Project - A 2-Terminal Test Oscillator

Peter Cole DA1PE describes a 2-terminal test oscillator for inductance measurement

Anyone who is interested in home construction will at some time or other have the need to measure the inductance of small coils. This can be a difficult problem, as commercially made equipment of sufficient accuracy is often far too expensive for occasional use in an amateur workshop. The simple LCR bridges that are affordable generally only work at audio frequency, and are notoriously inaccurate on their low inductance ranges. The result of this is that coil construction is often so hit-and-miss that for many applications the home constructor has to use expensive ready made coils, which could have been wound at home from materials costing a few pence if test facilities had been available.

The method of measurement described here is a inexpensive solution to the problem that I have been using for over 40 years. It uses the coil under test in parallel with a known 1% capacitor to form the tuned circuit for a 2-terminal test oscillator. After making allowance for circuit strays, the total circuit capacity and the oscillating frequency can be entered in the standard resonant circuit formula to calculate the inductance of the coil accurately enough for all normal purposes.

Using this method has the advantages that *a)* coils can be tested in a practical circuit at the operating frequency and *b)* measurements are just as easy to make on toroids and sealed coils such as IF transformers as they are on open coils. An additional bonus is that the circuit can be used for a variety of other purposes such as a signal generator, a dip meter or to measure small capacitors.

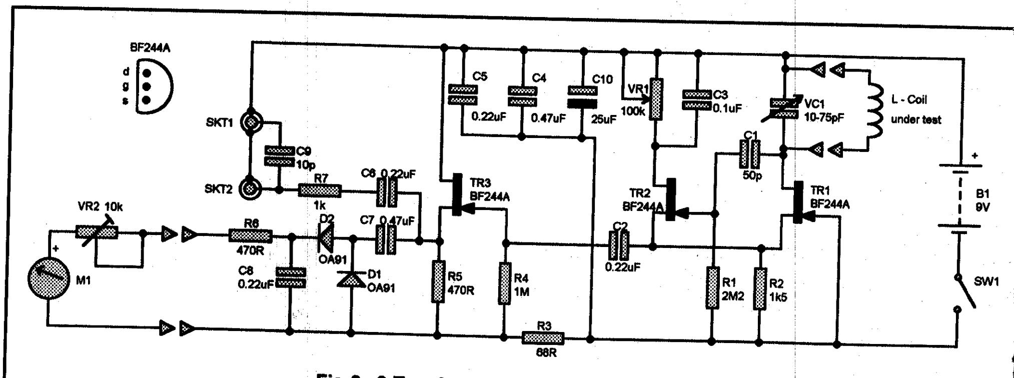


Fig 2. 2-Terminal Oscillator Circuit

The 2-Terminal Oscillator

Fig.1a shows the basic circuit of an FET source coupled 2-terminal oscillator, which is the semiconductor version of a valve circuit that was popular in the 1950s. This circuit, which was derived from an early radar pulse generator called a cathode-coupled multivibrator, forms a very active tuneable oscillator that can be made to work reliably from low audio frequencies up to the VHF and UHF ranges.

The great advantage of this circuit, and the thing that makes it so useful as a test oscillator, is that it doesn't need any sort of capacitive tap, inductive tap, or feedback winding to make it work. Simply connect a parallel tuned circuit across the two test terminals, apply power, and away it goes. The only criteria are that the tuned circuit has a realistic LC ratio (a minimum of 1-2 pF per metre of operating wavelength is a

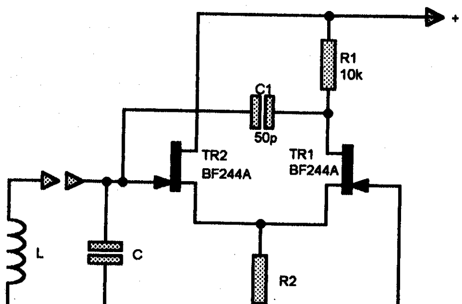


Fig 1a, a 2-terminal FET oscillator derived directly from a valve circuit that was popular in the 1950s

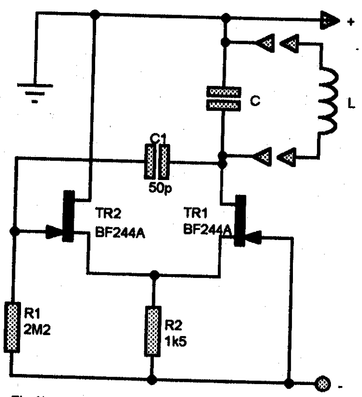
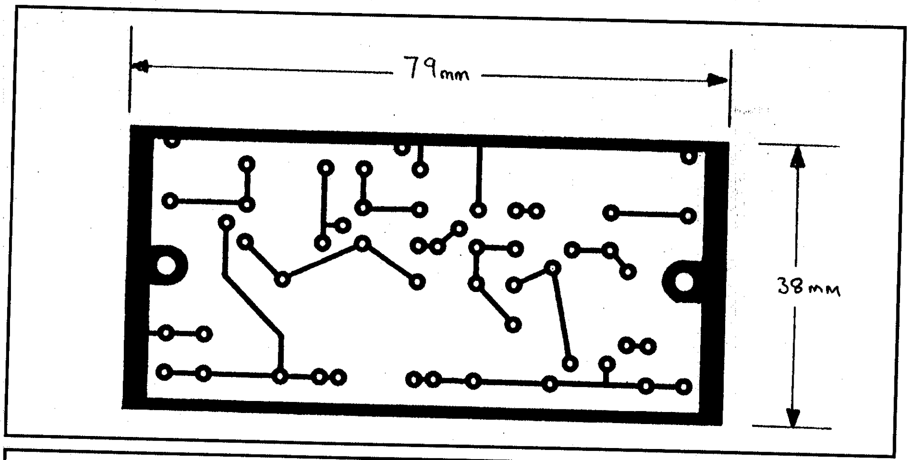
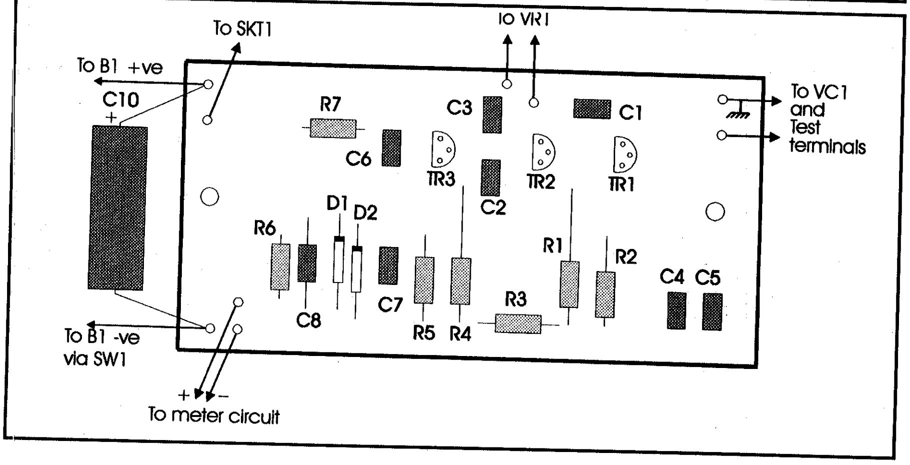


Fig 1b, the circuit rearranged to reduce damping by R1. With suiable FETs this circuit will work reliably from low AF up to the VHF/UHF range





good rule of thumb for the capacitor value), and is made from good quality components.

Operation of the circuit itself is quite straightforward. TR2 in Fig.1a is an FET source follower that is directly coupled to the common gate FET amplifier TR1 by way of their shared load resistor R2. C1 provides a positive feedback path from the drain of TR1 to the gate of TR2 and this maintains oscillation at the resonant frequency of LC so long as the loop gain of TR1,TR2 is enough to overcome circuit losses.

Fig 1b is the same circuit rearranged to allow R1 to be increased in value from 10k to 2M2. This reduces damping of the tuned circuit which in turn extends the frequency range and gives more consistent operation with low-Q coils. The improvement given by this simple change is quite significant, as with cheap general purpose 2N3819 FETs my original circuit oscillated up to 15MHz whereas the modified one worked to over 25MHz.

The BF244A FETs suggested in the parts list are suitable to 30MHz or more, but operation at higher frequencies than this calls for VHF type FETs. Out of several readily available types that I tested, the best were J310s (listed as VHF/UHF oscillators/amplifiers) with which the oscillator worked from a few hundred Hz (with a homemade ferrite pot-cored coil plus 1µF) up to 60MHz with a small hairpin loop tuned by 25pF (the stray capacity of my test oscillator).

Practical Circuit

Fig.2 gives the practical version of the tester, where TR1 and TR2 are connected as in the oscillator circuit of Fig 1b. VR1 is an amplitude level control, that has been added mainly to allow the circuit to be used as a dip meter as explained later.

Output from the oscillator is taken from across the common source resistor R2, via C2, to the source follower TR3. This is used as a buffer amplifier to feed the output and monitoring sockets SKT1, SKT2 and the RF level metering circuit formed by D1 and D2. R7 is an isolating resistor included to minimise the effect on the metering circuit if a low impedance load is connected to SKT1. The value of R7 is not critical as long as it is at least twice the value of R5. Likewise the value of C9 is not important and this can be varied to set the level of signal fed to the frequency counter, if one is used.

Construction

The prototype was built on a 0.1 inch matrix board, and this was used to produce the PC board layout shown. Thus it should be a simple task to copy the layout back onto matrix board if you don't want the bother of etching a PCB.

Construction of the test oscillator is quite straightforward, as there is nothing critical about the components or layout except for the wiring to the tuning capacitor and the collector of TR1. These connections must be of thick wire or braid, and kept as short as possible so as to reduce the chance of parasitic oscillations which can give false readings on a frequency counter.

Transistor holders are recommended for the FETs. This makes it possible to experiment with different types and also allows the circuit to be used as a simple tester for small-signal N-channel FETs. This is easy to do by replacing TR1 with the FET to be tested and checking for oscillation. But don't forget that the PCB shown is designed for use with BF244A FETs, and look up the leadouts of other types before you plug them in (e.g. the gate and source of the J310 are reversed to those of the BF244A).

The oscillator itself should be built into a well shielded enclosure, e.g. a small diecast box as suggested in the parts list. This makes a compact, rigid unit so that when used as a dip meter the coil can be coupled to circuits in 'hard to reach' places.

Choosing the best value for the variable capacitor (VC1) is a trade-off between providing wide frequency coverage for use as a tuneable oscillator, and good bandspread for other measurements. These factors are also influenced to some degree by the quality of the tuning dial, but the suggested 10-75pF has been found to be a fair compromise when used with an 8:1 vernier reduction drive.

Coil and test sockets are very much a matter of availability and personal preference. I use a B9G valve holder and a pair of 2mm wander sockets only because they suit existing coils. Otherwise I would have chosen standard terminal posts which are more versatile as they accept wires, spade terminals or wander plugs.

M1 is a small edgewise VU meter of about 250µA FSD (mine was rescued from a scrapped cassette recorder). As it is not used to make any critical measurement,s the exact FSD and scale calibration of the meter are not too important. What is important though is that the pointer moves freely without sticking and it is wise to check this point carefully before cutting holes in an expensive diecast box to fit a salvaged meter.

PART TWO NEXT MONTH