Bob's Blue2 Ring Tester

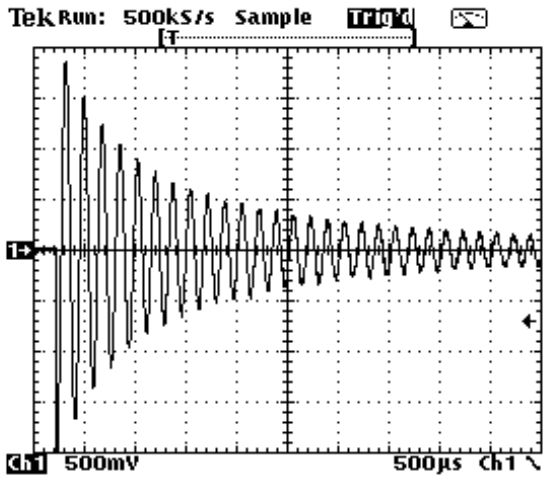
A lot of electronic equipment makes use of inductive components in the form of various kinds of transformers and chokes etc.

In circuitry like switch mode power supplies and LCD backlight inverters as well as older CRT line output (flyback) transformers and deflection yokes, high voltages are involved and there is always the risk that the insulation between wires in the windings of those components will break down.

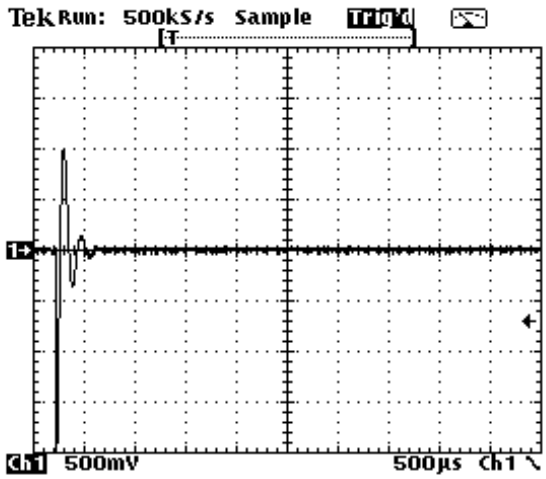
These parts are usually hard to find and always expensive. When the symptoms of a fault point to an internal breakdown in a transformer or inductor, the technician needs to be pretty sure that the part is defective before looking for a replacement.

This tester works on the principle that when a charged capacitor is connected to an inductor, it forms a resonant circuit. When there are only low losses in the circuit, the voltage across the inductor will be a decaying sine wave with a substantial number of oscillations. It's the electrical equivalent of tapping an empty glass, which “rings” at a particular frequency.

However if there is a breakdown between turns in a winding, it behaves like a new secondary winding with a low resistance load which absorbs a lot of the electrical energy in the circuit. Under those conditions, there will only be a small number of “rings”. The waveforms look like this:



Good coil



Shorted turn

All the functions of the tester are controlled by the firmware in a microcontroller IC. A low loss polypropylene capacitor is charged to 2V, and five times per second it is connected to the test leads by an electronic switch.

An impedance converter and voltage comparator circuit converts the oscillating waveform into a square wave until it has decayed to about 10mV.

The microcontroller counts and displays the number of “rings”. If it counts more than 99, it will only display “99” to avoid confusion.

Using the tester

The tester is powered by two “AA” size cells which can be rechargeable NiMH, or non-rechargeable alkaline or carbon-zinc types. Slide off the battery compartment cover and install the cells with the positive end first (that's the only way to get them in). The tester will be operating immediately after putting the cells in. Turn it off by pressing the button once.

To get the cells back out, you can either put a piece of sticky tape around the negative end and leave a bit in the air before you install them and use it to pull them out, or bang the case on the heel of your hand to dislodge them.

Turn the tester on by pushing the button once. With nothing connected to its leads, it will display a “whirling” pattern as an eye-catching reminder that it is still turned on. If there are no measurements for 5 minutes, it will turn itself off automatically. To turn it off manually, press the button again.

When the batteries are very discharged, the displays will dim and flash “**bA**” every two seconds to show that they need recharging or replacing.

Testing inductive components

Inductive components generally fall into two categories. There are high frequency types which usually have ferrite cores and very low losses. They include switchmode power supply and monitor/TV LCD backlighting inverter transformers. This tester is designed to also test low frequency iron-cored transformers such as in valve (tube) amplifier output stages and mains power supplies. Normally the tester will be connected to the primary winding of a transformer being tested.

The tester only outputs a low voltage. In many cases it can be used to test inductive components while they are still in their circuit, as long as there are no faults in the circuit or resistive loads on any output windings. If in doubt, take the inductive component out of the circuit and test it.

Typical readings

I'm indebted to **Jestine Yong** at https://www.JestineYong.com for providing a lot of this usage information.

High frequency transformers

Most low loss ferrite-cored transformers in switching power supplies and inverters will produce readings above **50** up to **99** rings. If there are shorted turns, the reading will almost always drop below **10**. However if an entire secondary winding is short-circuited (very unusual), the tester can show a deceptive high reading, e.g. “**37**”, so be aware of this possibility.

Many LCD Monitors and TVs will have more than one inverter transformer making it easy to compare a suspect transformer with a good one.

If you suspect that there is a partial short circuit in a transformer's primary winding, put a short circuit onto one of the secondary windings. For a good transformer, the reading will drop to about **50%** of the initial reading, e.g. from **99** down to **~50**. However on a transformer with a partially shorted primary, the same test will have less effect and the reading will not drop so much, e.g. dropping from an initial **37** down to **34**.

If you have a high voltage insulation tester, it might show up internal breakdowns between windings which this ring tester cannot see due to its low test voltage.

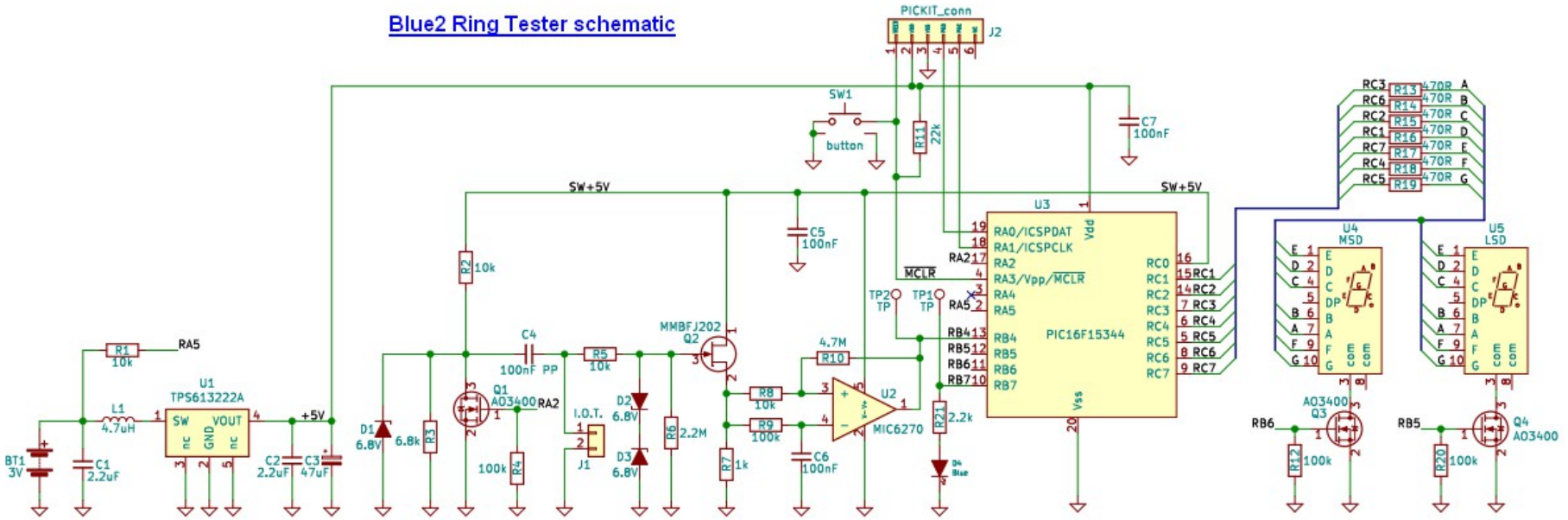
Low frequency transformers

50/60Hz mains and tube output transformer primary windings produce much lower readings than ferrite cored transformers. If possible, always compare the tester's readings on a suspect transformer with its readings on a known good transformer of the same kind.

Typical readings are around **15** to **30** for a good transformer primary winding without any interference from other components in the circuit. Shorted turns usually drop the reading to less than **10**, however a solid short circuit on a secondary winding can produce a reading similar to a good transformer, so keep this in mind.

Please try out the tester on as many transformers and inductors as you can, to get a “feel” for what are normal readings. There are so many different inductors and transformers that it's not possible to provide “hard and fast” readings for all of them.

Blue2 Ring Tester schematic



Drawn in KiCad by Bob