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Europacable – Whitepaper

Single Pair Ethernet (SPE) for Smart Building Automation

PART 2

December 2025

Table of Content

This Whitepaper is divided in two documents:

- This first document addresses SPE as a new technology trend for smart building automation and explores related applications.
- The second document covers international and European standardisation, with respect to single pair cabling.

1. Introduction: Standards and Technical Foundations of SPE

In the first part of this white paper, we explored the growing importance of smart buildings and how the rapid evolution of building automation is shaping more efficient, sustainable, and responsive environments. We examined the proliferation of IoT devices and sensors as key enablers of this transformation, highlighting how building automation contributes to both operational efficiency and occupant well-being. The document also addressed the current state of building automation infrastructure and introduced Single Pair Ethernet (SPE) as a promising technology to meet future connectivity and power requirements.

Building on that foundation, this second part explores the technical standards and specifications that support SPE. Understanding these standards is essential for those looking to design, deploy, or future-proof building infrastructure with SPE. We will provide an overview of the core SPE standards established by IEEE, along with international and European cabling and connectivity standards developed by ISO/IEC and CENELEC. This comprehensive review will clarify how the global standardisation landscape supports the deployment of SPE in smart building environments.

2. What is SPE? Which standards?

Currently Ethernet protocols require the use of 2 or 4 pairs but the IP convergence is now extended to devices that don't require the high data rate needed by computers, CCTV cameras or WIFI access Points for instance.
IoT devices such as sensors can perform adequately using the more limited data rate provided by the new Single Pair Ethernet protocols.

Single Pair Ethernet (SPE) is a technology that allows Ethernet data transmission and power delivery over a single twisted pair of copper wires, as well as traditional four pairs were initially developed for industrial and automotive environments but is increasingly being considered for smart building applications.

Furthermore, SPE infrastructure can utilize existing 4-pair generic structured LAN cabling, reducing the costs of implementing a new SPE network. Cable sharing is addressed in the new SPE-dedicated chapters of the revisions of

ISO/IEC and CENELEC standards, which have been released in 2025. Additionally, an ISO/IEC Technical Report specifying SPE transmission over 4-pair cables is also released in 2025.

2.1. IEEE Ethernet Standards (IEEE 802.3 group)

- **IEEE 802.3cg**: Defines 10 Mbps transmission over up to 1.000 meters of a single pair, primarily for building automation and industrial applications.
- **IEEE 802.3bw**: Defines 100 Mbps transmission up to 40 meters.
- **IEEE 802.3bp**: Defines 1 Gbps transmission up to 40 meters.

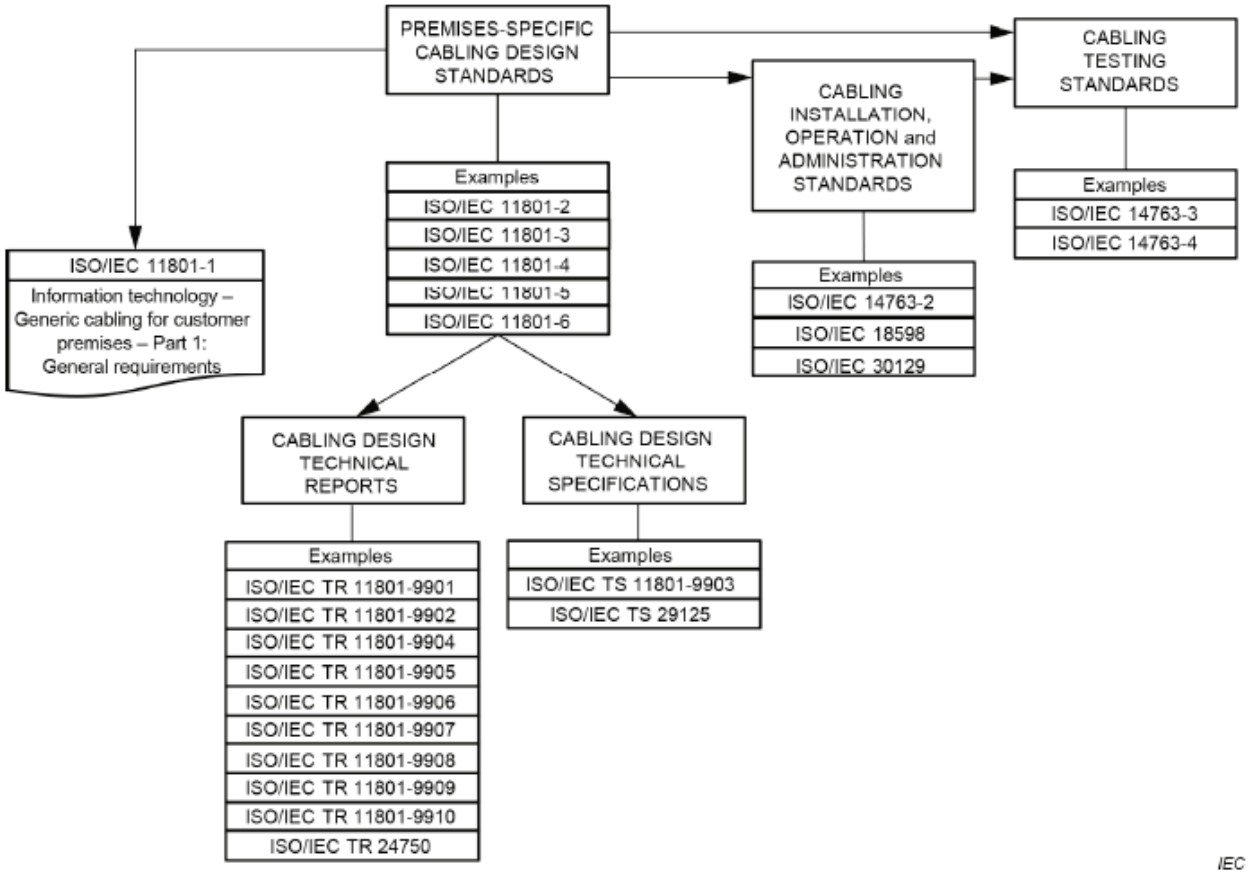
These standards enable low data-rate applications with extended reach, ideal for building automation where sensors and actuators often require low bandwidth and power.

IEEE is defining limited applications specific lengths which not in any case covers the needs of building lengths. Therefore, international and European standards address a generic approach covering a standard of 100 meters.

2.2. ISO/IEC international cabling standards

➢ **Relationships between the ISO/IEC generic cabling documents**

- ISO/IEC 11801-1 defines the general requirements for the design of generic cabling systems.
- ISO/IEC 11801-2 to -6 those parts specify detailed requirements for cabling design in specific environment, such as industrial spaces, and building services.
- ISO/IEC 11801-1, -3 and -6 have recently been updated to include both general and environment-specific requirements for generic **single-pair (1-pair) cabling**.
- ISO/IEC 14763-2 document addresses the installation operation and administration of cabling systems. It is currently under revision to include specific provisions for **1-pair cabling**.
- Others documents cover testing standards and performance specifications.



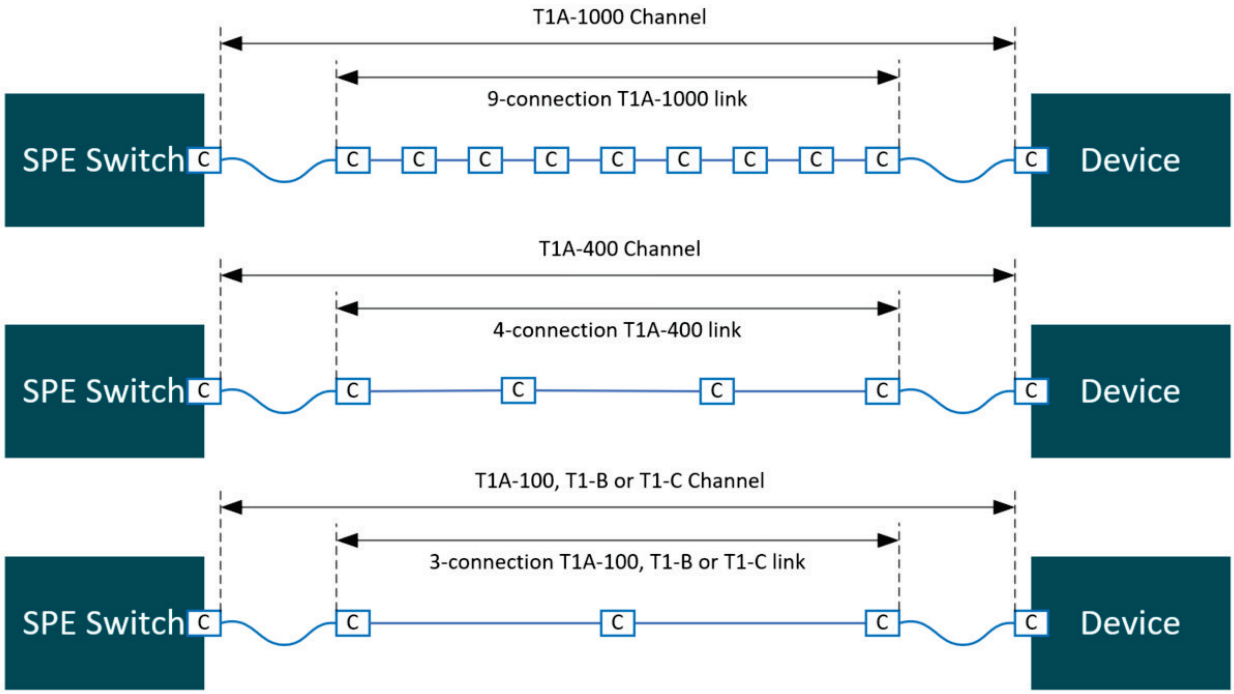
Source: ISO/IEC 11801-1 standard

- Technical reports contain various additional information and guidance. A new report (TR 11801-9911) - not yet included in the following diagram - was released at the end of 2024 and offers guidelines for using SPE applications within 4-pair cabling systems (i-e cable sharing).
- ISO/IEC TS 29125 provides requirements and guidance for remote powering over balanced twisted-pair telecommunications cabling.

➢ ISO/IEC 11801-1 AMD1

- General SPE cabling requirements added
- Specifies cabling channels & link classes TI-A, T1-B & T1-C
  - ✓ Class T1-A is specified from 0,1 MHz to 20 MHz ➔ 10BASE-T1 (IEEE 802.3cg)

- ✓ Class T1-B is specified from 0,1 MHz to 600 MHz ➔ 100BASE-T1 (IEEE 802.3bw)
- ✓ Class T1-C is specified from 0,1 MHz to 1250 MHz ➔ 1000BASE-T1 (IEEE 802.3bp)



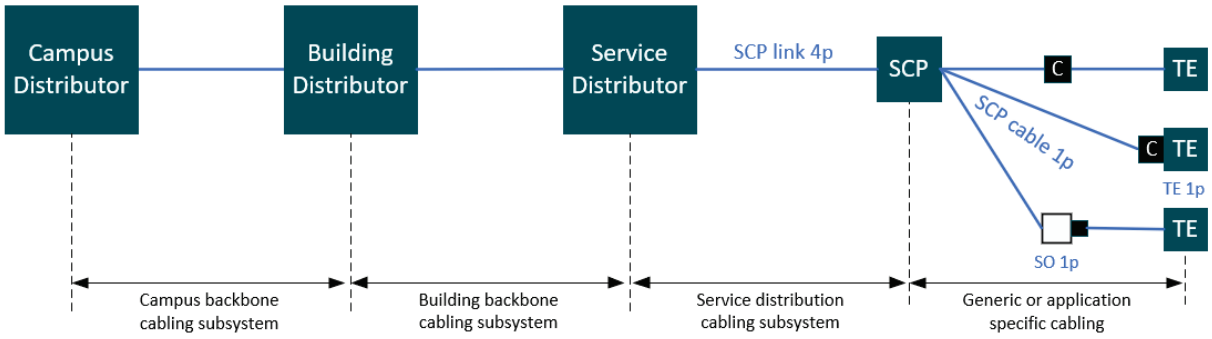
- Not a replacement for generic 4-pair channels
- Additional media type for use in intelligent building and industrial automation devices
- Has distinct structures and distribution architectures detailed in other parts of ISO/IEC 11801 series
- Remote powering on SPE (SPoE)
- Cable sharing specified in the clause dedicated to channel parameters
- 4-pair channels shall be compliant to SPE channel parameters
- Annex H (Cable sharing for SPE channels) refer to ISO/IEC TR 11801-9911

➢ **ISO/IEC 11801-3 AMD1**

Introduces updates to the structured cabling standard for industrial premises, specifically integrating Single Pair Ethernet (SPE) cabling requirements.

➢ **ISO/IEC 11801-6 AMD1**

- General SPE requirements added
- Type A generic cabling to the SO shall be 4 pair copper or fibre
- Type B generic cabling to the SCP provides more flexibility
  - ✓ application-specific cabling to be installed between the SCP and terminal equipment
  - ✓ application-specific equipment to be connected at the SCP
  - ✓ generic cabling to be installed between the SCP and the SO



SCP: Service Concentration point
SO: Service Outlet
TE: Terminal Equipment
C: Connection

➢ **ISO/IEC 11801-9911**

- ✓ Guidelines for the use of balanced single pair applications within a balanced 4-pair cabling system
- ✓ describes the rules of implementation of balanced single pair within a balanced 4-pair cabling system with a current carrying capacity up to 0,75 A
- ✓ creating up to four single pair channels based on 4-pair cabling that conforms to T1-A, T1-B or T1-C
- ✓ Class E_A or higher is recommended

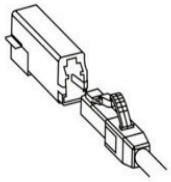
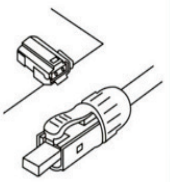
➢ **ISO/IEC 14763-2 (Draft)**

- ✓ planning, installation and operation of cabling and cabling infrastructures
- ✓ main updates related to
  - SPE cabling installation rules

2.3. IEC international cable and connectivity standards

➢ **IEC 63171 series (SPE Connectors)**

- Six different specifications in IEC 63171 series
- Cover circular or rectangular connectors for single-pair data and power transmission
- Various IP rating for building and industrial applications
- IEC 63171-1 (LC type) and IEC 63171-6 are the preferred ones
- Connecting hardware specified in ISO/IEC 11801-1 /AMD1

IEC 63171-1	IEC 63171-6
	
LC-Style	Rectangle / M8 / Push-Pull
1	1
IP20	IP20 / IP67

➢ **IEC 61156 (Cables)**

- IEC 61156-11: Symmetrical single pair cables with transmission characteristics up to 1,25 GHz – Horizontal floor wiring – Sectional specification.
- IEC 61156-12: Symmetrical single pair cables with transmission characteristics up to 1,25 GHz - Work area wiring - Sectional specification.

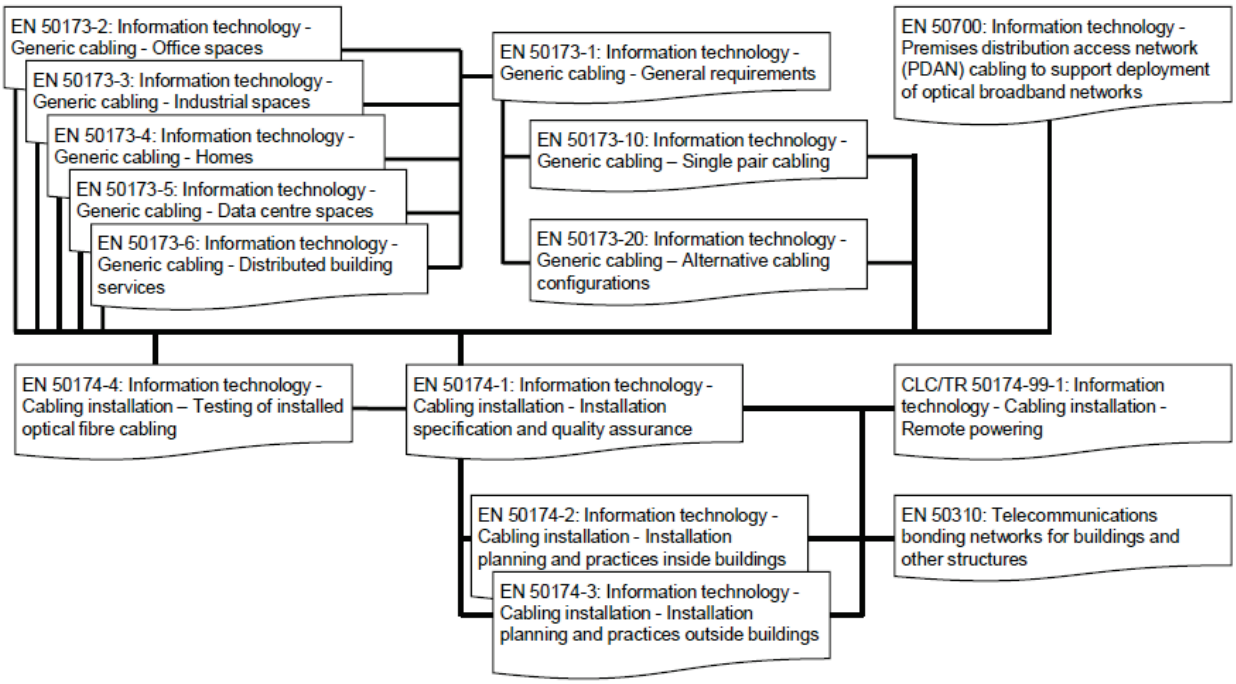
- IEC 61156-13: Symmetrical single pair cables with transmission characteristics up to 20 MHz – Horizontal floor wiring – Sectional specification.
- IEC 61156-14: Symmetrical single pair cables with transmission characteristics up to 20 MHz - Work area wiring – Sectional specification.

2.4. EN European cabling standards

➢ **Schematic relationship between the EN 50173 and EN 50174 series and other relevant standards**

- The generic structured cabling design is described in EN 50173-1
- EN 50173-2 to -6 documents support the EN 50173-1 standard by specifying generic 4-pair cabling in various environment including Industrial spaces, and building services.
- EN 50173-10, recently introduced, defines general requirements for generic 1-pair cabling supporting the same generic cabling principles described in EN50173-1
- EN 50174 series comprises 4 parts
    - Parts 1 to 3 address the specification, installation and operational aspects of cabling
    - Part 4 defines methods for measuring installed fibre optic cabling

EN 50174-1 and EN 50174-2 are currently under revision to include generic 1-pair cabling installation rules.



Source: European standard EN 50174-1

- **EN 50173-10**
  - ✓ General SPE requirements
  - ✓ not a replacement for the generic 4-pair channels
  - ✓ additional media type intended for use in industrial automation networks and “intelligent buildings”
  - ✓ Cable sharing also included
  - ✓ EN 50173-3 & -6 (Equivalent to ISO 11801-3 & -6) will be updated to refer to new EN 50173-10

1-pair cabling Channels [1]

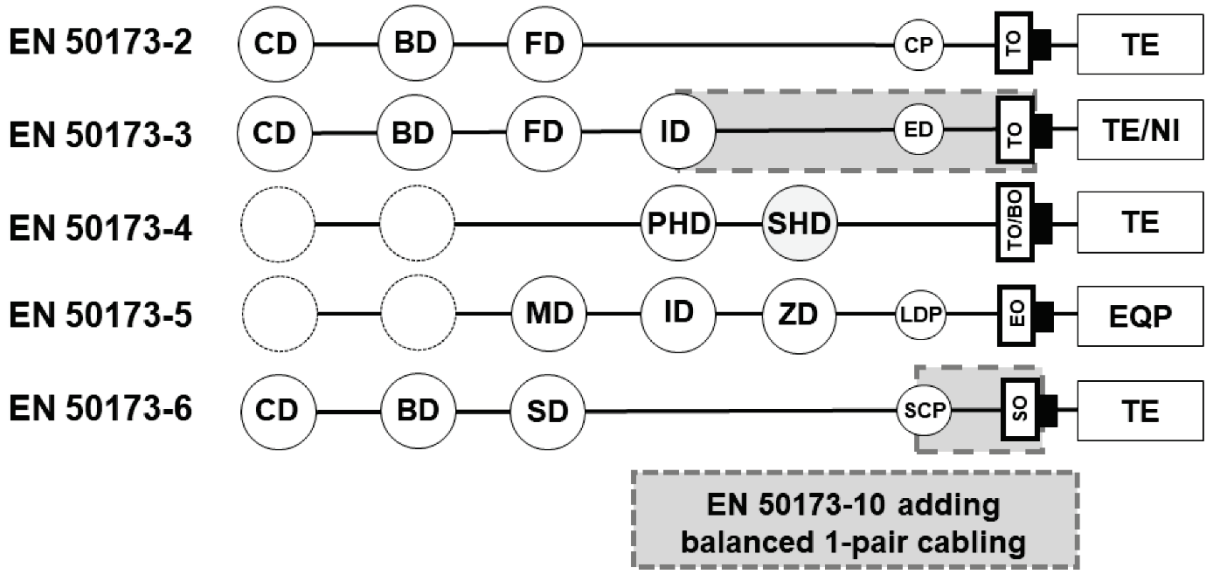


Figure 1- General structure of 1-pair cabling in EN 50173-10

a) T1-20: 1-pair cabling up to 20 MHz; designed for 10 Mbit/s transmission up to 100 m and current carrying capacity of minimum 0,75 A per conductor.

b) T1-20A: 1-pair cabling up to 20 MHz; designed for 10 Mbit/s transmission up to 230 m and current carrying capacity of minimum 0,25 A per conductor.

c) T1-600: 1-pair cabling up to 600 MHz; designed for 1 Gbit/s transmission up to 100 m and current carrying capacity of minimum 0,75 A per conductor.

d) P1-20: 1-pair cabling up to 20 MHz; designed for 10 Mbit/s transmission up to 100 m and current carrying capacity of minimum 2 A per conductor.

e) P1-20A: 1-pair cabling up to 60 MHz; designed for 10 Mbit/s transmission up to 300 m and current carrying capacity of minimum 0,75 A per conductor.

[1] *Source: European standard EN 50173-10*

f) P1-20B: 1-pair cabling up to 20 MHz; designed for 10 Mbit/s transmission up to 1 000 m and current carrying capacity of minimum 0,25 A per conductor.

- **EN 50174-1 and -2 (Draft)**
  - ✓ EN 50174-1: Information technology – Cabling installation – Installation specification and quality assurance
  - ✓ EN 50174-2: Information technology – Cabling installation – Part 2: Installation planning and practices inside buildings
  - ✓ Main updates related to SPE cables installation rules

2.5. EN European cable and connectivity standards

- ✓ Connectivity: EN IEC 63171-1 (LC type) and EN IEC 63171-6 (Industrial)
- ✓ Cables: will be similar to IEC but still to be implemented in CENELEC (EN 50288-20 and EN 50288-21)

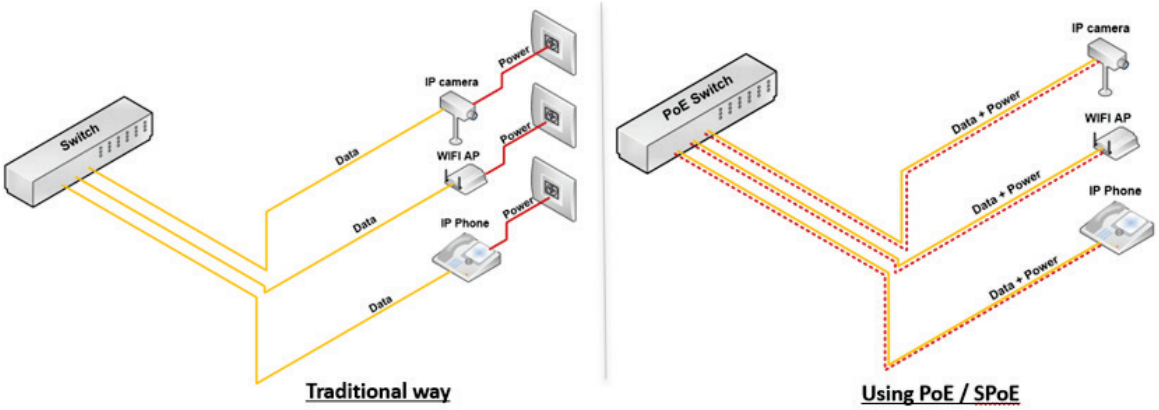
3. About PoE and SPoE

Obviously Network devices connected to the Ethernet network have to be powered. In the traditional way the device requires two connections: a network connection is installed in order for the device to communicate with the server through the Ethernet switch and a power connection is required to deliver the electrical power the device needs to operate.
Using PoE or SPoE both the power connection and the Ethernet network connection are provided to the device through the data cables. Power outlets are not needed anymore for these devices.

In other words Power over Ethernet provide organizations with a simple and convenient option for powering devices such as IP phones, CCTV cameras, WIFI access point or information screens for instance.

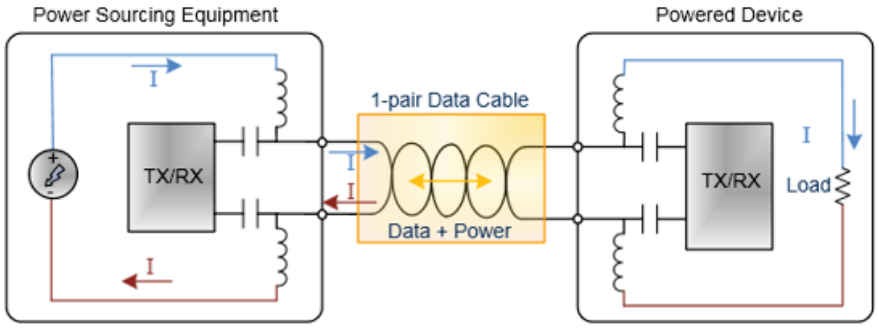
SPoE is the equivalent of PoE but dedicated to 1-pair cabling systems.
The transmission of PoE makes use of at least two pairs. The current is flowing through the two wires of the pair. Half the current is transmitted through each wire with a maximum of 500 mA per wire in each of the 4 pairs for the PoE type 4.

For SPoE only one pair is available. It means that the total current needed to power the device will have to flow through a single wire.
The SPoE standard defines several classes of devices that could need up to 52 Watts with a maximum current of 1,58 A flowing in the 1-pair cable.



ISO/IEC/IEEE 802.3:2001 clause 104

7,7W 231 mA (Class 13)	20 W 600 mA (Class 14)	52 W 1580 mA (Class 15)	Over 1 pair



4. Conclusion

As explored in this second part, the successful adoption and deployment of Single Pair Ethernet (SPE) in smart building environments relies heavily on a clear understanding of the relevant international and regional standards. The IEEE 802.3 standards define the physical and data link layer specifications that ensure reliable and interoperable Ethernet communication over a single pair of wires. Meanwhile, ISO/IEC and CENELEC standards provide the necessary foundation for cabling and connectivity, helping to ensure consistent performance, safety, and compatibility across different use cases.

These standards collectively enable the integration of SPE into structured cabling systems, paving the way for a scalable and future-ready infrastructure that supports the growing density of IoT devices and sensors. With power and data delivered efficiently over a single twisted pair, SPE simplifies installation, reduces material usage, and opens the door to innovative applications in building automation and beyond.

Together with the insights from the first part of this white paper (focused on the market context and value proposition of SPE) this technical overview provides a comprehensive foundation for stakeholders considering SPE as a strategic enabler of the next generation of smart buildings. In addition, SPE, in conjunction with PoE and SPoE, can create significant added value for building owners, tenants, and integrators.

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The content of the document is not legally binding and is not intended as a substitute for user's or manufacturer's own assessment and decision-making.

Readers of this document are encouraged to seek information on specific matters regarding Single Pair Ethernet from the manufacturer or provider and to consider the Technical Standards relating to the selected products.

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