

33108

Limited-Energy Cabling

Electronic Systems Technician

Overview

Electronic Systems Technicians (ESTs) are frequently required to pull various types of low-voltage cable through conduit and wireways. At other times, they are required to install cable inside walls, over ceilings, and under floors. This module covers general procedures for installing low-voltage cable in commercial and residential structures. It also evaluates common types of low-voltage cable, including optical fiber used for nonpower-limited, power-limited, remote control, signaling, fire alarm, and communication circuits.

Learning Objective 1

Successful completion of this module prepares trainees to:

Explain the relationship between wire gauge and a conductor's current-carrying capacity.

- a. Explain how stranding relates to signal attenuation.
- b. Explain how *NEC*[®] requirements impact low-voltage cable installation.
- c. Describe the types of low-voltage cable and how they can be identified.

Learning Objective 2

Successful completion of this module prepares trainees to:

Explain how to pull cable in commercial structures.

- a. Describe and identify cable pulling tools.
- b. Describe key considerations when planning cable installations.
- c. Describe key activities related to setting up equipment prior to pulling the cable.
- d. Describe the methods used to pull cable in vertical and horizontal pathways.

Learning Objective 3

Successful completion of this module prepares trainees to:

Explain how to pull cable in residential structures.

- a. Describe key factors to consider when installing residential cable.

Learning Objective 4

Successful completion of this module prepares trainees to:
Identify NEC[®] requirements for interior cable installations.

- a. Describe NEC[®] communications cable categories.

Learning Objective 5

Successful completion of this module prepares trainees to:

Describe the primary factors impacting installation of telephone and data systems cabling.

- a. Explain premises and outside wiring requirements for commercial and residential installations.
- b. Explain how to reduce EMI when installing low-voltage cable.

Performance Tasks

1. Use a wire gauge to select a specific wire size.
2. Identify cables by their markings.
3. Perform a cable pull using a fish tape.

Recommended Teaching Time: 20 hours

Classroom Equipment and Materials

- Whiteboard and markers
- Pencils and paper
- PowerPoint[®] Presentations for Module 33108
- A variety of standard marker sizes
- Poster board
- Flip chart
- LCD projector and screen
- Computer with Internet access
- Module Review answer key
- Module Examinations

- A copy of the *National Electrical Code*[®]

Performance Task 1

- Samples of various types of wire and insulation
- Standard wire gauge

Performance Task 2

Samples of the following:

- Multimode and single-mode optical fiber cables
- Cables with *NEC*[®] classification markings

Performance Task 3

- Gloves
- Eye protection
- Fish tape
- Fish poles
- Power fishing system
- Cable pull stocking
- Pull lines
- Cable caddy
- Cable lubricant
- Various sizes of cable on reels or in boxes, pay-out packs, or reels-in-a-box

33208

Limited-Energy Cable Selection

Electronic Systems Technician

Overview

Electronic Systems Technicians (ESTs) regularly select and install cable used in signaling and communications systems. Therefore, it is critical for you to understand how to choose the right cable based on job criteria and cable options. Knowing the properties and types of low-voltage and fiber-optic cable, as well as their physical and performance specifications, are key to ensuring your installations are safe, reliable, and compliant with all applicable codes and standards.

Learning Objective 1

Successful completion of this module prepares trainees to:

Describe how low-voltage cable is rated and how this relates to cable selection.

- a. Identify the types of conductors and insulators used in cabling.

Learning Objective 2

Successful completion of this module prepares trainees to:

Describe criteria used in the selection of different types of low-voltage cable.

- a. Describe the criteria that should always be considered when selecting low-voltage cable.
- b. Identify criteria used to select fire alarm and security system cable.
- c. Identify criteria used to select coaxial cable.
- d. Identify the criteria used to select telecommunications and data cable.

Learning Objective 3

Successful completion of this module prepares trainees to:

Explain how to calculate voltage drop.

- a. Identify the different approaches taken to calculate voltage drop.

Learning Objective 4

Successful completion of this module prepares trainees to:

Explain how to calculate the necessary wire size for a speaker system.

- a. Describe how to calculate power loss, impedance, and resistance in speaker systems.

Performance Tasks

1. Determine the correct cable conductor size based on a given load.
2. Calculate the voltage drop for various applications.

Recommended Teaching Time: 10 hours

Classroom Equipment and Materials

- Whiteboard and markers
- Pencils and paper
- PowerPoint® Presentations for Module 33208
- A variety of standard marker sizes
- Poster board
- Flip chart
- LCD projector and screen
- Computer with Internet access
- Module Review answer key
- Module Examinations
- A copy of the *National Electrical Code*®

Performance Tasks 1 and 2

- Load Current Wire Selection Tables
- Calculators
- Performance Profile sheets

33209

Limited-Energy Cable Termination

Electronic Systems Technician

Overview

This module covers a variety of conductor and cable termination devices used for low-voltage circuits. The five major types of terminations covered in this module include: coaxial, twisted pair, optical fiber, solderless (crimp), and solder type.

Along with inspection and testing procedures, the module also addresses typical tools and procedures for installing cable or conductors to some of the most commonly used devices.

Learning Objective 1

Successful completion of this module prepares trainees to:

Describe how to terminate coaxial cable.

- a. Describe coaxial cable characteristics and the connectors used to terminate them.

Learning Objective 2

Successful completion of this module prepares trainees to:

Describe how to terminate UTP and optical fiber cable.

- a. Explain how to organize and manage UTP cable prior to termination.
- b. Describe UTP connectors and tools used to install station jacks, plugs, and punchdown blocks.
- c. Describe available IDC termination blocks and associated procedures.
- d. Describe connectors and methods used to terminate optical fiber cable.

Learning Objective 3

Successful completion of this module prepares trainees to:

Describe how to terminate cable using solderless methods.

- a. Describe solderless connector methods.

- b. Describe how to terminate conductors to solderless connectors.

Learning Objective 4

Successful completion of this module prepares trainees to:

Describe the soldering process.

- a. Identify soldering components and safety guidelines.
- b. Describe how to solder and desolder wires and components.

Performance Tasks

1. Prepare and terminate coaxial and UTP cable.
2. Splice conductors using solderless connectors.

Recommended Teaching Time: 25 hours

Classroom Equipment and Materials

- Whiteboard and markers
- Pencils and paper
- PowerPoint® Presentations for Module 33209
- A variety of standard marker sizes
- Poster board
- Flip chart
- LCD projector and screen
- Computer with Internet access
- Module Review answer key
- Module Examinations
- A copy of the *National Electrical Code*®

Performance Task 1

- Appropriate PPE
- Various types of coaxial cable
- Wire cutters
- Stripping tools
- Coaxial cable stripper
- Crimping and assembly tools
- Coaxial cable connectors

- Snap-in station outlet couplers
- Punchdown blocks
- Patch cord plugs
- Performance Profile sheets

Performance Task 2

- Appropriate PPE
- Various types of coaxial cable
- Wire cutters
- Stripping tools
- Coaxial cable stripper
- Crimping and assembly tools
- Crimp connectors for screw terminals
- Splice-type crimp connectors
- Wire nuts
- Performance Profile sheets

33301

Limited-Energy Network Installations

Electronic Systems Technician

Overview

This module covers topics related to networks, which are communication links between two or more intelligent devices or components within a computer system. The bus—or *data bus*—provides the communication pathway for all devices within the network. In your career as an EST, many installations may involve working with components tied to one or more networks. In fact, if the trend continues, most of the systems you install or service will be linked together through a variety of different networks.

Learning Objective 1

Successful completion of this module prepares trainees to:

Summarize the history of networking and describe serial and parallel data communication.

- a. Describe key components of networking and its history.
- b. Explain how data is transferred between computers and components.
- c. Explain the purpose of computer data buses.

Learning Objective 2

Successful completion of this module prepares trainees to:

Describe the OSI Reference Model and how network protocols relate to it.

- a. Describe the seven functional layers of the OSI Reference Model.
- b. Identify network protocols related to the OSI model.

Learning Objective 3

Successful completion of this module prepares trainees to:

Identify and describe common network topologies and methods of access control.

- a. Describe common network topologies.
- b. Identify and describe common methods of network access control.

- c. Identify threats to network security and methods used to prevent unauthorized access.

Learning Objective 4

Successful completion of this module prepares trainees to:

Describe the internet and cloud.

- a. Describe the application and structure of TCP/IP internet protocols.
- b. Describe internet application protocols.
- c. Describe the cloud and its benefits.

Learning Objective 5

Successful completion of this module prepares trainees to:

Describe the components and architecture of ethernet networks, LANs, and PLCs.

- a. Describe the components and architecture of ethernet networks.
- b. Describe the components and architecture of LANs.
- c. Identify and describe PLCs, routers, bridges, gateways, and repeaters.

Performance Tasks

1. Design a basic network.
2. Identify IP addresses of the devices on a network.
3. Demonstrate PC configuration of IP and serial connections.
4. Demonstrate various procedures for troubleshooting media access problems to a network.

Recommended Teaching Time: 25 hours

Classroom Equipment and Materials

- Whiteboard and markers
- Pencils and paper
- PowerPoint® Presentations for Module 33301
- A variety of standard marker sizes
- Poster board
- Flip chart
- LCD projector and screen

- Computer with Internet access
- Module Review answer key
- Module Examinations
- A copy of the *National Electrical Code*[®]

Performance Task 1

- Appropriate PPE
- Equipment and computers for setting up a network
- Performance Profile sheets

Performance Task 2

- Appropriate PPE
- Computers networked with peripheral devices
- Performance Profile sheets

Performance Task 3

- Appropriate PPE
- Computers networked with peripheral devices
- Performance Profile sheets

Performance Task 4

- Appropriate PPE
- Computers networked with peripheral devices
- Performance Profile sheets

33302

Fiber Optics

Electronic Systems Technician

Overview

Fiber optics is a technology in which data is transmitted and received in the form of light pulses that pass through glass or plastic fibers. In addition to the fibers themselves, other components and connectors are necessary to complete a fiber optic network that is capable of transmitting information for data networking, telecommunications, and countless other applications. This module describes fiber optic technology and introduces trainees to the types of equipment and methods used in fiber optic cable installation.

Learning Objective 1

Successful completion of this module prepares trainees to:

Explain the basic principles of fiber optic systems.

- a. Describe the basic operating theory behind fiber optics.
- b. Describe the major components and operation of a fiber optic system.
- c. Describe operational considerations of fiber optic systems.

Learning Objective 2

Successful completion of this module prepares trainees to:

Identify the uses of various fiber optic cables and devices.

- a. Describe optical fiber construction and types.
- b. Describe fiber optic cable construction.
- c. Describe types of fiber optic cable.
- d. Describe characteristics of fiber optic cable.

Learning Objective 3

Successful completion of this module prepares trainees to:

Describe the design, operation, and performance of a fiber optic system.

- a. Describe transmitter signal types.
- b. Identify and describe fiber optic light sources.
- c. Describe fiber optic receivers.

Learning Objective 4

Successful completion of this module prepares trainees to:

Explain the features of fiber optic connectors, splices, and splitters.

- a. Describe fiber optic connectors and splices.
- b. Describe fiber optic splitters.

Learning Objective 5

Successful completion of this module prepares trainees to:

Explain the requirements for the installation of fiber optic cabling and support equipment.

- a. Identify and describe common types of cable installation.
- b. Describe enclosures and organizers used in fiber optic cable installations.
- c. Describe hardware used in fiber optic cable installations.

Learning Objective 6

Successful completion of this module prepares trainees to:

Describe how to perform a fiber optic termination.

- a. Describe mechanical considerations that apply to terminating fiber optic cables.
- b. Describe fiber optic connector structure.
- c. Describe fiber optic connector types.
- d. Describe fiber optic connector installation.

Learning Objective 7

Successful completion of this module prepares trainees to:

Describe how to splice and test a fiber optic cable to ensure that the installed system meets performance requirements.

- a. Describe how to splice fiber optic cable.
- b. Describe fiber optic splicing issues.
- c. Describe common tests performed on fiber optic cable and systems.

Performance Tasks

1. Perform a fiber optic termination.
2. Test a fiber optic link.

Recommended Teaching Time: 25 hours

Classroom Equipment and Materials

- Whiteboard and markers
- Pencils and paper
- PowerPoint® Presentations for Module 33302
- A variety of standard marker sizes
- Poster board
- Flip chart
- LCD projector and screen
- Computer with Internet access
- Module Review answer key
- Module Examinations
- A copy of the *National Electrical Code*®

Performance Task 1

- Appropriate PPE
- Parts and tools to terminate fiber optic cables
- Adapters
- Connectors
- Ferrules
- Adhesive
- Fiber optic stripping tools
- Fiber optic strands
- Fiber cleavers
- Polishing paper and other supplies as required

- Performance Profile sheets

Performance Task 2

- Appropriate PPE
- OTDR
- Fiber optic strands with splices or connectors
- Performance Profile sheets

33303

Wireless Communication

Electronic Systems Technician

Overview

This module introduces the trainee to wireless communication, which involves sending and receiving signals carried through the air using a variety of hardware components and communication technologies. Common examples include radio, cell phones, wireless internet, and televisions. Because of the advancements in wireless technology, ESTs need to be alert to the potential impacts these changes may have on new or existing installations.

Learning Objective 1

Successful completion of this module prepares trainees to:

Identify and describe wireless communication principles.

- a. Identify basic wireless technologies.

Learning Objective 2

Successful completion of this module prepares trainees to:

Identify and describe common wireless systems.

- a. Describe the operation of various radio frequency systems.
- b. Identify different types of RF testing equipment.
- c. Describe IR systems and components.

Learning Objective 3

Successful completion of this module prepares trainees to:

Describe wireless networks and their characteristics.

- a. Summarize the development of wireless networks.
- b. Identify common applications for wireless networks.

- c. Identify and describe wireless network components and related security measures.

Learning Objective 4

Successful completion of this module prepares trainees to:

Describe the operation and characteristics of satellite communication systems.

- a. Identify the basic features and characteristics of satellite communication.
- b. Describe satellite orbits and signal meters.

Learning Objective 5

Successful completion of this module prepares trainees to:

Describe antenna installation practices.

- a. Identify common antenna installation requirements.
- b. Describe EMI and techniques used to detect it.

Performance Tasks

This is a knowledge-based module. There are no Performance Tasks.

Recommended Teaching Time: 15 hours

Classroom Equipment and Materials

- Whiteboard and markers
- Pencils and paper
- PowerPoint® Presentations for Module 33303
- A variety of standard marker sizes
- Poster board
- Flip chart
- LCD projector and screen
- Computer with Internet access
- Module Review answer key
- Module Examinations
- A copy of the *National Electrical Code*®

33304

Site Survey, Project Planning, and Documentation

Electronic Systems Technician

Overview

This module reviews the tasks involved in planning a job from start to finish, including how to perform site surveys for both new and tenant installation construction projects. Starting with the approach necessary for creating a successful bid, it covers the technology, drawings, specifications, and other documents commonly used with a construction project.

Learning Objective 1

Successful completion of this module prepares trainees to:

Describe how to estimate a job for the purpose of submitting a bid.

- a. Describe key factors influencing a decision to bid on a job.
- b. Describe the drawings and specifications used to create a bid.

Learning Objective 2

Successful completion of this module prepares trainees to:

Describe the steps required to plan and complete a job after a contract has been awarded.

- a. Describe the tasks necessary to perform a site survey.
- b. Describe the steps to perform after completing the site survey and scheduling the job.

Learning Objective 3

Successful completion of this module prepares trainees to:

Describe the steps required to perform a tenant installation.

- a. Describe similarities and differences between new construction and tenant installations.

Learning Objective 4

Successful completion of this module prepares trainees to:

Describe contractual and legal documents used during construction and installation projects.

- a. Describe who creates and maintains contractual and legal construction documents.

Performance Tasks

1. Interpret contract documents in order to determine the requirements for a selected job.
2. Perform a site survey in order to accomplish the following:
 - Compare the working drawings for the site against the actual building structure to identify specific locations and the work to be performed.
 - Confirm the installed locations of new and/or existing equipment and the routing of the related cabling.
 - Measure the routing and length of selected cable pathways and raceways to verify measurements shown on floor plans and/or estimate takeoff sheets.
3. Use task and labor hours data recorded on estimating forms and/or takeoff sheets for a selected job to develop a detailed schedule for accomplishing the job.

Recommended Teaching Time: 15 hours

Classroom Equipment and Materials

- Whiteboard and markers
- Pencils and paper
- PowerPoint® Presentations for Module 33304
- A variety of standard marker sizes
- Poster board
- Flip chart
- LCD projector and screen
- Computer with Internet access
- Module Review answer key
- Module Examinations
- A copy of the *National Electrical Code*®

Performance Task 1

- Appropriate PPE
- Complete set of construction drawings
- Examples of as-built drawings

- Examples of CSI-formatted specifications
- Copy of a typical scope of work
- Addenda
- Liens
- Stop-work orders
- RFIs
- Change orders
- Project logs
- Punch list
- Performance Profile sheets

Performance Task 2

- Appropriate PPE
- Complete set of construction drawings
- Examples of as-built drawings
- Examples of materials estimates takeoff sheets/estimating forms
- Ladders
- Flashlight
- Measuring device (wheel/50' tape/laser)
- Handheld tape recorder
- Still or video camera
- Architect's rule
- Performance Profile sheets

Performance Task 3

- Appropriate PPE
- Examples of graphic-type and text-type project schedules
- Examples of tasks and labor estimates takeoff sheets/estimating forms
- Personal computer with project scheduling software (optional)
- Graph paper for making schedules
- Performance Profile sheets

33305

Rack Assembly

Electronic Systems Technician

Overview

This module covers various types of equipment racks used to house electronic equipment. Along with reviewing the types of available racks, this module covers grounding and ventilation requirements for racks and rack-mounted equipment.

Learning Objective 1

Successful completion of this module prepares trainees to:

Identify various types of electronic equipment racks and their characteristics.

- a. Identify various types of electronic equipment racks and their standard dimensions.
- b. Describe equipment rack power systems.
- c. Describe how properly grounded and bonded racks prevent ground loops.

Learning Objective 2

Successful completion of this module prepares trainees to:

Describe equipment rack cooling and ventilation systems.

- a. Explain how to calculate equipment rack heat loads.
- b. Describe active and passive rack ventilation systems.
- c. Describe common equipment rack heat exchangers and air conditioning equipment.

Learning Objective 3

Successful completion of this module prepares trainees to:

Identify common equipment rack installation practices.

- a. Identify common installation hardware and accessories.

Performance Tasks

1. Select a rack unit for a given application.
2. Calculate power requirements and heat dissipation for a rack installation.
3. Assemble a rack and ensure it is properly bonded.
4. Prepare a rack layout drawing.
5. Properly install electronic equipment in a rack, including the wire management systems.

Recommended Teaching Time: 17.5 hours

Classroom Equipment and Materials

- Whiteboard and markers
- Pencils and paper
- PowerPoint® Presentations for Module 33305
- A variety of standard marker sizes
- Poster board
- Flip chart
- LCD projector and screen
- Computer with Internet access
- Module Review answer key
- Module Examinations
- A copy of the *National Electrical Code*®

Performance Task 1

- Appropriate PPE
- Examples of a system installation
- Performance Profile sheets

Performance Task 2

- Appropriate PPE
- Example rack installations for calculations
- Performance Profile sheets

Performance Task 3

- Appropriate PPE
- Equipment racks
- Rack accessories, including support base, mounting hardware, casters, rack ears, power strips

- Performance Profile sheets

Performance Task 4

- Appropriate PPE
- Rack layout drawing
- Equipment lists
- CAD or computer drawing program
- Performance Profile sheets

Performance Task 5

- Appropriate PPE
- Equipment racks
- Rack accessories, including support base, casters, mounting hardware, rack ears, power strips
- Rack-mount equipment, including blank panels, ventilating fans, cable/wire management devices
- Electronic equipment
- Performance Profile sheets

33306

System Commissioning and User Training

Electronic Systems Technician

Overview

This module explains the commissioning process used to verify the correct operation of a system following its installation. Along with a description of each step of the commissioning process, this module reviews key elements needed to create an effective user training program.

Learning Objective 1

Successful completion of this module prepares trainees to:

Describe the system commissioning process.

- a. Describe system pre-installation activities and explain how commissioning plans are developed.
- b. Identify installation activities.
- c. Identify functional testing activities.
- d. Describe user training and documentation requirements.
- e. Identify system-user acceptance and post-acceptance activities.

Learning Objective 2

Successful completion of this module prepares trainees to:

Describe the user training process and explain how to develop a training plan.

- a. Explain how to define the scope of training and identify factors affecting training preparation.
- b. Explain how to conduct a user training session.
- c. Describe on-the-job learning programs and their implementation.

Performance Task

1. Prepare and conduct a user training session.

Recommended Teaching Time: 20 hours

Classroom Equipment and Materials

- Whiteboard and markers
- Pencils and paper
- PowerPoint® Presentations for Module 33306
- A variety of standard marker sizes
- Poster board
- Flip chart
- LCD projector and screen
- Computer with Internet access
- Module Review answer key
- Module Examinations
- A copy of the *National Electrical Code*®

Performance Task 1

- Appropriate PPE
- Samples of course objectives and course outlines
- Performance Profile sheets

33307

Maintenance and Repair

Electronic Systems Technician

Overview

This module provides information and instructions for maintenance and repair of limited-energy systems and equipment. Along with providing a systematic approach and component-level troubleshooting concepts, common repair methods are addressed. The final section presents general guidelines for various preventive maintenance tasks, including inspections.

Learning Objective 1

Successful completion of this module prepares trainees to:

Identify common types of electrical equipment failure and how to determine their cause.

- a. Describe common factors causing equipment failure.
- b. Identify common faults that occur in electronic equipment.
- c. Identify common test equipment used for troubleshooting electrical problems.

Learning Objective 2

Successful completion of this module prepares trainees to:

Describe the basic troubleshooting process and identify troubleshooting resources.

- a. Describe the systematic approach to troubleshooting.
- b. Identify and describe various manufacturer troubleshooting aids.

Learning Objective 3

Successful completion of this module prepares trainees to:

Explain how to identify component faults and conduct preventive maintenance.

- a. Explain how to troubleshoot power inputs and power supplies.
- b. Explain how to troubleshoot controls and central processing circuits.

- c. Explain how to troubleshoot copper cable.
- d. Explain how to troubleshoot fiber optic cable, software, and hardware.
- e. Identify and describe preventive maintenance activities.

Performance Tasks

1. Follow a manufacturer's troubleshooting aids to identify the source of a problem.
2. Determine if a power supply is defective.
3. Determine if a printed circuit board is defective.
4. Determine if hardware or software is defective.
5. Isolate common faults in copper and fiber-optic wired networks.

Recommended Teaching Time: 20 hours

Classroom Equipment and Materials

- Whiteboard and markers
- Pencils and paper
- PowerPoint® Presentations for Module 33307
- A variety of standard marker sizes
- Poster board
- Flip chart
- LCD projector and screen
- Computer with Internet access
- Module Review answer key
- Module Examinations
- A copy of the *National Electrical Code*®

Performance Task 1

- Appropriate PPE
- Low-voltage system/equipment that requires troubleshooting
- Manufacturers' troubleshooting aids
- Test equipment, as applicable
- Performance Profile sheets

Performance Task 2

- Appropriate PPE
- Several power supplies, some defective and some working
- Multimeter (VOM/DMM)

- Oscilloscope
- Performance Profile sheets

Performance Task 3

- Appropriate PPE
- Several printed circuit boards, some defective and some working
- Test equipment, as applicable
- Performance Profile sheets

Performance Task 4

- Appropriate PPE
- Several computers with hardware problems in some and software problems in others
- Performance Profile sheets

Performance Task 5

- Appropriate PPE
- Test equipment, as applicable
- Copper cable-wired network
- Fiber optic cable-wired network
- Light source
- Power meter
- Fiber optic cable
- Performance Profile sheets