

Functional Overview of the Ford Scorpio 95+ Charging System

Introduction

All models of Ford Scorpio 95+, utilise an Alternator and Battery charging system. The alternator is spun around by the engine, this provides electrical current to charge the battery, providing for all the electrical systems incorporated into the Scorpio.

Different variations of Alternator and Battery are used on different models.

Engine	Alternator
12 valve Ford & 24 valve Ford Cosworth	Magneti Marelli A1271 100A
Ford DOHC 8 & 16 valve	Bosch KC 90A
Diesel *	Magneti Marelli A127 70A

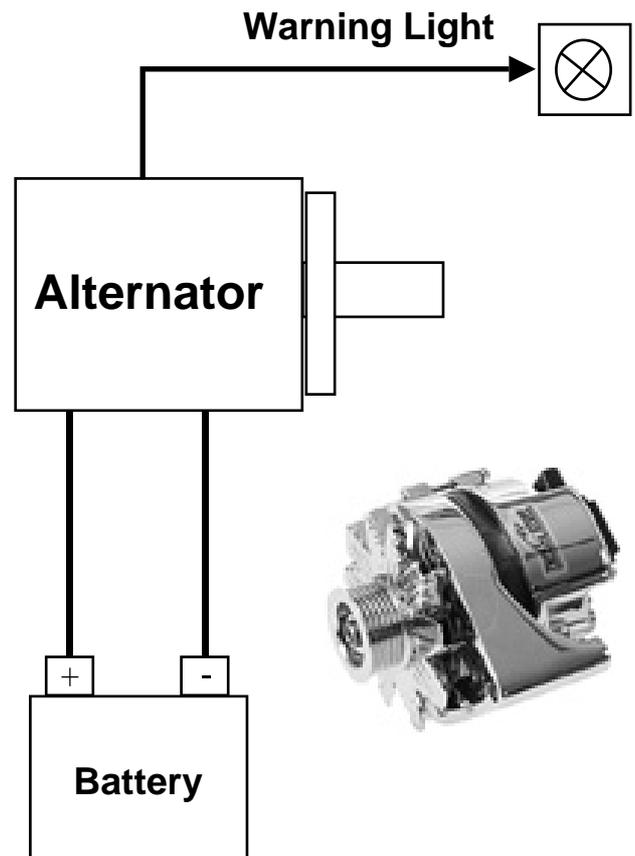
*Diesel variants, two types of alternator may have been used, changing 10/96.

Basic Alternator

Its not required to understand the following description for basic fault finding.

The alternator, electrically consists of a few basic components. These are the Rotor, Stator, Regulator and Diodes.

The Rotar is a coil of wire around an iron core. The Rotar rotates as the alternator shaft rotates, current passes through brushes. The Rotar winding passes the Field current. This causes the Rotar to produce a magnetic field. So basically the Rotar is a rotating electro magnet.

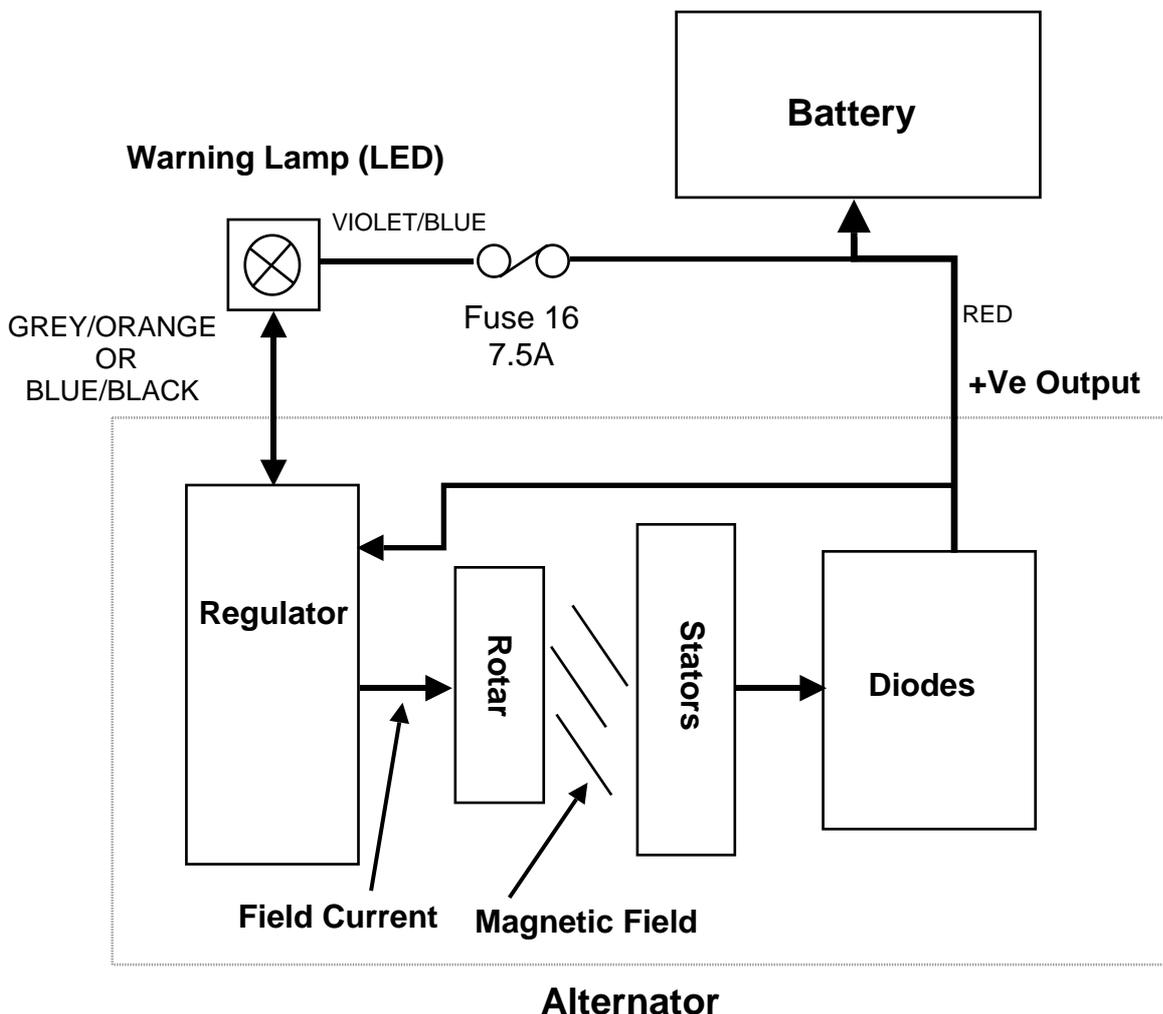


The Stator is a set of three windings fixed to the case of the alternator, the stator windings are static ie don't rotate. As the Rotar rotates its magnetic field "cuts" each Stator winding in turn, this induces a current in each winding. The output from the Stator windings are 120 deg apart and are alternating current, they swing nominal from +12V to -12V.

The Field current to the Rotar is provided by the Stator windings through diodes. Or when the engine is off and no Stator voltage exists the Field current is derived through the Warning Light, this provides a mechanism to start the Alternator generating, when its not moving. (Sometimes called Pre Induction).

Diodes rectify the alternating 3 phases from the Stators and combine them into a single Direct Current.

The Regulator controls the Field current flowing into the Rotar. If the systems voltage increases the Field current is reduced, this causes a reduction in the magnetic field of the Rotar and thus the final output voltage.



Warning Light

The Warning Light or Charge Light, is the one designated with a Battery symbol and lights Red.

This is an LED, and provides an indication of faults within the charging system. However the warning is not reliable under all conditions and failure modes.

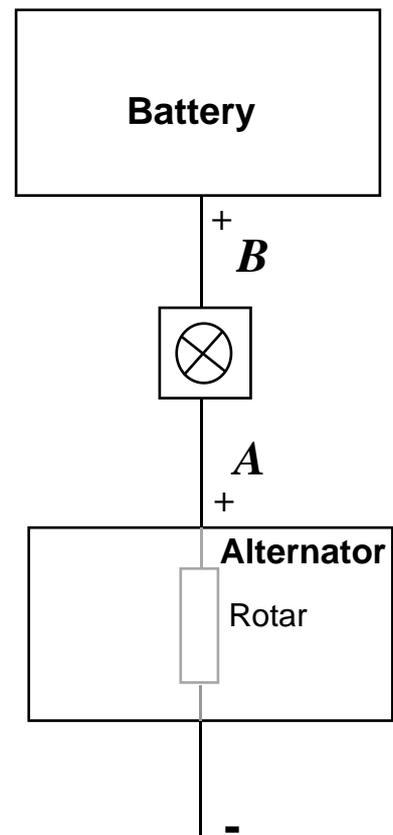
The best way to consider the operation of the Warning Light, is to view it as a light with one connection to the battery + post and the other side to the Alternator Output, in fact this is a slight simplification.

When the engine is not running and hence the Alternator is not rotating and the ignition Key is to on, current flows from the battery + post through the warning light, through the Rotar and out to ground (-). (In practice, depending on the alternator design, the current also flows through internal electronics then to ground). The Warning Light should be illuminated at this point, so always check the illumination of the Warning Light when starting, ie with engine off and key to on. The current flowing through the Rotar provides enough Magnetic Field to start the Induction in the Stator. (This is sometimes called Pre Induction). If this circuit, including the indicator LED is faulty no Pre Induction can take place.

When the engine is running and the Alternator is turning and working correctly, the output from the alternator at *A* is the same as the battery voltage at *B*, hence no current flows through the Warning Light and the Light is off. (The Alternator is sometimes said to be in Self Induction at this point when the engine is turning)

If the alternator or battery either fails or its efficiency is reduced a difference in voltage would occur across *A* and *B*, this will cause the Warning Light to come on.

This can provide useful information on the health of the system, the following table may help when fault finding the Scorpios charging system. Note the Warning Light may not show subtle faults, also if the regulator or diodes are open circuit the light will not illuminate



Light	Possible Fault
Light on fully, when engine is running.	Faulty Alternator or Battery (Or Both)
Light is dimly on, when engine is running, and increases in brightness with engine revs.	Alternator output higher than Battery, possible regulator fault, diode(s) or battery.
Light goes dimmer with revs.	Alternator output low and approaches battery output with higher revs, possibly regulator fault, diode(s) or battery
No Light with Ignition off	Faulty Alternator Regulator or Diode, fault in Warning Light/Pre Induction Circuit, check Fuse F16

Checking The Alternator & Battery

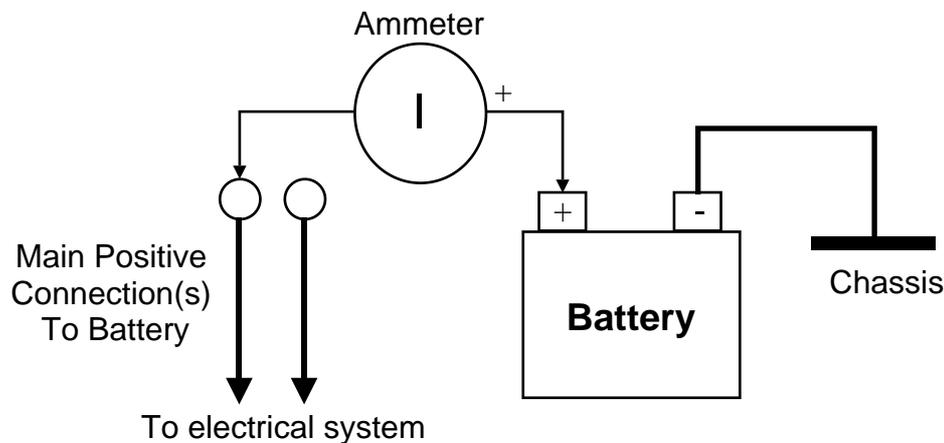
A common problem is how to distinguish between an Alternator or Battery fault. Note its not uncommon for a Battery and an Alternator to both be faulty, failing Alternators with Regulator faults can damage Battery Capacities.

The Battery Discharges When Parked - Measuring Discharge Current

This procedure requires the reprogramming of various systems including Radio Code, after the Battery is reconnected. Ensure you have the Radio Code before proceeding.

If the electrical system appears to work ok when driving, but after parking the car for some hours it has a discharged battery, the following test of Key Off discharge current can be performed.

Various faults within the Scorpios electrical system can lead to a slow discharge of the Battery when the ignition is off, to check for discharge current. Measure the current flowing from the battery when the ignition is off and all electrical equipment is turned off (as far as possible), waiting 1.5 hours after switching off will ensure power saving relay has shut down any normal drain. To do this you will either require a DC non contact ammeter or a DMM with DC current range. **WARNING THE ENERGY STORED IN THE SCORPIOS BATTERY HAS THE POTENTIAL TO CAUSE SEVERE BURNS AND EXPLOSIONS DO NOT SHORT CIRCUIT THE BATTERY.** With a DMM ensure its set to the highest current range and the leads are plugged into the correct sockets for current measurement, also ensure the meter carries either an internal fuse or has fused leads. If using a DMM the battery wire from the + terminal should be removed, if two wires are fitted to the + post remove both. **DO NOT ACCIDENTALLY ALLOW A SHORT FROM THE + TERMINAL TO THE CARS METAL WORK.** Measure the current flowing in from the battery to the cable(s).



If the current flowing is over 80mA a problem exists with a discharge fault some-
place in the electrical system. This must be found and rectified. A faulty Alternator
short circuited Diode can also cause this problem. After factory equipment, Car Cell
phones, Alarms etc can often add excessive discharge currents.

Battery Not Charging - Check For Bad Connections

Many faults with the Scorpios charging system can be caused by bad connections,
check all connections to the Battery and Alternator including all ground (earth) con-
nections

Battery Not Charging - Testing The Battery

The best and surest way to check for a failing Battery, is to totally remove it from the
charging system and charge it with an external battery charger. Charge with the ex-
ternal charger following the charger manufacturers instructions, noting all safety im-
plications. Once the Battery has been connected to the charger for the
recommended time remove it from the charger and have a "Dead Short Test" per-
formed. Most garages and Auto electricians can do this. This test places a heavy
electrical load directly across the battery, from this the Garage or Auto electrician
should be able to report the Batteries health. Any other form of testing is not as con-
clusive and a "Dead Short Test" is recommended. NEVER PERFORM SUCH
TESTS, WITH THE BATTERY CONNECTED TO THE SCORPIOS ELECTRICAL
SYSTEM. SEVERE DAMAGE MAY RESULT.

Battery Not Charging - Testing The Alternator

If the Battery passes a "Dead Short Test" and a charging fault exists, in many cases
the Alternator can be assumed to be faulty.

In fact the Alternator should be able to provide all the electrical current required by
the Scorpio with the Battery disconnected, once the engine is running NEVER AC-
TUALY DISCONNECT THE BATTERY WITH THE ENGINE RUNNING SEVERE
DAMAGE MAY RESULT.

However if with a heavy electrical load ie Headlamps and heated screen, once the engine is running the Alternator should provide sufficient current to power these (and charge the battery). If the Battery is known to be good and with prolonged electrical loading its noticed that Headlamps dim etc, the probable cause is a faulty or failing Alternator not providing enough current. In this condition the Battery begins to rapidly discharge as it provides current to the electrical system, in effect current flows out of the battery to power the load but no current flows into the Battery to charge it.

