

Testing and Loss Measurement Techniques in Optical FIBER for Healthy Optical FIBER Communication

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Abstract: Practically in all kind of communication system, more or less losses are involved. To make the system more efficient, it is needed to identify and trace the faults & losses. In optical fiber communication, optical time domain reflectometry (OTDR) is a commonly used technique for characterization and fault location of optical fiber transmission systems. It involves measuring the fraction of a probe pulse that is scattered back from a silica fiber. Because of the very small levels of backscatter in single-mode fiber at long wavelengths, very sensitive optical detection is necessary to achieve proper range performance. For uptime and efficient performance of fiber networks requires testing and evaluation at multiple stages. This paper includes various testing methods for optical fiber such as continuity test, continuity of splice, splice loss testing, fiber loss testing, fiber quality testing, reflectance of splice and connector testing and loss measurement techniques such as splice loss measurement, detection of fault locations, insertion loss. This paper describes different testing methods and the way to reduce the losses in fiber cable for healthy communication.

Keywords: Light source and power meters (LSPMs), Optical Fiber, optical loss test set (OLTS), Optical time domain reflectometry (OTDR)

I. Introduction

Optic fiber cables (OFC) are being increasingly deployed across the world to support the growing bandwidth requirements of internet users. Most fiber cable networks comprise several single-mode short distance cables (5-12 km) joined through splices and connectors. Consequently, checking for splice loss becomes essential in order to ensure reliable functioning of the fiber cable system throughout its lifetime. Basic fiber test can be done with the help of power meter and visible laser. Different losses like splice loss, dispersion loss can be measured with an optical time domain reflectometer (OTDR), which also measures the length of the cable and identifies the fault location. These tests and measurements are performed at the design stage and prior to the installation of the fiber cable. The fiber cable network is tested for end-to-end insertion loss and continuity. While tests for the insertion loss are carried out through a light source and power meters (LSPMs) or an optical loss test set (OLTS), continuity is tested with a fiber tracer.[1]

II. Basic Testing of fiber cable[2]

An **optical fiber** is a flexible, transparent fiber made by glass silica or plastic to a diameter slightly thicker than that of a human hair. Optical fibers are used most often as a means to transmit light between the two ends of the fiber.

2.1 Determination of continuity to fiber end:-

2.1.1 By using a simple optical power meter to check for light at the receiver end.

2.1.2 By using visible laser, check the continuity visually.

2.2 Locate a break in fiber cable:-

A visible laser source is used for detecting breaks in the fiber.

2.3 Determine continuity of splice:-

Optical power meter is used to check for the presence of light.

2.4 Overall Return Loss(ORL):-

Overall return loss also called optical return loss or ORL. It is the total amount of light returned from a fiber for a given amount of light injected into it. This includes all reflections and backscatter in a fiber. It describes how much light comes back to the transmitter (light source).

ORL can be measured by using a calibrated light source and power meter along with other specialized components or these may all be combined into one ORL meter.

2.5 Measuring end-to-end insertion loss:-

Once the optic fibre cable is installed, it must be tested for end-to-end insertion losses with the LSPM or the OLTS. If the difference between the loss budget and the measured loss is significant, individual components are tested to identify the cause of the difference in losses.

III. Measurements with OTDR

[2]Optical time domain reflectometers (OTDRs) are impressive pieces of equipment. They send pulses of light into optical fibers at a wide range of pulse widths,analyze the minuscule amounts of light reflected back to them from faults in the fibers, and use complex computations to determine the size and distance to events encountered in the fiber run. Events are defined as losses or changes in the fiber’s light-carrying capacity.

Block diagram of Optical Time Domain Reflectometer (OTDR)[3]

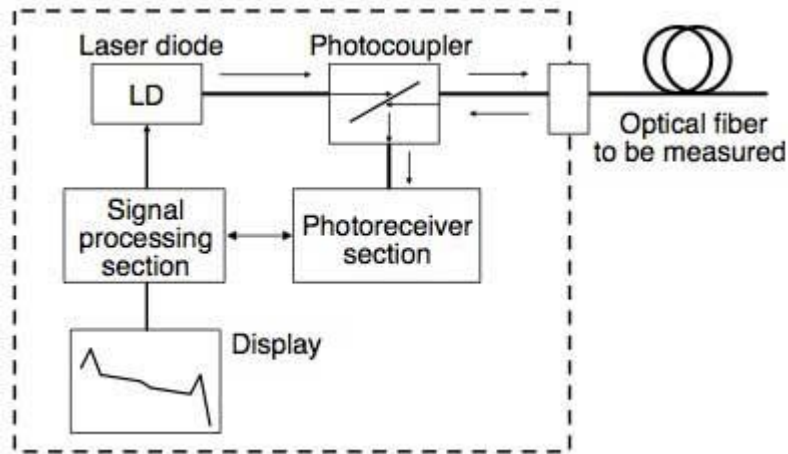


Fig. 1

OTDR also perform some special tests which are as follows:-

IV. OFC loss measurement techniques performed by OTDR:-[2][5]

4.1 Testing and detecting fault locations:-

The pulse traversing the fibre path gets scattered at various intervals and is reflected from connectors. A part of this light travels back towards the source, and along with the reflected light, helps the OTDR in measuring faults. The OTDR displays data on loss measurement in the form of a graphic image known as trace or signature, which is used as a benchmark and compared with future traces for detecting faults. An OTDR underestimates splice losses by 3-10 dB

4.2 Measure spice and connector loss:-

True measurement of splice loss can only be done by comparing the amount of light just before the splice and after the splice. OTDR type test equipment is the only test equipment which is designed to make a true splice loss measurement. Reflectance of splices and connectors can be measure with OTDR.

4.3 Measure fiber quality:-

The quality of fiber is measured in the amount of loss it has per kilometres. The lower this dB/km value, the longer the system can be with the same loss budget, because the fiber attenuates the light less. A dB/km measurement is made by testing for overall loss and dividing the result by the length of the fiber. It is done most efficiently and easily with an OTDR.

Summery of testing Equipment [6][7]

Testing Task	Power meter e.g. GN-6025	Loss test set e.g. GN-6025/Axx	Visible Laser e.g. VLF-670	Fault locator e.g. CMA-40	OTDR e. g. CMA-4000	Remote OTDR e.g. ORION
Determination of continuity to fiber end	w/source	.	.	.	.	.
Locate a break in fiber cable			.	.	.	.
Determine continuity of splice	w/AM-450	w/AM-450	.	.	.	.

Measure splice loss				.	.	.
Measure fiber loss	w/source			.	.	.
Measure fiber quality				.	.	.
Measure reflectance of splice and connector		.		.	.	.
Overall Return Loss	(.)	.		.	.	.

Table 1

V. Conclusion:

The Telecommunications Industry Association specifies that power losses in the fibre cable should be measured using an LSPM or OLTS. Most cable manufacturers also prefer an OLTS for loss measurement as an OTDR generates an underestimated value, especially for multimode fibres. However, an OTDR measures the loss for individual components of the fibre cable. This is useful for the cable manufacturer when the loss measured using an OLTS differs significantly from the loss budget and in the event of infinite losses. An OTDR provides information about fault location, a feature not available with OLTS testing. In sum, both the testing techniques gives the value of different losses and in turn helpful for selection of fiber cable for the particular application. Thus healthy fiber optic communication will achieved.

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