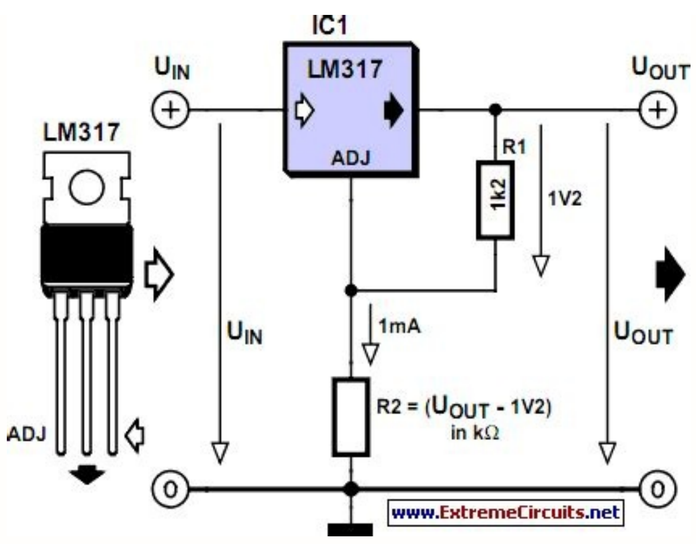
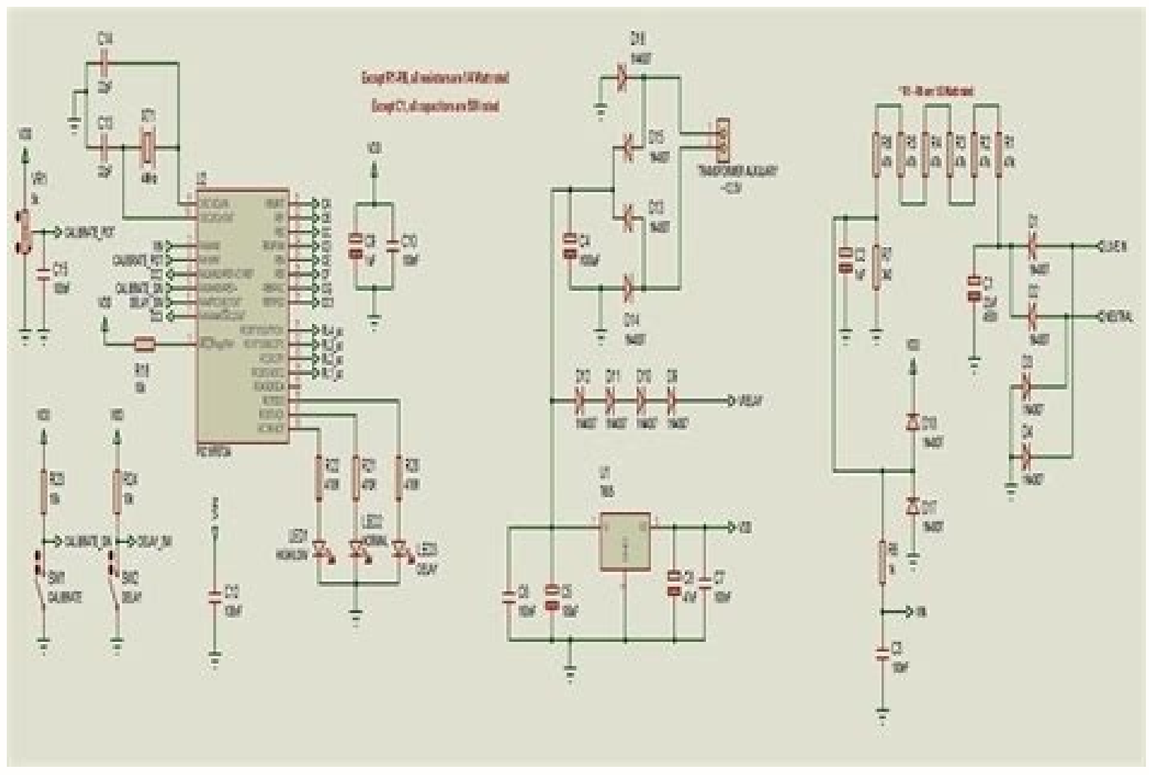
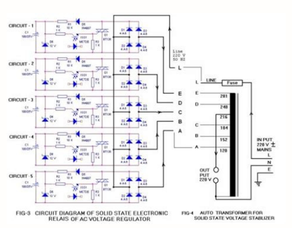
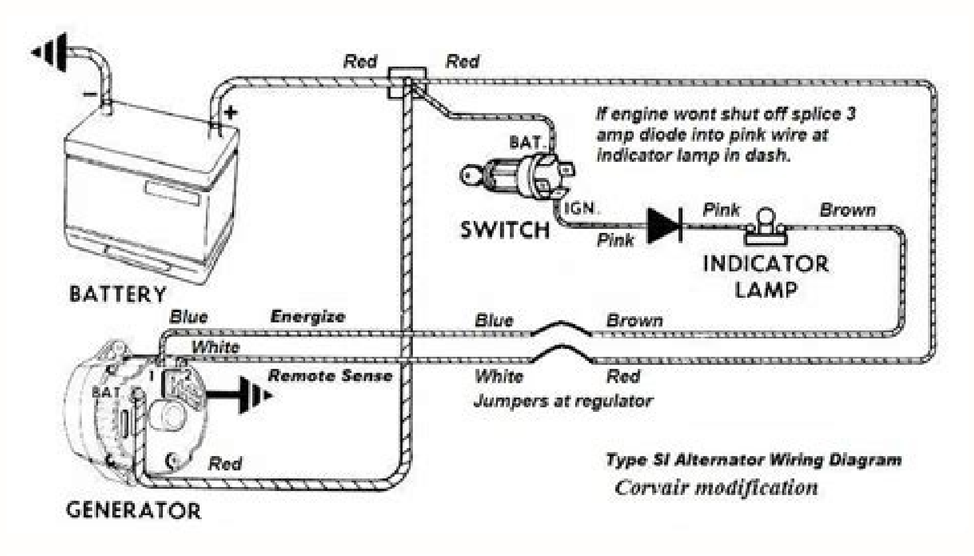
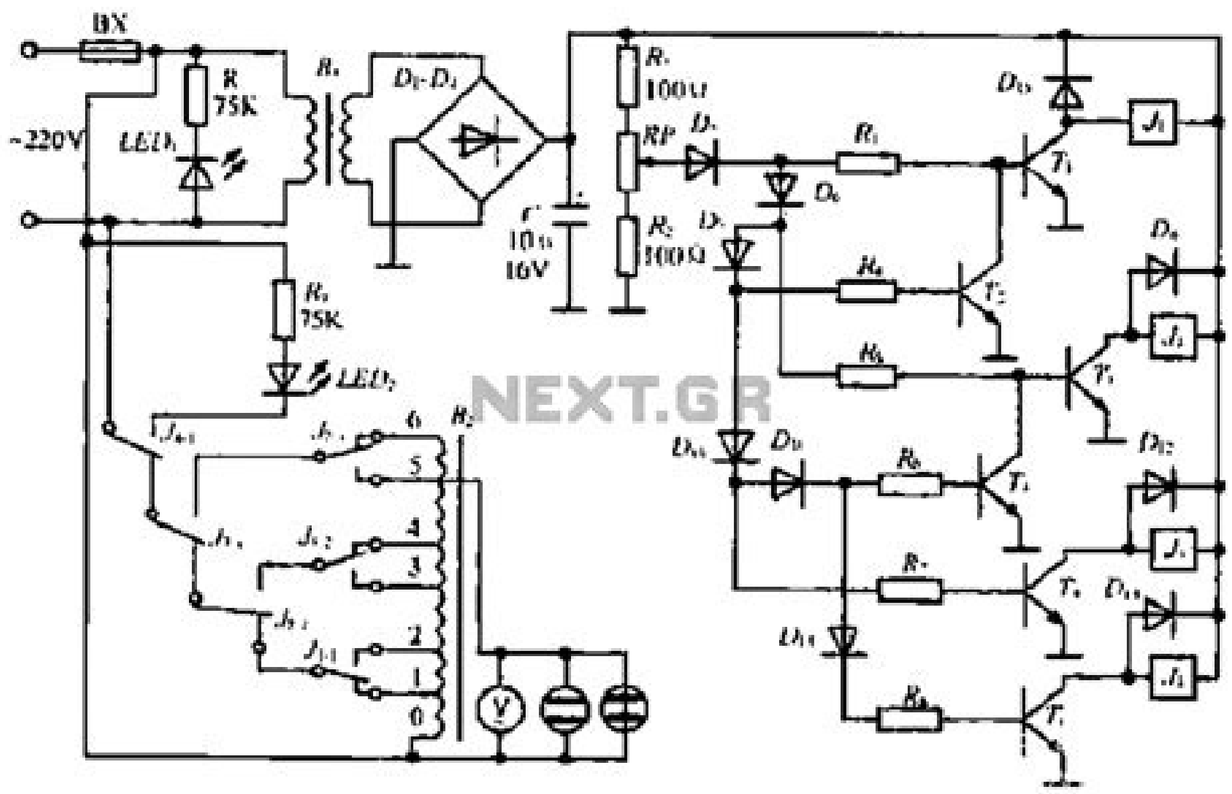
Automatic voltage regulator circuit diagram











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An automatic voltage regulator (AVR) is a electronic device for automatically maintaining generator output terminal voltage at a set value under varying load and operating temperature. It controls output by sensing the voltage Vout at a power-generating coil and comparing it to a stable reference. The error signal is then used to adjust an average value of the field current. Some small cheap portable generators have fixed excitation. In such machines, when an alternator is loaded, its terminal voltage Vout drops due to its internal impedance. This impedance is formed of leakage reactance, armature reactance and armature resistance. The Vout also depends on the power factor of the load. That's why to maintain output within tighter limits, most models use an AVR. Note that all AVRs help regulating the output primarily in a steady state operation, but are generally slow to respond to fast transient loads. Some high-end devices, such as many Honda models, use more accurate digital DAVR with better transient response. The block diagram to the right illustrates the basic concepts used in stabilizing the output of gensets with self-excited alternators. Here is how it works. When the rotor is rotated by the engine, an AC voltage is generated in the excitation winding. This AC is converted to DC by the rectifier bridge "RB"and filter capacitor "C". The detection circuit compares a voltage representing Vout with a target value and turns ON and OFF the transistor "Q". When "Q" is ON, a current flows through the field winding. When "Q" is OFF, the field current is decaying while continue flowing via free-wheeling diode "D". The rotor may include a small permanent magnet to provide some baseline current when "Q" is OFF. By properly varying duty cycle of the operation of the transistor "Q" the Vout can be regulated. Note that in theory "Q" can also work in a linear mode, but its heat dissipation will increase. The diagram below shows a generic AVR implementation. This type of circuit has been around for years. Its numerous variations are found in both portable generators and automotive alternators and are described in various patents, such as General Motor's US3376496 for 3-phase applications and Honda's US6522106. A rectifier RB1 with capacitor C1 produces DC level close to the peak of Vout. A small resistor R1 limits C1 charge current and prevents sinewave "clipping". In theory it may be omitted. If the divider R2-R3-R4 is properly set, when Vout is below its required value, Q1 will be OFF, Q2 will be forward biased via R6, and Darlington pair Q2, Q3 will energize the field winding. Conversely, when Vout raises and voltage at the cathode of D1 exceeds approximately Vz+0.7 volt, Q1 opens and shuts down both Q2 and Q3. Here is a possible parts list, which is slightly modified from what was provided in this discussion: RB1/RB2=GBU6J, R1=10Ω /1W, C1=2.2μ/250V, R2=56k, R3=2.49k, R4=0...2k (pot), R5=2.49k, C2=0.01μ, D1=1N4738 (Vz=8.2V), Q1=MPSA06, Q2=2N6515, Q3=BU931T, D2,D3=1N4005, C3=470μ/200V. Of course, different manufacturers may use different configurations. For example, here you can see a reverse engineered old Generac regulator that uses SCRs and UJT. Many modern machines often use a MOSFET instead of a bipolar transistors Q2-Q3 to lower switching losses. You just need to protect its gate with an additional zener. All information here is provided AS IS for technical reference only without guarantee and liability of any type, neither explicit or implicit, and does not constitute a professional advice- read our complete disclaimer. The automatic voltage regulator is used to regulate the voltage. It takes the fluctuate voltage and changes them into a constant voltage. The fluctuation in the voltage mainly occurs due to the variation in load on the supply system. The variation in voltage damages the equipment of the power system. The variation in the voltage can be controlled by installing the voltage control equipment at several places likes near the transformers, generator, feeders, etc., The voltage regulator is provided in more than one point in the power system for controlling the voltage variations. In DC supply system the voltage can be controlled by using over compound generators in case of feeders of equal length, but in the case of feeders of different lengths the voltage at the end of each feeder is kept constant using feeder booster. In AC system the voltage can be controlled by using the various methods likes booster transformers, induction regulators, shunt condensers, etc., Working Principle of Voltage Regulator It works on the principle of detection of errors. The output voltage of an AC generator obtained through a potential transformer and then it is rectified, filtered and compared with a reference. The difference between the actual voltage and the reference voltage is known as the error voltage. This error voltage is amplified by an amplifier and then supplied to the main exciter or pilot exciter. Thus, the amplified error signals control the excitation of the main or pilot exciter through a buck or a boost action (i.e. controls the fluctuation of the voltage). Exciter output control leads to the controls of the main alternator terminal voltage. Application of the Automatic Voltage Regulator The main functions of an AVR are as follows. It controls the voltage of the system and has the operation of the machine nearer to the steady state stability. It divides the reactive load between the alternators operating in parallel. The automatic voltage regulators reduce the overvoltages which occur because of the sudden loss of load on the system. It increases the excitation of the system under fault conditions so that the maximum synchronising power exists at the time of clearance of the fault. When there is a sudden change in load in the alternator, there should be a change in the excitation system to provide the same voltage under the new load condition. This can be done by the help of the automatic voltage regulator. The automatic voltage regulator equipment operates in the exciter field and changes the exciter output voltage, and the field current. During the violent fluctuation, the ARV does not give a quick response. For getting the quick response, the quick acting voltage regulators based on the overshooting the mark principle are used. In overshoot mark principle, when the load increase the excitation of the system also increase. Before the voltage increase to the value corresponding to the increased excitation, the regulator reduces the excitation of the proper value. Automatic Voltage Control – Figure 8.20 gives the schematic diagram of an automatic voltage regulator of a generator. It basically consists of a main exciter which excites the alternator field to control the output voltage. The exciter field is automatically controlled through error e = Vref – VT, suitably amplified through voltage and power amplifiers. It is a type-0 system which requires a constant error e for a specified voltage at generator terminals. The block diagram of the system is given in Fig. 8.21. The function of important components and their transfer functions is given below: Potential transformer: It gives a sample of terminal voltage VT. Differencing device: It gives the actuating error The error initiates the corrective action of adjusting the alternator excitation. Error wave form is suppressed carrier modulated, the carrier frequency being the system frequency of 50 Hz. Error amplifier: It demodulates and amplifies the error signal. Its gain is Ka. SCR power amplifier and exciter field: It provides the necessary power amplification to the signal for controlling the exciter field. Assuming the amplifier time constant to be small enough to be neglected, the overall transfer function of these two is where Tef is the exciter field time constant. Alternator: Its field is excited by the main exciter voltage vE. Under no load it produces a voltage proportional to field current. The no load transfer function is where Tgf = generator field time constant. The load causes a voltage drop which is a complex function of direct and quadrature axis currents. The effect is only schematically represented by block GL. The exact load model of the alternator is beyond the scope of this book. Stabilizing transformer: Tef and Tgf are large enough time constants to impair the system’s dynamic response. It is well known that the dynamic response of a control system can be improved by the internal derivative feedback loop. The derivative feedback in this system is provided by means of a stabilizing transformer excited by the exciter output voltage vE. The output of the stabilizing transformer is fed negatively at the input terminals of the SCR power amplifier. The transfer function of the stabilizing transformer is derived below. Since the secondary is connected at the input terminals of an amplifier, it can be assumed to draw zero current. Now Taking the Laplace transform, we get Accurate state variable models of loaded alternator around an operating point are available in literature using which optimal voltage regulation schemes can be devised. An automatic voltage regulator circuit is quite well used where Voltage supply is only 120VAC. Many gadgets can operate good at 220V Ac that is why Voltage regulation is needed.By: Mehran Manzoor For this matter an appropriate voltage Regulator circuit is designed which can operate up to capacity of 1KW and gives Variable voltage at different steps (ranges).Circuit Operation:The Mains 120V AC Line and Neutral contains a switch and a fuse up to 10A. The DPDT Switch is used for Voltage up and Down. DPDT Switch has a four ends.The Neutral from mains enters directly in first end of DPDT and the Line/Phase enters the transformer primary winding which is of 220 Turns of 6 layers.It has seven Secondary Winding of 55 turns and one winding of 60 turns. These windings are connected to Rotary switch 1 to 8 respectively. The rotary switch has eight steps which can selected on by one.The common of rotary switch are connected to second end of DPDT switch. The third end of DPDT are connected to first secondary winding of transformer.The last end of DPDT are connected to Common of relay. The relay in a circuit is used for Auto cut off.The N/O of Relay becomes the first output Mains AC Supply.The N/C of relay is connected to first terminal of Red Neon lamp as an indicator to detect the auto cut off. the other terminal of Red Neon lamp is connected to other terminal of output Supply which is common to circuit. It directly comes from Line/Phase wire of Input mains 120V AC.The common of relay is connected to fourth end of DPDT switch and second terminal of 500mA transformer for sensing the voltage. the relay can operate from Auto cut Circuit as shown in Diagram.The Voltmeter is connected parallel with Green Neon Lamp to output Supply which indicates the presence of power and voltage across the output terminalsAuto cut Circuit:The above automatic voltage regulator circuit clearly shows that AC 12V enters through 500mA Transformer to auto cut circuit.The two Capacitors C1 and C2 adjoining with D1 and D2 produces first terminal to relay and other terminal can be adjusted by preset which are joined to emitter of Transistor Q1.The output produced by collector becomes another terminal to relay. the value of the preset can be adjusted as per required. When the voltage is reached above the adjusted value the circuit automatically cuts off.Parts Required for Auto cut circuit:C1-C2: 100μ 25VD1-D2: 1N4007R1:1.5KΩR2:220ΩVR1: 5K presetZ1: 8.2VQ1: BC547

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