

Refer to the booklet “*How to Safely Test Electrical Outlets*” for troubleshooting tips on outlets. If the short circuit seems to be in the wiring, make sure the breaker is in the OFF position then check each outlet, light fixture and switch on the circuit for resistance between the hot and neutral wires and between the hot and ground wires. The resistance will be lower as you get closer to the device (outlet or switch) with the short circuit. Repair or replace any damaged items.

#### 4. Where to Go From Here:

By now you should have isolated and fixed the problem. However, if the above steps do not solve the problem, it may be that the circuit breaker is just old and worn out. When this happens, they can trip even when the current draw is below their rated capacity. Replace the circuit breaker. Never replace a circuit breaker with one that has a higher current rating than the one you are replacing. The breaker rating is matched to the current carrying capacity of the wiring in the wall. Replacing a breaker with one at a higher current rating will not adequately protect the wiring and may result in fire.

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website: [www.metermantesttools.com](http://www.metermantesttools.com)  
email: [info@metermantesttools.com](mailto:info@metermantesttools.com)

6920 Seaway Blvd.  
Everett, WA 98203  
fax: 425-446-4882  
tel: 877-596-2680

Meterman Test Tools Europe  
P.O. Box 1186  
5602 BD Eindhoven  
The Netherlands

1643541 B-ENG-N Rev. A



### How-to Test it Yourself

# Circuit breakers

Electrical #2

#### Problem:

A circuit breaker is like an “automatic switch” that is designed to “trip”, or shut off power to the circuit, in the event of a circuit overload or short circuit. Circuit breakers that trip repeatedly or suddenly could be a sign of too many devices on the same circuit, a worn out breaker, or a faulty appliance or wiring.

#### Task Summary:

This booklet will help you determine if the circuit breaker is tripping due to a circuit overload, a faulty device or appliance plugged into the circuit, damaged or faulty wiring, or a worn out breaker. Some of the steps will require you to open the electrical panel and access the wiring inside. Use caution whenever working around live electrical circuits.

#### Recommended Tools:

You will need a clamp-on current measuring multimeter (Clamp meter) that measures ac current, ac voltage, resistance, and continuity. As an alternative, you can use a digital multimeter (DMM) that measures ac voltage, resistance, and continuity along with an ac current measuring accessory, or current clamp. It is assumed you have basic knowledge of how to make basic measurements with a DMM or Clamp Meter. If not, you should start by reading “*Basic DMM Measurements*” and your DMM or Clamp Meter owner’s manual.



## Step by step troubleshooting:

### 1. Getting Started:

Often circuit breakers trip due to a momentary power surge (like a lightning strike). If this happens, just turn the breaker back ON. But if the breaker keeps tripping after being reset there is another problem.

The first step is to identify everything powered by the circuit breaker that keeps tripping. Each breaker in the electrical panel protects one circuit made up of one or more wall outlets, light fixtures, or major appliances (e.g. dishwasher, clothes dryer, etc.). Note that any given circuit may power outlets or fixtures in more than one room or floor of the house. (see figure 3)

Locate your electrical panel and open the door. Your electrical panel should have a list showing what is connected to each circuit breaker. If it doesn't you'll have to take a little time to find out what's connected to the tripping breaker. With the breaker turned OFF, go through the house checking all outlets, light fixtures and appliances to see which ones do not work. To check outlets that don't have anything plugged into them, set your meter to the ac volts function, 200 V range and test each outlet for power. Place the tip of one test lead into the long vertical slot of the outlet, and place the tip of the other test lead into the short vertical slot. Your meter should show a reading of about zero volts. If it shows about 120 volts, that outlet is not controlled by the circuit breaker you turned OFF.

### 2. Troubleshooting Overloads:

Overloads can be caused by operating too many devices on one circuit – such as plugging all the outdoor Christmas lights into one outlet or running the toaster, waffle iron and an electric fry pan all at the same time. They can also be caused by an item that isn't working correctly, such as an electric motor that isn't able to turn freely.

To check for an overload, first carefully remove the cover of the electrical panel. Inspect inside for obvious loose or damaged wires. In the US, the “hot” wires are usually black or red, and the “neutral” wires are usually white. The ground wires are usually bare copper.

#### Caution:

**Do not touch any exposed wires, connectors, or terminals inside the electrical panel.**

**Direct contact with these may result in severe injury or death.**

If no damage is observed, set the clamp-meter to ac amps and clamp it around the “hot” or load wire connected to the tripped breaker. Make sure all the lights or appliances you usually have on the circuit are turned on. Reset the breaker by pushing the switch to the ON position (if it trips immediately, see the section on Short Circuits).

Look at the reading on the clamp-meter. (See figure 2) If it is higher than the rating on the breaker then

you have an overload. The circuit breaker will have its maximum load printed on it (most residential breakers are 15, 20, or 30 amps). Turn the breaker to the OFF position. See below for what to do to remedy the situation.

If the reading on the meter is somewhat lower than the rating on the breaker, there may still be the possibility of an overload. Ask an assistant to turn on additional appliances or lights – such as a ceiling fan, hair dryer, space heater, or room air conditioner – while you continue to monitor the clamp meter reading. Sometimes an appliance that cycles on and off by itself – such as a heater – is enough to cause the current draw to exceed the breaker rating resulting in an intermittent overload.

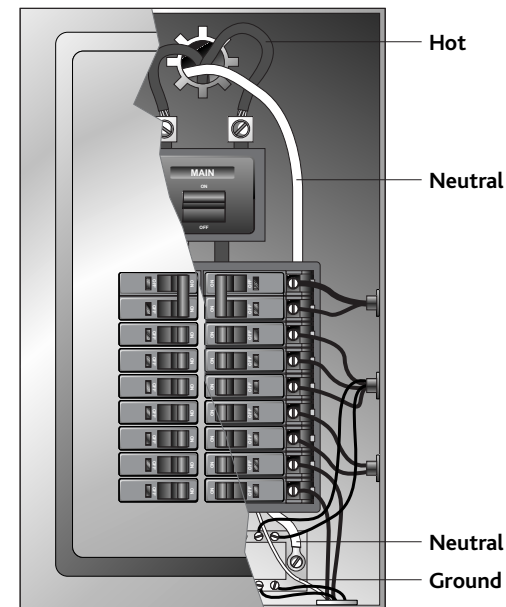


figure 1

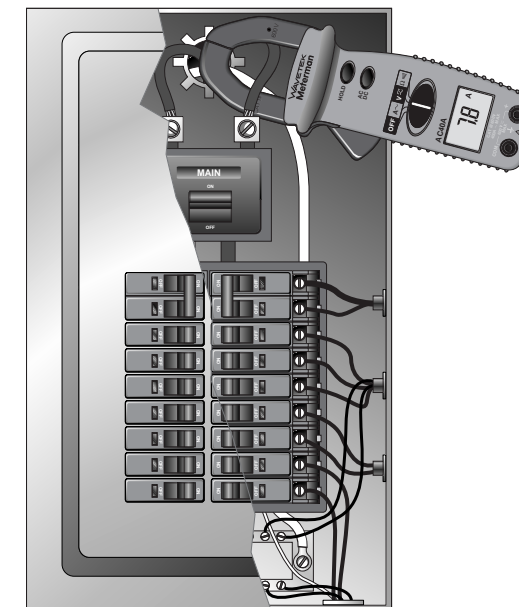


figure 2

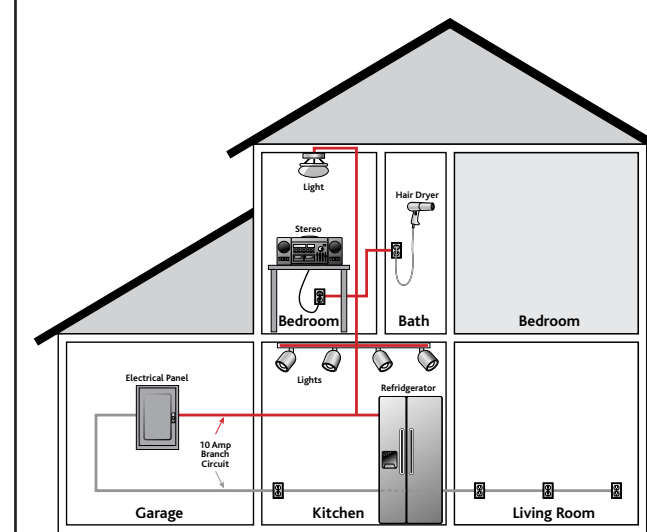


figure 3

# Troubleshooting circuit breakers

The solution to an overload is to fix or replace any item that is not working properly and redistribute the load. To redistribute the load, move some items from the overloaded circuit to another one. Note that two or more outlets in a room may be on the same circuit. Just moving an item from one outlet to another may not solve the problem. Move the item to an outlet that you know is connected to a different circuit (see Figure 3). You should re-check the current draw on both circuits to make sure you have reduced the draw on the first one enough and not added too much to the new circuit. You should keep the normal current draw to less than 80 % of the rated current for each circuit breaker.

If you cannot find any common causes for the overload, call an electrician to have the problem fixed.

### 3. Troubleshooting Short Circuits:

Short circuits can have many causes. Wiring or fixtures may have been installed incorrectly or become damaged, or a device that is plugged into an outlet may have a problem. Whatever the cause, short circuits pose a significant risk of fire or electrical shock and should be fixed immediately.

To find the short circuit, first unplug all electrical appliances and lamps on the circuit, and then reset the breaker. If the breaker remains on, the problem is with one of the devices that was plugged in. If the breaker trips immediately, the short circuit could

be in the wiring, an outlet, or a ceiling or wall fixture.

In most plug-in appliances and lamps a short circuit is typically in the power cord. Check for a short in each device that was plugged into the circuit by testing for continuity between the blades of the plugs on each device. Using the Ohms function of the clamp meter, hold the black test probe to one blade of the plug, and touch the red probe to the other blade. If you measure resistance of a few ohms the device is the likely cause of the short circuit. A high resistance reading or a reading of “OL” means the device is not likely the problem. Plug in each device after you've tested it and make sure the breaker doesn't trip as a result.

## Work safely!



Electricity can be dangerous. Protect yourself and your home by remembering to follow a few simple rules when working with electrical circuits:

- Always turn the power off at the electrical panel before handling wires or terminals. Don't assume that you know which wire is hot! Use your meter to verify the power is off before handling any wires or terminals.

- Make sure your meter is working with a 3-point check: Measure a known live circuit, next measure the circuit you're working on and finally re-check the known live circuit.

- Use caution when measuring live circuits. Don't stand in water, use one hand to probe whenever possible, and don't wear metal jewelry.

- Only use a meter that has the proper voltage ranges for the job at hand and make sure the meter has the proper safety ratings and protection.

(continued on back)