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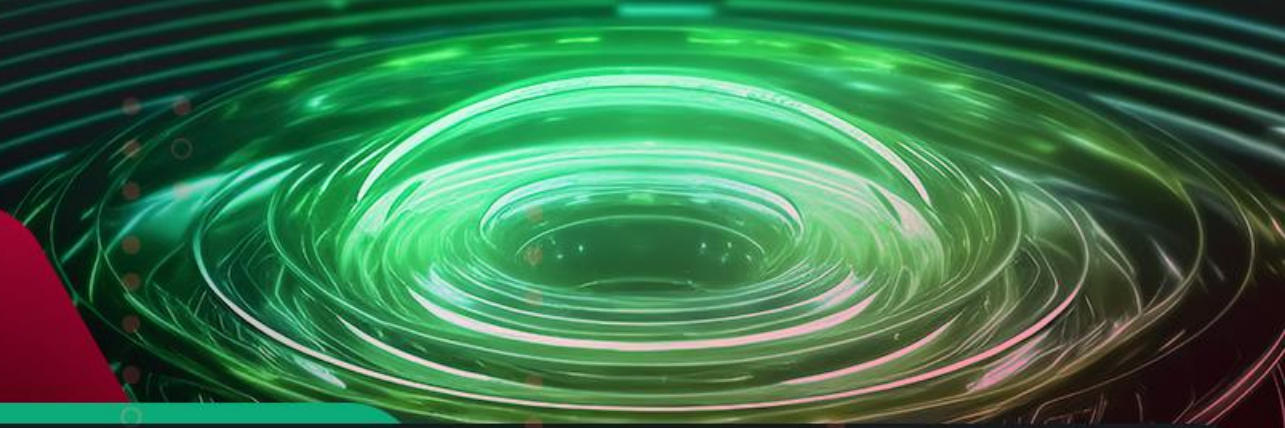
ICT SUMMIT MEXICO 2024

El futuro de ICT - Inteligencia Artificial, Convergencia y Sustentabilidad



24 DE ABRIL

Hotel Galería Plaza, San Jerónimo, Ciudad de Mexico.

ORGANIZA:

LATAM RED

www.latamred.com

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Five Best Practices You Need to Know About MPO Testing in Data Centers

Jesús Eduardo Reséndiz Flores

Application Engineer, Mexico / Central America / Caribbean

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AGENDA

MPO Connectors

Best practices for:

1. Inspection
2. OLTS testing
3. References
4. Polarity validation
5. End-to-end certification

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MPO CONNECTORS

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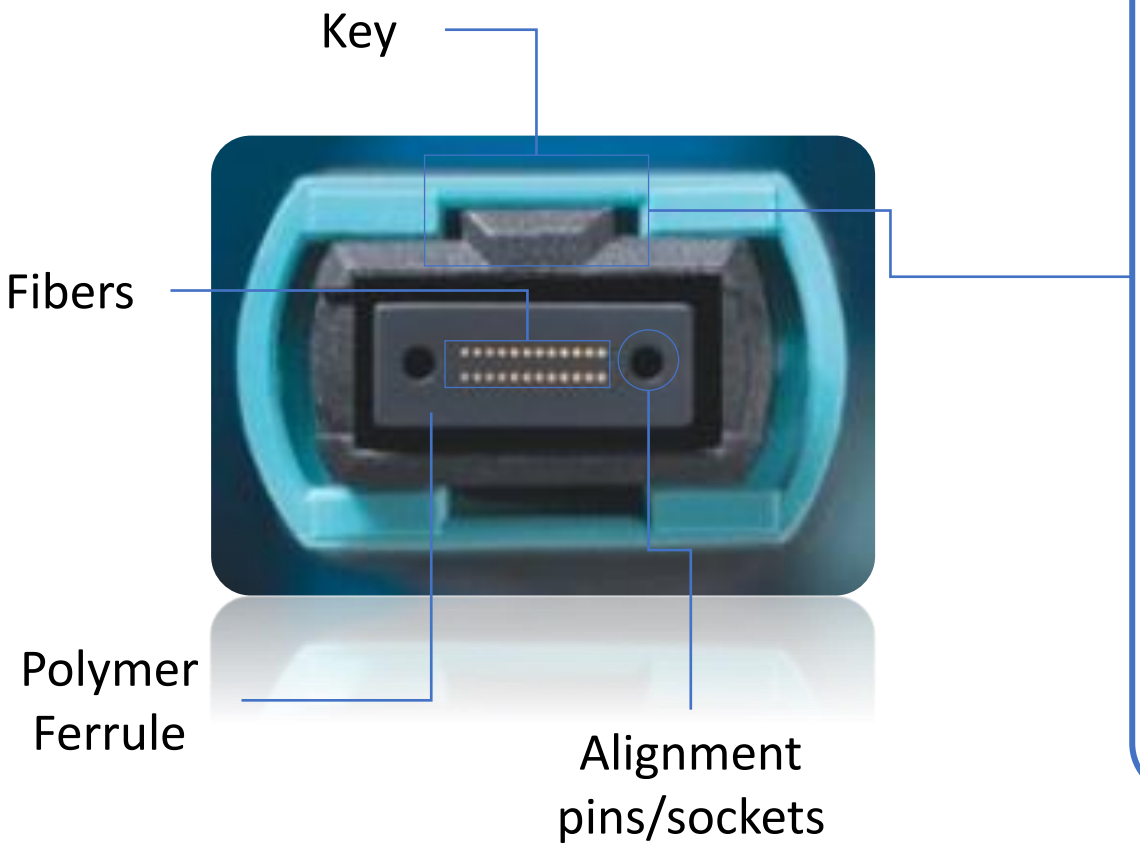
MPO Connector



MPO 8, 12 & 24 connectors

Key is centered

MPO 16 & 32 connectors

Key is on the side

Color coding – connectors

- **Multimode connectors**
  - UPC (flat connectors)
  - Connector outer housing is aqua bl (OM3)
  - Other connector housing color exist depending on the fiber type

- **Singlemode connecto**
  - APC (angled connecto
  - Connector outer hous green or yellow

Color coding – cables

Multimode cables = aqua blue

MM fiber type	Colors
OM1	
OM2	
OM3	
OM4	
OM5	

Singlemode cables = yellow


INSPECTION

Why is inspecting multi-fiber connectors even more important?

#1

cause of network failures is contaminated connectors

80%

of networks have connector issues

Disposing and replacing MPO jump cables is expensive

Multi-fiber connectors have greater impact as a single bad connector impacts multiple links

Cleaning an MPO connector when not needed can make it worse

BER, performance and reliability of networks are directly impacted by bad connectors

High speed networks are more sensitive to contamination

Inspecting guarantees quality and avoids plug and pray

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What is a Fiber Inspection Probe ?

FIP = Fiber Inspection Probe
Also called Fiber Inspection Scope

Definition:
A FIP is a specialized microscope that :

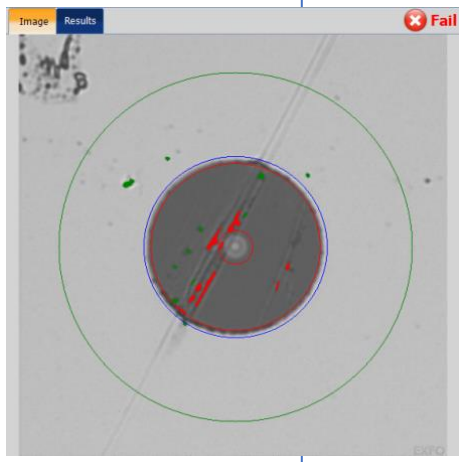
1. Takes a picture of the small connector end-face,
2. Locates and measures all defect and scratches found on the connector end-face
3. Applies industry standard thresholds
4. Gives a clear Pass/Fail status on the quality of the connector end-face

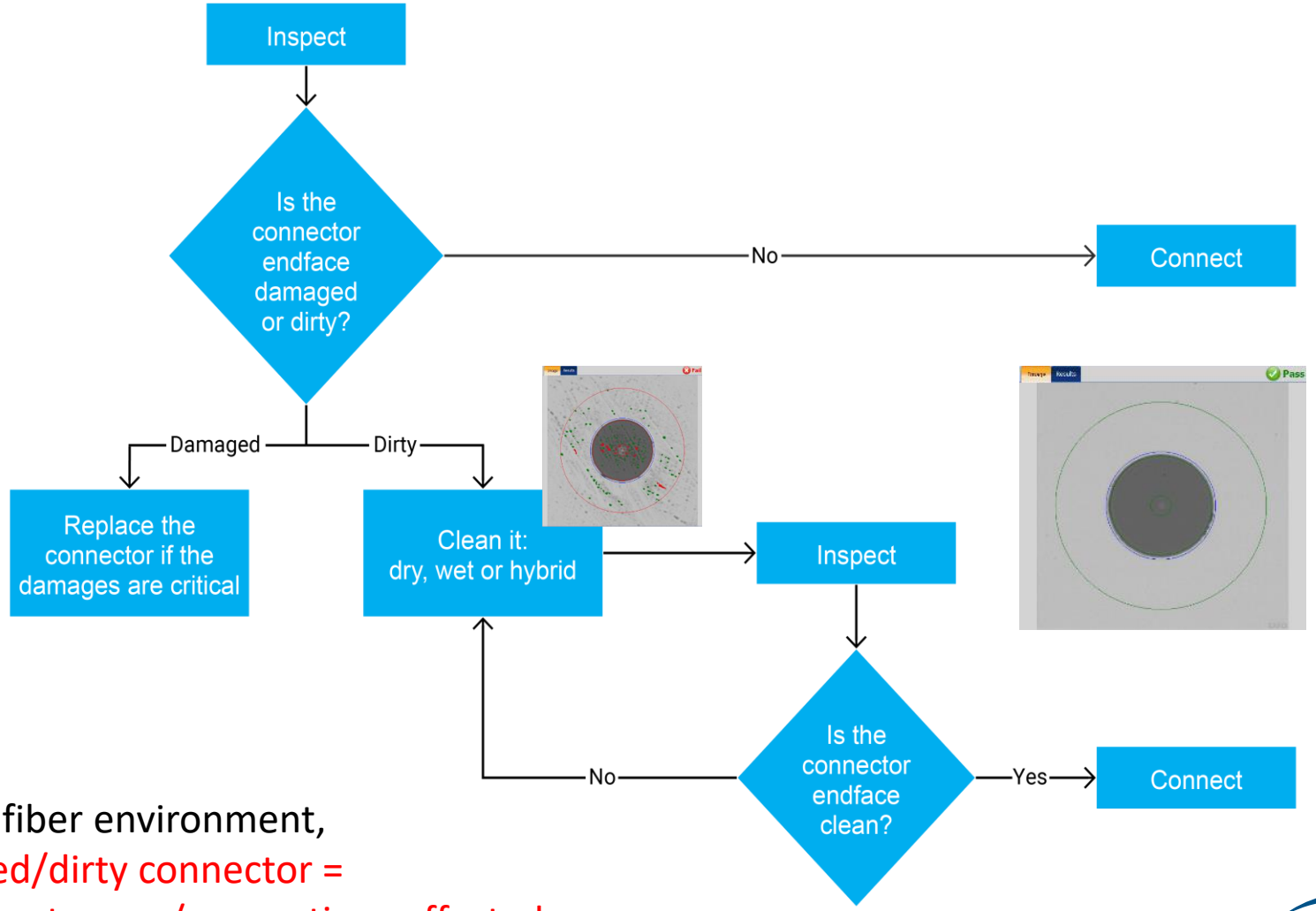
Optical connectors: **the weakest point**

> Dirty connectors are the no.1 cause of network failures

DAMAGED = REPLACE

Cleaning a damaged connector is worthless!





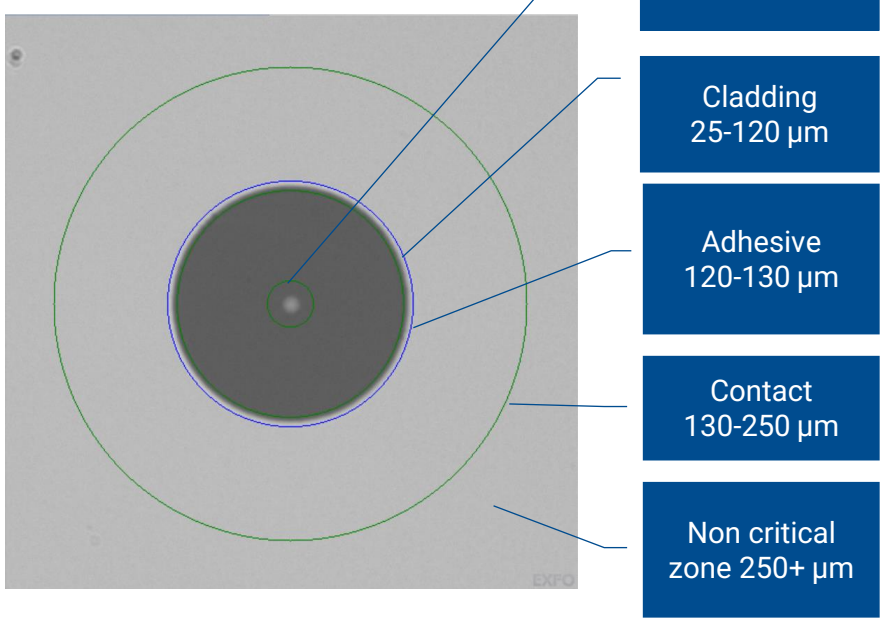
In a multifiber environment,
1 damaged/dirty connector =
8/12/24 customers/connections affected

Connector inspection standards

Connector inspection standard-based criteria

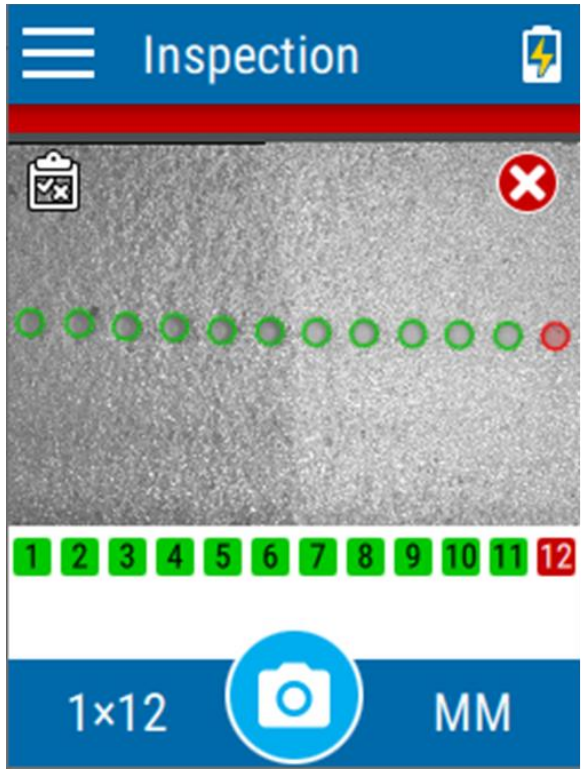
IEC 61300-3-35 Ed2

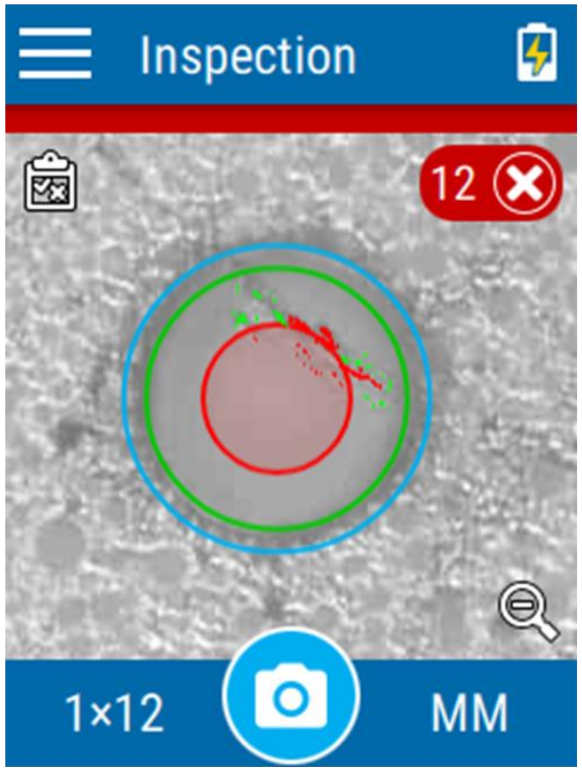
Zones	Scratches	Defects
A: Core	None	None
B: Cladding	No limit ≤3 µm None >3 µm	No limit <2 µm 5 from 2 – 5 µm None >5 µm
C: Adhesive	No limit	No limit
D: Contact	No limit	None ≥10 µm



Pass/Fail is assessed according to IEC criteria

MPO inspection results

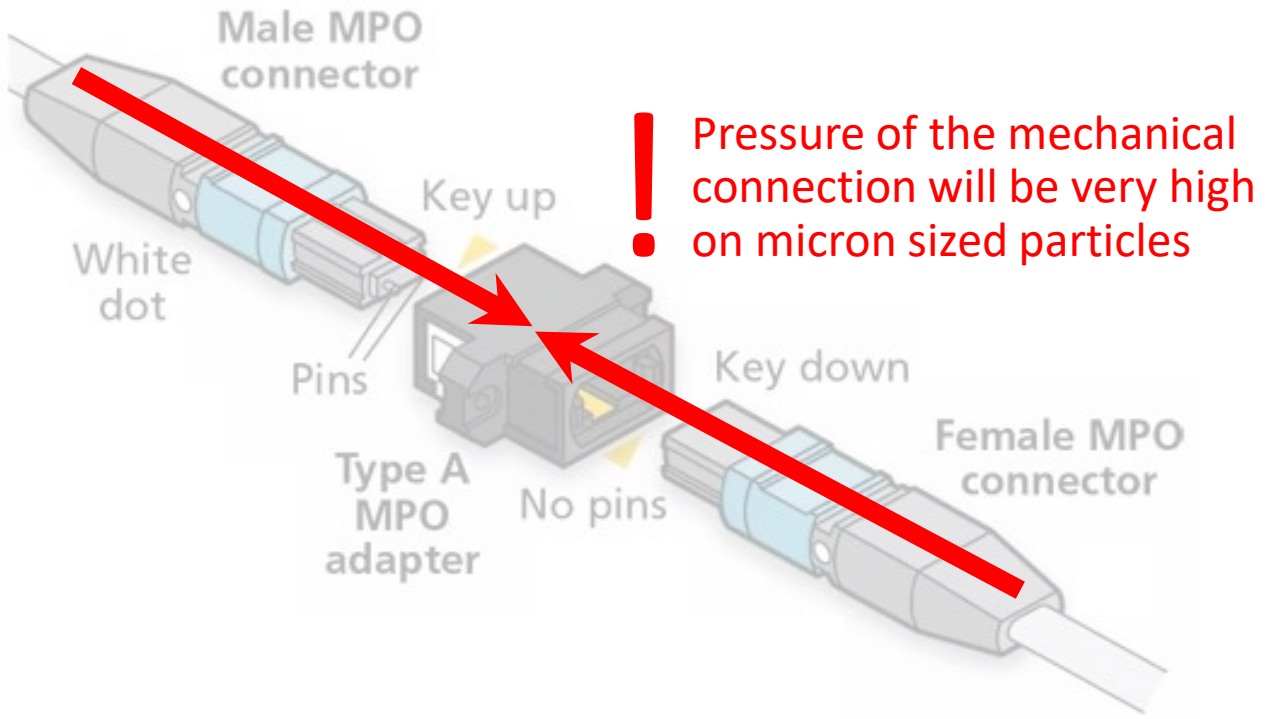




Inspection

Dust/dirt residue

- Construction sites often carry dust from drywall, concrete or fine sand
- Residue can chip ferrules when mated and lead to permanent damage
- A dirty connector that could have been cleaned becomes damaged and must be replaced



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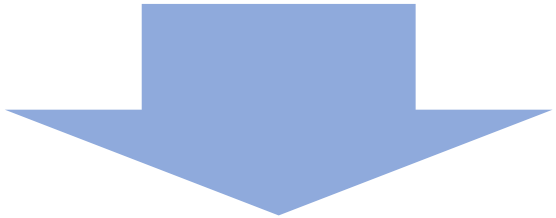
Inspection

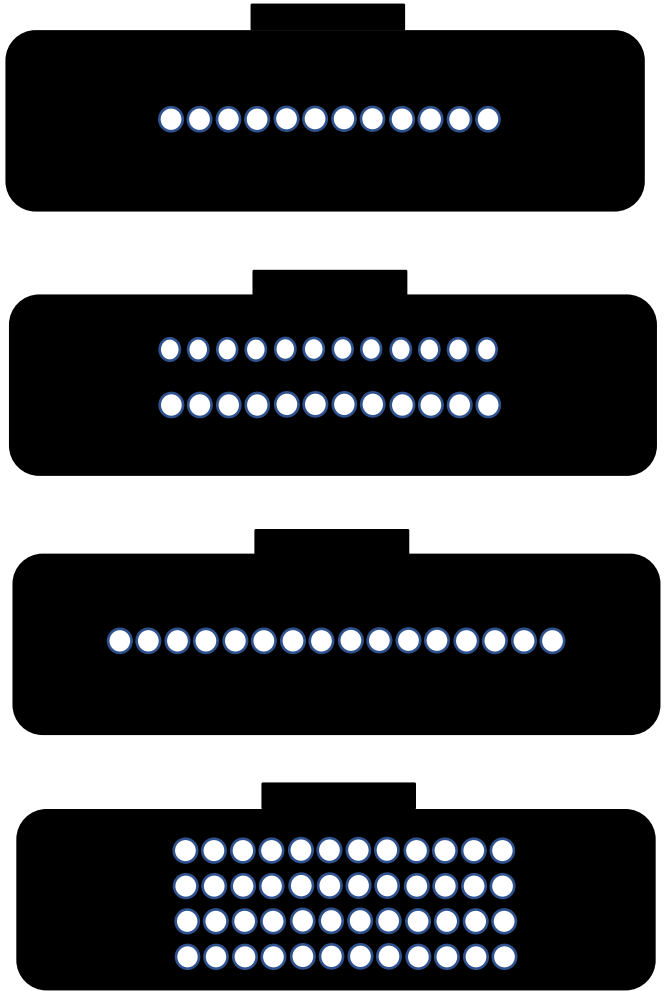
MPO connectors

- Come in various fiber configurations
- Various fiber count in rows: 8, 12, 16, etc
- Single or multiple rows: 1, 2, 4



Multiplies the occurrence of damaged or dirty fibers

Multiplies possibilities of a failing link/channel



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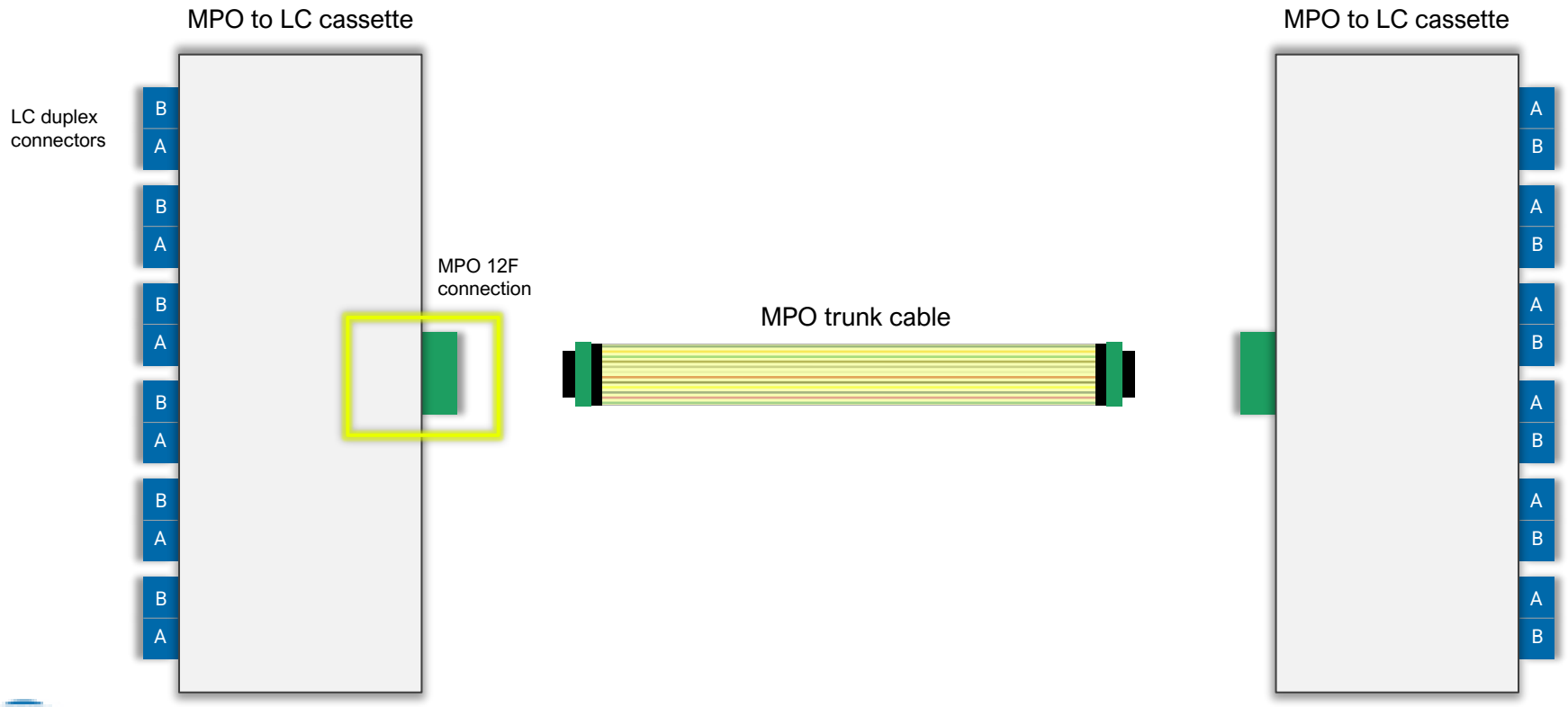
Inspecting MPO trunk connections

Before plugging in the trunk cable, inspect the MPO connector on the cable and cassette



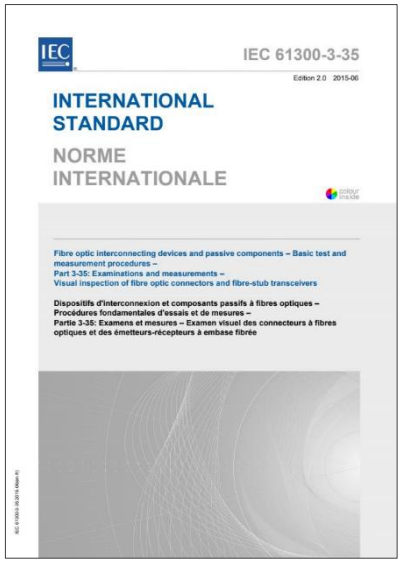
Inspecting MPO trunk connections

MPO is a multi-fiber connector

Can contain up to 72F

Key up or key down (Type A/B/C)

Inspecting MPO trunk connections



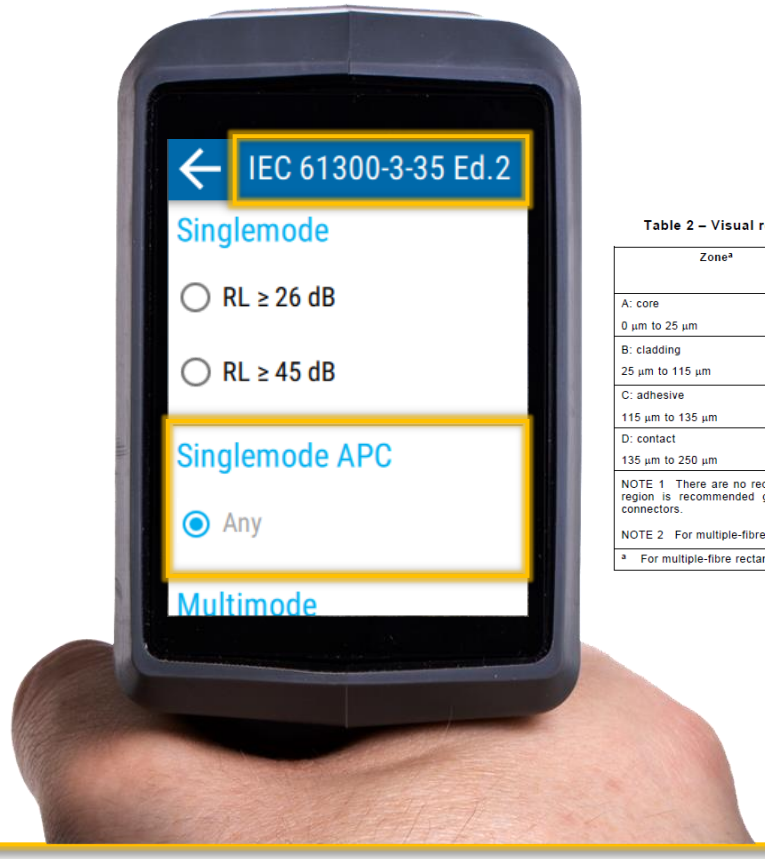


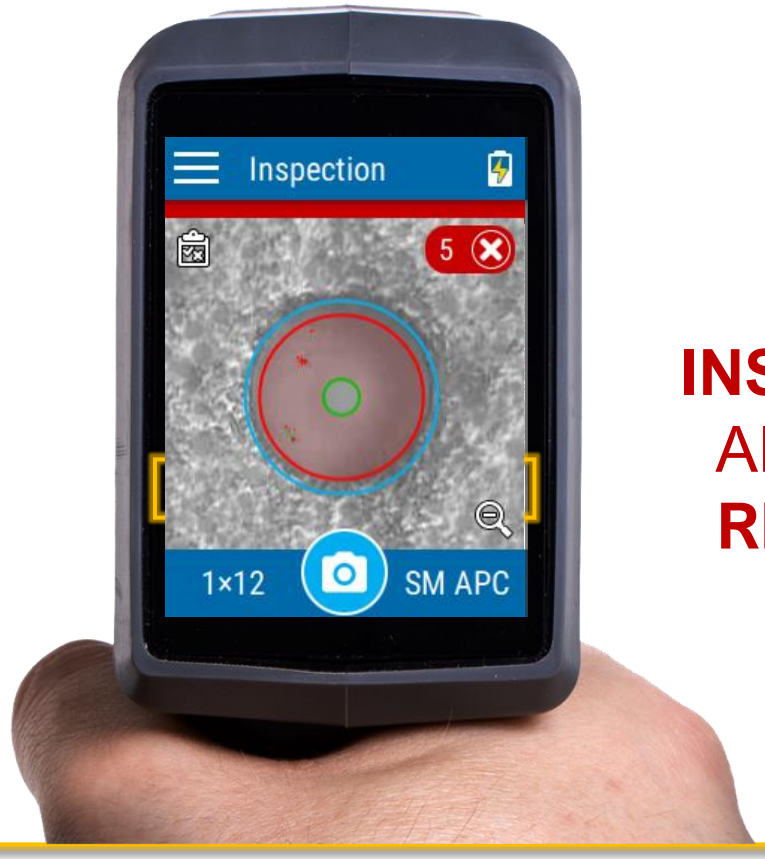
Table 2 – Visual requirements for single-mode angle polished (APC) connectors

Zone[a]	Scratches (maximum number of a given dimension)	Defects (maximum number of a given dimension)
A: core 0 µm to 25 µm	4 ≤ 3 µm	None
B: cladding 25 µm to 115 µm	No limit	No limit < 2 µm 5 from 2 µm to 5 µm None > 5 µm
C: adhesive 115 µm to 135 µm	No limit	No limit
D: contact 135 µm to 250 µm	No limit	None > 10 µm
NOTE 1 There are no requirements for the area outside the contact zone. Cleaning loose debris beyond this region is recommended good practice. This is of particular concern for multiple-fibre rectangular-ferrule connectors. NOTE 2 For multiple-fibre rectangular-ferrule connectors, the criteria apply to all fibres in the array.		
[a] For multiple-fibre rectangular-ferrule connectors, only the requirements of Zone A and Zone B apply.		

Source: IEC (2015) Part 3-35: Examinations and measurements –Visual inspection of fiber optic connectors and fiber-stub transceivers

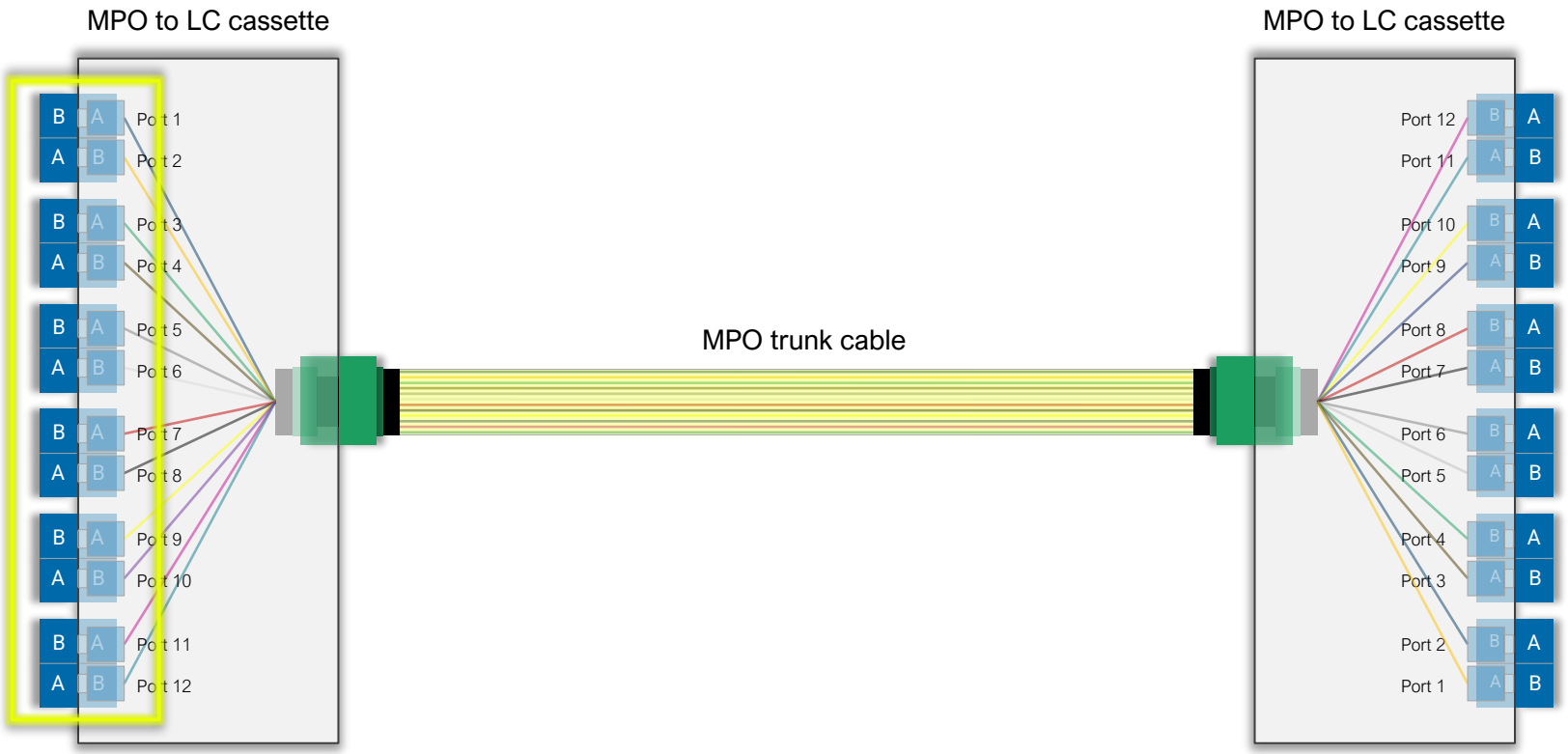
Inspecting MPO trunk connections

FIBERS
5 AND 12
FAILED



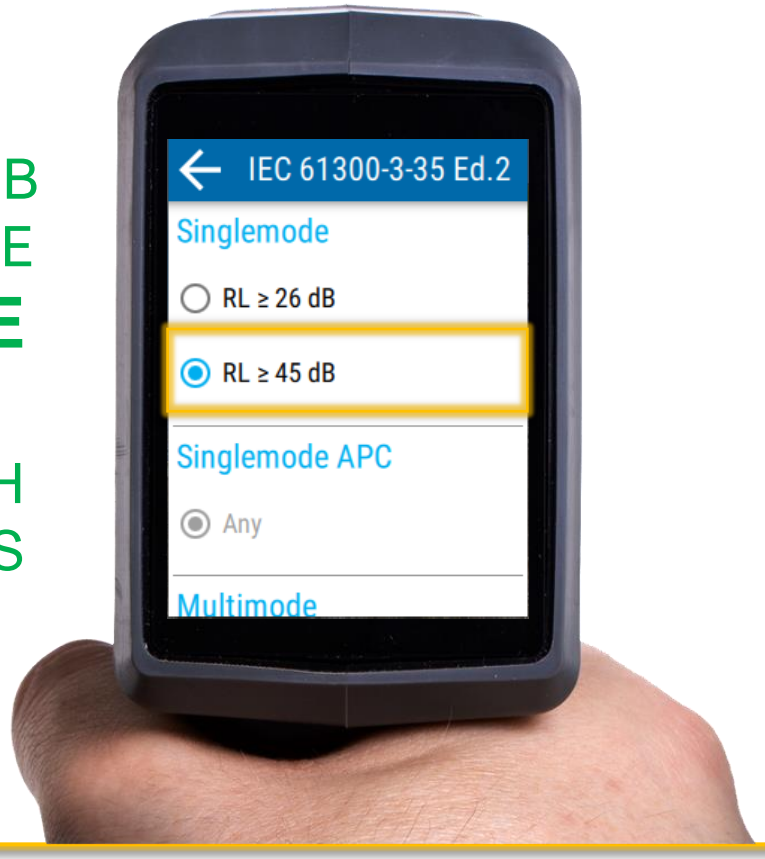
MAY CAUSE
INSERTION LOSS
AND DISCRETE
REFLECTANCE
ISSUES

Inspecting LC connectors

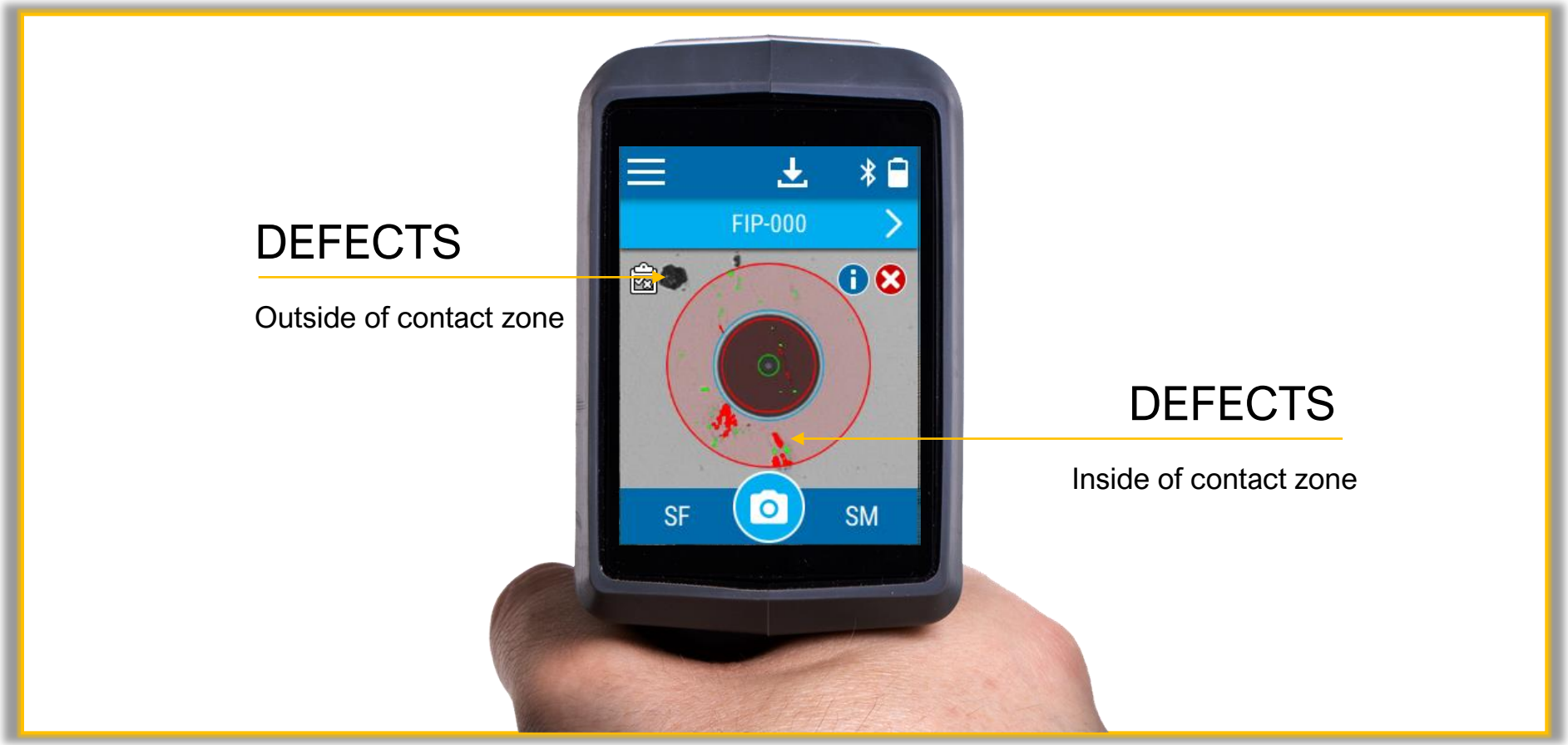


Inspecting LC connectors

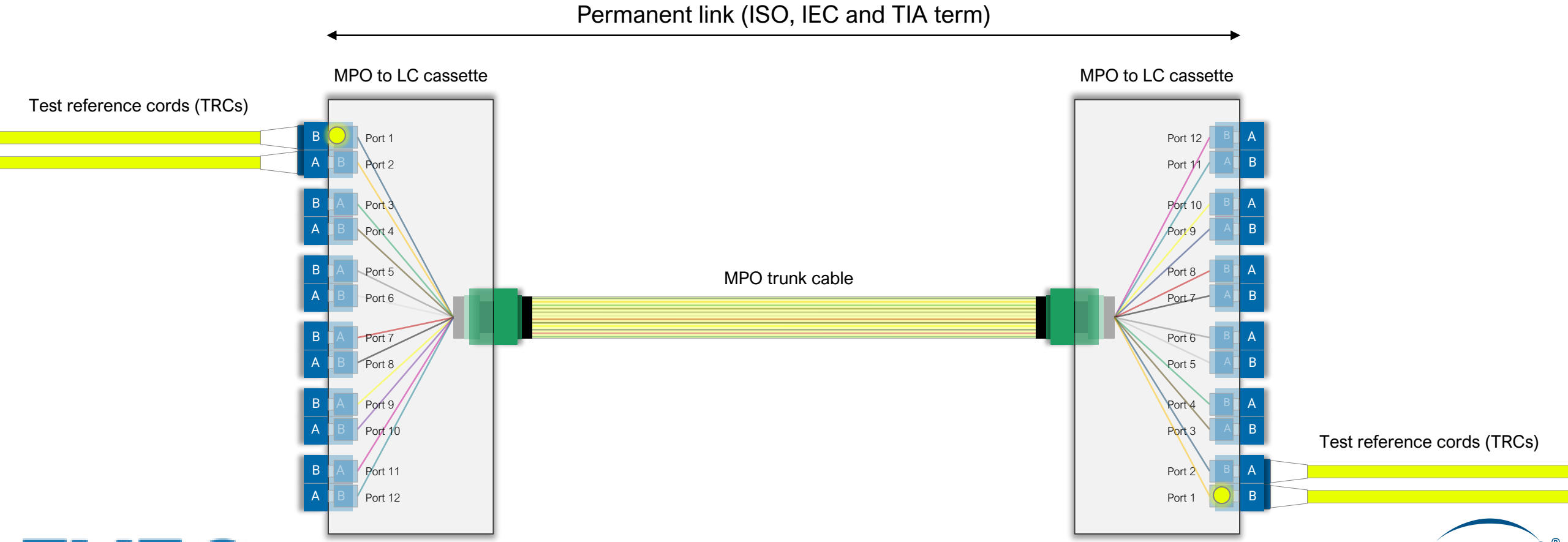
TESTING TO ≥ 45 dB
WILL HELP REDUCE
REFLECTANCE ISSUES
ASSOCIATED WITH
200/400G SYSTEMS

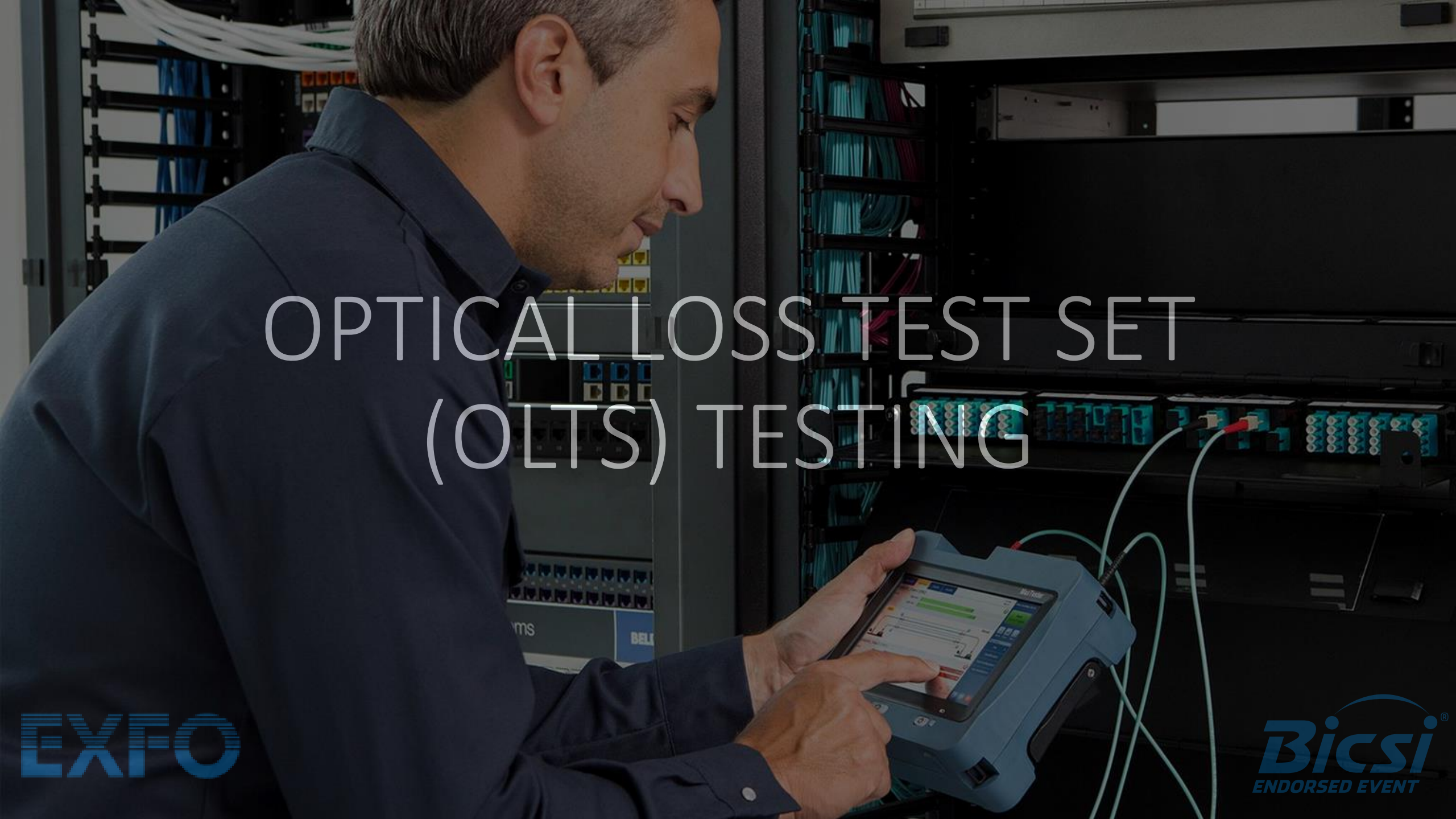


Inspecting LC connectors



Tier 1 certification testing on LC





OPTICAL LOSS TEST SET (OLTS) TESTING

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Tier-1 testing definition

TIA-568 : Optical Fiber Cabling and Components Standard

- Testing installed optical fiber cabling for attenuation with an optical loss test set (OLTS), as described in cabling standards, and verifying the cabling length and polarity constitutes Tier 1 testing.

- An OLTS includes an optical power meter to measure received optical power and a light source that closely resembles a system transmitter (e.g., an LED for multimode optical links, a laser for single-mode optical links). An OLTS may be a single instrument or separable optical power meter and light source.

Tier 1 certification testing on LC

Fiber type

Cabling standard

Link details

CONNECTORS, SPLICES

Tier 1 certification testing on LC

SET REFERENCE
USING
1 CORD RTM

STEP 1

STEP 2

Tier 1 certification testing on LC

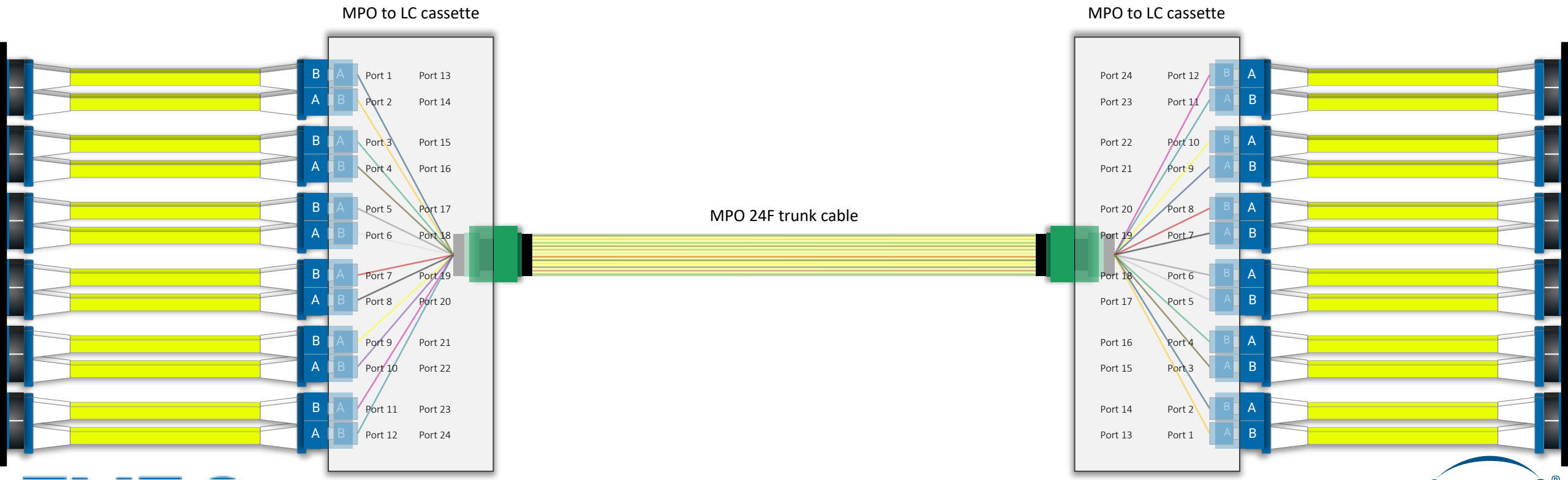
LOW LOSS

PASS

WILL SUPPORT
HIGH SPEED
100/200/400G

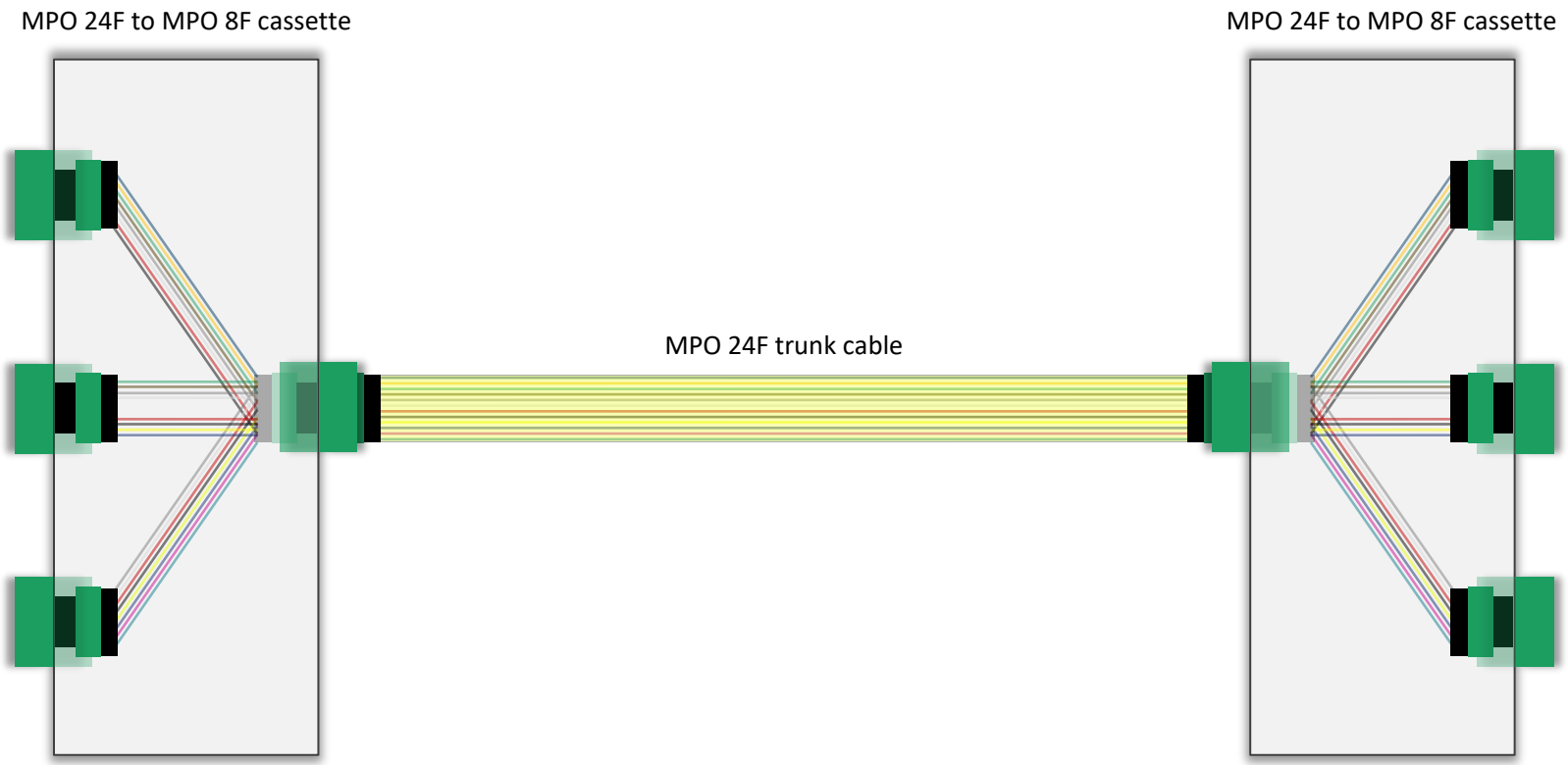
Moving to parallel optics

10G to 100/200/400G migration using existing trunk cabling

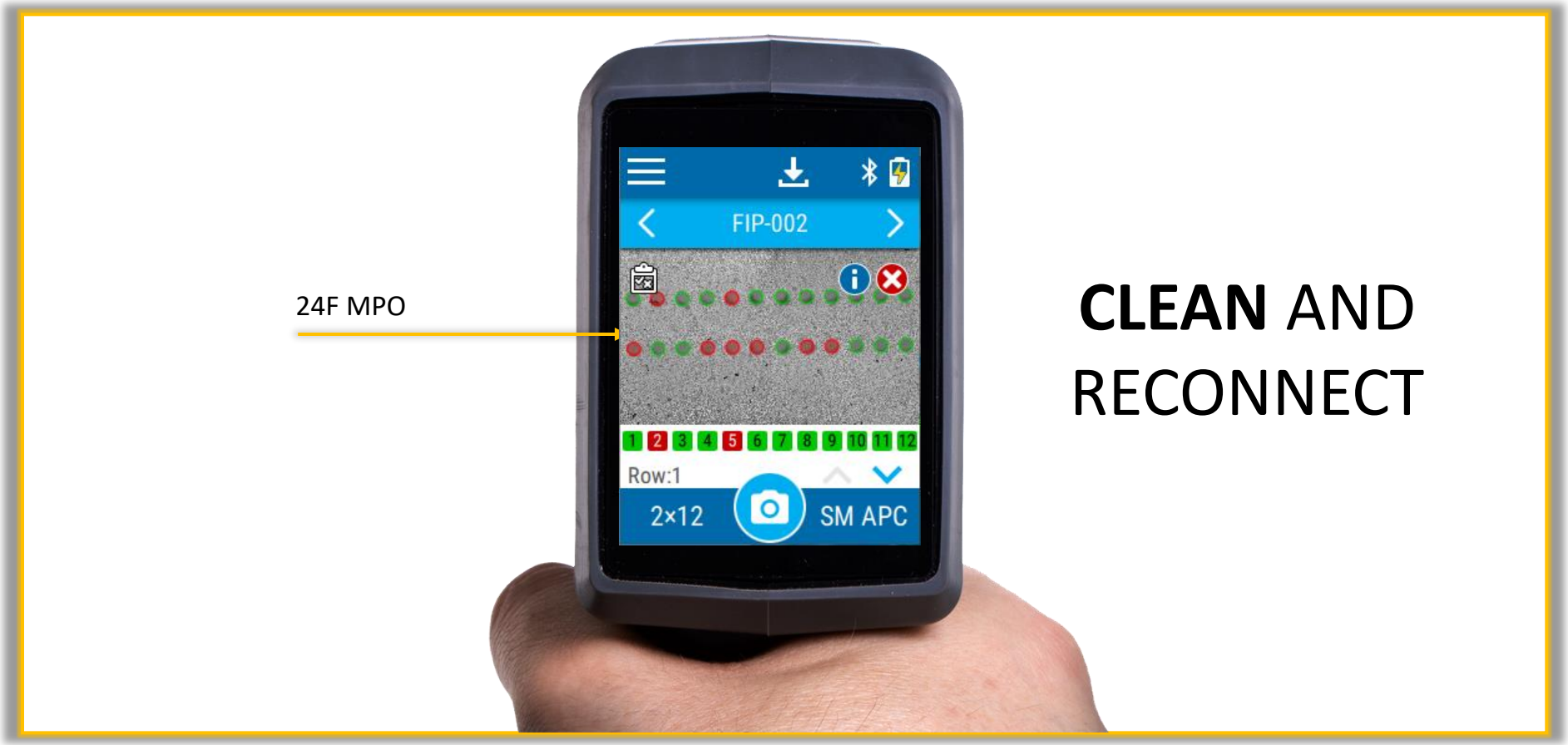


Moving to parallel optics

Replace the cassette with 24F MPO to create 3 x 8F MPO links

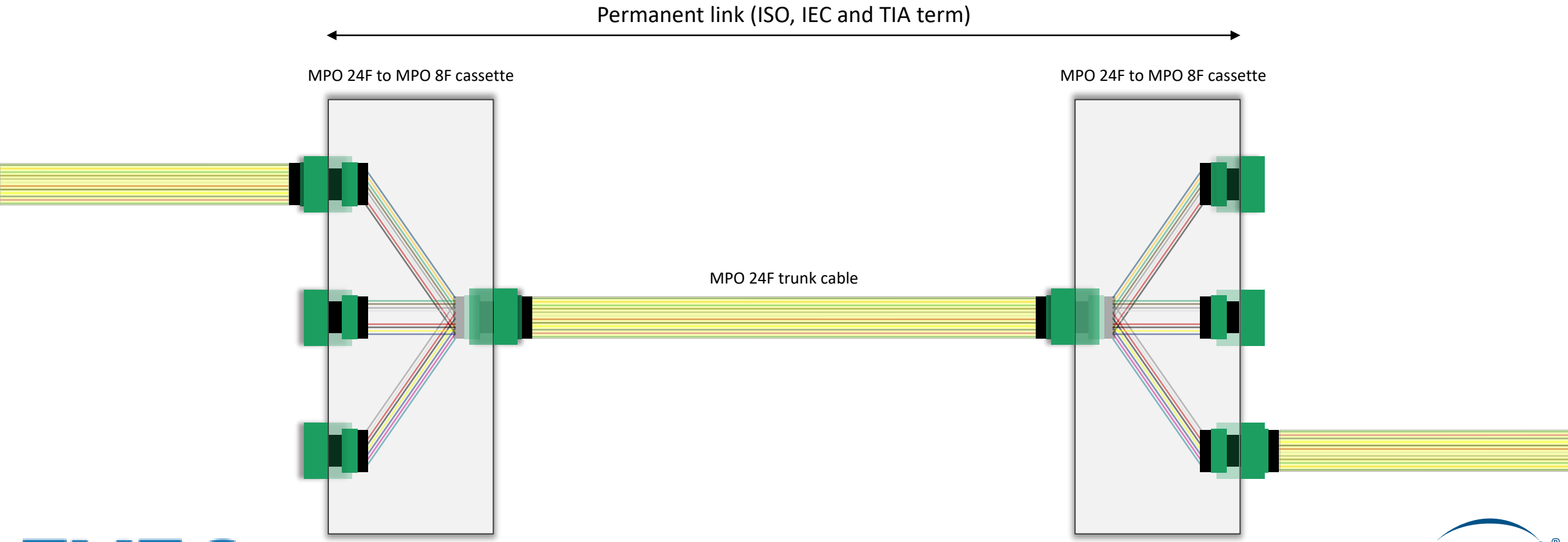


Inspect MPO connections



Inspect MPO connections

Tier 1 certification testing on MPO 8F

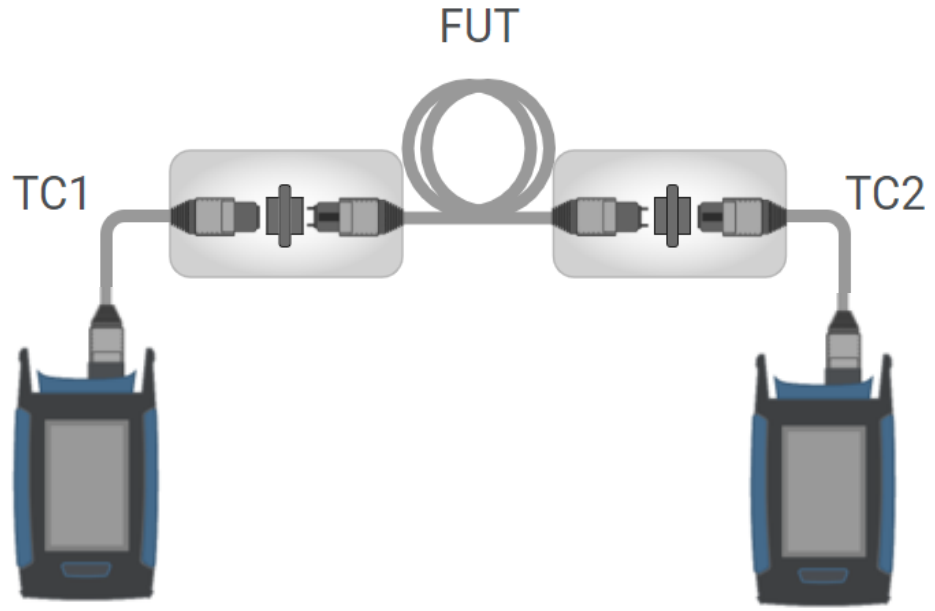


Tier 1 certification testing on MPO 8F

MPO power meter and light source for Tier-1 testing

Testing with a MPO power meter and light source would provide:

- Insertion loss per channel
- Continuity validation
- Polarity type confirmation
- Fiber length



MPO Light Source

MPO power meter

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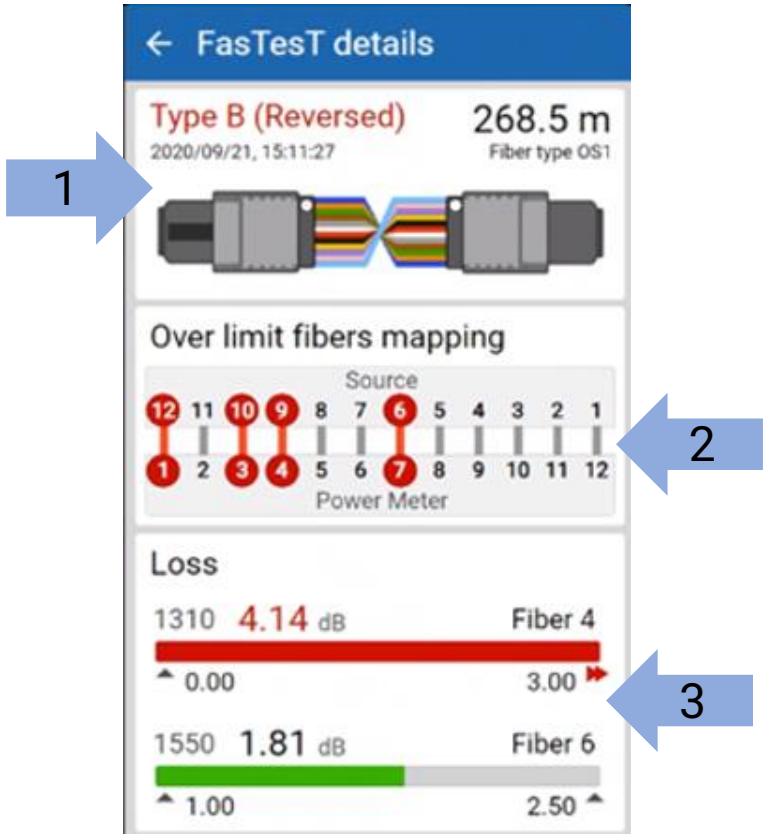
MPO OLTS test results example

Main screen

1. P/F global status
2. Worst fiber loss
3. Length
4. 12-Fiber bar graph



FasTest details

1. Polarity validation
2. Fiber mapping
3. Loss thresholds

Fiber details

1. Individual fiber results
2. Loss/lambda/fiber

REFERENCE METHODS FOR OLTS TESTING

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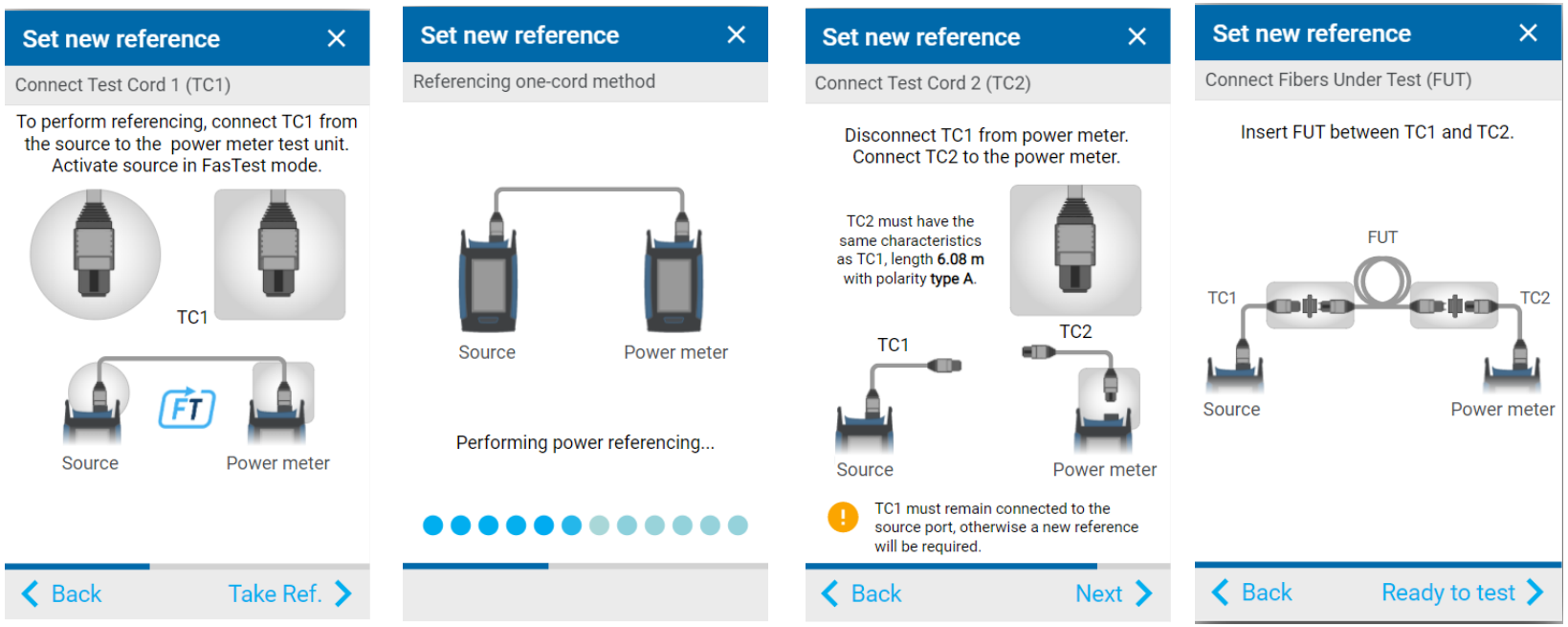
MPO reference assistant

- Reference is the main cause of error
- A bad reference will result in bad measurements
- An onboard reference assistant will ensure the reference is done correctly



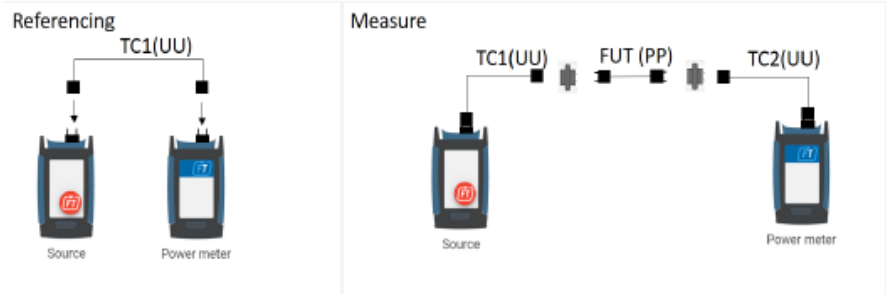
Reference methods

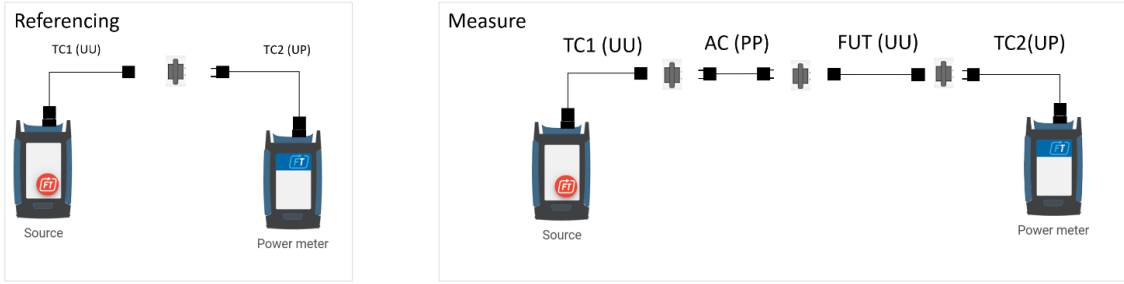
As recommended in IEC 61280-4-5

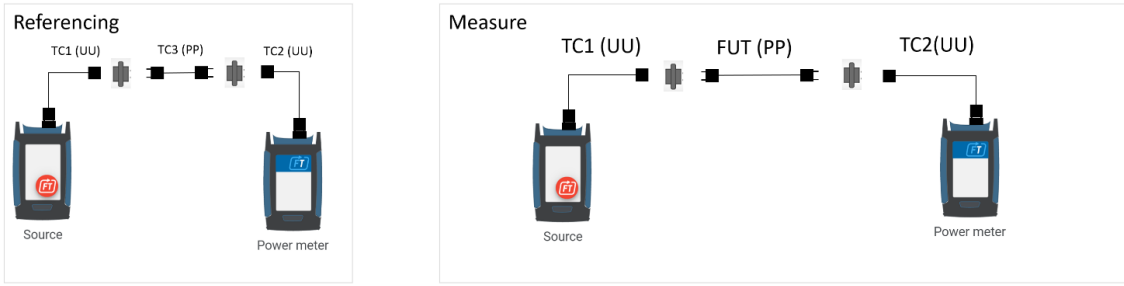
- **One cord:** *Includes both the first and last connections in the loss budget. Lowest uncertainty possible (less connectors)*

- ***Adapter cord**: Includes only the first or last connection in the loss budget. To accommodate connector gender vs. port on units.*

- **Three cords:** *Excludes both the first and last connections in the loss budget*



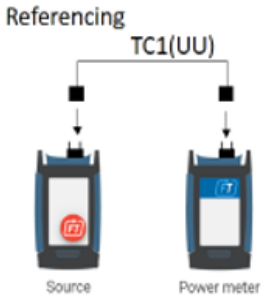




Reference methods

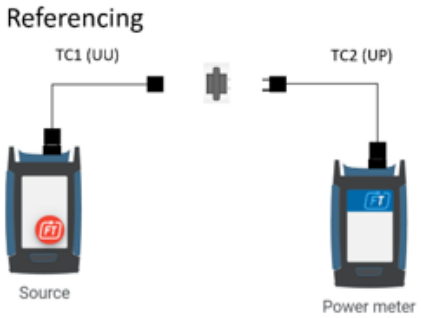
As recommended in IEC 61280-4-5

- **1 cord:** *Includes both the first and last connections in the loss budget.*



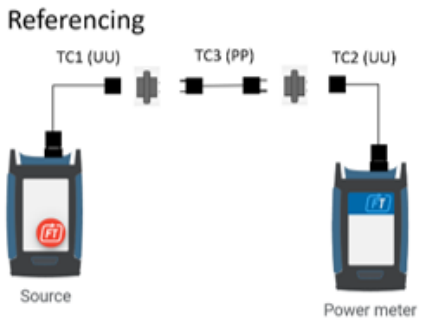
A second patch cord is required but not tested

- ***Adapter cord**: Includes only the first or last connection in the loss budget.*



Includes one connection in the reference

- **3 cords:** *Excludes both the first and last connections in the loss budget*



Includes two connections in the reference

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POLARITY VALIDATION

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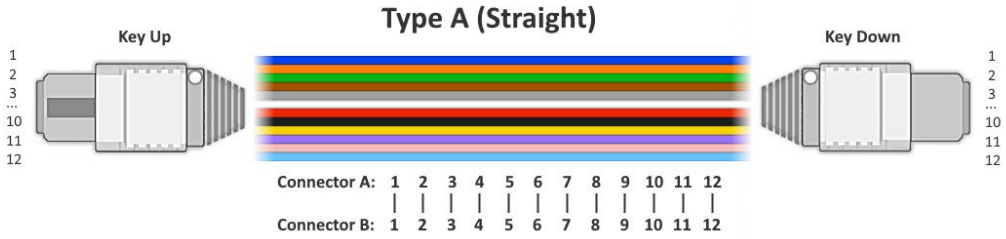
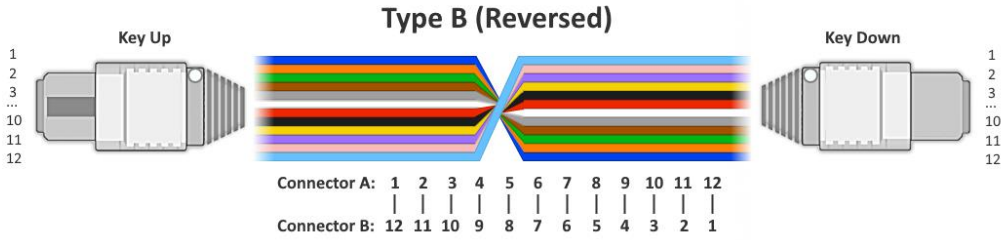
30%

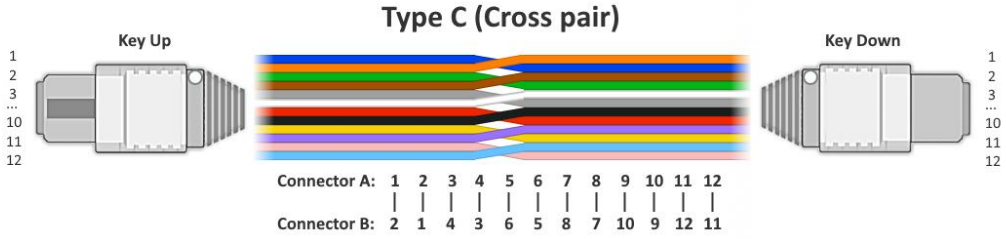
of MPO-cable users report that determining polarity type is confusing

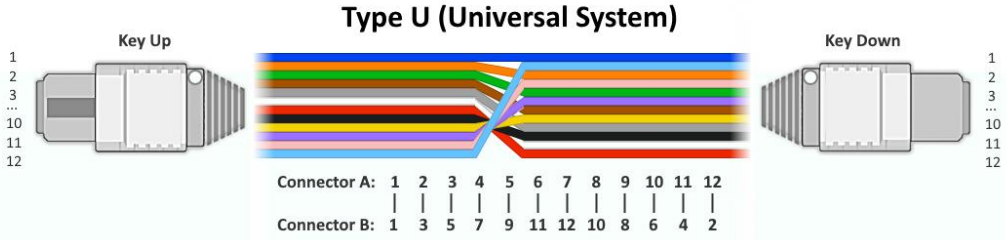
- Navigating MPO waters: 2018 survey

Polarity types









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MPO OLTS test & validation

Expected polarity

- Unspecified ✓
- Type A (Straight)
- Type B (Reversed)
- Type C (Cross pair)
- Type U (Universal System)

FasTesT details

Type A (Straight)

2022-07-05, 00:00:30

Over limit fibers mapping

	1	2	3	4	5	6	7	8	9	10	11	12
Source	1	2	3	4	5	6	7	8	9	10	11	12
Power Meter												

Loss

1310 2.65 dB Fiber 4

0.00 2.00

1550 3.12 dB Fiber 4

0.00 2.00

Fibers details

Loss (dB)

Fibers	1310	1550
1	0.22	1.88
2	0.70	1.61
3	0.00	1.37
4	2.65	3.12
5	0.05	0.74
6	0.55	1.40
7	0.08	0.95
8	0.43	1.62
9	0.89	1.69
10	0.07	0.72
11	0.59	1.66
12	0.10	1.24

Show reference values

Thresholds

Expected polarity: Type A (Straight)

Fibers layout: 1x12 12 fibers

1310 nm

Minimum link loss: None

Maximum link loss: 2.00 dB

1550 nm

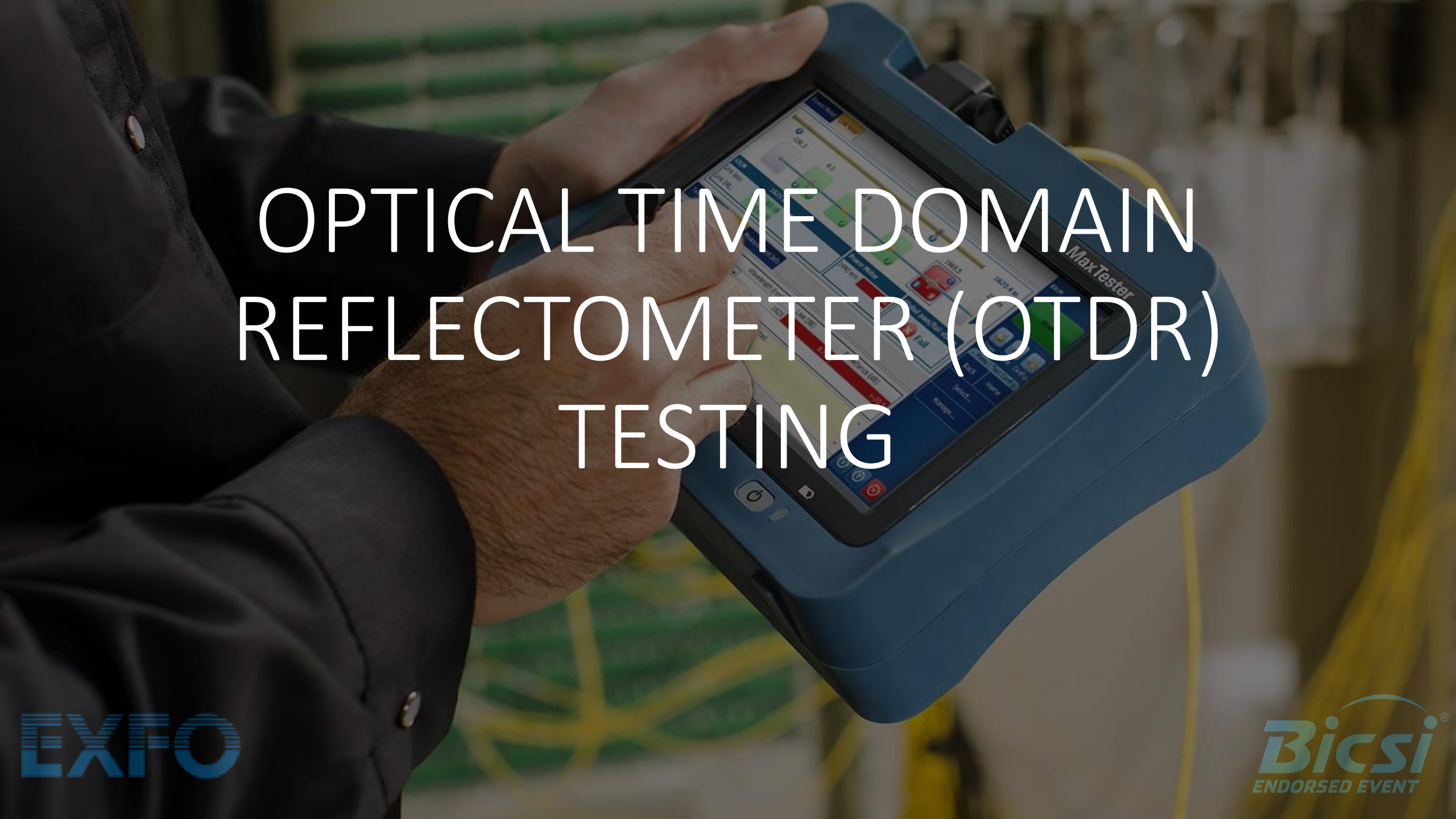
Minimum link loss: None

Maximum link loss: 2.00 dB

Reference details

2022-07-04 23:56:22
Adapter-cord
Polarity A

OPTICAL TIME DOMAIN REFLECTOMETER (OTDR) TESTING



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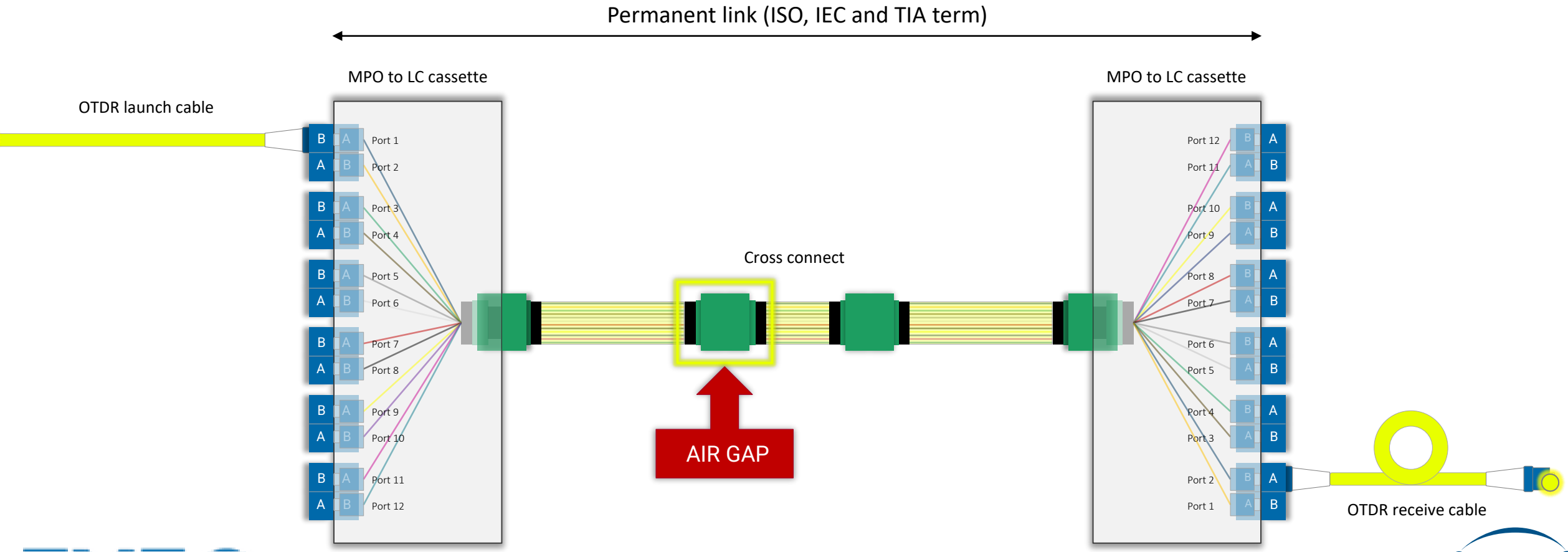
Troubleshooting using an OTDR



Troubleshooting using an OTDR

FAILURE

IN CROSS CONNECTION

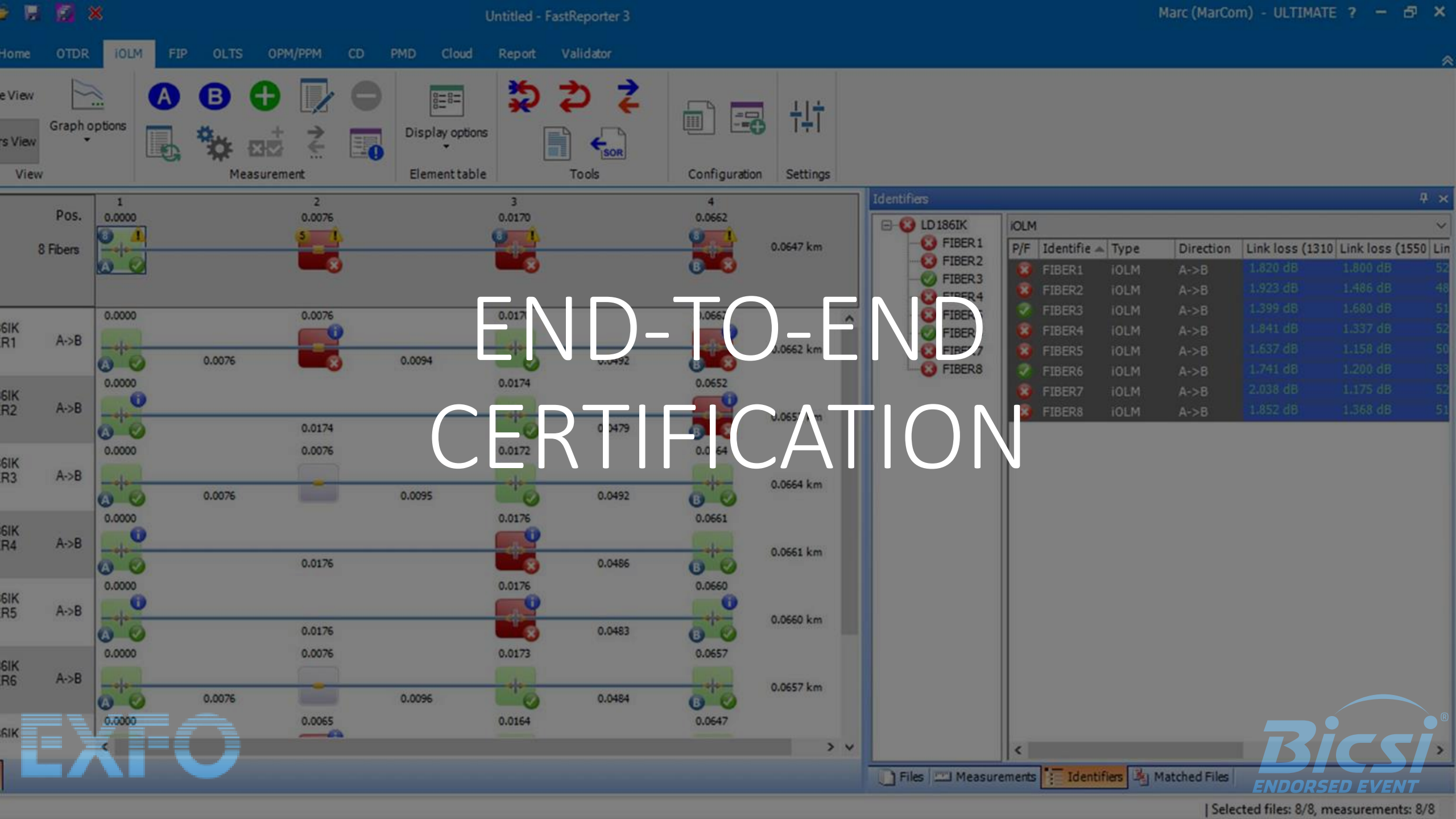
Troubleshooting using an OTDR

HIGH REFLECTANCE

Troubleshooting using an OTDR

GOOD REFLECTANCE

BOTH CONNECTIONS VISIBLE



END-TO-END CERTIFICATION

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Different tools for fiber (link) testing

- Fiber Inspection Scope
- Optical loss test set (OLTS)
- Optical time domain reflectometer (OTDR)
- Optical fiber multimeter (OFM)

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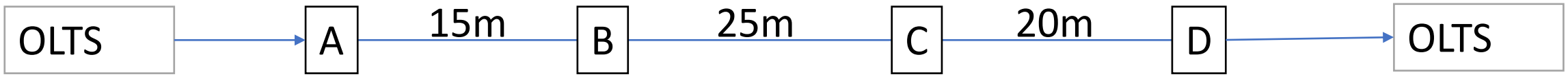
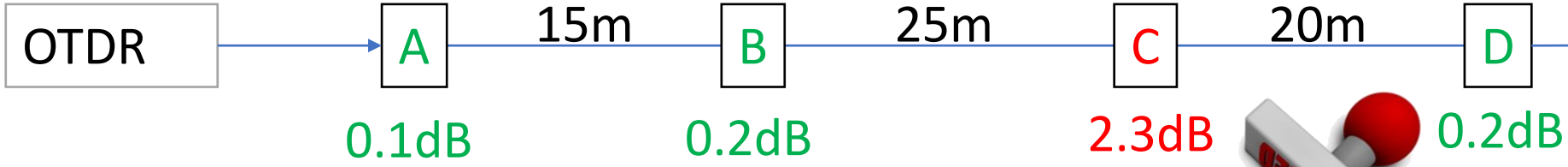
Self-reflections on the “certification” concept

- Let’s assume a link with 4 connections (3 segments)



Total loss tolerance: 4 connections (0.75dBx4) + 60m x 1dB/Km = 3.06dB

OLTS E2E loss measured: 2.9dB



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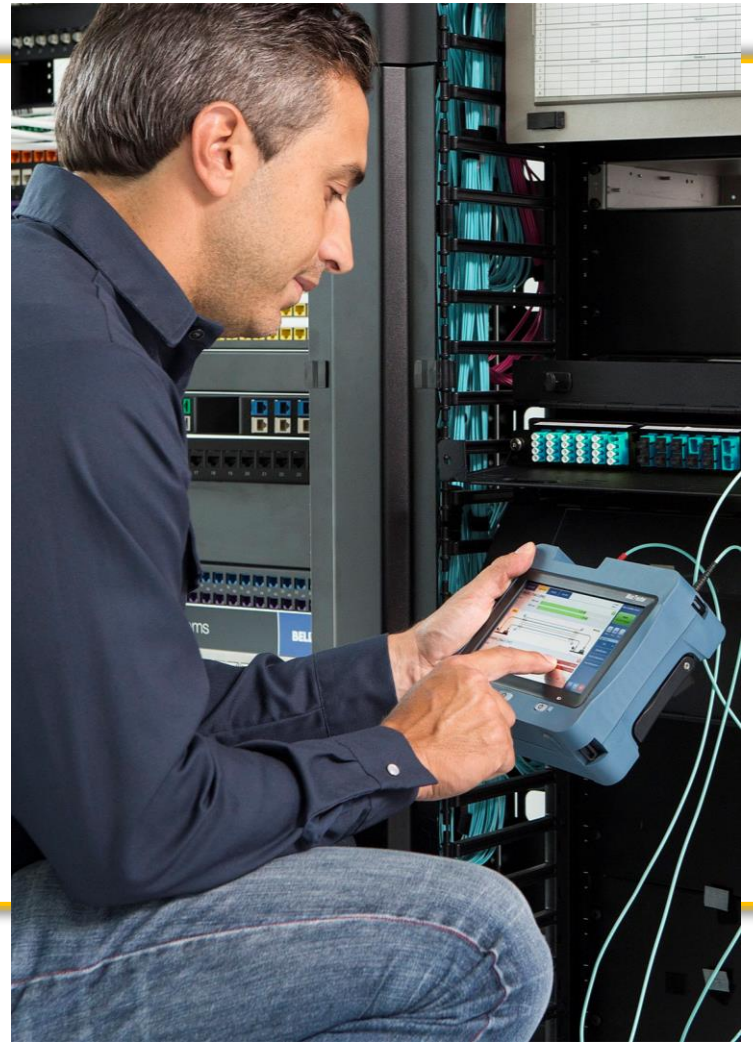
OLTS pros/cons

Ideal for certification



Strengths

- Automated IL+ORL+Length
- Fast
- Reference validation
- E2E Loss measurement + Polarity + continuity
- Bidirectional or unidirectional

Weaknesses

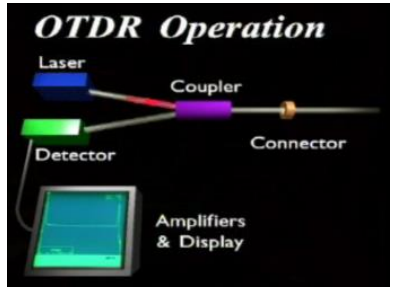
- Needs referencing
- Cannot pinpoint faults
- No distributed loss

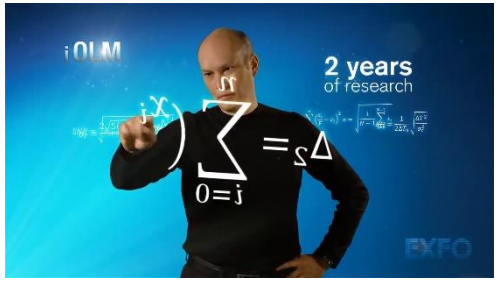
Measuring loss with OTDR/IOLM

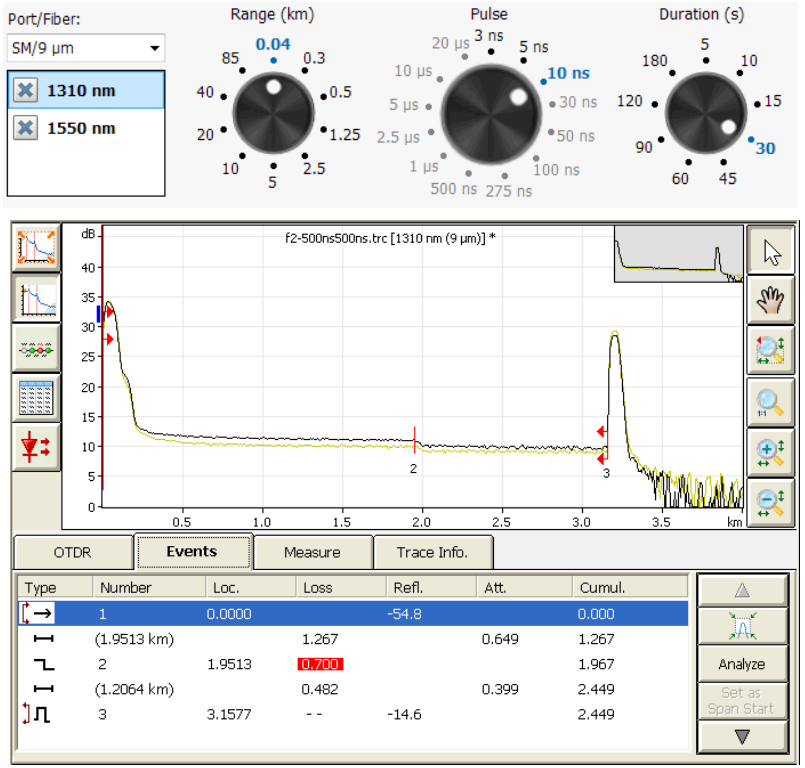
- The uncertainty of IL measurements with OTDRs is dependent of the **methodology** as well as the **analysis**:
  - Reflectometry vs. advanced reflectometry
  - Using a launch fiber
  - Using a launch and a receive fiber
  - Uni-directional or bi-directional
  - Central wavelength
  - BAD SETTINGS = false measurements

OTDR vs iOLM

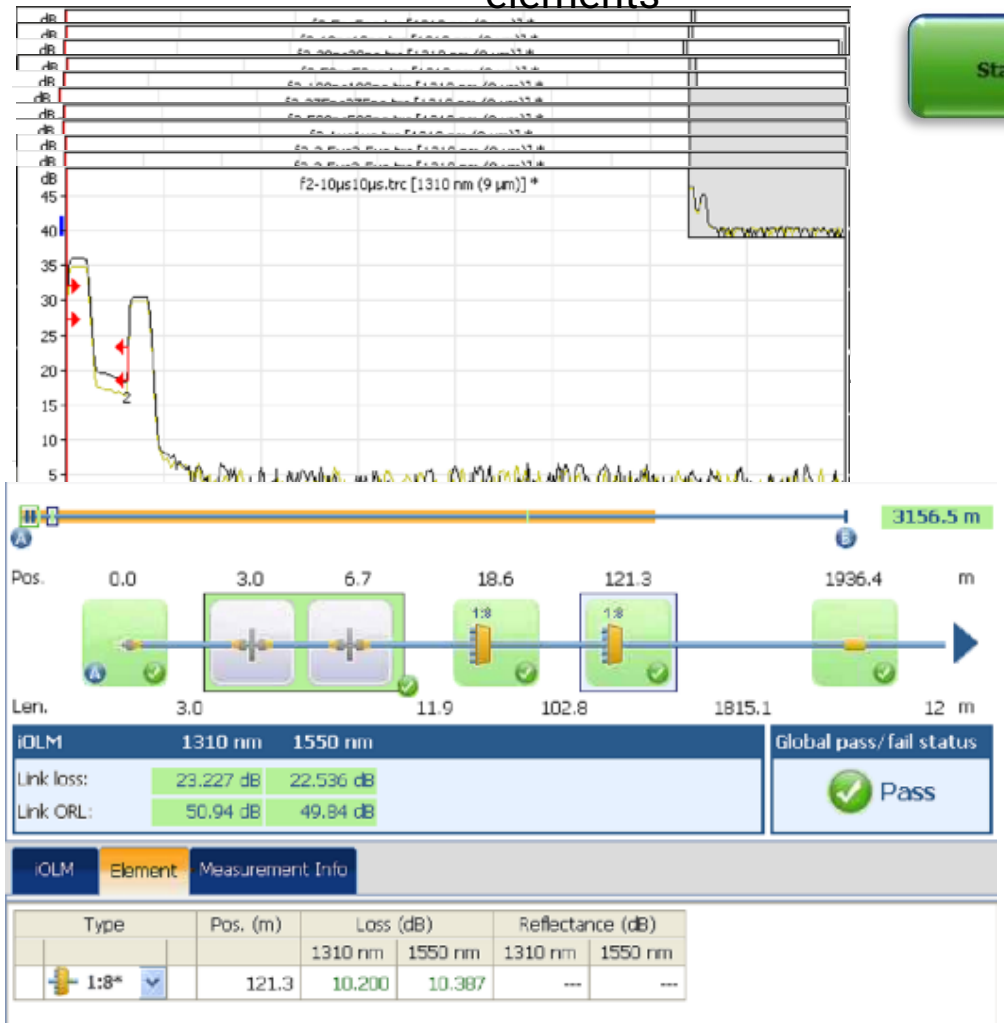
- Reflectometry: single pulse







Advanced reflectometry: Adaptative multipulse acquisition with smart recognition and diagnostic of all elements



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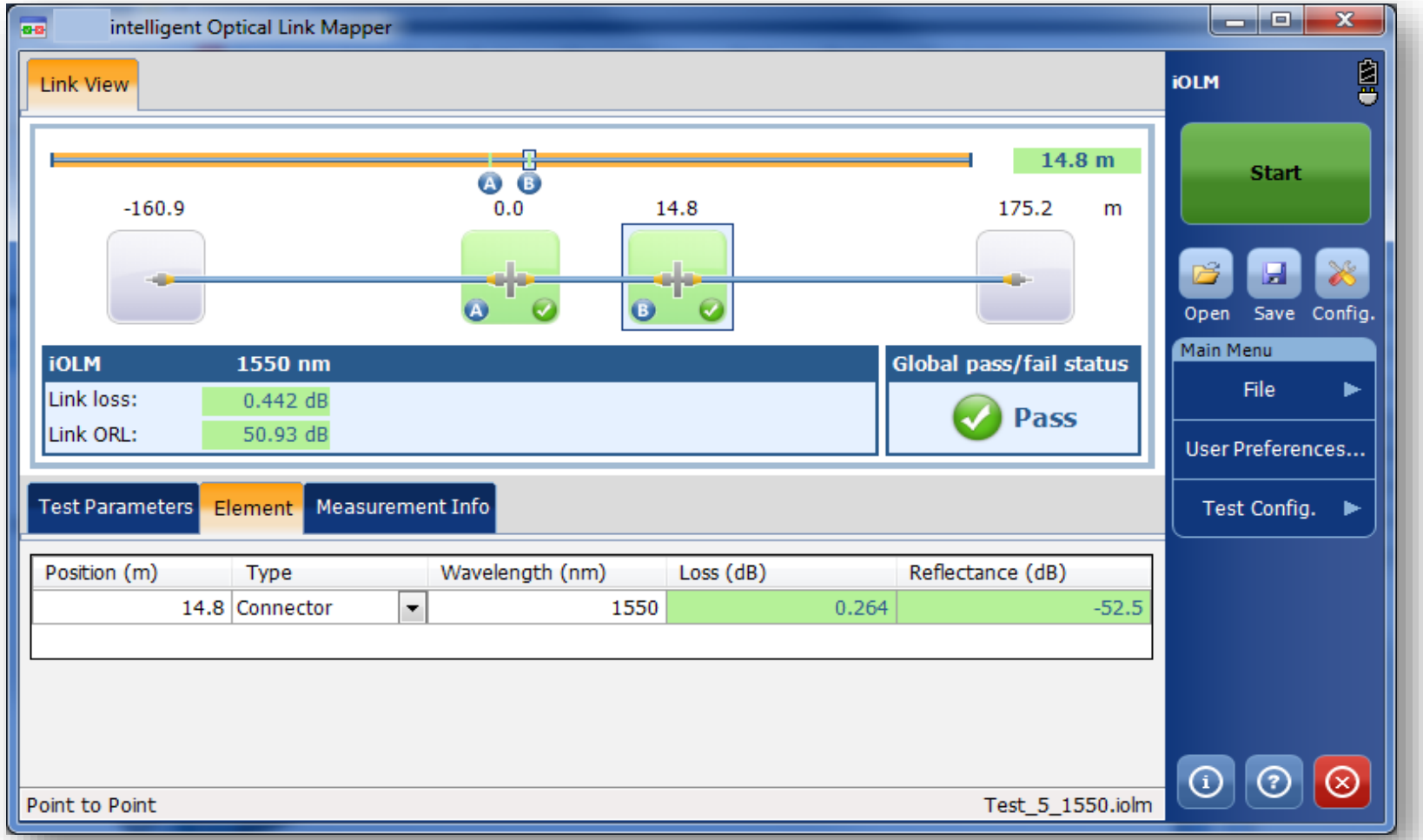
End-to-end loss using the iOLM



TIP: Even if the loss is within the budget, distributed loss must be performed too

OTDR/iOLM pros/cons

Ideal for characterization and Tier 2 certification

Strengths

- No reference
- Accurate (E2E and events)
- Distributed loss measurement
- Mapping of event
- iOLM is fully automated
- E2E loss measurement + continuity using LF and RF
- Bidir or unidirectional

Weaknesses

- Test time longer than OLTS
- Not Tier 1
- Traditional OTDR complexity

Definition of an OFM

An optical fiber multimeter (OFM) is an essential handheld tool for fiber optic technicians, alike to well-known multimeters used for electrical circuits.

OFMs do quick measurements of multiple key optical parameters :

- loss (dB),
- optical return loss (dB),
- length (meters)
- power (dBm).

It helps technicians verify fiber optic link health, measure signal strength and troubleshoot potential issues.

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Optical fiber multimeter

The first of a new category of intruments:
optical fiber multimeter (OFM)

VFL

OLTS, light sources & power meters

OFM

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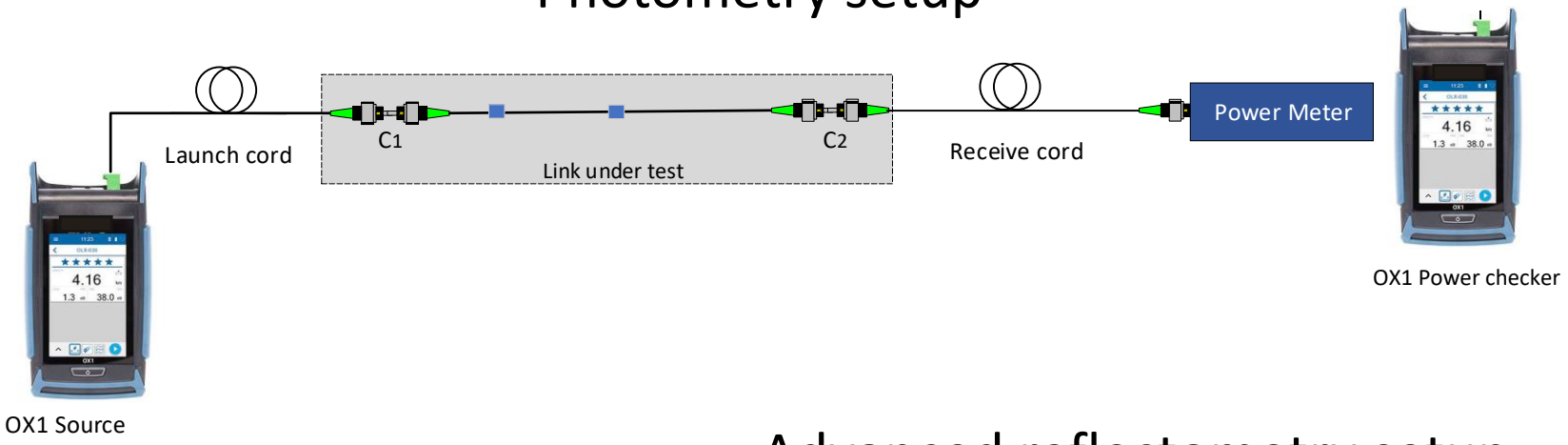
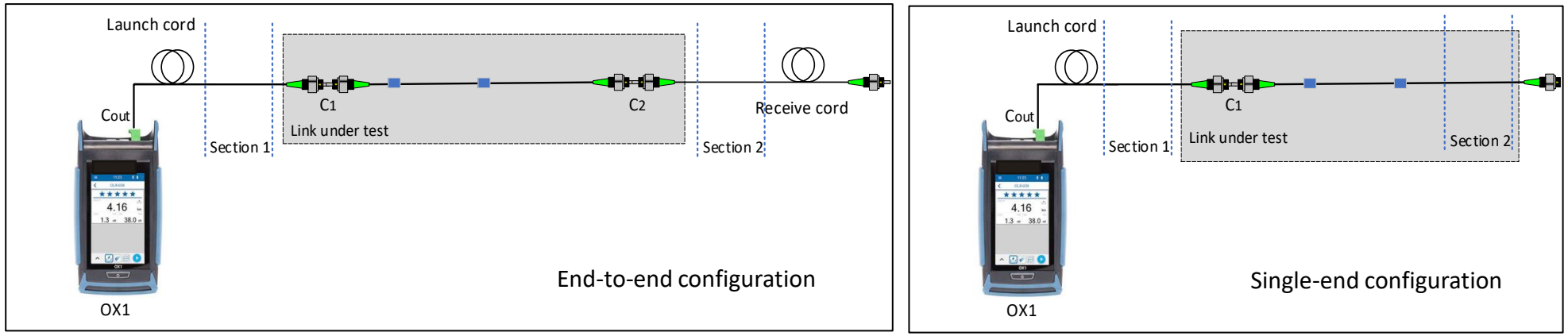
Photometry setup

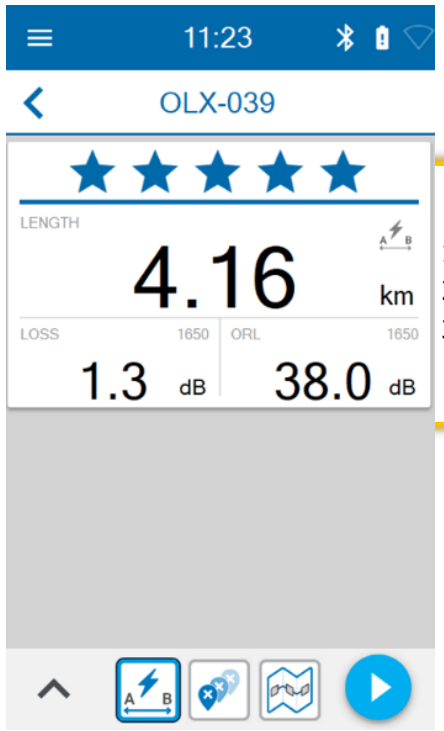


Advanced reflectometry setup

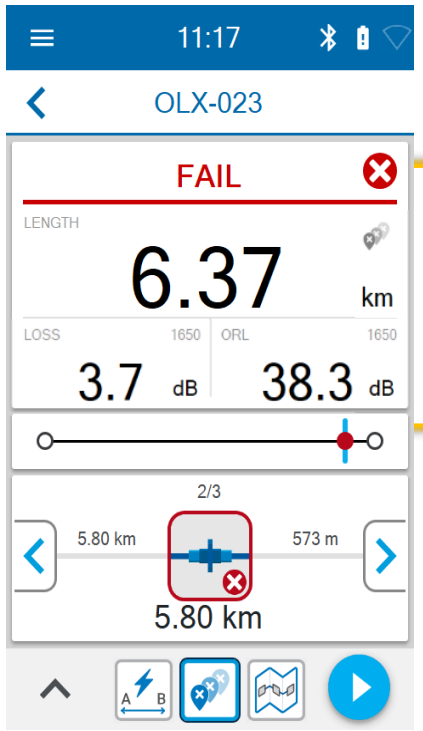


Optical fiber multimeter

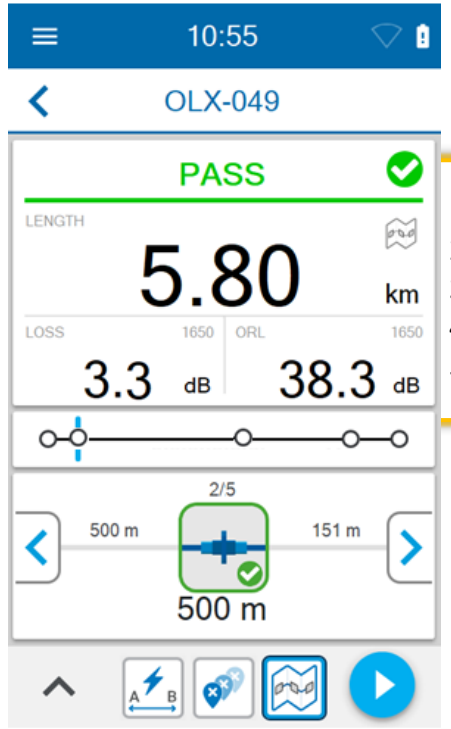
- Enables quick link validation
- Simple interface adapted to various use cases
- Optimized test speed



1. Link quality validation
2. Total loss & ORL
3. Length measurement



1. Link quality validation
2. Fault tracking
3. Total loss & ORL
4. Length measurement



1. Link quality validation
2. Fault tracking
3. Basic link mapping
4. Total loss & ORL
5. Length measurement

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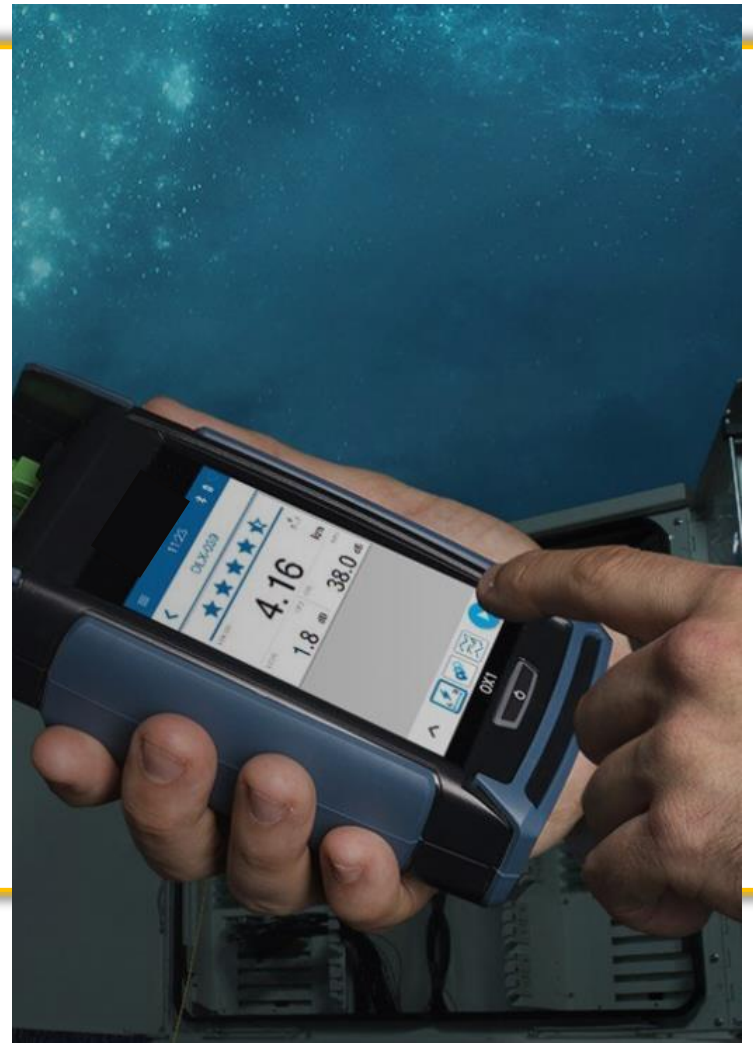
Optical fiber multimeter: pros/cons

Ideal for verification and fault tracking

Strengths:

- Fast
- Fully automated
- No reference
- Accurate (E2E and faults)
- Basic link mapper
- Photometry and advanced reflectometry



Weaknesses:

- Limited to 40 km
- Not designed to characterize a link, link map provides detectable elements and may miss small events

Recap

MPO Connectors

Best practices for:

1. Inspection
2. OLTS testing
3. References
4. Polarity validation
5. End-to-end certification

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THANK YOU

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