

Cable Selection for Power over Ethernet (PoE) Applications

Power over Ethernet (PoE) is a standardized system that utilizes standard balanced twisted pair cabling (Category 3 or higher) to supply electrical power along with Ethernet data. This technology allows a single cable to provide the required communication and electrical power to a variety of devices. While PoE is designed to operate on Category 3 or higher, the proper cabling selection can have a significant impact on the performance of the system. Factors such as power requirements of the PoE device, allowable voltage drop, heat dissipation, and data transmission performance impact the cabling requirements and ultimate performance of the PoE system. The following guidelines are provided to assist in cabling selection for a successful PoE implementation.

Power over Ethernet (PoE) Standards

The IEEE (Institute of Electrical and Electronics Engineers) standards for Power over Ethernet (PoE) are 802.3af, 802.3at, and 802.3bt.

IEEE 802.3af-2003 (Type 1 PoE) was the first PoE standard to be developed by the IEEE. It provides 15.4 watts at 48 volts DC with 12.95 watts assured to be available at the powered device and has a maximum current rating of 350mA per pair. 802.3af requires the use of Category 3 or higher rated cable to support it.

IEEE 802.3at-2009 (Type 2 PoE Plus) was developed to meet the need of devices that require more power than 802.3af. 802.3at provides 30 watts at 48 volts DC with 25.5 watts assured to be available at the powered device and has a maximum current rating of 600mA per pair. 802.3at requires the use of Category 5e or higher rated cables to support it.

IEEE 802.3bt (4-pairs PoE or 4PPoE) is the next generation PoE standard under development by the IEEE. The new standard will add requirements for Type 3 ($\leq 60W$ at the Power Sourcing Equipment (PSE)) and Type 4 ($\leq 99.9W$ at the PSE). 802.3bt requires the use of Category 5e or higher rated cables to support it.

Factors in Selecting Cable Type

There are several factors that should be considered when selecting the cable type used for PoE applications. The first consideration is the amount of power the PoE device requires for operation. This power requirement will dictate which IEEE standard to follow, and subsequently the minimum category cabling that may be used. Although each standard dictates a minimum category of cabling, other factors should be considered for optimal performance of the network. These include voltage drop, heat dissipation and data transmission performance. Voltage drop determines how much of the supplied power reaches the receiving device. The energy that is lost over the length of the cable transforms to heat and is referred to as heat dissipation. Excessive heat build-up can cause an increase in attenuation as well as premature aging of the cabling jacket. Another factor to consider is the data transmission requirement (e.g., 1000BASE-T, 10GBASE-T) of the device(s) being utilized. Devices such as megapixel IP cameras may require higher grade cabling in order to deliver the video signal as well as the required power.

Recognized Cable Standards

The Telecommunications Industry Association (TIA) recognizes four standards of twisted pair cabling used for Ethernet applications. These include Category 3, Category 5e, Category 6 and Category 6A. The different categories of cabling are based upon their electrical performance characteristics. As indicated in the table below, Category 3 cabling utilizes a 24 AWG copper conductor and has a maximum bandwidth of 16 MHz. Category 3 cabling is only approved for 802.3af devices that require low power. In comparison, Category 6A cable has a maximum bandwidth of 500 MHz and utilizes a 23 AWG copper conductor. The larger conductor used in Category 6 and 6A cabling is preferred for PoE applications due to it having less voltage drop over the length of cable. Even among nominal gauge sizes, slight differences in actual conductor diameter can have measurable effects on system performance. This allows more of the supplied power to be received at the device. Note that Ethernet cable distance limitations apply to PoE applications as well.

The following table indicates the recognized cabling standards and their Approved PoE Applications.

Category	Nominal Conductor Size AWG	TIA Maximum Bandwidth MHz	Common Ethernet Applications	Approved PoE Application(s)	Voltage Drop* volts
Superior Essex Category 3	24	16	10BASE-T	802.3af	5.00
Superior Essex Marathon LAN® Category 5e	24	100	1000BASE-T	802.3af, 802.3at, 802.3bt	4.91
Superior Essex Cobra Category 5e+	24	100	1000BASE-T	802.3af, 802.3at, 802.3bt	4.91
PowerWise® 1G 4PPoE	22	100	1000BASE-T	802.3af, 802.3at, 802.3bt	2.72
Superior Essex DataGain® Category 6	23	250	1000BASE-T	802.3af, 802.3at, 802.3bt	3.95
Superior Essex NextGain® Category 6+	23	250	1000BASE-T	802.3af, 802.3at, 802.3bt	4.05
Superior Essex 10Gain® Category 6A	23	500	10GBASE-T	802.3af, 802.3at, 802.3bt	4.11
PowerWise® 10G 4PPoE	22	500	10GBASE-T	802.3af, 802.3at, 802.3bt	3.07

*Voltage drop parameters = 48 volts input voltage, 350 mA input current, 250' length of cable. Voltage drop calculation based on circular mils of conductors.

Summary

All of the recognized cabling categories are acceptable for Power over Ethernet applications; however, higher grade cabling is preferred because it can deliver more power with greater efficiency. This will result in a greater cost savings over time, and it will also result in cooler temperatures in the cabling plant. For this reason, several standards in development at TIA are recommending CAT 6A as the minimum cabling category for POE applications.