Product Information

Testing A Dynamo for Start Up voltage and Bootstrapping

Introduction

The DVR3 and DVR4 are solid state all surface mount electronic voltage regulators with integral cut out and overcurrent protection. Although they provide the same functionality as the old mechanical regulator they offer significant advantages over the mechanical regulator.

- brighter & more consistent lighting ('steady ammeter reading')
- reliable charging from lower engine speed
- easier starting due to greater battery power
- longer battery and bulb life
- lower maintenance (no adjustments to make & less battery top up)

However there are subtle differences that a use has to take into account when replacing a mechanical regulator with an electronic one. The mechanical regulator is essentially a set of electromagnetic switches with metal switch contacts, the electronic regulator uses transistors as switches as there are no mechanical parts. As a result the electronic regulator has to have a minimum voltage applied before it will operate.

General Description of startup

The Dynamo comprises 2 essential parts – the armature and the field coils. Electromagnetic induction ensures that when the armature with a coil of wire on it is rotated in a magnetic field it will induce a voltage in the wire causing a current to flow. (see the article on how a dynamo works) The field coils work in reverse – when a current is flowing through the coils they produce a magnetic field. It is the field coils magnetic field that the armature rotates in so as the produce the current that runs the vehicles electrical equipment.

However – there is an issue – when a dynamo starts to rotate there is no field coil current flow as the field coil receives it current from the armature, but if there is no field coil magnetic field then there is no armature current. SO NOTHING HAPPENS.

How this is solved is simple – the dynamo is made from iron and when a current flows in the field coils it not only induces a field in the armature it also magnetises the iron in the dynamo making it a permanent magnet. It is this "residual field" that allows the armature to start to produces current (not very much as the field is weak) but enough to feedback into the field coils which in turn reinforce the residual field which produces more current in a positive feedback loop.

The current from the armature must flow though not only the field coils but also the regulator as the whole method of regulation is to chop the field coils current on and off to control the output voltage and current from the armature. Here is where issues can occur.

In a mechanical regulator its simply a pair of metal contacts that join the field to the armature (ignoring if its high or low side regulation) so even a very poor residual field will allow the positive feedback to start. However in an electronic regulator the transistors need some voltage impressed on them in order to conduct – so called threshold voltage. Think of any piece of electronics if the battery is flat they don't work as there is no voltage to drive the current.

Testing the startup voltage of a dynamo

In the LUCAS manual there is a specification of a test to ensure that the dynamo is working correctly. This involves measuring the voltage output when the dynamo is running but with the field disconnected. In other words it tests the strength of the residual field. Now this test assumes that the dynamo has been "polarised" – so what is that ?

Polarising the dynamo is done to set the output polarity of the dynamo and create the residual field in the iron. It involves passing a current through the field coils from the battery to ground. This is also known as "flashing" the dynamo. If your dynamo does not meet the minium output voltage (especially if its been lying idle for a while) then "flashing" it may reset the field so it works correctly. To do this disconnect all wires from the dynamo. Take a wire from the battery live (live depends on if your car is positive or negative earth) and touch the field terminal for 2 seconds. A flash will occur as it arcs and the field coils will pulse a magnetic field into the iron. DONT do this for long as it heats the field windings.

Once this has been done take a 20 watt headlight bulb and connect it between the D and the ground of the vehicle (nothing else connected). Run the engine at around 2000 rpm and test the voltage on the D output. It should be between 3 and 4 volts. If it is then all well and good the electronic regulator will start perfectly.

If it is not at this voltage then you have a weak dynamo – this can be caused by a few things – dirty commutator, bad brushes or more likely rusty laminations, but it can also be that the dynamo has been converted from a 3 to a 2 brush without modifying the field coils or its been changed from a positive to a negative earth system. What ever is the cause its NOT GOING TO WORK with an electronic regulator in its current state.

Solutions for a weak field dynamo

There are several ways to increase the voltage to the required 3 volts minimum start voltage. They are:

1. Have the dynamo rebuilt with new coils
2. Try Flashing a repolarising the dynamo coils
3. Change the pulley to increase the RPM of the dynamo relative to engine speed (more revs more volts)
4. Bootstrap the regulator/dynamo

Bootstrapping the dynamo

By this I mean allowing the weak magnetic field to generate what ever voltage it can and bypass the regulator until the minimum operating voltage has been achieved (around 3 volts for the DVR3/4N). Since the field/armature form a positive feedback system even a small voltage will "kick start" the process. Often we see the "cut in" of the dynamo when the rev's hit a certain level and "blipping" the engine to increase the revs suddenly sees the ammeter come alive.

To do this a simple low resistance connected between the field and the D terminal (LUCAS or high side regulation) or between field and ground (BOSCH or low side regulation)will allow current to flow into the field coil and start the feedback process, the volts will come up and once above 3 volts the regulator will come alive and take over. The resistor depends on how "knackered" your residual field is but typically 22 ohms at 10 watts for a 12 volt system or 15 ohms at 5 watts for a 6 volt system work well. The downside is you are wasting power in the resistor but for a typical 300 watt dynamo its only 3% of peak output. It does generate heat so this has to be taken into consideration

An alternative is to use a "loss less" resistor. Electrodynamicsolutions manufacture an electronic "resistor" which has a very low on resistance acting essentially as a wire connection until the 3 volt threshold is reached when it becomes a very high resistance essentially an open switch. It dissipates virtually no power and has no effect on regulation so can be installed in the old regulator housing along with the DVR3/4

If in any doubt about fitting consult a competent auto-electrician.

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