

Application Note

Power Over Ethernet (PoE)

12th September, 2007

CUE, a.s., K Nouzovu 2090/6, 143 00 Praha 4, Czech Republic
phone: +420 241 091 240
fax: +420 241 432 446
www.cuesystem.com
support@cuesystem.com

cue

OVERVIEW

The CUE has implemented Power Over Ethernet (PoE) to touch panels airCUE and, in near future, is going to do so with other products as well.

Power over Ethernet (PoE), sometimes also called Active Ethernet, provides a way for your network devices to be powered by their data cables rather than by separate power cords. Power over Ethernet works much like serial USB—just plug in one cable and your device works. In many applications, particularly in the installation of touchpanels, keyboards, sensors, wireless access points or IP telephones, PoE can significantly reduce installation costs.

POWER OVER ETHERNET BENEFITS

Power over Ethernet is suitable for use with low-power peripherals such as touchpanels, control keyboards, sensors, IP telephones, wireless access points, Web cameras, and audio speakers. PoE is ideal for applications such as building control and management, video surveillance, retail video kiosks, smart signs, vending machines, and retail point of information systems.

The primary advantage of PoE is that you only have to run one cable—the data cable—to each peripheral. This simple elimination of a separate power cable provides a wide range of benefits.

- Save money by eliminating the need to run electrical wiring. By eliminating the need to install separate outlets for data and power, users can save up to 50% in installation costs.
- Easily move peripherals with minimal disruption.
- If your LAN is protected from power failure by a UPS, the PoE devices connected to your LAN are also protected from power failure.
- Safety - no mains voltages usage, only safe direct-current 48V levels (SELV).
- As PoE becomes more common, the 8-pin modular connector will become the industry-standard power jack.
- Central management— by adding your low-voltage peripherals to your Ethernet network, everything from control touchpanels to the HVAC system can be accessed and controlled over your network.
- Inexpensive to implement. Power over Ethernet is an extension of the Ethernet standard, meaning it's universal and inexpensive.
- It's easy—most people already know how Ethernet works!

POWER OVER ETHERNET STANDARD - IEEE 802.3AF

The most popular PoE standard is the IEEE 802.3af specification adopted in 2003, which describes Ethernet Power- Sourcing Equipment (PSEs) and Powered Devices (PDs). 802.3af calls for 48 volts of AC power over unshielded twisted-pair (UTP) cabling. It works with any grade of UTP wire, including Category 3, 5, 5e, and 6. The specification is compatible with standard Ethernet UTP hardware, including patch panels and outlets, without requiring modification.

Before the official IEEE 802.3af specification was adopted in 2003, many pre-standard versions of PoE were in use, most notably a Cisco PoE standard introduced in 2000. Although these older standards still have an installed base, newer PoE products usually follow the IEEE 802.3af standard.

The 802.3af standard calls for the maximum power available to any powered device to be 12.95 W with a voltage range of 36 V DC to 57 V DC. This is more than enough to power typical PoE devices such as wireless access points.

802.3af equipment contains a detection mechanism to prevent sending power to noncompliant devices. Only devices that present a PoE signature receive power. If a non-PoE device is accidentally plugged in, it won't receive power and won't be damaged. This power detection mechanism also provides an optional means of identifying the amount of power required by each device.

POE SYSTEM ARCHITECTURE

The IEEE 802.3af specification defines PSE as the element responsible for inserting power onto a Ethernet cable. The PD is the natural termination of this link, receiving the power, and could be a touchpanel, keypad, controller, interface, IP phone, a WLAN access point or any other IP device requires power.

There are two basic types of PSE: Endspan and Midspan. Endspan PSE integrates PoE into Ethernet switches, while Midspan PSE is an element resides between the switch and the terminal, providing power only.

Endspans are mainly for green-field installations thus what many vendors are starting to sell. Midspan devices, on the other hand, are for organizations looking to upgrade a network without replacing existing switches.

The Endspan is a switch that integrates the PoE source, to simplify the infrastructure, using "Phantom Feeding" on the center tap of the Ethernet pulse transformer. 802.3af allows the Endspan to use the spare pairs for power delivery instead of the data pairs, though the latter configuration is more commonly used (Fig. 1).

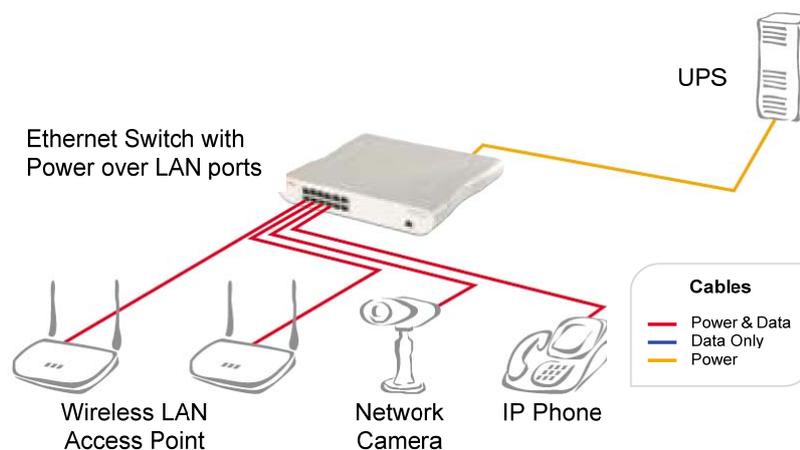


Fig. 1 - Endspan PSE configuration

The Midspan is a patch panel like device that receives data lines from the switch and inserts power over the spare pairs, providing data and power out to the PD (Fig. 2).

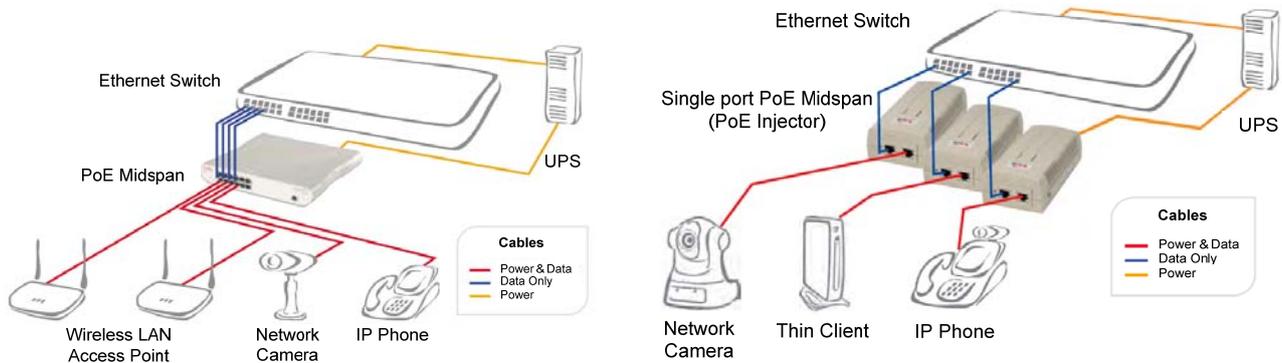


Fig. 2 - Midspan PSE configuration

POE ELECTRICAL PARAMETERS

The standard IEEE 802.3af defines some electrical parameters to be kept in PoE design:

- Operating voltage is normally 48 V dc, but it may vary between 44 to 57 V dc. In any case it should always be under the maximal SELV requirement of 60V dc.
- Maximal current generated by the PSE is to vary between 350 to 400 mA. This level protects the Ethernet cables from over heating due to their parasitic resistance.
- The above values result in minimum of 15.4 watts in the PSE's port output. After cable loss, caused by parasitic resistance of about 20 Ω for a pair, the maximal power a PD can count on is 12.95 watts.

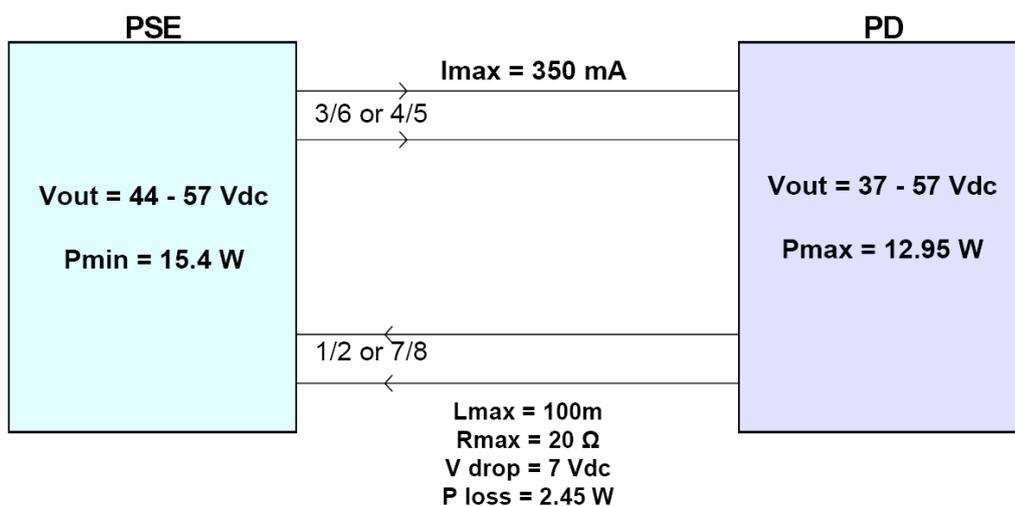


Fig. 3 - PSE and PD interconnection

802.3af works very simply. A standard CAT5 Ethernet cable has four twisted pairs, but only two of these are used for 10BASE-T and 100BASE-T. The specification allows two options for using these cables for power:

- The spare pairs are used. Figure 4 shows the pair on pins 4 and 5 connected together and forming the positive supply, and the pair on pins 7 and 8 connected together and forming the negative supply. (In fact, a late change to the spec allows either polarity to be used).
- The data pairs are used. Since Ethernet pairs are transformer coupled at each end, it is possible to apply DC power to the center tap of the isolation transformer without upsetting the data transfer. In this mode of operation the pair on pins 3 and 6 and the pair on pins 1 and 2 can be of either polarity. This is shown in Figure 5.

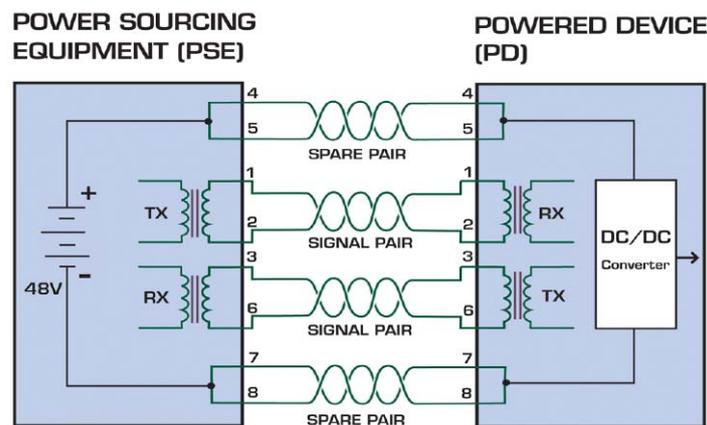


Fig. 4 - Power Through the Cable on the Spare Pairs

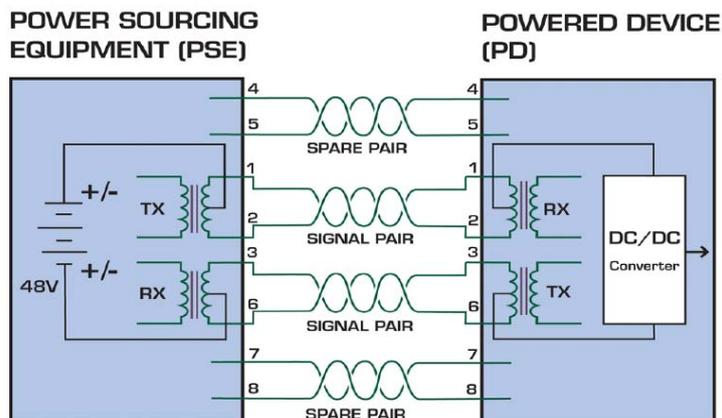


Fig. 5 - Power Through the Cable on the Data Pairs

Although sending power over the data pairs rather than the spare pairs would seem to be counterintuitive, data and power transmissions don't interfere with each other because electricity is DC, and data transmissions have frequencies that can range from 10 to 100 MHz. Because data and electricity are at opposite ends of the frequency spectrum, they can travel over the same cable without interference.

THE POE PROVISION PROCESS

While adding PoE support to networked devices is relatively painless, it should be realized that power cannot simply be transferred over existing CAT-5 cables. Without proper preparation, doing so may result in damage to devices that are not designed to support provision of power over their network interfaces.

Figure 6 below illustrates the basic necessary elements required during the PoE power provisioning cycle. The PSE is the manager of the PoE process. In the beginning, only small voltage level is induced on the port's output, till a valid PD is detected during the Detection period (1). The PSE may choose to perform classification (2), to estimate the amount of power to be consumed by this PD. After a timecontrolled start-up (3), the PSE begins supplying the 48 Vdc level to the PD (4), till it is physically or electrically disconnected (5). Upon disconnection, voltage and power shut down. Right afterwards, the cycle is restarted (1).

Several incidents as consumption overload, short circuit, out-of-power-budget and other scenarios, may terminate the process in the middle, only to restart it from phase (1) again.

Since the PSE is responsible for the PoE process timing, it is the one generating the probing signals prior to operating the PD and monitoring the various scenarios that may occur during operation. All probing is done using voltage induction and current measurement in return.

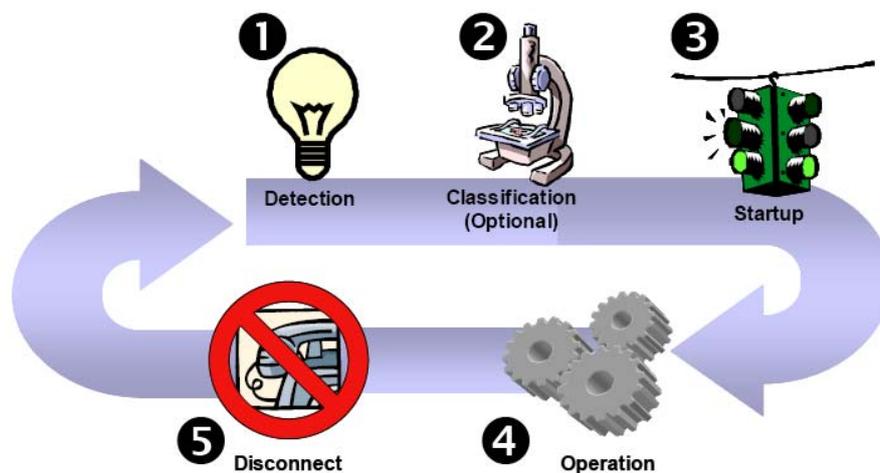


Fig. 6 - PoE Process Cycle