WAYS TO REDUCE LOSSES IN OPTICAL FIBER!

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Annotation: *This article mainly discusses how fiber optic cable, which is lighter, more compact, and more flexible than copper, can transmit signals at higher speeds and over longer distances. However, the performance of fiber optic transmission can be affected by many factors. Among them, optical fiber loss is a fairly easy problem to solve and a priority for engineers developing solutions to it.*

Keywords: *fiber optic transmission, multimode, single mode, optical fiber, intermodal.*

Types of loss in optical fiber.

Losses in optical fiber can be caused by both external and internal factors. Signal attenuation is a consequence of the inherent characteristics of the fiber (multimode and single-mode). In addition to fiber internal loss, there are other types of factors that cause splice loss, such as splices, splices, fiber bends, and so on.

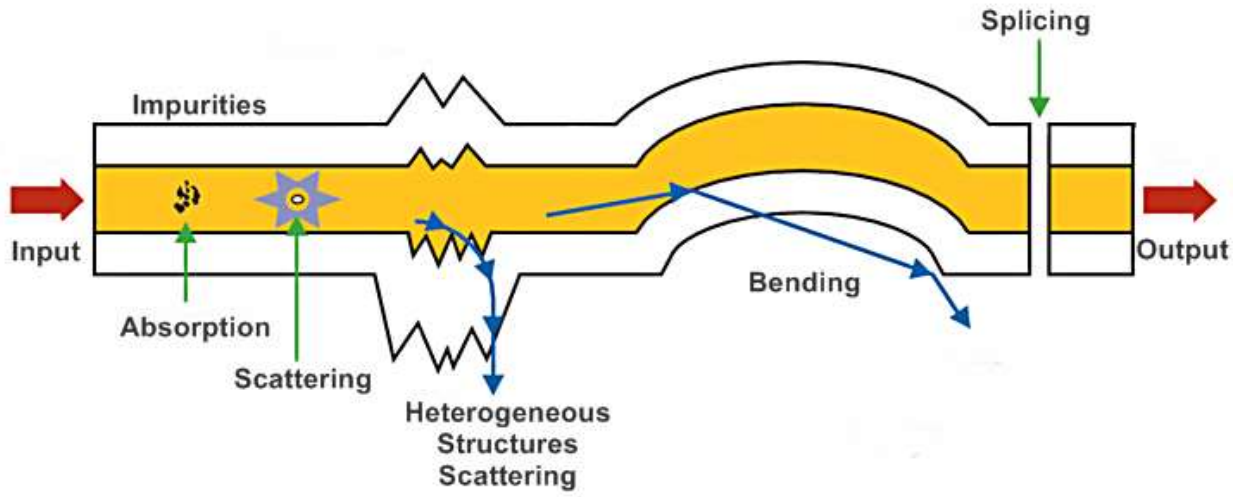

Figure 1: Different types of loss in optical fiber.

Internal fiber loss

The loss caused by signal absorption in the optical fiber is the main cause of signal attenuation during its transmission. When photons interact with glass components such as electrons or metal ions, light energy due to molecular resonance and wavelength impurities are absorbed and converted into other forms of energy, such as heat.

Dispersion loss is the result of the distortion of the light signal as it is transmitted over the optical fiber. Losses of this type can be intermodal or intramodal. Intermodal dispersion is the scattering of momentum due to differences in propagation delay between modes in a multimode fiber. In turn, intramodal dispersion manifests itself during signal propagation in a single-mode fiber, since the refractive index or propagation constant varies with wavelength.

Stray loss in an optical fiber is caused by microscopic variations in material density, compositional fluctuations, structural inhomogeneities, and manufacturing defects.

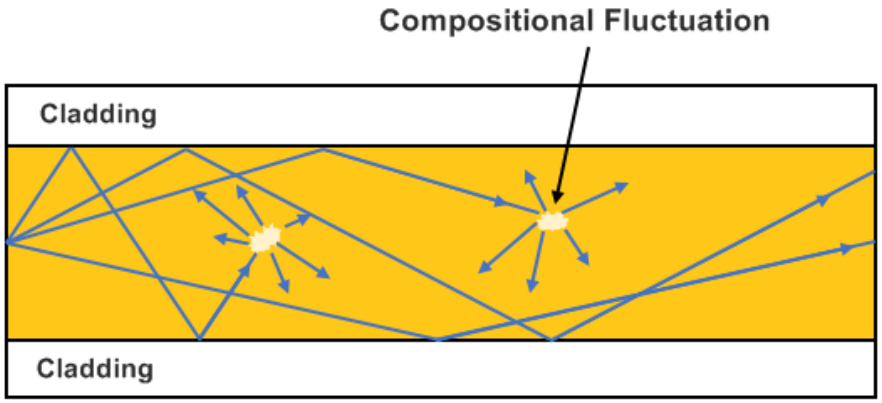

Figure 2: Light scattering due to compositional fluctuations.

The three factors listed above refer to the inherent attenuation factors of a signal in an optical fiber. The EIA/TIA-568 standard defines the following loss values for different fiber types:

Fiber type	Wavelength	Losses
Multimode 50/125 μm (OM2/OM3/OM4)	850 nm	850 nm
Multimode 62.5/125 μm (OM1)	850 nm	3.5dB/km
Singlemode 9 μm	1310 nm	0.4dB/km
Singlemode 9 μm	1550 nm	0.4dB/km

Table 1. Performance characteristics of each connector class

External loss in optical fiber

Losses at fiber junctions are a different type of loss. When splicing two ends of an optical fiber, the main goal should be a smooth signal transition through the splice and no significant power loss. But no matter how well the splice is done, losses are inevitable at this point. Splicing loss by fusion is 0.1 - 0.5 dB, i.e. 0.3 dB is the average value. For single-mode fiber, fusion splicing loss typically does not exceed 0.05 dB.

Connector loss, or fiber input loss, is the attenuation of signal strength caused by the presence of a foreign device in the signal transmission line. Multimode connectors are characterized by loss values of 0.2 - 0.5 dB (0.3 dB typically). The loss values of factory

single-mode connectors do not exceed 0.1 - 0.2 dB, and the losses when terminating with connectors in the field are 0.5 - 1.0 dB (0.75 dB is the maximum value allowed by the TIA-568 standard).

Fiber bending is a common phenomenon that can lead to optical loss if the fiber is not routed correctly. There are two main types of bends and the losses they cause micro and macro bends (as shown in the picture below). Macrobends are called fiber bends with a radius of more than 2 mm.

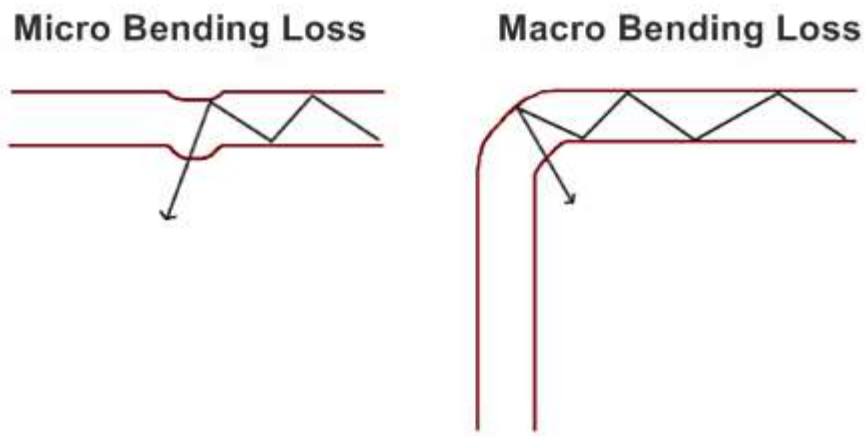

Figure 3: Losses at fiber bends.

Ways to reduce loss in optical fiber.

To ensure that the output signal strength falls within the sensitivity of the receiver, and also that there is a sufficient margin of safety, calculated on the degradation of network performance over time, it is necessary to reduce the losses in the fiber optic connection as much as possible. Below are some general approaches to achieve this goal when designing and laying a fiber optic network. Use high-quality cables with the same characteristics as possible.

• Choose proven connectors with input loss of less than 0.3dB and added loss of less than 0.2dB.

• Use the maximum length of a single cable (one coil over 500 m) to minimize the number of cable connections.

• Strictly follow the splicing procedure and environmental requirements.

• The connected ends must match perfectly and be closed to prevent leakage of the light signal.

• Keep connectors clean.

• Choose the best route and ways of laying fiber during the project development process.

• Form a professional team of specialists to ensure the quality of work.

• Carry out work to strengthen the protection of the connection, especially protection against lightning, electrical, and anti-corrosion, as well as protection against mechanical damage.

• Use high-quality heat shrink tubing.

Bend-insensitive, ultra-low-loss optical cables

In terms of high-quality fiber optic cables to help reduce loss, FS offers bend-insensitive cables with ultra-low loss and a small bend radius for high-performance data transmission. Our Bend Insensitive Patch Cords (BISMF) are made from Corning G.657.A1 fiber optics and 0.12 dB input loss connectors with a minimum bend radius of 10mm. The input loss of this category of patch cords belongs to interface class B, which is characterized by a fairly high performance by the IEC 61753-1 standard. Bend-insensitive multimode fiber (BIMMF) has an input loss of 0.15 dB and a minimum bend radius of 7.5 mm. Our BIMMF cables can be easily connected to standard fiber optic cables.

Figure 4: Bend-insensitive ultra-low loss FS cables.

Conclusion

Based on the study of theoretical material and study of all basic aspects of signal transmission over optical fiber, the key characteristics affecting the performance of the Fibre optic cables, as well as the methods used to avoid or reduce

possible signal losses when transmitting it over long distances. Adhering to all the requirements specified in this paper to reduce signal attenuation in optical fiber, it remains possible to transmit optical signals over enormous distances and avoid the various problems distortion problems.

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