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Flat Battery Warning Light

Many items of electronic equipment, particularly test gear, are battery operated and have a regulated supply voltage. A problem which can easily arise here is that of the battery voltage falling to a level which is inadequate to drive the regulator circuitry properly. This can result in the unit providing erroneous results.

Some such pieces of equipment have an integral battery check facility of some form or another, but it is an easy matter to add this feature to apparatus which is not already equipped in this way. One very simple form of battery check device is a circuit which turns on a warning light if the supply voltage falls below some predetermined level, and it is a simple unit of this type which is described here.

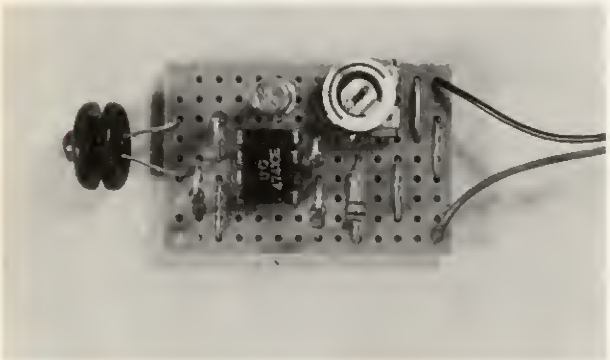

Figure 2.1

Flat battery warning light board

The unit (Fig. 2.1) can be used to monitor equipment other than test gear, of course, and can be used wherever it is necessary to ensure that a battery voltage does not fall below a certain critical level. It can

also be used in cars, boats, etc., to provide warning of a nearly discharged battery. Another application is in battery powered equipment which is used infrequently, or in alarm systems (such as the one described in the previous project) where the equipment is left switched on for prolonged periods and draws no significant current. In either of these cases it is very easy to neglect the battery and let it deteriorate to the point where it begins to leak. This can cause severe damage to the equipment owing to the highly corrosive nature of the leaking substance. This can be avoided by fitting to the equipment a circuit of the type described here, and using it to check the battery condition periodically.

The unit can be used with a minimum supply voltage of a little under 7V and it is advisable to keep the maximum supply voltage to no more than about 20V or so.

The circuit

The circuit is based on an operation amplifier i.c. which is used here as a comparator. The circuit diagram of the unit appears in Fig. 2.2 and IC1 is the operational amplifier.

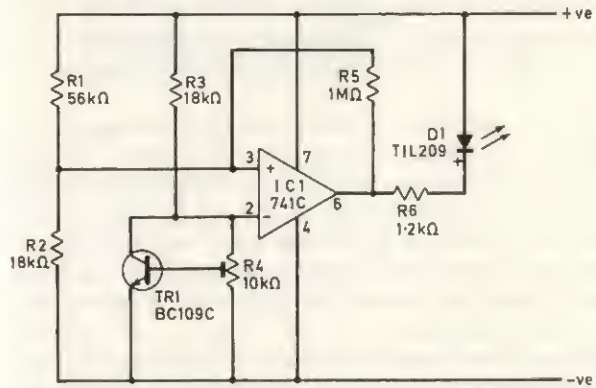

Figure 2.2

Circuit diagram of the indicator

The output of IC1 drives a light emitting diode indicator (D1) via current limiting resistor R6. When the output of IC1 is low (at virtually the negative supply rail potential), current will be supplied to D1 and it will light up. When the output of IC1 is high (at virtually the full positive supply rail potential) D1 will not be supplied with any significant current and will not light up.

Which output state the i.c. assumes depends upon the comparative input voltages. If the non-inverting (+) input is at a higher voltage than the inverting (–) input, the output goes high. If the comparative input levels are reversed, then the output goes to the low state. The non-inverting input is given a small positive bias voltage by the potential divider R1 and R2. The exact voltage at the non-inverting input obviously depends to a large extent on the supply voltage.

A simple voltage stabiliser circuit is used to provide a regulated potential at the inverting input of IC1. The regulator circuit consists of R3, TR1, and R4, with TR1 being used as what is often termed an amplified diode. This type of regulator relies upon the fact that a high gain silicon transistor such as TR1 will not begin to conduct until its base–emitter voltage reaches a level of about 0.6V, but a voltage only fractionally higher than this is sufficient to saturate the transistor. Therefore, if the slider of R4 is set a quarter of the way up its track, for instance, a current will flow through R3 and R4 and the voltage at TR1 base will rise to about 0.6V. It cannot rise much above this level as this causes TR1 to turn on and divert some of the current from R3 through its collector–emitter circuit. The voltage at TR1 base is thus stabilised at about 0.6V, and by a simple potential divider action the voltage at TR1 collector must be four times this level, or 2.4V in other words.

R4 can obviously adjust the potential at TR1 collector over quite wide limits, since taking the slider of R4 further down its track will increase the voltage required at TR1 collector in order to produce 0.6V at TR1 base. Taking R4 slider higher up its track will have the opposite effect.

In practice, R4 is adjusted to produce the same voltage at the inverting input of IC1 as appears at the non-inverting input when the supply voltage is at the minimum acceptable level. If the supply voltage is above the critical level, then the output of IC1 will be high and the LED indicator will not come on. If, on the other hand, the supply voltage falls below the critical level, the voltage at the non-inverting input will be below that at the inverting input, and D1 will be switched on as the output of IC1 will go low.

One slight problem with the circuit is that with very small voltage differences across the inputs, say a few hundred microvolts or less, the output can take up an intermediate state and produce an indecisive output from D1. This is overcome by the inclusion of R5. If the output of IC1 starts to go negative the current through R5 takes the non-inverting input more negative, which in turn takes the output more negative. This regenerative action continues until the output is fully negative, and in this way intermediate output states are eliminated.

Construction

All the components can be accommodated on a small 0.1in matrix stripboard panel which has 9 copper strips by 14 holes. Full details of

this panel are given in Fig. 2.3. Construction is quite straightforward, but be careful not to omit any of the four link wires or the five breaks in the copper strips. Also be careful not to bridge any copper strips with small blobs of excess solder, as this is easily done on this compact 0.1in matrix stripboard, particularly when soldering in the i.c. It is a good idea to check the completed board with a continuity tester to ensure that no short circuits of this type are present.

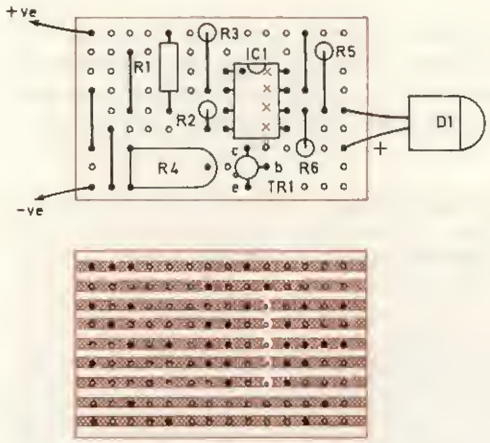

Figure 2.3

Constructional details of the board

If the leadout wires of D1 are bent at right angles it will then be possible to mount this component in an ordinary LED panel clip. As the component panel is quite small and light, this also provides an adequate mounting for the panel, but the leads of D1 must be kept quite short in order to provide a reasonably firm mounting. Owing to the small size of the unit, it will not normally be too difficult to fit it into a piece of equipment, although it may always be built as a separate unit in its own case where integration is not feasible. If this approach is adopted it will be necessary to bring the monitored supply rails out to a socket mounted at some convenient point on the main equipment. The input lead of the indicator circuit would then be terminated in a suitable plug so that it could be connected to the main equipment whenever necessary.

The unit has a current consumption of only about 1mA from a 9V supply, and so it will not normally reduce battery life to any great extent. However, it could do so under certain circumstances, and if this should be the case a push-to-make non-locking pushbutton switch can be connected in series with the positive supply rail. The unit will then draw no standby current, but it will be necessary to operate the pushbutton switch in order to check the battery condition, of course. The current consumption with the indicator lamp on is about 8mA from a 9V supply.

Adjustment

To enable the unit to be adjusted correctly it must be connected to a supply potential which is equal to the minimum acceptable battery voltage. R4 is then adjusted as far in a clockwise direction as possible without the indicator lamp coming on. The unit is then ready for use.

Components list for the flat battery indicator

Resistors (miniature ¼W, 5% except where noted otherwise)	
R1	56kΩ
R2	18kΩ
R3	18kΩ
R4	10kΩ sub-miniature (0.1W) horizontal preset
R5	1MΩ
R6	1.2kΩ
Semiconductors	
TR1	BC109C
IC1	741C
D1	TIL209 or any small panel mounting LED with holder
Miscellaneous	
0.1in matrix stripboard	
Wire, solder, etc.	