Understanding Fiber Polarity:

Implications at 10G, 40G, & 100G

FIBER POLARITY: 10G and 40/100G OPTIONS

Why is this significant in the data center?

Data centers will be one of the first places where we will see 40G and 100G transmission speeds. Large data centers being built today should be preparing for 40/100G transmission. Those specifying for these projects need to understand how to best specify fiber systems today that will be able to support these higher data rates.

So what's it all about?

To ensure that fiber systems work, each fiber must have a transmitter at one end, and a receiver at the other. It's like data travels along a one way road. It is vital that this type of connection is made. For multi-fiber arrays using MPO/MTP connectors, the TIA 568 standard provides three methods for configuring systems to ensure that proper connections are made, Methods A, B & C. Each of these methods handle the transition from a transmit position to a receive position in a slightly different manner, and each employs a backbone cable that is constructed in a specific manner. So essentially, there are three different ways to build the road from start to finish.

Unlike traditional 2-fiber configurations, with one send and one receive, 40G & 100G Ethernet implementations over multimode fibers use multiple parallel 10G connections that are aggregated. 40G uses four 10G fibers to send and four 10G fibers to receive, while 100G uses ten 10G fibers in each direction.

Before looking at each method in detail, it is important to orient oneself to the MTP™/MPO connector, hereafter referred to strictly as MTP.
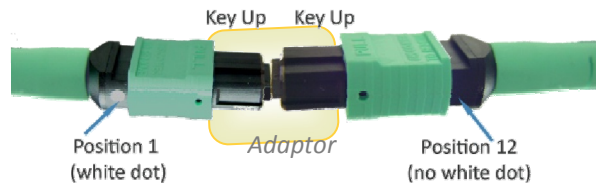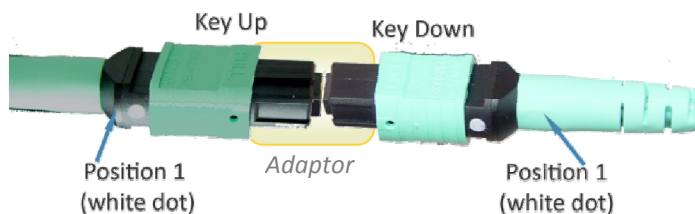
Each MTP connector has a key on one side of the connector body. When the key sits on top, this is referred to as the key up position. In this orientation, each of the fiber holes in the connector is numbered in sequence from left to right. We will refer to these connector holes as positions, or P1, P2, etc.

Each connector is additionally marked with a white dot on the connector body to designate the position 1 side of the connector when it is plugged in.
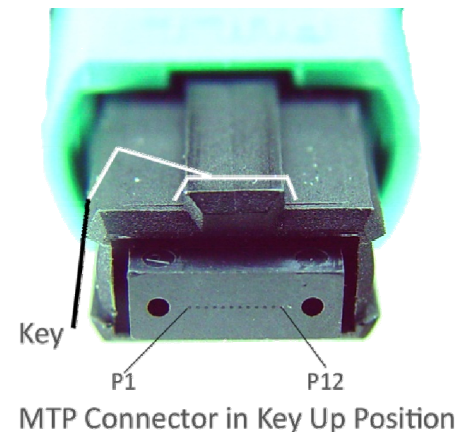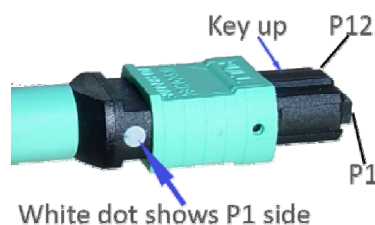
When you look at the diagrams that follow, remember that positions are defined by the **CONNECTOR** face, when viewed from a head on position as shown above.

The adaptor on a cassette is simply a holder with keying designed to hold the two facing ends of the MTPs in correct alignment. The two photos below show you what the MTPs held within the adaptor would look like if you were able to see them in profile view.

Key Up — Key Down

Position 1 (white dot) — *Adaptor* — Position 1 (white dot)

Key Up — Key Up

Position 1 (white dot) — *Adaptor* — Position 12 (no white dot)

In the illustrations below, since we can't show you both connectors from a head-on perspective, we use the following diagram to indicate the connector positions of the obscured connector face. Please note, the positions are numbered to show you the perspective of looking through the connector body within the cassette, toward the facing end of the trunk cable connector.

So, a connector in the position shown at far right, would have its endface represented as at right.

P11   P9   P7   P5   P3   P1
P12   P10   P8   P6   P4   P2

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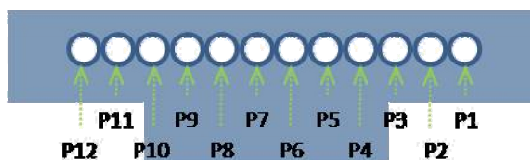
METHOD A: Polarity flip in A-to-A patch cord

For method A, the transmit-receive flip must happen in the patch cords, and the trunk cable is a straight through transmission, with the key up on one end, and the key down on the opposite end. This means that the blue fiber (F1) located in Position 1 (P1) of the connector on the left will arrive at P1 at the other connector.

Method A Backbone detail

Key up

Position 1

Position 12

Key down

Position 1

Position 12

Note: Fiber 1 is in position 1 at both ends of the cable

Rotation in cable

Key up connector faces

White dot: position 1

White dot: position 1

Key up to Key down Adaptor

Key up to Key down Adaptor

White dot: position 1

White dot: position 1

Fiber Cassette

Fiber Cassette

Key up to Key up

Key up to Key up

A-to-B *Patch Cord*

A-to-A *Patch Cord*

Rx A B Tx

Rx A B Tx

Optical Path

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METHOD B: Polarity flip in cassette

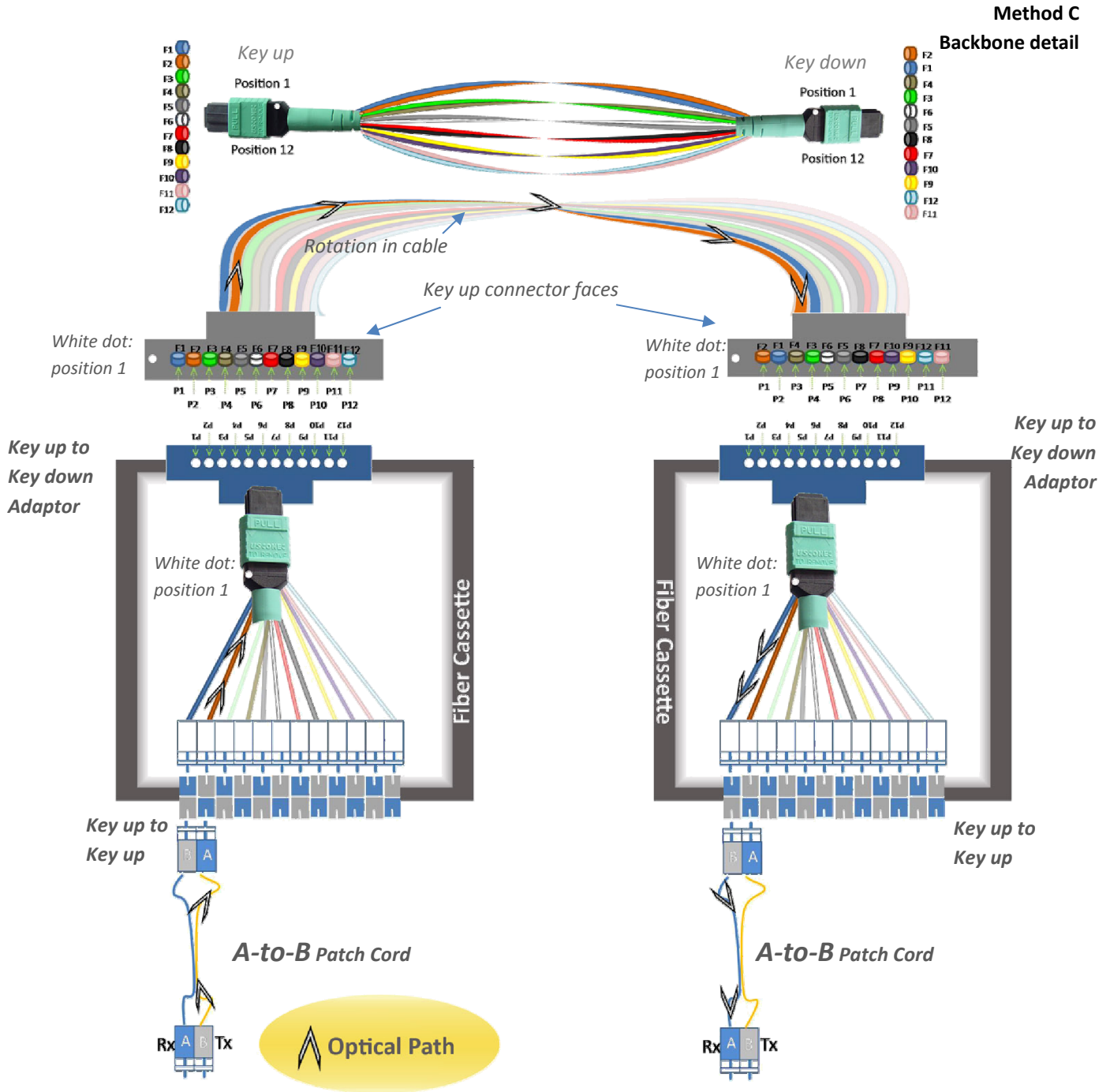The keys are in an up position at both ends (remember to imagine yourself facing the front of the connector) of the trunk cable, but the fiber that is at position 1 in one connector end is in position twelve at the opposite end, and the fiber that is in position 12 at the originating end is in position 1 at the opposing end.

Method B
Backbone detail

Key down

Position 12

Position 1

Key down

Position 1

Position 12

Note: By flipping the connector, Fiber 1 moves from position 1 at the left to position 12 at the right.

Key down connector faces

White dot: position 1

White dot: position 1

Key down to Key down Adaptor

Key down to Key down Adaptor

White dot: position 1

White dot: position 1

Fiber Cassette

Fiber Cassette

Key up to Key up

Key up to Key up

A-to-B *Patch Cord*

A-to-B *Patch Cord*

Rx A B Tx

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Rx A B Tx

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METHOD C: Flip by pairs

For Method C, each adjacent pair of fibers at one end are flipped at the other end. Notice the swapping of the color positions in the diagram.

Method C
Backbone detail

Key up

Position 1

Position 12

Key down

Position 1

Position 12

Rotation in cable

Key up connector faces

White dot: position 1

White dot: position 1

P1   P3   P5   P7   P9   P11
P2   P4   P6   P8   P10 P12

P1   P3   P5   P7   P9   P11
P2   P4   P6   P8   P10 P12

Key up to Key down Adaptor

Key up to Key down Adaptor

White dot: position 1

White dot: position 1

Fiber Cassette

Fiber Cassette

Key up to Key up

Key up to Key up

A-to-B Patch Cord

A-to-B Patch Cord

Rx A B Tx

Rx A B Tx

⋀ **Optical Path**

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Corning's approach to polarity is a bit different. Corning does not use any of the identified methods outlined in the standard, and instead uses a proprietary configuration. If a customer chooses Corning for their pre-terminated solution, Corning's position is that the system will need to remain all Corning, a closed proprietary system. However, testing from the Nexans DCCC has shown that we can provide backbone cabling using a Method B backbone cable and still be compatible with Corning Cassettes' Polarity System.

The specifics for pre-terminated assemblies to support 40G & 100G transmission are fairly straightforward.

First, 40/100G has standardized on MPO/MTP connectors.

Second, transmission lanes are not specifically assigned. Each multi-fiber connector will create a single high-speed connection.

Third, each speed will be achieved with multimode fiber by transmitting multiple parallel 10G transmissions that will then be recombined when received.
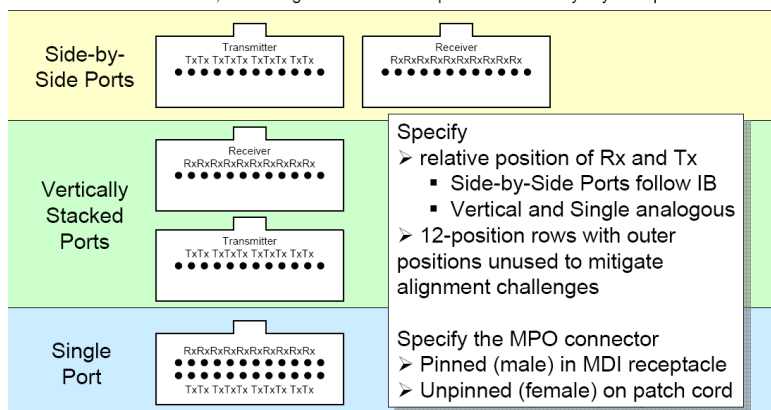
While lanes are not specifically assigned, the current draft standard for 40G shows the following configuration for the connectors on switches and routers. If you looked at the port of a 40G switch, the left four fibers would be blasting light at you and the last four fibers on the right would be waiting to receive light (see figure at right).

TxTx TxTx   RxRxRxRx

40GBASE-SR4
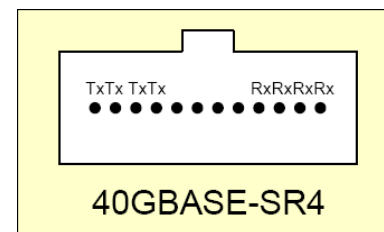
This approach would transmit 40G using four parallel 10G lanes in each direction. With the key in an up position, the four left most positions would be transmits, the four in the center would be unused, and the four to the right would be receives.

100GBASE-SR10
Three variants, all looking into the MDI receptacle with the keyway on top

Side-by-Side Ports
Transmitter
TxTx TxTxTx TxTxTx TxTx

Receiver
RxRxRxRxRxRxRxRxRxRx

Vertically Stacked Ports
Receiver
RxRxRxRxRxRxRxRxRxRx

Transmitter
TxTx TxTxTx TxTxTx TxTx

Single Port
RxRxRxRxRxRxRxRxRxRx
TxTx TxTxTx TxTxTx TxTx

Specify
➤ relative position of Rx and Tx
   ▪ Side-by-Side Ports follow IB
   ▪ Vertical and Single analogous
➤ 12-position rows with outer positions unused to mitigate alignment challenges

Specify the MPO connector
➤ Pinned (male) in MDI receptacle
➤ Unpinned (female) on patch cord

For 100G, there are multiple configurations, shown at left. However, increasingly it appears that the single port 24-fiber connector will be the preferred approach once connector loss is improved.

Again, the 100G speed will be reached by employing 10 parallel 10G lanes in each direction. In all of the configurations shown, the center 10 positions would be used, and the two positions furthest to the outside would be unused.

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So, what will these configurations mean for polarity at 40G & 100G?

If anyone has heard that polarity doesn't matter, that's not the entire story. For the IEEE, saying that polarity doesn't matter means that any transmit position can send to any receive position, and once the signal is received, the electronics will sort out and organize the stream of data. However, transmits will still need to be connected to receives. And every send needs its own receive.

Here's an analogy to illustrate: Think of ball players. You have pitchers & catchers.

For 10G transmission, Pitcher 1 needs to throw to Catcher 1, Pitcher 2 to Catcher 2 and so on.
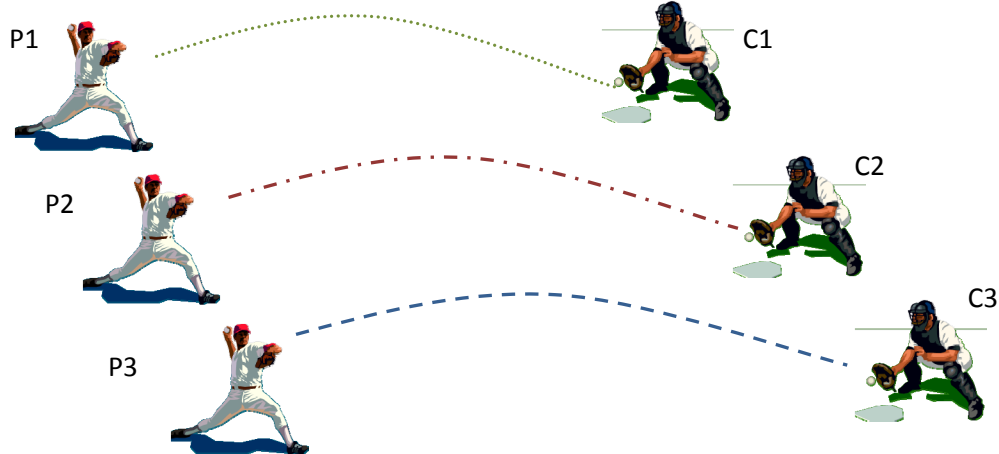
For 40/100G, any pitcher can throw to any catcher.
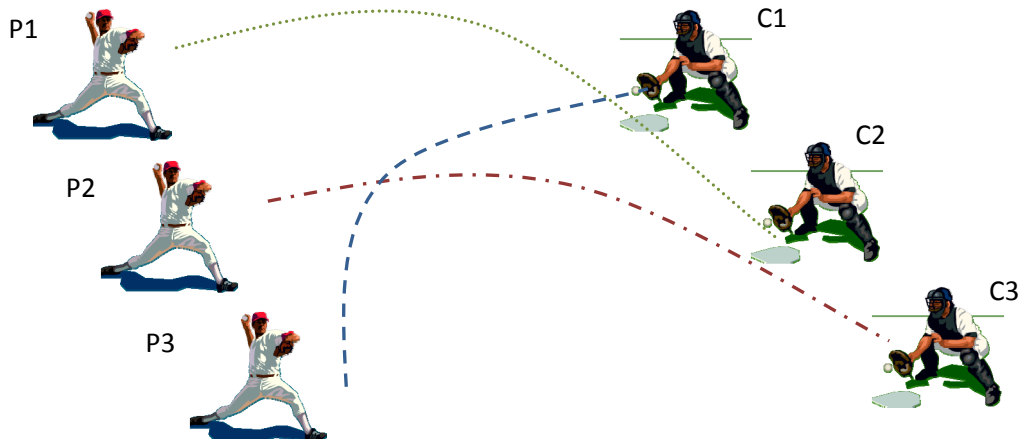
But if you've got two catchers looking at each other – there isn't a whole lot happening.

How does structured cabling fit in?

Structured cabling fully supports 1G and 10G systems today and can guarantee support of 40G/100G in the future provided the correct multimode fiber is selected. OM3 (2000 MHz•km bandwidth at 850nm) multimode fiber is the minimum performance level required. Preliminary data further shows that OM4 (4700 MHz•km bandwidth at 850nm) enables longer distances and additional connector mating options. OM4 promises to enable greater configuration flexibility for 40G or 100G architectures.

The Berk-Tek and NetClear Approach to Polarity

To support 10G, NetClear has used a method A approach in the construction of backbones, cassettes & patch cords. This method was chosen as it is the simplest design to install and support.

For 40G applications, a method A backbone is still the NetClear recommended approach. Using an MTP-to-MTP backbone assembly with MTP-to-MTP patch panels and MTP-to-MTP patch cords will enable flexibility to address MACs as well as promoting proper installation best practices.

If considering point-to-point 40G cabling, don't forget to review the overall benefits of a structured cabling approach for the data center. While it is possible to connect directly from a switch to a switch or a switch to a server using a backbone cable, this type of installation loses out on the flexibility of a structured cabling approach. Additionally, either cabling cannot be installed prior to device installation or there is an increased risk of damage to the cables and connectors that are loose until active equipment arrives.

The implementation of 40G is very similar to the current Method A, replacing cassettes with patch panels. The polarity flip will need to be accomplished in either an A to A patch cord or possibly with a key up/key down patch panel.

Method B multimode backbone cables can also readily support 40G applications because the polarity flip happens in the cable itself. For a structured cabling approach, method B will still use a patch panel and patch cords, though as with current method B, both patch cords could be A to B cords.

Method C backbones should not be selected by any customers considering 40G as completing the channel will involve complex patch cord configurations.

It appears that 100G will use the 24-fiber MPO connector. With transmits in the top row and receives in the bottom row, the connection will still be best made using a standardized structured cabling approach.