Fiber Optics for Enterprise Networks

Detailed Course Outline

Light Brigade®
FIBER OPTIC TRAINING

This course provides the practical knowledge and hands-on skills required to specify products, install, and maintain fiber optic premises and data center networks. Students will use the latest fiber optic technology and equipment to splice, connectorize, test, and troubleshoot fiber networks to increase efficiency and reliability as well as reduce cost and downtime. It is intended for installation contractors, technicians, and end users involved in building and maintaining premises or private networks and data centers per TIA-568, 758, and 942 standards.

Prerequisites: Entry level. Basic fiber or copper cabling experience is beneficial.

Certifications and Credits: ETA Fiber Optics Technician—Inside Plant (FOT-ISP) Certification
Light Brigade Digital Credentialing

Classroom Training (Day 1, Day 2 AM)

Why Fiber Optics?

- Fiber Versus Copper
- Advantages of Fiber Optics
- Fiber Versus UTP
- Using Light as a Communications Method
- Media Selection & Bandwidth Comparison
- The Telecommunications Revolution
- High-speed Transmission Rates

Applications

- Application Areas of Optical Fiber
- Enterprise Networks
- Storage and Data Centers
- Passive Optical LAN Architecture
- Topologies

Fiber Optics Transmission Theory

- What is an Optical Fiber?
- Basic Units of Measure in Fiber Optics
- Total Internal Reflection
- Numerical Aperture
- Speed of Light
- Refraction
- What is a Mode?
- The Electromagnetic Spectrum
- Lightwave Transmission
- Standard Wavelengths
- Light Loss Measurement
- Optical Power Loss
- Attenuation
- Intrinsic Attenuation
- Extrinsic Attenuation
- Multimode Fiber Terminology
- Optical Dispersion
- Modal Dispersion
- Multimode Bandwidth
- Bandwidth Limiters
- Multimode System with VCSEL Source
- Multimode System with LED Source
- Single-mode Dispersion
- Mode Field Diameter (MFD)
- Fresnel Reflection
- Single-mode System with Laser Source
- What About Optical Power?
- Photodetectors

Standards and Codes

- Standard or Code?
- Standards Committees
- Common Fiber Optic Standards

- Code Setting Organizations
- National Electrical Code
- NEC Spaces
- National Electric Safety Code
- NESC Spaces
- TIA-568
- TIA-569
- TIA-606
- TIA-758
- TIA-942

Safety Best Practices

- Fiber Optic Safety Concerns
- The Work Area
- Working with Optical Fibers
- Personal Protective Equipment
- Safety Eyewear
- Working with Lasers
- Laser Classifications
- Visual Safety Using Fiber Optic Sources
- Safety Data Sheets (SDS)

Optical Fibers

- A Fiber Comparison
- Multimode Fiber Types
- Legacy Multimode Fibers
- OM5 Fiber
- Typical Fiber Specifications
- ITU-T G.657 Bend-insensitive Fibers
- Multimode Fiber
- Single-mode Fiber
- High-speed Fiber Applications
- Fiber Coatings
- Optical Fiber Color Coding
- New Color Code Charts
- Optical Fiber Manufacturing

Optical Cables

- Fiber Optic Cable Design Objectives
- Why Different Cables?
- Cable Design Objectives
- Cable Structural Elements
- Tight Buffered Cable Designs
- Distribution Cables
- Fiber and Buffer Color Codes
- Breakout Cables
- Standard Cable Cordage
- Applications
- Plenum and Riser Cables
- Premises Ribbon Applications
- Tight Buffered Cable Specifications
- Loose Tube Cable
- Loose Tube Cable Designs
- Stranded Cables
- Unitube / Central Tube Cables
- Indoor/Outdoor Cables
- Composite and Hybrid Cables
- Sample Optical Cable Specifications
- Cable Interconnection Options
- Elements and Types of Cable Construction

Fiber Management Products

- Fiber Versus Cable Management
- Fiber and Cable Management
- Data Center Cabling
- TIA-942 Revisions
- Wall Mounted Patch Panels
- Rack Mounted Patch Panels
- Rack Space
- Labeling/Administration Scheme
- Labeling Demonstration
- Labeling Activity
- Abandoned Cables
- Cable Trays and Duct Benefits
- Raceways for Optical Fiber Cable
- Raceways in Telecom Spaces
- Raceways in Data Centers
- Fiber Management
- Patch and Splice Modules
- Splice Panels
- Splice Trays
- Fiber Optic Distribution Frames
- Rack Layout
- Top of Rack (ToR) Design Scheme
- End of Row (EoR) Design Scheme
- Server Rack Cable Routing
- Top of Rack (ToR) Switching

- End of Row (EoR) Switching
- Overhead
- Underfloor into Wall Mount
- Optical Cable Entrance Facility (OCEF)
- Fiber Distribution Units
- Fiber Distribution Hubs
- Work Area (WA) Media Outlets
- OSP Fiber and Cable Management
- Splice Closures
- Rack Space

Connectors

- Why Connectors?
- What to Look for in a Connector
- Specifying Optical Connectors
- Optical Reflection
- Typical Connector Boot Colors
- Primary Single-Fiber Connectors
- MPO/MTP®
- MPO Connectors and Adapter
- Trunk/Patch Cord Polarity
- 16-fiber MT Ferrule
- Termination Options

Fiber Splicing

- Reasons to Splice
- Fusion Splicing
- Mechanical Splicing
- Pigtail Splicing
- Factory-polished Pigtail Installation
- Splice Protection
- Splice Enclosures and Closures

Installation

- Optical Cable Installation
- Buildings and Campuses
- Firestop
- Campus or Building Star Topology
- Typical Building Layout
- Campus Buildings in a Ring Topology
- Enterprise Site Survey Activity
- Cable Pre-Pull Planning
- Cable Placement – Bend Radius
- Cable Placement – Tension
- Microducts for Fiber Optic Cables
- Air Blown Fiber
- Short Indoor Runs
- Outdoor Runs
- Post Pull
- Pulling Cable with Preterminated Assemblies
- Customer-owned Outside Plant
- Slack Storage Methods
- Underground Installation
- Cable Trenching
- Aerial Installation
- Sequential Markings

Test Equipment

- Testing Fiber Networks
- Optical Tests and Test Equipment
- TIA-568 Testing Terminology
- Optical Loss Testing
- Optical Loss Test Equipment
- Test Reference Cords
- Launch Conditions
- Encircled Flux (EF)
- Overfilled Fiber
- The Mode Filter
- Referencing for Loss Testing
- TIA-526-14 Test Methods
- One-Jumper Reference
- Certification Test Set
- Certification Test Set Reference
- MPO Test Sets
- Traditional MPO Testing
- Connect to Trunk and Run the Test
- MPO Testing
- TIA-568 Testing Terminology
- Optical Time-Domain Reflectometers
- OTDR Testing
- How the OTDR Works
- Launch Boxes and Optical Terminators
- OTDR Index of Refraction Set Up Values
- OTDR Testing
- Generating an OTDR Baseline Trace
- Poor Launch Conditions
- Launch Levels

- Interpreting OTDR Traces
- Fusion Splice OTDR Signature
- Reflective Signatures
- Ghost Signatures
- How to Resolve Gain Splices
- Visual Laser for Troubleshooting
- Visual Inspection and Cleaning
- The Ferrule Endface
- Cleaning and Inspection Activity
- Troubleshooting
- Fault Location Flow Chart
- System Related Problems

Decoding Transceivers

- Multimode Fiber Specifications
- Effective Modal Bandwidth
- Data Center Links
- Transceiver Parameters
- Form Factor and Protocol
- Multiple Fiber Channels
- Multifiber and Multiwavelength Channels
- Transmission and Line Rate Standards
- Serial and Parallel Transmission
- Sample of Real-world Product Offerings

Loss Budgeting

- Elements of System Design
- Typical Span Distances
- Fiber Optic Receivers
- Equipment Needs
- Add Up the Losses
- Loss Budget Calculation
- Loss Estimation
- Power Budget Calculation
- Loss Estimation
- Power Budget Calculation
- The Need for Lower Attenuation

Reference Materials

- NEC Article 770
- TIA Standards
- Fiber Installation Inspection Report
- Next Generation Data Rates
- Serial and Parallel Transmission

Hands-on Skills Learning (Day 2 PM, Day 3)

Cable Preparation

- Cable sheath removal and fiber access
- Fan-out kit installation for direct termination of loose tube cable
- Pulling grip basics
- Pre-terminated cable protection

Fusion Splicing

- Proper cleaning and fiber cleaving processes
- Attenuation measurement

Connectorization

- Field-installable connectors
- Splice-on connectors
- 900-micron multimode jumpers
- Attenuation measurement

Field Testing

- Evaluate connector end-face
- MPO test equipment and setup
- MPO to MPO
- MPO to LC or SC
- Tier 1 Testing
- Bidirectional loss measurement
- Link certification testing
- Tier 2 Testing
- OTDR test set-up
- Trace analysis
- Compute a link loss budget

Wrap Up and Review