



Hale Instructional Lab Activity Objectives

INDUSTRIAL ELECTRICITY

ELECTRICAL CONTROLS, CONNECTIONS & LADDER LOGIC

LAB OUTLINE

Lab 1 WORKING SAFELY WITH ELECTRICITY

At the completion of this lab, learner will be able to:

1. Work safely with electricity.
2. Use personal safety equipment to protect yourself against the hazards of electricity.

Lab 2 ELECTRICAL CONTROLS TRAINER FAMILIARIZATION

At the completion of this lab, learner will be able to:

1. Identify the major components of the Electrical Controls Trainer.
2. Explain the function and features of the major components on the Electrical Controls Trainer.
3. "Power up" the Electrical Controls Trainer and check it for proper operation.

Lab 3 VOLTAGE MEASUREMENT

At the completion of this lab, learner will be able to:

1. Safely take voltage measurements using a voltage tester or DMM.
2. Explain the procedure for inspecting a test instrument before each use.
3. Identify the AC power conductors in the Electrical Controls Trainer.
4. Measure three phase AC voltages.
5. Explain the hazard of measuring AC voltage with a DMM that is setup to measure DC voltage.

Lab 4 CONTROL TRANSFORMERS

At the completion of this lab, learner will be able to:

1. Identify analog I/O devices on the trainer.
2. Read and interpret analog scales.
3. Identify the terminals on a potentiometer.
4. Use resistance measurements to check the operation of a potentiometer.
5. Calculate the minimum and maximum current values in an analog circuit.

Lab 5 OVERCURRENT PROTECTION

At the completion of this lab, learner will be able to:

1. Identify the voltage, current, and interrupting capacity of a fuse or circuit breaker.
2. Locate a "blown" fuse in a three phase circuit.
3. Use circuit breakers to protect the primary and secondary windings of a control transformer against overcurrent conditions.
4. Measure the control circuit supply voltage.
5. Locate an open circuit breaker or fuse in a control circuit.

Lab 6 CONTINUITY TESTERS

At the completion of this lab, learner will be able to:

1. Check a continuity tester for proper operation
2. Use a continuity tester to check a fuse.
3. Use a continuity tester to check the windings in a control transformer.
4. Use a continuity tester to locate an "open" circuit.
5. Use a continuity tester to check a "ground" connection.

Lab 7 PUSHBUTTON CONTROLS

At the completion of this lab, learner will be able to:

1. Identify the operator on a pushbutton control.
2. Identify the terminals on a contact block.
3. Check a contact block using a continuity tester.
4. Draw a target diagram for a selector switch.
5. Determine the electrical rating of a contact block.

Lab 8 PILOT LIGHTS

At the completion of this lab, learner will be able to:

1. Identify full voltage and push to test pilot lights.
2. Determine the electrical rating of a pilot light.
3. Connect and test the operation of a "push to test" pilot light circuit.
4. Connect and test the operation of a "light stack".
5. Connect and test the operation of a "ground fault detection" circuit.
6. Troubleshoot a pilot light using a voltage tester.

Lab 9 MECHANICAL LIMIT SWITCHES

At the completion of this lab, learner will be able to:

1. Identify the actuator on a mechanical limit switch.
2. Identify the terminals on a mechanical limit switch.
3. Adjust a limit switch to operate within a specified operating range.
4. Use a continuity tester to check a mechanical limit switch for proper operation.
5. Explain the function of a safety interlock switch

Lab 10 PROXIMITY SWITCHES

At the completion of this lab, learner will be able to:

1. Identify the terminals on a proximity switch
2. Determine the sensing range of a proximity switch.
3. Adjust a proximity switch to operate within a specified operating range.
4. Use a digital multimeter (DMM) to check the operation of a proximity switch.



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Lab 11 PHOTOELECTRIC SWITCHES

At the completion of this lab, learner will be able to:

1. Identify the terminals on a photoelectric switch.
2. Determine the sensing range of a photoelectric switch.
3. Explain the operation of a convergent mode photoelectric switch
4. Use a voltage tester to check a photoelectric switch for proper operation.

Lab 12 SOLENOIDS

At the completion of this lab, learner will be able to:

1. Identify the components of a solenoid.
2. Use a continuity tester to check a solenoid coil.
3. Construct a circuit that uses a solenoid to operate a mechanical clamp.
4. Determine when a plunger is properly seated in the frame of a solenoid.

Lab 13 CONTROL RELAYS

At the completion of this lab, learner will be able to:

1. Identify the coil and contact terminals in a control relay.
2. Construct a coil and contact circuit.
3. Explain the operation of a pushbutton interlock circuit.
4. Troubleshoot control relay circuits.

Lab 14 LATCHING RELAYS

At the completion of this lab, learner will be able to:

1. Identify the coil and contact terminals on a latching relay.
2. Construct latch, unlatch and contact circuits.
3. Explain the operation of a latching relay circuit.
4. Troubleshoot a latching relay circuit.

Lab 15 TIME DELAY RELAYS

At the completion of this lab, learner will be able to:

1. Identify the contact terminals on a time delay relay.
2. Construct a time delay relay circuit.
3. Adjust the delay time of a time delay relay.
4. Explain the operation of a time delay relay circuit.
5. Troubleshoot a time delay relay circuit.

Lab 16 PLUG IN RELAYS

At the completion of this lab, learner will be able to:

1. Identify the coil terminals on a plug in relay.
2. Identify the contact terminals on a plug in relay.
3. Identify the contact configuration of a plug in relay.
4. Check the coil and contacts in a plug in relay.
5. Draw a control circuit using a plug in relay.

Lab 17 TIMERS

At the completion of this lab, learner will be able to:

1. Identify the power and contact terminals on a solid state timer.
2. Construct reset and repeat cycle timer circuits.
3. Adjust the "on" or "off" times of a timer.
4. Explain the difference in operation between reset and repeat cycle timers.
5. Troubleshoot timer circuits.

Lab 18 THREE PHASE MOTORS

At the completion of this lab, learner will be able to:

1. Identify the connection leads on a three phase motor.
2. Connect a dual voltage motor for low voltage operation.
3. Connect a dual voltage motor for high voltage operation.
4. Use the service factor to calculate the maximum current and horsepower ratings of a motor.

Lab 19 NON-REVERSING MOTOR STARTERS

At the completion of this lab, learner will be able to:

1. Identify the power and control terminals on a motor starter.
2. Select the proper size heater for a motor starter.
3. Adjust the "trip" point of a bimetallic overload relay.
4. Construct a motor starter control circuit.
5. Troubleshoot motor starter circuits.

Lab 20 REVERSING MOTOR STARTERS

At the completion of this lab, learner will be able to:

1. Identify the power and control terminals on a reversing motor starter.
2. Test the operation of a mechanical interlock on a reversing motor starter.
3. Construct a reversing motor starter control circuit.
4. Troubleshoot reversing motor starter circuits.

Lab 21 Wiring Diagrams

At the completion of this lab, learner will be able to:

1. Identify control and power terminals on a wiring diagram.
2. Use a ladder diagram to construct a wiring diagram.

Lab 22 LADDER DIAGRAMS

At the completion of this lab, learner will be able to:

1. Identify symbols used in electrical drawings.
2. Assign reference numbers to conductors in a ladder diagram.
3. Assign cross reference numbers for control relay coils in a ladder diagram.

Lab 23 TWO WIRE CONTROL

At the completion of this lab, learner will be able to:

1. Design a circuit that uses a two-wire control device to control an air compressor.
2. Design a circuit that uses a two-wire control device to control a heater.

Lab 24 MULTIPLE PUSHBUTTONS

At the completion of this lab, learner will be able to:

2. Distinguish between on-delay and off-delay timers.
3. Program on-delay and off-delay timers in a PLC.
4. Explain the operation of on-delay and off-delay timers.

Lab 25 MANUAL-OFF-AUTOMATIC OPERATION

At the completion of this lab, learner will be able to:

1. Design a circuit that uses a selector switch to select the manual, off, or automatic mode of operation to control a motor starter.

Lab 26 MANUAL SEQUENCING

At the completion of this lab, learner will be able to:

1. Design a circuit that requires a human operator to manually start three motors in a predetermined sequence.

Lab 27 AUTOMATIC SEQUENCING

At the completion of this lab, learner will be able to:

1. Design a circuit that uses a single start button to automatically start three motors in a predetermined sequence

Lab 28 ELECTRICAL INTERLOCK

At the completion of this lab, learner will be able to:

1. Design a circuit that uses electrical interlocks to control the operation of the spindle motor in a drill press.

Lab 29 JOGGING

At the completion of this lab, learner will be able to:

1. Design a circuit that uses a selector switch to "jog" a non-reversing motor starter.
2. Design a circuit that uses a selector switch to "jog" a reversing motor starter.

Lab 30 DRILL STATION

At the completion of this lab, learner will be able to:

1. Use a ladder diagram to wire a control circuit.
2. Interpret electrical drawings.
3. Configure the trainer to function as a drill station.

Hands On Learning – Makes It Real

Hale Training delivers its greatest results when the Hale Course Curriculum is studied and Hale Lab Exercise Assignments are completed on the Electrical Controls Trainers.



Hale Electrical Controls Trainer