

Optic fibre cables (OFC) are being increasingly deployed across the world to support the growing bandwidth requirements of internet users. An increase in the demand for video-based services, which require high speed broadband access and low latency, has driven service providers to deploy fibre in the access network.

Ensuring uptime and efficient performance of fibre networks requires testing and evaluation at multiple stages. The cables are first tested in a laboratory in extreme conditions and subsequently in real-world conditions upon their deployment.

Most fibre 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 fibre cable system throughout its lifetime. Tests on individual splices are performed through 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 fibre cable.

Following its installation, the fibre 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 fibre tracer. Manufacturers also perform tests for chromatic dispersion and polarisation mode dispersion on ultra-long fibre cable networks.

Testing splice loss and detecting fault locations

An OTDR consists of a high power laser transmitter that sends a laser pulse from one end of the single-mode fibre cable to the other. The pulse traversing the fibre path gets scattered at various intervals and is reflected from splices/connectors. A part of this light travels back towards the source, and along with the reflected light, helps the OTDR in measuring splice losses.

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 and losses. The accuracy of these measurements depends on the cable's attenuation coefficient, which is based on the wavelength of the laser pulse. Accurate measurement of

losses using the OTDR requires the laser pulse to have a wavelength similar to that of fibre (1,310 nanometres [nm] and 1,550 nm).

Errors in splice loss measurements are also observed when several fibre cables with different core diameters are connected to form a long distance network. Variations in the diameters of cable cores result in different percentages of light scattered and leads to higher attenuation in one direction. This error can be rectified by performing tests at both ends of the cable and taking an average of the two measurements to calculate the expected true loss.

Also, an OTDR is not suitable for measuring losses in multimode fibre cables, which are installed in university campuses and buildings. An OTDR underestimates splice losses by 3-10 dB. This is because the laser pulse transmitted by the OTDR has a low emission angle and consequently, the loss estimated from backscattered light from connectors is lower.

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. The cable is tested for losses at different wavelengths depending on its characteristics. While a multimode fibre cable is tested at 850 nm and 1,300 nm with a light emitting diode pulse, a single-mode cable is checked at 1,310 nm and 1,550 nm with a laser pulse. The loss measured using the OLTS is then compared with an estimated loss for the cable, which is known as loss budget. The estimated loss is determined on the basis of losses observed in components such as splices, connectors and fibre. 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.

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 have advantages as well as shortcomings and, therefore, the selection of a testing technology should be based on the characteristics of the fibre cable network

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