

# Power Over Ethernet, PoE

## 1 What is Power Over Ethernet?

Power Over Ethernet (or PoE) is a technology that integrates data, voice and power on standard Ethernet infrastructure providing new options for power distribution. This allows IP telephones, wireless LAN access points, surveillance cameras and other embedded appliances to receive power as well as data over existing CAT5 cabling. Formally approved as an international standard, Power over Ethernet is established as an economical, safe power distribution method and is already deployed in corporations throughout the world.

In simple terms, it uses the unused wires in standard CAT5 LAN cabling to send power up the LAN leads to the operating device. The device can then take its power from the LAN cable which precludes the requirement for a separate, local, power supply close to the device. e.g. if the device is an outdoor wireless bridging unit then you can use PoE to send the power and data up the connecting LAN cable to the outdoor unit thus removing the requirement to route mains power to the box.

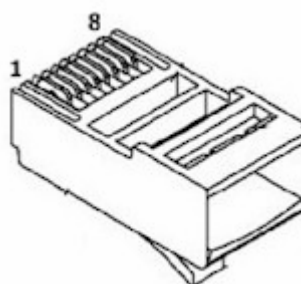
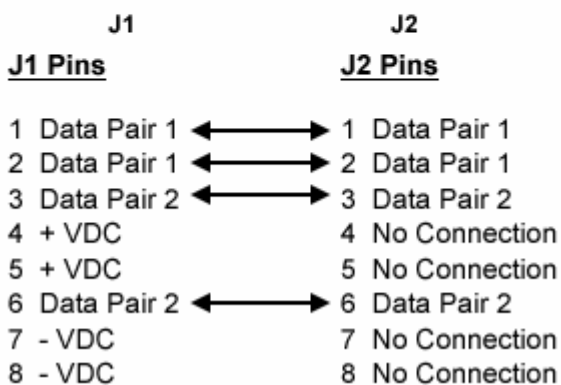
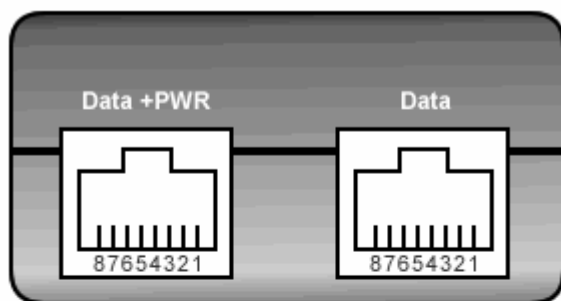
The IEEE standard 802.3af (often erroneously called 802.11af) describes a mechanism for Power over Ethernet (PoE). The standard provides the capability to deliver both power (max 12.95W) and data over standard ethernet Cat.3/Cat.5 cabling.

## 2 PoE: IEEE 802.3af

IEEE 802.3af provides 48 volts DC over two out of four available pairs on a Cat.3/Cat.5 cable with a maximum current of 400 mA for a maximum load power of 19.20 watts, although, after counting losses, only about 12.95 watts are available. Most switched power supplies will lose another 10-20% of the available energy. A "phantom" technique is used so that the powered pairs may also carry data. This permits its use not only with 10BASE-T and 100BASE-TX, which use only two of the four pairs in the cable, but also with 1000BASE-T (Gigabit Ethernet), which uses all four pairs for data transmission. This is possible because all versions of Ethernet over twisted pair cable specify differential data transmission over each pair with transformer coupling; the DC supply and load connections can be made to the transformer centre-taps at each end. Each pair thus operates in "common mode" as one side of the DC supply, so two pairs are required to complete the circuit. The polarity of the DC supply is unspecified; the powered device must operate with either polarity or pair 45+78 or 12+36 with the use of a bridge rectifier. However, the industry standards are for 48V to be delivered as DC+ on data pins 1 and 2 and DC- data on pins 3 and 6 (called Alternative A) OR DC+ on unused (on Base 10/100 ethernet) pins 4 and 5 and DC- on unused pins 7 and 8 (called Alternative B). If you want to cover both bases, then you can deliver power on BOTH the data AND the unused pins but the total power remains the same ☺

## 3 So how's it done?

With PoE the LAN cable serves as the data/power interface between the two Ethernet elements (e.g. one end might be an outdoor wireless bridge and the other end a switch in the office, on the end of the LAN cable). There are two optional connection methods used with PoE, named Alternative A & B. Most common PoE uses are with Alternative B so this is the one I shall discuss first of all. With Alternative B the DC power, typically 48V, is transmitted over the ethernet wires connected to pins 4,5 and 7,8 which are not used for Base 10/100 networks:



## Alternative B Wiring

Thus, power is carried over the spare pairs (4/5 & 7/8). Each pair's wires are shorted to one another.

**Note: Because a PoE system Alternative B uses the unused wires in a LAN cable it is vital that your LAN cables are fully, 8 wire, populated. If you don't have all 8 wires connected up in your LAN connection then it won't work! ☺ It also means that Alternative B wiring is incompatible with any system which actually uses the 'unused pins 4,5,7,8 e.g. Gigabit networking.**

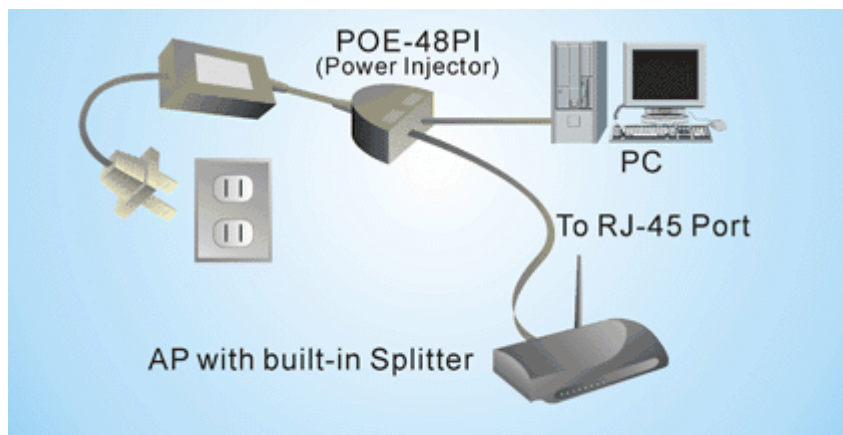
In Alternative A wiring the DC power is superimposed onto the data pins 1,2 and 3,6. Since the same pins are used for both data AND power then Alternative A wiring is compatible with applications where the pins 4,5 and 7,8 are employed for other purposes e.g. in Gigabit network cabling.

The table below shows the various wiring and power systems sometimes used for sending power over ethernet cables:

Table 1. Summary Comparison of Various PoE Standards												
STANDARD	SOURCE									LOAD		REMARKS
	Ethernet RJ-45 connector pin number									Load Voltage	DC Load Connector	
	Source Voltage	1	2	3	4	5	6	7	8			
IEEE 802.3af using data pairs	48 V DC, protected	RX, DC+	RX, DC+	TX, DC-	spare	spare	TX, DC-	spare	spare	(embedded)		Industry Standard for embedded PoE – Alternative A wiring
IEEE 802.3af using spare pairs	48 V DC, protected	RX	RX	TX	DC+	DC+	TX	DC-	DC-	(embedded)		Industry Standard for embedded PoE – Alternative B wiring
Intel, Symbol, Orinoco	Usually 12 or 24 V DC	RX	RX	TX	DC+	DC+	TX	DC-	DC-	(embedded)		Alternative to 'Alternative B' wiring which uses a lower DC voltage
Cisco	48 V DC	RX	RX	TX	DC-	DC-	TX	DC+	DC+	(embedded)		Older Cisco

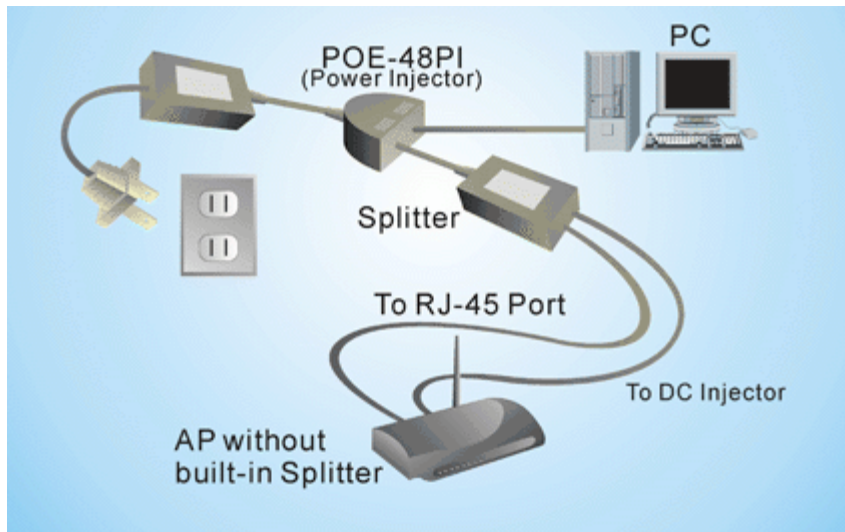
(OLD old standard)													polarity is <b>REVERSED</b>
Cisco (NEW old standard)	48 V DC	RX	RX	TX	DC+	DC+	TX	DC-	DC-	(embedded)			New Cisco is IEEE compliant using Alternative B system
D-Link (Adapter)	48 V DC	RX	RX	TX	DC??	DC??	TX	DC??	DC??	5VDC @ 2.5A	DC coaxial 5.5/2.5mm		D-Link PoE Adapter for non-PoE products.
Apple MacIntosh AirPort PoE, Extreme	48 V DC	RX	RX	TX	DC??	DC??	TX	DC??	DC??	Converted to ???	DC coaxial (???)		Mac Polarity Unknown
HyperLink	Many DC Voltages Available	RX	RX	TX	DC+	DC+	TX	DC-	DC-	same as input	DC coaxial and others available		Variety of Options Available to Fit Most Brands of PoE
NYC Wireless "Roll Your Own"	12 or 24 or 48 V DC	RX	RX	TX	DC+	DC+	TX	DC-	DC-	same as input	DC coaxial or as reqd		New York City Wireless PoE

In any PoE system, the device that inserts the power into the LAN cable is called the 'injector'. The feature/device at the product end which takes the power out of the LAN cable is called the 'splitter'.



e.g. above shows a LAN cable, with data, coming from a PC. The injector takes in the data cable and inserts the power into the ongoing LAN cable going to the wireless AP. The AP has a built in 'splitter' which extracts the power from the LAN cable and passes it internally onto the built in power circuits. This is an AP with built in PoE capability.

For devices which don't have built in PoE capability then you can, instead, get a separate splitter which sits on the LAN cable in front of the device and extracts the power from the incoming LAN cable. The separate splitter then normally has a short DC type power lead which is then plugged into the devices power socket. e.g.



So, in above, the splitter is connected to the LAN cable from the injector. Then, from the splitter, there are two cables going to the AP: One is a short data only LAN cable, the other is a short DC power lead. Generally the splitter does more than just split out the 48V from the LAN cable; it normally performs a second function of 'dropping' the 48V to the native power voltage required by the device e.g. 12 or 5V.

## 4 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.

To try and reduce the potential for damage with misuse of PoE systems, the 802.3af standard incorporates a series of management checks that the PoE systems must go through to determine if it's safe to put the power onto the LAN cable. In the beginning, only small voltage level is induced on the injector port's output, until a valid end device is detected. Sometimes the injector may also do tests to estimate the amount of power to be consumed by this end device. After a time controlled start-up, the injector begins supplying the 48 VDC level to the device until it is physically or electrically disconnected. Upon disconnection, voltage and power shut down. Several incidents such as consumption overload, short circuit, out-of-power-budget and other scenarios, may terminate the process in the middle, only to restart it from the beginning.

Thus, fully, 802.3af PoE devices do a lot more than simple power delivery: They also have built in intelligence to properly control and manage the process outlined above. This high level of additional intelligence does tend to mean that fully 802.3af PoE devices are a bit on the expensive side. Therefore, most lower cost PoE systems remove some or all of this intelligence and are simple devices which simply inject the 48V onto the pins 4/5 and 7/8 (Alternative B wiring).

## 5 Products in detail

Let's look at some specific products so as to, hopefully, clear up any confusion still left ☺

First of all a 48V, PoE injector:

## 5.1 NET-POEINJECT48

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This is a PoE injector. It consists of the injector body which has a LAN in port (data only) and a Data+Power out port which has the data on pins 1,2,3,6 and then 48V on pins 4,5,7,8. Also included is a separate mains powered 48V DC power supply which powers the injector part. In operation data LAN cable from (for example) your switch goes in one side and the data+power LAN cable comes out the other (and then to, for example, your outdoor AP). This device is not fully 802.3af compliant since it doesn't include the extra sensing and intelligence to determine if the Power Device (called the PD) can accept power over the LAN cable. As such it's important that the user verifies that the PD is suitable.

## 5.2 NET-POE12V

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The NET-POE12V is an IEEE 802.3af 48V Power Injector and Splitter (12V, 2.1Ø/5.5Ø). It's intended for end devices which don't have any inbuilt PoE capability. The way it works is one part of the kit is a normal PoE injector; this sits down near your switch (for example). The other half of the kit is the splitter. The splitter sits next to your device to be powered (e.g. an IP camera). The LAN cable carrying data+power comes from the injector and goes into the splitter. The splitter then has a short, data only, LAN cable coming out which goes to the LAN data port of the device to be powered (e.g. IP camera). Also coming out from the splitter is a short DC power lead which plugs into the normal DC power socket on your device. This takes the place of the normal mains powered power supply the device would normally use.

To support a range of different devices this kit is available with DC 5V output (naturally, for end devices that need 5V) or with DC 12V output (for devices needed 12V). The NET-POE kits can typically be used to power Ethernet devices such as IP telephone, Web Camera and Wireless AP. The POE kits include features like Short Circuit Protection, Over Load Protection and High Voltage Protection to prevent Ethernet devices from circuit shortage resulted from wrong pin installation or cable damage. Please note the maximum power for PoE is only 12W so, for the 12V kit, ensure your device doesn't need more than 1Amp. For the 5V kit the limit is 2Amp.

## 5.3 POEADAPTSKT/PLG

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These two products are simple units which simply allow any power to put onto or take off the normal, Alternative B, PoE power pins (4,5,7,8). Each device has a data only plus a data+power LAN port. Each device also has a short DC power lead: One with a 5.5mm DC socket and the other with the equivalent plug. Each part can be used separately or as a pair. Their application is as a simple, very low cost injector (typically the POEADAPTSKT unit) or as a basic splitter (the POEADAPTPLG unit). A separate power supply should be added to the 'injector' end (POEADAPTSKT) so as to inject power onto the normal power pins (4,5,7,8). For 'normal' PoE applications your would use a 48VDC power supply like this....



so the DC plug from the power supply attaches to the DC socket on the POEADAPTSKT unit. You also, just like any PoE injector connect your data only LAN cable and also your data+power LAN cable. The other end of the data+power LAN cable could be then connected to a PoE compliant product (outdoor AP or similar). Please note, however, these devices are very simple units which simply allow for basic power transfer applications on LAN cables: They do not include the extra management or intelligence present in fully 802.3af units. As such, if your PoE compliant product demands these extra functions then it will probably NOT work!

Another application of these products is to use them as a pair (injector and splitter) in combination with the normal DC power supply supplied with the product you intend to power. e.g. if you have a wireless AP that is supplied with a 12V DC power supply and you want to place the AP in a location where it's

hard to route a mains supply to then, down at the switch, connect the 12V power supply to the POEADAPTSKT unit. Also connect a short LAN cable from this to your switch (or whatever). Then run a full (8 wires) LAN cable from the data+power socket on the POEADAPTSKT up to where the AP is located. Connect the LAN cable to the data+power socket on the POEADAPTPLG unit. Then run a short LAN cable from the data LAN socket on the POEADAPTPLG to the normal LAN connection on the AP. Then, take the short DC power plug from the POEADAPTPLG and connect to the power socket on the AP. In this way, 12V is injected onto the connecting LAN cable and then split out at the AP end.

**Note: The amount of power transmission loss in the RJ45 plug and LAN cable is (for the same power) inversely proportional to the voltage you are sending i.e. the power lost in the cable at 12V compared with 48V is 17 times greater at the lower voltage! In effect, this means that, what started as 12V, when you injected it into the LAN cable can, over a short distance, start to drop off by quite a lot. Where as 'normal' 48V PoE typically quotes a maximum connecting LAN cable length of 100m, when you change this to 12V you should expect that maximum cable length to drop to less than 10m! If you use a 5V power source then the effective cable length could be substantially lower; maybe just a few metres. You would need to test, in your particular application, if your powered device operates correctly despite this power and voltage drop on the line.**