Assembly Manual

Car Battery Monitor

Cat No. **K 4611**

(Shortform – PCB & components only)

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K I T

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A flat battery is inconvenient to the least. This simple electronic voltmeter lets you monitor the condition of your car's battery so that you can act before getting stranded.

Most new cars these days are fitted with a voltmeter but there are many older cars (and still quite a few new ones) which lack this important accessory. A voltmeter allows you to monitor the condition of your car's battery and will quickly show up potential problems.

By far the most useful sort of voltmeter is the expanded scale type, with a range from about 11-15V DC. With this type of voltmeter, you can tell at a glance whether the battery is charged correctly, whether it is overcharging, or whether its voltage is low.

Our new Car Battery Monitor is of the expanded scale type but, instead of using an expensive mechanical meter with suppressed zero, it is fully electronic. The readout consists of 10 rectangular LEDs arranged as a bar graph. Three different LED colours are used to indicate "low", "normal" or "overcharging".

The first three LEDs in the sequence are yellow and these indicate the low condition, ranging from 11-12V (approx). Following these are six green LEDs which indicate the normal range from 12-14.4V. A single red LED completes the lineup and lights when the battery voltage exceeds 14.4 V to indicate overcharging.

If the battery voltage is less than 11V, none of the LEDs light and you've really got trouble.

What to look for

One of the most frustrating battery problems is when the vehicle will not start because the battery voltage is too low. The symptoms are easy to recognise: the motor struggles to turn over when cranked and refuses to "fire" because the ignition system cannot provide a satisfactory spark.

This problem could be due to a faulty cell in the battery or, alternatively, a bad battery contact. Quite often, a battery monitor will reveal any such faults before they become serious enough to disable the vehicle. Initially, an abnormally low battery voltage would be displayed when the battery is under load; eg, when starting or with the headlights on.

A more subtle battery problem can occur on a rainy night with the headlights, windscreen wipers, ventilation fan and other accessories all operating. If, in these conditions, the engine spends long periods at idle, as in heavy traffic, the alternator may not be able to cope with the load.

The result is a flat battery and a stalled car. As before, this problem can be prevented by monitoring and acting on the fall in battery voltage. In this case, it's simply a matter of turning off as many accessories as possible to reduce
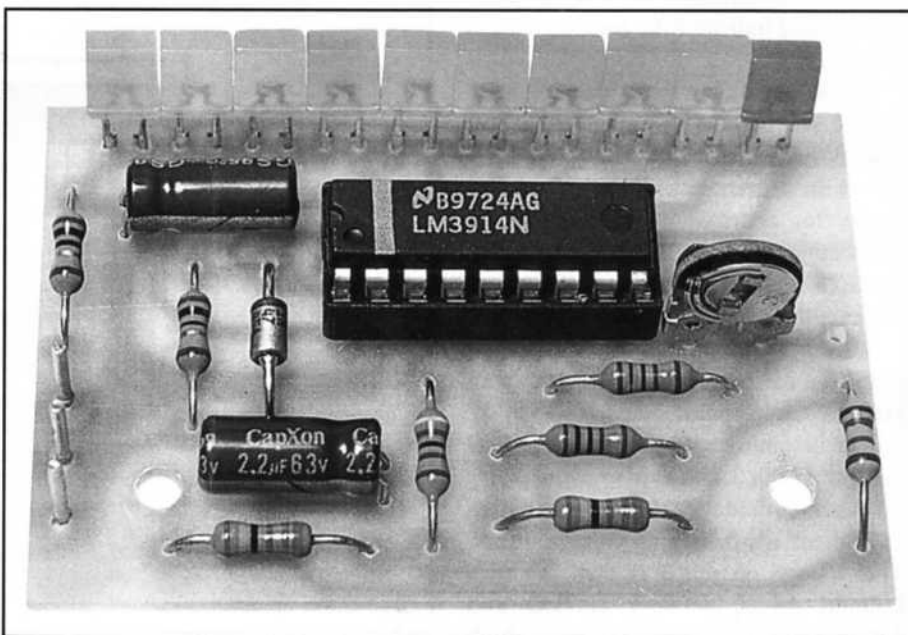
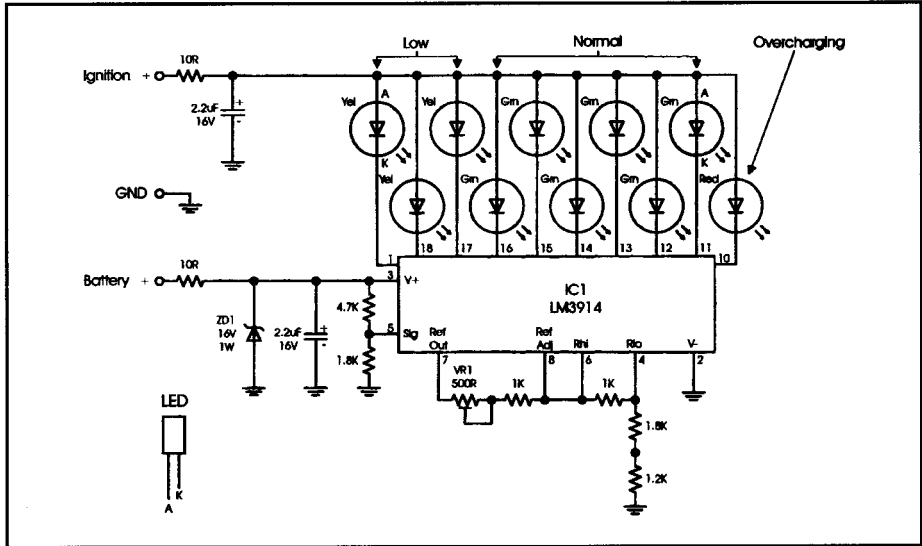*The trimpot is adjusted so that the red LED lights when the voltage reaches 14.4V.*

Text and illustrations courtesy of Electronics Australia

Fig.1: The circuit is based on an LM3914 dot/bar display driver IC.

Parts List

the load, and keeping the engine at a fast idle while the vehicle is stationary.

Another possible cause of battery problems is a broken alternator belt. While this problem should be immediately indicated by alternator warning light, the battery monitor can provide useful reinforcement to alert the driver.

Finally, the battery monitor will detect if the regulator is faulty. If the regulator does not limit the voltage of the battery to 14.4V, then the final LED on the monitor will light to indicate overcharging. Note that overcharging will eventually lead to battery overheating, resulting in water loss and damaged cells.

How it works

The circuit is very simple and is based on an LM3914 dot/bar display driver IC. This IC monitors the analog input voltage and indicates the level on a LED display.

In this circuit, pin 9 has been left open circuit so that the IC operates in dot display mode; ie, it lights only one LED at a time. Alternatively, the IC can be made to operate in bar mode by connecting pin 9 to V+ (pin 3). In this mode, a column of LEDs will light to indicate the battery voltage.

Let's not assume that the IC is wired in the dot display mode, as in our circuit. Here's what happens:

The incoming battery is fed via a 10Ω resistor to pin 3 and is also clamped by 16V zener diode ZD1 which removes any potentially damaging voltage spikes. The voltage on pin 3 is then fed to a voltage driver network (4.7kΩ and 1.8kΩ) to derive a signal voltage which is fed to pin 5.

This signal voltage is equal to the reference high (RHI) input on pin 6 when the battery voltage is 14.4V, and equal to the reference low (RLO) input on pin 4 when the battery voltage is 10.8V.

What this means in practice is that the LEDs only light for input voltages greater than 10.8V. As soon as the 10.8V level is exceeded, the first yellow LED in the series lights. Each LED then lights in turn and the previous LED goes out as the battery voltage increases. The final LED in the sequence at pin 10 lights when the battery voltage exceeds the RHI voltage on pin 10.

The reference voltages are set using the Ref Out voltage at pin 7 to source current to a voltage divider consisting of a 1kΩ resistor between RHI and RLO and a 3kΩ resistor (1.2kΩ and 1.8kΩ in series) from RLO to ground.

The series 1kΩ resistor and 470Ω trimpot between Ref Adj and Ref Out set the current through the voltage divider to about 1mA. This gives the required 3V at RLO and 4V at RHI.

The supply for the LED anodes is derived from the ignition switch and decoupled with a 10Ω resistor and 2.2μF capacitor. Note, however, that the supply for IC1 is derived directly from the battery. This arrangement is used so that the circuit will not be affected by any voltage drop between the battery and the ignition switch.

Construction

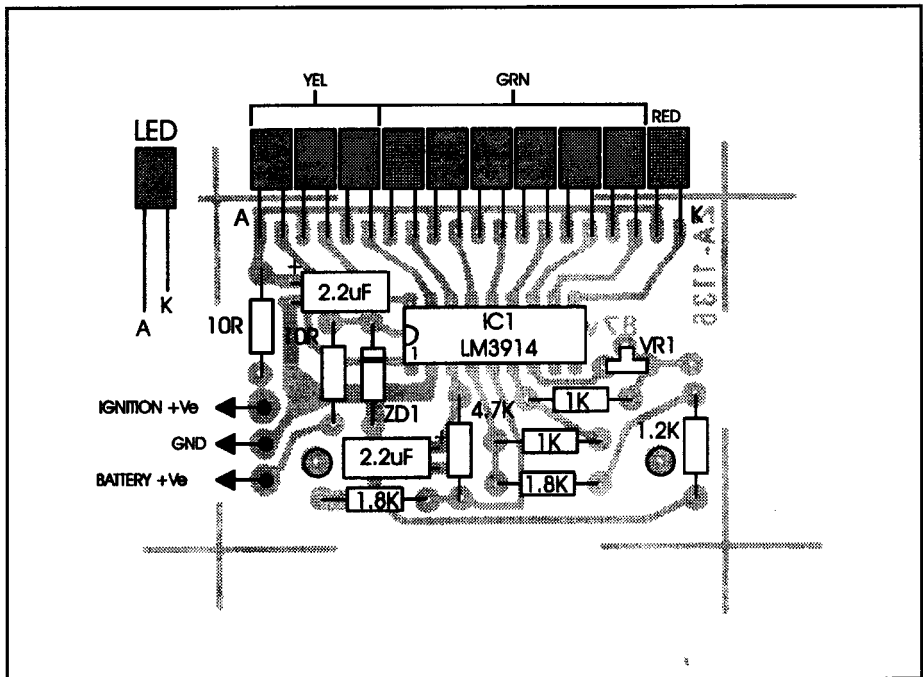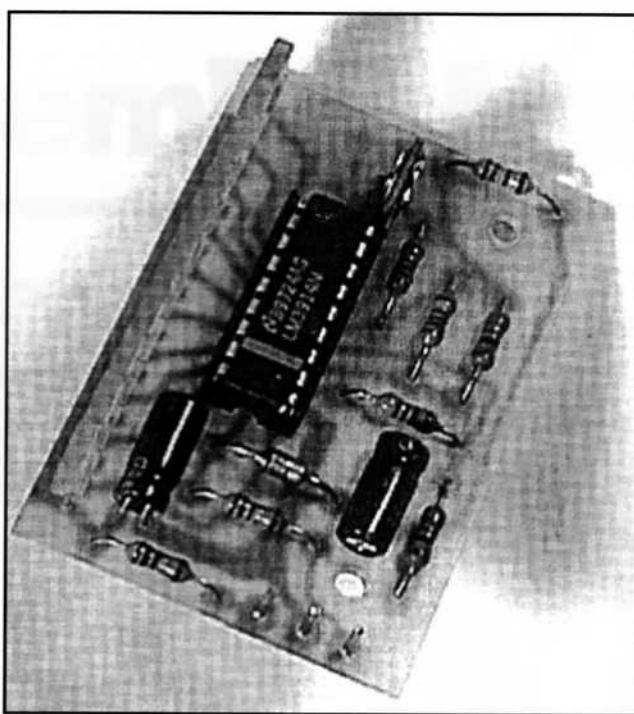The parts for the Car Battery Monitor are all mounted on a small PCB coded

Fig.2: It should only take you a few minutes to assemble the PCB. Take care with component orientation.

Text and illustrations courtesy of Electronics Australia

ZA1136 (87vm3) and measuring 63 x 43mm. Follow the overlay diagram (Fig.2) carefully when installing the parts on the PCB and note the orientation of the electrolytics, zener diode and IC.

Note also that the 2.2µF electrolytic capacitors are mounted flat against the PCB and an IC socket is used for IC1.

The LEDs should be installed so that they line up to make a neat display. Make sure that they are all oriented correctly (see circuit diagram or overlay for pinouts) and initially solder only one lead first so they can be easily adjusted. Once the LEDs are correctly aligned, the remaining leads can be soldered.

We used PCB pins for the three wiring terminal points, but these can be considered optional.

Note - LEDs can either be mounted at edge of board as shown in Fig.2 or at 90° to PCB as shown above.

Testing

To test the unit, you will require a variable power supply (11 to 15V) and a multimeter. Connect the Ignition and Battery terminals of the monitor to the supply positive, and the Ground terminals to supply negative. This done, connect your multimeter across the power supply and adjust VR 1 so that the red LED just lights at 14.4V.

Finally, check that the first yellow

LED extinguishes when the supply drops below about 11V.

Installation

The unit may be installed so that the LEDs protrude through a slot cut in the dashboard, or you can mount the PCB in a small plastic case. Another possibility is to mount the LEDs separately in a small fascia panel and connect them to the PCB via rainbow cable.

The Ground terminal can be connected to a nearby chassis point, while the Battery connection should be connected directly to the positive battery terminal or to a wire which runs directly to this terminal. The Ignition terminal can be connected to any convenient terminal in the fusebox which is switched on and off by the ignition switch.

Once the wiring has been completed, the monitor should display the battery voltage whenever the ignition is on. Make sure that you don't disturb the setting of VR1 during installation otherwise you'll upset the reference voltages.

Resistor Colour Codes		
Value	4 Band (1 %)	5 Band (1 %)
10R	Brn - Blk - Blk - Brn	Brn - Blk - Blk - Gld - Brn
1K	Brn - Blk - Red - Brn	Brn - Blk - Blk - Brn - Brn
1.2K	Brn - Red - Red - Brn	Brn - Red - Blk - Brn - Brn
1.8K	Brn - Gry - Red - Brn	Brn - Gry - Blk - Brn - Brn
4.7K	Yel - Vio - Red - Brn	Yel - Vio - Blk Brn - Brn

Notes & Errata

$16V$ zener $= Vcc$

$V_{\text{b}} = Vcc \times \dfrac{4.7K}{4.7K + 1.8K}$

$V_{SIG} = 11.5V$

$RH1$ PIN $6 = 11.5$ when input Battery is $14.4V$

$RH1$

Ref out pin 7.

$Vcc = 10.8V$

$V_{SIG} = 10.8 \times 0.72$

$V_{SIG} = 7.8V$

Pin 4 $= 7.8V$ when input Battery is $10.8V$ $R10$