AMMETER USING BATTERY GROUND STRAP SHUNT

2008 December 30
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You know the old joke about the drunk who is looking for his lost keys one night under the streetlight? He didn't lose them in that spot, but he is looking there because "the light is better." That's what I think of when people check their charging systems using a voltmeter.

A voltmeter is nearly useless as a diagnostic tool in automotive/bikerly charging. But when there is grief with batteries, people reach for their voltmeters — not because they are useful but because they are handy.

Most kinds of batteries maintain their chemically defined voltages until nearly depleted. Each cell of a "battery" of cells is about 2.1 volts. That's the chemically induced voltage you get when sulfuric acid meets the metal lead. That's the case both for drain and for charging.

If you want to know something about the state of charge of a cell, you need (1) to see how concentrated is the sulfuric acid at that moment (not possible with today's sealed batteries) or (2) to keep track of what volume of current been *going into* and what's been *coming out of* (a complex business not feasible until achieved by automation of the "fuel gauge" in recent electric cars).

An ammeter, especially one hooked-up to indicate flow *into* and *out of* the battery is very useful because it pretty much tells you all you want to know about the presence, direction, and extent of the flow. Traditionally, these meters have been crude and/or expensive and they are an effort to set up since you must interrupt a circuit to interpose the ammeter. In this write-up, I describe a very simple alternative ammeter concept that is very easy to set up. In fact, there is nothing easier to set-up and use although it may strike you as unintuitive at first hearing. So pay close attention.

The method

You simply put your DVM across the ground strap of the battery. It is as if you were measuring the voltage drop across (or down) the strap… which happens to be just what you are doing. Set the voltmeter to the most sensitive voltage range. The ground strap has some tiny resistance (easy to calculate, as you'll see) which, for the technically minded, serves as the ammeter shunt. It is easy to do this set-up since there is nothing you need to do except snap the voltmeter alligator clips to both ends of the ground strap, and that's that.

In practice, you must hook one voltmeter alligator clip to the battery ground terminal[1]. The other alligator lead is connected *anywhere* to the bike chassis. If this ammeter doesn't seem to be working right, come back and read that first sentence again.

Explanation

If any little electrons creep into the battery, they *have* to go up or down that ground strap. So you'll see 'em. End of explanation.

Calibration

With the key off, is there any reading? A reading indicates something is moving into or out of the battery. There might be a tiny voltage since your EFI/ECU can be hot (so as to preserve volatile memories) with the key off. Or the clock. Turn on the key. Turn on a headlight or brake light, give it a honk, and so on while watching the meter. At this point, you should be able to correctly guess whether a plus or minus reading on your meter represents a battery drain or a battery gain; it doesn't really matter if your meter shows "+" to report charging or "-" — so long as you keep track of which it is.

Let's do some math. If you turn on your headlight (about 60 watts) and the voltage increases by, say 7 millivolts, then each millivolt represents about 8.5 watts or .65 amps. If you honk your horn and the meter shows 12 millivolts increase, then your horn takes 120 watts, and so on. You can see if any circuit that should be working isn't drawing anything. You can play with Ohm's Law. The ground strap is acting like a shunt of about .01 ohms.

Observing the state of charging

But the most interesting questions have to do with charging. For example, what rpm produces what amount of charging? All you do is…. starting at idle, you should be showing a discharge. Then you rev up some until the meter crosses zero and that's where charging is starting. Easy enough to explore all kinds of issues having to do with charging in this way. What rpm do you need to spin to charge when your beer can cooler is operating?

For sure some dark night you'll be wondering, has something gone wonky about my charging system? Hint: have a look-see at your charging system *today* so that you'll have some perspective on the charging situation on that dark night.

Another way

Actually, a 1-0-1 milliammeter works nice too, just string it across the ground strap-as-shunt because it really acts as a voltmeter (don't ask). A mechanical meter movement provides natural damping as the voltage jumps around. Fun to ride around with it and

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[1] Bike have a well-concealed battery like the R1100S? Discussed below.

watch. Of course, if it is connected while you are cranking the engine, say "bye-bye" to that ammeter because it will be reading a very enormously current, much too big for the little meter movement[2]. That, of course, is not an issue if you use a DVM instead of a raw ammeter movement. It is also not an issue if you don't have an electric starter.

Simple?

Note for bikes with concealed batteries

Some bikes have hard-to-reach batteries (like the R1100S). So it can be hard to reach the negative terminal. Do you have any auxiliary wires attached to the ground terminal such as direct-to-battery connections for electrically heated clothing? Remember, you are measuring the main current going up and down the ground strap. It doesn't matter if you are connecting right there to the very ends of the ground strap, just so long as you are measuring the voltage you would have found at each end. That's why you can connect to any point on the chassis because all points have about the same voltage as the spot where the ground strap connects.

If you are big into preventive maintenance, next time you see your battery, you could connect a little wire to the ground terminal. Since it is just at ground voltage, doesn't matter a whole lot if the loose end flops around… because you know it is there waiting until the dark night when you need to connect to it.

In the case of the R1100S, you might have installed a connection to the positive terminal through the side of the starter-motor cover. It is a smart modification handy for some dark night when you need to boost the battery. If you have such a contact and if you also have another wire going to directly to the battery plus terminal (lots of those around a bike), then you can assess the current *going into* and *out of* the positive strap. Remember, you are working with the hot side of the battery and must take care not to short to the chassis. So this method is only for folks who know their way around electrical systems.

[2] Be great if someone could spec crossed diodes to protect a mechanical meter movement.