Choosing the Right Fiber Optic Cable

Fiber optic cable has become a standard component in most contemporary cable 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. In fact, fiber optic cable is now run down many residential streets and brought directly to the house. However, for many, fiber optic cable, how it works and its uses are still an elusive concept. This paper 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, or optical glass, 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 some cable constructions to provide additional longitudinal strength.

For transmitting a signal over the fiber glass 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 Singlemode

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 Mbit/sec or 100 Mbit/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 Gbit/sec and 10 Gbit/sec and does so relatively inexpensively when used with the appropriate grade of fiber.

To accommodate VCSEL technology, glass manufacturers developed a new, higher performing stand of glass called laser optimized optical glass. The 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, known as OM4, can accommodate 10 Gbit/sec up to 550 meters.

Singlemode optical fiber generally has a core that is 8.3 microns in diameter. Singlemode fiber requires laser technology for sending and receiving data. Although a laser is used, light in a singlemode fiber also refracts off the fiber cladding. Singlemode has the ability to carry a signal for miles, which makes it ideal for telephone and cable television providers.

The electronics needed for singlemode 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 singlemode 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.

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 join the main distribution frame (MDF), where typically network servers reside, to telecommunication closets (TC) throughout the building.

For example, a small cluster of cubicles and their occupants may be located 500 feet from the 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.

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

Although 62.5 micron fiber was the most popular only a few years ago, 50 micron quickly gained market share and is continuing to do so. 50 micron fiber can have up to 20 times the bandwidth (data throughput capacity) of 62.5 micron. For identification purposes, multimode fiber, and also singlemode fiber, is often referred to by its performance level identified by ISO/IEC (International Organization of Standards and International Electrotechnical Committee), which is based on the fibers bandwidth capabilities. 62.5 micron multimode is referred to as OM1. 50 micron fiber is referred to as OM2, OM3 and the recently added OM4. As you would imagine, OM4 has greater bandwidth than OM3 and OM3 has greater bandwidth than OM2.

Fifty micron OM3 fiber is designed to accommodate 10 Gigabit Ethernet up to 300 meters, and OM4 can accommodate it up to 550 meters. Therefore, many users are now choosing OM3 and OM4 over the other glass types. In fact, nearly 80% of 50 micron fiber sold is OM3 or OM4.

If you require higher data rates or plan on upgrading your network in the near future, laser optimized 50 micron (OM3 or OM4) 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 constructions consist 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 powders or gels are required to protect the optical glass. These attributes contribute to a larger outside diameter. Therefore, loose tube optical glass is used to minimize the overall cable diameter.

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 optic cables being 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 permits it to 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. Also, with the advent of bend- insensitive optical glass, installation and termination has become even easier. Bend- insensitive glass permits very tight bend radii with little to no decrease in signal propagation. This means you can run it in tighter spaces and still get the required throughput. HCA uses ClearCurve TM bend-insensitive glass from Corning Optical Fiber as the standard glass for all its multimode fiber optic cables.

What types of connectors should be used?

There are a number of connector styles on the market including LC, FC, MT-RJ, ST and SC. There are also MT/MTP® style connectors that will accommodate up to 12 strands of fiber 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 most popular connectors are SC, which push in then click when seated, and ST, also known as bayonet style, that are pushed in and twisted to lock. Manufacturers and distributors are more likely to have equipment to accommodate SC and ST style connectors than any other connector style. That should be a consideration when making product selections.

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 metal conduit or plastic innerduct. 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.

To learn more about other Hitachi Cable products, visit the company website at http://www.hca.hitachi-cable.com.