Module Overview

This module introduces the trainee to DC electrical circuits. It offers a general introduction to electrical concepts used in Ohm’s law. It includes atomic theory, electromagnetic force, resistance, and electric power equations, and describes series, parallel, and series-parallel circuits.

Prerequisites

Prior to training with this module, it is recommended that the trainee shall have successfully completed Core Curriculum and Electronic Systems Technician Level One.

Objectives

Upon completion of this module, the trainee will be able to do the following:

1. Define voltage and identify the ways in which it can be produced.
2. Explain the difference between conductors and insulators.
3. Define the units of measurement for the properties of electricity.
4. Explain the basic characteristics of series, parallel, and series-parallel circuits.
5. Using Kirchhoff’s voltage law, calculate the voltage drop in series, parallel, and series-parallel circuits.
6. Using Kirchhoff’s current law, calculate the total current in series, parallel, and series-parallel circuits.
7. Using Ohm’s law, find the unknown parameters in series, parallel, and series-parallel circuits.

Performance Tasks

This is a knowledge-based module; there are no performance tasks.

Materials and Equipment

- Markers/chalk
- Pencils and scratch paper
- Whiteboard/chalkboard
- Multimedia projector and screen
- Computer
- Basic electrical circuit, including:
  - Battery/power source
  - Wiring
  - Loads
  - Switches
- Examples of conductors, insulators, and semiconductors
- Magnets
- Simple electromagnet
- Metal sheet
- Iron filings
- Battery
- Sample schematics
- Color-coded resistors
- Multimeter
- Copies of the Quick Quiz*
- Module Examinations**

*Located at the back of this module
**Single-module AIG purchases include the printed exam and performance task sheet. If you have purchased the perfect-bound version of this title, download these materials from the IRC using your access code.

Safety Considerations

Ensure that the trainees are equipped with appropriate personal protective equipment and know how to use it properly. Review basic electrical safety. This module may require that the trainees visit job sites. Ensure that trainees are briefed on site safety policies prior to any site visits.
**Additional Resources**

This module presents thorough resources for task training. The following resource material is suggested for further study.


**Teaching Time for This Module**

An outline for use in developing your lesson plan is presented below. Note that each Roman numeral in the outline equates to one session of instruction. Each session has a suggested time period of 2½ hours. This includes 10 minutes at the beginning of each session for administrative tasks and one 10-minute break during the session. Approximately 15 hours are suggested to cover *DC Circuits*. You will need to adjust the time required for hands-on activity and testing based on your class size and resources.

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<td>C. Electrical Power</td>
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<td>3. Series-Parallel Circuits</td>
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Session V. Applying Ohm’s Law; Kirchhoff’s Laws

A. Applying Ohm’s Law
   1. Voltage and Current in Series Circuits
   2. Voltage and Current in Parallel Circuits
   3. Voltage and Current in Series-Parallel Circuits

B. Kirchhoff’s Laws
   1. Kirchhoff’s Current Law
   2. Kirchhoff’s Voltage Law
   3. Loop Equations

Session VI. Review and Testing

A. Module Review

B. Module Examination
   1. Trainees must score 70 percent or higher to receive recognition from NCCER.
   2. Record the testing results on Training Report Form 200, and submit the results to the Training Program Sponsor.
AC Circuits
Annotated Instructor’s Guide
Module 33202-10

Module Overview
This module provides an introduction to AC theory, circuits, and components including inductors, capacitors, and transformers. It covers the calculation of reactance and impedance in RL, RC, LC, and RLC circuits using math and vector analysis.

Prerequisites
Prior to training with this module, it is recommended that the trainee shall have successfully completed Core Curriculum; Electronic Systems Technician Level One; and Electronic Systems Technician Level Two, Module 33201-10.

Objectives
Upon completion of this module, the trainee will be able to do the following:
1. Calculate the peak and effective voltage or current values for an AC waveform.
2. Calculate the phase relationship between two AC waveforms.
3. Describe the voltage and current phase relationship in a resistive AC circuit.
4. Describe the voltage and current transients that occur in an inductive circuit.
5. Define inductive reactance and state how it is affected by frequency.
6. Describe the voltage and current transients that occur in a capacitive circuit.
7. Define capacitive reactance and state how it is affected by frequency.
8. Explain the relationship between voltage and current in the following types of AC circuits:
   • RL
   • RC
   • LC
   • RLC
9. Explain the following terms as they relate to AC circuits:
   • True power
   • Apparent power
   • Reactive power
   • Power factor
10. Explain basic transformer action.

Performance Tasks
This is a knowledge-based module; there are no performance tasks.

Materials and Equipment
Markers/chalk
Pencils and scratch paper
Whiteboard/chalkboard
Electronic Systems Technician Level Two
   PowerPoint® Presentation Slides
   (ISBN 978-0-13-257332-0)
Multimedia projector and screen
Computer
Appropriate personal protective equipment

*Located at the back of this module
*Single-module AIG purchases include the printed exam and performance task sheet. If you have purchased the perfect-bound version of this title, download these materials from the IRC using your access code.
**Safety Considerations**

Ensure that the trainees are equipped with appropriate personal protective equipment and know how to use it properly. Ensure that trainees are briefed on basic electrical safety and shop safety policies.

**Additional Resources**

This module presents thorough resources for task training. The following resource material is suggested for further study.


**Teaching Time for This Module**

An outline for use in developing your lesson plan is presented below. Note that each Roman numeral in the outline equates to one session of instruction. Each session has a suggested time period of 2½ hours. This includes 10 minutes at the beginning of each session for administrative tasks and one 10-minute break during the session. Approximately 20 hours are suggested to cover *AC Circuits*. You will need to adjust the time required for hands-on activity and testing based on your class size and resources.

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<td>F. Transformer Selection</td>
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</table>
Session VIII. Review and Testing

A. Module Review

B. Module Examination

1. Trainees must score 70 percent or higher to receive recognition from NCCER.

2. Record the testing results on Training Report Form 200, and submit the results to the Training Program Sponsor.
Module Overview

This module describes different types and configurations of switches, relays, timers, and photoelectric devices and explains their operating principles. Guidelines are presented for using specification sheets to select an appropriate device for a specific application.

Prerequisites

Prior to training with this module, it is recommended that the trainee shall have successfully completed Core Curriculum; Electronic Systems Technician Level One; and Electronic Systems Technician Level Two, Modules 33201-10 and 33202-10.

Objectives

Upon completion of this module, the trainee will be able to do the following:

1. Identify and describe the operation of commonly used types of switches.
2. Classify switches based on schematic diagram symbols, according to the number of poles and throws.
3. Identify photoelectric devices and describe how they operate.
4. Describe the applications and operation of relays.
5. Explain the differences between electromechanical and solid-state relays.
6. Identify different types of timing devices and describe how they operate.
7. Select, install, and test a relay for a stated application.

Performance Tasks

Under the supervision of the instructor, the trainee should be able to do the following:

1. Identify and select various types of switches for the specific application.
2. Select, install, and test a relay for a stated application.

Materials and Equipment

Pencils and scratch paper
Whiteboard/chalkboard
Markers/chalk
Electronic Systems Technician Level Two
PowerPoint® Presentation Slides
(ISBN 978-0-13-257332-0)
Multimedia projector and screen
Computer
Appropriate personal protective equipment
Samples or pictures of the following devices:
  - Single-pole switch
  - Three-way switch
  - Double-pole switch
  - Float switch
  - Pneumatic switch
  - Limit switch
  - SCR
  - Reed relay
  - General-purpose relay with plug-in base

Machine control relay
Solid-state relay
Dashpot timer relay
Pneumatic timer
Time clock or timer relay
Solid-state timer
Photocell switcher
Solar cells
Motion detectors
Proximity switch
Specification sheets and/or manufacturer’s product catalogs/data sheets for various switches, relays, timers, time clocks, and photoelectric devices
Test light
Ohmmeter
Wiring, relays, photocells, motion detectors, loads, and switches to build simple circuits
Module Examinations*
Performance Profile Sheets*

*Single-module AIG purchases include the printed exam and performance task sheet. If you have purchased the perfect-bound version of this title, download these materials from the IRC using your access code.
**Safety Considerations**

Ensure that the trainees are equipped with appropriate personal protective equipment and know how to use it properly. This module requires that the trainees build circuits and operate various electrical meters. Ensure that trainees are briefed on basic electrical safety and shop safety policies.

**Additional Resources**

This module presents thorough resources for task training. The following resource material is suggested for further study.


**Teaching Time for This Module**

An outline for use in developing your lesson plan is presented below. Note that each Roman numeral in the outline equates to one session of instruction. Each session has a suggested time period of 2½ hours. This includes 10 minutes at the beginning of each session for administrative tasks and one 10-minute break during the session. Approximately 15 hours are suggested to cover *Switching Devices and Timers.* You will need to adjust the time required for hands-on activity and testing based on your class size and resources. Because laboratories often correspond to Performance Tasks, the proficiency of the trainees may be noted during these exercises for Performance Testing purposes.

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<td>Have trainees identify and select various types of switches for specific applications. This laboratory corresponds to Performance Task 1.</td>
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<td>3. Relay Selection</td>
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<td>B. Laboratory</td>
<td>Have trainees select, install, and test relays for specific applications. This laboratory corresponds with Performance Task 2.</td>
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<td>C. Timers</td>
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<td>1. Solid-State Timers</td>
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<td>2. Programmable Electronic Time Switches</td>
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</table>
Session VI. Review and Testing

A. Module Review

B. Module Examination
   1. Trainees must score 70 percent or higher to receive recognition from NCCER.
   2. Record the testing results on Training Report Form 200, and submit the results to the Training Program Sponsor.

C. Performance Testing
   1. Trainees must perform each task to the satisfaction of the instructor to receive recognition from NCCER. If applicable, proficiency noted during laboratory exercises can be used to satisfy the Performance Testing requirements.
   2. Record the testing results on Training Report Form 200, and submit the results to the Training Program Sponsor.
Module Overview

This module provides an introduction to the principles of electronics and semiconductor theory, components, and applications.

Prerequisites

Prior to training with this module, it is recommended that the trainee shall have successfully completed Core Curriculum; Electronic Systems Technician Level One; and Electronic Systems Technician Level Two, Modules 33201-10 through 33203-10.

Objectives

Upon completion of this module, the trainee will be able to do the following:

1. Identify electronic system components.
2. Describe the materials and electrical characteristics of solid-state devices.
3. Identify the various types of transistors and explain how they operate.
4. Describe and connect diodes including:
   - Rectifiers
   - Light-emitting diodes (LEDs)
   - Silicon-controlled rectifiers (SCRs)
5. Identify the leads of various solid-state devices.
6. Describe integrated circuits.
7. Identify a microprocessor and applicable pin numbers.
8. Explain the purpose of logic gates.
9. Build a simple circuit that includes a solid-state device.

Performance Tasks

Under the supervision of the instructor, the trainee should be able to do the following:

1. Identify the leads of various solid-state devices.
2. Identify a microprocessor and applicable pin numbers.
3. Build a simple circuit that includes a solid-state device.

Materials and Equipment

Markers/chalk
Pencils and scratch paper
Whiteboard/chalkboard
Electronic Systems Technician Level Two
   PowerPoint® Presentation Slides
   (ISBN 978-0-13-257332-0)
Multimedia projector and screen
Computer
Appropriate personal protective equipment
24V transformer with a plug and power cord
Filter capacitor
Oscilloscope
Selection of diodes, LEDs, transistors, and SCRs
Multimeter
Grounding strap
ESD protection products
Selection of schematic and logic diagrams
Selection of printed circuit boards, sealed
   components, integrated circuits, and
   microprocessors
Pushbutton
Components and wire to connect basic test circuits
Module Examinations*
Performance Profile Sheets*

*Single-module AIG purchases include the printed exam and performance task sheet. If you have purchased the perfect-bound version of this title, download these materials from the IRC using your access code.
Safety Considerations

Ensure that the trainees are equipped with appropriate personal protective equipment and know how to use it properly. This module requires that the trainees build circuits and operate various electrical meters. Ensure that trainees are briefed on basic electrical safety and shop safety policies.

Additional Resources

This module presents thorough resources for task training. The following resource material is suggested for further study.


Teaching Time for This Module

An outline for use in developing your lesson plan is presented below. Note that each Roman numeral in the outline equates to one session of instruction. Each session has a suggested time period of 2½ hours. This includes 10 minutes at the beginning of each session for administrative tasks and one 10-minute break during the session. Approximately 10 hours are suggested to cover *Semiconductors and Integrated Circuits.* You will need to adjust the time required for hands-on activity and testing based on your class size and resources. Because laboratories often correspond to Performance Tasks, the proficiency of the trainees may be noted during these exercises for Performance Testing purposes.

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<td>C. Diodes</td>
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<td>D. Laboratory</td>
<td>Have trainees practice building a simple circuit that includes a solid-state device. This laboratory corresponds to Performance Task 3.</td>
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<td>A. Light-Emitting Diodes</td>
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<td>B. Laboratory</td>
<td>Have trainees practice identifying the leads of various solid-state devices. This laboratory corresponds to Performance Task 1.</td>
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<td>C. Photo Diodes</td>
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<td>C. Printed Circuit Boards</td>
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<tr>
<td>D. Laboratory</td>
<td>Have trainees identify a microprocessor and applicable pin numbers. This laboratory corresponds with Performance Task 2.</td>
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</table>
Session IV. Operational Amplifiers and Digital Gates; Review and Testing

A. Operational Amplifiers
B. Basic Digital Gates
C. Module Review
D. Module Examination
1. Trainees must score 70 percent or higher to receive recognition from NCCER.
2. Record the testing results on Training Report Form 200, and submit the results to the Training Program Sponsor.
E. Performance Testing
1. Trainees must perform each task to the satisfaction of the instructor to receive recognition from NCCER. If applicable, proficiency noted during laboratory exercises can be used to satisfy the Performance Testing requirements.
2. Record the testing results on Training Report Form 200, and submit the results to the Training Program Sponsor.
Module Overview

This module describes the selection, inspection, use, and maintenance of the analog and digital meters used in the installation and checkout of electronic systems.

Prerequisites

Prior to training with this module, it is recommended that the trainee shall have successfully completed Core Curriculum; Electronic Systems Technician Level One; and Electronic Systems Technician Level Two, Modules 33201-10 through 33204-10.

Objectives

Upon completion of this module, the trainee will be able to do the following:

1. Describe and explain the operation of the following pieces of test equipment:
   - Ammeter
   - Voltmeter
   - Ohmmeter
   - Multimeter
   - Continuity tester
   - Voltage tester
   - Electrical outlet tester
2. Explain the operation and use of specialized test equipment used in the checkout and troubleshooting of electronic equipment, cables, and cabling systems.
3. Select the correct item of test equipment to be used in specific situations.
4. Describe how to measure and generate various waveforms.
5. Set up and use selected cable testers to check out cables and evaluate the performance of copper and optical fiber cable.

Performance Tasks

Under the supervision of the instructor, the trainee should be able to do the following:

1. Measure AC/DC voltage, current, and resistance using a multimeter.
2. Set up and use selected cable testers to check out cables and evaluate the performance of copper and optical fiber cable.

Materials and Equipment

| Markers/chalk | Assortment of cables for test purposes |
| Whiteboard/chalkboard | Various test instruments and their operation manuals, including: |
| Pencils and scratch paper |  |
| Multimedia projector and screen | Voltmeter |
| Computer | Ohmmeter |
| Appropriate personal protective equipment | Multimeter (analog and digital) |
| Grounding strap | Continuity tester |
| Power supplies, circuit boards, or equipment used as a source of test voltages and currents | Voltage tester |
| Signal or function generator, or other source of test waveforms | Oscilloscope |
| Batteries | Wattmeter |
| Resistors | Megohmmeter |
| Components and wire to connect basic test circuits | Line frequency meter |
| | Frequency counter |
| | Power factor meter |
| | Recording instruments |
Lineman’s test set  Signal level meter
Cable toner  TDR/OTDR
Cable certification tester  Spectrum analyzer
Sound pressure level meter  Signal generator
Time domain reflectometer  Module Examinations*
RF power meter  Performance Profile Sheets*

*Single-module AIG purchases include the printed exam and performance task sheet. If you have purchased the perfect-bound version of this title, download these materials from the IRC using your access code.

**Safety Considerations**

Ensure that the trainees are equipped with appropriate personal protective equipment and know how to use it properly. This module requires the trainees to test electronic circuits with various electrical instruments. Ensure that trainees are briefed on basic electrical safety and shop safety policies. Review safety guidelines for all test instruments used, especially the megohmmeter.

**Additional Resources**

This module presents thorough resources for task training. The following resource material is suggested for further study.


**Teaching Time for this Module**

An outline for use in developing your lesson plan is presented below. Note that each Roman numeral in the outline equates to one session of instruction. Each session has a suggested time period of 2½; hours. This includes 10 minutes at the beginning of each session for administrative tasks and one 10-minute break during the session. Approximately 10 hours are suggested to cover Test Equipment. You will need to adjust the time required for hands-on activity and testing based on your class size and resources. Because laboratories often correspond to Performance Tasks, the proficiency of the trainees may be noted during these exercises for Performance Testing purposes.

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<tr>
<td><strong>Session I. Introduction; Types of Meters</strong></td>
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<tr>
<td>A. Introduction</td>
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<tr>
<td>B. Meters</td>
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<tr>
<td>C. Ammeter</td>
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<tr>
<td>D. Voltmeter</td>
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<td>E. Ohmmeter</td>
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<tr>
<td>F. Multimeters</td>
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<tr>
<td>G. Digital Meters</td>
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<tr>
<td>H. Laboratory</td>
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<tr>
<td>Have trainees measure AC/DC voltage, current, and resistance using a multimeter. This laboratory corresponds with Performance Task 1.</td>
<td></td>
</tr>
<tr>
<td><strong>Session II. Continuity and Voltage Testers; Oscilloscopes</strong></td>
<td></td>
</tr>
<tr>
<td>A. Continuity Tester</td>
<td></td>
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<tr>
<td>B. Voltage Tester</td>
<td></td>
</tr>
<tr>
<td>C. Oscilloscopes</td>
<td></td>
</tr>
</tbody>
</table>
Session III. Wattmeters; Meggers; Line, Cable, and Signal Meters

A. Wattmeter
B. Megohmmeter (Megger)
C. Line Frequency Meter
D. Power Factor Meter
E. Recording Instruments
F. Lineman’s Test Set
G. Cable Toner
H. Cable Certification Testers
I. Sound Pressure Level Meters
J. RF Power Meter
K. Signal Level Meter
L. Time-Domain Reflectometer
M. Spectrum Analyzer
N. Signal Generators
O. Category Ratings
P. Testing and Troubleshooting
Q. Safety
R. Laboratory

Have trainees set up and use selected cable testing equipment to check out cables and evaluate the performance of copper and optical fiber links. This laboratory corresponds with Performance Task 2.

Session IV. Review and Testing

A. Module Review
B. Module Examination
   1. Trainees must score 70 percent or higher to receive recognition from NCCER.
   2. Record the testing results on Training Report Form 200, and submit the results to the Training Program Sponsor.
C. Performance Testing
   1. Trainees must perform each task to the satisfaction of the instructor to receive recognition from NCCER. If applicable, proficiency noted during laboratory exercises can be used to satisfy the Performance Testing requirements.
   2. Record the testing results on Training Report Form 200, and submit the results to the Training Program Sponsor.
Module Overview

This module provides trainees with an introduction to electrical prints, drawings, and symbols. Trainees learn the types of information they can find on schematics, one-line drawings, and wiring diagrams.

Prerequisites

Prior to training with this module, it is recommended that the trainee shall have successfully completed Core Curriculum; Electronic Systems Technician Level One; and Electronic Systems Technician Level Two, Modules 33201-10 through 33205-10.

Objectives

Upon completion of this module, the trainee will be able to do the following:

1. Identify the elements of a drawing set.
2. Identify and describe the types of drawings commonly used in low-voltage work.
3. Identify the types of lines and symbols used on electrical drawings.
4. Describe and demonstrate the use of an architect’s and engineer’s scales.
5. Interpret drawings, including site plans, floor plans, detail drawings, and wiring diagrams.
6. Describe the type of information included in electrical specifications.
7. Look up devices on drawings and perform a takeoff.

Performance Tasks

Under the supervision of the instructor, the trainee should be able to do the following:

1. Demonstrate the use of an architect’s and engineer’s scale.
2. Interpret electrical drawings, including site plans, floor plans, detail drawings, and schedules.
3. Perform a takeoff of low-voltage cabling and material using drawings provided by the instructor.

Materials and Equipment

<table>
<thead>
<tr>
<th>Markers/chalk</th>
<th>Engineer’s scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pencils and scratch paper</td>
<td>Standard 12-inch ruler</td>
</tr>
<tr>
<td>Whiteboard/chalkboard</td>
<td>Metric ruler</td>
</tr>
<tr>
<td>Electronic Systems Technician Level Two</td>
<td>Electronic wheel scaler</td>
</tr>
<tr>
<td>PowerPoint® Presentation Slides</td>
<td>Scientific calculator</td>
</tr>
<tr>
<td>Multimedia projector and screen</td>
<td>Appropriate personal protective equipment</td>
</tr>
<tr>
<td>Computer</td>
<td>Golf ball</td>
</tr>
<tr>
<td>Various electrical drawings, schedules, site plans, floor plans, etc.</td>
<td>Vise</td>
</tr>
<tr>
<td>Architect’s scale</td>
<td>Hacksaw</td>
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<td></td>
<td>Module Examinations*</td>
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<tr>
<td></td>
<td>Performance Profile Sheets*</td>
</tr>
</tbody>
</table>

*Single-module AIG purchases include the printed exam and performance task sheet. If you have purchased the perfect-bound version of this title, download these materials from the IRC using your access code.

Additional Resources

This module presents thorough resources for task training. The following resource material is suggested for further study.

Teaching Time for This Module

An outline for use in developing your lesson plan is presented below. Note that each Roman numeral in the outline equates to one session of instruction. Each session has a suggested time period of 2½ hours. This includes 10 minutes at the beginning of each session for administrative tasks and one 10-minute break during the session. Approximately 10 hours are suggested to cover *Introduction to Electrical Drawings*. You will need to adjust the time required for hands-on activity and testing based on your class size and resources. Because laboratories often correspond to Performance Tasks, the proficiency of the trainees may be noted during these exercises for Performance Testing purposes.

<table>
<thead>
<tr>
<th>Topic</th>
<th>Planned Time</th>
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<tbody>
<tr>
<td><strong>Session I. Introduction to Electrical Drawings</strong></td>
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<tr>
<td>A. Introduction</td>
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<tr>
<td>B. Drawing Layout</td>
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<tr>
<td>C. Drafting Lines</td>
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<tr>
<td>D. Electrical Symbols</td>
<td></td>
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<tr>
<td><strong>Session II. Scale Drawings; Types of Electrical Drawings</strong></td>
<td></td>
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<tr>
<td>A. Scale Drawings</td>
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<tr>
<td>B. Analyzing Electrical Drawings</td>
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<tr>
<td>C. Typical Site Electrical Plan</td>
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<tr>
<td>D. Power Plans</td>
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<tr>
<td>E. Special Electrical System Plans</td>
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</tr>
<tr>
<td>F. Laboratory</td>
<td>Have trainees demonstrate the proper use of architect’s and engineer’s scales. This laboratory corresponds with Performance Task 1.</td>
</tr>
<tr>
<td><strong>Session III. Electrical Details and Diagrams; Written Specifications; Quantity Takeoffs; As-Built Drawings</strong></td>
<td></td>
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<tr>
<td>A. Electrical Details and Diagrams</td>
<td></td>
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<tr>
<td>B. Written Specifications</td>
<td></td>
</tr>
<tr>
<td>C. Laboratory</td>
<td>Have trainees interpret various types of electrical drawings, site plans, floor plans, detail drawings, and schedules. This laboratory corresponds with Performance Task 2.</td>
</tr>
<tr>
<td>D. Quantity Takeoffs</td>
<td></td>
</tr>
<tr>
<td>E. As-Built Drawings</td>
<td></td>
</tr>
<tr>
<td>F. Laboratory</td>
<td>Using drawings provided by the instructor, have trainees perform a takeoff of low-voltage cabling and material. This laboratory corresponds with Performance Task 3.</td>
</tr>
<tr>
<td><strong>Session IV. Review and Testing</strong></td>
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<tr>
<td>A. Module Review</td>
<td></td>
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<tr>
<td>B. Module Examination</td>
<td></td>
</tr>
<tr>
<td>1. Trainees must score 70 percent or higher to receive recognition from NCCER.</td>
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<tr>
<td>2. Record the testing results on Training Report Form 200, and submit the results to the Training Program Sponsor.</td>
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<tr>
<td>C. Performance Testing</td>
<td></td>
</tr>
<tr>
<td>1. Trainees must perform each task to the satisfaction of the instructor to receive recognition from NCCER. If applicable, proficiency noted during laboratory exercises can be used to satisfy the Performance Testing requirements.</td>
<td></td>
</tr>
<tr>
<td>2. Record the testing results on Training Report Form 200, and submit the results to the Training Program Sponsor.</td>
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</tbody>
</table>
Module Overview

This module describes the scope and content of the major codes and standards that apply to telecommunications, life safety, security, and other low-voltage systems. Emphasis is placed on familiarization with and use of the National Electrical Code® (NEC®).

Prerequisites

Prior to training with this module, it is recommended that the trainee shall have successfully completed Core Curriculum; Electronic Systems Technician Level One; and Electronic Systems Technician Level Two, Modules 33201-10 through 33206-10.

Objectives

Upon completion of this module, the trainee will be able to do the following:

1. Identify trade-relevant codes and standards, and identify the differences between them.
2. Explain how to find and use information in the National Electrical Code® (NEC®).
3. Use a code or standard to determine the specific requirements for a given application.
4. Explain the role of testing laboratories.

Performance Tasks

Under the supervision of the instructor, the trainee should be able to do the following:

1. Use a code or standard to determine the specific requirements for a given application.

Materials and Equipment

Marketers/chalk
Pencils and scratch paper
Whiteboard/chalkboard
Electronic Systems Technician Level Two PowerPoint® Presentation Slides
Multimedia projector and screen
Computer
Copies of the latest ANSI/TIA/EIA standards:
   ANSI/TIA/EIA-568, Commercial Building Telecommunications Cabling Standard Plus Addenda 1 through 3, and Telecommunications Systems Bulletins TSB-67, TSB-72, and TSB-75
   ANSI/TIA/EIA-569-B, Commercial Building Standards for Telecommunications Pathways and Spaces
   ANSI/TIA/EIA-570-B, Residential Telecommunications Cabling Standard
   ANSI/TIA/EIA-606, Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
   ANSI/TIA/EIA-607, Commercial Building Grounding and Bonding Requirements for Telecommunications
   Copies of the latest IEEE standards:
      Standard 802.3, CSMA/CD Access Method
      Standard 1394, Standard for a High-Performance Serial Bus
   Copy of the latest edition of the International Building Code®
   Copy of the latest edition of the Uniform Building Code™
   Cop of the latest edition of the Standard Building Code
   Examples of industry and company standards
   Examples of manufacturer’s instructions
   Module examinations* Performance Profile Sheets*

*Single-module AIG purchases include the printed exam and performance task sheet. If you have purchased the perfect-bound version of this title, download these materials from the IRC using your access code.
Safety Considerations

Ensure that the trainees are equipped with appropriate personal protective equipment and know how to use it properly.

Additional Resources

This module presents thorough resources for task training. The following resource material is suggested for further study.

ANSI/TIA/EIA-568, Commercial Building Telecommunications Cabling Standard Plus Addenda 1 through 3, and Telecommunications Systems Bulletins TSB-67, TSB-72, and TSB-75
ANSI/TIA/EIA-568 Commercial Building Standards for Telecommunications Pathways and Spaces
ANSI/TIA/EIA-570, Residential Telecommunications Cabling Standard
ANSI/TIA/EIA-606, Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
ANSI/TIA/EIA-607, Commercial Building Grounding and Bonding Requirements for Telecommunications

Standard 802.3, CSMA/CD Access Method
Standard 802.5, Token Ring Access Method
Standard 1394, Standard for a High Performance Serial Bus


NFPA 5000, Building Construction and Safety Code®
NFPA 13, Installation of Sprinkler Systems
NFPA 13D, Installation of Sprinkler Systems in One- and Two-Family Dwellings and Manufactured Homes
NFPA 13R, Installation of Sprinkler Systems in Residential Occupancies up to and Including Four Stories in Height
NFPA 70, National Electrical Code®
NFPA 72, National Fire Alarm and Signaling Code®
NFPA 75, Protection of Information Technology Equipment
NFPA 77, Recommended Practice on Static Electricity
NFPA 780, Standard for Installation of Lightning Protection Systems

ANSI/SCTE 74 2003 (formerly IPS SP 001), Specification for Braided 75 Ohm Flexible RF Coaxial Drop Cable

Websites:
www.bicsi.org
www.nfpa.org
www.tiaonline.org

Teaching Time for this Module

An outline for use in developing your lesson plan is presented below. Note that each Roman numeral in the outline equates to one session of instruction. Each session has a suggested time period of 2½ hours. This includes 10 minutes at the beginning of each session for administrative tasks and one 10-minute break during the session. Approximately 10 hours are suggested to cover Introduction to Codes and Standards. You will need to adjust the time required for hands-on activity and testing based on your class size and resources. Because laboratories often correspond to Performance Tasks, the proficiency of the trainees may be noted during these exercises for Performance Testing purposes.
Topic

Session I. Introduction; Overview of Codes and Standards

A. Introduction
B. The Purpose of Codes and Standards
C. Determining Which Codes and Standards to Follow
D. Words with Special Meanings
E. Code Deviations and Conflicts

Session II. The National Electrical Code®

A. The National Electrical Code®
B. Laboratory
   Have trainees practice using the National Electrical Code® to determine the specific requirements for a given telecommunications and/or life safety system application. This laboratory corresponds to Performance Task 1.

Session III. NFPA; Building Codes; Telecommunication and Related Standards

A. National Fire Alarm and Signaling Code® (NFPA 72®)
B. Life Safety Code® (NFPA 101®)
C. Other NFPA Codes
D. Building Codes
E. Telecommunication Standards
F. Related Standards
G. Laboratory
   Have trainees practice using applicable ANSI/TIA/EIA standards to determine the specific requirements for a given telecommunications and/or life safety system application. This laboratory corresponds to Performance Task 1.

Session IV. Testing Laboratories; Review and Testing

A. Testing Laboratories
B. Module Review
C. Module Examination
   1. Trainees must score 70 percent or higher to receive recognition from NCCER.
   2. Record the testing results on Training Report Form 200, and submit the results to the Training Program Sponsor.
D. Performance Testing
   1. Trainees must perform each task to the satisfaction of the instructor to receive recognition from NCCER. If applicable, proficiency noted during laboratory exercises can be used to satisfy the Performance Testing requirements.
   2. Record the testing results on Training Report Form 200, and submit the results to the Training Program Sponsor.
Module Overview

This module covers the properties of common types of low-voltage cable and fiber-optic cable used in signaling and communication systems. It describes the main cable types along with their physical and performance specifications. Guidelines for selecting and sizing the right cable for a given application are also presented.

Prerequisites

Prior to training with this module, it is recommended that the trainee shall have successfully completed Core Curriculum; Electronic Systems Technician Level One; and Electronic Systems Technician Level Two, Modules 33201-10 through 33207-10.

Objectives

Upon completion of this module, the trainee will be able to do the following:

1. Select cables for specific applications.
2. Calculate the voltage drop for various applications.
3. Interpret and apply NEC® regulations governing conductors and cables.
4. Size cable conductors for a given load.
5. Understand and apply various formulas and charts for load calculations.

Performance Tasks

Under the supervision of the instructor, the trainee should be able to do the following:

1. Select and size cable for specific applications.
2. Calculate the voltage drop for various applications.
3. Size cable conductors for a load using various load calculation charts.

Materials and Equipment

Markers/chalk
Pencils and scratch paper
Whiteboard/chalkboard
Electronic Systems Technician Level Two
   PowerPoint® Presentation Slides
   (ISBN 978-0-13-257332-0)
Multimedia projector and screen
Appropriate personal protective equipment
Computer
Calculator

Samples of different types of coax and data cable
Copies of the Quick Quiz*
Module Examinations**
Performance Profile Sheets**

*Located at the back of this module
**Single-module AIG purchases include the printed exam and performance task sheet. If you have purchased the perfect-bound version of this title, download these materials from the IRC using your access code.

Safety Considerations

Ensure that the trainees are equipped with appropriate personal protective equipment and know how to use it properly. This module may require that the trainees visit job sites. Ensure that trainees are briefed on site safety policies prior to any site visits.
Additional Resources

This module presents thorough resources for task training. The following resource material is suggested for further study.


Teaching Time for This Module

An outline for use in developing your lesson plan is presented below. Note that each Roman numeral in the outline equates to one session of instruction. Each session has a suggested time period of 2½ hours. This includes 10 minutes at the beginning of each session for administrative tasks and one 10-minute break during the session. Approximately 10 hours are suggested to cover *Cable Selection*. You will need to adjust the time required for hands-on activity and testing based on your class size and resources. Because laboratories often correspond to Performance Tasks, the proficiency of the trainees may be noted during these exercises for Performance Testing purposes.

<table>
<thead>
<tr>
<th>Topic</th>
<th>Planned Time</th>
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<tbody>
<tr>
<td><strong>Session I. Introduction; Cable Selection; Fire Alarm and Security Systems</strong></td>
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<tr>
<td>A. Introduction</td>
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<tr>
<td>B. Common Factors in Cable Selection</td>
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<tr>
<td>C. Fire Alarm and Security System Cabling</td>
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<tr>
<td><strong>Session II. Coaxial Cable Selection; Telecommunications and Data Cable; Optical Multi-Fiber Cable</strong></td>
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<tr>
<td>A. Coaxial Cable Selection</td>
<td></td>
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<tr>
<td>B. Telecommunications and Data Cable</td>
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<tr>
<td>C. Optical Multi-Fiber Cable</td>
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<tr>
<td>D. Laboratory</td>
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<tr>
<td>Have trainees select and size cable for specific applications. This laboratory corresponds to Performance Task 1.</td>
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<tr>
<td><strong>Session III. Voltage and Power Drop</strong></td>
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<tr>
<td>A. Conductor Voltage Drop</td>
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<tr>
<td>B. Coaxial Cable Voltage Drop</td>
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<tr>
<td>C. Speaker Cable Power Drop</td>
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<tr>
<td>D. Laboratory</td>
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<tr>
<td>Have trainees calculate the voltage drop for various applications. This laboratory corresponds to Performance Task 2.</td>
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<tr>
<td>E. Laboratory</td>
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<tr>
<td>Have trainees size cable conductors for a load using various load calculation charts. This laboratory corresponds to Performance Task 3.</td>
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<tr>
<td><strong>Session IV. Review and Testing</strong></td>
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<tr>
<td>A. Module Review</td>
<td></td>
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<tr>
<td>B. Module Examination</td>
<td></td>
</tr>
<tr>
<td>1. Trainees must score 70 percent or higher to receive recognition from NCCER.</td>
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<tr>
<td>2. Record the testing results on Training Report Form 200, and submit the results to the Training Program Sponsor.</td>
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<tr>
<td>C. Performance Testing</td>
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</tr>
<tr>
<td>1. Trainees must perform each task to the satisfaction of the instructor to receive recognition from NCCER. If applicable, proficiency noted during laboratory exercises can be used to satisfy the Performance Testing requirements.</td>
<td></td>
</tr>
<tr>
<td>2. Record the testing results on Training Report Form 200, and submit the results to the Training Program Sponsor.</td>
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</table>
Module Overview

This module provides information and detailed instructions for selecting, installing, and testing connectors and other terminating devices on the various cables used in low-voltage work, including telecommunications, video and audio, and fiber optics.

Prerequisites

Prior to training with this module, it is recommended that the trainee shall have successfully completed Core Curriculum; Electronic Systems Technician Level One; and Electronic Systems Technician Level Two, Modules 33201-10 through 33208-10.

Objectives

Upon completion of this module, the trainee will be able to do the following:

1. Describe the connectors, tools, and methods used to terminate telecommunications cable.
2. Describe the connectors, tools, and methods used to terminate coaxial cable.
3. Describe the connectors, tools, and methods that apply to solderless connectors.
4. Describe the soldering process.
5. Prepare and terminate UTP and coaxial cable.

Performance Tasks

Under the supervision of the instructor, the trainee should be able to do the following:

1. Properly prepare and terminate a cable or wire with various types of connectors.

Materials and Equipment

Markers/chalk
Pencils and scratch paper
Whiteboard/chalkboard
Electronic Systems Technician Level Two
PowerPoint® Presentation Slides
(ISBN 978-0-13-257332-0)
Multimedia projector and screen
Computer
Appropriate personal protective equipment
Various types of coaxial cable
Coaxial cable connectors, including:
  F-type connectors
  BNC connectors
Literature and instructions from connector manufacturers
Manufacturer’s literature on communications/data network equipment
Crimping and assembly tools, including:
  Punchdown tool
  Plier-type crimping tool
  Leveraged crimping tool
  Modular plug crimping tool
  Multimeter
  Time-domain reflectometer
  Wire cutters
  Stripping tools
  Coaxial cable stripper
  Screwdriver
  Pliers
  Diagonal cutting tool
  Category 1 and 2 telephone wiring jacks and connectors
  Category 3 and higher cable
  Snap-in station outlet couplers
  Punchdown blocks
  Patch cord plugs
  Pre-assembled patch cords
  Wire/cable management devices
  Soldering iron
  Solder
  Soldering flux
  Desoldering pump
  ANSI/TIA/EIA-586A-compliant data communications cables
  Shielded twisted-pair cable
  Workstation coupler plugs and jacks
Compact 5e modules
Surface-mount box
Modular plugs
Type 66 and 110 blocks and block plugs
IDC termination blocks
Cable management hardware
Crimp connectors for screw terminals

Splice-type crimp connectors
Wire nuts
Multipair punchdown/cutoff tools
Fiber-optic connectors
Module Examinations*
Performance Profile Sheets*

*Single-module AIG purchases include the printed exam and performance task sheet. If you have purchased the perfect-bound version of this title, download these materials from the IRC using your access code.

Safety Considerations

Ensure that the trainees are equipped with appropriate personal protective equipment and know how to use it properly. This module requires that the trainees use various electrical hand tools and a soldering iron. Ensure that trainees are briefed on basic hand tool safety, electrical safety, and shop safety policies.

Additional Resources

This module presents thorough resources for task training. The following resource material is suggested for further study.


Teaching Time for This Module

An outline for use in developing your lesson plan is presented below. Note that each Roman numeral in the outline equates to one session of instruction. Each session has a suggested time period of 2½ hours. This includes 10 minutes at the beginning of each session for administrative tasks and one 10-minute break during the session. Approximately 25 hours are suggested to cover Wire and Cable Terminations. You will need to adjust the time required for hands-on activity and testing based on your class size and resources. Because laboratories often correspond to Performance Tasks, the proficiency of the trainees may be noted during these exercises for Performance Testing purposes.

<table>
<thead>
<tr>
<th>Topic</th>
<th>Planned Time</th>
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<tbody>
<tr>
<td>Session I. Introduction; Coaxial Cable Terminations</td>
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</tr>
<tr>
<td>A. Introduction</td>
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<tr>
<td>B. Coaxial Cable Terminations</td>
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<tr>
<td>Sessions II– III. Terminating UTP Cable</td>
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<tr>
<td>A. Types of UTP Connectors</td>
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<td>B. UTP Cable Management</td>
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<tr>
<td>C. Consolidation Point or Cross-Connect Block Terminations</td>
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<td>D. Type 110 Block Terminations</td>
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<tr>
<td>E. Workstation Coupler or Modular Jack Terminations</td>
<td></td>
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<tr>
<td>F. Surface-Mount Box Terminations</td>
<td></td>
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<tr>
<td>G. Modular Plug/Cord Fabrication and Termination</td>
<td></td>
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<tr>
<td>H. Patch Cord and 110 Block Plug Termination</td>
<td></td>
</tr>
<tr>
<td>I. Testing Twisted-Pair Cable</td>
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</tbody>
</table>
Sessions IV–VI. Solderless Connections
   A. Crimp Connectors for Screw Terminals
   B. Splice-Type Crimp Connections
   C. Wire Nuts
   D. Cable/Conductor Routing and Inspection
   E. Termination of Conductors/Cables to Solderless Connectors
   F. Terminating Typical Shielded Cable

Sessions VII and VIII. Solder-Type Connectors
   A. Solder
   B. Soldering Flux
   C. Soldering Irons
   D. The Soldering Process
   E. Soldering Safety
   F. Terminating an RCA Connector
   G. Terminating an XLR Connector

Session IX. Optical Fiber Cable Connectors; Legacy Connectors; Laboratory
   A. Optical Fiber Cable Connectors
   B. Legacy Communications Connectors and Terminations
   C. Laboratory
      Have trainees properly prepare and terminate cables and wires with various types of connectors. This exercise corresponds with Performance Task 1.

Session X. Review and Testing
   A. Module Review
   B. Module Examination
      1. Trainees must score 70 percent or higher to receive recognition from NCCER.
      2. Record the testing results on Training Report Form 200, and submit the results to the Training Program Sponsor.
   C. Performance Testing
      1. Trainees must perform each task to the satisfaction of the instructor to receive recognition from NCCER. If applicable, proficiency noted during laboratory exercises can be used to satisfy the Performance Testing requirements.
      2. Record the testing results on Training Report Form 200, and submit the results to the Training Program Sponsor.
Module Overview

This module provides instruction on the fundamentals of power systems and their grounding schemes. It examines conditions that can cause poor power quality, as well as the equipment and devices that correct or protect against power quality degradation.

Prerequisites

Prior to training with this module, it is recommended that the trainee shall have successfully completed Core Curriculum; Electronic Systems Technician Level One; and Electronic Systems Technician Level Two, Modules 33201-10 through 33209-10.

Objectives

Upon completion of this module, the trainee will be able to do the following:

1. Explain the purpose of grounding.
2. Determine the National Electrical Code® (NEC®) requirements for electrical system and telecommunications equipment grounding.
3. Recognize and describe the purpose of the components used for grounding and bonding a telecommunications system in a typical commercial multistory building.
4. Recognize and describe the purpose for using various AC power system protection and conditioning devices, including:
   - Isolation transformers
   - Surge protecting devices
   - Power line conditioners
   - Harmonic and noise suppression filters
   - Motor and engine-generator sets
   - Uninterruptible power supplies
5. Select and test DC power supplies used in electronic equipment.
6. Describe cable shielding and grounding techniques used to minimize EMI.

Performance Tasks

Under the supervision of the instructor, the trainee should be able to do the following:

1. Select and test DC power supplies used in electronic equipment.

Materials and Equipment

Multimedia projector and screen
Whiteboard/chalkboard
Markers/chalk
Pencils and scratch paper
Appropriate personal protective equipment
Computer
Calculator
Copy of latest edition of the National Electrical Code® (NEC®)

Copies of NEC Article 250
Selection of isolation transformers and surge protection devices
Manufacturer’s data sheets/catalogs for system protection and conditioning devices
Metal oxide varistors
Voltage regulators
Examples of UPS systems
VOM/DMM
Oscilloscope
Battery charger system
Shielded cables

(continued)
Safety Considerations

Ensure that the trainees are equipped with appropriate personal protective equipment and know how to use it properly. This module requires that the trainees work with electronic test circuits. Ensure that trainees are briefed on basic electrical safety and shop safety policies. Review safety guidelines for all test instruments used. This module requires that trainees visit job sites. Ensure that trainees are briefed on all site safety protocols.

Additional Resources

This module presents thorough resources for task training. The following resource material is suggested for further study.


Teaching Time for This Module

An outline for use in developing your lesson plan is presented below. Note that each Roman numeral in the outline equates to one session of instruction. Each session has a suggested time period of 2½ hours. This includes 10 minutes at the beginning of each session for administrative tasks and one 10-minute break during the session. Approximately 20 hours are suggested to cover Power Quality and Grounding. You will need to adjust the time required for hands-on activity and testing based on your class size and resources. Because laboratories often correspond to Performance Tasks, the proficiency of the trainees may be noted during these exercises for Performance Testing purposes.

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<thead>
<tr>
<th>Topic</th>
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<tr>
<td><strong>Session I. Introduction; Overview of Electrical System Grounding</strong></td>
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<tr>
<td>A. Introduction</td>
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<td>B. Premises Wiring</td>
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<td>C. Overview of Premises Electrical System Grounding</td>
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<td><strong>Session II. System and Equipment Grounding</strong></td>
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<tr>
<td>A. Basic Grounding System</td>
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<td><strong>Session III. Causes of Poor AC Power Quality</strong></td>
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<td>A. Voltage Transients and Surges</td>
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<td>B. Voltage Swells and Sags</td>
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<td>C. Overvoltage/Undervoltage/Interruptions</td>
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<td>D. Frequency Variations</td>
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<td>E. Harmonics/Noise/EMI</td>
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<td><strong>Session IV. Power System Protection and Conditioning</strong></td>
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<td>A. Filters and Regulators</td>
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<td>B. Transformers</td>
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<td>C. Surge Protection</td>
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<td>D. Voltage Regulation</td>
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<tr>
<td>E. Power Line Conditioners</td>
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<tr>
<td>F. Harmonics and Noise Suppression</td>
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</table>

Selection of DC power supplies and test equipment along with manufacturer’s catalog/data sheets
Copies of the Quick Quiz*
Module Examinations**
Performance Profile Sheets**
*Located in the back of this module
**Single-module AIG purchases include the printed exam and performance task sheet. If you have purchased the perfect-bound version of this title, download these materials from the IRC using your access code.
Session V. Backup Power; Uninterruptible Power Supplies

A. Engine-Generator Backup Power Sets

B. Static Uninterruptible Power Supply
   1. Double-Conversion UPS
   2. Single-Conversion UPS

Session VI. Direct Current Power

A. DC Power Supplies
   1. Linear Power Supplies
   2. Nonlinear Power Supplies
   3. Selecting a Power Supply

B. Laboratory
   Have trainees select and test a DC power supply for a given application. This exercise corresponds with Performance Task 1.

C. Battery and Charger Operation

Session VII. Cable Shielding and Grounding Techniques

A. Cable Shields

B. Preventing Ground Loops

Session VIII. Review and Testing

A. Module Review

B. Module Examination
   1. Trainees must score 70 percent or higher to receive recognition from NCCER.
   2. Record the testing results on Training Report Form 200, and submit the results to the Training Program Sponsor.

C. Performance Testing
   1. Trainees must perform each task to the satisfaction of the instructor to receive recognition from NCCER. If applicable, proficiency noted during laboratory exercises can be used to satisfy the Performance Testing requirements.
   2. Record the testing results on Training Report Form 200, and submit the results to the Training Program Sponsor.