H2Max
Maximum Performance

Product Selection Guide

If you are in the process of selecting network infrastructure products for a future project, you will find a variety of performance levels available. Data speeds and throughput rates are constantly on the increase. There are Category 6A, Category 6 and Category 5e solutions available. These solutions consist of jacks, patch panels (or other compliant termination devices), patch cables and horizontal cable. Though network infrastructure components are tested by their manufacturers, it is the integration of those components and how they are installed that ultimately determines the level of performance you will receive from your infrastructure. The cable, patch cables and termination devices, often referred together as a channel, can provide access to the information highway or restrict like a bottleneck on your network. Fiber optic cables are also a typical component of most network infrastructures. Whether you're linking buildings or telecommunications rooms within a building, fiber optic cable is likely to play a crucial role in your network.

When it comes to selecting the appropriate copper solution, there are a number of factors to take into consideration. Near-End Crosstalk (NEXT) channel requirements are established by the Telecommunications Industry Association (TIA) for Category 6A, 6 and 5e solutions. NEXT is the measure of signal coupling from one pair to another pair within a cable. NEXT is just one of many parameters with specific performance requirements for each solution category. However, NEXT is often the primary parameter considered when choosing a cable or a solution. The purpose of the chart *(see page 2)* is to show not only the NEXT values for each category, but to illustrate that, as the categories progress numerically, so does the frequency to which it is tested. The higher performing categories allow for greater flexibility when selecting the applications that will run over the network. This guide provides information regarding the variety of fiber optic cables available and which one is the most appropriate one for your particular application.

HellermannTyton and Hitachi Cable America have strategically aligned to offer H2Max, a unique family of high performance network infrastructure solutions.

H2Max solutions include all the required components that are necessary to provide **a true end-to-end solution.** And, with H2Max, you can be confident that you are getting the highest level of performance possible. Both companies are leaders in the market and both are engineering driven.

H2Max offers a new and simple approach to selecting network infrastructure components. This Product Selection Guide was developed to provide a thorough, but straight-to-the-point description of the various network infrastructure options available. This guide describes the features and benefits of the available solutions and will help you determine which one is the most appropriate for your application.

HellermannTyton

HITACHI
Inspire the Next

CATEGORY 6A

For the highest demanding applications and emerging technologies, Category 6A is the most recent Category standard designed to support 10 Gigabit Ethernet.

The latest advancement in network infrastructure is the development of Category 6A cable and components. Category 6A, tested to 500 MHz, is designed to accommodate up to 10-gigabit Ethernet for a full 100 meters.

For those who intend to keep their networks current regarding the latest advancements in network electronics, Category 6A is the preferred choice. What makes Category 6A unique is that it is the first category of cable that has had to strongly address the issue of alien crosstalk.

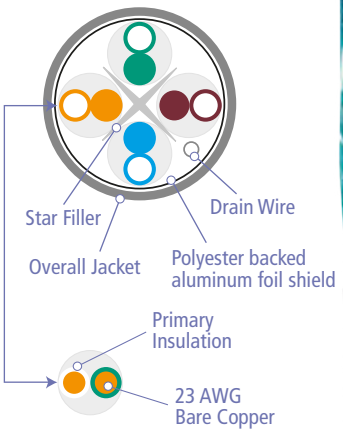
Alien crosstalk occurs when signal from a cable couples to an adjacent cable. Like crosstalk that can occur between pairs in a cable, alien crosstalk can corrupt the transmitted signal. At 500 MHz, crosstalk of any kind becomes a significant issue. Alien crosstalk in the channel has been overcome by the use of shielding within the cable, or alterations to standard cable designs. These modifications, however, have typically resulted in larger outside diameter cables. Typically, shielded Category 6A cables are smaller in outside diameter than unshielded (UTP) versions. This size difference can be a factor when planning the size of conduit that must be used in a project. Plan accordingly to ensure that the conduits will accommodate the number of cables required in the system.

H2Max offers a shielded 10-gigabit solution that exceeds the requirements of the Category 6A standard. The shielded solution eliminates alien crosstalk issues by incorporating a foil shield around the cables core, just beneath the cable jacket. What's ideal about the H2Max Category 6A solution is that the cable incorporates a foil around all pairs, rather than individual foil shields around each pair, as some competitors' cables do. This feature helps reduce the outside diameter of the cable even more and also makes terminations quick and easy. Shielded connective devices are also employed. By choosing a 10-gigabit solution, you are ensuring that your infrastructure will be viable for years to come.

(NEXT)
NEAR-END CROSSTALK

(ANEXT)
ALIEN CROSSTALK

Category 6A Features

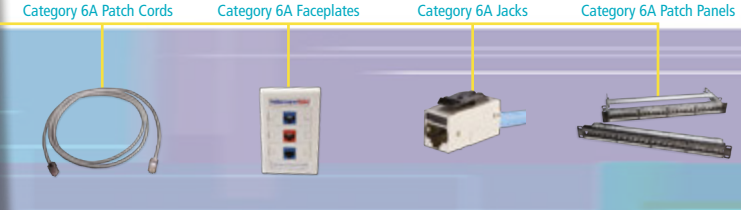


H2Max NEXT Performance

FREQUENCY (MHz)	CAT 6A Standard Limit	CAT 6A H2Max	CAT 6 Standard Limit	CAT 6 H2Max	CAT 5e Standard Limit	CAT 5e H2Max
1.00	65.0	83.1	65.0	85.6	> 60.0	74.3
4.00	63.0	74.2	63.0	77.4	53.5	65.4
8.00	58.2	71.9	58.2	73.7	48.6	61.4
10.00	56.0	73.9	56.6	71.0	47.0	58.2
16.00	53.2	67.1	53.2	67.1	43.6	58.4
31.25	48.4	65.1	48.4	61.2	38.7	50.4
62.50	43.4	54.5	43.4	55.8	33.6	42.9
100.00	39.9	52.2	39.9	50.0	30.1	40.5
250.00	33.1	46.8	33.1	45.1		
500.00	26.1	40.8				

Note: H2Max performance levels independently verified by ETL show worst case values for four connector channel.

* Category 6A also has Alien Crosstalk (ANEXT) requirements whereas the other standards do not. ANEXT is the measure of signal coupling from one pair of conductors within a cable to a pair of conductors in an adjacent cable. At higher frequencies, this becomes a greater concern.



CATEGORY 6

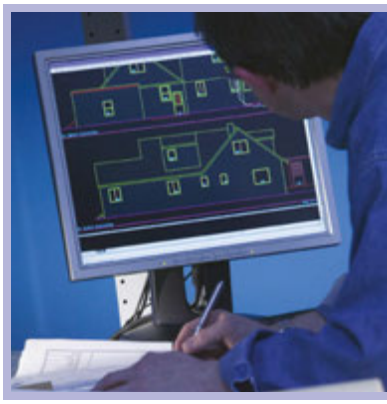
Ratified as a standard in 2002, Category 6 offers double the bandwidth of Category 5e to support 1000Base-T Ethernet and demanding applications.

Category 6 cable, which is typically larger in diameter than Category 5e cable and includes conductors that are larger than those of Category 5e cable, is tested to 250 MHz. The additional bandwidth makes it ideal for faster applications such as gigabit Ethernet. Category 6 solutions can also support applications with higher data rates. With these applications, the characteristics of the cable and its installation and termination will have an impact on performance. For that reason, multiple performance levels of Category 6 are available. H2Max offers two Category 6 solutions: H2Max Category 6 and H2Max Category 6+.

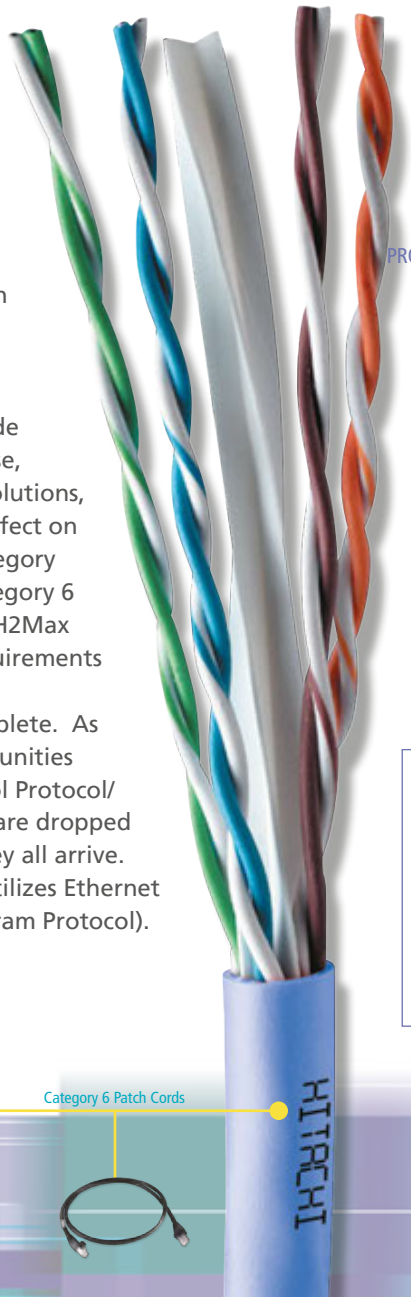
There are two gigabit Ethernet protocols currently in use, 1000Base-T and 1000Base-TX. 1000Base-T transmits and receives data at 250 Mbits/sec on each of the four pairs, for a total transfer rate of 1000 Mbits/sec. The transfer of data is bi-directional on each of the four pairs. 1000Base-TX transmits data at 500 Mbits/sec on two pairs then receives data on the remaining two pairs at the same data rate. Signal delay skew, which is the difference between the slowest and fastest signals within a system, becomes increasingly important as data rates increase and more cable pairs are utilized. The nominal velocity of propagation, NVP, is the speed of a signal through a system measured as a percentage of the speed of light. The delay of each signal is directly proportional to its NVP. Though not an issue with protocols that utilize only two pairs, such as 10Base-T and 100Base-T, a system that has even slightly different NVP values for two of its four pairs could have a negative impact on protocols that utilize all four pairs, such as gigabit Ethernet. 1000Base-T and 1000Base-TX may not work properly over these cables. For these reasons, only a high quality solution, such as H2Max, should be used.

Though there are a number of factors that influence which grade of Category 6 cable a building owner or IT professional may choose, performance is typically the driving factor. As with Category 5e solutions, installation practices of Category 6 systems can have a dramatic effect on the performance of the overall network. A properly installed Category 6 system is designed to support 1000Base-T or TX. An H2Max Category 6 solution will easily accommodate 1000Base-T or TX. However an H2Max Category 6+ solution provides the best assurance to meet the requirements of 1000Base-T or TX with a zero bit-error-rate (BER).

A zero BER ensures all data packets reach their destination complete. As frequencies increase to accommodate the faster protocols, opportunities for dropped data packets increase. In TCP/IP, (Transmission Control Protocol/ Internet Protocol) the basic communications language, if packets are dropped during communication, TCP/IP simply resends the packets until they all arrive. Voice-Over-Internet Protocol (VOIP), a growing technology that utilizes Ethernet technology to send voice signals, operates using UDP (User Datagram Protocol). While TCP/IP retransmits lost or corrupted packets, UDP does not.



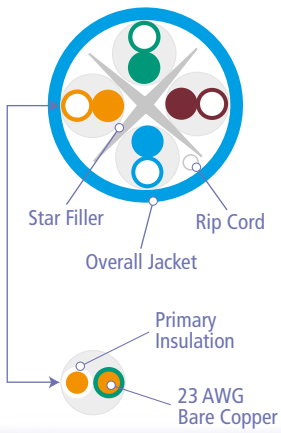
Performance you can count on. All H2Max products are third party validated to assure customers a repeatable performance level.

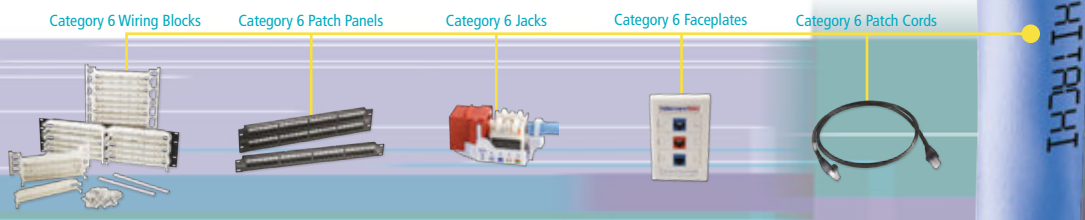


(TCP/IP)
TRANSMISSION CONTROL PROTOCOL/INTERNET PROTOCOL

(NVP)
NOMINAL VELOCITY OF PROPAGATION

Category 6 Features





CATEGORY 5e CATEGORY 5e+

Peace of Mind. H2Max performance **guarantees** the components are matched and the solution remains stable over a wide frequency.

Due to the nature of voice communication, if packets of data are dropped, they are not retransmitted. Dropped packets in VOIP result in an inferior audio signal. For those end-users who anticipate using a VOIP telephone system, the performance of the cable will have a direct impact on the performance of the VOIP system. To ensure the best possible performance from the system, use of an enhanced Category 6 network infrastructure would be appropriate.

An enhanced Category 6 solution, such as H2Max Category 6+ can also be used for 10G Base-T, or 10 gigabit Ethernet (10,000 Mbits/sec). The standard for 10G Base-T Ethernet is known as IEEE 802.3an. The cabling standard addressing cable performance for 10G Base-T is known as TIA-568-B.2-10. Technical Service Bulletin-155 permits the use of standard Category 6 cable for 10G Base-T up to a distance of 55 meters. This is due to the high frequencies at which 10G Base-T will operate. Category 6 cables used for 10G Base-T are tested to 500MHZ and must be capable of exceptional performance in regards to both individual cable performance and cable performance in a bundle. For this reason, a Category 6 enhanced solution should be chosen. The higher frequencies of 10G Base-T will induce alien crosstalk in adjacent cables and challenge the performance of a standard Category 6 cable.

Just like 1000Base-T pushes the performance levels of Category 5e cabling, 10G Base-T will push the limits of Category 6 cabling. The H2Max Category 6+ solution is designed with high performance in mind. And, with its zero BER, the H2Max Category 6+ solution will provide superior 10G Base-T performance up to 55 meters. By installing an enhanced Category 6 infrastructure, you can be confident that the infrastructure will support all current applications and most future applications as well. This performance headroom permits the cable to withstand a tough installation and still provide exceptional throughput. H2Max offers two levels of Category 6 performance to meet your specific network performance needs.

(EMI)
ELECTROMAGNETIC INTERFERENCE

(BER)
BIT ERROR RATIO

(RFI)
RADIO FREQUENCY INTERFERENCE

CATEGORY 5e

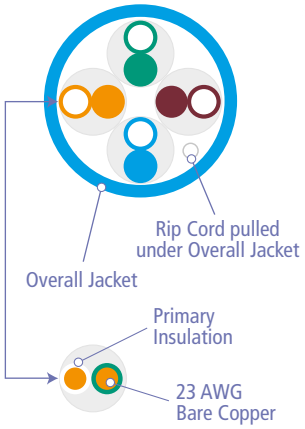
Category 5e is the industry standard – developed to support 10, 100, and 1000Base-T Ethernet applications.

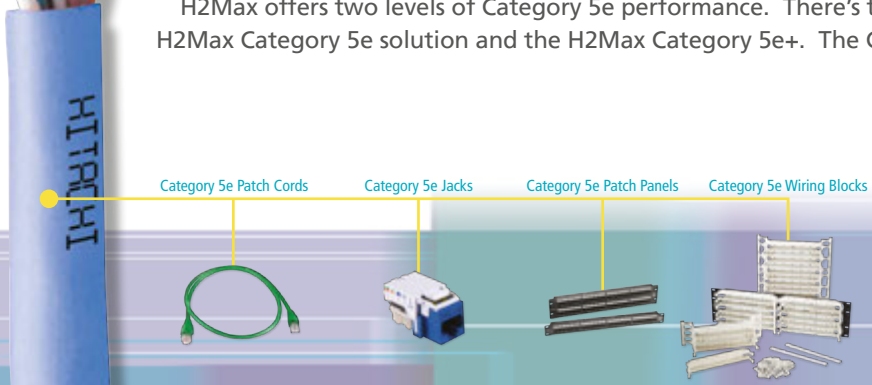
A Category 5e solution includes Category 5e jacks, patch panels, (or other compliant termination devices), patch cords and Category 5e cable. Tested to 100 MHz, Category 5e remains the choice for some end users. However, with constant increases in network data rates, such as streaming video, Category 5e can be restrictive. It will not accommodate the latest performance protocols and will not support future growth. If you have minimal throughput needs and you are not concerned with upgrading your electronics, Category 5e may be the solution for you.

Category 5e has been commercially available since 1995. Since its inception, many cable manufacturers have developed varying performance levels of Category 5e cable. Most offer a cable that meets Category 5e requirements and one that exceeds it to some degree.

H2Max offers two levels of Category 5e performance. There's the standard H2Max Category 5e solution and the H2Max Category 5e+. The Category 5e+

Category 5e Features





solution offers significant performance improvements over and above the requirements of standard Category 5e channel performance. This additional performance contributes significantly to network capability. Though a Category 5e cable infrastructure will safely accommodate the widely used 10 and 100 megabit-per-second (Mbits/sec) Ethernet protocols, 10Base-T and 100Base-T respectively, the ability to accommodate the needs of the gigabit Ethernet (1000 Mbits/sec) will be impacted by the quality of the cable and its installation. The protocols 10Base-T and 100Base-T operate over only two of the four pairs in the cable. One pair is dedicated to sending data while another is dedicated to receiving data. Two pairs go unused. 1000Base-T, however, operates over all four pairs. A cable of lower quality may result in damage to packets and collisions between packets, thus requiring the packets to be resent and, therefore, slowing network throughput. This condition is commonly referred to as the bit error rate or ratio (BER).

IT managers looking to obtain maximum performance from their network may be disappointed by installing a minimally compliant Category 5e solution.

The installation process for network infrastructure can also erode the performance of the network. Deviations from the proper methods for cable installation and termination as well as aspects of the installation environment can impact the performance of the system and diminish the networks capabilities. Solutions that offer superior channel performance, such as the H2Max Category 5e+ Solution, provide a system that ensures the highest throughput possible, while minimizing the BER of a Category 5e solution.

A Solution for Today and Tomorrow. H2Max systems come with a lifetime warranty on its certified horizontal systems.

(VOIP)
VOICE OVER INTERNET PROTOCOL

(UDP)
USER DATAGRAM PROTOCOL

FIBER OPTIC

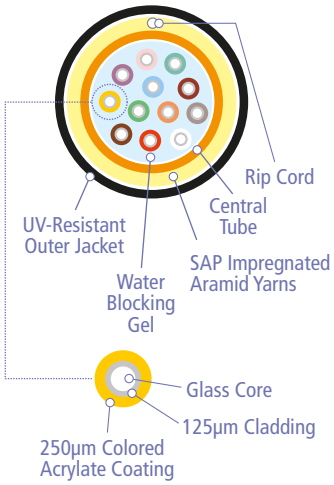
Fiber optic cables can transport more data and do so over a greater distance than typical copper communication cables.

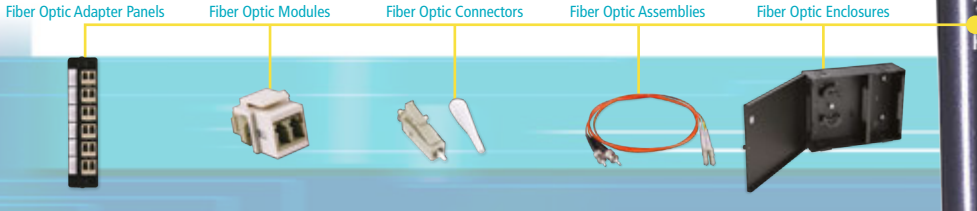
Fiber optic cable has become a standard component in most contemporary network infrastructures. Its immunity to electromagnetic interference (EMI) and radio frequency interference (RFI) make it a desirable cable medium. Its ability to transport signals for significant distances has also earned it a place in most networks, whether they are local, wide area or metropolitan. However, for many, fiber optic cable, how it works and its uses are still elusive concepts. This next section will try to answer some of the basic questions about fiber optic cable and provide some insight into when and how it should be utilized.

What is optical fiber?

Optical fiber is essentially a very thin glass strand through which a pulse of light is transmitted. As the light travels down the strand, it is contained within the glass by a thin jacket called the cladding. These optical fiber strands are then bundled together inside an overall jacket to form a cable. Since pulling on the fiber strands during installation would likely damage them, Aramid yarns (ex. Kevlar™) are typically included in the cable for pulling purposes. A solid strength member such as a rod of composite materials is often added to provide longitudinal strength to the cable.

Fiber Optic Features





FIBER

H2Max products are easy to purchase, install, perform consistantly and include a lifetime warranty. All this – plus our unique "get it done" service and support adds up to a program with value.

(LED)
LIGHT EMITTING DIODE

(VCSEL)
VERTICAL CAVITY SURFACE EMITTING LASER

(MDF)
MAIN DISTRIBUTION FRAME

For transmitting a signal over the fiber strands, electrical devices called optical transmitters convert electrical signals (electrons) into pulses of light (photons). The pulses are modulated in a manner so the receiving end can interpret the modulated signal from the transmitting end. Once the signal is received, it is converted back from photons to electrons and then passed along to the network. A typical fiber link requires two strands of fiber, one for sending and one for receiving.

There are two types of optical fiber – Multimode and Single mode

Multimode fiber, as the name suggests, permits the signal to travel in multiple modes, or pathways, along the inside of the glass strand or core. It is available with fiber core diameters of 62.5 and a slightly smaller 50 micron. A micron is 1 millionth of a meter. For comparison, a human hair is about 100 microns in diameter.

In a multimode fiber, the light is generated from an inexpensive light source called a light-emitting diode (LED). It is similar to those used in digital clocks. This LED based optical transmitter is commonly referred to as a media converter. As the signal from the media converter travels down the glass, it bounces back and forth along the inner wall of the cladding until it reaches its destination. This process, which occurs millions of times each second, provides data rates such as 10 Mbits/sec or 100 Mbits/sec.

Since demand for greater data throughput has increased, slower LEDs haven't been able to keep up. To achieve faster data rates, the market responded with the vertical cavity surface-emitting laser, or VCSEL. VCSELs focus the light to a narrower band within the glass and operate at higher speeds. VCSEL technology allows transmission speeds of 1 Gbits/sec and 10 Gbits/sec and does so relatively inexpensively when used with the appropriate grade of fiber, such as that described below.

To accommodate VCSEL technology, glass manufacturers developed a new, higher performing strand of glass called laser optimized or OM3 fiber optic glass. The specially designed glass works exceptionally well at higher performing strand of glass called laser optimized fiber optic glass. This specially designed glass works exceptionally well at higher data rates and permits the signals to travel farther. For example, the highest performing laser optimized 50 micron fiber, OM4, can accommodate 10 Gbits/sec up to 550 meters.

Single mode fiber optic cable generally has a core that is 8.3 microns in diameter. Single mode requires laser technology for sending and receiving data. Although a laser is used, light in a single mode fiber also refracts off the fiber cladding. Single mode has the ability to carry a signal for miles, which makes it ideal for telephone and cable television providers. The electronics needed for single mode transmission, however, are significantly more expensive than multimode, so therefore, not often used in a local area network.

Although the core sizes of multimode and single mode fiber differ, after the cladding and another layer for durability are applied, both fiber types end up with an outer diameter of about 250 microns. This makes it both more robust and easier to work with. To help differentiate between fiber strands when terminating, since some loose tube designs can have up to 432 strands, they are coated with a thin layer of paint. In cables where there are more than 12 strands, the fibers are separated into bundles of 12.

FIBER OPTIC Q&A

When would you use fiber optic cable?

Fiber optic cables can transport more data and do so over a greater distance than typical copper communication cables. Fiber is used to link the networks of buildings together, link the dorms and buildings on a college campus, and today, link more and more residential customers to their television and telephone providers. In most commercial buildings, however, fiber is used to link telecommunication rooms within a building.

For example, a small cluster of cubicles and their occupants may be located 500 feet from the main distribution frame (MDF). You'd like to have all of their computers on the network. Since standard copper communication cables are limited to 295 feet of installed cable, they will not work at that distance. Multimode fiber is the solution. The cubicles can be wired with copper communication cables to a nearby enclosure. By placing the network switches and including a media converter in that enclosure, you can utilize a fiber optic cable to bridge the 500-foot gap. A media converter at the other end of the fiber optic cable completes the channel.

The above scenario describes a typical use for multimode fiber optic cable within a building. However, it is just one example of how fiber optic cable can be utilized for the transport of data. Fiber optic cable can also be installed where space is a concern since one small fiber optic cable can replace hundreds of copper communication cables.

Fiber Optic Specifications Source: ANSI/TIA/EIA 568-B

Optical Fiber Multimode	Wavelength (nm)	Maximum Attenuation (dB/Km)	Minimum** Bandwidth Length (MHz.km)
62.5/125	850	3.5	160
62.5/125	1300	1.5	500
50.0/125	850	3.5	500
50.0/125	1300	1.5	500
50.0/125*	850	3.5	1500***
50.0/125*	1300	1.5	500

* OM3-Laser Optimized
** Overfilled Modal
*** Laser Launch 2000MHz at 850nm

Which optical fiber should I choose 50 micron or 62.5 micron?

Although 62.5 micron glass represents the majority of multimode fiber sold, 50 micron is gaining market share. 50 micron can have up to 20 times the bandwidth (data throughput capacity) of 62.5 micron. And, with laser optimized 50 micron OM3 and OM4 fibers made to accommodate 10 Gigabit Ethernet, many users are choosing it over the other glass types. In fact, nearly 80% of 50 micron fiber sold is laser optimized.

If you require higher data rates or plan on upgrading your network in the near future, laser optimized 50 micron would be the logical choice.

What's the difference between loose tube and tight buffered?

When it comes to the individual strands of optical glass, there are two options available, loose tube and tight buffered. Loose tube construction consists of the glass core and cladding with protective acrylate coating. This is optical fiber in its most basic, usable form for installation purposes. The diameter of a loose tube fiber strand is 250 microns. Loose tube fibers are generally used in outside plant constructions where high-strand counts are required and bulky protective jackets and water-blocking gels result in larger diameter cables.

However, newer constructions of indoor fiber are also employing loose tube constructions. These no-gel loose tube constructions permit more optical strands within a smaller diameter cable. Typical termination of loose tube fibers requires the use of a breakout kit, or fan-out kit. This process involves placing small tubes over the individual glass strands so they become strong enough to handle when

plugging into active equipment.

Tight buffered is the more popular of the two constructions when it comes to fiber installed within a building. Tight buffered fiber has a protective jacket extruded directly over the 250 micron fiber strand. The final outer diameter is typically 900 microns. This protective jacket makes the fiber easy to work with and can be terminated without the need of a breakout kit. Also, no-gel indoor/outdoor cables are available with tight buffered fibers so you can connect buildings, go directly to data closets then easily terminate the individual strands.

What types of cable constructions are available?

There are numerous fiber optic cable designs to choose from and a unique design for virtually every installation environment. As mentioned earlier, indoor/outdoor cables with tight buffered fibers are very popular when the cable must leave the building for a short distance then re-enter the same or another facility. There are indoor armored cables that can be used in manufacturing areas or any area where the cable could be exposed to harm. This type of cable can also save money since the armoring is an alternative to conduit. There are indoor loose tube cables without gel that offer a greater number of strands and do so within a small diameter cable. There are multi-unit constructions that physically separate the fibers into multiple jacketed subunits. So, as you can see, selecting the appropriate cable design for your application should require a thorough review of the entire pathway for the cable as well determining how much protection is required for the fiber strands, how you want the fibers broken out in the data closet and how you intend to terminate them.

What types of connectors should be used?

There are a number of connector styles on the market including SC, LC, ST, MT-RJ and FC. There are also MTP/MPO style connectors that will accommodate high fiber count cables and take up far less space than other connectors. This connector is intended for use with indoor loose tube no-gel cable constructions. However, the two most popular connectors are the SC, which push in then click when seated, and the LC connector which, due to its small size, is popular in high density applications such as data centers. The ST connector, also known as bayonet style that are pushed in and twisted to lock, have a large installed base and continue to be utilized although they are larger in size then both the SC or LC connectors. Manufacturers and distributors are more likely to have equipment to accommodate SC, LC and ST style connectors than any other connector style. That should be a consideration when making product selections.

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