HELUKABEL®

» SINGLE PAIR ETHERNET

What is Single Pair Ethernet (SPE) and why do we actually need it? Industrial use of the Ethernet has surely been established for a long time now. These are the classical questions a person asks when confronted with the topic of Single Pair Ethernet for the first time.

Historical facts:

The first „data cables" were PVC-insulated single cores that were stranded into pairs to prevent possible faults.

Later, it was ascertained that low-capacity[1)] insulation (e.g. Polyethylene) has improved electric properties, enables longer ranges, and can reduce the use of ferrites (magnets that contribute to fault-free data transmission) in cable assembly. This was common practice in analogue technology. And for controlling each function and each device of a system, a separate pair was required.

This changed with the advent of digital technology. Impedance, cable attenuation, near-end crosstalk and other properties were defined as cable parameters, and bus technology found its way into automation, system and mechanical engineering. Suddenly, many devices of a network could be controlled with one cable pair, e.g., Profibus. This succeeded thanks to digital technology and the addressing of each individual device. The data transmission of the BUS cables, however, was still very slow in comparison to today's possibilities, and achieved a maximum of 20 Mbit.

The Ethernet, a uniform data network for networks (LAN technology), was originally used exclusively for office communication. It was not until the turn of the millennium that industrial equipment, connectors and Ethernet cables were made suitable for industrial use. The Industrial Ethernet was born.

THE INDUSTRIAL ETHERNET HAS DIFFERENT CHARACTERISTICS:

Structure	Data transmission category	Range*
2-pair or star quad, pairs unscreened	Cat 5 100 Mbit	Up to 100 m without Repeater
4-pair, pairs unscreened	Cat 6 up to 250 MHz	
4-pair, pairs screened	Cat 6_A up to 500 MHz	
	Cat 7 up to 600 MHz	
	Cat 7_A up to 1000 MHz	

* Range depends on cable cross-section and number of connector transitions

In 2015, the automotive industry started to rely more heavily on Single Pair Ethernet. The advantages are that it is space-saving, high-performance, and light. It is ideal therefore for the enormously increased data rates caused by cruise control, autonomous driving, or the camera system in the vehicle. In the car, an unscreened cable is usually used for 100BASE-T1, as the application lengths are < 15 m.

In order to make the Single Pair Ethernet suitable for industrial use, and to help shape the technological changes, we joined the SPE Industrial Network e.V. :
SPE Industrial Network https://single-pair-ethernet.com

[1)] Low capacity insulations such as Polyethylene store less energy and provide a better, more efficient, data transmission performance.

Will Single Pair Ethernet replace the classical Industrial Ethernet?

No. The classical 2- and 4-pair cabling has advantages when it comes to range, reaching up to 100 metres without repeater. A further aspect is that 4-pair cabling still guarantees a residual transmission of 100 Mbit in the case of failures, or when a pair is mechanically overloaded.

With Single Pair Ethernet, the analogue sensor system could be digitalised and the comparatively slow bus technology gradually replaced. Furthermore, Single Pair Ethernet offers additional advantage compared to the classical Industrial Ethernet, especially when it comes to small systems. These include thinner bending radii, smaller cables, and transmission rates of up to 1 Gbit on one wire pair. Space advantages like these are decisive for small cameras, in particular, or for cobots, i.e., collaborative robots that collaborate with humans.

How does 1-pair data transmission actually function?

The classical Ethernet works with a 4-pair Cat 5 cable within a frequency range of up 100 MHz. The individual pairs send/receive interchangeably, and thus up to 1 Gbit can be transmitted.

In the case of Single Pair Ethernet, only 1 pair is available. In order to be able to transmit 1 Gbit, chip sets with a range of up to 600 MHz are used. Some frequencies of the wide spectrum receive, while other frequencies send... This is how SPE works!

Why is Single Pair Ethernet of interest for industrial use?

Single Pair Ethernet enables consistent data transmission up to field level. In contrast to before, only one pair is required to transmit the signals (instead of previously two or four pairs).

This results for example in:

1 Gbit 1000BASE - T1 up to 40m range

Single Pair Ethernet

with AWG 22 and AWG 26

or

10 Mbit 10BASE - T1L up to 1000m range

Single Pair Ethernet

with AWG 18

In this way, Single Pair Ethernet matches the requirement profile of industry exactly, and offers the following advantages (in contrast to the classical Industrial Ethernet):

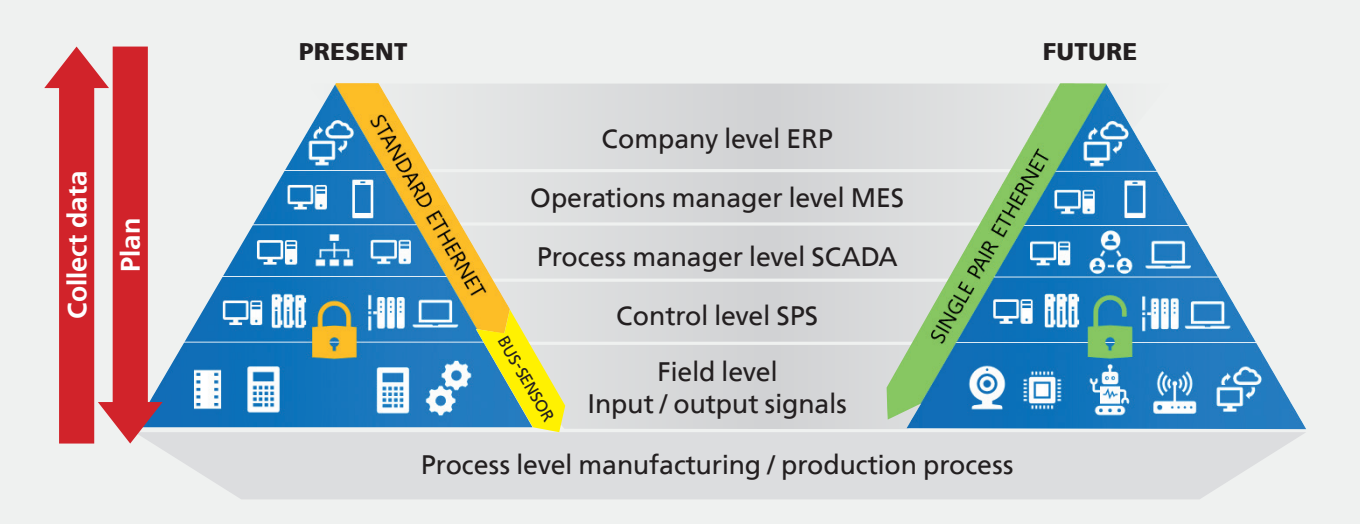
- Thinner cables
- Lower cost of assembly
- Less space requirements, lower weight, smaller laying system possible, if necessary
- Smaller bending radii and smaller chains in the case of moving applications
- Lower caloric load, less smoke development
- Less materials like copper or plastic => protects resources

Type	Part no.	Data rate	Ø mm	Copper value	Weight	Range
PROFInet 2x2xAWG22/1 PVC	Helu 800653	100 Mbit	6,5	32	67	up to 100
Ind. Ethernet 4x2xAWG26/19 PUR	Helu 82839	1 Gbit	6,6	31	56	approx. 70
Ind. Ethernet 4x2xAWG26/7 PUR	Helu 805548	10 Gbit	7,8	34	64	approx. 70
SPE 1x2xAWG26/19 PUR	Helu 11018067	1 Gbit	5,0	16	29	up to 40
SPE 1x2xAWG22/19 PUR	Helu 11018068	1 Gbit	6,4	24	50	up to 40

Weight reduction & copper reduction approx 48 %

Weight reduction & copper reduction approx 25%

A further point is that, nowadays, despite Industrial Ethernet, digital bus technology and analogue sensor technology is used at the lowest level. Single Pair Ethernet lays the foundations for the digitalisation of the previous sensor technology, so that the Ethernet can be used right up to the sensor.



Standardisation

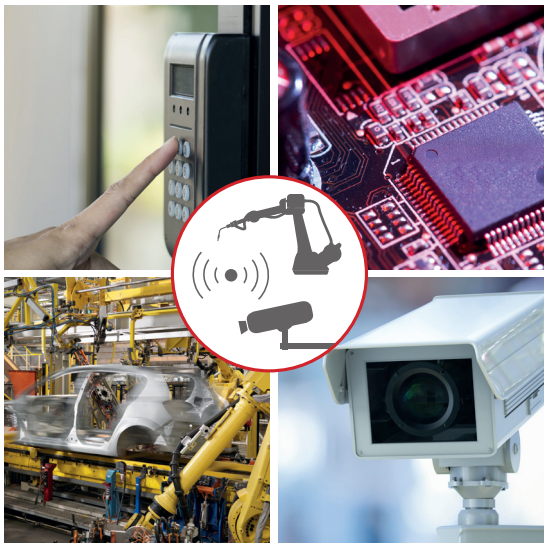
Definition for	Standardisation
Cables	According to IEC 61156 & ISO/IEC 11801-X
Cabling standards	According to ISO/IEC JTC 1/SC 25/WG3 & TIA42
Ethernet protocol standards	According to IEEE802.3
Connectors for industrial use	According to IEC 63171-6
Connectors for building cabling	According to IEC 63171-1

Application areas

Single Pair Ethernet covers the requirements of diverse industries. This means that cables are used depending on the application, e.g., for fixed installation, for flexible use, or for highly dynamic applications, such as in drag chains or in robots. Jacket materials can be PVC, FRNC, or PUR, depending on customer needs and application. High-temperature materials such as FEP may also be implemented.

Type	Part no.	Ø mm	Copper value kg/km	Weight kg
CAN 1x2x0,34mm² PUR f. drag chain	802182	6,9	30	54
SPE 1x2xAWG22/19 PUR f. drag chain	11018068	6,4	24	50
	Reduction	`- 7%	`- 20%	`- 7%

Example 1 – **FACTORY AUTOMATION**



Camera, sensor, robot, machine

Example 2 – **PROCESS AUTOMATION**

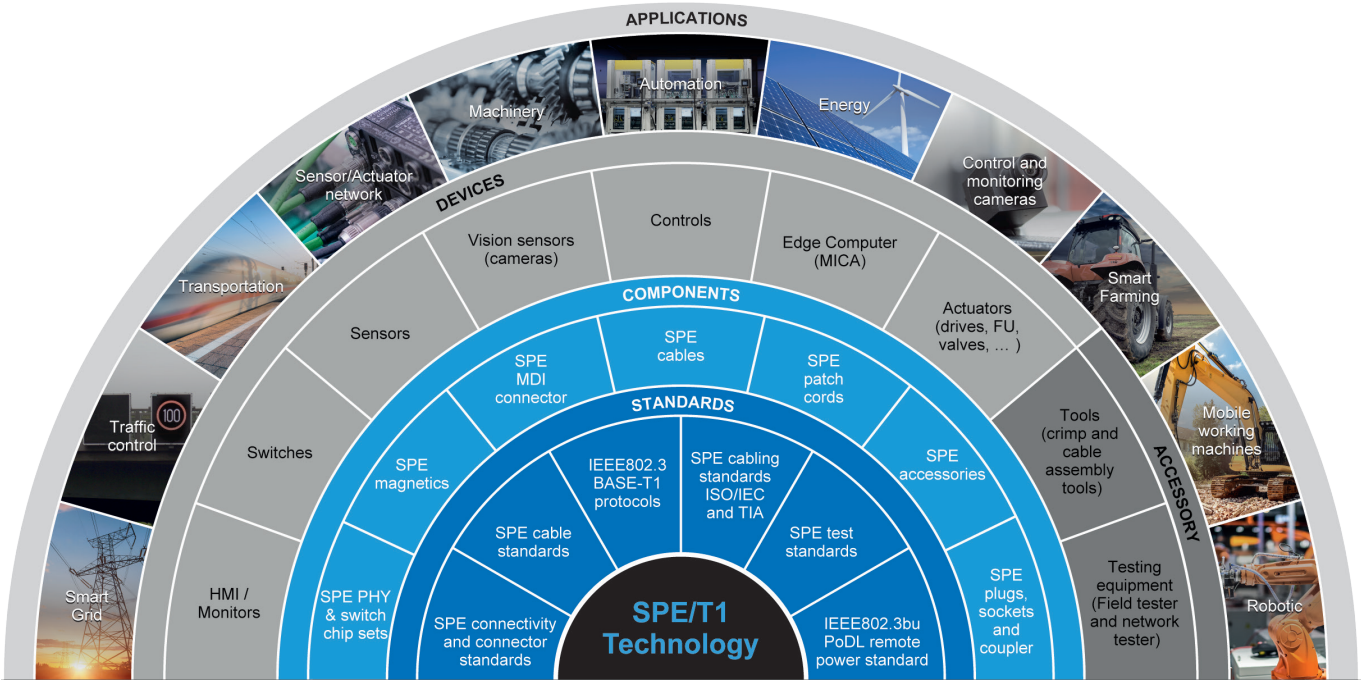
Valve, pressure measurement, temperature sensor

FACTORY AUTOMATION

In addition to the options for expanding or substituting SPE in classical sensor cables and Industrial Ethernet, there will also be future possibilities with CAN bus of working with SPE 1000Base-T1 up to the 40 m range. As well as saving on weight, this will enormously increase data speed.

PROCESS AUTOMATION

With 10BASE-T1L, SPE also offers a quantum leap in process automation, where for decades data rate transmission has been 31.25 kBit. For example, SPE10BASE-T1L 10 Mbit enables video transmissions from security cameras up to max. 1000 m (not possible with Profibus PA).



Power over Data Line (PoDL)

Thanks to PoDL, Single Pair Ethernet also makes the power supply possible parallel to data transmission. The following classifications provide an overview for end devices up to maximum 50 Watts power transmission.

100BASE-T1 and 1000BASE-T1

PSE	12 V unregulated		12 V regulated		24 V unregulated		24 V regulated		48 V regulated	
Class	0	1	2	3	4	5	6	7	8	9
$V_{PSE(max)}$(V)[a]	18	18	18	18	36	36	36	36	60	60
$V_{PSE\_OC(min)}$(V)[b]	6	6	14,4	14,4	12	12	26	26	48	48
$V_{PSE(min)}$(V)	5,6	5,77	14,4	14,4	11,7	11,7	26	26	48	48
$I_{PI(max)}$ (mA)[c]	101	227	249	471	97	339	215	461	735	1360
$P_{class(min)}$ (W)[d]	0,566	1,31	3,59	6,79	1,14	3,97	5,59	12	35,3	65,3
$V_{PD(min)}$(V)	4,94	4,41	12	10,6	10,3	8,86	23,3	21,7	40,8	36,7
$P_{PD(max)}$(W)	0,5	1	3	5	1	3	5	10	30	50

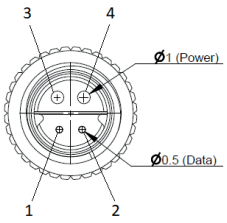
10BASE-T1L PODL POWERED DEVICE CLASSIFICATION

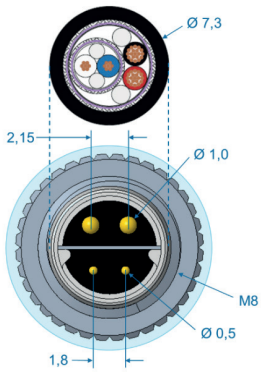
Class	10	11	12	13	14	15
$V_{PSE(max)}$(V)	36	36	36	60	60	60
$V_{PSE\_OC(min)}$(V)	20	20	20	50	50	50
$V_{PSE(min)}$(V)	20	20	20	50	50	50
$I_{PI(max)}$ (mA)	102	155	169	254	388	400
$P_{class(min)}$ (W)	2.04	3.1	3.38	12.71	9.4	20
$V_{PD(min)}$(V)	13.98	13.96	13.92	35.01	34.87	35.6
$P_{PD(max)}$(W)	1.43	2.16	2.35	8.89	13.53	14.24
Cable AWG	18	14	24	18	14	24
Cable length (m)	1000	1000	300	1000	1000	300

Hybrid cables for larger power requirements

If the PoDL classifications up to max. 50 Watts do not cover the power requirements of the device, SPE hybrid cables and M8 connectors provide the ideal solution with more power.

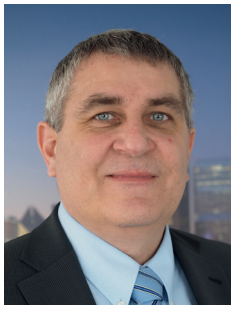
In this case, the cable contains an Ethernet pair with AWG 22-24 and two power cores with AWG 18 that provide up to 400 Watts at 60V over a distance of 40 m. The pair screening via the data element is mandatory. An overall screen is optionally possible.





CONNECTOR ASSIGNMENT:

PIN	PMA signal	Core colour
1	BI_DA+	Blue
2	BI_DA-	White
3	DC +	Red
4	DC -	Black



» CONTACT

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