Zener diode tester plugs into your multimeter

Geoff Nicholls

This handy little adjunct for your multimeter allows you to read out the actual zener voltage of any zener diode up to 60 volts and will also test LEDs!

EVER DUG INTO a tray of components looking for a zener diode only to find that the markings have worn off? Even a brand new zener is usually marked with a code number giving little indication of the thing you want to know — the actual zener voltage rating. This simple tester will save you thumbing through the data books looking for a 1N4XXX, and allows easy identification of those unmarked diodes.

Most multimeters have a diode check position, but few can test LEDs, let alone zeners. This handy little adjunct for your multimeter allows you to test zeners up to about 60 volts, and can drive enough current through a LED to light it (and give you a reading of its forward voltage drop).

The tester simply plugs into your multimeter (a digital meter is ideal) and gives a direct reading of zener voltage. The circuit uses an inverter to provide a current-limited output of up to 70 volts dc from a nine volt battery. Table 1 shows the output characteristics of the prototype.

The leads on diodes are designated *anode* and *cathode*, the latter being marked by a band. When connected to the tester with the cathode to the black or negative terminal, the multimeter will indicate the diode forward voltage. For a silicon diode this will be about 650 mV while a germanium diode will read around 300 mV. Zener diodes are normally operated in reverse bias and are therefore tested with the cathode (banded end) connected to the red or positive terminal so that the zener voltage is displayed on the meter.

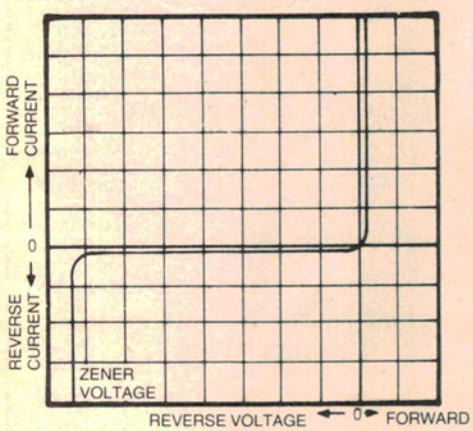


Figure 1. The fundamental characteristics of a zener diode. Little reverse current flows until a certain voltage — the zener voltage — is reached. This voltage is almost constant.

Zener characteristics

The zener voltage rating of a diode is only a nominal figure and should be considered with other parameters when designing circuitry. The first thing to realise is that the zener voltage is rounded to the *nearest preferred value*. Secondly, the voltage rating is dependent on the current passing through the diode. The diode manufacturers usually quote zener voltages at a current of 5 mA for voltages up to 30 volts and at 2 mA above this.

Low voltage zeners will not develop their nominal voltage until the current reaches a few milliamperes. As the diode current is increased the voltage drop will also increase, representing a dynamic resistance which varies from tens of ohms for zeners between six and ten volts, to hundreds of ohms outside these limits.

Lastly, the zener exhibits a temperature sensitivity that varies with zener voltage as shown in Figure 2. A detailed explanation of the temperature characteristic may be found in any solid state physics textbook, the essential features being a negative temperature coefficient associated with true zener breakdown below six volts and a positive temperature coefficient associated with avalanche breakdown above six volts.

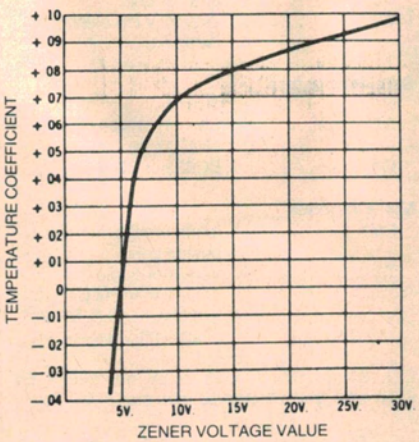
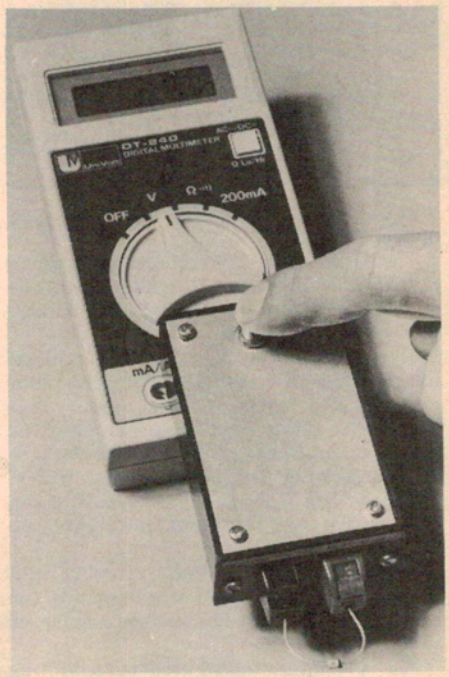


Figure 2. Temperature characteristics of zener diodes — depends on the zener voltage value.



Push-to-read. The tester is housed in a 'zippy' box with banana plugs protruding from the rear spaced to suit the multimeter input sockets spacing.

It is possible to combine zener diodes with opposing temperature coefficients in order to obtain a near temperature-independent reference, or to use a normal diode (with a negative coefficient) and a zener with the same result.

For further information on practical zener usage, refer to *ETI Circuit Techniques, Vol. 1*, pages 136 to 141.

Construction

I built the zener tester into a plastic zippy box with metal lid measuring about 30 x 50 x 80 mm. This is the smallest common low cost box that will accommodate the electronics and battery.

The pushbutton switch is mounted centrally in the lid about 10 mm from one end with the two banana plugs in the box underneath the switch. The spring terminals mount on the other end of the box, as shown in the photographs. You may wish to vary construction to suit the components on hand, but check ▶

TRANSFORMER NOTES

The transformer used in this zener tester is a 'transistor audio transformer'. Two separate types were tested, with virtually equivalent results.

The Dick Smith M-0216, described in the catalogue as being 'primary 1k ohm CT/secondary 8 ohm' was the one used in designing the circuit (CT means 'centre tapped'). Although described as having a ferrite core, the several we purchased had iron cores.

Many component suppliers stock this transformer, or an equivalent type. For example, Altronics call it an 'output transformer', catalogue number M 0216; Electronic Agencies have a '1k CT/8 ohm' mini transformer listed as cat. no. ME4012.

Just for safety's sake, in case the 1k CT/8 ohm transformers may not be available at some time or another, we tried a 500 ohm CT/8 ohm type from Altronics, cat. no. M 0226. Many other suppliers stock a transformer like this, too. As results were virtually equivalent, we can safely say transformers of this type may be used for T1 also. Connections were found to be the same as the M-0216.

Note that it may be physically larger, necessitating mounting R1 on the copper side of the board.

that the bits all fit together before chopping up your box.

The banana plugs are mounted at a spacing of 0.75", or about 19 mm, which allows the tester to plug straight into a standard multimeter with 'GR' inputs.

To mount the plugs, first remove the plastic handles and cut them down to 20 mm so they can be fitted inside the box. Solder about 100 mm of insulated wire to each plug and feed the end through the holes in the box. Grab each plug with pliers and push them through the holes from the bottom. Now slip the handles over the wires and tighten up the plugs.

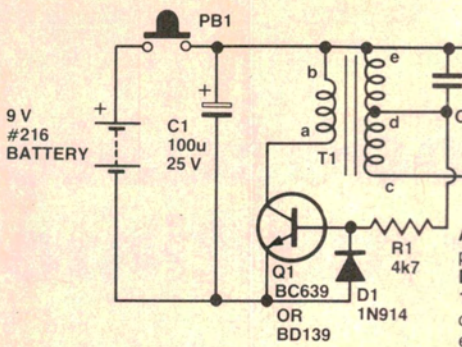
If all that seems too much, you may want to simply bring a couple of wires out to the multimeter with the banana plugs soldered to the ends.

The spring terminals I used had mounting holes about 45 mm apart which allowed screws to tap into the plastic pillars in the corners of the box. You may also mount the terminals on the long side of the box. In any case, a couple of holes will be necessary under the spring terminals to allow the solder lugs to pass through.

The pc board is straightforward to assemble, watch the orientation of the electrolytic capacitors, the two diodes (note: D1 is the smaller) and the transistor. There are several types of transformer available and some may require R1 to be mounted on the copper side of the board in order to fit properly. The pc board may slot into a groove inside the box, or simply lay alongside the battery as in our prototype. ●

TABLE 1 Performance of prototype.

OUTPUT VOLTAGE volts	OUTPUT CURRENT mA	BATTERY DRAIN mA
0	5	140
5	8	160
15	9	190
24	9	190
48	5	160
60	1.5	130
72	0	120



Artwork. A same-size film positive or negative of the pc board artwork can be obtained for $1 post paid from **ETI-164 Artwork, ETI Artwork Sales, ETI Magazine, 140 Joynton Ave, Waterloo NSW 2017.** Make out cheques or money orders to 'ETI Artwork Sales' and ensure you ask for a positive or negative as you require.

HOW IT WORKS — ETI-164

The operation of apparently simple inverter circuits is usually exceedingly complex, so the following is a simplified explanation!

After PB1 is closed, current flows through terminals 'e' and 'd' of the transformer (and C2) to the base of Q1 via R1. Q1 starts to conduct and causes current flow through transformer terminals 'b' and 'a' (the primary winding) which causes the magnetic field to build up in the transformer. This field increases the base current to Q1 because of the phasing of the windings.

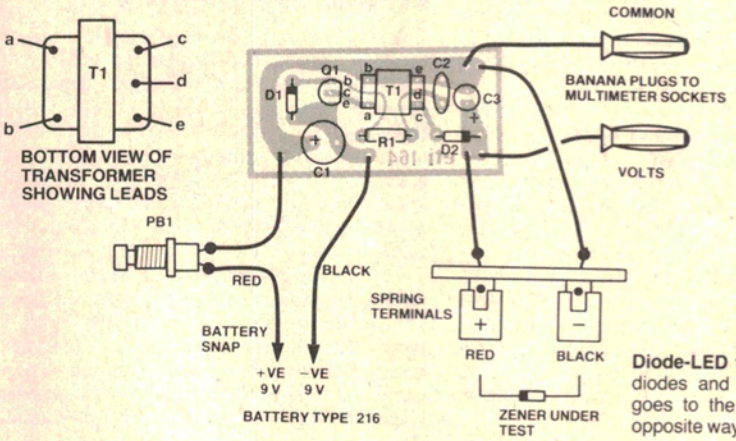
The magnetic field increases until the transformer core saturates, when the transistor base current reverses, turning the transistor off.

Diode D1 protects the base-emitter junction against excessive reverse bias voltage.

The energy in the transformer's magnetic field is dissipated via several mechanisms, one being to charge C3 via D2.

The whole cycle repeats at a rate of a few kilohertz.

Capacitor C1 provides a low impedance source to ac signals and improves operation with a battery supply.



Diode-LED test. When testing diodes and LEDs, the **anode** goes to the **red** terminal, the opposite way to zeners.

PARTS LIST — ETI-164

Resistor ..... ¼W, 5%
R1 ..... 4k7

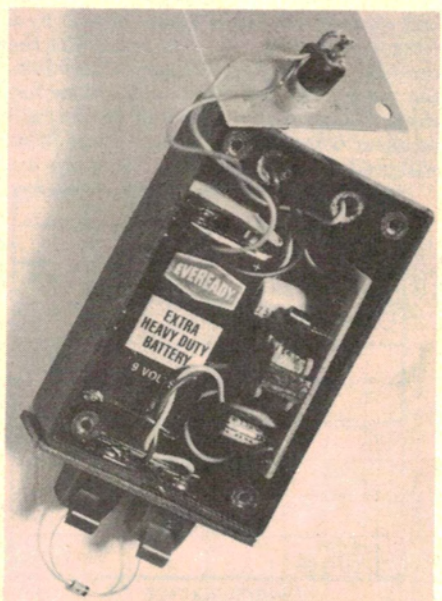
Capacitors
C1 ..... 100u/25 V (or 16 V) RB electro.
C2 ..... 3n3 ceramic
C3 ..... 2u2/50 V RB electro. (see text).

Semiconductors
D1 ..... 1N914
D2 ..... EM401, 1N4001, EM402, 1N4002, etc.
Q1 ..... BC639 or BD139

Miscellaneous
PB1 ..... momentary action pushbutton
T1 ..... transistor audio transformer, '1k CT to 8 ohm', D.S.E. M-0216 or similar (see text).

ETI-164 pc board; UB5 zippy box (28 x 54 x 83 mm); spring terminals; wire etc.

Price estimate $8 — $9



Inside story. Internal view of the zener tester. Note the cut-down banana plug handles at the top of the box.