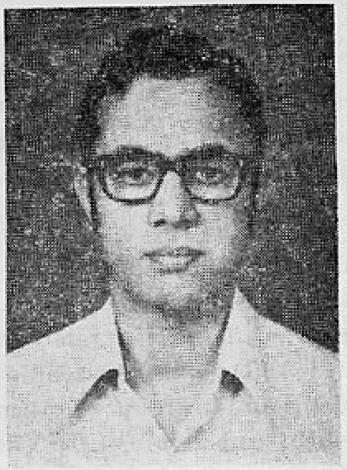

A STABLE 7 MHz VFO

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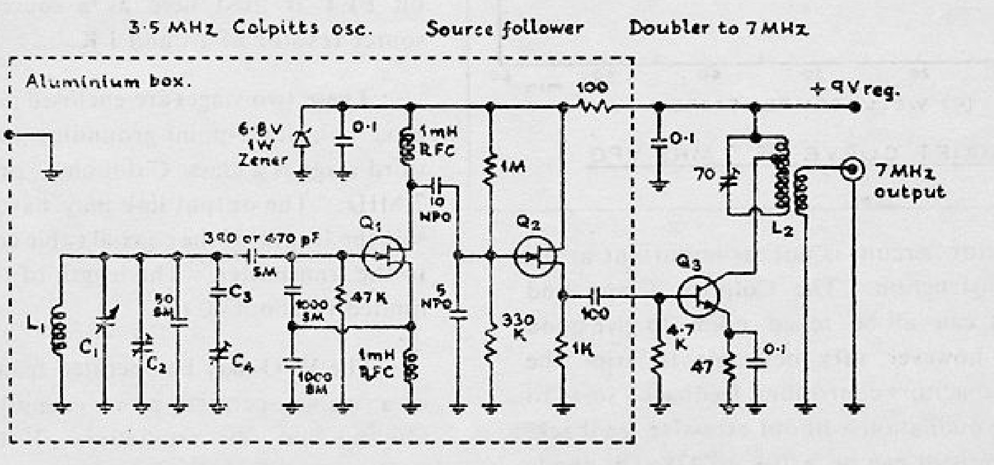
VFO stability is a topic of perennial interest to all amateur wireless experimenters. Not long ago, a VFO was considered 'good' if it had a 1-hour stability of 100 ppm (700 Hz at 7 MHz). But with the use of field-effect transisters (FET), careful selection of components and the judicious use of thermal compensation, it is now possible to achieve a 1 hour stability of the order of 8 ppm. This may sound too good to be true, but the writer has been able to abtain this order of stability, and so has G 3 PDM (vide 'Amateur Radio Techniques' published by the Radio Society of Great Britain). A good FET VFO offers extremely low warm-up drift, excellent stability and remarkable insensitivity to supply voltage variations

The choice of the FET for the oscillator is quite critical. It should be a sharp-cutoff high-transconductance FET, which will turn off at a gate bias of less than 1.5 volts (negative with respect to the source in the case of N-channelFET's). In the writer's opinion, a Junction FET (JFET) is as good as or even preferable to a Metal Oxide Semiconductor FET (MOSFET), since the former obviates the need for the bias-rectifying diode — the less the number of components in a VFO, the better! Having tried quite a few FET's the writer has found the N-channel JFET 2 N 3819 to be excellent for a FET oscillator. It is also cheap, at $0.50 apiece in the U. S. A. Remote cutoff FET's like the MPF 105 and the BFW 10 give inferior performance.

It is a well-known dictum that a VFO is only as good as it is constructed. The circuit board used should be a fibre-glass or 100% phenolic board, never the cheap-quality paper-base-laminate boards. The VFO tuning condenser should be a double ball-bearing type, and should be connected to the dial drive through a flexible shaft-coupling. The tank coil

FIG. 1. 7 MHz FET VFO



Q_1 : 2N3819 JFET. Q_2 : BFW10 JFET Q_3 : 2N2219 or SL100, heat-sinked.

L_1 : 5 μH Rigid tank coil, about 2 cm dia. L_2 : Coil prl. 10 μH, turns ratio $\frac{0.2+0.8}{0.5}$

C_1 : 50 pF air, Tuning. C_2 : 70 pF air, Bandsetting. C_3 : 50 pF NTC ceramic, −680 ppm/°C. C_4 : 50 pF air, Temp. Compensator. Values > 1 are in pF.

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should be space-wound rigidly on a ceramic or low-loss polystyrene former of about 2 cm diameter to diameter to give an inductance of 5 μH. For the trimmers, APC or Phillips air-trimmers can be used. RF bypass capacitors can be disc ceramics, while all other fixed capacitors should be zero-temperature-coefficient silver micas. All components should be rigidly mounted. Straight point-to-point wiring with 18-gauge wire is recommended.

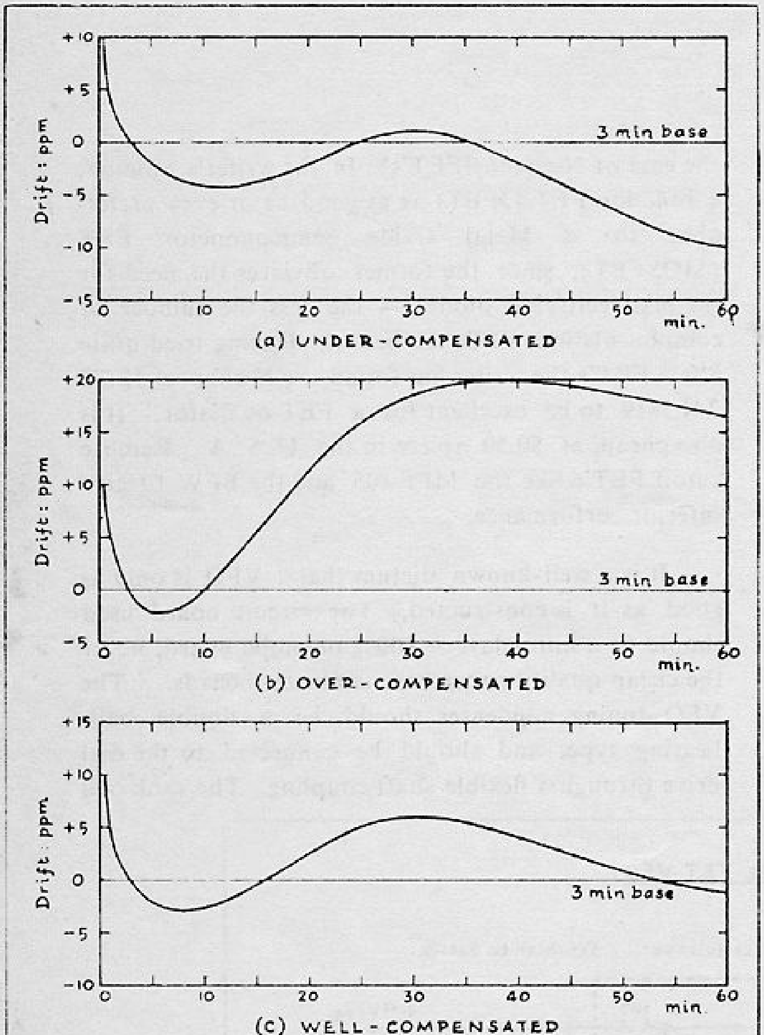

FIG. 2. DRIFT CURVE OF 7 MHz VFO

The oscillator circuit is not as important as the quality of construction. The Colpitts, Clapp and Vackar circuits can all be relied upon to give good results. It is however very desirable to trim the values of the capacitors controlling feedback, so as to maintain stable oscillation without excessive feedback. The gate-leak resistor can be a 10K to 47K 1W good-quality carbon resistor. In many published Colpitts and Clapp circuits, the output of the oscillator is taken from the source. This is not to be recommended for the following reasons; (1) The second active device also becomes part of the crucial tank circuit, thus reducing isolation of the oscillator and increasing the risk of drift; (2) The signal voltage available at the source is low compared to that available at the drain. In the VFO circuit shown in fig. 1, the output is taken from the drain via a 10 pF coupling capacitor.

A good VFO should be compensated against nominal temperature variations. Assuming that all capacitors are drift-free (which however is rarely the case!), a non-compensated VFO will exhibit a slow exponentially decaying downward drift due to expansion of the tank coil as the temperature of the VFO compartment rises. This downward drift can be compensated by employing controlled temperature compensation. Compensation, however, should not be looked upon as a panacea for the ills of a badly constructed VFO. All attempts should be made to minimise the VFO drift (by trying different capacitors etc.) and make it slightly negative before compensation is applied. The lower the warm-up drift of a non-compensated VFO, the better will be the tracking of the compensation circuit during the warm-up period.

In the writer's VFO, a 50 pF N 680 K NTC ceramic capacitor in series with a 50 pF air-trimmer is used across the oscillator tank circuit for temperature compensation. Fig. 2 shows the warm-up drift of the VFO for different settings of the trimmer C_4. With correct adjustment of this trimmer, the maximum drift after a 3 minute warm-up period is less than 8 ppm during the first one hour of operation.

An important point that is usually not given due appreciation is that it is as important to use FET for the second stage as for the oscillator. A remote cut-off FET is used here as a source-follower, with a source resistor of around 1 K.

These two stages are enclosed in a rigid aluminium box, with single-point grounding to the chassis. The third stage is a class-C doubler, providing output on 7 MHz. The output link may have to be modified to suit the length of the coaxial cable connecting the VFO to the transmitter. The length of the cable should be limited to about 40 cm.

The VFO may be operated from a 9 volt battery or a mains-operated power supply having excellent filtering and fair regulation. If a power supply is used, each end of the secondary winding of the power transformer should be bypassed to ground with a 0.1 μF 50 V ceramic capacitor.

The writer hopes that many Radio amateurs and experimenters will find this VFO a useful and satisfying project.