Best Practices for using Fiber Optic Cables in Rental & Staging

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More and more companies are using Fiber Optic cables for their productions and events. Fiber Optic cables are being used to carry Audio, Video, Lighting, and Data around a venue. The use of fiber optics allows the transmission of signals and data in a venue without any degradation or interference from power or other devices in the venue. Fiber Optic cables are also smaller and lighter than copper cables, and can carry signals over long distances with less loss than that of copper cables. The fibers inside these cables are about the size of a human hair and made of glass covered by a buffer. Because of the index of refraction, the light shined at one end of the fiber will reflect along the sides of the fiber and come out the other end.

This document is not intended to teach you everything about fiber optic handling and use, but rather to give you a basic understanding and to help you go forward reducing issues that may arise in their use in the Rental & Staging market.

Cable Types

There are several types of optical fibers.

Singlemode fibers have a core that is about 9 µm in diameter with a cladding diameter 125 µm. Singlemode fibers are mainly used for longer distance transmissions, over many kilometers. You may see designations like OS1 or OS2 for this type of fiber. Singlemode fiber is not commonly used in the Rental and Staging applications, unless it is being used to connect to another venue that is some distance away.

Multimode fibers have a core that is 50 or 62.5 µm in diameter with a cladding diameter of 125 µm. Multimode fibers are used for shorter distance transmissions, up to a few kilometers. You may see designations like OM1, OM2, OM3, and OM4 for this type of fiber. Most fibers being used in Rental & Staging applications are going to be Multimode. OM1 fiber has a larger core diameter of 62.5 µm and is typically used for LED based transmitters. OM2 fiber has a core diameter of 50 µm and is also typically used for LED based transmitters. OM3 and OM4 fibers both have a core diameter of 50 µm and are optimized for LASER based transmitters.

This is somewhat important because there are some subtle differences in multimode fiber types, and in transmitters/receivers that companies are using. While you can use laser based transmitters on OM1 and OM2 fibers, these types of fibers will greatly limit the usable length of fiber, typically 50-100 meters as best. OM3 and OM4 fibers are better suited for laser based transmission of the higher bandwidth HD video signals.

Cables also come with different fiber counts. Shorter patch cords are typically a single fiber (simplex), or 2 fibers (duplex) usually in a zipcord. Breakout cables contain multiple fibers and can have 2, 4, 6, 8 or more fibers in them. Some cables have both fiber and copper in the same jacket, these are referred to as Composite cables (like SMPTE 311M cables).

In some cases you may have more fibers available in a breakout than you need, these are often backup spares, or may be used for different devices, usually in pairs. Breakout cables use a color code standard from the telephone industry, and it is best to follow this standard when possible.

Fiber Number	Color	Data Direction at source	Example Device
1	Blue	> Tx 1	Projector 1
2	Orange	< Rx 1	Projector 1
3	Green	> Tx 2	Projector 2
4	Brown	< Rx 2	Projector 2
5	Slate	> Tx 3	LAN 1
6	White	< Rx 3	LAN 1
7	Red	> Tx 4	Lighting 1
8	Black	< Rx 4	Lighting 1
9	Yellow	> Tx 5	Spare 1
10	Violet	< Rx 5	Spare 1
11	Rose	> Tx 6	Spare 2
12	Aqua	< Rx 6	Spare 2

Fiber cables can be extended, as long as you use the same fiber type, and are within the link loss budget for the transmitter/receiver pair. An example may be fibers run through an elaborate truss setup, where audio, video, and lighting cables need to be disconnected at a point so a portion of the truss rig can be raised or lowered separately from another. Fiber couplers can be placed at the same location, to provide a break point with the other cables in the same location. Transmitters and receivers have been engineered to operate with a reasonable amount of light loss through the fiber. Connectors, Splices, and the fiber itself will reduce the amount of light going through the fiber, and can be calculated based on industry standards, or measured with an Optical Test Set.

Cable Handling and Routing

Fiber Optic Cable in itself is fairly tough, as the fibers are protected by aramid yarn surrounding all the fibers inside the jacket. The pulling strength of the cable can vary based on type of cables used, usually anywhere from 100 lbs. for indoor cable up to 600 lbs. for tactical cable. Even so, care should still be taken when deploying and retrieving the fiber optic cable to avoid twists, turns, and sharp bends, as well as excessive pulling strength.

The most susceptible points to cause damage are at the connector ends, whether it is DVI style connectors on DVI Fiber cables, or optical connectors on the ends of standard fiber cables. Special care should be made to protect these in handling.

I have often seen DVI style fiber optic cables being run through the center of truss sections, and when being removed the cable is pulled out with the connector smacking each rung of the truss along the way. Running fiber optic cables through the center of truss sections should be avoided as much as possible. However in some cases, the inside of the truss is sometimes the best option, so extra care should be taken in removing the cables from the truss.

Two main problems with cable routing are Macrobends and Microbends.

Macrobends are when the bend radius of the cable is too small, to the point where the light no longer bounces effectively off the cladding, thus reducing the light output at the other end of the fiber. The best example is when fiber goes up or comes down from a truss or a cable pick in the ceiling, and the cable bends too sharply. Most cables have a bend radius of around 6" or more, so when going around corners, imagine running the fiber around the outside of something the size of your typical medium pizza.

Microbends are caused by pinches or deviations in the core of the fiber, also causing problems where the light no longer bounces off the cladding, and reducing the amount of light output at the other end of the cable. A good example of this would be the use of tie wraps around cables on a truss, or where the weight of cables on top of the fiber cable is pinching the fiber against something on the truss, or against a steel flex spansets.

Consider the fiber like a hose with water running through it, bend it too sharply, and the hose collapses and restricts water flow. And if you pinch the hose with your fingers or something else, that also restricts the flow of water. The light needs to flow through the fiber unrestricted to get to the other end, and the more that gets through, the less likely you are to have issues.

Connector Types

There are numerous types of optical connectors used for fiber optic cables. The following are the most common types used currently in the Rental & Staging world for AV, but not all of them:

ST Connector >
A Round Bayonet type with a 2.5mm ferrule

< SC Connector
A Square Push/Pull type with a 2.5mm ferrule

LC Connector >
A Small Square Push/Pull type with a 1.25mm ferrule

< OpticalCON DUO Connector
A Ruggedized Circular Push/Pull style connector offering dust protection for Duplex-LC connectors manufactured by Neutrik

DVI Fiber >
These are typically Factory terminated and can not be serviced, although some versions now use 4 LC connectors

< SMPTE 304M Connector
A Ruggedized Circular Push/Pull style utilizing 2 fiber connections, as well as power and signal electrical connections. Primarily used for HD Cameras

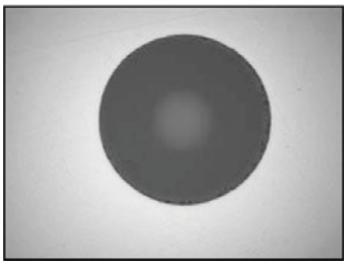
Connector Cleaning

The number one cause of problems with using fibers is due to contamination of the connector on the fiber endface. Dust, dirt, hair, and fingerprints can all degrade the amount of light going through a fiber optic connection. Dust caps on the connector ferrules are a good idea and help protect the fiber endface, but are a bit of a misnomer, as they are more likely to contain dust that to prevent endface from being contaminated with dust. Port caps/covers on transmitters and receivers are also a good idea to help keep debris from getting on the source led/laser and the detector on the receiver, but again can not be counted on providing dust free protection. Often fiber, transmitters, and receivers are stored in road cases with foam that often breaks down and gets on everything inside the case, this is one of many reasons why you should always keep fiber ferrules and ports covered when not in use. Most connector dust caps have a strap that attaches to the fiber, so they are not as easy to lose. Port covers are usually just a small cap and can be lost easily, so try and put them all together in a small bag or container, or tape them to the top of the transmitter or receiver with a small piece of gaff tape, so you can find them to replace when you strike at the end of the event.

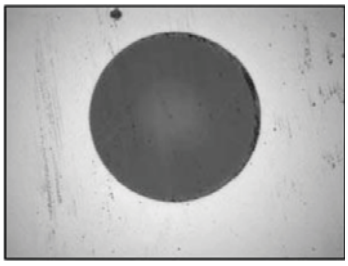
The best way to inspect the endface of the fiber on a connector is by using a Fiber Optic Microscope. This allows you to examine the end of the fiber for dirt or damage to make sure that you have a clean connector prior to making the connection to another device or connector. Word of caution, always make sure that the other end of the fiber is not connected to a live source while viewing the end, with or with out a microscope. Some sources use infrared (IR) sources that are invisible to the human eye, and may cause damage to your eye.

F1MS200X Compact 200X Microscope
with 2.5mm & 1.25 mm Adapters
from Fiber Instrument Sales

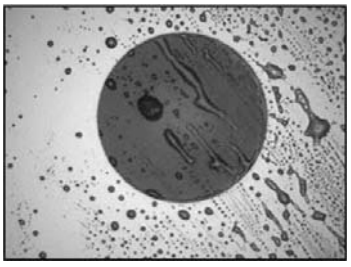
Below are some examples of what you may see when viewing through a microscope at about 200x magnification:



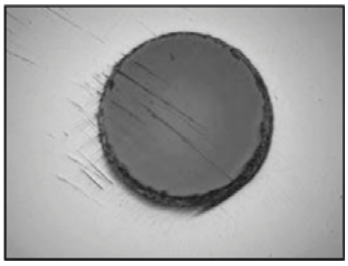
< Clean Connector



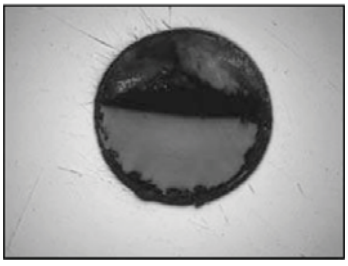
Dirty Connector >
Needs to be cleaned



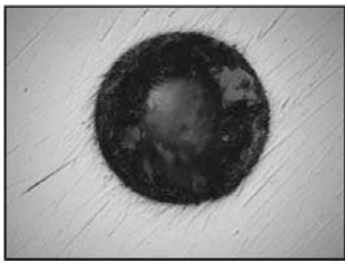
< Fingerprint Oil
Needs to be cleaned



Scratched Fiber >
Needs to be re-polished



< Cracked Fiber
Needs to be re-polished or possibly replaced



Crushed Connector >
Needs to be replaced

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Cleaning a connector is easy. Take out a clean optical wipe, and wet one end of it with a few drops of optical grade cleaning solution. Lay the wipe across the palm of your hand holding it in place with your thumb. Place the connector on the damp spot on the wipe, and drag the connector through the damp spot across to the dry area. Dispose of wipe. Inspect the end-face to verify cleanliness and then mate the connector.

A basic cleaning kit with optical grade tissues, cleaning solvent, port cleaning swabs, and a separate 200x Fiber Optic Microscope can be obtained for about $200 USD.

Sticklers® Fiber Optic Cleaning Kit

Another good tool to have is a Visual Fault Locator or VFL. This tool contains a small laser light source and has a port to connect the ferrule of a fiber connector to, allowing you to send light down a fiber so that you can do a end to end check of the fiber for continuity, and for tracing of possible mislabeled fibers. They often also have a flashing mode that can help with location in some instances. These range in price from around $150 to $350 USD. Some may need an additional adapter to use with 1.25mm ferrules on LC connectors.

Repairs

With the proper tools and training, most damaged fibers can be repaired on site, in some cases within 10 minutes or less depending on the termination style the technician uses. If you do not have a fiber technician on site, make sure you know what type fiber and connectors you are using before you call one, so that they can let you know if they have the proper parts on hand to make the repair.

Training and Certification

If you regularly use fiber for Rental & Staging Events, it may be a good idea to hire a Certified Fiber Optic Technician or have interested members of your staff receive training and certification. There are Fiber Optic training and Certification courses available throughout the year in major cities all over. A typical basic course is 2-3 days long and costs about $700-$1000 USD, and often times includes Certified Fiber Optic Technician (CFOT) certification from The Fiber Optic Association (FOA).

For more information on fiber optics and certification, please visit the The Fiber Optic Association at:

http://www.thefoa.org

Current version of this document can be found at:

http://bit.ly/eventfiber