Bob's Basic Digital Ring Tester

Circuit description

If you're really interested in knowing how it works, printing out the **basic_schematic.pdf** file will be helpful.

Switching of the 9V supply is done by PNP transistor Q1, controlled by small MOSFETs Q2 and Q3 which form a bistable flip-flop. C2 charges or discharges to the opposite logic polarity of what's on Q2's gate. Each time the power button is pushed, C3 transfers a short pulse from C2 to Q2's gate, flipping the circuit to its other state.

Comparator U1A and its surrounding components functions as the oscillator to provide the measurement cycle timing, generating a square wave which is high for about 30ms and low for about 150ms. Q4 inverts this waveform and provides enough current to switch MOSFET Q5 on very quickly. In its TO-220 power package, Q5 looks out of place but I chose it because its on-state source-drain resistance is very low so that it won't degrade the "ringing" measurements.

Voltage divider R14 and R16 charge low-loss polypropylene capacitor C4

to about 2V via the inductor being tested, during the 30ms period between 150ms measuring cycles.

At the start of a new measuring cycle, Q5 is quickly switched on and dumps the charge in C4 into the inductor, forming a parallel resonant circuit. The "ringing" waveform is applied to JFET source follower Q6 which puts very little load on the resonant circuit. R17, D2 and D3 are there to protect Q6 from externally applied voltages on the test leads.

The ringing signal is fed into comparator U1B which has a small amount of positive feedback so that its output is a sharp square wave down to a specific "ring" level (~30mV P-P on the inductor). The square wave goes to the cascaded decade counters of U2B and U2A, and their Binary Coded Decimal outputs are stored in U4 and U5, to be decoded into 7-segment format and displayed at the end of each measuring cycle. Diodes D6-9 form an AND logic gate so that if the counters get to "99", they are stopped from counting any further. Otherwise they would "overflow" to "00" and keep counting to give a confusing reading. Not many inductors ring >99 times.

C9 and R27 provide a very brief reset pulse to the decade counters at the start of a new measurement cycle, while C7 and R29 tell display drivers U4 and U5 to update the displays at the end of each measurement cycle. R30-R43 limit the current to each display segment to a bit less than 2mA.

Building one

Before you consider building one of these ring testers, I have to point out that the microcontroller-based Blue2 Ring Tester available ready-built from **EVB in Portugal** is smaller, has automatic power-down, runs from two cheap AA size batteries which can be rechargeable, and would probably be cheaper to buy than assembling this tester. You have been warned!

All the parts are listed in the *basic_ringer_parts_list.txt* file. Most of the components are reasonably easy to get hold of but a few are specialised, especially the double-sided PCB. The *basic_ringer_gerbers.zip* file contains all the gerber and drill files which any PCB manufacturer should be able to make boards from. My prototypes came from **JLCPCB** who are very cheap. Hopefully **EVB** in Portugal will be making the PCBs available.

The translucent blue case is part number **1553DTBUBKBAT** made by Hammond Manufacturing and it's available from **Digikey**, **Mouser Electronics** and some other companies including Ebay sellers. The push button switch and cap is also available from those companies. I got most of the other parts including the displays from **LCSC Electronics** in China.

You'll need to drill two holes in the end window of the case for the push

button switch and the 8mm test lead cable grommet. I've included a sketch as **end-window.png** which gives the dimensions.

The traditional way of assembling through-hole PCBs is to install the components from the lowest height first up to the tallest last. So start with all the diodes, being careful not to mix up the 1N4148s with the two 6.8V zeners. Then put in all the resistors etc. There are lots of 100nF (0.1µF) capacitors and there are three different types. Please use the following PCB photo to see where they all belong.

The 7-segment displays need to be as close to the front of the case as possible so they look nice and sharp, so only insert their legs far enough into the PCB to reliably solder them.

Congratulations! (I hope)

If you've reached this point, install a 9V alkaline battery (terminals end first), push the button and you should see "00" displayed. Connect the test leads to some inductors and see that you get reasonable readings. Now read through the **basic_ring_tester_manual.pdf** file to get familiar with using it.

What if it doesn't work properly?

The most likely cause would be that one or more components are in the wrong place or the wrong way around on the PCB. The **PCB_front.jpg** photo shows the correct layout in a lot of detail. Please carefully compare your PCB against it.

If you're sure that everything is exactly where it belongs, the next most likely problem would be a solder bridge between adjacent joints. Please very carefully compare the back of your PCB against the detailed **PCB_back.jpg** photo.

If you feel like getting very technical, I've provided some waveform pictures from important points in the circuit. Please take note of the image names and the timebase, trigger and vertical sensitivity settings at the bottom of each image.