

# TROUBLESHOOTING ELECTRICAL CONTROL CIRCUITS

## CLASS FORMAT:

Lab + classroom

The participant is able to “learn-by-doing” in the course; this knowledge can be transferred to the workplace.

## STANDARD CLASS SIZE:

NTT recommends a class of no more than 12 participants for the best results

## NTT TO PROVIDE:

- 3 days (24 contact hours) of on-site instruction
- Student textbooks and lab manuals
- Classroom consumables
- Completion certificates
- Shipping and instructor travel logistics.

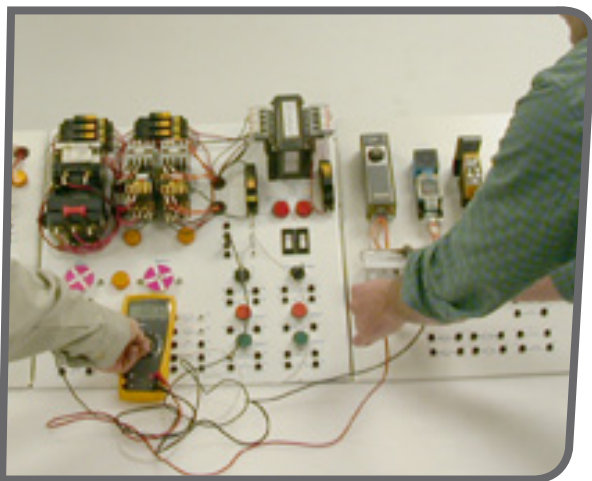
## CLIENT TO PROVIDE:

- A classroom, with easy access, of 750 square feet or greater
- Projection screen, white board and/or flip chart(s)
- A dock facility or a forklift to unload the training equipment
- A pallet jack to move the crates around after they have been unloaded may also be needed
- The equipment should be placed in the training room for the NTT instructor to test and setup prior to the start of class

## SHIPPING:

5 cases @ 900 lbs.

- 4 cases @ 47" x 22" x 17" = 190 lbs. each
- 1 case @ 47" x 22" x 17" = 140 lbs.



*About 70% of the time is spent working, hands-on, at a troubleshooting station with motor control circuits (operating at a safe, low level of 24 volts).*

**This is a basic course, without any prerequisites, that helps you develop a solid foundation to build your troubleshooting knowledge and skills. You will learn techniques that will help locate faults quickly.**

Learn basic troubleshooting techniques in a logical sequence to cover all the standard control circuits. Gain practical, useful techniques that can be put into immediate use.

This program is ideal for apprentice electricians just starting out, journeymen wishing to upgrade their skills, or any engineering, maintenance, operations, or management personnel who come into contact with electrical control systems in the course of their daily activity.

## COURSE AGENDA

### ELECTRICAL SCHEMATICS

- Power and control circuits

### MAPPING CONTROL CIRCUITS— LADDER DIAGRAMS

- Power rails and wire colors
- Arrangements—control element, load, circuit
- Line and wire numbers
- Tag names and common electrical symbol abbreviations

### LOGICAL CIRCUITS

- AND – Series circuit
- OR – Parallel circuit
- Compound and complex circuits
- NOT circuit

### BASIC ELECTRICAL PRINCIPLES

- Power sources—transformers
- Flow of electricity
- Switches—allow or prohibit current flow
- Loads

### TRANSFORMERS

- Magnetism
- Induction
- Primary/secondary
- Turn ratio
- Grounded and floating ground

# TROUBLESHOOTING ELECTRICAL CONTROL CIRCUITS

## DISCONNECTING DEVICES AND SYMBOLOGY

- Knife switch
- Disconnects
- Circuit breakers

## CONTROL ELEMENTS, SWITCHES & SYMBOLOGY

- Relay contacts—normally open, normally closed
- Solid-state, timing, overload relays

## SUPPLEMENTARY CONTACT SYMBOLS & TERMS

- Breaks, poles, throws
- Single break, double break
- Single pole, double pole
- Single throw, double throw

## MANUAL SWITCHES—FUNCTIONALITY AND SYMBOLOGY

- Selector switches
- Push buttons
- Drum and foot switches

## AUTOMATIC SWITCHES

- Limit switches
- Temperature, pressure, flow and float switches
- Motion switches
- Proximity and photo switches

## TROUBLESHOOTING SUGGESTIONS

- Measuring ohms, voltage and current
- Open faults and shorts
- Using the proper tools and meters
- Logical and sequential troubleshooting methods
- Meter categories and types
- Safety and precautions

## GROUND-FAULT AND OVERLOAD PROTECTION

- Conductor sizing
- Ground-fault protection devices and sizing
- Motor starter sizing
- Motor overload protection sizing
- Disconnect sizing

## MOTOR OVERLOAD PROTECTION

- Thermal overloads
- Bimetallic overloads
- Magnetic overloads
- Solid-state overloads

## APPLICATION SPECIFIC CIRCUITS

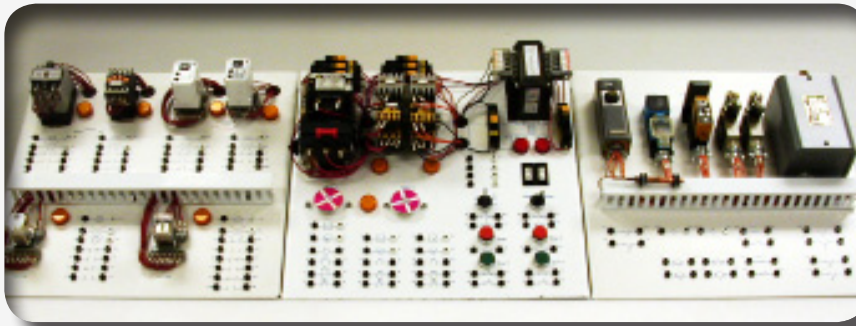
- Common pumping circuits
- Common heating/cooling circuits

## LAB EXERCISE CIRCUITS

- Two-wire control and hands-off/auto
- Three-wire control—start/stop
- Jog/inch circuits
- Sequencing start and stop circuits
- Timing circuits
- Automatic sequencing circuits
- Forward/reversing circuits
- Plug stop and anti-plugging circuits
- Two-speed motor control
- Reduced voltage starting circuits
- Alarming and latching circuits
- Conveyor control circuits

## SAFETY AWARENESS

- Electrical safety
- Lockout/tagout procedures
- Safe work practices
- Personal protective equipment (PPE)



Troubleshooting stations consist of 3 units. Students wire up control circuits (to the terminals) that consist of relays, motor starters, timers, push buttons, selector switches, temperature switches, limit switches, float switches, proximity sensors, photoeyes, etc.