Understanding Category Cable Specs

Natural Interference

Since inception, category cable generations (aka ethernet cables) have progressed significantly from their humble beginnings. Early generations were designed to interface with telephone systems and transmit voice while requiring little bandwidth. Today, advanced construction technologies like those used to create ProPlex CAT 5e "Ultra" and ProPlex CAT6a Extended have resulted in some of the best cables on the market, capable of utilizing gigabit and 10 gigabit bandwidths for extremely long cable runs.

While improvements in build quality are vital to many consumer and professional applications, not all cables are the same. Inferior products that you might find "off-the-shelf" are naturally susceptible to interference which can negatively affect performance. The electrical pulses of data sent through the twisted pairs within category cables create magnetic fields that interact with one another, resulting in electromagnetic interference (EMI). The term "crosstalk" describes this undesired interference between twisted pairs and subsequent errors in data transmission. We have taken great pains to develop and rigorously test our ProPlex ethernet cables to withstand the most extreme conditions of the real world and minimize effects of interference.

Measuring Crosstalk

Crosstalk performance indicators measure the ability of a cable to reject crosstalk between twisted pair or multiple pairs at either end of a cable link. They are essentially a differential strength measurement in decibels (dB) between a twisted pair with signal introduced (aka disturbing pair) and the effect on another adjacent pair or pairs (disturbed pair(s)). Ideally you want the difference between the disturbed and disturbing pairs to be larger number, therefore the higher the decibel level, the greater the rejection of crosstalk.

All crosstalk measurements vary with signal frequency (measured in MHz) so you will commonly see category cables specify measurements for a range of different frequencies. The ability to reject crosstalk at a certain frequency is partially how cables are approved for their category designation standards and are important specs to pay attention to.

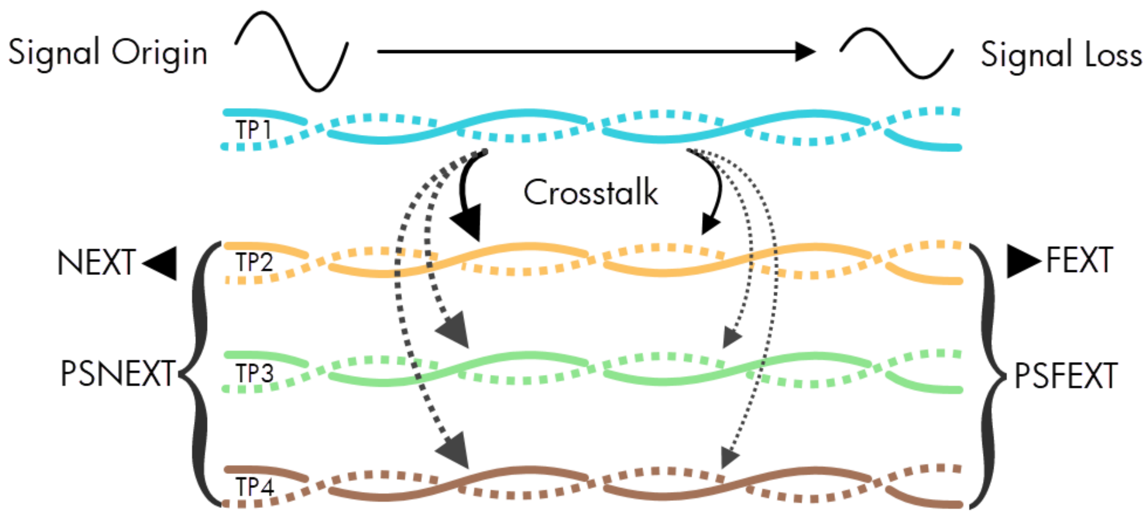
The main method to reducing crosstalk is physically twisting the pairs together. Pairs should be twisted in a tight ratio which allows opposing fields to cancel each other. Thus, you can somewhat infer the quality of the cable build by its crosstalk rejection specs. However, this is not the only factor. Excessive crosstalk is frequently caused by poorly twisted termination with connecting hardware. Maintaining the twist ratio is very important in cable assembly construction. While we cannot completely control field installations of raw cable, all our custom made TMB ethernet cable assemblies are meticulously built in-house with rigorous quality standards to ensure proper termination.

Crosstalk Performance Indicators

Near-end Crosstalk **(NEXT)**	crosstalk rejection measured between two adjacent pairs at the nearest end of cable
Power Sum Near-end Crosstalk **(PSNEXT)**	near-end effect of crosstalk on multiple adjacent pairs - consists of a summed measurement of crosstalk between all twisted pair combinations against the disturbing pair
Far-end crosstalk **(FEXT)**	crosstalk rejection measured between two adjacent pairs at the nearest end of cable, after signal is weakened due to insertion loss (more on that below)
Power Sum Far-end crosstalk **(PSFEXT)**	far-end effect of crosstalk on multiple adjacent pairs - consists of a summed measurement of crosstalk between all twisted pair combinations against the disturbing pair
Alien crosstalk **(AXT)**	interference source originating from outside the measured cable, i.e. from one cable to another

sales@tmb.com
www.tmb.com

Los Angeles +1 818.899.8818 | London +44 (0)20.8574.9700 | New York +1 201.896.8600 | Beijing +86 10.8492.1587 | Toronto +1 519.538.0888



Insertion and Return Loss

Another unavoidable characteristic of category cable is the loss of electrical signal energy as it travels along a length of cable. Insertion loss (aka attenuation) is a measurable effect of the resistance of the cable to the transmission of electric signals. It is calculated in decibels (dB) and expresses the ratio of energy loss between the output voltage at the far-end of the cable and the incidental input voltage at the near-end. The smaller the number, the better the result. Insertion loss can be influenced by several factors.

Conductor gauge	Thicker gauge wires will have less insertion loss at the same length than thinner gauge wires. Stranded cables also experience more insertion loss than solid conductors.
Frequency	Cables show more insertion loss for higher frequency signals. For example, specifications for CAT6a cables should have insertion loss verified for frequencies ranging from 1 MHz to 500 MHz.
Cable length	Excessive cable length can cause cables to fail insertion loss standards. Category cable loss specifications determine the max run length, and specific cables are measured against the standard.

Return Loss has become an important measurement with the advent of bidirectional signaling such as gigabit ethernet. Return Loss is the sum of all signal energy that is reflection back toward the origin of the signal, like a signal echo. Impedance mismatches are a common cause of increased return loss. Interconnected equipment in a LAN is frequently mismatched, for example, horizontal ethernet cables being rated at a lower impedance than patch cables. When the two sources of mismatched impedance are interfaced, the result is increased return loss. As with crosstalk, termination of cable to connectors while maintaining twist ratios is also very important to mitigate RL.

Very microscopic inconsistencies in cable construction can also attribute to mismatched impedance, like differences in core diameter, twisting precision, centering of core inside of insulation, and variations in insulation material. Additionally, structural inconsistencies like bent or kinked cables can create barriers to electric pulses and cause more reflection. Cheaper, “off-the-shelf cables” are mass produced and can succumb to these inconsistencies and are notoriously susceptible to kinking. TMB ProPlex Ethernet cables are carefully constructed and rigorously tested to re-coil over and over, withstanding the most extreme handling conditions imaginable on the road and earning the title of “The World’s Most Durable Ethernet Cables”.

sales@tmb.com
www.tmb.com

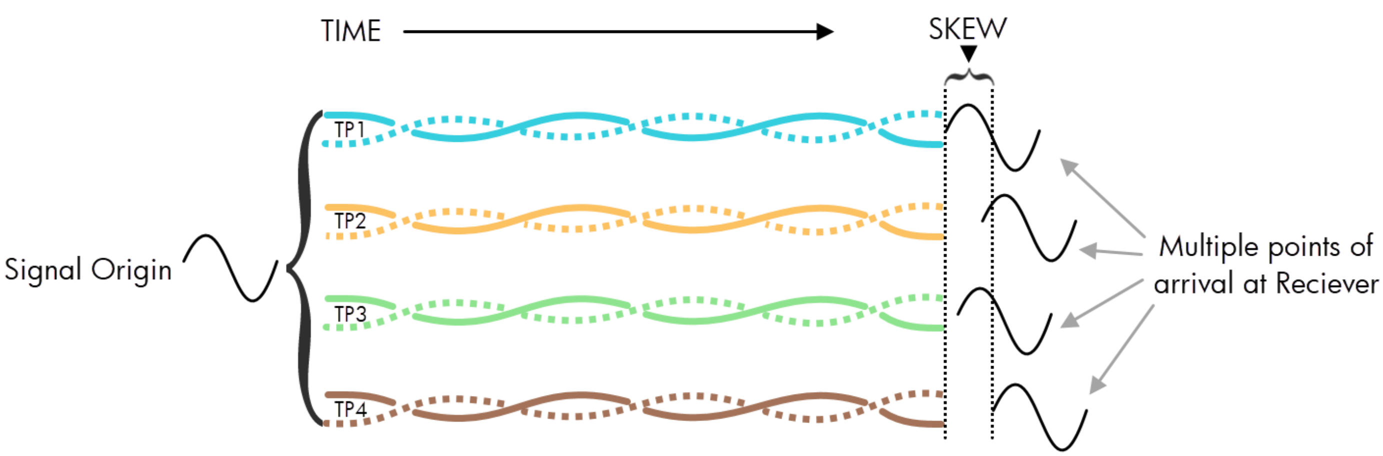
Los Angeles +1 818.899.8818 | London +44 (0)20.8574.9700 | New York +1 201.896.8600 | Beijing +86 10.8492.1587 | Toronto +1 519.538.0888

Skew Delay

The skew of a category cable refers to the difference of the fastest and slowest signal arrival times on each twisted pair of a cable. If the skew delay is higher, it means data can be slowed on one of more pairs and thus the arrival of data at the receiving end can be significantly different across the pairs. Consequently, it becomes a problem for the receiver to accurately interpret the original signal.

Early single-direction Ethernet standards such as 10BASE-T and 100BASE-T (10 and 100 megabit per second Ethernet) only used 4 out of 8 conductors in a category cable, so higher skew measurements weren't as much of a concern. The advent of Gigabit and 10 Gigabit Ethernet fundamentally changed the encoding of data to use all 4 twisted pairs of category cables to transmit and receive data bi-directionally. So skew delay in our current world of Ethernet has become an extremely important measurement.

Skew Delay will be measured in nanoseconds (nSec) over a 100 meter link – the lower the number, the better. An acceptable range of skew is between 45 and 50 nSec per 100 meter link. Once again we must say that not all cables are the same. We are proud of the excellent skew results for our ProPlex Ethernet cables, 25 nSec per 100m on both ProPlex CAT5e "Ultra" and ProPlex CAT6a Extended, making ProPlex an outstanding cut above the rest.



sales@tmb.com
www.tmb.com
Los Angeles +1 818.899.8818
London +44 (0)20.8574.9700
New York +1 201.896.8600
Beijing +86 10.8492.1587
Toronto +1 519.538.0888