Application Note 031 – Fibre Optic Cables

This document describes the ruggedisation and connectorisation processes of optical fibre

Introduction

Fibre optic technology has been utilised by the communication industries to transport broadband information services over either multimode or single mode optical fibre (see application note 030 – optical fibres). Multimode systems are typically deployed in campus and premise installations that support short reach (<500m), low bandwidth information transport. For longer haul transport of broadband information over wide area networks (WAN) or enterprise networks single mode fibre is usually installed.

Information is typically transmitted at 850nm over multimode fibre. In the case of single mode fibre networks, traffic is generally transported within the 1310nm or 1550nm window. Before optical fibre is deployed in the field it must be protected from the environment for long-term reliability, as well as undergo a process where the ends of the fibre are terminated with connectors.

Fibre Optic Cable Design

The construction of a typical fibre optic cable has a number of components that fulfils the need for environmental protection, strengthening, and long-term reliability. These components include:-

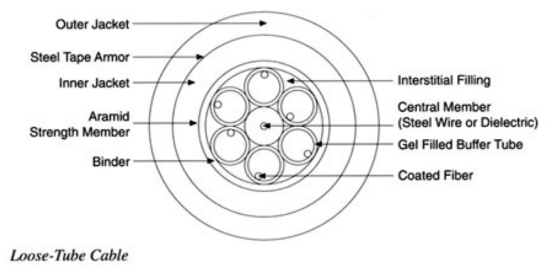
- A number of optical fibres, comprising core and cladding
- A buffer that prevents stretch problems when the fibre cable is being pulled
- Aramid yarn tensile strength member
- PVC jacket to protect against abrasion, solvents, and other contaminants

There are two basic cable designs. Loose-tube cable is primarily used for outdoor installations, whilst tight buffered cable tends to be deployed indoors within premise installations.

Loose-Tube Cable

Loose-tube cable fulfils many design criteria including bending capacity, strippability, easy termination and crush resistance. More importantly it is constructed from material that is self-extinguishing, low smoke and halogen free. An optional gel filling compound can be included in the construction that impedes water penetration. A schematic of a loose-tube cable construction is shown in figure 1.

Figure 1

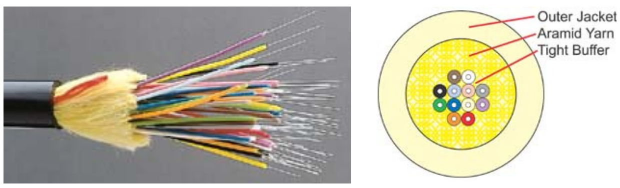


The outer polyethylene jacket is extruded over the core. For installations that require additional protection, as in tempest cabling, a corrugated steel tape component can be incorporated during the cable construction process. This cable configuration can hold up to twelve fibres per buffer tube, and multiple buffer tubes can be incorporated within a single cable construction.

Tight-Buffered Cable

Tight-buffered cables are commonly used as pigtails, patchcords and jumpers to terminate cross-site cables with terminal equipment and systems. The buffer tubing is typically made from a thermoplastic elastomer that is in direct contact with the fibre and protects individual fibres during handling, routing and termination, as shown in figure 2. Multi-core cable configurations are used in premise installs, risers, and plenum applications. Tactical cable incorporates tight buffer designs to protect against harsh environments and is the preferred all-dielectric cable when secure links are required.

Figure 2



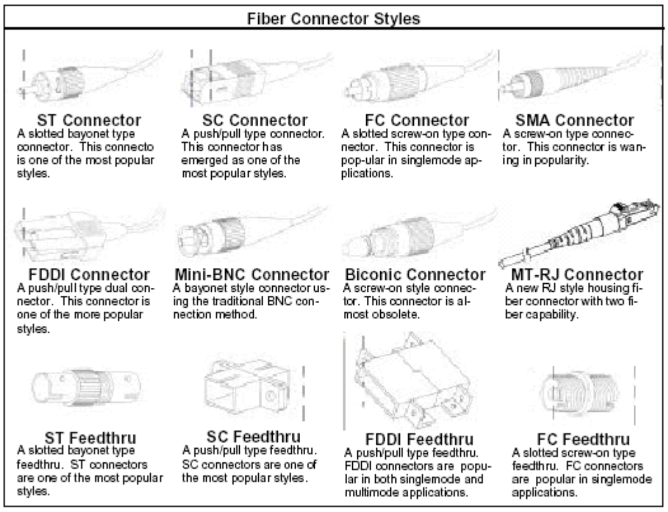
Fibre optic cables must meet the following international specifications:-

- IEC 60794-1-2
- IEC 61300-2-22
- IEC 60794-1-2 F5A/B
- IEC331, IEC 332-1
- ITU G.652
- DIN VDE 0888, part 3

Fibre termination and connectors

To complete the transfer of information from the optical fibre to the termination equipment, the fibre needs to carry a stable mechanical interconnect. There is an extensive range of optical connectors available for use in fibre termination shown in figure 3.

Figure 3



PPM has standardised on the FC/APC (Physical Contact) optical connector. This is a one-piece, full ceramic connector that meets IEC61754-B and TIA604-4-A. Insertion loss is typically 0.15dB @ 1310nm, and the return loss > 85dB for APC (8° angled facet). An example of a single mode fibre patch cord fitted with FC/APC connectors is shown in figure 4 below.

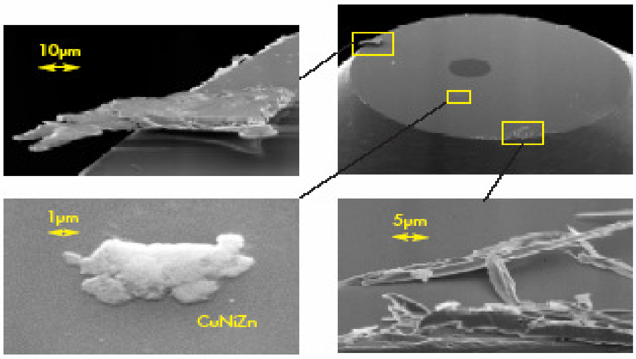
Figure 4

The actual termination process is extremely specialised and is driven by specific industry standard. The process starts by stripping the cable back to the bare fibre prior to being cemented into a ceramic ferrule.

Several polishing stages then follow before the end-facet preparation is measurable against international standards. The connector termination process includes crimping, termination, curing glue, cable stripping, visual inspection, assembly tuning and final end face inspection. The polishing process is designed to meet the exacting end face geometry requirement according to GR-326-CORE Issue 3.

The termination process ends with 100% 'core-tuning' where the optical axis of the fibre is aligned to the mechanical axis of the connector housing. End-face inspection for contaminants (as shown in figure 5) brings the process to a conclusion.

Figure 5



Conclusions

Optical fibre is used in many communication applications. Single optical fibres are fragile and are either primary or secondary coated with polymers. These single fibres are then fitted inside a more robust cable and have connectors fitted to allow easy use. A widely used connector standard is the FC/APC, such as is used on all PPM products. In most installations, multiple core fibre optical cables are used. These consist of a number of coated fibres held together and further ruggedised for indoor, outdoor or field deployable use. Several cable types with multiple fibre cores are available from PPM as are single fibre optical patch leads.