

VERACITY WHITE PAPER 001:

POWER WITHOUT THE STRUGGLE

THE BENEFITS OF POE TECHNOLOGY, AND HOW TO TAKE FULL ADVANTAGE OF THEM

Summary

Power over Ethernet (PoE) compatibility has become commonplace as a feature of network devices in many technological fields, and, thanks to the adoption of a near-universal standard, PoE is a simple and robust means to implement power distribution in networked installations. Yet despite this, the technology is still not well understood, or being used to best advantage, by those designing and installing networks. For example, many hardened IT gurus, skilled in the design of VoIP or wireless installations, may find even the basic concepts of electrical power to be alien and uninteresting. Conversely, security installers with a wealth of experience in more traditional wiring may not be able to translate this expertise to the power distribution within the newer medium of network cabling, when planning a digital video or access control system.

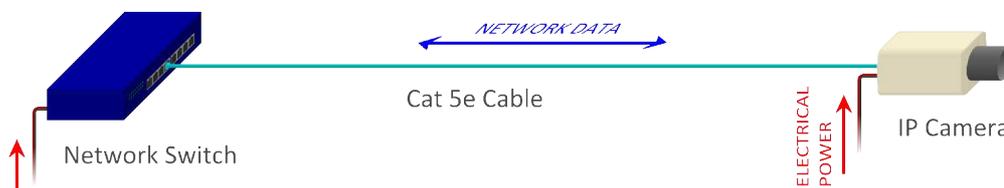
In order to address this, this article provides an introduction to the basic concepts of PoE technology, and presents the case for deploying PoE wherever possible, explaining the evident benefits and introducing some more subtle advantages as well. The limitations of PoE in its usual form are also considered, and recommendations are made for making best use of the technology when designing an installation.

PoE – the very basics

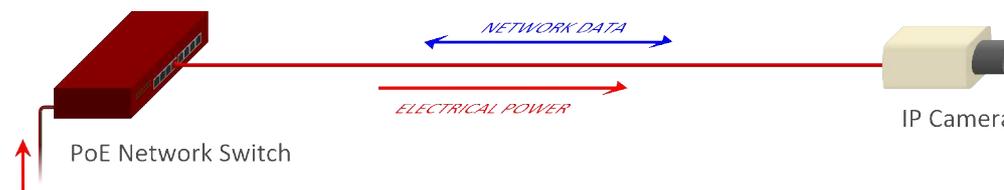
To explain PoE's operation we must start with a few definitions. The term “Power over Ethernet”, as might be expected, refers to the use of Ethernet data cabling to carry electrical power, in order to allow devices such as IP video cameras to receive their power, and communicate with a network, via a single connection. However, the definition is usually narrower than this: if a device is described as “PoE compatible”, this normally indicates that it complies with the universal standard for PoE, *IEEE 802.3af*, which means that it can safely be connected to other PoE compatible devices.

As well as dictating how PoE devices must behave, this standard also contributes to the myriad of terms used to describe PoE equipment and applications. These are defined across a single network link, i.e. two devices connected by a network cable: an IP camera, wireless access point, etc., which receives its power supply via its network cable is termed a *PD* (Powered Device); and a device that makes power available on the cable is known as a *PSE* (Power Sourcing Equipment). Typically the PSE will be a PoE-enabled network switch, or alternatively a *midspan* can be patched in to inject PoE power into a link, and would normally be used as a cost-effective or flexible way to upgrade the ports of an existing network switch to PoE.

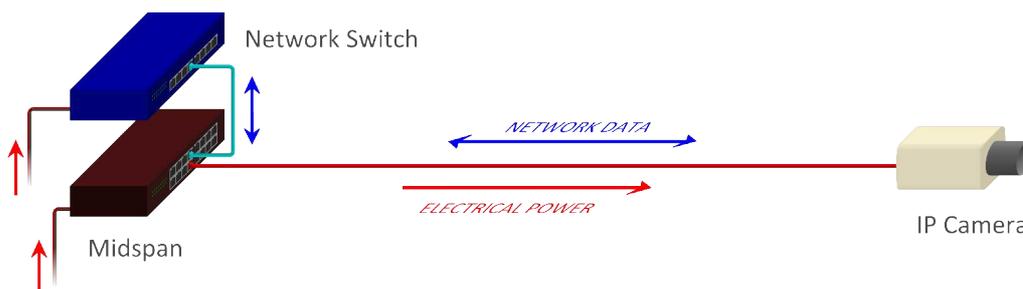
Because not all network devices are designed to be able to receive PoE, the standard includes a procedure to check for compatibility before power is “switched on”. The PD must display a *signature* which the PSE checks for before enabling PoE to the port. This takes place automatically within a few seconds of connection, which means that that wiring a PD for power is as simple as connecting its network cable, with safety guaranteed.



A typical connection from a network switch to an IP camera without PoE



Using a PoE switch to power the IP camera removes the need for local power



Alternatively, a midspan injector can be used to upgrade an existing connection

Advantages of using PoE power

Once the basic operation of PoE is understood, many of its benefits become apparent, and the most important and best-known of these benefits is the saving which can be made in electrical installation costs. The voltage that PSEs provide (typically 48V DC) is high enough to be carried efficiently over standard gauge Cat5 cable, yet low enough to be safe, which means that all cable installation required to fit or relocate a powered device can be undertaken by the IT or security installer, thus avoiding the cost, time and complications of bringing in a qualified electrician to bury or armour the cable. Plus of course the cable and connectors required are familiar, standard and universal, and there is no need to deal with a wide and incompatible range of clumsy external power supplies, with loose-fitting DC connectors or heavy low-voltage power cable.

Beyond these obvious practical advantages, however, there are several measures employed by PoE equipment behind the scenes to ensure the safety and robustness of their operation. Because of the range of ad hoc PoE implementations that existed before standardisation, and the need to be compatible with existing non-PoE devices and different cabling practices, there is much more to PoE implementation than simply connecting a power supply to a cable.

First of all, the signature detection procedure prevents damage to non-compatible equipment – that is, you can use a PoE-enabled network switch channel for a conventional data-only connection without any risk of damaging a non-PoE device. After the signature has been recognised and power has been enabled, built-in *current monitoring* ensures power can be disconnected from the cable if a malfunctioning PD draws too much power or is unplugged, and the PSE will automatically recover and reinstate power delivery if the PD returns to drawing a permitted power level, or when a new device is connected. Also, for straightforward installation, PoE delivery is immune to bad wiring or polarity reversal, and *isolation* is incorporated to eliminate problems with ground levels or mains voltages. PoE can be retrofitted to existing Cat 3 and Cat 5/6 infrastructure and the power can coexist with Ethernet data on the same twisted pairs without degrading the signal.

For more advanced installations, the use of PoE allows more sophisticated device control and power management to be implemented. As the power to many network devices may be routed through a single network wiring cabinet, an *uninterruptible power supply (UPS)* can be installed at this location to provide continuous power for critical devices during any interruptions. Indeed, the original driving motivation for developing power over Ethernet was to provide centrally backed power for VoIP phones, to mimic, and achieve the reliability of, conventional telephone installations, where network downtime can be hugely expensive. And, of course, continuous operation is imperative in security applications such as CCTV, access control and alarm systems.

Features such as the use of power *classification*, where PDs provide an indication of how much power they require (in bands called *power classes* of up to approximately 4, 7 and 13 Watts), means that switches and midspans can allocate their available power effectively, and remote power monitoring and switching of devices (using SNMP for example) provides the further option of controlling which devices are active at different times in order to waste as little energy as possible. In particular, the ability to control power remotely makes it possible to reset malfunctioning devices: even manually unplugging a network cable from a switch is far preferable to the time and expense required to call out an engineer to reset a remotely located camera which has “hung” or “frozen”.

All of this means that PoE is in many regards a perfectly optimised means of wiring power for low-wattage devices, regardless of whether the cable carries data. Indeed, products such as the latest range of PoE-powered LED lighting for security cameras can reap all these benefits even while discarding the network connection itself, and many of the more advanced IP video cameras on the market are designed for a PoE supply only.

Limitations of conventional PoE equipment

Despite PoE's technical elegance, however, there are still some hurdles that installers will come across; gaps in the complete networked power delivery solution that PoE ought to be able to offer.

The upper limit to network cable length is a factor which frequently restricts the optimum placement of PoE devices such as IP cameras and wireless access points - these are products designed to be located at the very edge of the network, so security installers, used to pulling 300 metres or more of analogue video cable, can find the 100 metre limit for Ethernet cables frustratingly restrictive. This is compounded by the fact that installed cable lengths frequently turn out to be longer than expected, which can result in further electrical installation to supply edge PoE switches, which in turn renders any central UPS supply or power management redundant.

Although the extra initial cost of PoE-enabled equipment is normally considerably lower than the savings to be made, in some more specialised applications the advantages can be less clear. In particular, whereas PoE devices draw low power at a safe voltage, a line voltage supply is still required for their PSEs, and this is not always available. For example, in a retrofit or upgrade situation, only a lower-voltage power feed may have been required for the original equipment. Alternatively, the legacy power supply may be suitable for the new network devices – such as where IP cameras are to be retrofitted in place of analogue ones – so the PoE supply would appear to be redundant.

A final limitation imposed by the current PoE standard is the maximum power available per device. Although the present 13 Watt limit has enabled many applications in VoIP telephony, Wireless, CCTV and access control, it is insufficient to offer a complete solution for these markets in areas such as videoconferencing, 802.11n routers, pan-tilt-zoom or heated cameras, and door interlock systems respectively. This is due to be addressed by the forthcoming *PoE Plus* standard, 802.3at, which will initially increase available power to around 25W, made possible by specifying Cat 5 or better cable only and a higher minimum voltage. However, a combination of speculation, misinformation, “pre-standard” equipment and excessively complicated technical requirements for PDs means it may be some time before devices become universally compatible, although higher-power PoE will certainly find more applications in closed configurations in the shorter term.

Taking advantage of PoE

Whether these limitations can be overcome or not (and with the right products they can, easily – see appendix) the case to deploy PoE is compelling. However the best way to go about this is to be aware of the operation and technological benefits of PoE as described above, so that one can “think PoE” when planning a system, rather than using it as an add-on or “fix” in an otherwise conventional installation.

To the edge of the network, it is particularly important to capitalise on the flexibility of location that PoE powered devices offer. Untethered from a mains outlet, cameras and wireless APs can be placed precisely where they are required, or fitted temporarily so they can be relocated to their optimum position following a late-stage site survey. The relative ease of moving or adding devices post-installation, where changes in requirements or upgrades to technology are anticipated, can be factored in as well. And choosing more PoE-oriented equipment over its conventional equivalent can also bring benefits, for example a compact network time server can be located much nearer to its satellite antenna. Even if PoE-powered versions of equipment are not available, they can often be upgraded using a *splitter*, which taps the PoE power from the cable and converts it into a separate DC supply and network connection.

The topology of a PoE-enabled network may also differ slightly from that of a conventional installation, in that it will be more biased towards a “single-star” layout, with minimal use of edge switching in order to route as much power as possible through a central and UPS-backed supply. This is the optimum configuration from a power-distribution point of view if the aforementioned distance limitation can be overcome. It is also one which security installers will be familiar with, as it more closely resembles a coaxial cable installation for analogue video, and indeed the use of PoE along with the ability to retrofit network connections to coaxial cable are factors which help keep the network installation in the domain of the security installer.

Finally, careful design and forward planning in the control room or wiring cabinet allows the implementation of a PoE-enabled installation that is manageable, energy-efficient and future-proof. PoE switches are generally preferable to midspans for new installations, although not always better value, as they take up less rack space and reduce cabling complexity. Remote management allows sophisticated control schemes to be put in place if desired, to lower electrical bills or improve resilience to power outages. Spare PoE channels obviously ready the system for future expansion, although leaving room for the addition of a midspan is a good alternative, especially as later devices may require PoE Plus or custom PoE power. Until the PoE Plus standard is accepted, however, manufacturers' recommended PSEs should always be used for high-power equipment.

The power requirements of an equipment rack also greatly increase when PoE must be delivered, and allowance must be made for the maximum specified wattage of all PSEs, so that all channels could if necessary deliver maximum PoE power without causing an overload. Thermal output greatly increases as well of course: although most power is routed to external devices, a not insignificant proportion – up to a third – of the PSEs' requirement will be converted into heat in the wiring closet. Again, PoE enables easy expansion and upgrading of installed equipment, so reasonable allowances should be made for future power and cooling requirements.

Conclusion

The Power over Ethernet standard has been shown to incorporate a host of technical benefits and robustness-enhancing features, and as a result PoE is a very elegant and well-optimised power delivery method that integrates seamlessly with existing Ethernet technology. As Ethernet itself is already well-standardised and auto-configuring, PoE completes the package to enable fully plug-and-play physical installation of network devices. In the security industry, its universal availability strengthens the case for the transition to IP, and its ease of implementation and maintenance should, once appreciated, remove another obstacle in the acceptance of digital technology. If PoE is used to best effect, by designing with its advantages in mind and using innovative products that overcome its limitations, then it offers a complete and optimal solution for distributing power to Ethernet devices.

Appendix: How Veracity's products enable PoE applications

Extend the range of PoE using OUTREACH

OUTREACH allows network installers to overcome the 100 metre (328 foot) distance limitation of conventional Ethernet. OUTREACH is simply connected in-line with the cable to restore the network data and intelligently forward power to PoE devices.



OUTREACH is compact, wall-mountable and self-configuring, and multiple OUTREACHes can be connected in a chain to extend Ethernet connections with or without PoE to up to 1000 metres (3280 feet).

In the example shown, two OUTREACHes allow an IP camera to be located up to 300 metres (1000 feet) away from a standard PoE network switch. As power for all devices is sourced from the switch, no other electrical installation is required.

Add or boost PoE power with OUTSOURCE

OUTSOURCE is a single-channel 802.3af PoE injector, used to upgrade individual network ports to PoE.



It can also deliver boosted power to OUTREACH for long-distance or high-power applications. In the example above, OUTSOURCE injects PoE power into a standard network switch channel, and provides the extra power required to enable an OUTREACH and a wireless access point of any power class, across 200 metres (660 feet) of cat 5 cable.

OUTSOURCE midspans are also available in multi-port, rack-mounted, and PoE Plus variants.

Extend PoE Plus and custom PoE with OUTREACH PLUS

OUTREACH PLUS adds high-current capability to OUTREACH's Ethernet extension technology. It can be used to extend network connections to devices such as PTZ cameras, access control interlocks, videoconferencing phones and high-power wireless devices (e.g. 802.11n WAPs), without further electrical power installation.

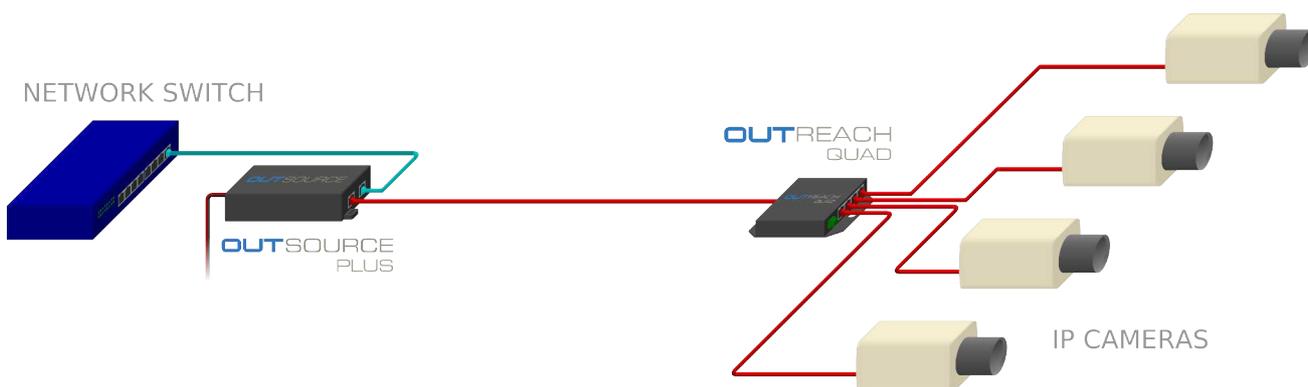


OUTREACH PLUS is compatible with high-power PoE standards such as PoE Plus (802.3at) and many manufacturer-specific PoE implementations.

Extend, expand and distribute PoE using OUTREACH QUAD

OUTREACH QUAD uses Veracity's patented power management technology to allow PoE to be safely forwarded to multiple network devices beyond the 100 metre (328 foot) cat 5 cable limit.

OUTREACH QUAD can be powered by PoE or PoE Plus, either conventional or OUTSOURCE-enhanced, and incorporates an unmanaged 10/100 network switch with four intelligent PoE-forwarding ports. It can be designed-in to installations to reduce cabling costs, or used to quickly add new devices to existing networks.



In the typical application shown, OUTREACH QUAD enables up to four IP cameras to draw their power from a single OUTSOURCE PLUS midspan, located up to 200 metres (660 feet) away.

OUTREACH QUAD is also available with an adaptive 12 volt DC output, which can be used to power auxiliary equipment including camera heaters, fans, or non-PoE network devices.

Upgrade to IP video without re-cabling using HIGHWIRE and HIGHWIRE POE

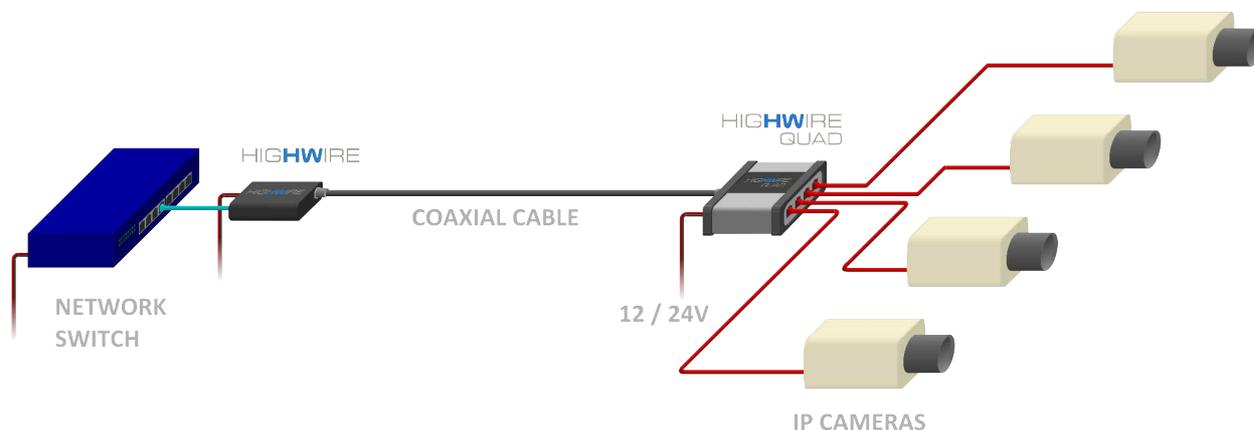
HIGHWIRE POE allows an analogue IP camera to be replaced with a PoE-powered IP camera, without the expense and inconvenience of replacing the existing coax cable or camera power supply.



Veracity's HIGHWIRE technology creates an instant 100BASE-T Ethernet connection across up to 270 metres (900 feet) of standard RG-59 cable, so no installation of Cat 5 is necessary. HIGHWIRE POE also converts the existing 12 volt DC or 24 volt AC supply into a universal PoE power source for the new camera.

Upgrade to IP video and add extra cameras with HIGHWIRE and HIGHWIRE QUAD

HIGHWIRE QUAD allows an analogue IP camera to be replaced with up to four PoE-powered IP cameras, again with no need to replace the existing coaxial cable.

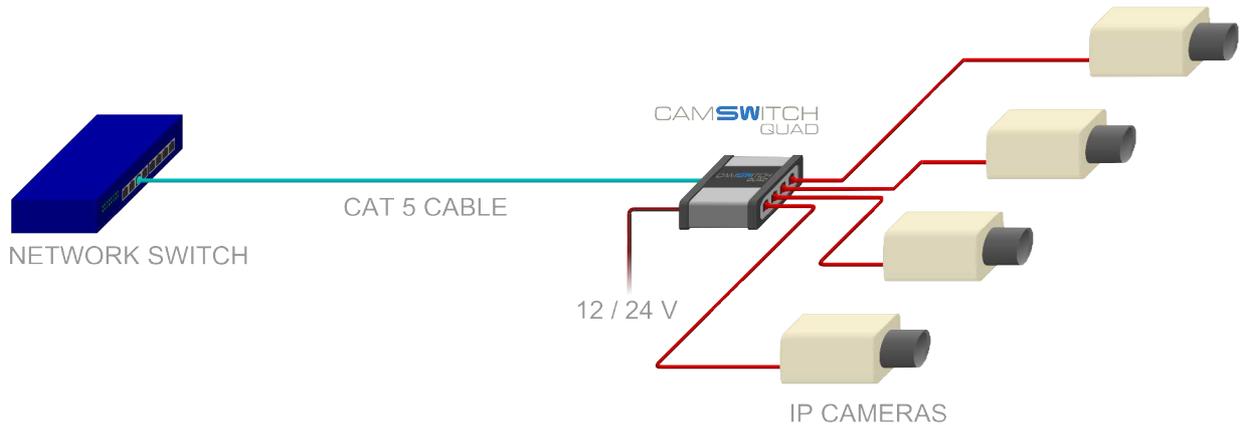


HIGHWIRE QUAD integrates a HIGHWIRE Ethernet-over-coax interface with a four-port 10/100 PoE switch, all powered from a legacy 12 volt DC or 24 volt AC supply. A standard HIGHWIRE at the other end of the coaxial cable is used to convert the signal back to Ethernet.

All Veracity's HIGHWIRE products are compact, rugged and wall-mountable. Straightforward installation is assured, as all connections – power input, coaxial, Ethernet and PoE – are set up automatically, and the Ethernet-over-coax conversion is entirely transparent to the network.

Deliver PoE from a low-voltage supply using CAMSWITCH

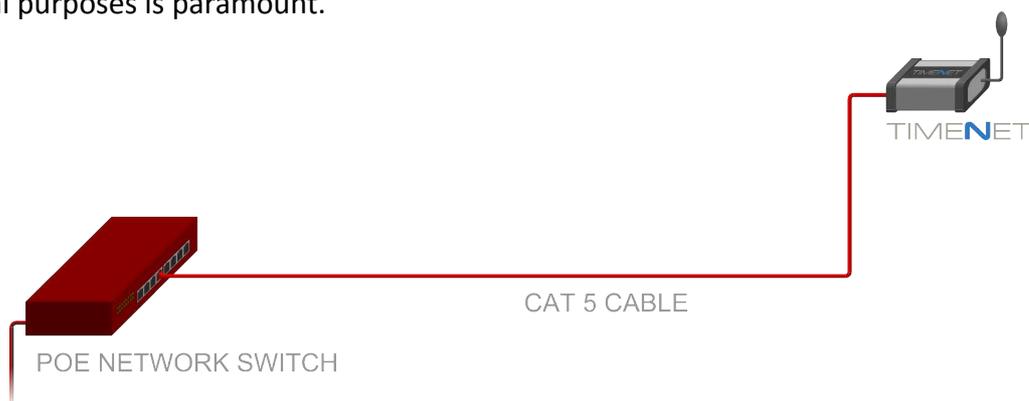
CAMSWITCH QUAD is a compact and rugged network switch which can deliver up to 30 watts of PoE power over four of its five 10/100 Ethernet ports. It features a unique 12 volt DC or 24 volt AC power input (auto-configuring) and is wall-mountable.



In the example installation shown, CAMSWITCH QUAD allows four IP video cameras to receive their PoE power from a single legacy low-voltage supply.

Synchronise networks to atomic time with TIMENET

TIMENET allows all devices on a network to synchronise to the same, precise reference clock. This is an essential requirement for installations of Digital Video Recorders, where correct time-stamping for evidential purposes is paramount.



TIMENET is a self-contained NTP master clock and GPS receiver, receiving its accurate atomic time signal via satellite. Its compact dimensions and optional PoE power supply mean it is not confined to an equipment rack, and can be located at the edge of the network, at the optimal site for receiving the satellite signal.

Correct power classes and connect to non-compliant devices with OUTCLASS

OUTCLASS is an in-line adaptor which converts the power class of a PoE device's signature, preventing power budget and compatibility problems with unclassified or incorrectly-classed devices.



It displays a Class 2 signature as standard, so fitting an OUTCLASS to an unclassified 5 watt IP camera would reduce the power it requested from its PoE source from 15 watts to 7 watts. This allows the power budget of a PoE switch to be allocated effectively. In the above example, OUTCLASS enables operation with HIGHWIRE POE, as HIGHWIRE POE will not deliver PoE to devices that request more than 7 watts.

OUTCLASS can also be retrofitted to many devices that are not compliant with the 802.3af specification, including those which use different PoE configurations, or are not fully compliant by design, so that they can be used with standard 802.3af equipment.