

IGNITION WARNING LIGHT FAULT FINDING – DYNAMO ONLY

Disclaimer – This document has been prepared solely for information purposes for the use of the recipient and without any commitment or responsibility on the part of the author.

This document was put together to help diagnose issues with the charging light staying on under normal conditions but the battery is charging OK.

I originally wrote one to help resolve a problem on a Fiat 500f fitted with a Fiat 126 650 engine with Alternator. I have produced this document for Dynamo equipped cars.

SAFETY FIRST

Always disconnect the Battery before working on electrical circuits. Make sure ALL electrical circuits are switched off before disconnecting or reconnecting the battery terminals.

Batteries give off hydrogen gas when charging and any spark near the battery could result in an explosion.

If in doubt take it to an auto electrician.

Basic Ignition Light Operation

The Ignition Warning Light (IWL) basically measures the voltage or potential difference (PD) between the output from the Dynamo (14.2 – 14.4 Volts) and the Battery. If there is a potential difference (PD) between the two voltages, the IWL will come on. Its intensity varies with the PD which is why when you turn the ignition on before you crank the engine to spin the Dynamo, the lamp is at its brightest since it has the battery voltage on one side and an earth via the resistance of the Dynamo Field coils on the other.

The IWL also carries out another important function – namely the initial energisation of the Dynamo Field coils.

Dynamo Operation

Basic electromagnetic Induction (Faradays Law)

The basic principle of a Dynamo is that when a conductive wire passes through a magnetic field (or a varying magnetic field is applied to a wire) a voltage is induced into the wire. The voltage is proportional to the magnetic field strength and the speed at which the wire passes through the magnetic field.

Unlike an Alternator which has fixed Field coils and rotating Output coils, the Dynamo is the reverse of this. The Field coils which produce the magnetic field are mounted on the Stator. The output coils which generate the output voltage are on the rotor. For a Dynamo to produce electricity, the Field coils have to generate a magnetic field. Without this magnetic field, the output coils (Rotor winding) will not generate an output voltage.

Basic Dynamo Operation

When the output coils spin in the magnetic field produced by the Field coils, the voltage changes polarity as it moves between the North and South poles. This produces an Alternating Current (AC) which is not suitable for a car's electrical system which is Direct Current (DC). To convert the AC to DC, the output windings terminate on copper strips called a Commutator mounted on the armature. If just two strips were used, the output voltage would vary from zero to maximum voltage and then zero again in a half sine wave, which means that for most of the output cycle it would be well below the charging voltage. To overcome this, the commutator has a number of windings terminating on many commutator strips. This means the output approximates to a constant output voltage. Spring loaded carbon brushes collect the output current from the armature.

When the car is first started, the Dynamo has not yet produced an output voltage because the Field winding (Armature winding) is not energised because the Dynamo isn't generating an output voltage (the original chicken and egg). To overcome this, one side of the IWL is connected to the battery

feed and the other to the D+ terminal on the Control Box. This provides a voltage back to the Field coils via the DF terminal on the Control Box (see explanation below) via an internal “switch”. Once the Dynamo is spinning after the initial excitation via the IWL it generates its own electricity to power the field coils.

Because of the commutator/brush arrangement for collecting the output current, Dynamos are limited to about 6000 rpm.

Dynamo Polarisation

If a Dynamo is old or has had a hard physical knock it may need re-magnetising. Also if you buy a reconditioned Dynamo it may not be polarised since the Dynamo can be used for a Negative or Positive earth car. Someone selling a recon'd Dynamo may assume that since you have been able to diagnose a Dynamo problem then you must also have the technical nouse to know you need to polarise the Dynamo before use.

Polarising a Dynamo means momentarily sending a high current through the Field Coils (Terminal 67) – this is sometimes called “Flashing” (no cheap jokes please).

To do this, take the DF connector off the Dynamo (leave the D+ output terminal 51 on). Connect a jumper lead to the DF terminal on the Dynamo. Now flash this jumper lead against a 12V termination (the live wire on the starter solenoid is suitable). There should be a blue flash as you pull the lead away. The Dynamo is now polarised. Because the field coils are wound round ferromagnetic material they retain a magnetic force (its called remnance). It's this residual magnetism in the Dynamo which helps generate the initial magnetic field.

Never flash against a Battery terminal, you can cause a battery explosion

Note: If you connect the jumper lead to the 12V supply first you will have a live wire in your hand and if you accidentally touch any earth connection – **BANG** – you have been warned.

DO NOT FLASH THE BATTERY TERMINALS – YOU WILL GET AN EXPLOSION FROM THE HYDROGEN GAS.

Again if in doubt take it to an Auto Electrician

Dynamo Connections

A Dynamo usually has 2 or 3 connections depending on whether it has a dedicated earth or is earthed through a physical body connection to the engine. Typical terminals are:

D (or +) Output Terminal Post– this provides the main heavy duty charging current for the battery. Typically there is a thick cable going from the Output terminal on the Dynamo to Terminal 51 on the regulator. This is fed from the Rotor output coils via the commutator.

F (or DF) - Field Windings – these provide the electromagnetic field. This should only be connected to DF on the Dynamo Control Box (see below).

“-“ or D- Negative or ground. This is the earth return. Some Dynamos are earthed through physical contact with the body via mounting bolts. Always ensure the Dynamo has a good earth connection via its mounting bolts especially if the engine block has been painted.

You'll need to check with the Dynamo to see what terminals are present and then refer to the wiring diagram in the Workshop Manual to understand their function.

Dynamo Control Box Operation

Associated with the Dynamo is a Control Box.

There are two types – the Two Bobbin or Compensated Voltage Control Box or the Three Bobbin Current Voltage Control. They basically perform the same functions but in a slightly different manner.

If a Dynamo was connected directly to the Battery it would create several serious problems.

- a) As the Dynamo speeds up its output voltage rises (basic electromagnetic theory) and can go to 30V – this is far too high for a cars electrical system so it needs a **VOLTAGE REGULATOR Relay** to keep the voltage at a maximum of 14.2V. This is enough to ensure the battery charges at a sufficient rate.
- b) When the Dynamo is stationary or at low idle speed, the output voltage is low therefore the Battery will discharge into the Dynamo. To prevent this there is **VOLTAGE CUT OUT Relay** which when the Dynamo output falls below 13.2V it disconnects the battery feed to the Dynamo.
- c) Dynamos produce a higher current when hot. If the Battery is in poor condition or discharged and there is a heavy load applied, then the Dynamo will try and supply all the current. Because of the physical Brush and Commutator arrangement which delivers the output current, too high an output current will irreparably damage the commutator. Therefore there is a **CURRENT REGULATOR Relay** in the Control Box.

Control Box Terminals

Although the Lucas RB340 is the more common unit in classic cars I have written this for the Fiat 500 Control box.

D+ (Terminal 51) this is connected to the output of the Dynamo so is measuring the true output voltage of the Dynamo.

DF (Terminal 67) this is connected to DF (terminal 67) on the Dynamo and controls the voltage to the Field Winding. When the control box senses that the output voltage reaches 14.2V it cuts out the voltage feed to the field winding, the magnetic field collapses so the Dynamo output drops. The Control box senses the output voltage has dropped and reconnects the field winding so the output voltage climbs back to 14.2V again. This all happens in milliseconds with the Voltage Regulator relay behaving like a buzzer trying to maintain a steady output voltage of 14.2Volts.

B+ (Terminal 30) Battery Regulated Output - this provides a regulated 14.2V output (when the engine is spinning above approx 1200rpm – the IWL should be out) to charge the battery.

D- this provides a ground connection for current return path.

Never run a Dynamo without the Control Box or battery connected - unless you really know what you are doing – an unregulated Dynamo without a load can get to 30 Volts – car electrics weren't meant for that kind of voltage.

Control Boxes should not be tampered with – there are critical temperature related settings which need careful and delicate adjustment. If you think it's faulty take it to an auto electrician for checking or replace it.

Tracing the Problem

Since this is to do with voltages under normal operating conditions, some tests must be carried out with the ignition on and engine running.

The testing is to determine why we have a PD across the IWL when the engine is running.

The usual culprit is a high resistance connection somewhere in the IWL wiring, or the battery charge circuit due to dirty/poor contacts.

So before you start carefully clean all the contacts with 400 grade wet/dry and ensure connections are tight.

Also check the IWL bulb is a 12Volt 2.5 Watt bulb.

WARNING ! – some of the cables you will be working on go back to the battery and are HOT/UNFUSED and must be treated with the utmost respect.

A series of voltage measurements need to be taken to determine where the PD on the ignition light is located, so you need a good 2 decimal place voltmeter (VM) with quality insulated leads. Have a pen/paper handy and note down the voltages or resistance readings.

The first thing we need to do is attach the negative lead of the VM to a known good clean earth on the car. Normally I would say the negative battery post, but since this is located at the front of the car this might be problematic so find one nearest to the Dynamo that you can. Switch the VM to the lowest resistance range and check on other earths in the engine compartment that you get a reading less than 0.5Ω. This will tell you your testing earth is good for measurements.

Starting Testing

KEEP THE VM TEST LEAD CLEAR OF MOVING PARTS

Test 1 – Battery Test

The battery must have at least a 70% charge before you start fault finding. The Battery in its idle state should show about 12 -13 Volts

Test 2 – Fan Belt

Check that the fan belt is not slipping and has about 10mm movement (please refer to your Workshop manual)

Test 3 – Dynamo Earth Bonding Resistance

For the Dynamo to work efficiently, if at all, **the Dynamo body must have a good earth.**

Connect your 2 test probes together – this will give you the test lead resistance (usually about 1 ohm for budget test meters) which must be subtracted from any low resistance readings taken.

Now measure the resistance between the engine earth braid (or some other good clean earth point) and the solenoid body (remember to subtract the test lead resistance for the true reading. It must be less than 1 ohm. If not, check the physical contact between the Dynamo body and the car chassis. Make sure you have clean bright surfaces that mate together.

Test 4 Dynamo Output Coil Test

Disconnect the leads from the Dynamo. Connect a voltmeter between a known good earth and the Dynamo output terminal. Start the Engine. **Slowly raise the revs to 1500 rpm.** The Voltmeter should read approx 2 Volts (WARNING – do not exceed 1500 rpm). Switch off after testing.

If there is no voltage reading then the armature coils or brushes are suspect or the Dynamo needs repolarising.

Now connect a jumper lead between the dynamo output coils and the field coil. Start the engine.

Slowly raise the revs to 1500 rpm. Measure the voltage between earth and the jumper lead – it should be approx 12 - 15V. In effect the output from the coils is fed back into the Field coils which generate a stronger field, so the Dynamo energises itself. If there is a low output voltage (1 volt) then the Field winding is suspect. An output of 4 – 6 volts would indicate the armature requires attention.

Test 5 Dynamo Field Coil Test

With the Dynamo leads still removed put the Test Meter on its lowest resistance range. Now measure the resistance between the **DF** (Field) terminal and a known good earth. It should be about 6 to 8 ohms. If there is no reading the field coils are probably open circuit.

Test 6 Dynamo Leads

Reconnect the Dynamo leads. If the above tests all read OK then check the wiring between the Dynamo and the Control Box by measuring the resistance across each wire from terminal to terminal. They should read less than 1 ohm.

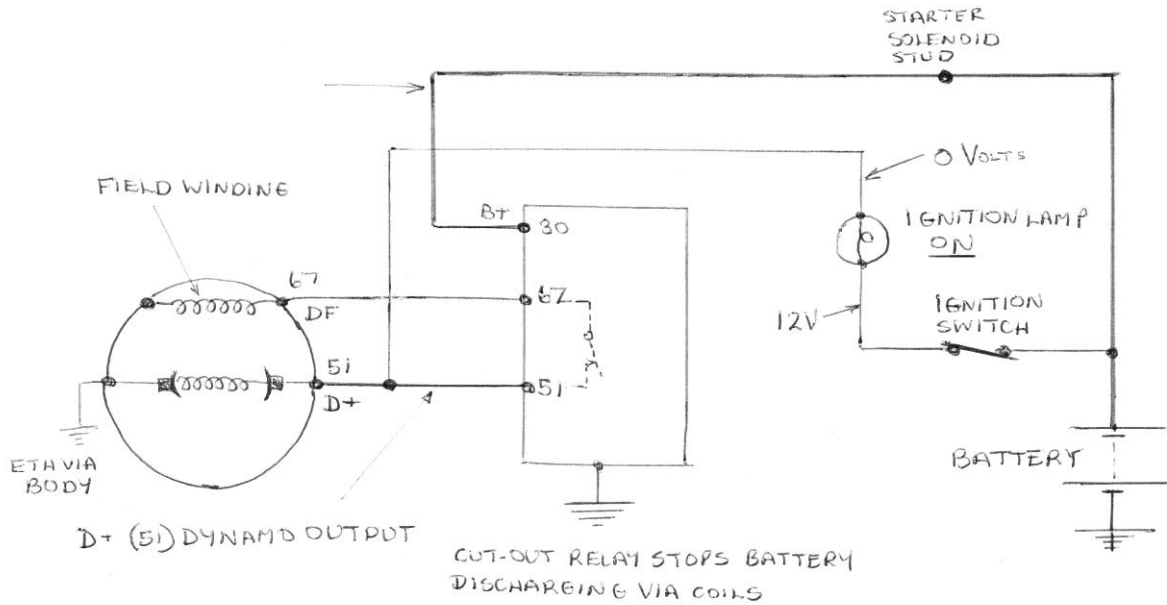
Test 7 Wiring between Control Box and Ignition Lamp.

If all the above tests OK and the Dynamo output voltage at the Control Box (Terminal 51) with the engine running at greater than 1500 rpm reaches 14.2V, then check the wiring between the Control Box and the IWL for excessive voltage drops.

After testing please ensure you reconnect all the leads correctly. Clean the terminals before reconnecting.

DYNAMO WIRING (SIMPLIFIED)

① IGNITION ON - ENGINE NOT STARTED



② IGNITION ON - ENGINE RUNNING (ABOVE 1500 r.p.m)

