Screened and Shielded Cabling

– Facts and Fiction

Note: This brief overview is based on the in-depth Siemon technical whitepaper entitled "Screened and Shielded Cabling – Noise Immunity, Grounding and the Antenna Myth" by Valerie Rybinski. The complete version of this document may be downloaded or ordered in hardcopy at www.siemon.com.

BALANCED CABLING:
In theory, perfectly balanced twisted-pair cabling is immune to interference from outside noise sources. In actuality, twisted-pair cables are not perfectly balanced. Balance can improve noise immunity up to 30 MHz. After that, screens and shields must be relied upon to improve noise immunity.

FUNDAMENTALS OF NOISE INTERFERENCE:
Noise can be coupled onto a twisted-pair cabling transmission line in any or all of three ways:

1. Induced from an adjacent twisted-pair or balanced cable (i.e. differential noise)
2. Induced by an external electromagnetic field
3. Induced by a difference in potential between conductor ends (i.e. ground loops)

Differential noise disturbers:
Alien crosstalk and internal crosstalk are examples of differential mode noise disturbers that must be minimized through proper cabling system design. Susceptibility to interference from differential mode sources is dependent upon system balance, but can be significantly improved by using screens and shields.

Environmental noise disturbers:
Environmental noise is comprised of magnetic and electric fields. Magnetic field coupling occurs only at low frequencies (i.e. 50 Hz or 60 Hz) and its impact can be ignored for all types of balanced cabling. Electric fields, however, can produce disturbing signal voltages on balanced cables. The magnitude of the voltage induced can be modeled assuming that the cabling system is susceptible to interference in the same manner as a simple loop antenna. Loop antenna models demonstrate that screened and fully-shielded cables offer 100 to 1,000 times the immunity protection from electric fields than UTP cables do!

It is important to remember that the overall susceptibility of twisted-pair cables to electric field disturbance is dependent upon both the balance performance of the cabling and the presence of a screen or shield. Well balanced (i.e. category 6 and higher) cables should be immune to electromagnetic interference up to 30 MHz. The presence of a shield or screen is necessary to avoid electromagnetic interference at higher frequencies, which is an especially critical consideration for next generation applications.

Ground loops:
Ground loops develop when there is more than one ground connection and the difference in voltage potential at these connections introduces (generates) noise on the cabling. It is a misconception that common mode noise from ground loops can only appear on screens and shields; this noise regularly appears on the twisted-pairs, as well. Since the common mode voltage generated by ground loops is low frequency (i.e. 50 Hz or 60 Hz), the balance performance of the cabling plant is sufficient to ensure immunity regardless of the actual voltage present.

Design of screens and shields:
Solid aluminum foil is the preferred shielding media for telecommunications cables because it provides 100% coverage for high frequency (i.e. greater than 100 MHz) applications, as well as low electrical resistance. The thickness of the foil shield is selected so that 30 MHz and higher frequency signals cannot penetrate the shield. This design approach ensures that higher frequency signals will not be able to penetrate the foil shield and lower frequency signals will not interfere with the twisted-pairs due to their good balance performance.

Grounding of cabling systems:
ANSI-J-STD-607-A-2002 defines the building telecommunications grounding and bonding infrastructure that originates at the service equipment (power) ground and extends throughout the building. TIA and ISO standards state that the cable shields shall be bonded to the telecommunications grounding busbar (TGB) in the telecommunications room and that grounding at the work area may be accomplished through the equipment power connection. This procedure is intended to support the optimum configuration of one ground connection to minimize the appearance of ground loops, but recognizes that multiple ground connections may be present along the cabling.

WHY USE SCREENED/FULLY-SHIELDED CABLING?
The performance benefits of using screened and fully-shielded cabling 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 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

THE ANTENNA MYTH:
It is a common myth that screens and shields can behave as antennas because they are long lengths of metal. The fear is that screens and shields can "attract" signals that are in the environment or radiate signals that appear on the twisted-pairs. The fact is that both screens and shields and the copper balanced twisted-pairs in a UTP cable will behave as an antenna to some degree. Models and experiments prove that UTP cables have 100 times more potential to radiate and receive signals (i.e. behave like an antenna) than F/UTP cables under ideal termination conditions and 10 times more potential than F/UTP cables inappropriately left ungrounded on both ends.

THE GROUND LOOP MYTH:
It is a common myth that ground loops only appear on screened and shielded cabling systems. The fear is that ground loops resulting from a difference in voltage potential between the screen/shield and ground connections cause interference that can adversely affect data transmission. The fact is that, due to the excellent balance exhibited by twisted-pair cabling at the low frequency (i.e. 50 Hz or 60 Hz) associated with the noise signals induced by ground loops, noise currents induced onto the twisted-pair either directly from equipment impedance differentials or coupled from a screen/shield are simply subtracted out by the transceiver as part of the twisted-pair transmission protocol.

TERMINATION MYTH: While it is true that shielded connector termination takes longer to terminate than a UTP connector, the difference is not as significant as many would think. For Siemon screened MAX modules, the termination time – including cable preparation – can be completed in less than 3 minutes. For Siemon's fully-shielded TERA outlet, the complete termination can be performed in less than 4 minutes. However, this increase in termination time may be essentially nullified if field testing for alien crosstalk is required. Due to the higher susceptibility of alien crosstalk for UTP installations, some end users require field testing of this parameter which is a time consuming endeavor for installers.

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