Rosenberger

TECHNICAL ARTICLE

Make way for SPE

The standardization of Single Pair Ethernet is on the verge of a breakthrough. This removes a major hurdle: the confusing array of connector types that has caused many companies to hesitate until now. The new universal connector standard is set to significantly simplify industrial IoT networking for digital AI services and smart factories in particular.

In recent years, Single Pair Ethernet (SPE) has already proven itself in the automotive industry. Increasing connectivity in "software-defined vehicles" requires secure, compact cabling in the confined space of a vehicle to connect sensors and controls for autonomous driving, battery management, and driver assistance systems. As a partner to OEMs, Rosenberger has been accompanying the paradigm shift in automotive data transmission since 2012 and has made a significant contribution to the development of modern connectors. Many years of experience in protocol and interface development have been directly incorporated into the design of the connector solutions and support the current standardization process. This is reflected in the new hybrid connector standard IEC 63171-7 (ED2), which will form the basis for comprehensive interoperability in the future.

SPE has potential for a wide range of applications

Long-range transmission technology that combines power supply and data transmission in a single cable is also becoming increasingly important in industrial networking. Developments relating to Industry 4.0, digitalization and networking are becoming increasingly relevant. The basis for this is data! Although existing protocols are already being used in industrial networking, in practice it remains a problem to access data in a cost-effective, sustainable, and efficient manner. As sensor and actuator technology in IoT applications provide the necessary information that is analyzed by AI systems for predictive maintenance or simulations, for example, the demand for affordable, intelligent networking continues to grow. SPE is a sensible alternative here, which also enables security strategies such as Time Sensitive Networking (TSN) for security- and safety-critical real-time applications.

SPE has numerous application scenarios in a wide range of industries. The technology is particularly relevant in automation and robotics, where much narrower, more flexible SPE cables contribute to greater freedom of movement. Another example is agricultural vehicles, which increasingly incorporate data on soil conditions and weather. Applications are also emerging in electromobility, such as sensor technology in charging stations and the reuse of vehicle batteries in large energy storage systems that require complex cabling. SPE can simplify the networking of train compartments, and it is now also a trending topic in building automation.

The variety of protocols in industry makes development more expensive

Where high-performance networking is important, SPE excels with features such as miniaturization, power supply via the data cable (Power over Dataline [PoDL]) and significant material savings. Multidrop topology also allows multiple sensors and actuators to be controlled simultaneously via a single cable. In the IoT environment in particular, many small devices also need to be powered at the

same time – wireless approaches are therefore generally not sufficient for industrial applications. They continue to play a minor role in factory automation: HMS Networks' market analysis for 2024 finds that only seven percent of all newly installed network nodes are based on wireless communication.

In industrial networking, there are currently over 80 different protocols that individual components can use to communicate with each other. Expensive gateways are needed to translate these protocols. Above all, however, implementation is costly because it requires an elevated level of expertise in these protocols – an area in which skilled workers are in short supply. This leads to relatively high development costs in areas such as machine and plant design. The more sensor, actuator and connector manufacturers rely on SPE, the faster a complete system could communicate exclusively via Ethernet protocol – without gateways. In a research project with the Technical University of Munich for a CNC system, this resulted in savings of up to 25 percent in development costs. With the increasing spread of Single Pair Ethernet, the costs for this communication technology will decrease. So far, SPE has mainly been used to supplement existing Ethernet cabling for new digital, IoT-based scenarios. In the future, SPE could also become the basis for new products and production sites.

Why a uniform connector face strengthens the spread of SPE

The IEEE 802.3 standard describes Ethernet in general and integrates Single Pair Ethernet (SPE) as one of several variants. The corresponding extensions were developed specifically for the requirements of the automotive industry, transportation, and factory, building, and process automation. IEEE 802.3 lays the foundation for SPE protocols in terms of the physical layer and data transfer speeds. While 25 gigabits per second are required in the automotive industry due to the high data volumes, this would be oversized in the building industry, for example. In up to 80 percent of industrial use cases, 10 Mbit is sufficient, and 100 Mbit can cover almost all cases. The respective protocols also take different distances into account: While in greenhouses or chemical parks, sensors must interact over hundreds of meters or several kilometers, only short cable distances are necessary in a machine, plant, or robot.

Based on earlier standardization efforts, there is already an entire range of standardized industrial connectors for SPE, which are described in the sub-standards of IEC 63171. They are suitable for different application scenarios, some of which overlap. In addition, there are many nonstandard connectors on the market. This leads to a lot of complexity for both manufacturers and operators. This uncertainty prompted many companies to adopt a wait-and-see approach. At the end of 2024, the Profibus User Organization (PNO) announced that it intends to standardize a uniform connector face with IEC 63171-7 (ED2) and establish it as an industry standard. This should cover all application scenarios, including those in protected areas. From Rosenberger's point of view, this takes into account the previous development work in the automotive industry, for which connectors are already being manufactured fully automatically in mass production (300 million in 2024): With the "High-Speed Modular Twisted Pair Data", a single-panel connector for high data rates that is completely shielded has been available here since 2016. The connector recommended by the PNO in future is almost similar to this connector developed for the automotive industry, particularly in terms of size and shielding.

The right time to evaluate SPE

The standardization process currently underway, in which the key players have already agreed on a design, should result in a CDV standard by the end of 2025 – and then herald the interoperability desired and required by the market. The fact that many companies are already ready to go there shows great interest on the part of customers and the palpable relief that the "connector drama" is ending. However, SPE is still uncharted territory for many, and there is a considerable need for advice: an important aspect is still the need to analyze each application case in detail and based on this, select the proper physical layer and protocol to maximize the benefits.

Every innovative technology needs time to gain a foothold in the market. However, the automotive industry is a good example of how SPE can prove itself relatively quickly thanks to its advantages. The current economic downturn with less well-filled order books could – as has already been seen with other innovation leaps – provide the necessary breathing space to invest more resources in exploring modern technology. For anyone working in a company dealing with data communication, now is the right time to investigate SPE – whether it's automation and robotics, building automation, cooling systems in the food industry or plant development. Manufacturers should evaluate the advantages SPE offers for the next generation of products to increase their competitiveness.

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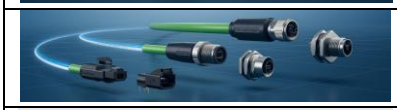
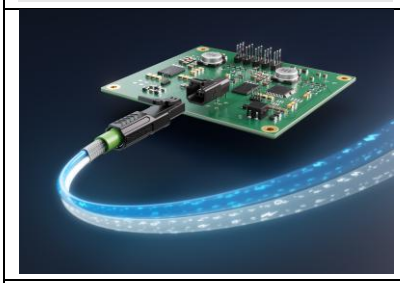
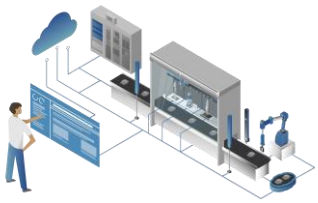
	The IEC 63171-7 ED2 standard specifies a universal mating face for use in control cabinets and field applications.
	SPE industrial connectors

	SPE connectors are based on the international IEC 63171 standard, promoting compatibility and ensuring reliable use in a variety of applications.
	See above
	SPE industrial connector interface
	The IEC 63171-7 ED2 standard, initiated by the PROFIBUS User Organization (PNO), is a new industry standard that forms an important basis for the further development and success of Single Pair Ethernet.
	SPE offers standardized, Ethernet-based communication from the sensor to the cloud and is a key technology for IIoT and smart factory applications.

About Rosenberger

Rosenberger, a globally renowned manufacturer of electronic components and systems, stands for cutting-edge technologies, development expertise and uncompromising quality. Headquartered in Germany, the Rosenberger Group has sales and production sites around the world and offers a wide range of standardized and customized connection solutions in high-frequency, high-voltage and fiber optic technologies.

Rosenberger ensures the reliable transmission of signals, data, and energy in the most demanding applications. Leading high-tech companies in the fields of mobile communications and telecommunications, industrial measurement technology, automotive electronics, medical and industrial electronics, data centers and aerospace rely on Rosenberger products, which are characterized by precision and maximum reliability. The CNC machining division manufactures precision parts for various industries, including the automotive and commercial vehicle industry, shipbuilding and traditional mechanical and plant engineering.

Rosenberger has been family-owned since its foundation in 1958 and employs around 15,000 people worldwide (m/f/d), who stand for commitment, innovation and quality awareness in the tradition of a family-owned company.

Further information can be found at www.rosenberger.com

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