# Ground and Earth

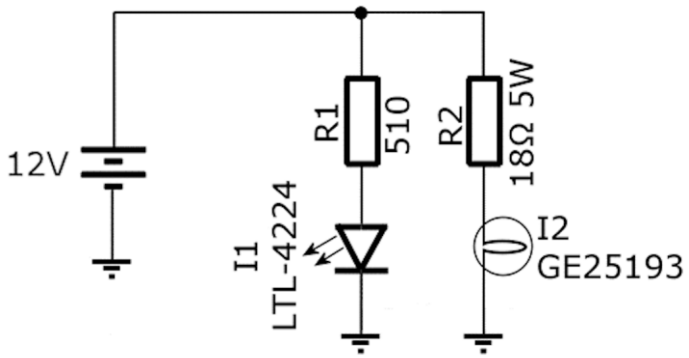
In electronics, the term *ground* usually refers to a common return point to the power source, not directly to the earth.

This can sometimes be confusing, since we also use the term *earth ground* to refer to conventional *grounding* — meaning a physical connection to earth. This sort of "ground" is therefore often called *earth*.

There is no confusion about the schematic symbols however:

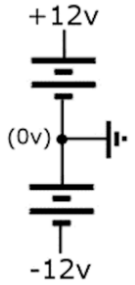

Ground symbols are used on schematic diagrams simply as a convenience that keeps things from getting messy and confusing.

For example, combining the circuits from the previous lecture …




Wherever the ground symbol appears in this diagram, it represents a physical connection back to the *zero reference* node of the power source — usually meaning the negative side of a single-polarity system.

Systems sometimes make use of both positive and negative voltages. In that case, ground refers to the common node between the positive and negative power sources …




In automobiles, ground connections are often completed using the car's metal frame.

But in electronics, they're always hardwired, either with actual wiring, or via a

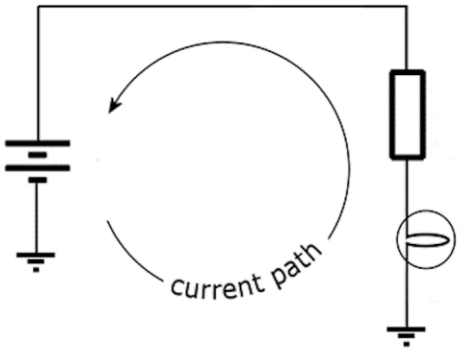
printed circuit's *ground plane* — usually a large area of copper which serves as a return path for current from different components on the board.

Electronics chassis ("chas-eez" - pl) or cabinets are sometimes physically connected to earth by wiring them to water pipes or a long copper rod. The purpose of this sort of grounding is usually electrical safety. This is also sometimes done to help prevent stray electromagnetic fields from affecting sensitive circuitry by conducting them to earth ground.

## What Is a "Circuit"

An electronic system involves connecting a source of energy to various components which are configured in a logical way as needed to provide certain useful functions.

The operative medium is current, which travels continuously from the negative side of the energy source, through the connected components, and back to its positive side.




Within the energy source, the current can be thought of as moving internally from the positive side back to the negative side, thus having completed a *circuit* — a circular journey, beginning and ending at the same place.

This is where the term comes from. Its use has been expanded in the trade to loosely refer to the entire system — the energy source and whatever is connected to it, either in part or in full.

## Shorts and Opens

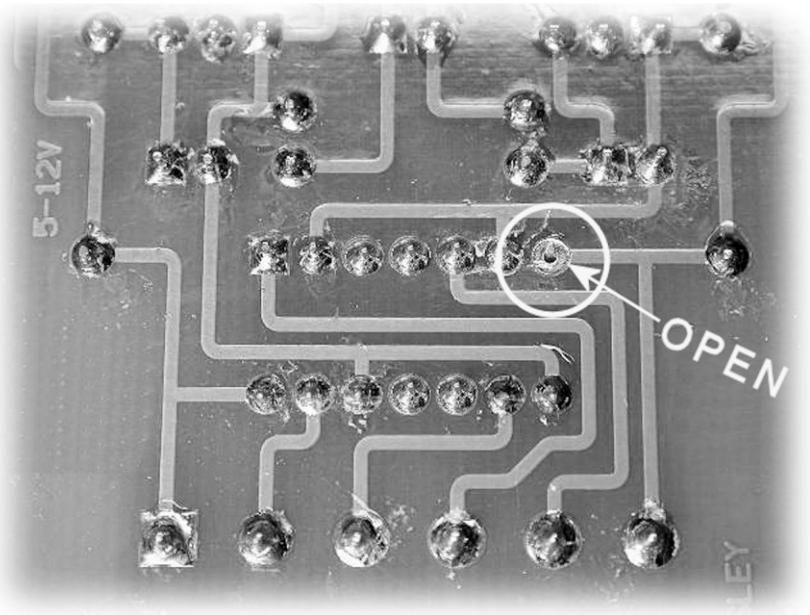
When the current path in such a system is interrupted for some reason, it is said to be *open-circuited*. If a fault develops which somehow diverts the current in some unintended direction such that the designed

function cannot be provided, the system is said to be *short-circuited*.

These sorts of faults are simply called “opens” and “shorts”.

Opens are usually traceable to blown fuses, broken wires or loose connections, are usually not destructive, and are usually easy to find and correct.

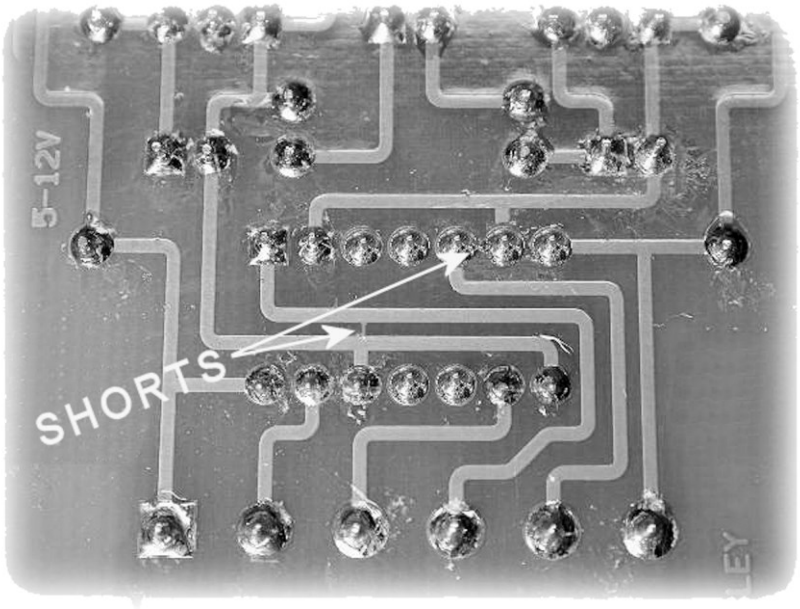
Here’s a picture of a common situation; a missed solder joint on a hand-soldered printed circuit board.




Initially, this board would probably make it through testing, if the unsoldered pin was

still physically in contact with the circuit board pad. But with age, a tiny bit of corrosion and perhaps a little vibration the contact would be lost, resulting in an open circuit.

Shorts, on the other hand, can sometimes damage circuit components, and are often not so easy to find when power supplies include some form of current-limiting that shuts them down when an over-current condition is detected. A short somewhere in the circuitry is therefore likely to trigger that protection, making any sort of methodical troubleshooting through the circuit, function by function, impossible. The troubleshooting options then are visual inspections … or the "old smoke test".




As you can see from this example, showing a solder bridge, and a hair-line flaw on the printed circuit board, both problems could be discovered merely with a close visual inspection.

So, let this be a lesson to you: when problems happen, a close visual inspection should always be your first troubleshooting step.

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We talked about things being “connected in series”. Before closing out this section

one resistive circuits, let’s find out what the significance of that is, exactly.

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