



## Ground Fault Circuit Interrupters (GFCI)

### What is a Ground Fault Circuit Interrupter?

The ground-fault circuit interrupter, or GFCI, is a fast-acting circuit breaker designed to shut off electric power in the event of a ground-fault within as little as 1/40 of a second. It works by comparing the amount of current *going to* and *returning from* equipment along the circuit conductors. When the amount *going* differs from the amount *returning* by approximately 5 milliamperes, the GFCI interrupts the current.

The GFCI will *not* protect you from line contact hazards (i.e. a person holding two "hot" wires, a hot and a neutral wire in each hand, or contacting an overhead power line). However, it protects against the most common form of electrical shock hazard, the ground-fault. It also protects against fires, overheating, and destruction of wire insulation.

Effects of Electrical Current* on the Body <sup>3</sup>	
Current	Reaction
1 milliamp	Just a faint tingle.
5 milliamps	Slight shock felt. Disturbing, but not painful. Most people can "let go." However, strong involuntary movements can cause injuries.
6–25 milliamps (women)† 9–30 milliamps (men)	Painful shock. Muscular control is lost. This is the range where "freezing currents" start. It may not be possible to "let go."
50–150 milliamps	Extremely painful shock, respiratory arrest (breathing stops), severe muscle contractions. Flexor muscles may cause holding on; extensor muscles may cause intense pushing away. Death is possible.
1,000–4,300 milliamps (1–4.3 amps)	Ventricular fibrillation (heart pumping action not rhythmic) occurs. Muscles contract; nerve damage occurs. Death is likely.
10,000 milliamps (10 amps)	Cardiac arrest and severe burns occur. Death is probable.
15,000 milliamps (15 amps)	Lowest overcurrent at which a typical fuse or circuit breaker opens a circuit!

\*Effects are for voltages less than about 600 volts. Higher voltages also cause severe burns.  
†Differences in muscle and fat content affect the severity of shock.

Ground fault circuit interrupters (GFCI) can help prevent electrocution. GFCIs are an effective means of protecting against electrical shock, however, they must be tested regularly - UL recommends once a month -- to verify they are working properly.

### To properly test GFCI receptacles in your laboratory:

- Push the "Reset" button located on the GFCI receptacle, first to assure normal GFCI operation.
- Plug a light (with an "ON/OFF" switch) into the GFCI receptacle and turn the product "ON."
- Push the "Test" button located on the GFCI receptacle. The light should go "OFF."
- Push the "Reset" button, again. The light or other product should go "ON" again.

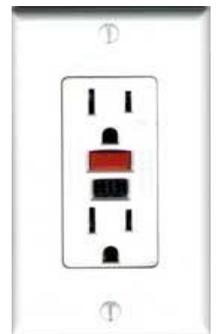


If the light or other product remains "ON" when the "Test" button is pushed, the GFCI is not working properly or has been incorrectly installed (miswired). If your GFCI is not working properly, call your Building Manager or certified electrician who can assess the situation, rewire the GFCI if necessary or replace the device.

GFCIs are proven lifesavers; however, Laboratory staff must take a few minutes each month to do this simple test. By taking action, you can help protect yourself from the risk of electric shock.

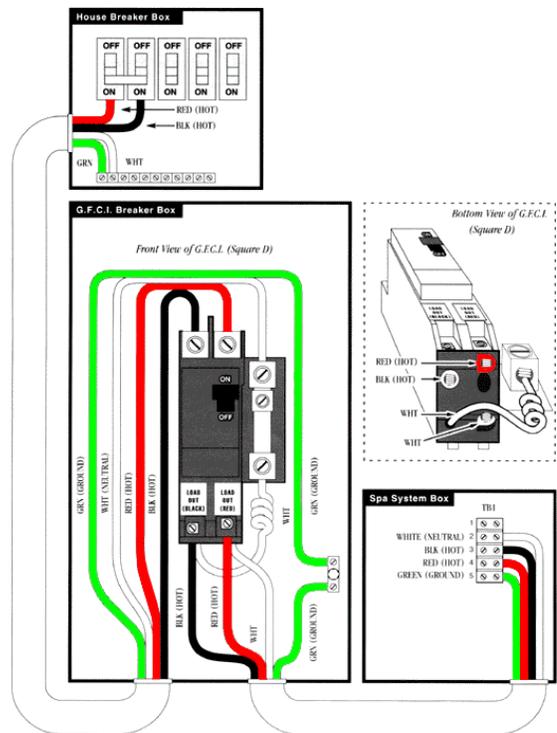
**Several Types of GFCIs May Be Installed In/Around Your Laboratory.**

**Wall Receptacle GFCI** - This type of GFCI - the most widely used - fits into a standard outlet and protects against ground faults whenever an electrical product is plugged into the outlet. Wall receptacle GFCIs are most often installed in kitchens, bath and laundry rooms, and out-of-doors where water and electricity are most likely to be in close proximity. EH&S recommends the installation of GFCI for all outlets within six feet of a sink or water source.



**Circuit Breaker GFCI** - In homes equipped with circuit breakers, this type of GFCI may be installed in a panel box to give protection to selected circuits. Circuit breaker GFCIs should also be checked monthly. Keep in mind that the test will disconnect power to all lights and appliances on the circuit.

**Portable GFCI** - A portable GFCI requires no special knowledge or equipment to install. One type contains the GFCI circuitry in a self-contained enclosure with plug blades in the back and receptacle slots in the front. It can then be plugged into a receptacle, and the electrical products are plugged into the GFCI. Another type of portable GFCI is an extension cord combined with a GFCI. It adds flexibility in using receptacles that are not protected by GFCIs. **Portable GFCIs should only be used on a temporary basis and should be tested prior to every use.**





### **Electrical Definitions**

**Ampere:** The unit by which the flow of current through a conductor is measured.

**Arc:** A discharge of electricity through a gas, such as air.

**Attachment Cap:** See [Plug](#).

**Circuit:** The path along which electric current flows from start to finish is called a circuit. The circuit includes the generator or battery which starts the current, the wires, and any electrical device that the current operates. If any part of the circuit is removed, the current cannot flow. The circuit is then broken or open. Because electric current seeks to complete its circuit, it will travel along any path that is presented (path of least resistance), which is why humans are at risk of electrocution when they handle damaged tools or cords, or contact un-insulated wires. In effect, they become part of the circuit.

**Circuit Breaker:** A protective device which automatically opens, or trips, a circuit, without damage to itself, when the current exceeds a predetermined level.

**Conductor:** A substance or body that allows a current of electricity to pass continuously along it. Metals, such as copper or aluminum, are good conductors. In a circuit, current-carrying wires are termed "conductors", as in a flexible cord.

**Current:** The flow of electrons through a conductor, measured in amperes (amps). If the current flows back and forth through a conductor, it is called alternating current (AC). If the current flows in one direction only, as in a car battery, it is called direct current (DC). AC is most widely used because it is possible to increase ("step up") or decrease ("step down") the current through a transformer. For example, when current from an overhead power line is run through a pole-mounted transformer, it can be stepped down to normal household current. Also, alternating current can travel enormous distances with little loss of voltage, or power.

**Cycle:** When alternating current flows back and forth through a conductor, it is said to cycle. In each cycle, the electrons flow first in one direction, then the other. In the United States, the normal rate for power transmission is 60 cycles per second, or 60 Hertz (Hz).

**De-energize:** To free from any electric connection and/or electric charge.

**Electricity:** The flow of an atom's electrons through a conductor.

**Electrode:** A conductor used to establish electrical contact with a nonmetallic part of a circuit.

**Energize:** To direct electric current through a conductor. Power lines and wires can be intentionally energized (or de-energized) to carry current to an electrical device. But conductive surfaces which are unintentionally energized, like the metal case of a tool, the metal housing of a circuit box, or a metal object such as an aluminum ladder, present a danger of electrocution.

**Fault:** An insulation failure that exposes electrified conductors, causing current to leak and possibly resulting in electric shock.

**Fuse:** A protective device which allows a piece of metal to become part of a circuit. The metal melts under heat created by excessive current, thereby interrupting the circuit and preventing the flow of electricity from exceeding the circuit's current-carrying capacity.



**GFCI (Ground Fault Circuit Interrupter):** A device that detects an insulation failure by comparing the amount of current flowing to electrical equipment with the amount of current returning from the equipment. Whenever the difference is greater than 5 milliamps, the GFCI trips and thereby interrupts the flow of electricity.

**Ground:** A conducting connection, intentional or unintentional, between an electrical circuit or equipment and the earth, or to some conducting body that serves in place of the earth.

**Ground Fault:** A fault, or insulation failure, in the wire used to create a path to ground.

**Grounding:** To prevent the buildup of hazardous voltages in a circuit by creating a low-resistance path to earth or some other ground plane.

**Guarding:** Placement of live parts of electrical equipment where they cannot accidentally be contacted, such as in a vault, behind a shield, or on a raised platform, to which only qualified persons have access.

**Impedance:** Opposition to the flow of alternating (AC) electric current. See [Resistance](#).

**Insulation:** Non-conductive materials used to cover or surround a conductor, permitting it to be handled without danger of electric shock.

**Insulator:** Any material, such as glass or rubber, which prevents the flow of electric current.

**Kilowatt:** One thousand watts.

**Lockout:** To lock a switch in the "off" position by means of a padlock, or to lock electrified equipment behind a locked door, to which only qualified persons have the key.

**Low-Impedance:** Low resistance to A/C current.

**Milliamperere:** A unit of measurement equaling one thousandth (1/1000) of an ampere.

**Ohm:** The unit by which resistance to electrical current is measured. From Ohm's Law (Current=Voltage/Resistance, or in other words, Current=Voltage/Ohms), a mathematical expression of the relationship between these three elements.

**Overcurrent:** Any current in excess of the rated capacity of equipment or of a conductor.

**Phase:** In AC power systems, load current is drawn from a voltage source which typically takes the form of a sine wave. Ideally, the current drawn by the loads in the system is also a sine wave. With a simple, resistive load such as a light bulb, the current sine wave is always aligned with the voltage sine wave. This is called single-phase. A single-phase power system normally uses three wires, called hot, neutral, and ground, and the voltage is typically 120/240. Most home and office outlets operate in this manner.

With some loads, such as motors, and in high voltage systems, the current sine wave is purposely delayed and lags behind the voltage sine wave. The amount of this lag is expressed in degrees and is called a phase difference. A common example is three-phase power, where the system has three "hot" wires, each 120 degrees out of phase with each other.

**Plug:** A device to which the conductors of a cord are attached, which is used to connect to the conductors permanently attached to a receptacle.



**Polarity:** The relationship between poles of positive and negative charge, particularly with regard to wiring of conductors where the ungrounded (hot) conductor and grounded (neutral) conductor form a circuit.

**Qualified Person:** One familiar with the construction and operation of the equipment and the hazards involved.

**Raceway:** A channel designed expressly for holding wires, cables, or busbars, including conduit, tubing, wireways, busways, gutters, or moldings.

**Rating:** The stated operating limit of a piece of equipment, expressed in a unit of measure such as volts or watts.

**Receptacle:** A device, such as a jack or an outlet, to which conductors are attached, and where a plug makes contact with a source of electric current.

**Resistance:** Anything that impedes the flow of electricity, particularly in direct (DC) current. Resistance is measured in *ohms*.

**Tag:** To identify electric equipment by class, group, and the temperature range for which it is approved.

**Volt:** The unit by which electrical force or pressure is measured.

**Voltage:** The fundamental force or pressure that causes electricity to flow through a conductor; measured in *volts*.

**Watt:** The unit by which *electric energy*, or the ability of electricity to do work, is measured. A thousand watts, or one *kilowatt*, equals 1.34 horsepower.

### **Resources:**

U.S. Department of Labor  
Occupational Health & Safety Administration  
Ground-Fault Circuit Interrupters (GFCI)  
[http://www.osha.gov/SLTC/etools/construction/electrical\\_incidents/gfci.html](http://www.osha.gov/SLTC/etools/construction/electrical_incidents/gfci.html)

Consumer Product Safety Commission Fact Sheet  
U.S. Consumer Product Safety Commission, Bethesda, MD 20814  
(800) 638-2772  
<https://www.cpsc.gov>  
<http://www.cpsc.gov/PageFiles/118853/099.pdf>