Zener Tester

How do you identify zener diodes when their markings rub off? How do you distinguish them from ordinary diodes, and also work out which lead is which? The little tester presented here solves these familiar problems neatly, and also lets you check the breakdown voltage of transistors and normal diodes without damage. It also happens to be our first project using the new VMOS power transistors.

by LEO SIMPSON

At some time or other, everyone who is involved in electonics has come up against the problem of miniature zener diodes. They are so small that the minuscule printing on their body is difficult enough to decipher at the best of times. But you only have to handle them once or twice and the printing becomes completely obliterated.

The problem is bad enough when only one zener is used in the circuit you are constructing but when several are involved you just cannot proceed until they are all identified. If only one zener diode is involved, you may solve the problem fairly simply. If you purchased it this morning (and the printing is already rubbed off) then you can identify positive and negative leads by using the low "Ohms" range of your multimeter.

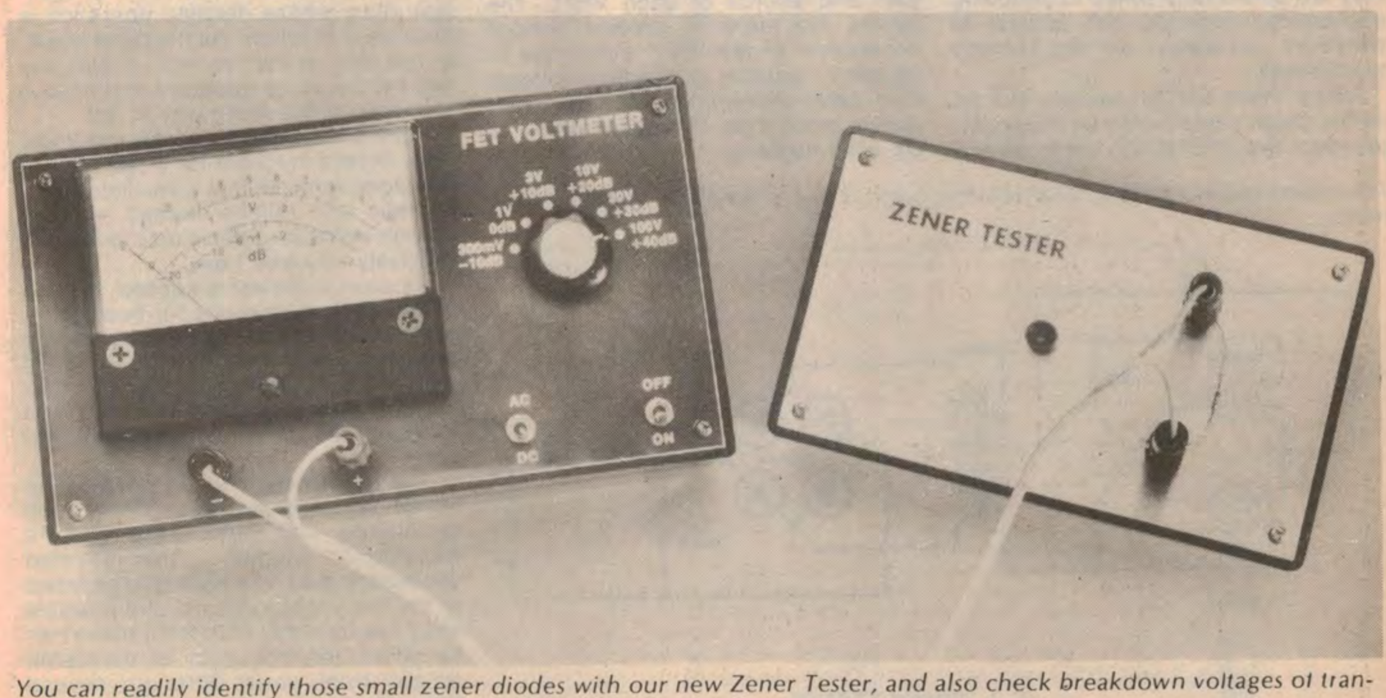
This presupposes that you know, without any doubt, that the zener dioded in question was the correct value. With this knowledge you can confidently install the zener in circuit and be sure it will work. However, to be able to use a multimeter to determine diode polarity, you need to know which probe is positive when the unit is switched to the "Ohms" range.

Usually, but not always, the probe polarity of a multimeter is reversed when used on the "Ohms" range. You can check this by testing it with another multimeter (ON A LOW "Volts DC" range) or by using an ordinary diode on which the polarity marking is clear. On most diodes, the cathode lead is identified by a stripe at the cathode end of the body.

While a multimeter may give polarity identification of a zener diode it is of little use in identifying the reverse breakdown voltage. To do this, you need some sort of constant current source. In practice, this takes the form of a high voltage DC supply together with a series limiting resistor, to protect both the supply and the zener diode to be tested.

The method of test is simple: Connect the zener diode across the high voltage DC supply together with a suitable current limiting resistor, to prevent over-dissipation in the zener. Then use a multimeter switched to an appropiate DC voltage range to measure the zener voltage. Or you could make up a composite instrument, with built-in voltmeter.

In its simplest form, a suitable a high voltage supply could be realised with a small mains transformer having a secondary winding of 150 volts or so. Couple this to a half-wave rectifier and filter capacitor and it will provide about 200 volts DC, which is more than adequate for the purpose. Many hobbyists will have a suitable transformer in their stock of oddments but for those who don't, such a transformer is expensive



You can readily identify those small zener diodes with our new Zener Tester, and also check breakdown voltages of transistors.

and not readily available over the counter.

With the above difficulty in mind, we set about producing a high voltage supply using cheaper and more readily available components. Our approach was to develop a low power transistor inverter using a small readily available mains transformer with a centre-tapped 12.6V winding. The transformer is used back-to-front, ie., a low voltage waveform is applied to the "secondary" and stepped up in the "primary".

> We estimate that the current cost of this zener tester is approximately
>
> **$18**
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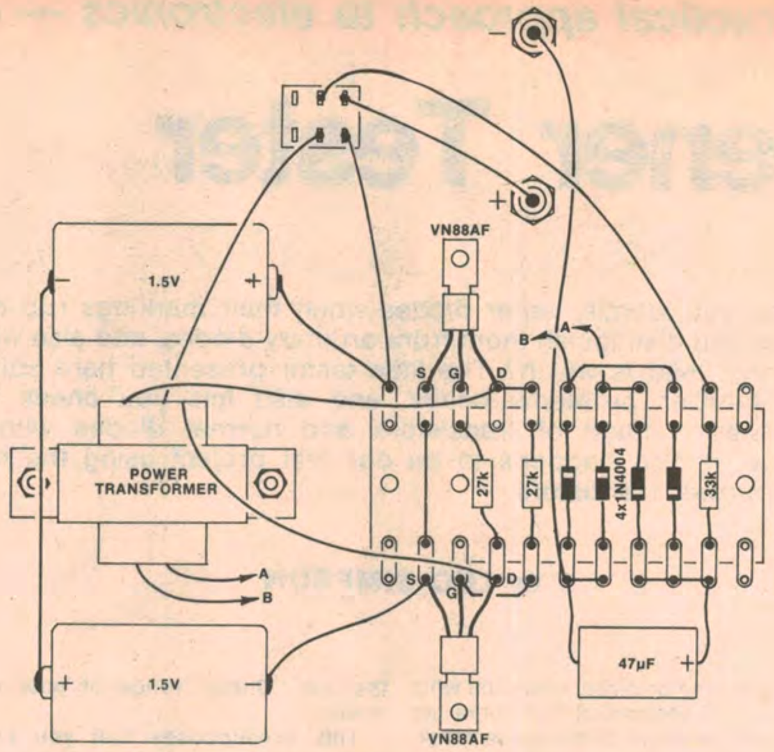
> This includes sales tax.



Even without a PCB, this circuit is easy to assemble. You could have it going in an hour.

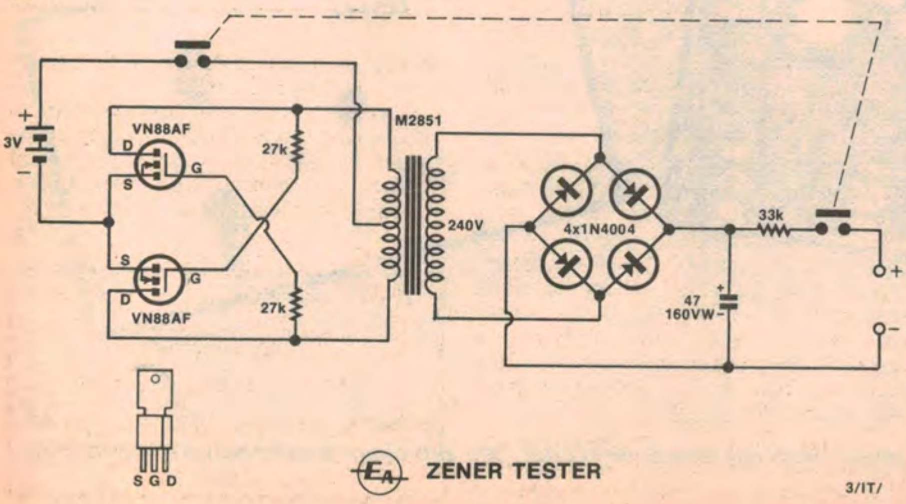
This is acheived by connecting a transistor multivibrator across the low voltage winding. The square waveform produced by the switching action of the transistors is multiplied approximately 20 times by the transformer, to appear as high amplitude waveform across th 240V winding. This can be rectified to produce high voltage DC.

In the past, we have used bipolar transistors for this sort of application but since VMOS FETs have just recently become available at reasonable prices, we deicded to use those instead. They are ideal for the jobs as they are particularly suited to switching applications and are not subject to thermal runaway or secondary breakdown.

Using these VMOS devices, the inverter circuit could hardly be more simple. Just two VFETs, two resistors and the transformer are all that is needed. The resistors are not necessary to provide current limiting to the VFET gates, as would be required in the base of an equivalent bipolar transistor circuit; Since they are an insulated gate device, VFETs do not draw any gate current as such.

Instead, the 27k resistors provide current limiting for the internal protective zener diode connected between gate and source of each VFET. The zeners are there to prevent voltage breakdown of the VFET gates due to excessive positive or negative voltage. Each zener prevents its gate from being pulled more than 15 volts positive or 0.6 volts negative.

The circuit below operates very reliably, but it is not as simple in operation as it looks.



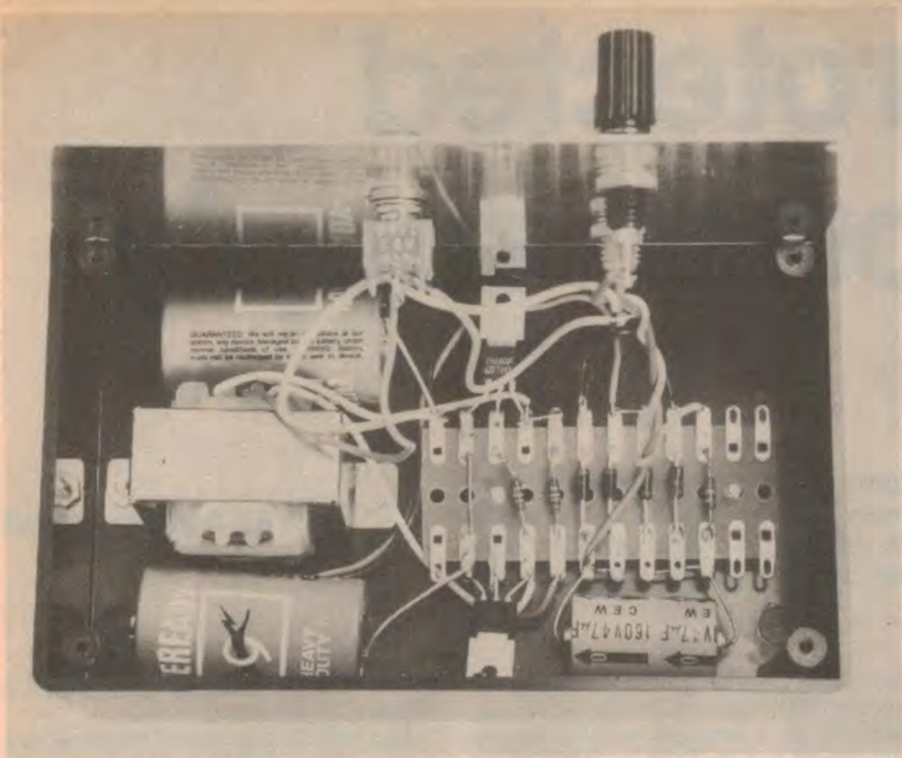
Despite the apparent simplicity of this particular type of inverter circuit, its operation actually seems to be quite complex. In fact after a lengthy and at times rather animated discussion among the EA staff, we came to the conclusion that we didn't really understand exactly how it does work.

It is one of those "variant" circuits which superficially seems only slightly different from a more familiar configuration, whose detailed operation is quite easy to follow. yet the more closely you look at the "variant" circuit, the more it becomes apparent that it does not work in the same way at all!

For the moment, therefore, you'll just have to take my word for it that the circuit does work. In fact it oscillates very strongly and reliably indeed — even though we're at rather a loss to explain precisely why and how.

As soon as power is applied, the two VFETs begin a vigorous flip-flop action, with each device alternately driven between cutoff and saturation. As a result the transformer winding has current flowing alternately in one half and then the other, in opposite directions.

The frequency at which this flip-flop action takes place depends on the resistance and inductance on the transformer winding , the reflected secondary load, the output impedance of the low voltage source, and possibly stray capacitance. With the transformer specified, the frequency of oscillation ranges from about 30Hz up several kilohertz, depending on the load on the secondary.



We used miniature tagboard instead of a PCB to keep the cost down.

When rectified and filtered, the output of the high voltage winding produces a litttle over 100 volts DC, with no load connected.

We wished to test all the commonly available zener diodes up to 75V. Zener diodes below 30V are usually tested at 5mA, while those above and up to 75V are tested at 2mA. To satisfy those conditions with this circuit requires a battery input voltage of 4.5 of 6 volts at quite a heavy current drain.

To obtain a more modest current drain we decided to use a battery input voltage of 3 volts. This results in an open-circuit voltage of just over 100V, as noted before. With a 33k current limiting resistor, the maximum current into a short circuit (and thus into low voltage zener diodes) is 2 milliamps. For a 50V zener diode the current is reduced to about 1 milliamp, reducing to about 0.5mA for a 75V zener.

Because these currents are lower than the standard test currents for most zeners, the voltage registered will be slightly below the actual or nominal breakdown voltage of the zener. Even so, the voltage registered will be within 10% of the nominal value (assuming a 5% zener tolerance), which is close enough for this purpose.

Current drain is about 90 milliamps from the 3V supply with no load and about 150 milliamps with the output shorted. This order of current can be comfortably provided by C-size cells for short periods, or by a 3V plugpack of the type normally intended for running a calculator.

Efficiency of the circuit is about 45% when the maximum current of 2 milliamps is being drawn from the output terminals. Most of the losses are due to the transformer but an appreciable portion is due to losses in the VFETs. The reason for this is that while VFETs are very effective as switches and do not require much drive power, they have quite high saturation voltage compared with bipolar transistors.

The zener tester realised with this circuit is very easy to use. Just connect a multimeter to the output terminals and switch to the 100V DC range. Connect the zener across the terminals as well, and push the button. The meter pointer should rise up the scale to indicate the zener's voltage. If the reading is low, switch down a range or two to get a reading as close as possible to full-scale deflection.

If the reading is only about 0.6V then you have the zener connected the wrong way around. If the reading is zero, then the device is short-circuit. It takes only a moment to take a reading. When you release the push-button the reading will drop to zero, as the switch disconnects the high voltage source, to avoid the possibility of shock.

Construction of the device is straightforward and should present few problems. The tester is housed in a plastic utility box with aluminium lid. We have not used a PC board. Instead, the total of only ten components is soldered to a length o miniature tagboard. While this may look like more work, it involves very little in extra soldering and saves a dollar or two on two on the PCB.

The only fiddly part of the construction involves the mounting of the two C-size cells. We were unable to obtain a battery holder for these, so they are wired directly into circuit. The two cells are wired in series with a piece of 18-gauge tinned copper wire, which is sleeved with spaghetti and held in place under the transformer core — this provides positive location of the batteries, on either side of the transformer. The remaining battery electrodes are soldered by a short length of tinned copper wire, to the tagboard.

If you have a 3V plugpack in your possession you can dispense with batteries and install a suitable power socket instead.

Since this unit has a low testing current it may also be used to check the voltage ratings of normal diodes; also bipolar transistors (ie., Vcbo and Vceo). The method of test is the same as for zeners, with the emitter or base left unconnected as required.

Considering the low cost of the tranformer and the relative simplicity of the circuit, we are sure that many will want to build this handy little tester. It is a neat and practical solution to a common problem.

PARTS LIST

1 plastic case with aluminium lid, 160 x 50 x 96mm
2 binding post terminals, one red, one black
1 momentary contact push-button switch with normally-off DPST or DPDT contacts
1 miniature power transformer with 12.6 VAC winding: A&R 6474, Ferguson 2851 or DSE M-2851.
1 12-lug length of miniature tagboard
2 VN88AF VFETs (Siliconix)
4 1N4004 silicon diodes
1 47uF/160VW electrolytic capacitor
1 33k/¼W resistor
1 27k/¼W resistors
2 C-size 1.5V cells
Hook-up wire, screws, nuts, lockwashers, tinned copper wire, spaghetti sleeving solder, multimeter.

NOTE Passive components with higher ratings may be used if space permits. Siliconix VFETs are distributed by IRH Components, Natronics Pty Ltd, 2 The Crescent, Kingsgrove, NSW 2208.