

Did your battery ever go dead suddenly? Do you ever wonder if your battery needs charging or if your charging system is working right? Have you added electrical accessories to your bike? If you answered yes to any of these questions, you should install either a voltmeter or ammeter to monitor the motorcycle's electrical system. Both devices show the state of the charging system and the battery but one displays the information in voltage and the other in current (amps). Which one to install is the question. I'll try to tell you the advantages of each to help you decide. Here's how each meter displays information when the battery is discharging, charging, and maintaining a charge.

## Voltmeter

A voltmeter shows the voltage potential across the battery terminals. The voltmeter shows the battery's true voltage when the engine is off. If you leave the engine off, you can watch the voltage go down slowly as the battery drains. Figure 1 shows the voltmeter of a bike with its engine off and a weak battery. Start the engine and watch the voltmeter reading jump to thirteen or fourteen volts because the alternator starts pumping out current to run the electrical systems and charge up the battery. The meter shows more than twelve volts because the alternator's output adds to the voltage potential of the battery's twelve volts. The voltmeter in Figure 2 shows a healthy alternator charging the battery.

## How to Read a Meter

After a while the battery becomes fully charged and the regulator reduces alternator current to just enough to run the bike and maintain the charge in the battery. The meter reading changes slightly while the battery recovers its charge. While the battery is recovering its charge lost starting the engine, the voltmeter reads about thirteen and a half volts. After the battery is charged up, the voltage rises to just under fourteen volts. This half volt (or less) change is so slight that it's difficult to read on a meter that swings from eight to sixteen volts in less than 180 degrees.

On my Gold Wing 1500, a voltmeter shows 13.6 volts at 2,000 R.P.M right after starting the bike with a slightly discharged battery. After riding the bike enough to charge up the battery, I stopped and checked the voltage again. It showed 13.8 volts. I used a digital voltmeter for these readings because an analog (needle swinging in a round case) meter would not move enough to accurately measure tenths of volts.

If the alternator cannot produce enough electricity at low RPM to satisfy the bike's needs, the voltmeter will drop to twelve or fewer volts showing the battery discharge. As the revs climb, the voltmeter will again swing past twelve volts when the alternator output exceeds the motorcycle's demands and extra current is available for the battery. Figure 3 shows this break even point when the alternator makes more electricity than the bike needs to run and power its lights. Above the break even point, the bike charges the battery, below it the battery discharges to help power the bike.

An excessive load can make your meter look like Figure 1 again. If extra lights and accessories made the needle swing this far to the left, turn off the excessive loads.

If the accessories are already off, turn off electrical items not required to run the motorcycle and get to a repair shop quickly. Figure 1 also represents a running engine with a bad charging system. After the alternator goes, the battery can provide spark for the plugs for a short time.

## Charging System Failure

- Turn off radios and accessory lights.
- If you must stop, leave the engine running.
- If it's daylight, pull off the road. Pull out the fuses for the headlight and tail lights. **Leave the brake lights connected.**

- Go straight to a repair shop.

Although the voltmeter does not clearly tell you when the battery has regained its charge, it can tell you if the battery is strong enough to retain a charge. This simple test does not require a voltmeter mounted on the bike; a hand held unit connected to the battery terminals works just as well.

#### Battery Voltage Test

- Make sure the battery is fully charged. Either ride it enough to charge it or use a battery charger.
- If using a hand held meter, connect it.
- Turn the kill switch to off so the engine will NOT start.
- Turn on the ignition and note the voltage. It should be twelve volts.
- Hold down the starter button for five seconds. The engine will not start because the kill switch is off.
- Read the meter while the starter motor is turning. It should read about ten and a half volts.
- Release the starter button. The voltage should jump back up to twelve volts.
- Turn the ignition off.

If your battery shows significantly less than ten and a half volts, then it is over the hill. Ten and four tenths or ten and three tenths should be okay but ten or less volts definitely means the battery is not long for this world. I replaced my last battery when it showed nine and a half volts. You should play it safe and replace it before it fails. Although you could get some more use out of it, you don't know how much longer it will last. Better to replace it now than wait until you get stranded far from home or else a bad battery damages another, more expensive, electrical part.

## Ammeter

An ammeter shows the current coming from or absorbed by the battery. When the engine is off the ammeter shows a negative current flow from the battery equal to the load of the electrical system; see Figure 4. The needle will remain steady until the battery is almost dead.

With the engine off and the ignition on, watch the needle swing left (more negative) as you turn lights on and off. See how the extra electrical load requires more current from the battery.

### How to Read a Meter

The amperage difference on the meter equals the current draw of the device you turned on.

Start the engine and watch the needle swing quickly to a high positive number in response to the alternator output; see Figure 5. The alternator is pumping out current to run the bike and charge up the battery. The ammeter only shows the current the battery absorbs to recharge. It does not show all the current consumed by the motorcycle. While the ammeter shows this high reading, turn on more lights and watch the needle swing left to a smaller number. This does not suggest less of an electrical load for the alternator. The alternator works near its maximum current output after engine start to recharge the battery. The needle movement shows that some of the current that was charging the battery must be diverted to power the new lights.

As the battery becomes charged, the needle slowly moves down to a small positive number because the battery needs only a small amount of energy to maintain a full charge. Remember that an ammeter shows only the battery's demand, not the total amount of electricity used by the motorcycle. See Figure 6 for an example of an ammeter showing a good alternator output and a fully charged battery. Now that the battery is recharged and the engine is revving, turn on some extra lights. The regulator sends some of the electricity it was throwing away as heat to the new load. The needle does not move because the meter shows only the **battery's** demand on the alternator.

The time to charge the battery varies, but it should be only a minute or two if the rider only used the battery to start the bike. If the needle stays at a high positive number, then the battery can no longer hold a charge and might not start the engine again. If the needle takes a long time to settle to the low positive reading, the battery is nearing the end of its useful life and must be replaced soon.

### Battery Amperage Test

- Make a baseline with a battery you know is good by following the next three steps:
- Start the bike normally and ride it along a familiar, uncrowded route.
- Make a note of the approximate mileage or the time spent riding when the ammeter swings down and settles on three or four amps. Make sure you give enough attention to the traffic and road to ride safely!
- Write the time or mileage down after you finish riding.

## How to Read a Meter

■ Test a questionable battery against your measured baseline. As the battery nears the end of its useful life, it will take much longer to regain the energy used to start the bike. Instead of three to five miles, an old battery might need fifteen or more.

Start the bike and let it idle. Turn lights and accessories on and off to see which ones affect the alternator's break even point at zero amps. That's the engine speed in R.P.M. when the charging system begins to charge the battery. GL1500 Gold Wings will charge their batteries at idle with the stock electrical load but a few extra lights will exceed its alternator's capacity at low RPM.

With the engine at a speed that puts the ammeter needle at zero or a negative number, you can turn accessories on and off to see how much current each one takes. This is a handy way to tell if something is on or not. Turn on your electric vest at idle and watch the needle. It will swing immediately even though it takes a while before you will notice the heat. Tap the brakes on and off at a stoplight and watch the meter. The needle's movement tells you the light is on or off.

## Which type of meter is better?

Both types of meters clearly show the engine speed where the alternator output equals the demand of your bike and accessories. You can use either type of meter to find your bike's break even point. Both meters will tell you at a glance if the bike's charging system works. Careful monitoring of either meter type can alert you to a battery nearing the end of a normal life cycle. However only the ammeter will clearly inform you when the battery has recovered its charge; voltmeters don't move enough to clearly show this information.

Since an ammeter measures current in series with the circuit, you must install it between the battery and the rest of the electrical system. Install the ammeter between the starter solenoid and the rest of the bike's electrical system. Ammeters have their disadvantages. All the bike's electric current flows through the meter so the lights and engine will turn off if the gauge breaks. The wires carrying that current up to the dash and back down to the harness must be routed away from sensitive radios to prevent interference. Also ammeters with a small range (-20 to +20) suitable for motorcycles are hard to find.

## How to Read a Meter

On the other hand, voltmeters are easier to buy and install. Every automotive supply store carries analog and digital units suitable for motorcycle use. Since voltage is measured in parallel with the circuit, it can be plugged into the accessory terminal or any convenient positive and ground. They also allow you to monitor the battery's condition with the engine off. That could be handy if you play your radio in your garage. Yet, they don't warn the user of a deteriorating battery during daily use as an ammeter does. Finally, unless it's a digital meter or an analog device with a very wide needle swing, the voltmeter does not tell the rider when the battery is fully charged.

Each type of meter has its proponents but you won't go wrong with either one. However you might go wrong without one. Either type will help you determine when it's time to replace your battery. Either one will alert you to a sudden alternator failure so you know to pull the fuses on unnecessary lights and head for the nearest repair shop. Motorcyclists can't resist modifying their electrical systems so every bike needs an electrical meter.