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Checking Fiber Optic Communication Lines with Optical Time Domain Reflectometer Slots

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***Abstract*—The most commonly used and most accepted way of analysis of the fiber-optic link is checking her with OTDR slots (Optical Time Domain Reflectometer - OTDR). OTDR sends along the fiber-short light pulse, the duration of which is between 2 us and 30 us (depending on the type and length of the optical fiber) and then measures and records the reflected light energy fiber. Reflection can be caused by a connector, compound, fracture, or impurities fibers. By measuring the time required for the return of the reflected light source and knowing the refractive index of the fiber, can accurately calculate the distance to the reflection.**

Keywords— fiber-optic transmission systems; reflection; insertion loss; calibration; measurements

I. INTRODUCTION

Modern fiber-optic transmission systems (FOTS) represent complicated technical complexes, consisting of many components, such as optical transceiver equipment and fiber-optic communication lines. To ensure reliable and high-quality work of FOTS one needs to implement a set of activities, which include testing of each component of FOTS. Particular details of transceiver testing equipment FOTS were considered in [1].

One important aspect of all tests of fiber-optic link that can be performed is to check its integrity [2].

One of the most common tests conducted in the fiber optic system, is to measure the attenuation length of the fiber. This value allows you to check most of the elements designed system.

II. EXPERIMENTAL

In most cases, the measurement of insertion loss (Insertion Loss Testing) is conducted with the source and power meter. First, the power meter is calibrated with the source device by connecting both short length of the optical fiber length of about 2 m. Typically, the source is mounted on the transmission power level of –10 dBm, then the meter to fit the corresponding value of –10 dBm. It is necessary to ensure that the meter is used to calibrate the power level is within its dynamic range.

After calibration, a power meter, it is delivered to the place and is connected to the communication line. The resulting value of the level meter can be used to calculate insertion loss. This includes losses caused by the optical fiber connections and connectors. The verification procedure is shown in fig. 1 [1].

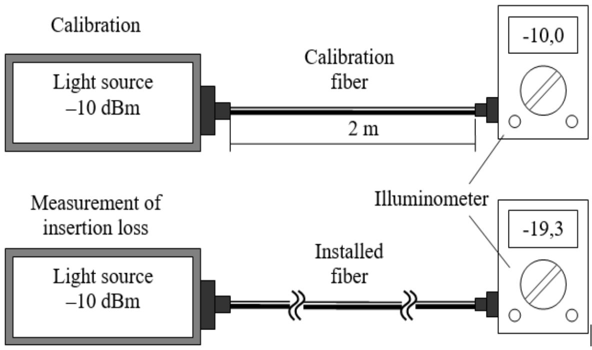

Fig. 1. Fiber Inspection Procedure

If the source and power meter calibrated in watts, the formula for converting a loss in decibels as follows:

$$\text{Attenuation} = -\log\,(P_0\,/P_i)$$

where P_0 - output power from the fiber; P_i - input power into the fiber.

To calculate the insertion loss, subtract the resulting measure of value of 8 dBm input power source. For example: the insertion loss shown in fig. 1, is equal to 9.3 dB [1, 2].

The most commonly used and most accepted way of analysis of the fiber-optic link is checking her with OTDR slots (Optical Time Domain Reflectometer - OTDR). OTDR sends along the fiber-short light pulse, the duration of which is between 2 us and 30 us (depending on the type and length of the optical fiber) and then measures and records the reflected light energy fiber. Reflection can be caused by a connector, compound, fracture, or impurities fibers. By measuring the time required for the return of the reflected light source and knowing the refractive index of the fiber, can accurately calculate the distance to the reflection. Impurities cause permanent glass reflected low power light as it passes along the glass fiber that is fading. This is called the backscatter. The strength of the backscattered signal received source gradually decreases with increasing distance from the pulse source. This can be seen as a gradual OTDR scaling down received reflected signal and the slope of this line is to reduce the fiber attenuation (dB per km). Fig. 2 shows a typical reflection curve and indicates OTDR backscatter [1].

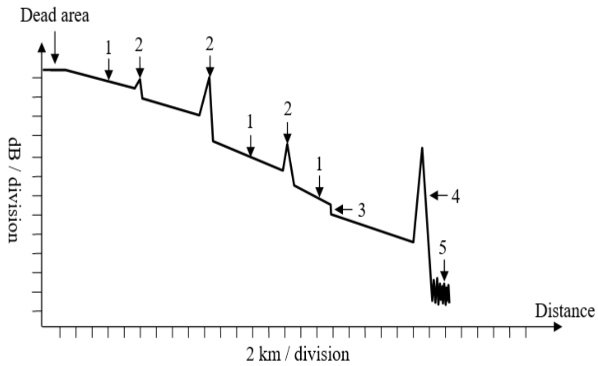

Fig. 2. Record of OTDR

Usually, OTDR does not provide accurate data on irregularities and fiber losses for the first 15 meters of cable. This is because the length and OTDR pulse rise time is relatively large compared with the time required for the impulse to overcome the short distance to the reflection point in the range of 15 m, and conversely, even if we consider the speed of light in the fiber is reduced by approximately 1/3. To resolve this issue between the OTDR and test the communication line is inserted into the coil cable. When reading data from the screen OTDR first cable length is ignored and called dead zone (Deadband).

The chart in Fig.2 OTDR, axis Y is the relative amplitude of the reflected light signal, the X axis represents time. The time axis is directly translated and displayed as distance OTDR.

Sharp peaks occurring along the slope, are the points at which there is a reflection, and the reflected light is stronger backscatter. Fig. 2 shows the five dots of reflection:

1) backscatter fiber;
2) reflection from the fiber microcracks;
3) reflection of the compound;
4) reflection from the connector;
5) the noise level of the instrument.

After each of the reflections decay curve slope abruptly decreases. This decline represents a loss, bringing connector or fiber connectors is defective.

Fig. 2 marked at a dot (3) shows the compound, wherein the cores of the fibers are well suited for light traveling toward the source. In this connection there is no reflection, there is only loss. Type drop dot (3) on the decay curve can also be a part of the sharp bends through which the light exits from the fiber and is reflected back. Some types of fiber defects also give the same result.

Dot (5) marked in fig. 2 indicates the noise level of the instrument. This is the lowest level of the received signal, which may take the device. Measurements made near this level is not very accurate.

OTDR testing can provide a very accurate analysis of defects for almost any length of fiber. It is important that before the production of measurements between the OTDR and the communication line is always inserted section of fiber to the dead zone. With better quality devices can be obtained by resolution of less than 1 m for the location of the defect and 0.01 dB for line losses. Some devices can work with a range of up to 400 km and above.

In general, the OTDR is relatively simple to use, and to download the test results and, if necessary, conduct a detailed analysis of them can download and use special software packages. Sad lack OTDR technology is that it is usually very expensive. Even small devices with reduced capabilities may be prohibitively expensive.

OTDR test must be carried out for each fiber optic link, while it is still in the coil, before installation to ensure that the fiber is not damaged. The results of these tests must be stored in electronic memory, or as a printout. After installing for each optical fiber should again conduct tests OTDR. Then the test results immediately after installation can be compared with the results of tests prior to installation to determine whether the fibers were not damaged or poorly installed.

Results preinstallation and post-installation tests should be stored as part of the documentation system commissioning. If you later discover damage to the system, the results of acceptance tests can be used to detect the location of defects. For highly reliable systems after a few years of operation costs to audit the system again spending OTDR test and comparing its results with the results of the acceptance tests to assess the deterioration of fiber-optic communication system after installation.

OTDR can be used to obtain accurate measurements of attenuation provided that the reflectometer used a high quality, which is regularly calibrated [1, 2].

III. CONCLUSION

Thus, it can be said that methods for diagnosing an optical fiber there is a sufficient amount. The differences between them are usually unimportant, however, the results obtained allow us to determine the state of the optical link before and after its installation, which is an important factor in the process of its operation.

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