



Fiber Characterization

Detailed Course Outline

This two-day class combines classroom lecture and hands-on testing skills to provide an understanding of the principles behind building and maintaining high speed optical networks. Key parameters such as polarization mode dispersion (PMD), chromatic dispersion (CD), and optical return loss (ORL) need to be calculated in order to evaluate system capabilities and network upgrades to higher bit rate systems.

Prerequisites: This class requires basic knowledge of fiber optic theory. It is intended for people involved with equipment or outside plant where fiber characterization is needed to assure proper operation of 10 Gb/s or higher data rates.

Certifications and Credits: Light Brigade Certificate of Completion

Introduction

- The three big issues
- Optical units
- Standards committees
- High-speed transmission rates
- SONET optical carrier rates
- Time domain multiplexing systems
- Wavelength dimension in WDM systems
- Optical fiber transmission system
- Four tiers of fiber industry providers
- Optical network enabling technologies
- Optical network evolution
- Evolving to the all-optical network

Optical Fiber

- Fiber optic system basics
- Lightwave transmission
- Fiber composition
- Mode field diameter
- Single-mode versus multimode
- Single-mode optical fibers
- G.652 single-mode fiber
- ITU-T G.652 and G.652D
- Pulse spreading
- G.653 dispersion shifted SMF
- Single-mode fibers for DWDM technology
- Four wave mixing
- G.655 nonzero dispersion-shifted fiber
- ITU-T G.655
- Dispersion-compensating fiber
- Fiber optic color code standard

Connectors

- What to look for in a connector
- Typical connector roles
- Single-mode connector polishes
- Visual inspection equipment
- Visual safety using fiber optic sources
- IEC 61300-3-35
- Fiber optic cleaning methods
- Optical return loss and the ODN
- Reflection testing
- Terminators

Components Overview

- Light sources – lasers
- Laser spectral width
- Fabry-Perot lasers
- Distributed feedback lasers
- Direct and indirect modulation
- Pulse chirping
- Signal information in a light beam
- Reflection causes and issues
- Optical isolators
- Tunable lasers
- Laser safety
- Photodiodes
- Detector types
- Attenuators
- Bit error rate
- System related problems
- Eye diagrams

Regeneration

- Repeaters, regenerators, and amplifiers
- Factors for regenerator usage
- DWDM system spans
- Optical amplification
- Roles of optical repeaters

Optical Multiplexing

- Wavelength division multiplexing
- Fiber optic transponders
- Fiber optic passive devices
- Multiplexing basics
- Coarse wavelength division multiplexing
- Dense wavelength division multiplexing
- Optical demultiplexing
- Fiber Bragg gratings
- Optical circulators
- System loss budgets

Dispersion

- Dispersion power penalties
- Dispersion formulas
- Pulse spreading
- Modulation
- Pulse compression and broadening
- Pulse appearances
- Calculating dispersion penalty
- Dispersion in submarine systems

Chromatic Dispersion

- Components of chromatic dispersion
- Chromatic dispersion compensation
- Dispersion-compensating fiber and modules
- Chromatic dispersion measurement
- Spectral group delay in the time domain
- Interferometry method

Polarization

- Polarization mode dispersion
- Birefringence in fiber
- Linear polarization states
- Controlling polarization
- Polarization-dependent loss
- Simple PMD calculations
- PMD testing and measurement methods
- Complete PMD fiber characterization
- PMD first order limits

Test Equipment

- Optical loss test sets
- Optical talk sets
- Optical time-domain reflectometers
- Optical reflection
- Extrinsic loss and fiber tolerances
- Pulsewidth
- OTDR signatures
- Fiber tolerance issues
- Resolving fiber versus cable length
- Reflection testing
- Measuring reflectance with a deadzone box
- Reflectometers
- Optical spectrum analyzers
- Multiwavelength meters
- Testing WDM networks
- Optical dispersion testing
- Testing 100G systems

The Future

- New and future bandwidth demands
- TCP/IP
- 40/100G transmission
- Advanced technologies and trends

Wrap-up and Review

Hands-on Skills Learning

Dispersion Testing

- Build and test an 80-km span with G.655 fiber
- Build and test a 50-km span with G.652 fiber
- Polarization mode dispersion testing
- Chromatic dispersion testing
- Test fiber spans with fiber mismatches
- Retest spans with dispersion compensating modules

Reflection Testing

- Optical return loss
- Reflectance
- Documentation
- Polarization mode dispersion
- Chromatic dispersion