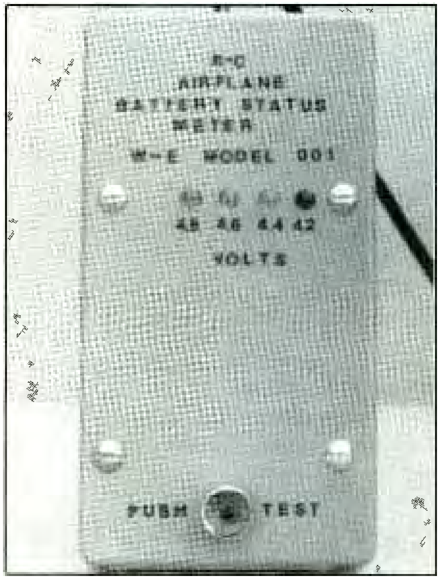
R/C Aircraft Crash Saver

An accurate battery status indicator for on-board radio-control gear ensures availability of sufficient power for takeoff and landing of costly model airplanes

By Harold Wright

More than 100,000 enthusiastic radio-control hobbyists put a lot of money at risk every time they send their models into the wild blue yonder. Some of these models have 6-foot wing spans and took hundreds of hours to build and get into flying condition, aside from the cost of the model and its accompanying radio-control receiver, transmitter and servomechanisms. The whole system depends on a small Ni-Cd battery's power, which has only a 0.6-volt cushion to ensure that it will operate the airborne model's rudder, elevator, ailerons and throttle. If battery voltage drops below this tolerance, the airborne model may not be able to be landed safely.

The accurate (to two decimal places) push-to-test battery status indicator presented here ensures that there is enough power left to make a smooth, controlled landing. Typically, an airborne receiver and servosystem battery pack has four Ni-Cd cells, each delivering 1.2 volts, series connected to provide 4.8 volts when fully charged. It is considered risky to launch an R/C model aircraft if battery output drops to 4.2 volts, so the "pilot" needs to know with considerable accuracy if he might be sending up his plane just once too often. With only 0.6-volt tolerance, the usual expanded-scale analog meter used for this purpose is inadequate.



Out R/C model airplane battery status meter uses a quad comparator, an adjustable voltage-reference chip and a series of four light-emitting diodes in three colors to tell you when your batteries are fully charges, when they are at intermediate levels of charge, and when the charge on them is too low for safe operation. This simple tester, in its raw state, weighs between 1 and 2 ounces and can be built right into a model airplane. If you have more than one model, you can build the project into a hand-held case and use it to monitor the status of the batteries in all of them.

About the Circuit

As shown in Fig. 1, the heart of the battery test meter is 339 quad comparator *IC1*. The principle used to display battery status is similar to that used in such bargraph ICs as the 3914. With this meter, however, each individual step can be calibrated to a high degree of accuracy. All inverting (−) inputs can be tied to LM336Z 2.5-volt reference *IC2*. Calibrated with *R26*, *IC2* holds the reference at 2.50 volts through a wider range of input voltages than is needed for this project meter.

Battery voltage to be monitored connects between the circuit common (negative pole) and the inverting inputs of *IC1A* through *IC1D* (positive pole) through multi-turn trimmer potentiometers *R1*, *R7*, *R13* and *R19*. When it goes high, the output of each comparator turns on its

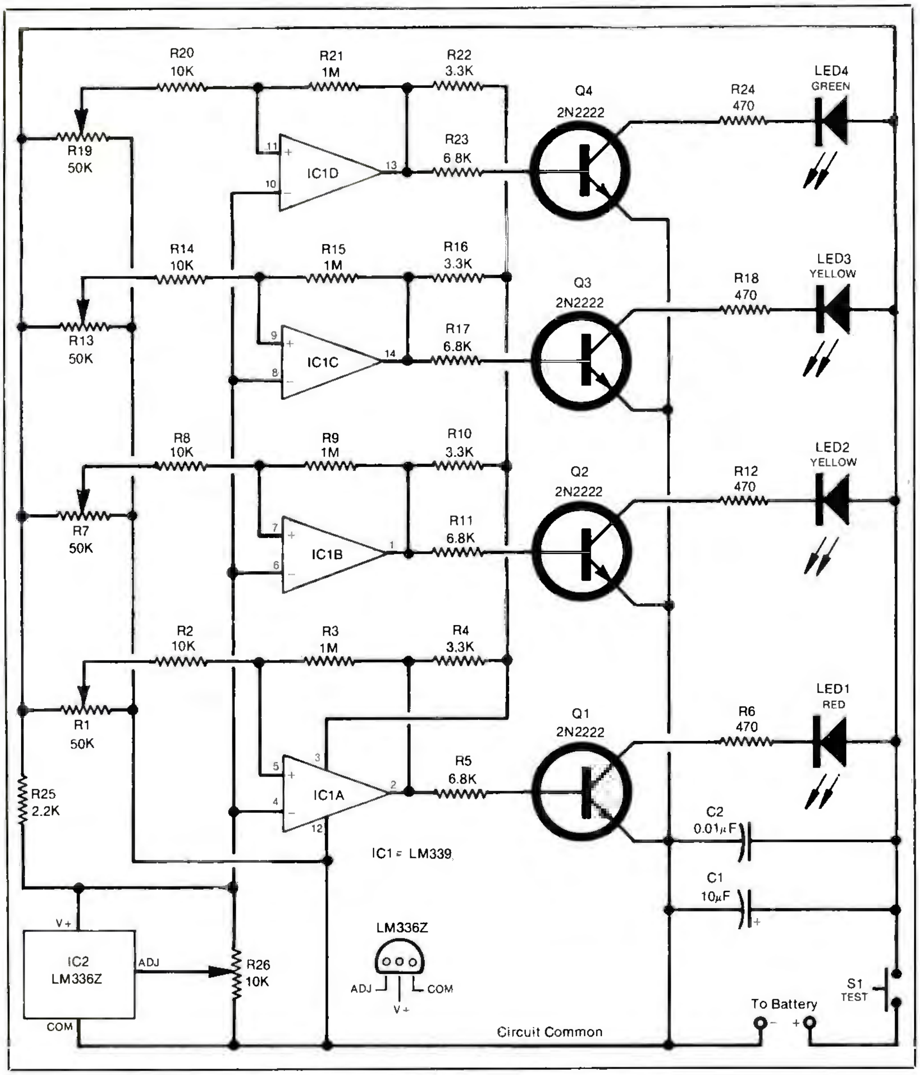


Fig. 1. Complete schematic diagram of battery tester.

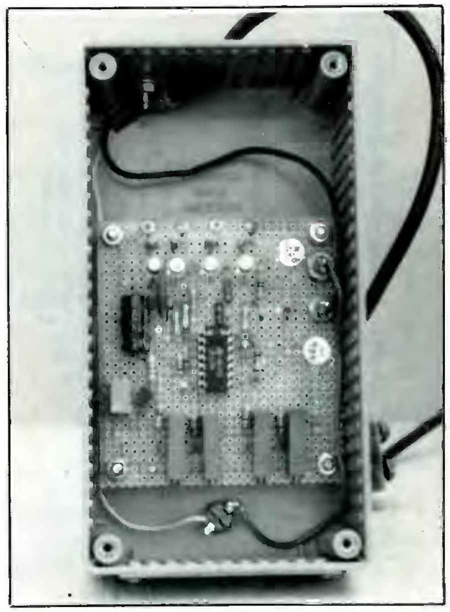


Fig. 2. Interior view of project.

associated transistor and lights the light-emitting diode connected to it.

Calibration is such that with 4.80 volts on the input line, all four LEDs light. If there is a drop of a few hundredths of a volt, green light-emitting diode *LED4* extinguishes. The remaining LEDs extinguish with lower battery voltages: yellow *LED3* just below 4.6 volts and yellow *LED2* just below 4.4 volts. With only red *LED1* on, battery output is 4.2 volts or less.

With slowly changing input voltages, the LM339 has a tendency to oscillate. By giving the comparators a small amount of "snap" action, any tendency toward oscillation is eliminated. Resistors *R3*, *R9*, *R15* and *R21* connected between the non-inverting (+) inputs and the outputs of each comparator provide the needed snap action for *IC1A* through *IC1D*, respectively.

To minimize the drain on the battery under test, *S1* is a momentary-action, normally-open pushbutton switch. To make a battery test, *S1* would be pressed for only as long a time as needed for the display to stabilize.

Construction

Construction is simple and straightforward. It should take only a couple of hours to build the project.

Weighing only an ounce or so, the circuit could be mounted inside the fuselage of the R/C model airplane, with the LEDs visible through a small clear plastic window and the TEST switch (*S1*) where it can be easily reached to press from outside the model. If there is a problem (perhaps because the button interferes with

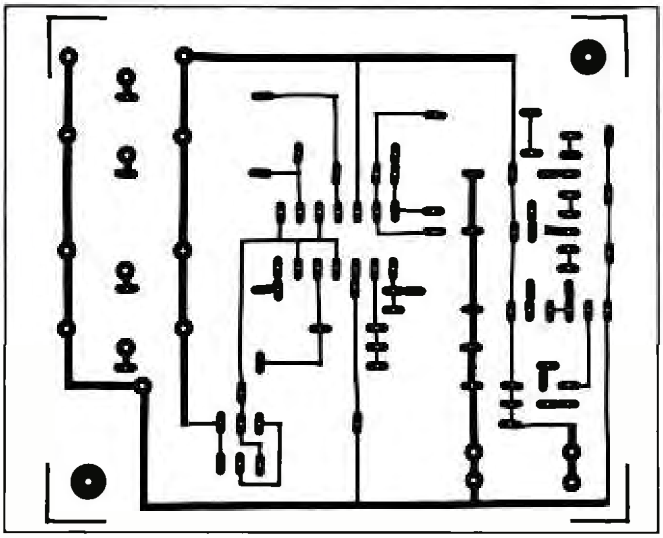


Fig. 3. Actual-size etching-and-drilling guide for fabricating printed-circuit board.

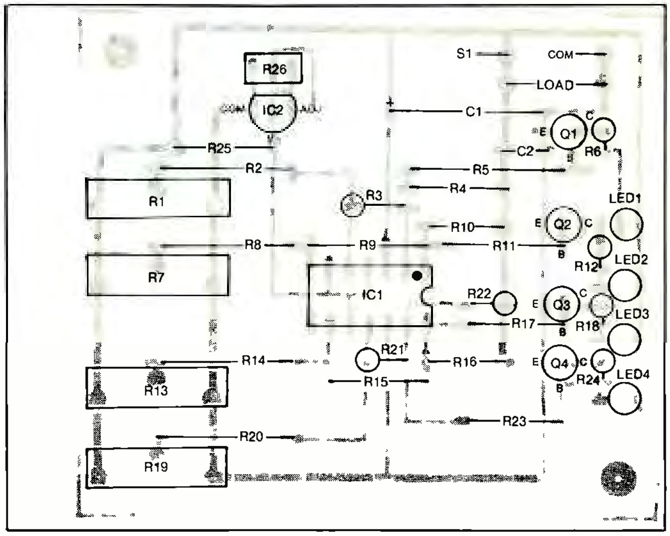


Fig. 4. Wiring guide for pc board.

PARTS LIST

Semiconductors
LED1—High-efficiency red light-emitting diode
LED2,LED3—High-efficiency yellow light-emitting diode
LED4—High-efficiency green light-emitting diode
IC1—LM339 quad comparator
IC2—LM336Z 2.5-volt reference
Q1 thru Q4—2N2222 npn transistor
Capacitors
C1—10-μF, 10-volt electrolytic
C2—0.01-μF disc
Resistors (¼-watt, 10% tolerance)
R2,R8,R14,R20—10,000 ohms
R3,R9,R15,R21—1 megohm
R4,R10,R16,R22—3,300 ohms
R5,R11,R17,R23—6,800 ohms
R6,R12,R18,R24—470 ohms
R25—2,200 ohms
R1,R7,R13,R19—50,000-ohm trimmer potentiometer (Bourns No. 3006P-1-503 or equivalent)
R26—10,000-ohm trimmer potentiometer (Bourns No. 3299W-1-103 top-adjust)
Miscellaneous
S1—Spst normally open, momentary-action pushbutton switch
Printed-circuit board or other wiring medium (see text); suitable enclosure (see text); 24-inch two-conductor cable; load resistor (see text); battery connector (see text); lettering kit; machine hardware and spacers; hookup wire; solder; etc.

the plane's streamlining), you can cement a small normally-open reed switch on an inside surface of the model in place of the pushbutton switch and place a magnet near the reed when you want to take a reading.

If you have more than one model, it would be better to build the battery tester into a small hand-held plastic case and equip it with a length of twin-conductor cable terminated with a connector that mates with the one normally used for charging the battery. If you have more than one model, use the same type of connector on all of them for easy, convenient testing. (There does not seem to be a set standard for these connectors among the various manufacturers of batteries.)

Because this is a pure dc circuit, no special component layout is required when wiring the components into place. Therefore, you can use any traditional method of wiring that suits you. Figure 2 is a photo of the prototype assembled on an unclad matrix board with holes on 0.1-inch centers. Wiring here was accomplished with the aid of the stick-on copper pattern and tape system described in "The 'Easy Circuit' Way to Make Circuit Boards (*Modern Electronics*, March 1985). However, you can use appropriate solder-type or Wire Wrap hardware or a home-fabricated printed-circuit board.

If you use the self-stick pattern-and-tape method, make sure you check each soldered joint with a low-range ohmmeter. Joints that look good to the eye can remain open circuits if the end of one tape curls a little where it overlays another tape or pattern.

You can fabricate your own printed-circuit board from the actual-size etching-and-drilling guide shown in Fig. 2. Once you have the board ready, refer to the wiring diagram in Fig. 3 to install a good-quality DIP socket for *IC1*, then install the resistors, capacitors, transistors and *IC2* in that order. Make sure you properly polarize electrolytic capacitor *C1* and have the basings correct