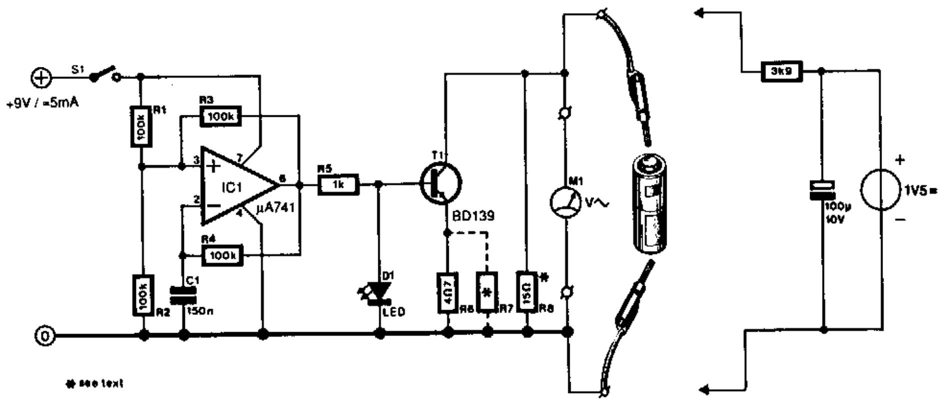
INTERNAL RESISTANCE BATTERY TESTER



ELEKTOR ELECTRONICS

Fig. 14-1

A designer often needs to know the value of the internal resistance of a battery. Quite a few testers give a relative indication of the value, but this is seldom in ohms. The present tester can, in principle, provide that information.

The basic idea behind it is to load the battery with a varying current, so as to cause an alternating-voltage drop across the internal resistance that can be measured at the battery terminals. Provided that current variations are regular and constant, the voltage drop is directly proportional to the internal resistance.

Choose the variation of the current carefully to read the value of the internal resistance directly on the scale of an ac voltmeter.

The load current is varied with the aid of a current source, T1 in the diagram, which is switched on and off by square-wave generator IC1. The chosen switching frequency of 50 Hz ensures that the ac component at the battery terminals can be measured by a standard ac voltmeter (universal meter).

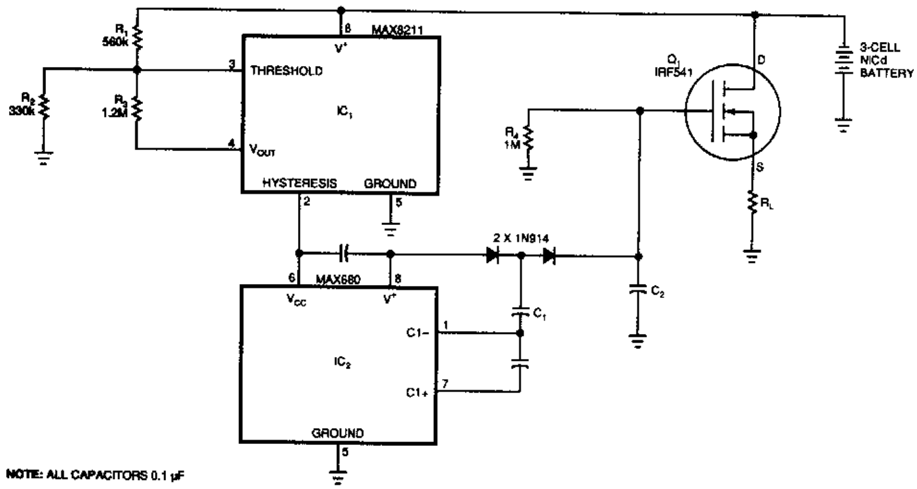
The battery is loaded constantly by R8, which has a value of 1.5 Ω for 1.5-V batteries, shunted by the ac voltmeter. The indicated voltage times 10 is the value of the internal resistance of the battery. When the battery under test is flat or if the supply battery is flat, no current flows and the meter will read zero. It would then appear as if the battery under test is an ideal type—without internal resistance.

A flat supply battery is indicated if D1 does not light. You can ascertain that the battery under test is flat by measuring the direct voltage across its terminals. The load must be left connected, of course, otherwise the emf is measured and this may well be 1.5 V—even if the battery is flat.

The tester is calibrated with the aid of the auxiliary circuit (shown at the extreme right in the circuit diagram). The 1.5-V supply and electrolytic capacitor form a virtually ideal voltage source, of which the 3.9-Ω resistor forms the internal resistance. With this source connected across the output terminals of the tester, a suitable value should be ascertained for R7. That value is found when the ac voltmeter shows 0.39 V. Notice that this procedure is not the same for all measuring instruments: the alternate use of the digital and a moving coil meter, for instance, is not feasible.

The tester is intended for 1.5-V batteries. The load current is fairly high: about 100 mA through R8 and around 170 mA through T1. For 9-V batteries that current is too high: the current should then be reduced by taking greater values for R6 through R8.

BATTERY-SAVING DISCONNECT SWITCH



NOTE: ALL CAPACITORS 0.1 µF

EDN

Fig. 14-2

At a predetermined level of declining terminal voltage, the circuit disconnects the battery from the load and halts potentially destructive battery discharge. Q1, a high-side, floating-source MOSFET, acts as the switch. The overall circuit draws about 500 μA when the switch is closed and about 8 μA when it's open.

The values of R_1, R_2, and R_3 set the upper and lower voltage thresholds, V_U and V_L, according to the relationships

$$R_1 = R_2 \left(\frac{V_L}{1.15} \right) - 1$$

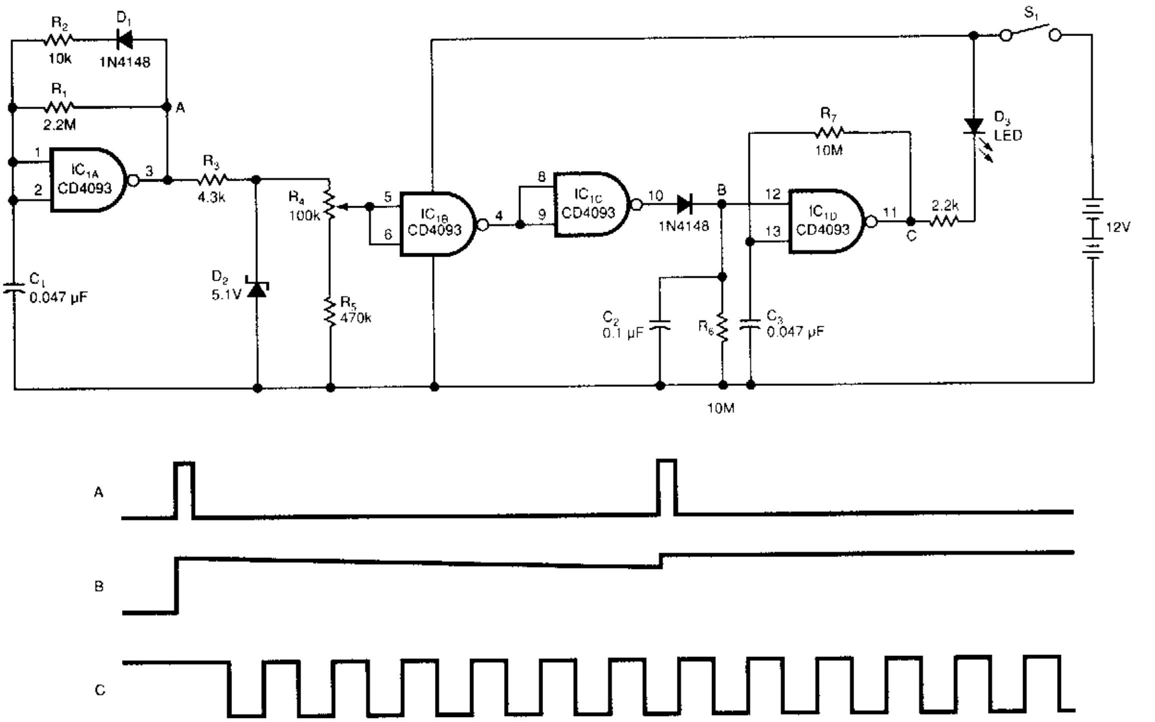
and

$$R_3 = 1.15 \left(\frac{R_1}{V_U - V_L} \right)$$

For the circuit to start, $V+$ must exceed V_U. The voltage detector IC1 then powers IC2, but only while $V+$ remains above V_L. Otherwise, IC2 loses its power, removes gate drive from Q1, and turns it off. IC2 is a dual charge-pump inverter that normally converts 5 V to ± 10 V. Capacitors C1, C2, and the two associated diodes form a voltage tripler that generates a gate drive for Q1 that is approximately equal to two times the battery voltage.

With the values in the schematic, the circuit disconnects 3-cell Nicad battery from its load when $V+$ reaches a V_L of 3.1 V. Approximately 0.5 V of hysteresis prevents the switch from turning on immediately when the circuit removes the load; $V+$ must first return to V_U, which is 3.6 V. The gate drive declines as the battery voltage declines, cause the ON-resistance of Q1 to reach a maximum of approximately 0.1 Ω, just before $V+$ reaches its 3.1-V threshold. A 300-mA load current at that time will cause a 30-mV drop across the disconnect switch. The drop will be 2 to 3 mV less for higher battery voltages. Resistor R4 ensures that Q1 can adequately turn off by providing a discharge path for C2.

LOW-BATTERY DETECTOR



EDN

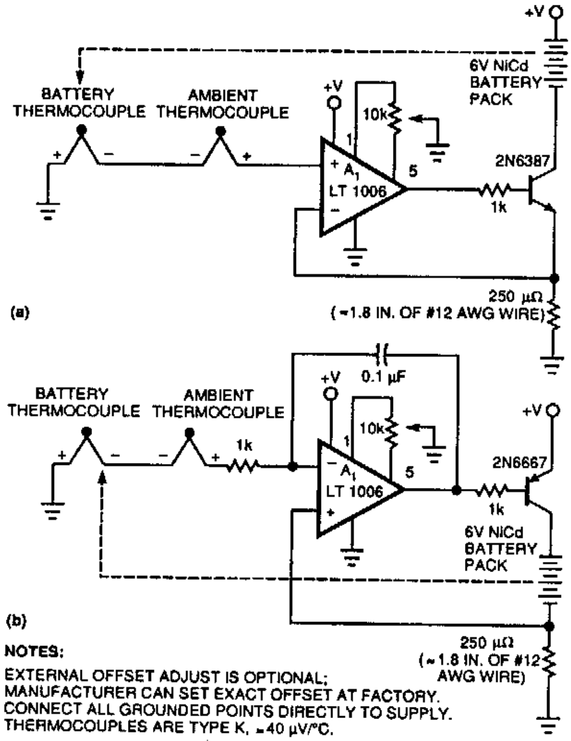
Fig. 14-3

The battery low-voltage detector uses a CD4093 Schmitt trigger and a capacitor that acts as a 1-bit dynamic RAM. The circuit conserves power by using a periodic test method. IC1A, C1, R1, R2, and D1 generate a narrow, positive pulse at point A.

D2, R4, and R5 regulate and divide the signal at A. Thus, the input of IC1B is independent of the power supply. Because the threshold voltage of the Schmitt trigger depends on the power supply, the threshold voltage will drop if the power-supply voltage drops. When the threshold voltage is lower than the input voltage, IC1B will become low, and IC1C's output will become high.

Capacitor C2 stores the results of the periodic test. The time constant C2 and R6 set is 1 s, and the test period is approximately 0.1 s. When point B is high, which implies that the battery is low, IC1D, C3, and R7 generate a square waveform, which lights D3. You can adjust the detected voltage level by adjusting R4. You can test different battery voltages by changing the voltage level of D2.

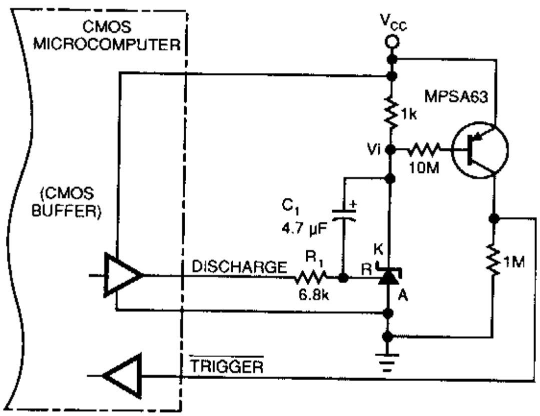
BATTERY-TEMPERATURE SENSING NICAD CHARGER



EDN *Fig. 14-4*

Two simple circuits permit Nicad charging of a battery based on temperature differences between the battery pack and the ambient temperature. This method has the advantage of allowing fast charging because the circuit senses the temperature rise that occurs after charging is complete and the battery under charge is producing heat, not accumulating charge.

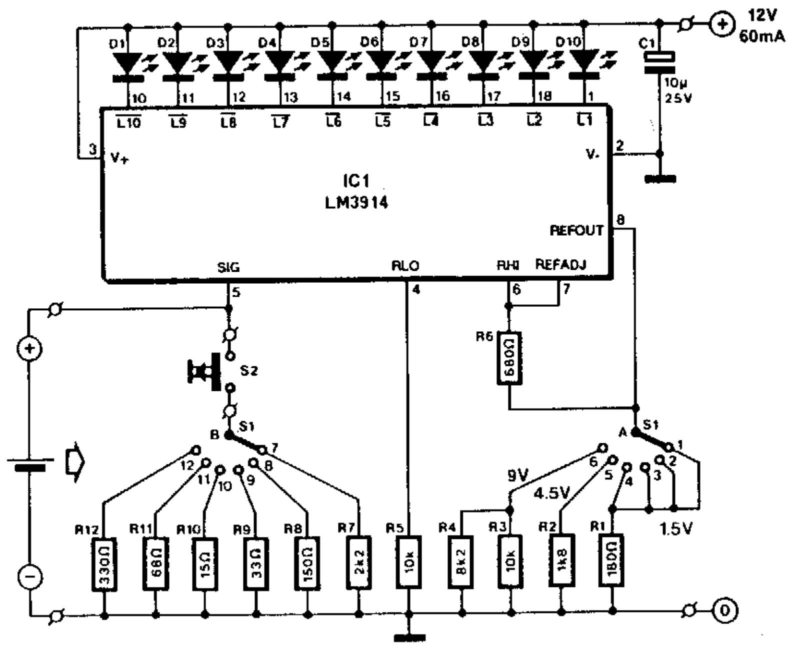
BATTERY-VOLTAGE MEASURING REGULATOR



EDN *Fig. 14-5*

This circuit allows a microprocessor system to measure its own battery voltage. A Texas Instrument TI431 precision shunt regulator acts as a precision reference and integrator/amplifier, measuring its own supply via voltage-dependent charge/discharge time intervals. Notice that you must write a short control and voltage calculation software routine for your system.

BATTERY TESTER



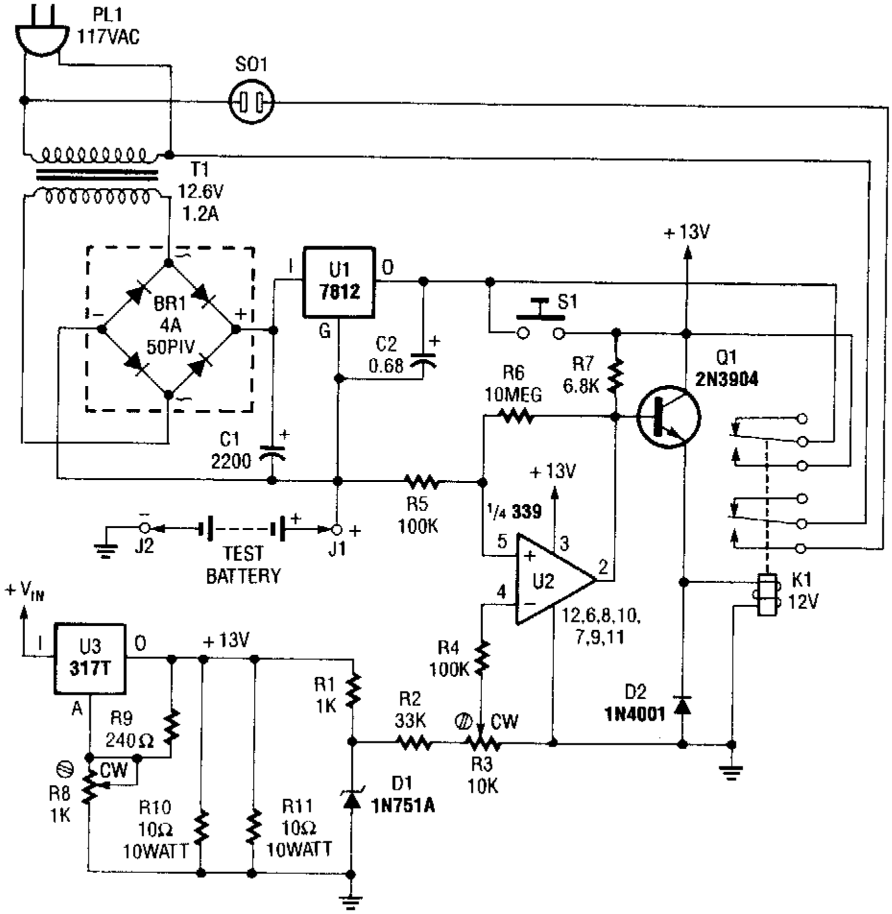
Range	LED									
	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10
	red	orange		green						
1.5 V	0.86	0.96	1.04	1.13	1.21	1.29	1.38	1.46	1.55	1.63
4.5 V	2.58	2.83	3.05	3.31	3.57	3.82	4.07	4.33	4.57	4.82
9.0 V	5.3	5.8	6.3	6.9	7.4	7.9	8.5	9.0	9.5	10.2

ELEKTOR ELECTRONICS

Fig. 14-6

This battery tester makes use of an LM3914 bar-graph driver IC. S1 selects load on battery under test and programs the voltage range. S2 loads the battery under test. The table gives the calibration factors for the tester. LEDs D1 through D10 are used as indicators.

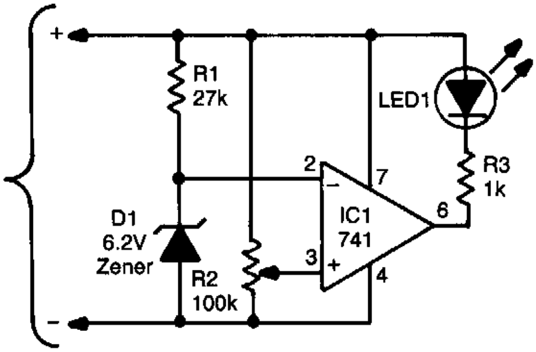
NICAD BATTERY TESTER



POPULAR ELECTRONICS *Fig. 14-7*

This Nicad battery tester discharges the test battery at a rate of 500 mA. When the endpoint of 1 V (determined by setting of R3) is resolved, pin 2 of U2 becomes low, deactivating Q1 and disconnecting the test battery from the circuit. Power for U3 comes from the 12-V regulator in series with the battery being tested. A clock or timer can be plugged into S1 to indicate the time it takes to discharge the battery under test.

LOW-BATTERY INDICATOR

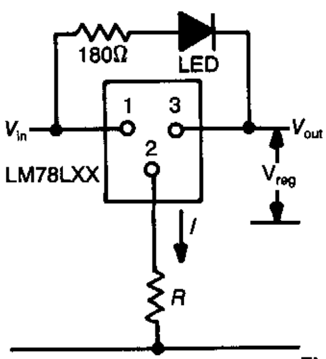


42 NEW IDEAS

Fig. 14-8

The sensing circuit consists of a 741 op amp set up as a voltage comparator, using a zener diode as a voltage reference. The op amp is inserted as a bridge between two resistance ladders, one which contains the zener reference, and the other a high-value linear potentiometer. When the voltage at the wiper of the potentiometer drops below the voltage set by the zener, the output of the op amp becomes low; that turns on the LED connected between it and V_{CC}. The circuit can be adapted to work with battery-powered circuits that require between 6 and 18 V; the only changes needed would be a lower-voltage zener and a smaller current-limiting resistor in the case of voltage below 9 V, and a larger resistor for higher voltages.

VOLTAGE-LEVEL INDICATOR



ELECTRONIC ENGINEERING

Fig. 14-9(a)

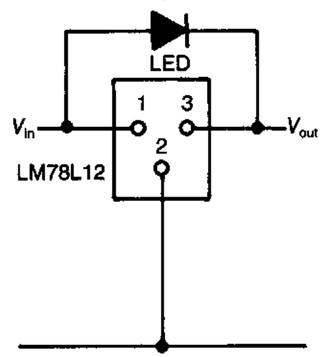


Fig. 14-9(b)

Three-terminal regulator device (LM78LXX) has $V_{out} = V_{in}$ until the input rises 1.5 to 2 V above the output when the regulated voltage $V_{reg} = XX$ is obtained. A differential of 1.5 V between input and output is necessary to light the LED. Thus, the LED lights when V_{in} rises above $V_{reg} + IR + 1.5$ V, where I is typically 6 mA (a zener diode could be used in place of R). For input voltages much higher than necessary to light the LED, a current-limiting resistor in series might be necessary. A useful automotive application is shown in Fig. 14-9(b). The circuit indicates when battery voltage is above 13.5 V which indicates (in conjunction with an ammeter) whether the alternator/regulator/battery system is operating correctly. With the engine off, the battery voltage drops to 12 V and the LED extinguishes. The circuit requires no calibration.