Basic Information

Data Center Introduction

Data center is particular global collaboration network unit for the Internet infrastructure transmission, acceleration, display, computing, data storage. Currently the data center room cabling system consists of two parts, SAN network cabling systems and high-density network cabling system.

Our high-density data center cabling products have the following features: Plug and play, high-density, scalable, pre-terminated fiber optic system solutions, modular systems management and pre-terminated components that can reduce installation time, data center easy for deploy, migration and upgrade.

Features

- Respond quickly to any network migration and upgrade. centralized or star cabling structure, the patch panel is flexible for routing
- Space-saving wiring and installation time: high-density, small-diameter cable, pre-terminated, save 50% space, 80% installation time
- Support future network applications: 40G, 100G access capability, easy upgrade late

MPO or MTP-Migration Path to 40/100Gigabit Ethernet

MTP (Mechanical Transfer Push-on) connector structure is an improved version of MPO (Multi-fiber push-on) connector. The MTP connector has elliptical guide pins of noncorrosive steel for accurate location of fibers of the two commutating connectors and reduction of wear. Also, the MT-ferrule has a floating structure that provides integrity of physical contact of the connectors under load.

Difference between MPO Connector and MTP Connector

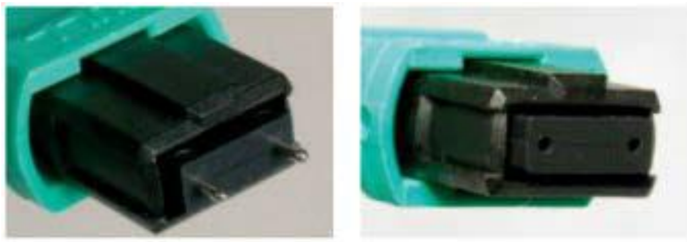
From the outside there is very little noticeable difference between MPO and MTP connectors. In fact, they are completely compatible and inter-mateable. For example, an MTP trunk cable can plug into an MPO outlet and vice versa.

The main difference is in relation to its optical and mechanical performance. MTP is a registered trademark and design of US Conec, and provides some advantages over a generic MPO connector. Since MPO / MTP optic fiber alignment is critical to ensure a precise connection there are some benefits in utilizing the MTP connector. The MTP connector is a high performance MPO connector with multiple engineered product enhancements to improve optical and mechanical performance when compared to generic MPO connectors. The MTP fiber optic connector has floating internal ferrule which allows two mated ferrules to maintain contact while under load. In addition, The MTP connector spring design maximizes ribbon clearance for twelve fiber and multifiber ribbon applications to prevent fiber damage.

Overall it provides a more reliable and precise connection. In addition, it is also important when specifying an MPO/MTP system to ensure the correct polarity options and which cables and outlets have female or male pins.

The MPO connector, MPO pins, keys

The MPO connector was developed by NTT-AT in the mid-1980s and is internationally standardized in IEC 61754-7 as well as TIA/EIA 604-5. The MPO connectors are factory terminated in pinned and unpinned versions, as shown below.



MPO (m) pinned connector MPO (f) unpinned connector

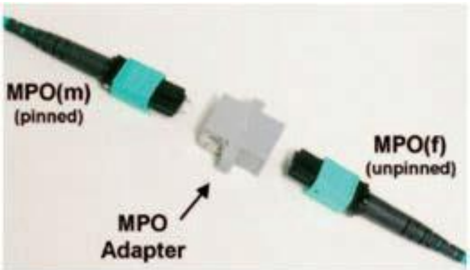
The pinned MPO is commonly referred to as male, or MPO(m), while the MPO without pins is referred to as female, or MPO(f). With the exception of the pins, the MPO connectors are identical. A pair of MPO connectors are mated by aligning the precision guide pins on the MPO(m) connector with the pin holes in the MPO(f) connector.

Depending on the application, MPO connectors are available in 8-fiber, 12-fiber or 24-fiber configurations.

8-fiber 12-fiber 24-fiber

Usually, MPO connectors with aqua colored grips denote OM2, OM3 or OM4 fiber type, lime green denotes OM5, green denote SM.

The MPO adapter provides coarse connector alignment and orientation, and includes retention features to secure the connectors. It is a passive device, it has no active components, no optical components and no precision alignment features (no pins, holes or sleeves).



Note that two female MPO connectors will insert and latch in an MPO adapter, however, due to the lack of the precision guide pins required for proper alignment, the two connectors will be misaligned—resulting in significant channel loss. Conversely, two male MPO connectors will not insert and latch in an adapter without inflicting permanent damage to one or both of the connectors.

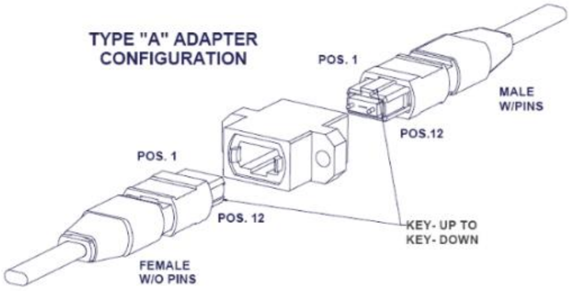
MPO connectors and adapters have interlocking lugs and notches (commonly referred to as “keys”) that ensure proper orientation of the mating connectors. MPO keys are critical components of both polarity management and single-mode angle management.

Premium cabling systems may assure correct system polarity regardless of the network design topology. Polarity refers to the basic fiber-optic design premise that every fiber must connect a signal source at one end to the proper signal receiver at the other end.

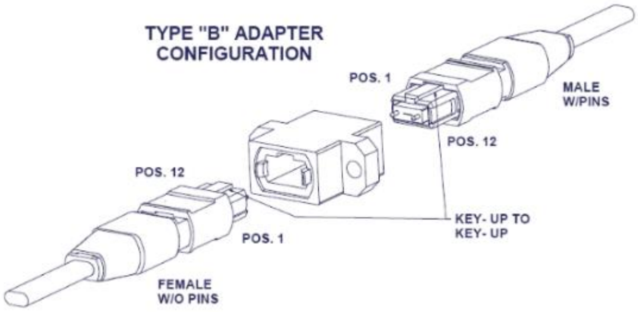
Usually, cabling systems utilize Method A, B or C polarity control, which uses “aligned key” or “opposed key” MPO adapters. Key orientation on MPO connectors is established in the factory to implement specific polarity design criteria.

That is to say, there are two types of array adapters, Type-A and Type-B. Type-A adapters shall be identified to distinguish them from Type-B adapters.

Type-A adapters shall mate two array connectors with the connector keys key-up to key-down. The complete designation for a Type-A MPO adapter is FOCIS 5 A-1-0, as defined in ANSI/TIA/EIA-604-5.



Type-B adapters shall mate two array connectors with the connector keys key-up to key-up (keys aligned). The complete designation for a Type-B MPO adapter is FOCIS 5 A-2-0, as defined in ANSI/TIA/EIA-604-5.



Unless color coding is used for some other purpose, the connector strain relief and adapter housing should be identifiable by the following colors:

- 850 nm laser-optimized 50/125μm fiber – aqua
- 50/125μm fiber – black
- 62.5/125μm fiber – beige
- Single-mode fiber – blue
- Angled contact ferrule single-mode connectors – green

In addition, unless color coding is used for some other purpose, the connector plug body should be generically identified by the following colors, where possible:

Multimode – beige, black or aqua

Single-mode – blue

Angled contact ferrule single-mode connectors – green

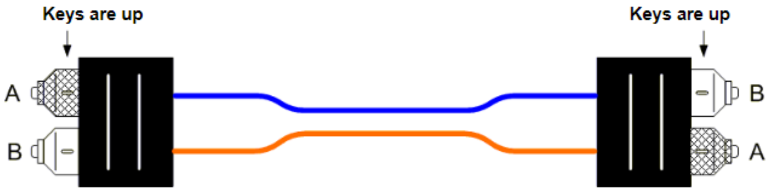
Anyway, aligned-key adapters are easily recognized by their light gray color, and opposed-key adapters are black in color usually.

POLARITY INTRODUCTION

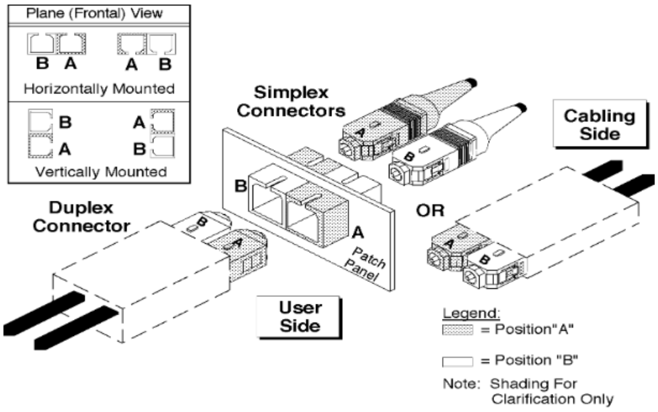
While the coding on MPO plug connectors and adapters are intended to ensure that the plug connection is always oriented correctly, the polarity defined under TIA-568-C are intended to guarantee the bi-directional assignment is correct. This section contains a brief explanation of these methods.

Duplex Patch Cord Polarity

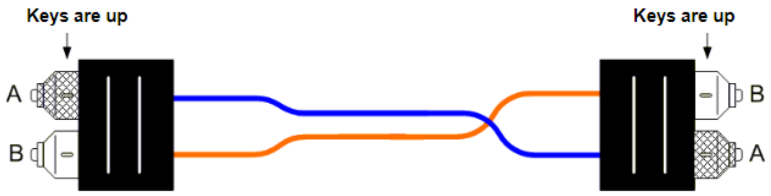
- A to B: A-to-B duplex patch cords shall be of an orientation such that Position A connects to Position B on one fiber, and Position B connects Position A (as shown below). Each end of the patch cord shall indicate Position A and Position B if the connector can be separated into its simplex components. For connector designs utilizing latches, the latch defines the positioning in the same manner as the keys.



NOTE - SC connectors are shown, but this assembly may be built using any duplex single-fiber connectors or connectors with two fixed fibers that meet the requirements of a published Fiber Optic Connector Inter-mateability Standard (FOCIS).



- A to A: A-to-A duplex patch cords shall be built as specified above, except Position A shall be connected to Position A and Position B connected to Position B (as shown below). A-to-A patch cords do not reverse the fiber positions. The A-to-A duplex patch cords shall be of an orientation such that Position A goes to Position A on one fiber, and Position B goes to Position B on the other fiber. The A-to-A duplex patch cords shall be clearly identified (by color or prominent labeling) to distinguish them from A-to-B patch cords.



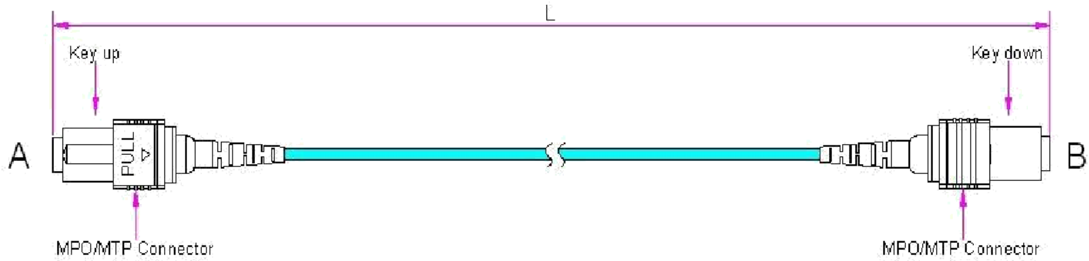
NOTE – A-to-A patch cords are not commonly deployed and should be used only when necessary as part of a polarity method (See ANSI/TIA-568-C.0).

MPO/MTP Patch Cord Polarity

Polarity ensures the MPO or MTP connectors and adaptors that are able to plug correctly, based on TIA-568-C, there are three types of polarity method, Type A, type B and Type C, the following explanation and figure help operators understanding polarity better. The main purpose is to guarantee the right bi-directional allocation.

- **Straight (Type A):** Method A uses straight through-connected Type A backbones (pin1 to pin1) and MPO adapters of Type A (key-up to key-down). An uncrossed patch cord (A-to-B) is used at one end of the link, while a crossed patch cord (A-to-A) is used at the other end. The pairwise polarity inversion therefore occurs on the patch side. Note that only one A-to-A patch cord per link may be used. This method is easy to implement, saving time and money. Since, for example, just only one cassette type is required, and the method is certainly the most widely distributed.

MPO/MTP to MPO/MTP Patch Cord



A		B
Pin No.	Fiber colour	Pin No.
1	BLUE	1
2	ORANGE	2
3	GREEN	3
4	BROWN	4
5	GREY	5
6	WHITE	6
7	RED	7
8	BLACK	8
9	YELLOW	9
10	PURPLE	10
11	PINK	11
12	AQUA	12

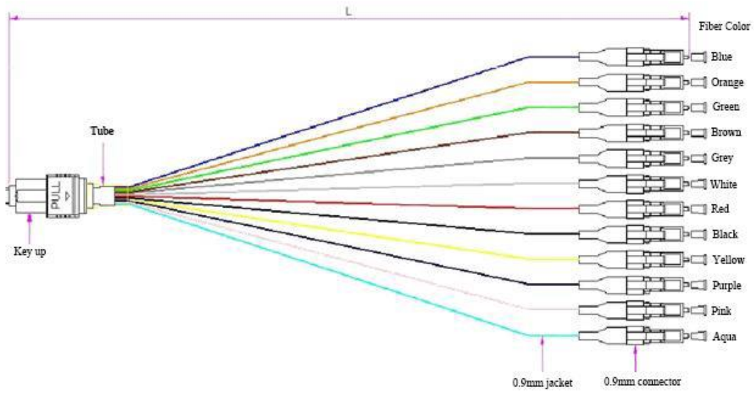
12-Core

A		B
Pin No.	Fiber colour	Pin No.
1	BLUE	13
2	ORANGE	14
3	GREEN	15
4	BROWN	16
5	GREY	17
6	WHITE	18
7	RED	19
8	BLACK	20
9	YELLOW	21
10	PURPLE	22
11	PINK	23
12	AQUA	24

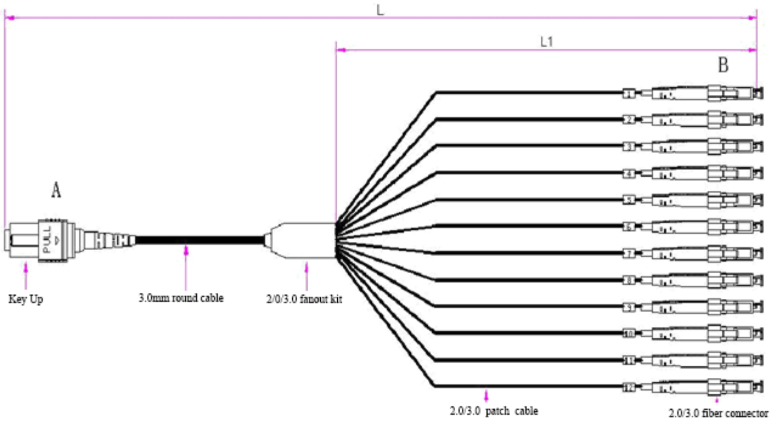
A		B
Pin No.	Fiber colour	Pin No.
13	BLUE	1
14	ORANGE	2
15	GREEN	3
16	BROWN	4
17	GREY	5
18	WHITE	6
19	RED	7
20	BLACK	8
21	YELLOW	9
22	PURPLE	10
23	PINK	11
24	AQUA	12

24-Core

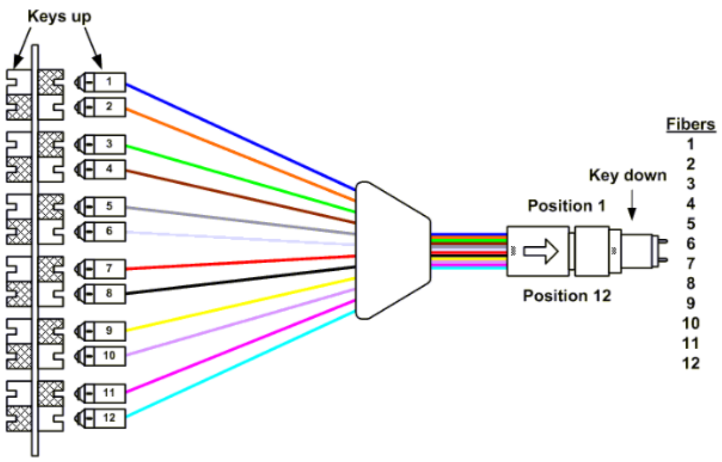
MPO/MTP-LC 12-core, MPO/MTP Hydra cable, 0.9mm cable (standard: type A)



MPO/MTP-LC 12 core Harness cable, branch 2.0/3.0mm cable, straight (Standard: type A)

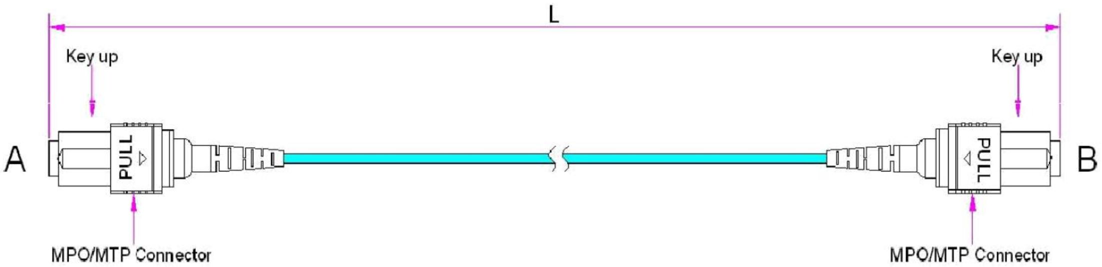


MPO/MTP-SC 12 core Harness cable, branch 2.0/3.0mm cable, straight (Standard: type A)



- **Full Crossed (Type B):** Method B uses crossed Type B backbones (pin1 to pin12) and MPO adapters of Type B (key-up to key-up). However, as the Type B adapters are used differently on both sides (key-up to key-up, key-down to key-down), single mode cannot be used in method B and it is necessary to prepare two types for cassette modules, a higher level of planning effort and expense are required compared with method A. An uncrossed patch cord (A-to-B) is used at both ends of the link.

Method B is not widespread, due to the higher amount of planning required and also because the method does not allow for use of single-mode MPO connectors. (Not widely-used, or rather, upon specific customer request)



A		B
Pin No.	Fiber colour	Pin No.
1	BLUE	12
2	ORANGE	11
3	GREEN	10
4	BROWN	9
5	GREY	8
6	WHITE	7
7	RED	6
8	BLACK	5
9	YELLOW	4
10	PURPLE	3
11	PINK	2
12	AQUA	1

12-Core

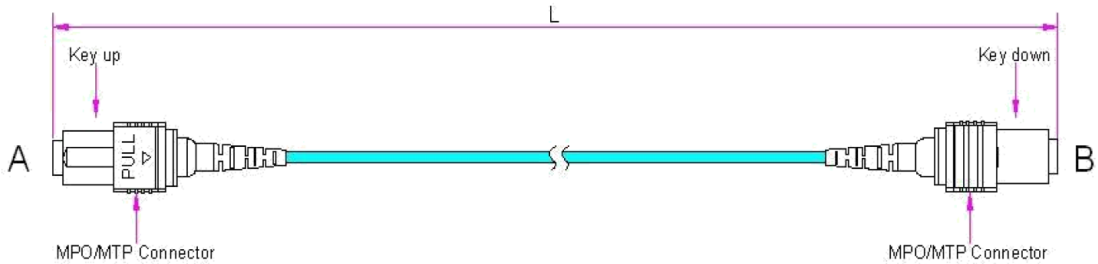
A		B
Pin No.	Fiber colour	Pin No.
1	BLUE	12
2	ORANGE	11
3	GREEN	10
4	BROWN	9
5	GREY	8
6	WHITE	7
7	RED	6
8	BLACK	5
9	YELLOW	4
10	PURPLE	3
11	PINK	2
12	AQUA	1

A		B
Pin No.	Fiber colour	Pin No.
13	BLUE	24
14	ORANGE	23
15	GREEN	22
16	BROWN	21
17	GREY	20
18	WHITE	19
19	RED	18
20	BLACK	17
21	YELLOW	16
22	PURPLE	15
23	PINK	14
24	AQUA	13

24-Core

- **Pairwise Crossed (Type C):** Method C uses pairwise crossed Type C backbones and MPO adapters of Type A (key-up to key-down). An uncrossed (straight-through) patch cord (A-to-B) is used at both ends of the link. The pairwise polarity inversion therefore occurs in the backbone, which absolutely involves an increased level of planning in the case of linked backbones. An A-to-A patch cord is required when the number of linked backbones is even.

Method C is not very widespread, due to the increased planning effort required and also because the method does not provide for a migration path to 40/100GbE, in other words, method C increases expense. (Not widely-used, or rather, upon specific customer request).



A		B
Pin No.	Fiber colour	Pin No.
1	BLUE	2
2	ORANGE	1
3	GREEN	4
4	BROWN	3
5	GREY	6
6	WHITE	5
7	RED	8
8	BLACK	7
9	YELLOW	10
10	PURPLE	9
11	PINK	12
12	AQUA	11

12-Core

A		B
Pin No.	Fiber colour	Pin No.
1	BLUE	14
2	ORANGE	13
3	GREEN	16
4	BROWN	15
5	GREY	18
6	WHITE	17
7	RED	20
8	BLACK	19
9	YELLOW	22
10	PURPLE	21
11	PINK	24
12	AQUA	23

A		B
Pin No.	Fiber colour	Pin No.
13	BLUE	2
14	ORANGE	1
15	GREEN	4
16	BROWN	3
17	GREY	6
18	WHITE	5
19	RED	8
20	BLACK	7
21	YELLOW	10
22	PURPLE	9
23	PINK	12
24	AQUA	11

24-Core

The Polarity Methods

The following table reviews and summarizes the methods described above:

TIA-568.C Standard (Duplex Signals)							
Polarity Method	Patch Cord Type at one end of the link	MTP/MPO adaptor type at the back of cassette	Array Cable-to cassette keying	Array Cable Type	MTP/MPO adaptor type at the back of cassette	Array Cable-to-cassette keying	Patch Cord Type at one end of the link
Method A	A-to-B	A	Key up to Key down	A	A	Key up to Key down	A-to-A
Method B	A-to-B	B	Key down to Key down	B	B	Key up to Key up	A-to-B
Method C	A-to-B	A	Key up to Key down	C	A	Key up to Key down	A-to-B

TIA-568.C Standard (Parallel Signals)			
Polarity Method	MPO/MTP Cable	Adapter Plate	MPO/MTP Patch Cord
A	Type A	Type A	1xType A 1xType B
B	Type B	Type B	2xType B

The construction of a completely new data center is definitely not an everyday occurrence. In this case, planners and decision makers have the possibility to immediately build upon the latest technologies and provide for higher bandwidths. By contrast, the gradual conversion and upgrade of an existing data center infrastructure to 100 Gbit/s will, indeed must, involve a broadscale effort implemented over a number of years. A sensible approach in this case is a gradual replacement of existing passive components followed by a replacement of active components as soon as these become available and economically viable.

This upgrade is normally carried out in three stages:

- Upgrading Existing 10G Environments
- Upgrade from 10G to 40G
- Upgrade from 40G to 100G

Upgrading Existing 10G Environments

Guidelines for data center network planning can be found in the standards TIA-942-A, EN 50173-5, EN 501742:2009/A1:2011, ISO/IEC 24764 and the soon-to-be-available IEC 50600-2-4. The steps below only describe the steps involved in migration, and require that the network is appropriately planned and installed.

Without a doubt, the first step in migrating from 10GbE to 40/100GbE is to upgrade the existing 10GbE environment. In this process, the backbone is replaced by a 12-fiber MPO cable, and LC/MPO modules and patch cords establish the connection to 10G switches.

It is important to note here that the TIA-568-C standard for duplex signals refers to female trunk cables and male modules. However, for reasons of simpler migration, it is recommended that trunk cables be installed as male versions and modules as female versions, so that female-female MPO patch cords can be connected to the trunk during the migration up to parallel optical signals. This is one step to reducing the complexity of the cabling systems. Migration is also possible using conventional methods and female-female trunk cables.

However, because transceivers have an MPO male interface, either the existing trunk cables must be replaced or "hybrid" patch cords (male-female) used.

A number of different configurations result depending on the existing infrastructure and polarity method used.

Method A, 10G, case 1 - MPO trunk cables (Type A, male-male) replace the existing duplex trunk (center), MPO modules (Type A, female) enable the transition to the existing A-to-B (left) and A-to-A (right) LC duplex patch cords. Since HD MPO modules have two trunk-side MPO adapters, the option is available of consolidating the two 12-fiber MPOs into one 24-fiber trunk cable.

Method A, 10G, case 2 - MPO trunk cables (Type A, male-male) replace the duplex trunk (center), an MPO module (Type A, female) enables the transition to the existing A-to-B LC duplex patch cord (left), adapter plate (Type A) and harness cable (female) replace the LC duplex patch cord.

Method A, 10G, case 3 – Connection from A-to-B LC duplex patch cord, MPO module (Type A, female) and harness cable (male).

Upgrading from 10G to 40G

If the next step involves replacing 10G with 40G versions, the next adaptation can be carried out very easily by using MPO adapter plates in place of MPO modules. In addition, the polarity method in use must be observed.

Method A, replacement of MPO modules with Type A adapter plates and LC duplex patch cords by MPO patch cords of Type A, female-female (left) and Type B, female-female (right). An existing 24-fiber trunk cable can now serve two 40G links.

Method B, replacement of MPO modules with Type B adapter plates and LC duplex patch cords by MPO patch cords of Type B, female-female (left, right). When this configuration is compared to the TIA-568.C standard, we notice immediately that method B is identical for parallel optical signals. An existing 24-fiber trunk cable can serve two 40G links in this case as well.

Upgrading from 40G to 100G

In the final step, the use of 24-fiber MPO cables may also be necessary when 100G switches are being implemented. In this case, either the existing 12-fiber connection can be extended by a second 12-fiber connection, or replaced by one with 24 fibers.

Method A, extension of MPO trunk cable (male-male) by a second one, Type A adapter plates remain as is, patch cords are replaced by 1x2 Y conversion cables.

Method A, the MPO-24 solution- Use of an MPO-24 trunk cable of Type A male-male, Type A adapter plates remain as is. MPO-24 patch cords of Type A, female-female (left) and Type B, female-female (right) are used as patch cords.

Method B, extension of MPO trunk cable (male-male) by a second one, Type B adapter plates remain as is, patch cords are replaced by 1x2 Y conversion cables.

Method B, the MPO-24 solution- Use of an MPO-24 trunk cable of Type B male-male, Type B adapter plates remain as is. MPO-24 patch cords of Type B, female-female are used as patch cords on both sides.

Expansion in 10G	A-to-B patch cord (LC or SC)	Cassette (Type A)	MTP/MPO array cord 12-fiber (Type A)	Cassette (Type A)	A-to-A patch cord (LC or SC)
	A-to-B patch cord (LC or SC)	Cassette (Type A)	MTP/MPO array cord 12-fiber (Type A)	MTP/MPO adaptor plate (Type A)	Harness/Trunk Harness (MTP/MPO to LC/SC)
	A-to-B patch cord (LC or SC)	Cassette (Type A)	*	*	Harness/Trunk Harness (MTP/MPO to LC/SC)
10G to 40G	MTP/MPO array cord 12-fiber (Type A)	MTP/MPO adaptor plate (Type A)	MTP/MPO array cord 12-fiber (Type A)	MTP/MPO adaptor plate (Type A)	MTP/MPO array cord 12-fiber (Type B)
	MTP/MPO array cord 12-fiber (Type B)	MTP/MPO adaptor plate (Type B)	MTP/MPO array cord 12-fiber (Type B)	MTP/MPO adaptor plate (Type B)	MTP/MPO array cord 12-fiber (Type B)
40G to 100G	MTP/MPO Trunk (Type A, 2x12-fiber in one MTP/MPO 24-fiber)	MTP/MPO adaptor plate (Type A)	MTP/MPO array cord 12-fiber (Type A) x 2 pcs	MTP/MPO adaptor plate (Type A)	MTP/MPO Trunk (Type B, 2x12-fiber in one MTP/MPO 24-fiber)
	MTP/MPO Trunk 24-fiber (Type A)	MTP/MPO adaptor plate (Type A)	MTP/MPO array cord 24-fiber (Type A)	MTP/MPO adaptor plate (Type A)	MTP/MPO Trunk 24-fiber (Type B)
	MTP/MPO Trunk (Type B, 2x12-fiber in one MTP/MPO 24-fiber)	MTP/MPO adaptor plate (Type B)	MTP/MPO array cord 12-fiber (Type B) x 2 pcs	MTP/MPO adaptor plate (Type B)	MTP/MPO Trunk (Type B, 2x12-fiber in one MTP/MPO 24-fiber)
	MTP/MPO Trunk 24-fiber (Type B)	MTP/MPO adaptor plate (Type B)	MTP/MPO array cord 24-fiber (Type B)	MTP/MPO adaptor plate (Type B)	MTP/MPO Trunk 24-fiber (Type B)

Summary

The implementation of MPO components and parallel optical connections translates into new challenges for data center planners and decision makers. Cable lengths must be carefully planned, MPO types correctly selected, polarities maintained over the entire link and insertion loss budgets calculated precisely. Short-term changes are either barely possible or are not possible at all, while errors in planning can be expensive.
Nevertheless, it is very worthwhile to switch to the new technology, especially since it is already becoming a technological necessity over the medium term. It therefore makes sense to have switch points already placed

early on, and to at least adapt passive components to future requirements. The high expense is more than offset by the technology's short installation times, quality that is inspected and documented for every single component, and operational reliability and investment security that will bring peace of mind for years to come.

Fiber Type

OM3 or OM4

Why OM3&OM4 is widely deployed in data center? Statistics show that among the backbone optical fiber links in the data centers, 88% are shorter than 100 meters, 94% are shorter than 125 meters and 100% are shorter than 300 meters. Basically 100 meters are enough. IEEE ultimately adopted OM4 as it is capable of transmitting 40/100Gb/s over 150m and thereby supports over 97% of all links in data center.

Compared with OM3, the OM4 fiber with longer transmission distance, for example, for 40/100 Gbit Ethernet, maximum channel length using OM3 is 100m, and using OM4 is150 meters.

Fiber Type		**OM3**	**OM4**
Wavelengths (nm)		850	850
Core Diameter (um)		50/125	50/125
Attenuation (dB/km)		3.5	3.5
Min. OFL Bandwidth (MHz·km)		1500	3500
Min. Effective Modal Bandwidth (MHz·km)		2000	4700
Max. Transmission Distance (m)	1G	1000	1000
	10G	300	550
	40/100G	100	150

OM5

OM5, also named as wideband multimode fiber (WBMMF). It is a 50/125-micron laser-optimized fiber that is optimized for enhanced performance for single-wavelength or multi-wavelength transmission systems with wavelengths in the vicinity of 850nm to 950nm. The actual operating band is from 850 to 953nm. The effective modal bandwidth for this new fiber is specified at the lower and upper wavelengths: 4700 MHz.km at 850nm and 2470 MHz.km at 953nm.

Fiber Type		**OM5**
Core Diameter (um)		50/125
Attenuation (dB/km)		2.3
Min. OFL Bandwidth (MHz·km)	850nm	3500
	983nm	1850
	1300nm	500
Min. Effective Modal Bandwidth (MHz·km)	850nm	4700
	983nm	2470
Max. Transmission Distance (m)	1G	1100
	10G	600
	40/100G	200

*Lime green is the official OM5 jacket color

Another Table for Reference

Application	**OM1**		**OM2**		**OM3**		**OM4**		**OS1/OS2**	
Wavelength	850nm	1300nm	850nm	1300nm	850nm	1300nm	850nm	1300nm	1310nm	1550nm
FDDI OMD		2000m		2000m		2000m		2000m		
FDDI SMF-PMD									10000m	
10/100Base-SX	300m		300m		300m		300m			
100Base-FX		2000m		2000m		2000m		2000m		
1000Base-SX	275m		550m		800m		800m			
1000Base-LX		550m		550m		800m		800m	5000m	
10GBase-S	33m		82m		300m		550m			
10GBase-LX4		300m		300m		300m		300m	10000m	
10GBase-L									10000m	
10GBase-LRM		220m		220m		220m		220m		
10GBase-E										40000m
40GBase-SR4					100m		150m			
40GBase-LR4									10000m	
10GBase-SR10					100m		150m			
100GBase-LR4									10000m	
100GBase-ER4										30000m

Link Loss Budget

Low Loss

Total connector loss within a system channel impacts the ability of a system to operate over the maximum supportable distance for a given data rate. The 40/100G Ethernet standard specifies the OM3 fiber 100M distance maximum channel loss to be 1.9dB (a 1.5dB total connector is included). The OM4 fiber 150M distance maximum channel loss is 1.5dB, which includes a 1.0dB total connector loss budget. With low-loss MTP connectivity components, maximum flexibility can be obtained with the ability to introduce multiple connector mating into the connectivity link.

Fiber Pre-terminated Cabling Performance (dB)

We recommend using pre-terminated trunks and harness whenever and wherever possible. With 100% factory testing and no need for field terminations or splices, installation time and cost are reduced by up to 50%.

Connector Mated Pairs	Multimode (OM3&OM4)						Single-mode (OS1, OS2)		
	Duplex Typical IL	Duplex Max. IL	Duplex Max. IL (Low-loss)	12-fiber Standard Typical IL	12-fiber Standard Max. IL	12-fiber Standard Max. IL (Low-loss)	Typical IL	Max. IL	Low Loss Max. IL
LC	0.15dB	0.50dB	0.15dB	-	-	-	0.25dB	0.30dB	0.15dB
SC	0.20dB	0.50dB	0.15dB	-	-	-	0.25dB	0.30dB	0.15dB
MTP/MPO	-	-	-	0.40dB	0.50dB	0.35dB	0.30dB	0.75dB	0.35dB

MTP/MPO Modules & Harness	Multimode (OM3 & OM4)			Single-mode (OS1, OS2)		
	12-fiber Standard Typical IL	12-fiber Standard Max. IL	12-fiber Standard Max. IL (Low-loss)	Typical IL	Max. IL	Low Loss Max. IL
LC	-	0.50dB	0.50dB	0.50dB	0.50dB	0.50dB
SC	-	0.50dB	0.50dB	0.50dB	0.50dB	0.50dB
MTP/MPO	0.40dB	0.50dB	0.35dB	0.60dB	0.75dB	0.35dB

Standard Loss Maximum Channel Loss = Fiber Loss + 1.5dB				
Tx/Rx Transceiver (Patch Cord)	Module or Harness	Trunk Fiber Loss	Module or Harness	Tx/Rx Transceiver (Patch Cord)
	0.75dB		0.75dB	

Low Loss Maximum Channel Loss = Fiber Loss + 1.0dB				
Tx/Rx Transceiver (Patch Cord)	Module or Harness	Trunk Fiber Loss	Module or Harness	Tx/Rx Transceiver (Patch Cord)
	0.5dB		0.5dB	

How to Calculate IL?

When you start to calculate the maximum distance for an optical link, consider table 1 and 2:

Table 1:

For Wavelength: 1310nm	Attenuation Km (dB/Km)	Attenuation/Optical Connector (dB)	Attenuation/Join (dB)	
Min.	0.30	0.40	0.02	Best Conditions
Average	0.38	0.60	0.10	Normal
Max.	0.50	1.00	0.20	Worst

Table 2:

For Wavelength: 1550nm	Attenuation Km (dB/Km)	Attenuation/Optical Connector (dB)	Attenuation/Join (dB)	
Min.	0.17	0.20	0.01	Best Conditions
Average	0.22	0.35	0.05	Normal
Max.	0.40	0.70	0.10	Worst

Total Attenuation (TA) = nxC+CxJ+Lxa+M,
n-number of connectors,
C-attenuation for one optical connector (dB),
c-number of splices in elementary cable section,
J-attenuation for one splice (dB),
L-total length of the optical cable,
a-attenuation for optical cable (dB/Km),
M-system margin (patch cord, cable bend, unpredictable optical attenuation events, and so on, should be considerate around 3dB).

When you apply this formula to the example, and assume certain values for the optical cards, you obtain these results:
For wavelength 1310nm: Normal **TA=**
nxC+CxJ+Lxa+M=2x0.6dB+4x0.1dB+20.5Kmx0.38dB/Km+3dB=12.39dB,

For wavelength 1310nm: Worst Situation **TA=**
nxC+CxJ+Lxa+M=2x1.00dB+4x0.2dB+20.5Kmx0.5dB/Km+3dB=16.05dB,

For wavelength 1550nm: Normal **TA=**
nxC+CxJ+Lxa+M=2x0.35dB+4x0.05dB+20.5Kmx0.22dB/Km+3dB=8.41dB,

For wavelength 1310nm: Worst Situation **TA=**
nxC+CxJ+Lxa+M=2x0.7dB+4x0.1dB+20.5Kmx0.4dB/Km+3dB=13dB,

Assume that the optical card has these specifications:
Tx=-3dB to 0dB at 1310nm, Rx=-20dB to -27dB at 1310nm, in this case, the power budget is between 27dB and 17dB. If you consider the worst card, which has the power budget at 17dB at 1310nm, and the worst situation for the optical link to be 16.05dB at 1310nm, you can estimate that your optical link will work without any problem. In order to be sure of this, you must measure the link.