

IND220 Lab 2.4: HL Troubleshooting Basic Electrical Circuits

Upon completion of this lab, the student should be able to:

1. Explain how contacts from multiple relays can be configured for control
2. Measure the voltage that should be at various points in a circuit
3. Explain the operation of a multiple relay type of electrical circuit
4. Determine which components could be faulty if a circuit does not work
5. Explain the operation of a DC motor with selector switch and series resistors
6. Explain how a DPDT relay configuration can control the direction of rotation of a DC motor

Part 1: Two relay circuit operation and voltage checks

*Connect the following circuit on the AC/DC wiring training units

*Use the lower portion of the DPDT switch for Sw2 (see Figure 1)

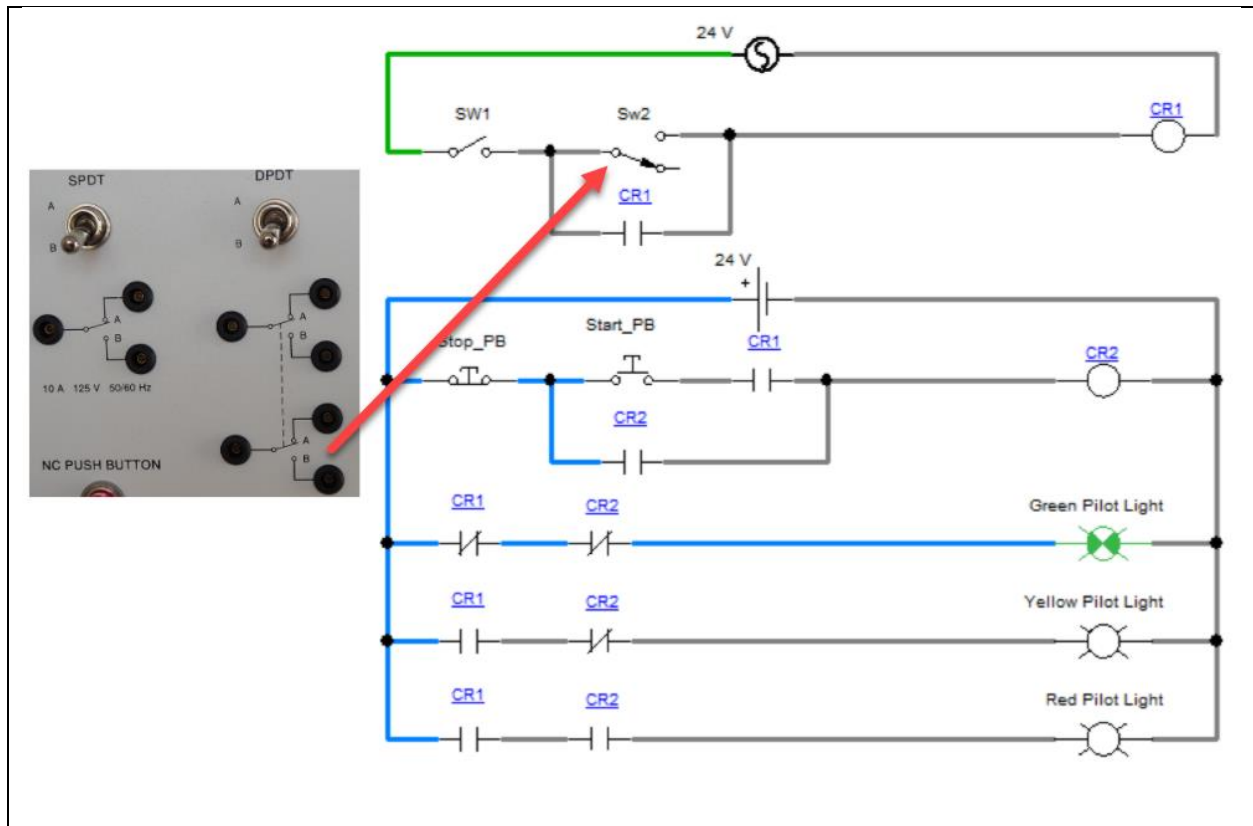


Figure 1. IND220 Lab 2.4 Circuit 1

Figure 1 shows the first circuit of this lab that consists of an AC relay and a DC relay, with the contacts of each relay being used together to turn on 3 pilot lights, based on the relay contact

configuration. Since this circuit was created in Automation Studio, you can actually open the file and run the circuit through an online simulation.

Answer the following few questions based on your review of the circuit in Figure 1:

1. What needs to occur to turn on CR1?
2. What needs to occur to turn off CR1?
3. What needs to occur to turn on CR2?
4. What needs to occur to turn off CR2?

Figure 2 shows Circuit 1 with the line numbers (left hand side of the ladder circuit diagram), as well as the numbers for each electrical node (wire number).

In line 2, a SPST switch (SW1) is used to function as a stop pushbutton, and Sw2 (a SPDT Sw) is used to function as a start pushbutton. The CR1 contact in line 3 is used as a hold-in contact so CR1 remains energized after Sw2 is toggle closed, then back open.

Notice on line 5 in the circuit in Figure 2, CR1 contact must be closed (CR1 coil is energized) and the Start_PB has to be actuated in order to energize CR2.

Line 7 shows two normally-closed contacts (one from CR1 and the other from CR2). Since a normally-closed contact has continuity when its coil is off, the logic for rung 7 could be said as: when CR1 is not on, and CR2 is not on, the Green Pilot light will turn on.

Since a normally-open contact has continuity when the relay it is on is energized, the logic in line 8 could be said as: when CR1 is on, and CR2 if off, the Yellow Pilot Lt will turn on.

Line 9 logic would be said as: when CR1 is on, and CR2 is on, the Red Pilot Lt will turn on.

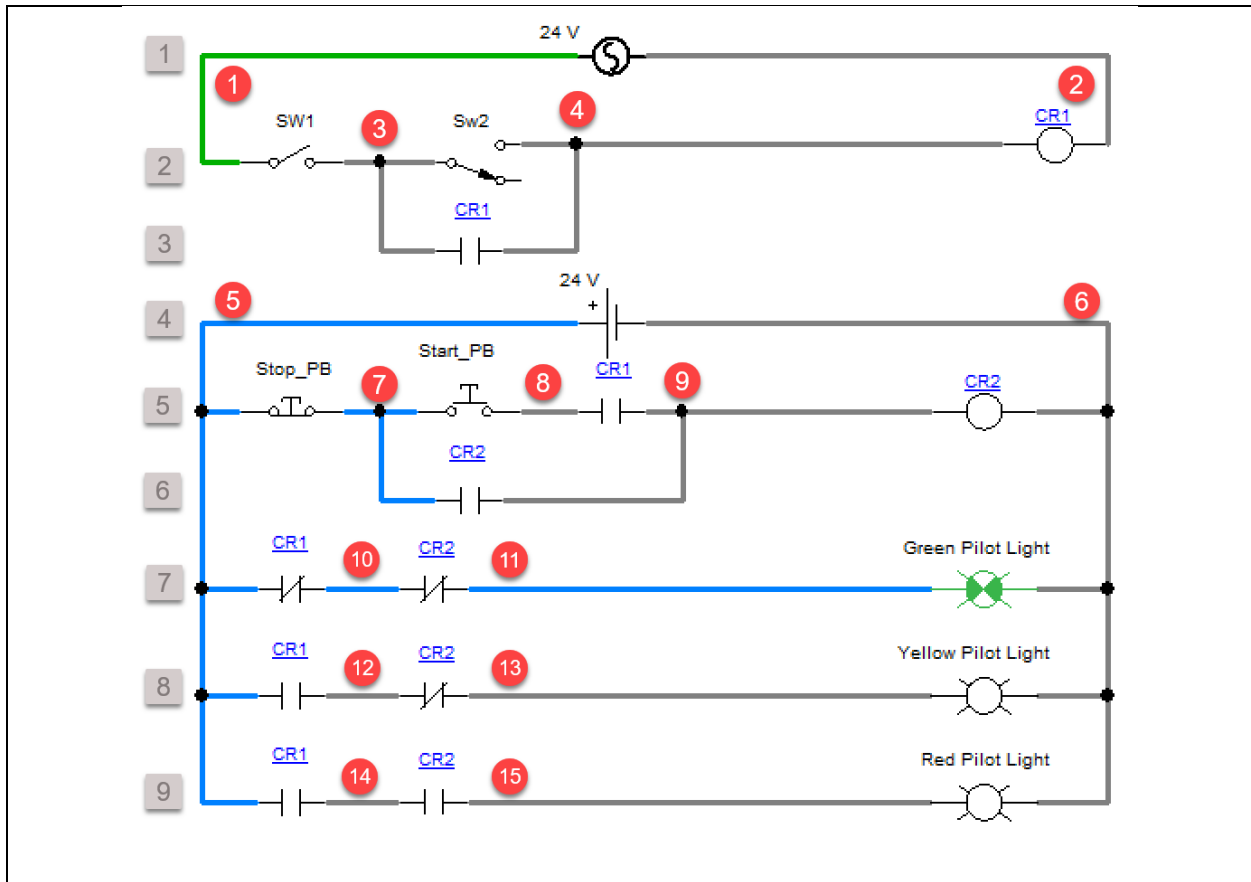


Figure 2. IND220 Lab 2.4 Circuit 1, with line and wire numbers added

Power up the AC/DC training unit to do the following measurements:

Voltage Measurements:

1. If neither relay is on, what will be the following voltage measurements?
 - a. Voltage between 1 and 2? _____
 - b. Voltage between 3 and 2? _____
 - c. Voltage between 4 and 2? _____
 - d. Voltage between 10 and 6? _____
 - e. Voltage between 11 and 6? _____
 - f. Voltage between 12 and 6? _____
 - g. Voltage between 14 and 6? _____

2. Turn on the CR1 relay.
 - a. Voltage between 10 and 6? _____
 - b. Voltage between 11 and 6? _____
 - c. Voltage between 12 and 6? _____

- d. Voltage between 14 and 6? _____
3. Turn on the CR1 relay, and CR2 relay.
 - a. Voltage between 10 and 6? _____
 - b. Voltage between 11 and 6? _____
 - c. Voltage between 12 and 6? _____
 - d. Voltage between 14 and 6? _____
4. Turn on Fault Switch #2 on the AC/DC training unit.
 - a. Try operating the circuit by turning on the AC relay, then the DC relay
 - b. What in the circuit is not working? _____
 - c. Troubleshoot to determine what component has failed.
 - d. Which component was found to be faulty? _____
 - e. Turn off fault switch #2.
5. Turn on Fault Switch #3 on the AC/DC training unit.
 - a. Try operating the circuit by turning on the AC relay, then the DC relay
 - b. What in the circuit is not working? _____
 - c. Troubleshoot to determine what component has failed.
 - d. Which component was found to be faulty? _____
 - e. Turn off fault switch #3.
6. Disconnect the circuit

Part 2: Circuit to control the speed and direction of a DC PM motor

*Connect the following circuit on the AC/DC wiring training units

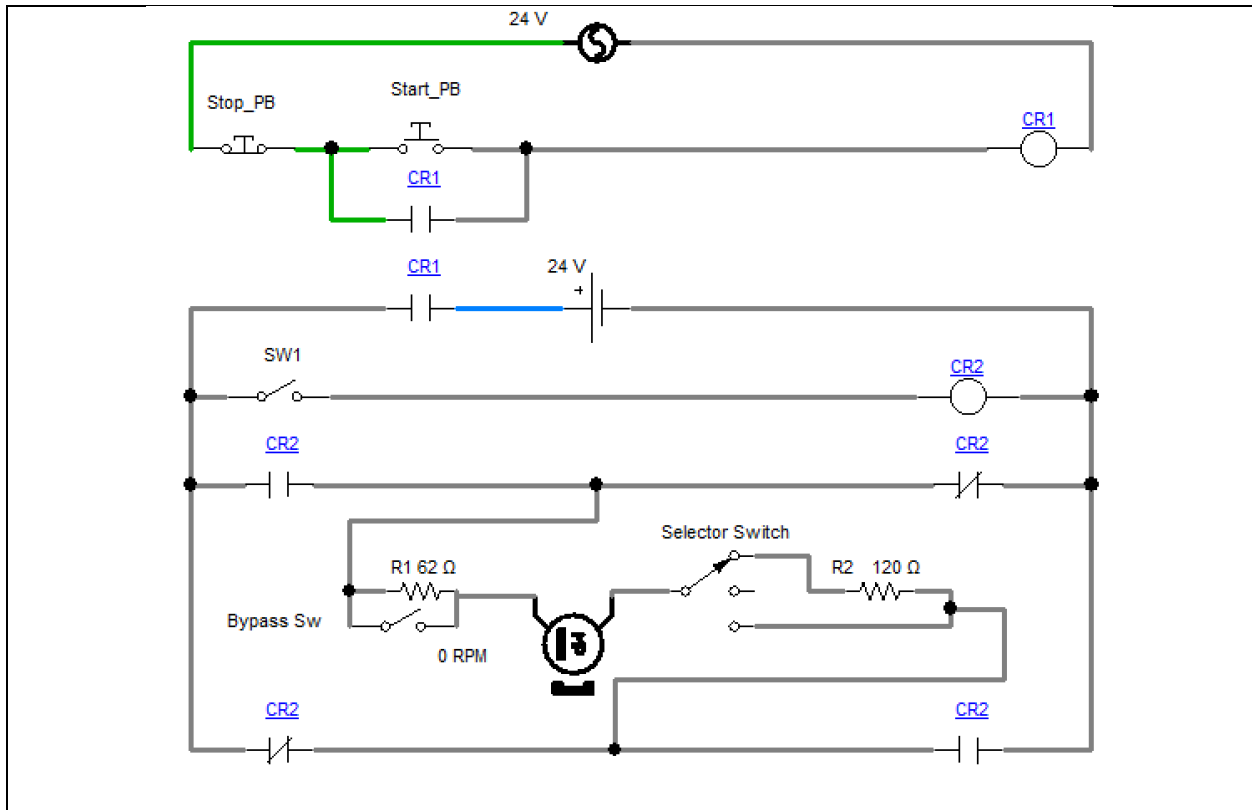


Figure 3. IND220 Lab 2.4 Circuit 2

The circuit in Figure 3 is using a start/stop/hold-in circuit to control an AC relay (CR1). When CR1 is energized, it enables the DC circuit, which uses a 24 Vdc power source. The DC circuit will be used to control the direction of rotation of the DC permanent magnet motor using SW1. When SW1 is open and CR2 is off, the N.C. contacts of CR2 deliver DC voltage to the motor. When CR2 is energized, the polarity of the DC supply is reversed going to the motor.

A series of switches and resistors is used to change the speed of the DC permanent magnet motor.

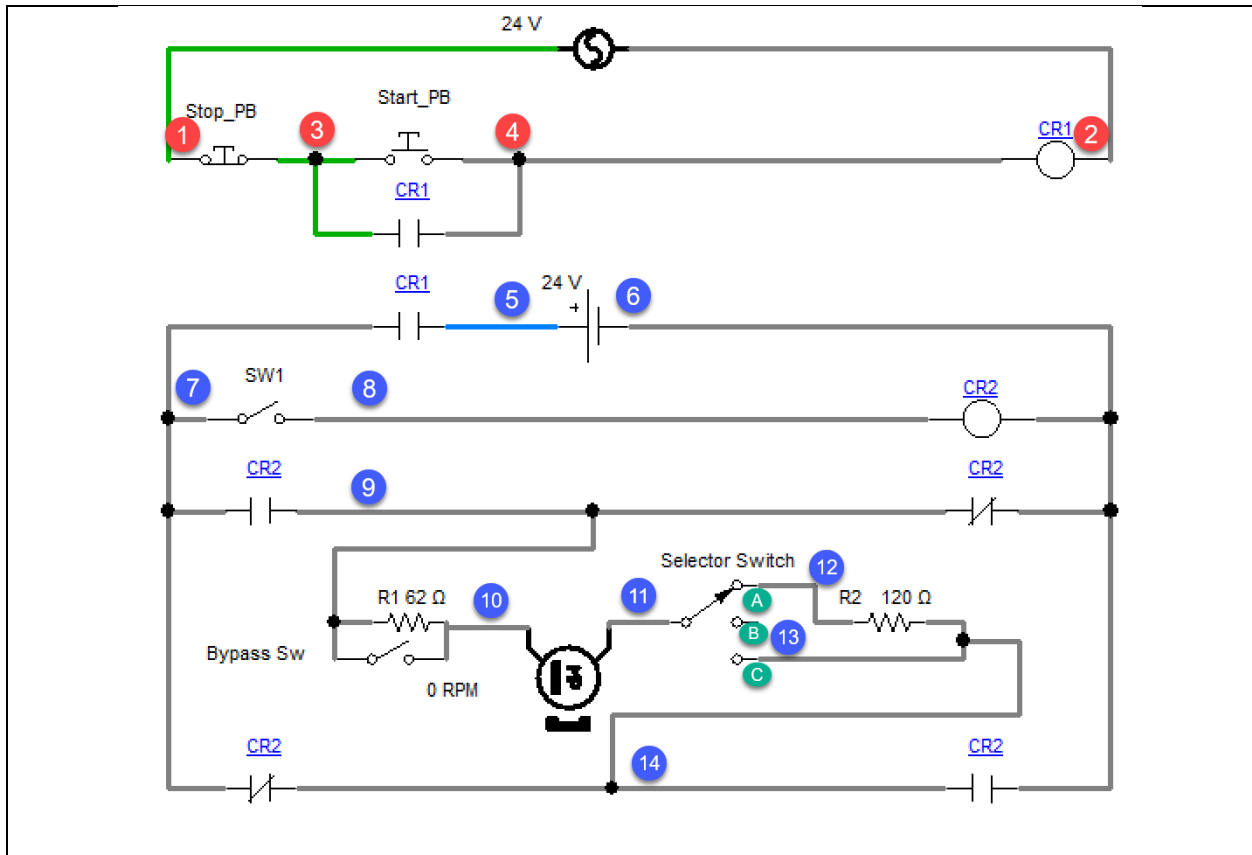


Figure 4. IND220 Lab 2.4 Circuit 2, with wire numbers added

Currently in the circuit in Figure 4, the Bypass Sw is open, which puts the R1 62 ohm resistor, and the Selector Switch is in position “A” which also puts the R2 120 ohm resistor in series with the motor. In this scenario, the motor is running at a slower than maximum speed. If one or both of the resistors is in series with the motor, part of the voltage from the 24 Vdc will be dropped across the resistor(s) leaving less voltage for the motor, which will slow the motor down.

Step 1: Click on the Start_PB to energize CR1. This should enable the DC circuit that controls the motor.

Step 2: Close the bypass switch and put the Selector Switch into position “C”. Also, open SW1, turning off CR2.

What is the voltage on the motor? _____

Step 3: Close SW1, energizing CR2.

Does the motor reverse direction? _____

What is the voltage on the motor? _____

Step 3: Open the Bypass Sw, keeping the Selector Switch in the “C” position.

- a. What is the voltage on the motor? _____
- b. What is the voltage across R1? _____ What is the voltage across R2? _____

Step 4: Move the Selector Switch to the “A” position.

- a. What is the voltage on the motor? _____
- b. What is the voltage across R1? _____ What is the voltage across R2? _____

Step 5: Press the Stop_PB, resetting the circuit.

Turn on Fault Switch #5 on the AC/DC training unit.

- a. Try operating the circuit by turning on the AC relay, then the DC relay
- b. What in the circuit is not working? _____
- c. Troubleshoot to determine what component has failed.
- d. Which component was found to be faulty? _____
- e. Turn off fault switch #5.

Step 6: Press the Stop_PB, resetting the circuit.

Turn on Fault Switch #4 on the AC/DC training unit.

- a. Try operating the circuit by turning on the AC relay, then the DC relay
- b. What in the circuit is not working? _____
- c. Troubleshoot to determine what component has failed.
- d. Which component was found to be faulty? _____

- e. Turn off fault switch #4.

Step 7: Disconnect the circuit