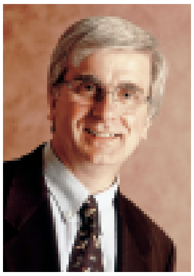
Time to talk about the noise

When it comes to external noise coupling, both UTP and ScTP cabling can be designed to work effectively to reduce it.



I have always intended to write something on the subject of noise coupling, but avoided doing so because of the controversial nature of the subject.

This has become a hot topic in the industry with strong proponents arguing in favour of either unshielded twisted-pair (UTP) or screened twisted-pair (ScTP) cabling for 10 Gb/s applications over copper.

Just to alleviate some concerns that I may have a bias towards UTP cabling, I will make every effort to present both sides of the issue. I do not pretend to have all the answers, but it is important for the end user to understand the sources of noise, the types of noise coupling and the mechanisms for counteracting external noise.

The good news is that 10 Gig cabling and in particular Category 6A has the "potential" to offer a very significant improvement in noise immunity.

However, the noise immunity performance depends very much on the pair balance and also on the shield construction, termination and grounding in the case of ScTP.

Let's start with the basics. There are two transmission modes for balanced pair cabling: differential mode and common mode. A differential mode signal has equal and opposite voltages on both conductors of a pair. A common mode signal has the same voltage on both conductors of a pair.

Balanced pair transmission, as the name implies, is intended to support differential mode signals. Unbalanced transmission results when a common mode voltage is superimposed on a differential mode signal.

Common mode signals are generated due to component unbalances in the cabling, which convert part of the differential mode signal into a common mode signal.

Conversely, component unbalances can convert an external common mode noise signal into differential mode noise, which can impair signal transmission. I will talk more about this later.

Pair balance

The ratio of the differential mode voltage to the common mode voltage, expressed in dB, is a measure of the pair balance for a component, permanent link or channel. Pair balance is currently specified for Category 6 components in the TIA 568 B.2-1 standard and for Category 6A components, permanent links and channels in TIA 568 B.2-10 (draft) standard.

The pair balance parameters are defined as Longitudinal Conversion Loss (LCL) and Longitudinal Conversion Transfer Loss (LCTL). Currently, there is no equipment to measure pair balance parameters in the field. This may change in the future.

The noise parameters that are currently specified in the cabling standards are differential mode noise coupling.

These include NEXT and FEXT coupling between pairs within the same component, permanent link or channel and alien NEXT and FEXT between pairs in different components, permanent links or channels.

What about other sources of external noise? These other noise sources can include electrical fast transients (EFT) from nearby power lines, transformers, electric motors as well as radio frequency interference (RFI) from mobile radios, medical equipment, industrial equipment, arc welders and commercial television and radio transmitters.

The noise coupling from these sources is induced common mode noise and also conducted common mode noise due to ground potential differences for ScTP cabling. One thing about these noise sources is that they are dependent on the environment and can be difficult to troubleshoot.

What are the countermeasures to control external common mode noise?

Specify cabling with improved pair balance parameters. Pair balance measurements from Belden and another manufacturer of Category 6A UTP cabling indicate a 10 to 15 dB improvement compared to the draft TIA requirements. UTP cabling generally performs better than screened cabling for pair balance. This is because the proximity of the pairs to the screen and the displacement of the screen can affect performance.

Proponents of screened cabling argue that pair balance is not that important, because of the screening attenuation.

For the shield to work effectively at high frequencies, it needs to be grounded at both ends through a low impedance ground. A ground at one end only, looks like an open circuit at a ¼ wavelength and at odd multiples of ¼ wavelength. At 100 MHz, a ¼ wavelength corresponds to ½ meter of cable. At those frequencies, the screen acts as an antenna. That only leaves pair balance as an effective countermeasure.

There is a lot more that can be said on this subject. The effect of ground loops and conducted noise is another consideration. While I will leave this for a subsequent article, I would like to conclude that both UTP and ScTP cabling can be designed to work effectively to reduce external noise coupling.

In my opinion, pair balance is an important parameter for both screened and unscreened cabling to reduce the susceptibility to external noise. CNS

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