

## Lab 6.2: Basic Electrical Concepts in Hardware Lab

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

1. Interpret the electrical circuit diagrams and symbols used in this lab
2. Measure the resistance of N.O. and N.C. contacts using a digital multimeter
3. Measure the resistance of a relay coil using a digital multimeter
4. Assemble a basic 24 Vdc relay circuit based on an electrical print
5. Assemble a basic 24 Vdc relay circuit controlling pilot lights
6. Assemble a basic 24 Vdc relay circuit with a start/stop/hold-in configuration

\*This lab should be performed in the Advanced Manufacturing Lab, on the Motor Control System training unit shown in Figure 1.

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*Important Safety Information: When working on the Amatrol Motor Control System, it is important to always wear safety glasses, and make sure you only work on the 24 Vdc components. It is beyond the scope of this course to work on the 208 Vac portion of this training unit, which will also require a higher level of Personal Protective Equipment (PPE).*

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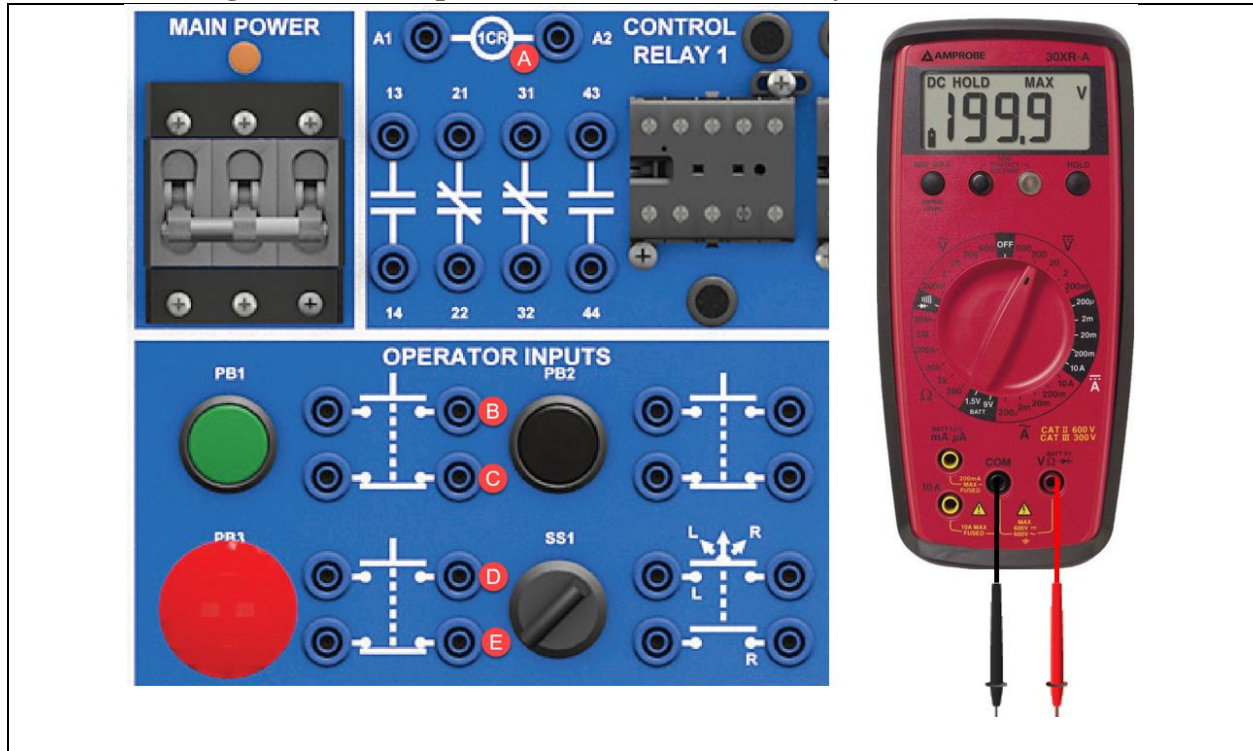


**Figure 1. The Amatrol Motor Control Training Unit at South Ark CC.**

1. Access the Motor Control System training unit and a digital multimeter, as shown in Figure 1.

- Put the digital multimeter dial scale on the 2K Ohm option in the lower left of the dial indicators, to measure the resistance.

### Part 1: Checking Resistance of pushbutton contacts and relay coil



**Figure 2. Measuring Resistance of electrical components.**

- Figure 2 shows components marked with a red circle that the student will measure the resistive value of the component:

A. Relay coil: Resistance measures: \_\_\_\_\_ Ohms

***Green and Red Pushbuttons are not actuated:***

B. Green Pushbutton N.O. contact: Resistance measures: \_\_\_\_\_ Ohms

C. Green Pushbutton N.C. contact: Resistance measures: \_\_\_\_\_ Ohms

D. Red Pushbutton N.O. contact: Resistance measures: \_\_\_\_\_ Ohms

E. Red Pushbutton N.C. contact: Resistance measures: \_\_\_\_\_ Ohms

***Green and Red Pushbuttons should be actuated for the following measurements:***

B. Green Pushbutton N.O. contact: Resistance measures: \_\_\_\_\_ Ohms

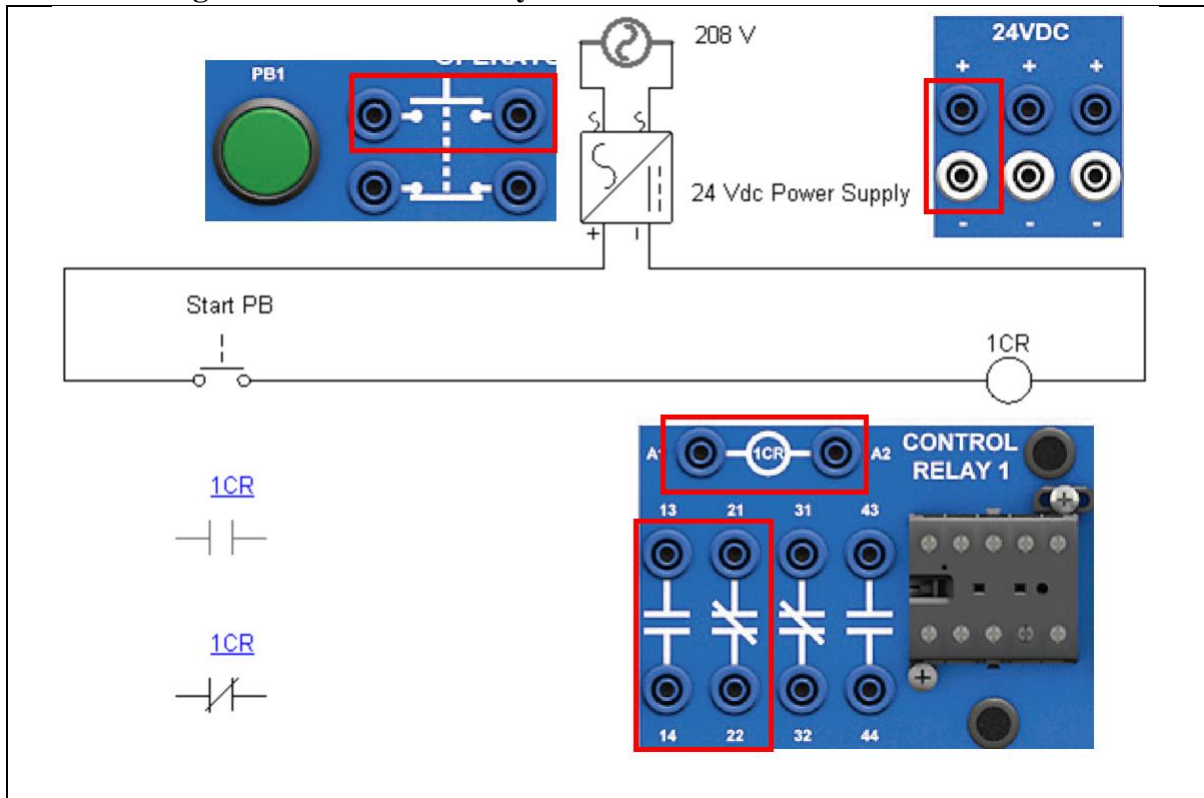
C. Green Pushbutton N.C. contact: Resistance measures: \_\_\_\_\_ Ohms

D. Red Pushbutton N.O. contact: Resistance measures: \_\_\_\_\_ Ohms

E. Red Pushbutton N.C. contact: Resistance measures: \_\_\_\_\_ Ohms

\_\_\_\_\_ (Instructor Initials) The student demonstrated the skills of measuring the resistance of pushbutton contacts and the resistance of a relay coil.

## Part 2: Measuring the Resistance of Relay Contacts.



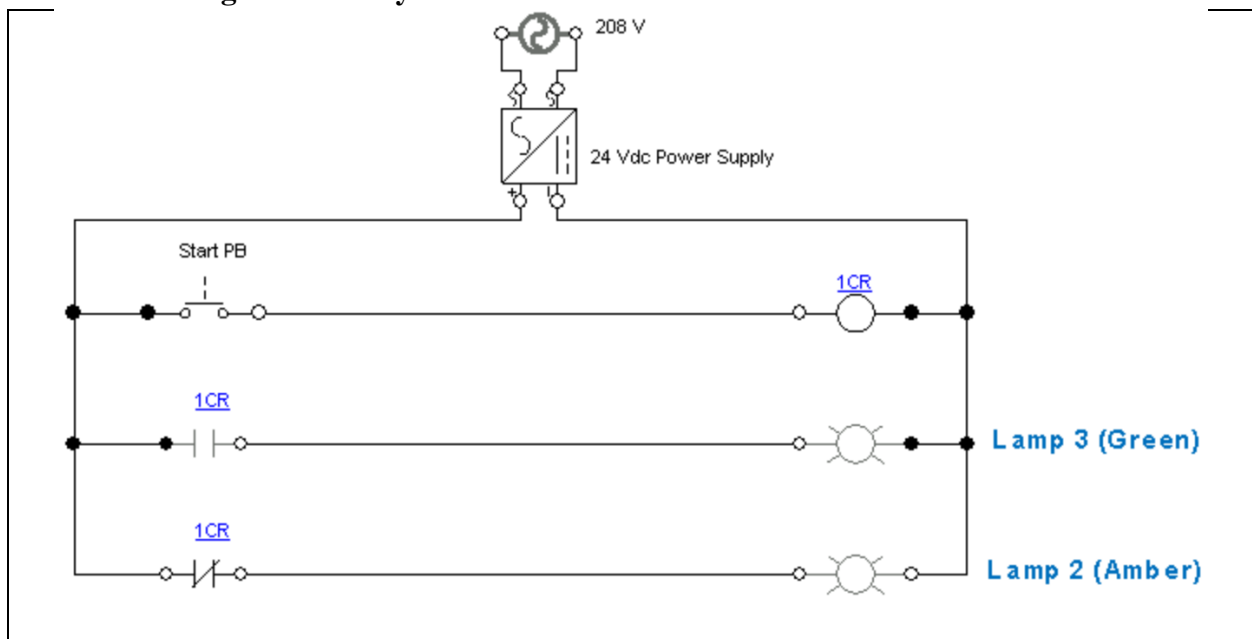
**Figure 3. Checking the resistance of relay contacts.**

2. Figure 3 shows the coil of 1CR controlled by a N.O. pushbutton (Start PB). It is important to understand how the relay contacts react when the coil is energized.
3. Assemble the circuit in Figure 3 on the Motor Control training unit, then power on the system.
4. Measure the resistance of the N.O. relay contact with the multimeter when the relay coil is not energizes: \_\_\_\_\_ Ohms.
5. Energize the relay coil by pressing the Start PB (and holding it). Now measure the resistance of the N.O. relay contact with the multimeter (when the relay coil is energized): \_\_\_\_\_ Ohms.

6. Measure the resistance of the N.C. relay contact with the multimeter when the relay coil is not energizes: \_\_\_\_\_ Ohms.
7. Energize the relay coil by pressing the Start PB (and holding it). Now measure the resistance of the N.O. relay contact with the multimeter (when the relay coil is energized): \_\_\_\_\_ Ohms.

\_\_\_\_\_ (Instructor Initials) *The student demonstrated the skills of measuring the resistance of relay contacts when the relay was off, and also when it was actuated.*

### Part 3: Learning how a Relay Works.



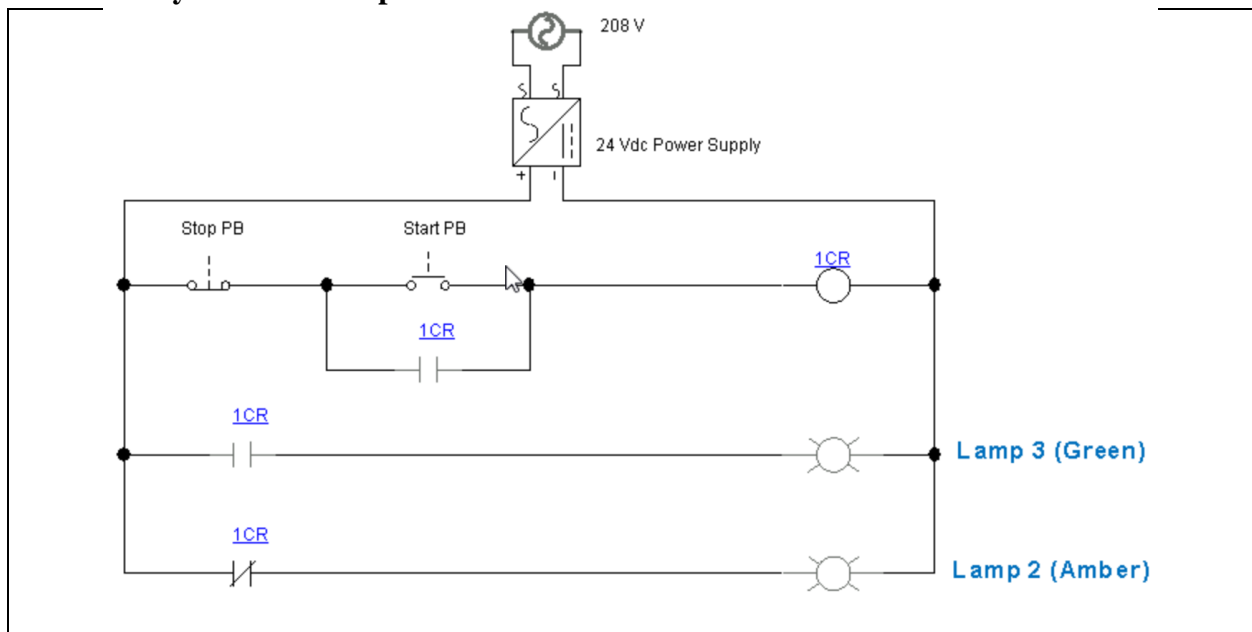
**Figure 4. Verifying how a relay works.**

1. Figure 4 shows a normally-open pushbutton controlling the relay coil, and two relay contacts controlling 2 pilot lights (Amber and Green, which are also on the Motor Control training unit).
2. Assemble the circuit in Figure 4, then turn power on the unit and do the following voltage checks.

3. With the Start PB not actuated, what voltage is measured across the relay coil? \_\_\_\_\_ Vdc
4. With the Start PB not actuated, what voltage is measured across Lamp 3? \_\_\_\_\_ Vdc
5. With the Start PB not actuated, what voltage is measured across Lamp 2? \_\_\_\_\_ Vdc
6. With the Start PB actuated, what voltage is measured across the relay coil? \_\_\_\_\_ Vdc
7. With the Start PB actuated, what voltage is measured across Lamp 3? \_\_\_\_\_ Vdc
8. With the Start PB actuated, what voltage is measured across Lamp 2? \_\_\_\_\_ Vdc

\_\_\_\_\_ (Instructor Initials) The student demonstrated the skills assembling the circuit in Figure 4, then also measuring the voltages at specified points in the circuit, and explaining to the Instructor how the relay contacts operate when the relay coil is on, and also when it is off.

#### Part 4: Relay in a Start/Stop Circuit.



**Figure 5. Relay in a start/stop/hold-in configuration.**



1. Figure 5 shows a relay used in a start/stop circuit configuration, with a N.O. relay contact in parallel with the Start PB. The purpose of this N.O. relay contact is to keep the relay coil held in, after the Start PB is released.
2. Assemble the circuit in Figure 5, then turn power on the unit.
3. Press the Start PB. The relay coil should actuate. Release the Start PB. Does the relay coil remain energized? \_\_\_\_\_
4. Press the Stop PB. Does the relay coil de-energize (shut off)? \_\_\_\_\_

\_\_\_\_\_ (*Instructor Initials*) *The student demonstrated the skills assembling the circuit in Figure 5, then also measuring the voltages at specified points in the circuit, and explaining to the Instructor how the relay contacts operate when the relay coil is on, and also when it is off.*

*Important: The outcomes of this exercise (listed on page 1) specifies the skills that the Student must demonstrate to the Instructor. Once the Instructor is satisfied with the demonstration of Knowledge & Skills by the individual student, they will sign this document (for the student), then enter a 100% into the Hands-On Assessment grade in Blackboard.*

I verify that this student has completed all of the requirements of this Hands-On Assessment:

Student Name: \_\_\_\_\_

Faculty Signature: \_\_\_\_\_ Date: \_\_\_\_\_

Questions:

1. When measuring DC voltage with a digital multimeter, the black lead typically connects to which side of the DC power supply, in order to get a positive voltage reading?
  - a. Negative side
  - b. Positive side
  - c. AC side
  
2. What could be the issue if when measuring the voltage across an energized relay coil, the multimeter read -24 Vdc, instead of 24 Vdc?
  - a. The relay coil is faulty
  - b. The multimeter is faulty
  - c. The leads of the multimeter are reversed
  - d. The dial on the multimeter is set for AC volts instead of DC volts

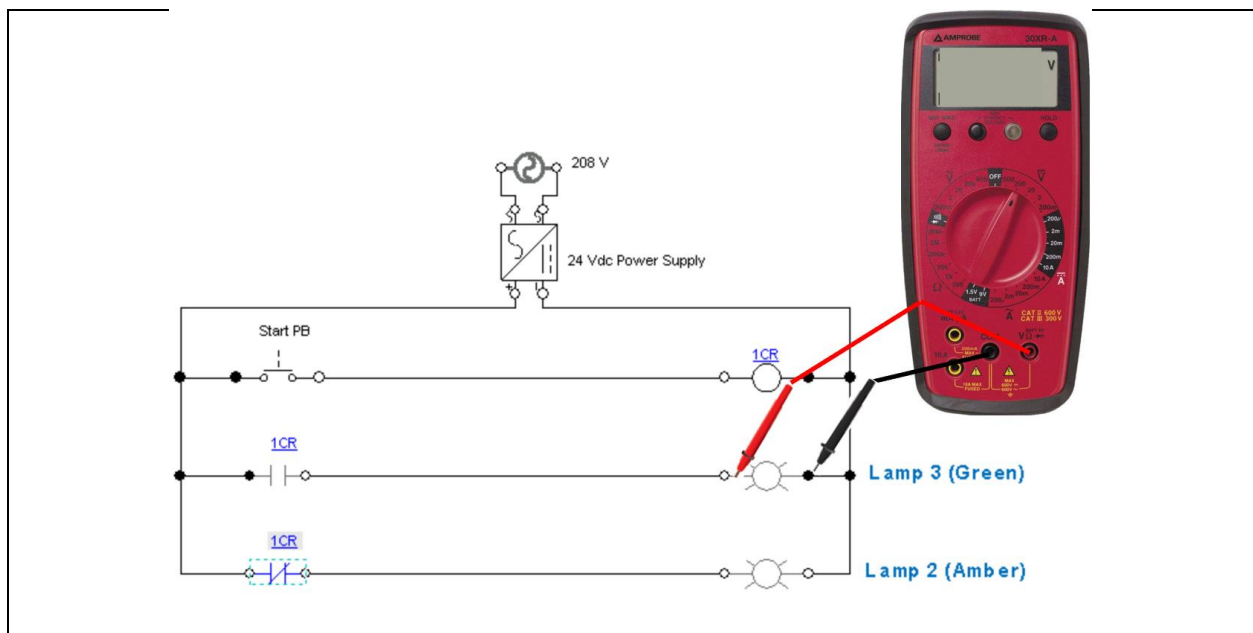
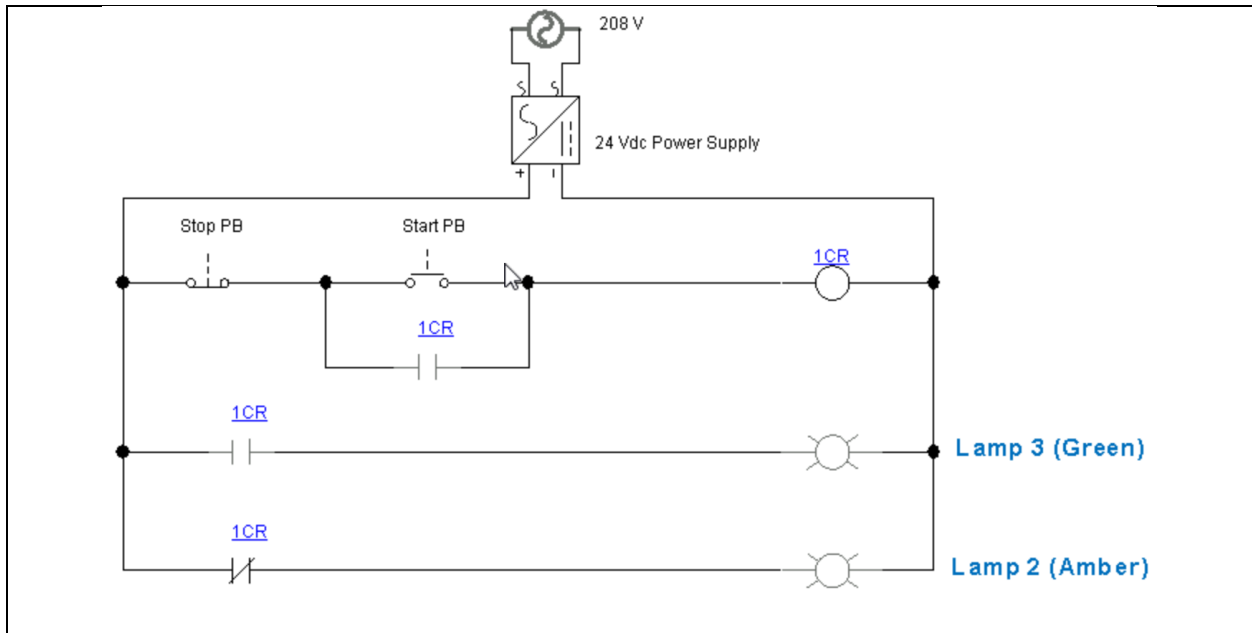


Figure 6. Circuit for Question 3 and 4.

3. What should the voltmeter read in Figure 6, if the StartPB is actuated?
  - a. 0 V
  - b. 24 Vdc
  - c. 24 Vac
  - d. 208 Vac

4. What should the voltmeter read in Figure 6, if the Start PB is not actuated?
- 0 V
  - 24 Vdc
  - 24 Vac
  - 208 Vac



**Figure 7. Circuit for Question 5 & 6.**

5. What voltage should be measured across Lamp 2 (Amber) if relay coil 1CR is energized?
- 0 V
  - 24 Vdc
  - 24 Vac
  - 208 Vac
6. What voltage should be measured across Lamp 2 (Amber) if relay coil 1CR is not energized?
- 0 V
  - 24 Vdc
  - 24 Vac
  - 208 Vac





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