

Gigaclear Documentation

Optical Build and Testing Standard

Optical Time Domain Reflectometry (OTDR) and EXFO iOLM Standard Operating Procedure

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2. Scope and Purpose

This document explains the standard process for performing tests based on optical time-domain reflectometry (OTDR) testing methodologies, including the EXFO proprietary iOLM (intelligent optical link mapper) test, on the Gigaclear network. When working on the network, this document must be read alongside:

- the Optical Build and Testing Standard document
- the Fibre Inspection and Cleaning SOP
- the Gigaclear Health and Safety policy and relevant documents

Equipment required for the execution of this SOP is covered in the Optical Build and Testing Standard document. This document also covers important information about fibre hygiene that should be observed carefully when performing OTDR tests.

3. Risks and Safety

Working on Gigaclear's network generally involves outdoor work at the roadside. **Risks, hazards, required PPE and safe working practices are covered in Gigaclear's civils documentation and this document should be read alongside the civils documentation for a full view of the risks.** This document will only discuss hazards specific to fibre optic working.

Additional risks encountered while cleaving, splicing, cleaning and testing fibre include:

- Risk of fibre shards and sharps contaminating clothing or coming into contact with skin
- Risk of fibre shards or sharps being ingested, causing internal damage
- Solvent risks from the use of isopropyl alcohol and similar chemicals
- Optical risks from the use of test equipment or active equipment connected to fibre
- Risk of gas near ducts and buried assets

Gigaclear recommends contractors conduct a risk assessment for all activities; at a minimum the following PPE is required, in addition to civils PPE appropriate to the site:

- Safety goggles or glasses with side shields to be used when cleaving or splicing fibre
- Gloves (latex or nitrile) to be worn when cleaving or splicing fibre
- Sharps bins must be used for disposal of waste when cleaving or splicing fibre
- Overalls or disposable aprons used to minimise risk of fibre sharps contaminating clothing
- Laser safety glasses when working on live fibre that may carry high power

Whenever work is being done on a fibre, no matter when the work is done, fibres **must be treated as live**, and therefore unsafe to observe. This must be strictly enforced by contractors to ensure the safety of operatives working on the network. The ends of fibres must always be kept at least 30cm from the eye to avoid eye damage from live fibre.

Gigaclear generally uses low-power (<3dBm), short-range optical transceivers. These have few safety implications in and of themselves. However, Gigaclear also operates high power (~24-30dBm, Raman amplified) transmission systems. These systems are equipped with safety cut-out devices, but these must not be relied upon to ensure the safety of operatives, as automated restart procedures can still result in short pulses (eye-safe without magnification or focusing). These systems are used across Gigaclear's network, including access segments, so **all fibres must be treated as if they were carrying high power transmission systems. Optical microscopes must never be used anywhere in the network, and direct viewing of fibre ends must never be performed.**

The highest moments of risk are when cutting, stripping, cleaving, and splicing fibre, as well as when inspecting connectors. During these phases, care should be taken to keep fibres well away from the eyes, so that reflected or emitted light remains at a safe level and sharps are kept away from the face. Indirect viewing, such as using the screen on an automated inspection microscope, or the alignment microscope in a fusion splicer, should be used to inspect fibres when needed.

Always treat fibres as live!

Never view the end of a fibre or connector endface directly – use an automated inspection microscope with a camera to check connector cleanliness safely

4. Preparation and Materials

4.1. Documentation and Location

Before starting work, ensure that you are at the correct site. Check the site's label and location. If your work requires you to disconnect fibres in use, ensure you have notified the network operations centre and have any required permissions to begin work.

Fibre inspection reports are typically performed using EXFO TestFlow, using an EXFO Max-Tester. This allows Gigaclear to provide the pre-labelled tests to be performed, along with the test configuration and pass/fail thresholds.

For tests that are being performed in an ad-hoc manner or where tests are performed prior to connecting further test equipment or active equipment, TestFlow is not required. However, fibre hygiene and cleaning processes must be performed, and pass/fail checks should always use Gigaclear configurations.

4.2. Equipment Preparation

Refer to the Optical Build and Testing document, section 6, for more information about what equipment you will need to take with you to site. Particularly, check which inspection probe tips and launch/receive leads you will need and make sure you take them to site.

Before testing, ensure that you have configured your tester and inspection probe in accordance with the configuration guidance.

4.3. Consumables

Unless fibres are being tested immediately before connection, once testing has been performed the dust cap must be replaced. It is recommended that contractors take spare dust caps to site, of both bulkhead and connector types, and keep them in a clean condition prior to fitting.

Cleaning is likely to be required when performing OTDR tests; swabs, wipes, isopropyl alcohol and one-click cleaning devices are likely to be required. Refer to the main optical build and test standard document for a comprehensive list of cleaning supplies.

5. Process

5.1. Site Preparation

5.1.1. Paperwork and Consumables

Testing is a two-site, two-person task. Communication between sites will be required throughout the process; ensure that mobile phone numbers have been exchanged between engineers or make alternative arrangements for communication (fibre talk set, radio, etc).

Ensure that you have all the consumables and launch/receive leads required to complete the whole job without leaving site.

Proceed to the sites and proceed with the site arrival process.

5.1.2. Safety of Site

Ensure that the sites are safe to work at, and will remain safe as you work, by setting out required roadwork and pedestrian guarding. This must include any required signage to indicate the safe route for vehicles and pedestrians. Make sure your vehicles are parked safely and considerately.

You must refer to Gigaclear's HSE policy for the current information on safe working at the road-side, as well as the required safety equipment

5.1.3. Cabinet and Chamber Access

Open the cabinet or chamber being worked on, making sure to check in to the site with the Network Operations Centre (NOC) if required.

When working on connectorized closures, be sure to draw the closure out carefully to a location it can be worked on safely, rather than working on the closure in situ.

It may be appropriate to erect a tent if the weather is poor to avoid rain being blown into equipment or fibre ends.

5.2. Performing OTDR tests

The process of performing an OTDR based test is always the same, regardless of the exact test method used (iOLM or OTDR). The fibre under test is connected to the tester via a launch lead, and to a receive lead at the far end. The use of both launch and receive leads allows the tester to "see" both the first and last connector in the link and for operators to prove continuity. If the receive lead cannot be seen by the tester, it indicates that splicing has at some point been performed incorrectly.

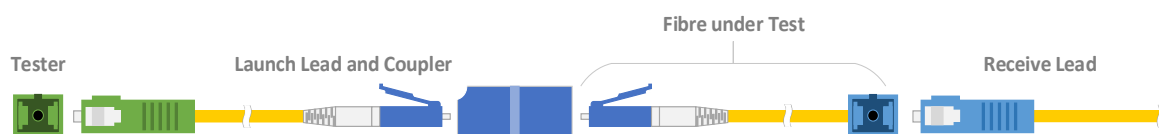
The typical configuration of cables required for a fanout-to-CDC test is shown below:



Where a patch panel is present in the active cabinet the typical configuration is simplified:



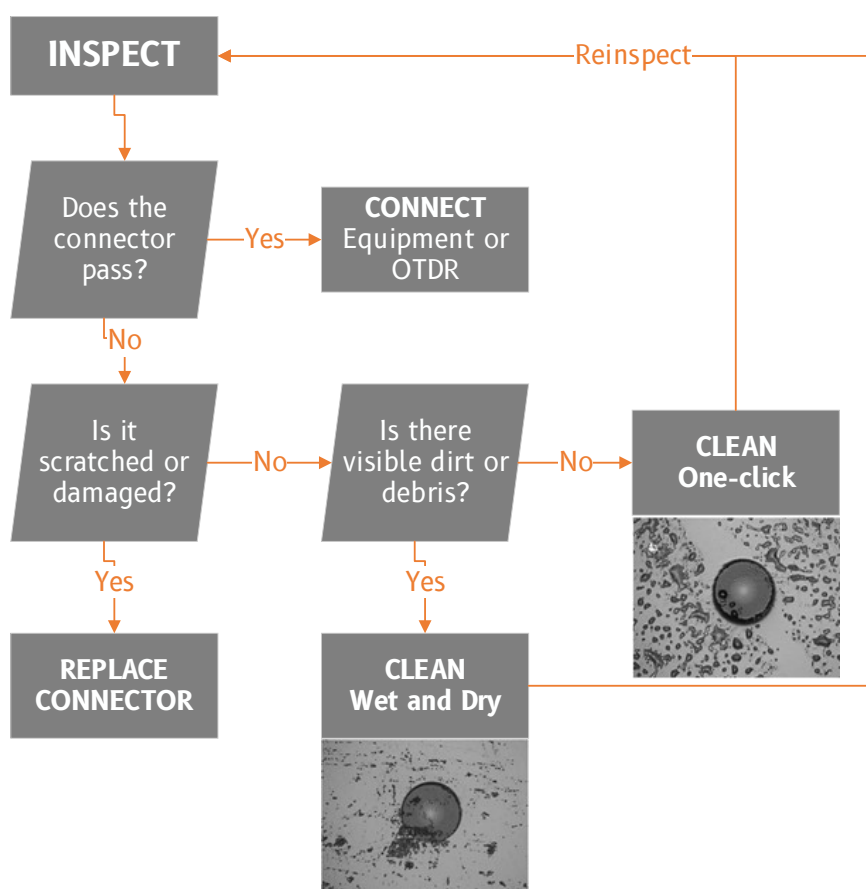
For older network areas where a microclosure is the target, an SC/UPC receive lead will be required.



5.2.1. Fibre Hygiene

The most important part of OTDR testing is to ensure the cleanliness of fibre connectors before connections are made. Because connections are made to all of the network, there is a very good chance of causing damage through cross-contamination of the network.

For this reason, care must be taken to inspect and, if needed, clean and reinspect *all* connectors before connecting to test. The launch lead's "fibre under test" end must be kept clean and should be periodically reinspected between tests to ensure no dirt has migrated onto the connector.



ALWAYS TREAT FIBRES AS LIVE

Optical microscopes must never be used on the Gigaclear network!

Do not bring optical microscopes to site. Do not have them in your toolbox. Do not allow your colleagues to use them. They are unsafe, and can cause instant, permanent blindness if used to observe a live fibre. Damage an inspection probe, not your eye!

ALWAYS USE AN AUTOMATED INSPECTION PROBE

5.2.2. Lead and tester checkout

Before connecting your launch or receive lead to your tester, inspect the test connector with an automated inspection probe. Clean and reinspect if required.

Immediately inspect, and if required clean and reinspect the launch lead's tester end. Once clean, attach it to the tester. This connection should not be broken from this point on in the testing, so as to minimise the risk of damage to the tester.

Inspect, and if required clean and reinspect the launch lead's fibre-under-test end.

If a coupler is required (e.g. to test to a fanout cable) then attach this and reinspect. If required, clean the connector to remove any debris or dirt that may have been introduced by the coupler.

Place the launch lead to the side, making sure that it is not re-contaminated before connecting. Do not affix a dust cap unless the lead is not to be used for some time, as dust caps can reintroduce contamination. Reinspect the connector after removing a dust cap.

5.2.3. Receive lead connection

At the far end, the same process should be followed for the receive lead; inspect and if required clean and reinspect the receive lead's fibre-under-test end.

Place the receive lead to the side, making sure that it is not re-contaminated before connecting. Do not affix a dust cap unless the lead is not to be used for some time, as dust caps can reintroduce contamination. Reinspect the connector after removing a dust cap.

5.2.4. Test procedure – using TestFlow

Close the CMax2 software on the tester/phone and open the TestFlow software. Log in if not already authenticated and select the job you are attending.

Identify the fibre under test based on the test selected and the identifiers shown. The test should list three sub-tests – one fibre connector inspection test at each end, and one iOLM test. Ensure that "Run test in background" is disabled in the User Preferences window.

Report generation can slow down testing considerably!

You should check that under "User Preferences -> General -> File Functionalities", the "Export Bellcore file on save" and "Generate report on save" options are unchecked. These options are not required for TestFlow to function.

Use the FIP sub-tests to run the fibre inspection test for each end of the fibre under test. Connect your microscope to the fibre connector, and press the circle corresponding to the test. If the test fails, clean and repeat the test until it passes. If the test cannot be made to pass after several cleaning attempts due to scratches or other damage, the connector should be replaced or repolished and that fibre test skipped.

Once the FIP test has passed, the launch or receive lead should be immediately connected. If there is any concern that the launch or receive lead may have been contaminated it should be reinspected and cleaned as necessary.

Once the launch and receive cables are attached, click the circle corresponding to the iOLM job. When running the first job of the day, ensure that length values for launch and receive cables are set correctly. Run the test and click the TestFlow icon to return to the test list.

Leave the launch and receive cables connected until the next fibre to test has been located and inspected. Once the launch and receive cables are attached to the next fibre, fit dust caps to the fibre that has just been tested.

5.2.5. Test procedure – ad-hoc iOLM

The process for ad-hoc iOLM testing is nearly identical to the TestFlow process.

However, the identification fields in both ConnectorMax2 and iOLM test software must be manually set and the test configuration for both applications must be correctly set. If you have used TestFlow on the device, then Gigaclear's configurations should be present in the test configuration menu; simply select the appropriate configuration for your test. Otherwise, you will need to install the Gigaclear configuration files manually or via EXFO Connect.

5.2.6. Test procedure – ad-hoc OTDR

OTDR testing is an advanced procedure that is not generally used by Gigaclear due to the complexity of interpreting results and the potential for missing event information by incorrect configuration of testers. Generally, technicians performing OTDR testing should be appropriately trained.

However, OTDR testing can be performed with the following settings for a generally satisfactory result:

- Pulse width: $0.5\mu s$ – $5\mu s$ for access network spans, $10\mu s$ – $30\mu s$ for aggregation network spans; generally, multiple pulse widths will need to be acquired to fully capture detail across most spans.
- Acquisition duration: minimum 30 seconds, longer as required. The end of fibre (a final reflective event) should be clearly visible above any noise floor; 60 seconds is recommended.
- Range: Select a setting approximately one and a half times the expected length of fibre, including launch/receive leads, or the next range option above that distance
- Launch and receive fibre lengths should be set correctly in the extended settings
- First connector checking should be enabled

Identification of tests should be configured as per the ad-hoc iOLM procedure.

5.2.7. Finishing testing

Once all tests are complete a final check should be conducted to ensure dust caps have been affixed to all connectors in each site. Never leave fibre connectors or bulkheads without a dust cap.

5.3. Site Closure

5.3.1. Cabinet/Chamber Closure

Close the cabinets or chambers, ensuring that mating surfaces are clean and any locks are fully engaged and secure.

If a closure was accessed to reach the connectors, ensure the O-ring is clean and the sealing surfaces are free of debris before resealing.

5.3.2. Site Closure Paperwork

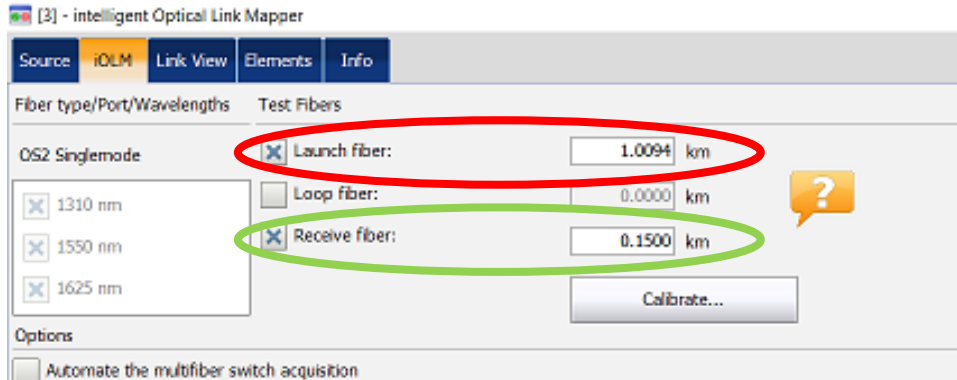
Once all works are complete, clear your sites up and remove any barriers.

Complete any required paperwork such as your JSSP.

Ensure the site is clean and clear, and all waste has been recovered.

6. Appendix – EXFO iOLM Configuration

The most important parameter to set correctly when using iOLM is the launch and receive cable lengths. These can be found in the “iOLM” tab of the iOLM application:



You should use the “Calibrate” button to measure the lead lengths where possible, as this will lead to the most accurate measurement of cables.

7. Version History

Version	Date	Notes
1.0	2019-06-21	First issue