Parts of a fiber optic connector engineering essay

Engineering

A fiber optical connector terminates the end of an optical fiber, & enables quicker connections and disconnection than splicing. The connectors mechanically couple & align the cores of fibers so light can pass. Better connectors lose very little light due to reflection or misalignment of the fibers. [1]

Application

Optical fiber connectors are used to join optical fibers where a connect/disconnect capability is required. The basic connector unit is a connector assembly. A connector assembly consists of an adapter & two connector plugs. Due to the polishing & tuning procedures that may be incorporated into optical connector manufacturing, connectors are generally assembled onto optical fiber in a supplier’s manufacturing facility. Optical fiber connectors are used in telephone company central offices, at installations on customer premises & in outside plant applications to connect equipment & cables, or to cross-connect cables. [1]C: Documents and SettingsuserDesktop220px-MMF_optical. jpgFigure 2. 1: LC & ST Fiber Optical Connectors

Parts of a Fiber Optic Connector

Fiber to fiber interconnection can consist of a splice, a permanent connection or a connector, which differs from the splice in its ability to be disconnected & reconnected. Fiber optic connector types are as various as the application for which they were developed. Different connector types have different characteristics, different advantages & disadvantages, & different performance parameters. [6]01All connectors have the same four basic components:-The FerruleThe Connector BodyThe CableThe Coupling Device

The Ferrule

The fiber is mounted in a long, thin cylinder, the ferrule which acts as a fiber alignment mechanism. The ferrule is bored through the center at a diameter that is slightly larger than the diameter of the fiber cladding. The end of the fiber is located at the end of the ferrule. Ferrules are typically made of metal or ceramic, but they may also be constructed of plastic. [6]

The Connector Body

Also called the connector housing, the connector body holds the ferrule. It is usually constructed of metal or plastic & includes one or more assembled pieces which hold the fiber in place. The details of these connector body assemblies vary among connectors, but bonding and/or crimping is commonly used to attach strength members & cable jackets to the connector body. The ferrule extends past the connector body to slip into the coupling device. [6]

The Cable

The cable is attached to the connector body. It acts as the point of entry for the fiber. Typically, a strain-relief boot is added over the junction between the cable & the connector body, providing extra strength to the junction. [6]

The Coupling Device

Most fiber optic connectors do not use the male-female configuration common to electronic connectors. Instead, a coupling device such as an alignment sleeve is used to mate the connectors. Similar devices may be installed in the fiber optic transmitters & receivers to allow these devices to

be mated via a connector. These devices are also known as feed-through bulkhead adapters. [7]02

Types of Optical Connectors

Following table shows some types of optical connectors & lists some specifications. ConnectorInsertion LossRepeatabilityFiber TypeApplicationFC0. 50-1. 00dB0. 20 dBSM, MMDatacom, TelecommunicationsFDDI0. 20-0. 70 dB0. 20 dBSM, MMFiber Optic NetworkLC0. 15dB (SM)0. 10dB(MM)0. 2 dBSM, MMHigh Density InterconnectionMT Array0. 30-1. 00 dB0. 25 dBSM, MMHigh Density InterconnectionSC0. 20-0. 45 dB0. 10 dBSM, MMDatacomSC Duplex0. 20-0. 45 dB0. 10 dBSM, MMDatacomSTTyp: 0. 40 dB (SM)Typ: 0. 5 dB (MM)Typ: 0. 4 dB (SM)Typ: 0. 20 dB (MM)SM, MMInter/Intra-building, Security, Navy[7]Each connector type has strong points. For example, ST connectors are good choice for easy field installations; the FC connector has a floating ferrule that provides good mechanical isolation; the SC connector offers excellent packing density, & its push-pull design resists fiber and face contact damage during unmating & remating cycles. [7]C: Documents and SettingsuserDesktopfiber connectors. jpgFigure 4. 1: Optical Fiber Connector Types03

FC Connector

A FC connector is a fiber-optic connector with a threaded body, which was designed for use in high-vibration environments. It’s commonly used with both single-mode optical fiber & polarization-maintaining optical fiber. FC connectors are used in datacom, telecommunications, measurement equipment & single mode lasers. The FC connector has been standardized in

a FOCIS 4 (Fiber Optic Connector Intermateability Standards) in EIA/TIA-604-04. Applications: - Datacom & Telecommunications[9]Figure 4. 1: FC Connector. C: Documents and SettingsuserDesktopFC connector. jpgDesign: The fiber end is embedded in a 2. 5 mm ferrule made of zirconia (Zirconium dioxide) ceramic or stainless steel. The tip is then typically polished to produce a rounded surface, called " physical contact" polish. This surface profile means that when the fibers are mated they touch only at their cores, allowing transmission with low loss. [9]

FDDI Connector

Fiber Distributed Data Interface (FDDI) provides a 100 Mbit optical standard for data transmission in a LAN network that can extended in range up to 200Km. And FDDI logical topology is a ring-based token network. C: Documents and SettingsuserDesktopdownload (2). jpgFigure 4. 2: FDDI ConnectorApplications: - Fiber Optic Network. [8]04

LC Connector

The LC Connector, developed by OFS Laboratories, represents next generation small form factor (SFF) connector. The LC Connector Solution reduces the space required onpanels, outlets & in closets by approximately 50% throughout the network. It simplifies moves, adds and changes & helps save you money. The LC Connector uses an improved version of the familiar, user-friendly RJ-style telephone plug that provides a reassuring, audible click when engaged. The new, one-piece design enhances the connector’s durability & meets side-load requirements of standard 2. 5 mm connectors. C: Documents and SettingsuserDesktopLC. jpgFigure 4. 3: LC Connector. Applications: - High Density Interconnections [5]

MT Array

The MT connector utilizes the same rectangular plastic ferrule technology as the MTP array-style connector first developed by NTT, with a single ferrule body housing two fibers at a 750µm pitch. These ferrules are available in both single-mode & multimode tolerances, with the low cost multimode version typically comprised of a glass-filled thermoplastic & the critically tolerance single-mode version comprised of a glass-filled thermo-set material. C: Documents and SettingsuserDesktopMT RJ CONNECTOR FEMALE. pngBy design the alignment of two MT Array ferrules is achieved by mating a pair of metal guide pins with a corresponding pair of holes in the receptacle. Figure 4. 4: MT Array Connector. 05This feature makes the MT Array the only small form factor connector with a distinct male & female connector. As a general rule, wall outlets, transceivers & internal patch panel connectors will retain the guide pins & the interconnecting jumpers won't have any pins. There are three construction styles:-Two fiber ribbon construction. Dual 250 micron construction. Dual 900 micron construction. Two fiber ribbon constructionThis style consists of the two optical fibers encapsulated within a ribbon at a 750-um pitch. This approach is unique to the MT Array connector & designed specifically to match the fiber spacing to the pitch of the ferrule for ease of fiber insertion. This construction style may be ideal for a MT-array termination. C: Documents and SettingsuserDesktopTwo fiber ribbon construction. pngFigure 4. 5: Two fiber ribbon construction. Dual 250 micron constructionThis design is more universal, utilizes a single 900-um buffer to house two 250-um fibers and more conductive to hybrid cable manufacturing but the fibers will naturally maintain a 250-um pitch, thus making fiber insertion rather difficult. 06C: Documents and SettingsuserDesktop3. 4.

pngFigure 4. 6: Dual 250 micron construction. Dual 900 micron construction. This is considered a standard construction & is used across the industry. In this configuration each individual fiber is buffered with a PVC coating. The coating thickness is typically 900 um, but as in the previous case this does cause a mismatch of the fiber to ferrule pitch. C: Documents and SettingsuserDesktop3. 5. pngFigure 4. 7: Dual 900 micron construction.

SC

SC stands for Subscriber Connector – a general purpose push/pull style connector developed by NTT. SC has an advantage in keyed duplexibility to support send/receive channels. SC connectors are frequently used for newer Network applications. The SC is a snap-in connector that is widely used in single-mode systems for its performance. The SC connector is also available in a Duplex configuration. They offer low cost, simplicity &07Durability. SC connectors provides for accurate alignment via their ceramic ferrules. The square snap-in connector latches with a simple push-pull motion and is keyed. They feature a 2. 5mm Ferrule & molded housing for protection. Typically matches SC connectors are rated for 1000 mating cycles & have an Insertion Loss of 0. 20dB. [10]C: Documents and SettingsuserDesktopSC. jpg Application: - Datacom. [14]Figure 4. 8: SC Connector.

SC Duplex Connector

SC connector has a duplexing clip, which allows each connector to be removed individually. In the event fiber polarity is reversed during termination, there’s no need to discard the connector. Simply remove connectors from the clip & switch to correct the mistake, saving valuable installation time & money. The duplexing clip also speeds troubleshooting. In

the event there’s a fault with a single connection, an individual connector can be removed from the clip & re-terminate without disturbing the adjacent connector. [15]Applications: - Datacom. [15]C: Documents and SettingsuserDesktopSC d. jpgFigure 4. 9: SC Duplex Connector. 08

ST Connectors

ST stands for Straight Tip – a quick release bayonet style Connector developed by AT & T. STs was predominant in the late 80s & early 90s. ST Connectors are among the most commonly used Fiber optic connectors in networking applications. They are cylindrical with twist lock coupling, 2. 5mm keyed ferrule. ST Connectors are used both short distance applications & long line systems. The ST connectors have a bayonet mount &a long cylindrical Ferrule to hold the fiber. Because they are spring-loaded, you have to make sure they are stayed properly. They are easily inserted & removed due to their design. If you experience high Light loss, try reconnecting. ST connectors come in two versions: ST and ST-2. These are keyed & spring-loaded. They are push-in and twist types. They are rated for 500 mating cycles. The typical Insertion Loss for matched ST connector is 0. 25 dB. C: Documents and SettingsuserDesktopST. jpgFigure 4. 10: ST Connector. Applications: - Inter/Intra-Building, Security, Navy etc. [10]

Installing Fiber Optic Connectors

The method for attaching fiber optic connectors to optical fibers varies among connector types. [7]Cut the cable one inch longer than the required finished length. [7]Carefully strip the outer jacket of the fiber with " no nick" fiber strippers. Cut the exposed strength members, & remove the fiber coating. The fiber coating may be removed two ways: by soaking the fiber

for two minutes in paint thinner & wiping the fiber clean with a soft, lint-free cloth or by carefully stripping the fiber with a fiber stripper. Be sure to use strippers made especially for use with fiber rather than metal wire strippers as damage can occur, weakening the fiber.[7]Thoroughly clean the bared fiber with isopropyl alcohol poured onto a soft, lint-free cloth such as Kim wipes. NEVER clean the fiber with a dry tissue.[7]The Connector may be connected by applying epoxy or by crimping. If using epoxy, fill the connector with enough epoxy to allow a small bead of epoxy to09Form at the tip of the connector. Insert the clean, stripped fiber into the connector. Cure the epoxy according to the instructions provided by the epoxy manufacturer. [7]Anchor the cable strength members to the connector body. This prevents directStress on the fiber. Slide the back end of the connector into place. [7]Prepare the fiber face to achieve a good optical finish by cleaving & polishing the fiber end. [7]

Cleaving

A cleave in an optical fiber is a deliberate, controlled brake, intended to create a perfectly flat end-face, perpendicular to the longitudinal axis of the fiber. Since there are no crystalline planes in glass, this process isn’t cleavage in the crystallographic sense of the word, although the techniques used & the finished result is quite similar. [14]A good cleave is required for a successful splice of an optical fiber, whether by fusion or mechanical means. Also, some types of fiber-optic connectors do not employ abrasives & polishers. Instead, they use some type of cleaving technique to trim the fiber to its proper length, & produce a smooth, flat perpendicular end-face. [14]C:

Documents and SettingsuserDesktopcleaving. jpgFigure 5. 1: Cleaving a Fiber.

Polishing

After a clean cleaves has been achieved, the fiber end face is attached to a10Polishing brush & the fiber is ground& polished. The proper finish is achieved by rubbing the connectorized fiber and against polishing paper in a figure-eight pattern approximately sixty times. To increase the ease & repeatability of connector installation, some companies offer connector kit. Some connectors required to use of an alignment sleeve, also called an interconnection sleeve. This sleeve serves to increase repeatability from connection to connection. [5]C: Documents and SettingsuserDesktopAN107-13. gifFigure 5. 2: Polishing Technique.

Care & Handling of Fiber Optic Connectors

A number of events can damage fiber optic connectors. Unprotected connector ends can experience damage by impact, airborne dust particles, or excess humidity or moisture. The increased optical output power of modern lasers also has the potential to damage a connector, an often overlooked factor in discussions about handling & caring for optical fibers & connectors. Most designers tend to think of the power levels in optical fibers as relatively insignificant. However, a few milli watts at 850nm will do permanent damage to a retina. Today, optical amplifiers can generate optical powers of 1W of more into a single-mode fiber. This become quite significant when one consider that the optical power is confined in the optical core only a few microns in diameter. Power densities in a single-mode fiber carrying an optical power of 1W can reach 3 MW or 30 GW! To put it in every

day terms, sunlight at the surface of the earth has a power density of about 1000W. [5]

Effects on Fiber Optic Connectors

One should never clean an optical connector attached to a fiber that is carrying light. Optical power levels as low as +15dBm, or 32mW, may cause an explosive ignition of the cleaning material when it contacts the end of the optical connector, destroying the connector. Typical cleaning materials, such as tissues saturated with alcohol, will combust almost instantaneously when exposed to optical power levels of +15dBm or higher. The micro-explosions at the tip of the connector can leave pits in the end of the connector & crack the connector's surface, destroying its ability to carry light with low less. 11C: Documents and SettingsuserDesktopdamaged-connector. GIFFigure 6. 1: Damaged Optical Connector

Cleaning Technique

Required equipment: Kimwipes or any lens-grade, lint-free tissue. The type sold for eyeglasses work quite well: Denatured alcohol. Note: Use only industrial grade 99% pure (ultra-pure) isopropyl (propan-2-ol) alcohol. Commercially available propan-2-ol is for medicinal use & is diluted with water & a light mineral oil. Industrial grade propan-2-ol should be used exclusively: 30X microscope: Canned dry air. [5]Fold the tissue twice so it's for layers thick.[5]Saturate the tissue with alcohol.[5]First clean the sides of the connector ferrule. Place the connector ferrule in the tissue, & apply pressure to the sides of the ferrule.[5]Now move to a clean part of the tissue. Be sure it's still saturated from alcohol & that is still for layers thick. Put the tissue against the end of the connector ferrule. Put your fingernail against

the tissue so that is directly over the ferrule. Now scrape the end of the connector until it squeaks. It will sound like a crystal glass that has been rubbed when it’s wet. [5]Use the microscope to verify the quality of the cleaning. If it isn’t completely clean, repeat he steps with a clean tissue. Repeat until you have a cleaning technique that yields good, reproducible results. [5]Mate the connector immediately! Don’t let the connector lie around & collect dust before mating. [5]Air can be used to remove lint or loose dust from the port of a transmitter or receiver to be mated or receiver to be mated with the connector. Never insert any liquid into the ports. [5]13C: Documents and SettingsuserDesktopcleaning. jpgFigure 7. 1: Cleaning a Fiber Optic Connector. 14