

# Basic Electrical Troubleshooting

4 Days, 2.8 CEUs

Effectively troubleshooting electrical systems is an essential skill for any technician responsible for maintenance in an industrial, commercial or utility facility. The inexperienced troubleshooter may “chase the voltage” or mistake symptoms for problems – which leads to replacing the same parts repeatedly. Technicians who understand effective electrical troubleshooting techniques can save their organization money by properly identifying faulty components and preventing accidents and equipment damage that can occur from failures. Utilizing safe, effective troubleshooting techniques also ensures compliance with OSHA 1910.333(a)(1) which covers the requirements for de-energized work.

This hands-on course is intended for electricians and technicians responsible for troubleshooting electrical system problems and supervisors responsible for overseeing troubleshooting electrical system problems. The class participant should have basic knowledge of AC/DC electricity.

## Lab and Classroom Attire

AVO is committed to the personal safety of each participant and requires safety glasses, long pants and ANSI rated “safety-toe” work shoes for lab activities. Lecture courses may involve a tour of a work or shop area and for this reason open-toe shoes and shorts are not considered appropriate attire for the classroom.

## Learning Objectives

To receive 2.8 CEUs, participants must attend 4 days of class (28 contact hours) and attain a minimum average grade of 80% (overall grade will consist of 50% lab practice and 50% final exam). Upon completion of this course and lab practice, the participant will demonstrate that he/she is able to:

- Apply formulas derived from Ohm’s law and Kirchhoff’s law to solve for electrical values in circuits.
- Describe hazards of electrical work and means to work safely.
- Utilize electrical test equipment safely and correctly.
- Identify common electrical components and their general applications in circuits.
- Practice systematic, deenergized troubleshooting methods for common control circuits.

## SCOPE

### Day 1\* (7 Contact Hours)

#### I. Introduction (0.5 hours)

- A. Schedule
- B. Course Outline

#### II. Electrical Theory Review (1.5 hours)

- A. Electrical Circuits
- B. Amps, Volts, & Ohms
- C. Ohm’s Law
- D. Kirchhoff’s Law
- E. Solving for Unknown Values in Series, Parallel, and Combination Circuits

AM Break

#### III. Electrical Safety (2 hours)

- A. Electrical Hazards
- B. Electrical Risk Assessment

#### C. Electrical Safe-work practices

1. Electrical Work Procedures
2. LOTO
3. Work Protection Boundaries
4. PPE Selection

Lunch

#### IV. Electrical Test Instrument Operation (3 hours)

- A. Voltmeters
- B. Ammeters
- C. Ohmmeters
  1. 2-Wire Resistance Measurements (DMM)
  2. 3-Wire Resistance Measurements (Megohmmeter)

#### 3. 4-Wire Resistance Measurements (DLRO)

PM Break

- D. Digital Multi-meter Safety
- E. Miscellaneous Meters
  1. Frequency meters
  2. Infrared & Acoustic
  3. Power Quality Analyzers
  4. Thermometers
  5. Tachometers
  6. Lumen meters (footcandles)
  7. Phase sequence meters
  8. Power Factor meters
  9. Cable test equipment (TDR, VLF, etc.)

\*Class scheduling times may vary based on discussions and size of class

# Basic Electrical Troubleshooting

4 Days, 2.8 CEUs

## SCOPE (continued)

### Day 2 (7 Contact Hours)

#### V. Electrical Components and Circuits (14 hours)

- A. Passive & Active Circuit Components
1. Insulation & Conductors

#### AM Break

2. Switches
3. Generators, Transformers, & Batteries (Line)
4. Lights, Heaters, Motors, & Solenoids (Load)

#### Lunch

- B. Indicators (lights), Exercise 2.1
- C. Switches
1. NO & NC / MAIN-MOM, Exercises 3.1-3.6
  2. Limit Switches, Exercise 3.7

#### PM Break

- D. Control Relays, Exercises 4.1-4.6
- E. Timers, Exercises 5.1-5.3
- F. Proximity Sensors, Exercises 6.1-6.3

### Day 3 (7 Contact Hours)

#### V. Electrical Components and Circuits (continued)

- G. Contactors & Motor Starters, Exercises 7.1-7.4

#### AM Break

- H. Electrical Circuits Illustrated in Ladder Diagrams
1. Industrial Electrical Symbols

#### Lunch

2. Logic (IOs)

#### PM Break

3. Ladder Information, Ladder diagrams in Appendix A

### Day 4 (7 Contact Hours)

#### VI. Electrical Troubleshooting Steps (6 hours)

- A. Shorts and Opens
- B. Troubleshooting Test Procedures

#### AM Break

- C. Troubleshooting by Dividing Control Elements in Half (Divide and Conquer)
- D. Measuring Amps, Volts & Ohms in a Circuit, Exercises 8.1-8.2

#### Lunch

- E. Measuring Current
- F. Rules for Troubleshooting, Exercises 8.3-8.11

#### PM Break

#### VII. Conclusion (1 hour)

- A. Review
- B. Final Exam

# STANDARD EQUIPMENT LIST

## BASIC ELECTRICAL TROUBLESHOOTING

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REVISED 7/11/19 C. HELMICK  
COURSE NUMBER 410, REV.1  
4 DAYS

### **TEXT**

1 / STUDENT

*BASIC ELECTRICAL TROUBLESHOOTING*  
COURSE NUMBER 410 REV1, MAY 2019

### **HANDOUT**

1 / STUDENT

*UGLY'S ELECTRICAL REFERENCES*  
LATEST EDITION

### **EQUIPMENT**

1 / STUDENT

CALCULATOR

1 / CLASS

TRAINER WITH ACCESSORIES

1/ CLASS

BET TOOL BOX

1 / CLASS

DIGITAL MULTI-METER (CAT III)

1 / CLASS

SPERRY AMPCLAMP

1/ CLASS

AMPCLAMP W/120V SPLITTER

1/ CLASS

INSULATION RESISTANCE TESTER (1 kV)

1 / CLASS

CONTROL TRANSFORMER (480P-240/120S)

1/ CLASS

MOTOR WITH TURN TO TURN SHORT

1 / CLASS

MOTOR VISIBLE DAMAGE

1 / CLASS

9-LEAD, FRACTIONAL HP DUAL VOLTAGE MOTOR

1 / CLASS

ALLEN BRADLEY MOTOR STARTER

## **Basic Electrical Troubleshooting (BET)**

### **Tool Box List**

1. 1 roll of Scotch 33 electrical tape
2. 1 roll of shipping tape
3. Packet of wire numbering labels
4. Wire nuts
5. Spare parts for bugging simulator
6. Basic hand tools
  - a. #2 phillips screwdriver
  - b. Cabinet slot screwdriver (6 inch)
  - c. Klien 12 in 1 screwdriver #32500
  - d. Wire strippers
  - e. 9 inch lineman pliers
  - f. 10 inch crescent wrench
  - g. 10 inch adjustable pliers (channellocks)
  - h. Diagonal cutting pliers
  - i. Box knife