Car Battery Tester

Using five transistors

By **Elektor Labs India**

Even though modern cars have a whole lot of technical and electronic novelties on board, a simple indication of the state of the car battery is often absent. With the aid of a small circuit, using a few transistors and LEDs, it is simple to make such a thing yourself.

This small, practical tester continually monitors the state of the battery in a car and indicates the battery voltage using a few LEDs. There are only three LEDs present, but that is sufficient to give a good indication, provided that each is set to show an appropriate voltage range.

Operation

The entire circuit is built using only discrete components, not even opamps have been used. The voltages at which the appropriate transistors in **Figure 1** turn on and off are entirely determined by a few zener voltages and the base-emitter threshold voltages of the transistors.

The red LED (LED1) lights up when the battery voltage is lower than 12 V. In that case the battery needs to be checked or recharged. The yellow LED (LED2) lights up together with the red LED when the voltage is between 12 V and 13 V. This will be the case when the battery is partially charged but is not currently being charged. The red LED turns off above 13 V, between 13 and 14 V only the yellow LED will be on, to show that the battery is nearly completely charged. The green LED (LED3) will light up when the voltage is higher than 14 V, this means that the battery is being charged.

The voltage reference is created using two zener diodes of 5.6 V each, D1 and D2. These two together have a nominal zener voltage of 11.2 V, but because the current through the zener diodes is quite small, the actual zener voltage will be a little lower. The current through the zener diodes runs via P1, R1 and P2. Transistor T2 will start to conduct when the battery voltage is higher than the voltage across D1+D2, plus the voltage across P1, plus the

Table 1. Voltage indication of the LEDs.		
LED1		< 12 V
LED1+LED2	12–13 V	
LED2		13–14 V
LED2+LED3	> 14 V	

base-emitter voltage of T2. (The voltage across R1 can be ignored, the sole purpose of this resistor is to limit the base current into T2.) In this case T2 pulls the base of T3 to ground, with the result that this transistor is off and that LED1 does not light up. However, if the battery voltage is below 12 V, then T2 will be off, T3 will start to conduct and then LED1 will light up. When the voltage is greater than 12 V, at some point, depending on the setting of P2, T1 will turn on, which in turn will cause T4 to conduct and then LED2 will light up. The switching points of T1 and T2 are not very 'hard', so as a result there is a cross-over region of about 1 V where both LED1 and LED2 are on together. This depends, among other things, on the relative settings of P1 and P2. Finally we have the control signal for the green LED3 from T5. Because this transistor receives its base voltage from the 'bottom' of the two zener diodes, it will only start to conduct at an input voltage of about two zener voltages, plus the voltage across P1, plus the b-e threshold voltage of T5, plus the voltage across LED3, adding up to about 14 V. This can be adjusted somewhat with trimpot P3, which provides T5 with a small bias current.

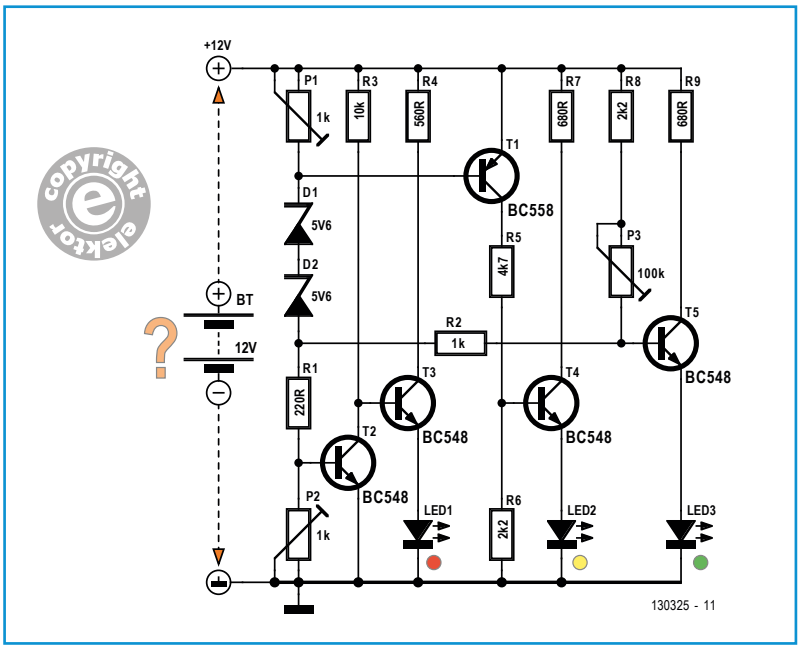


Figure 1.
The schematic comprises only five transistors, three LEDs and a few passive components.

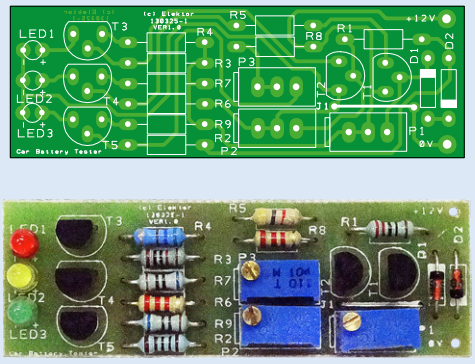
Construction

The small circuit board in **Figure 2** is designed such that it will fit in a small enclosure as can be seen in the photographs accompanying this article. The layout for this single-sided circuit board can be downloaded from the web page for this project on the Elektor Magazine website [1]. The mounting of the parts will certainly not be a problem for anyone who has assembled a circuit board in the past since only standard components have been used here. Make sure that for the trimpots you use the type with the adjustment screw on the top, otherwise they will not fit on the circuit board. Observe the correct polarity for the zener diodes and the LEDs and fit the transistors correctly.
The circuit board can be mounted in a small enclosure which has a plug for the car cigarette lighter socket bolted onto it. The photographs provide sufficient explanation about the mounting of the circuit board into the

Component List

Resistors
R1 = 220Ω
R2 = 1kΩ
R3 = 10kΩ
R4 = 560Ω
R5 = 4.7kΩ
R6,R8 = 2.2kΩ
R7,R9 = 680Ω
P1,P2 = 1kΩ preset, multiturn, vertical
P3 = 100kΩ preset, multiturn, vertical

Semiconductors
D1,D2 = 5.6V 0.4W zener diode
LED1 = LED, red, 3mm
LED2 = LED, yellow, 3mm
LED1 = LED, green, 3mm
T1 = BC558
T2,T3,T4,T5 = BC548



Miscellaneous
PCB no. 130325-1 [1]

Figure 2.
The circuit board for the circuit is rectangular in shape, so that it will fit easily into a small enclosure.

enclosure. Depending in the desired location of the LEDs, you can place these either vertically or at right-angles on the circuit board. Finally you will need to attach two short wires between the positive (+) and negative (–) terminals and the connector.

Calibration and use

Connect the assembled circuit board to an adjustable power supply and start by setting the power supply voltage to 12 V. Adjust trimpot P2 such that LED1 just turns off and set P1 so that LED2 just turns on. Repeat this a few times because P1 and P2 influence each other. Now turn the voltage slowly up from 11 V and check that LED2 begins to turn on at 12 V and that LED1 turns off at around 13 V. If not, then refine the adjustments of P1 and P2 a little more. Finally P3 is adjusted such that LED3 starts to turn on from 14 V. As already mentioned, the calibration procedure is bit fiddly and will have to be repeated a few times because the various settings interact. The usage of the tester is very simple. It is plugged into the appropriate connection on the dashboard and will immediately show that state of the battery. If the suggested colors have been used for the different LEDs, then the state of the battery can be read at a glance: red corresponds to a ‘battery almost flat’, yellow (with or without red) means ‘battery okay’ and green lights up together with yellow during ‘battery charging’.

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Web Link

[1] www.elektor-magazine.com/en/extra/post.html

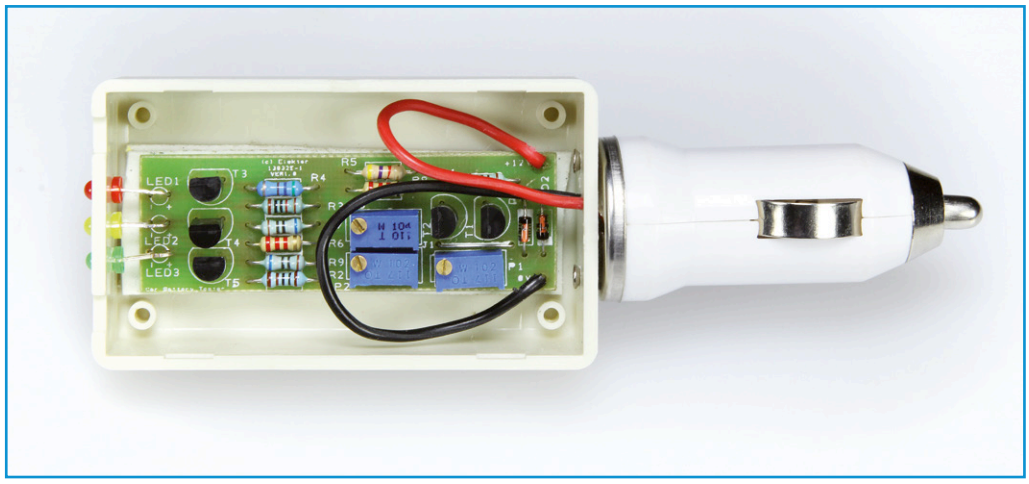

Figure 3.
The prototype, built into an enclosure which has a plug for a cigarette lighter socket bolted onto it.