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Ground Part 10 of (14) Parts
Measuring Ground Voltage – Establish a Good DMM Ground

Summary of Part 1 through Part 9:
We explained that electron current is the movement of negatively charged electrons through a completed circuit (when switch CLOSED). Electrons leave the negative terminal of the voltage source, travel through the circuit and return to the positive terminal of the **same** voltage source. This concept is important because the battery and the generator are connected in a parallel circuit arrangement. If the battery supplies electron current (engine OFF), the electrons leave the -BATT terminal and return to +BATT. If the generator supplies electron current (engine RUN), the electrons leave the -GEN terminal and return to +GEN.

We traced then measured electron current through the ground circuit at various points and discovered battery recharge current which is an important issue often overlooked. Excessive battery recharge current could smoke a perfectly good generator's diode bridge rectifier and we discussed how to measure battery recharge current.

Several have asked questions during the nine electron current concepts we discussed. These questions resulted in a general misunderstanding of the difference between voltage and electron current in a circuit. Keep these points straight in your mind.

(1) Electron Current "flows" through the circuit, in a negative to positive direction.
(2) Voltage is stationary at the voltage source but causes the electrons to flow.
(3) No voltage = no electron flow. (No water pressure = no water flow.)
(4) Lower voltage = lower electron flow. (Low water pressure = low water flow.)
(5) Higher voltage = higher electron flow. (High water pressure = high water flow.)

Voltage does not flow. Only electrons flow.
However, because **voltage drops (abbr. "Vds") appear around the circuit as electron current flows through resistance in the circuit,** it is easy to misinterpret that fact as voltage moving (flowing) around the circuit.

A misunderstanding about the differences in voltage and electron current can cause confusion. Remember that voltage and electron current are two distinctively different parameters in a circuit. We measure electron current as it is flowing in units of amperes (amps) with a current clamp or ammeter. We measure voltage with a voltmeter in units of volts, at various places throughout the operating circuit to determine if there is a problem, such as an excessive voltage drop (abbr. Vd).

Think of a voltage drop (Vd) as a difference in voltage between two points in a circuit. It may be a good Vd or a bad Vd. Or it could be a larger voltage difference than specifications allow. For example, the Society of automotive engineers (S.A.E.) recommends a ground circuit voltage drop should not exceed 0.10 volt.

It is also important to measure voltage at the source. We measure battery voltage at the battery terminals during engine OFF. We measure generator voltage (charging voltage) during engine RUN at the generator terminals to verify there is sufficient voltage to operate all vehicle circuits. Each reading indicates certain conditions which we will discuss in future articles.

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Measuring Ground Voltage

Measuring voltage in the ground circuit must be done correctly since the voltage readings are very small and appear in the millivolt range (less than 1.0 V). Sometimes a few millivolts can separate a good ground from a bad ground.

Following specific procedures as outlined in this series of articles will help prevent an incorrect reading in a ground circuit that would seem to indicate a ground circuit tests good when it's bad or tests bad when it's really good. This leads to a lot of misdiagnosis and frustration. Either way misdiagnosis is very time consuming and can lead to replacing parts without fixing the circuit. We have all experienced this at different times in our careers. The author is no exception to this frustration. In fact, some of my diagnosis mistakes have turned into some great teaching moments which I am happy to share with you.

First and foremost, you need a good digital multimeter, referred to as a DMM. They are worth the investment. So buy a quality DMM with quality test leads.

Here is something important to understand about your DMM. Below in Figure G01V the DMM indicates 0.00. What does this mean?

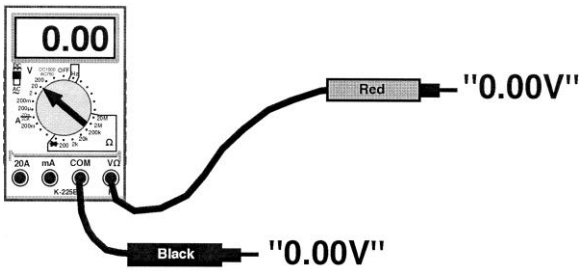

Fig. G01V

Your first reaction might be there is no voltage being measured so the DMM indicates 0.00 V. But it is important to understand what the DMM is "thinking." **The DMM sees no difference in voltage between the probe tips. That is why the DMM indicates 0.00.** Here is another example in Figure G02V.

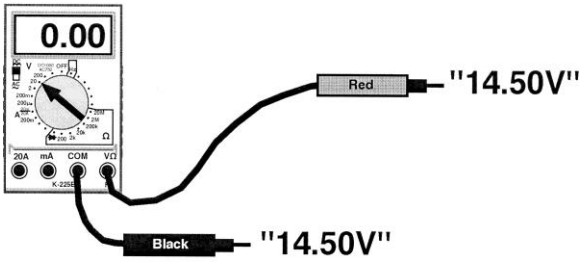

Fig. G02V

The DMM indicates 0.00 and yet both the red and black test leads are touching 14.50V. There is definitely voltage present at each probe tip. **But the DMM indicates 0.00 because it sees no difference in voltage between its probe tips.**

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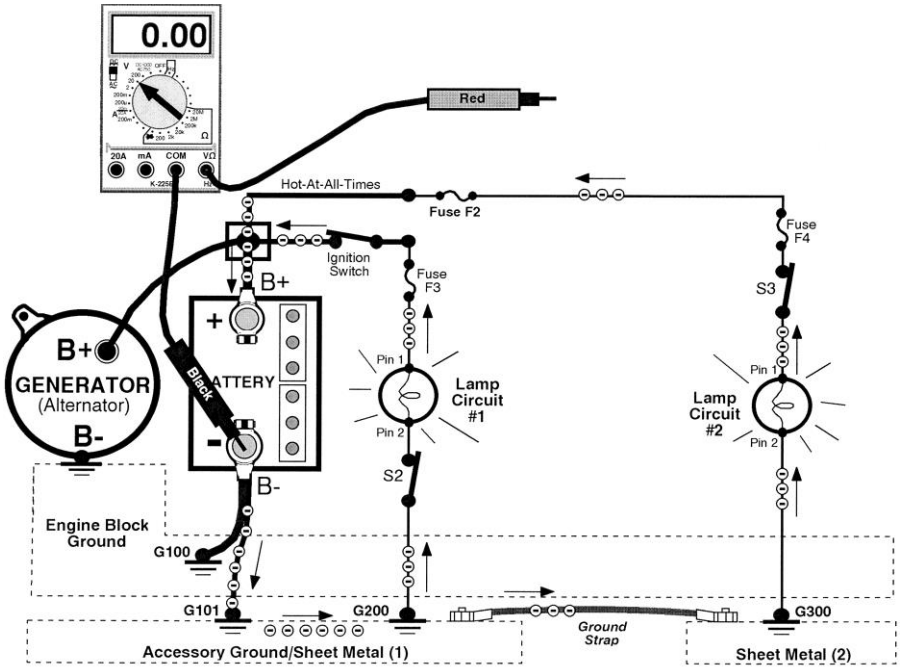
Of course, you want the reading on the DMM to indicate the true voltage present in the circuit where you are probing with the red test lead. In order to get a true indication of the voltage present where you are probing, make sure the black test lead is connected (grounded) to 0.00V.

In Figure G02V above, if the black test lead was touching 0.00V (-BATT) the DMM would indicate 14.50V present at the red test lead.

There are two places on the vehicle where you find a good ground (0.00) for the DMM's black (COM) test lead. Which one you select depends on which one is online providing the voltage.

Ground when engine NOT running:
If the engine is not running, the battery is supplying the voltage. Use the -BATT post as shown below in Figure G03V.



DMM Grounded to –BATT

Fig. G03V

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Ground when engine IS running:
If the engine is running, the generator is supplying the voltage. Use -GEN, the case of the generator as shown below in Figure G04V.

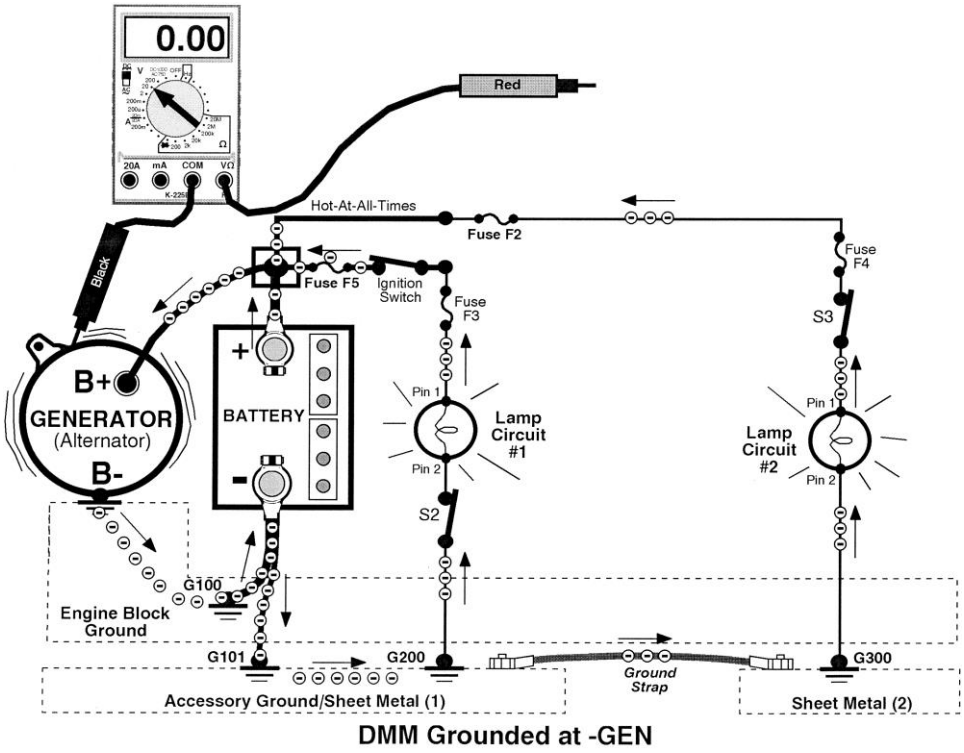

Fig. G04V

Either ground point should put 0.00V on the DMM's black COM test lead to ensure accurate voltage readings, especially when measuring the ground side of a circuit where the difference in a few millivolts can mean the difference between a good ground connection or a bad ground connection. This concept will be explored in more detail as these articles continue.

Select the best DMM ground:
Suppose you can't easily access the -BATT post or the -GEN (generator housing) to ground the black test lead?
Can you use -BATT if you can't get to -GEN?
Can you use -GEN if you can't get to -BATT?
Which is better to ground the DMM; -BATT or -GEN?
Does it make a difference?

To verify both -BATT and -GEN are both good ground points for the DMM we must first verify there is no voltage difference (no voltage drop) between the two ground points. See how in Figure G05V below.

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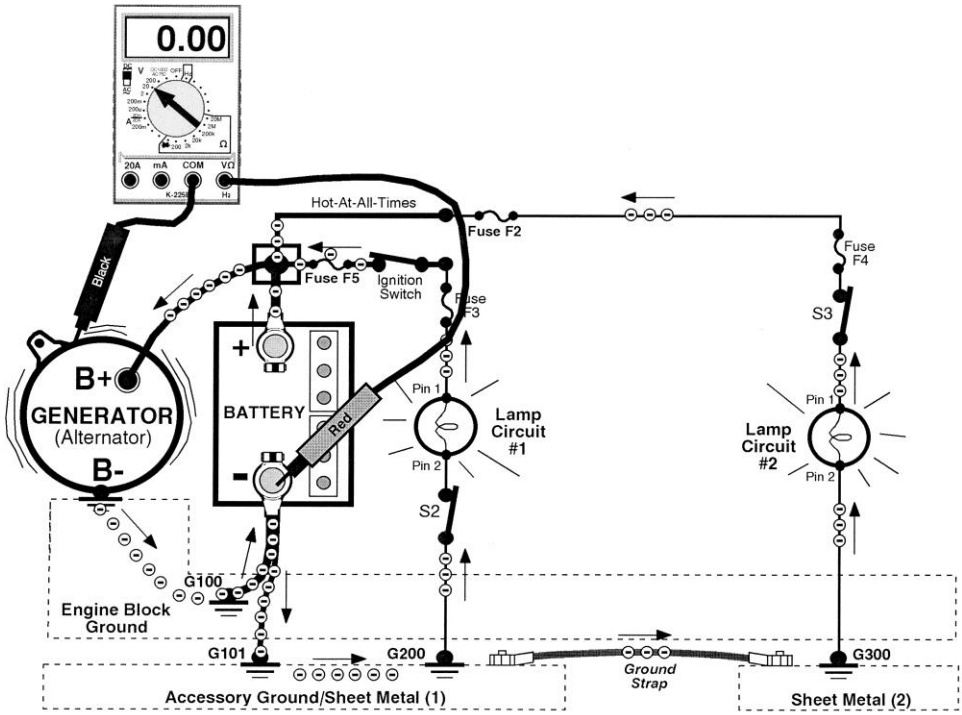

Proving Both Grounds Are Valid DMM Ground Connections
Fig. G05V

Remember, we have established that a DMM indicates the difference in voltage between the probe tips.

With the engine running, place the DMM test leads as shown above in Figure G05V. Black COM test lead to -GEN (generator housing) and red V/Ω test lead to -BATT. Any voltage difference between the two ground points appears on the DMM. A reading of 0.00 means there is no difference in voltage and either ground point is an accurate ground point for the DMM. The -BATT terminal post is therefore a good ground point during engine RUN on this vehicle. Never assume. Always test and verify.

A reading of 0.01 indicates there is a voltage difference of 10 mV between the two ground points. This means -BATT is 10 mV higher than -GEN. For most electrical work this should cause no problem using -BATT for the DMM ground point. However, when measuring on-board computer grounds, it would be best to use the 0.00V ground found at -GEN. We discuss on-board computer grounds further in future installments in these articles.

If the reading is 0.10 (100 mV) it would be wise to address this ground issue.
Clean the -BATT post.
Clean the engine ground connection to the engine block.
Ensure the generator and mounting bracket is cleanly bolted to the engine block.
Inspect the engine battery ground cable for corrosion. Replace if corroded.

Cleaning these connections should reduce the -BATT to -GEN voltage drop to 0.00V. You might be surprised that some electrical issues in this vehicle have also disappeared.

