

Reversible Alternators

Considering construction solutions, these Valeo alternators can be divided into two groups. The alternators of the first type have integrated parts rectifying diodes, voltage regulator and an inverter. In the alternators of the second group, the diodes, the voltage regulator and the inverter are a distinct system, mounted separately outside the alternator. It is easy to recognize them, as the plus terminal is divided into three segments, each corresponding to one of the three stator windings

Principle of Operation

The reversible alternator fulfill functions of both alternator and starter. When the rotor is driven by the motor's crankshaft, the rotor's magnetic field will cause the induction of alternating voltage in the stator phases. The frequency of the alternating voltage will be proportional to the rotor's speed of rotation and phase displacements resulting from the winding arrangement on the circumference of the stator. The application of the rectifier circuit and voltage control allows the automotive electrical system receivers to be supplied with voltage.

When the alternator transforms the alternating current generator into an electric motor, it's the stator's spinning magnetic field that is responsible for the rotation of the rotor. At that moment, the direct current is delivered to the rotor winding (the rotor becomes an electromagnet), while the inverter, which transforms the constant voltage into a three-phase system of alternating voltages, supplies the stator windings of the alternator. Moreover, both the rectifier circuit and the voltage regulator don't take part in the process of feeding the stator windings with the system of alternating voltages. The change of the stator magnetic field in relation to the magnetic field of the rotor forces the rotor to rotate. The supply of the following stator windings is switched in such a way, that the stator magnetic field changes appropriately to the position of the rotor. Thanks to this, the highest power output can be achieved.



In order to determine the optimum time for the inverter control system, the position of the rotor to switch the phases uses Hall sensors. On the basis of their signals, a simple logic circuit defines the right phase switching sequence.

However, in the moment of starting, the phase switching sequence of the system of voltages created by the inverter is random and doesn't necessarily have to correspond to the proper phase.

Nevertheless, it is enough for the rotor to start moving and next the Hall sensor turns on. In a split second this information is transferred to the inverter control system and the phase switching sequence is changed, so that it corresponds to the position of the rotor. In this way, the reversible alternator fulfills the role of an electric motor and can achieve a maximum torque, able to start a car engine.



Diagnostic

Depending on the rotor position, the phase switching control system requires, that after such an alternator is repaired, the Hall sensors should be properly positioned. Otherwise, the generator won't have enough power to rotate the crankshaft.

Till now, there is only one known instrument that can diagnose and test the Valeo ST35 series reversible alternators: The VC-09ST bench top tester, produced by MOTOPLAT.



In order to check an alternator by means of this device, one has to do as follows:

First you install the VC-09ST on your current test bench.

Then you mount the alternator on the test bench connect it to the VC-09ST and next, as it is done in the case of a conventional alternator, you test the parameters. In other words: you check power and voltage values according to the rotational speed. After this test, the Hall sensors should be positioned and on the screen of the tester you can check whether their position is correct or not. On

the screen will appear an oscilloscope graph of the signal received from the Hall sensor (the rectangular wave) and the one of the phases. The correctness of the Hall sensor's position is displayed on the basis of points where both waves intersect each other.

After checking the parameters and adjusting the Hall sensors, there is no need to start the alternator as an electric motor because of two reasons. The first reason is technical: in order to check the motor's parameters, a proper brake would be indispensable.

The second and most important result from the very principle of operation of reversible alternators:

If we deal with an alternating current reversible generator, it will be 100% efficient as an alternator. For example an alternating current generator and at the same time its Hall sensors are correctly positioned, it will be 100% efficient as an alternating current motor, for example in this case, a starter.

