Antennas

More on the Grid Dip Oscillator (GDO)

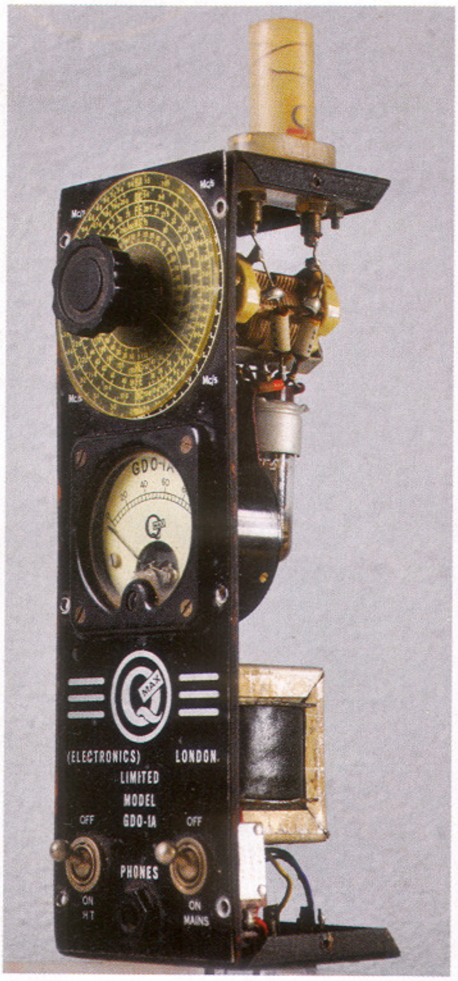

PHOTO 1: Q-Max GDO-1A uses a 12AT7 double triode, one half used as an oscillator and the other half as a half-wave rectifier.

GRID DIP OSCILLATOR. A very useful item of test equipment when working with antennas and tuned circuits is the Grid Dip Oscillator, generally known as a GDO. For newcomers who may not know of this device, it is used for measuring the resonance of tuned circuits and antenna elements without actually connecting the instrument to the circuit under test.

When a tuneable oscillator is placed close to a nearby resonant circuit, some of the oscillator power is absorbed when the oscillator is tuned to the same frequency. Some indication of oscillator energy loss is can be used to indicate this condition. The original instruments used a valve with a microammeter connected between the grid and earth, as shown in **Figure 1**. This measured grid current, which is proportional to the peak-to-peak level of the oscillator waveform. In practice a dip in the grid current level is observed as the oscillator is tuned past thé resonant frequency of circuit under test, hence the title of this instrument: Grid Dip Oscillator (GDO).

The circuit shown in Figure 1 is from the *ARRL Radio Handbook*, 1947 **[1]**. This instrument is designed as a portable workshop item of equipment for measuring the resonance of tuned circuits. It uses a probe made from a short length of twin transmission line and a loop L2 to access tuned circuits within transmitters or receivers. This GDO was built into an enclosure 150mm (6in) square so was quite different from the shape of GDOs to which we are now accustomed.

It was also used for determining the values of capacitors and inductors using the arrangements shown in Figure 1a and b. The link-coupled probe L2 is used to measure the resonances of tuned circuits in confined spaces. It can also be used to measure the resonant frequency of a tuned circuit where the inductance is a ferrite ring by coupling L2 around the ring. There was no mention in [1] of using this GDO to measure transmission line or antenna element resonances.

An example of a later GDO is shown in **Photo 1**. It is an old Q-Max GDO-1A that operates very well right up into the VHF band. It comprises a 12AT7 double triode, one half used as an oscillator and the other half as a half-wave rectifier for the 330V HT supply.

A FET GDO. These days most of these instruments use solid state devices, usually a FET. In this case we are interested in the variations in gate current so we can still call it a GDO (Gate Dip Oscillator). The subject of GDOs was prompted by a question from Paul Badley, M0PIB, who was building a published version a GDO **[2]**. He wanted to know where he could obtain a dual-ganged 365pF variable capacitor shown in this circuit and the diameter of the coils. The circuit I described in [2] was based on two very similar designs published in *QST*, Technical Correspondence **[3] [4]**. The circuit of my variation of these two designs is shown in **Figure 2**.

This circuit does not measure FET gate current directly; instead it measures the total source current, which is affected by the voltage at the gate of the FET. However, the variation of current through resonance is only a small part of the total source current. The dip is enhanced by offsetting the meter reading using a potentiometer in a bleeder network. This is set so that the meter reads about 75% FSD when the instrument is not coupled to the resonant circuit under test.

I built one version of the FET GDO into a defunct Japanese nuvistor LDM-810 GDO by using the chassis, case, calibrated tuning mechanism and coils. The value of the twin-ganged capacitor turned out to be 120pF as shown in **Photo 2**.

At a later date, G3ZOM used this circuit as a basis for a GDO kit and he specified a two-ganged 365pF polyvaricon variable capacitor together with the speaker DIN plugs as coil formers, shown in the circuit that appears in [2].

A GDO should possess good sensitivity, which can be checked by squeezing the coil of the GDO between the thumb and forefinger and noting the meter deflection; this should dip to at least 50% of the maximum reading. The GDO should also be capable of measuring resonance of a high-Q tuned circuit at a distance of 6 to 7cm (2-3in). I use a parallel tuned circuit, comprising a 5mH inductor with a 100pF capacitance, as a 7MHz standard. The circuit shown in Figure 2 possesses this sensitivity in the HF and lower VHF bands but is unsuitable for VHF without modification to some component values.

A good indication of the resonance dip is important. Some commercial GDOs have small meters, which are a problem for optically challenged old-timers like me. A large meter makes using this instrument much easier. The G3WPO FET dip meter **[5]** uses an audio indication of dip, which is very nice – rather like using a metal detector.

A QUESTION OF VALUES. In answer to M0PIB's question regarding the value of the variable tuning capacitor, various capacitance values have advantages and disadvantages. If a large value of capacitance is used then fewer coils are required to cover a given frequency range. The down side is that the resonance dip will be more difficult to locate because of the large oscillator frequency shift for a give amount of capacitor rotation. If a smaller capacitance is used it gives the frequency dial a bandspread effect and the dip is easier to locate, however more coils will be required to cover a given frequency range. The Q-max GDO uses quite a small dual ganged 40pF capacitor and the frequency coverage 1.5 to 300MHz requires 8 coils. It does make for a readable frequency dial as shown on **Photo 3**.

Building many items of electronic equipment can be likened to following a cooking recipe. You can use the 'Delia Smith method' where you follow the recipe exactly using the exact

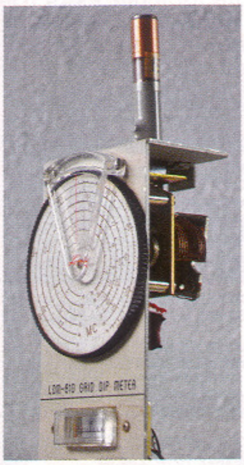

PHOTO 2: A FET GDO using the chassis, case, calibrated tuning mechanism and coils of a defunct LDM-810 nuvistor GDO.

PHOTO 3 : Frequency dial of the Q-Max GDO.

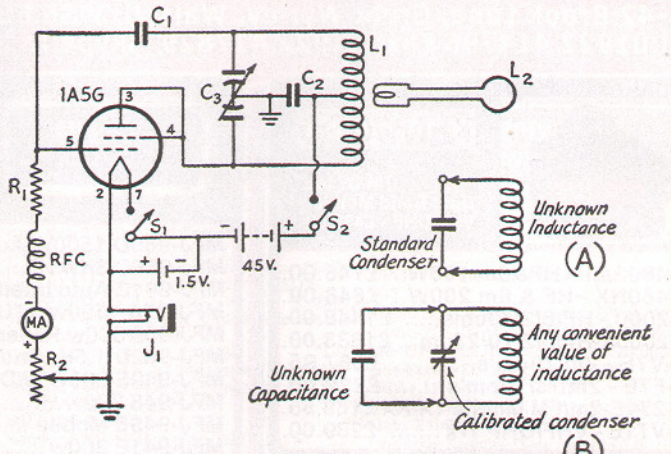

FIGURE 1: Grid dip oscillator for 3 to 60MHz using a battery valve type 1A5G. Reproduced from the *ARRL Radio Handbook*, 1947.

values of specified components. Or you can use the more interesting 'Jamie Oliver approach' where you throw in components whose values or types you know from experience will do the trick. In this way the design can be built around the components from the junk box.

The most important part of a dip oscillator is the tuning capacitor, slow motion drive and if possible a read-out dial that can be calibrated in frequency. Sometimes a whole assembly can be obtained from an old transistor radio. Choose a coil plug and socket arrangement that is practical. The circuit shown in Figure 2 uses 2-pin coils, which allows the use of crystal holders or 2-pin plugs and sockets for the coil.

JUNK BOX GDO. A junk box GDO, using the circuit shown in Figure 2, is shown in **Photo 4**. It uses a two-ganged 60pF variable capacitor for tuning and a crystal holder for the plug in coils. The coil socket should be located as close to the tuning capacitor as possible so that the coil leads can be kept short. The rest of the circuit can be wired around these main components.

The arrangement shown in Photo 4 was designed for a specific application, measuring the resonant frequency of antenna elements. There are two main departures from the traditional GDO design.

The first is the coil. Coupling a small diameter GDO coil to wire or tubular antenna elements is almost impossible because the coupling is very loose. G6XN suggested using a coat hanger shaped coil where flat section of the coil can be arranged in close proximity to the antenna element. While this is fine for VHF this arrangement is very cumbersome at HF frequencies because of physical size of the coil. A more practical solution is to wind the coil on a rectangular section using several turns to make up the required inductance. This former can be a short wooden board, say, 4 inches wide and half an inch thick.

The coil shown in Photo 4 uses 7 turns of 16SWG (or similar) plastic covered wire, which tunes from 8 to 18MHz, covering the 14MHz band (the band of interest at the time). The other departure from the traditional GDO is the use of a frequency counter instead of a calibrated frequency dial. A frequency counter is a worthwhile investment and has many other uses in home construction projects. If you are using a GDO without a connection for a frequency counter the frequency can be sampled using single turn loop round the GDO coil. The coupling of this pick-up coil to the coil winding can be adjusted with respect to the main winding until just enough energy is available to operate the frequency counter.

The coil former board also provides a platform for the GDO, frequency counter and even a note pad. The flat sided coil couples into any antenna element, with the board providing a stable point to rest the measuring kit against the element while measurements are being made. The coupling between the GDO coil and the wire antenna element is maintained by placing the wire antenna element in the grove formed by plastic wire fixing clips. This is a useful feature if you are balanced on top of a step-ladder trying to measure the resonance of a parasitic quad element.

REFERENCES

[1] *The Radio Amateur's Handbook, 1947 Edition*, ARRL.
[2] *The Antenna experimenter's Guide, Second Edition*, Peter Dodd, G3LDO.
[3] 'Technical Correspondence', *QST* June 1972, Peter Lumb, G3IRM.
[4] 'Technical Correspondence', *QST*, November 1971, W1CER.
[5] 'The G3WPO FET Dip Oscillator Mk2', by A L Bailey, G3WPO *RadCom* April 1987.

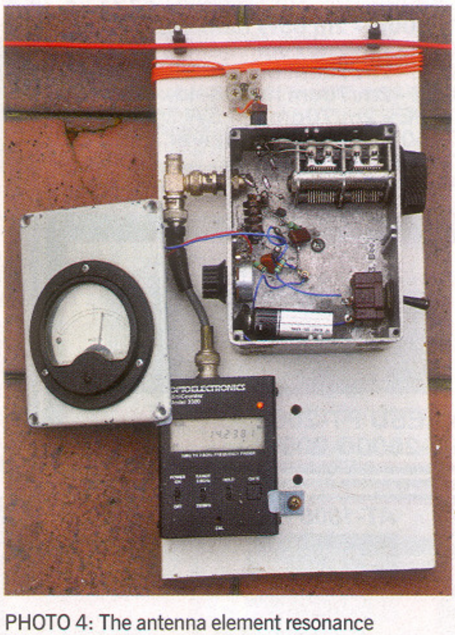

PHOTO 4: The antenna element resonance measuring kit. Note the method of maintaining a constant coupling to the antenna element (red wire) and the GDO coil.

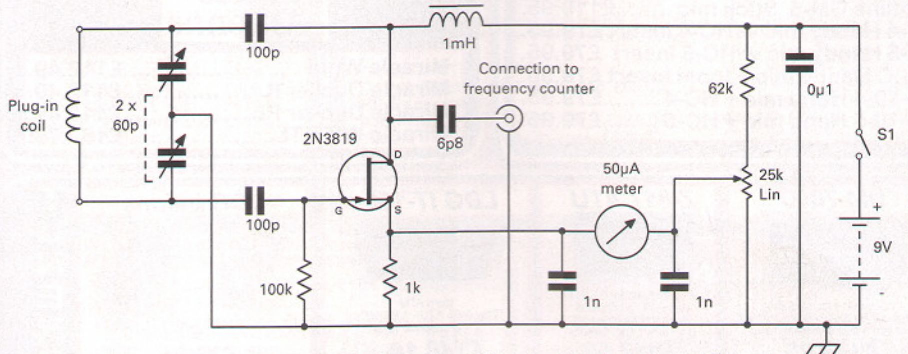

FIGURE 2: Circuit diagram of a FET GDO. Operation of the circuit is described in the text.