Hands-On

Fiber Optic Designer (ETA-FOD)

Course Description

Fiber optic systems are a key part of new communications services. Teir success depends upon good design. This Hands-On course will cover the particulars of how fiber optic networks are designed within the context of complete communications systems or construction projects. It will and provide an in depth knowledge of processes in delivering new services and selecting the most appropriate plant for successful fiber optic system.

The focus is geared on the design. This includes network protocols, network configurations, optical cabling, industry communications standards, and determination of fiber count, hardware selection, splicing /termination methods, cable system testing/troubleshooting and proper documentation.

This Fiber Optics Designer course provides detailed instruction and Hands-On labs of fiber optic design throughout the course.

Certification(s)
ETA (FOD) Fiber Optic Designer Certification can be administered during this course, upon request.

Students Will Learn

- **Produce a design specification for a Fiber Optic Network Service**
- **Select the correct kind of Fiber links to match application requirements**
- **Specify the Physical Plant Layout**
- **Identify the Network Protocols and Network Configurations to be used**
- **Implement services using Industry Communications Standards**
- **Determine Fiber, Splicing, Termination, Testing and Troubleshooting procedures**
- **Calculate Link Loss, throughput and availability of the finished service**
- **Deliver Documentation matching Industry Standards**
- **OTDR reading results and interpretation documentation**
- **And More...**

Target Audience

Anyone in the design, support and planning of Fiber Optic systems.

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Prerequisites

A basic understanding of telecommunications and hands-on experience with Fiber Optic systems is assumed.

This information can be obtained in our courses below or equivalent knowledge
-Basic Telephony & Telecom Electronics
-Essential Fiber Optics & Testing

Course Outline

MODULE 1. THEORY AND PRINCIPLES OF FIBER OPTICS

Outline the basic structure of optical fiber
Describe the terms:
Core
Cladding
Coating
Describe the principles of operation as the light travels down the fiber
Define the term index of refraction
Describe the angles of incidence and refraction
Describe the principle of total internal reflection
Describe numerical aperture
Describe the system parameters that affect the transmission systems operation
Discuss the properties of electromagnetic signals
Distinguish between the transmitter power and receiver sensitivity ranges
Examine the two key characteristics attenuation and dispersion
Define attenuation
Describe intrinsic attenuation factors controlled by manufacturer
Describe extrinsic factors controlled by fiber optics cable installer
Relate the term microbend loss to extrinsic attenuation
Relate the term macrobend loss to extrinsic attenuation
Discuss the term dispersion and the affect it has on the pulse as it travels down the fiber
Define and describe the three main types of dispersion to include:
Modal dispersion
Chromatic dispersion
Material dispersion
Waveguide dispersion
Polarization mode dispersion
Define the term bandwidth

MODULE 2. OPTICAL SOURCES

Recall the typical operational wavelengths for communication systems
Compare the output pattern (sometimes referred to as spot size) of the LED and laser light sources
Distinguish the main difference between an LED and a laser regarding emission
Describe the attributes of the laser and how they differ from the LED
Name and describe the different types of LED sources

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Name and describe the different types of Laser sources
Define the term chirp that occurs in directly-modulated lasers
Describe the different modulation techniques used with optical sources to include:
Direct modulation
Integrated modulation
External modulation

MODULE 3. FIBER TYPES

Outline the types and basic construction of optical fiber
Associate the differences between multimode and single-mode core and cladding diameters
List the common classifications for optical fibers
Describe the four different types of optical fiber material makeup to include:
Multimode step index
Multimode graded index
Single-mode step index
Single-mode segmented core
Describe the differences between over filled launch (OFL) and restricted mode launch (RML) bandwidth measurement specifications
Define differential mode delay effects on conventional 50 ?m and 62.5 ?m optical fibers
Associate the need for a mode conditioning patch cord on gigabit or higher equipment
Summarize the fiber types that correspond to the referenced fiber designations OM1, OM2, OM3, and OM4 in accordance with ISO/IEC (the International Organization for Standardization/International Electrotechnical Commission) requirements
Point out that the mode field diameter is a measure of the spot size or beam width of light propagation in a single-mode fiber
Summarize the fiber types that correspond to the referenced fiber designations OS1, and OS2 in accordance with ISO/IEC (the International Organization for Standardization/International Electrotechnical Commission) requirements

MODULE 4. CABLE SELECTION IN NETWORK DESIGN

Discuss both Insulated Cable Engineers Association (ICEA) and ANSI/TIA-568-C specifications for the optical fiber cables recognized in premises cabling standards to include:
Inside plant cable
Indoor-outdoor cable
Outside plant cable
Drop cable
Describe the different types of buffers used in fiber optic cables
Tight buffer
Loose tube
Single tube
Describe the temperature effects on loose tube fiber optic cables
Explain why ribbon cables are typically used in high-density, high fiber count applications
Describe the design benefits of single tube fiber optic cables
Recognize the recommended indoor, indoor/outdoor, and outdoor cable types for an application
Determine and select the proper optical fiber cable given an installation scenario

MODULE 5. NATIONAL ELECTRICAL CODE

Distinguish the various environments inside a building in which a fiber optic cable is installed

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Infer that the National Electrical Code (NEC) is purely advisory and is made available for a wide variety of both public and private uses in the interest of life and property protection
Identify the point of entrance, NEC Article 800.2, as the point within the building at which the wire or cable emerges from an external wall
Explain that the intermediate metal conduit (IMC) must be connected by a bonding conductor or grounding electrode in accordance with NEC Article 800.100(B)
List the NEC optical fiber cable types including:
Abandoned optical fiber cable
Nonconductive optical fiber cable
Composite optical fiber cable
Conductive optical fiber cable
Describe the NEC listing requirements for:
Optical fiber cables
Optical fiber raceways
Define the maximum distance that an unlisted outside plant communications cable shall be permitted to be installed in a building (NEC Article 800.48)
Discuss the grounding considerations for fiber optic cable installation inside a building to include NEC Article 770.100, NEC Article 250, and ANSI/TIA-607 Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications
Discuss the NEC Article 645 requirements for cabling information technology equipment
Describe the possible cabling scenarios and considerations to take into account when developing a cost comparison model

MODULE 6. FIBER OPTIC TERMINATION

Define fiber optic termination
Summarize the anatomy of a fiber optic connector
Compare advantages and disadvantages of termination versus splicing
Explain where connectors are used
Discuss the performance of a multimode fiber optic link using the following sections of the ANSI/TIA-568-C Optical Cabling Components Standard
Section 4.2 cable transmission performance
Section 5.3 optical fiber splice
Annex A (Normative) optical fiber connector performance specifications
Discuss the performance of a single-mode fiber optic link using the following sections of the ANSI/TIA-568-C Optical Cabling Components Standard, ANSI/TIA-758 CustomerOwned Outside Plant Telecommunications Cabling Standard, and Telcordia GR-326 Core Generic Requirements for Single-mode Optical Connectors and Jumper Assemblies
ANSI/TIA-568-C Section 4.2 cable transmission performance
ANSI/TIA-758 Section 6.3.4.1.2 attenuation
ANSI/TIA-568-C Annex A (Normative) optical fiber connector performance specifications
Define physical contact (PC) and angled physical contact (APC) finish
Explain how PC and APC finishes affect both insertion loss and back reflectance
Recall how to properly perform a connector endface cleaning and visual inspection in accordance with ANSI/TIA-455-57B Preparation and Examination of Optical Fiber Endface for Testing Purposes
Associate how physical contact depends on connector end-face geometry to include the Telcordia GR-326 three key parameters for optimal fiber contact:
Radius of curvature
Apex offset
Fiber undercut and protrusion
Name and describe the different single fiber termination connector styles
Name and describe the different multi-fiber termination connector styles

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Describe the field installable connector technologies
Describe the heat cured epoxy technology
Describe quick cure terminations
Describe no epoxy, no polish terminations
Define pigtail splicing
Describe preconnectorized assemblies and cables

MODULE 7. FIBER OPTIC SPLICING

Define a fiber optic splice
Distinguish between a mechanical and fusion splice
Explain where splices are used
List ANSI/TIA-568-C inside plant splice performance requirements
Cite ANSI/TIA-758 outside plant splice performance requirements
Explain the intrinsic factors that affect splice performance
Relate the extrinsic factors that affect splice performance
Describe splicing types and methods
Outline mechanical splice technology
Discuss fusion splice technologies to include:
Local injection and detection (LID)
Lens profile alignment system (LPAS)
Profile alignment system (PAS)
Core detection system (CDS)
Fixed V-Groove
Examine the critical steps involved in splicing
Planning
Work area
Preparing the fiber
Splicing
Protection

MODULE 8. HARDWARE

Discuss the reasons why and where hardware is used
Compare the differences of hardware designs without cable management and with cable management products
Define the typical usage areas of rack (frame) mounted patch panel hardware
Explain how to provide for and install horizontal cable management products
Explain how to provide for and install vertical cable management products
Discuss the different styles of hardware adapter (connector) panels
Define the different types and typical usage areas of wall mountable housing hardware
Describe work area outlet hardware types
Define distributed zone architecture
Describe a fiber zone box (FZB)
Define other hardware options such as splice closures and splice trays

MODULE 9. CROSS-CONNECT

Explain that a cross connection is the termination point of a system
Describe the numerous factors, which will affect how to terminate a cross connection design

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including:
Location
Growth
Capacity
Cable type
Fiber count
Identify the strategy or process used to determine a cross connect fiber termination capacity including:
Type of optical connector
Number of terminations per connector panel
Number of connector panels
Patch panel density and size
Identify the strategy or process used to determine a cross connect splice capacity including:
Number of trays a housing can accommodate
Number and types of splices a tray can accommodate
Number and types of cable a tray may accommodate
Explain the strategy and factors involved in the process of determining space allocation including:
Growth strategy
Connectivity scheme (interconnect or cross-connect)
Cable routing and jumper management capabilities
Hardware dimensions
Hardware access requirements
Explain the strategy and factors involved in the process of determining layout including:
Network size
Segregation requirements
Define the basic rules of fiber jumper management

MODULE 10. ANSI/TIA-568 BUILDING CODES

Identify the major telecommunication standards and governing bodies
Interpret ANSI/TIA-568-C.0 Generic Telecommunications Cabling for Customer Premises to
include:
Telecommunications cabling system structure
Cabling installation requirements
Cabling transmission performance and test requirements
Understand ANSI/TIA-568-C.1 Commercial Building Telecommunications Cabling Standard to include:
Entrance facilities
Equipment rooms
Telecommunications rooms and telecommunications enclosures
Backbone cabling (cabling subsystem 2 and cabling subsystem 3)
Horizontal cabling (cabling subsystem 1)
Work area
Cabling installation requirements
Interpret ANSI/TIA-568-C.3 Optical Fiber Cabling Components Standard including: 10.4.1 Optical fiber cable transmission performance and physical requirements 10.4.2 Connecting hardware
Optical fiber patch cords and optical fiber transitions
Define structured optical fiber cabling distances
Describe structured cabling architecture
Define open office design practices using multi-user telecommunications outlet assemblies (MUTOAs)

MODULE 11. LOGICAL NETWORKS

Define a logical topology

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Describe logical bus network topology 11.1.2 Describe logical ring network topology 11.1.3 Describe logical star network topology 11.1.4 Describe logical mesh network topology

MODULE 12. INTERNETWORKING

Compare and contrast characteristics of internetworking physical media to include:
Physical media
Logical architectures
Communication technologies
In the network describe the role of a:
Repeater 12.2.2 Hub 12.2.3 Bridge 12.2.4 Switch 12.2.5 Router
Identify differences between switched and routed network design considerations

MODULE 13. ETHERNET

Describe the genesis of Ethernet (IEEE 802.3)
Explain Carrier Sense Multiple Access/Collision Detection (CSMA/CD) technology
Describe the various Physical Layer Medium Dependent (PMD) speeds at which a standards-based implementation of Ethernet operates
Describe the features, functions and components of the 1000 Mbps Gigabit Ethernet
Describe the features, functions and components of the 10 Gigabit Ethernet
Define differential mode delay and the purpose of a Mode Conditioning Patch Cord
Differentiate between the operating ranges for Ethernet IEEE 802.3 series to include:
Physical Medium Dependent (PMD) options 13.7.2 Nominal speed
Light source and wavelength
Overfilled Launch Bandwidth (OFL)
Effective Modal Bandwidth (EMB) 13.7.6 Maximum supportable distances
FOD Competencies 5

MODULE 14. FIBRE CHANNEL

Explain Fibre Channel technology as a computer communications protocol in accordance with the ANSI/International Committee for Information Technology Standards (INCITS)
Define the different applications and technologies that Fibre Channel supports
Describe the different physical cabling topologies of a Fibre Channel network to include:
Point-to-Point (FC-P2P)
Arbitrated Loop (FC-AL)
Switched Fabric (FC-SW)
Describe the various Physical Interfaces (PI) speeds at which a standards-based implementation of Fibre Channel operates
Differentiate between the operating ranges for ANSI/INCITS Fibre Channel series to include:
Fibre Channel Physical Interface (FC-PI) options
Nominal speed
Light source and wavelength
Overfilled Launch Bandwidth (OFL)
Effective Modal Bandwidth (EMB)
Maximum supportable distances

MODULE 15. DATA CENTER CABLE DESIGNS

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Define a data center
Recognize the different types of data centers to include:
Co-location Hosting Services
Managed Hosting Services
Enterprise
Describe the various functional areas of data centers to include the following:
Main Distribution Area (MDA)
Server Area
Storage Area Network (SAN) Area
Compare and contrast the functionality and major differences between the data center cabling requirements and considerations
Recognize ANSI/TIA-942 Telecommunications Infrastructure Standard for Data Centers provides information on the factors to consider when planning and preparing the installation of a data center or computer room
Identify ANSI/TIA-942 Telecommunications Infrastructure Standard for Data Centers telecommunication spaces to include:
Entrance Room
Main Distribution Area (MDA)
Horizontal Distribution Area (HDA)
Zone Distribution Area (ZDA)
Equipment Distribution Area (EDA)
Identify ANSI/TIA-942 Telecommunications Infrastructure Standard for Data Centers telecommunication cabling to include:
Horizontal cabling
Backbone cabling
Centralized cabling
Explain the difference between Structured versus Un-structured cabling solutions
Outline the zone distribution data center layout utilizing a Zone Distribution Area (ZDA) with star topology to include the following:
In-cabinet Zone Distribution
Sub-floor Zone Distribution
Overhead Zone Distribution
Discuss the importance of maintaining proper system polarity in the data center design so that the optical fibers connected to a transmitter on one end of an optical fiber link connects to a receiver on the other end

MODULE 16. DATA CENTER CABLING SOLUTIONS

Define plug and play
Explain and breakdown the major benefits of designing a plug and play system in the data center
Compare the alternatives to a standard plug and play design to include:
Star topology with Main Distribution Area (MDA)
High density truck cables from the Main Distribution Area (MDA) to the Zone Distribution Area (ZDA)
Describe the ANSI/TIA-942 recommended compliant design (star topology) for the Storage Area Network (SAN)

MODULE 17. VOICE NETWORKS

Describe the evolution and components of voice networks
Delineate the transmission process involved in voice communication, both analog and digital
Describe the different multiplexing techniques used in a voice network
Define the basic design rules of voice technologies that apply to a voice network design
Explain Voice over Internet Protocol (VoIP) design considerations

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MODULE 18. SECURITY VIDEO

Differentiate between a distributed backbone and centralized cabling security video networking design
Describe the distributed backbone security video network design to include:
Reduces fiber count
Increases electronics
Works well with large networks
Placement of video multiplexers will affect fiber allocation
Describe the centralized cabling security video network design to include:
Increases fiber count
Decreases electronics
Works well with small networks

MODULE 19. FIBER TYPES AND COUNTS

Describe how to design the cabling infrastructure in accordance with ANSI/TIA-568-C to include:
Location of the main cross-connect (MC), intermediate cross-connects (IC) and horizontal cross-connects (HC)
Determine cable routes
Determine the fiber distances
Describe how to choose the cable routes and physical topology when designing the cabling infrastructure to include the following: 19.2.1 Ring
Star
Special configurations
Describe how to determine fiber types and fiber counts when designing the cabling infrastructure
Outline the considerations for Gigabit Ethernet (GigE) and 10 Gigabit Ethernet (10 GigE) to include the following:
Length restrictions for Gigabit Ethernet and 10 Gigabit Ethernet
Redundancy requirements
Trunking requirements

MODULE 20. TESTING AND MEASUREMENTS

Describe the reasons for testing
Identify the optical testing procedures to include:
Connector and splice loss testing
Attenuation testing
Optical Time Domain Reflectometer (OTDR) testing
Outline the ANSI/TIA-568-C and Telcordia testing standards component requirements to include:
Connector pair loss
Splice loss
Connector reflectance
Optical fiber attenuation
Describe the purpose and procedures of end-to-end attenuation testing
Explain the purpose of mandrel wrapping during reference and system test
Determine proper ANSI/TIA-568-C (1, 2, or 3 jumper) reference based on the optical fiber link architecture
Describe the purpose of Optical Time Domain Reflectometer (OTDR) testing
Describe the purpose of chromatic dispersion testing
Describe polarization mode dispersion testing
Breakdown a Link Loss Budget Calculation to include:
Determine fiber loss at operating wavelength 20.10.2 Determine connection loss
Determine splice loss

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Determine total system budget loss

Delivery Method

Instructor-Led with numerous case-studies and exercises.

Equipment Requirements

(This apply's to our hands-on courses only)

BTS always provides equipment to have a very successful Hands-On course. BTS also encourages all attendees to bring their own equipment to the course. This will provide attendees the opportunity to incorporate their own gear into the labs and gain valuable training using their specific equipment.

Course Length

5 Days

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