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# AC/DC ELECTRICAL SYSTEMS



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## HANDS-ON SKILLS FOR LEARNING ACTIVITY PACKET 1:

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### BASIC ELECTRICAL CIRCUITS

#### ITEMS NEEDED FOR HANDS-ON SKILLS

Amatrol Supplied

1 T7017 AC/DC Electrical Learning System

FIRST EDITION, LAP 1, REV. D

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**Procedure Overview**

In this procedure, you will test a wall outlet for the presence of AC current using a circuit tester. The procedure is shown using a 120 VAC 60 Hz circuit. If your voltage is different, the procedure will still be performed in the same manner.

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**CAUTION**

Two basic safety rules to remember when working around electricity are:

1. Avoid touching bare wires or component leads when the power is on.
2. Make sure the power is off before installing, removing, or replacing components in a circuit.

Electricity does many good things for us, like provide power for our favorite devices. However, it can also be very dangerous. We don't need to fear electricity, but we do need to have a healthy respect for it. It only takes a small amount of current to cause a severe shock or even death.

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- 1. Locate an electrical wall outlet.
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**CAUTION**

Do not touch the metal part of the test leads while inserting them into the outlet.

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- 2. Insert one test lead into the left slot of the outlet and the other test lead into the right slot, as shown in figure 1-1. If your voltage is different than 120 VAC, your receptacle will look different than the one shown.



Figure 1-1. A Common Circuit Tester on 120 V Outlet

- 3. Observe if the indicator light is on.  
Indicator Light Status \_\_\_\_\_(On / Off)  
It should be on.
- 4. Now, carefully remove one of the test leads from the outlet.  
The indicator light should now be off because you have broken the path for current to flow through the indicator light.  
Whenever a circuit does not provide a complete path for current to flow through, the circuit is said to be open.
- 5. Now, carefully insert the test lead back into the slot. The indicator light should be on again.  
You have completed the path for current to flow through the light. The circuit is now closed.
- 6. Carefully remove both leads from the outlet and store the circuit tester.

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**Procedure Overview**

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In this procedure, you will first identify the components of the T7017 AC/DC Electrical System. You will then connect and operate its power supply.

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- 1. Position yourself in front of the Model T7017 AC/DC Electrical System shown in figure 2-1.

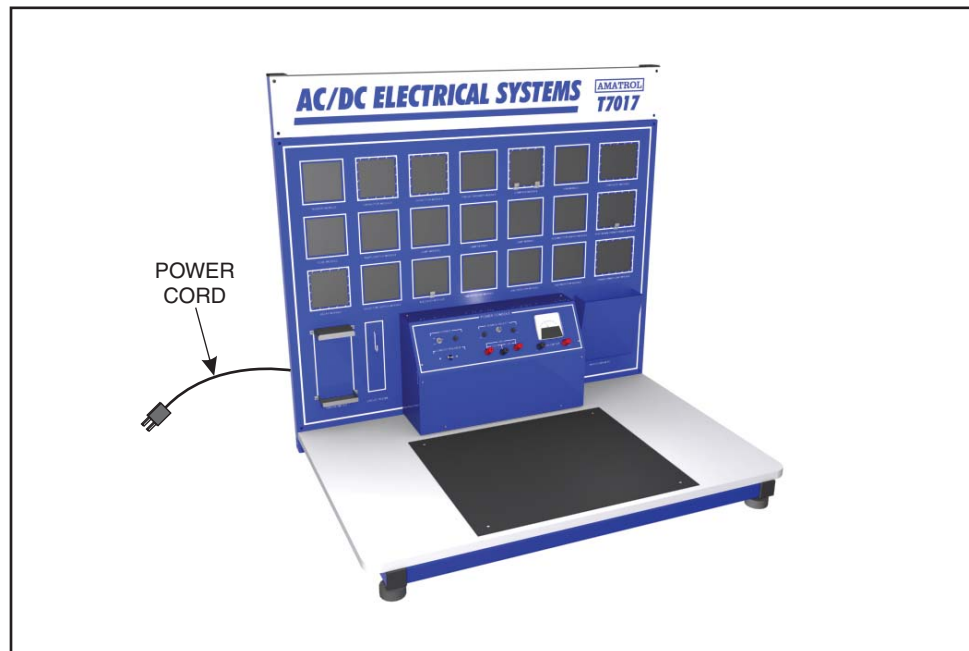


Figure 2-1. The Model T7017 AC/DC Electrical System

- 2. Locate the **Power Cord**.

This cord plugs into a wall outlet to supply electricity to the trainer.

- ❑ 3. Perform the following substeps to locate the various control panel components on the T7017 AC/DC Electrical System, as shown in figure 2-2.

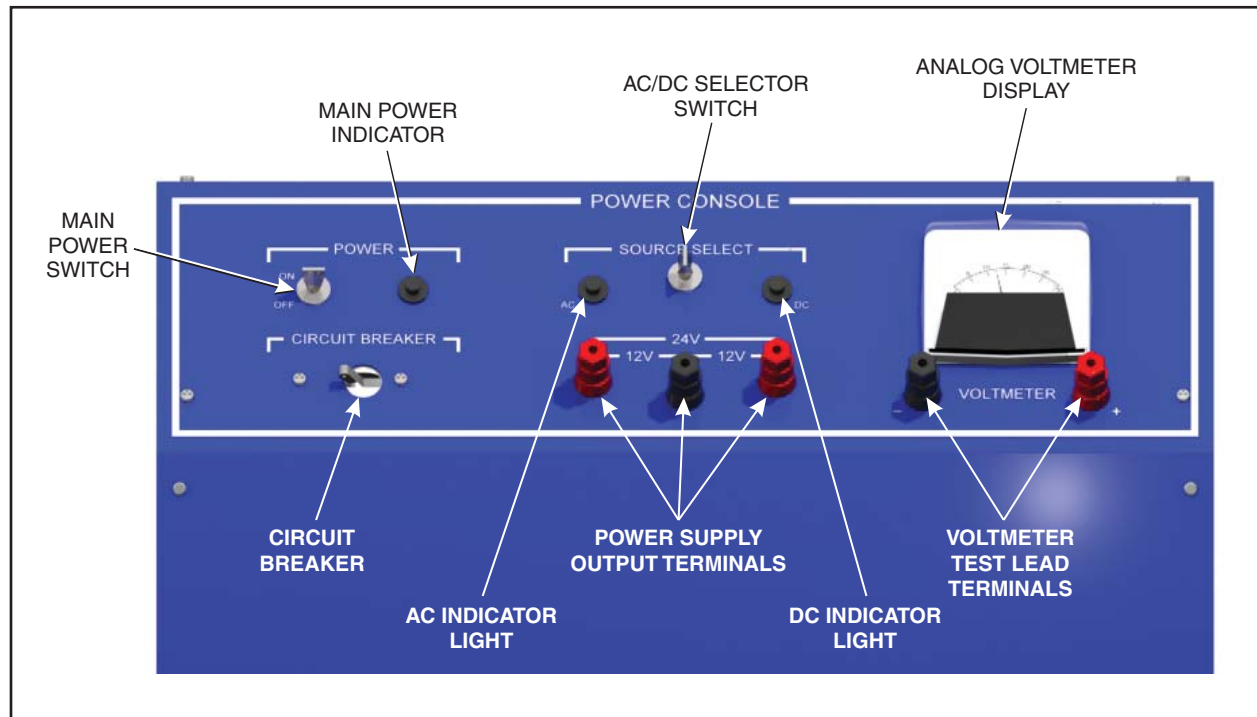


Figure 2-2. Control Panel of the T7017 AC/DC Electrical System

A. Locate the **Main Power Switch**.

This switch turns the power on or off for the entire trainer. Up is the on position. Down is the off position.

B. Locate the **Main Power Indicator** light.

This light will be lit when the power cord is plugged in and the main power switch is in the on position. The light will not be lit if the main power switch is in the off position or if the power cord is not plugged into a wall outlet.

C. Locate the **Circuit Breaker**.

The circuit breaker is a protection device that protects the trainer from the effects of excessive amounts of current. You will learn more about the function of a circuit breaker later.

D. Locate the **AC/DC Selector Switch**.

This switch allows you to select which type of current (direct current or alternating current) is supplied at the terminals. If the switch is in the left-hand position, AC is selected. If the switch is in the right-hand position, DC is selected.

E. Locate the **AC Indicator Light**.

This light will be lit when the AC/DC selector switch is in the left-hand (AC) position and the main power is on.

**F. Locate the DC Indicator Light.**

This light will be lit when the AC/DC selector switch is in the right-hand (DC) position and the main power is on.

**G. Locate the Power Supply Output Terminals.**

The output terminals provide a source of either alternating current or direct current. The type of current supplied and the function of the separate terminals will depend on the setting of the AC/DC selector switch.

If DC is selected, the right-hand terminal is the positive terminal. This will be the point from which the current is pushed through whatever circuit is connected to the power supply. The left-hand terminal is the negative (return) terminal for the positive terminal if 24 volts is needed. The center terminal is the return terminal for the positive terminal if 12 volts is needed. This is shown in figure 2-3.

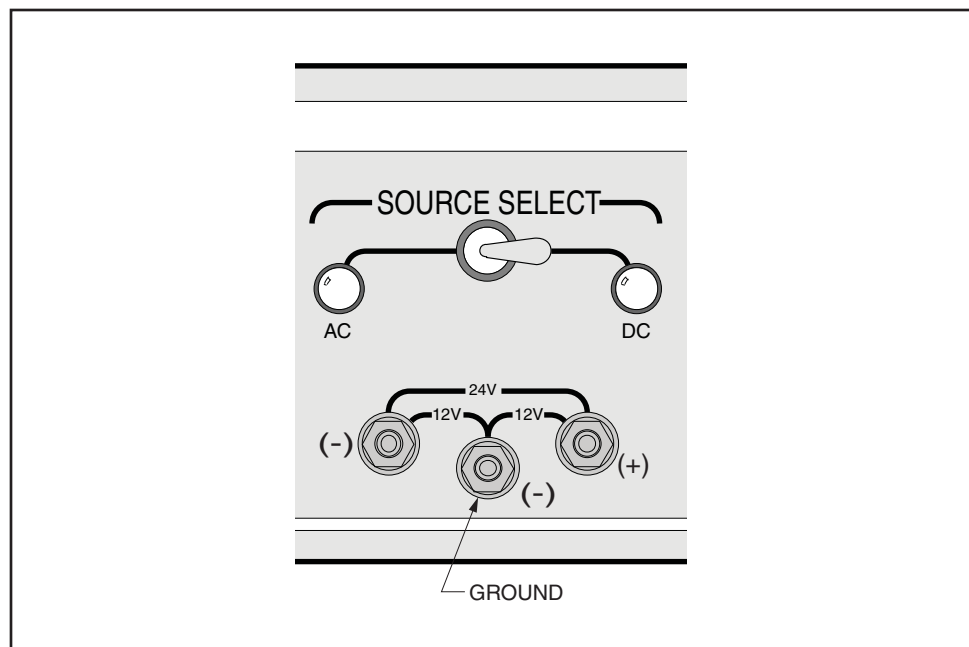


Figure 2-3. Positive, Negative, and Ground Terminals for the DC Supply

The center terminal is actually a special return point called a ground. A ground is usually a common return point for many different circuits. You will learn more about a ground later.

If AC is selected, the polarity of the terminals is not a factor since the current flow is continuously changing directions. Connecting to the right terminal and the left terminal will provide 24 volts. Connecting to either the left or right terminal and the center terminal will provide 12 volts.

**H. Locate the Analog Voltmeter Display.**

A voltmeter is an electrical measurement device. You will learn more about this later.

I. Locate the **Voltmeter Test Lead Terminals**, as identified in figure 2-3.

The test leads for the voltmeter are connected here. The test leads are used to perform the measurements.

- 4. Locate the various component modules. The components are listed below and shown in figure 2-4.

REF.	DESCRIPTION	QTY.
A.	Buzzer Module	1
B.	Capacitor Module	2
C.	Circuit Breaker Module	1
D.	Magnetic Compass Module	1
E.	Fan Module	1
F.	Rheostat Module	1
G.	Fuse Module	1
H.	DPDT Knife Switch Module	1
I.	Lamp Module	3
J.	Pushbutton Switch Module	1
K.	Transformer Module	1
L.	Relay Module	1
M.	Selector Switch Module	1
N.	Solenoid Module	1
O.	Resistor Module 10 Ohm	1
P.	Resistor Module 25 Ohm	2
Q.	Transformer Load Module	1



Figure 2-4. Component Modules for the T7017

- 5. Locate the connection wires and test equipment included with the T7017, as listed below and shown in figure 2-5.

REF.	DESCRIPTION	QTY.
R.	Test Lead Pair, 1 Red/1 Black	1
S.	Digital Handheld Multimeter	1
T.	Neon Circuit Tester	1
U.	Patch Cord-Spade to Spade	10
V.	Patch Cord-Spade to Banana	4
W.	Fuse Puller	1

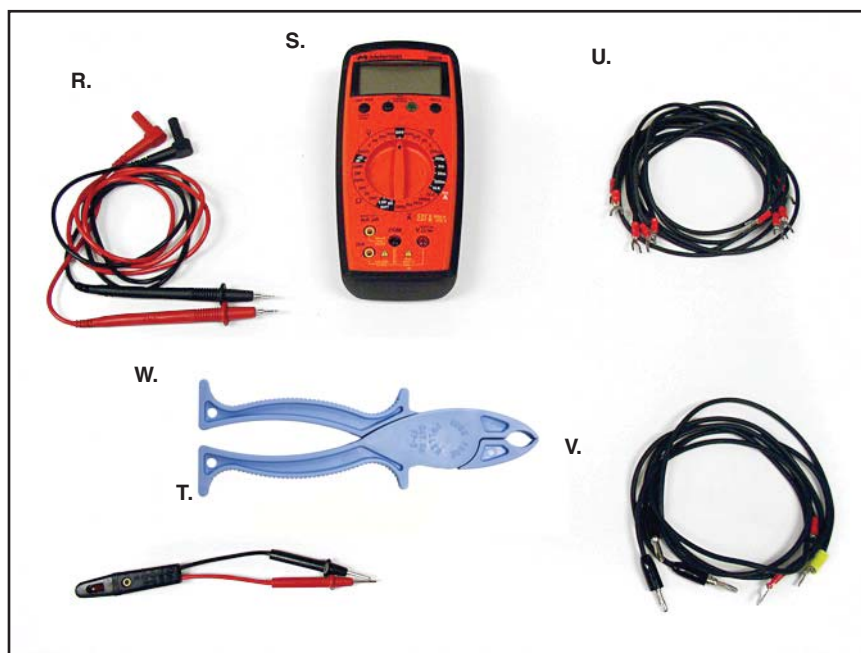


Figure 2-5. T7017 Instruments and Connectors



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**NOTE**

If any of these components are not present, notify your instructor.

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- 6. Perform the following substeps to connect the power supply.
  - A. Make sure the main power switch on the front panel of your trainer is in the OFF position.
  - B. Carefully plug the main power cord attached to the back of the trainer into an available wall outlet.

Be sure not to touch the metal prongs on the plug when you insert the plug into the outlet.
  - C. Observe the power supply output terminals just below the AC-DC selector switch.

You can get different output values (24 or 12) from the terminals as indicated on the panel. These values are available for AC or DC output.
- 7. Perform the following substeps to operate the power supply.
  - A. Make sure the circuit breaker is in the on (right) position.
  - B. Turn on the main power switch.

The main power indicator lamp should be on. If it is not, turn the main power switch OFF and check to make sure your power cord is properly inserted into the wall outlet. Then, turn it back on again.
  - C. Place the AC/DC selector switch in the **DC** position. The indicator light above DC should be on.
  - D. Place the AC/DC selector switch in the **AC** position.

The indicator light above AC should be on.
- 8. Perform the following substeps to shut down the power supply.
  - A. Turn off the main power switch.

All indicator lights should go out.
  - B. Make sure there are no wires connected to the power supply output terminals.

### SKILL 3

## CONNECT AND OPERATE A CIRCUIT USING THREE TYPES OF MANUAL SWITCHES

### Procedure Overview

In this procedure, you will connect three types of manual switches in an electrical circuit and use them to control a lamp.



- ❑ 1. Position yourself in front of the T7017.
- ❑ 2. Perform the following substeps to prepare the power supply.
  - A. Make sure the main power switch is in the OFF position.
  - B. Place the AC-DC selector switch in the **DC** position.
  - C. Make sure there are no wires connected to the output terminals of the power supply.
- ❑ 3. Connect the circuit shown in figure 3-1.  
Make sure that the knife position is as shown.  
Figure 3-2 shows how to connect the wires to the terminals.

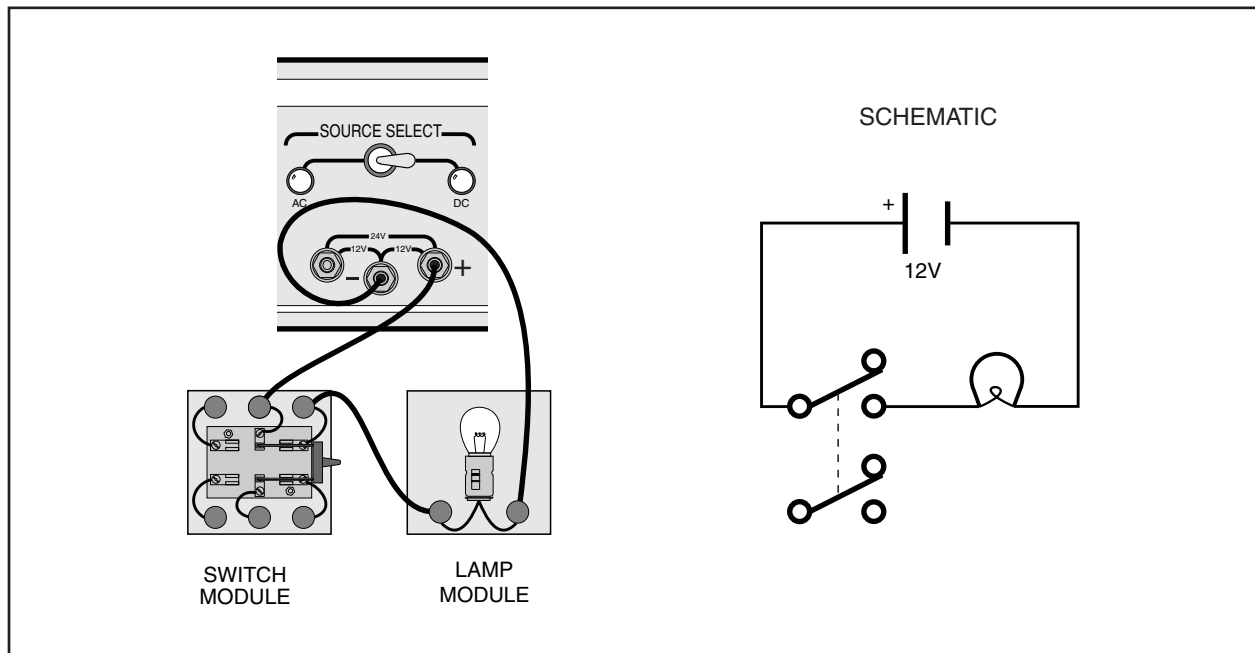


Figure 3-1. A Circuit with a Knife Switch and a Lamp

Notice in figure 3-1 the schematic symbol of a lamp.

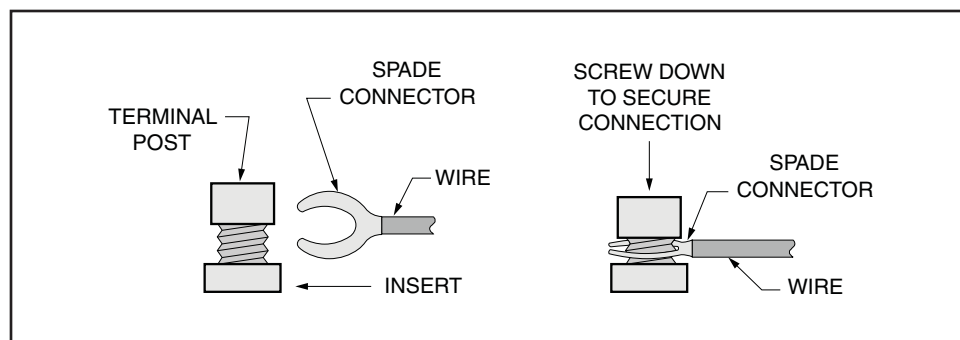


Figure 3-2. How to Connect the Wires to the Terminals on the Model T7017 Electrical System

- 4. Perform the following substeps to operate the circuit.

A. Turn on the main power switch.

B. Close the knife switch and observe the lamp's status.

Lamp status \_\_\_\_\_ (On/Off)

The lamp should be on (lighted).

C. Open the knife switch and observe the lamp's status.

Lamp status \_\_\_\_\_ (On/Off)

The lamp should be off.

D. Repeat closing and opening the switch a few more times to become more familiar with it's operation.

A knife switch is a very basic manually operated switch. The main power disconnect switch on a residential or commercial electrical panel is usually a knife switch.

The knife switch with the T7017 is a double-pole double-throw (DPDT) switch, which means that it has two sets of contacts. It is basically the same as having two separate switches in one.

- 5. Now close the knife switch in the other direction and observe the status of the lamp.

Lamp Status \_\_\_\_\_ (On/Off)

The lamp should not be on even though the contacts are closed. This is because the lamp is not connected to this set of contacts and they do not affect the lamp.

- ❑ 6. Turn off the main power switch.  
All indicator lights should go out.
- ❑ 7. Disconnect all wires from the components and the power supply terminals.
- ❑ 8. Connect the circuit represented by the schematic diagram in figure 3-3.

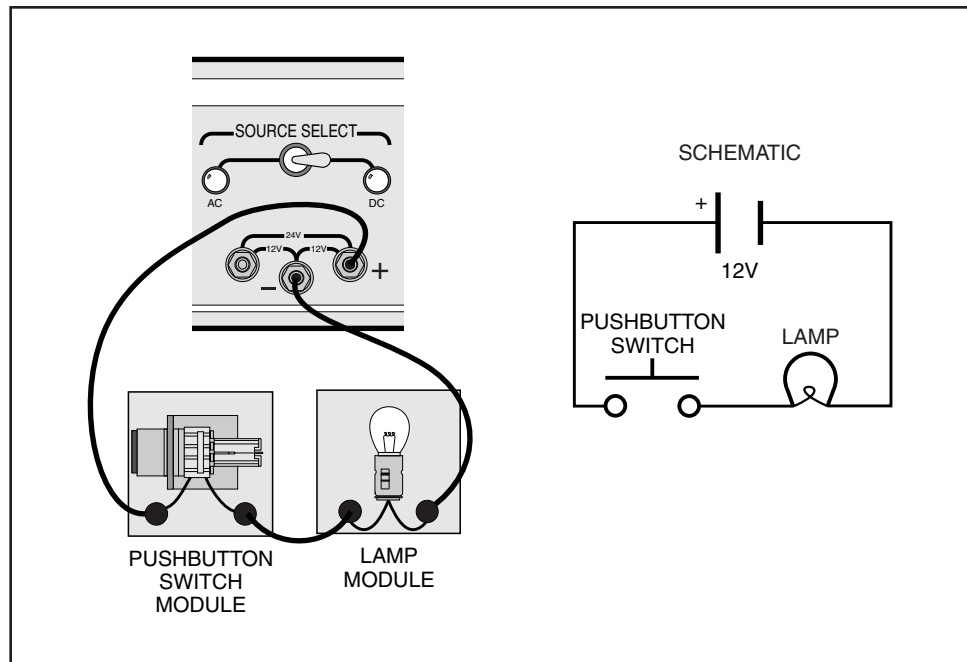


Figure 3-3. A Schematic Diagram and Pictorial of a Circuit with a Pushbutton Switch and a Lamp

- ❑ 9. Perform the following substeps to operate the circuit.
  - A. Turn on the main power switch.
  - B. Press and hold the pushbutton switch and observe the lamp.  
Lamp status \_\_\_\_\_(On/Off)  
The lamp should now be on.
  - C. Release the pushbutton and observe the lamp.  
Lamp status \_\_\_\_\_(On/Off)  
The lamp should be out.
  - D. Repeat pressing and releasing the pushbutton a few more times to familiarize yourself with it's operation.
- ❑ 10. Turn off the main power switch.
- ❑ 11. Disconnect the wires connected to the components and the power supply output terminals.

□12. Connect the circuit represented by the schematic diagram in figure 3-4.

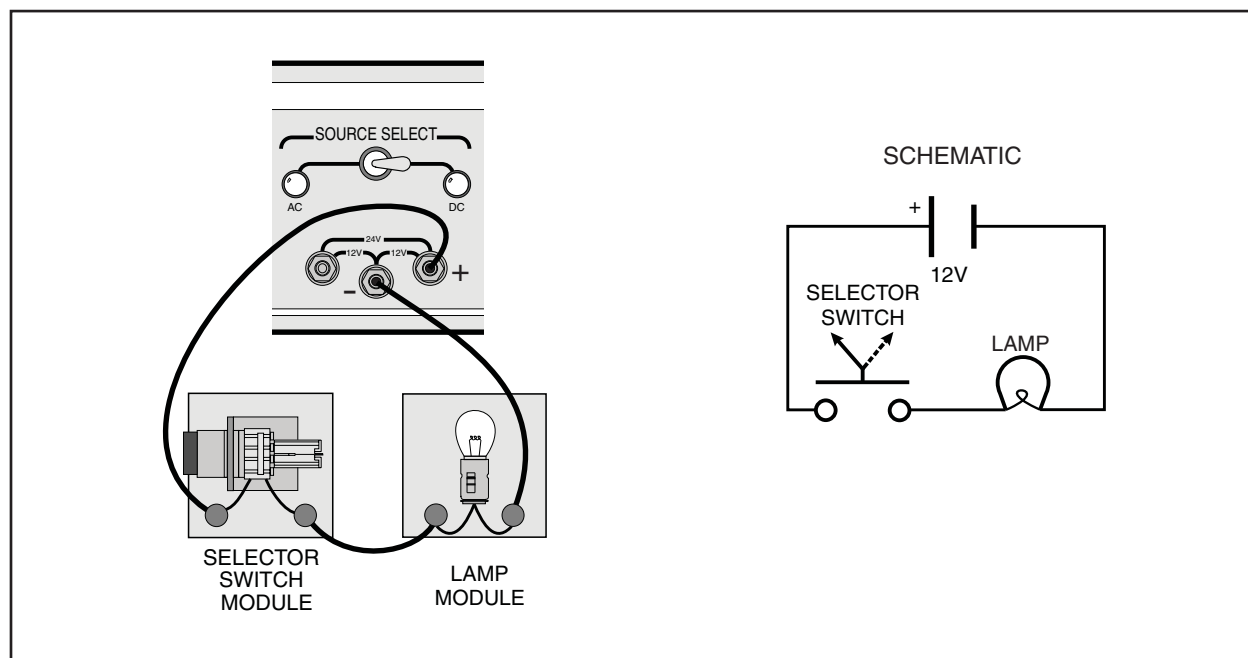


Figure 3-4. Schematic Diagram and Pictorial of a Circuit with a Selector Switch and a Lamp

□13. Perform the following substeps to operate the circuit.

- A. Make sure the selector switch knob is rotated to the left and turn on the main power switch.
- B. Rotate the selector switch to the right and observe the lamp.

Lamp status \_\_\_\_\_ (On/Off)

The lamp should now be on.

- C. Rotate the selector switch in the other direction and observe the lamp.

Lamp status \_\_\_\_\_ (On/Off)

The lamp should go off.

- D. Repeat energizing and de-energizing the selector switch a few more times to familiarize yourself with its operation.

Another type of selector switch is the one on the front panel of your training unit. This switch is used to turn the main power on and off. Another just like it is used to select between AC or DC output. These are instrument-quality selector switches. They have a different appearance but operate the same as their industrial counterparts.

□14. Perform the following substeps to turn off and secure the power supply.

- A. Turn off the main power switch.
- B. Disconnect any wires or components that may be connected to the power supply output terminals and store them.

## SKILL 4

## CONNECT AND OPERATE AN ELECTRICAL CIRCUIT WITH A RESISTOR

### Procedure Overview

In this procedure, you will connect a resistor in an electrical circuit and use a pushbutton switch to control the current flow to it. You should also note that when current is applied to the resistor, the resistor body becomes hot.



- 1. Perform the following substeps to connect the power supply.
  - A. Make sure the main power switch is OFF.
  - B. Place the AC-DC selector switch in the DC position.
  - C. Make sure there are no wires connected to the power supply terminals.
- 2. Connect the circuit shown in the schematic diagram in figure 4-1.

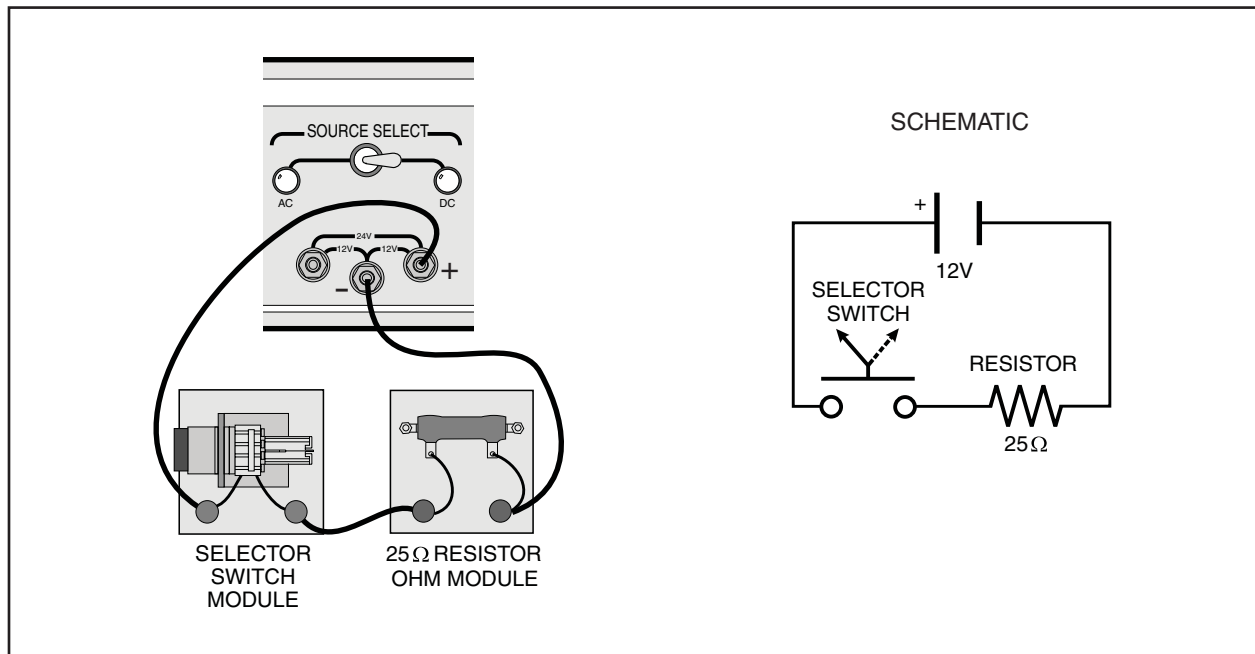


Figure 4-1. A Schematic Diagram and Pictorial of a Circuit with a Selector Switch and a Resistor

- 3. Perform the following substeps to operate the circuit.
  - A. Turn on the main power switch.
  - B. Face the operator of the selector switch and make sure it is turned to the left-hand position. This position will put the contacts in their normal state (open).
  - C. Change the position of the selector switch selector knob to the right-hand position. This will cause the contacts to close.
  - D. Put your hand close to the resistor body.



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**CAUTION**

Do not physically touch the resistor body. It gets very hot and can burn you.

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Resistor status \_\_\_\_\_ (Hot/Cool)

It should get hot.

When electrical current flows through a resistor it gives off heat. For most circuits, this heat is carried away by a fan or some type of cooling system. However, this concept can be applied for applications where heat is the desired output.

The heating elements used on electric ranges or electric hot water heaters are basically resistors.

- E. Return the selector switch to the left-hand position and wait about 30 seconds. Then check the resistor again.

Resistor status \_\_\_\_\_ (Hot/Cool)

The resistor body should be cool.



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**NOTE**

This is the same basic operation as turning on and off a heater.

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- F. Repeat energizing the selector switch and feeling the resistor body to familiarize yourself with the operation.
- 4. Perform the following substeps to turn off and secure the power supply.
    - A. Turn off the main power switch.
    - B. Disconnect any wires or components that may be connected to the power supply output terminals and store them.

## SKILL 5

## CONNECT AND OPERATE AN ELECTRICAL CIRCUIT WITH A BUZZER

### Procedure Overview

In this procedure, you will connect a buzzer in an electrical circuit and use a pushbutton switch to control it.



- ❑ 1. Perform the following substeps to connect the power supply.
  - A. Make sure the main power switch is OFF.
  - B. Place the AC-DC selector switch in the **DC** position.
  - C. Make sure there are no wires connected to the power supply terminals.
- ❑ 2. Connect the circuit shown in the schematic diagram in figure 5-1. Be sure to observe the polarity of the buzzer when you connect it.

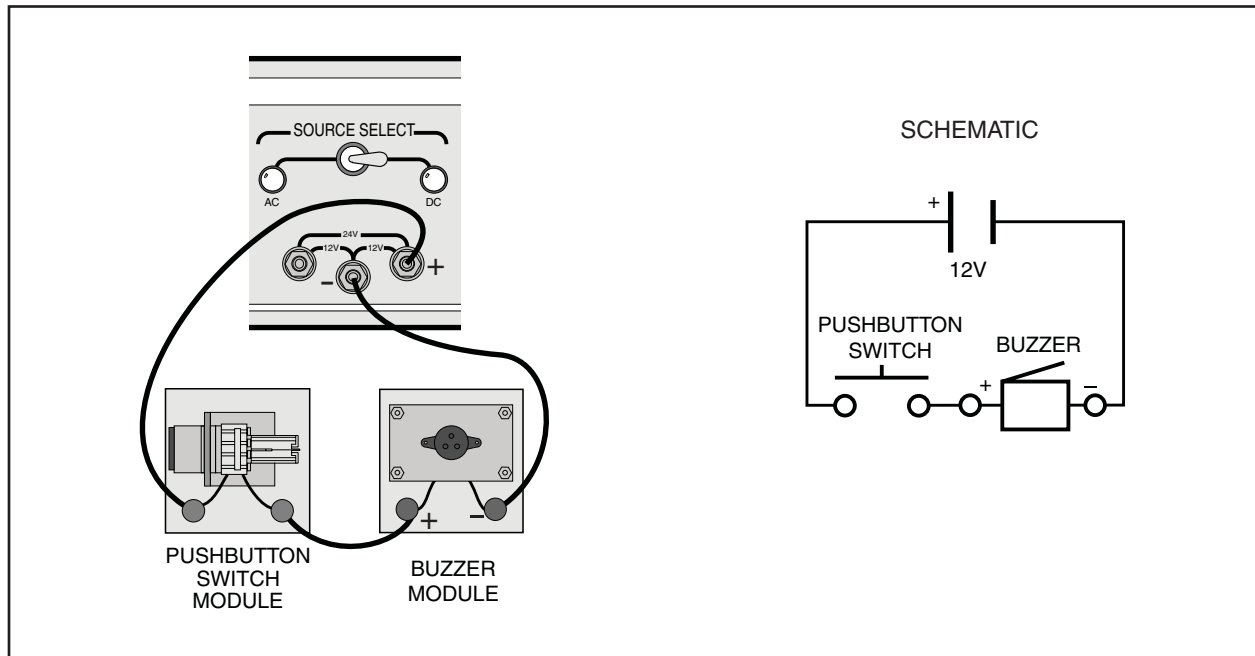


Figure 5-1. A Schematic Diagram and Pictorial of a Circuit with a Pushbutton Switch and a Buzzer



- 3. Perform the following substeps to operate the circuit.

- A. Turn on the main power switch.

- B. Press and hold the pushbutton switch and listen.

- Buzzer status \_\_\_\_\_ (Sounding/Not Sounding)

- The buzzer should sound.

- C. Release the pushbutton switch and listen.

- Buzzer status \_\_\_\_\_ (Sounding/Not Sounding)

- The buzzer should stop.

- This is like pushing a doorbell button.

- D. Repeat pressing and releasing the pushbutton switch a few more times.

- 4. Perform the following substeps to turn off and secure the power supply.

- A. Turn off the main power switch.

- B. Disconnect any wires and components that may be connected to the power supply output terminals and store them.

## SKILL 6

## CONNECT AND OPERATE AN ELECTRICAL CIRCUIT WITH A SOLENOID

### Procedure Overview

In this procedure, you will connect a solenoid in an electrical circuit and control it using a pushbutton switch.



- 1. Perform the following substeps to connect the power supply.
  - A. Make sure the main power switch is OFF.
  - B. Place the AC-DC selector switch in the **DC** position.
  - C. Make sure there are no wires connected to the power supply terminals.
- 2. Connect the circuit shown in the schematic diagram in figure 6-1.

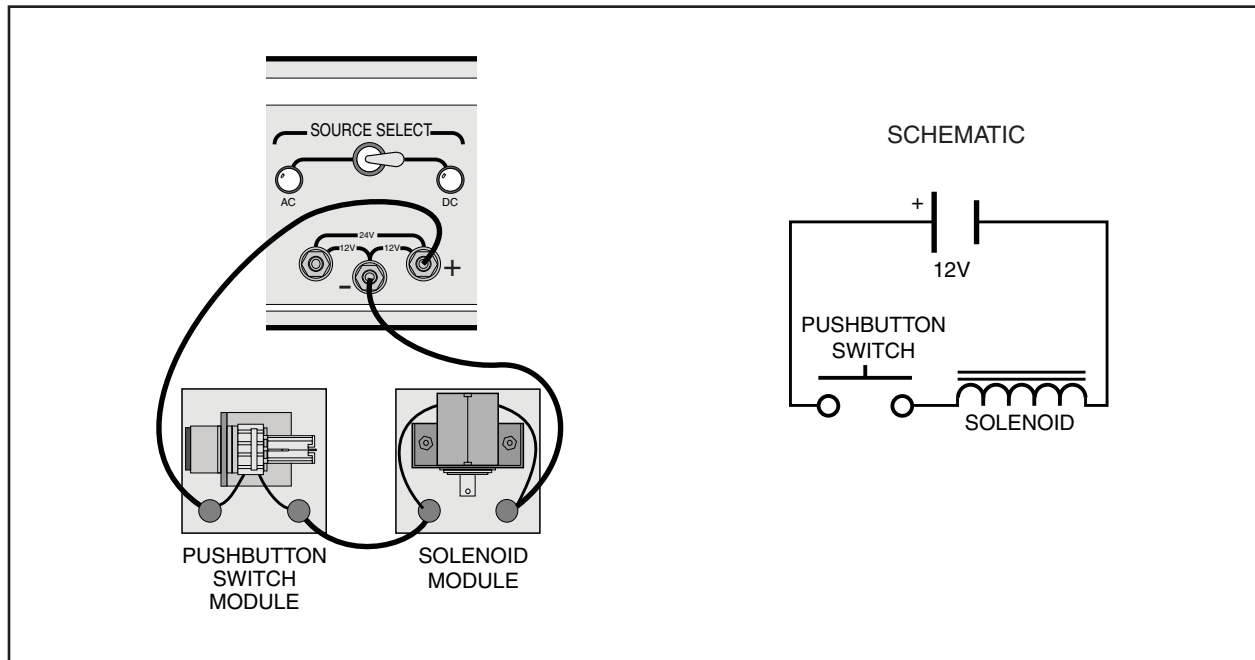


Figure 6-1. A Schematic Diagram and Pictorial of a Circuit with a Pushbutton Switch and a Solenoid

- ❑ 3. Perform the following substeps to operate the circuit.

- A. Turn on the main power switch.

- B. Insert the armature of the solenoid barely into the solenoid.

- C. Push and hold the pushbutton switch and observe the armature.

- Armature status \_\_\_\_\_ (In/Out)

- The armature should be pulled inside the solenoid or retracted.

- D. Release the pushbutton switch and pull the armature out.

- E. Repeat steps C and D a few more times.

- ❑ 4. Perform the following substeps to turn off and secure the power supply.

- A. Turn off the main power switch.

- B. Disconnect any wires and components that may be connected to the power supply output terminals and store them.

**Procedure Overview**

In this procedure, you will connect and operate the motor of a fan and use a selector switch to control it.



- 1. Perform the following substeps to connect the power supply.
  - A. Make sure the main power switch is OFF.
  - B. Place the AC-DC selector switch in the DC position.
  - C. Make sure there are no wires connected to the power supply terminals.
- 2. Connect the circuit shown in the schematic diagram in figure 7-1. Be sure to observe the polarity of the fan motor when you connect it.

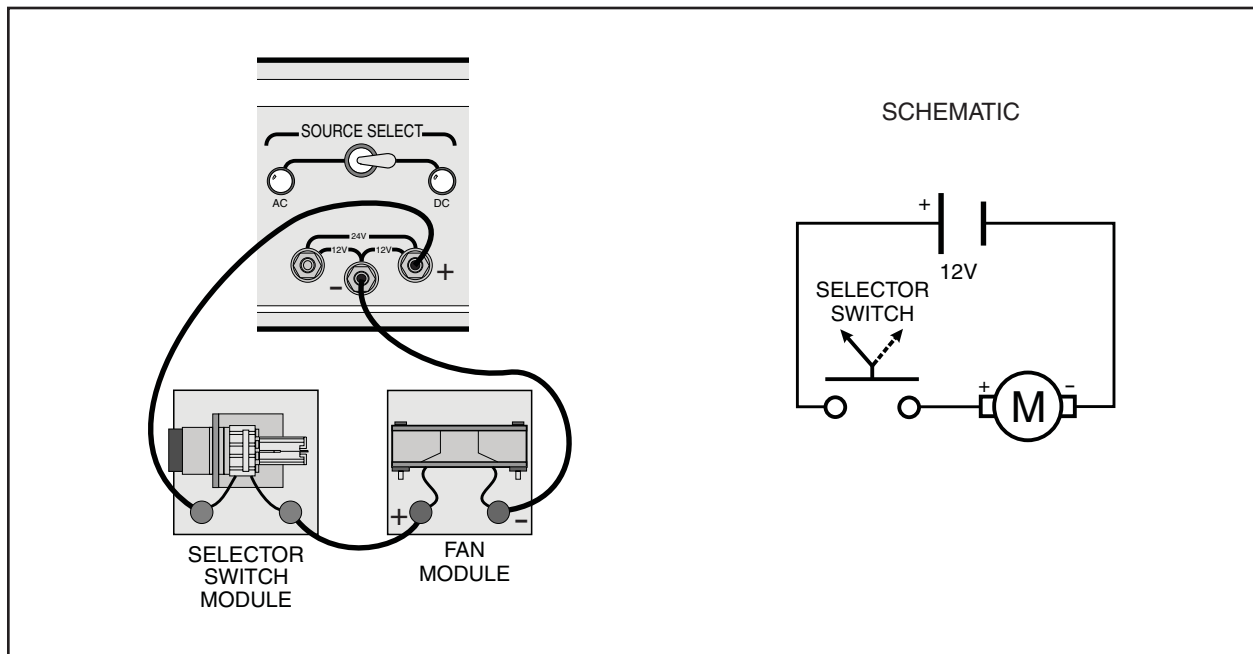


Figure 7-1. A Schematic Diagram and Pictorial of a Circuit with a Selector Switch and a Motor

- 3. Perform the following substeps to operate the circuit.
  - A. Make sure the selector knob is to the left and turn on the main power switch.
  - B. Rotate the selector switch in the circuit and observe the fan.  
Fan status \_\_\_\_\_(Blowing/Not Blowing)  
The fan should start blowing.
  - C. Rotate the selector switch back to the left and observe the fan.  
Fan status \_\_\_\_\_(Blowing/Not Blowing)  
The fan should stop blowing.  
This is basically how your fan at home works.
  - D. Repeat energizing and releasing the selector switch a few more times to familiarize yourself with the operation.
- 4. Perform the following substeps to turn off and secure the power supply.
  - A. Turn off the main power switch.
  - B. Unplug the main power cord from the wall outlet.
  - C. Disconnect any wires and components that may be connected to the power supply output terminals and store them.