Understanding Fiber 101

Fiber Optic technology has now been around for over three decades. At Cleerline, we like to say we have two very different customers: those who have been certified and using fiber for 10, 20, and sometimes 30 years and those who are new, having to adopt fiber after avoiding it for as long as possible.

Much is happening around fiber optics these days, and more and more people are distributing or repeating outdated information. We're here to help clear the air and give the AV community a baseline understanding to help them make informed decisions about this new technology platform.

Fiber Optics generally speaking is the transfer of information using light energy. Don't try to look at the light! The data communications systems (not Toslink) use bands of light that are invisible to the naked eye. Given enough power, these frequencies can burn your retina and cause permanent damage.

Different Types of Fiber Physical Attributes:

At the most basic level, fiber is a core that signal is sent down with a cladding that keeps the light from escaping the core. There are several different ways to make fiber, and all of them are very useful for different reasons. We've listed the three most common varieties our industry will encounter as fiber is adopted for video transport and networking.

Standard fiber is very simple, and this covers bend-insensitive fibers. The construction of 125um fiber is a glass core and a glass cladding with a 200-250um acrylate over-coating applied for protection. The size of the core determines the type of fiber and whether it requires additional materials deposited within the silica to maintain industry transmission frequency standards for the size of core. One of the selling points of bend-insensitive fiber is the ability to take for the glass to tolerate a bend of 5mm. (Yes, the glass.) Glass fiber can take the bend and work today within the applications. However, due to the mechanical attributes of the glass being bent to that degree, micro-fractures will be created that slowly (as with your windshield) grow larger and eventually cause the fiber to fail. This being the case, one significant issue with standard glass is its life expectancy over time. In general, most fiber companies will require a certified installer to install and terminate their fiber in order to honor the warranty of the cable.

POF (Plastic Optical Fiber) is just that: a plastic made to transmit light energy like silica. There are limitations to distance and frequency, but these fibers exhibit an incredible amount of durability, are lower in cost to produce, and are also safer to handle. POF still has a core and cladding similar to standard glass fiber, but the clarity of the plastic doesn't hold up over long distances. POF has huge following in industrial applications for machinery and sensors, and is used in the AV industry in some of the more advanced Hybrid HDMI Cable designs. Currently, its only limitation is distance, at 30meters.

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GGP or Glass, Glass, Polymer (Cleerline SSF™) is a construction that utilizes the same glass core geometries of standard glass fiber, but with a slightly smaller glass cladding geometry and proprietary P-coating bringing the geometry to the 125um used in standard fiber connectors. This is a unique design in the market for data communications cable, exhibiting improved durability over plastic fiber, ease of use, and meeting telecommunications standards for multimode and singlemode fibers. Unlike standard glass fibers, SSF™ can bend to 2.2mm while maintaining a life expectancy of 31 years, or 5mm with a life expectancy of 75+ years. Therefore Cleerline does not require a certification process for warranty.

Singlemode vs. Multimode and What to use?

This question always comes up. To be perfectly clear, there are many ways to answer it. There are very scientific ways, very simplistic ways, and then there are very practical ways. There are also a lot of *wrong* ways, creating broad use assumptions that are simply not accurate.

First of all, we must understand that multimode came before singlemode. Singlemode is more advanced and theoretically has infinite bandwidth. Multimode has been deemed to be limited due to modal dispersion (and that's probably as scientific as we need to get).

The easiest explanation to understand goes something like this:

- Multimode - Multimode uses a larger core. Common cores found in data communications, telecommunications, and AV are 62.5um, 50um, and 80um. With the larger core, multiple frequencies of light have room to travel down the cable's length, bouncing off of the cladding. Multimode is akin to a large hallway, with people at different widths apart traveling at different speeds. The distance limitation of multimode is specifically due to modal dispersion, when spread of the waves becomes so great it is difficult to determine the leading edge of the waveform and the trailing edge, making the signal nonfunctional. Signal attenuation measured in decibels is higher, however, because there is more core to light up. The light is dispersed and becomes less powerful much quicker as compared to singlemode.
- Singlemode - Singlemode uses a much smaller core: 7 to 9um in diameter. The core determines that only a singlemode of light can travel down the core of the fiber. That, however, has some extreme benefits. With a singlemode fiber we are dealing with a single file line down a very narrow hall: the signal can travel faster for a much longer distance using the same amount of power as multimode. Another way of looking at the power and speed concept is to compare singlemode to a small water pipe. The smaller the pipe, the great the water pressure, and the longer distance can be achieved with limited power consumption.
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So why does multimode still exist? What is the benefit of using multimode? This is a frequently asked question and can be very frustrating for those just beginning to work with fiber. In general, previous industries that have adopted fiber have engineers who

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understand the parameters as to when to use multimode vs. singlemode, and what the benefits are.

Within the AV community, frequently the engineer is the technician as well as the programmer, and, in many instances, the sales person. The reality is we need to make this simple and as easy as understanding Category cable.

So here it is: multimode with its larger core allows for a greater margin of error for terminating fiber, as well as having the laser light source engage the core. This significant difference makes multimode hardware components lower cost in the market, lowering the overall cost of ownership for fiber deployment. Multimode fiber, however, is more expensive to produce. The larger core and modal dispersion as outlined above will also have distance restrictions per the grade of fiber deployed.

Before we cover what to use, let's go a little deeper into the different grades of multimode fiber. Multimode fiber was the first fiber. The scientists at AT&T Bell Labs first developed OM1, the telecommunications standard for 62.5/125um multimode fiber. O = Optical, M = Multimode, 1=1 Grade 1. OM1 and 62.5/125um OM2 62.5/125um are still found in legacy systems and can still be used for new systems at short lengths, typically under 200ft. (While not recommended, you will find that it can work). This original grade of glass was designed for step-indexed systems and LED light sources. For new adopters of fiber, there is very little reason to understand or work with 62.5 OM1 or OM2 unless you find a legacy infrastructure in place and you are forced to.

The current multimode fiber standard is based around 50/125um Laser optimized multimode design. This is the most common construction used in today's technology. The most confusing aspect of this fiber is the misconceptions regarding the grades of OM2, OM3, and OM4.

To understand the grading, we should cover the fiber fabrication. The process is relatively easy to explain in broad terms. The first step is depositing rare earth materials into the core and cladding separately. Each are two solid pieces of silica roughly 6-10ft long, and their diameters differ. The core and cladding are fused together to create what is called a Pre-form. The Pre-form is then hung within a drawing tower 4 to 5 stories tall. The glass is heated by torch at its tip, and gravity enables the fiber to drop 4-5 stories, where it can be spooled. Within the tower the diameter is continually checked, and an acrylate coating is put on the outside of the glass to protect the silica from the elements. With Cleerline SSF™ the P-Coating is also applied during the drawing process.

When the profile for the fiber is designed, the engineers/scientists are looking to provide a fiber that has clarity and precision across multiple frequencies for the longest possible distance. Specifically, the standards for OM2, OM3 and OM4 are centered on the passage of

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the 850nm and 1300nm frequencies. These are the core frequencies used within the data communications and telecommunications industries for creating 10 and 40Gps networks.

The simplest explanation is to equate the core to a lens similar to one used for your eyes. The process of drawing fiber will change the focal point of the lens as you draw the glass down. If the lens originally is designed to focus 850nm at 550m, which would qualify it for OM4, it will begin to drift to the point where the lens is focused on 850nm at 300m, or OM3. Lastly, it will drift further to where the focal point is 850nm at 500ft. Effectively, the only difference in performance for the frequencies commonly used is distance, and the effective distance of each grade is as follows:

Grade	10Gps	40Gps
OM2	500ft/150m	130ft/40m
OM3	1000ft/305m	750ft/230m
OM4	1600ft/500m	1000ft/305m

One overlooked concept is that OM2 patch cable can be used on the end of a long run of OM4 with no signal issues. This is in some ways is very similar to the coax world.

What do you install in your next job?

We recommend OM2 or OM3 Multimode fiber. The AV industry is focused on multimode because of the lower cost of hardware. With multimode you have more available options currently on the market, and in the end distance (and when we say distance we mean miles, not feet) is not a priority for inside premise cabling. For 90% of the jobs in the market we can probably get away with OM2, and it will be sufficient for 20-30 years. Many of the equipment manufacturers have standardized on OM3 and will require OM3 for their warranty. We also recommend running multiple strands to each location, typically between 2-12 strands.

Over time the industry will become more modular, and the Small Form Factor Pluggable transceiver will be common on most devices. You might be familiar with this SFP or GBIC device from networking. This type of modularity allows the installer to adapt the hardware for the cable infrastructure installed or for the specific requirements of the installation. Basically, it allows the devices to be either singlemode or multimode dependent upon what SFP is selected.

The ultimate reason we suggest multimode vs. singlemode at this time is because many manufacturers in their equipment designs, like Broadata as an example, are developing proprietary links, using chip sets and light engines that use more frequencies within the fiber. A prime example of this is Broadata's first to market 4k/2k 60 4.4.4 over fiber

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solution. Here they have channelized the data into 4 x 6Gps streams enabling them to pass 24Gps over a single strand of multimode fiber. To do this type of multiplexing via singlemode is much more costly and would not be economically viable.

In summary, by installing Cleerline's SSF™ optical glass fibers, fiber becomes more durable compared to category cable or coax, and Cleerline SSF™ is the most durable option among fiber solutions. Fiber is now also easier to install and terminate compared to any category cable or coax solution. New staff can be trained to install and terminate without the safety considerations of typical glass fiber. By adopting fiber, you are also adopting the most future-proof cable solution available today for you and your customers. Installing fiber today provides the installer and the end customer the most flexibility in the long run.

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