Understanding 802.3at

PoE Plus Standard Increases Available Power

June 2011

Overview

Power over Ethernet (PoE) has greatly eased the deployment of many IP-enabled devices by allowing the same cable that delivers data to also deliver power. With PoE, devices such as security cameras can be controlled and powered via a single cable, reducing the cost of installation.

The rollout of PoE first started with proprietary solutions, but with the introduction of IEEE 802.3af in 2003, standardization was brought to the PoE market. However, 802.3af applications are limited in the amount of power they can consume. The recently introduced IEEE 802.3at-2009, also known as PoE Plus, nearly quadruples the available power to 51 watts, greatly expanding the range of potential applications.

PoE Basics

Two major drivers were behind the development of power over Ethernet (PoE): voice over IP (VoIP) and wireless networking (WLAN). In the case of VoIP, the need to support desktop phones without an additional power supply drove the desire to line power the phones similar to the way plain old telephone service (POTS) had done, where DC power is transmitted along with data. For WLAN applications, access points are often needed where it may be impractical or expensive to run AC power. The ability to power Ethernet devices with the same cable used for data decreases the costs of deploying IP technology.

There are additional advantages gained with the deployment of PoE:

- Easier control over the power of remotely connected devices, which leads to better overall network power management.
- Enables easy building-wide power back-up of critical systems; for example, all VoIP telephones, security cameras, etc. can be supplied with redundant power during power outages and brownouts via their network connections alone.
- Lower cabling cost because no additional wiring is needed to support powering the remote device.
- Lower installation costs because a licensed electrician is not needed to run data cable, nor must the installation be officially inspected.

Power Network Topology

Whereas the first solutions were proprietary in nature, the introduction of IEEE 802.3af brought standardization to the market—standardization that was further enhanced with the recent adoption of IEEE 802.3at. The new standard defines two power topologies. In the first scenario, power is supplied via power-sourcing equipment (PSE) located in the switch/hub (endspan). In the second scenario, the standard allows for power insertion in the network via a PSE located in a midspan, allowing for support of legacy networks as well as more control of which network segments are powered. The network device at the other end is simply referred to as a powered device (PD).

PoE is supported for 10BASE-T, 100BASE-TX, and 1000BASE-T networks.

PSE

From a power perspective, 802.3at defines two types of PSEs:

- Type 1 (over two pairs) – The PSE can supply a maximum of 15.4 W over a voltage range of 44 to 57 VDC using Category 3 cabling or better. This type provides support for legacy installations.
- Type 2 – The PSE can supply 30 W (over two pairs) or 60 W (over four pairs) over a voltage range of 50 to 57 VDC using Category 5 or better cabling.

The standard supports two alternatives for power injection (refer to the "Powering Schemes" section on page 3):

- Alternative A, where power is supplied via the center taps of the coupling transformers on data pairs 1/2 and 3/6.
- Alternative B, where power is transmitted over pairs 4/5 and 7/8.

PD

The PD is limited to a maximum of 13.0 W for Type 1, 25.5 W for Type 2 over two pairs, or 51 W for Type 2 over four pairs, all over a voltage range between 37 V to 57 VDC (which accounts for worst-case power losses in the cable). The PD must be capable of receiving power regardless of which powering scheme is used.

The PD negotiates a power class during the time of initial connection (see "Power Management"). To prevent damage to non-PoE devices, all PDs must include a 25 kΩ resistor across powered pairs to allow for detection by the PSE. This scheme also allows the PSE to detect when a PD is disconnected from the network. The detection signature is visible by both Alternative A and Alternative B PSEs.

Powering Schemes

There are four basic powering schemes, each with two alternative power insertion methods (alternative A shown in green; alternative B shown in red):

- Endspan PSE, supporting 10BASE-T/100BASE-TX networks only (Figure 1)
- Endspan PSE, supporting 10BASE-T/100BASE-TX/1000BASE-T (Figure 2 on page 4)
- Midspan PSE, supporting 10BASE-T/100BASE-TX networks only (Figure 3 on page 4)
- Midspan PSE, supporting 10BASE-T/100BASE-TX/1000BASE-T (Figure 4 on page 5)
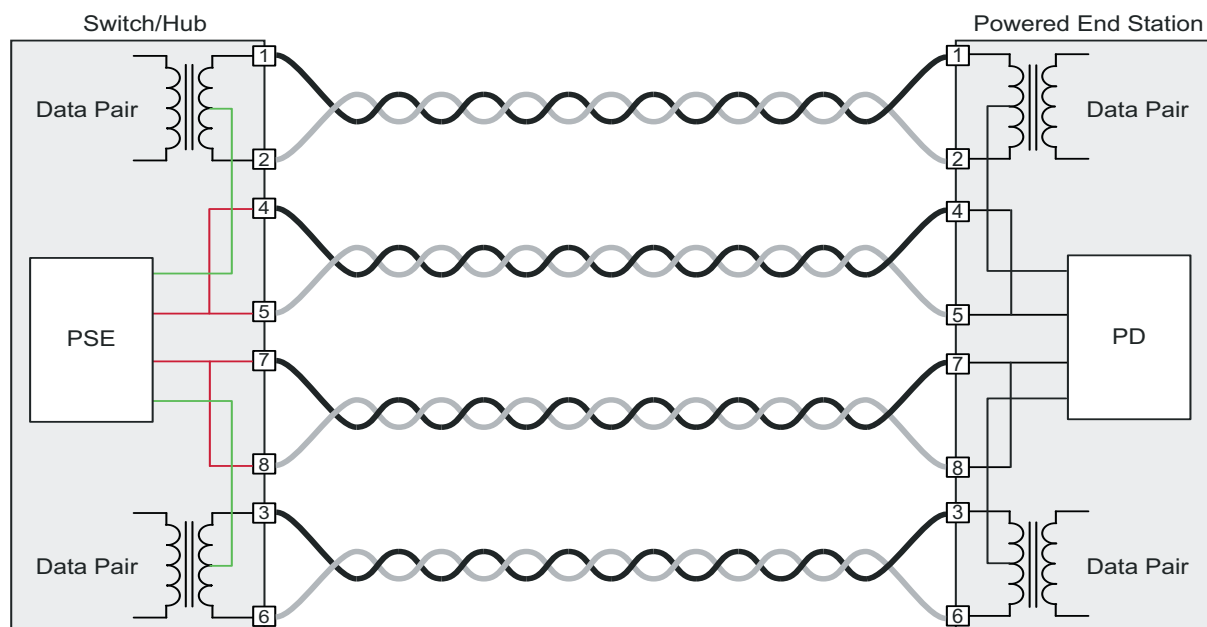

Figure 1: **10BASE-T/100BASE-TX Endspan Powered (Alternative A – Green; Alternative B – Red)**
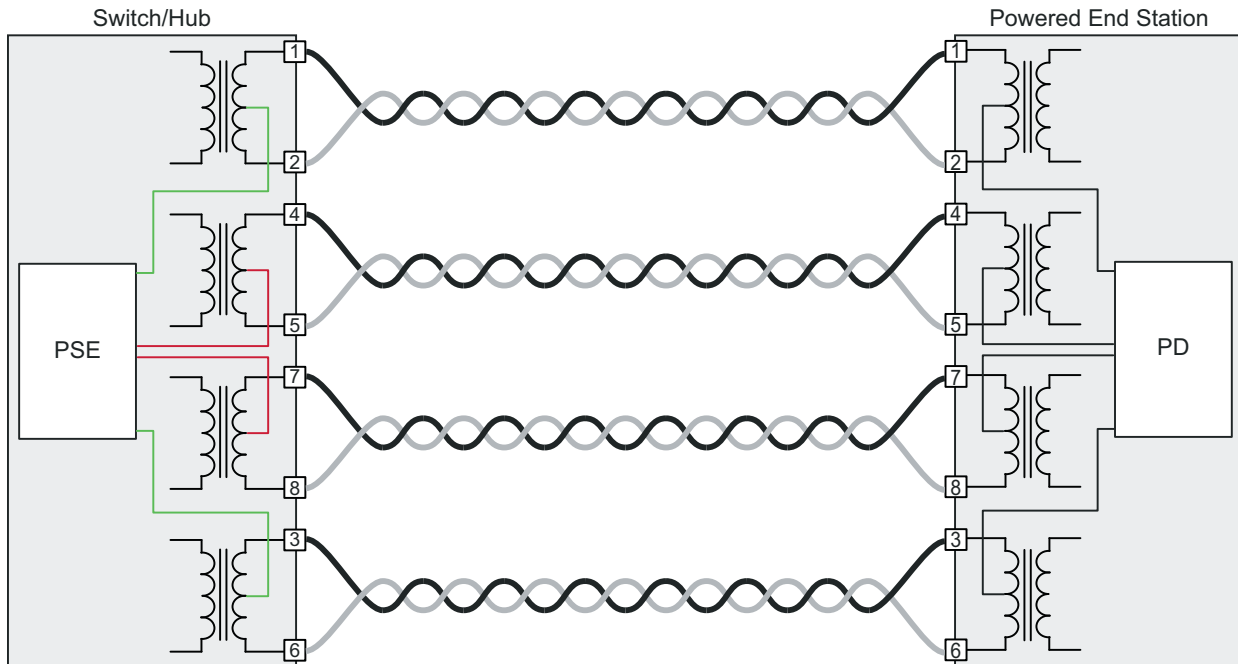
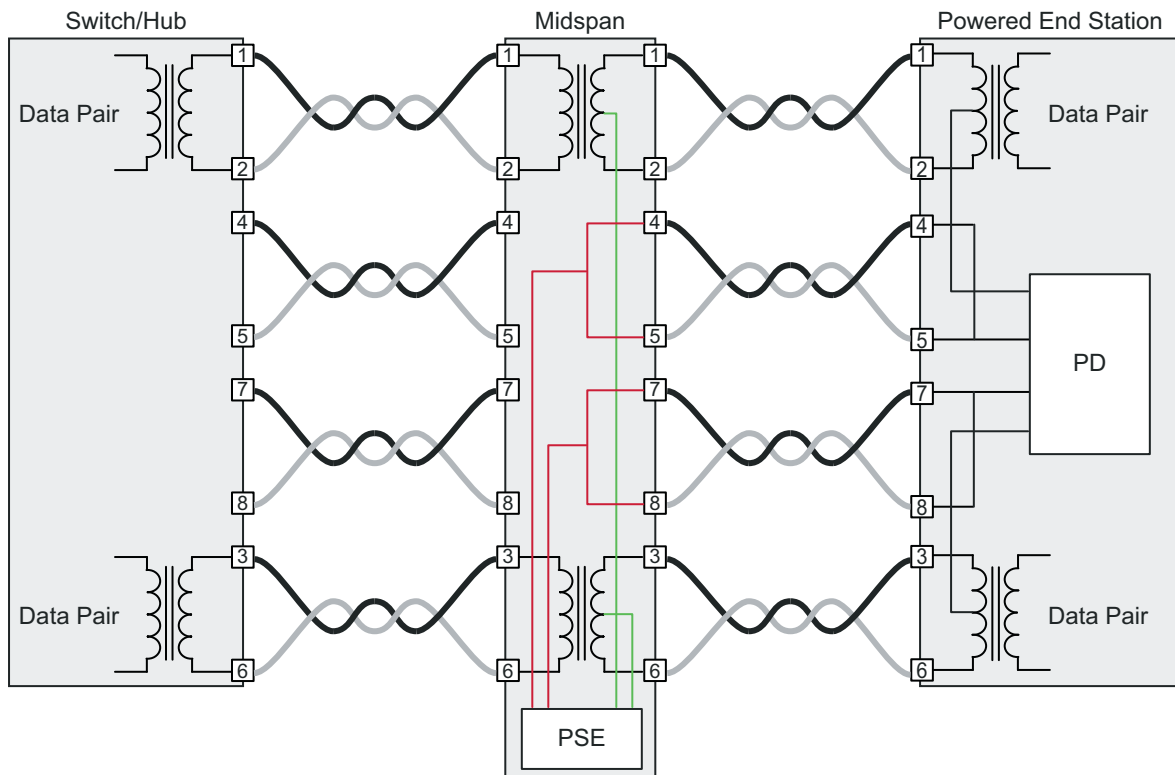*Figure 2:* **1000BASE-T Endspan Powered (Alternative A – Green; Alternative B – Red)**

Figure 3: **10BASE-T/100BASE-TX Midspan Powered (Alternative A – Green; Alternative B – Red)**
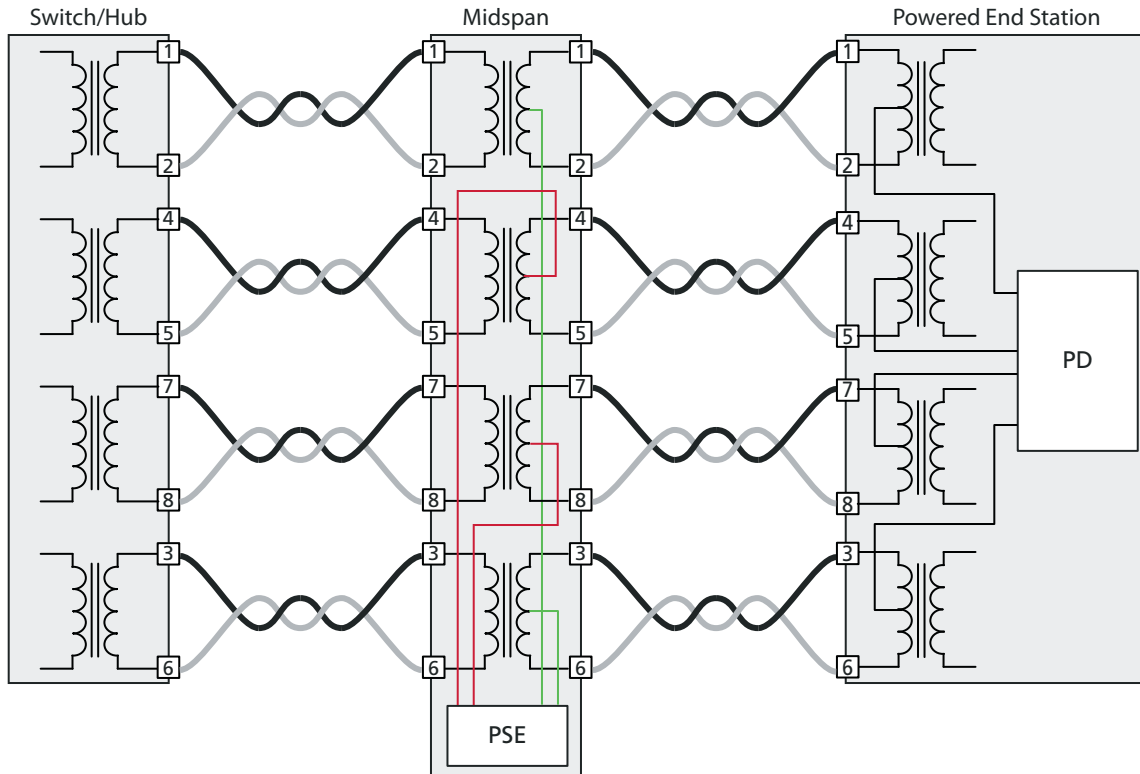
Figure 4: **1000BASE-T Midspan Powered (Alternative A – Green; Alternative B – Red)**

Interoperability

Essential to successful deployment of IEEE 802.3at equipment is its ability to coexist with IEEE 802.3af network elements. In other words, an 802.3at PSE needs the ability to power 802.3af PDs on both Category 3 and Category 5 cabling. Similarly, an 802.3at PD has to detect whether it is being powered via an 802.3af or 802.3at PSE. From the perspective of the standard, network elements compatible only with 802.3af are classified as Type 1, and elements compatible with 802.3at are listed as Type 2.

During link power-up, both Type 2 PSEs and Type 2 PDs identify the link type before applying full power.

Power Management

During link power-up, after determining the type of link, the PSE must determine the power classification of the PD (basically how much power must be supplied to the PD). The standard provides two mechanisms for managing power supplied to the PD: physical layer or data link-layer classification.

Physical Layer Classification

Physical layer classification uses the link's cable and PD electrical characteristics to determine which power class to assign the PD. This classification mechanism is similar to that used in 802.3af but adds an additional power class (Table 1). Four-pair PDs may exhibit different class levels for each of their connections (Alternate A and B).

Table 1: **Power Classes (for Two-Pair Powering)**

Power Class	Maximum Average Power Available at PD
Class 0	13.0 W
Class 1	3.84 W
Class 2	6.49 W
Class 3	13.0 W
Class 4	25.5 W

Data Link-Layer Classification

With data link-layer (DLL) classification, after the data link is established, the PSE and PD communicate using Media Endpoint Discovery—an extension of the Ethernet Link Layer Discovery Protocol (LLDP-MED). This classification method has finer power resolution (1.11 W increments) than the physical layer classification scheme and the ability for the PSE and PD to participate in dynamic power allocation during PD operation. The PD can periodically communicate its power requirements to the PSE.

Type 2 PDs requiring more than 13.0 W must support data link-layer classification but the method is optional for all other devices, making allocation of power solely based on classification problematic.

Advanced Techniques

Power classification is a coarse method for determining actual power consumption since it specifies only the worst-case power needed by a PD, leading to power inefficiencies. To combat this issue, advanced PSEs either sense the amount of power actually required by the PD dynamically or employ a mix of classification with dynamic sensing.

Conclusion

Power-over-Ethernet has proven popular as a means of powering remote connected devices such as VoIP telephones, WLAN access points, and network cameras. The first PoE standard limited delivered power to 12.95 W, but the recent introduction of IEEE 802.3at nearly quadruples the delivered power to 51 W, paving the way to turning the Ethernet jack into the first universal power port.

Microsemi.®

Microsemi Corporate Headquarters
One Enterprise, Aliso Viejo, CA 92656 USA
Within the USA: +1 (800) 713-4113
Outside the USA: +1 (949) 380-6100
Sales: +1 (949) 380-6136
Fax: +1 (949) 215-4996
email: sales.support@microsemi.com
www.microsemi.com

Microsemi Corporation (Nasdaq: MSCC) offers a comprehensive portfolio of semiconductor and system solutions for communications, defense & security, aerospace and industrial markets. Products include high-performance and radiation-hardened analog mixed-signal integrated circuits, FPGAs, SoCs and ASICs; power management products; timing and synchronization devices and precise time solutions, setting the world's standard for time; voice processing devices; RF solutions; discrete components; security technologies and scalable anti-tamper products; Power-over-Ethernet ICs and midspans; as well as custom design capabilities and services. Microsemi is headquartered in Aliso Viejo, Calif., and has approximately 3,400 employees globally. Learn more at www.microsemi.com.