10BASE-T1L/SPoE Switch and Remote Adapters
Centralized Cabling: Intelligent Buildings, Data Centers, Commercial Buildings, and Outside Plant Applications

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10BASE-T1L/SPoE Topology

- IEEE P802.3cg 10 Mb/s Single Pair Ethernet Task
  - 10BASE-T1L – 10 Mb/s operation over a long reach single balanced twisted-pair link segment supporting up to ten in-line connectors for up to at least 1000 m.
  - Optional: Serial communication classification protocol (SCCP) and power distribution
    + Classifies end device prior to application of power
    + Can measure cable resistance

- The SPE switch provides power and data through the medium dependent interface (MDI) over single pair twisted-pair link segments. Single pair power over Ethernet (SPoE) is used here to connotate the power over data lines (PoDL) implementation where end devices are classified prior to application of power via SCCP.
SPE - Standardized cabling, and field testing

- **ANSI/TIA-568.5** – Single Pair Cabling & Components - Published
  - Specifications for cable, connectors, cords, and channels
  - General use environments (M₁I₁C₁E₁, IP20)
  - Cabling topologies

- **ANSI/TIA-568.7** – Single-Pair Cabling & Components for Industrial - Draft
  - Harsher environments (M₂I₂C₂E₂ / M₃I₃C₃E₃, IP55+)
  - Cabling topologies for industrial and process control

- **ANSI/TIA-5071** – Single-Pair Cabling Field Testing - Published
  - Reporting and accuracy requirements of SPE field test equipment

- **TSB 184-A-2** – Power Delivery over Balanced Single Twisted-Pair Cabling - Draft
  - Addendum to TSB-184-A, to add single-pair cabling
10BASE-T1L/SPoE Switch and Remote Adapters

- Standardized: 10BASE-T1L devices, SPoE powering; adapters for MPE/POE<>SPE/SPoE

**10BASE-T1L/SPoE Switch**

- **PoE Switch Power**
- RJ45 stacking port

**Remote Adapter**

- **MPE/PoE end-points**
  - Cameras
  - Sensors

- **SPE/SPoE end-points**
  - Cameras
  - Sensors

- **MPE/POE end-points**
  - Cameras
  - Sensors

1. **Auxiliary Power Supply Input**
2. **RJ45 10/100/1000 Port with 802.3bt PoE PD**
3. **RJ45 10/100/1000 port non-PoE - stacking port**
4. **SPE Port-1 (Class 13/14 PoDL PSE)**
5. **SPE Port-2 (Class 13/14 PoDLPSE)**
6. **SPE Port-3 (Class 13/14 PoDLPSE)**
7. **SPE Port-4 (Class 13/14 PoDLPSE)**

**MPE - Multipair Ethernet**

**SPE - single pair Ethernet**

**SPoE - single pair power over Ethernet (PoDL) with classification**

<table>
<thead>
<tr>
<th>Class</th>
<th>(V_{\text{PSE-Max}}) (V)</th>
<th>(P_{\text{PD-Max}}) (W)</th>
<th>Loop Resistance (\Omega)</th>
</tr>
</thead>
<tbody>
<tr>
<td>13</td>
<td>58</td>
<td>7.7</td>
<td>&lt; 65</td>
</tr>
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<td>14</td>
<td>58</td>
<td>20</td>
<td>&lt; 25</td>
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</tbody>
</table>

802.24.2 IoT Task Group
• ANSI/TIA-568.5 Balanced single twisted-pair telecommunications cabling and components Standard

SP1-1000 channel test configuration

SP1-400 channel test configuration
Maximum dc loop resistance of channels aligned with UL 144

<table>
<thead>
<tr>
<th>Category</th>
<th>Channel length (m)</th>
<th>DCR @ 20 ºC (Ω)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SP1-1000 (18 AWG)</td>
<td>1000</td>
<td>49.4 TBD</td>
</tr>
<tr>
<td>SP1-400 (23 AWG)</td>
<td>400</td>
<td>62.9 TBD</td>
</tr>
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</table>

Nominal dc loop resistance of channels at 60 ºC

<table>
<thead>
<tr>
<th>Category</th>
<th>Channel length (m)</th>
<th>DCR @ 60 ºC (Ω)</th>
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<tbody>
<tr>
<td>SP1-1000 (18 AWG)</td>
<td>1000</td>
<td>56.5 TBD</td>
</tr>
<tr>
<td>SP1-400 (23 AWG)</td>
<td>400</td>
<td>72.5 TBD</td>
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Reference: IEEE Std 802.3-2022: Clause 104

<table>
<thead>
<tr>
<th>Class</th>
<th>V_{PSE-Max} (V)</th>
<th>V_{PSE-Min} (V)</th>
<th>I_P (mA)</th>
<th>P_{Class-Min} (W)</th>
<th>V_{PD-Min} (V)</th>
<th>P_{PD-Max} (W)</th>
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<td>13</td>
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ANSI/TIA-Standards - Balanced Single Twisted-Pair Cabling

- **ANSI/TIA-568.0-E-1** Generic Telecommunications Cabling for Customer Premises Addendum 1: Balanced Single Twisted-Pair Cabling
  - *Centralized cabling (Annex A) Centralized optical fiber or balanced single twisted-pair cabling*

Balanced single twisted-pair cabling supportable distances

The table is based on the minimum performance requirements of specific balanced single twisted-pair cabling categories established by ANSI/TIA-568.5.

### Maximum supportable distances for balanced single twisted-pair cabling applications

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<th>Application</th>
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<th>Distance m (ft)</th>
<th>Comments</th>
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<td>Ethernet 10BASE-T1L</td>
<td>Category SP1-400</td>
<td>400 (1312)</td>
<td>Maximum 5 connections</td>
</tr>
<tr>
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<td>Category SP1-1000</td>
<td>1000 (3280)</td>
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10BASE-T1L/SPoE Switch

Centralized Cabling Stacking Switch

 Illustrated of centralized balanced single twisted-pair cabling

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ANSI/TIA-Standards - Balanced Single Twisted-Pair Cabling

• Structured Cabling Infrastructure Standard for Intelligent Building Systems - ANSI/TIA-PN-862-C-R1

**ANSI/TIA-568.0-E-1 Centralized single twisted-pair cabling**

**Balanced single twisted-pair cabling supportable distances**

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**Legend**
- EF: Entrance facility
- DA: Distributor A
- DB: Distributor B
- DC: Distributor C
- DL: Door lock (security device)
- HCP: Horizontal connection point
- ID: Intrusion detector (security device)
- MR: Mechanical room
- SD: Smoke detector (IBS device)
- T: Thermostat (IBS device)
- Equipment outlet
- Camera (security device)
**ANSI/TIA-Standards - Balanced Single Twisted-Pair Cabling**

- **ANSI/TIA-PN-942-C** - Telecommunications Infrastructure Standard for Data Centers

  - *Centralized cabling (Annex A) Centralized optical fiber or balanced single twisted-pair cabling*

  Centralized balanced single twisted-pair cabling meeting the requirements of ANSI/TIA-568.0 is allowed as an alternative to the cross-connection located in the HDA to utilize centralized electronics.

**Example of a basic data center topology**

- Today's Data Center monitoring predominately battery operated sensors networked with wireless connectivity
- SPoE easier to maintain, more reliable, and environmentally friendly than batteries

**Electrical monitoring**
- Power systems

**Environmental systems monitoring and control**
- Temperature and humidity readings
- Ventilation or cooling equipment status
- Corrosion Rate
- Differential pressure across filters
- Water intrusion
- Other

**Physical security and safety monitoring**
- Surveillance systems (e.g., cameras, motion/occupancy sensors, forced entry detection, etc.)
- Enclosure/cabinet access systems (e.g., biometric, electronic locks, door position, etc.)
- Lighting system
- Smoke/fire detection system
- Suppression system notifications (if present)
- Leak detection system
- Patch panel port sensing for unauthorized changes to patch cord connectivity.
Outside Plant Comparisons - MPE/PoE-SPE/SPoE

Outside Plant

Building
Switch Router
POE+ Power
48 V DC
Power
Supply

Outside Plant

Multi-pair Ethernet

Outside Plant

Standardized: data, power, cabling, and field testing

10BASE-T1L/SPoE Switch

1000+ m/18 AWG - 7.7 w
484+ m/18 AWG - 20 w
400 m/23 AWG - 7.7 w
100 m/23 AWG - 20 w

Remote Adapter

MPE/PoE end-points
• Cameras
• Sensors

SPE/SPoE end-points
• Cameras
• Sensors

802.24.2 IoT Task Group
Extended Reach Applications - Comparisons - MPE/PoE-SPE/SPoE

**Multi-pair Ethernet**

- Copper Media Converter
- Fiber PoE Media Converter (PSE)

- 100 meters

**Standardized: data, power, cabling, and field testing**

<table>
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<tr>
<th>Distance</th>
<th>Power Consumption</th>
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<td>1000+ m/18 AWG</td>
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**10BASE-T1L/SPoE Switch**

- Remote Adapter

**SPE/SPoE end-points**
- Cameras
- Sensors

**MPE/PoE end-points**
- Cameras
- Sensors

**Single-pair Ethernet**
Extended Reach Applications - SPE/MPE Topology

Standardized: data, power, cabling, and field testing

10BASE-T1L/SPOE Switch

1000+ m/18 AWG - 7.7 w
484+ m/18 AWG - 20 w
400 m/23 AWG - 7.7 w
100 m/23 AWG - 20 w

Remote Adapter

MPE/PoE- 100 m

MPE/PoE end-points
- Cameras
- Sensors

SPE/SPoE end-points
- Cameras
- Sensors

Single-pair Ethernet

Multi-pair Ethernet
The Link Segment Channel Emulator enables the PSE and PD to be tested over different Unshielded Twisted Pair (UTP) or Shielded Twisted Pair (STP) link segments of varying types (Size and Insertion Loss), Delay (Latency), DC Resistance and length.

Integration of test instruments enables seamless compliance testing without reconfiguring.