ELECTRICAL THEORY – PART 2

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ELECTRICAL CIRCUITS

What Is An Electrical Circuit?

A circuit is a path where electrical current flows. A circuit is an unbroken circular path of current. A circuit will start at a power source and end at ground.

For example, the circuit may start at the battery (power source) and it will end at ground. The circuit may also start at the alternator (power source) and it will end at ground.

Although this sounds like a “one way journey” – from power source to ground – the electrons in a circuit actually flow in a circular routine. Electrons flow: 1) out of the power source, 2) to the load, 3) back to ground, 4) out of the power source again, 5) to the load, 6) back to ground, and so on.

Circuits are maps of where current flows. The maps describe what components receive power from the current in the circuit. For example, the battery sends current through the lighting circuit. The headlight is part of the lighting circuit. The battery also sends current through the starting circuit. The starter is part of the starting circuit.

The battery may power a fuel-injection circuit that feeds current to the fuel injectors. An alternator will power the charging circuit which re-charges the battery. The ignition coil will power the ignition circuit that will send up to 45,000 volts to the spark plugs.

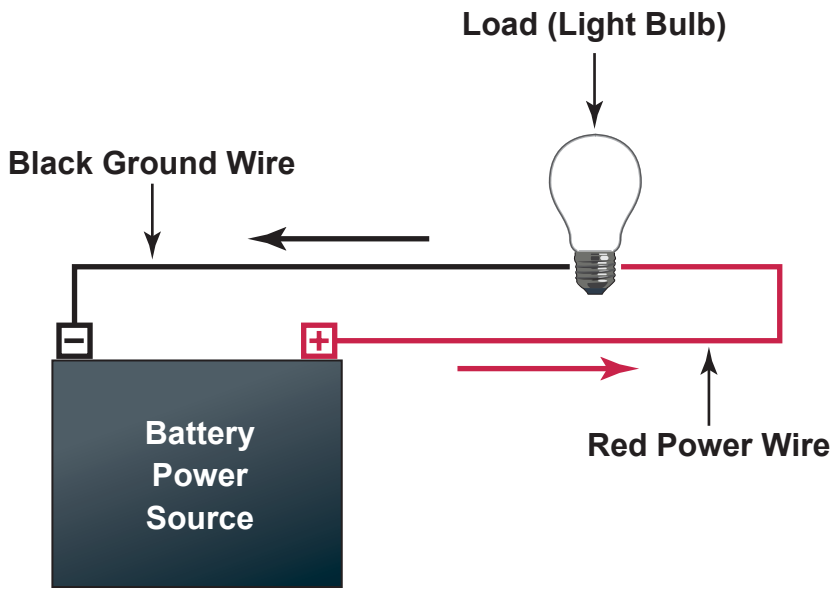
The Circuit: Power Source, Conductor, Load, Ground, Switch

A circuit path starts with a power source such as a battery. The battery will push electrons (current) along the circuit path.

Another power source, the alternator, serves to recharge the battery. However, the battery is still the location where electrical potential is stored and ready to be sent out to power load devices such as the starter or lights.

The current from the power source flows through a conductor. The conductor is simply a wire such as a copper wire. A copper wire is the super-highway that free electrons will travel.

Basic Electrical Circuit



A basic electrical circuit contains a power source, a conductor to transport the power, a load, and a ground return. The power source here is the battery positive terminal. The red wire is the conductor that transports power to the load. The light bulb is the load. The ground return completes the circuit by returning to the negative battery terminal through the ground wire (conductor).

Electrical wire – the conductor - is covered by plastic, ceramic or glass which is called an insulator. An insulator prevents short circuits. The insulator surrounds the copper wire and provides protection for the copper wire where the free electrons will travel.

The current from the power source flows to a load (or “load device”). For example, a load can be the starter, or spark plugs, or the headlight. The

load uses electric current to turn the starter, fire the spark plugs, or light the headlight.

After flowing through the load, the remaining electrons flow back to the power source through the ground return wire. The ground return completes the circuit. A complete unbroken circuit is a closed circle of electron flow.

A ground return can be a ground wire, the motorcycle frame, the engine, or the transmission. If the battery ground cable runs from the negative battery terminal to where it is bolted directly to the frame, this makes the frame part of the ground return to the battery.

In other words, **a load device attached to the frame will use the frame as a ground return path back to the negative battery terminal.**

Most circuits have a switch to complete the circuit. A switch turns the circuit on and allows the current to flow. The circuit is referred to as a “closed circuit” when the switch is on, and the current is flowing through the circuit.

Current in the closed circuit flows in the form of a closed loop – an unbroken circle from the power source, through the load, and then back to the power source through the ground return.

A switch in the “on position” can be visualized as a drawbridge over a river that is in the “down position”. When the drawbridge is down, the traffic (electrons) can move over the river.

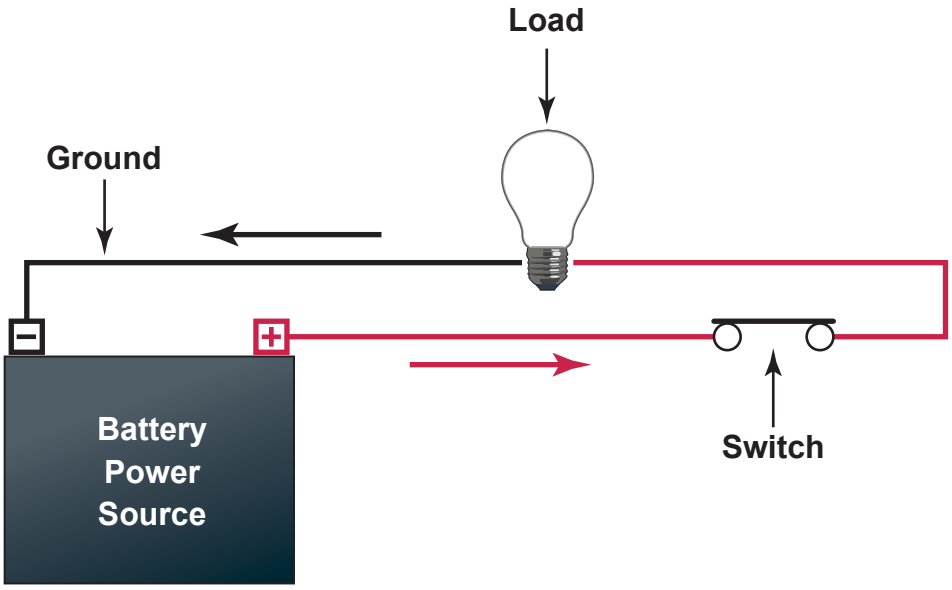
A switch can also break the flow of current in the circuit, and prevent the current from energizing a load device. The circuit is then referred to as an open circuit. If a circuit is open, the switch is off, and current does not flow. An open circuit is like a circle that is broken. The circle is not complete.

A switch in the “off position” can also be visualized as a raised drawbridge over a river. When the drawbridge is up, the traffic (electrons) cannot move across the river. All traffic is stopped.

Circuits: Closed, Open, Grounded, Shorted

A closed circuit refers to the condition of the circuit where the switch is turned on, and there is no “opening” or break in the circuit. The switch has completed the circuit. The circuit is complete.

Electrical Circuit with Switch
Closed Circuit



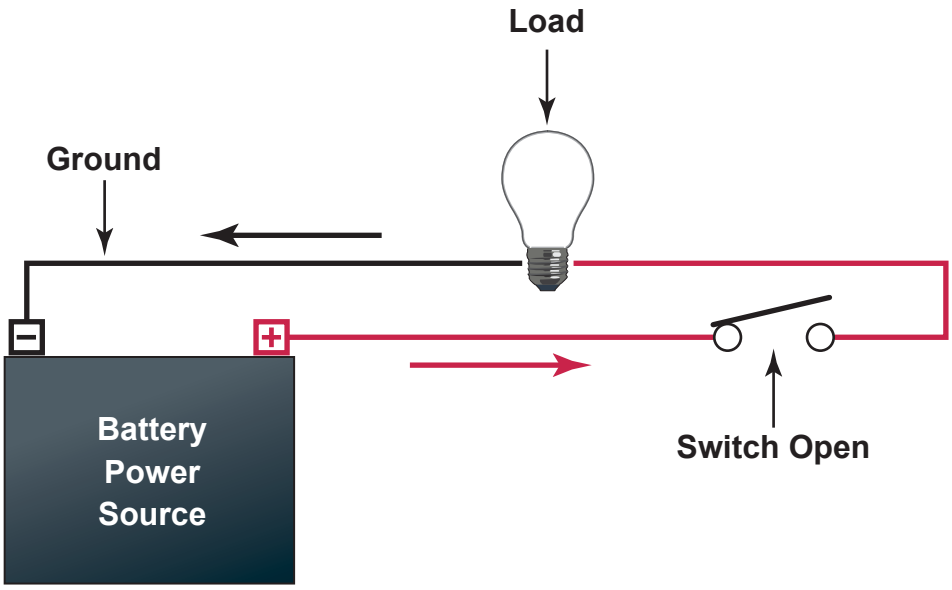
This basic electrical circuit includes a switch that controls the power to the load. The switch is in the closed position and the circuit is “on” and supplying power to the load. This is a “closed circuit” and it is live.

An open circuit refers to the condition of the circuit where the switch is turned off. The switch has created a break in the circuit. The circuit is not complete.

All circuits must have a ground return from the load device back to the power source. The ground return completes the circuit. If a ground is properly installed in a circuit, the circuit is said to be properly grounded. A complete circuit represents an unbroken circular flow of electrons. Without a ground, a circuit cannot be complete.

A short circuit refers to the condition of a circuit where the electrons have jumped off the circuit path before reaching the load, and the electrons then return to the power source prematurely through the ground. The electrons do not go through the load device. Electricity is lazy and will take the easiest route back to the power source.

Electrical Circuit with Switch
Open Circuit

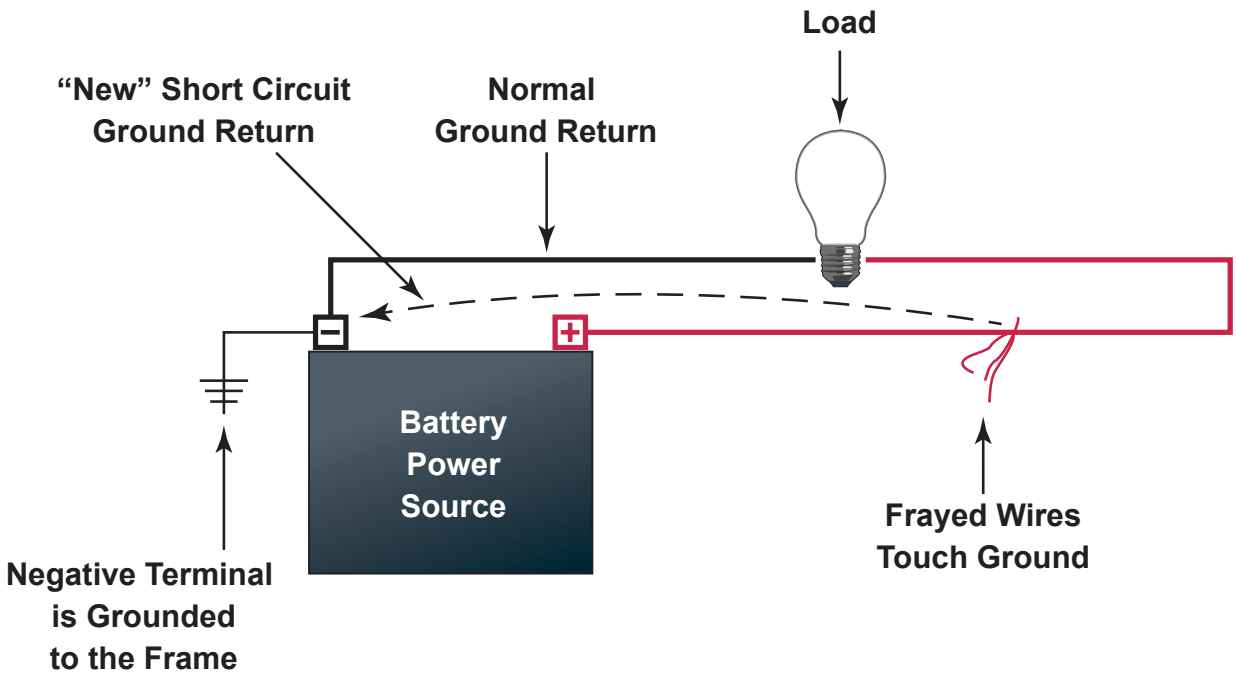


In this electrical circuit the switch is in the open position. This circuit has been turned off. This is an "open circuit". The switch symbol is similar to a draw bridge over a river. When the draw bridge is up, no traffic can cross the river. No power is being supplied to the load in this drawing.

If the electrons are allowed to break out of the circuit through a wire that is frayed – before reaching the load – and, the frayed wire touches a ground

return such as the motorcycle frame, this “short circuit” can allow all of the cold cranking amperage potential in the battery to flow out into the circuit.

Electrical Circuit Short Circuited



This diagram illustrates a short circuit. The hot wire feeding electrical current to the load has had some insulation torn off, and some bare wires are now touching the motorcycle frame. The current “short circuits”. Instead of the current passing though the load, and then through the ground wire back to the battery negative terminal, the electrons take a “short cut” back to the battery negative side. This could melt the wire insulation, or start a fire if there is no fuse along the “hot” wire path going to the load.

Unfortunately, this short will likely result in the release of many hundreds of “cold cranking amps” stored in the battery – amps that normally flow through a thick cable from the battery to the starter. Ordinary wire gauges cannot carry this much amperage, and will likely get too hot and the wiring insulation will melt and start to burn.

There should be an electrical fuse in the hot wire to the load. In the event of a short circuit, the fuse will burn and disconnect the hot wire to the load. This will prevent the release of the massive amperage that the battery has the potential of releasing.

There does not need to be a fuse on the ground side of a circuit. If the ground wire frays and contacts ground, the ground return will simply “reach