Fiber Optics 1-2-3

Detailed Course Outline

This four-day course has been developed with two days of classroom learning and two days of hands-on skills labs, review, and certification testing time. The labs provide the practical understanding and skills required to properly design, install, and maintain fiber optic networks. Students can attend the first two-days of this course either in person, or online via our instructor-led, remote classroom option.

This course is applicable to anyone working with fiber optic communications systems in telco/broadband, premises, traffic, rail applications, and more. Students will learn how to splice, connectorize, test, and troubleshoot optical fiber networks to increase efficiency, reliability, and on-the-job safety as well as reduce cost and downtime.

Prerequisites: None. Entry level. Fiber Foundations (online) is recommended but not required.

Certifications and Credits: ETA Fiber Optics Installer (FOI) Certification
BICSI Continuing Education Credits
Light Brigade Certificate of Completion

Classroom Lecture

Fiber Basics

- Digital communications
- What is an optical fiber?
- Fiber coatings
- Optical fiber color coding
- Basic units of measure in fiber optics
- Advantages and disadvantages
- Standards committees

Fiber Optic Transmission Theory

- The electromagnetic spectrum
- Fiber optic transmitters
- Fiber optic receivers
- Optical power
- The dBm scale
- Loss and attenuation
- Refraction
- Total internal reflection
- Numerical aperture
- Optical reflection
- Optical dispersion
- Fiber tolerances
- Bandwidth

Fiber

- The physical plant
- Fiber comparison
- What is a mode?
- Multimode fiber characteristics
- Multimode optical fiber types
- Application supported distance
- Single-mode fiber characteristics
- Mode field diameter
- Single-mode optical fiber types
- Dispersion in single-mode fibers

Cable

- Cable materials and structure
- Indoor optical cables
- Distribution cables
- Armored cable
- Breakout cables
- Fiber optic cable cordage
- Indoor/outdoor cables
- Loose tube outside plant cables
- Ribbon cables
- Microduct cables

- Aerial fiber optic cables
- FTTx drop cables
- Typical optical cable specifications
- Fiber and buffer color codes
- Composite and hybrid cables
- Cable interconnection options

Connectors

- Main connector components
- Connector types
- What to look for in a connector
- Typical connector roles
- Subscriber connector (SC)
- BFOC/2.5 (ST)
- LC connector
- Multifiber connectors
- Older connector styles
- Termination techniques
- Fiber optic connector inspection
- Cleaning methods
- Single-mode field connectorization issues
- Attenuators
- Terminators

Splicing

- Why do we need to splice?
- The splicing sequence
- Splicing considerations
- Fiber cleaving
- Common fiber optic cleavers
- Fusion splicing
- Ribbon splicing
- Mechanical splicing
- Pigtail splicing
- Protecting a splice

Fiber and Cable Management

- Fiber management scenarios
- Rack and wall mount patch panels
- Splice panels
- Optical entrance enclosures
- Fiber distribution units
- Splice closures
- Splice trays
- Fanout and breakout kits
- Fiber raceway systems
- Work area media outlets
- Fiber to the building installations
- OSP fiber and cable slack management
- FTTx cable management products
- Fiber distribution hubs
- Fiber access terminals
- Multiport service terminals
- Fiber transition terminals
- Vaults and handholes
- Panel and closure considerations

Installation

- Cable handling
- Guidelines for fiber optic cable installation
- Standards, regulations, and codes
- Air blown fiber
- Cabling buildings
- Cable trays and cable duct benefits
- Cable installation products

OSP Installation

- Underground installation techniques
- Proper route planning and engineering
- Conduit and duct installation
- Cable pulling methods
- Tension monitoring
- Air blown fiber
- Aerial installation
- Utility applications of fiber optics
- Mid-span (express) entries
- Storage methods and products
- Sequential markings

Test Equipment

- Optical loss test sets
- Optical time-domain reflectometers (OTDRs)*
- Key considerations for OTDRs
- Fiber identifiers
- Visual tracers
- Visual inspection
- Optical talk sets
- Optical dispersion testers
- Testing documentation

Optical Testing

- TIA-568 testing terminology
- Test methods
- Multimode launch conditions
- Optical loss testing with encircled flux or mandrel
- Reference test methods

*Brillouin OTDRs are not covered in this course.

- Insertion loss method
- “Not to exceed” charts
- Testing transmitter and receiver power
- OTDR deadzone
- OTDR signatures
- Gainers on OTDR traces
- Fiber roll-off
- Testing through fiber optic splitters
- Key points to understanding IOR
- Documentation

Restoration

- Typical causes of failure
- Types of fiber optic damage
- Pre-emergency planning activities
- Equipment used in the restoration role
- Troubleshooting flow chart
- Emergency restoration ‘jump kit’
- Aerial restorations
- OSP restorations
- Fiber optic restoration for premises
- Proactive planning vs. reactive restorations
- The need for slack cable
- Post-restoration recommendations

Communication System Basics

- Fiber optic transmitters
- Laser light sources
- Lasers in single-mode systems
- Light sources in multimode systems
- Laser and LED spectral width
- Reflection concerns
- Fiber optic receivers
- Photo diodes
- Typical span distances
- Repeaters, regenerators, and amplifiers
- Factors for regenerator usage
- Basic components for optical transmission
- Point to point
- Point to multipoint
- Passive devices
- Optical splitters
- WDMs and bidi devices
- CWDM and DWDM

Loss Budgets

- Loss budget basics
- Design options for fiber optic networks
- Safety margins
- Multimode system budgets
- 10/40/100 Gigabit networks
- Single-mode system budgets
- Loss budgets for FTTx networks (point-to-multipoint)

Safety

- Fiber optic safety best practices
- Visual safety using fiber optic sources
- Wavelengths and the eye
- Laser classifications
- Working with lasers
- Safety eyewear
- Working with optical fibers
- Personal protective equipment
- Chemicals
- Safety data sheets (SDS)
- The work area
- Installation practices

Appendix A — Worksheets

- Fiber selection
- Cabling options
- Cable management products
- Test equipment selection
- Placement technique
- Fiber installation inspection report
- OTDR acceptance test form
- Splice loss record

Appendix B — Miscellaneous

- National and Canadian electrical codes
- TIA-569

Wrap up and Review

Hands-on Skills Learning

Review of Safety Practices

Connectors

- Prepare a simplex jacketed fiber for termination.
- Prepare a simplex 900-micron fiber for termination.
- Build a hand-polished anaerobic connector.
- Clean a fiber connector endface.
- Use inspection scopes to view a connector endface.
- Use a light source and power meter to measure loss on a mated connector pair.
- Prepare and install a mechanical splice-on connector.
- Use a visual fault locator to identify nearby bends and breaks.
- Assemble an ETA-compliant patch-cord.
- Practice proper tool usage for connector preparation.
- Recognize acceptable hand-polished endface conditions.

Cable Preparation for Termination

- Practice proper tool usage for cable and buffer tube preparation.
- Identify fiber optic cable and jacket types.
- Prepare a stranded cable for installation into a fiber closure/panel.
- Prepare buffer tube for a splice tray.
- Prepare a fanout kit.

Splicing and OTDRs

- Clean the test port and all connectors of an OTDR.
- Modify typical OTDR settings to obtain a clear interpretable trace.
- Recognize and interpret events depicted by an OTDR.
- Use an OTDR to test and identify events in a span.
- Use a launch box to enable identification of events close to the OTDR.
- Join fibers with a mechanical splice.
- Strip and cleave an optical fiber.
- Modify typical splicer settings to obtain a high-quality splice.
- Perform arc calibration on a fusion splicer.
- Create a fusion splice.
- Learn how to install a fusion splice-on connector.

Optical Loss Testing

- Inspect and identify connector contamination.
- Clean connector endfaces using wet and dry cleaning methods.
- Clean connectors using commercially-available fiber optic cleaning products.
- Identify damaged connectors.
- Use a light source and power meter to observe the effects of a macrobend and microbend on a fiber.
- Learn one-, two- and three-cord reference testing.
- Create a loss budget for sample span of fiber.
- Measure optical loss for a span of fiber and compare to the calculated loss budget.
- Use a fiber identifier to detect active fibers.