

# TALKING ELECTRONICS

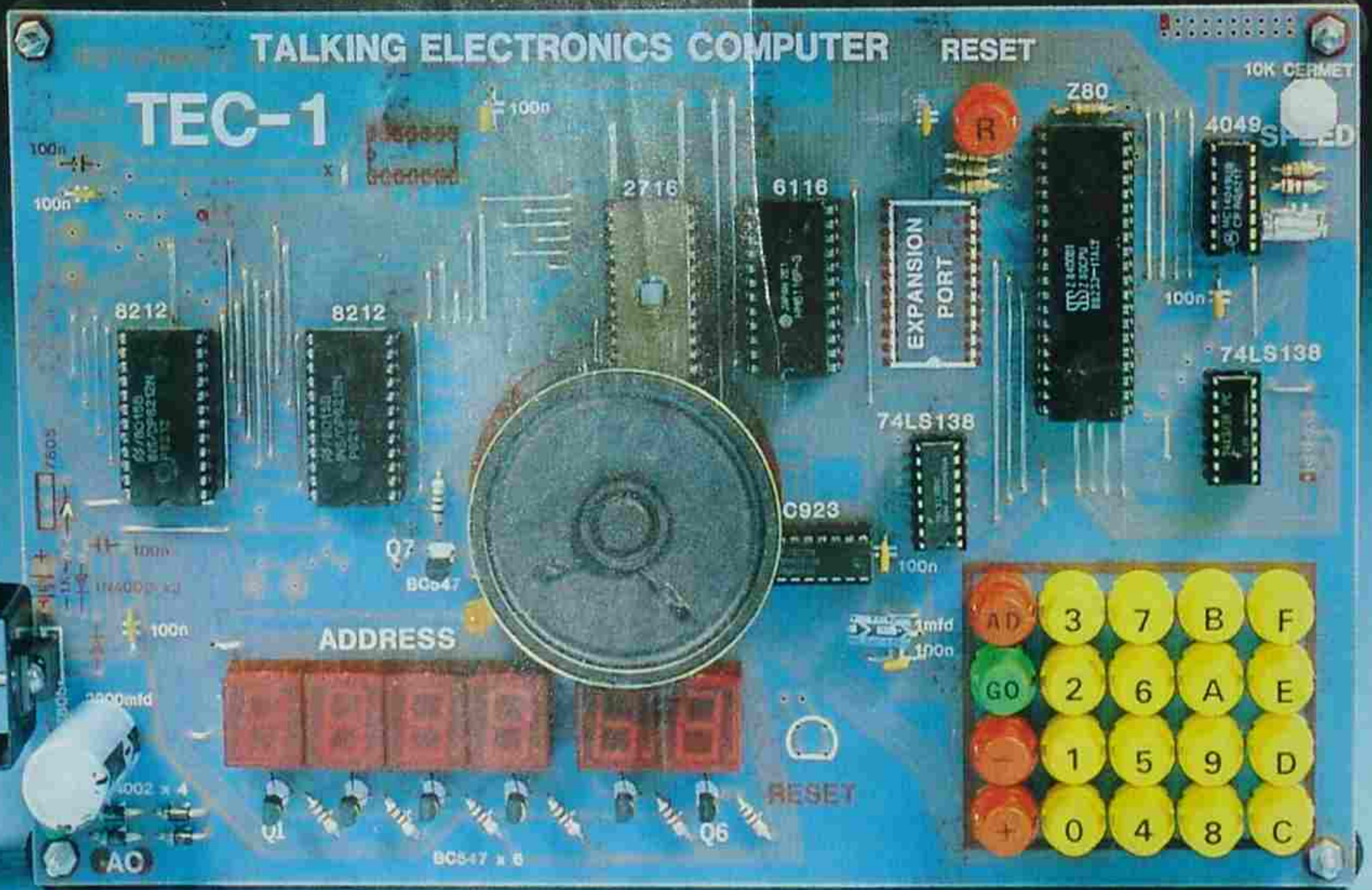
\$1.80\*

\$2.40NZ

Issue No 10.

## TEC-1

TALKING ELECTRONICS COMPUTER



**LOGIC PROBE**

**ROULED**

**COUNTER MODULE - ONE SHOT**

# TALKING ELECTRONICS

**Editorial...**

**Vol. 1 No: 10.**

This is our COMPUTER ISSUE. By bringing out the computer in this issue, we have advanced faster than I have ever intended. But it has been the requests from readers, schools and industry that has caused us to do so.

At first we considered one of the mini computers already on the market, would provide a suitable basis for instruction but on further investigation, this was not to be the case. We required something in the low-price bracket, easy to construct and most important of all, it had to be a Z80 based circuit.

Thus we had to design and develop a whole system ourselves. And after seeing the final design, I think you will agree it has been totally worthwhile.

Designed by John Hardy, TEC-1 is our answer to all those requests.

It is a simple, single-board computer which enables you to learn programming in Machine Code as well as play a number of simple computer games.

Construction is quite easy and if you have produced 8 or more projects from our previous issues, you will be eligible. We have been very careful to include only easy-to-obtain components and of course the CPU (Central Processing Unit) is a Z80 chip. This amazing chip is so cheap that you cannot go past it for performance and price.

The total chip count has been kept very low at 9 and you learn the operation of each and how it controls or is controlled by the rest of the circuit.

But before I use any technical terms, I want to explain the approach we are adopting.

TEC-1 will be divided into 3 stages.

Not 3 EQUAL stages but 3 sections which are intended to draw you into the computer field without causing any frustration.

Even if you don't know the difference between BITE and BYTE, you will be able to build this project, learn how it works, play a few computer games and then create some simple programmes of your own.

It works this way:

Stage 1 is the construction of the board. Just like any other project, it is purely assembly - very delicate assembly - but no computer terms will be involved.

Stage 2 is playing games on the computer. Simple games like Nim, Music, Lunar Landers and producing letter and words. Still no new terms.

Stage 3 is learning about the technical side. Programming in Machine Code, the uses and possibilities for the computer and construction of "add-ons". This issue covers stages 1 and 2.

I will pretend to know nothing so that we can both start together and combat the COMPUTER BARRIER.

*Colin Mitchell.*

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# INDEX

- 5 LOGIC PROBE**
- 11 MODEL RAILWAY CLOCK**
- 13 ROULED**
- 16 DESIGNING YOUR OWN POWER SUPPLIES**
- 22 VIC-20 CLUB**
- 24 COMPLETE RANGE OF TE KITS**
- 33 COUNTER MODULE UNIT COUNT**
- 37 BACK ISSUES PROJECT BOOKS**
- 40 ORDER FORMS**
- 41 SUBSCRIPTION FORM**
- 43 SHOP TALK**
- 47 LETTERS**
- 50 TEN MINUTE DIGITAL COURSE**
- 57 TEC-1 TALKING ELECTRONICS COMPUTER**
- 75 PC ARTWORK FOR TEC-1**
- 76 DATA**

## **TECHNICAL**

*Ken Stone*

## **ARTWORK**

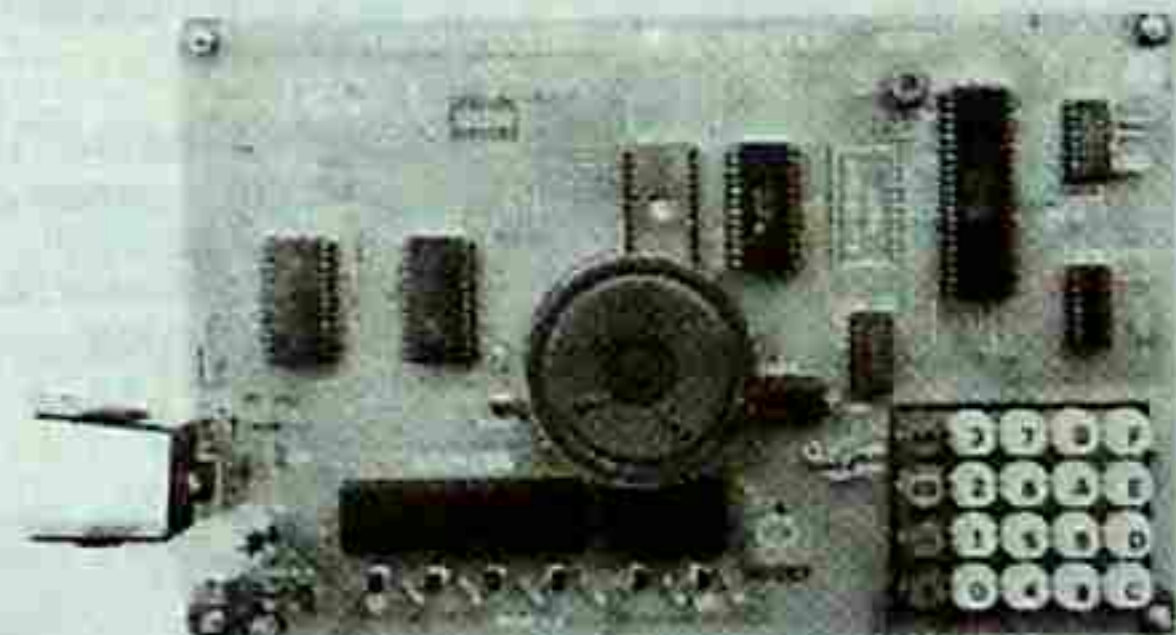
*Ken Stone*

## **ENQUIRIES**

*10 Minute queries will be answered on 584 2386*

## **ADVERTISING**

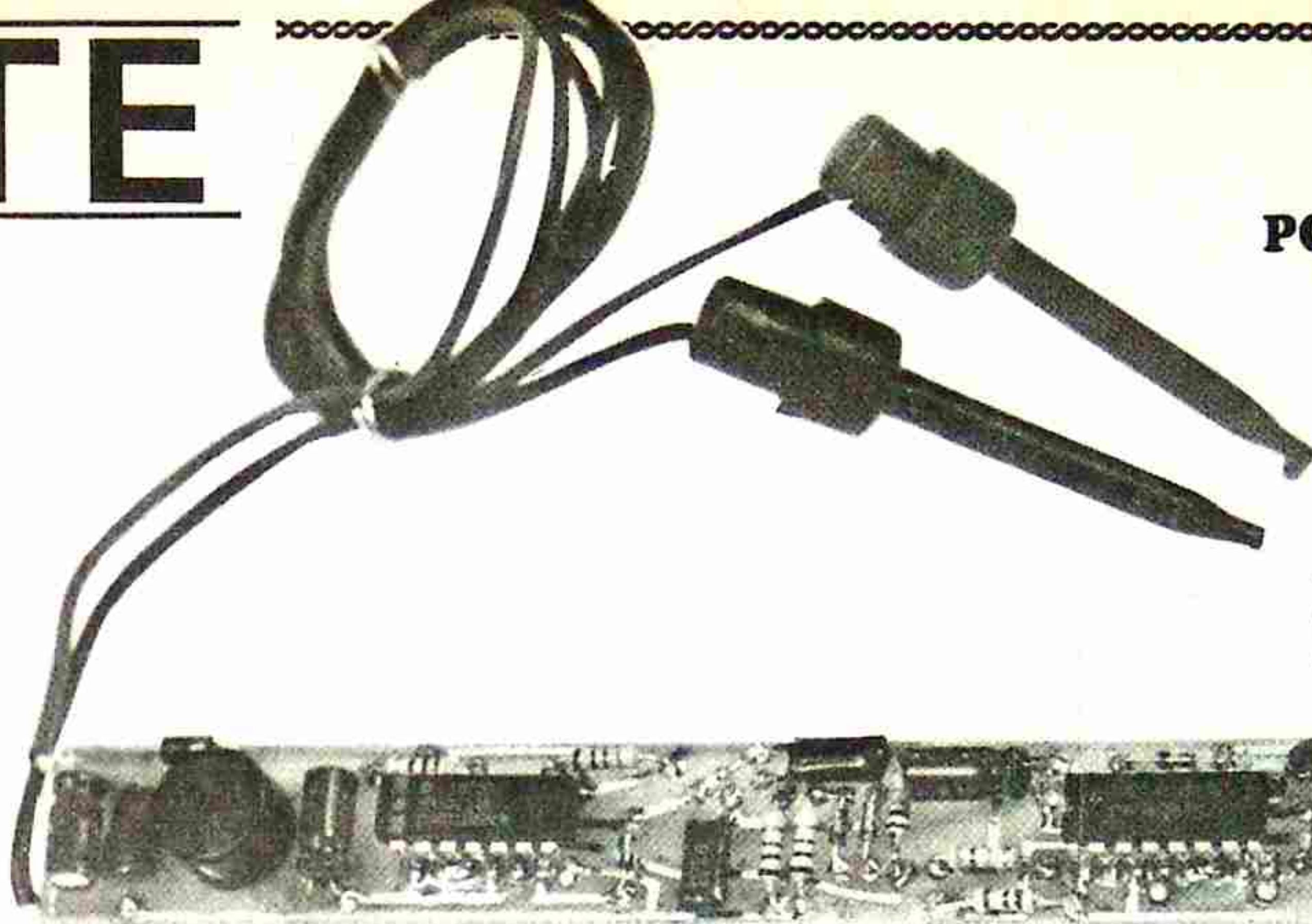
**Talking Electronics (03) 584 2386**



**The TEC-1 ready for programming.**  
This will be the only colour issue, so don't think we are getting BIGGER! The colourful TEC-1 was too good to show in black & white.

# TE

Parts: \$7.60  
PC board: \$2.50



The LOGIC PROBE is ideal for testing the TEC-1 computer.

# LOGIC PROBE

A LOGIC PROBE is possibly the most important of all pieces of test equipment for the digital designer.

Comparatively speaking, it is equivalent to an electrician's multimeter or an audio technician's CRO.

You may be wondering why we have not described a Logic Probe before. Well, basically, there are two reasons. Firstly we have not had the need for it and secondly the complexity of the circuit has not fitted the scheme of things.

But the time has now come for its application. This is our computer issue and to build a computer without having access to a PROBE is like taking the car on a long journey without a spare tyre.

In fact, with the computer project, the circuit is tested at various stages with the probe to make sure it is functioning correctly.

So, to be without this piece of test equipment is digital suicide.

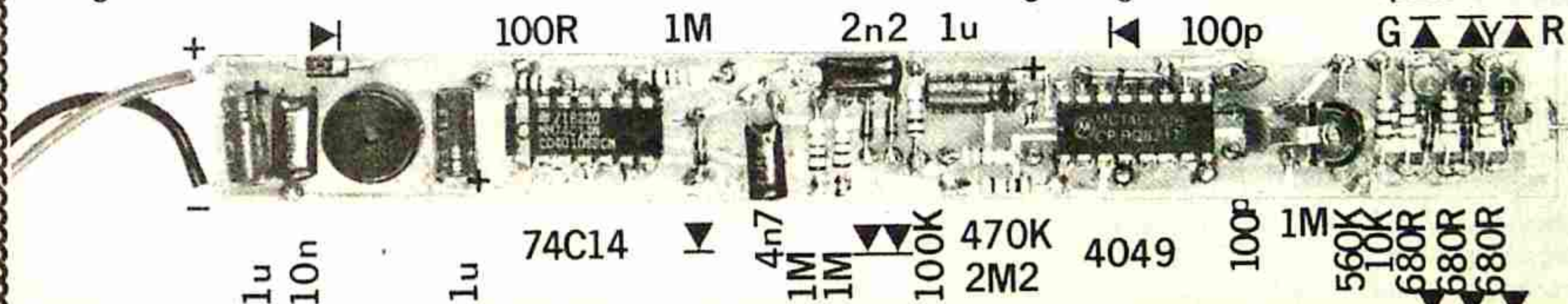
As with all our projects, this probe is the culmination of many hours investigation and diagnosis of the various equivalent products on the market and we have come up with the best design ever.

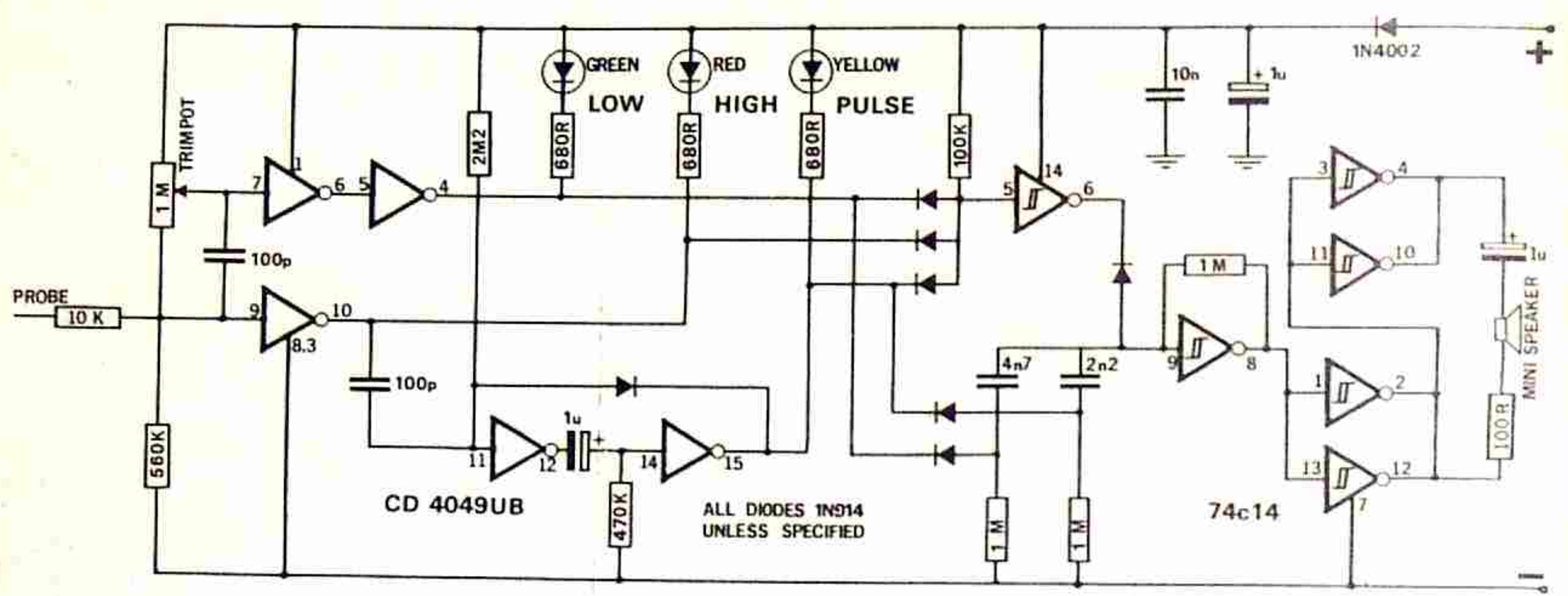
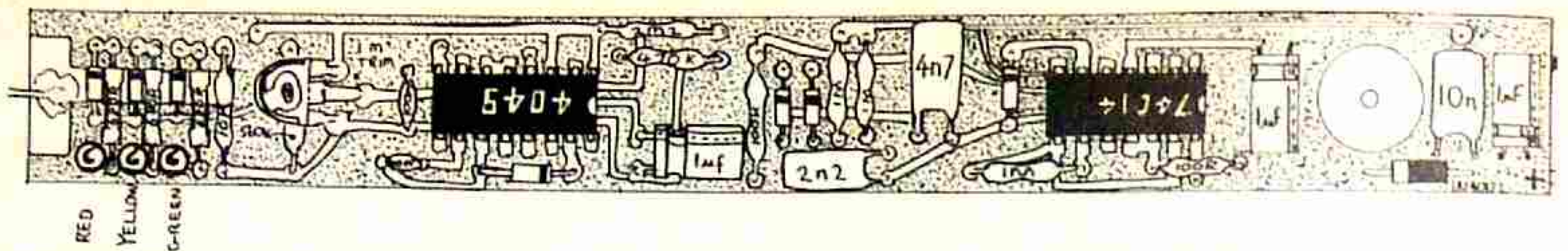
The probe has both visual and audible indication of HIGH, LOW and PULSE and if you have ever used a probe for trouble-shooting, you will know the advantage of an audible signal.

Whenever you are probing around the pins of an IC, it is absolutely essential that you do not take your eyes off the probe, even for an instant.

If your attention is diverted to looking at the indicator LEDs, you can allow the probe to slip off the IC pin and cause a short between two pins. This could easily damage the chip.

But with our design, this cannot happen. The audible tone will keep you up to date with the state of each pin and you can concentrate on advancing along each row of outputs.





## HOW THE CIRCUIT WORKS

The three indicator LEDs are connected to inverters. Each inverter performs a different function and this is how we get the HIGH, LOW PULSE outputs.

The outputs of these three stages must be HIGH when the probe is in the no-signal condition as the LEDs are driven via negative-logic. This simply means the LEDs will illuminate when the output of the driving buffer is low.

The 1M mini trim pot on the input line, sets the voltage level on pin 7 of the top inverter so that the LOW LED is illuminated when the probe detects a LOW.

The section dealing with the LOW signal is the pair of inverters between pins 7 & 6 and 5 & 4. This produces a double inversion so that a LOW on the input will produce a LOW on the output. This LOW illuminates the LED and this is why it is called NEGATIVE LOGIC.

A single inverter between pins 9 & 10 is used to drive the HIGH and once again negative logic causes the LED to be illuminated.

A 100pf capacitor between the inputs of these two circuit blocks acts as a SPEED UP capacitor.

The PULSE-STRETCHER arrangement is a monostable circuit in which pin 11 of the first inverter is normally HIGH, making the output

LOW. The 1mfd electrolytic sits in an un-charged condition. The circuit is triggered into operation via the 100pf capacitor on input pin 11. When a LOW is created on pin 10 of the "HIGH" BUFFER, it is passed through the capacitor to pin 11 of the pulse-stretcher circuit. This will cause pin 12 to go HIGH and take pin 14 HIGH with it.

Pin 15 goes LOW and the latching feature is provided by the diode between pins 15 and 11. When pin 15 goes LOW, pin 11 is also pulled LOW and the circuit latches in this state.

The time-delay for the circuit is controlled by the capacitor (and also the 470k resistor). Pin 12 is HIGH and it begins to charge the capacitor at a slow rate due to the 470k resistor in series with the charging voltage.

The voltage on pin 14 gradually decreases until a point is reached when the second inverter will change state. The voltage on pin 14 falls and this will create a HIGH on pin 15. The PULSE LED will be extinguished and the LOW on pin 11 (produced by the diode) will be removed. The first inverter will change state and the charge on the 1mfd electrolytic will be removed fairly rapidly due to the presence of diodes on the input line of the inverter.

The next two blocks on the circuit diagram provide gating for the Schmitt Trigger oscillator.

The actual Schmitt oscillator circuit is made up of the 4n7 capacitor (and/or the 2n2 capacitor), the 1M resistor and the Schmitt Trigger between pins 9 and 8.

But to get this oscillator to produce 3 different frequencies, via a gating arrangement, is not an easy task.

The oscillator requires the earthy end of the capacitors to be connected to ground for the oscillator to keep oscillating. Otherwise it gradually dies away due to the high impedance provided by the gating circuitry.

The three diodes in the centre of the circuit produce a negative logic OR gate and this means it is detecting a LOW on one of the input lines to change the state of the output.

The output of the gate is connected to input pin 5 of a Schmitt Trigger which is acting as an inverter to GATE the Schmitt oscillator.

When pin 5 is HIGH, the output pin 6 is LOW and the oscillator between pins 9 and 8 is prevented from functioning due to the forward-biased diode keeping the voltage below .6v.

When any input of the diode gate goes LOW, the output goes LOW and this causes pin 6 to go HIGH. The oscillator gating diode is now effectively out of circuit and the Schmitt oscillator will produce a frequency which is determined by the value of the capacitors in the earth circuit.

When the LOW LED is illuminated, the 4n7 capacitor will set the frequency. When the PULSE LED is illuminated, the 2n2 will set the frequency. When the HIGH LED is illuminated, the frequency will be set by both capacitors and the 1M resistors in series with them. The isolation diodes on the earthy ends of the capacitors will prevent the HIGH from the inverters from affecting the frequency.

With the 4 remaining Schmitt Triggers, we have paralleled them to provide a push-pull arrangement for the mini speaker. Strictly speaking this is not necessary but it is best to utilize all the gates in a package.

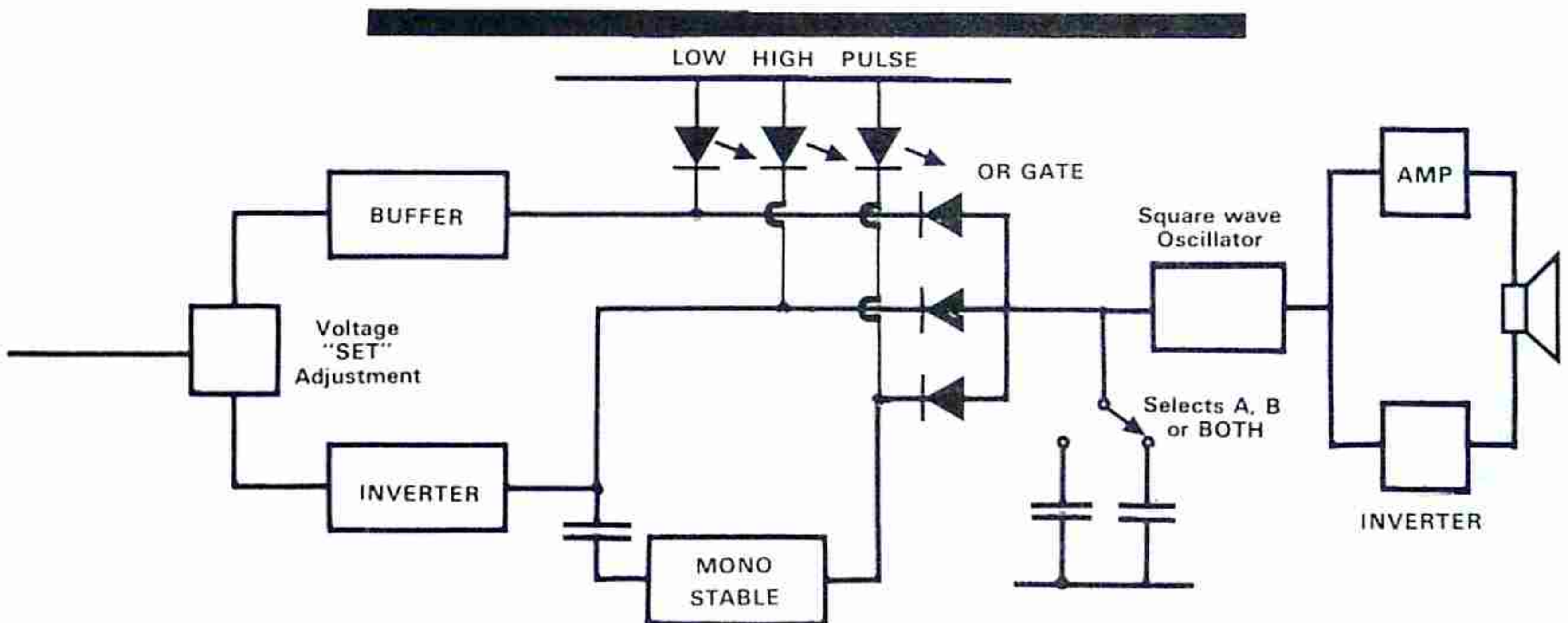
The choice of a 100R resistor and 1mfd electrolytic in line with the speaker prevents overloading of the gates.

A power diode is provided in the positive rail to prevent damaging the probe with reverse voltage if it is connected to the power around the wrong way.

The 1mfd (1u in the schematic) and 10n capacitor across the power rails help remove spikes from the power rails and prevent false triggering.

The 10k input resistor prevents the circuit being tested, from overload or damage.

Finally, one of the inverters of the CD 4049 is unused. Its input line has been tied to earth (pin 3) to prevent the inverter self-oscillating.



### LOGIC PROBE BLOCK DIAGRAM

The input block is a 'VOLTAGE SET' control to turn the HIGH/LOW indicator LEDs off when no input voltage is present.

The incoming signal is passed through a non-inverting buffer (two

inverting buffers in series) and also one inverting buffer. The output of these gives the HIGH/LOW indication.

A pulse-stretcher circuit provides an indication of a pulse as short as 1 micro-second.

The output of the three buffer circuits is fed to an OR gate and this controls a Schmitt Trigger oscillator. Three different tones are produced by selecting a combination of the two capacitors. The output of the Schmitt Trigger feeds a push-pull arrangement to drive a mini speaker.