XS650 Charging Systems for Dummies *by Jim Dent*

To troubleshoot your charging system, you need, at least a basic understanding of what's going on in a charging system and the components involved. Once you know how all this stuff works, it's actually pretty easy...

Hundreds of years ago some very smart people discovered that if you wrap copper wires around a chunk of iron and give it some juice (volts), it creates a magnetic field. They also discovered that if you pass a magnet through a copper coil, you create electricity. So, knowing this, we can take a small voltage to create a magnetic field... spin that magnetic field inside some copper coils and generate stronger electricity.

That's sent back to the battery for storage, to run other electrical systems and to supply power back to the rotor field to keep the cycle going.

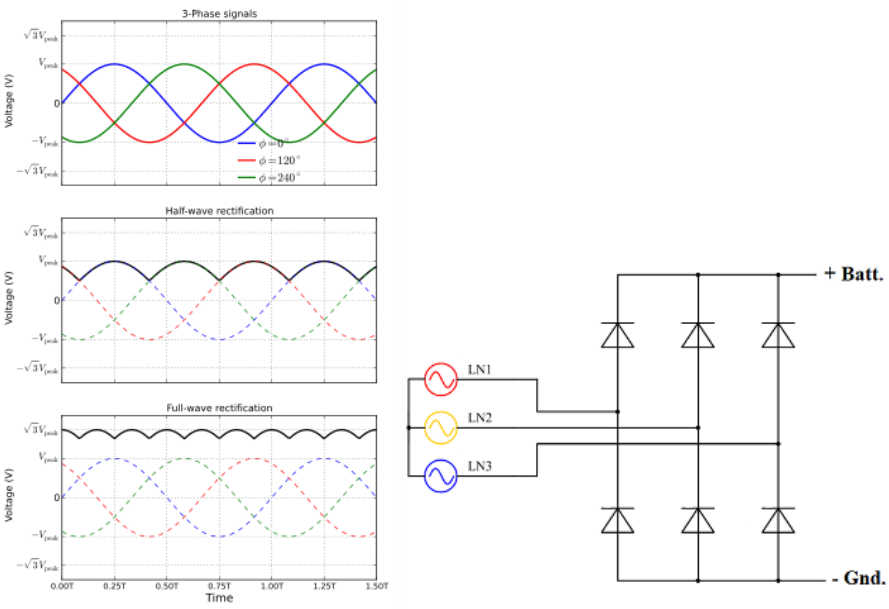
First up, the battery. Yes, Virginia, as well as being a storage device, the battery is a component of the charging system on the XS650. We're using a 12V system.
12V from the battery is sent to the **voltage regulator (VR or reg.)**. The VR needs the battery voltage for 2 reasons. One, it has to know what the voltages is in order to regulate the amount of voltage going back to the battery to charge it. So, we can say the VR is a voltage sensing device. Second, it takes that battery voltage and sends it to the rotor's coil to create (and regulate) a magnetic field.

The **rotor** consists of an iron core wrapped with about a half a pound of thin insulated copper wire. The ends of those wires are connected to slip rings so that we can keep it electrically connected to the reg. while we spin it. The iron core is arranged in "fingers" so that they alternate the magnetic field between north and south as it spins.

Carbon brushes ride on the two slip rings as the rotor spins to provide power to the rotor. One brush supplies power (from the reg.) to the coil and the other supplies a return path commonly referred to as a ground to complete the electrical circuit. More on that in a bit.

The **stator** consists of a series of iron cores wrapped with copper coils. These are arranged so that there are 3 outputs 120° from each other. When the rotor spins inside the stator, the coils are subjected to the alternating north/south magnetic field of the rotor. This generates an alternating, or AC voltage which is substantially stronger than the DC voltage we used to create the magnetic field. Furthermore, by controlling (regulating) the field strength of the rotor, we can control the output of the stator. Less power to the rotor means less voltage out the stator.... and more power in means more power out. Remember this quick jingle; rotors rotate, stators are stationary.

- Finally, the 3 phases of AC from the stator are sent to the **rectifier** (rec.). The rec. is simply a bridge diode network. The 6 diodes of the bridge allow only the positive half of the AC current to pass. So what's sent to the battery is what's called a "pulse (or ripple) DC."



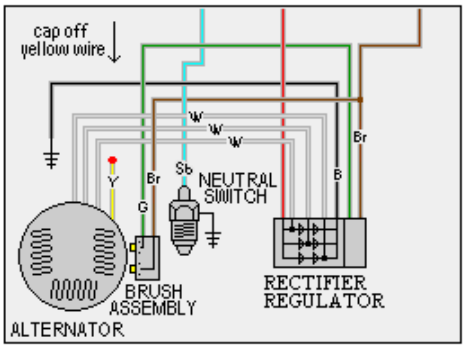
Krishnavedala https://commons.wikimedia.org/w/index.php?curid=15447198 Schematic by Clampower. Mod. By Jim.

So... to recap:

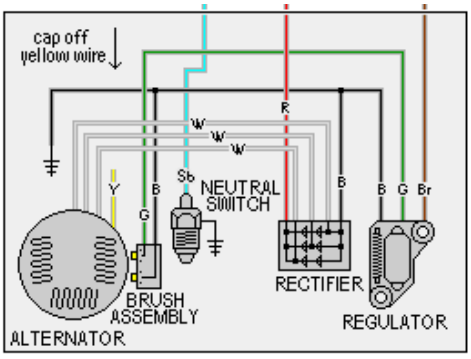
- **Battery;** stores energy from the alternator and supplies excitation to the rotor field windings (by way of the reg.).
- **Regulator;** senses battery voltage and sends power to the rotor accordingly.
- **Brushes;** electrically connect the reg. to the rotor thru the slip rings.
- **Rotor;** creates an alternating north/south magnetic field inside the stator.
- **Stator;** generates 3-phase AC output based on the strength of the rotors magnetic field.
- **Rectifier;** converts AC to DC to charge the battery and to run ancillary electrical systems.

Misc. Notes: There are two types of regulators:

- **Type A reg.** is used on 1980 and newer bikes and;
- **Type B on 79** and older.



The ***Type A*** regulator sends full power all the time to the rotor on the brown wire, and regulates the ground return wire (green). The newer combined reg/rec is a **Type A.**



The ***Type B*** regulator is permanently grounded: the green wire is regulated power from the reg. The older separate reg. is a **Type B**.

Troubleshooting

I'm not going to try to reinvent the wheel here. The following is from the **charging system guide** in the Tech section. Thanks @gggGary

1. First charge your battery to at least 12.5-12.7V.
    - Is the battery Good?
    - Will it hold voltage overnight or longer?
    - Will it light a turn signal or other bulb for 15 or 20 minutes and still have 12 volts?

A good battery will run the headlight on low beam for 20 min. with only about a 1-1.5 volt drop.

- Is the fluid at the correct level? Use ONLY distilled water to refill if needed.

If the battery is questionable buy a new one. A too small battery can be a problem, while idling the charging system will not keep up to the load of a headlight, tail light, ignition etc. and the battery will slowly discharge. Small batteries discharge faster.

Yamaha calls for a 1200 RPM idle speed is to keep the battery charging, a too slow idle won't keep a battery charged. A good charging system won't fix a bad battery but a bad battery will break a GOOD charging system.

A VOM (Volt Ohm Meter) is needed and it doesn't have to be fancy. One can often found at the hardware store, home center, farm store, auto store, electronics store for less than $10.00. Either analog (a meter with a needle) or digital will work (digital meters are easier to read and they auto-range so you don't need to pick a range). You just need to know what you want to measure, DC volts and Ohms are the functions we will use most. A diode test function is nice but not a must".

Forum member @I am Carbon compiled some **YouTube videos on how to use a multimeter** into one thread. If you're shaky on using a meter, I suggest you have a look.

A 3 ft. jumper wire is nice to have and use 16-gauge wire or more (14-is heavier than 16 in wire gauge) two alligator clips or a solderless lug U and an alligator clip are handy ends to have on it.

Normal hand tools: slot and a *good* ~~**Philips**~~ **JIS** screw drivers, wrenches etc. When loosening screws push firmly in, then apply torque. Do not strip the heads. Some of the screws may have been machine tightened 30 years ago. An hand impact driver is a real time and money saver.

Does my charging system work?

1. Start the bike in a shady area if possible, and point the headlight at a garage door or wall, rev the engine, does the light get brighter and then dim a bit as the engine goes back to idle?

If it does you have at least *SOME* charging system activity – which is good.

Stock, 1980 or later, and the headlight doesn't light at all?

2. You may not have any charging, the headlight is controlled by a relay that is powered directly from the stator, no charging, the relay won't close, no headlight.
3. Find a really thin feeler gauge like 0.010" or 0.015" or a wrench, steel ruler, a putty knife, or any piece of steel that can be lightly held near the alternator cover works too, see picture) and hold it pointed down about a half inch away from your generator cover on the engine.

Now turn the key on.

If your regulator and rotor are working the feeler gauge should slap the case when the magnetic field is created in the rotor. If nothing happens or the magnetic effect seems really weak then go on to the next test.

JIM EDIT: Here's a quick video on how to do the "slap test." *https://youtu.be/lFvrId8VjeE*

4. On the solid state regulator models (1980 and newer) all you need to do is locate the green wire at the regulator plug and make a jump from it to ground to bypass the regulator and allow full battery current to flow through the brushes out of the rotor through the green wire to ground.

That causes the rotor to make a stronger magnetic field which in turn causes more current to flow in the stator. If your battery terminal charge voltage jumps up to 14.5VDC when you rev the engine, then the regulator or the ground connection for the regulator is your problem.

5. If nothing changes then it's time to check the voltage on the brown wire (it may be black on your bike) at the positive brush with the key on. It should be very close to battery voltage. The brown wire that feeds the brush gets its power from the brown wire at the key switch.

If you don't have battery voltage at the brush then check the voltage at the switch connector while it's plugged in, by probing from the backside of the connector with the key on.

Again you should see the same voltage as the battery.

If you do get full battery voltage, there then repair the brown wire circuit between the switch and the positive brush. If not, then the switch is either bad or the red wire from the battery is not passing the full current like it should.

If that's the case then keep going back along the red wire, through the main fuse until you find the source of the voltage drop. No more than 0.3 VDC drop is acceptable.

NOTE: *a bigger voltage drop could overcharge your battery - overheating the rotor in the process.*

6. Once you have full voltage to the positive brush re-check the charging voltage to see if you're getting 14.5 VDC or better at the battery when revved to about 3,000 rpm.

If you still don't have a charge, then do the feeler gauge test again. If it slaps the case your rotor and regulator are working and you can go on to stator checks.

If not, then pull the brushes out of their holder and use an ohm meter to test the rotor. Measure the rotor first by touching the tester leads to the brass slip rings.

Then take one lead and touch anywhere on the engine that's not painted. For the first test you should see between 5 and 5.5 ohms between the slip rings.

On the second test between one slip ring and the engine you should see infinity on the meter.

Any reading lower than 5 ohms on the first test or less than infinity on the second test means you have a bad rotor - replace it.

If it tests good then go on to the stator checks.

7. At the stator wire connector locate the three white wires. Use a voltmeter set on the AC scale to test the three possible connections between the white wires by probing from the backside of the connector (the connector should be plugged together for this test):
    - With the engine running at idle you should see about 10.5 to 11 ***AC*** volts (**NOT DC**) on each of the three combinations of white to white that you make.

If you get a very low reading on one or two legs, then something is grounding your stator.

If you have high readings on any of the legs (i.e. 16-18VDC) then your rectifier is bad.

JIM EDIT: Here's a video on testing the rectifier: ***https://youtu.be/HIY2xBBTe7Q***

8. If you got low readings on any of the stator voltage checks then unplug the connector and use your ohm meter to check the stator windings.

Check the resistance between the three fabric covered wires (stator side) on the side of the connector. On each white to white connection you should read about 0.4 to 0.5 Ohms. If you get a very low reading on all of the three combinations find the single Yellow wire connector and disconnect it. Re-check your stator resistance.

If the readings are now good, then the yellow wire or safety relay are shorted.

If there is one or more that still read low after disconnecting the yellow, then check those legs by touching one lead to ground with the other on the white wire. You should see a very high kilo-ohm or infinite reading.

If you get a low resistance check the stator lead pigtail to see if it is pinched by the cases or rubbed through on the frame. If that looks ok then your stator is shorted and needs to be replaced.

And that's about it except to say that dirty connections and worn brushes account for most of the charging system problems. Good Luck you'll find the problem.