



Electronically Controlled Alternator

The production and distribution of electric energy on the board of a modern car already require computer control as well as adequate diagnostic instruments.

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The Conventional Alternator

Apart from the rectifier and alternating voltage generated in three windings of the stator, the alternating current generator or the alternator has to be equipped with a voltage regulator. Its task is to maintain constant voltage between the minus terminal and the plus terminal of the alternator. In the traditional solution, working of such a control system is based on impulses. If the voltage on the alternator terminals exceeds the limit value (13.8 – 14.6V), the voltage regulator cuts off the excitation current that flows through the rotor winding. The voltage generated by the alternator starts to fall. The moment it reaches a value smaller than the limit value, the regulator again allows the current to flow through the rotor winding. The rotor generates the magnetic flux. The voltage on the working terminals of the alternator increases. The whole control process starts again and lasts non-stop in successive cycles from the moment the motor is started till it is switched off.

Multifunctional Regulators

Along with the development of electronic systems in alternators, which also were modernized, multifunctional voltage regulators capable of fulfilling additional functions appeared on the market. Those new functions improved the vehicle's electric supply system and protected its elements against damage. A multifunctional regulator can, for example, reduce starting resistance by delaying the moment the excitation current is turned on. The burnout of the battery charge lamp or a gap in its circuit doesn't mean that the alternator stops working. In this case, an automatic excitation occurs. The multifunctional alternator also enables a so-called soft power boost, which manifests itself in a gentle excitation current boost during the load change. In this way, load changes affect the engine speed change in a much lesser degree. Other multifunctional regulators also enable an emergency control in the case of a broken conductor, used for the direct measurement of voltage on the battery terminals.



Energy Management

Growing amount of electronic elements and electric equipment in cars resulted in a simultaneous increase of demand on electric energy. Such an uncontrolled requirement may lead to a situation when there is not enough energy to, for example, restart the engine. This is the reason why the car needs to be equipped with the electric energy management system. The main tasks of the device that manages this system are to monitor the state of battery charge, control receivers through data buses, reduce the current consumption by disabling functions and obtain a charging voltage that is optimum at this moment. All these things are done in order to avoid the situation when the battery is discharged too much and to ensure that the engine can be started at any given time.



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Tasks of the computer in the energy management system are realized through different 'so-called' operation modules. The first one is responsible for diagnosing the battery. The second module deals with the quiescent current management by turning off (if it's necessary) the receivers during the standstill, when the car engine is stopped. The third one, a dynamic module, is responsible for controlling the charging voltage and reduce the number of receivers that are turned on while the motor is working.

The battery diagnosis requires that certain parameters are determined by the energy management system computer. These are the battery's temperature, voltage, current and working time. On the basis of these data, one defines the starting capacity at the moment and the current state of battery charge. These are the basic values required for managing energy consumption. The state of battery charge can be shown as a set of indicators or on a screen of a multifunctional display. If the engine is working and the receivers are turned on, the accumulator discharges. The moment its starting capacity reaches the limit level, there appears a request to restart the engine. In the situation when the car stands still, the energy management system ensures the quiescent current is small enough, so that one can start the motor even after a long time. If the state of battery charge is too low, the computer begins to turn off active receivers. This process follows according to a programmed order that is usually divided into a couple of stages. Each of them depends on the level of battery charge. The moment the motor is started, the dynamic system of energy management is turned on. Its task is to distribute the electric energy generated by the alternator among the individual systems according to their needs and to produce a charging current that is suitable for the battery.



The Battery Voltage Regulation

The dynamic system of electric energy management requires the voltage generated by the accumulator to be regulated according to the requirements that occur in a given moment. Unfortunately, the conventional control system is completely unsuitable for this task. What we need is a system that gives us a lot more opportunities to control the voltage and the current generated in the stator windings of the alternator. The solution of this problem is to control the alternator by means of a signal sent to it by the computer of the electric energy management system.

The computer's module, which is responsible for controlling the accumulator, defines the voltage value required on the battery terminals on the basis of the temperature and the state of battery charge. Then the computer sends the information about the required voltage value to the alternator. This process can be carried through by means of an analog signal in the form of a current that have a particular value. In this case, the current reaches the rotor winding. One can also use a numerical signal for this purpose. In the latter situation, the alternator has to be equipped with an instrument capable of transforming the signal into an adequate reaction of the excitation system. In other words, it has to have its own controller. In order to enable communication between the computer and the controller, the producers of alternators use single-wire systems for data exchange operating within the framework of LIN(Local Interconnect Network) data bus or with a joint containing the Bit Synchronous Single-wire (BSS).



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Diagnostic

In the case of an alternator equipped with a conventional voltage regulator, one only has to connect a common voltmeter to the alternator terminals in order to check the state of the battery charging system. In cars with alternators controlled by more or less advanced computer controlled communication systems, using a multimeter to measure the voltage may lead to absolutely wrong conclusions. For instance, in the situation when the computer reduces the power demand or turns off the alternator, the multimeter indicates a voltage value that may suggest the battery is out of order. Moreover, an excessive voltage (above 15V) can be equally misleading for an inexperienced diagnostician and doesn't necessarily mean that the voltage regulator is damaged. The accumulators working with the energy management systems easily withstand such a high level of voltage which was triggered by the computer to, for example, cover quickly the energy shortage that has occurred. One can check the electronically controlled alternator by means of a diagnostic computer. It is preferred to use one that is dedicated to a particular make of vehicle or a special tester.

An example of such tester is the VC-11R developed by MOTOPLAT.

After it is connected to the power supply and the computer, the VC-11R shows the control system (LIN or BBS) and a so-called rotor solidity, for example of the percentage of the maximum excitation current flow through the rotor winding. It also indicates what voltage is required by the primary control program and the voltage the alternator generates.

In addition, the tester enables to control the voltage in order to verify whether the car battery works correctly. With this end in view, the diagnostician forces the alternator to generate different levels of the required voltage (12.5V, 13.5V and 15.5V) and observes its reaction.

The instrument that can be used to check in this way a much wider range of electronically controlled alternators is the VC-07 USB, a tester that is commonly encountered in workshops. The VC-07 USB can recognize three BSS versions and 14 different protocols sent through the LIN data bus.



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