INDUSTRIAL PARTNER NETWORK

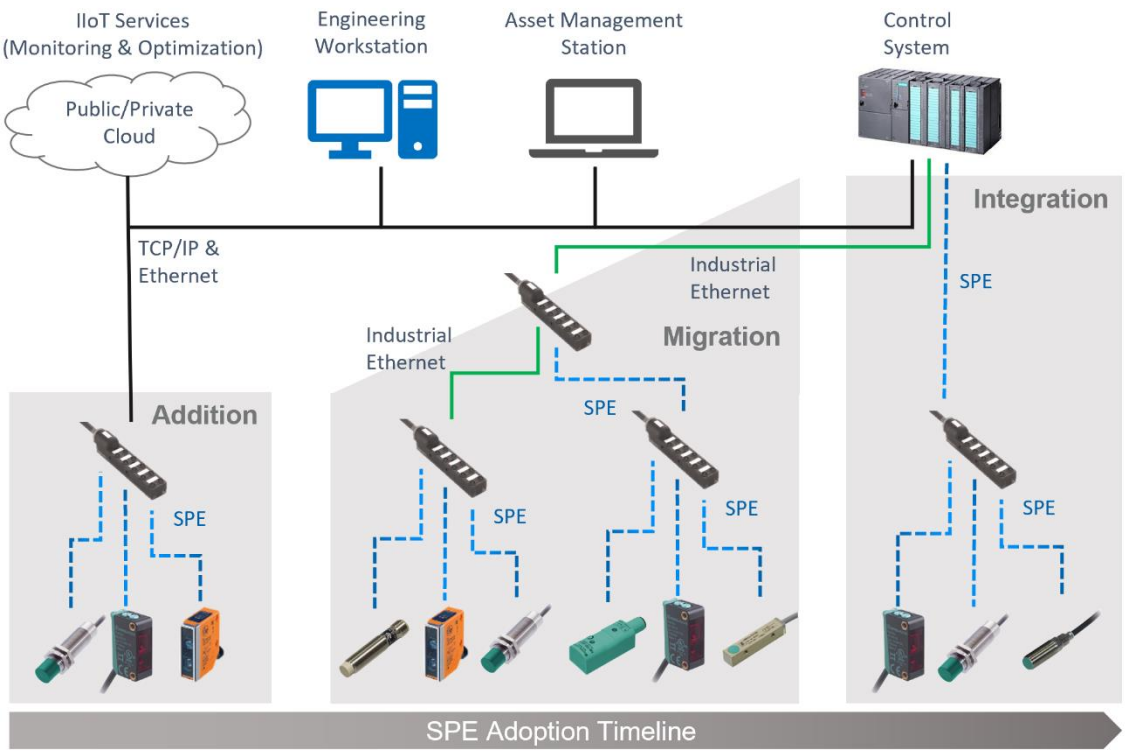
APPLICATION NOTE

POWER SUPPLY FOR SINGLE PAIR ETHERNET DEVICES

SPE IS A PROMISING TECHNOLOGY FOR NETWORKING SENSOR AND ACTUATOR NETWORKS WITH IP TECHNOLOGY. IN ADDITION TO THE SELECTION OF THE APPROPRIATE SPE PROTOCOL, THE CHOICE OF AN OPTIMAL POWER SUPPLY IS ALSO AN IMPORTANT FACTOR FOR THE SUCCESS OF SPE IN THE MARKET.

SPE APPLICATIONS

Single Pair Ethernet as a new simple physical layer with only one wire pair enables the use of Ethernet-based data transmission in many areas where other transmission methods still dominate today. Much has already been reported about the corresponding advantages of SPE such as reduced installation space, weight and uniform Ethernet protocols throughout. The possible applications are also diverse. In the field of building and industrial automation, the focus for SPE is concentrated on the area of sensors and actuators - here, discrete or analog 4-20 mA sensors and a variety of bus systems still dominate the market today. The greatest advantages are realized here through the use of SPE.



Picture 1: Possible scenario for implementation of SPE (source TE)

Picture 1 shows a very probable scenario of how the use of SPE, starting from the field level, will shape up and become established in the market.

SPE for Sensor and actuator networks

SPE at the field level can significantly reduce the multitude of transmission systems in use today and thus simplify the planning, installation and maintenance of sensor networks while providing higher data rates. If you take a close look at the cabling and connection technology here, one market requirement in particular stands out. Almost all sensors and very many actuators are connected via robust single-cable solutions with a high degree of protection. Thus, in addition to the selection of the appropriate SPE protocol, in terms of data rate and achievable range, the appropriate power supply is also a key issue that must be considered and solved. Depending on the application, the following combinations of SPE protocol, power supply concept and network structure are useful:

SPE Protocol	Power supply system	Network structure / Connectivity
10BASE-T1S	M8 Hybrid with an additional contact pair for power supply	PtoP (15 m) and/or PtoMP (min. 25 m with min. 8 Nodes) via M8 Hybrid Connector acc. to IEC 63171-6
10BASE-T1L	PoDL or Engineered PoDL (for example APL)	PtoP Minimum 1.000 m via IP65/67 SPE Connector acc. to IEC 63171-6
100BASE-T1 oder 1000BASE-T1	PoDL or simplified PoDL with 24 V DC only	PtoP Minimum 40 m via IP65/67 SPE Connector acc. to IEC 63171-6
100BASE-T1 oder 1000BASE-T1	M8 Hybrid with 2 additional contacts or M12 Hybrid with 2 to 5 additional contacts for power supply	Switched Lines or star structure via M8 or M12 Hybrid connector acc. to IEC 63171-6 or IEC 63171-7

Table 1: Different SPE protocols with different transmission speeds and suitable power supply system

Option 1 – 10BASE-T1S and hybrid power supply

provides the useful features for sensor/actuator networks within automation applications due to the following characteristics:

- PtoP (point to point) or PtoMP (point to multipoint or bus) structure with 10 Mbit/s
- M8 hybrid cabling system supports daisy chain structures and easy powering of the device without additional components for PoDL powering.
- With MultiDrop PtoMP, a much smaller number of ports are needed on the switches to connect a high number of devices.

Option 2 – 10BASE-T1L in combination with an adapted remote power supply system

These systems, known as **A**dvanced **P**hysical **L**ayer (APL for short), are used for the process industry. Here, a long link length is typical and cable costs play a major role. For such applications in EX areas, power is supplied via remote power supply via the same data pair. Corresponding power classes are defined depending on the transmission length and intrinsic safety (EXi) requirements. For the intrinsically safe 200 m track segments, this is 15 V and max. 1.17 W, and for the trunk segments up to

1,000 m long, 50 V and max. 92 W. These networks are precisely planned and permanently installed. The appropriate power class is permanently set and connected at the supplying switch.

	APL Port Profile					Unit
Class	**15 V**			**50 V**		
Class#	A	B	C			
$V_{PSE(max)}$	15			50		V
$V_{PSE(min)}$	9,6	10,1	11,61	46		V
$I_{PI(max)}$	55,56	115	95	1250	2000	mA
$P_{PD(max)}$	0,54	1,17	1,1	57,5	92	W

Table 2: APL Port Profile Specification

Option 3 – SPE in combination with Power over DataLine (PoDL) remote powering

This is the best-known solution on the market for combining data transmission and power supply in one wire pair. For remote power supply via PoDL, a procedure is available with the Serial Communication Classification Protocol (SCCP) to automatically negotiate the respective power class between **P**ower **S**ourcing **E**quipment (PSE) and **P**owered **D**evice (PD). According to IEEE802.3bu, ten power classes are defined: 12 V / 5 W max., 24 V / 10 W max. and 48 V / 50 W max. In IEEE802.3cg, six additional power classes with 24 V / 8.3 W max. and 55 V / 52 W have been added. If the devices are permanently installed and the line classes are known, a "simplified" PoDL without SCCP can also be used. For economic reasons, it does not make sense for a PSE or PD to support all 16 classes. The effort, especially in the switches or PoDL injectors, would simply be too great and uneconomical. A restriction, for example to the usual 24 V for automation, seems appropriate here and should be specified in the Industrial Ethernet groups in order to establish a type of "Industrial PoDL" with 24 V DC on the market

	IEEE 802.3bu										IEEE 802.3cg						Unit
Class	**12 V** unregulated		**12 V** regulated		**24 V** unregulated		**24 V** regulated		**48 V** regulated		**24 V**			**55 V**			
Class#	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
$V_{PSE(max)}$	18				36				60		30			58			V
$V_{PSE(min)}$	6		14,4		12		26		48		20			50			V
$I_{PI(max)}$	101	227	249	471	97	339	215	461	735	1360	92	240	632	231	600	1579	mA
$P_{PD(max)}$	0,5	1	3	5	1	3	5	10	30	50	1,23	3,2	8,3	7,7	20	52	W

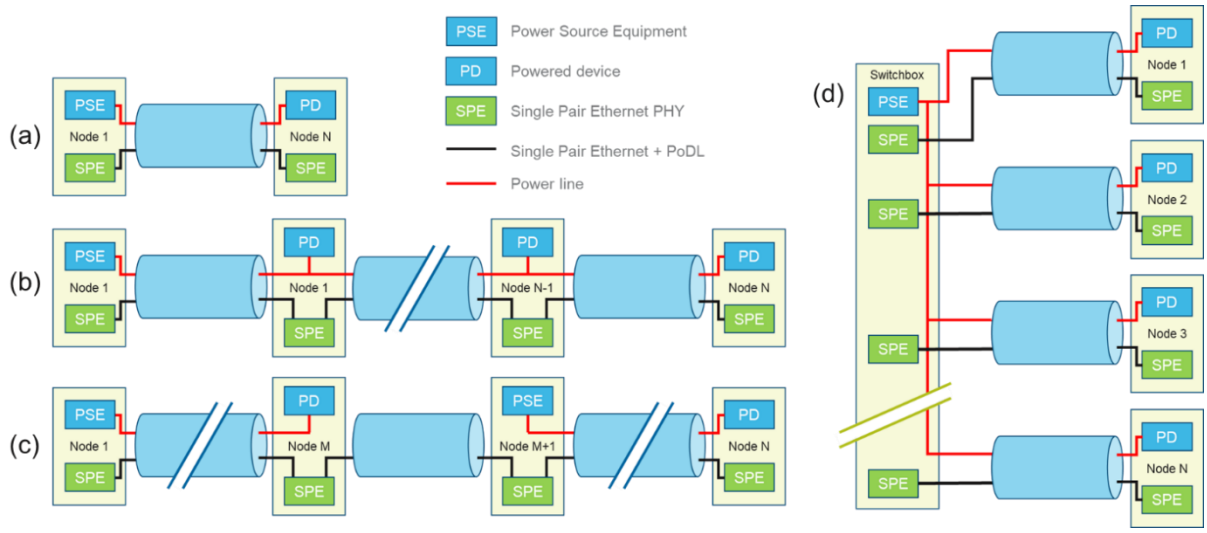
Table 3: PoDL classes acc to IEEE802.3bu and IEEE802.3cg

Option 4 – SPE in combination with a hybrid power supply system

Option 4 is another possibility for the power supply is with an additional pair of wires only for the power supply. This hybrid power supply allows higher power and also line structures, with the possibility to loop through the power supply from device to device. With the M8 Hybrid, an interface standardized in IEC 63171-6 for 60 V / 8 A is also available for this purpose. Further M12-based combined interfaces for SPE and power are in progress and will be standardized in IEC 63171-7.

Picture 2: M8 Hybrid acc. to IEC 63171-6

Using this hybrid power supply, in addition to the classic point-to-point connection, line structures or any construction structures are also possible (see Picture 3). If the power requirements of the connected devices are greater or the voltage drop is too high, the network can also be divided and equipped with distributed power supplies as shown under (c) in Picture 3.



Picture 3: Varius network topologies: (a) point-to-point, (b) bus-powered, (c) bus-powered with additional resupply points, (d) switch with hybrid power supply with the M8 Hybrid according to IEC 63171-6

Comparison of the possible power supply concepts

For the supply of SPE devices the power supply can be done via, PoDL, hybrid with two separate in the same connector and cable or directly with two separate connectors and cable. All concepts have their advantages and disadvantages (see table 4).

Feature	PoDL	Hybrid	Direct
Power	bis 10 W @24 V DC bis 50 W @48 V DC	bis 200 W @24 V DC bis 400 W @48 V DC	Unlimited
Cable	Ein dünnes Kabel	Ein Kabel	Two separate cables
Connector size	M8 or M12 Type (IEC 63171-6)	M8 Hybrid (IEC 63171-6) or M12 Hybrid (IEC 63171-7) Type	Two interfaces
Network structure	Only point to point	Point to point, line or tree	Point to point, line or tree
EMV	Data and power supply in the same wire pair	Galvanically isolated wire pairs for data and power supply	
Typical applications	Sensor networks	Sensor and actuator networks	Devices in the control cabinet and devices with high current demand

Table 4: Comparison of the different power supply concepts

SPE Cablingstandardization

Before SPE can be used on a large scale in industry, the appropriate cabling is also required. In April 2021, the ISO/IEC 11801-3 AMD1 for single-pair industrial cabling was adopted. The associated installation standard IEC 61918 AMD1 for SPE is also in progress and will be published shortly. In these standards and also the upcoming TIA 568.7, the user will find precise information on the design of the cabling, such as the number of permissible connection points and cable lengths, as well as references to the cable types and connectors to be used. As a permissible interface, reference is made here to IEC 63171-6 with its uniform mating face in the proven industrial designs.

Picture 4: SPE connector versions according to IEC 63171-6 as IP65/67 as well as IP20 versions (top row from left to right: M12 PushPull Stvb., M8 PushPull Stvb., M8 SnapIn Stvb. and IP20 Stvb. / bottom row from left to right: M12 socket with screw and PushPull locking, M8 socket with SnapIn and PushPull locking, angled IP20 PCB socket) (Source: HARTING)

DOKUMENT INFORMATION

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