REFLEXPHOTONICS

Parallel Fiber Application Note

Introduction to types and uses of parallel multi-mode ribbon cable in optical fiber data transmission.

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Revision History

Revision	Date	Author	Notes
1.0	April 15, 2010	R.Coenen	Initial release

1 Introduction

1.1 Scope

This document explains the different types of parallel multi-mode fiber cable.

2 Parallel Multi-mode Optical Fiber

Figure 2.1 -Standard parallel multi-mode optical fiber terminated with MPO connectors

As compared to single-strand optical fiber, parallel (or ribbon) fiber has multiple fibers running down the same fiber cable. The multiple fibers are terminated with a single MPO (or MTP which is inter-changeable) connector. The MPO connector guides the multiple fibers into place, so that they all connect properly with a similar connector.

This document deals with multi-mode fiber (MMF) but single-mode fiber parallel cables also exist.

2.1 Parallel MMF connectors

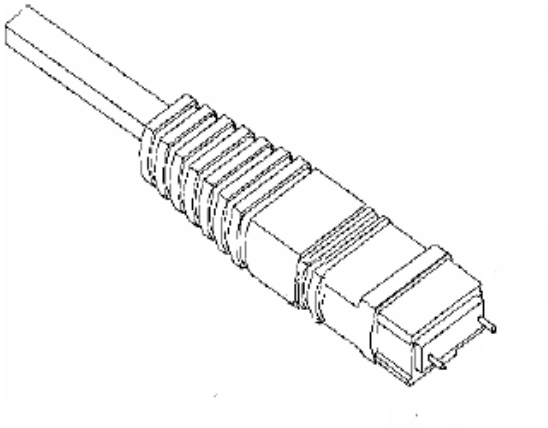

Figure 2.2 - MPO connectors, "female" and "male"

Parallel multi-mode fiber cables are terminated with MPO connectors. MPO connectors come in female and male versions, differentiated by the absence or presence of guide pins. MPO connectors have springs inside to keep the fibers pressed together.

Figure 2.3 - Mating MPO connectors

Two MPO connectors can be connected together with a bulkhead mating adapter to hold them in place.

The multiple fibers terminated at the MPO connector are arranged in rows of twelve fibers each.

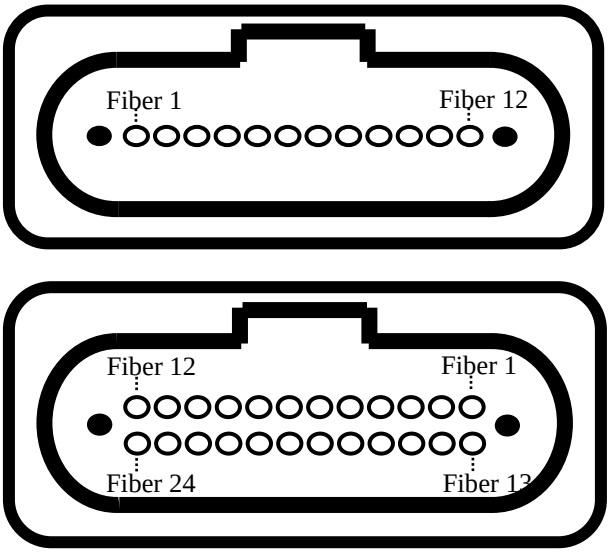

Figure 2.4 - Drawing of the face of an MPO connector receptacle with 12 and 24 fibers.

A single MPO connector can connect:
12
24
36
48
60 or
72
fibers together at once.

Figure 2.5 - 72 fiber MPO connector

An MPO connector can withstand handling and is robust enough to be used outside a chassis; connecting together chassis to chassis, chassis to test equipment, etc.

The MPO connector consists of an MT ferrule surrounded by a sleeve and mating hardware. The MT ferrule holds and guides the fibers into place.

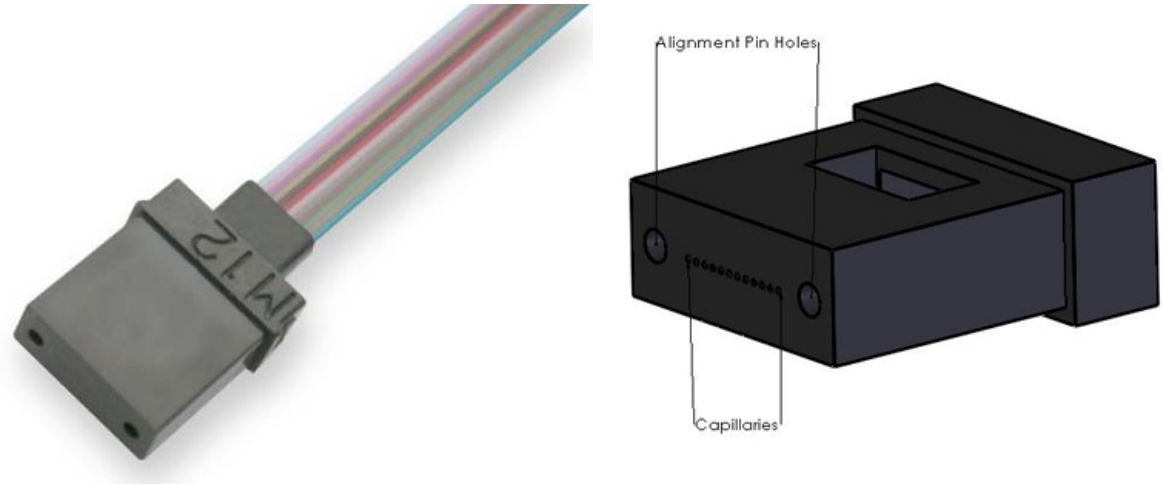

Figure 2.6 - MT ferrule

MT ferrules can be used as connectors in their own right as long as there is a means of mechanically pressing the two MTs together so that they stay mated in the presence of vibrations.

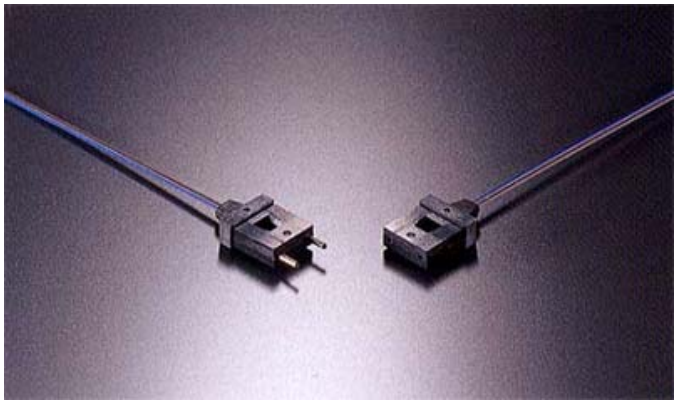

Figure 2.7 -MT ferrules, Male and Female.

In the case of the Reflex LightABLE optical engine, which has an MT ferrule connector, the incoming MT-terminated fiber ribbon is held in place with a metal clip.

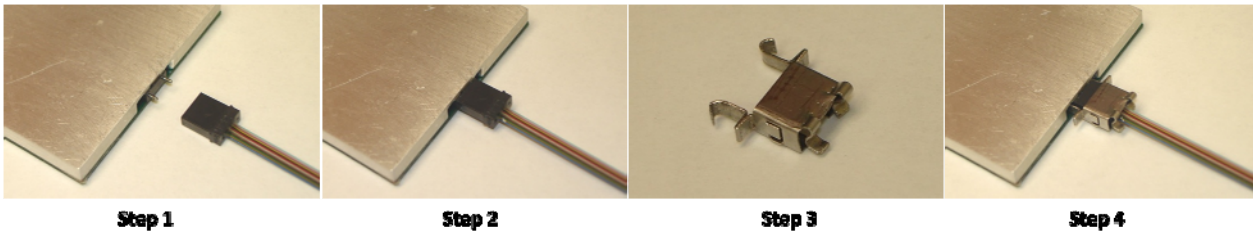

Figure 2.8 - Reflex LightABLE engine attached to MT-terminated fiber with metal clip.

Very similar to the standard MPO connector is the MTP connector. These two connectors vary only slightly in construction and are compatible with each other.

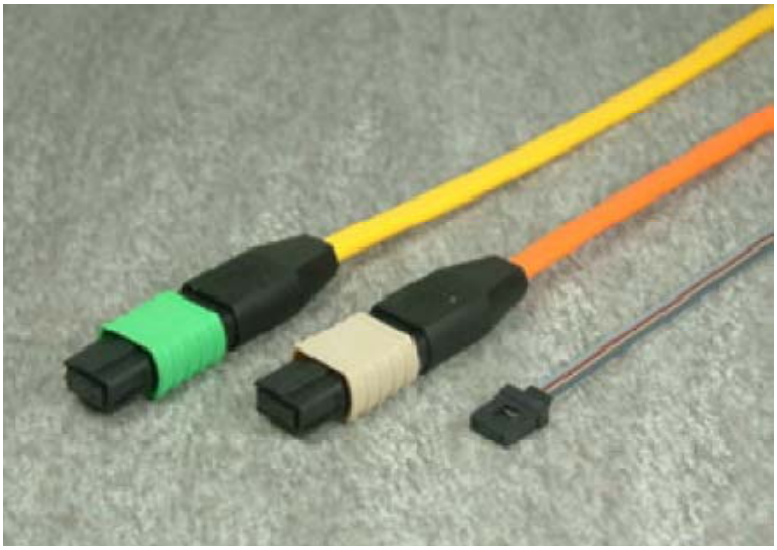

Figure 2.9 - MTP, MPO and MT terminated parallel fiber.

Figure 2.9 -also shows ribbon cable vs. ribbon fiber. Like the case of single-strand fiber, parallel fiber comes in a jacketed cable form for use outside a chassis and a "bare" ribbon form which only has a thin plastic coating over the fibers to keep them together and protect them from breakage.

2.2 Types of multi-mode fiber

The multi-mode optical fiber within a parallel fiber cable can come in more than one "grade" like the way single-mode fiber can come in various types such as dispersion-shifted and non-zero dispersion shifted. The two grades of parallel multi-mode fiber cable available commercially available are OM3 and OM4. These designations refer to the TIA standards by which their respective properties are set. Previously, a grade of multi-mode fiber designated OM2 (and before that OM1) was commercially available but it stopped being used before parallel multi-mode fiber started becoming widely used.

The major difference in the two grades of multi-mode fiber is the distance which an optical data signal will travel before it has degraded to the point at which errors start to occur at the receiver. The major source of optical data signal degradation in multi-mode fiber is multi-mode dispersion. In a multi-mode fiber, the laser light can travel different spatial paths down a fiber (as compared to single-mode fiber where only one path guides light) and these different paths have different lengths from the transmitter to the receiver. As the fiber gets longer, the difference in time delay of the various paths increases so therefore the different arrival times of the various modes of a single bit increases which degrades the jitter and signal-to-noise ratio of the optical data to the point at which errors start to occur.

	Max. Reach Distance			
Fiber Type and Modal Bandwidth	2.5 Gbps	3.3 Gbps	6.25 Gbps	10 Gbps
OM1 62.5/125 MMF 200 MHz·km	130 m	100 m	35 m	< 20 m
OM2 50/125 MMF 500 MHz·km	325 m	200 m	100 m	~ 60 m
OM3 50/125 MMF 2000 MHz·km	500 m	300 m	190 m	100 m
OM4 50/125 MMF xxx MHz·km	TBD	TBD	TBD	TBD

Figure 2.10 - Informative Link Reach.

Often the distance which optical data signals can propagate down a multi-mode fiber is quantified by modal bandwidth. This is a measure of the bandwidth per length of the fiber as in a sense the fiber can be though of as a low-pass filter whose roll-off frequency decreases with increasing fiber length. For more information on multi-mode fiber bandwidth and properties, see the TIA standards documents and datasheets of respective fiber manufacturers.

A final property of parallel multi-mode cable is bend radius. Multi-mode optical fiber manufacturers have in the past couple years come out with various types of "bend- resistant" fiber which can have a lower radius of curvature without significant loss of power than standard MMF. Parallel MMF can also be jacketed in "loose-tube" cable which decreases the strain on the fiber cable when it is bent around corners.

2.3 Number of fibers per cable

In the case of MPO terminated parallel MMF, the standard number of fibers per cable are:
12
24
36
48
60
72

Cables with 84 and 96 fibers have also been reported.

Increasing the number of fibers per cable is useful in lowering the size and weight of the combined fibers as well as making fiber management easier when the application is to connect together two chassis' with a large number of fibers.

To connect these fibers to electrical-to-optical and optical-to-electrical converters, break-out cables are used to connect the single MPO connector with multiple parallel transmitters and receivers.
For example: In Figure 2.10 a 72 fiber "trunk" cable is connected to 6 Snap-12 modules by means of a break-out cable which has a 72-fiber MPO connector on one end and 6 12-fiber MPO connectors on the other, attaching to Snap-12 modules.

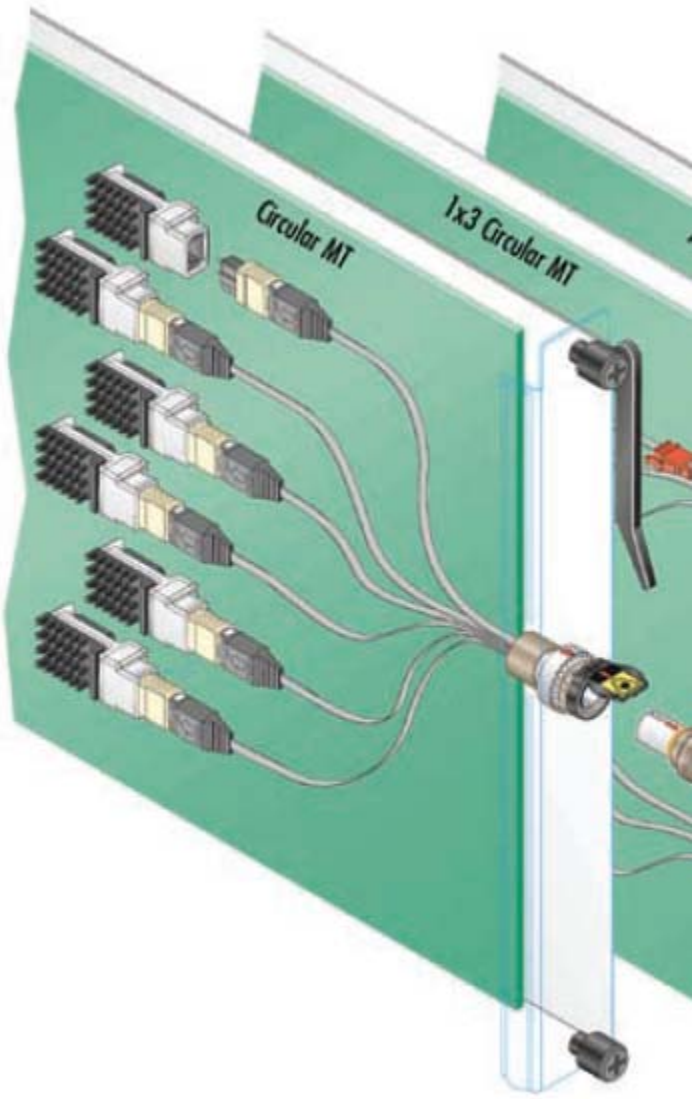

Figure 2.11 - Six Snap-12 modules connecting to a single 72-fiber cable via a break-out cable.

Breakout cables can also be used to bring out the individual fiber strands to separate connectors.

Figure 2.12 - 12-fiber breakout cable to SC connectors.

2.4 Cleaning MPO / MTP connectors

The most common problem when troubleshooting parallel MMF fiber links is connector contamination.

The ends of MPO and MT connectors and receptacles must be kept clean of all contaminants for proper operation. Fiber cleaners, specifically designed for MPO terminated parallel fiber are available. Examples are shown below.

Figure 2.13 - MPO fiber cleaners.

These cleaners are particularly useful for cleaning the receptacles at the front of optical transceivers such as Snap 12, QSFP and CFP because these specialized cleaners can get in between the guide pins which make proper cleaning with standard single-fiber cleaners impossible.