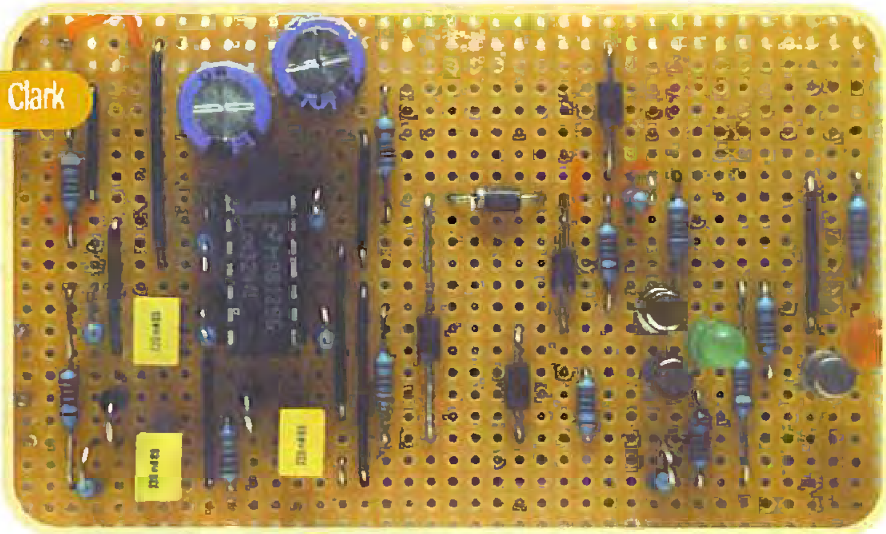
The lazy person's DIODE TESTER

THE LAZY PERSON'S DIODE TESTER WILL TAKE THE HARD WORK OUT OF CHECKING DIODES, PERHAPS THOSE RETRIEVED FROM THE BOTTOM OF THE SALVAGED COMPONENTS BOX. SIMPLY CONNECT THE TEST LEADS TO THE DIODE - THERE'S NO NEED TO WORRY ABOUT GETTING THE POLARITY RIGHT - THE CIRCUIT DOES THE REST! A RED AND A GREEN LIGHT EMITTING DIODE (LED) INDICATE WHETHER THE DIODE IS FAULTY OR OK WITH ONE SIMPLE CHECK.

by David Clark



There's no need to mess about swapping leads to test the conduction in both directions, and no more having to guess whether the p-n junction is operating correctly by deciphering the resistance reading on a multimeter. This device will test whether or not a diode does just what a diode is supposed to do - rectify.

As well as being an extremely useful device in its own right the circuit uses several principles that it is instructive to see employed in a practical situation.

Functional Description

The circuit is composed of five main blocks:

- dual voltage supply
- oscillator
- signal steering, rectification and smoothing
- amplification
- logic and LED drivers

(See figure 1).

The dual voltage supply converts a single 9V supply into a regulated and smoothed ± 4.5V supply for the circuit.

The oscillator generates a square wave at approximately 2 kHz to provide the test signal that is applied to the diode.

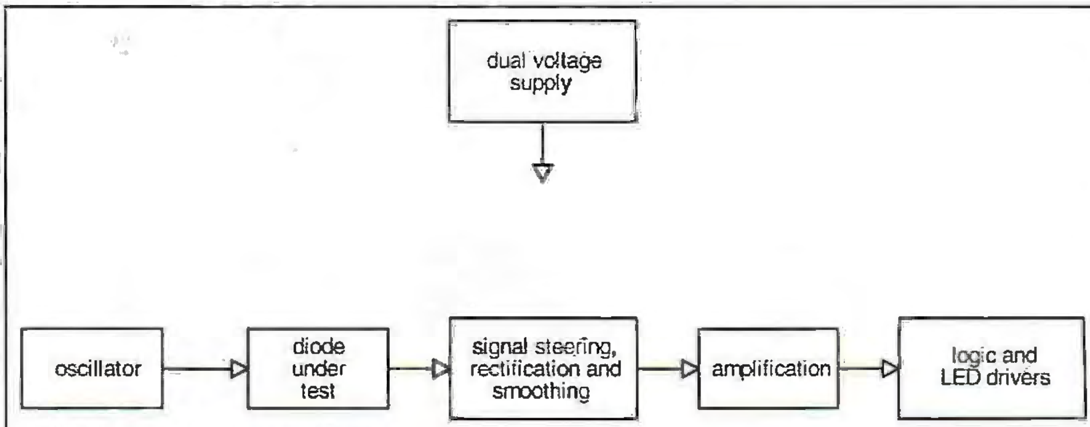
The form of the signal that appears at the input to the signal steering, rectification and smoothing circuit will depend on whether the diode is functioning correctly or not. The signal steering, rectification and smoothing circuit generates from this input signal two other signals that allow the unit to differentiate between a faulty and an OK diode.

Before the voltages can be applied to the logic decoding part of the circuit they must be 'standardised'. This is the role of the amplification stage.

The amplification stage converts the signals into either a 0V or a + 4.5V level. These are then effectively '0' or '1' logic signals which can be applied to the next and final section.

The logic and LED driver section decodes these signals and switches on the green LED if the diode under test is OK, or the red LED if it is faulty and not rectifying ie either open circuit, short circuit, or acting as a resistance or impedance.

The next sections describe how each part of the circuit works. The circuit diagram is shown in figure 2.



Block diagram of the Lazy Person's Diode Tester

Dual Voltage Supply

As the intention of the circuit is to test a diode without having to worry about which way round it is connected into the circuit a test signal that flips between a positive and a negative voltage is used. This means that the circuit must be powered by both a positive and a negative supply voltage. Obtaining two voltages from a single battery is straightforward - the mid-point

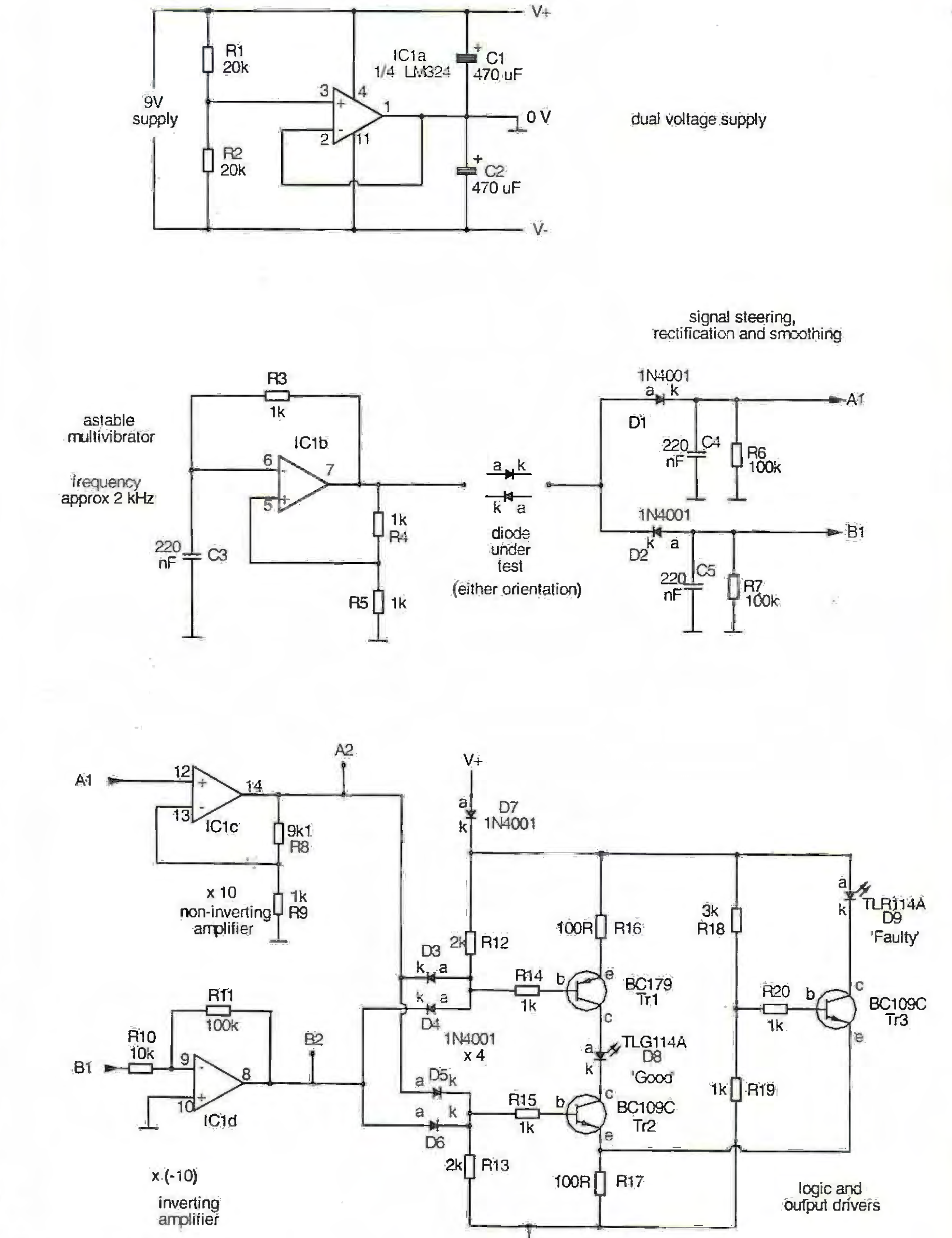


Figure 2. Circuit Diagram

of a two-resistor voltage divider between the positive and negative terminals of the battery provides a zero volt reference point and an op-amp voltage follower maintains this reference voltage even under varying supply current demands on both supply rails. The capacitors provide smoothing to prevent any spikes or dips appearing on the supply voltage rails that might be generated by the square wave oscillator or that are introduced by the power supply if one is used instead of a battery.

Oscillator

The oscillator is an op-amp astable multivibrator operating at around 2 kHz, a frequency that will test audio frequency, radio frequency, signal and rectification diodes. It also means that extreme values are not required for the oscillator and smoothing and rectification components.

Signal Steering, Rectification and Smoothing

This section generates one of four possible combinations of voltage on points A1 and B1 depending on the four possible states of the diode under test, namely:

- non-conducting in both directions, ie open circuit (faulty)
- conducting in both directions, ie short circuit or acting as a resistance or impedance (faulty)
- rectifying in one orientation (OK)
- rectifying in the other orientation (OK)

D1 and D2 rectify any non-rectified signal present, for example if the diode under test is short-circuited. Otherwise they pass on unchanged (other than introducing a further diode voltage drop) any signal already rectified by the test diode. The signals are 'steered' by the respective diodes to C4/R6 or C5/R7. The time constant for these capacitor/resistor pairs is long compared to the period of the astable waveform thus smoothing it and providing a DC output. The resistors also provide a discharge path to allow the output voltages to sink to zero when there is no signal present.

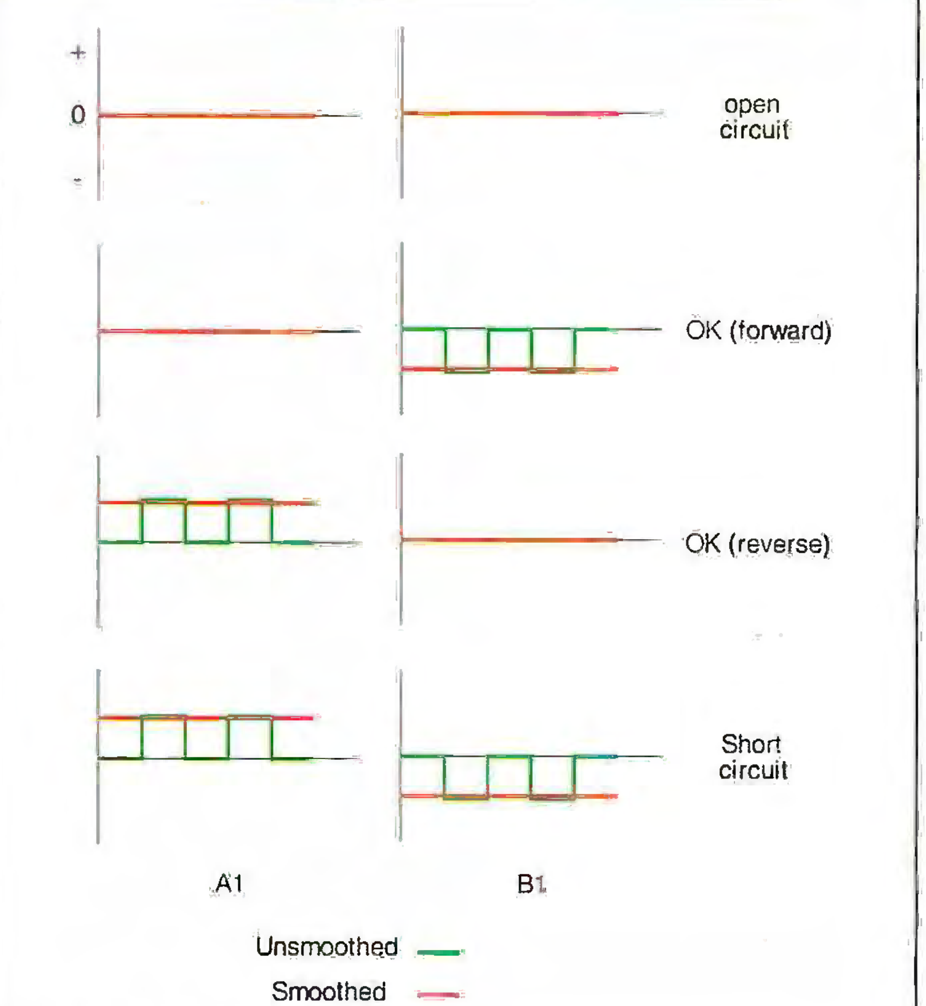


Figure 3. Waveforms at A1 and B1

Figure 3 shows the waveforms that result at A1 and B1 for each of the possibilities.

Amplification

It can be seen that the signal at A1 is always zero or positive, and that at B1 is always zero or negative. Their magnitude is around 1 to 1.5 volts, due to the astable output voltage being 'dropped' across the diode under test and D1 or D2. To 'standardise' these signals to form the basis of logic signals two amplifiers are used, both with a gain of around 10, one being inverting (IC1d) and one non-inverting (IC1c). Thus the signals at A2 and B2 are either at around V+ (logic '1'), gently 'saturating' at the maximum op-amp output, or 0V (logic '0'). In fact logic '0' is likely to be not exactly zero, but a few millivolts positive or negative due to any op-amp offset current present. This however is still a great deal less than the voltage necessary to give a false '1' namely the ±700 millivolts it would need to cause any of the diodes D3 to D6 to conduct.

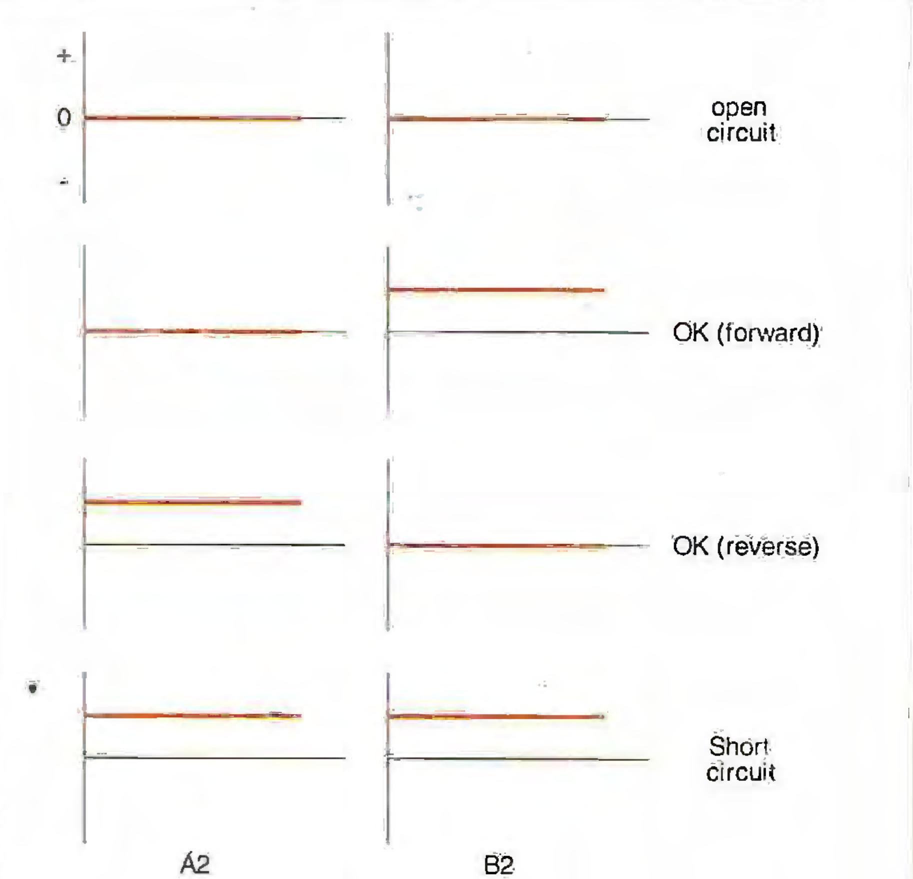


Figure 4. Waveforms at A2 and B2

Figure 4 illustrates the signals at A2 and B2; table 1 shows these represented as logic signals.

Diode Under Test	A2	B2	Green LED	Red LED
Open Circuit	0	0	Off	On
OK (forward)	0	1	On	Off
OK (reverse)	1	0	On	Off
Short Circuit	1	1	Off	On

Table 1

This demonstrates that the green LED needs to light, indicating that the diode is OK, when A2 and B2 are in opposite logic states, but to not light if they are in the same logic state. This is the logic 'exclusive OR' or 'XOR' function. The table also shows what is perhaps obvious, that the red LED, indicating that the diode is faulty, needs to light when the green LED does not. The final section of the circuit implements both the logic and diode driver functions.

Logic and LED Drivers

To implement logic and diode driver functions together it is practical to use a circuit employing transistors, resistors and diodes instead of using integrated circuits (ICs) containing committed logic gates in combination with a transistor current driver. This avoids the special power supply requirements that are necessary when interfacing logic gates with op-amp circuitry.

One realisation of an XOR function is shown in figure 5 and this is implemented in this section as follows.

Having the green 'OK' LED in series with transistors Tr1 and Tr2 means that it will only light when transistor Tr1 AND transistor Tr2 are both conducting. This is equivalent to gate G3.

Tr1, being a PNP type, will conduct in this arrangement when its base is '0'. D3, D4, R12, R14 and Tr1 therefore act as a negated input OR gate (gate G1).

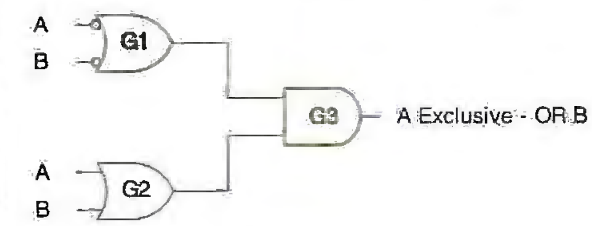


Figure 5. Exclusive-OR Implementation

Tr2, being an NPN type, will conduct in this arrangement when its base is '1'. D5, D6, R13, R16 and Tr2 therefore act as an OR gate (gate G2).

If either A2 or B2 is exclusively '1', ie the other is '0', then V1 will be '0' and Tr1 will conduct. V_2 will be '1' and Tr2 will also conduct, hence the OK LED will light.

However if both A2 and B2 are '1' then V_1 will be '1' and Tr1 will not conduct. The OK LED will not light.

If both A2 and B2 are '0' then V_2 will be '0' and Tr2 will not conduct. Again, the OK LED will not light.

By virtue of the fact that there will be a voltage drop across it when conducting, diode D7 effectively reduces V+ slightly to this section of the circuit and so ensures that Tr1 will switch off fully when A2 or B2 is '1'.

The 'Faulty' LED

Through the voltage divider action of R18 and R19, V3 is fixed at around 1V. Tr3 will therefore conduct, lighting the 'Faulty' LED D9, if the voltage between the base and emitter is around 0.7 V, which it will be if the OK LED is not lit. But if the green OK LED lights the current through R17 increases, increasing the voltage drop across the resistor. This reduces the voltage between the base and emitter of Tr3 to less than the 0.7 V required for it to conduct, switching it off and extinguishing D9. The 'Faulty' LED therefore lights whenever the OK LED is not lit, in other words the 'Faulty' LED always lights unless the diode under test is functioning correctly as a rectifier.

Construction

A suitable strip board layout for this project is shown in figure 6, and the appropriate track cuts necessary are shown in figure 7. Note that the characters 'k' and 'a' associated with D1 and D2 shown in figure 6 indicate that the cathode and anode respectively for these vertically positioned components are uppermost.

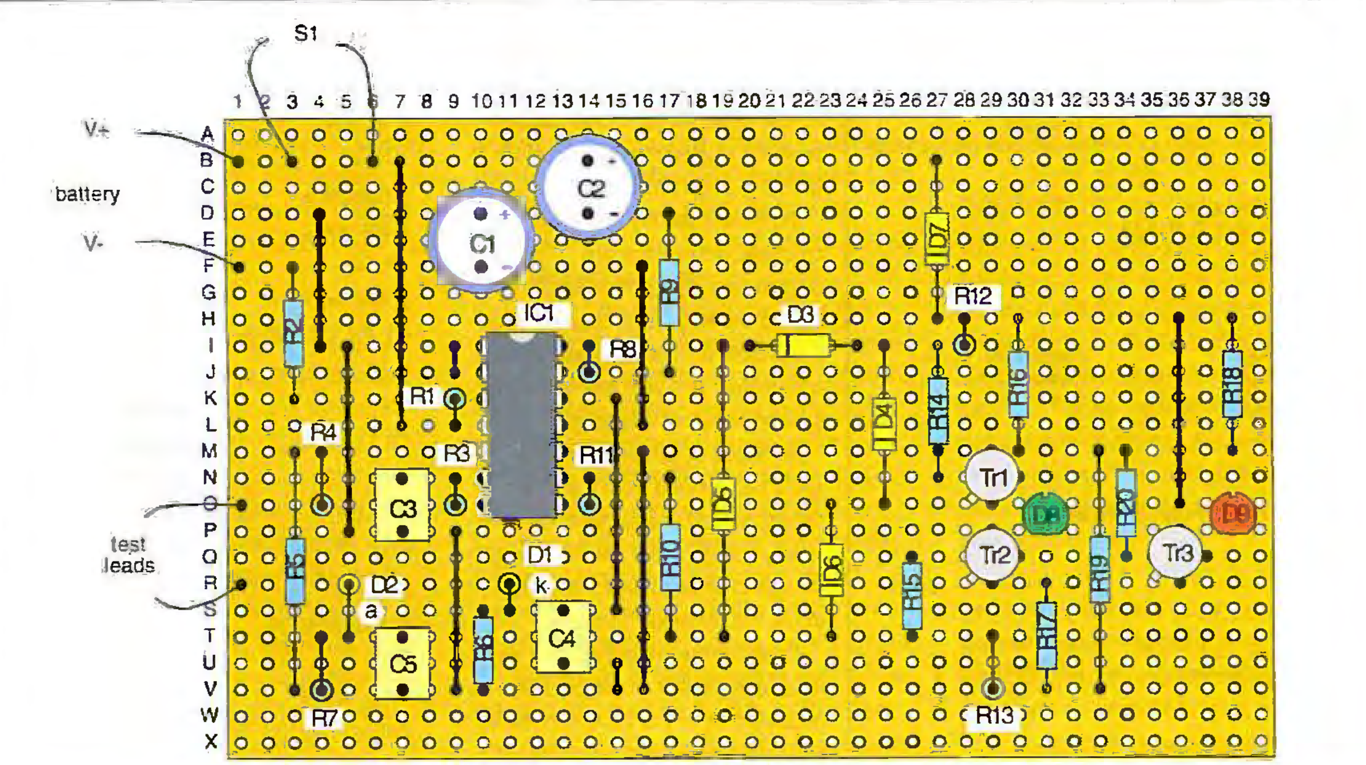


Figure 6. Strip Board layout (component side)

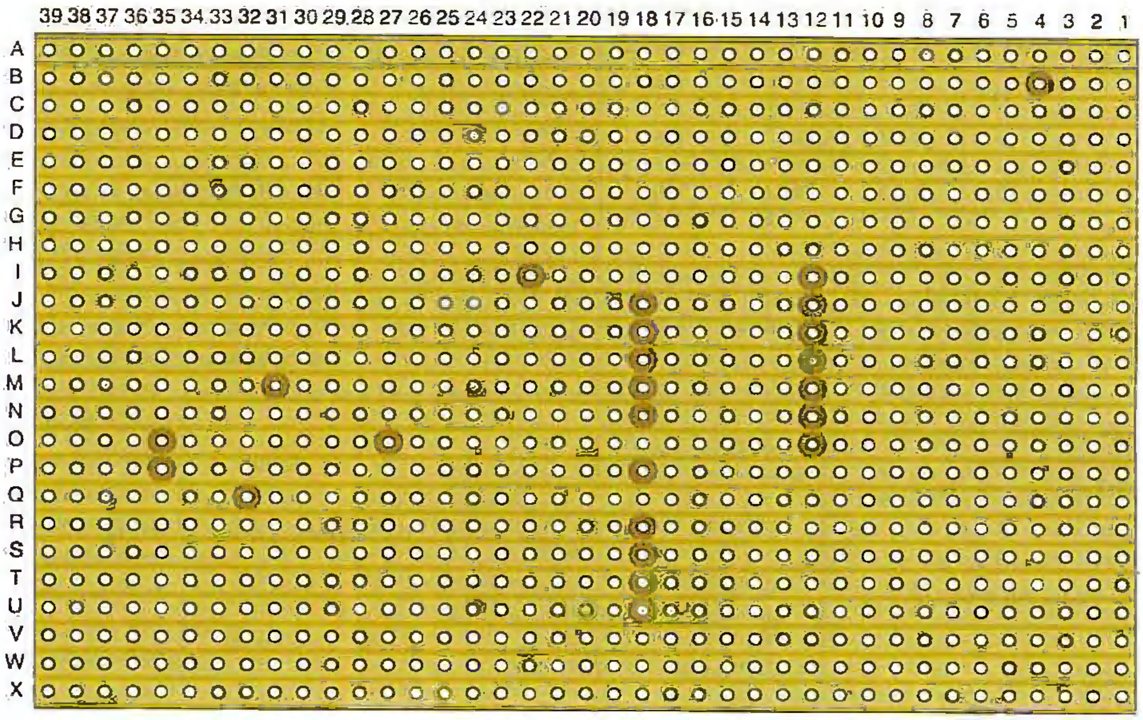


Figure 7. The Track Cuts Required On The Strip Board Layout (track side view).

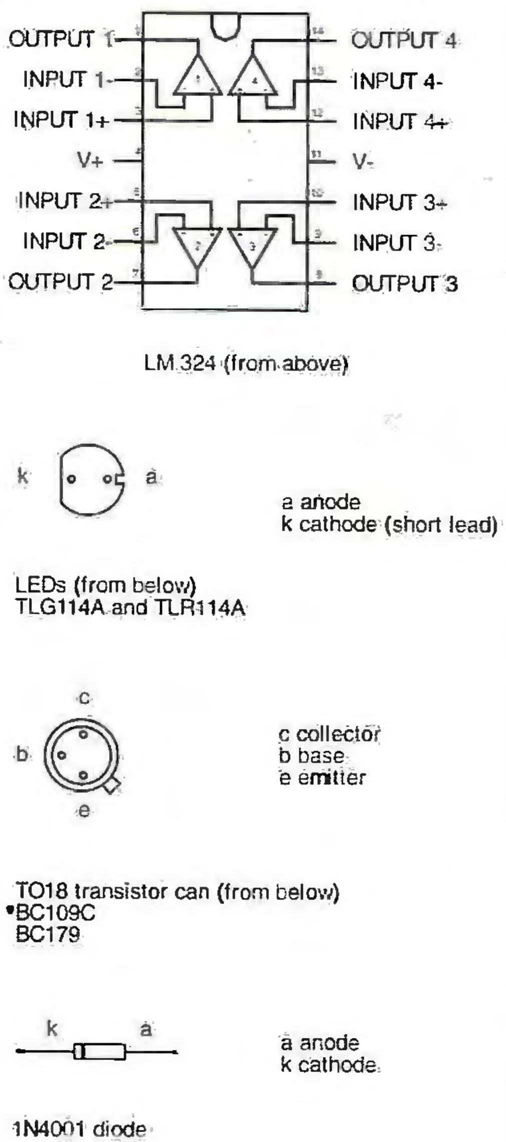


Figure 8. Component orientations

The correct orientation of the transistors, diodes and LEDs, and electrolytic capacitors needs to be observed. The polarity of an electrolytic capacitor is marked on its cover; figure 8 gives details of the physical configuration of the other components.

The usual order of mounting components should be followed, though it's not critical for this project. Fit the links and horizontal components first, then the capacitors and vertically mounted components, and finally the semiconductors, the IC last of all. An IC socket can be used if it is preferred not to solder the IC in place directly.

Terminate the test leads with small crocodile or test clips for convenience of testing. Colour coding the leads is not important as the project is of course designed for a 'one-stop' test with the test diode connected either way round.

As hinted at earlier the device could be powered from a power supply instead of a battery. The supply voltage of 9V should be kept though to ensure correct operation of the 'Faulty Diode' indicator.

Finally, if the project were to be housed in a box it would of course be necessary to fix the LEDs into the lid and attach them to the strip board by extra wiring.

In Use

Simply connect the diode under test to the test leads, either way round, and note which LED lights. Throw away any faulty diodes!

Parts List

Resistors (metal film, 0.6W, 1%)	
R1, R2	20k
R3, R4, R5, R9, R14,	
R15, R19, R20	1k
R6, R7, R11	100k
R8	9k1
R10	10k
R12, R13	2k
R16, R17	100R
R18 3k	
Capacitors	
electrolytic	
C1, C2	470 µF
polyester film	
C3, C4, C5 220 nF	
Semiconductors	
IC1	LM324
TR 1	BC179
TR2, TR3	BC109C
D1 - D7	1N4001
D8	TLG 114A green LED
D9	TLR 114A red LED
Miscellaneous	
Sw1	SPDT switch
Strip board	
Battery clip (for PP3 power supply battery)	
Test clips or small crocodile clips	
Box to suit	