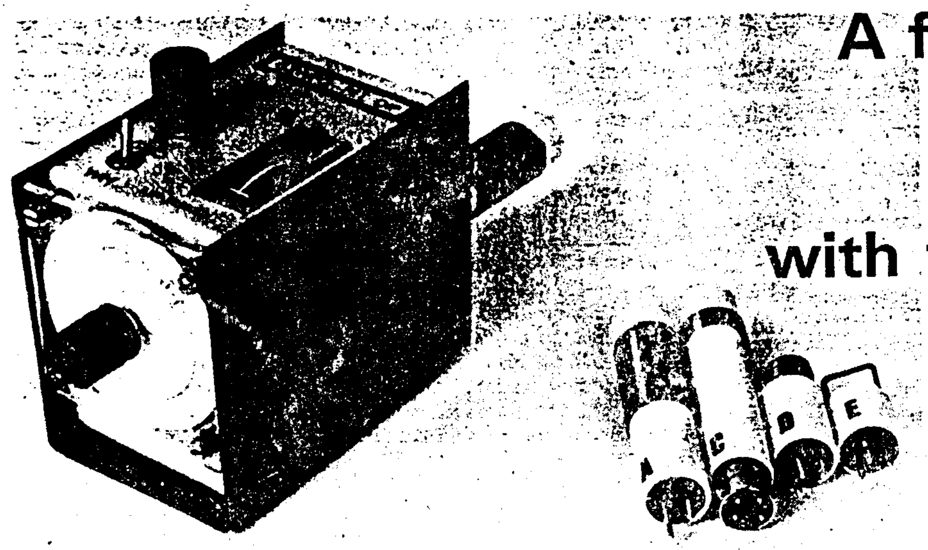
A fet dip oscillator for 1·6–215MHz with tone dip feature

by A.L. BAILEY, G3WPO*



The assembled unit with coils

Introduction

The dip oscillator is an essential piece of test equipment for any radio amateur involved in rf-orientated construction, and will help to meet the requirements of the amateur licence concerning measuring equipment. The instrument to be described covers 1·6 to 215MHz in five ranges, and in addition to the standard meter indication of energy absorption, also features an audio oscillator whose frequency is lowered during resonance. This assists in locating the dip when rapidly tuning across the instrument's coverage. All of the rf circuitry is accommodated on one pcb, thus making the design reproducible.

Over 30 of these have been built as a Worthing & District Amateur Radio Club project.

Circuit description

The rf oscillator is based on a fet Kalitron oscillator, identical to that used by G3HBW for his vhf/uhf gdo, but with component modifications for operation at hf. A large number of different oscillators were tried for this application, and this circuit offers the most consistent output and wide range, without resort to tapped coils, feedback arrangements or similar complications.

The tuning capacitor is always the problem area in a dip oscillator design, and it is currently very difficult to find a suitable off-the-shelf component, as those who have tried to construct some existing designs will have found. Also, the construction of the rf circuitry directly around the capacitor terminals is not conducive to uniformity between constructors. A capacitor was required which could easily be attached to a pcb, and, without too much hope of success, a plastic-type variable capacitor (polyvaricon) of the type invariably seen in Japanese transistor radios was tried—the likely problem area being the loss of Q inherent in the capacitor's construction. To the author's surprise the circuit did function, and with a few rearrangements to the pcb layout, and improvement of the stator earthing arrangements, the existing design was arrived at.

The overall circuit Q is lower than would be achieved with an air dielectric capacitor, but the dip obtained is adequate, and in conjunction with the audio oscillator, easy to find when tuning. The balanced configuration of the oscillator is retained on the pcb, athough a little offset by the tuning capacitor's internal construction.

The two rf chokes (L2,3) exhibit no strong self-resonances within the scale coverage, aided by damping with R4,5. It is possible to extend the vhf

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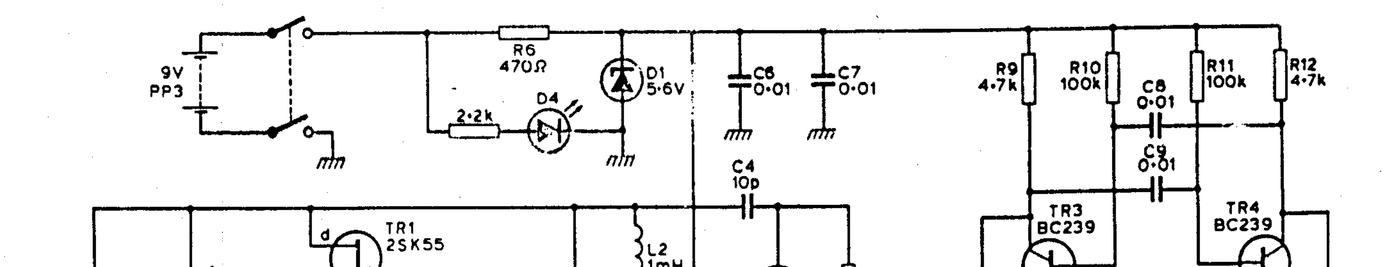


Fig 1. Circuit diagram

coverage by lowering the value of L2,3 and the coupling capacitors, but the oscillator will refuse to function on the lowest band, and the LC ratio at vhf is too high for sustained oscillation across all of the tuning capacitor's swing. However, as the oscillator was primarily intended to be for hf use, with the two common vhf bands covered, the existing circuit was thought to be adequate.

Removal of power to the rf oscillator only, allows use as a wavemeter, in which case resonance is indicated by the meter reading, and by the audio oscillator commencing oscillation—the pitch being highest at resonance. The instrument is powered by a 9V PP3 battery, stabilized at 5·6V by D1, allowing battery usage down to about 6V. Current consumption is around 7mA.

RF from the oscillator is rectified by D2,3; both being point-contact germanium diodes (OA91) dc isolated by C4,5. RV1 functions as a sensitivity control for the meter driver TR5. The output from the oscillator is reasonably constant over each band, dropping gradually as the frequency is increased, until the highest band is reached—when the output drops noticeably—but is easily recovered by the sensitivity control.

Audio output is by a simple multivibrator (TR3,4) with a piezo-ceramic resonator connected between the two collectors. These resonators are small, inexpensive and provide a good level of sound for very little drive. The total current flowing through the circuit, and thus the frequency of audio oscillation, is controlled by TR5 and varies with the rectified voltage to RV1. The multivibrator will commence oscillation at about mid-scale reading of M1, with a gentle oscillation at about full-scale reading. R13 can be added to intensify the audio output but the sensitivity will be decreased as the value of R13 increases.

Coil formers

Several types of coil former construction were tried, including battery plugs, speaker plugs and more complicated arrangements. The final choice was three-pin DIN plugs (only two pins are actually used), with the former itself made from plastic electrical conduit tubing which can be Araldited to the plug; the shroud and plastic surround not being used. The plugs should be of the silverplated type. The conduit specified is widely available from electrical stockists, and is not expensive—a damaged length sufficient to make the formers could probably be scrounged from a contractor.

The lower range coils are wound directly on to the formers, but the two high ranges are air wound, with the former used as a protective handling shroud over the lower ends of the coils.

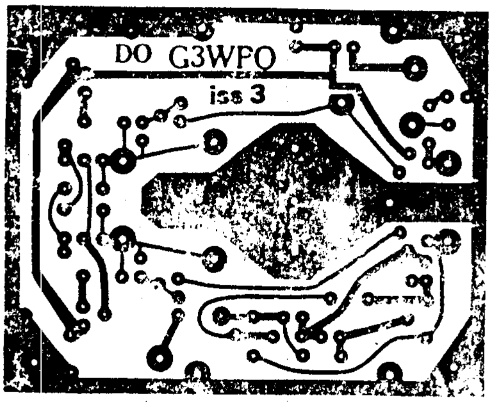
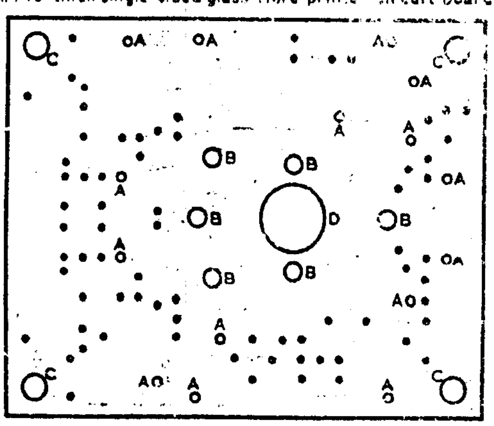


Fig 2. PCB

Material ....1/16" thick single-sided glass-fibre printed circuit board

Size.... 64x51mm



Holes shown • are 0·85mm dia   15 holes 'A'....1mm dia

6 holes 'B'.... 2mm dia   4 holes 'C'....3mm dia   1 hole 'D'.... 8·5mm dia

Viewed from track side

Fig 3. PCB drilling details

Construction

The pcb (Figs 2,3) accommodates the rf circuitry and all remaining components, except for the external controls, meter and ceramic resonator which are mounted directly on the chassis. It is important that the pcb is copied exactly if the instrument's coverage is to be the same as the original and will allow the precalibrated dial to be used. Photographic reproduction is best, otherwise careful drawing by hand using a fine pcb marking pen will suffice. Alternatively, a ready-screened, drilled glass-fibre pcb is available, together with all other components, including metalwork and the coil formers.

Construction is best started with the pcb itself, as the instrument's general operation can be checked after assembly and then built into the case. All leads of components mounted on the pcb must be kept as short as possible around the rf oscillator section, with not more than 3mm of the fet (TR1,2) leads above the pcb surface. All components except for the tuning capacitor mount on the non-track side of the pcb.

1. Insert and solder the connection pins. Those marked "X" being inserted from the foil side, and the four marked "Y" from the non-foil side so that the polyvaricon stator lead earthing straps can be soldered to them. Push all of the pins hard home with a suitable tool before soldering.

2. Insert and solder all fixed resistors, mounting horizontally or vertically as indicated by Fig 4. Vertical resistors should be inserted with the body-end resting against the pcb upper surface in the same positions as indicated.

3. Insert and solder the fixed capacitors, keeping the leads as short as possible for C2,3,4,5. Mylar capacitors are green.

4. Insert and solder D2,3, taking care when bending the leads so as not to break the glass encapsulation.

5. Insert and solder D1 (mounted vertically).

6. Insert and solder L2,3.

7. Insert and solder TR1,2,3,4,5 with TR1,2 leads 3mm above the pcb surface.

8. Solder in the two links, using insulated wire.

9. Insert the polyvaricon capacitor from the foil side of the pcb with the five leads through the appropriate holes (spindle first). Ensure it is flat

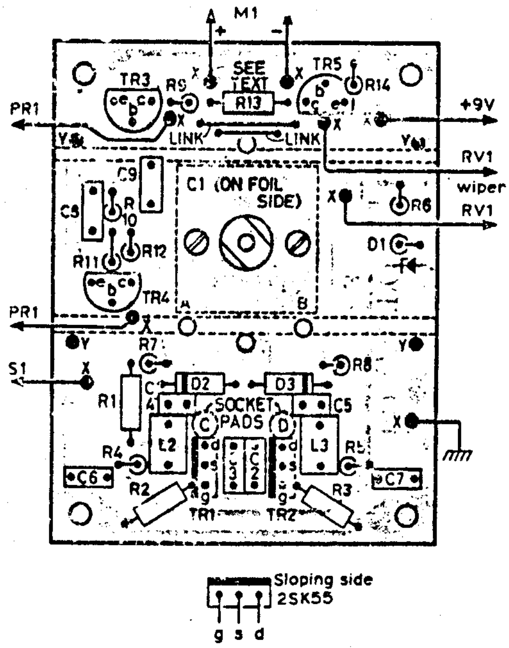


Fig 4. Component layout

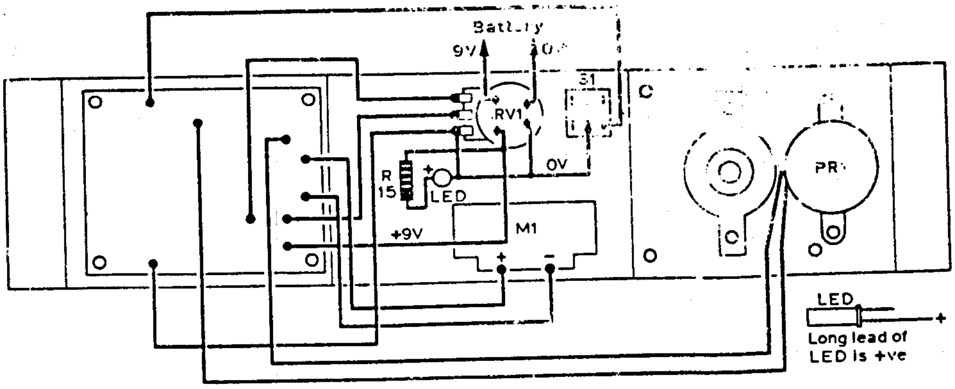


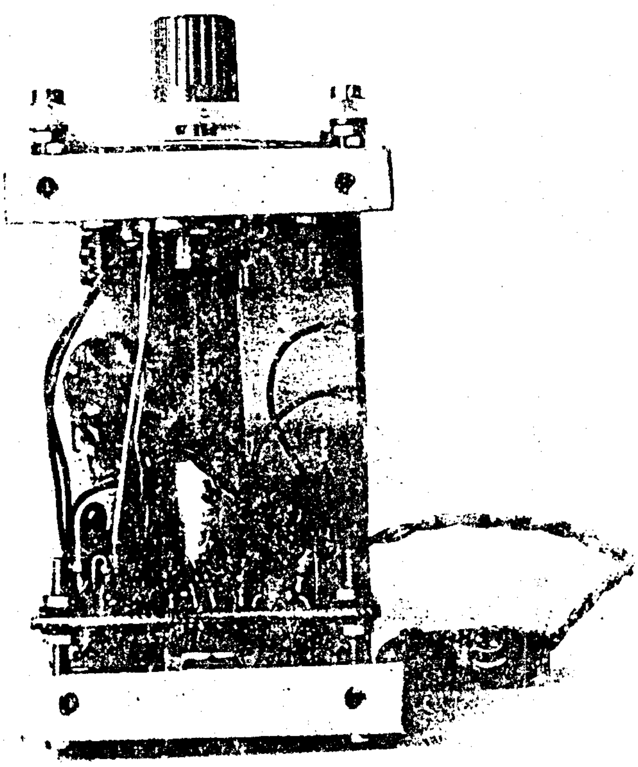
Fig 5. Wiring diagram

against the pcb, and solder the two rotor leads (A and B) to the pcb, taking care not to melt the capacitor body.

10. Prepare the two stator earthing straps from single-sided pcb material, and tin with a hot iron across the copper surface. Both straps mount with the tinned surface against the inside of the connection pins (relative to the polyvaricon) and with the strap between the stator lead and the polyvaricon body. Solder the straps to the pins first, with the lower edge of the strap just clear of the pcb to avoid shorts. Then solder the straps to the stator leads, and finally the stator leads to the pcb proper. Cut off the excess leads close to the pcb on the component side.

On the top of the polyvaricon are four short leads which are connected to the four internal trimmers. These should be cut off close to the plastic body, and the trimmers set to minimum capacitance (vanes open) with a small screwdriver. Also, if the kit of components is used, two small screws are supplied to attach the polyvaricon to the pcb via the mounting holes on the pcb. Carefully tighten these up. UNDER NO CIRCUMSTANCES use any other screws, such as the two 8BA ones for the piezo-ceramic resonator mounting which are too long and will damage the vanes of the polyvaricon beyond repair.

11. DOUBLE CHECK the pcb for solder bridges and component positioning.



Underside view

Checking operation

In order to check the operation, coil C is required and should be made as described under "Coil construction".

First, clip off half the length of each of the DIN socket connections, and entirely remove the lug (if any) protruding from the surrounding metal cover. Solder temporarily to pads C and D on the foil side of the pcb.

Temporarily connect the meter (Fig 5), sensitivity control, switch, piezo sounder and battery. If possible check that the current consumption is around 7mA and that the voltage at D1 is approximately 5·6V. With no coil inserted, the rf section will self-oscillate at around 20MHz, but this does not affect the operation once the coil is inserted. Insert the coil, set the sensitivity control to read about seven-eighths fsd on the meter; the audio oscillator should then be oscillating. If the audio oscillator does not function, either there is a fault in that part of the circuit, or the rf oscillator is not working (in which case the meter will not read). The multivibrator and meter drive circuit can be checked by temporarily connecting a 10kΩ resistor between +V and the non-earthy side of the sensitivity control. The audio output should commence at around mid-scale reading and increase in pitch as the sensitivity is increased. Check also that the oscillator functions over the total tuning capacitor range and that the audio/meter readings vary smoothly.

To check the dip, either construct coil A, which has a self-resonance around 40MHz, or use another inductor/capacitor combination whose frequency is within coil C's range.

Once all is working, the wavemeter function can be checked if required, although there is very little chance of this not functioning if the previous checks have been satisfactory. In use as a wavemeter, the supply to the oscillator is removed, and the detected rf will drive the meter/audio with a peak in both as resonance is reached. Turn the sensitivity control fully clockwise for this and then adjust as required.

Components list

R1	220Ω	D1	5·6V 400mW Zener diode
R2,3	10kΩ	D2,3	OA9
R4,5	47Ω	D4	3mm red dome LED
R6	470Ω	TR1,2	2SK55
R7,8	33kΩ	TR3,4,5	BC237/8/9
R9,12	4·7kΩ	M1	200μA type 909
R10,11	100kΩ	PR1	Piezo resonator Toko type PB2720
R13,14	1kΩ		
R15	2·2kΩ		

All resistors are 0·25W 5% carbon film.

RV1	100kΩ linear Alps potentiometer with on/off switch
C1	2 × 266pF polyvaricon Toko type 2A20ST7
C2,3	56pF ceramic plaquette
C4,5	10pF ceramic plaquette
C6,7	0·01μF ceramic disc
C8,9	0·01μF mylar
L2,3	1mH choke Toko type 7BA
Slow motion drive	Jackson epicyclic 6:1
S1	SPCO miniature toggle switch
Spindle coupler	RS type 509-793
Wire	Insulated 1·25, ·56 and ·25mm dia (enamelled copper)

18 and 22swg aluminium sheet, 2/3mm perspex sheet, 6 and 8BA nuts and bolts. PP3 battery connector. Two knobs. PP3 battery.

Toko and Alps components, and the meter, are obtainable from Ambit International, as is a complete set of components, together with drilled screened pcb, coil formers and the metalwork. Please enclose an sae with all enquiries.

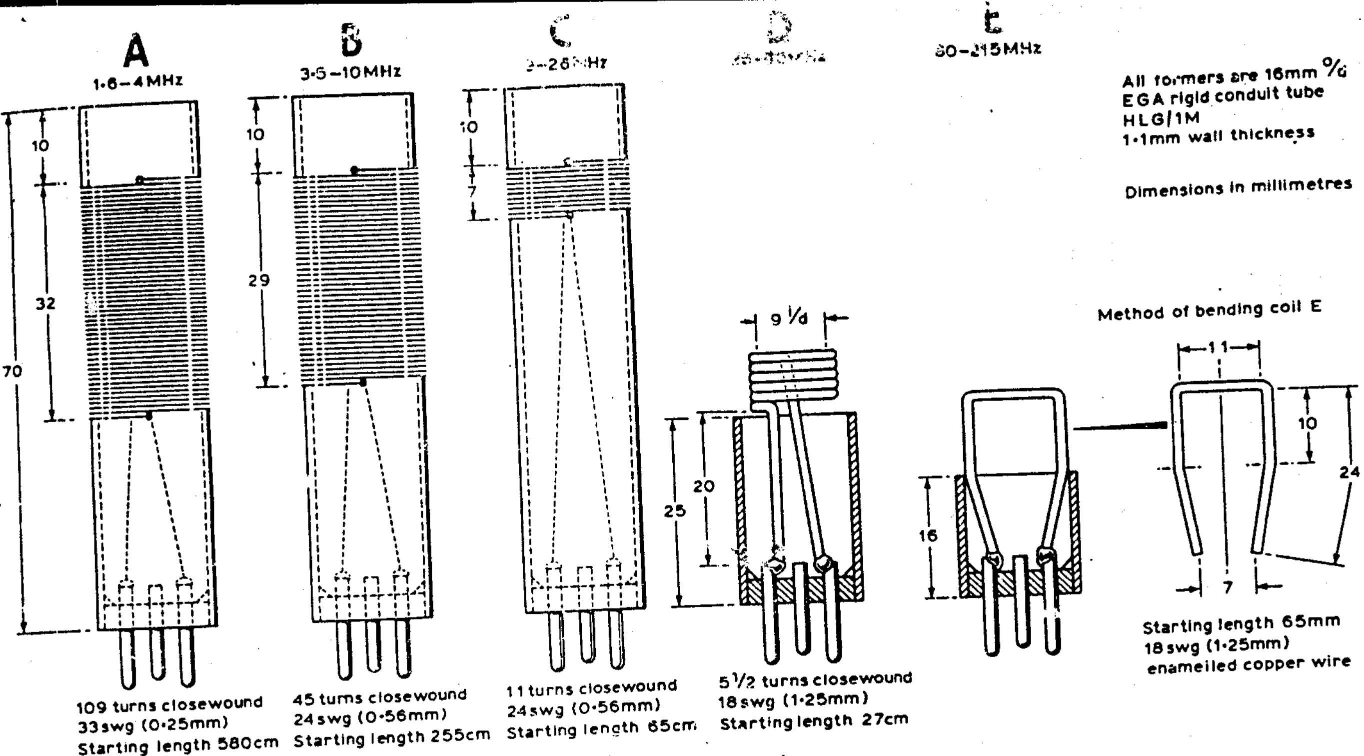


Fig 6. Coil construction

Coil construction

Again, it is important that the constructional details are followed if the precalibrated scale is to be used. Referring to Fig 6, cut the coil formers to the lengths indicated and drill two holes in each of the long formers in the positions indicated, using a 1mm (or near) diameter drill. Take the length of wire indicated, feed through the lower hole from the outside of the former, and out through the bottom, leaving 20mm protruding from the former. Close-wind the number of turns stated towards the other hole, then feed through the hole and out of the bottom of the former again. Secure the windings in place with a tiny drop of cyanoacrylate or Araldite at each hole and around the last turn at each end of the winding. Reduce the two ends of the wire to 10mm in length and strip 3mm of insulation off each. Tin and solder to the DIN plug connections. Prepare and smear a good layer of Araldite (rapid if available) around the lower inside edge of the former to about 3–5mm depth and carefully insert the plug, pushing the wire back into the former. Make sure the plug is at right angles to the former all the way round, and leave to set hard.

The two upper range coils are air wound. Coil D should be wound round a 0·375in diameter drill or other suitable former, the lower lead bent at right-angles to the main winding, and the upper lead bent into the centre of the winding and cut off at the centre. Strip a few millimetres of insulation from the upper lead and solder a straight piece of wire of the same gauge to this running down from the centre of the coil. Cut the two leads to 20mm in length, measuring from the lower side of the bottom turn. Solder to the plug connections, with the lower ends of the wires resting against the plastic of the plug former. Prepare the shroud, slide over the coil from the plug end, and Araldite into place.

Coil E is made as shown in the drawing, and the shroud fitted in a similar manner to coil D, with the wire ends again resting against the plastic of the plug former. Some form of protection should be offered to the coils when not in use.

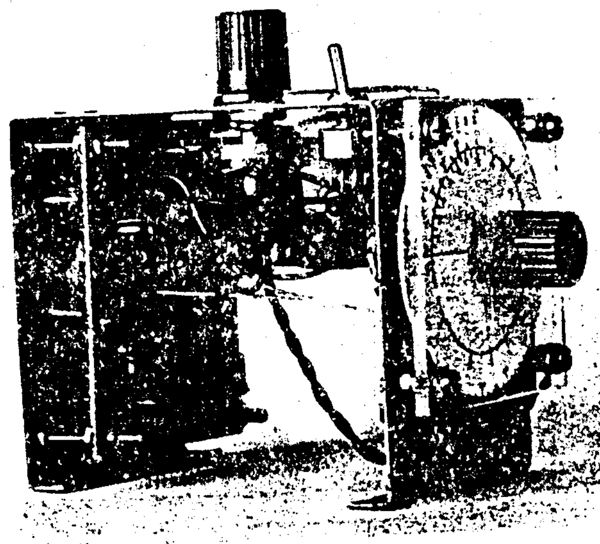
The case

The design of the case is somewhat dictated by the physical construction of the polyvaricon, and requires that the tuning scale be at the rear end of the instrument if a reasonably-sized scale is to be used. This is a slight disadvantage over a conventional design but one soon becomes adjusted to it after practice.

A slow-motion drive is provided to which the tuning scale is affixed, with the drive coupled to the capacitor by a short 0·25in spindle and aluminium coupling. The piezo resonator is fixed to the rear panel, with the controls, meter and an indicating on/off l.e.d. to the top panel.

A simple two-part case construction is utilized, and, bearing in mind that many people have difficulties in bending covers to fit neatly (the author is no exception), the cover is made first, and the main chassis cut to fit it; all measurements are made from a centre line, thus guaranteeing a good fit. The prototype was made from vinyl-coated steel plate, which happened to be to hand, and is very durable, but 18swg aluminium sheet is perfectly suitable, and the drawings accommodate either. The bending is easily accomplished with a vice and two pieces of 1–2in section steel angle iron, or by any other method used by the constructor.

Start by cutting, marking and drilling the cover, then clamp the centre panel exactly on the bending line and bend at 90°. Turn round and repeat with the other side. Make sure the two sides are parallel, and measure the inside dimension accurately. Now mark out the main chassis panel, using the dimension just obtained for the short side. Accurately mark a centre line down the panel length, and mark the rest of the panel out. Centre punch and pilot drill all holes, then enlarge to the correct sizes. The meter cut-out should be filed until the meter is a good fit.



Left front-angle view

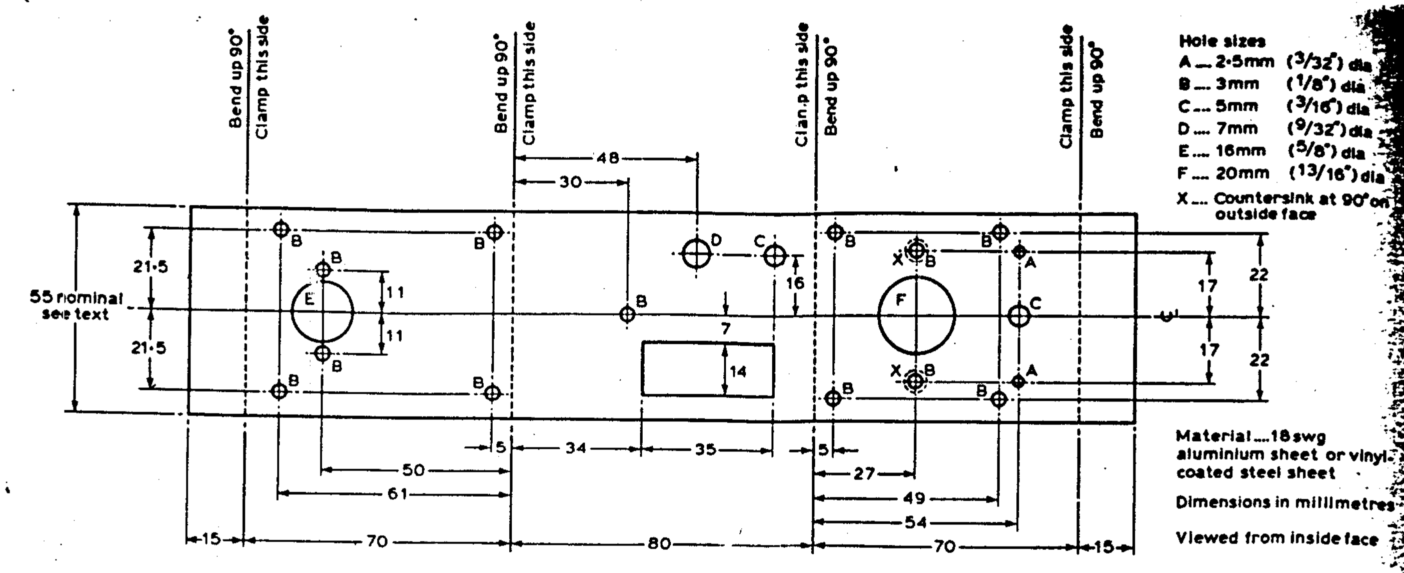


Fig 7. Chassis plan

Now bend the chassis, in the same manner as the cover, first clamping the centre panel bending lines in turn for the first two bends, followed by clamping the back and front panels to bend the two end flanges. It will probably be necessary to file the edges of the flanges on the outside to ensure that the chassis fits neatly into the cover at the bends. Position the front of the chassis 2mm in from the front of the cover and mark the centre of the four fixing holes for self-tapping screws on to the two flanges, and punch and drill these.

If aluminium has been used, clean up with wire wool or liquid scouring cream. The chassis and cover can be primed and spray painted as desired, or simply covered with Contact or Fablon type materials which have the advantage of being easily replaced, as the cover will tend to be chipped during use on the bench.

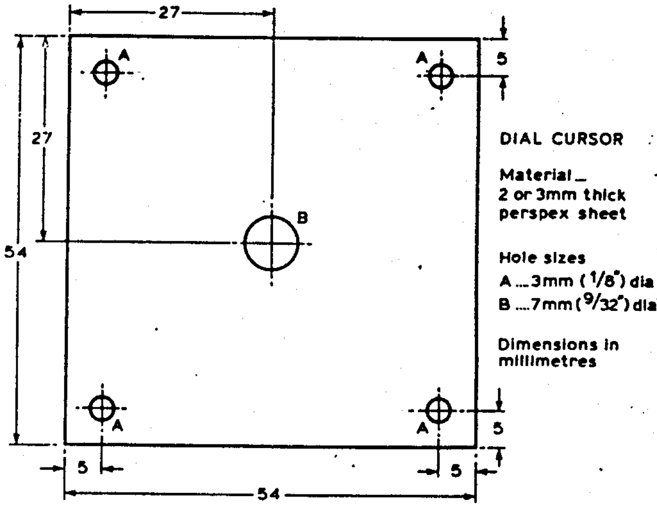
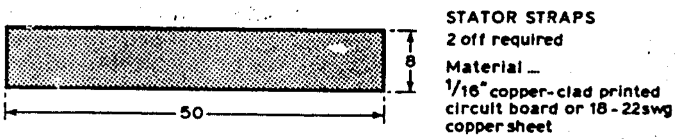


Fig 9. Dial cursor



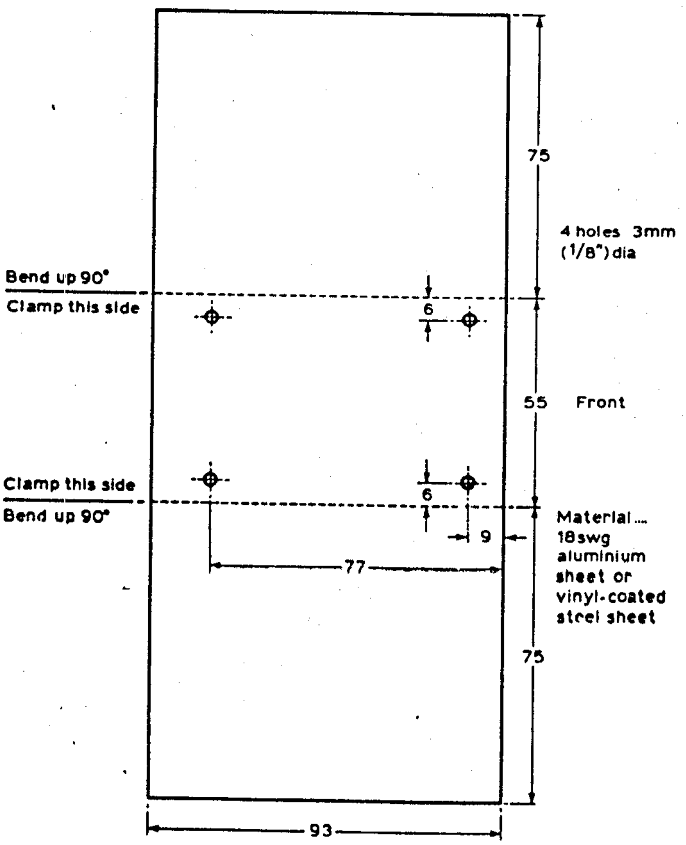


Fig 8. Cover

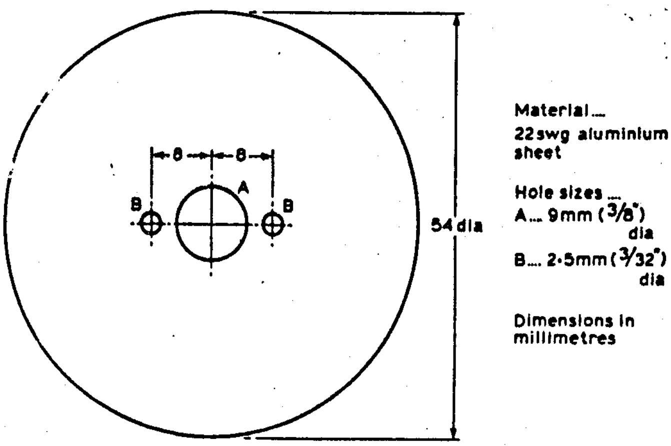
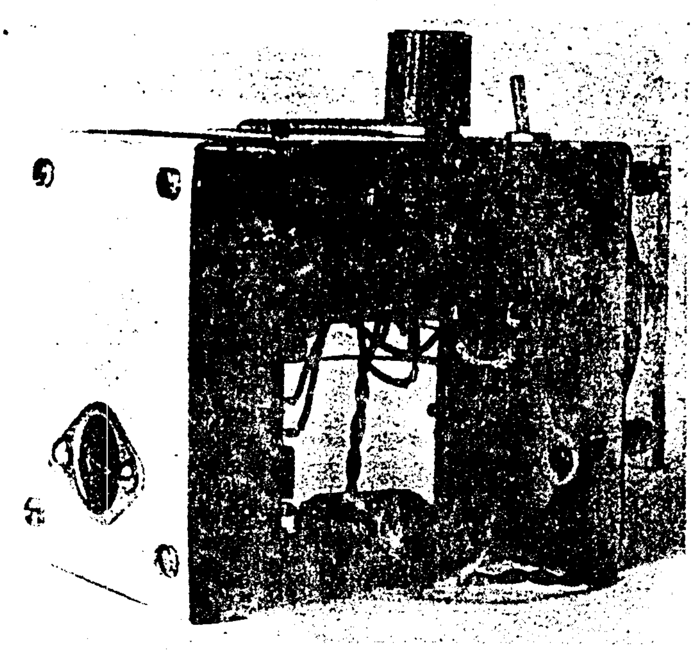
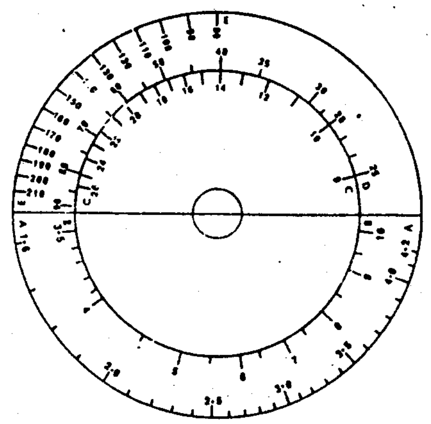


Fig 10. Dial plate



Right rear-angle view



The precalibrated dial

Assembly of instrument

It is suggested that the following order of assembly is followed:

1. Bolt the DIN socket into place on the front panel (with leads clipped as previously indicated).

2. Fix the 4×25mm 6BA bolts on to the front panel with a lockwasher and nut each, and screw one nut on to each. Mount the pcb on to the bolts and slowly screw down each nut until the DIN socket leads are just touching the two connection pads on the rear of the pcb. Check that the pcb is parallel with the front panel on all sides, solder the socket leads to the pads by inserting a soldering iron carefully through the gap, and finally fix the pcb into place using additional lockwashers and nuts.

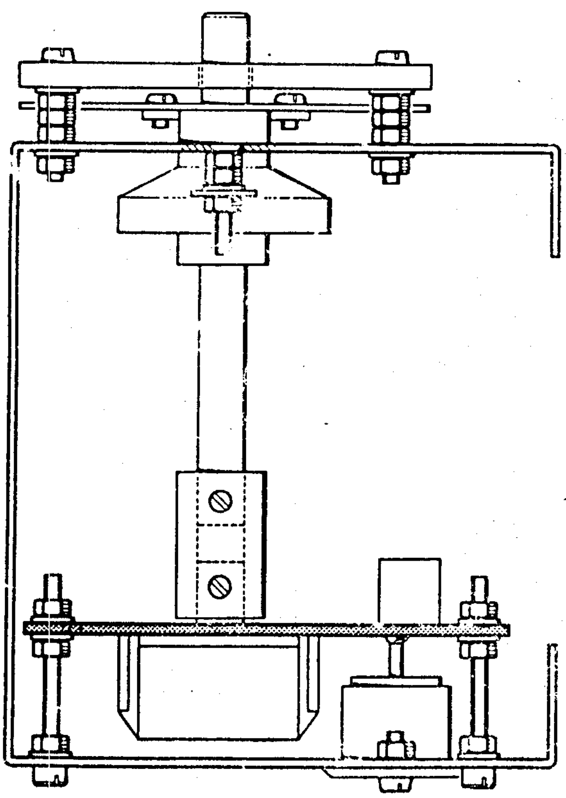


Fig 11. Mechanical detail of case and drive

3. Reduce the potentiometer spindle to 10mm in length and mount with tags facing the front panel.

4. Fix toggle switch into place.

5. Mount meter into position with the tags facing the outside edge of the chassis, using a couple of small spots of Araldite or cyanoacrylate adhesive on the face of the meter side flanges.

6. Mount the piezo resonator using 8BA nuts and bolts (countersunk) with an extra nut and a plain washer between each flange and chassis to prevent the flange breaking when tightened.

7. Insert two 12mm 6BA countersunk bolts through the slow-motion drive mounting holes, with a shakeproof washer and two 6BA nuts on the inside of each. Reduce the shaft of the slow-motion drive to 15mm in length and mount into place with nuts and washers.

8. Cut the extension spindle to length (38mm), using any suitable material (a spindle from a potentiometer could be used), place the coupler on the polyvaricon and insert the extension spindle into the coupler and slow-motion drive. It may be necessary to slightly flex out the chassis ends to achieve this. Tighten up and make sure the two chassis end plates are parallel.

9. Prepare the dial and the perspex cursor. Perspex can be cut with an ordinary hacksaw, but be careful not to saw in jerky motions. When drilling, start with a small drill and slowly work up to the correct diameter, using a fast drill speed and moderate pressure. The cursor can be polished with metal polish if required. Scribe a fine line through the centre for a pointer.

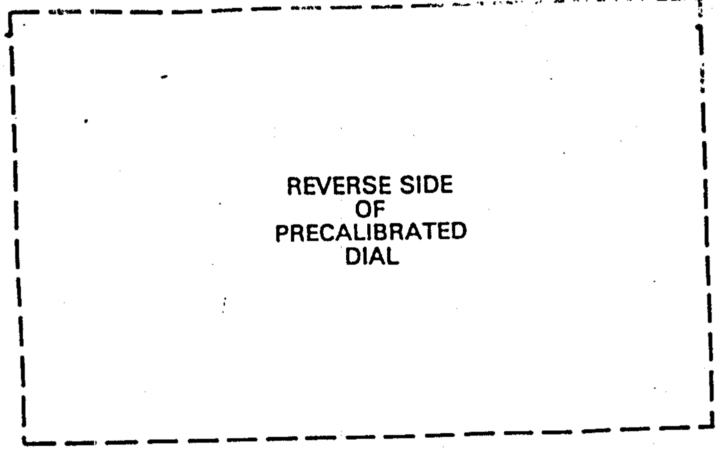
10. If using the precalibrated dial, carefully cut out the scale from the page and glue to the aluminium dial plate, the exact orientation with respect to the fixing holes being unimportant at this stage. Fix the dial into place with two screws on the slow-motion drive. (If a drive with flange is unobtainable, the scale can be fixed to the front face of the drive with adhesive, after cleaning off the lubricating grease which will be on the face.)

11. Fix the cursor into place with 6BA nuts and bolts as indicated in the drawing, with the pointer line upright. Do not overtighten the bolts.

12. The internal wiring can now be completed, following Fig 5. The only point to note is that the wires should avoid the tuning capacitor shaft. The leads on the battery connector are a little short to allow easy removal of the cover with the battery in place, and can usefully be extended by about 30mm (either extend the wires and insulate, or remake the connector with new leads after slitting the plastic cover open).

13. The battery should be fixed in place on the bottom cover (using double-sided adhesive tape, or a small aluminium clip if preferred) approximately in the centre, long side facing the open end of the cover, avoiding the slow-motion drive and tuning capacitor shaft.

14. The only remaining work is to orientate the dial to a known calibration marker. This can be done by first finding the gdo signal on a receiver—preferably towards the higher end of the ranges. Then release the grub screws holding the shaft to the slow-motion drive, and while holding the shaft turn the dial until the desired calibration point lines up with the cursor. Retighten the grub screws.



The frequency coverage should be verified at the extreme ends of each range, using a frequency counter coupled to the coil, or a general coverage receiver. As long as the coverage is correct at each end the remainder of the scale should be correct. Note that coil E does not oscillate over the full swing of the tuning capacitor, but the non-oscillating section is overlapped by coil D. In the event of an unacceptable discrepancy, check that the coils have been wound correctly. In the unlikely event that there is an unacceptable calibration error, a new scale will have to be made and calibrated by hand.

Use of the instrument

The most accurate frequency indication will be with the coil coupled to the circuit under test; maximum coupling being obtained if the axis of the oscillator coil is at right angles to the direction of current flow. The distance between the two coils should be adjusted for the minimum dip detectable with certainty for the greatest accuracy. Overcoupling will produce a spectacular dip but an inaccurate one.

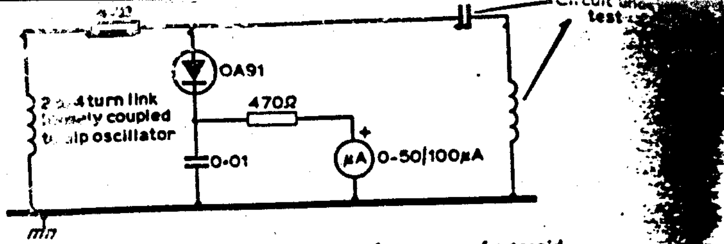


Fig 12. Measuring resonant frequency of a toroid

With power to the dip oscillator removed by S1, a sensitive wavemeter is obtained which will indicate the frequency of a transmitter or oscillator. It can also show the presence of harmonics with a transmitter. Other uses are for the measurement of inductance and capacitance (see [2] for details) and resonant frequency of antennas, since these are also tuned circuits.

The instrument will also double as a rudimentary signal generator, with the advantage that the rf output is modulated at the frequency of the audio oscillator, enabling easy location on a receiver.

One type of inductor/capacitance combination which cannot readily be dipped with an instrument such as this is that using a toroid core. One method of carrying out such a measurement is to use the dip oscillator as a signal generator, loosely coupled to a detecting circuit, via a 2–4-turn link coil. Fig 12 shows the circuit, and resonance is indicated by the meter. Knowing the value of the capacitance, the inductance of the toroid winding can also be calculated if desired, allowing for circuit strays.

References and further reading

[1] "A vhf dip oscillator", A.L. Mynett, G3HBW. *Rad Com* September 1970.
[2] "The 'squeak box' or tone dip oscillator", P.W. Sollom, G3BGL. *Rad Com* March 1974.
[3] "Gate dip meter that really dips", W3WLX. *Ham Radio*, June 1977.
[4] *Test Equipment for the Radio Amateur* (2nd edn). RSGB, pp3.9–3.19.

The effects of preamplifiers on receiver performance, and a review of some currently available 144MHz preamplifiers

by J. N. GANNAWAY, DPhil, G3YGF*

PART 1

Introduction

At first sight the use of a low-noise preamplifier would appear to be a straightforward way of improving the performance of a poor receiver, but in reality it is not so simple. While a preamplifier can improve some aspects of the performance of a poor receiver it inevitably degrades others. If used with understanding, these adverse effects can be minimized and a worthwhile improvement obtained, but when used without this understanding, the performance of even a good receiver can be unnecessarily degraded. In this two-part article, the overall objective is to describe how a preamplifier can be used to best advantage.

The first part is intended to provide an adequate technical background to the design and use of preamplifiers. It is concerned with the characteristics of a receiver that are likely to be affected by the use of a preamplifier, and the aspects of the preamplifier's performance that will be relevant when it is used as part of an overall receiving system. Although the discussion concentrates on 144MHz, the basic principles described are equally valid at other frequencies.

The second part of the article consists of a technical review of a number of 144MHz preamplifiers which are currently available in the UK, either as kits or ready assembled and tested. In both cases the noise figure obtained will depend on the method used to align the input matching circuitry, and results of using several methods are compared. It is hoped that the article will provide both the understanding required to use a preamplifier to best effect, and also the means to assess the suitability of those currently available.

Technical background

Many receivers have a poor performance which is due to basic design faults such as excessive gain before the mixer and filter, or the use of inefficient circuitry such as low gain or high-noise-figure transistors and mixers. Ideally the solution would be to rebuild the first stage or stages using improved techniques and the devices that are currently used in preamplifiers, and then the overall performance could be improved without any compromises. However, this is often not considered practical, and the use of a separate low-noise preamplifier becomes an attractive alternative.

The advantages of a preamplifier can be summarized as follows:

(a) The receiver sensitivity can be improved, as the overall noise figure of the receiver/preamplifier combination can be made close to that of the preamplifier itself, given sufficient gain in the preamplifier.

(b) If the preamplifier has a narrow passband, it can improve the receiver's performance by attenuating out-of-band signals and reducing any overloading effects that they may cause in the receiver. It can also improve the rejection of spurious responses such as the image, or i.f. breakthrough.

(c) A preamplifier mounted at the antenna can effectively eliminate the effects of feeder losses on the noise figure.

(d) All these benefits can be obtained with little or no modification to the receiver.

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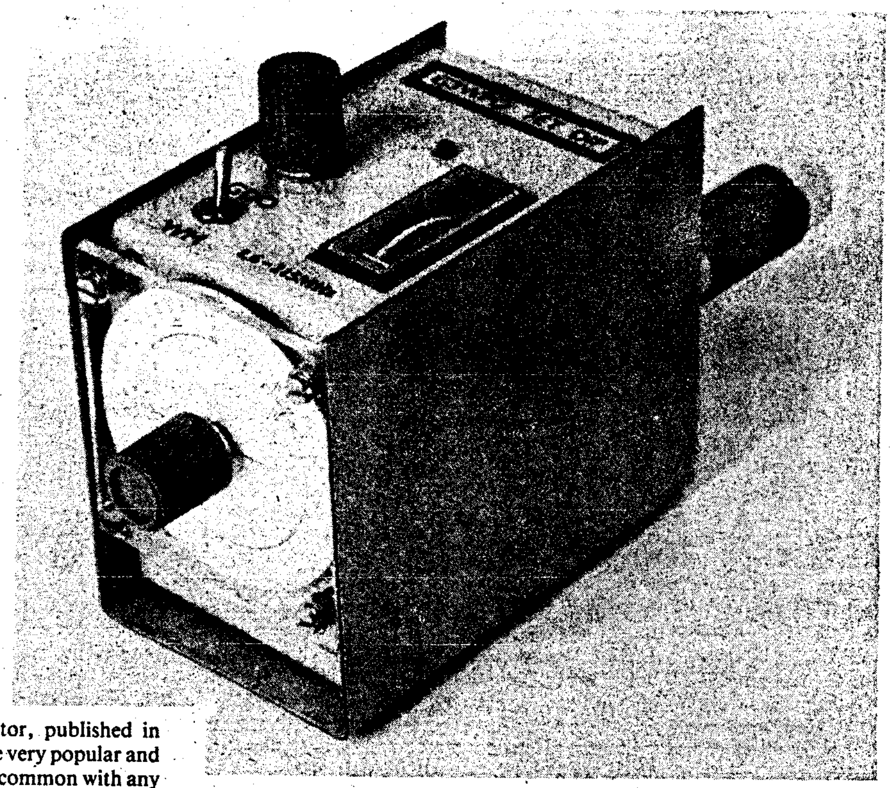
THE G3WPO FET DIP OSCILLATOR Mk2



Tony Bailey, G3WPO*

THE ORIGINAL DESIGN for a kit-form dip oscillator, published in *Radio Communication*, November 1981, has proved to be very popular and reliable, with over 4,000 of the kits built and working. In common with any design, however, a number of improvements have been suggested over the past five years by constructors and, together with some circuit improvements from the author, a revised pcb design is presented in this article which shows a very considerable enhancement in performance both in dip and in wavemeter modes.

Like the original design, full kits of parts will be available and, as the new design uses nearly all of the original parts except for a new pcb, coils and recalibration, a modification kit is to be made available for those who wish to rebuild the Mk1 version.

The new design features:

(*i*) coverage of 0·8–170MHz in six ranges;
(*ii*) enhanced dip and wavemeter functions;
(*iii*) reproducible design on one pcb;
(*iv*) new precalibrated scale; and
(*v*) audio and meter dip/wavemeter indications.

Mk1 problems

The original circuit utilized a fet kaliatron oscillator covering 1·6–215MHz. Both meter and audio indication of the dip point were provided. While the dip indication obtained was reliable at the higher frequencies, at the lower end the dip was much less pronounced and, depending on fet transconductance, sometimes difficult to detect. The main reason for this is that with such a wide (135:1) range oscillator having no inbuilt means of adjusting the gain between bands, the level of oscillation varies tremendously, and at the lower end is so high that very close coupling is often required to produce a visible or audible change in the detected output, particularly so in the 1·6–30MHz region.

The other main problem was that of insensitivity in the wavemeter mode, where the voltage supply to the oscillator is removed and the circuit simply used to detect and indicate the frequency of an rf oscillator.

Tony Bailey was born in 1945 and first licensed in 1967, after several years as an swl, and has always been interested in home-construction. After many years on top band, he moved to vhf/uhf, where he became one of the first stations on 432MHz ssb using homebrew gear. He is a founder and honorary life member of the Mid-Sussex ARS.

He is well known as a homebrew designer and author of constructional articles, and was awarded the Ostermeyer Trophy for his work in this field in 1981 and 1982. His interests in the hobby are varied, having attempted nearly all aspects, and he was the first editor of *Oscar News* for several years. Originally trained as a chemist, he is a freelance writer for both amateur and professional electronic journals, also turning his pen to novels in his spare-time.

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Improvements

One of the concepts behind the original design was that the plug-in coils should not be complicated by needing taps, either inductive or capacitive. This eases reproducibility problems and, provided that the coil-winding details are followed to the letter, it should be possible to use the precalibrated scale provided, cutting out the tedious calibration procedure.

The original kaliatron oscillator has been retained but now uses two dual-gate mosfets rather than single-gate fets. This change in itself produces a somewhat better dip, but the presence of the second gate now provides an ideal means by which the gain of the oscillator can be preset quite easily on

Components list (required to convert a Mk1)

R1	10kΩ	C1	Toko polyvaricon
R2,7	39kΩ	C2,3,8,9	10nF ceramic disc
R3,5	56kΩ	C4,5	12pF ceramic disc 5%
R4,6,18,19	100kΩ	C6,7	10pF ceramic disc 5%
R8	220Ω	C10,11	10nF mylar
R9	2·2kΩ	L2,3	Toko 470μH choke type 7BS
R10,11	47Ω		
R12,21	1·5kΩ	TR1,2	3SK88
R13	3·3kΩ	TR3,4,5	BC238 or similar npn
R14	470Ω	D1	3mm red l.e.d
R15,16	33kΩ	D2,3	BA481
R17,20	4·7kΩ	ZD1	5·6V 400mW
R22	1kΩ	Extension spindle	Cirkit
All resistors are 0·25W 5% carbon film types.		Wire	Insulated copper, 0·2mm diameter
VR1	470Ω vertical mount 10mm preset		

Toko and Alps components are available from Cirkit Holdings plc, as is a Mk1 modification kit, or a complete set of components for the Mk2 together with drilled pcb, coil formers and finished case (see advert on page 294).

Members who wish to homebrew the pcb can obtain a copy of the construction details and diagrams by sending a large self-addressed envelope to the editor at RSGB headquarters.

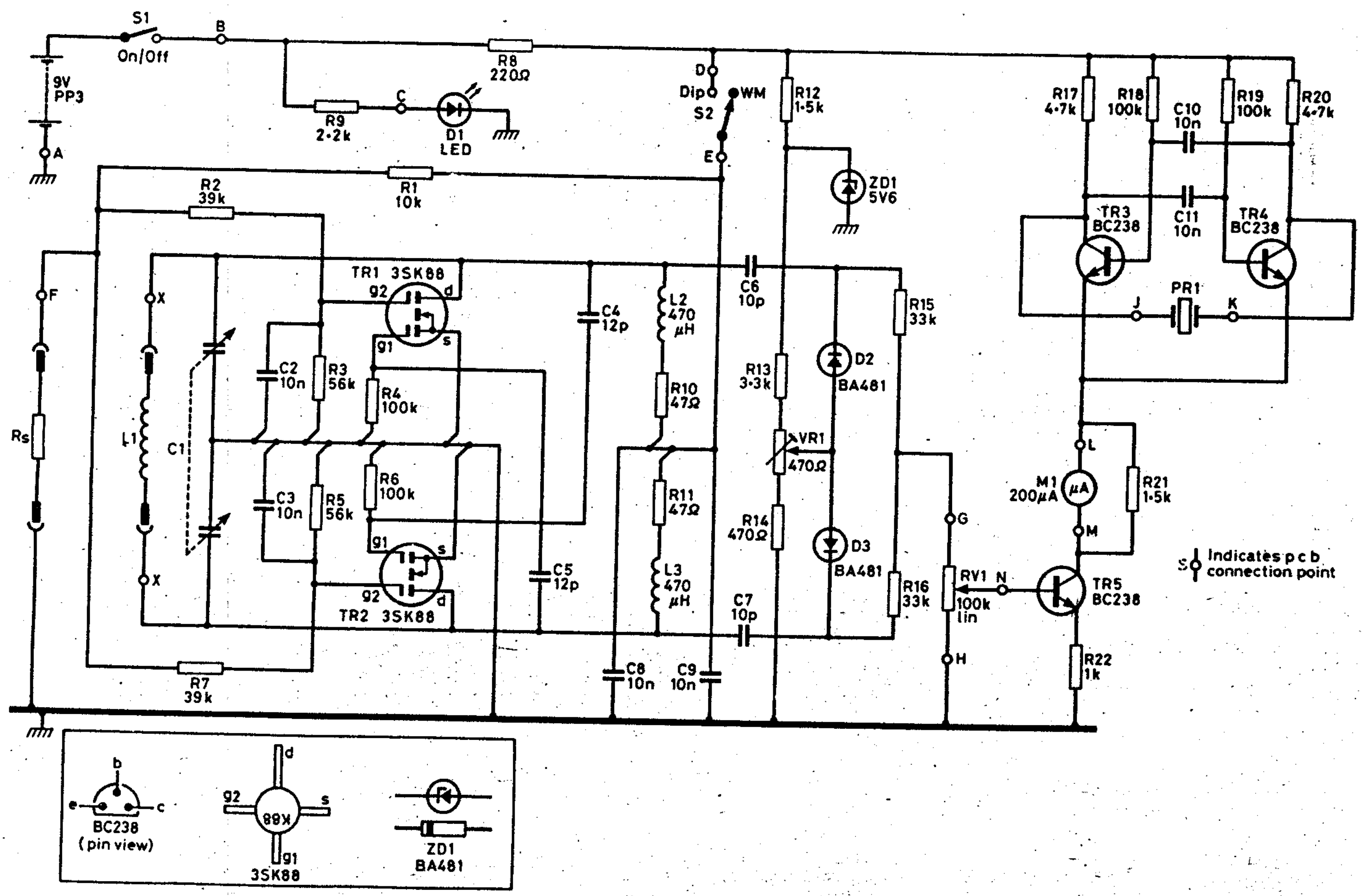


Fig 1. Circuit diagram

each range by means of a single fixed resistor. The resulting dip is now very considerably improved on all ranges.

To improve the sensitivity of the wavemeter, again by a large factor, the two detector diodes have been changed to Schottky barrier types, with these being permanently biased into conduction by a small standing current.

For those without a copy of the original article, photocopies are also available from the editor at RSGB headquarters.

Circuit

The new rf oscillator is a mosfet kaliatron design, offering wide coverage and the ability to control the overall gain by varying the Gate 2 voltage from an external fixed resistor mounted within the coil former. Inductor L1 sets the frequency coverage in conjunction with C1. The latter is a Japanese polyvaricon dual-gang type and, despite the low cost, has a very high reproducible specification.

Without Rs in place, the Gate 2 voltage is fixed at around half the drain voltage by (for TR1) R1/2/3, with the circuit running at maximum gain. On all frequency ranges, the gain is reduced by the addition of Rs as the other half of a voltage divider with R1, thus lowering the Gate 2 voltage and the overall gain. The circuit is capable of oscillating up to about 240MHz (the upper limit being fixed by circuit strays and the minimum capacitance/self-inductance of the polyvaricon) but it is difficult to optimize the performance at this high a frequency when also trying to obtain coverage below 3MHz. Consequently, the upper limit has been fixed at 170MHz for this version, thus still covering all the amateur hf and vhf bands. The self-inductance of the capacitor has been reduced by improving the stator earthing arrangement.

R10/11 damp the two rf chokes in the drain circuits, reducing to low levels inherent false dips from self-resonances. The rf is detected by D2/D3, which are Schottky barrier types biased into conduction by a stable bias voltage adjustable by preset resistor VR1—this is set so that the indicating meter reads half-scale deflection with the sensitivity control RV1 at maximum. This bias current is primarily designed to increase the sensitivity in "Wavemeter" mode, where the supply is removed from the oscillator and the circuit used as a passive indicating wavemeter, but also assists the dip slightly so has been left as a permanent feature. It also has the advantage of acting as a battery condition indicator.

The detected dc voltage is applied to the base of an npn transistor, TR5, which controls the current flowing through a simple audio multivibrator consisting of TR3/4. As the current through TR5 increases, so the audio note from the piezo resonator (PR1) increases in frequency, and the reading on meter M1 also increases. The meter and audio levels are set by the sensitivity control, RV1. This circuit has a higher audio output than the original by the addition of R21 as a meter shunt. The multivibrator commences oscillation at about mid-scale meter reading, and has a readily detectable note which drops sharply as resonance of the rf circuit is reached.

In use as a wavemeter, S2 removes the voltage supply to the oscillator, and the circuit becomes a passive wavemeter with an increase in meter reading and a rise in the audio frequency as resonance is reached. The circuit runs from a PP3 9V battery, with R8 acting as a current limiting resistor. Consumption varies, depending on the band, from about 5mA up to 15mA on the highest band. LED D1 is provided to act as an on/off indicator.

Coil formers

As with the original, DIN plugs fitted into rigid plastic electrical conduit tubes are used as coil formers. These are now five-pin types, two pins used for the coil connections and two for the gain setting resistor Rs. Only the actual plug end itself is used, and is Araldited into the former after winding the coil. The conduit is widely available from electrical stockists. The lowest four range coils are wound directly onto the formers, but the two highest ranges are air wound with the former used a protective plastic shroud.

This design now uses an additional coil to extend the lf coverage down to 0·8MHz, with the highest range coil also modified against the original to suit the new circuit constants.

Table 1. Value of Rs vs band

Band	Rs	Band	Rs
A	150Ω	D	680Ω
B	470Ω	E	2·2kΩ
C	470Ω	F	10kΩ

These values can be adjusted for improved sensitivity by lowering Rs until oscillation ceases at some point, then increasing the value slightly.

GDO Parts list.

2x BF981 TR1, TR2
~~4~~ x BC238 TR3, 4, 5, 7
1 x ~~2N3819~~ MPF102 TR6
2x BA481 shottky barrier rect. D2, D3
1 1 x RED LED D1
1 x 5V6 Zener 400mW ZD1

1/4 watt 5% Resistors.

2x47R R10, R11
2x220R R8, R26
1x470R R14
~~x~~3x 1K R22, R23, R25
2x 1K5 R12, R21
1x 2K2 R9
1x 3K3 R13
~~2x 4K7~~
~~1x 10K~~
~~2x 33K~~
~~x~~2x 4K7 R17, R20
~~x~~1x 10K R1
2x 33K R15, R16
2x39K R2, R7
2x 56K R3, R5
4x 100K R4, R6, R18, R19
1x 1M R24

Ceramic disc caps

1x 5p C12
2x 12p C4, C5
2x10p C6, C7
6x10n C2, C3, C8, C10, C11, C13

C1 variable capacitor
C9 omitted

CA3039
CA3724G

RFC1, RFC2 470μH.

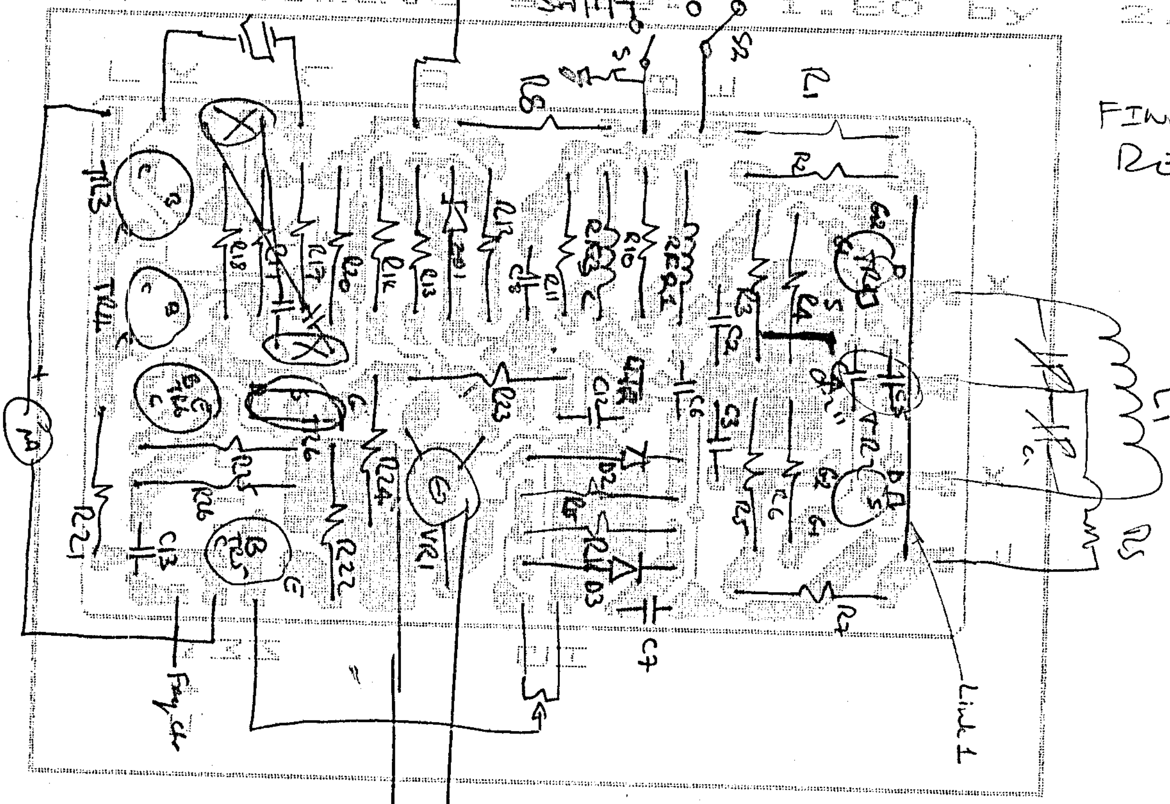
Piezo resonator.

200μA meter

14 pin tulip cap socket

2X checkplot 6 Jun 1990 18:20:21
dip.pcb
V1.2 r3 ... 127
approximate size: 1.60 by 2.45 inches
solder side

FINAL GDO PCB
REV Ø



Mistake #1
C11 & C10 swapped!
C5 C4 0.2"
0.1" extra per diode.
0.05 extra overall PCB
try to get C13 further from PCB pins.

0.05" extra on each side of PCB.