Qualifying FTTH Network before Equipment Installation

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Introduction

This document sets the test requirements for qualifying the fiber portion of a fiber-to-the-home (FTTH) network prior to equipment installation and turn-up. The steps for this stage are:

- testing connectors and connections
- qualifying the loss, optical return loss (ORL), and distance of the link, using either an optical time domain reflectometer (OTDR) or loss test set

Various access points can be used in qualifying the FTTH network as Figure 1 shows.

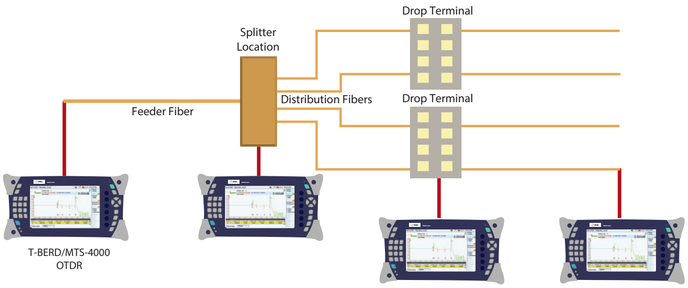

Figure 1. Possible access points for FTTH network qualification

Connection Qualification of the Link

Contamination is the #1 cause for troubleshooting in optical networks.

A single particle mated into the core of a fiber can cause significant back reflection (also known as return loss), insertion loss, and equipment damage. Visual inspection is the only way to determine if fiber connectors are truly clean before mating them.

Implementing a simple yet important process of proactive visual inspection and cleaning can eliminate poor optical signal performance and avoid potential equipment damage. Therefore, Viavi recommends using an inspection scope to carry out this process.

Fiber Connector End Face Inspection Zones

Inspection zones reveal a series of concentric circles that identify areas of interest on the connector end face. The inner-most zones are more sensitive to contamination than outer zones.

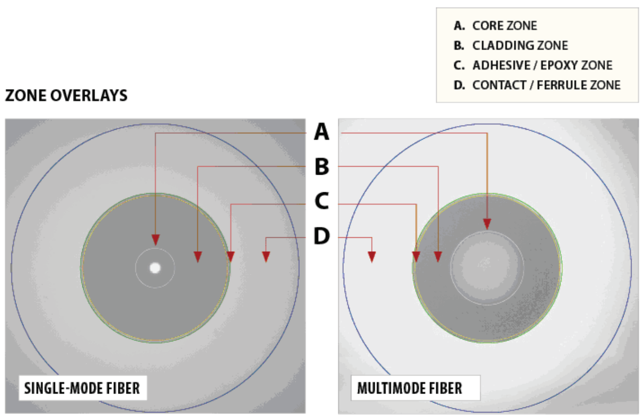

Figure 2. Fiber connector end face inspection zones

Several commonly known fiber end face defects are contamination, particles, pits, chips, scratches, loose contamination, and embedded contamination.

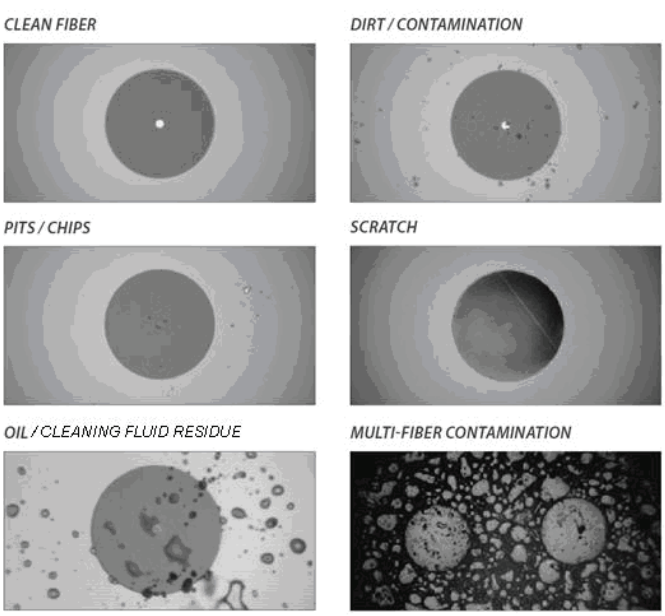

Figure 3. Fiber connections and various connector end face views as seen through an inspection scopeIdeally the fiber end face should be free from defects or scratches as Figure 4 shows.

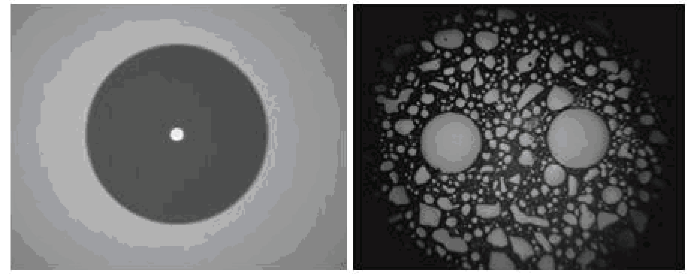

Figure 4. Microscopic views of clean connector end facesFiber Connector Inspect/Clean/Connect Process

Visually inspecting the fiber interconnects is the only way to determine if connectors are clean prior to mating them. A video microscope can magnify the connector end face image for viewing on either a laptop or portable display depending on the product used.

The Inspect/Clean/Connect Process Flow is described below and illustrated in Figure 5.

INSPECT Select the appropriate tip for inspecting the connector/ adaptor.

Using the microscope, inspect both connector end faces (patchcord/bulkhead/pluggable interface).

IS IT CLEAN? **No.** Close inspection shows defects on the end face.

CLEAN Clean the connector using a cleaning tool designed for cleaning optics.

CONNECT **Yes.** If non-removable, nonlinear features and scratches meet acceptance criteria limits according to IEC standard IEC 61300-3-35, connect the fiber interfaces.

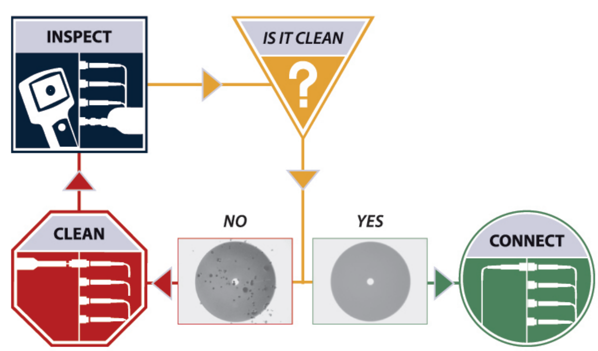

Figure 5. Optical connector Inspect/Clean/Connect Process

Optical Fiber Interface Inspection

Inspecting fiber end face can be performed using two different methods. If the cable assembly is accessible, you can insert the connector ferrule into the microscope to conduct the inspection, which is generally referred to as a patchcord inspection. If the connector is within a mating adaptor on the device or patch panel, insert a "probe" microscope into the open end of the adaptor to view the connector inside; this is known as inspection through the bulkhead/adaptor connector.

Patchcord Inspection

Select the appropriate tip that corresponds to the connector type that you wish to inspect and attach it onto the microscope.

Insert the connector into the tip as shown in Figure 6 and adjust the focus to inspect.

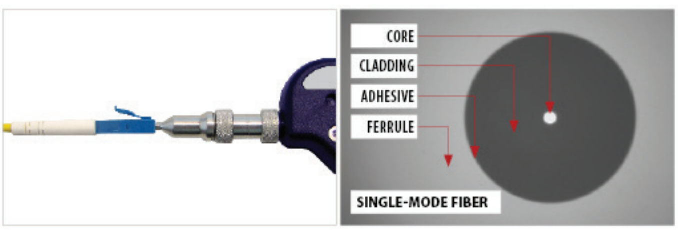

Figure 6. Patchcord microscope inspection

Inspection through the Bulkhead/Adaptor Connector

Select the appropriate tip/probe that corresponds to the connector type for the bulkhead or adaptor connector you wish to inspect and attach it to the probe microscope. Insert the probe into the bulkhead or adaptor connector and adjust the focus to inspect.

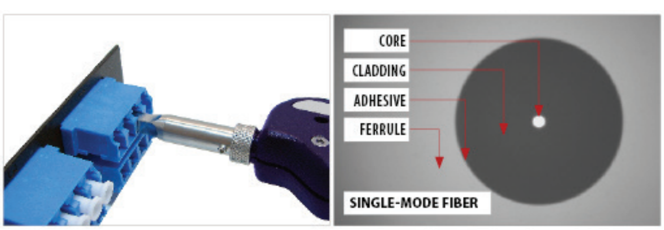

Figure 7. Microscope Inspection through the bulkhead/adaptor connector

Cleaning Optical Fiber Interfaces

General principles of optical interface cleaning:

- Optical components such as connectors and transceivers must be clean to work optimally or, in some cases, at all.
- Use of connector end caps can prevent damage, however, they do not ensure cleanliness.
- Foam and cotton materials are unsuitable for cleaning optics as they can break down and deposit debris on the optical end face.
- Compressed air is ineffective in cleaning optical connectors or transceivers.
- Avoid using a hard surface to clean against because it can damage the connector. Use cleaning tools designed specifically for optics because they have a firm, yet yielding, backing.
- Use a dry cleaning method first before attempting to use solvents. Most cleaning solvents including Isopropyl Alcohol (IPA) leave unacceptable residue if not applied and used correctly. Instead use a solvent or IPA designed specifically for optics such as a 70-percent IPA Medi-swab.
- Do not saturate the optical interface with solvent. Always follow solvent applications with a dry cleaning process.
- Cleaning machines that use solvent without mechanical action may be exempt from the above precautions regarding overuse of solvents.
- Inspect before you connect. Every time. This is the only way to ensure that interconnecting optical fiber interfaces are acceptable for mating.

Cleaning Wipes and Tools

Dry Cleaning

Simple dry cleaning wipes including many types of lint-free wipes and other purpose built wipes are available. This category also includes purpose built optical fiber connector cleaning cassettes and reels, such as Cletop cartridges. Figure 8 shows the various types of dry cleaning wipes and optical fiber connector tools available.

Warning! Exposed wipes can easily become cross-contaminated in the field. Protect cleaning materials from contamination until just prior to use. Use wipes in your hands, on a soft surface, or resilient pad. Using wipes on a hard surface can cause damage to the fiber. Do not use the surface of the wipe that you have handled as this now can contain finger grease residue.

Figure 8. Examples of dry cleaning wipes and tools for optical fiber connectors

Damp Cleaning

- Cleaning fluids or solvents are generally used in combination with wipes to provide a combination of chemical and mechanical action to clean the fiber end face, as examples in Figure 9 show. Pre-soaked wipes supplied in sealed sachets are also available such as IPA Medi-swabs.
- Some cleaning fluids, particularly IPA, can leave a residue that can be difficult to remove.
- Cleaning fluid is only effective when used with wipe providing mechanical action.
- The solvent type must be fast drying.
- Follow safe handling procedures.
- Do not over saturate the end face, rather lightly moisten the wipe.
- Clean the ferrule immediately with a clean, dry wipe.
- Do not to leave solvent on the side walls of the ferrule as this will transfer onto the optical alignment sleeve during connection.
- Use wipes in the hand, on a soft surface, or resilient pad. Using wipes on a hard surface can cause damage to the fiber.

Figure 9. Examples of cleaning fluid and wipes

Cleaning Tools for Use through Bulkhead/Adaptor Connectors

This section discusses common methods for cleaning optical fiber end faces that remain within an alignment sleeve, bulkhead/through adaptor, transceiver, or other receptacle type device.

Adaptors within connectors, or insitu, often cannot be readily removed through a bulkhead/adaptor making them, therefore, more difficult to access. This category of adaptors includes ferrule interface (or fiber stubs) and physical contact lenses within an optical transceiver, but does not include non-contact lens elements within such devices.

Sticks and bulkhead cleaners, such as those shown in Figure 10, enable reaching into alignment sleeves and other cavities to clean the end face/lens and remove debris such as moveable nonlinear features. These tools allow for cleaning the end face/lens within the adaptor, or insitu, without removing the bulkhead connector. Prior to cleaning transceivers or receptacles, carefully identify what is within the port first. Use caution when cleaning transceiver flat lenses to avoid possible damage.

Figure 10. Cleaning tools for use through bulkhead/adaptor connectors

Viavi microscopes with their automatic pass/fail analysis capabilities (in compliance with the IEC-61300-3-35 standard) together with the accessories fulfill the purpose of the "inspect before you connect" principle.

Loss, ORL, and Distance Qualification of the Link

Two separate tools are available for loss, ORL, and distance qualification. Which tool to select will depend upon the expertise of the user as well as the complexity of the network.

Networks using video overlay (1550 nm) and high power levels require ORL measurements. Otherwise ORL measurements are optional.

Expert users prefer OTDR test tools, as this is a single-ended test, however the trace analysis of a passive optical network (PON) is quite complex and becomes even more difficult to interpret on complex PONs with cascaded networks and when testing directly from the central office to the customer premises. Furthermore, while the bidirectional OTDR testing method is the measurement of reference within the international standard, unidirectional OTDR testing leads to less accurate loss results, except when the backscattered coefficient of fibers used along the network are similar (see the Bidirectional Analysis chapter of the Reference Guide to Fiber Optic Testing Volume 1 for further information).

Other users prefer loss test set/ORL meters, because of its easy operation and intuitive results analysis. However, this method requires two people to perform the test and at several different locations. Should a problem arise, use of an OTDR is then required to locate/identify the issue along the link. See Figure 11 which illustrates uses of an OTDR in acceptance testing.

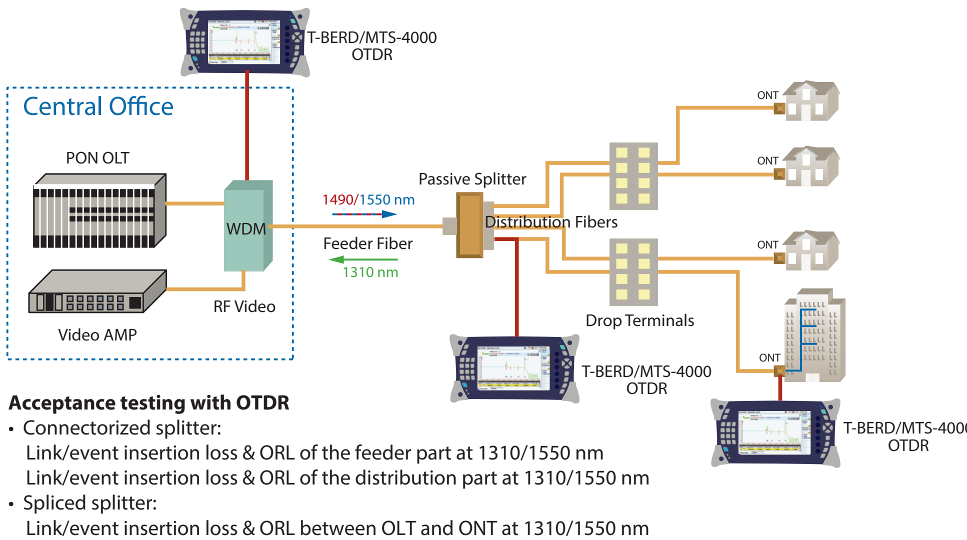

Figure 11. Qualifying a FTTH network with an OTDR

Using an OTDR

In addition to using the OTDR as a qualification tool, it can also be used as a troubleshooting tool to pinpoint issues along the link. Another simple tool that can easily troubleshoot fiber issues is the visual fault locator (VFL), which is the standard tool for fiber testing crews.

OTDR Test Alternative 1: Independently testing the feeder and the distribution cables from the splitter location

First, conduct an OTDR test of the feeder and the distribution cables independently from the splitter location to eliminate a truck roll. This test can easily qualify the network without qualifying the splitter and only validates the splitter(s) connection(s) during turn-up of the system with a power meter.

Performing the measurements with two wavelengths is mandatory to identify possible bends along the link as indicated by higher loss at 1550 nm than at 1310 nm at the bend location.

To fully qualify the network connector at the beginning and at the end of the link, use two 300 m minimum launch cables (launch cable and received cables).

If using a launch cable, connect the OTDR to the launch cable, and then the launch cable to the connector going to the optical network termination (ONT) port. Otherwise, just connect the OTDR to the network. If using a receive cable, also connect it at the other end of the link.

Set the following parameters for the OTDR:

- select the construction (or expert) mode
- select the pulse width between 10 and 100 ns
- select the range for slightly longer than the range of the link
- set the resolution to Auto
- set the acquisition time to 30 s
- set the launch/receive cable, if any

Perform an acquisition using the START key.

At the end of the acquisition, a result screen should appear similar to the one shown in Figure 12 below:

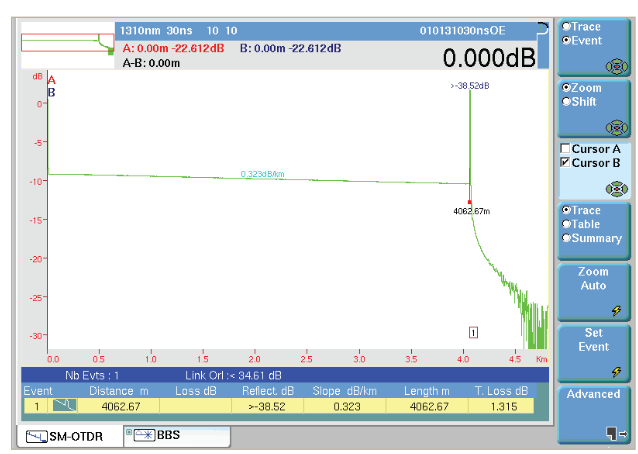

Figure 12. Feeder or distribution cable test only

The short distance of the distribution link limits the number of events displayed on the table (usually one, but there may have also been mechanical splices or connectors along the link as well). The example in Figure 12 shows only one event, which is the closest splitter location.

OTDR Test Alternative 2: Testing from the customer premises/ONT toward the central office/OLT

Perform an OTDR test from the ONT to fully qualify the network between the ONT and the OLT.

For qualifying networks using up to a 1x32 splitter (cascaded or not), we recommend using the Viavi MTS-4000 with its 8126MA 1310/1550 nm OTDR module. For qualifying any type of network (including up to 1x128), we recommend using the Viavi MTS-6000 with its 1310/1550 nm 8126LR OTDR.

Performing the measurements with two wavelengths is mandatory to identify possible bends along the link as indicated by a higher loss at 1550 nm than at 1310 nm at the bend location.

To fully qualify the network connector at the beginning and at the end of the link, use two 300 m minimum launch cables (launch cable and receive cables).

If using a launch cable, connect the OTDR to the launch cable, and then the launch cable to the connector going to the ONT port. Otherwise, just connect the OTDR to the network. If using a receive cable, also connect it at the other end of the link.

Set the following parameters for the OTDR:

- select the construction (or expert) mode
- select the pulse width between 100 and 300 ns to qualify through the splitter, or between 10 and 100 ns to qualify up to the splitter
- select the range for slightly longer than the range of the link
- set the resolution to Auto
- set the acquisition time to 30s
- set the detection of the splitter as Auto
- set the launch/receive cable, if any

Perform an acquisition using the START key.

At the end of the acquisition, a result screen should appear similar to the one shown in Figure 13 below, for distribution qualification only:

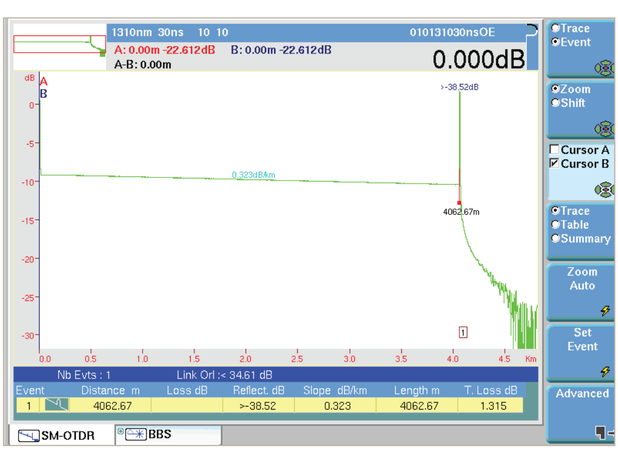

Figure 13. Distribution test only from ONT to first splitter, without launch cable

The short distance of the distribution link limits the number of events displayed on the table (usually one, but there may have also been mechanical splices or connectors along the link as well). The example in Figure 13 shows only one event, which is the closest splitter location.

For complete PON qualification from the ONT:

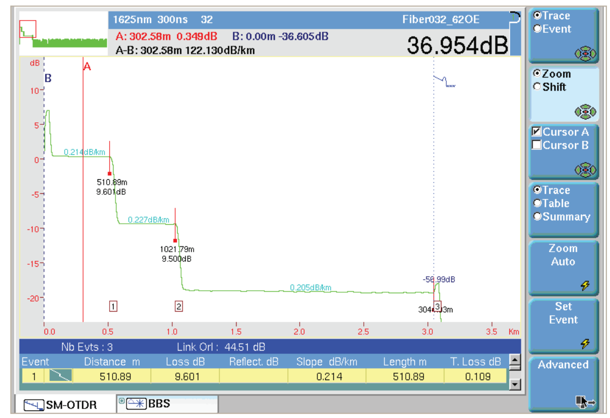

Figure 14. Cascaded splitter network test from ONT, without launch cable

Testing through the splitter provides a table of results with the splitter(s) losses, the fiber end, as well as eventually connector/splice losses.

Figure 14 above shows two splitters, each giving around 9 dB of loss, a typical value for 1x8 splitters with the fiber end at around 3044 meters.

OTDR Test Alternative 3: Testing from the central office/OLT toward the customer premises/ONT

Testing from the central office requires a good understanding of the OTDR trace, because in testing from the central office the OTDR trace displays all the various legs after the splitter without differentiating them along the trace. Therefore, the table of results requires expert interpretation and detailed analysis of the network layout.

For qualifying network using up to 1x32 splitter (cascaded or not), we recommend using the Viavi MTS-4000 with its 8126MA 1310/1550 nm OTDR module. For qualifying any type of network (including up to 1x128), we recommend using the Viavi MTS-6000 with its 1310/1550 nm 8126LR OTDR.

Performing the measurements with two wavelengths is mandatory to identify any possible bends along the link as indicated by a higher loss at 1550 nm than at 1310 nm at the bend location.

To fully qualify the network connector at the beginning and at the end of the link, use two 300 m launch cables (launch cable and receive cables).

If using a launch cable, connect the OTDR to the launch cable, and then the launch cable to the connector going to the ONT port. Otherwise, just connect the OTDR to the network. If using a receive cable, also connect the received cable at the other end of the link.

Set the following parameters for the OTDR:

- select the construction (or expert) mode
- select the pulse width between 100 and 300 ns to qualify through the splitter, or between 10 and 100 ns to qualify up to the splitter
- select the range for slightly longer than the range of the link
- set the resolution to Auto
- set the acquisition time to 30s
- set the detection of the splitter as Auto
- set the launch/receive cable, if any

Perform an acquisition using the START key

At the end of the acquisition, a result screen should appear similar to the one shown in Figure 15 below for
Feeder test only:

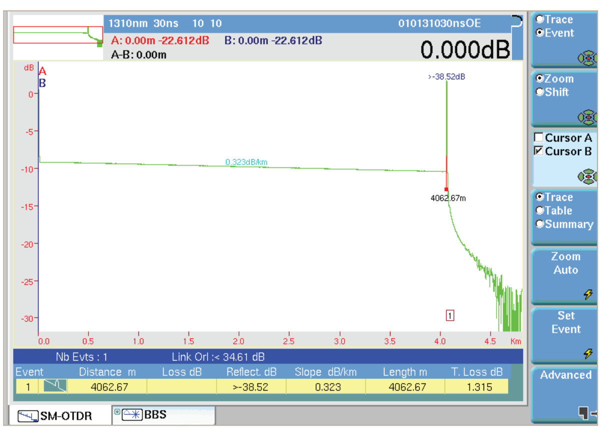

Figure 15. Feeder test only from the OLT to first splitter, without launch cable

The short distance of the feeder link limits the number of events displayed on the table (usually one, but there may have also been mechanical splices or connectors along the link as well). The example in Figure 15 shows only one event, which is the closest splitter location.

Figure 16. Cascaded splitter network test from OLT, without launch cable

Testing through the splitter provides a table of results with the splitter(s), the leg ends (which may not all be shown because they can be at similar distances from the OLT and, therefore, hidden on the OTDR trace), as well as eventually connector/splice locations.

The example above shows two splitters and multiple legs. However, not knowing the exact layout of the network makes it very difficult to interpret the table of results after the first splitter because it does not exactly represent the loss of the individual events (splitters, connectors, leg ends, splices), rather it represents the loss of the individual events together with the results from the other legs.

Therefore we are left to analyze the information from feeder to the first splitter, and then the distances of the following events that are shown in the OTDR trace and eliminating their losses provided in the table of results.

Result Analysis

After performing the acquisition, compare the results to those expected according to network and customer standards. The OTDR serves as a qualification tool as well as a troubleshooting tool, therefore, troubleshooting information is automatically provided in case of problems. Section 3 provides typical acceptance values.

When using an OTDR, especially when not using launch cables, it is important to note that the insertion loss values may not integrate the loss and reflectance (and therefore ORL) of the connectors at the beginning and/or the end of the link. If using launch cables, set this under the OTDR setup when necessary.

Current issues encountered with PON networks are defined below:

- No fiber detected—Check/clean the connection between the OTDR and the network and use a VFL to investigate the presence of a bend or break along the patch panel.
- Distance differs from the expected—Indicates the presence of a break along the link or the fiber tested. Check the fiber number to ensure it is the correct fiber selection with the correct continuity.
- Total loss is greater than expected—Look at the table of events for large splices, connectors, or bends.
- ORL is worse than expected (a smaller number, such as 30 dB vs. 40 dB, indicates poor ORL)—Look at the table of events for indications of bad reflectance values and check sectionalized ORL on the OTDR trace.

Using a Loss Test Set/ORL Meter

A loss test set/ORL meter can be used for end-to-end testing except when issues are found which then requires the use of additional tools such as an OTDR or VFL.

For qualifying a PON network, Viavi recommends using its OLT-55/ORL-55 1310/1550 nm, as shown in Figure 17, or the T-BERD/MTS-6000 with its 8126OFI1 1310/1550 nm loss test set/ORL module. Testing at 1490 nm generally is unnecessary as it does not add information found at 1550 nm, however, it is available. Performing measurements with two wavelengths is mandatory for identifying possible bends along the link which are shown when the total loss of the link is greater at 1550 nm than at 1310 nm. However, OTDR is then required to localize the bend.

Testing can be performed either at the splitter location to qualify the individual feeder and distribution cables or end-to-end between the OLT and the ONT.

When using a loss test set/ORL meter to pinpoint an issue, testing is also required using an OTDR. Viavi recommends its MTS-4000 with the 4126MA 1310/1550 nm OTDR module or its MTS-6000 with the 8126LR 1310/1550 nm OTDR module.

Loss and ORL Referencing

Perform loss and ORL referencing on both units once per day or when changing the test jumpers. After performing this, do not disconnect the jumpers from the source side.

Loss Referencing

The recommended and most accurate method for loss referencing is conducting the side-by-side reference measurement, placing that the two loss test sets next to each other and connecting them with the respective jumpers (one for each unit) and a mating adapter before performing the reference steps on the unit.

If unable to perform the side-by-side reference, for example when the two units are not at the same location, consider performing the loopback reference instead. In this case, connect the jumper between the source and the specific power meter before performing the reference steps on the unit.

ORL Referencing

ORL referencing requires a two-step process for all units. First connect the source to the specific power meter to measure the output power at the output of the jumper. Then disconnect the jumper from the specific power meter, add a non-reflective terminator (or perform a mandrel wrap), and perform a zero ORL reference measurement. Remove the mandrel or the non-reflective terminator, but keep the jumper attached to the unit itself.

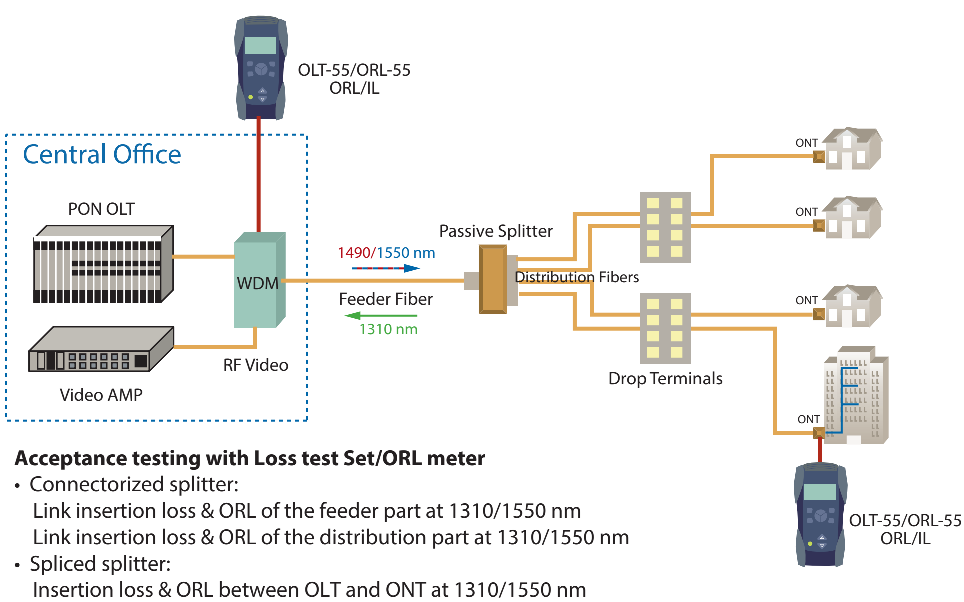

Figure 17. Qualifying the FTTH network with a loss test set/ORL meter

At the end of the reference measurement, the unit will display a result for the highest value that can be measured for the network. Therefore, be careful when performing this measurement. Also using an APC connector for the unit itself is highly recommended because it increases the measurement range of the ORL.

Loss and ORL Measurements

After completing the referencing process, connect the jumpers to each end of the network and perform measurements., This tool makes analyzing insertion loss and ORL results simple without requiring further expertise for performing OTDR measurements.

Result Analysis

After performing the acquisition, compare the results to those expected according to network and customer standards. Network problems require use of an OTDR to troubleshoot, identify, and locate the issue(s).

PON networks can have 1490/1550 nm downstream and 1310 nm upstream, therefore, the most critical ORL values to consider are the 1550 nm ORL measurements from central office/OLT to the customer premises/ONT and the 1310 nm ORL measurement from customer premises/ONT to the central office/OLT. However, conducting all ORL measurements in both directions can simplify the process..

When using the loss test set/ORL meter, the insertion loss values integrate the loss of the connectors at the beginning and the end of the link as well as integrating the jumper connectors.

Listed below are the most common issues found on PON networks:

- Lack of communication between units—Check/clean the connection between the units and the network, as well as use a VFL to investigate whether a bend and break exists along the patch panel or along the link. If so, perform an OTDR measurement to locate the break or issue.
- Distance differs from that expected, meaning that the fiber tested differs from the expected number—Check the fiber number to ensure correct fiber selection or correct continuity.
- Total loss is greater than expected—Perform an OTDR measurement and observe the table of events for large splices, connectors, or bends.
- ORL is worse than the expected, indicated by a smaller ORL number, such as 30 dB which is worse than a 40 dB—Perform an OTDR measurement and observe the table of events for bad reflectance values and check the sectionalized ORL on the OTDR trace.

Typical Acceptance Values

Acceptance values on insertion loss, ORL, and distance are for reference purposes only and are not applicable to all types of networks. One must analyze the type of network before setting the acceptance values.

The IEC-61300-3-35 standard defines the pass/fail criteria for connector inspection. Also, some PON standards provide the recommendations listed in Table 1 for insertion loss, ORL, and distance limitations.

Table 1. Specifications and acceptance values based on ITU and IEEE standards

	G-PON G.982, G.983.1, G.984.2, and G.652 Fiber Specs	**E-PON IEEE 802.3**
Attenuation ranges	Class A: 5 to 20 dB Class B: 10 to 25 dB Class C: 15 to 30 dB (Table 3/G.982)	PX-10: up to 23 dB PX-20: up to 26 dB (Table 60-9)
Differential optical loss	15 dB (Table 4-a/G.983.1)	—
Maximum split ratio	1x64 (Table 2a/G.984.2)	1x32
Minimum ORL of ODN	32 dB, optionally 20 dB (Table 2b/G.984.2)	20 dB (Table 60-3)
Maximum reflectance of equipment, measured at receiver wavelength, for OLT receiver	Less than –20 dB (Table 2b/G.984.2)	—
Maximum reflectance	–35 dB (G.982 Chapter 11.4)	–26 dB (Chapter 60.9.3)
Reach	Up to 20 km Up to 60 km logical reach (Table 2a/G.984.2)	PX-10: Up to 10 km PX-20: Up to 20 km (Table 60-1)
Fusion splice reflectance	–50 dB recommended (G.982 Chapter 11.4)	Not defined
Splitter loss	—	1x16: 14.5 typical (Chapter 60.9.3)
Connector loss	—	0.5 dB per connection 0.75 dB for 2 connections (Chapter 60.9.3)
Cable attenuation	Example of G.652.B fiber (but other fiber types exist, with other specs): 0.4 dB/km max at 1310 nm 0.35 dB/km max at 1550 nm (Table 3/G.652)	0.4 dB/km max at 1310 nm 0.35 dB/km max at 1550 nm (Table 60-14)
Concatenated cable attenuation (including typical splices and connectors)	Typical 0.5 dB/km at 1310 nm Typical 0.35 dB/km at 1550 nm (Table I.1/G652)	—

For most of the individual elements of the network, the ITU-T G.671 provides typical individual values as well as other typical values found in the field. However this information may vary according to equipment vendors. So specification and acceptance values can be defined as shown in Table 2.

Table 2. Typical specifications and acceptance values

Fiber Network Element	Typical Loss (dB)	Maximum Loss (dB)	Typical ORL (dB) (or reflectance when applicable)	Min ORL (dB) (or reflectance when applicable)
Fiber attenuation	0.35 dB/km at 1310 nm 0.2 dB/km at 1550 nm	—	30 dB (long distance)/ 40 dB (150 m) at 1310 nm 30 dB (long distance)/40 dB (150 m) at 1550 nm	30
Fusion splice	0.1	0.2 0.3 (G.651)	None	None –70 (G.671)
Mechanical splice	0.2	0.5 (G.651)	None	–50 –40 (G.671)
Connector	0.5	0.7 0.5 (G.671)	65 (APC) 55 (UPC)	–50 (APC) –40 (UPC) –35 (G.671)
Splitter	1x2 3.5 1x4 6.5 1x8 9.5 1x16 12.5 1x32 16 1x64 20 1x128 23	(G.671) 1x2 4.2 1x4 7.8 1x8 11.4 1x16 15 1x32 18.6 1x64 22 1x128 25	None	–55 –40 (G.671)

Add values when qualifying the complete network according to the various elements and wavelengths.

For example, the network has:

- 5 km of fiber on the feeder side, one fusion splice at 1.5 km, and an APC connector at the beginning of the link
- a connectorized 1x32 splitter with APC type
- multiple legs, one of 1 km that is fusion spliced at 400 m and an APC connector at the end of the link

Calculating the total loss for the link described in the network above requires adding the loss of the individual elements. Table 3 provides the information to calculate the total link loss.

Table 3. Total link loss calculation

Fiber Network Typical Insertion Loss Calculation				
Element	**Typical Individual Loss at 1310 nm (dB)**	**Typical Cumulative Loss at 1310 nm (dB)**	**Typical Individual Loss at 1550 nm (dB)**	**Typical Cumulative Loss at 1550 nm (dB)**
1 connector	0.5	0.5	0.5	0.5
5 km of fiber	5x0.35 = 1.75	2.25	5x0.2 = 1.0	1.5
1 fusion splice	0.1	2.35	0.1	1.6
1 connector	0.5	2.85	0.5	2.1
1x32 splitter	16	18.85	16	18.1
1 connector	0.5	19.35	0.5	18.6
1 km of fiber	1x0.35 = 0.35	19.7	1x0.2 = 0.2	18.8
1 fusion splice	0.1	19.8	0.1	18.9
1 connector	0.5	20.3	0.5	19.4

Table 4 provides the information necessary to calculate the total upstream ORL at 1310 nm. Table 5 provides the information necessary to calculate the total downstream ORL at 1550 nm.

Table 4. Total ORL calculation at 1310 nm

Fiber Network 1310 nm ORL Typical Calculation Upstream (from ONT to OLT)		
Element	**Typical ORL per Element at 1310 nm (dB)**	**Typical Cumulative ORL at 1310 nm (dB)**
1 connector	50	50
1 km of fiber	40	40
1 fusion splice	None	40
1 connector	50	40
1x32 splitter	None	40
1 connector	50	40
5 km of fiber	32	40
1 fusion splice	None	40
1 connector	50	40

Table 5. Total ORL calculation at 1550 nm

Fiber Network 1550nm ORL Typical Calculation Downstream (from OLT to ONT)		
Element	**Typical ORL per Element at 1550 nm (dB)**	**Typical Cumulative ORL at 1550 nm (dB)**
1 connector	50	50
5 km of fiber	35	35
1 fusion splice	None	35
1 connector	50	35
1x32 splitter	None	35
1 connector	50	35
1 km of fiber	40	35
1 fusion splice	None	35
1 connector	50	35

Performing insertion loss and ORL measurements for this specific fiber link requires comparing the test results to the cumulative insertion loss of 20.3 dB and ORL of 40 dB (from ONT) at 1310 nm and the insertion loss of 19.4 dB and ORL of 35 dB (from OLT) at 1550 nm.

If using an OTDR without a launch cable, omit the connector losses and ORL at the beginning and end of the link and compare the test results to the cumulative insertion loss of 19.3 dB and ORL of 40 dB at 1310 nm for example.

The report at the end of the tests will provide the following information dependent upon whether the insertion loss test set or OTDR is used.

Using the insertion loss test set:

- Insertion loss at 1310/1550 nm (and eventually at 1490 nm)
- ORL at 1310/1550 nm (and eventually at 1490 nm)
- Link distance information
- Comments or issues

Using the OTDR:

- Insertion loss at 1310/1550 nm
- ORL at 1310/1550nm
- Link distance information
- Comments or issues
- If required, detailed information such as:
  - Distances of all sections
  - Loss and ORL of all elements such as splice, connector, or splitter
  - Reflectance of all reflective elements such as the connectors

Recommended Viavi Test Tools for FTTH Networks

This document only describes the process for FTTH network qualification before installing equipment which is the first stage of FTTH network deployment. The complete process for FTTH networks is:

- qualification / fiber construction (no active equipment involved)
- turn-up (involves active equipment such as OLTs and ONTs)
- troubleshooting
- monitoring

Each stage requires specific test tools as provided in the following subsections. Viavi is the unique test equipment provider that offers a complete test suite that can fully qualify the network from fiber construction to network monitoring.

Qualification Tools

The following list shows the recommended test tools for FTTH network qualification.

- Optical microscope: Viavi FBP probes with HD2/3 displays or Viavi HP3–60 fiber inspection and test tool.
- OTDRs: Viavi T-BERD/MTS-4000 with 4126MA 1310/1550 nm OTDR module or Viavi T-BERD/MTS-6000 with 8126LR 1310/1550 nm OTDR module. If requested, 1490 or 1625 nm/1650 nm wavelengths can also be provided.
- Loss test set/ORL meters: Viavi OLT-55 and ORL-55 or Viavi T-BERD/MTS-6000 with 8126OFI1 1310/1550 nm loss test set/ORL module. If requested, 1490 or 1625 nm wavelengths can also be provided. The use of this tool may also require an optical talk set (if cell phones cannot be used). Viavi OTS-55 or the talk set option for Viavi MTS units are available.
- VFL: A full range of Viavi solutions, either standalone or part of the platform.

Turn-up Tools

Turn-up Optical Tools

The following is a list of recommended test tools for FTTH network turn-up on the optical side as Figure 18 shows.

- Optical microscope: Viavi FBP probes with HD2/3 displays or Viavi HP3–60 fiber inspection and test tool
- Standard power meter (in case of point-to-point networks)
- Fiber identifiers: Viavi FI-11/FI-10
- PON power meter (in case of PON networks)
- VFL: A full range of Viavi solutions, either stand-alone or as part of the platform

Turn-up Service Tools

The following is a list of recommended test tools for FTTH network turn-up on the services side.

- Copper, VDSL, and triple-play test equipment: A full range of Viavi solutions, including the Viavi T-BERD/MTS-4000 with its copper/xDSL/triple-play applications, the Viavi SmartClass family, or the Viavi HST-3000 handheld services tester
- Home wiring test equipment: A full range of Viavi solutions, including the the HST-3000 handheld services tester

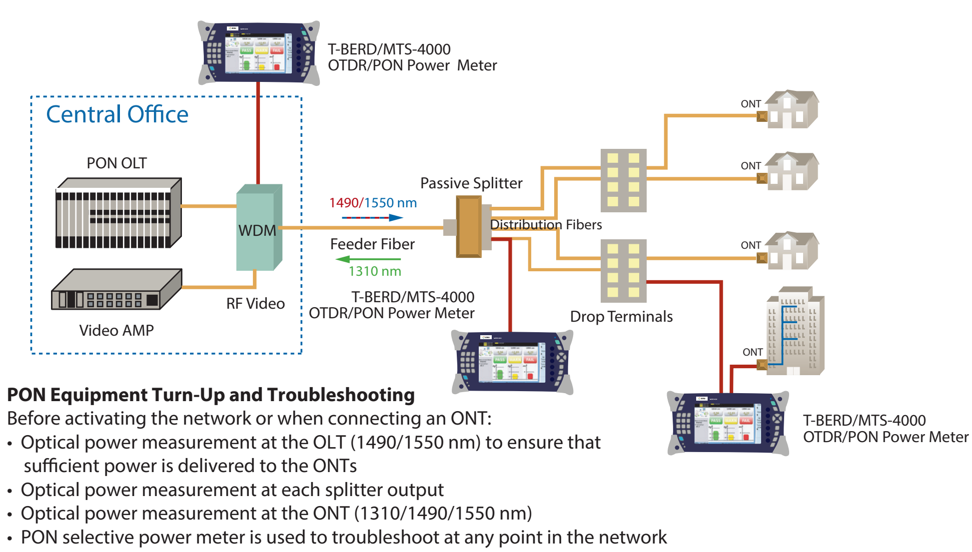

Figure 18. FTTH Network turn-up optical tools

Troubleshooting Tools

Optical Troubleshooting Tools

The following is a list of recommended test tools for FTTH network troubleshooting on the optical side as
Figure 19 shows.

- Optical microscope: Viavi FBP probes with HD2/3 displays or Viavi HP3–60 fiber inspection and test tool.
- Power meter (in case of point-to-point networks): Viavi OLP-35 or OLP-55.
- PON power meter (in case of PON networks): Viavi OLP-57 or T-BERD/ MTS-4000 with OLP-4057 PON meter module.
- VFL: A full range of Viavi solutions, either standalone or part of the platform.
- OTDRs: Viavi T-BERD/MTS-4000 with 4126MA 1310/1550 nm OTDR module or Viavi T-BERD/
MTS-6000 with 8126LR 1310/1550 nm OTDR module. If requested, 1490 nm or 1625/1650 nm wavelengths can also be provided.
- Loss test set/ORL meters: Viavi OTS-55 and ORL-55 or Viavi T-BERD/ MTS-6000 with 8126OFI1 1310/1550 nm loss test set/ORL module. If requested, 1490 or 1625 nm wavelengths can also be provided. The use of this tool may also require an optical talk set (if cell phones cannot be used). Viavi OTS-55 or the talk set option of Viavi MTS units are available.
- Fiber identifiers: Viavi FI-11/FI-10.

Service Troubleshooting Tools

The following is a list of recommended test tools for FTTH network troubleshooting on the services side.

- Copper, VDSL, and triple-play test equipment: a full range of Viavi solutions, including the Viavi T-BERD/MTS-4000 with its copper/xDSL/ triple-play applications, the Viavi SmartClass family, or the Viavi HST-3000 handheld services tester
- Home wiring test equipment: a full range of Viavi solutions, including the HST-3000 handheld services tester

Monitoring Tools

The following is a list of recommended test tools for FTTH network monitoring as Figure 20 shows.

- Optical layer monitoring: Viavi ONMS monitoring system
- Services layer monitoring: Viavi NetComplete® home Performance Management (PM)

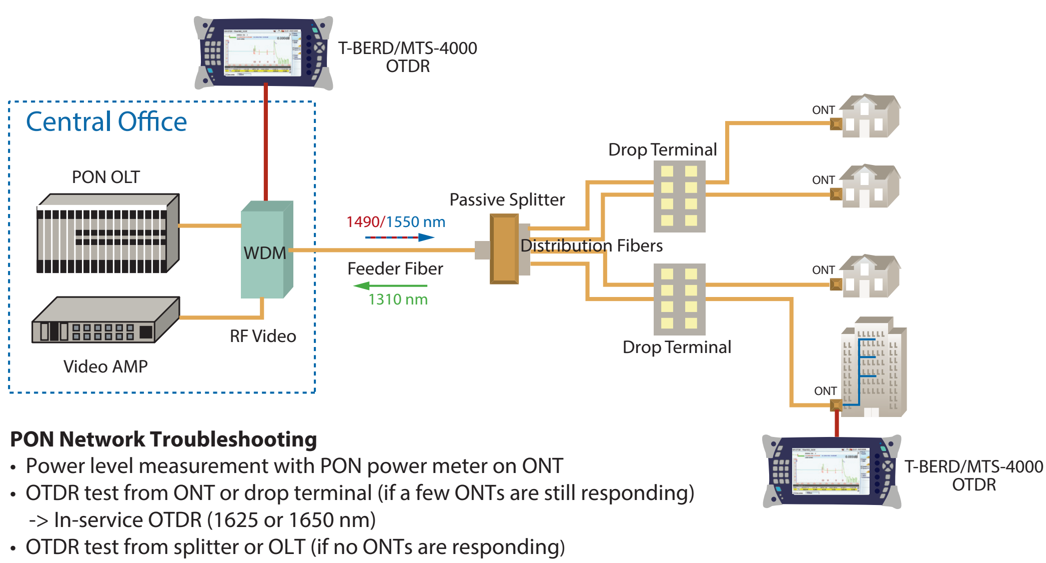

Figure 19. FTTH Network troubleshooting optical tools

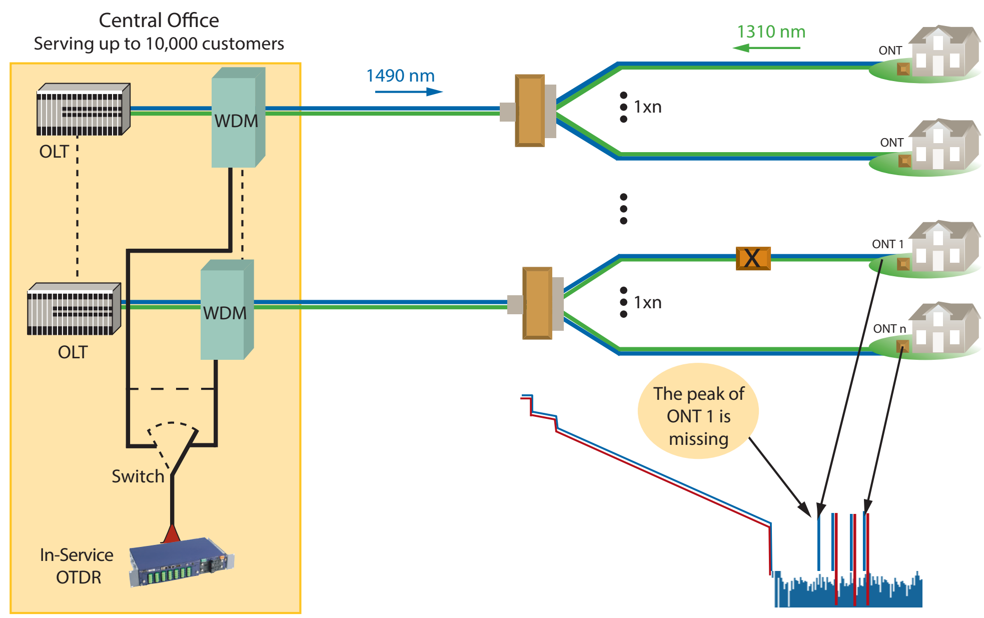

Figure 20. FTTH network monitoring tools

Related Documents

Viavi Fiber Optic Guide Volume 1

Viavi FTTP measurements white paper: consult Viavi

Viavi Understanding Passive Optical Networks Poster

Viavi Understanding Fiber Optics Poster

Viavi Understanding Optical Time Domain Reflectometry Poster

Viavi FTTX Triple Play Technologies and Applications Poster

Viavi Triple-Play Service Deployment Book

Viavi Automated End-to-end PON Fiber Test white paper: consult Viavi

Viavi Maintenance & Troubleshooting of a PON Network with an OTDR application note: consult Viavi

Viavi WDM-PON and CWDM Networks: Function and Measurement Tasks white paper

Viavi Testing the Outside Plant article (Broadband Properties)

Viavi Best Practices for Testing FTTH Deployments (Broadband Properties)

FTTH Council Europe FTTH Handbook (Upload from the FTTH Council Europe site)

Cenelec CLC/TR 50510:2007 Fibre Optic Access to End-user —A Guideline to Building of FTTH Fibre Optic Network

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