TECHtips

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Electronics Manufacturing Insights from ACI Technologies, Inc.

Fiber Optic Cabling

Fiber optic harnesses appear simple, but they have been designed to maintain all of the critical areas of aligning two fibers and minimize the losses associated with a break in the transmission path. In order to understand how the connectors overcome alignment issues, we must first understand the issues. Fiber optic communications networks use specific wavelengths of light (or colors) to transmit information through a clear fiber at high speed. They use the property of internal reflection along the fiber's axis to contain the light and keep the optical power high enough to be detected at the receiving end.

Light in a fiber can "bounce" within the fiber when the angle that the ray approaches the edge is less than a critical angle that is determined by the refractive indexes of the core and cladding (Figure 1).

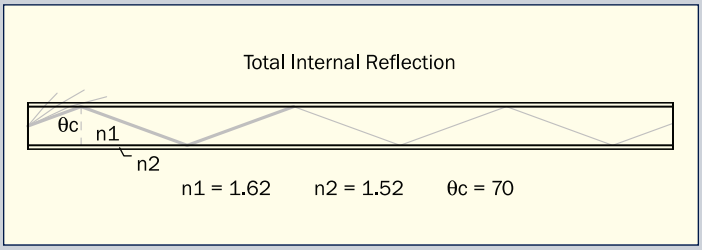

Figure 1: Critical angle for total internal reflection.

Fibers can be joined together to allow the light to transmit data over long distances. There are two basic ways to join fiber: by fusion, which creates a permanent connection, or by utilizing a connector, which creates a removable junction. This article will focus on the technology of fiber optic connectors.

Fiber optic connectors are designed to minimize the losses that occur when joining fibers. In order to understand the features of the different types of connectors, one must first understand the types of losses. Fiber optic cabling creates a path to transmit light from one system to another. Any change in the path can lead to a loss; an escape or redirection of the light energy. Losses can come from a rough fiber face or a misalignment of the fiber (Figure 2).

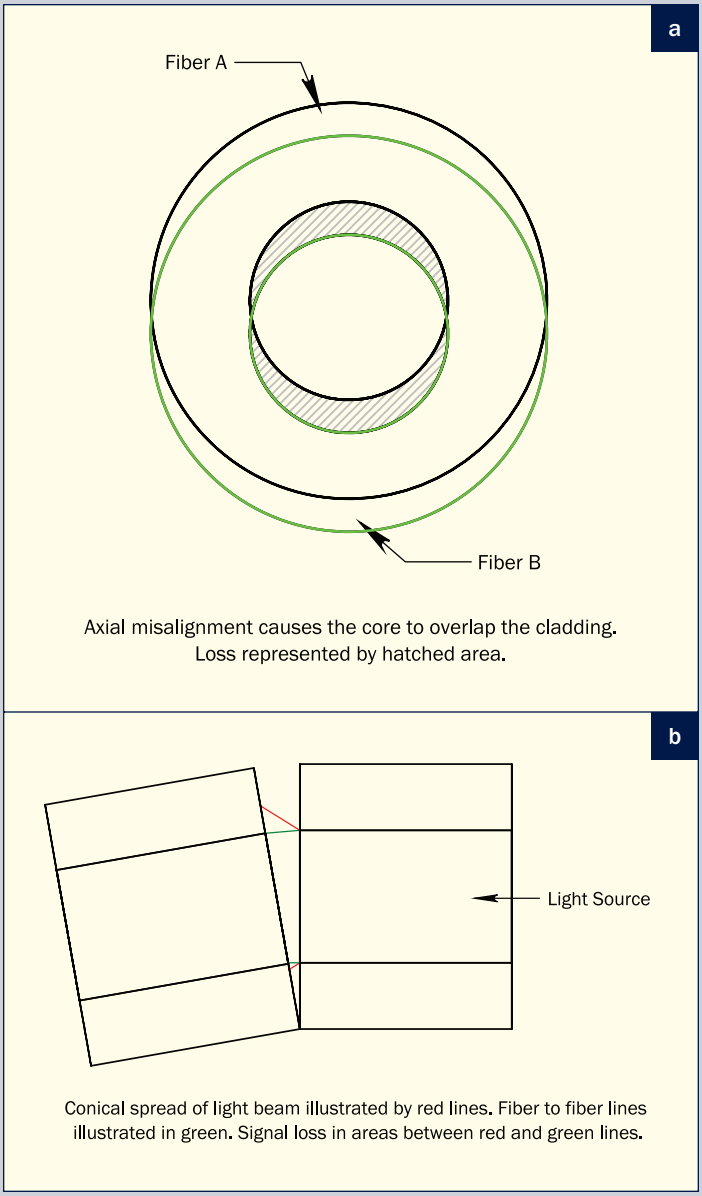

Figure 2: Junction losses: axial misalignment (a) and angular misalignment (b).

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The typical fiber optic connector will have a spring loaded mechanism to maintain the fiber ends in direct contact, a core ferrule to ensure the fiber core is aligned straight, a keying system to ensure that the connection is repeatable, and a mechanical locking feature to ensure that the connector will not decouple during system operation. Some of the common types of fiber optic connectors are the straight tip (ST), fiber connector (FC), mini-BNC, biconic, subscriber connector (SC), and fixed shroud duplex (FSD).

Most of these connectors are available in flat, physical contact (PC), or angled physical contact (APC) based on the shape of the fiber end polish. Flat polish is the default and is usually unspecified. With a flat polish, the fibers physically touch, but any imperfections in the flat surface will cause an air gap and associated losses. As the forward transmission losses increase, the back reflections (light energy reflected back toward the source) also increase causing possible data loss and laser heating.

PC fiber ends are ground and polished with a slight radius, this allows a single point of contact between the fiber ends with no air gap and smaller back reflections.

APC fiber ends are polished with an angle that is exactly 8° from perpendicular. This angle is greater than the critical angle needed for internal reflection so any reflected light enters the cladding and does not harm the laser source. APC ends require a connector that has an alignment key to ensure that the angled fiber ends meet correctly.

With any fiber optic connection, the key to achieving good signal transmission is to have a clean contact area with no scratches in the fiber or debris in the connector. With fiber optic cores as small as nine microns, even a one micron particle can significantly block data transmission. Contamination should be prevented by:

- leaving protective caps in place on unplugged connectors
- never touching a fiber endface
- never reusing cleaning materials

Microscopic inspection of the fiber end prior to assembly is essential to ensure a good connection. Cleaning can be performed using a dry cleaning method (air spray, lint-free wipes or swab) or a wet cleaning method using a solvent such as isopropyl alcohol (IPA). After inspection and cleaning, a re-inspection is critical before the final connection.

Contact ACI Technologies at 610.362.1320, via email to helpline@aciusa.org or visit the website at www.aciusa.org for more information or assistance with fiber optic cables and assemblies.

ACI Technologies, Inc.