

Fiber inspection technical poster



No. 1 cause of network failures is contaminated connectors.
* NTT-Advanced Technology Research

AN OUNCE OF PREVENTION IS WORTH A POUND OF CURE
If a chain is only as strong as its weakest link, then fiber networks are only as strong as their weakest connector. It is therefore critical to ensure that they are free of contamination and working properly.

- Prevent optical network failures
- Avoid permanent connector damage
- Ensure more accurate testing results
- Decrease unnecessary connector replacements
- Lower maintenance costs
- Future-proof your network for upcoming 40G to 800G or higher speeds expansion

Common fiber connector types

EXFO has the largest range of tip adapters in the industry to match any connector, in any setting. Common types of connectors include:

Single-fiber connectors			Duplex connectors		
Connector	APC	UPC	Connector	Jumper	Bulkhead
SC simplex			LC/UPC duplex		LC/UPC duplex bulkhead adapter
SC duplex			LC/APC duplex		LC/APC duplex bulkhead adapter
FC simplex			SN duplex		SN bulkhead adapter
ST simplex			CS duplex		CS bulkhead adapter
E2000 simplex			MDC duplex APC		MDC bulkhead adapter
E2000 duplex			Q-ODC duplex		
MU simplex					
MU duplex					
LC simplex					

Multi-fiber connectors			FTTx connectors		
Connector	Jumper	Bulkhead	Connector	Plug	Socket
MPO-8/12/16/24/32/48/64 APC			DLX connector		
MPO-8/12/16/24/32/48/64 UPC			OptiTap® (OptiSheath®) multiport terminal, in-line tether extender or flexible service terminals		
SN-MT/APC			Coming Evolv® solution with Pushlock™ technology		
Evolv® multifiber Pushlock™			Outdoor connector ODC-2 fibers		
CommScope SYSTEMAX			Outdoor connector ODC-4 fibers		
MPO-MT Ferrule UPC		RAC-MPO-12-MT	Outdoor connector ODC-12 UPC		
MPO-MT Ferrule APC		RAC-MPO-12-MT	Outdoor connector Q-ODC-12 APC		
MMC APC 12/16/24		MMC bulkhead adapter	Outdoor connector Q-ODC-12 APC		
opticalCON MTP® 12/16/24/48 APC			Q-ODC duplex		
opticalCON MTP® 12/16/24/48 UPC			OptiTap® and HMFDC Up to 12 fibers		
			IP9-MPO		
			FastConnect MPO/APC		

APC: Angled-polished connector
UPC: Ultra-polished connector

SEE THE FULL GUIDE TO TIPS, SMARTIPS, AND ADAPTERS

Connector issues

Dust/dirt residue

- If not cleaned properly, residues will transfer and can lead to permanent damage when mating
- Soil, such as sand and dust, can chip ferrules when mated and lead to permanent damage

Wet residue

- Most often caused by an incorrect cleaning technique—fibers must be carefully dried after a wet cleaning

Oily residue

- Most often caused by touching with fingers—technicians must never touch fiber ends
- An oily residue may act as a matching gel:
 - May not affect insertion loss (IL) and optical return loss (ORL) in the short term
 - May trap dust and increase IL and ORL over time

Circular residue

- Most often caused by an incorrect cleaning technique
- Occurs when fiber is mated while still wet
- Typically happens in the contact area
- Contamination will migrate from male to female fiber ends

Adhesive region defects

- May occur during the manufacturing process or from mishandling
- Epoxy residue and chips may occur in the adhesive region
- Normal if size does not exceed standards

Dirty/damaged connector

- Most often results from poor handling or cleaning
- Defects appear small, but may still affect network performance and fail inspection criteria

Scratches

- May appear as light or dark defects
- May be hard to see with the naked eye
- Critical when in the core area of singlemode fibers

Wipe on a shirt

- Inexperienced technicians use their clothes to "clean" a fiber connector
- While common, this issue is often not taken seriously; teaching the best practices will prevent it

Chips on connector or in cladding

- Drywall dust, concrete dust, sand, etc.
- Can damage the endface when pressure is applied to mate the connectors

Solutions



Single-fiber inspection

Connector checker

- Provides a fast verdict
- Does not provide connector image
- Easy to use
- Standalone rugged design

Connected inspection

- Available in wired or wireless models
- Connects to a phone or platform for image viewing
- Fully automated with fast pass/fail verdict
- Inspects male and female connectors
- Very secure, no direct eye exposure to laser radiations
- Requires many manipulations
- Final result still subject to human interpretation

Duplex and multi-fiber inspection

Standalone versatile inspection

- Image viewing on embedded screen
- Quick-connect mechanism to switch from single- to multi-fiber or connector type (including VSFF)
- Fast automated pass/fail verdict
- Easy to use
- Long-lasting battery ~ 11-hour autonomy

Where to inspect/clean

The following items should always be on your inspection/cleaning list:

- Patch panel (e.g., splitter cabinet)
- Test jumpers
- Cable connectors

When to clean

The very first step is connector inspection. This applies to all testing phases—construction, activation and maintenance. **Connectors should be cleaned only if the inspection reveals that they are dirty.**

How to inspect

Using a manual inspection probe.

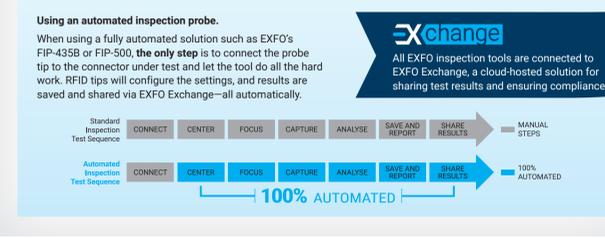
1. Connect the probe to the connector and select the corresponding IEC standard.
2. Set magnification to high.
3. Find the fiber image, center it and adjust the focus.
4. Start the analysis using the Capture button.
5. View the Pass or Fail result.
6. Clean or replace the connector depending on the result.
7. Save the analysis report.

Using an automated inspection probe.

When using a fully automated solution such as EXFO's FIP-435B or FIP-500, the **only** step is to connect the probe tip to the connector under test and let the tool do all the hard work. RFID tips will configure the settings, and results are saved and shared via EXFO Exchange—all automatically.

EXchange

All EXFO inspection tools are connected to EXFO Exchange, a cloud-hosted solution for sharing test results and ensuring compliance.



Connector inspection criteria

Standards-based criteria

IEC 61300-3-35 (Ed. 2 and Ed. 3)
Fiber-optic interconnecting devices and passive components—basic test and measurement procedures
webstore.iec.ch

IPC 8497-1
Cleaning methods and contamination assessment for optical assembly
www.ipc.org

A connector endface has multiple zones

- Dimensions will depend on the connector and fiber type
- Multimode and singlemode connectors have different sizes
- Zone tolerances will differ

Multimode

Adhesive (120-130 µm)
Core (6-55 µm)
Cladding (65-120 µm)
Contact (130-250 µm)

Singlemode

Adhesive (120-130 µm)
Core (9-25 µm)
Cladding (25-120 µm)
Contact (130-250 µm)

IEC zone sizes for PC polished connectors, multimode fibers
IEC zone sizes for polished connectors, singlemode non-dispersion shifted fiber, RL ≥45 dB

Connector endface pass/fail analysis

Thanks to the powerful processing capabilities of EXFO test platforms, technicians can perform IEC and IPC automatic pass/fail analysis via ConnectorMax, the most powerful field-analysis tool on the market. In just a few seconds, a full connector certification test is performed and a test report is generated. All this at the touch of a button, no training required.

ConnectorMax

- Guarantees a uniform level of acceptance:
 - Between users within an organization
 - Between suppliers and customers
 - Between contractors and network operators
- Facilitates the decision-making process by removing subjectivity

No tip swapping: Save time and manipulations

The ConnectorMax fiber inspection probe series uses the same tip to inspect a patch panel and a patchcord.

Bulkhead inspection

1. Connect the bulkhead tip to the inspection probe.
2. Inspect the patch-panel connector.

Patchcord inspection

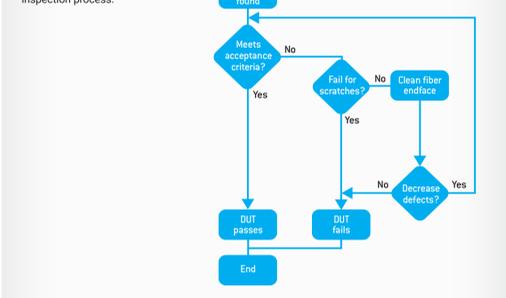
1. Connect the mating adapter to the patch cord.
2. Inspect the patch-cord connector.

Cleaning connectors

Suggested inspection/cleaning procedure

If the fiber fails inspection, the user shall clean the fiber and repeat the inspection process.

Quick tip
Always clean twice before rejecting a connector.



Boost accuracy with autofocus

Ever heard of false-positives?

Have you ever noticed that some failing connectors can result in a pass verdict if the analysis is performed on an out-of-focus image? This is called a false-positive result.

VS

Focus protection

- Ensures that each connector image is captured with maximum quality
- Boosts the accuracy and repeatability of inspection test results
- Facilitates the identification of defects
- Prevents false-positives

Automatic focus adjustment and optimization

Autofocus

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Contaminated/Defective connectors

- 1. Impact on higher data rates**
Higher speed networks (e.g., 100G, 400G, 800G), such as in data centers or high-speed transport networks, have very limited loss budget. 1 or 2 dB loss from a dirty/bad connector can lead to link failure.
- 2. Impact on general test results**
Since dirty connectors typically exhibit more reflectance and loss, the ORL and IL readings taken by an OTDR, OLTS or PM/LS will be higher. Every system has a maximum ORL and loss, and clean connectors help keep reflectance at a minimum (e.g., single Raman-amplified systems).

Contaminants in a connection will impact reflectance and loss.

Before cleaning

Acceptable values for loss at 1310/1550 nm are:

- Less than 0.25 dB connection (industry average)
- Less than -50 dB reflectance if UPC, less than -65 dB if APC

After cleaning

3. Impact on OTN bit error rate tests (BERT)

Dirty connectors affect the signal-to-noise ratio at the receiver, and most PIN receivers react the same way to noise (i.e., a proportional increase in BERT).

- Erratic readings during 100G/400G OTN BERTs
- Forward error correction (FEC)
- Alarm indication signal (AIS)
- Backward defect indicator (BDI)
- Unnecessary Tx/Rx troubleshooting

FIP-500 SmarTips

Fastest inspection in the industry for duplex, single-fiber, and multi-fiber connectors.

Did you know?

By tapping your SmarTip on the FIP-500, pass/fail thresholds will be automatically adjusted to the type of connector under test. This remarkable level of automation prevents threshold selection mistakes, making fiber inspection easier than ever!

Innovative quick-connect mechanism

Swap tips in a quarter-turn click—a game-changing innovation. No loose parts, not a second wasted. Tip switching can be done with one hand, if needed. It has never been easier to swap between single-fiber, duplex and multi-fiber tips.

Lightwave Innovation Reviews

4.5

ConnectorMax solutions: Testing capability chart

Features	USB wired	Wireless	Autonomous		
	FIP-410B	FIP-420B	FIP-435B	FIP-200	FIP-500
Image capture	•	•	•	•	•
Five-megapixel CMOS capturing device	•	•	•	•	•
Automatic fiber image-centering function and focus adjustment	•	•	•	•	•
Automatic fiber image-focus adjustment	•	•	•	•	•
Onboard pass/fail analysis	•	•	•	•	•
Pass/fail LED indicator	•	•	•	•	•
USB connectivity to an EXFO platform or PC	•	•	•	•	•
Wireless connectivity to an EXFO platform or PC	•	•	•	•	•
Wireless connectivity to a smartphone	•	•	•	•	•
Semi-automated multifiber/MPO inspection	•	•	•	•	•
Fully automated multifiber/MPO inspection	•	•	•	•	•
Onboard touch screen and data storage	•	•	•	•	•
SmarTips with automated thresholds and quick-connect mechanism	•	•	•	•	•

Dirty cleaning

Dry cleaning using a mechanical cleaner is recommended as the first step. If, after two dry cleaning attempts, soil is still present on the connector, try hybrid cleaning.

Single-fiber mechanical cleaner (male/female)
Multifiber mechanical cleaner (MTP/MPO) (male/female)
Patch-cord mechanical cleaner (female only)

How to dry clean

Insert the jumper and push the outer shell to begin cleaning. A click sound will indicate that the cleaning is complete. Some mechanical cleaners are compatible with male and female jumpers as well as with MPO and other connectors.

Hybrid cleaning

Hybrid cleaning is a mix of the wet and dry cleaning methods and involves using a solvent. The first step is to clean the connector endface with a solvent and then dry any remaining residue with either a wipe or a swab.

If, after using the hybrid cleaning method, the connector still fails to meet the acceptance criteria, consider replacing the connector.

Cleaning pen
Used to dispense optical grade solvent to clean optical connectors

Cleaning swabs
Used to clean the inside of female connectors and adapters

Lint-free wipes
Used in dry cleaning procedures and also used to dry off any solvent

How to clean using the hybrid method

1. Wet a corner of the wipe with solvent.
2. In a smooth linear motion, trace the endface of the jumper twice over the wet area.
3. In a smooth linear motion, trace the endface of the jumper three times over the dry area.

SEE THE FULLY AUTOMATED PROBE IN ACTION

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