DIY KIT 110. CONTINUITY TESTER

INTRODUCTION
A Continuity Tester is one of the most useful pieces of test equipment to have. It is used for testing the electrical path (continuity) between two points. It is more useful and efficient than using a multimeter to do the same job.

Our Continuity Tester has an audible output so you can keep your eyes on the probe tips while working. In addition it will only “buzz” through a specified resistance or less. Above this value the tester will not make any sound. A switch is provided to allow this resistance to be varied. The Tester runs from a 9V battery (not supplied).

For the values used in this kit, the Tester will “buzz” up to about **2.8Ω** for the **LO** position and up to **185Ω** for the **HI** position (this may vary slightly due to component tolerances).

The kit is constructed on a single-sided PCB measuring 51mm x 38mm (2” x 1.5”). Protel Autotrax & Schematic were used to design the PCB.

ASSEMBLY INSTRUCTIONS
Follow the component overlay on the PCB, starting with the lowest height components first. Make sure that the electrolytic capacitors are inserted the correct way around. The positive lead is marked on the overlay. The negative is marked on the body of the capacitor.

Leave the battery harness and probe wiring until last. When ready, cut and strip about 5mm from the end of each wire. Twist the ends to hold the strands together and tin with some solder. Insert the tinned ends into the PCB and solder into place.

CIRCUIT DESCRIPTION
The kit is based around an LM324 quad op-amp IC. The circuit can be broken down into four functional blocks.

1. IC1:D - power supply splitter
2. IC1:A - unity gain voltage follower/buffer.
3. IC1:B - voltage comparator.
4. IC1:C - square wave oscillator

Most op amps require a dual polarity power supply. This is the job of IC1:D. It is configured as a unity gain voltage follower with its positive input held at half the battery voltage by resistors R9 and R10. The output “follows” the input and is also at half the battery voltage. The op-amp output impedance is very low, ensuring a stable output and return path. We now have a dual polarity supply, with the output as the “zero volt” reference and each side of the battery as the positive and negative rails.

The probes are connected between the positive input of IC1:A and ground. This provides a very high input impedance, minimising any loading on the circuit under test.

Actually the circuit doesn’t detect resistance at all. The resistance between the probe tips and resistor R1 act as a voltage divider. This input voltage appears at the output of IC1:A and is compared against a threshold voltage by voltage comparator IC1:B. This threshold voltage is set by resistors R2, R3 and R4. If the input voltage is greater than the threshold voltage then the comparator output is high. If the input voltage is less than the threshold voltage then the comparator output is low. Capacitor C1 improves the switching response of the comparator.

The comparator output is used to switch the oscillator, IC1:C, on or off. If the output is high, the oscillator is off. If the output is low the oscillator is on. Resistor R5 and capacitor C3 set the oscillator frequency.

With the input open circuit (probes not connected) resistor R1 holds the input high and therefore the output of IC1:A will also be high. This voltage will be greater than the preset threshold voltage so the comparator output will also be high. This will keep capacitor C3 fully charged via diode D1. The output of IC1:C will remain low and the oscillator will be off.

If the probe tips are shorted together the input voltage will fall to “zero” as will the output of IC1:A. This voltage will now be less than the threshold voltage and the comparator output will switch low. This reverse biases diode D1 and capacitor C3 begins to discharge via resistor R5 and the low output of IC1:C. When the voltage across C3 falls below the feedback voltage from resistors R6 and R7 the output of IC1:C will go high. This will start charging C3 via R5. Once the voltage across C3 is greater than the feedback voltage from R6 and R7 the output of IC1:C will go low and the whole process will repeat.

We said before that the circuit doesn’t test resistance at all but compares an input voltage with a preset threshold voltage. The threshold voltage will change as the battery voltage changes but so will the input voltage. This will not affect the operation of the circuit because the ratio of the two voltages relative to each other will not change.

The threshold voltage is set by the ratio of R4 and R3 to R2. The input voltage is set by the ratio of the resistance between the probes to resistor R1.

Switch SW2 is used to change the threshold ratio. This enables the Tester to “buzz” through two different input resistance values. The value of the input resistance that the Tester will “buzz” through is given by the equation:

$$R_x = \frac{R_T \times R_1}{R_2}$$

where Rx is the input resistance and R_T is the combined value of R4 and/or R3.

For the values shown, the Tester will “buzz” through 2.8Ω or less with SW2 in the LO position and 185Ω or less with SW2 in the HI position.These can be varied by changing the values of resistor R3 and/or R4. In the LO range there seems to be an input offset voltage associated with the opamp which is not taken into account in the formula.

TESTING

Before connecting the battery, check that all parts are inserted in the correct position. Make sure that the electrolytic capacitors are the right way around.

Switch on and short the probe tips together. The Tester will beep as long as the probes are shorted together. The amount of resistance that the Tester will "buzz" through may now be checked using various resistor values in combination with the position of SW2.

IF IT DOES NOT WORK

Poor soldering ("dry joints") is the most common reason for the circuit not working. Check all soldered joints carefully under a good light. Re-solder any that look suspicious. Check that all components are in their correct position on the PCB. Are the electrolytic capacitors the right way round? Is the IC inserted correctly?

Use the circuit description to check each of the various stages of the circuit. Start with the split power supply section. The oscillator can be easily checked by simply removing diode D1 - the oscillator should operate continuously. Connect any small value resistor (< 1K) across the probes and measure the voltage across it. This voltage should also appear on the output IC1:A (pin 1).

Now measure the threshold voltage on pin 6 of voltage comparator. If this is less than the input voltage (pin 5) then the output on pin 7 should be high, otherwise the output should be low.

PARTS LIST - KIT 110

Resistors (0.25W carbon, 5%)		
1K2 brown red red	R8	1
1K5 brown green red	R1	1
2K7 red violet red	R4	1
39K orange white orange	R9,10	2
47K yellow violet orange	R5	1
100K brown black yellow	R6,7	2
270K red violet yellow	R3	1
2M2 red red green	R2	1
Capacitors		
1.8nF polyester	C2	1
4.7nF polyester	C3	1
47nF polyester	C1	1
10uF 16/25V electrolytic	C4,5	2
Semiconductors		
LM324, Quad Op-Amp	IC1	1
1N4148 diode	D1	1
Miscellaneous		
Slide switch	SW1,2	2
Piezo external drive buzzer		1
9V battery harness		1
PCB, K110		1

You may email the designer of this kit, Frank Crivelli at

ozitronics@c031.aone.net.au