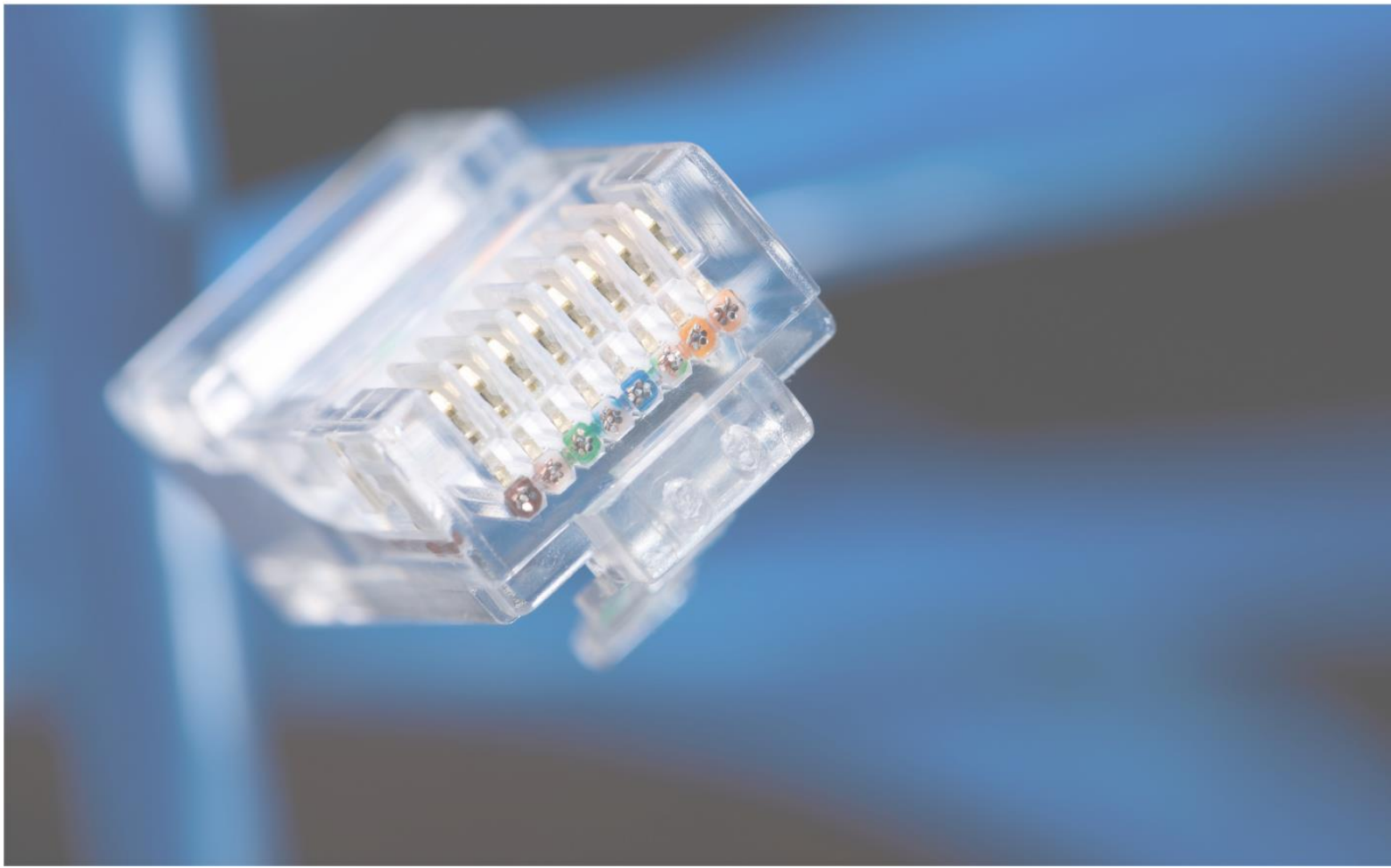
FIBERROAD

TECH NOTE

PoE of Things



About The Tech Note

Introduction

This document includes an introduction to the Power over Ethernet Features and Fiberroad products family. To give you a quick overview of the Fiberroad products.

Conventions

This document contains notices, figures, screen captures, and specific conventions.

Figures and Screen Captures

This document provides figures and screen captures as an example. These examples contain sample data. This data may vary from the actual data on an installed system.

Power over Ethernet

Power over Ethernet (PoE) is a technology that passes electric power over twisted-pair Ethernet cable to powered devices (PD), such as wireless access points, IP cameras, and VoIP phones in addition to the data that the cable usually carries. It enables one RJ45 cable to provide both data connection and electric power to PDs instead of having a separate cable for each.

PoE allows professionals to install remote or outside equipment without connecting to AC power to deliver power to several locations without installing additional electrical infrastructure or power outlets. PoE is also highly cost-effective as it allows you to use one cable for both power and data transmission, so paying to purchase and run multiple cables isn't necessary. In addition, PoE makes it easier to expand and install a network and is also highly efficient and responsive.

Figure 1: Concept of Power over Ethernet

What are PD and PSE devices?

There are always two types of devices in a PoE-powered system: one that supplies power and consumes power. In the language of the PoE standard, these are referred to as the Powered Device (PD) and the Power Sourcing Equipment (PSE):

PD (Powered Device) – Any network device that PoE powers is referred to as a powered device, or PD. Wireless access points, IP security cameras and VoIP phones are common examples. The rise of the more powerful IEEE 802.3bt standard has paved the way for more power-hungry applications such as PoE LED lighting and High-Speed HD Outdoor PoE network cameras with climate control.

PSE (Power Sourcing Equipment) – PSE devices send power and data over the Ethernet cable to a connected PD. PSE devices are classified as either "midspan" or "endspan.".

PoE Types

IEEE 802.3af-2003 standard is commonly known as **"PoE"**. It defines PoE Classes 0-3, with maximum power at PD being 12.95W.

IEEE 802.3at-2009 standard is commonly known as **"PoE+"** or **"PoE Plus"**, and it is the later update to the IEEE 802.3af-2003 "PoE" standard. It defines PoE Classes 0-4, where Classes 0-3 are incorporated from the older 802.3af "PoE" standard under "Type 1", and "Type 2" only includes Class 4 with maximum power at PD being 25.5W.

IEEE 802.3bt-2018 is named **"4PPoE"**. It incorporated Classes 0-4 from the earlier standards and added "Type 3" (Classes 5-6) and "Type 4" (Classes 7-8), with maximum power at PD being 71.3W.

❖ **PoE Type 1**

Name: PoE, 2-pair PoE
Standard: IEEE 802.3af
Maximum port power: 15.4W
'PoE' was initially designed to power low-power devices such as IP telephones. In 2003, IEEE 802.3af was standardised to use two of the four twisted pairs of wires in standard (at the time) Cat3 Ethernet wire runs. IEEE 802.3af provides up to 12.95W to powered devices at 37V-57V. There is some loss, so a PoE switch port is generally rated at 15.4W and between 44V-57V. Examples of devices that PoE Type 1 can support include static surveillance cameras, wireless access points and VoIP phones.

❖ **PoE Type 2**

Name: PoE+, 2-pair PoE
Standard: IEEE 802.3at
Maximum port power: 30W
Like PoE Type 1, PoE Type 2 also utilises 2-pair PoE. Its basis is the PoE+ or IEEE 802.3at Ethernet standard, which the Institute of Electrical and Electronics Engineers released in 2009. It delivers up to 30W of power at the port level over an Ethernet twisted pair cable and up to 25.5W of power to each device. It connects higher-powered devices to a network, such as PTZ cameras, RFID readers, video IP phones, and alarm systems. However, because it is backwards compatible, it can support the types of devices typically supported by PoE Type 1 and devices supported by PoE Type 2. It supports Cat 5 cables or better.

❖ **PoE Type 3**

Name: PoE++, 4-pair PoE, 4P PoE, Ultra PoE
Standard: IEEE 802.3bt
Maximum port power: 60W
Also known as 4-pair PoE, 4PPoE, PoE++, or Ultra PoE, Type 3 PoE uses all four pairs in a twisted-pair copper cable to deliver power at the PD—unlike Type 1 and 2, which only use two pairs. This higher level of PoE adheres to the IEEE 802.3bt standard, which came out in 2011. It provides up to 60W of power to each PoE port and up to 51W of power to each device. These higher levels of power support devices include multi-radio wireless access points, PTZ cameras, building management devices, and video conferencing equipment. It supports Cat5 cables or better.

❖ **PoE Type 4**

Name: Higher-Power PoE, PoE++
Standard: IEEE 802.3bt
Maximum port power: 100W
Commonly known as Higher-Power PoE, Type 4 PoE offers the highest power capabilities of all existing PoE types. This PoE type helps satisfy the growing power requirements of network devices and IoT. Conforming to the newest IEEE 802.3bt standard, Type 4 PoE delivers 90W of power from the PSE and up to 70W of input power at the PD to each

device. However, it has the potential to supply a maximum of 100W of power per port if necessary. Due to the high quantities of power that it produces, Type 4 PoE can support extremely power-hungry devices such as laptops and flat screens. Supported cables include Cat5 cables or better.

	PoE	PoE+	PoE++	PoE++
IEEE Standard	IEEE 802.3af	IEEE 802.3at	IEEE 802.3bt	IEEE 802.3bt
PoE Type	Type 1	Type 2	Type 3	Type 4
Switch Port Power				
Max Port Power	15.4W	30W	60W	100W
Port Voltage Range	44-57V	50-57V	50-57V	52-57V
Cables				
Supported Cables	Cat3/Above	Cat5/Above	Cat5/Above	Cat5/Above
Twisted Pairs Used	2-pair	2-pair	2/4-pair	4-pair
Power Device Power				
Max Power to Device	12.95W	25.5W	51W	71W
Voltage Range to Device	37-57V	42.5-57V	42.5-57V	41.1-57V

Table 1: PoE Types

PoE PSE Types

There are three main types of PSE in use today; all are compatible with Cat5e or higher category cable. PSE type is chosen based on the existing infrastructure and the number of PoE devices eventually connected.

PoE Switch and PoE Media Converter

A PoE switch looks like an average Ethernet switch. However, it provides an all-in-one device for data switching and power provision. Typically, this is the most flexible and economical solution, especially if new networking hardware is required and multiple PDs need PoE.

Figures 2 & 3, PoE Switch and PoE Media Converter

A PoE media converter combines power and data on one cable offering copper to fibre connectivity while providing Power over Ethernet to PD. The PoE media converter offers an economical path to extend the transmission distance of an existing network.

Single-Port PoE Injector(Midspan)

A Single-Port PoE Injector (Midspan) is designed in line with the Ethernet cable to provide power to a single device. It suits applications where there aren't enough PoE devices to

warrant the cost of a PoE switch or if the data needs first to be transmitted a long distance (e.g. via fibre) before being converted back to copper cabling, and then have PoE applied.
The downside to using a Single-Port PoE Injector is the requirement for a mains outlet to operate, and the tendency to become costly when more than a few devices require power.

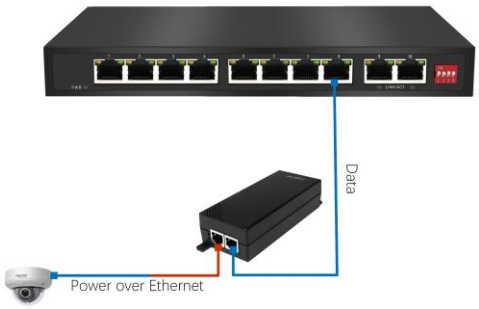


Figure 4: Single-Port Injector

PoE Negotiation

If a PD is connected to the PSE, it undergoes a PoE negotiation procedure before receiving the needed power for operation. The PoE negotiation procedure is defined by the IEEE 802.3af/at standards. Also, non-PoE devices will not be damaged if they are connected to a PSE due to this procedure.
PoE negotiation is comprised of three stages: discovery, classification and operation.

Discovery

PSE leaves the Ethernet port unpowered and periodically checks if something has been plugged in. The low voltage used during detection is unlikely to damage a device not designed for PoE. When a PD is connected to the PSE's port, the PSE detects this and carries on to the classification stage.

Classification

Classification is the process by which the PSE determines whether the connected device requires PoE, and, if so, what class of PoE it requires. Classification may happen in a 1-event or 2-event form, depending on the PoE class of the PD.

1-event classification – for PDs of 802.3af/at Class 0-3

PSE sends a single voltage impulse to the PD, reads the current value on the wire, checks what PoE class this current value corresponds to, and provides power accordingly. If the PD returns Class 1, 2 or 3 value, the PSE provides Class 1, 2 or 3 power, respectively. If PD returns a Class 0 value, Class 3 power is supplied.

Figure 5: 1-event classification

2-event classification – for PDs of 802.3at Class 4

When the PD is identified as a Class 4 device, the PSE will use a second event to verify that the PD really needs a higher level of power. This second event can be either of the two following methods:

Hardware-based 2-event classification

PSE first performs 1-event classification as described above. If it reads the Class 4 current value from the PD, it only supplies Class 3 power and repeats the voltage impulse for the second time. If after this 2nd event it is confirmed that the PD is Class 4, the PSE provides Class 4 power to the PD.

Software-based LLDP classification

PSE first performs 1-event classification as described above. If it reads the Class 4 current value from the PD, it only supplies Class 3 power and requests confirmation from the PD via Layer 2 LLDP protocol on whether the PD is indeed Class 4. If after this 2nd event it is confirmed that the PD is Class 4, the PSE provides Class 4 power to the PD.

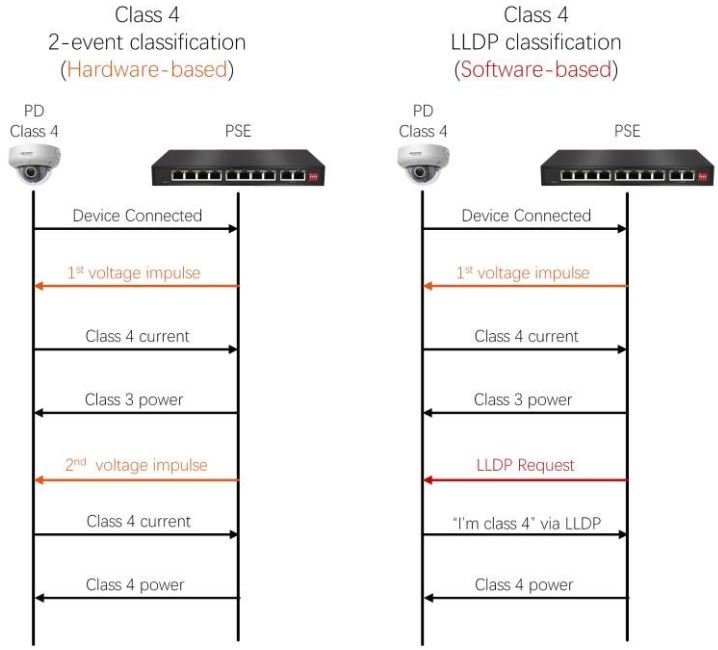


Figure 6: Hardware and Software-based classification

2-event classification support

IEEE 802.3at standard defines that Class 4 PDs must support both hardware-based 2-event classification and software-based LLDP classification, while PSE must only support one of the two but may support both. PoE+ injectors typically only support hardware-based 2-event sort. Many PoE+ switches support both methods.

Figure 7: 2-event classification support

PoE Power Supply Budget Calculation

Step1: Add Up The Demand For PoE In Watts

Add up the expected demand for power for each Powered Device (PD) in watts. Allow for the maximum power and upper end of PD classification. Any unspecified devices should be assumed Class 0.

For example, an IEEE802.3af, Class 0 device may consume 9 watts; however, as it's Class 0, assume 15.4 watts.

Round the numbers up, occasionally, to account for the additional consumption of the UTP (unshielded twisted-pair) ethernet cable that runs between the PD and PoE switch.

For example, if an IEEE802.3at Class 4 IP camera consumes 25.5 watts, round to 30 watts, which adds a buffer to balance out the loss between the PoE switch and the device.

Include room for future capacity. It's convenient to have at least one spare port for diagnostics, troubleshooting, or monitoring. And many clients want extra ports for the option to add more PD devices in the future. However, as long as devices are appropriately selected and integrated, accounting for spare ports isn't required for a PoE power budget calculation.

Step 2: Scale For The Operating Environment

When performing a PoE power budget calculation, it's essential to account for environmental conditions.

Accommodate for the conditions. Expect the long-term performance of a power supply to be 70% of its rating in a benign/conditioned environment (somewhere with steady temperatures between 32°F/0°C and 120°F/50°C). In a benign environment, divide the total wattage from step one by 0.7.

If the power supply is subject to a harsh environment (cold temperatures less than 32°F/0°C or heat above 120°F/50°C), plan for diminished performance. Divide the total wattage from step one by 0.6 for this type of setting.

In extreme conditions, industrial-grade mode, such as Fiberroad Industrial PoE Series, DIN rail mountable, DC 48V power supplies.

Take this harsh scenario, for instance:

A switch and its power supply will be stored in a metal enclosure, exposed to direct sun, at a site in the northeastern United States. In winter, the temperature inside the enclosure could be as low as –10°F/–24°C. And in summer, it could be as high as 140°F/60°C. Accounting for the temperature inflexions, expect the power supply to operate at 60% of its power rating.

It's always safe to assume a conservative long-term performance drop of 50%, no matter the conditions. That means totalling the anticipated power demand (step 1) and dividing by 0.5 (step 2) to get a power budget in watts.

Step 3: Select The Power Source

After determining the demand for PoE power and accounting for the surroundings, it's time to select an appropriate supply. Fiberroad has DC 48-56V supplies with ratings from 30 watts to 480 watts.

Energy-Efficient Ethernet(EEE)

Energy-Efficient Ethernet(EEE) is a set of enhancements to twised-pair, twinaxial, backplane and optical fiber ethernet physical-layer variants that reduce power consumption during periods of law data activity. The intention is to reduce power consumption by 50% or more, while retaining full compatibility with existing equipment.

Cabling

In modern networks, PSEs supply power to PDs over the same standard network cabling that carries the data.Cat5e or higher category cable is suitable for both IEEE 802.3af and IEEE 802.3at compliant devices.

The maximum recommended length of any Ethernet cable run is 328 ft (100m) from switch to PD, even if a Midspan device is located between the switch and the PD. The Midspan PoE injector should be viewed as a patch panel connection. If the 100m distance is exceeded, power provision and data communication can be negatively affected.

Nevertheless, AI Extend is becoming increasingly popular among POE devices, which can extend PoE distance up to 250m. Fiberroad AI POE series support this function by DIP Switch, whenever tune on as needed. The AI Extend feature is suitable for situations where your power source is too far away. However, that bandwidth limitation to be aware of.

Note that cable type, number of interconnects, the integrity of termination and even ambient temperature will affect the electrical resistance presented by the cable path. These factors may reduce the maximum allowable length of the cable.

> The AI PoE feature allows the switch to check the ports for activity periodically. If a port is not passing traffic for a certain amount of time, the switch will reset power on that specific port. The device on the other end will reboot with the idea that it returns to a working state. This is a great feature to automate this process. It can save lots of time on support and driving out to the site to troubleshoot or manually power cycle equipment.

Data and Power Pinout

	10/100BASE-TX (802.3af/at, Mode A)		10/100BASE-TX (802.3af/at, Mode B)		1000BASE-TX (802.3af/at, Mode A)		1000BASE-TX (802.3af/at, Mode B)		1000BASE-TX (802.3bt)	
Pin	Data	Power	Data	Power	Data	Power	Data	Power	Data	Power
1	Rx +	DC +	Rx +		TxRx A +	DC +	TxRx A +		TxRx A +	DC +
2	Rx -	DC +	Rx -		TxRx A -	DC +	TxRx A -		TxRx A -	DC +
3	Tx +	DC -	Tx +		TxRx B +	DC -	TxRx B +		TxRx B +	DC -
4	Unused			DC +	TxRx C +		TxRx C +	DC +	TxRx C +	DC +
5	Unused			DC +	TxRx C -		TxRx C -	DC +	TxRx C -	DC +
6	Tx -	DC -	Tx -		TxRx B -	DC -	TxRx B -		TxRx B -	DC -
7	Unused			DC -	TxRx D +		TxRx D +	DC -	TxRx D +	DC -
8	Unused			DC -	TxRx D -		TxRx D -	DC -	TxRx D -	DC -

Notes:

- Power must only be applied in one mode at a time, and this decision is made by the PSE. The PSE can support mode A or B, or both. Typically, the method selected is not a concern for an end-user because it is a requirement of the IEEE 802.3af/at standards that all PDs must support both modes.
- With Mode B, the phantom power technique allows the powered pairs also to carry data in 10/100 Mbit/s Ethernet.
- Both Modes A and B are supported in Gigabit Ethernet. The phantom power technique is utilised for both modes, as in Gigabit Ethernet, all four pairs are used for data transmission.
- IEEE 802.3bt "4PPoE" uses all for pairs to provide power in Gigabit Ethernet, hence the name of the standard - 4PPoE ("4-pair Power over Ethernet").