Get Onto 50 The Cheap a

The 4 metre band is not renowned for its great activity especially in my area of South Wales. However, with the increase in use of converted Pye and Storno equipment — which are crystal controlled — for this and the 6m band, a VFO unit could become very useful and an inexpensive alternative to buying crystals. This circuit also includes a simple but effective FM section which will enable you to use your Pye convert on FM.

Got a Vanguard, Cambridge, Storno or Wessie to put onto 4 or 6m? Well, this VFO design from Ted Nield, GW3ARP, will save you crystals and give you FM as well!

With Pye Vanguards and Cambridges, the fundamental frequency range required to cover 70-70.5MHz is 8.75-8.8125MHz. For the Pye Westminster, the range is 2.9166-2.9375MHz and Stornos require a range of 3.8888-3.9166MHz, both of which only need the oscillator coil and capacitor to be altered in this design. You may find that the frequency controlling elements of the varicap will need some small adjustment.

Initially, I used a mechanical tuning device consisting of a coil and metal vane which could be moved in relation to the former. However, this has been replaced by the varicap which is much easier to make. It also offers even more stable frequency control if you use a thermistor device.

As you can see from **Fig. 1**, the unit is remarkably stable especially with the thermistor where frequency drift after the first 30 seconds was less than 1.5kHz. After five minutes the drift is less than 200Hz for the next half hour. After running the unit another two hours, the output is still well within the 5kHz band of the receiver. Without the thermistor, you should still get the same stability after two hours.

How It Works

Having experienced the rather unstable Hartley oscillator circuit on HF projects I was unwilling to let it loose on VHF. I decided instead to use the much neglected Franklin circuit which is noted for its stability and immunity from external causes of frequency variation. In applying this idea to solid state devices, I settled on using a pair of 2N3819 JFETs.

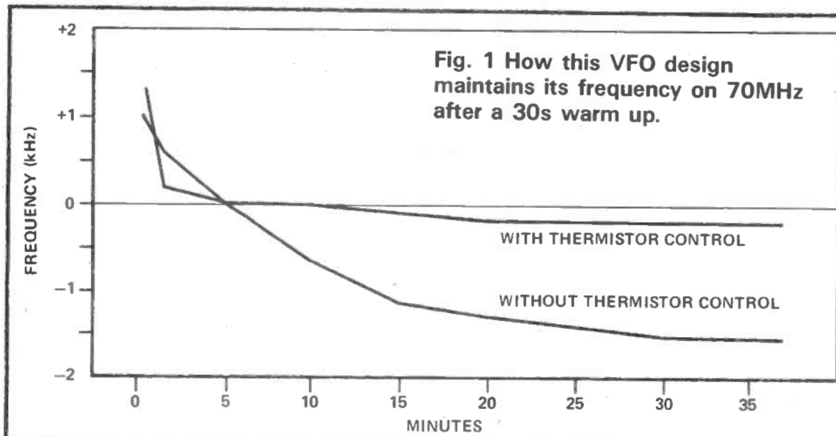

Fig. 1 How this VFO design maintains its frequency on 70MHz after a 30s warm up.

Looking at the circuit diagram shown in **Fig. 2**, you can see that the tuned circuit L1 and its tuning capacitor are isolated by the very small capacitors C6 and C7 to minimise any effects that might alter its natural resonant frequency.

Following the oscillator transistors, Q1 and Q2, is the source follower Q3. This is coupled to the oscillator at its least sensitive point at the base of Q2. Q3 further isolates the oscillator from Q4, the output transistor, driving the transmitter via its crystal socket.

To maintain a constant frequency between overs, the oscillator must run uninterruptedly. Since most conversations are conducted on a common frequency, the oscillator — running during receive periods — would interfere drastically with the received signal. This is avoided by a system of frequency shifting whereby the VFO frequency is automatically shifted down by about 100kHz during reception periods. Then RLA1 shunts point C on the varicap unit to earth via R18 and SW1B. This lowers the voltage applied to the cathode of VD1 and hence the oscillator frequency.

On the modulator side of the circuit, the cathode of varicap diode VD2 is at a higher potential than its anode, ensuring correct bias. The capacitor of VD2, which is in effect in parallel with the tuned circuit L1/C3, is dependent upon the DC voltage at its cathode. This is varied at audio frequency by the microphone signal which enters the board at point 6 after amplification by Q5.

In this way, the oscillator is directly frequency modulated, and the deviation may be adjusted by RV3. The usual moving coil or electret microphone will be found to give a satisfactory level of output voltage.

The 'Net' switch is normally in the 'run' position. When it is required

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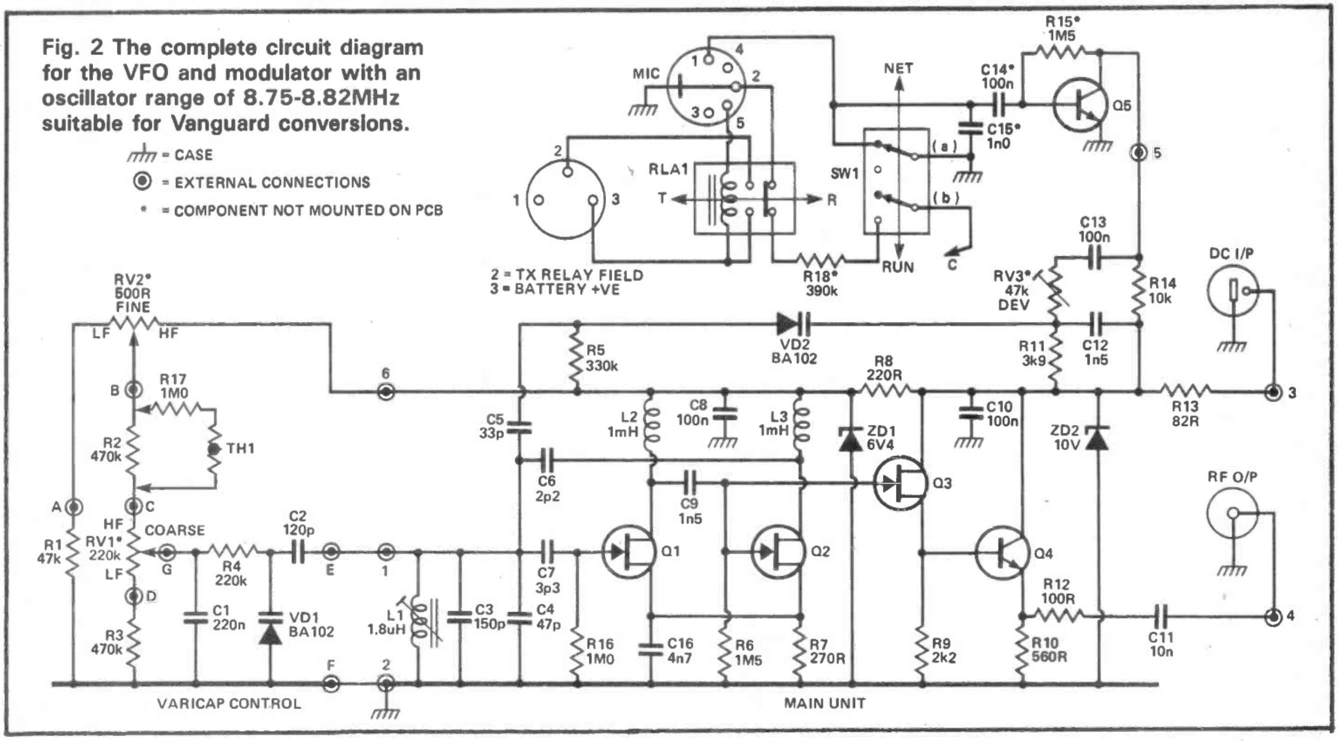

Fig. 2 The complete circuit diagram for the VFO and modulator with an oscillator range of 8.75-8.82MHz suitable for Vanguard conversions.

= CASE

◉ = EXTERNAL CONNECTIONS

• = COMPONENT NOT MOUNTED ON PCB

to tune the VFO to the frequency of the incoming signal, it is moved to 'net'. This allows the oscillator to run at the working frequency and it is now an easy matter to tune the VFO to zero beat with the received signal.

When netting onto a frequency, an S meter can be used if fitted. SW1A shunts the audio signal to ground to prevent audio feedback. SW1 is returned to 'run' before transmitting.

The varicap unit containing the varicap diode VD1 needs some explanation. The diode used is a BA102. If insufficient frequency coverage is obtained due to component tolerances, C2 may be increased in value, or R3 reduced in value. Alternatively, two diodes in parallel may be used with possible changes in value of C2 and R3.

The potentiometers RV1 and RV2 are respectively the 'coarse' and 'fine' frequency controls and act by varying the DC voltage applied to VD1. The resultant change in capacity in series with C2 acts upon the tuned circuit to alter its working frequency. The range of frequencies covered may be shifted bodily by adjustment to the core of L1.

The thermistor, TH1, and swamping resistor R17 act in parallel with R2 to compensate for changes in frequency brought about by

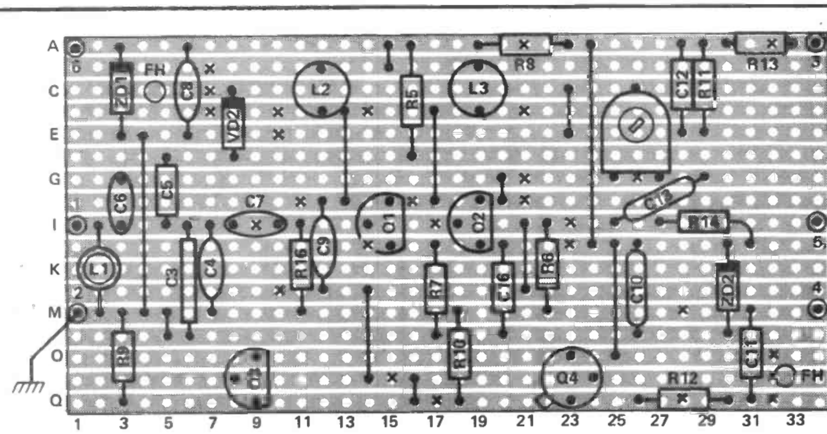

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Fig. 3 The overlay for the main board.

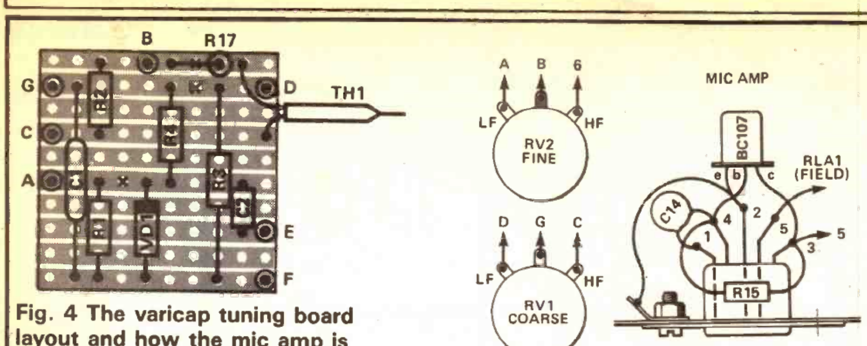

Fig. 4 The varicap tuning board layout and how the mic amp is wired in.

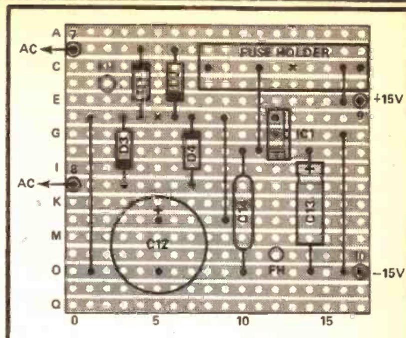

Fig. 5 The power supply layout, and the modification to be made to the main VFO board.

temperature variations.

Power Supply

A separate PSU powers the VFO, but note that in spite of the stabilising effect of ZD2, the VFO is sensitive to supply voltage changes. This requires the use of either a PSU with good stabilisation or else one which supplies only the VFO. A simple PSU without any form of stabilisation is not recommended as mains voltage variations will have a serious effect upon frequency stability.

Any arrangement using the same car battery that is powering the converted unit will be unsatisfactory as load variations between transmit and receive would upset the VFO frequency enough to render the netting process inaccurate. A small 12V car or motorcycle battery, used exclusively for the VFO (and receiver tuner unit published last month) is ideal, and may be considered, particularly if the equipment has its own mains PSU.

12-14V at about 50mA is required, but it is better to budget for 100mA to supply the receiver tuner unit as well.

The 'Transmit-Receive' function is controlled from the mike of course. When the latter was removed from its original location and installed in the VFO unit, the original weird microphone plug was changed for a DIN 5 pin 180° type. A standard mike socket may be used if preferred provided it has enough spare tags to accommodate the AF amplifier which is built onto it.

On the Vanguard, the mike switch completes the circuit between the transmit relay field and the positive supply. In the VFO unit a pair of contacts on RLA1 which close on 'transmit' are used for this purpose and brought to a 3 pin DIN socket. This is linked to another DIN socket fitted to the rear panel of the Vanguard to which the necessary connections to the relay field and battery positive are made. The other pair of contacts on RLA 1 open on 'transmit' and allow the voltage applied to VD1 and hence the oscillator frequency to rise to their normal values.

It will also be noticed that the field supply for RLA 1 is obtained via the link from the main unit supply. This is to avoid a changing load on the PSU supplying the oscillator. Different type sockets prevent accidental wrong connections.

How To Build and Use Your VFO

Veroboard construction was used, with the varicap components on one board measuring 2.5cm^2 and the main circuit on a second board measuring 8.5cm×4.5cm.

The AF amplifier is built onto the rear of the 5 pin DIN socket as shown in detail in **Fig. 4.** The components on the varicap board are soldered onto the track side, as the reverse side, backed by a layer of thin perspex is fastened by a suitable contact adhesive to the rear cover of RV1.

The case is actually a mild steel double wall switch housing, as used in domestic lighting installation. The open side is covered by an aluminium plate with rubber feet attached. Two holes in the plate give access to RV3 and L1. The case must be a metal one and above all perfectly rigid. A die-cast aluminium box is ideal. The larger board is fixed in place by two bolts with spacers to give a minimum clearance of 4mm.

The thermistor may be difficult to obtain, but types G16, GL16 and Th-B11 listed in the current Maplin and BS catalogues should prove suitable. As a guide, the STC component used measures approximately 500k at room temperature. The oscillator

The voltages table

	Q1	Q2	Q3	Q4	Q5
c (d)	6.2	6.2	10	10	3.6
b	–	–	–	4.3	0.6
e (s)	2.2	2.2	4.3	3.5	0

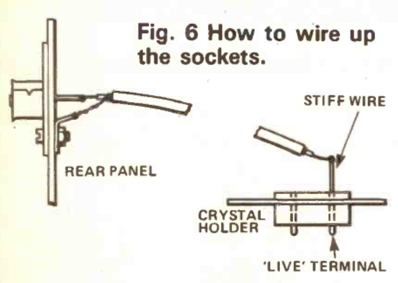

Fig. 6 How to wire up the sockets.

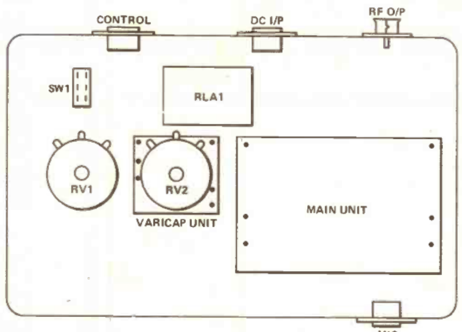

Fig. 7 Putting it all together in the die cast box.

coil is wound on a 5mm former with slug, fixed in a hole in the veroboard with epoxy resin. It holds 20 turns of close wound 24swg wire. For use with Pye Westminster or Storno equipment more turns would of course be needed with an increase in the value of C3.

The output is fed into the main unit via a short length of TV coax which couples to another TV socket fitted to the rear of the case. A further short length of narrow coax supplies this to the Tx crystal socket, **Fig. 6.**

The table gives the approximate voltages to expect at the electrodes of the transistors — as measured with a 100kohm/V meter.

To set the VFO to the frequency of any crystal one may possess, you have to switch to the appropriate crystal channel in the 'receive' mode and to tune the VFO until its 70MHz signal is heard in the receiver. Should the rig be fitted with BFO or a S meter, the VFO should be tuned to zero beat or maximum deflection. If using the matching tuner unit, tune in the received signal and zero beat the VFO to it.

Components List

RESISTORS	
R1	47k
R2,3	470k
R4	220k
R5	330k
R6, 15	1.5M
R7	270R
R8	220R
R9	2.2k
R10	560R
R11	3.9k
R12	100R
R13	82R
R14	10k
R16,17	1M
R18	390k
RV1	220k linear pot
RV2	500R linear pot
RV3	47k horizontal preset

All fixed resistors 0.25W 5% carbon film

CAPACITORS	
C1	220n
C2	120p
C3	150p silver mica
C4	47p polystyrene
C5	33p
C6	2.2p
C7	3.3p
C8, 10, 13, 14	100n
C9, 12	1.5n
C11	10n
C15	1n
C16	4.7n

All capacitors miniature ceramic unless otherwise stated.

INDUCTORS	
L1	1.8uH 20 turns 24swg close wound on 5mm core with slug.
L2, 3	1mH type Toko 187LY-102
SEMICONDUCTORS	
Q1, 2, 3	2N3819
Q4	BFY 51
Q5	BC107
VD1, 2	BA102 varicap
ZD1	BZY88 series 6.4V (400mW)
ZD2	BZX61 series 10V (1.3W)
TH1	Thermistor type A 5513 100 (STC)

MISCELLANEOUS

DIN socket (2-pin); DIN socket (3-pin); DIN socket (5-pin 180°); TV type socket; 12V miniature relay DP changeover; DPDT slider switch SW1; 2 knobs; metal case.

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