joining forces with the aim of jointly informing the global market about the advantages of SPE technology.

At the same time, the Alliance is enabling participating companies to more quickly develop the know-how required for faster and more reliable implementation of Single Pair Ethernet in products.

"These partners share the mission of bringing Single Pair Ethernet to the market as an end-to-end infrastructure," says Simon Seereiner of Weidmüller. And Verena Neuhaus of Phoenix Contact adds, "The SPE Alliance and its members are driving the technology as a whole – and that includes much more than a connector."

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Round robin test

The round robin test evaluates the shielding properties of cables and connectors, referred to as channels. As a rule, data cables and their shielding properties from the IEC 61156-x series of standards are described in the frequency range 1 MHz-80 MHz by their transfer impedance and above 30 MHz by means of coupling attenuation. The new application SPE 10 Base-T1 describes cable requirements in IEC 61156-13 in the frequency range from 0.1 MHz to 20 MHz. Against this background, a new requirement for coupling attenuation with the technical term "low-frequency coupling attenuation" was created from 0.1 MHz. The measurement procedure and the measurement setup were described in advance in the international standardisation. However, practical proof of the feasibility of the measurement method was lacking until now. Members of the SPE System Alliance have jointly tested various connectors and cable types and will present the results at the next ITG symposium.

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