

Power Over Ethernet (PoE)

Cabling Guide

Powering Devices Through Infinique Copper Cable

What is PoE ?

Power Over Ethernet, popularly known as PoE is a method for transmitting DC power along with data over twisted pair cable to power devices. Since a single cable is used for both data and power, PoE eliminates the need for separate electrical cable and power outlets thus significantly reducing the installation costs and point of failure. With the growth in Ethernet, a wide range of devices, such as lighting, digital signage, wireless access points, nurse call stations, and thin clients, have power requirement beyond PoE standard. This has resulted in the development of PoE++ equipment that will supply 51 to 71 watts.

How PoE works, some basics:

Ethernet uses 4 twisted pairs and initially only 2 pairs were used for transmitting data, so the spare pairs were utilized to carry power in the first PoE standard. As data rates increased from 10/100 to 1000Base-T the two spare pairs were also used to carry data. So the PoE standard was established to provide two options to carry power, one to use the spare pairs and another to use the data pairs. It was defined that only one type of option can be used and both options cannot be used together.

The PoE standard helps power PoE devices and has protection built for non-PoE devices. A 25-kW resistor is added between the power pairs in the PD (Powered Device) and the PSE (Power Sourcing Equipment) begins to provide power only if a resistive value close to the required threshold is detected at the PD (Powered Device). As a DC powered device requires correct polarity, there is polarity protection provided by using a bridge rectifier to ensure that the PD (Powered Device) receives the correct polarity power.

What are the different PoE Standards?

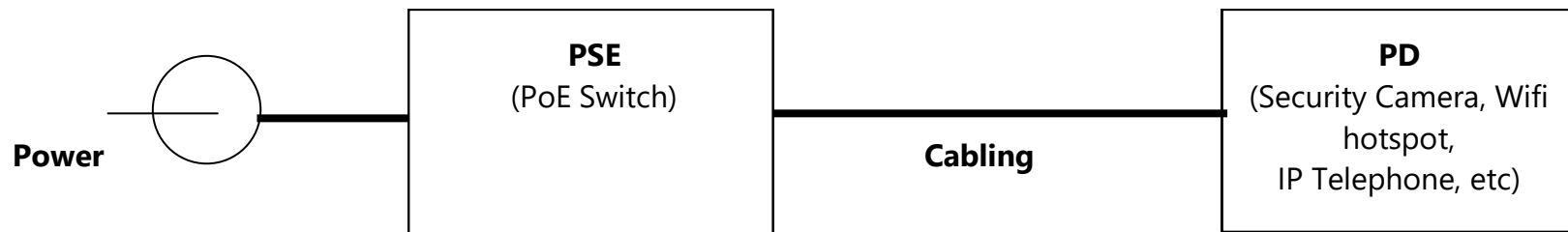
Below is a list of current PoE standards along with the maximum power:

1. IEEE 802.3af, which provides a maximum of 15.4 W per port
2. IEEE 802.3at, which provides a maximum of 30 W per port
3. IEEE 802.3bt, which provides a maximum of 90 W per port

What is a PoE Circuit?

In simple terms, a PE Circuit is one that connects a Power Sourcing Equipment (example: a PoE Switch) which is powered by an external power source to a device which needs to be powered i.e. Powered Device (example: a network or IP camera) through an Ethernet Cable.

In the below diagram you can see that there are three components that are required to complete a PoE Circuit. The first component is the PSE (Power Sourcing Equipment) which transmits the power signals on the same cable as the data. PSE is generally a PoE Switch or a Mid-span Injector.



The second component is the twisted pair cable which transmits both the power and the data signals. And the third component is the Powered Device (PD), which is the device that is powered, such as a security camera, IP telephone and wireless access point.

Advantages of transmitting power using PoE

Ease of Installation

The main benefit of PoE is to transmit power and data using a single cable to the Powered Device (PD). For instance if the PD is a security camera, install the camera at the right location and connect one end of the Ethernet Cable into the RJ45 socket of the security camera and the other end to the PoE Switch, it's fast and simple.

Safety

PoE uses low voltage typically 48V DC, which has been classified as a safe voltage by UL Standards. As per the IEEE PoE standards, power is transmitted by the Power Sourcing Equipment (PSE) only when it is requested by the PD. If the PD is disconnected, the PSE will automatically stop transmitting the power. It will ensure that the handshaking process is complete with the PD before sending the power again. This makes PoE safer than typical AC power which is always present at the outlet.

Reliability

The PoE Switches which are part of the network can be centrally supported with an Uninterruptible Power Supply (UPS), any loss of power would mean that the UPS can still power the PoE Switches. This feature is important for critical applications such as video surveillance where the security cameras can be powered without interruption.

Savings

In a non-PoE installation, you have the cost of running two cables one for power and another for data plus there is a need to provide an AC outlet for power which has to be installed and serviced by a specialist electrician to meet the safety regulations and building codes, all add up to the installation expenses. Whereas in a PoE based installation, the infrastructure cost are low due to its simple and efficient design of using a single cable for both power and data.

What are PoE Classes?

The PoE standards and classes have evolved over a period of time. Based on the PoE Standards and the power requirement of different types of PD devices, PoE classes have emerged to satisfy the needs of different power requirements.

The table below lists the PoE Classes along with the PSE and PD power specifications along with the Ethernet Cable pairs used.

Standard	PoE Type	Class	Cable Category	Cable Pairs Used	PSE Power	PD Power
802.3af	Type 1	Class 0	Cat,3, Cat.5	2 Pairs	15.4 W	0.44 - 12.95 W
802.3af	Type 1	Class 1	Cat,3, Cat.5	2 Pairs	4.0 W	0.44 - 3.84 W
802.3af	Type 1	Class 2	Cat,3, Cat.5	2 Pairs	7.0 W	3.84 - 6.49 W
802.3af	Type 1	Class 3	Cat,3, Cat.5	2 Pairs	15.4 W	6.49 - 12.95 W
802.3at	Type 2	Class 4	Cat.5	2 Pairs	30 W	12.95 - 25.5 W
802.3bt	Type 3	Class 5	Cat.6	4 Pairs	45 W	40 W
802.3bt	Type 3	Class 6	Cat.6	4 Pairs	60 W	51 W
802.3bt	Type 4	Class 7	Cat.6	4 Pairs	75 W	62 W
802.3bt	Type 4	Class 8	Cat.6	4 Pairs	90 W	71.3 W

What is the maximum distance that can be used between PSE and PD?

Using Power over Ethernet (POE), 10/100/1000 Mbps of data and 15W, 30W, 60W, and up to 90W of power can be sent from PSE to PD over Ethernet cables for a maximum distance of 100m.

Is there a way of increasing the maximum distance beyond 100 meters?

Yes there are ways to extend the PoE distance beyond 100 meters.

PoE Extenders

These are capable of extending the distance up to 400 meters. However, there can be energy loss in the cable and this needs to be considered. As only two twisted pairs are used to transmit the power, only 7.91W power remains at the end of 400 meters. The power loss not only depends on transmitting distance but also on the quality of Ethernet cable. Cables made with pure copper is the best choice for repeating the PoE and reducing the power loss. For example the maximum PoE distance can shorten down to 60 meters when low cost copper clad aluminum cable is used, whereas we can achieve up to 120 meters when Category 6 pure copper cable is used. So when choosing Ethernet cable, always make sure the twisted pairs are made of pure copper.

PoE Switch with VLAN

Once the VLAN is selected in the PoE switch, it can support up to 250 meters transmission length. The trade off is the network speed, as it will be downgraded to 10 Mbps network. As IP cameras generally require around 8mbps bandwidth, this solution works fine for security applications. However if access points are added to this network, then this is not the right solution. The VLAN isolates the ports and allocates individual non-sharable 10 Mbps bandwidth to each port. In this scenario each PoE port can only communicate with the uplink ports, but not with each other. These PoE switches usually inject higher voltage power than DC48V, so that there is more power margin to adapt to voltage drop after 250 meters.

Structured Cabling Considerations for PoE

As the transmitted power level through the Ethernet cables increases, so does the current amperage. This has an impact on the increase in the heat generated within a cable. The Ethernet cables and connectors, by themselves, can handle the 960 mA current and the 71 W of power. The concerns with running PoE in cables has to do with heat and temperature rise that occurs when the cables are bundled, and the concern with connectors is arcing that occurs when a plug is removed from a connector with live PoE.

Factors to Consider

While using Ethernet Cables and Components for PoE, please note the following factors:

- 1) Bundle size - the heat that is generated when cables are bundled together
- 2) Arcing - that occurs in the connectors when a plug is removed from a connection with live PoE

Heat Generation in Cable Bundles

The bundle size of the cables affects the ability of the cables to dissipate heat resulting in the inner cables within the bundle to heat up. This results in an increase in channel transmission parameters such as insertion loss and DC resistance, which require some considerations to achieve the standard cabling lengths. The increase in attenuation could harm the performance and could even cause network downtime in worst case. Hence, when planning applications that utilize PoE, great care must be taken in choosing the optimal cabling system; and in certain situations it may be necessary to impose limitations.

The increase in temperature is due to the higher current level with PoE+ had a greater effect on bundles with a higher number of conductors. In cables with smaller conductor diameters and large bundles there is an increase in temperature. In cables with bigger conductor diameters, the increase in temperature was not significant and they performed distinctly better.

In an installation if 92 cable runs are required to connect to the PoE devices, it is possible to have one large bundle of 92 Category 6A 23 AWG UTP cables for PoE++, or 4 smaller bundles of 23 runs of Category 6 24 AWG or Category 5e 24 AWG UTP Cables. Both these methods are accepted to limit the increase in temperature. These bundles can be placed adjacent to each other.

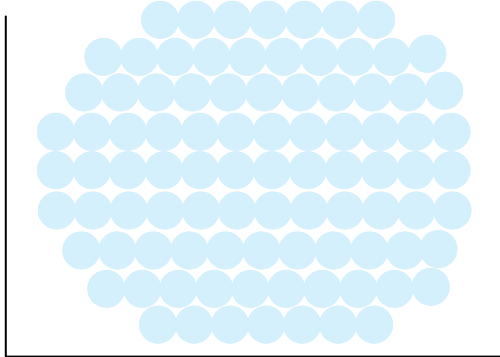
Depending on the installation and bundle size, Category 6A 23 AWG UTP or Category 6 24 AWG UTP Cable can be used. It should be noted that since Category 6A 23 AWG UTP has no bundle size limitations it can safely be used for PoE++ applications.

Arcing

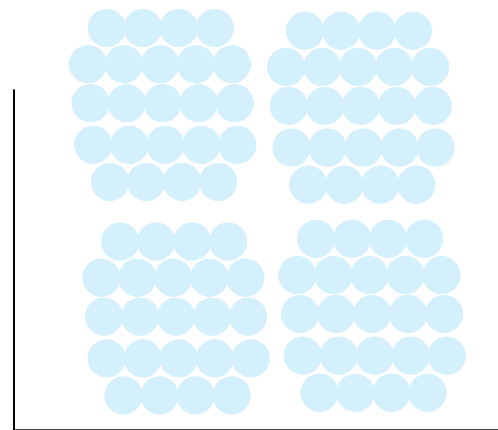
The arcing is the spark discharge caused by the un-mating of live connections that can cause damage to the plug and jack contacts, making the transmission through them impossible. Contacts in the plug and the jack must be designed so that damage by the arc does not occur where the plug and jack mate. These components should be manufactured adhering to the test standards IEC 60512-9-3 and IEC 60512-99-001 to avoid arcing. Infinique components are designed to pass the test methods of IEC 60512-9-3 and IEC 60512-99-001 to ensure that when arcing occurs, it will not damage the critical plug and jack mating point.

Recommendations for PoE Cabling

- Use the right category of cabling solution based on the power requirement of the Powered Device (PD) used in the application.
- Select a type of pathway infrastructure to support the cables which can help reduce heating issues
- Reduce the number of cables in bundle to mitigate the increase in cable temperatures. Use maximum of 24 cables in a bundle when using cables with smaller conductor diameter for reducing increase in temperature as per ISO/IEC TR 29125 and TIA TSB-184-A.
- Transmission parameters are specified up to 60°C in cabling standards such as ISO and TIA. So it is a good practice to design applications below this temperatures for ideal performance.



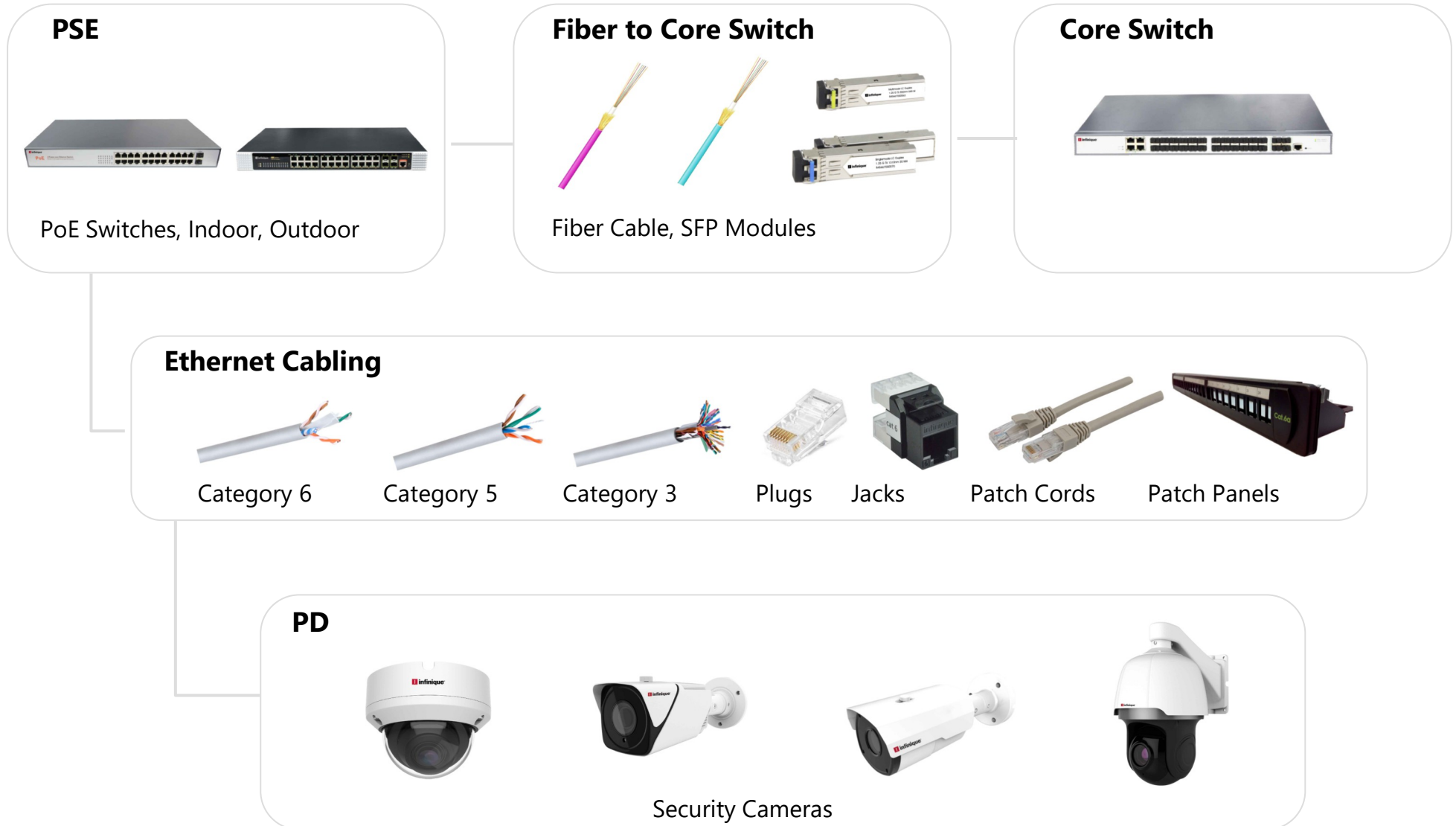
Category 6A 23 AWG UTP bundle of 92 cable



Category 5e 24 AWG UTP 4 bundles of 23 cable

What products can I get from Infinique for my PoE installation ?

Infinique has a wide range of security cameras, structured cabling solution for both copper and fiber systems, and PoE switches. The product matrix below will give you an idea about how you can use Infinique products in your installation.



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