

**Knowledge Domain: Power Supply**  
**Unit: Plug/Cable**  
**Skill: Outlets and Plug Variations**

**Tools and Parts Required:**

- 1) Digital multimeter (DMM)**
- 2) Electrical outlet**
- 3) Power cord for a piece of equipment**

**Introduction**

Power plugs and cables are used to connect electrical devices to AC power. Plugs or electrical outlets that are incorrectly wired can prevent a machine from working properly. Plugs and electrical outlets with loose connections or faulty contacts can also prevent a machine from working properly. Ungrounded outlets can be a source of danger. Devices connected to ungrounded outlets can cause electric shock. Ungrounded outlets should be clearly marked so all users are aware of the danger.

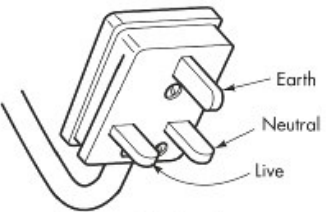
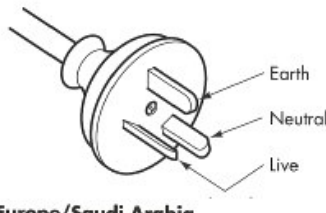
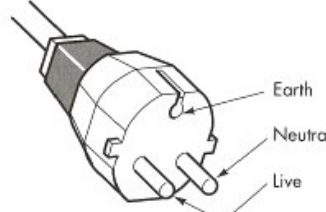

**Example**

**Plugs**

There are numerous types of electrical plugs. Plugs vary in shape, orientation and number of pins. All plugs must be wired as shown to function safely. The colors listed are the recognized standard wire colors. Many plugs will not be wired with the colors listed. Different colors are acceptable.






The earth connection is the ground connection. It is only for safety. The live connection carries power. The live connection can return current through the ground connection or the neutral connection. The neutral connection is the correct place to return the current. There should be no current flowing between the ground connection and the neutral connection. Current leaving the live connection must return through the ground connection or the neutral connection.

Below are examples of common electrical plugs.

Plug	Wire Colors	Current/Voltage
<b>United Kingdom</b>  <p>Earth Neutral Live</p>	Green/Yellow Light Blue Brown	13 Amp/250 V ac
<b>Australia/New Zealand</b>  <p>Earth Neutral Live</p>	Green/Yellow Light Blue or Black Light Brown or Red	15 Amp/250 V ac
<b>Europe/Saudi Arabia</b>  <p>Earth Neutral Live</p>	Green/Yellow Light Blue Brown	16 Amp/250 V ac
<b>USA/Canada</b>  <p>Earth Live Neutral</p>	Green/Yellow or Green Brown or Black Light Blue or White	15 Amp/125 V ac

## Outlets

Variations in outlet appearance can be geographically observed. Outlets may or may not provide a facility to insert a grounding pin. Devices with a grounding pin in their plug necessarily need an outlet with grounding pin attachment. Plugs without grounding pins can be attached to outlets of any sort. Polarity is not a matter of concern in such plugs. See the picture below for examples on outlet variations. Frequency and voltage can be matched to the type of plugs the outlets are meant to receive.

Plug	Common usage
	<b>Grounded, United kingdom</b>
	<b>Grounded, Australia/ New Zealand</b>
	<b>Grounded, Europe</b>
	<b>Ungrounded, Europe</b>
	<b>Grounded, US/Canada</b>

### Identification and Diagnosis

If a device is not functioning, the power plug and cable should be inspected. The following checks can be performed on any plug and cable.

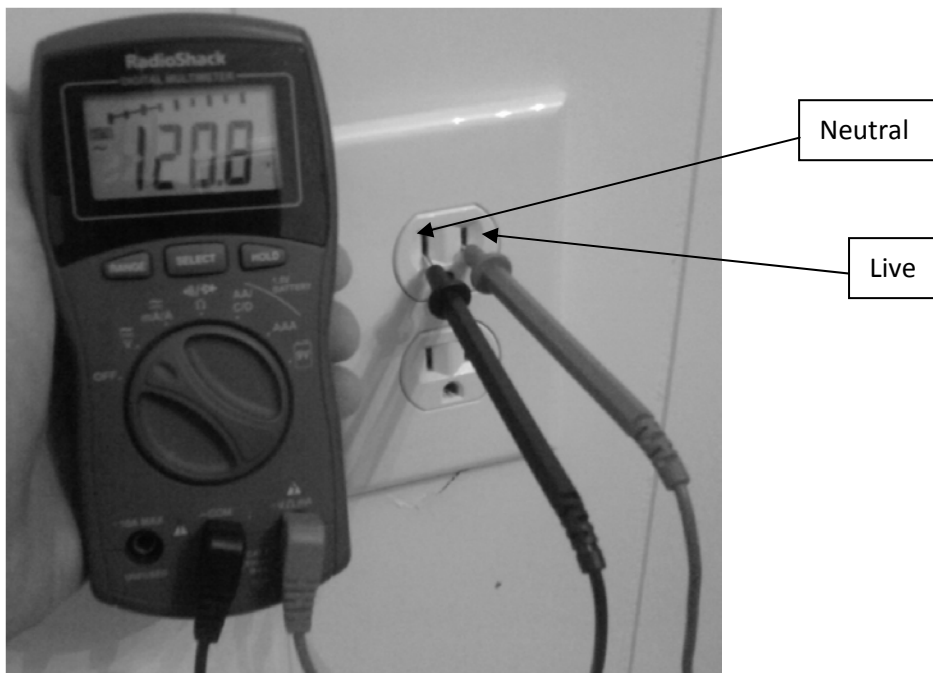
- Verify that the pins of the plug do not wiggle. Tighten loose pins if possible or replace the plug.
- Verify that the pins of the plug are not bent. Straighten bent pins with pliers.
- Verify that the pins of the plug are clean. Remove dirt or remove rust with sand paper.

- Verify that the cable is not frayed or damaged in any way.
- Use a DMM to verify that there is less than  $1\Omega$  of resistance between the male and female ends of each wire. Remove the plug to perform this check if possible. If the plug is attached to the device, open the device to access the cable terminals.
- Verify that the proper voltage is being delivered to the device. Locate the AC voltage rating on the device. Locate acceptable frequencies on the device. Do not trust the shape of the outlet or plug to determine the voltage. Measure the voltage between the live and neutral connections.
- Verify that the ground (earth) wire of the electrical outlet is properly connected.
- Verify that the voltage being delivered to the device is delivered at the correct frequency.

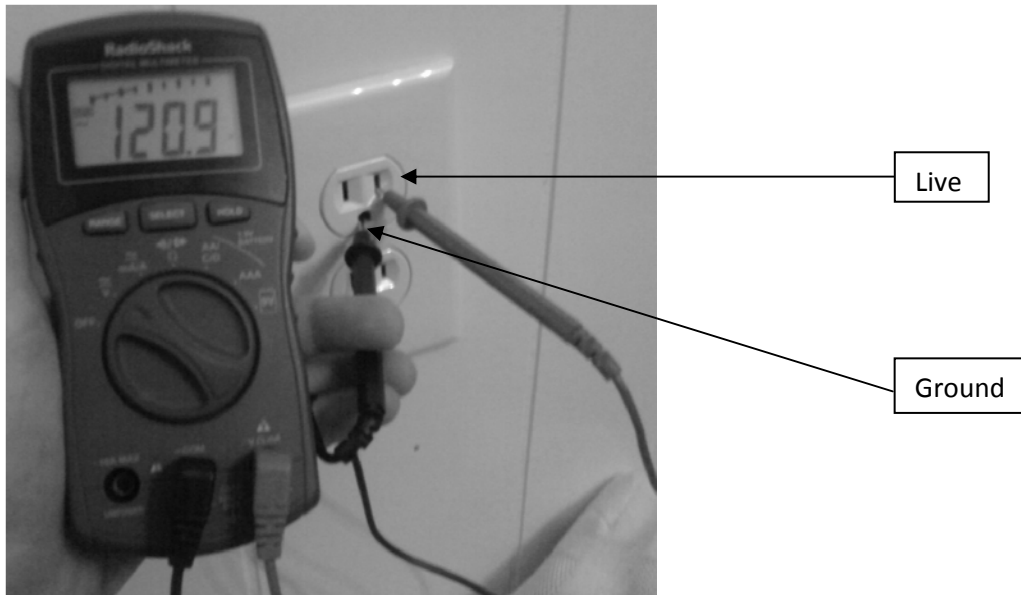
### Procedure

Outlets must be wired correctly. It is often necessary for outlets to be grounded. The following procedure can be used to verify that an outlet is wired correctly and that the ground wire is properly connected. Refer to the picture on the previous page for proper pin layouts.

1. Set the DMM to measure AC volts.
2. Use the DMM probes to measure from the live slot of the electrical outlet to the neutral slot.



3. Verify that the voltage matches the expected voltage.
4. Use the DMM probes to measure from the live slot of the electrical outlet to the ground slot.



5. The voltages shown above are the expected voltages in US/Canada. The measured voltage may vary depending on geographical location and supply. Verify your expected value with your instructor.
6. Check with your instructor the expected voltage between neutral and ground.
7. . If the voltage measured in each case does not match, continue to step 6.
8. Connect a light bulb from the neutral slot of the electrical outlet to the ground slot. If the bulb lights, the live and neutral wires are reversed within the outlet and should be switched. If the bulb does not light, there is a problem with the ground connection. Repair the ground connection. Refer to the module “Adding Proper Grounding” for more information on this.

### **Exercise**

Check an electrical outlet to make sure it is wired correctly, including the ground wire if available. Take a power cord from a piece of equipment. Verify that the connections are intact. Identify the power outlet and plug requirements of medical devices provided by your instructor. Your instructor must verify your work before you continue.

### **Preventative Maintenance and Calibration**

Maintain pins on plugs and verify that all electrical outlets are wired properly and grounded if necessary.

Always calibrate every medical device before returning it to use.