

Enabling devices for a Power over Ethernet world

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Introduction

Power over Ethernet (PoE) brings a host of benefits to the design, implementation and long-term usability of wired Ethernet local area networks (LANs). Cost, flexibility and even safety are all enhanced. PoE overcomes the major limitation that system designers often encounter whereby they must locate powered network devices within close proximity to AC power outlets.

With PoE, both data and power at a safe nominal 48VDC are carried over the same Ethernet cable. If network devices can be configured to run from 48V, the need for devices on the network to be supplied with intrinsically unsafe AC power from a separate power cable connected to a building's AC ring main is eliminated. The freedom this gives to position devices where they are needed rather than where power cords dictate, and the long-term flexibility to move devices around to suit the changing operational needs of the business, are both highly desirable benefits for any organisation. As an example, networked security cameras benefit from PoE as they normally need to be sited high up on walls, away from AC outlets. Typical devices used on a powered Ethernet such as VoIP phones, cameras and Wi-Fi access points may need to be specially designed or adapted to run from Ethernet 48VDC. DC/DC converters in the network devices will normally be required to drop and isolate the 48V supply down to a lower voltage such as 5V, suitable for the device circuitry. To take full advantage of PoE, the network devices will also be required to handle the handshaking process that allows the network hub to recognise a device as being PoE enabled and understand and manage its specific power needs.

The basics of a PoE network

There are three main elements to a PoE system:

Power sourcing equipment (PSE) – Connected to the Ethernet switch and often itself powered by an uninterruptible power supply (UPS) providing 48V, the PSE feeds data to all devices on the network, and data plus power to all PoE compatible devices. Although the nominal output is 48VDC, the allowed range is 44 to 57VDC.

Powered device (PD) – The range of PoE powered devices is continually growing as the adoption of, and market for PoE continues to expand rapidly. Current types of enabled devices include VoIP phones, EPOS systems and Wi-Fi access points. The PD gives a 'signature' to the PSE to indicate that it is PoE enabled and how much power it requires. The management and conversion of the incoming power is normally handled by a DC/DC converter in the PD, described in more detail later in this article.

Cable – Ever since CAT5 cable was invented for the purpose of carrying data, the spare conductors have been utilised to additionally carry power to the other end of the cable. The PoE standard IEEE802.3af defines the detail of how this is done and provides the platform for industry to adopt a single approach for the design and implementation of PoE.

Transferring power to the PD

A standard CAT5 Ethernet cable has four twisted pairs, only two of which are required for the transmission of data. With PoE, there is a high degree of flexibility with the IEEE802.3af standard allowing DC power of either polarity to be transferred using either the two spare pairs or superimposed on the two data pairs. Fully compliant PoE Devices must be able to accept power from either option.

Currently, the IEEE standard allows nominal 48V and approximately 15W of power to be transferred over a single powered Ethernet cable with a minimum of about 13W available to the powered device. The restricted available power does limit the types of peripheral devices that can be used with PoE. However, future changes to the standard are being proposed which will allow for much higher power levels and consequently a wider variety of devices to be operated via Cat5 cables on the Ethernet. PoE-enabled laptops for example might be charged directly from network connections without cumbersome AC adapters.

In order to prevent damage to existing Ethernet equipment, which may not be compatible, the IEEE802.3af standard requires that a 'discovery process' be instigated by the PSE. This examines the cables looking for PoE enabled devices. It checks for the presence of a 25KOhm parallel resistor in the remote devices and only if this is found is the full 48V applied. The supply is current-limited to prevent any damage to the equipment and cables should a fault condition occur. Before connection, the PD also signals back to the PSE what current it expects to draw in four categories. If the powered device does not draw a minimum current - which may occur for example when the device is unplugged from the network - then the PSE removes the power from that particular cable and is then aware that the power is available for other devices. The PSE might also remove power from selected non-critical devices on a power outage, to maximise the run time of a UPS, maintaining more critical security devices.

Power conversion

Isolated DC/DC converters are usually required within PoE enabled devices to transform the 48V supply to a lower voltage appropriate for the PD. IEEE802.3af defines stringent low-noise, start-up and isolation requirements for the converters to be used in PoE applications. As an example, the C&D Technologies NPH10 range is ideally suited. C&D also offers a full interface solution in its NMPD product which integrates the data isolation transformers, PoE handshaking and DC/DC conversion

with customer-specified output voltage. The SIP module provides the full PoE-compliant data and power interface to the Ethernet line.

The 48V Ethernet power source is also defined by the IEEE standard, (actually 44 to 57VDC) at the hub. However, with significant voltage drops along the Ethernet cables, the PoE standard allows the minimum voltage at the powered devices to be as low as 30V. The nominal 48V can be derived from an AC/DC converter but also from an existing system 48V. In this case another high power isolated DC/DC converter is required in the PSE. Although not defined by the PoE standards, this DC/DC converter, designed to be incorporated into the PSE, should ideally possess a number of characteristics and features to make it more suited to the task. As an example, C&D Technologies' HHS04-520 has been specifically designed with PoE in mind. As well as complying with the requirements of the standard, it has extremely high power density enabling it to manage and deliver 200W in a very small package. This is important as many non-PoE hubs may be re-engineered to make them suitable for use on a powered network. Engineers will often be tasked with squeezing any PoE related circuitry into the existing enclosure - so clearly the smaller the converter the better.

The HHS04 operates from a nominal 48V input and delivers an isolated 52.5V and 200W at its output with a high efficiency of 92% at full load. IEEE802.3af specifies an open frame design that allows for better thermal management of the product when fitted in the end system. It also decreases component stress levels to provide increased reliability and module longevity. C&D also has a 400W part in development, the HHS08, for larger PoE systems.

Other useful features of a DC/DC converter that engineers may wish to consider when designing PoE enabled devices include over-temperature protection, remote sense and remote on/off and output trimming.

Next generation DC/DC converters for PoE enabled network devices are likely to include functions such as device to PSE handshaking and Ethernet data isolation within more integrated packages. This will help simplify the task of developing PoE devices by decreasing the amount of electronics design work required and reducing the PCB real-estate needed within the device to give PoE compatibility.

Summary

PoE is undoubtedly going to change the way that many pieces of electrical equipment are powered. The benefits and flexibility that the approach provides are huge and make it impossible to ignore for businesses of all types. For companies building new premises or those refitting their existing locations, it is well worth them considering becoming early adopters of PoE.

SIDEBAR

Benefit breakdown

The key benefits of a PoE network compared to a network with power supplied by conventional AC power cords are:

- **Flexibility** to install devices regardless of proximity to AC mains and move them around to suit changing workplace requirements.
- **Safety** as no mains voltage is present.
- **Low cost of deployment** through reduced amount of wiring which need not be installed by certified electricians.
- **Enhanced operational support** through simple network management protocol (SNMP) that allows control of devices remotely to perform functions such as shut down and resetting.
- **Simplified international deployment** as manufacturers do not need to satisfy the different mains power requirements of various countries.

Continuous power is guaranteed, as using a UPS ensures that the entire PoE network is unaffected by a mains power failure.