CONSTANT-CURRENT BATTERY CHARGER

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There are many ways of battery charging but constant-current charging, in particular, is a popular method for lead-acid and Ni-Cd batteries. In this circuit, the battery is charged with a constant current that is generally one-tenth of the battery capacity in ampere-hours. So for a 4.5Ah battery, constant charging current would be 450 mA.

This battery charger has the following features:

1. It can charge 6V, 9V and 12V batteries. Batteries rated at other voltages can be charged by changing the values of zener diodes ZD1 and ZD2.

2. Constant current can be set as per the battery capacity by using a potmeter and multimeter in series with the battery.

3. Once the battery is fully charged, it will attain certain voltage level (e.g. 13.5-14.2V in the case of a 12V battery), give indication and the charger will switch off automatically. You need not remove the battery from the circuit.

4. If the battery is discharged below a limit, it will give deep-discharge indication.

5. Quiescent current is less than 5 mA and mostly due to zeners.

6. DC source voltage (V_{CC}) ranges from 9V to 24V.

7. The charger is short-circuit protected.

D1 is a low-forward-drop schottky diode SB560 having peak reverse voltage (PRV) of 60V at 5A or a 1N5822 diode having 40V PRV at 3A. Normally, the minimum DC source voltage should be 'D1 drop+Full charged battery voltage+V_{DSS}+ R2 drop,' which is approximately 'Full charged battery voltage+5V.' For example, if we take full-charge voltage as 14V for a 12V battery, the source voltage should be 14+5=19V.

For the sake of simplicity, this constant-current battery charger circuit is divided into three sections: constant-current source, overcharge protection and deep-discharge protection sections.

The constant-current source is built around MOSFET T5, transistor T1, diodes D1 and D2, resistors R1, R2, R10 and R11, and potmeter VR1. Diode D2 is a low-temperature-coefficient, highly stable reference diode LM236-5. LM336-5 can also be used with reduced operating temperature range of 0 to +70°C. Gate-source voltage (V_{GS}) of T5 is set by adjusting VR1 slightly above 4V. By setting V_{GS}, charging current can be fixed depending on the battery capacity. First, decide the charging current (one-tenth of the battery's Ah capacity) and then calculate the nearest standard value of R2 as follows:

R2 = 0.7/Safe fault current

*TESTING WAS DONE USING 5.1V ZENER DIODE
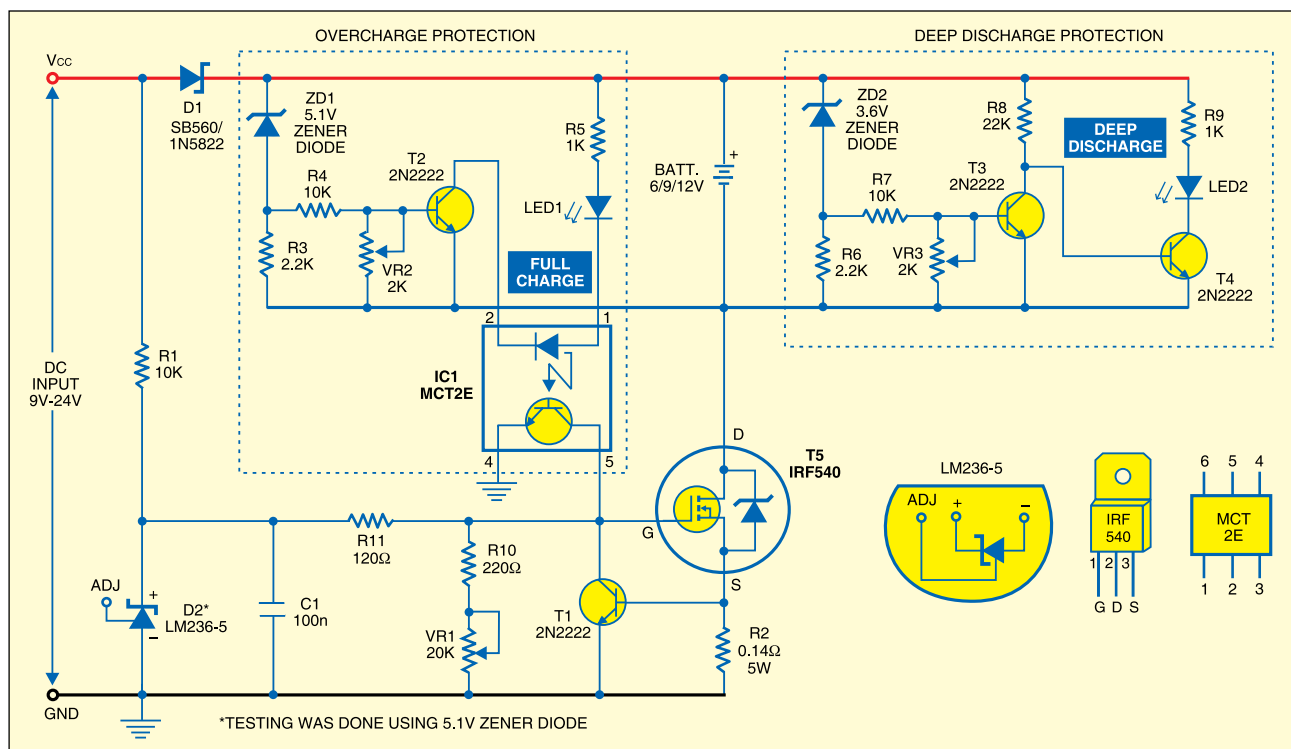
R2 and T1 limit the charging current if something fails or battery terminals get short-circuited accidentally.

To set a charging current, while a multimeter is connected in series with the battery and source supply is present, adjust potmeter VR1 slowly until the charging current reaches its required value.

Overcharge and deep-discharge protection have been shown in dotted areas of the circuit diagram. All components in these areas are subjected to a maximum of the battery voltage and not the DC source voltage. This makes the circuit work under a wide range of source voltages and without any influence from the charging current value. Set overcharge and deep-discharge voltage of the battery using potmeters VR1 and VR2 before charging the battery.

In overcharge protection, zener diode ZD1 starts conducting after its breakdown voltage is reached, i.e., it conducts when the battery voltage goes beyond a prefixed high level. Adjust VR2 when the battery is fully charged (say, 13.5V in case of a 12V battery) so that V_{GS} of T5 is set to zero and hence charging current stops flowing to the battery. LED1 glows to indicate that the battery is fully charged. When LED1 glows, the internal LED of the optocoupler also glows and the internal transistor conducts. As a result, gate-source voltage (V_{GS}) of MOSFET T5 becomes zero and charging stops.

Normally, zener diode ZD2 conducts to drive transistor T3 into conduction and thus make transistor T4 cut-off. If the battery terminal voltage drops to, say, 11V in case of a 12V battery, adjust potmeter VR3 such that transistor T3 is cut-off and T4 conducts.

LED2 will glow to indicate that the battery voltage is low.

Values of zener diodes ZD1 and ZD2 will be the same for 6V, 9V and 12V batteries. For other voltages, you need to suitably change the values of ZD1 and ZD2. Charging current provided by this circuit is 1 mA to 1 A, and no heat-sink is required for T5. If the maximum charging current required is 5A, put another LM236-5 in series with diode D2, change the value of R11 to 1 kilo-ohm, replace D1 with two SB560 devices in parallel and provide a good heat-sink for MOSFET T1. TO-220 package of IRF540 can handle up to 50W.

Assemble the circuit on a general-purpose PCB and enclose in a box after setting the charging current, overcharge voltage and deep-discharge voltage. Mount potmeters VR1, VR2 and VR3 on the front panel of the box. ●