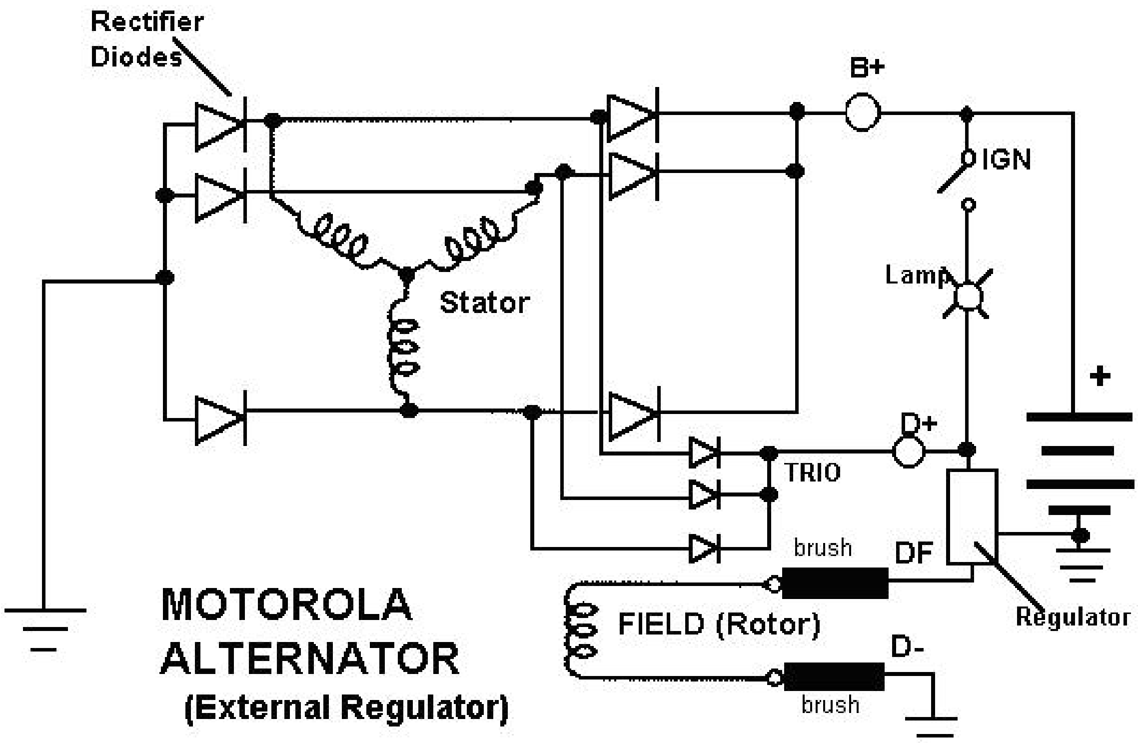
TECHNICAL DATA SHEETS

ALTERNATOR OPERATION



Introduction - The diagram above shows the internal wiring of the Motorola alternator with the external regulator. Generally all alternators generate a full wave rectified three phase output and use the battery as a smoothing device to produce the DC voltage we are familiar with.
The principles following apply to all alternators although there may be minor differences in internal wiring.

The Stator - is the stationary non-rotating part and is generally the part of the frame used to mount to device to the engine. The electrical part consists of a laminated iron frame with three windings of enamelled copper wire wound distributed around it. Electrically, these windings are 120° apart and are the basis of the three phases.

The Rotor - is an electromagnet consisting of windings of enamelled copper wire wound round a solid former upon which the pulley used to drive the device is mounted. Current fed through the slip rings energizes the enamelled copper windings and brushes mounted at the rear of the device this current generate a magnetic field. As the rotor magnetic field sweeps past the stator windings, it induces an alternating current in the windings. There are actually three voltages; each 120º out of phase.

Rectification - To convert the three phase alternating current to DC to charge the battery, a full-wave bridge rectifier is used. This consists of the six large rectifier diodes shown in the drawing; these diodes handle to full output current of the alternator. Any time a winding has positive polarity, the diode on the right conducts, connecting it to battery. In the next half cycle, when the winding is negative polarity, the diode on the left conducts. A "full-wave" circuit means that all the windings are used all the time.

The output voltage is a combination of the waveforms from the 3 windings. This results in an output that is pretty close to DC.

When the alternator is not turning, the diodes prevent battery current from flowing back into the alternator. Thus, no cut-out relay is required as with dynamos.

Rotor Field Excitation - To control the output voltage, and maintain the correct battery charge, the field winding current is varied. The regulator is a solid-state sensor that monitors battery voltage. When the battery voltage is low, more field current is supplied.

Excitation voltage is supplied by the alternator windings, rectified by the Trio diodes (shown as the smaller diodes on the drawing). These diodes are quite small since maximum field current is only about 2 Amps. The regulator acts as a rheostat, controlling the current from the Trio diodes to the field.

Unlike a dynamo, the alternator is not self-exciting at start-up. A dynamo has field poles made of soft iron that hold a residual magnetism. The alternator field structure has little residual magnetism and thus has almost no output unless field current is supplied.

To get the alternator going, a tiny field current must be supplied. In most designs, the instrument cluster warning light initially provides this current. With the Ignition switch closed, current flows through the Lamp to the regulator and into the field winding. If the dash warning light is burned out or disconnected, the alternator probably won't begin charging.

As the alternator speeds up, stator voltage increases until the Trio diode voltage is sufficient to provide field excitation. As the voltage approaches 12 Volts, the dash Lamp goes off because it has the same potential on both sides.

Regulation - How does the regulator sense the battery voltage when it's not even connected to the battery? The answer is that the voltage at D+ almost exactly follows the voltage at B+ because the forward voltage drop in the Trio diodes is almost the same as that in the larger rectifier diodes.

If battery voltage drops, the regulator circuitry senses that fact (at D+) and increases the current flowing into DF until battery voltage is restored. Most regulators also include some form of temperature compensation. A cold battery requires slightly higher voltage to fully charge. A temperature compensation element in the regulator increases output voltage at low temperatures.

Current limiting is not provided in alternator regulators since the alternator magnetic structure inherently limits the maximum current that can be produced.