6Port SPE 2Port Ethernet CLSW-6PSE-2ETH

Industrial Switch User Manual

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I. Technical Background

Single-Pair Ethernet (SPE) is new technology that uses only one pair of twisted wires for data transmission. By significantly reducing the number of wires, it maintains efficient Ethernet communication while greatly lowering wiring complexity, cost, and space requirements. This brings transformative changes especially to industrial automation, automotive electronics, and other fields.

The revolutionary aspects of SPE are reflected in the following core features:

- Extremely simplified wiring: Compared with traditional Ethernet that requires four or two pairs of twisted wires, SPE needs only one pair, directly reducing cable weight, volume, and cost.
- Power over Data Line (PoDL): SPE supports supplying DC power to remote devices (such as sensors and actuators) through the same single pair, eliminating the need for separate power cables and greatly simplifying installation.
- Long-distance transmission with high bandwidth: SPE technology offers a variety of choices between distance and bandwidth. For example, 10BASE-T1S supports up to 15 meters, while 10BASE-T1L reaches up to 1,000 meters at 10 Mb/s.
- Seamless integration into the Ethernet ecosystem: SPE follows standard Ethernet protocols (OSI layers 2–7), meaning existing upper-layer software and protocols (such as TCP/IP) can be used directly without modification, achieving true end-to-end Ethernet connectivity from the control layer to field devices.

Thanks to these technical characteristics, SPE is rapidly gaining adoption in multiple fields:

- Industrial automation: In factories, SPE can directly connect field sensors, actuators, and I/O modules to PLCs or controllers, simplifying traditional hierarchical networks and enabling direct sensor-to-cloud connectivity. It can

replace conventional fieldbus systems or serve as a lightweight alternative to multi-pair Ethernet.

- Automotive electronics: SPE was originally standardized to meet automotive requirements and has become the ideal choice for connecting in-vehicle cameras, radar, LiDAR, infotainment components, etc., helping reduce wiring harness weight and complexity.
- Process industry: Ethernet-APL based on 10BASE-T1L enables long-distance communication and power supply for field instruments (pressure transmitters, flowmeters, etc.), even in hazardous areas, and is ideal for intrinsic safety applications.
- Building and infrastructure: In building automation, SPE simplifies connections for lighting control, HVAC, security sensors, etc., enabling Ethernet access with thinner cables.

Single-Pair Ethernet (SPE) embodies the design philosophy of “simplifying complexity” and extends Ethernet capabilities to areas that were previously difficult to reach. It is not only a simplification of cabling, but also a key bridge for deep convergence between operational technology (OT) and information technology (IT) networks, realizing the vision of Industrial IoT (IIoT) and “Industry 4.0.”

The CLSW series SPE + Ethernet switches launched by Cooled consist of two main functional parts: physical media conversion and data switching. They are complementary to SPE — SPE solves the “last mile” physical connection problem, while the switch provides intelligent management and data exchange. This enables SPE devices to seamlessly integrate into existing standard Ethernet networks, making it an ideal solution for building end-to-end Ethernet architectures from field sensors to cloud platforms.

- Physical media conversion: Implements physical layer media and signal encoding conversion. It performs mutual conversion between 10BASE-T1L SPE signals and standard Ethernet signals (100BASE-TX or 1000BASE-T).

- Data switching: Performs Layer 2 (data link layer) switching. A Layer 2 switch is an intelligent, hardware-based frame forwarding device. It uses the core mechanism of “learning MAC addresses and forwarding precisely on demand” to efficiently organize communication within the local network.

The switch features:

- 6 ports compliant with IEEE 802.3cg-2019 10BASE-T1L standard, 10 Mbit/s Single-Pair Ethernet ports
- Maximum SPE transmission distance: 1500 meters
- 2 ports 10/100 Mbit/s auto-adaptive standard Ethernet ports with RJ45 connectors

The 6 SPE ports support PoDL power supply over twisted-pair cables to power remote SPE terminal devices (e.g., various field sensors, actuators, network cameras, etc.). Support PoDL power classes: Class 10, Class 11, Class 12, Class 13, Class 14.

All 6 SPE ports share a common input power voltage with no power isolation between ports (but isolated from the SPE signal channels). Power supply is enabled via DIP switches (no need complex detection or classification process); corresponding red LEDs indicate power supply status. The PoDL output voltage on each SPE port equals the input working voltage of the switch.

Important note: The total power output from all 6 SPE ports must be less than the total input power supplied to the switch.

2 Specification

Parameters	Input Voltage（V）	DC 18-60V
	Power（W）	Switch Function <3W
	PoDL Power Supply	6 Port PoDL Power Supply, Class 10 to Class 14; IPI(MAX) = 600mA with PPD(MAX) = 20W. Total 6 ports power consumption shall be less than the input power.
	SPE Port	6Port AWG20-AWG24, Supports polarity detection and automatic polarity correction
	Ethernet Port	2 Port RJ45
	Signal Isolation	Input power supply isolated from internal switch circuitry; Isolation between SPE ports; Isolation between SPE ports and Ethernet ports; Isolation between Ethernet ports.
	Principle	Transparent data forwarding at the physical layer, Layer 2 switching based on MAC address table
SPE Ports	Transmission Rate	10Mbit/s Full Duplex
	Standard	IEEE802.3cg-2019，10Base-T1L,
	Cables	One Pair Twisted Max 1500 m，1.0 V p-p and 2.4 V p-p
	LED Indication	6 SPE Port Link/Activity (Green LEDs) 6 SPE Port Power Supply (Red LEDs)
Ethernet Ports	Transmission Rate	10/100 Mbit/s Auto-Negotiation
	Standard	IEEE802.3,100Base-TX/10BASE-T Ethernet Standard
	Cable	Maximum cable length: 100 m (Category 5, 4-pair twisted-pair cable)
	LED Indication	LED: Green (Link), Blinking Green (Activity)
Operating Environment	Operating Temperature	–40 to +80 degrees Celsius Ambient Temperature
	Safety and EMC Standards	CCC，CE，UL，FCC
	Life Time	>100000 Hours
Others	Dimension	122*104*45mm
	Mounting Method	DIN35m Rail Installment Ear Fixing Installment， IP20 Protection Level

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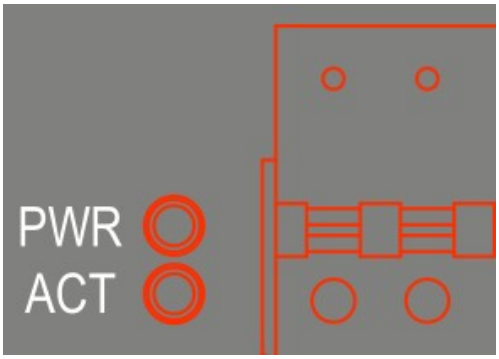
3. Wiring Instructions

3.1 6-Port SPE



+: Connect to PSE cable positive

- : Connect to PSE cable negative

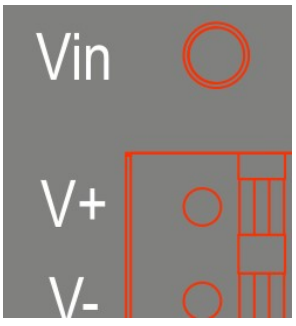
S : Connect to shield layer of cable

SPE cable recommendation: AWG22 (0.3 mm²) or AWG20 (0.5 mm²). Strip about 8 mm. For stranded wire, tin the ends.

Use a flat screwdriver to press the orange button, insert the wire, then release, the internal spring clamp will secure the conductor.

ACT LED (Green) on SPE port: lights steadily when link with remote SPE device is established; flashes when data is being transmitted.

3.2 Input Power



V+: Connect to positive

V-: Connect to negative

S: Connect to Earth

cable recommendation: AWG18 (1 mm²), connected in the same manner to the DC power input terminal.

Vin Power indicator (red) lights up when power is applied.

3.3 PoDL supply selection:

Toggle downward to enable power supply on the corresponding SPE port 1–6; the red LED of that channel lights up when enabled.

3.4 Ethernet Port:

RJ45 port LEDs flash to indicate link established and data activity.

4. Network Connection Topologies

The CLSW-6PSE-2ETH switch is a physical-layer switch that performs bidirectional transparent conversion between SPE and Ethernet. It supports all major industrial Ethernet upper-layer protocols, including Ethernet/IP,PROFINET,MODBUS TCP/IP, EtherCAT, CC-Link IE, POWERLINK, HART/IP, OPC UA, MQTT etc.

During configuration of these upper-layer protocols, the switch equipment only handles intermediate data conversion and does not require an IP address or network management.

The CLSW-6PSE-2ETH switch can be used standalone or cascaded via its standard Ethernet ports. There is no limit to the number of switches that can be cascaded.

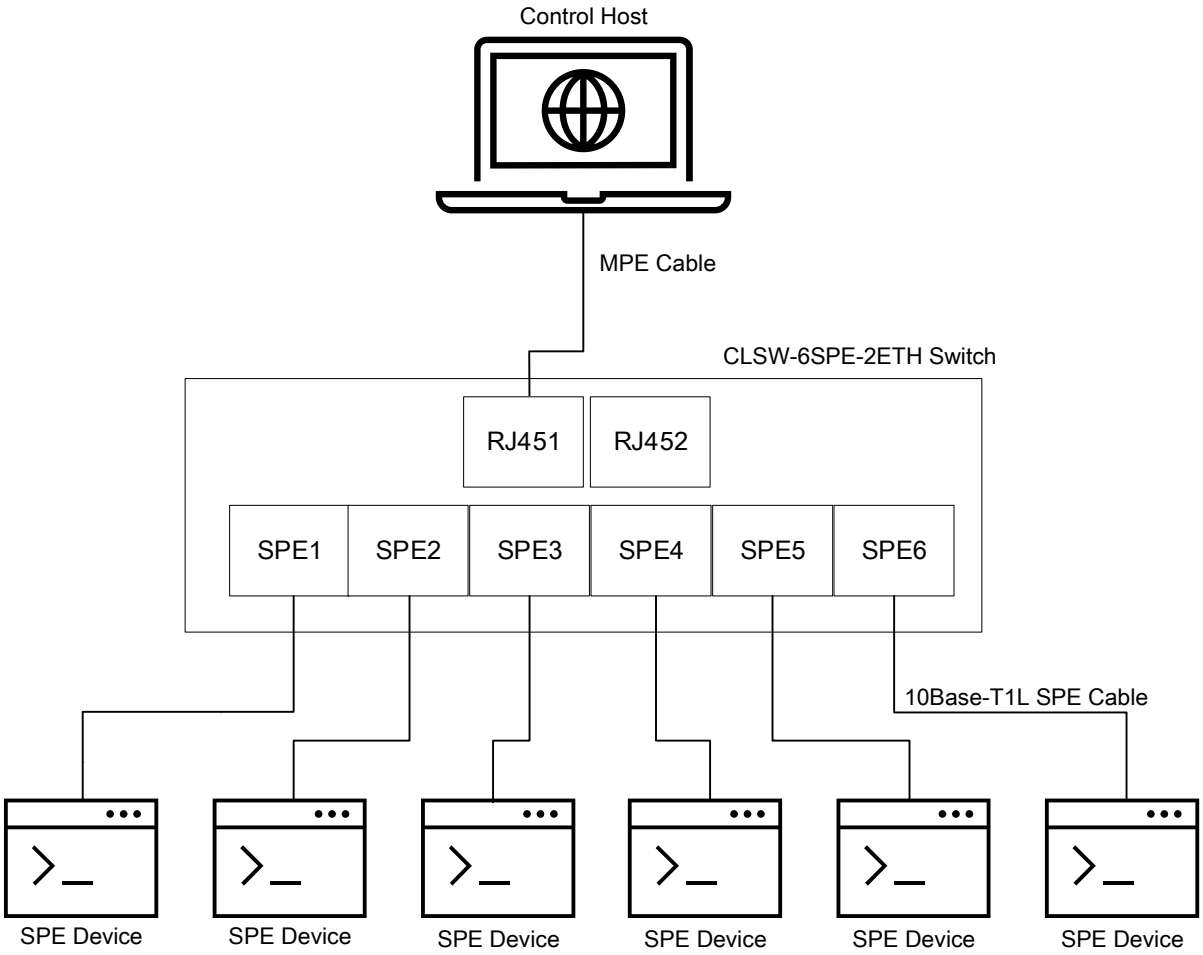
For devices that do not support SPE but have RJ45 interfaces, the Cooled product CLMC-SPE-ETH media converter can be used to connect them to the SPE network, taking full advantage of SPE's long-distance (up to 1500 m) capability.

The CLMC-SPE-ETH media converter can be powered via PoDL from the CLSW-6PSE-2ETH switch.

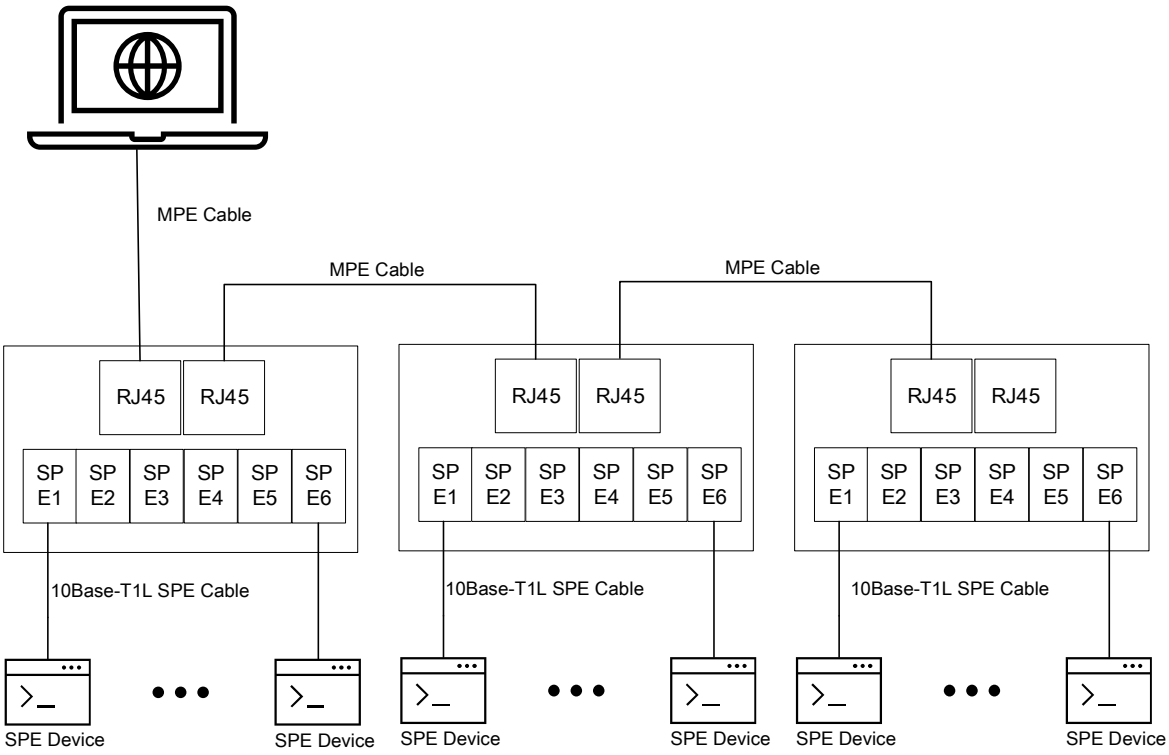
For devices using MODBUS-RTU, the Cooled CLMC-MODBUS-PSE converter can be used to connect them to the SPE switch. The converter could be powered via PoDL from

the CLSW-6PSE-2ETH. It converts MODBUS-RTU to MODBUS over TCP, allowing the host system to communicate directly using standard MODBUS TCP drivers.

4.1 Single switch topology



4.2 Multiple Switch Connection Topology 1



4.3 Multiple Switch Connection Topology 2