VIAVI Solutions

Application Note

Use Case: Testing MPO Networks

As the use of Multi-Fiber connectors such as MPO continues to grow, technicians that have traditionally worked with single fiber or duplex connectors (such as SC or LC) are overwhelmed with the testing challenges unique to MPO. While the tests they need to perform are the same (i.e. measure length and optical loss, check polarity, ensure end face condition), MPO connectors have several attributes that are more complex than a standard duplex link with LC or SC connectors. As a result, the testing process for MPO connections becomes much more time consuming and complex.

Most of the challenges that technicians encounter when testing MPO connectors result from using tools designed for single fiber connectors. For example, an Optical Loss Test Set (OLTS) can be used to measure length, optical loss, and check polarity of MPO links by using fan out cables that break the MPO down to individual LC or SC connectors. However, this process adds significant complexity to the test process, as well as expensive cable assemblies and test steps that technicians have previously not had to perform. Likewise, maintaining MPO connector end face condition is essential to getting the desired performance from these connectors. While they can use the same fiber microscopes to inspect the end faces of single fiber connectors like SC or LC by adding dedicated inspection tips for MPO connectors, the procedure for these multi-fiber connectors takes more time than for single fiber connectors.

Instead of testing MPO links with tools that were built for single or duplex fiber connections, new purpose-built MPO solutions, such as the MPOLx Optical Loss Test Sets and the FiberChek Sidewinder microscope have features and capabilities that are purpose-built for MPO connections. By using these tools, technicians can streamline their MPO test workflow to greatly reduce total test time and maintain best practices throughout the process.

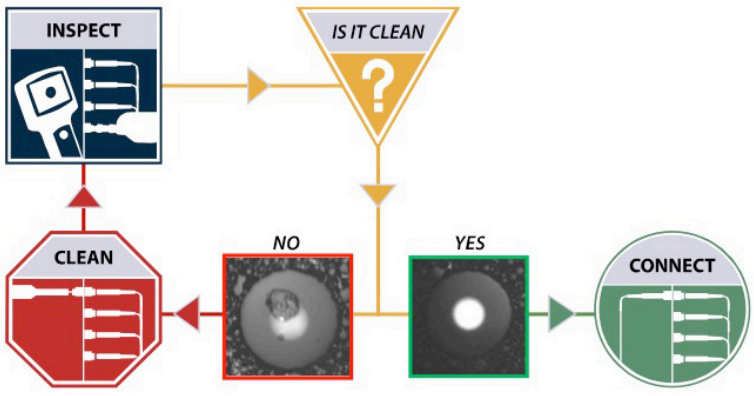
Use Case Scenario

This use case highlights the common tests that are required when certifying MPO connections and compares critical steps in legacy versus new test procedures. The scenario is for a mid-size project with 50 trunk (backbone) cables, each containing 12 MPO connectors (each containing 12 fibers), for a total of 600 MPO links. The scope of work is to provide Basic (Tier 1) certification for each fiber link. In other words, the technicians will need to test a total of 7,200 fibers to deliver certification of the Length, Optical Loss, and Polarity for all 600 MPO links.

- **Number of trunk cables:** 50
- **Each trunk cable contains:** 144 fibers (12 MPO connectors per end – each containing 12 fibers)
- **Total number of fibers:** 7,200 (50 x 144)
- **Total number of MPO links:** 600

There are several common terms that are used when talking about testing, so it's useful to define them.

- A **link** consists of the cabling in between patch panels. Fiber links can have connections and splices in them.
- A **channel** consists of the above link plus the equipment cords (patch cords) at either end of the link.
- A **backbone cable** is the span of cable between cassettes. It is sometimes called a trunk cable.
- **Device Under Test (DUT)** is a generic term that can apply to any link, channel, or backbone cable that is being tested. This use case will use the term "DUT" when referring to the MPO link(s) that are being tested.



Note: Since contamination is such a big problem with MPO connectors, the best practice is to ensure that all fiber end faces are clean before ever making a connection. This practice, known as "Inspect Before You Connect" (IBYC) will occur during both the referencing and testing stages, but for purposes of comparison, the time comparisons below will only focus on the testing portion.

Equipment

Measuring length, optical loss, and checking polarity is typically done using an Optical Loss Test Set (OLTS). This consists of two test instruments, one for each end of the link being tested. Optical signals are sent from one end and measured at the other. The instrument uses the information from this measurement to calculate the optical loss, determine the length, and confirm the polarity of the optical signal.

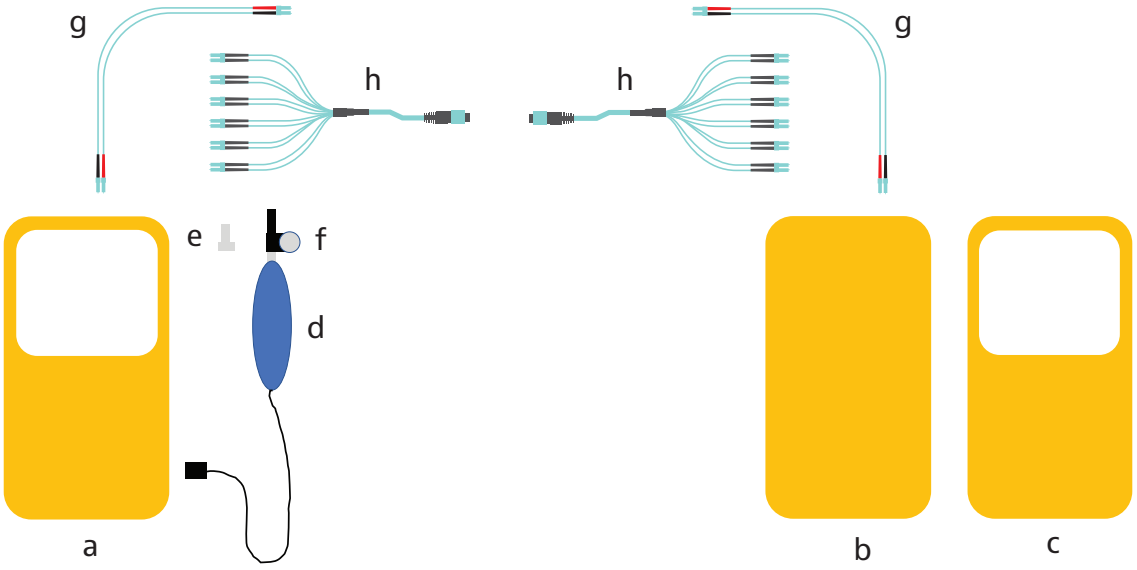


Figure 1

Equipment used in Legacy Process

a) Local Test Instrument

b) Remote Test Instrument

c) Video Display

d) Inspection Microscopes (qty: 2)

e) LC Inspection Tips (qty: 2)

f) MPO Inspection Tips (qty: 2)

g) Duplex Test Reference Cords (qty: 2)

h) Breakout Cables (qty: 2)

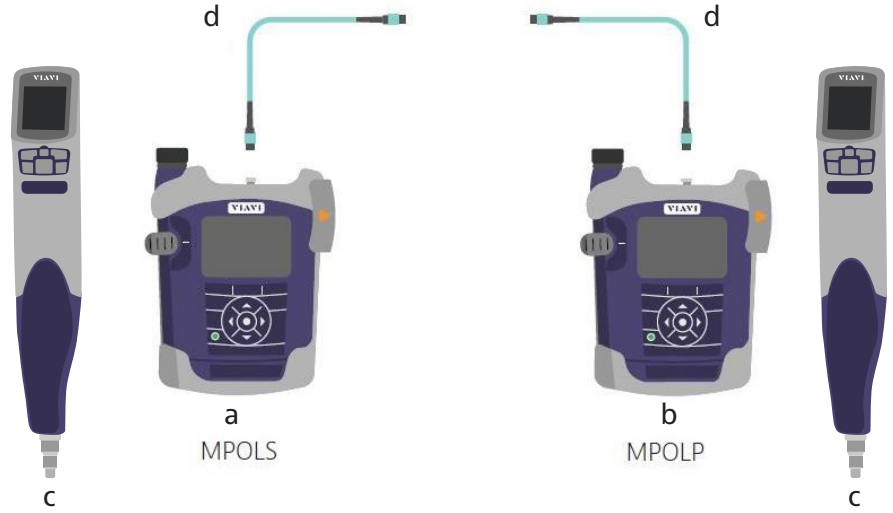


Figure 2

Equipment used in New Process

a) MPOLS

b) MPOLP

c) Sidewinder Microscopes (qty: 2)

d) MPO Test Reference Cords (qty: 2)

Legacy Process

A typical OLTS has either LC or SC input ports, so plugging an MPO connector directly into the device is not possible. To test MPO connections, an additional break-out/fan-out cable must be added between the MPO connector and the Test Reference Cables (TRCs) that connect to the test instrument port. These hybrid cables have an MPO connector at one end. The cable is then broken out into individual fibers that have LC or SC connectors on the other end. Two fibers at each end of the breakout cable are then connected to the TRCs (two at each end), which are connected to the transmit and receive ports on the test instruments. In addition to the OLTS, two inspection microscopes and another video display are required at each end to ensure that all fiber end faces are clean prior to making any connections.

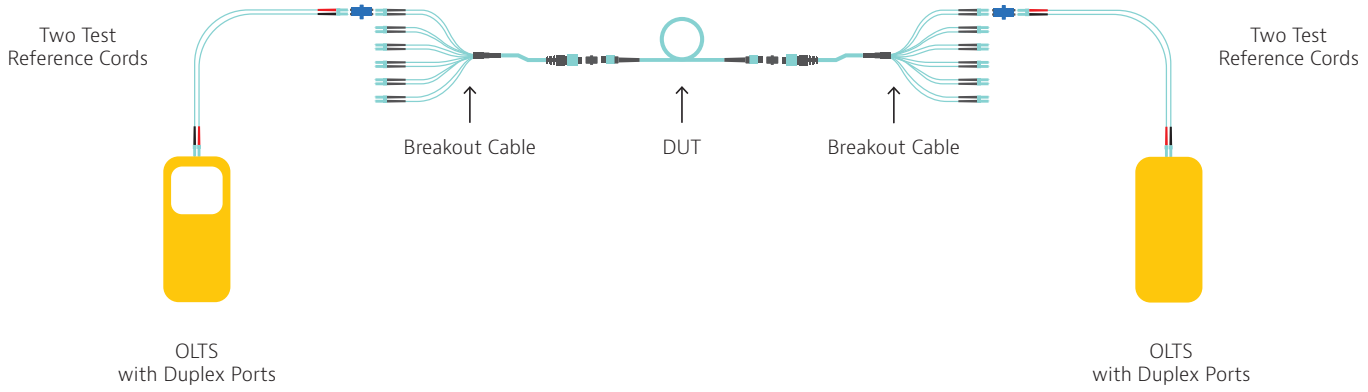


Figure 3

New Process

The MPO testing process is greatly simplified with the MPOLx. Since each device already has native MPO ports, break-out/fan-out cables are not needed. A TRC with MPO connectors connects the test instruments directly to the DUT. In addition, MPOLx devices with a built-in microscope allow the user to inspect the TRC cables. No additional video displays are needed as the screens on each MPOLx will display the end face images.

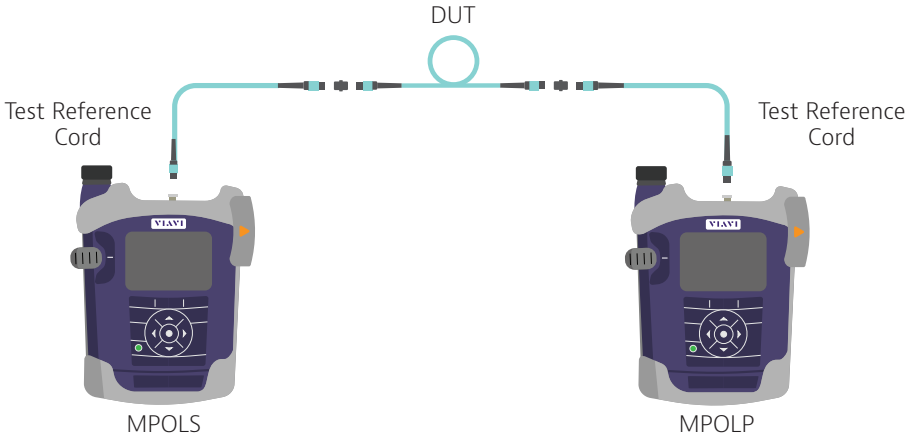


Figure 4

Endface Inspection and Analysis

As mentioned earlier, end face contamination is already the biggest problem in fiber networks; it is even a greater issue for MPO connectors. Simply put, they are more difficult to keep clean, so IBYC needs to be incorporated into workflows for handling and testing MPO connections. This practice applies to every connection that is made, including TRCs and test ports on the instruments, in addition to the connections in the network (DUT) itself.

Note: This scenario assumes that 25% of these connections will be contaminated and will require cleaning and re-inspection. This will likely be higher, but for demonstration purposes, we are assuming a best-case scenario.

Legacy Fiber Inspection Process

Some OLTS devices provide the ability to connect a probe microscope to the local unit and perform inspection. In some cases, the remote device does not have a screen, so another video display device will be required. Additional tips or adapters are also required to inspect both sides (connector and bulkhead) of the MPO and LC connections present in the breakout cables and TRCs.

The following chart summarizes the total number of end inspections that would occur in our project by using a legacy process. It shows the MPO connectors in the DUT, connections to the break-out cable, and connections to the TRCs and calculates the time spent to properly ensure that all of the connector end faces are in a proper condition for use in a network.

# of MPO end face (DUT) inspections	1,200	2 end faces per MPO link
# of MPO Break-out inspections	1,200	
Inspection and Test time per MPO	12 seconds	Focus and Pan Time
# of LC end face inspections	28,880	600 (MPO connectors) x 48 LC end faces (breakout cables and TRCs)
Inspection and Test time per LC	2 seconds	
TOTAL MPO (DUT and Break-out) Inspection TIME	8 hours	2,400 x 12 seconds = 480 minutes (8 hours)
TOTAL LC Inspection Time	16 hours	28,880 x 2 seconds = 960 minutes (16 hours)
TOTAL Inspection Time	24 hours	
End Face Requires Cleaning	25%	
Additional re-inspection	6 hours	
TOTAL Time	30 hours	No Certification provided*

*Note: Some traditional inspection devices provide automated Pass/Fail analysis and the ability to save results and generate reports. These tests are performed one fiber at a time. We find that most technicians using traditional microscopes skip the automated analysis (even if it is available) since it takes more time. For example, the scenario above shows a total of 30 hours to inspect all of the end faces. Performing automated Pass/Fail analysis on the 1,200 MPO connectors in the DUT would add 50 to 60 more hours to this scenario. Because this is not likely, the data above shows just visual inspection without providing certification.

New MPO Inspection Process:

All SmartClass Fiber devices from VIAVI, including the MPOLx feature a built-in 3.5" screen on both instruments, so they can also be used to inspect MPO end faces. It is essential that both sides of the connection are inspected, especially the Test Reference Cords, which have an extremely high duty cycle and can easily become dirty then damaged if not properly maintained. Dirty or damaged TRCs will then contaminate or damage the network ports as it is connected to perform tests. To ensure these TRCs are well cared for, SmartClass Fiber devices are available with an on-board Patch Cord Microscope (PCM) that allows users to quickly scan across the array of fibers and check for contamination. This connection is made with an MPO bulkhead adapter interface, so the image remains in focus and stays in the same position each time it is inserted. In addition to the inspection capability it provides, the PCM also functions as a "parking lot" for TRCs when not in use, preventing them from dragging across the floor and getting damaged.

Inspecting the DUT is performed with the FiberChek Sidewinder. This is a purpose-built microscope that fully automates the MPO inspection process by focusing, panning, and testing all the fibers in the MPO connector at the press of a button. The Pass/Fail criteria is based on the IEC 61300-3-35 standard for end face acceptance, but users can also customize their own criteria if needed. The average time for this process is 20 seconds.

In addition to making the MPO inspection process faster, the Sidewinder provides Pass/Fail analysis results that not only eliminate subjectivity, but also lets users document the connector quality and use for certification reports. When comparing the process using a Sidewinder to traditional microscopes, the process is not just faster, it is also much more reliable.

MPOLx with Patch Cord Microscope (PCM)

FiberChek Sidewinder

Figure 5

# of MPO end faces (DUT)	1,200	2 end faces per MPO link
# of MPO TRC inspections	1,200	
DUT Inspection and Test time per MPO	20 seconds	All 12 fibers tested with the FiberChek Sidewinder using automated analysis
Test Lead inspection time	6 seconds	All 12 fibers inspected with the PCM on the MPOLx
TOTAL DUT Inspection Time	6 hours 40 minutes	1,200 x 20 seconds = 400 minutes
Total TRC Inspection Time	2 hours*	1,200 x 6 seconds = 120 minutes
TOTAL Inspection Time	8 hours, 40 minutes	
End Face Requires Cleaning	25%	
Additional re-inspection	2 hours, 10 minutes	
TOTAL Time	11 hours	All DUT Connections Certified

*Note: This scenario assumes that all inspection is performed in a linear process, but much of this would be performed simultaneously. For example, as both local and remote units have inspection capabilities, each end would be inspected simultaneously resulting in half the test time shown. In addition, many technicians will also inspect the MPO test lead using the on-board Patch Cord Microscope at the same time they are inspecting the MPO bulkhead with the Sidewinder. The ability to perform these steps at the same time can cut the total time in half. With these time-savings in mind, the total time could be reduced to less than 6 hours.

Referencing

Proper referencing is essential to ensure accurate Fiber Certification. If the test results can't be trusted, then the entire effort of testing is wasted. The basic principle of referencing MPO links is the same as a traditional duplex fiber link, however using an OLTS requires several additional steps that add complexity and time to the process. The additional steps in a process using an OLTS also introduce more opportunities for errors and mistakes.

Legacy Referencing Process

Since using a traditional OLTS requires a set of break-out cables in conjunction with the TRCs, the reference process is more complicated than the standard 1-Cord reference (as described in our related article: Four Factors In Accurate Fiber Certification). The addition of two break-out cables also adds two more connections, so 3-Cord reference method (Figure 3) is typically used in an effort to reference out these additional connections. Once the reference is complete, the middle cord is removed, and the break-out cables are introduced. The TRCs are connected to one of duplex pairs on each end (Figure 4) and the MPO side of the breakout cables are connected with the DUT and the first two lanes of the MPO can be tested. This reference method involves making a total of 12 connections and results in 24 fiber end faces to inspect at each end of the DUT, before the first test can be performed.

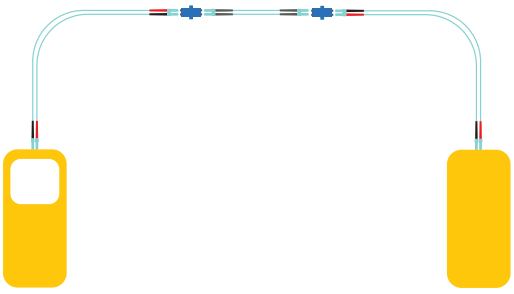


Figure 6. Three Cord Reference

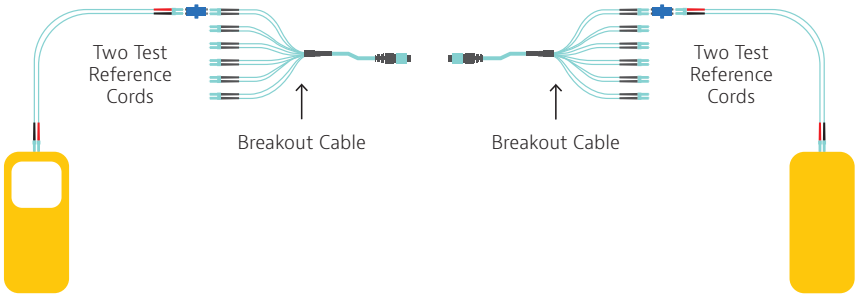


Figure 7. Breakout Cables added

This reference method involves a total of 3 connections and 4 fiber end faces to inspect.

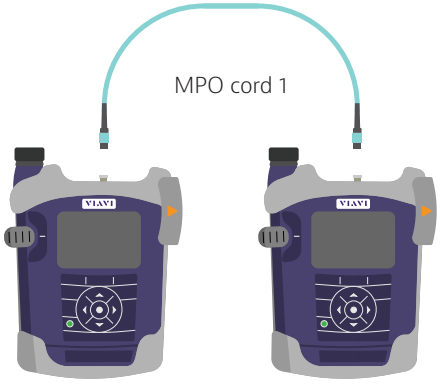


Figure 8. One Cord MPO Reference

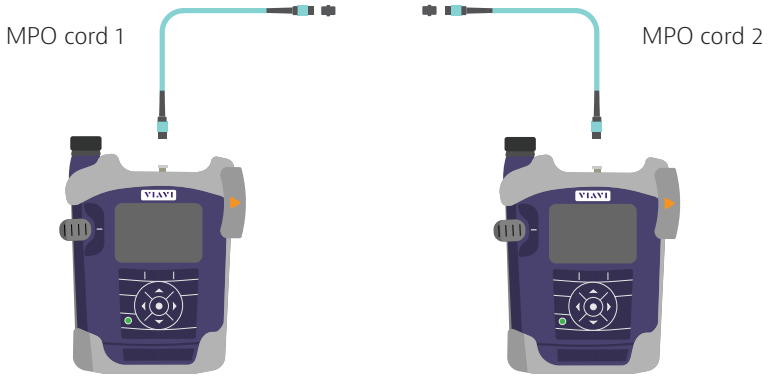


Figure 9. 2nd MPO cord added

New Referencing Process

The native MPO ports on the MPOLx greatly simplify the reference process. Since no additional break-out cables are needed, a standard 1-Cord reference method can be used. Once the reference is complete, the second MPO cord is added to the receive end and each end is connected to the DUT and all fibers in the MPO are ready to be tested.

Performing a Test (Measure Loss, Length, and Polarity)

Legacy Test Process

Once the first two fibers are tested with an OLTS, the TRC's are unplugged from the first two ports on breakout cables and connected to the next two ports. This process must be repeated a total of 4 to 6 times, depending on the architecture of the network. Assuming all 12 fibers need to be tested, this test scenario would require a total of 3,600 tests to be performed. At 3 seconds per test, the testing process would take a total of 3 hours to complete. It is also important to note that this scenario does not factor in the additional time associated with walking and re-connecting each pair, which could easily double the test time.

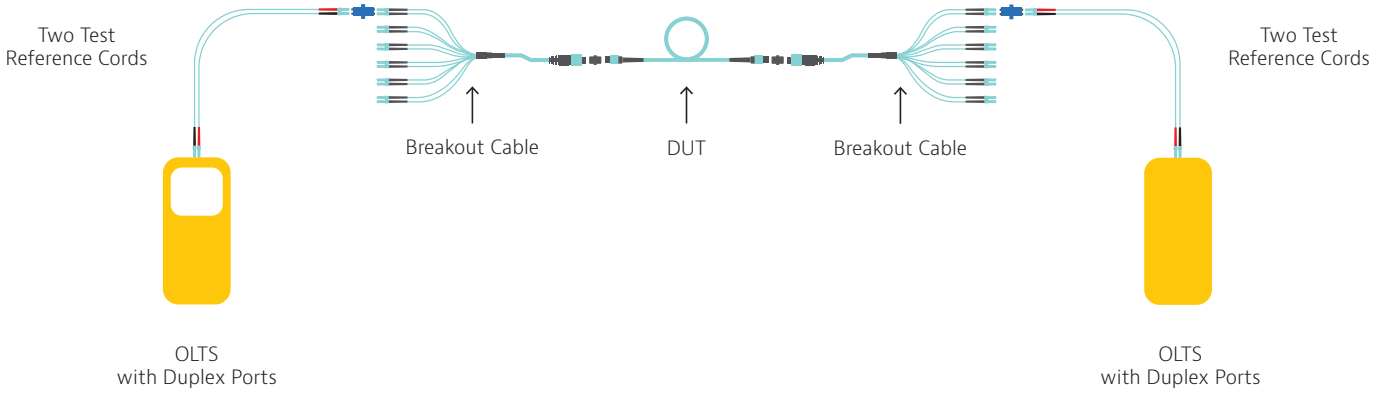


Figure 10

Total Number of MPO Links	600	50 Trunks x 12 MPO connectors each
Total Number of Fibers to Test	7,200	12 connectors x 12 fibers each
Total Number of Tests to Perform	3,600	Two fibers per test
Instrument Test Time	3 seconds	Typical OLTS
TOTAL TEST TIME	3 hours	3,600 x 3 = 10,800 seconds (180 minutes)

New Test Process

Once the test is complete for the first MPO link, the technician can proceed to testing the next MPO link. Using our scenario, a total of 600 links would need to be tested. At 6 seconds per test, the testing process would take a total of 1 hour to complete.

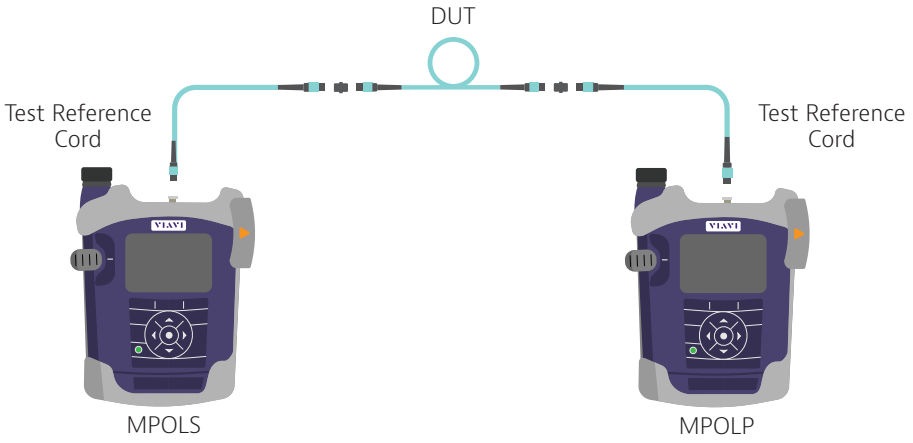


Figure 11

Total Number of MPO Links	600	50 Trunks x 12 MPO connectors each
Total Number of Fibers to Test	7,200	12 connectors x 12 fibers each
Total Number of Tests to Perform	600	12 fibers per test (entire MPO connection)
Instrument Test Time	6 seconds	Per MPOLx data sheet
TOTAL TEST TIME	1 hour	600 x 6 = 3600 seconds (60 minutes)

Summary

In a 2018 market survey from VIAVI Solutions about MPO Trends and Challenges, the majority of those already working with MPO connectivity predict MPO will grow by over 20% in the next 3 years. Results from this survey also revealed that the time it takes to test MPO links and the complexities using breakout cables are two of the biggest challenges technicians are experiencing.

The benefits of streamlined test procedures impact everyone from the field technicians and project managers to the owners of contracting companies and enterprise organizations. Using purpose built MPO test solutions streamlines the MPO test workflow and reduces the test time by 60 to 80% while maintaining best practices throughout the entire process. Time is money, and these time savings translate directly to cost savings. This not only includes direct labor hours being greatly reduced, but also reduces expenses for travel, lodging, and other overhead costs for project teams. As shown in this scenario, the MPO test solutions from VIAVI give users the ability to follow test procedures that are fast, intuitive and reliable.

	Traditional	**New**
Equipment	OLTS Probe Microscope (x2) Extra Video Display LC TRC (x4) MPO-LC Breakout Cables (x2)	MPOLx Probe Microscope (x2) MPO TRC (x2)
End Face Inspection Time	**30 Hours** No Endface Analysis No Certification Report	**11 Hours*** Includes Endface Analysis Includes Certification Report for DUT
Reference Method	3 Jumper 12 connections total	1 Jumper 3 connections total
Test Time (Loss/Length/Polarity)	**3 Hours**	**1 Hour**
TOTAL PROJECT TIME	**33 Hours**	**12 Hours***

*Note: This scenario assumes that all inspection is performed in a linear process, but much of this would be performed simultaneously. For example, as both local and remote units have inspection capabilities, each end would be inspected simultaneously resulting in half the test time shown. In addition, many technicians will also inspect the MPO test lead using the on-board Patch Cord Microscope at the same time they are inspecting the MPO bulkhead with the Sidewinder. The ability to perform these steps at the same time can cut the total time in half. With these time-savings in mind, the total inspection time could be reduced to less than 6 hours, for a total project time of 7 hours.

In addition to testing Loss, Length, and Polarity for MPO, OTDR testing provides even further detail about the DUT (as described in our related article: Testing Parallel Optics).

The Multi-Fiber MPO Switch Module for the T-BERD/MTS-4000 is a purpose-built OTDR solution for MPO that provides the same time saving benefits desicribed in this use case. By using these tools, technicians can streamline their MPO test workflow to greatly reduce total test time and maintain best practices throughout the process.

Learn more about MPO testing by visiting www.viavisolutions.com/mpo

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