Cleaning and Testing Fiber Optic Cable

Reference Guide

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Every effort has been made to ensure that the information in this manual is accurate. RLH is not responsible for printing or clerical errors. Because we are constantly seeking ways to improve our products, specifications and information contained in this document are subject to change without notice.

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1. Important Information

Intended Audience

This document is intended for use by knowledgeable telco/network installation, operation and repair personnel. Every effort has been made to ensure the accuracy of the information is accurate. However, due to constant product improvement, specifications and information contained in this document are subject to change without notice.

Conventions

Symbols for notes, attention, and caution are used throughout this manual to provide readers with additional information, advice when special attention is needed, and caution to prevent injury or equipment damage.

Notes: Helpful information to assist in installation or operation.

Attention: information essential to installation or operation.

Caution: Important information that may result in equipment damage or injury if ignored.

General Safety Practices

The equipment discussed in this manual may require tools designed for the purpose being described. RLH recommends that installation and service personnel be familiar with the correct handling and use of any equipment used, and follow all safety precautions including the use of protective personal equipment as required.

Laser Safety

- Radiation emitted by laser devices is invisible and dangerous to the human eye.
- Avoid eye exposure to direct or indirect radiation.
- Do not operate without fiber cable attached or dust caps installed.

2. Introduction

Fiber optic cable provides a low loss medium for high-speed communications. It also has the benefit of being dielectric. In other words, the glass fiber itself does not conduct electricity, and is immune to electromagnetic interference and power surges. Signals are transmitted through fiber using light, not electrical energy.

While the continuous fiber cable itself has very low transmission loss, the fiber terminations at each access point provide a potential Achilles heel. Light must pass from the end of one fiber optic connector to another with a minimum of attenuation. The biggest cause of signal loss across fiber optic connectors is contamination. Substandard installation practices in pathways and enclosures can also affect the signal loss of the fiber.

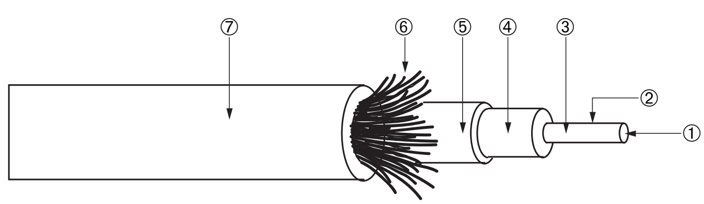
The growing prevalence of fiber requires network technicians have a general understanding of fiber optic cable testing to enable them to troubleshoot or qualify cables. A majority of issues can be identified with two steps:

- Cleaning/inspection of connector end-faces.
- Loss testing.

The TIA/TSB 140 standard requires that each fiber link be tested for attenuation with an Optical Loss Test Set (OLTS) kit. This standard considers an Optical Time Domain Reflectometer (OTDR) optional. An OLTS tester, using the appropriate reference method, will yield the most accurate loss reading. However, the OLTS tester cannot characterize the fiber to show the quality of the fiber spans, connections, and splices.

3. Clean and Inspect All Connectors

A note on regarding to size helps to visualize the impact of dust and dirt. Comparing an average human is around 85 microns in diameter. The core, being the signal carrying portion, of most widely used optical fibers is either 62.5 microns or 9 microns. It takes minimal amount of dust particles to block a 9 micron window. A blocked window means light is blocked and the network experiences signal loss.



Optical fiber cord

① Core
② Cladding
③ Optical fiber
④ Primary coat
⑤ Buffer
⑥ Kebler (A tensile strength material)
⑦ Jacket

Inspection

To view fiber connector ends for cleanliness use a fiber optic microscope with proper magnification, typically 200x to 400x. Some microscopes are all optical, which can direct laser light into a user's eye, while others are available with no optical path to the eye. All manufactures caution users not to view live fibers. A technician can easily inadvertently view live fiber because laser emissions are invisible to the human eye.

Cleaning

Using a fiber optic microscope the user can determine if the connectors are dirty, cracked, or pitted. Cracked or pitted fiber ends will need to be re-polished or replaced. More commonly the connector ends will be dirty. Do not make the mistake of cleaning a fiber end with a normal cloth, this is not helpful. Other contaminates capable of blocking a 9 micron window may be on that material no matter how clean it appears.

Cleaning fiber optic connectors requires proper fiber optic grade cleaning materials. Materials vary from optical grade wipes to cassette cleaners. Technicians often use these materials effectively alone as a dry wipe, but doing so can add a static charge across a connector end-face. Depending on the climate and season this may not present much of an issue. Although, in dry winter months and air-conditioned areas allow static charge to be a significant interference to the connector cleaning process.

For further questions and to acquire an order number for a cleaning kit contact a RLH sales representative or visit the RLH website.

Static Charge

Static charge build up on connectors attracts charged particles to the connector end-face. This can effectively nullify the dry cleaning process. Particles are drawn to the foremost part of the connector end-faces during mating and un-mating. Since fiber optic connectors are polished to have a radius end-face with the fiber core at the center, static charge may cause particles to migrate to the optimal signal blocking position.

ESD

Static charge is not ESD. Optical fiber is glass and single fiber connector ferrules are ceramic. There is no conductive path from the connector end-face to the fiber jacket. Therefore ESD protection will not eliminate static charge from connector end-faces. Fiber optic cleaning fluids are optimal for eliminating static charges.

Fiber Optic Cleaning Fluids

These fluids are static dissipative. A technician, using an optical-grade cleaning wipe, can wet a corner with the appropriate cleaning fluid and drag the connector end-face from the wet area into the dry area. The fluid will neutralize static charge and help to release particles from the end-face.

IPA Alcohol

The standard for fiber optic cleaning has long been IPA alcohol, which is a static dissuasive. However, it is far from an ideal optical cleaning fluid. For starters, it is hydrophilic - meaning it absorbs water. IPA in a dispenser bottle will absorb atmospheric moisture over time. This has a negative effect on the cleaning process for two reasons. First, water slows down the drying process and requires more air to evaporate off all the fluid. More air brings more dust unless working in a clean room. Water absorption into IPA is also bad as water can leave a streaky residue on the connector end-face. Although IPA has been a successful standard cleaning fluid there are safer cleaning solution alternatives available today that dry faster than alcohol, do not absorb water, are non-hazardous, and are not regulated.

It is important when cleaning to do both connectors on jumpers and the connector behind the panel. In the case of having an unaccessible connector or one where there is live traffic on adjacent fibers a commonly used option is to use a fiber optic cleaning stick to clean the end-face inside the adaptor. Insert the stick until it makes contact with the end-face, twist around ten times and discard. The twisting can generate a static charge so a quick drying static dissipative cleaning fluid is a plus.

4. Testing Fiber Optic Cables

Measuring Loss

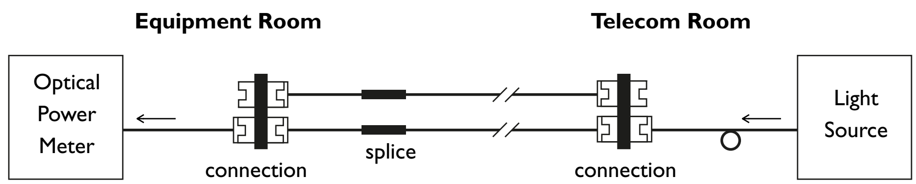
The TIA-standard requires you to make one and only one measurement, insertion loss, to certify a fiber optic cable. This is also known as “dB loss”, “attenuation”, or simply “loss”. Insertion loss is singled out by the TIA because it can be impacted by poor installation practices. Poorly polished or dirty connectors can cause high loss, or a cable pulled around a corner that does not meet minimum bend radius specifications may exhibit high loss.

OLTS Testing- Always Required

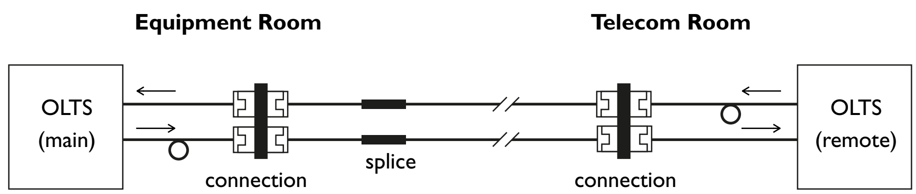
TIA-standards specify that you must measure loss using an optical power meter and the proper light source to certify an optical fiber cable. Multimode fiber loss measurements must be made using an LED source. Single-mode fiber loss measurements require a laser source.

Light sources and optical power meters are available as low-cost, stand-alone units, or may be integrated into optical loss tests sets (OLTS). OLTS offers additional features such as dual-fiber testing, length measurement, and pass/fail analysis. Either type of tester will provide accurate standards-compatible results as long as you use proper reference setting and connector cleaning procedures.

Optical Power Meter and Light Source Diagram



Testing Using OLTS Diagram



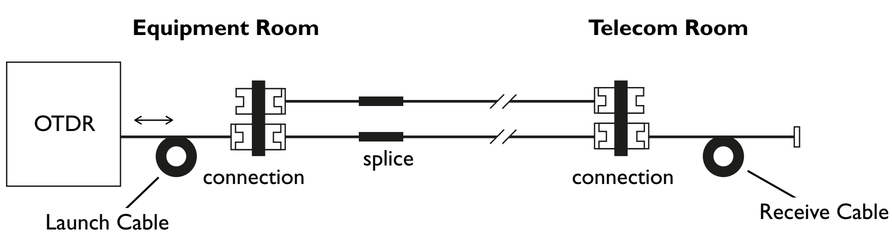
TIA-standards also specify maximum lengths for horizontal and backbone optical fiber cables, which you must verify as part of the certification process. Although the TIA-standard does not require that you optically measure cable length. You may use a tape measure or simply refer to length markings on the cable itself.

Note: To certify an optical fiber cable you will need either an optical power meter and compatible light source(s) or an OLTS main-remote pair. Other test equipment may be very useful as discussed next, but nothing else is required.

OTDR Testing- Optional but Beneficial

TIA-standards also contain component specifications including maximum loss values for connections, splices, and optical fiber segments. It is good practice to measure the loss of each connection and splice, and check cables for "macro-bends" and other defects for quality assurance purposes. The type of fiber tester normally used for these functions is an Optical Time Domain Reflectometer or OTDR.

OTDR to Measure End-to-End Loss Diagram



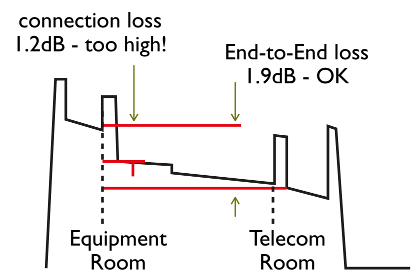
OTDR's operate like a radar. They generate short pulses of light and then sample the light backscattered by fiber segments and related by connections and other events. This allows the user (or OTDR software) to estimate the loss slope or "attenuation" of fiber segments and the insertion loss of individual connections and splices.

To measure the loss of the first and last connection in each fiber link or link segment under test you must use a launch and receive cable respectively. Launch and receive cables may also be called "launch reels", "pulse suppressors", or "test cables". Test cables usually include 100 or more meters of fiber in a ring-shaped or rectangular case, terminated by jumpers that will mate with the fiber under test.

To illustrate the advantages of an OTDR, consider a 100m (328ft.) backbone cable with the following component loss values.

- Equipment room connection 1.2 dB
- Splice 0.1dB
- Fiber 0.1dB
- Telecom closet connection 0.3dB

OTDR Trace Showing a Bad Connection



According to the TIA-standards, the maximum acceptable loss for this cable is :

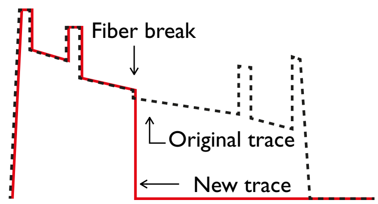
- 1.5dB of connection loss (0.75dB for each connection)
- 0.3dB splice loss
- 0.1dB fiber loss
- A total of 1.9dB

Since this cable has an overall (end-to-end) insertion loss of 1.7dB, it would probably be passed by an OLTS measurement. An OTDR trace of this cable would reveal that the telecom closet connection has a loss of 1.2dB, which exceeds the TIA-standard specified maximum of 0.75dB.

Note: An OTDR can indicate and localize problems that would often be missed by an OLTS or optical power meter and light source kit.

In cases where an OLTS can detect a fault, for example the "infinite" loss caused by an open connection or fiber break, it cannot tell you where the fault is located. An OTDR trace, on the other hand, will locate such events as shown below.

OTDR Trace Showing a Break in the Fiber



Note: An OTDR test can not replace an OTLS measurement. The OLTS test is required by the TIA-standards, and OTDR measurements can slightly under-estimate loss, especially on multimode fibers. An OLTS test would indicate fiber mis-matches of 50/125 and 62.5/125um fibers with a high loss reading. An OTDR which uses a laser and does not fill the outer modes may not pick up the core mismatch.

OTDR tests offer additional information that can help you detect and proactively fix problems often missed by OLTS tests. Some jobs may require tests on all optical fiber cables using an OTDR by a quality-conscious consumer. On other jobs, having an OTDR characterization of fiber(s) at the time you signed-off on the project can protect the installer from damages caused by installers that come in later and pull other cable(s) into the pathways that may damage the fiber, causing macro- or micro-bends or breaks.

Dust, dirt, oils, and other common contaminates, along with poor installation practices can cause hours of grief for network service technicians. Fortunately, proper cleaning tools and good test techniques allow trained technicians to effectively remove contaminates, find and correct fiber problems, and get networks back in service. Whether or not you do OTDR testing is up to your schedule, budget, and often your customer.

Recommended Approach to Cleaning, Inspecting, and Testing

- Always presume connectors are dirty prior to mating.
- Fiber optic termination has two connectors. **Always clean both!** Cleaning one and re-mating it to a dirty connector is counter productive.
- Use optical quality cleaning materials to clean fiber end-faces.
- Use an optical quality cleaning fluid to minimize the static build up.
- Use a fiber optic microscope with built in eye-protection to inspect connectors prior to mating.
- Use Light Source & Power Meter or OLTS kits to test for Attenuation.
- Use OTDR test to characterize the installation and get sign-off when required.

5. Support

Technical Support

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Please contact your RLH sales representative for pricing and delivery information.