Screened vs Unscreened Cabling

White paper

Introduction

A global standard since the 1980s, screened and shielded twisted-pair copper cabling varieties are still a mainstay in some markets. While many other markets have migrated largely to unshielded twisted-pair (U/UTP) cables, the recent ratification of the 10GBase-T standard for 10-Gbit/sec Ethernet over copper has re-established the commercial viability of screened and shielded systems, and has fueled greater adoption of these systems in markets that previously were UTP-centric.

Communications cable has always come in unscreened and screened versions. It has been shown that the introduction of 10GBase-T in fact has a considerable impact on the selection of cabling. The increased sensitivity of 10GBase-T transmissions compared to 1000Base-T was clearly evident with unshielded cabling in terms of immunity against external interference. In order to guarantee the operation of 10GBase-T, it is not sufficient to pay attention to the cabling alone, rather the environmental conditions must also be considered and the cabling components must be properly selected. Coupling attenuation can serve as a qualitative comparative parameter for the EMC behavior of cabling.

When looking at cables one should ask themselves about the need for canceling out electromagnetic interference (EMI). While all and any cable type may work for a specific application, it is important to understand where and when the cable will be required to provide protection from power frequency and/or electromagnetic interference (EMI). This is where shielded vs. unshielded cable come into play.

This white paper explores the difference between the screened and unscreened cabling solutions.

Electromagnetic Interference

First let's explore what is Electromagnetic Interference (EMI) or radio frequency interference (RFI) as it may also be called.

EMI is a disturbance. This disturbance is generated by an external source affecting an electrical circuit by electrostatic coupling, electromagnetic induction, or conduction. This type of disturbance may lower the performance of the circuit or stop it from functioning all together. Where there is a data path, these types of effects range from an increase in error rate all the way to a complete loss of the data.

Natural as well as man-made sources generate changing electrical currents and voltages that may cause electromagnetic interference. Examples for manmade sources include vehicle ignition systems, cell phones, etc. Natural sources include the sun, thunder storms, etc. Electromagnetic interference commonly affects AM radios, and may also affect FM radios, televisions and cell phones.

Screened or Unscreened?

The decision to use Unscreened or Screened cables will depend on a number of factors including the budget available, the performance of the cabling system, the electrical environment in to which the cabling will be installed (the level and type of Electromagnetic Interference (EMI)), the type of cable containment, the proximity of data cables to power cables and the availability of adequate points of earthing within the building to be cabled.

Screened cables typically contain similar elements as unscreened cables, but screened cables radiate much less electromagnetic energy, which can interfere with signals in other nearby cables due to the screen's ability to absorb and divert it.

Screened cabling also helps to protect the signal integrity from external interference in electrically noisy environments such as:

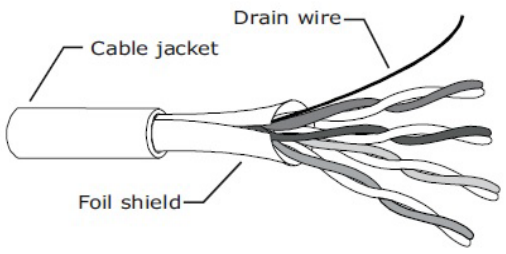
- Industrial factory floors.
- High-voltage/high-current electrical equipment or components proximity.
- High concentration of electrical equipment.
- Where secure communications are desired.

There are two type of cables shielded and unshielded type.

Shielded cables - Shielded cables reduce electrical noise and electromagnetic radiation. In other words, they help to keep the signal steady, and reduce interference with other devices. This is done with a shield that may be composed of copper tape, a layer of conducting polymer or a braid (made of copper or aluminum mostly), and is covered with a jacket. There are different levels of shielding. STP, SFTP, FTP. There are also different types of shielding, including braided shield, foil and screening.

To make sense of it all, let's break this down a bit.
The shield can be applied to each one of the pairs in a cable, or to all the pairs together.
Foiled – when the shielding is applied to individual pairs or quads.
Screening – when the shielding is applied to the collection of pairs.
Braiding – a type of shield made of braided strands of aluminium or copper.
U/UTP – Unshielded Twisted Pair
F/UTP – Shielded/Screened or Foiled Unshielded Twisted Pair
S/FTP – Screened & Foiled Twisted Pair
U/FTP – Foiled Twisted Pair
Shielded cables are thicker than unshielded cables, as well as more sensitive to work with. They are usually used in industrial installations where nearby equipment cause electromagnetic interference.

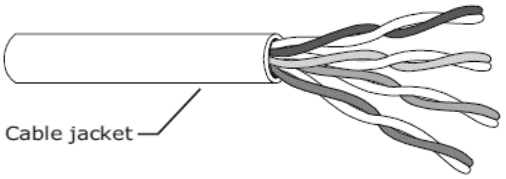
Shielded



Unshielded cables - (UTP) by definition do not have shielding serving them to reduce interference. They are designed to cancel electromagnetic interference with the way the pairs are twisted inside the cable. Due to its design and nature, unshielded twisted cable is most suitable for office LANS and similar network cabling systems. Unshielded cables are lightweight, thin and flexible.

They are also versatile and inexpensive. When properly installed, a well-designed unshielded cable will be easier to both install and maintain than a shielded one.

Unshielded



It is important to know the difference between the types of cables, their applications and pros and cons in order to make a knowledgeable decision which cable type to use, where, when, and why. Choosing the right cable type with enhance the network's performance, minimise errors and allow for a long-life span.

There are two different types of screen:

- Overall Screen - This is the screen that sits around the outside of all four of the pairs. It performs two functions, one to prevent the emission of signals (noise) out of the cable and, two, to protect the signals travelling within the cable from external interference. This screen may be either in the form of an aluminium foil or a tin-plated copper braid.
- Pair Screens - These foil screens are wrapped around each of the individual pairs within the cable and again perform two functions. The first is to prevent interference from the signal travelling in one pair of wires from affecting the signal travelling in another pair of wires in the same cable sheath (referred to as Near End Crosstalk or NEXT). The second function is to prevent the emission of signals (noise) out of the cable, where they could interfere with signals travelling in other, nearby cables (referred to as Alien Crosstalk).

In general, the higher the frequency of signal travelling down the cable the greater the need for screening. This is because, as the frequency rises, the signal travels further and further away from the centre of the core of the copper wire to the point at which it travels as an electromagnetic field around the core, which at this point becomes basically an aerial.

At very high frequencies the signals can actually migrate outside of the cable sheath, when Alien Crosstalk becomes a potential problem. Unscreened cables are cheaper than their screened alternative simply because they require fewer materials and manufacturing processes.

The majority of Cat 5e and Cat 6 U/UTP cables installed are unscreened as the frequencies of up to 250MHz do not tend to create issues with Alien Crosstalk. Screening really only need be considered in the case of Cat 5e and Cat 6 if the cables are to be run in areas where there is the potential for EMI and the risks cannot be mitigated through physical separation between the cables and the EMI source or through the use of metallic conduit that will, when properly earthed, provide an overall screen for the cables passing through it.

Cat 6A cables may be unscreened or screened. If they are unscreened then some mechanical measures need to be taken to minimise the risk of Alien Crosstalk. This is usually done through the use of special, non-circular sheath extrusions, e.g. oval or triangular. These help to ensure that cables do not lie parallel to each other over extended distances but they are generally more expensive than their screened counterparts and require the use of expensive and time consuming Alien Crosstalk testing at the time of installation. Screened Cat 6A cables tend to have a smaller overall diameter than the unscreened types which means that more cables can be installed in a given size of containment and cable bend radii are smaller.

Cat 7A cables are always screened, with a S/FTP construction, as they have the potential to carry signals with frequencies of up to 1000MHz, creating a very high risk of Alien Crosstalk if no screen were used.

How to Improve Cabling Immunity?

The following techniques are deployed to mitigate electromagnetic interference:

- Balancing
- Screening (Shielding)
- Bonding & Grounding

Cable screening (Shielding)

Screening means putting aluminium foil and/or copper braid around the conductors within the cable and/or around the whole cable as well. The purpose of screening is to keep external electromagnetic energy from getting into the cable and corrupting the data travelling down it. It also keeps electromagnetic energy inside the cable and thus stops the cable from being a source of interference.

Screening therefore seems like a good idea but the commonly perceived downside is larger and more expensive cables, compared to unscreened, and more complex installation techniques, as screens have to be correctly bonded to earth to work effectively.

Standards are considered to be living documents. It is important that the region-specific standards are quoted in the design and implementation.

The performance benefits of using screened and fully-shielded systems are numerous and include:

1. Reduced pair-to-pair crosstalk in fully-shielded designs
2. Reduced alien crosstalk in screened and fully-shielded designs
3. Screened category 6A cable diameters are generally smaller than 6A U/UTP cables allowing greater pathway fill/utilization
4. Substantially improved noise immunity at all frequencies and especially above 30 MHz when cable balance starts to significantly degrade
5. Significantly increased Shannon capacity for future applications

Achievable SNR margin is dependent upon the combined properties of cabling balance and the common mode and differential mode noise immunity provided by screens and shields. Applications rely on positive SNR margin to ensure proper signal transmission and minimum BER. With the emergence of 10GBASE-T, it's become clear that the noise isolation provided by good balance alone is just barely sufficient to support transmission objectives. The alien crosstalk and noise immunity benefits provided by F/UTP and S/FTP cabling designs have been demonstrated to offer almost double the Shannon capacity and this performance advantage has caught the attention of application developers and system specifiers.

It's often said that the telecommunications industry has come full circle in the specification of its preferred media type.

In actuality, today's screened and fully-shielded cabling systems represent a fusion of best features of the last two generations of LAN cabling: excellent balance to protect against low frequency interference and shielding to protect against high frequency interference.

Conclusion

Screening is used to reduce the effects of electromagnetic interference (EMI) or electrical noise which can disrupt the transmission performance in some environments. This noise may be as a result of external interference from other electrical equipment or as a result of interference generated within the cable from adjacent pairs (cross talk). Metal foil or braid may be used as a screen material, each with different properties and the screen may apply to the overall cable and/or to individual pairs in the cable.

The choice of screening is dependent on the environment where the cables are used and the applications they are required to run. For example, unscreened cables may be perfectly suitable for standard office applications, whereas screened cables may be preferred in industrial application or where higher performance transmission is required, or where data reliability and maximum throughput is paramount. In all cases cables should be installed and terminated in accordance with internationally recognised standards.

In conclusion, there are no hard and fast rules as to when or where unscreened or screened cables should be used and each installation should be assessed on a case by case basis.

The number of companies choosing a screened solution has been increasing since they have started to understand the benefits while at the same time the myths of screening have been dispelled by better education. It is time to pay the money and make your choice!

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