Fiberdyne Labs – Fiber Characterization Guide

Introduction

Fiber Characterization is defined as a series of tests taken on a fiber optic span to determine the integrity of the fiber, installation practices, and performance for a desired transmission rate (OC-48 or faster) and/or Service to be implemented (DWDM). There are 5 tests taken to qualify a fiber:

- Optical Return Loss (ORL)
  1550 nm wavelengths, bi-directionally
- OTDR
  1550 nm & 1625 nm wavelengths, bi-directionally averaged
- Power Meter and Light Source (Insertion Loss)
  1550 nm & 1625 nm wavelengths, bi-directionally averaged
- Polarization Mode Dispersion (PMD)
  1550 nm wavelength
- Chromatic Dispersion
  1520 nm to 1630 nm at 10 nm increments

Industry Standards

- Power Loss
  FOTP-171 / EIA-455-171 Attenuation by Substitution Measurement for short length Single-mode optical fiber cable assemblies
- Optical Return Loss (ORL)
  FOTP-107 / TIA/EIA-455-107A Return Loss for Fiber Optic components
- OTDR
  FOTP-59 / TIA/EIA-455-8 Measurement of Fiber Point Discontinuities Using an OTDR and FOTP-8 TIA/EIA
- Polarization Mode Dispersion (PMD)
  TIA-455-124 – FOTP124 – Polarization-mode Dispersion Measurements for Single-mode Optical Fibers by Interferometry Method
- Chromatic Dispersion
  FOTP – 175 / TIA-455-175-B Measurement Methods and Test Procedures-Chromatic Dispersion

Thresholds (Typical)

- ORL: ≥ 27 dB
- Loss Readings:
  ≤ 0.25 dB/km + 0.3 dB/splice + 0.5 dB/connector pair (bi-directional)
- OTDR:
  ≤ 0.25 dB/km + 0.3 dB/splice + 0.5 dB/connector pair (bi-directional)
- PMD: ≤ 40 ps for 2.5 GB/s, 10 ps for 10 GB/s, 2.5 ps for 40 GB/s
- CD: 16640 ps/nm for 2.5 GB/s, 1040 ps/nm for 10 GB/s, 65 ps/nm for 40 GB/s

Description of Tests

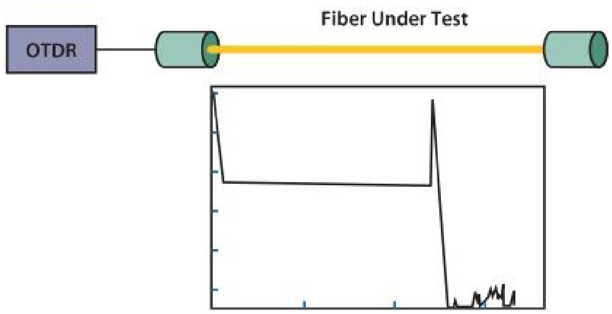
Optical Return Loss (ORL)

- ORL measures the total light reflected back to the transmitter caused by the fiber and the components including connector pairs, mechanical splices, etc.
- ORL provides a reading of the light that does not reach the opposite end of the fiber
- ORL determines overall fiber plant efficiency
- Reflective events include all connector pairs and mechanical splices
- ORL is measured as a +dB reading
- The higher the ORL reading, the better the reflections in the fiber under test

OTDR

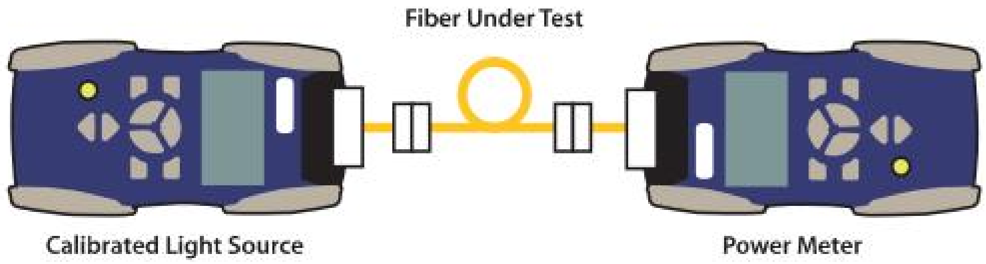
- The OTDR sends a light pulse down the fiber and measures the return signal power and travel time in order to calculate the fiber distance as well as loss of the fiber under test. Once the loss and distance are obtained they are plotted and a fiber trace is created.

  As well as plotting the optical distance of a fiber, the trace will show events such as splices and connector pairs.



- To accurately measure events, OTDR traces are taken bi-directionally and averaged.
- Typically, OTDR traces are taken at the 1550 nm and 1625 nm wavelengths to cover the C-band and L-band transmission windows.

Power Meter and Light Source



- A Power Meter and Light Source combination (Loss Test Set) is the most accurate way to provide end to end loss readings on an optical span, including the fiber attenuation and the initial and end connectors of the fiber under test.

  A power meter and light source is used to send continuous wave light from the source to the power meter. The difference in power is the total span loss.

Dist. (Km)	Site **A**	Port	1550 Loss (dB)	1625 Loss (dB)	Avg. Loss 1550	Avg. Loss 1550	1550 Loss (dB)	1625 Loss (dB)	Port	Site **B**
77.785		9	17.05	17.85	17.13	17.88	17.21	17.90	33	
		10	17.50	18.30	17.61	18.38	17.72	18.45	34	

Polarization Mode Dispersion

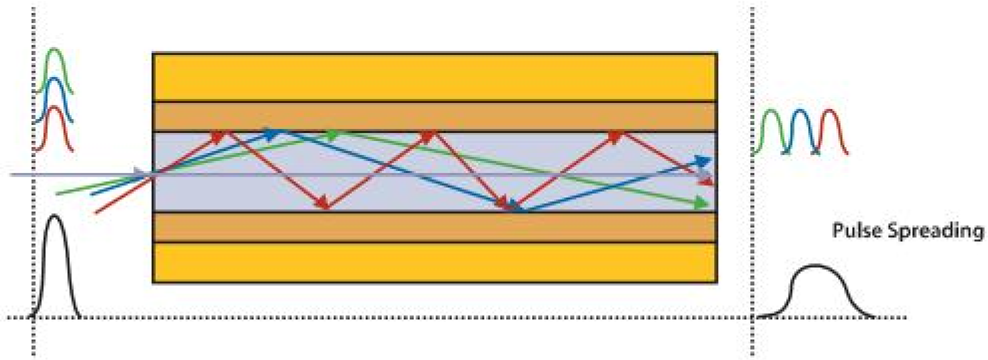
- Polarization Mode Dispersion (PMD) is the result of light traveling down a fiber along different paths. Each path will have a slightly different length which will result in different arrival times for each component of light. The difference in arrival times is PMD. This “differential delay” is measured in picoseconds (ps).

  PMD is performed at 1550 nm with a broadband light source. The test is performed taking several scans of the fiber under test. The result documented is the worst case result for the total delay and coefficient of the fiber under test. PMD is fitted to a Gaussian curve and determined to pass or fail based on industry standards.

SONET	Bit Rate	Bit Time	Delay
OC-48	2.5Gigabit/sec	401.88ps	40ps
OC-192	10Gigabit/sec	100.47ps	10ps
OC-768	40Gigabit/sec	25.12ps	2.5ps

Chromatic Dispersion

- Chromatic Dispersion is the result of different wavelengths traveling at different speeds of the non-zero spectral width of transmitters. Since transmitters are actually made up of several wavelengths and each wavelength travels at a different speed, the difference in arrival time of each wavelength causes pulse spreading or (chromatic) dispersion. This phenomenon is measured in ps/nm.



Typical CD set up would measure from 1520 nm to 1630 nm in 10 nm increments. The results are then plotted and graphed. The results include the dispersion slope, zero dispersion point and delay in ps/nm.

- Chromatic Dispersion is NOT a pass/fail reading
- The results determine if dispersion compensation is required
- The results are required for network engineering for proper transmission and network element requirements and placement.

SONET	Bit Rate	Total Dispersion
OC-48	2.5Gigabit/sec	16640ps/nm
OC-192	10Gigabit/sec	1040ps/nm
OC-768	40Gigabit/sec	65ps/nm