

Four-Channel Parallel Optic Connectivity Solutions Utilizing Base-12 Structured Cabling

AEN 151, Revision: 2

This Application Engineering Note will discuss the different Corning Optical Communications components that are available to provide fiber optic connectivity between parallel Quad Small Form-factor Pluggable (QFSP) transceivers utilizing Base-12 structured cabling. This document will be specific by providing connectivity solutions that use OM3/OM4 Laser-Optimized 50µm multimode and OS2 single-mode fiber (This document will only provide OM4 and OS2 part numbers). For Base-12 four-channel parallel to duplex transmission, please refer to AEN152 “Four-channel Parallel to Duplex Optical Connectivity Solutions Utilizing Base-12 Structured Cabling”. For Base-8 solutions, please refer to AEN156 “Connectivity Solutions Utilizing Base-8 Structured Cabling”.

A QFSP transceiver can be either an 8-fiber parallel link or a 2-fiber duplex link. In this document when QFSP is used we will be discussing an 8-fiber parallel link.

Four-channel Parallel Optical Links

A parallel optical link is accomplished by combining two or more channels. Parallel optical links can be achieved by using eight fibers (4 fibers for Tx and 4 fibers for Rx), twenty fibers (10 fibers for Tx and 10 fibers for Rx), or twenty-four fibers (12 fibers for Tx and 12 fibers for Rx). The standard cabling to accomplish an 8-fiber parallel optical link is a 12-fiber trunk with a MTP[®] connector interface (12-fiber connector), as shown in Figure 1.

For 8-fiber parallel connectivity, Tx1 has to follow a path that requires the data to exit on Rx1. As Figure 1 illustrates if Tx1 enters on fiber position 1 it needs to exit on fiber position 12. This is the same if the transmit enters on fiber position 12 it needs to exit on fiber position 1. This is accomplished by using a Type B polarity component (according to TIA-568). As components are added to the optical system an odd number of Type B components are required to maintain the correct polarity scheme so the light enters and exits (transmit versus receive) the correct fiber positions.

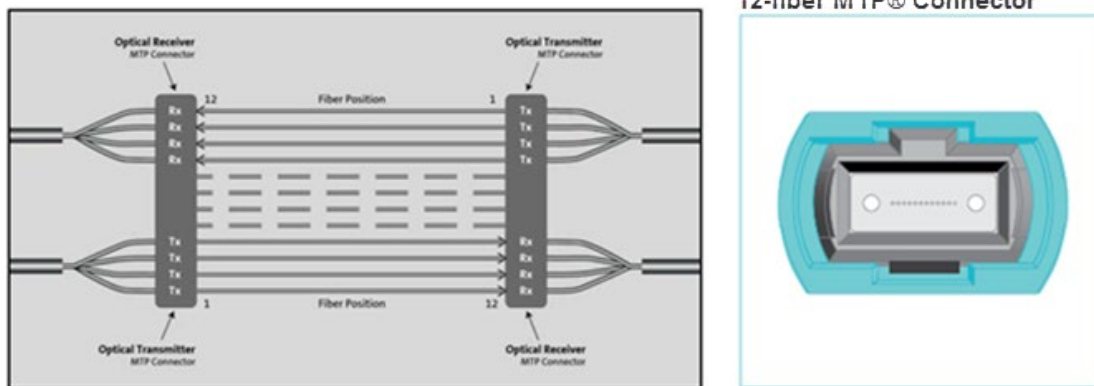


Figure 1: Parallel Fiber (8-fiber) Optic Transmission

Four-channel Parallel Optics Fiber Utilization

Since the connectivity for a four-channel parallel optic link uses 8-fibers out of the available 12-fibers in the connector, the question arises to either leave the four middle fibers dark or use some type of conversion device. A conversion device can convert two 12-fiber links into three 8-fiber links. This allows for all fibers to be utilized giving you three parallel ports for each 24 fibers of installed trunk cables.

There are three fundamental approaches for four-channel parallel optics cabling which will be discussed throughout this document:

1. Not using conversion devices which creates an additional cost of 33% for cabling (4 dark fibers per every 12 fibers installed).
2. Using conversion modules to utilize all unused fibers. This approach adds additional cost for MTP® connectivity, but all fibers will be utilized reducing cabling cost. For every 24 fibers that are installed the end result will be three parallel ports (8 fibers per link) with all fibers utilized.
3. Using MTP bulkhead adapters including a conversion assembly with two 12-fiber MTPs on one end and three 8-fiber MTPs on the other end. This approach can be used if all QSFP ports are located in the same general location (grouped on the switch chassis). Otherwise, the breakout assembly can create cabling challenges when crossing over blades or in between chassis.

The remaining information in this document will build on these three approaches. Different four-channel parallel optic link connectivity solutions will be explained with a drawing depicting the solution accompanied with a BOM of the required Corning products needed to deploy the discussed solution.

The polarity drawings for the following solutions will be housed in Appendix A at the end of the document. The protocols for which these solutions can be used include, but are not limited to, the following: 40GBase-SR4, 40GBase-xSR4/cSR4/eSR4, 40GBase-PLR4, 40GBase-PSM4, 100GBase-SR4, 100GBase-eSR4, 100GBase-PSM4, IB-4x-SX, and IB-4x-DDR-SX.

Four-channel Parallel Optics Connectivity Solutions

No Conversion Devices

The next three solutions are parallel connectivity solutions with no conversion devices. By using these solutions only 66% of installed fiber will be utilized. This can result in increased cabling cost.

When directly connecting one QSFP transceiver to another QSFP transceiver a Type-B non-pinned MTP® to non-pinned MTP cable assembly (jumper) is required. This type of direct connectivity is only suggested for short distances within a given row of racks/cabinets. Figure 2 shows two QSFP transceivers being connected with a MTP (non-pinned) jumper.

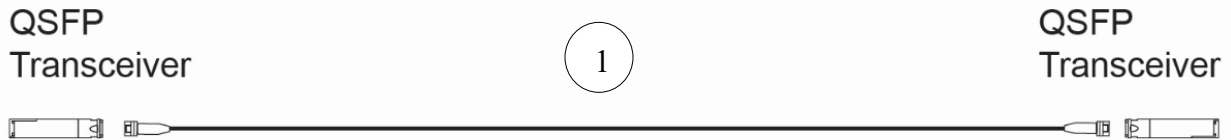


Figure 2: No Conversion Device - Direct Connectivity Using a MTP Jumper

Bill of Materials for Figure 2			
Item	OM4 Part Number	OS2 Part Number	Description
1	J757512QE8-NBxxxF	J909012GE8-NBxxxF	EDGE™, MTP (non-pinned) to MTP (non-pinned), 12 F Jumper, TIA-568 Type-B polarity, xxx ft.

The next solution is similar to the previous, but instead of using a 12-fiber jumper, a 12 to 576-fibers MTP trunk is deployed. Using MTP trunk cables provide for a durable solution that allows the cable to be placed in cable trays without the fear of the trunk cable being crushed. Structured cabling allows for easier moves, adds and changes (MACs). Figure 3 illustrates this solution.

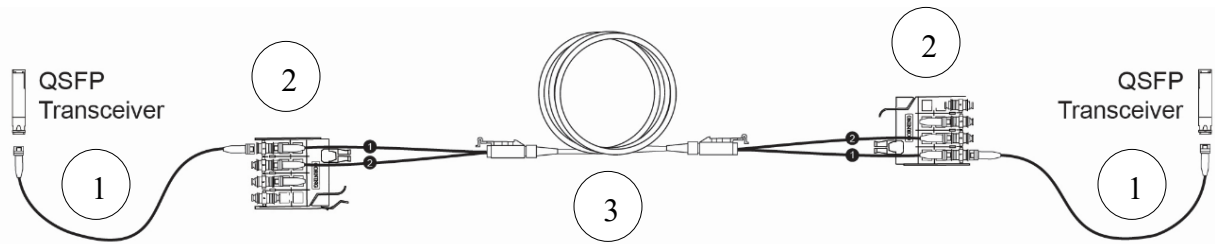


Figure 3: No Conversion Device - Connectivity with Inter-connect Structured Cabling

Bill of Materials for Figure 3			
Item	OM4 Part Number	OS2 Part Number	Description
1	J759312QE8-NBxxxF	J899012GE8-NBxxxF	EDGE™, MTP® (pinned) to MTP (non-pinned), 12 F Jumper, TIA-568 Type-B polarity, xxx ft.
2	EDGE-CP48-E3	EDGE-CP48-90	EDGE 48 Fibers MTP Adapter Panel, (4 ports)
3	G757524QPNDUxxxF	G909024GPNDUxxxF	EDGE Trunk Cable, MTP Connector (non-pinned) to MTP Connector (non-pinned), 24 Fibers, with 33/33 inch legs, pulling grip one side, xxx ft.

Note: EDGE trunk cables are available in fiber counts from 12 to 576 fibers.

The final solution without a conversion deploys structured cabling solution with cross-connect connectivity. This solution will allow all MACs to be made at one location (usually the Main Distribution Area - MDA) with maximum flexibility for “any port” to “any port” connection. Figure 4 illustrates the cross-connect with patching provided by the pinned MTP to pinned MTP Type-B polarity jumper.

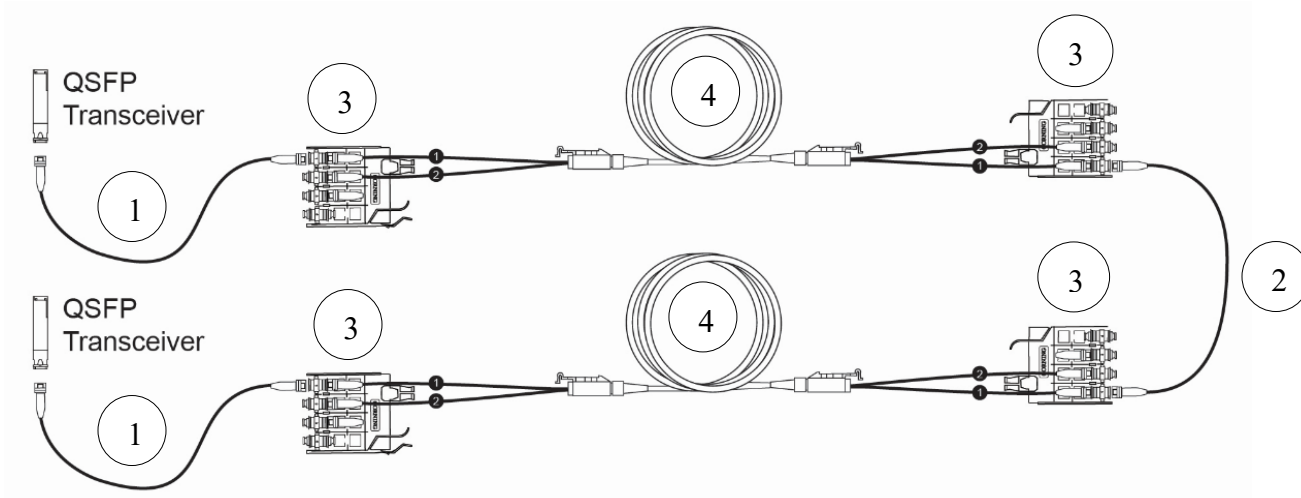


Figure 4: No Conversion Device - Connectivity with Cross-Connect Structured Cabling

Bill of Materials for Figure 4			
Item	OM4 Part Number	OS2 Part Number	Description
1	J759312QE8-NBxxxF	J899012GE8-NBxxxF	EDGE™, MTP® (pinned) to MTP (non-pinned), 12 F Jumper, TIA-568 Type-B polarity, xxx ft.
2	J939312QE8-NBxxxF	J898912GE8-NBxxxF	EDGE, MTP (pinned) to MTP (pinned), 12 F Jumper, TIA-568 Type-B polarity, xxx ft.
3	EDGE-CP48-E3	EDGE-CP48-90	EDGE 48 Fibers MTP Adapter Panel, (4 ports)
4	G757524QPNDUxxxF	G909024GPNDUxxxF	EDGE Trunk Cable, MTP Connector (non-pinned) to MTP Connector (non-pinned), 24 Fibers, with 33/33 inch legs, pulling grip one side, xxx ft.

Note: EDGE trunk cables are available in fiber counts from 12 to 576 fibers.

Conversion Devices: Modules

The next group of connectivity solutions are four-channel parallel connectivity which use conversion modules. The use of conversion modules allows for all trunk fibers to be utilized. For every two 12-fiber MTP® links plugged into a conversion module three 8-fiber MTP links (three four-channel parallel links) will exit the other side of the module. As previously mentioned, this solution does create additional MTP connectivity cost, but this is countered by the cost savings of 100% fiber utilization. This is extremely important when using previously installed trunk cables. This 100% fiber utilization eliminates the need to install additional fiber backbone, avoiding costs in both labor and materials. Using 100% of the installed fiber will result in a 33% reduction in cable tray congestion. Because the conversion modules are pinned, all MTP jumpers will be pinless-pinless Type-B, regardless of direct connect, interconnect, or cross-connect architecture. This characteristic makes cleaning easier for technicians and improves inventory management.

The inter-connect structured cabling solution in Figure 5 allows for 100% fiber utilization. This is accomplished by deploying conversion modules and is the most commonly deployed approach. This connectivity approach is easily accomplished by using Type-B non-pinned MTP to non-pinned MTP jumpers.

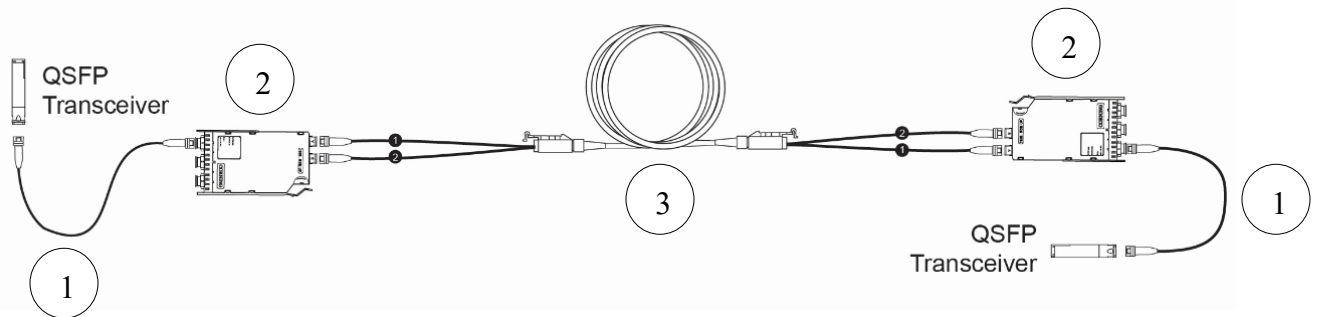


Figure 5: Conversion Module - Connectivity with Inter-connect Structured Cabling

Bill of Materials for Figure 5			
Item	OM4 Part Number	OS2 Part Number	Description
1	J757512QE8-NBxxxF	N/A	EDGE™, MTP (non-pinned) to MTP (non-pinned), 12 F Jumper, TIA-568 Type-B polarity, xxx ft.
2	ECM-UM24-93-93Q	N/A	EDGE AO 2x3 Conversion Module, 24 F, Pinned MTP to Pinned MTP
3	G757524QPNDUxxxF	N/A	EDGE Trunk Cable, MTP Connector (non-pinned) to MTP Connector (non-pinned), 24 Fibers, with 33/33 inch legs, pulling grip one side, xxx ft.

Note: EDGE trunk cables are available in fiber counts from 12 to 576 fibers.

The solution in Figure 6 utilizes MTP® trunk cables to provide a structured cable solution with cross-connect connectivity with complete port replication. This solution will allow all MACs to be made at one location (usually the MDA). This approach allows for 100% fiber utilization.

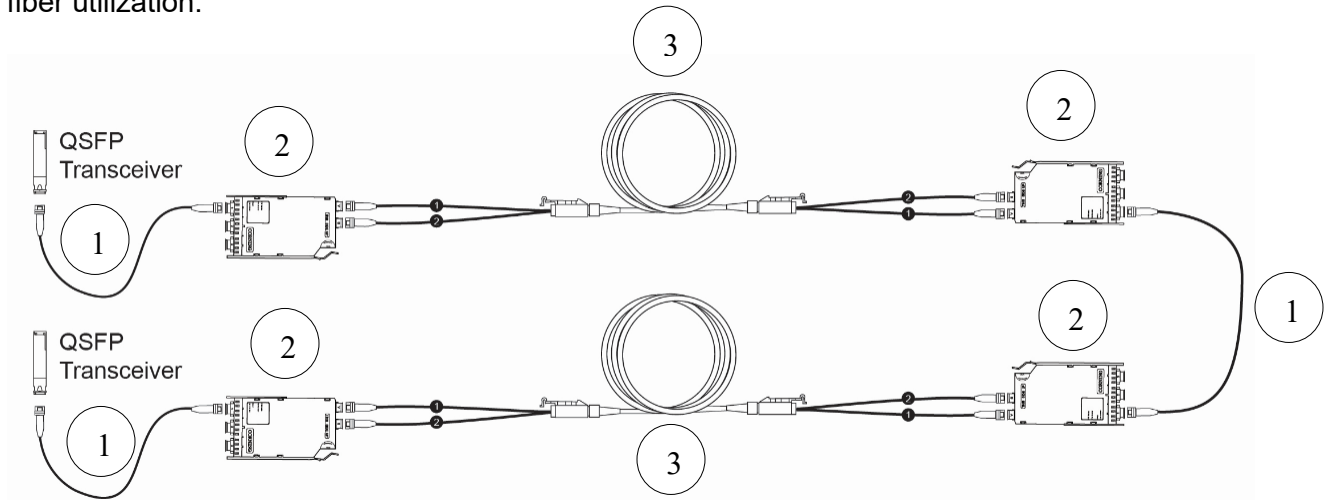


Figure 6: Conversion Module - Connectivity with Cross-connect Structured Cabling

Bill of Materials for Figure 6			
Item	OM4 Part Number	OS2 Part Number	Description
1	J757512QE8-NBxxxF	N/A	EDGE™, MTP (non-pinned) to MTP (non-pinned), 12 F Jumper, TIA-568 Type-B polarity, xxx ft.
2	ECM-UM24-93-93Q	N/A	EDGE AO 2x3 Conversion Module, 24 F, Pinned MTP to Pinned MTP
3	G757524QPNDUxxxF	N/A	EDGE Trunk Cable, MTP Connector (non-pinned) to MTP Connector (non-pinned), 24 Fibers, with 33/33 inch legs, pulling grip one side, xxx ft.

Note: EDGE trunk cables are available in fiber counts from 12 to 576 fibers.

The solution in Figure 7 is very similar to the approach used in Figure 5. The solution in Figure 7 still allows for 100% fiber utilization, but has added additional flexibility by adding a cross-connect in the MDA/HDA (Horizontal Distribution Area). The cross connect is achieved by port-replicating the QSFP ports into a patch panel. This provides a situation where switch ports can be cabled during the initial install, thus eliminating future risk of damaging a transceiver port.

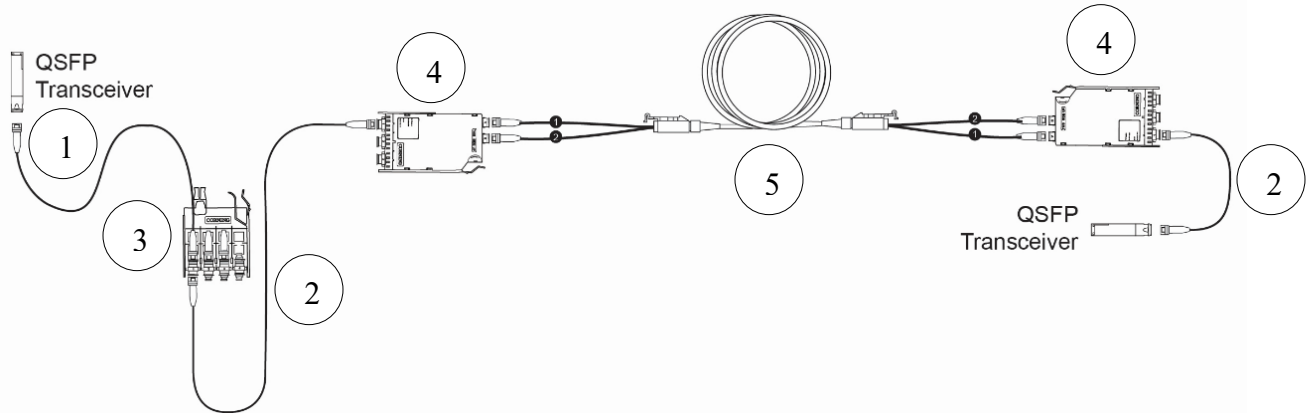


Figure 7: Conversion Module - Connectivity with Cross-connect and Inter-connect Structured Cabling

Bill of Materials for Figure 7			
Item	OM4 Part Number	OS2 Part Number	Description
1	J759312QE8-NAxxxF	N/A	EDGE™, MTP® (pinned) to MTP (non-pinned), 12 F Jumper, TIA-568 Type-A polarity, xxx ft.
2	J757512QE8-NBxxxF	N/A	EDGE, MTP (non-pinned) to MTP (non-pinned), 12 F Jumper, TIA-568 Type-B polarity, xxx ft.
3	EDGE-CP48-E3	N/A	EDGE 48 Fibers MTP Adapter Panel, (4 ports)
4	ECM-UM24-93-93Q	N/A	EDGE AO 2x3 Conversion Module, 24 F, Pinned MTP to Pinned MTP
5	G757524QPNDUxxxF	N/A	EDGE Trunk Cable, MTP Connector (non-pinned) to MTP Connector (non-pinned), 24 Fibers, with 33/33 inch legs, pulling grip one side, xxx ft.

Note: EDGE trunk cables are available in fiber counts from 12 to 576 fibers.

The connectivity solution in Figure 8 is very similar to the cross-connect solution in Figure 6. Unlike Figure 6 the following solution removes the conversion modules that were housed at the MDA/HDA. MTP® adapter panels have been installed in place of the conversion modules which will save cost, but comes with additional disadvantages. Using adapter panels instead of conversion modules means that each jumper in the MDA/HDA area has 12 active fibers instead of 8 fibers, 12 fibers are equivalent to one and a half QSFP ports. One way to overcome this issue is to cross connect in groups of three QSFP ports using 2 MTP jumpers. This could make it hard to manage labeling and patching, and also requires pinned MTP to pinned MTP jumpers which plug into the trunks adding additional part numbers and product management.

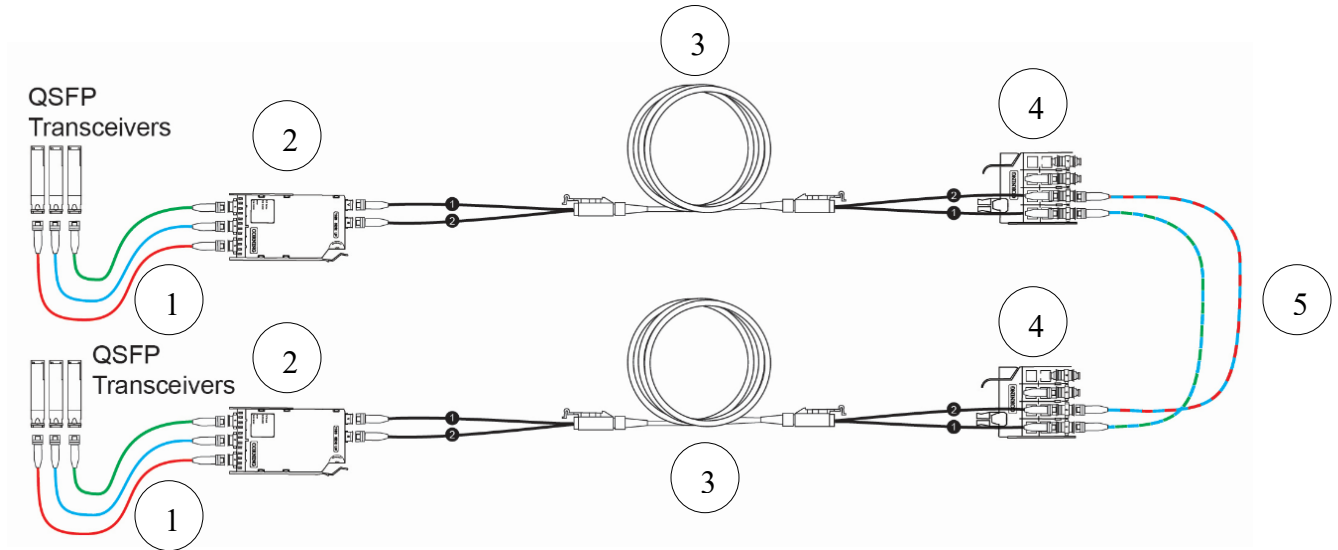


Figure 8: Conversion Module - Connectivity with Cross-connect Structured Cabling

Bill of Materials for Figure 8			
Item	OM4 Part Number	OS2 Part Number	Description
1	J757512QE8-NBxxxF	N/A	EDGE™, MTP (non-pinned) to MTP (non-pinned), 12 F Jumper, TIA-568 Type-B polarity, xxx ft.
2	ECM-UM24-93-93Q	N/A	EDGE AO 2x3 Conversion Module, 24 F, Pinned MTP to Pinned MTP
3	G757524QPNDUxxxF	N/A	EDGE Trunk Cable, MTP Connector (non-pinned) to MTP Connector (non-pinned), 24 Fibers, with 33/33 inch legs, pulling grip one side, xxx ft.
4	EDGE-CP48-E3	N/A	EDGE 48 Fibers MTP Adapter Panel, (4 ports)
5	J939312QE8-NBxxxF	N/A	EDGE™, MTP (pinned) to MTP (pinned), 12 F Jumper, TIA-568 Type-B polarity, xxx ft.

Note: EDGE trunk cables are available in fiber counts from 12 to 576 fibers.

Conversion Devices: Harnesses

The last group of solutions are parallel connectivity solutions which use conversion harnesses. The use of conversion harnesses also allows for all trunk fibers to be utilized. This is accomplished by deploying a harness assembly that has two 12-fiber MTPs on one end and three 8-fiber MTPs (three four-channel parallel optical links) on the other end. This connectivity would take place at a MTP® patch panel. The disadvantages of this approach are:

1. If all 8-fiber MTPs are not connected they will have to dangle in front of the electronics or inside the vertical managers, increasing pathway congestion.
2. The QSFP ports need to be located in the same chassis because the leg lengths for the three 8-fiber MTPs are the same.

This approach also utilizes 100% of the installed fiber previously mentioned in the conversion module approach with the same advantages.

Figure 9 is an inter-connect solution which is very similar to the solution in Figure 5. This solution has its advantages and disadvantages. The overall cost of using a conversion harness instead of a conversion module is lower because the need for MTP jumpers is eliminated. The disadvantage is that flexibility is lost at both ends to be able to connect to any port. As stated above the QSFP ports would need to be in the same chassis because the leg lengths for the three 8-fiber MTPs are the same. In the solution 100% of the fiber can be utilized, but if all the MTP connectors are not plugged into a port the MTP connector will dangle freely at the equipment.

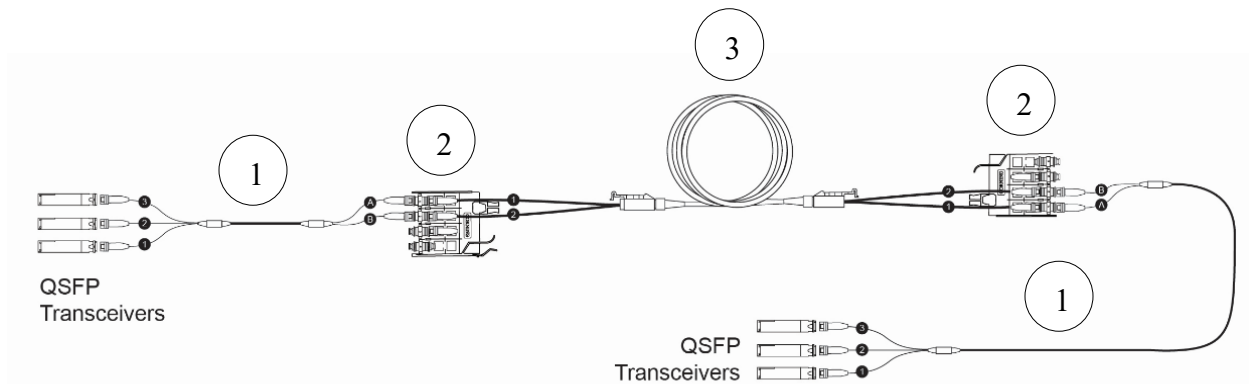


Figure 9: Conversion Harness - Connectivity with Inter-connect Structured Cabling

Bill of Materials for Figure 9			
Item	OM4 Part Number	OS2 Part Number	Description
1	H937524QPH-KKAxxxF	N/A	EDGE™ AO 2x3 Conversion Harness, 24 F, 2 x 12f MTP® (Pinned) 24-in Legs, 3 x 8f MTP (Non-Pinned) 24-in Legs, xxx ft.
4	EDGE-CP48-E3	N/A	EDGE 48 Fibers MTP Adapter Panel, (4 ports)
3	G757524QPNDUxxxF	N/A	EDGE Trunk Cable, MTP Connector (non-pinned) to MTP Connector (non-pinned), 24 Fibers, with 33/33 inch legs, pulling grip one side, xxx ft.

Note: EDGE trunk cables are available in fiber counts from 12 to 576 fibers.

The next solution while being similar to the previous solution will add flexibility. The solution in Figure 10 deploys a conversion harness on one end of the passive network and a conversion module on the other end. Adding the conversion module to the passive network will allow flexibility for port connectivity to equipment that is not concentrated in a small area. This will be the most likely application for the conversion harness, with the conversion module being placed at the switch area, while the harness would be placed at the access switch in the server area where the uplink ports are closely grouped. As with previous scenarios, this will allow for 100% fiber utilization, but using a conversion harness will have the disadvantages previously discussed.

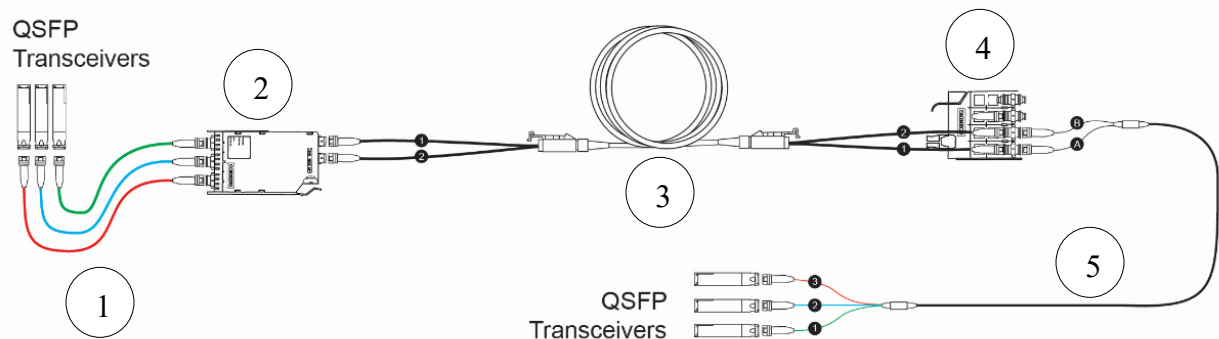


Figure 10: Conversion Module/Conversion Harness - Connectivity with Inter-connect Structured Cabling

Bill of Materials for Figure 10			
Item	OM4 Part Number	OS2 Part Number	Description
1	J757512QE8-NBxxxF	N/A	EDGE™, MTP® (non-pinned) to MTP (non-pinned), 12 F Jumper, TIA-568 Type-B polarity, xxx ft.
2	ECM-UM24-93-93Q	N/A	EDGE AO 2x3 Conversion Module, 24 F, Pinned MTP to Pinned MTP
3	G757524QPNDUxxxF	N/A	EDGE Trunk Cable, MTP Connector (non-pinned) to MTP Connector (non-pinned), 24 Fibers, with 33/33 inch legs, pulling grip one side, xxx ft.
4	EDGE-CP48-E3	N/A	EDGE 48 Fibers MTP Adapter Panel, (4 ports)
5	H937524QPH-KKAxxxF	N/A	EDGE™ AO 2x3 Conversion Harness, 24 F, 2 x 12f MTP (Pinned) 24-in Legs, 3 x 8f MTP (Non-Pinned) 24-in Legs, xxx ft.

Note: EDGE trunk cables are available in fiber counts from 12 to 576 fibers.

The last example is a cross-connect scenario where the switch connectivity is accomplished by using a conversion harness on one end and a conversion module/MTP jumper on the other. This is a combination of Figure 6 and Figure 10. Using a conversion harness reduces cost by removing one conversion module and a MTP jumper, but adds the disadvantage of requiring the QSFP ports to be in the same chassis. If the ports are on the same chassis on one end, this would be a viable solution.

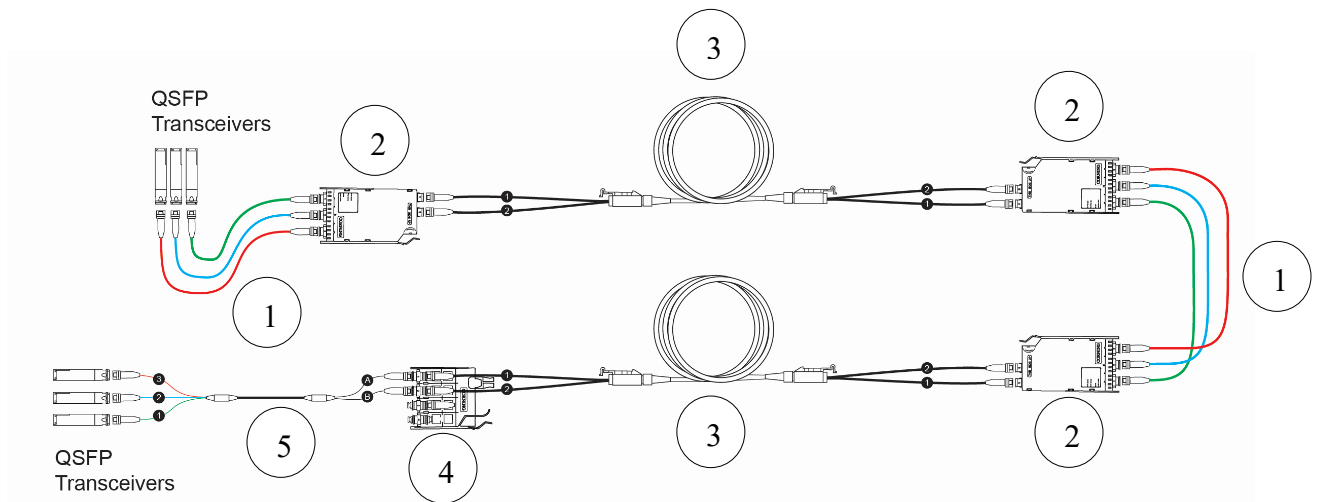


Figure 11: Conversion Module/Harness - Connectivity with Cross-connect Structured Cabling

Bill of Materials for Figure 11

Item	OM4 Part Number	OS2 Part Number	Description
1	J757512QE8-NBxxxF	N/A	EDGE™, MTP® (non-pinned) to MTP (non-pinned), 12 F Jumper, TIA-568 Type-B polarity, xxx ft.
2	ECM-UM24-93-93Q	N/A	EDGE AO 2x3 Conversion Module, 24 F, Pinned MTP to Pinned MTP
3	G757524QPNDUxxxF	N/A	EDGE Trunk Cable, MTP Connector (non-pinned) to MTP Connector (non-pinned), 24 Fibers, with 33/33 inch legs, pulling grip one side, xxx ft.
4	EDGE-CP48-E3	N/A	EDGE 48 Fibers MTP Adapter Panel, (4 ports)
5	H937524QPH-KKAxxxF	N/A	EDGE™ AO 2x3 Conversion Harness, 24 F, 2 x 12f MTP (Pinned) 24-in Legs, 3 x 8f MTP (Non-Pinned) 24-in Legs, xxx ft.

Note: EDGE trunk cables are available in fiber counts from 12 to 576 fibers.

There are multiple ways to deploy a four-channel parallel optic cabling infrastructure for your network using OM3/OM4 Laser-Optimized 50µm multimode and OS2 single-mode fiber.

Since connectivity for four-channel parallel optics only uses eight fibers out of the available twelve fibers in the MTP connector, the user can leave the four middle fibers dark or use some type of conversion device. A conversion device converts two 12-fiber links into three 8-fiber links. This allows for all fibers to be utilized resulting in three four-channel parallel optic links for each 24 fibers of installed trunk cables. The other alternative would be two four-channel parallel optic links and 8 dark fibers per 24 fibers of installed trunk cables.

The best application for your network will depend on many factors such as design, equipment location, migration path, cost, pathway availability, etc. For additional questions contact Corning Optical Communications' Technical Support Line at 800-743-2671 or dutyeng@corning.com

Appendix A: Polarity drawings for each scenario.

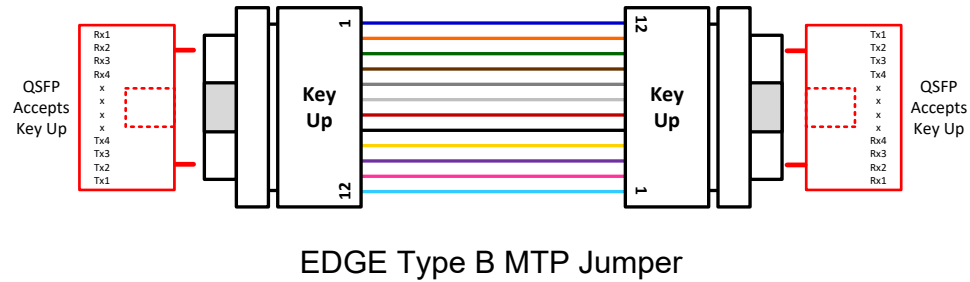


Figure 2-a: No Conversion Device - Direct Connectivity using a MTP® jumper

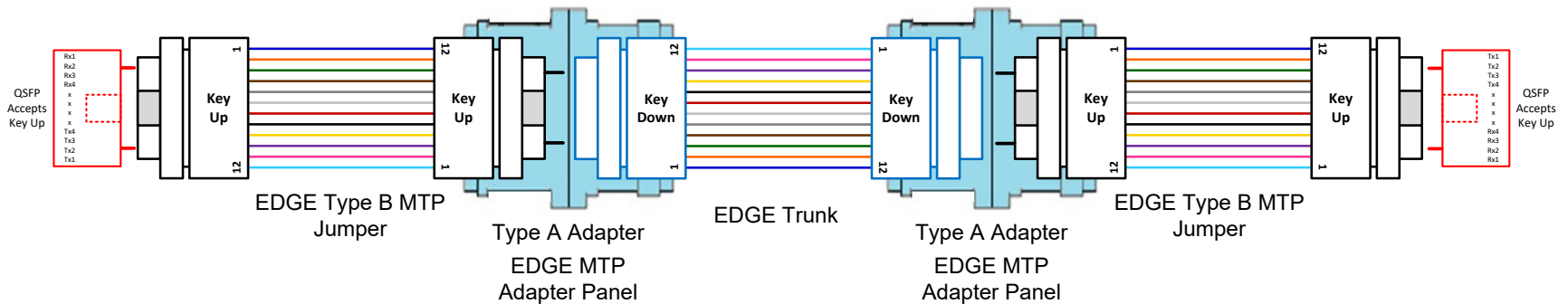


Figure 3-a: No Conversion Device - Connectivity with Inter-connect Structured Cabling

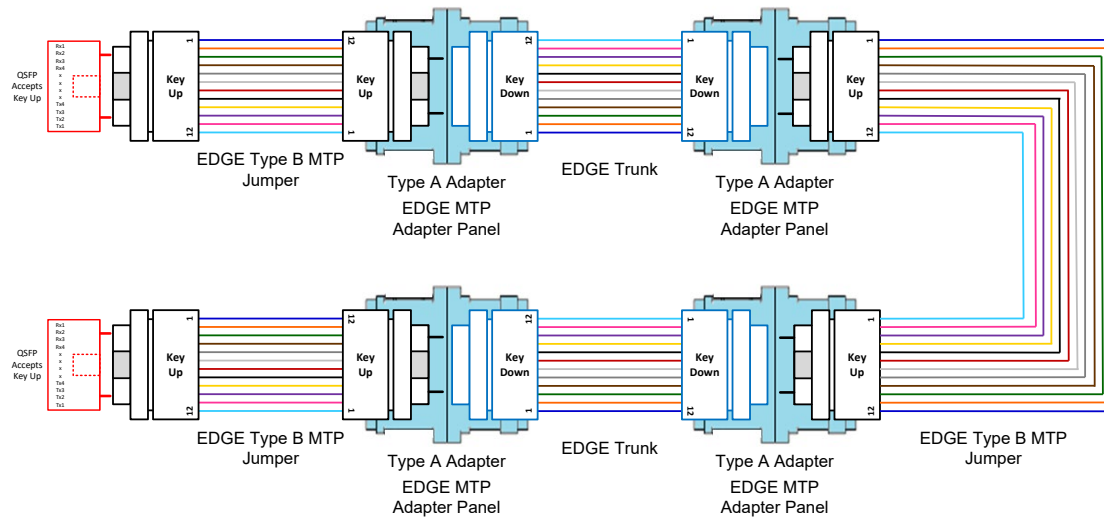


Figure 4-a: No Conversion Device - Connectivity with Cross-Connect Structured Cabling

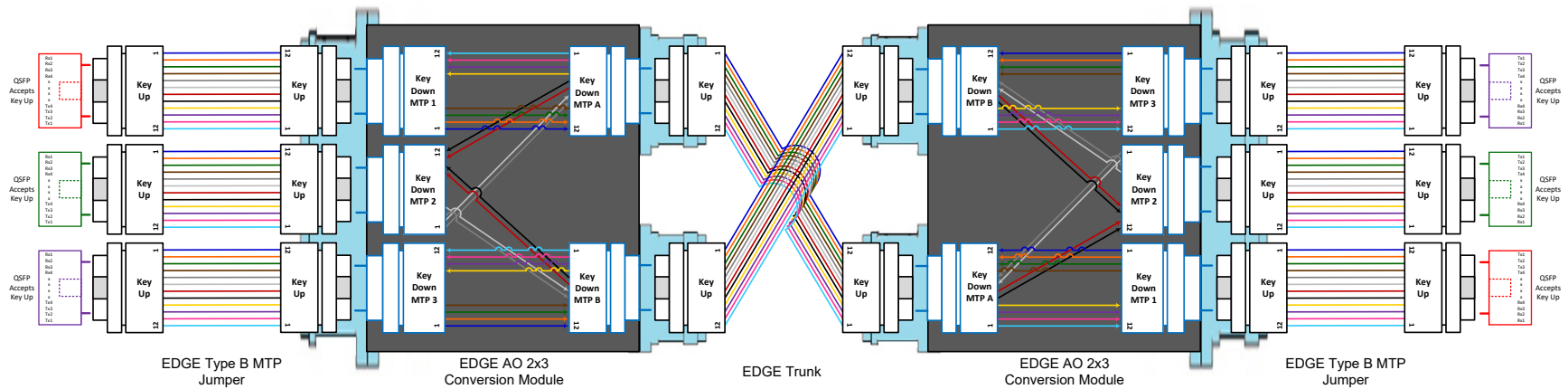


Figure 5-a: Conversion Module - Connectivity with Inter-connect Structured Cabling

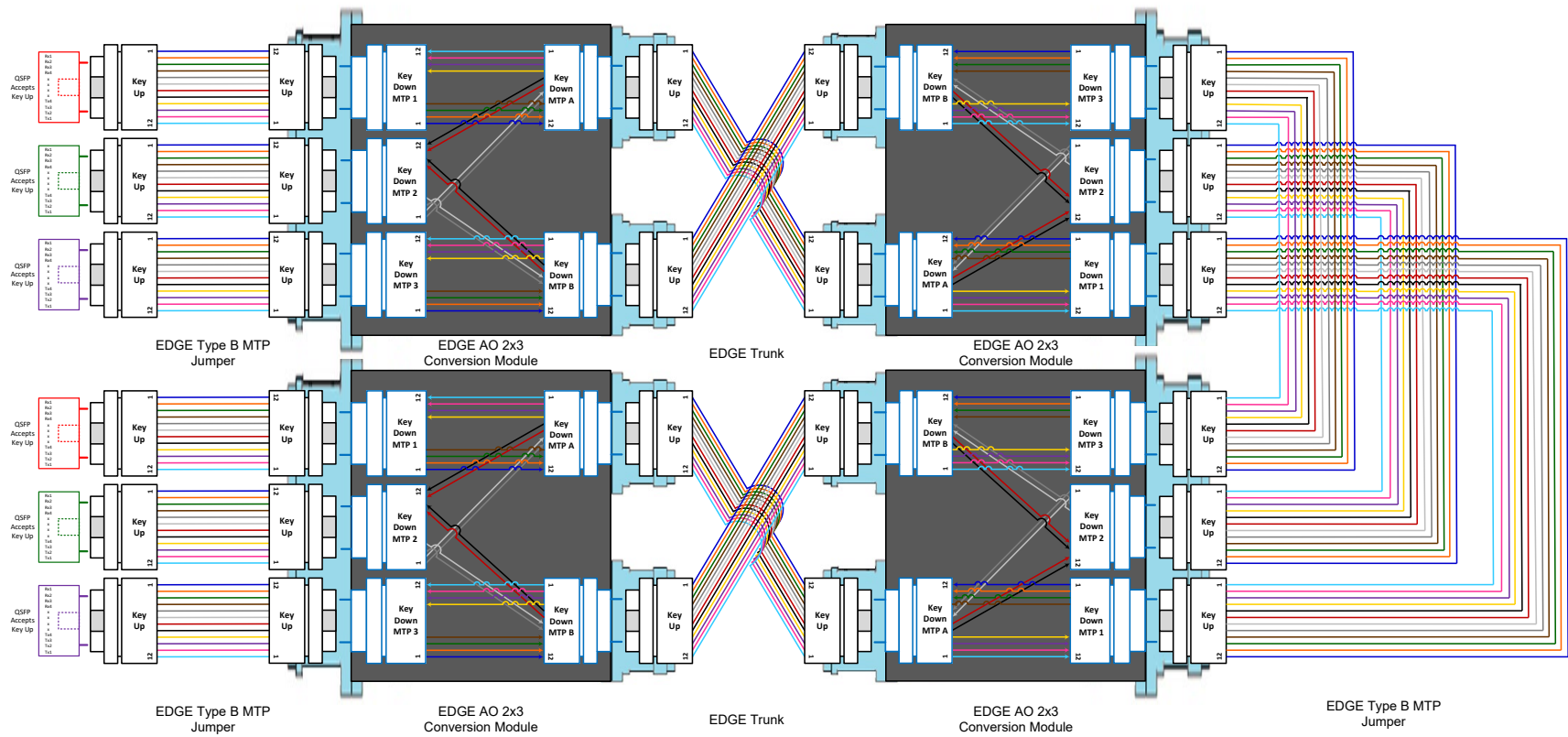


Figure 6-a: Conversion Module - Connectivity with Cross-connect Structured Cabling

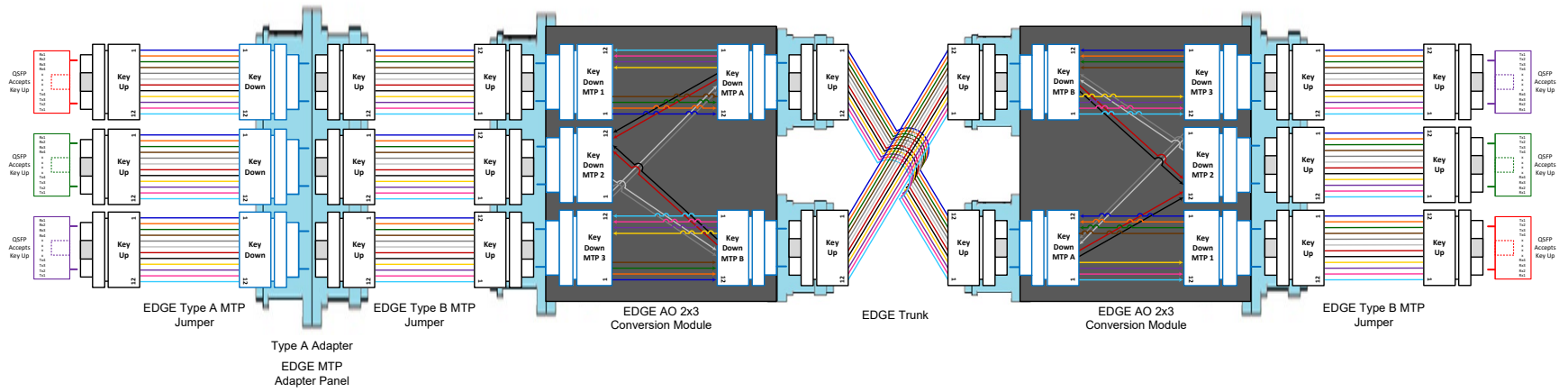


Figure 7-a: Conversion Module - Connectivity with Cross-connect and Inter-connect Structured Cabling

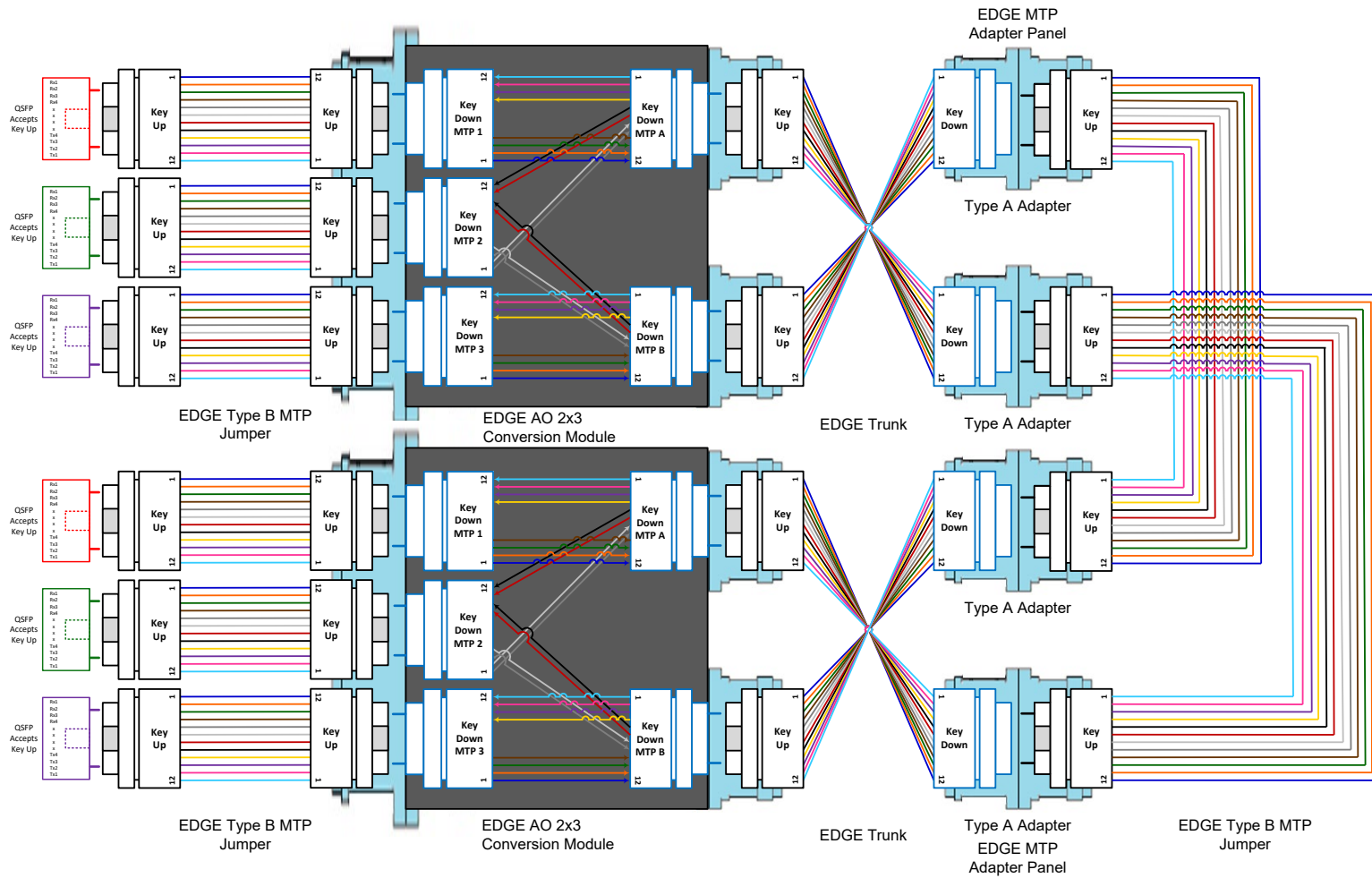


Figure 8-a: Conversion Module - Connectivity with Cross-connect Structured Cabling

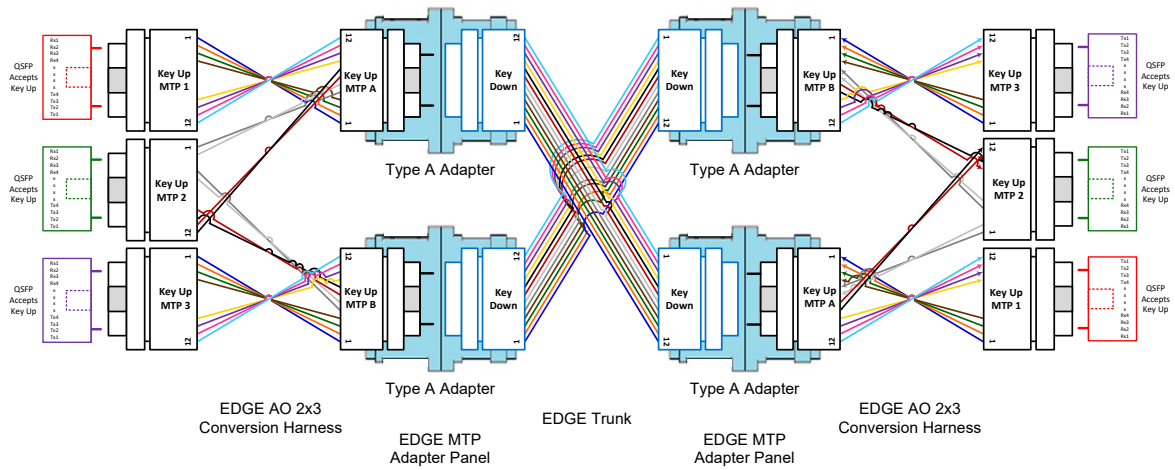


Figure 9-a: Conversion Harness - Connectivity with Inter-connect Structured Cabling

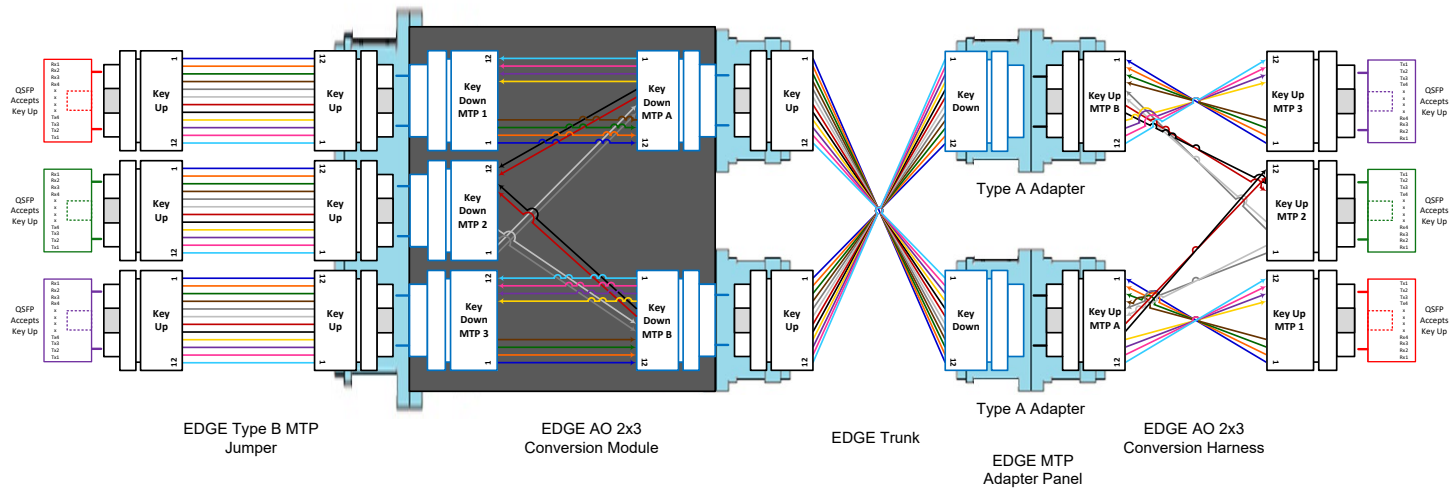


Figure 10-a: Conversion Module/Conversion Harness Connectivity with Inter-connect Structured Cabling

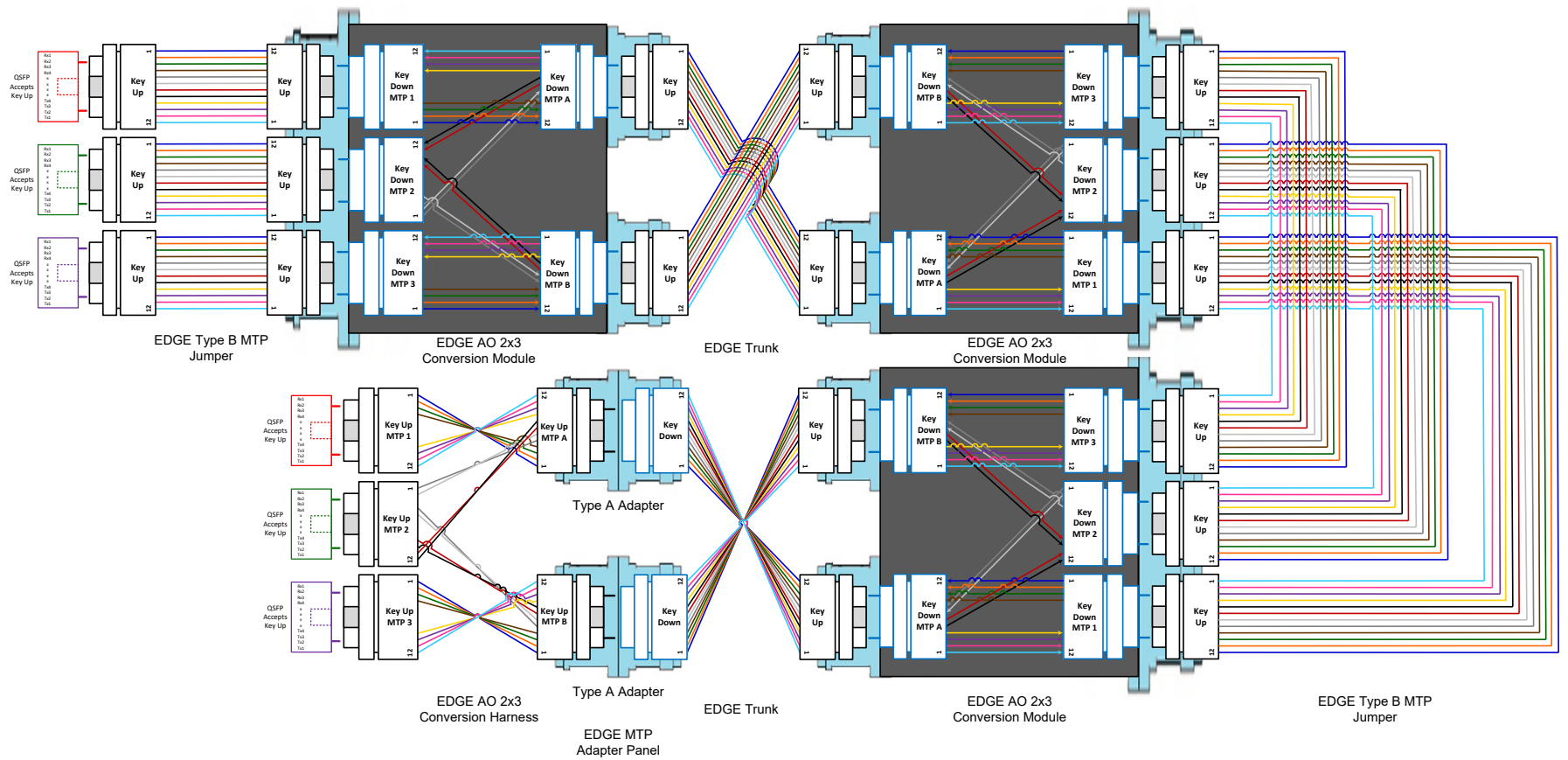


Figure 11-a: Conversion Module/Harness - Connectivity with Cross-connect Structured Cabling