Power over Ethernet (PoE)

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Common Applications

- Voice-over-IP Telephone
- Point-Tilt-Zoom (PTZ) conference room and high quality video cameras.
- Wired security cameras
- Outdoor roof and tower mounted microwave data radio (for example: AREDN)
- WiFi access point
- Small Switches and Routers (PoE in).
- Intercom
- IPTV decoder
- Wall clocks
- Industrial control system
- Intelligent lighting & controllers
- Point-of-Sale system
- Inline Ethernet extenders (repeater).

History

- Pre-2003: Proprietary Voice over IP phones and wireless access devices powered over the Ethernet cable.
  - Primarily Cisco
- 2003: IEEE 802.3af standardized: polarity, voltage, safety, signaling, injection for ~13 watt source.
  - Chip suppliers produced ICs to support
    - PSE – Power Sourcing Equipment
    - PD – Powered Device
- 2003 + : Equipment manufacturers started to migrate to 802.3 PoE.
- 2009 and 2016: higher power PoE+ and PoE++ standardized by IEEE 802.3.
- Many older Ubiquity devices use 24 volt proprietary PoE.
  - Newer products appear to have migrated to standard 802.3 PoE/+/++.

3 Types of PoE

- 802.3af-2003 – nickname: PoE
  - Uses two pairs for power.   About 13 watts.
- 802.3at-2009 – nickname: PoE+
  - Uses two pairs for power.   About 26 watts.
- 802.3bt-2016 – nickname: PoE++
  - Uses four pairs for power.   About 51-71 watts.

10 / 100 Power injection modes

- Mode A: Typically Endspan injection (the switch injects the power onto the data pairs.
  - Has access to the transformer center-taps.

- Mode B: Typically Midspan injection (separate injector module inline injects power onto the unused pairs.
  - Does not have access to data pair transformer center-taps. (Otherwise need additional set of transformers to inject onto data pairs.)
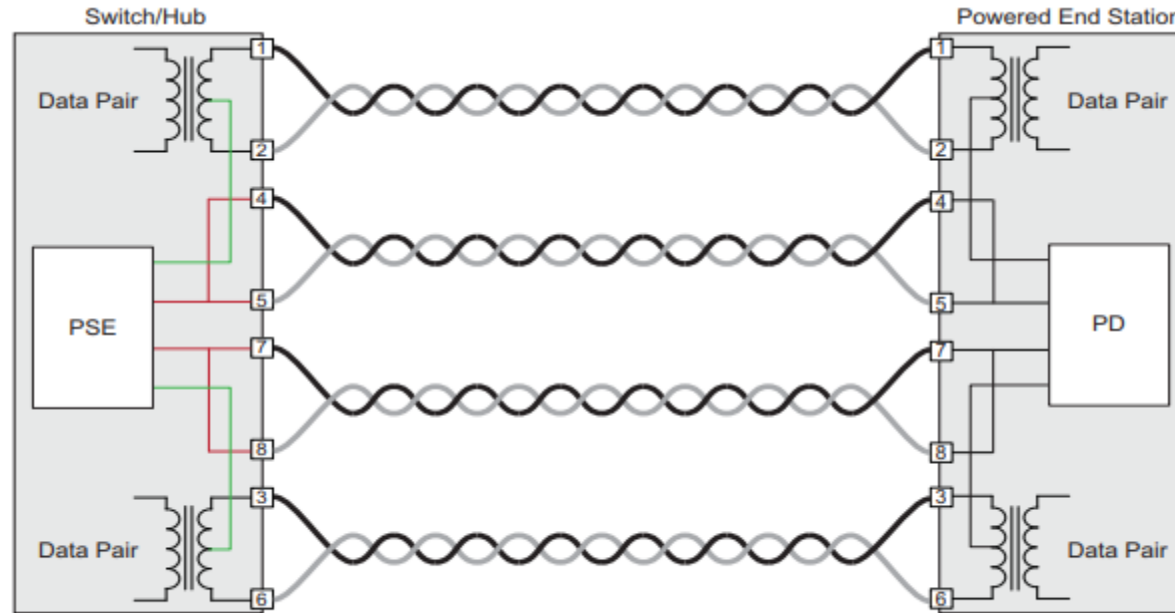
10 / 100 Endspan Injection PoE / PoE+

Figure 1: 10BASE-T/100BASE-TX Endspan Powered (Alternative A – Green; Alternative B – Red)

Note: color (red/green) distinguishes A/B mode, *NOT* the voltage polarity.

Figure: Microsemi

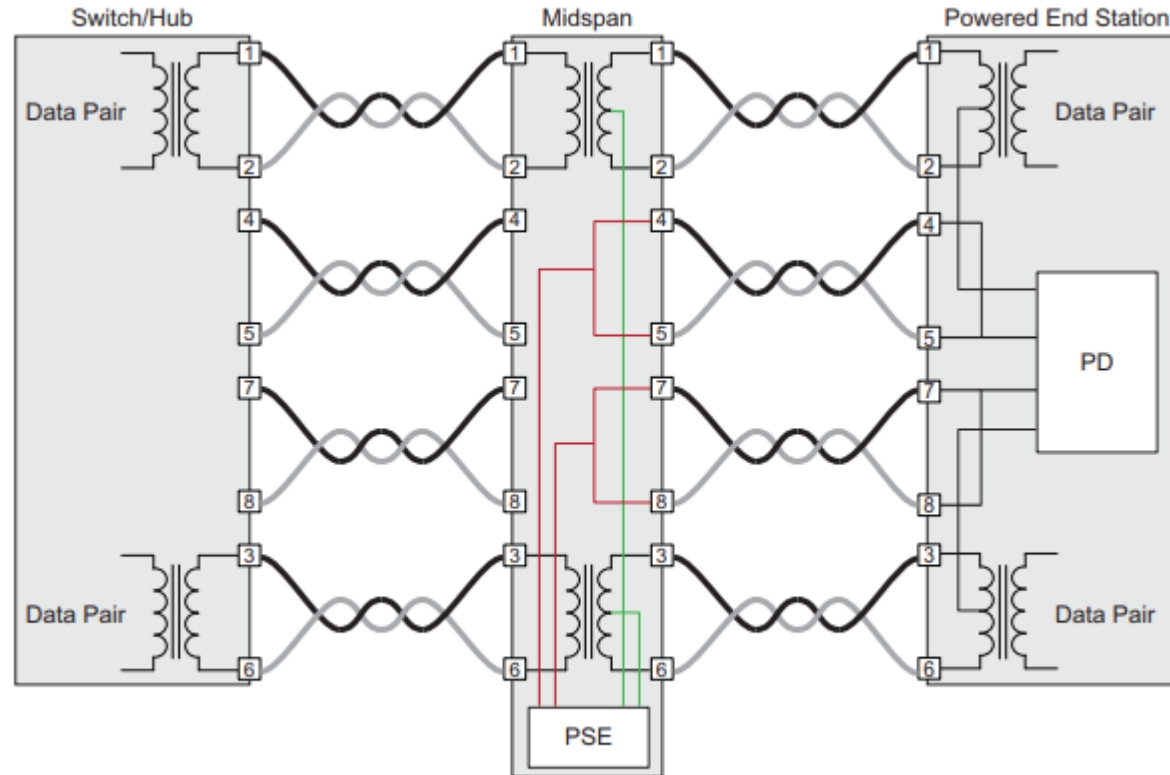# 10 / 100 Midspan Injection PoE / PoE+

Figure 3: 10BASE-T/100BASE-TX Midspan Powered (Alternative A – Green; Alternative B – Red)

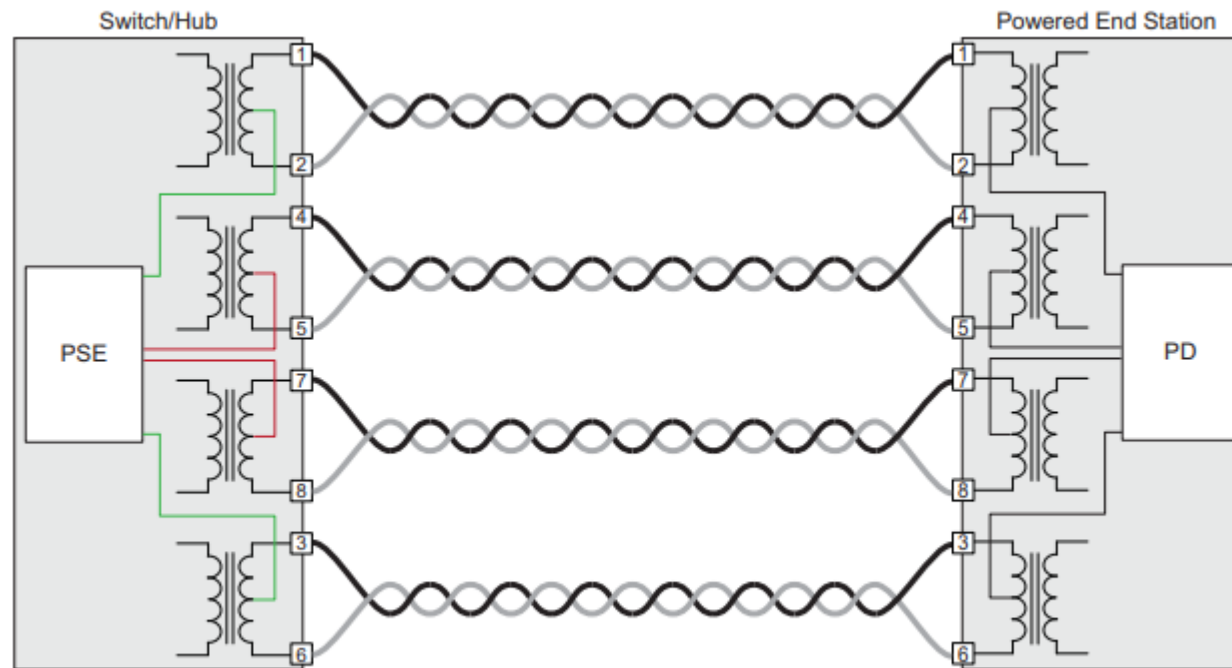Figure: Microsemi

1000 Endspan Injection PoE / PoE+

Figure 2: **1000BASE-T Endspan Powered (Alternative A – Green; Alternative B – Red)**

Figure: Microsemi
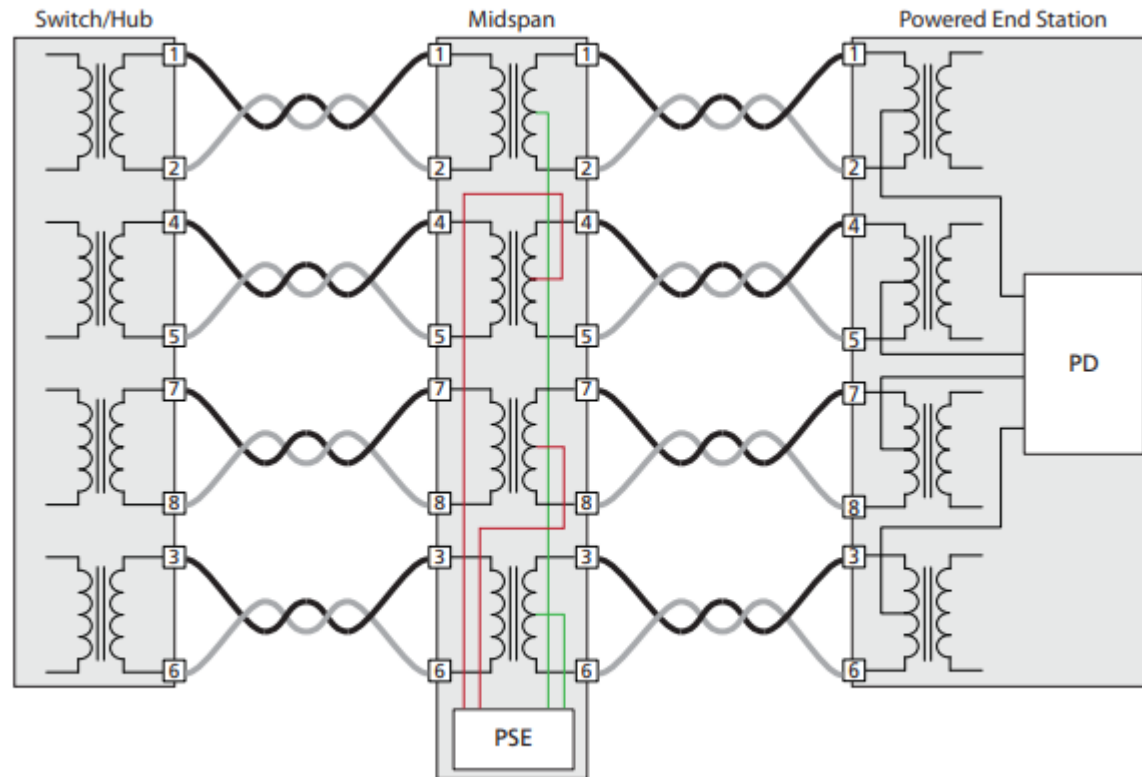
1000 Midspan Injection PoE / PoE+

Figure 4: **1000BASE-T Midspan Powered (Alternative A – Green; Alternative B – Red)**

Figure: Microsemi

PoE++ - Four pairs

- Essentially using the Green (mode A) plus Red (mode B) of the previous 1G PoE Endspan and Midspan figures.

Power Parameters

	Type 1 PoE	Type 2 PoE+	Type 3 PoE++	Type 4 PoE++
Power at PD	12.95 W	25.5 W	51 W	71 W
Voltage at PSE	44.0 - 57.0	50.0 – 57.0	50.0 – 57.0	52.0 – 57.0
Voltage at PD	37.0 – 57.0	42.5 – 57.0	42.5 – 57.0	41.1 – 57.0
Max Current	350 mA	600 mA	600 mA / pair	960 mA / pair
Max cable resistance	20 ohms	12.5 ohms	12.5 ohms	12.5 ohms

Safety

- The <u>Power Sourcing Equipment</u> (PSE) tests the load:
    - If open circuit – it limits the voltage to <= 19 volts.
    - If short-circuit – refuses to source power.
- The <u>Powered Device</u> (PD) must negotiate the current that it wants to consume *before* the PSE will supply the negotiated current.

Negotiating Power

- PD provides 19k – 26.5k *signature* resistance to indicate that it is a PoE-compatible device (and cable is neither open nor shorted).
- Then *classification* of the PD load begins:
  - Older method: PD tells PSE how much current is needed by consuming a specific classification current (at relatively limited voltage).
    - Only coarse current granularity.
    - Not as suitable for newer PoE+/++ standards.
  - Newer method: Use Ethernet Link-Layer Discovery Protocol (LLDP).
    - PSE powers up PD (limited voltage and current).
    - PD sends LLDP Type-Length-Value (TLV) packet requesting amount of current desired.
    - PSE responds with LLDP TLV packet specifying max current it will send.
- Then PSE ramps up the current to the PD.

Some Switches & Routers Integrate PoE Endspan Injectors.

- Much neater installation: eliminates separate injector-per-cable.

- Lower-end: Example: provide 4 regular and 4 PoE ports.
  - These are disappearing, being replaced by 8-port PoE+ switches.

- Higher-end: Example: provide 24 PoE+ ports.
  - Usually limited to 450-500 watts maximum, so cannot power all ports at full power.

PoE and PoE+ wiring

802.3af/at standards A and B from the power sourcing equipment perspective (MDI-X)

Pins at switch	T568A color	T568B color	10/100 mode B, DC on spares		10/100 mode A, mixed DC & data		1000 (1 gigabit) mode B, DC & bi-data		1000 (1 gigabit) mode A, DC & bi-data	
Pin 1	White/green stripe	White/orange stripe	Rx +		Rx +	DC +	TxRx A +		TxRx A +	DC +
Pin 2	Green solid	Orange solid	Rx −		Rx −	DC +	TxRx A −		TxRx A −	DC +
Pin 3	White/orange stripe	White/green stripe	Tx +		Tx +	DC −	TxRx B +		TxRx B +	DC −
Pin 4	Blue solid	Blue solid		DC +	Unused		TxRx C +	DC +	TxRx C +	
Pin 5	White/blue stripe	White/blue stripe		DC +	Unused		TxRx C −	DC +	TxRx C −	
Pin 6	Orange solid	Green solid	Tx −		Tx −	DC −	TxRx B −		TxRx B −	DC −
Pin 7	White/brown stripe	White/brown stripe		DC −	Unused		TxRx D +	DC −	TxRx D +	
Pin 8	Brown solid	Brown solid		DC −	Unused		TxRx D −	DC −	TxRx D −	

Source: Wikipedia

References

- Get IEEE 802.3
  - Complete standard available for free (6 months old version).
    - https://ieeexplore.ieee.org/browse/standards/get-program/page/series?id=68
- IEEE 802.3 Working group public area:
  - Additions to the standard currently in-process:
    - https://www.ieee802.org/3/
  - In-process drafts are not publically available.