Optical Return Loss Testing– Ensuring High-Quality Transmission

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As communication technologies and dense wavelength-division multiplexing (DWDM) systems evolve rapidly, measuring optical return loss (ORL) is a growing concern. High bit rates in digital fiber-optic transmission systems and networks continue to increase. The good news is that, in the past few years, we have witnessed the industry gain valuable experience in this area. In addition, the importance of ORL testing has also been getting the recognition it deserves. In this application note, we will briefly review the role of optical return loss testing and demonstrate how leading service providers use ORL testing to their benefit. We will also clarify the significant differences between true ORL measurements and optical time-domain reflectometer (OTDR) backreflection results.

Purpose of ORL Testing

ORL testing measures the backreflection of connectors and components in high-speed digital and analog systems used in Telco, CATV, LAN and WAN applications. To ensure proper stability of the lasers and their central wavelength, it is essential to measure backreflection when installing and maintaining networks designated to transmit at these speeds. Why? Because network installers need to ensure minimum backreflection prior to activating a DWDM system. Obviously, the industry-wide goal is to have error-free transmissions.

Simply expressed, ORL testing measures the difference between the amount of light a source sends out and the amount that returns to the source. Optical return loss has always presented a significant challenge for DWDM systems because it reduces the amount of light eventually transmitted.

Consequences of Backreflection

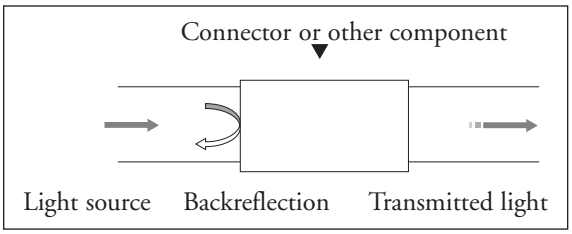
The main effects of backreflection include the following:

- Less light is transmitted
- Causes interference with light source signals
- Creates higher bit error rate (BER) in digital systems
- Reduces signal-to-noise ratio (SNR) in analog systems

Another effect of backreflection is that light returns to the light source. Since a light source is designed to emit and not to receive, high backreflection can bring about several consequences:

- Causes fluctuations in the light source's central wavelength
- Causes fluctuations in its output power
- Damages the light source permanently

Furthermore, wavelength fluctuations can cause calibration errors in the detector at the other end of the optical link. To guarantee performance, manufacturers specify the maximum amount of light that may return to the source without altering light signal quality and without loss of data transmission.



Accepted ORL values in the telecom industry vary according to the type of connector:

- PC (physical contact) is between 20 and 25 dB.
- UPC (Ultra-Polish physical contact) is between 35 and 55 dB.
- APC (angle physical contact) can vary between 55 to 70 dB.

Case Studies

A world-leading U.S.-based telecommunications company that offers fully integrated services (including local, long distance, international and internet) deploys 10 Gb/s systems (among others. They know that 10 Gb/s systems will fail if the ORL is too high. Therefore, not only are tests performed prior to system startup, but faulty connectors are also replaced regularly. Their conclusion? ORL testing must be performed before any fiber-optic system is activated.

Another service provider on the East Coast has integrated ORL testing as standard procedure. They believe that not testing for ORL means potential trouble. Defective connectors or any other kind of weakness to the fiber-optic line may result in higher bit error rate as well as cause potential damage to lasers. Consequently, testing or controlling the system's weaknesses avoids a major loss of time and money. It is a lot easier to troubleshoot a fiber before it is underground or in the air.

Differences between ORL and OTDR Testing

The port of an ORL tester is equipped with both a light source and a detector. The light source emits a continuous wave and the detector receives a reflected continuous wave to measure backreflection. On the other hand, the OTDR is designed with a different objective in mind. It emits pulses of light to find out the location of events; backreflection can be roughly evaluated with the returning pulse. As a result, OTDRs are less accurate with respect to backreflection measurements. They are affected by noise, distance and pulse width.

Another reason OTDRs cannot reliably test for ORL is the presence of dead zones that occur after strong reflectance. These dead zones prevent the OTDR from measuring small reflections that often follow a large event. ORL values obtained from an OTDR are considerably less accurate than those obtained with an ORL tester. In fact, the ORL tester is specifically designed for this sole purpose and is not affected by large events. Its main component is not influenced by noise, distance or pulse width.

Conclusion

Major players in the telecom industry have proved the importance and economic advantages of ORL testing. They have concluded not only that the numerous and negative effects of backreflection cannot be ignored, but also that ORL testing remains the best insurance for preventing backreflection and promoting a high quality of signal transmission.

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