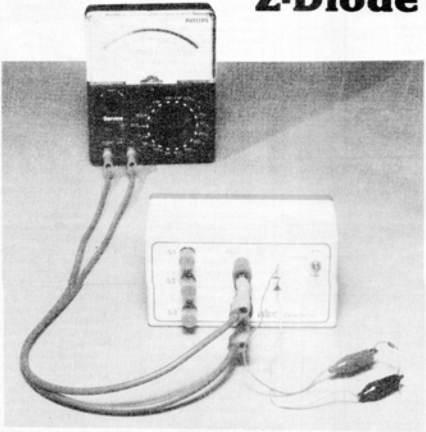
Z-Diode Tester



Right at the beginning, let us make it clear why we have called it a Z-Diode Tester and not a 'Zener Diode Tester as you might be expecting. A little bit of hair splitting is necessary to understand this. To be very precise, Zener Diodes are available only for the voltages between 2.7 and 5V. Ony these are the genuine Zener Diodes, based on the effect inverted by Mrs. Zener! The so-called Zener Diodes available for higher voltages are really 'Avalanche-Diodes' which are based on the Avalanche effect. Zener Diodes for voltages less then 2.7 V are also not true Zener diodes but they are just the combinations of two or three ordinary silicon diodes in series packaged in a single glass body.

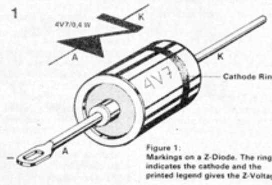


Figure 1:
Markings on a Z-Diode. The ring indicates the cathode and the printed legend gives the Z-Voltage.

Precisely for this reason, we have not used the name Zener Diode Tester. The name Z-Diode is used to cover all the three types of diodes.

The Z-Diode teter described here can be used for all types of Z-diodes, as well as for ordinary diodes. The tester can be used to test a Z-diode and find out if it can function, how well it can function and how high is the Z-Voltage.

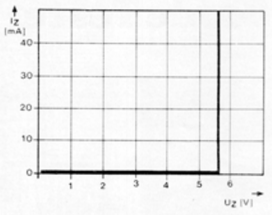
Normally the Z-voltage is marked on the body itself. For example, "4 V 7" or "5 V 6" means a Z-Voltage of 4.7V or 5.6V. However, there are some Z-Diodes which have code numbers only and no Z-Voltage markings. In case of these diodes, one must either consult the manufacturers data book or use the Z-Diode Tester to find out more about the diode.

Sometimes when using components removed from old circuit boards, one may come across a diode with illegible markings. In such a case, firstly we want to find out if it is a Z-Diode at all, and if it is , then we must find out the Z-Voltage.

How well a Z-Diode functions depends upon its V-I characterisistics. The V-I characteristics if ab udeak Z-Diode and a practical Z-Diode are shown in figure 2a and 2b. In case of an ideal Z-Diode, the diode is non conducting till the voltage reaches the Z-Voltage value. As soon as the Z-Voltage is reached, current flows through the diode and the diode behaves like a short circuit. The voltage remains clamped at the Z-Voltage value and remains independent of the amount of current flowig through the diode. The characteristic curve goes up vertically towards infinity. .
If we operate such a diode with a series resistance as show in figure 3, the voltage across the diode remains clamped at the Z-Voltage and only current changes with change in UB. This property is very useful in designing stabilised power supplies.

A practical Z-Diode does not function as effectively as an ideal Z-Diode. The characteristic curve of a practical Z-Diode is shown in fugure 2b.

2a



2b

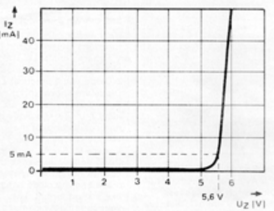


Figure 2a :
Characteristic curve of an ideal Z-Diode. Voltage across diode remains constant independant of current after it breaks down at the Z-Voltage.

Figure 2b:
Characteristic curve of a practical Z-Diode The voltage slightly increases with current.

Figure 3:
Principle of operation of the Z-Diode Tester.

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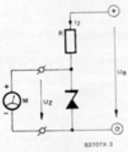


The curve does not rise vertically upwards, but does so at an angle. Due to this slightly slanted curve, the voltage across the Z-Diode does not remain fully independent of the diode current. How well the Z-Diode functions can be seen from how steeply the curve rises. The Z-Diode tester described here has a facility to measure the Z-Voltage at seven different currents flowing through the Z-Diode.

The Circuit

The principle of our Z-Diode Tester is similar to the circuit shown in figure 3. A DC voltage, a series resistance and a Z-diode. When the voltage is more than the Z-Voltage, a current flows through the circuit. Value of the current is decided by the series resistance and the Z-Voltage of the diode.

With a 9 V DC supply, a resistance of 1K and a Z-Voltage of 4.7V, the voltage across the resistor is 4.3V and current flowing through the circuit is 4.3 mA.

Now if we replace the Z-diode by another one with a Z-Voltage of 6.8V, then the voltage across the resistance is only 2.2V and the current through the circuit is only 2.2 mA.

From the above observations, we can draw a conclusion that just a series resistance is not enough if we want to test different Z-diodes at the same current. We need a constant current source for this, preferably one with different current settings available.

Figure 4 shows the practical circuit of the Z-Diode Tester with a constant current source and three switches to set the constant current value. Transistors T1 and T2 together function as a constant current source. These are connected in such a way that the colletor current of T1 always remains constant and depends on the resistance across the Base-Emitter of transistor T2; which can be varied in seven steps by setting the switches S1, S2 and S3 in different combinations.

To understand the functioning of the circuit, assume that switch S1 is closed. With the power supply connected across ⊕ and ⓪ various currents will flow in the circuit.

The collector current of T1 also flows through the Z-Diode and through the resistance R1. However, as the resistance R1 is directly connected between the base and emitter of transistor T2, voltage across R1 cannot exceed 0.6V which is the Base-Emitter voltage of T2. When voltage across R1 tries to cross 0.6V, T2 goes into conduction and its collector current flowing through R4 increases. With increased current through R4, the voltage on the base of T1 reduces. A drop in base voltage of T1 means a drop in its collector current; which is nothing but the Z-Diode current. These two actions balance each other in such a way that voltage across R1 in not allowed to rise beyond 0.6V and in effect the collector current which is also the Z-Diode current remains constant.

By changing the switch settings in various combinations, we can obtain seven different values of the diode current for our tester. The three switches give three independent settings, three combinations of two switches closed simultaneously and one combination where all three are closed simultaneously. When more than one switches are closed simultaneously it results into a parallel combination of resistances. Table 1 gives all the seven combinations, and the values of currents produced by them with a 24 V power supply.

Table 1

Switches closed	I_Z bei U_B = 24 V in mA
S1	2,22
S2	5
S3	21,3
S1 + S2	7,2
S1 + S3	23,5
S2 + S3	26
S1 + S2 + S3	28,4

With the power supply voltage of 24 V, Z-Diodes for voltages upto 21 volts can be tested. It is easier to obtain a supply voltage of 18 V rather than 24V, by connecting two 9V battery packs in series. With an 18 V supply, Z-Diodes for voltages upto 15V can be tested. The currents shown in table 1 will be slightly reduced with an 18V supply. Even otherwise, the currents will deviate by +10% due to tolerances in resistance values and transistor characteristics. Practical application of the Z-Diode Tester is not affected by this deviation. If need for testing Z-Diodes for voltages above 15V is expected, a 24V supply must be made available. One such circuit for a 24V battery eliminator is given in figure 5

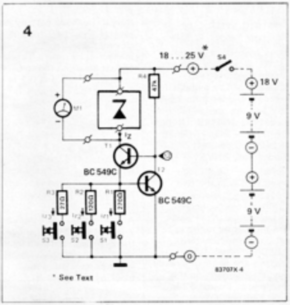
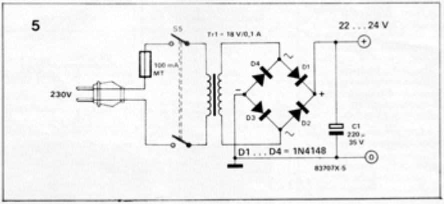


Figure 4:
The practical design of the Z-Diode Tester. A constant current source is incorporated.

Figure 5:
This simple battery eliminator circuit can be used to provide a 24V supply voltage to the Z-Diode Tester.



Construction

The circuit of the Z-Diode Tester is so simple to construct, it can be easily assembled on a size 1 SELEX PCB including two 9V battery packs.

The component layout is shown in figure 6. It occupies just half the area on the PCB, and if you are good at soldering, probably nothing can go wrong!

Details of the prototype mounted in a plastic cabinet are shown in the photograph which appears at the end of this description. The front panel layout can be seen in the photograph at the beginning of this article.

The switch appearing in the top right hand corner is the ON/OFF switch which connects or disconnects the power supply. Two small wires with crocodile clips are provided for connecting the Z-Diode under test, red for the cathode and black for the anode of the Z-diode. The symbol of the Z-Diode is also painted on the front panel between the two connecting wires. Two banana sockets are provided for connecting the multimeter leads, the colours chosen are again red for plus and black for minus. On the left handside of the panel, there are three push button switches S1 S2 and S3.

Once the assembly is complete, the functioning of the Z-Diode Tester can be checked as follows:

1) Check the supply voltage.
2) Connect the two crocodile clips together and check the voltage on the base of transistor T1 to be 1.2V and that on the base of transistor T2 to be about 0.6V. At least one of the three push buttons must be pressed during this measurement.
3) Connect the two crocodile clips to the leads of a multimeter and keep the multimeter in the 50 mA measuring range. Press the push buttons as per combinations shown in table 1 and check the current flowing through the collector of transistor T1. The measured current should agree with the values given in table 1 with a maximum deviation of + 10% for a 24V power supply. If an 18V power supply is given using two 9V battery packs, the current values may be a little less than those indicated in table 1.

If all the above tests are passed - your Z-Diode Tester is in perfect working order.

Testing with the Tester.

If you have used two 9V battery packs as the power supply of your Z-Diode Tester, it will be suitable for testing Z-Diodes from 1.5 to 15V and the normal silicon diodes like 1N4148, 1N4001 etc. (With a supply voltage of 24V, you can test Z-Diodes upto 21 V.)

For testing, the Z-Diode is connected with the two crocodile clips, and the multimeter is connected through the banana plugs. The measuring range to be set on the multimeter is 20V D.C. Switch S2 is now pressed and you can directly read theZ-Voltage on the multimeter. Switch S2 is used because it gives approximately 5 mA current through the Z-Diode, and the rated Z-Voltage is generally specified at 5 mA operating current. This is true for almost all 0.4W Z-Diodes. In case of 1 W Z-Diodes, keep all three switches pressed to give the maximum test current of about 28 mA when measuring the Z-Voltage.

The find out how well the Z-Diode functions, measure the Z-Voltage at every switch combination of table 1. The varioation in Z-Voltage with increase in current will tell you how steeply the characteristic curve rises. A 5.6V/0.4W Z-Diode may give a variation of about 0.2V in the Z-Voltage over the current range of 5mA to 28mA. The smaller this variation, the better is the Z-Diode.

If during the test, the multimeter shows a Z-Voltage comparable to the supply voltage itself, this can mean the following:

1. The Z-Voltage is beyond the measuring range of our tester.
2. The Z-Diode is open.
3. This is not a Z-Diode but it may be just an ordinary germanium or silicon diode.

Now if the diode polarity is reversed and switch S2 is closed, the voltage measured by the multimeter should be about 0.6 to 0.7V for Germanium and 0.2 to 0.4V for silicon diodes. If this voltage is less than 0.2 volts, it means that the diode is short circuited.

In case of a good Z-Diode which showed the Z-Voltage equal to the supply voltage, it should show a voltage of about 0.7 when its polarity is reversed.

A good diode (other than a Z-Diode) will always show the Z-Voltage to be almost equal to the supply voltage when connected in the blocking direction.

Component List :
R1 = 270Ω
R2 = 120Ω
R3 = 27Ω
R4 = 47KΩ
T1 = BC 549 C
T2 = BC 549 C

S1 ... S3 = S.P.S.T. Push button Switches

S4 = ON/OFF Toggle Switch.

Other parts.

2 wires with crocodile clips.
2 wires with banana plugs at both ends.
1 SELEX PCB Size 1.
2 9V minature batteries.
2 Connecting clips for batteries
1 Plastic casing and suitable assembly material.

Components for Battery Eliminator:

Tr 1 = Mains transformer 18V/0.1A
Si = 100mA slow blow fuse
S5 = DPST Mains Switch.
D1 ... D4 = 1N4148
C1 = 220μF/35V.

Other parts for Battery Eliminator:

1 Mains cord
1 Fuse holder

1 Suitable enclosure and other assembly material.

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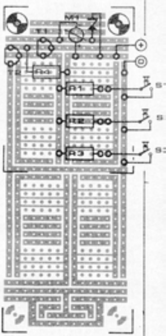

Figure 6:
The component layout of the Z-Diode Tester on a SELEX PCB, Size 1.