❖ HOT IRON ❖

Contents

Editorial

In my last Editorial I asked whether anybody thought they would like some form of micro-controller or other type of computer in their rigs, perhaps to control a synthesiser or DDS (Direct Digital Synthesiser) chip. I have to report that I have had a nil response, from which I gather that all readers who do bother to write are analogue people who would be uncomfortable with the digital world of micro controllers. I have much sympathy with this viewpoint because I think the fun of amateur radio building, is to do something over which you have complete control and hopefully a pretty good understanding of how the gadget works; sadly this is generally not the case where computers are concerned - no matter how simple their design. Many years ago I used to design specialist computers for use on warships but modern PCs are very different. We used to produce machines that had three address fields so that the sum a+b=c could be done in one instruction with the data being fetched from and sent to three different locations in memory. Modern processors do not allow this and the consequence is that programs are much longer than they used to be! This is acceptable because memory has become very cheap! The first machine I worked on, had the complete program for the handling of air traffic control flight data strips shoehorned into 4096 words of 24 bit memory or 12 Kbytes in modern compuspeak! The point of all this is that, although I understand the general language of modern computing, I wouldn't have the faintest idea of how to fault find on this 486 computer if it let me down; unfortunately the same would be true of most devices that one might use in a micro controller buried in a radio. Fine if its works first time but useless to those who have made some trivial mistake that prevents it ever doing anything useful. I shall try to avoid using them in my designs; however, future commercially built rigs are quite likely to be direct conversion phasing rigs where most of the signal processing is done digitally!

The Taunton

At long last, I am able to tell you the Taunton **is now available**! It has taken 18 months from serious start to launch. If anyone wants full details let me know; basically it is a 5 Watt TCVR capable of working on any single HF band by means of plug-in cards. All bands to 15m are available now. It starts as a phone superhet, CW is added with either a simple fixed or a very high spec. variable CW filter. The PCB is drilled for a range of optional extras which can be fitted initially or later. The phone rig, with optional extras, is all on one PCB 100 x 160 mm. The very full manual is available seperately at £5. The TCVR + any one HF band + membership of the Construction Club for 95/6 is discounted to £99. Extra bands at £14, optional extras at £24, fixed CW kit £17 or variable CW kit £37 and counter £47 if ordered together. P and P £1. Fantastic value!   Tim
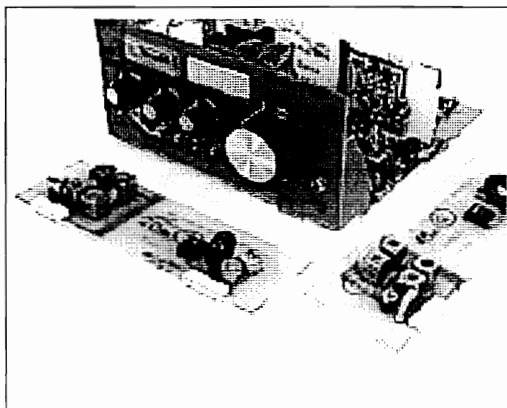
Small Board Construction by Tony Measures G3WUC

I wanted to build a Yeovil VFO for use with a synthesiser. A piece of double sided PCB was to hand. I put a good wad of blutak where I wished the Toko coil to be, and made a good footprint through the blutak. I then, using my mini drill stand, drilled through all the pin prints made by the coil pins, but not those made by the case lugs, and then removed the precious blutak to store! Carefully rule lines to run in between the drill holes lengthways and breadthways so as to cover the whole of the board area on which parts are to be mounted. My piece happened to be 40 x 65 mm. Put the board in a vice so that the line to be cut is up against the outside edge of the vice jaws; saw gently with blade firmly against the jaw sides, acting as a guide, being careful to go only sufficiently deep to cut through the copper (and NOT right through the board!). Continue until all lines have been given this treatment. Clean all saw cuts carefully. Put board in mini drill stand and drill holes through all the rectangular islands. The other intact side is a ground plane and holes have to be countersunk as required to prevent leads touching the ground plane. I had plenty of room to fit regulator, VFO, buffer amp, controls for coarse and fine tuning varactor tuning, and could have added RIT if wanted! Components for most parts can be mounted either side of the PCB and surplus lead clippings are useful for make extra connections through the board. A late streetwise suggestion is to leave a row of blank spaces all down one edge for edgewise soldering to, say, the back of the front panel. (Note also that in TT of Radcom April 1995, there is a more sophisticated version of this for multipin ICs etc. if you insist on having a nervous breakdown! I think mine is more KISS!)

Coil Construction for ATUs and QRP Use by Roy Boldock G0FFQ

Polystyrene cement suitable for securing coils can be made easily by obtaining a small jar, ex mustard pot etc. which is used as a vessel for dissolving polystyrene packaging or tiles into genuine turpentine. This can be obtained from an art or paint shop. While dissolving the polystyrene small bubbles may appear - this is normal. Add polystyrene until the mix is sufficiently thick.

Coils can be made using small plastic bottles, or spice bottles, as formers. Keep a selection of sizes on hand to suit different bands etc. Many people leave these bottles inside to act as a permanent former but losses will be lower if the plastic former can be removed! Having found a suitable former, wind on a tight layer of thin string all over the former. Cover this with two layers of plastic film such as used for carrier bags and secure in place at the ends. Now wind the coil over the plastic film, either closewound or side by side with another piece of string acting as spacer if the wire is bare. Tie the start and finish of the wire tightly so the turns cannot slip. Carefully remove the string spacer turns if fitted. Apply the above cement, or Araldite, in thin strips across the outside of the coil turns along the length of the former - put about 4 strips around the former circumference. Wait 2 days for the cement to harden fully, if OK , remove the string underneath the plastic film ontop of the former. This will release the former which can now be slid out. Apply more cement in strips on the inside of the now self supporting coil to increase its strength. You now have a low loss inductor. If you need a coupling coil, this can be made by the same technique with a smaller former so that the coupling coil will slide inside the main winding. If left as an adjustable sliding coil this can be used to adjust coupling for best match conditions in an ATU. Taps can easily be made on the outer coil for band changing; either by making doubled back "nibs" (carefully soldered) in the wire as the coil is wound. If the turns were spaced without insulation, then taps can be made with wire hooks which are carefully soldered around the coil wire in suitable positions.

Mounting PCBs in Diecast Boxes

PCBs can be mounted inside boxes on suitable length bolts without the heads showing outside by gluing the bolts to the inside of the box as follows. Before you load the PCB with parts, find a suitable number of long mounting bolts with two nuts for each bolt. Put one nut on each bolt and place through the PCB in its mounting holes so that the bolt can be secured to the PCB by the second nut. Adjust the nuts on all mounting bolts so that the board is level when placed with the bolt heads down on a flat surface - do the nuts up lightly. Place the assembly into the diecast box in the desired position so that the bolt head positions can be marked or noted. Thoroughly clean the inside of the diecast box with emery cloth to remove any tarnish on the surface. (It is aluminium oxide which prevents good adhesion and is the reason it is practically impossible to glue to plain aluminium since the oxide forms very quickly on plain sheet aluminium - Ed.) Apply a little Araldite cement to both the bolt heads and the intended positions of the bolts where you have cleaned the box. Offer up the PCB with its sticky mounting bolts, wriggle it sideways to fuse the cement and settle it down. Leave for a couple of days if ordinary Araldite or 12 hours if the quick setting version has been used. Undo the exposed nuts, remove the PCB and load with parts. Properly tighten the nuts when finally fitting. You now have a neat job with no external nuts or bolts! Internal cables can also be secured to the inside of the box using Araldite to keep them laid neatly in the folds of the box. This also gives a measure of screening. Again remember to clean the surfaces before applying glue!   Roy Boldock   G0FFQ

Fault Finding on Active Mixer Chips

Following my general note on fault finding in Hot Iron Issue 6, I did promise to return to the subject with more definitive advice where the obvious things are OK. Active mixer chips of the NE602 or 612 type are now very common so must be good candidates for failures in comparison to other less common devices! (This is not to imply that 612s are prone to failure - just that there are lots of them so many may get damaged etc.) Other active mixer chips such as the older MC1496 and SL6440 have much in common with the 612 so these notes may also help with those devices. The 612 and 602 are electrically interchangeable and have the same internal circuit so I shall refer to the 612 as it is usually cheaper! All these types have a Gilbert Cell as the mixer element which I have sketched alongside. Modern semiconductor processes have very good matching between devices on the same chip which gives a high degree of balance between the two halves of the chip, which is why their external circuits seldom have balance presets to improve on the natural matching of the two halves. With the 612 and 6440, internal biasing resistors are incorporated on chip but not for the 1496. In addition the 612 also has a separate section that can be used as an oscillator or buffer and which always feeds into one signal input of the mixer. All three types have balanced inputs and outputs with provision for push-pull or anti-phase connection; frequently only single ended drive (in or out) is used with the other side being decoupled for signal or ignored. **The important thing is that under normal conditions the DC voltage levels in the two halves should be the same.** I have sketched in the second box a typical circuit for a 612 when connected as a product detector linked with a CD4066 switching chip to make it act as a balanced modulator during transmit. I have listed typical DC voltages against the 612 pins; it is usual for the circuits connected to the 612, either directly or through a 4066 switch, to be AC coupled so that the 612's DC voltages are not altered by the external circuits. In the circuit on the right, the 4066 is literally connecting alternative input and output signals to the mixer chip in much the same way as a 2 pole changeover relay would work. Thus any DC voltages that are present on the 612 get transferred through the 4066 depending on which way its switches are made. The DC voltages shown against the 4066 pins are firstly those on receive when the control signal RXC is high (or at the 4066 positive supply voltage) and TXC low at 0 volts; these are followed by the DC voltages on transmit when TXC is high and RXC low. The switch "contacts" are closed when the control signal is high and are open circuit when the control is low. Signals can pass in either direction through the closed switch but their instantaneous voltage (DC plus superimposed AC) must be between 0 volts and the positive supply to the 4066. Normally this is no problem as the input and output levels to a 612 are

seldom over a volt p-p ontop of the DC voltage of about 1.25 at the input or about 5 to 6 volts DC at the outputs. To help explain the switch connections in the 4066 I have drawn out its pin connections separately. Each switch in a 4066 has a resistance of about 100 Ohms when on suggesting that it should only be used where the circuit impedances are significantly above this figure - hence its use with the 1K5 in and out
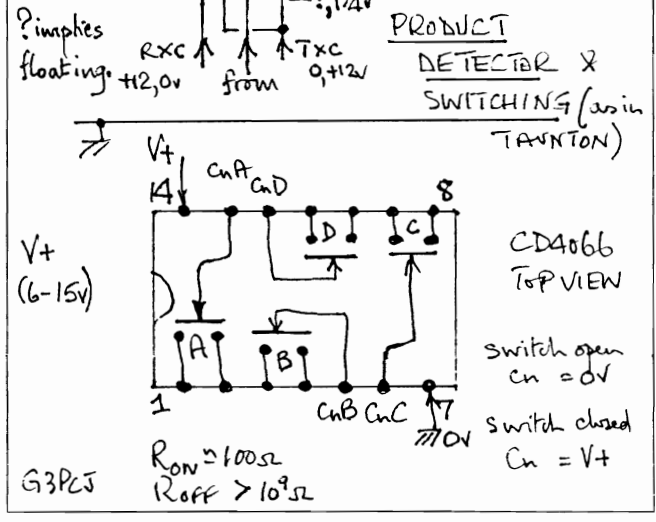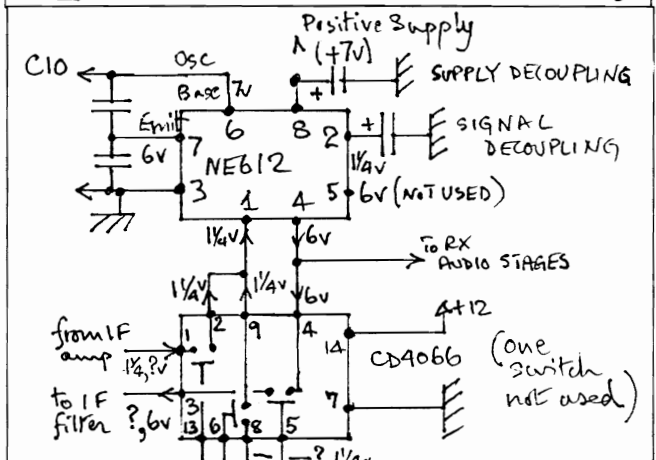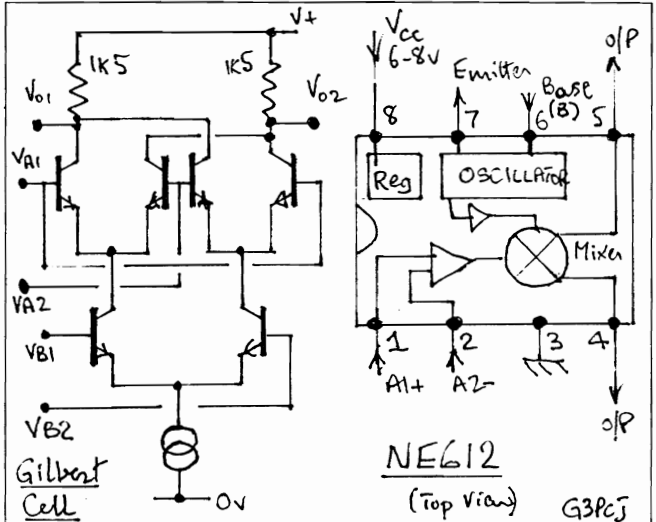
impedances of the 612. When **off**, the switch resistance is thousands of MOhms! Thus if you have a suspect 612, first check that pins 1 and 2 are equal and about 1.25 to 1.5 volts. Secondly, check these are properly transferred through any 4066 switches. The DC output voltages are not always equal since the outputs can be DC connected to the positive supply instead of relying solely on the internal 1K5 resistors between each output and the supply pin. If there is no external DC connection, the two output pins 4 and 5 should be equal and about 1 volt below the supply on pin 8; this is typically 6 to 7 volts leading to output voltages of 5 to 6 volts. If connected to a 4066 switch these should be transferred to the other side of the switch. If the voltages on pins 1 and 2 are higher than on 4 and 5, it is definitely faulty. The 612's oscillator section has internal biasing so that the base input pin 6 is usually at the device's supply voltage on pin 8. The DC voltage on the oscillator emitter, pin 7, is one V_{be} drop or 0.65 volts below that of the base input pin 6. So typical voltages would be 6 to 7 on pin 6 and 5.35 to 6.35 volts on pin 7 - these are seldom connected to switching type circuits using 4066s and are normally DC isolated by capacitors in the associated circuits. The conclusion of all of this is that a good high impedance DC voltmeter is all that is required to tell if your 612 and its associated 4066 is OK.
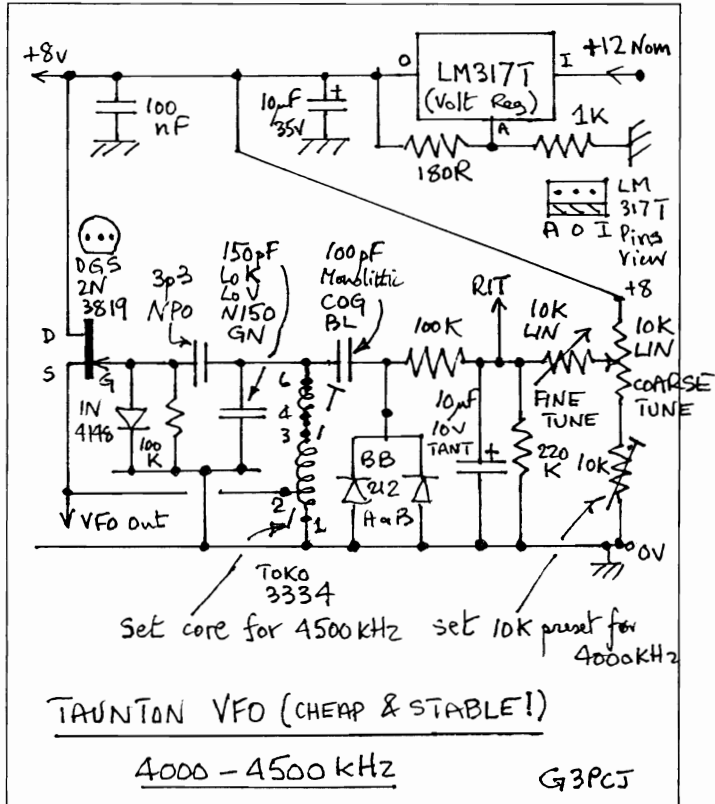
VFO Building and Design

I ended the last issue 7 of Hot Iron with the comment that the cheap problem free VFO continues to elude us! I very pleased to have a contribution from Peter Barville G3XJS about building super stable VFOs which fits neatly with further work of my own. Peter relays some notes from Steven Wilson and Mike Czuhajewski which I have combined. "The principles of building good stable VFOs have been known for many years, however many amateurs and some QRP equipment manufacturers seem to ignore them. (Due to cost compromises -Ed!). Stability is the usual problem; mechanically and electrically it must be built like a rock. Herewith some tips which should make it possible to get drift down to 100 Hz or less in 24 hours!

1. Use double ball bearing capacitors. The more common types with just a single control shaft bearing will not be as good. The sliding contact (if fitted) for the rotor should be carefully squirted with contact lubricant.
2. Once the coil is tuned, either by removing turns and/or squeezing or expanding, use Q-dope to secure it in place. (See notes about cement previously.) Best to add extra turns, remove if necessary later and finally squeeze.
3. Use the white or yellow **powdered iron** toroids, they have 2 or 3 times better temperature stability than red ones. Yellow ones will work down to 3.5 MHz. Do NOT use Ferrite cores. If in doubt about a core do not use it. Black cores maybe powdered iron or ferrite, so avoid them!
4. Fasten the coil down. Hardware stores have cone shaped rubber washers for fixing dripping taps that work well when you add a plastic nut and bolt. Do NOT use brass or steel bolts - they will alter the inductance.
5. Use 18, 20, or 24 gauge wire. Nylon coated types can be stripped with a really hot iron.
6. Use polystyrene capacitors for best temperature stability. NP0s help to trim some of the core drift. I prefer several caps in parallel rather than just one fixed tuning capacitor. Some silver mica types drift badly. You can also remove plates from the tuning capacitor if frequency is too low. (See later on capacitor types - Ed).
7. One sided PC boards are better for VFOs than double sided or multi-layer types.
8. Use a Vackar circuit if you can. Differences in drift over those of the more common configurations will only be noticeable when the mechanics and thermal characteristics of the tuning components are already excellent.
9. Use a good FET such as the 2N5484 and make certain its output is buffered."

Problem Free Cheap VFOs

My quest for good performance and simplicity in a 4.0 - 4.5 MHz varactor controlled VFO for the Taunton continued after the work mentioned in HI7, as the stability actually achieved with that circuit was not good enough. None of the capacitors were really suitable and the orange tipped N150 ceramics were incosistent; they were not dependable, some being good and others poor, (causing the VFO to wander quite quickly), rather like the reputation of silver mica capacitors. Eventually I started again and ordered samples of every cheap supposedly stable capacitor that I could obtain! My best compromise for the main tuning capacitor, is to use low K low voltage cement coated N150 disc ceramic types from RS which are made in Japan; these happen to be coloured green and are 8 mm diameter. I suspect the similar ones sold by Farnell are made by the same source but they are coloured buff! For the coupling to the tuning diodes I recommend a monolithic ceramic COG type having a nominal zero tempco (from Maplin) which happens to be coloured blue! This combination has removed all trace of short term wandering which was present with the orange tipped N150s. A further improvement in short term stability was obtained by decoupling the varactor tuning voltage with a solid tantalum electrolytic instead of an aluminium type. Many hours later I am able to report that this VFO moves less than 150 Hz (down) from cold after several hours when built with my open style of construction (on double

sided PCB) in conjunction with a TOKO coil; I reckon this is good enough for most people and avoids having to spend several pounds on each quality fixed capacitor . I hate to think what they and a double bearing air variable would do to kit prices! In use it is more than good enough; for example, immediately after turning on, I tuned to some long running net; one and a half hours later when the net controller packed it in I had not had to retune. (I know what you will be saying about his VFO!) I also investigated the effect of power supply changes since varactor supply voltage stability is crucial. After trying many different regulators I recommend using the LM317T; although the current rating of this device was not needed, its regulation and thermal properties were much better than others. An abrupt change from 12 to 18 volts produces a 300 Hz change which falls to a 100 Hz difference after several minutes; when the supply change was spread out over 2 minutes the change in frequency was nearer 60 Hz! This is appreciably better than my other designs so I have now ceased VFO development! The full circuit is on the right.   G3PCJ

TAUNTON VFO (CHEAP & STABLE!)
4000 – 4500 kHz   G3PCJ

Set core for 4500 kHz   set 10k preset for 4000kHz
TOKO 3334

PCB Production from Magazines by Simon Males G0EVZ

I often see projects in magazines that include a full size PCB layout; these boards purchased from a supplier can cost quite a bit, so I usually make my own using the following method:-

1. Obtain a piece of good quality PCB (preferably glass-fibre) roughly the required size.

2. Obtain a photocopy of the PCB layout. Cut out and "sellotape" it onto the copper side of the PCB. Then using a small centre punch (or even a hardened nail), centre pot as accurately as possible each hole marked on the track layout. Check that no holes are missed and then remove the paper layout. The board must be thoroughly cleaned to ensure the copper is shiny and free from grease.

3. Now comes the "fun bit". Using a special etch resist pen (available from component suppliers etc), join up the centre pot marks as in the track layout diagram. With care, even IC pads can be marked on to the copper. Ensure that no copper shows through the resist where you wish to retain the copper. Allow your board to dry and check very thoroughly for mistakes, omissions, etc., if necessary tidying up and scraping away any track bridges, using a scalpel or modellers knife.

4. Obtain a supply of ferric chloride either as a liquid or granules, water having to be added to the latter. This is used to etch the unwanted (uncovered) copper away by pouring some of the solution into a shallow plastic tray, and immersing the board until all unwanted copper is etched away. Etching is speeded up if the tray is rocked occasionally. Rinse the board thoroughly under water and then dry. Note. Ferric chloride is corrosive and must be kept clear of skin and eyes. Do not allow the ferric chloride to get onto a stainless steel sink!

5. With the aid of drills of sizes to suit the component leads (generally 0.8 to 1.2 mm) drill out all the centre poted holes. Finally, clean off the etch-resist with solvent and your board is ready to use.

6. The ferric chloride can be used many times so it should be stored in a sealed container in a safe place.

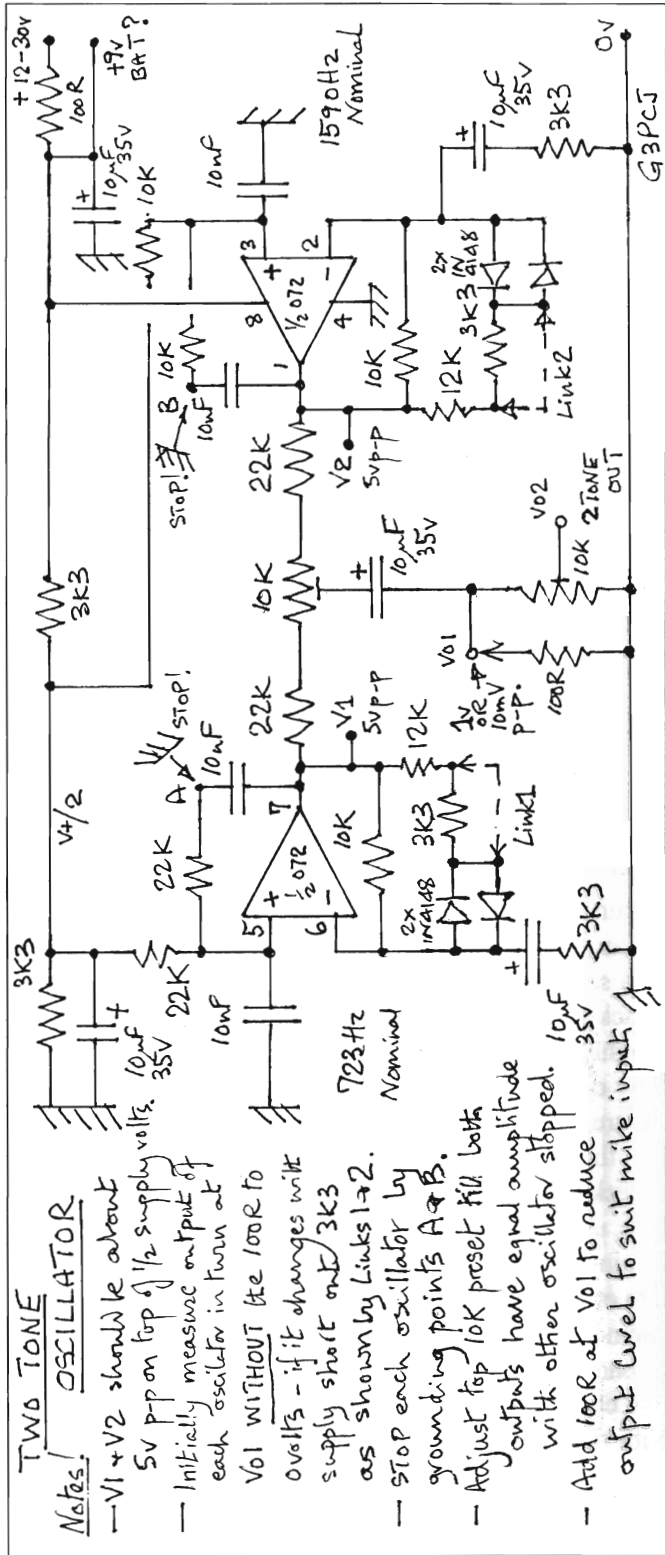7. I have made many boards satisfactorily by this technique, including double sided ones.

A Caution!

Reg Pattinson GW3KVX warns that you should be careful to make tidy and small topside connections when soldering earthy component leads to the ground plane of a double sided board. In a kit he recently purchased (I wonder where?) there was a missing hole; when he came to drill through the offending pad, the other side had a large blob of solder on it as he had been too generous with an earth connection. The general advice must be to have a good look at the PCB before you start loading it; if there any missing holes which you cannot drill out sensibly yourself, then send it back to the supplier. It is no excuse, but I can tell you from hard experience, that it is very difficult to be certain that you have drilled all holes in a dense board when doing it without numerically controlled drilling machines - your eyes get mesmerised by holes! Ed!

Two Tone Audio Oscillators for SSB rigs

Derek Alexander, G4GVM, asked me long ago to produce a design to assist in the proper setting up of a phone SSB rig. The important thing is to have two equal amplitude non harmonically related pretty pure audio sine wave oscillators; the outputs from these are added together and input into the mike input of the rig being set up. The resulting RF waveform output from the transmitter is a sinewave envelope whose frequency is the difference of the two audio frequencies. Normally this has to be observed with an oscilloscope (see later though) and will appear as two sinewave envelopes, 180 degrees out of phase, filled with RF in between. The test signal is used to check firstly that the rig output (or earlier) stages are not limiting with all the nasty splatter that this causes. Limiting is apparent as a flattening of the top and bottom of the RF envelope - it is usually caused by some stage, invariably the output one, not being able to generate any higher peak to peak RF voltage due to a variety of possible reasons. The transmitter's drive and modulation controls should be adjusted so that under normal conditions, the maximum output is just less than the level where flat topping begins. The other use for a two tone oscillator, is to set the carrier oscillator frequency to give the least residual carrier. As before, modulation is applied and the RF envelope observed on the 'scope. When the carrier oscillator is correctly set, the cross over of the two sine envelopes near 0 volts will be clean and sharply defined. Hence you should adjust the carrier oscillator frequency for the cleanest cross-over of the two envelopes. Remember to do it for both sidebands if the rig has facilities for both sidebands. I have put the circuit alongside for the two tone generator and resistive adder - this is acceptable because the output needs to be low level to feed into the rig's mike input. To set up the balance control, first measure the audio output level with only one audio oscillator working; then measure the level of the other oscillator with the first one stopped. Adjust the preset until they are equal. I shall be making this circuit available as a kit and I intend to add a simple detector circuit so that measurements can be made with a DC voltmeter instead of a 'scope. I will include rather fuller notes about how to use these gadgets with the kit!   G3PCJ

TWO TONE OSCILLATOR

Notes:
- V1 + V2 should be about 5v p-p on top of 1/2 supply volts.
- Initially measure output of each oscillator in turn at Vo1 WITHOUT the 100R to 0volts - if it changes with supply short out 3k3 as shown by Links 1→2.
- STOP each oscillator by grounding points A & B.
- Adjust top 10K preset till both outputs have equal amplitude with other oscillator stopped.
- Add 100R at Vo1 to reduce output level to suit mike input.

Circuit labels include: +12-30v, +9v BAT?, 0V, 100R, 10K, 10µF 35v, 3k3, 1590Hz Nominal, ½ 072, 777, V2 5vp-P, 12K, 2x 1N4148, Link2, 10K 2TONE OUT, Vo2, Vo1, 1K 10mV P-P, 100R, 22K, ¼ 072, V1 5vp-P, Link1, 2x 1N4148, 723Hz Nominal, G3PCJ

SUBSCRIPTIONS !

Since this is the last issue of our second year of Hot Iron, I am sorry to have to remind you to send me your subs if you wish to continue receiving Hot Iron. The rate remains unchanged at £5 for UK and £7 for overseas members. I regret that I shall NOT be sending out any reminders; this is the last warning you will get! I suggest you send off now before you forget. Many thanks for your continued support. Please don't forget that I am always after material for Hot Iron - your tips will certainly be of interest to others. Tim Walford G3PCJ