The Effect of Channel Margin on Throughput Performance For Structured Cabling Systems

In this paper, the final impairment is discussed and some example demonstrations are discussed that show the GigaSPEED® XL advantage.

**Near-End (NEXT) & Far-End (FEXT) Crosstalk** - Is the coupling of signals from one or more pairs onto other adjacent pairs.

![Crosstalk Diagram]

- The higher (larger value in dB) the Crosstalk isolation of a cable is, the lower the undesired coupling onto other pairs, therefore the better the cable. The best way to achieve good Crosstalk performance is to use short tight twists on the cable pairs. The Crosstalk performance of UTP cable is mainly determined by the twist scheme.

- If long twists are used, the conductors from different pairs tend to nest together or intrude inside an adjacent pair's cylinder. In the case of short twists, because the location of the pair rotates so fast within the cylinder, the conductors from the other pairs are prevented from invading the pair’s cylinder. Thereby, pair separation is increased and the distortion of the ideal helical shape of the twisted pair is decreased. Both effects result in significantly improved Crosstalk performance.

**Near End Crosstalk** (NEXT) refers to the undesired coupling of signals from the transmit pair onto the receive pair on the same (=near) end. NEXT isolation is expressed in dB and is a measure of how well the pairs in a cable are isolated from each other.
The pair-to-pair method is good for small pair-count cables (i.e., 4-pair or less) and is the usual way of measuring NEXT. The measurement assumes one disturbing pair and determines the amount of signal coupled into other pairs in the cable, as shown:

**Power Sum NEXT** (PSNEXT) refers to the undesired coupling of signals from all other pairs into one pair. Basically, Power Sum is a more stringent specification.

The Power Sum NEXT method of measuring NEXT is a more appropriate means for multi-pair and backbone cables and/or cables transmitting systems on all pairs, such as for Gigabit Ethernet, since it takes into account coupling from more than one disturbing pair at a time. This is the case for a multi-pair cable handling data signals from multiple users.
Far End Crosstalk (FEXT) refers to the undesired coupling of signals from the transmit pair onto the receive pair at the other (=far) end. FEXT isolation is also expressed in dB. For the newer high end applications this is now an important parameter.

Equal Level Far End Crosstalk (ELFEXT) is the same as FEXT, except that the coupled signal at the remote end is relative to the attenuated signal at the remote end on the pair the signal was applied to at the local end.

Both FEXT and ELFEXT are important parameters when using more than two pairs in a LAN application. Currently, the requirements related to FEXT and ELFEXT are being specified by the Cabling standards. Channel ELFEXT is the combined effect (sum) of all cabling in the channel (typically the cable plus four connectors). Ensuring connector FEXT is minimal is thus critical to ensure channel ELFEXT is good. Connector FEXT is typically much worse than connector NEXT. Channel ELFEXT is a relevant noise source that must be taken into consideration in parallel transmission schemes where more than one pair in the cable is energised at once.

Power Sum Equal Level Far End Crosstalk (PSELFEXT) is the sum of the ELFEXT power from all other pairs in the cable. This measurement is applicable for parallel transmission schemes when more than two pairs is the cable are used to transmit in each direction (e.g. 1000BASE-T).

In summary, the throughput performance of a structured cabling system channel is impacted by a number of potential impairments. NEXT/FEXT has a significant negative impact on BER and subsequently the throughput of a structured cabling system channel. Crosstalk can grow to unmanageable levels and affects a wide variety of applications in addition to the other impairments impacting a structured cabling system channel.

To demonstrate that GigaSPEED® XL cabling solutions provide measurably better throughput performance than solutions compliant with the Category 5e standards, SYSTIMAX SCS Labs have been conducting experiments utilizing three high speed, bandwidth intensive applications. Two four-connector channels were constructed for evaluation. One channel used commercially available Category 5e compliant products and the other channel used commercially available SYSTIMAX® SCS GigaSPEED® XL components. For the Serial Digital Video test, a Category 6 compliant channel was also used for comparison.

Demonstrations:
1. 100BASE-TX LAN Data File Transfer
2. 100BASE-TX LAN Streaming Video
3. Serial Digital Video (SDV)

The results of these demonstrations indicate that overall throughput can be significantly improved by using a cabling system with performance margin over the standards defined requirements. It additionally shows that there are existing applications in the market today that can take advantage of the performance offered by a GigaSPEED XL cabling system.

One of the unique benefits of the SYSTIMAX warranty and Labs support has been the dedication to supporting and realizing applications over the cabling channel. This is in addition to all the work on standardization and pure cabling performance work. Previous Bullets have already discussed in depth the requirements of gigabit networking and the benefits of the SYSTIMAX cabling for these applications. This additional work has looked at some real applications generally available and in use today and show how even these applications can benefit from the superior performance of the GigaSPEED® XL solution.

While there are a number of impairments that can affect throughput performance of high-speed, bandwidth intensive applications when transmitted over a structured cabling channel,
the demonstrations described clearly show that NEXT crosstalk has a critical impact. Two currently available Category 5e applications, file transfer and LAN video streaming, ran markedly better over the GigaSPEED® XL cabling system under worst-case NEXT conditions. The additional NEXT crosstalk margin afforded the GigaSPEED® XL channel, greatly improved data throughput. The extra margin improves the Signal-to-Noise ratio (SNR) and allows additional signal power to be transmitted while minimizing the amount of crosstalk introduced into the channel.

The other demonstration also shows that there are some applications today, such as 270 Mbps Serial Digital Video, which require channel performance beyond Category 5e and even potentially Category 6. Streaming video applications are transmitted and processed one packet at a time. Any impairment introduced by the structured cabling channel cannot be reversed, video frames and pixels are lost, and the original quality of the transmitted image becomes severely degraded.

In conclusion, throughput performance limitations due to channel impairments will be even more apparent as the number of high-speed applications and the need for bandwidth continue to grow in the future. Structured cabling system channels should support at minimum one generation beyond current data rates by providing margins against channel impairments in order to ensure adequate throughput performance. GigaSPEED® XL is that solution!