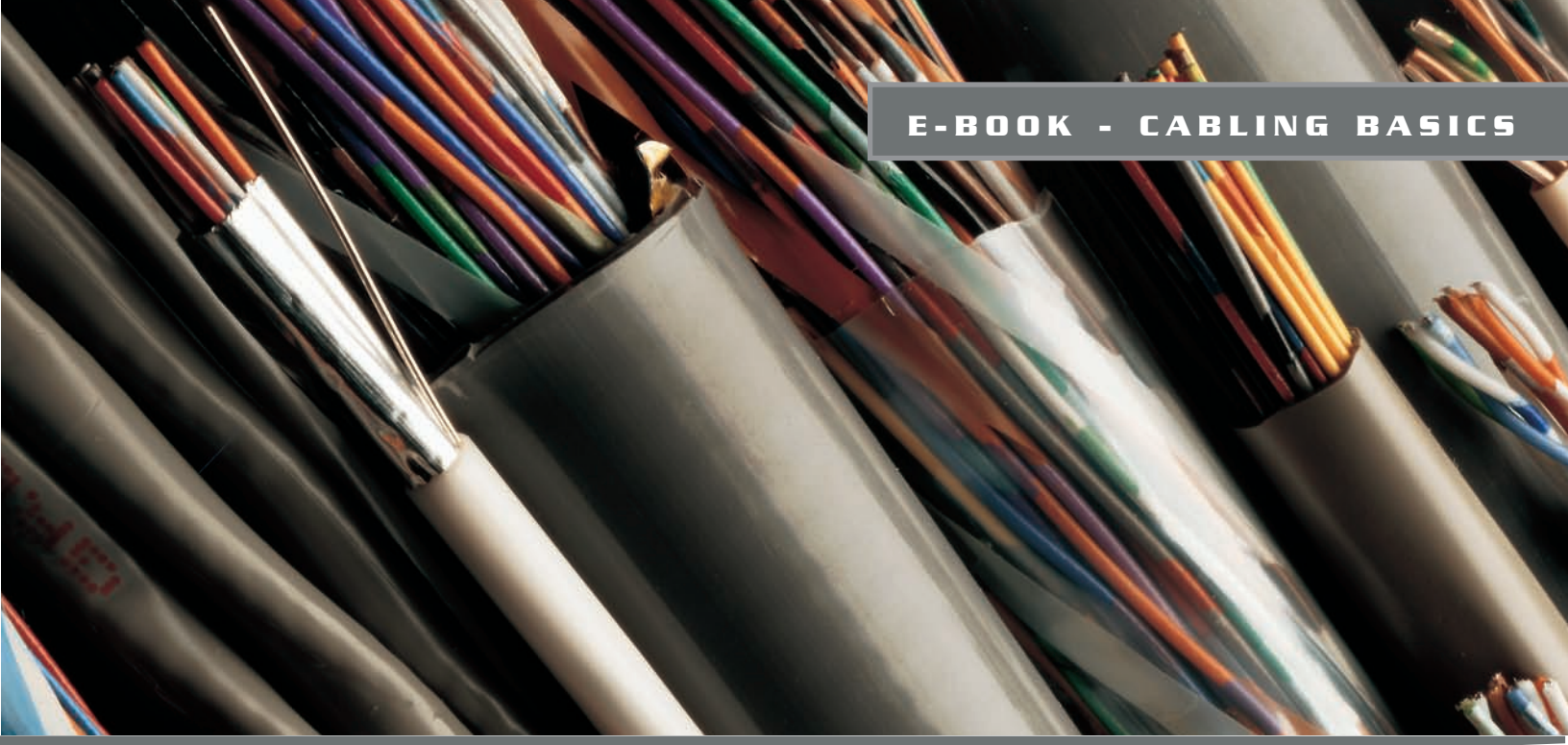

E-BOOK - CABLING BASICS

Network Cabling Basics

– What you need to know about 10Gb/s

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Cabling Lifecycles and Total Cost of Ownership

There are several factors that must be taken into consideration when determining the category or class of cabling that will be used in a network infrastructure. This is true for both copper and fiber. Factors that must be taken into consideration are:

- Expected installed lifetime of the cabling plant
- Applications that will run on the cabling plant over its useful life
- Timeframe during which standards, applications and electronics manufacturers will support the cabling plant
- Cost of active electronics
- Warranty length and covered components
- Price as it relates to performance
- Time the end-user will occupy a facility

What the standards mean to your network

With the IEEE 802.3an 10GBASE-T standard complete, performance demands on cabling infrastructures are expected to increase over the next few years. Cabling typically represents 5-7% of an overall network budget. Some specialty materials such as industrial rated products, conduit and limited combustible products may increase costs slightly higher. However, relying on price as the sole deciding factor is rarely a wise decision. Cabling systems, both copper and fiber, are designed to perform for 10 years, supporting 2-3 generations of active electronics. Overall lifecycle costs should be closely considered.

Cabling standards are regularly written and reviewed. For instance, ANSI/TIA/EIA (Now TIA) standards are reviewed every 5 years. At the end of the 5-year period they may be reaffirmed, rescinded or revised. ISO/IEC standards are written with a target lifespan of 10 years. IEEE application performance standards are written, revised or amended based on current manufacturing and product capabilities, application needs and contributions from companies, including cabling manufacturers, that participate in the standards process.

In some instances, overall network capabilities change at a greater pace than originally expected. This can shorten the lifecycle of a cabling system. Category 4 is a good example. This cable had a very short lifecycle due to expanding network performance requirements and the capabilities of higher performing category 5 and, eventually, category 5e. With the advent of 10GBASE-T, a higher performing category 6 cable known as Augmented Category 6 (6A) has been introduced. So the question is posed: how do I maximize my cabling investment, and what category of cabling should I install in my facility?

Active electronic manufacturers design equipment based on three factors: capabilities of the underlying infrastructure, industry standards and market share of the installed base of infrastructure. The technology must be technically feasible, have broad market appeal, and provide a unique feature set while coexisting with other technology. It would be virtually impossible to sell any active equipment that automatically requires replacement of a cabling plant.

Based on estimates from the major chip manufacturers, each iteration of a chip costs a developer approximately $1,000,000.00 and requires roughly 18 months from conception to market. Facing costs like these, most equipment producers are hesitant to venture too far from the standards. As standards eliminate or rescind support for cabling systems, the active equipment manufacturers will, as history shows, follow suit. There is an intricate balance between forward movement in technology and addressing the needs of legacy systems. In discussions within the 10GBASE-T study group, all categories, including 5e, category 6 and category 7/Class F, were examined to determine what the cabling would support and market share percentage held by each category. While category 5e has a greater market share, the cabling was not capable of supporting 10G b/s over distances more than 15 or 20 meters. Understanding that networks people have installed cabling lengths in excess of this limited distance, category 5e was written out of the standard and is not being considered. The final cabling choices for the pending 10GBASE-T standard is installed legacy category 6 with a supported distance up to 55 meters, augmented category 6 and category 7/class F, with the latter two supporting a distance of up to 100 meters.

It is important to note that the TIA 942 Data Center standard states that all horizontal cables shall be run to accommodate growth so that the horizontal does not need to be revisited. This is due to the significant cost and risk of downtime to adjacent systems. It is estimated that a data center will be in service for a period of 20 years and 10GBASE-T electronics will be added within 2-5 years.

Part of the cabling system selection process should include the cost of the cabling itself as well as other factors that contribute to the overall cost over its lifetime. As mentioned previously, a cabling infrastructure should last a customer 10 years and support 2 - 3 iterations of active equipment and applications. A costly factor in these calculations is labor, which may vary depending on geographic location; therefore national averages will be used.

The following analysis compares the total cost of ownership for a 24 channel cabling system ranging from category 5e through category 7/class F. Plenum-rated cable is used in all instances. Initial installation cost include the cost of components, installation and testing.

	Installed Cost	Lifecycle of System	Per Channel Average	Annualized Cost of Ownership
Cat 5e/Class D UTP	$4,103.66	5	$170.99	$820.73
Cat 6/Class E UTP	$5,560.74	7	$231.70	$794.39
10G 6A UTP	$8,129.86	10	$338.74	$812.99
10G 6A F/UTP	$9,026.24	10	$376.09	$902.62
TERA-Class F/Cat 7	$13,482.56	15	$561.77	$898.84

System life cycles are based on current standards developments, pending revisions, and the category's ability to support upcoming applications. For example, non-augmented category 6 systems will have a lesser lifecycle than augmented category 6 (6A) systems capable of supporting 10GBASE-T up to 100 meters. Category 7/Class F systems enjoy the longest lifecycle and are expected to support future applications beyond 10GBASE-T such as 40 Gb/s. The lifecycle costs for category 7/class F systems do not include the TERA®'s ability to run multiple 1 or 2-pair applications over one 4-pair cable and outlet which would make the TERA figures more attractive.

The previous table demonstrates that due to the shortened lifecycle of category 5e, the annualized cost of cat 5e (total installed cost divided by number of useful years) is near 10G 6A UTP. It is expected that during the next 2 -5 years, new 10GBASE-T copper electronics will be available and a cabling upgrade from 5e to at least augmented cat 6 (6A) will be necessary to support 10GBASE-T. It is fully expected that in the next 5-7 years, category 5e systems will move to an archive annex in their respective standards documents and will no longer be supported in the active equipment standards. Such was the case with category 3, 4 and 5 systems.

If a category 5e cabling plant was installed prior to adoption of additional performance parameters specified to support Gigabit Ethernet, the cabling plant should be retested for these parameters according to the latest standards. If we factor in the added labor to retest a legacy category 5e cabling plant, the total annualized cost increases. The following table shows additional lifetime costs of a 5e system compared to higher performing systems.

24 Channels	Installed Cost	Lifecycle of System	Annualized Cost	Incremental Testing for Gig	5 year Cost	New Annualized Cost of Ownership
Cat 5e/Class D UTP	$4,103.66	5	$820.73	$1,560.00	$5,663.66	$1,132.73
Cat 6/Class E UTP	$5,560.74	7	$794.39		$5,560.74	$794.39
10 G 6A™ UTP	$8,129.86	10	$812.99		$8,129.86	$812.99
10G 6A F/UTP	$9,026.24	10	$902.62		$9,026.24	$902.62
TERA®- Class F/Cat 7	$13,482.56	15	$898.84		$13,482.56	$898.84

In the above table, it becomes clear that over time, installation of a 5e system would cost significantly more. The figures above assume normal hours of operation and do not take into account overtime or other premiums that may be charged if the work is performed after hours to minimize disruption of the workforce.

It is important to note that category 5e is not being considered in the development of the pending IEEE 802.3an 10GBASE-T standard, In order to upgrade to support future 10GBASE-T applications (which is likely to occur over the next 10 years) additional labor will be required for both installation of the higher performing augmented category 6 cabling as well as removal of abandoned category 5e cable as now required by fire codes and legislation in many countries. In the category 6 UTP model, incremental labor is also added to test and verify 10GBASE-T support for channel lengths up to 55m as outlined in IEEE 802.3an as well as the corresponding TIA and ISO/IEC standards. According to recent work in the standards, 55m will only be viable with some type of mitigation to reduce the Alien Crosstalk. Again, we are not accounting for after-hours installation or tracing cables if the labeling and documentation on the system was not maintained. The cost to replace or run new conduit or drill new cores as needed to accommodate the new circuits due to increased cable diameters are not included. (See "New 10G Installation Practices" below).

24 Channels	Cost at 1Gig	Testing for 10GBASE-T	Removal of Abandoned Cables	Installation of 10G Capable Channels*	TCO to support 10GBASE-T	New Annualized Cost of Ownership
Cat 5e/Class D UTP	$5,663.66	Not-Supported	$1,560.00	New system required	New TCO applies	$1,444.73
Cat 6/Class E UTP	$5,560.74	$1,560.00	$390.00	$2,032.47	$9,543.21	$1,363.32
10G 6A UTP	$8,129.86	N/A	–	–	$8,129.86	$812.99
10G 6A F/UTP	$9,026.24	N/A	–	–	$9,026.24	$902.62
TERA - Class F/Cat 7	$13,482.56	N/A	–	–	$13,482.56	$898.84

*NOTE: The annualized cost of ownership stops after the removal of the abandoned cable and does not factor in the installation of the replacement 10G capable system. This is because the ROI/TCO calculation for the new 10G system starts with its installation. Cat 6/Class E UTP costs are based on replacement of 1 in 4 channels due to distances exceeding 55m as outlined in the standard. Costs for mitigation to support 55m are not included.

Factoring in Downtime Costs

If we consider downtime costs while testing and replacing the non-compliant 10G systems, the cat 5e and 6 total cost of ownership figures continue to increase. As cable testing is intrusive (the device at the other end must be disconnected in order to test), some downtime will occur with each iteration of testing and remediation.

Hourly employee costs will be estimated at the national hourly average wage as reported by the US Bureau of Labor Statistics weighted to account for overhead. For instance, the national average annual wage is $33,252.09. Adding overhead (taxes, office space, etc. using a 40% estimate) the figure is $46,562.66. On an hourly basis, the figure is $22.39 per employee per hour. This cost covers the expense of an employee being paid and unable to work. For each 24 employees that are down for one hour (time to shutdown, have their cable traced, tested, reinitialize their systems, and log on to applications, etc), the additional downtime costs for each 24-port system is calculated as follows:

24 employees * $22.39 per hour = $537.3

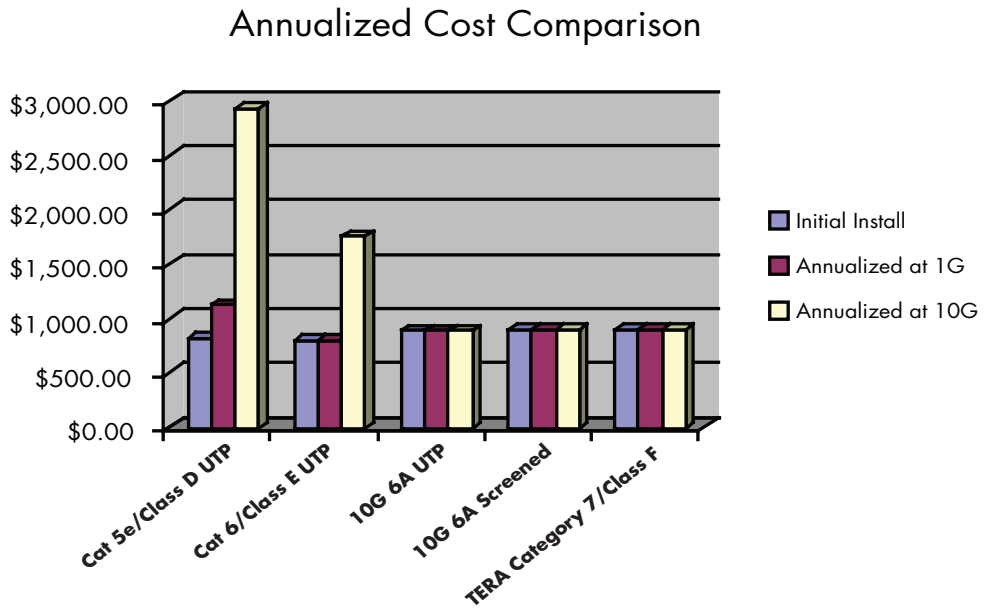
Each employee is also responsible for revenue. For this figure, we are estimating average hour revenue per employee. In utilizing the Fortune 1000 published revenue figures, we take total revenue and divide it by the number of employees and the hours worked (2080 per year) to obtain revenue per employee per hour (RH).

Total company revenue / total number of employees / hours worked per year = RH

Using Fortune 1000 data, average revenue equates to $132.40 per hour per employee or $3177.60 for 24 employees. Downtime is based on one user per cable. Data center connections such as those connected to servers would have many more users down while replacements occur. In the following table, downtime costs for lost wages/overhead and lost revenue per employee were accounted for in both category 5e and 6 systems. In the category 5e system add two hours of downtime per channel - one hour down to remove the channel and one hour down to replace the channel. For the category 6 system, downtime was calculated at 1 hour down for testing each channel plus 1 in 4 users down for 2 hours each to remove and replace non-compliant cabling channels over 55m.

24 Channels	TCO to support 10GBASE-T	Downtime Costs - Wages, Overhead and Revenue	TCO plus Downtime	New Annualized Cost of Ownership
Cat 5e/Class D UTP	New TCO applies	$7,435.07	$14,658.73	$2,931.75
Cat 6/Class E UTP	$9,543.21	$2,489.38	$12,032.59	$1,718.94
10G 6A™ UTP	$8,129.86		$8,129.86	$812.99
10G 6A F/UTP	$9,026.24		$9,026.24	$902.62
TERA® - Class F/Cat 7	$13,482.56		$13,482.56	$898.84

Any savings in downtime calculations (through work being performed after hours) would be offset by higher labor cost due to overtime rates for the installers. Testing time includes time to trace circuits. Keep in mind the average network has 1000 channels so these figures, once again, are very conservative. The following is a graphical comparison of the figures shown previously.



New 10G Cabling Installation Practices

Fill ratios are a significant change for 10G UTP systems. Due to the effects of Alien Crosstalk, a 40% fill ratio may be the maximum and other mitigation steps will be required as referenced in TSB-155. ISO 568-B.2-10 addresses the augmented category 6 systems and now allow for cable diameters to increase to 330 inches. In the calculations shown above, we have not included replacement of conduit or new core drills that may be required. Also bear in mind that categories of cable above 5e have larger cable diameters and may alter fill ratios for cable tray. Screened or Shielded systems will allow you to maintain a 60% fill ratio with a smaller cable diameter than augmented category 6, as the shield eliminates one of the greatest disturbers in 10G UTP system, which is ANEXT or Alien Near-End Crosstalk.

Copper vs Fiber to the Desktop

The idea of fiber to the desktop (FTTD) has been around for quite some time. Early proponents of FTTD sited problems with UTP systems and limited distances as their reasons for their recommendations. There are 10GBASE-X fiber applications, and in fact, those needing 10G bandwidth have had fiber options only for some time now. In evaluating copper versus fiber to the desktop, it is important to include overall network costs (including electronics), not just cabling costs.

Fiber components for 10G are expected to settle at a cost that is roughly 10x the cost of a gigabit port. On the copper side however, the cost will be about 3x the cost of a gigabit port or roughly one third the cost of a 10G fiber port. All PC's today ship with 10/100/1000 Mbps copper network interfaces. In order to use fiber to the desk, that investment will disappear and a new fiber card would need to be procured. The same cost differential applies. It is also noteworthy that the 10GBASE-T copper chips will auto-negotiate from 10Mbps up to 10Gbps. This means that one chip will be used for all network connections. It is far less expensive to mass produce one chip than several varieties. As 10GBASE-T chips begin mass production, they will begin to surface in server NICs, switch ports, etc.

Power over fiber is not a reality. There are several applications today that utilize Power over Ethernet (PoE) based on the IEEE 802.3af standard. 10GBASE-T is fully interoperable with power as an end-span solution (the power is supplied at the switch). The lack of ability to provide power over fiber may be limiting in some networks.

Fiber standards and lengths, have not been as stagnant as some people think. In looking at the chart below of supported lengths and types of fiber, from 100BASE-X to 10GBASE-X, it is easy to see that the similar replacements and/or remediation would be needed on some fiber channels in networks utilizing 62.5 micron fiber components for 10 gigabit applications.

Application	Wavelength	62.5 160/500	62.5 200/500	50 500/500	50 2000/500	SMF
100BASE-SX	850nm	300m	300m	√300m	300m	—
1000BASE-SX	850nm	220m	275m	550m	550m	—
1000BASE-LX	1300nm	550m	550m	550m	550m	5km
10GBASE-SX	850nm	28m	28m	86m	300m	—
10GBASE-LX	1310nm	—	—	—	—	10km
10GBASE-EX	1550nm	—	—	—	—	40km
10GBASE-LX4	1310nm	300m	300m	300m	300m	10km

Summary

For anyone responsible for selecting the right cabling infrastructure and who plans to occupy the premises for at least 5 years, this paper demonstrates that Augmented Category 6 (6A) or higher cabling systems are the most economical solutions, providing a solid return on investment. One should consider not only the initial costs, but ensuing follow on costs as well. Understanding the full lifecycle and industry trends will assist in your decisions. Remember that cabling represents only 5-7% of the overall network investment. It is expected to outlive most network components and is the most difficult and potentially costly component of a network to replace. There are few network investments more poorly made than the installation of a cabling system with a shortened lifespan that will require replacement sooner than economically forecasted.

Selecting a Structured Cabling Vendor

—A Balanced Scorecard for the Best Value

When selecting a cabling vendor, one of the most difficult tasks is sorting through the vendor-provided data and getting to the information most critical to you and your network. In that stack of marketing materials, you should immediately look not only for test reports, but also details of the vendor's contractor training program, available support services and warranty claims. If you can easily get that information from a vendor, you're off to a good start. But now the homework begins - is the documentation worth the paper (or web page) it is printed on? Here are a few things you should look for.

When the vendor selection process starts, many companies look first and solely to independent test reports. Test results can be promoted as either worst case or typical. It is important to know which type of results are represented by the report, as worst case and typical should never be compared as equivalent values. If all vendors under consideration are reporting worst-case results, it is then important to look at the test parameters to determine which will provide a better system. The same holds true for typical results. Although typical reports will provide more variable performance data, it is more important to compare solutions on an even playing field. That said, if a company has not provided the report (either best case or typical) you need for a fair comparison, ask for it. Most vendors should be able to provide both typical and worst case data.

Once you have established the type of report, it is critical to remember that seemingly similar results may not have been gained under "apples to apples" test criteria. While independent testing goes a long way to ensure validity of performance claims and can offer a degree of structure to the testing parameters, it leaves some holes. For instance, channels can provide different results based on test unit launch cords, lengths and other variables. A 100m channel can consist of an 80m cable with two 10m cables or a 90m channel with two 5m patch cords. You cannot compare different independent channel reports of different constructions (number of connectors, length of cords, horizontal cables, etc). Used as the sole means of evaluating a vendor, independent test results may not provide a clear indication of repeatable system performance.

When companies submit channels to an independent test lab, the components and channels are often handpicked and supplied as pre-terminated channels. The lab then runs tests based ONLY on these channels and will provide affirmation that the system performs as expected. Regardless of whether they are tested to worst-case or typical, pre-terminated or factory-terminated channels offer "best case" termination performance. Unless the testing procedure mimics typical field installations, such as testing components procured from distributor inventory and terminated on site, performance values in independent test reports may not be representative of actual field performance.

Because of the potential variability between test channels and actual field installations, most test results are provided back to the company with a statement of limitations. Statements of limitations predominantly follow these lines: "At the client's request, the purpose of this report is to provide electrical performance data on the test sample. It is not valid to use this report for any other purpose." While independent testing is helpful in validating system performance, selecting a cabling vendor based solely on a comparison of independent test data may not be wise.

Some end user companies take the route of performing their own "bake-offs" rather than relying upon independent test reports. A contractor may be selected to install and test multiple channels from multiple vendors in real-life conditions and compare the results. This allows a company to evaluate product based on their own channel configuration and testing. Unless you are buying pre-terminated links, the manufacturer will not be installing the product. Technicians and installers will have a large influence over the stability and testing of the channel.

A user-developed and monitored test bed environment is also a good place to test for other issues, such as the effects of re-terminations on system performance. If a connection has to be re-terminated and/or re-mated, will it still perform as expected? Does this change the test results greatly? Any cost savings gained from a lower performing cabling system or using a contractor who hasn't been properly trained or certified can quickly vanish if replacement connectors are required due to termination errors. The test bed environment also allows you to explore termination times, ease of product use and overall

product quality. This will provide far more insight into selecting the right system, and is reasonably easy to set up. Most quality suppliers will be happy to provide assistance for such efforts

Whether using independent test results or performing in-house tests, it becomes clear that installation quality is paramount to final system performance. It is critical to examine the installer training and certification programs provided by the manufacturer. Some contractor certifications are open to almost anyone and may only require a two-hour class in terminations. The better programs will include training on the entire channel for both copper and fiber and cover everything from design, cable installation, terminations, to testing.

Training programs certified by independent organizations such as BICSI provide an additional layer of quality assurance. Such certifications ensure that the training has been reviewed and the practices taught are sound. Typically, a body such as BICSI will award credits towards their own certifications based on approved vendor classes. The more credits awarded, the better and more thorough the training. The best training will also be supported by ISO 9001:2000. An ISO – certified training program will not only offer a high level of quality, but also assure global consistency of the program. All of the emphasis on training boils down to one question: Will the installers certified by a vendor provide a high quality, end-to-end installation?

Another consideration in selecting the right cabling vendor should be their offering of value-added support services. These services can include things like design assistance, contractor referrals, installation audits, continuing education, and other programs that are beneficial to your company. While many services are complimentary, some may be fee-based. Costs and service values should be closely explored for the best deal, but such programs and services allow you to form a business partnership with the vendor rather than just purchasing components. If the company has developed and funded these programs, it was most likely due to a need in the end user community. This tells you that the company listens and responds in order to better take care of their customers. This level of support can be critical to your project's success.

Finally, you will want to look at the variety of warranties they provide as well as what is covered within the warranty. Upon examination, most warranties vary greatly. Some only offer coverage for components (usually referred to as a product warranty). Product warranties may provide adequate coverage for your needs, however, be sure that any product replaced is new and not refurbished. In some cases where defective product may be an issue, a manufacturer will consider covering a portion of the labor required to have defective product removed and new product installed. This is a question to ask the manufacturer - how their product warranty supports product replacement. You will want to determine whether the cabling vendor or the installer holds the warranty. While there are countless examples of stable installer companies, some are smaller, less robust organizations and have difficulty supporting

customers after the installation is completed. By and large, cabling manufacturers will provide more stability and you should seek warranties in which the manufacturer issues the warranty direct to the customer.

A close examination of the fine print is essential. Sometimes even innocuous requirements can have negative effects. For instance, some warranties require that failure notices be provided in 5 days. If you are troubleshooting a problem, you may not know within 5 days that the infrastructure was to blame. In this case, much of your warranty support has evaporated just 5 days into a cabling plant that may be "covered" for 20 years.

Some warranties go above and beyond that of a product warranty. Other warranties can be referred to as performance warranties, applications warranties and system warranties, to name a few. Performance warranties represent a guaranteed performance of the cabling after it has been installed and tested. Applications assurance basically states that any applications that are designed to operate over the cabling system will be supported for the life of the warranty. A system warranty may be inclusive of product, applications, performance and labor.

You should select a warranty with a suitable period of coverage that provides direct manufacturer support as the single source of problem remediation. This support should not be limited by time constraints, beyond the full warranty term and there should be NO fine print that will present a problem in the future. You should also insist on 100% field-testing of all links/channels to provide the necessary documentation to support your infrastructure - this should be required in all performance, applications and system warranties. Finally, the manufacturer should review these test results to ensure that their product has been installed to provide optimal signal performance and will support the customer for the duration of the warranty. It is far easier to identify and fix problems early on rather than later when the system is in production and network downtime occurs.

In summary, several factors including those discussed herein, should be evaluated when selecting the right cabling partner. After all, when you purchase an automobile you look at more than the sticker on the window. You should do the same for your cabling infrastructure to assure that your applications and electronics will run smoothly over time. By selecting a partner rather than a parts supplier, you can be assured that in the end, the support will be there for this and future decisions.

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De-Mystifying Cabling Specifications

– From 5e to 7A

Structured cabling standards specify generic installation and design topologies that are characterized by a "category" or "class" of transmission performance. These cabling standards are subsequently referenced in applications standards, developed by committees such as IEEE and ATM, as a minimum level of performance necessary to ensure application operation. There are many advantages to be realized by specifying standards-compliant structured cabling. These include the assurance of applications operation, the flexibility of cable and connectivity choices that are backward compatible and interoperable, and a structured cabling design and topology that is universally recognized by cabling professionals responsible for managing cabling additions, upgrades, and changes.

The Telecommunications Industry Association (TIA) and International Standard for Organization (ISO) committees are the leaders in the development of structured cabling standards. Committee members work hand-in-hand with applications development committees to ensure that new grades of cabling will support the latest innovations in signal transmission technology. TIA Standards are often specified by North American end-users, while ISO Standards are more commonly referred to in the global marketplace. In addition to TIA and ISO, there are often regional cabling standards groups such as JSA/JSI (Japanese Standards Association), CSA (Canadian Standards Association), and CENELEC (European Committee for Electrotechnical Standardization) developing local specifications. These regional cabling standards groups contribute actively to their country's ISO technical advisory committees and the contents of their Standards are usually very much in harmony with TIA and ISO requirements.

While the technical requirements of TIA and ISO are very similar for various grades of cabling, the terminology for the level of performance within each committee's Standards can cause confusion. In TIA Standards, cabling components (e.g. cables, connecting hardware, and patch cords) are characterized by a performance "category" and are mated to form a permanent link or channel that is also described by a performance "category". In ISO, components are characterized by a performance "category" and permanent links and channels are described by a performance "class". TIA and ISO equivalent grades of performance are characterized by their frequency bandwidth and are shown in table 1.

TABLE 1: TIA AND ISO EQUIVALENT CLASSIFICATIONS

FREQUENCY BANDWIDTH	TIA COMPONENTS)	TIA (CABLING)	ISO (COMPONENTS)	ISO (CABLING)
1 – 100 MHz	Category 5e	Category 5e	Category 5e	Class D
1 – 250 MHz	Category 6	Category 6	Category 6	Class E
1 – 500 MHz	Category 6A	Category 6A	Category 6_A	Class E_A
1 – 600 MHz	n/s	n/s	Category 7	Class F
1 – 1,000 MHz	n/s	n/s	Category 7_A	Class F_A

When faced with the daunting task of upgrading an existing network or designing a new building facility, cabling experts are encouraged to look to the Standards for guidance on performance and lifecycle considerations. Both TIA and ISO state that the cabling systems specified in their Standards are intended to have a useful life in excess of 10 years. Since applications, such as Ethernet, typically have a useful life of 5 years, it is recommended practice to specify cabling systems that will support two generations of network applications. For most commercial building end-users, this means specifying a cabling plant that is capable of supporting 1000BASE-T (Gigabit Ethernet) today and a planned upgrade to 10GBASE-T in 5 years.

TIA categories and ISO classes of structured cabling that are recognized for the support of data-speed applications are specified in the Standards listed in Table 2.

TABLE 2: TIA AND ISO STANDARDS REFERENCES

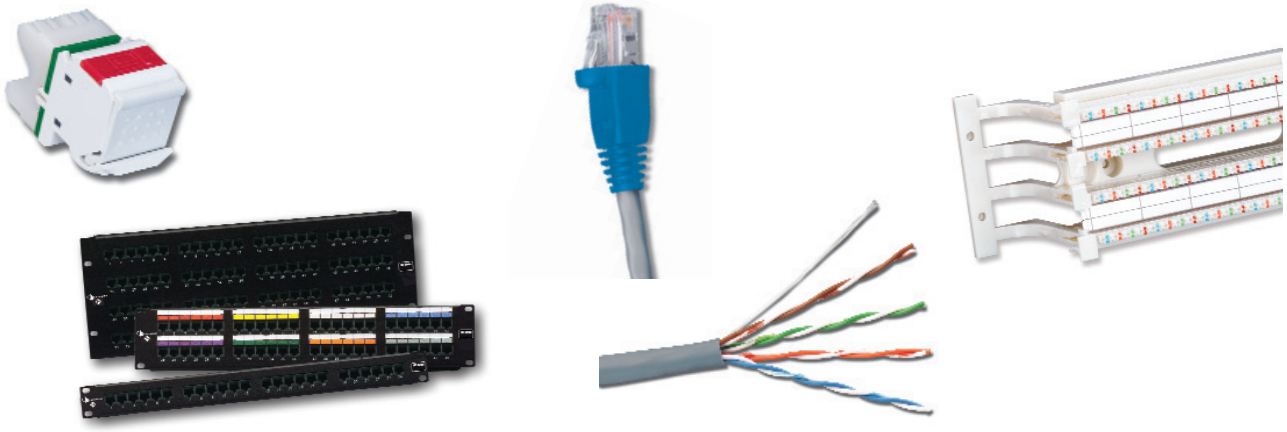
TIA CABLING STANDARDS	
Category 5e	ANSI/TIA/EIA-568-B.2, Commercial Building Telecommunications Standard Part 2: Balanced Twisted pair Cabling Components, 2001
Category 6	ANSI/TIA/EIA-568-B.2-1, Commercial Building Telecommunications Standard Part 2: Addendum 1: Transmission Performance Specifications for 4 Pair 100 Ohm category 6 cabling, 2002
Category 6A	ANSI/TIA/EIA-568-B.2-10, Commercial Building Telecommunications Standard Part 2: Addendum 10: Transmission Performance Specifications for 4 Pair 100 Ohm Augmented Category 6 Cabling, pending publication
ISO CABLING STANDARDS	
Class D	ISO/IEC 11801, 2nd Ed., Information technology – Generic Cabling for Customer Premises, 2002
Class E	ISO/IEC 11801, 2nd Ed., Information technology – Generic Cabling for Customer Premises, 2002
Class E_A	Amendment 1 to ISO/IEC 11801, 2nd Ed., Information technology – Generic Cabling for Customer Premises, pending publication
Class F	ISO/IEC 11801, 2nd Ed., Information technology – Generic Cabling for Customer Premises, 2002
Class F_A	Amendment 1 to ISO/IEC 11801, 2nd Ed., Information technology – Generic Cabling for Customer Premises, pending publication

Although the category 6A, class EA, and class FA Standards are not published at this time, the draft requirements have remained unchanged through several industry ballot cycles and are considered by cabling experts to be firm. These Standards are expected to be approved for publication within the next 6 months and are commonly specified in new commercial building cabling designs. It is important to remember that TIA and ISO Standards are copyright protected and are not available in the public domain. Copies of these Standards can be purchased online through IHS Global Engineering Documents (www.global.ihs.com).

CATEGORY 5E/CLASS D

Category 5e/class D cabling requirements were first published in 2000 in order to address the additional transmission performance characterization required by applications such as 1000BASE-T that utilize bi-directional and full four-pair transmission schemes. The Standard added headroom to category 5 performance limits and characterized several new transmission criteria that were required for support of Gigabit Ethernet over a worst case four-connector channel (the 1000BASE-T application was originally targeted for operation over category 5 channels having just two-connectors). To ensure that additional performance margins were satisfied, category 5e/class D specifications added headroom to the parameters of NEXT loss, ELFEXT loss, and return loss and introduced the characterization of crosstalk using power summation, which approximates the total crosstalk present when all pairs are energized as in a four-pair transmission scheme.

Although no longer recognized by the Standards for new installations, a substantial number of installed category 5 channels are likely to support the 1000BASE-T application. Information on the qualification of legacy category 5 installations for this application can be found in annex D of ANSI/TIA/EIA-568-B.2.

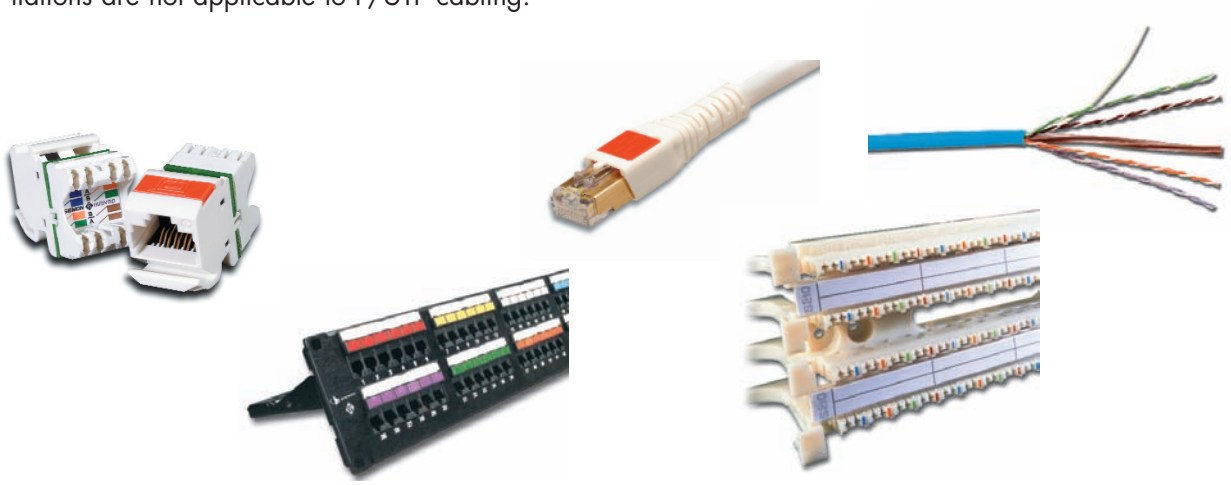


CATEGORY 6/CLASS E

The majority of structured cabling specified for new buildings in the past 5 years has been category 6/class E rated because it provided the maximum performance headroom and return-on-investment. Category 6/class E cabling delivered double the signal-to noise margin (attenuation-to-crosstalk margin is positive to 200 MHz) of category 5e/class D cabling and provided the performance headroom desired by end-users to ensure that their cabling plant could withstand the rigors of the cabling environment and still support 1000BASE-T when it was time for an application upgrade. The category 6/class E cabling specification development process also brought to light the need to limit the conversion of differential mode signals to common mode signals and vice versa through the characterization of component balance, resulting in cabling systems with improved electromagnetic compatibility (EMC) performance.

Although, category 6/class E cabling was primarily targeted to support 100BASE-T and 1000BASE-T applications, the good news is that some of the installed base of category 6/class E cabling can support the 10GBASE-T application. The newly published TIA TSB-155 and ISO/IEC 24750 technical bulletins identify the additional performance headroom, as well as applicable field qualification test requirements and procedures, which must be satisfied by the installed base of category 6/class E cabling in order to support the 10GBASE-T application.

Since the digital signal processing (DSP) capabilities of the 10GBASE-T application result in full internal pair-to-pair crosstalk cancellation, this application is particularly sensitive to undesired signal coupling between adjacent components and cabling. This coupling is called alien crosstalk and the characterization of alien crosstalk in the installed category 6/class E cabling plant is the main focus of the TIA TSB-155 and ISO/IEC 24750 technical bulletins. Because the alien crosstalk in category 6/class E UTP cabling is extremely dependent upon installation practices (e.g. bundling, the use of tie-wraps, and pathway fill), performance values were developed based upon a "typical" worst case environment meaning that 10GBASE-T should operate over category 6/class E UTP channel lengths of up to 37 meters and may operate over channel lengths of 37 to 55 meters of category 6/class E UTP cabling depending upon the actual alien crosstalk levels present. Since the overall foil in category 6/class E F/UTP cabling designs significantly reduces alien crosstalk, these length limitations are not applicable to F/UTP cabling.



TIA TSB-155 and ISO/IEC 24750 also specify recommended mitigation practices in the event that an installed category 6/class E channel does not satisfy the minimum alien crosstalk levels. Mitigation techniques include using non-adjacent patch panel ports to support the 10GBASE-T application, separating or using improved equipment cords, using F/UTP equipment cords, unbundling cables, reconfiguring cross-connects as interconnects, and replacing category 6/class E components with category 6A/class E_A components.

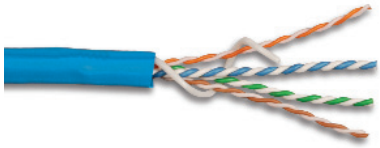
Category 6/class E cabling is not recommended for new installations targeted for support of the 10GBASE-T application. The reason for this is that, while field test devices for determining compliance to the new PSANEXT loss and PSAACRF (previously known as PSAELFEXT loss) parameters are just now being introduced to the market, the test methodology remains extremely time-consuming, overly onerous to implement, and may not be fully conclusive. Furthermore, in a majority of installations, alien crosstalk mitigation will be required. Often, the recognized mitigation methods cannot be easily implemented due to existing pathway fill restrictions and the potential need to replace components. In addition, there is no guidance on qualification procedures for large installations or future MAC work.

Since the category 6/class E Standard was published in 2002, it is at the halfway point of its targeted 10-year lifecycle. Today's cabling specifiers are looking to even higher performing grades of cabling to ensure maximum performance and return-on-investment.

CATEGORY 6A/CLASS E_A

Category 6A/class E_A cabling requirements are nearing finalization and were initially developed to address the extended frequency bandwidth and alien crosstalk headroom required to support 10GBASE-T over 100 meters of cabling containing up to four-connectors. Category 6A/class E_A cabling delivers positive signal-to-alien crosstalk margin up to 500 MHz and is recommended as the minimum grade of cabling capable of withstanding the rigors the cabling environment and supporting 10GBASE-T when it is time for an application upgrade. Balance requirements for channels and permanent links are also specified for the first time, thereby ensuring better electromagnetic compatibility (EMC) performance than any previous generation of cabling.
Performance headroom has been incorporated into all transmission parameters, including power sum alien crosstalk, and both laboratory and field test qualification methods are specified for category 6A/class E_A cabling. Average power sum alien crosstalk across all four-pairs is specified for use by the IEEE committee in their channel capacity modeling. It is interesting to note that the term "equal level far-end crosstalk loss" (or ELFEXT loss) previously used in TIA specifications has been replaced by "attenuation to crosstalk ratio, far-end" (or ACRF). The intent of this change is for TIA to harmonize with the ISO terminology and more accurately describe the actual test measurement configuration.

Category 6A/class $E_A$cabling provides the maximum return-on-investment when the calculations are performed using a 10-year lifecycle.



CLASS F

Class F requirements were published in 2002 and describe performance criteria for a fully shielded media type (i.e. cabling with an overall shield and individually shielded pairs). Category F cabling delivers positive attenuation-to-crosstalk margin up to 600 MHz and offers unsurpassed electromagnetic capability (EMC) performance because of its shielded construction.

Due to its ease of use, performance headroom, ability to support multiple applications under one sheath, and its specification as the recommended category 7 interface in the ISO 15018 Standard, the non-RJ style plug and socket interface specified in IEC 61076-3-104:2002 is the most commonly specified category 7 connector. This interface is commercially available from multiple manufacturers whose products are interoperable. There is significant evidence that the cabling industry and applications developers are ready to adopt fully-shielded cabling. For example, class F cabling was identified as the copper media of choice in one IEEE new application call-for-interest and the published ISO/IEC 14165-114 application Standard, entitled, "A Full Duplex Ethernet Physical Layer Specification for 1000 Mbit/s operating over balanced channels Class F (Category 7 twisted pair cabling)", specifies operation over a minimally rated class F channel.
It is interesting to note that, although TIA is not actively developing a standard for category 7 at this time, it is acceptable to specify class F cabling in North American markets. The rationale for this is that, in addition to being recognized by BICSI, NEMA, IEEE, and other standards organizations, class F is simply a superset of TIA category 6A requirements. Field test requirements and adapters for class F cabling qualification have been commercially available since 2002.

The advantage that class F has over other grades of cabling is that it is targeted for support of next generation applications beyond 10GBASE-T. Class F cabling is the only media to have a 15-year lifecycle and class F cabling provides the maximum return-on-investment when calculations are performed using a 15-year lifecycle.

CLASS F_A

Class F_A requirements are under development and are based upon the existing class F cabling requirements and category 7 non-RJ style plug and socket interface. The significant enhancement in class F_A specifications is the extension of the frequency bandwidth of characterization from 600 MHz to 1,000 MHz. This enhancement allows class F_A cabling to be uniquely capable of supporting all channels of broadband video (e.g. CATV) that operate up to 862 MHz. It is likely that all fully-shielded cabling solutions specified in the near future will be class F_A.

APPLICATIONS SUPPORT

Table 3 summarizes cabling types capable of supporting commonly specified applications over 100-meter, four-connector topologies.

TABLE 3: APPLICATIONS CHART

	CATEGORY 5E CLASS D	CATEGORY 6 CLASS E	CATEGORY 6A CLASS E_A	CLASS F	CLASS F_A
4/16 MBPS TOKEN RING	●	●	●	●	●
10BASE-T	●	●	●	●	●
100BASE-T4	●	●	●	●	●
155 MBPS ATM	●	●	●	●	●
1000BASE-T	●	●	●	●	●
1000BASE-TX		●	●	●	●
10GBASE-T			●	●	●
ISO/IEC 14165-144				●	●
BROADBAND CATV					●

PERFORMANCE COMPARISON CHART:

Table 4 provides comparative channel performance data at 100 MHz for category 5e/class D, category 6/class E, category 6A/class E_A, class F, and class F_A channels. Where there is a slight difference between TIA and ISO performance limits, ISO performance limits are indicated in parenthesis.

TABLE 4: INDUSTRY STANDARDS PERFORMANCE COMPARISON AT 100 MHZ FOR CHANNELS

	Category 5e/ Class D	Category 6 /Class E	Category 6A /Class E_A	Class F	Class F_A[4]
Frequency Range (MHz)	1 – 100	1 - 250	1 - 500	1 - 600	1 – 1,000
Insertion Loss (dB)	24.0	21.3 /21.7	20.9	20.8	20.3
NEXT Loss (dB)	30.1	39.9	39.9	62.9	65.0
PSNEXT Loss (dB)	27.1	37.1	37.1	59.9	62.0
ACR (dB)	6.1	18.6	18.6	42.1	46.1
PSACR (dB)	3.1	15.8	15.8	39.1	41.7
ACRF[1] (dB)	17.4	23.3	23.3 /25.5	44.4	47.4
PSACRF[2] (dB)	14.4	20.3	20.3 /22.5	41.4	44.4
Return Loss (dB)	10.0	12.0	12.0	12.0	12.0
PSANEXT Loss (dB)	n/s	n/s	60.0	n/s	67.0
PSAACRF (dB)	n/s	n/s	37.0	n/s	52.0
TCL (dB)	n/s	n/s	20.3	20.3	20.3
ELTCTL[3] (dB)	n/s	n/s	0.5/0	0	0
Propagation Delay (ns)	548	548	548	548	548
Delay Skew (ns)	50	50	50	30	30

[1] Specified as ELFEXT loss for category 5e/class D and category 6/class E.
[2] Specified as PSELFEXT loss for category 5e/class D and category 6/class E.
[3] ELTCTL is specified at 30 MHz.
[4] Industry specifications for category 6A/class E_A and class F_A cabling are not published yet.

CONCLUSION:
When designing and installing structured cabling systems, chose the strongest foundation to support your present and future network applications needs. To ensure support of emerging technologies that utilize the latest advances in signaling schemes, it is critical to be as informed as possible. Trust the TIA and ISO standards developmental groups to specify complete cabling criteria capable of providing applications assurance for tomorrow's technologies today.

IMPORTANT DEFINITIONS

Alien Crosstalk
Unwanted signal coupling from one component, channel, or permanent link to another is defined as alien crosstalk. Since alien crosstalk is an indicator of differential (or balanced) signal coupling, alien crosstalk cannot be adversely impacted by common mode noise (e.g. noise from motors or florescent lights) that is present in the environment. Alien crosstalk is only specified by the Standards as a power sum parameter for components and cabling to approximate the energy present when all pairs are energized. Power sum alien crosstalk measured at the near-end is called power sum alien near-end crosstalk loss (PSANEXT loss) and power sum alien crosstalk measured at the far-end is called power sum alien attenuation to crosstalk ratio, far-end (PSAACRF). High power sum alien crosstalk levels can compromise the operation of the 10GBASE-T application.

Attenuation to Crosstalk Ratio, Far-End (ACRF) (previously know as ELEFXT loss)
Pair-to-pair far-end crosstalk (FEXT) loss quantifies undesired signal coupling between adjacent pairs at the far-end (the opposite end of the transmit-end) of cabling or a component. ACRF is calculated by subtracting the measured insertion loss from the measured far-end crosstalk loss and yields a normalized value that can be used to compare cable and cabling performance independent of length. Poor ACRF levels can result in increased bit error rates and/or undeliverable signal packets. Note that NEXT loss margin alone is not sufficient to ensure proper ACRF performance.

Attenuation to Crosstalk Ratio (ACR)
A critical consideration in determining the capability of a cabling system is the difference between insertion loss and near-end crosstalk (NEXT) loss. This difference is known as the attenuation to crosstalk ratio (ACR). Positive ACR calculations mean that transmitted signal strength is stronger than that of near-end crosstalk. ACR can be used to define a signal bandwidth (i.e. 200 MHz for category 6) where signal to noise ratios are sufficient to support certain applications. It is interesting to note that digital signal processing (DSP) technology can perform crosstalk cancellation allowing some applications to expand useable bandwidth up to and beyond the point at which calculated ACR equals zero. Even so, the maximum frequency for which positive ACR is assured provides a benchmark to assess the useable bandwidth of twisted-pair cabling systems.

Balance
Twisted-pair transmission relies on signal symmetry or "balance" between the two conductors in a pair. Maintaining proper balance ensures that cabling systems and components do not emit unwanted electromagnetic radiation and are not susceptible to electrical noise. Component balance requirements are specified for category 6/class E cabling. Component and cabling balance requirements are specified for category 6A/class E_A and higher grades of cabling.

Balance may be characterized by longitudinal conversion loss (LCL), longitudinal conversion transfer loss (LCTL), transverse conversion loss (TCL), or equal level transverse converse transfer loss (ELTCTL).

Equal Level Far-End Crosstalk (ELFEXT) Loss
See definition for Attenuation to Crosstalk Ratio, Far-End.

Insertion Loss (Attenuation)
Insertion loss is a measure of the decrease in signal strength along the length of a transmission line. Ensuring minimal signal attenuation is critical because digital signal processing (DSP) technology can not compensate for excessive signal loss.

Near-End Crosstalk (NEXT) Loss
Pair-to-pair near-end crosstalk (NEXT) loss quantifies undesired signal coupling between adjacent pairs at the near-end (the same end as the transmit-end) of cabling or a component. Excessive NEXT loss can be detrimental to applications that do not employ crosstalk cancellation digital signal processing (DSP) technology.

Power Sum
All pair-to-pair crosstalk parameters can be expressed as a power summation, which approximates the level of undesired internal signal coupling present when all pairs are energized. Power sum NEXT loss, ACRF, ANEXT loss, and AACRF characterization confirms that the cabling is significantly robust to minimize crosstalk from multiple disturbers. This type of characterization is necessary to ensure cabling compatibility with applications that utilize all four pairs for transmitting and receiving signals simultaneously such as 1000BASE-T and applications that are sensitive to alien crosstalk such as 10GBASE-T.

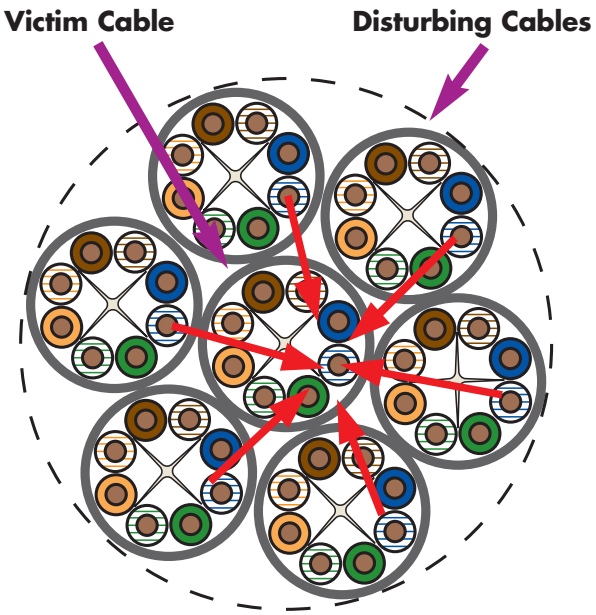
Propagation Delay & Delay Skew
Propagation delay is the amount of time that passes between when a signal is transmitted and when it is received at the opposite end of a cabling channel. The effect is akin to the delay in time between when lightning strikes and thunder is heard - except that electrical signals travel much faster than sound. Delay skew is the difference between the arrival times of the pair with the least delay and the pair with the most delay. Transmission errors that are associated with excessive delay and delay skew include increased jitter and bit error rates.

Return Loss
Return loss is a measure of the signal reflections occurring along a transmission line and is related to impedance mismatches that are present throughout a cabling channel. Because emerging applications such as 1000BASE-T and 10GBASE-T rely on full duplex transmission encoding schemes (transmit and receive signals are superimposed over the same conductor pair), they are sensitive to errors that may result from marginal return loss performance.

Transfer Impedance
Shield effectiveness characterizes the ability of screened (F/UTP) and fully shielded (S/FTP) cables and connecting hardware to maximize immunity from outside noise sources and minimize radiated emissions. Transfer impedance is a measure of shield effectiveness; lower transfer impedance values correlate to better shield effectiveness

Guide to Alien Crosstalk in Cabling Systems

Achieving 10Gbps transmission rates over balanced twisted-pair cabling requires advanced planning, proper system specification, and conscientious installation and maintenance practices. Alien crosstalk is the most significant transmission parameter impacting 10GBASE-T performance and should be carefully evaluated by end-users and installers during the cabling specification process.



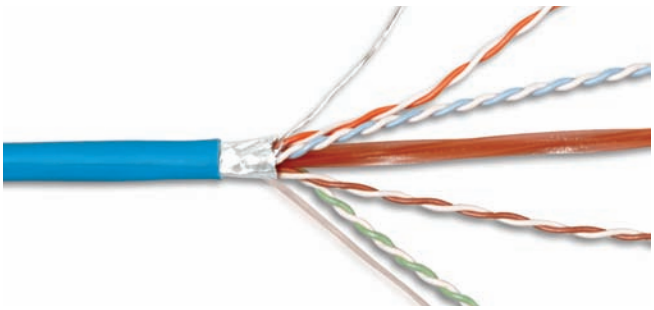
Alien crosstalk is defined as:
Unwanted signal coupling from one balanced twisted-pair component, channel, or permanent link to another.

Since alien crosstalk is only caused by differential (or balanced) signal coupling, alien crosstalk is not adversely impacted by common mode noise (e.g. noise from motors, transformers, or florescent lights) that is present in the environment.

Alien crosstalk is only specified by the current draft Standards as a power sum parameter for components and cabling to approximate the energy present when all cabling pairs are energized. High power sum alien crosstalk levels can compromise the operation of the 10GBASE-T application by significantly reducing expected signal-to-noise (SNR) margins, thus potentially causing re-transmissions or even auto-negotiation of the switch to a lower Ethernet speed. Power sum alien crosstalk measured at the near-end of the transmitter is called power sum alien near-end crosstalk loss (PSANEXT loss). Power sum alien crosstalk measured at the far-end of the transmitter is called power sum alien attenuation to crosstalk ratio, far-end (PSAACRF).

ALIEN CROSSTALK IN 10GBPS-READY CABLING SYSTEMS

Category6A/class E_A and class F/F_A cabling are specified to support the 10GBASE-T application over worst-case 100 meter, 4-connector channel topologies. Compliant cabling products are carefully designed to satisfy alien crosstalk requirements.



- **UTP (Category 6A/class E_A)**
  Has increased cable diameter up to 9.0 mm (0.354 in.) and separation between connectors to reduce alien crosstalk
- **F/UTP (Category 6A/class E_A)**
  Foil screen virtually eliminates alien crosstalk
- **S/FTP (Class F/F_A)**
  Full shielding eliminates alien crosstalk

ALIEN CROSSTALK IN THE CATEGORY 6A/CLASS E_A UTP SYSTEMS

The main difference between category 6A/class E_A and category 6/class E UTP cables is the greatly increased outside jacket wall thickness. Design strategies use thicker jackets to separate the copper cores from each other and ensure compliant alien crosstalk performance. Installation practices that deform the jacket (e.g. excessive pathway fill, over-cinched tie wraps, etc.) can compromise alien crosstalk performance.

The transmission specifications of category 6A/class E_A cabling are significantly more stringent than those specified for category 6/class E cabling. For example, category 6A/class E_A alien crosstalk limits support almost 80% less alien crosstalk voltage than that exhibited by a typical installed category 6 channel! Furthermore, category 6A/class E_A systems are also specified to have 27% more stringent insertion loss requirements in order to support the positive signal-to-alien crosstalk margin up to 500 MHz required by the 10GBASE-T application.

Siemon's 10G 6A UTP category 6A cabling solution combines 10Gbps-ready performance with compliance to all of the pending category 6A/class E_A cabling and component requirements, including alien crosstalk.

One of the key changes in **10G 6A UTP** products is a result of new design methods developed to minimize alien crosstalk. In lieu of using a metallic screen or shield, the primary method for reducing the effects of alien crosstalk along the length of a UTP channel is to create greater separation between cables. This is accomplished through cable designs that increase overall jacket wall thickness. This increased cable diameter is present on both UTP horizontal and patch cables. 10G 6A MAX® patch panels are designed with optimized port spacing to ensure alien crosstalk mitigation.

ALIEN CROSSTALK IN THE CATEGORY 6A/CLASS E_A F/UTP AND CLASS F/FA S/FTP SYSTEMS

Screened (F/UTP) and fully-shielded designs (S/FTP) reduce alien crosstalk to virtually zero levels, while offering the added benefit of substantially improved noise immunity at all frequencies. This immunity is especially critical at frequencies above 30 MHz, where the inherent balance of the cable starts to significantly degrade. Screened and fully-shielded cabling has the added benefit of greatly increased Shannon capacity for future applications.

Siemon's **10G 6A F/UTP** category 6A/ class E_A cabling solution combines 10Gbps-ready performance with compliance to all of the pending category 6A/class E_A cabling and component requirements and features significantly improved immunity to alien crosstalk compared to category 6A/class E_A UTP systems. This immunity eliminates the need for field testing of alien crosstalk.

Combining 10 Gb/s performance with the security, noise immunity, and pathway space maximization of a screened cabling system, Siemon's 10G 6A F/UTP end-to-end solution represents the cutting edge of category 6A/class E_A cabling. Specifically designed to handle tomorrow's most advanced and performance critical applications, 10G 6A F/UTP performs as well in secure or high EMI environments as it does in standard office spaces, by virtue of its screened construction.

Siemon's **TERA® class F/class F_A** cabling solution utilizes individual and overall pair shielding to virtually eliminate alien crosstalk and pair-to-pair crosstalk. The result is a 10Gbps-ready cabling solution that supports a 15-year lifecycle, provides maximum return-on-investment (ROI), ensures secure data transmission in sensitive environments, and supports cable sharing (running more than one low-speed, high speed application such as voice or 10/100BASE-T over one cable). TERA class F/class F_A cabling offers performance that far exceeds all performance requirements for 10GBASE-T, and with a bandwidth of 1.2 GHz per pair, Siemon's TERA connector is the highest performing connector on the market today. The need for field testing of alien crosstalk is also eliminated with TERA class F/class F_A cabling solutions.

INSTALLATION PRACTICES

Proper installation practices must be closely followed to help reduce alien crosstalk. Siemon trains its Certified Installers on proper installation techniques.
Siemon 10G 6A UTP cabling solutions comply with category 6A/class E_A alien crosstalk requirements, but, like all 10Gbps-ready UTP cabling solutions, may be sensitive to installation practices that deform the outer jacket such as:

- Over-cinched tie wraps
- Excessive conduit/pathway fill
- Exceeding bend radius

Because both Siemon 10G 6A F/UTP and TERA S/FTP cable designs resist deformation and their screens and shields are significantly less susceptible to damage, their overall performance is less likely to be adversely affected by poor installation practices. F/UTP cable offers resistance to crushing due to the foil reinforcement and fewer air spaces in the design. S/FTP cabling offers even more resistance to crushing due to the cable's increased foil and braid content and the connector's robust design.

As part of the installation process, field testing for alien crosstalk should be considered.

FIELD TESTING FOR ALIEN CROSSTALK

Since 10GBASE-T applications are sensitive to alien crosstalk, the requirements for field testers capable of assessing the performance of installed category 6A/class E_A cabling systems are specified within the pending TIA-568-B.2-10 and IEC 61935-1 standards. These Standards specifiy both the measurement procedures and accuracy requirements for level IIIe field testers for all historical parameters as well as the new alien crosstalk parameters PSANEXT loss, PSAFEXT loss and PSAACRF. Keep in mind that the level IIIe field test devices for determining compliance to these new parameters have just recently been introduced to the market and the field verification of alien crosstalk parameters is not required by these Standards.

Typically, field tests for alien crosstalk are not performed on F/UTP and S/FTP cabling systems. If installers or

end-users are interested in performing alien crosstalk testing at their discretion on 10G 6A UTP cabling systems, sample testing should be conducted based upon evaluating links that meet all of the following conditions:

1. Longest installed lengths
2. Cables within the same bundle
3. Adjacent ports in the patch panel

Siemon offers Network Cabling Services to ensure proper network cabling installation and design from the work area to the data center. For further assistance in answering your questions about alien crosstalk and product selection, please Contact Sales or Ask Siemon.

ALIEN CROSSTALK IN THE CATEGORY 6/CLASS E SYSTEMS

The characterization of alien crosstalk in the installed category 6/class E cabling plant was the main focus of the TIA TSB-155 and ISO/IEC 24750 technical bulletins. Because the alien crosstalk in category 6/class E UTP cabling is extremely dependent upon installation practices (e.g. bundling, the use of tie-wraps, and pathway fill), performance values were developed based upon a "typical" worst case environment meaning that 10GBASE-T should operate over category 6/class E UTP channel lengths of up to 37 meters and may operate over channel lengths of 37 to 55 meters of category 6/class E UTP cabling depending upon the actual alien crosstalk levels present. Since the overall foil in category 6/class E F/UTP cabling designs significantly reduces alien crosstalk, these length limitations are not applicable to F/UTP cabling.

TIA TSB-155 and ISO/IEC 24750 also specify recommended mitigation practices in the event that an installed category 6/class E channel does not satisfy the minimum alien crosstalk levels. Mitigation techniques include using non-adjacent patch panel ports to support the 10GBASE-T application, separating or using improved equipment cords, using F/UTP equipment cords, unbundling cables, reconfiguring cross-connects as interconnects, and replacing category 6/class E components with category 6A/class E_A components.

It should be noted that category 6/class E cabling is not recommended for new installations targeted for support of the 10GBASE-T application. The reason for this is that, while field test devices for determining compliance to the PSANEXT loss and PSAACRF parameters are just now being introduced to the market, the test methodology remains extremely time-consuming, overly onerous to implement, and may not be fully conclusive. Furthermore, in a majority of installations, alien crosstalk mitigation will be required. Often, the recognized mitigation methods cannot be easily implemented due to existing pathway fill restrictions and the potential need to replace components. In addition, there is no guidance on qualification procedures for large installations or future MAC work.

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