Hot Iron

Issue 15	"Journal of the Constructors Club"	Spring 1997

Contents

Editorial

We have a slight change in format as I am now preparing this on the toy which I obtained earlier this year. Just at the moment I am still fuming since it has taken me over an hour to get the headings etc. correct for this new format. I do wish that everything didn't change so much from one product of a family to another! But where would we be without them! I know it is really a case of lack of practice and one could easily spend many hours a day at one just learning how to use the latest gimmick! My son is constantly urging me to make an Internet connection and many letters contain their author's E-mail address. I just can't bring myself to spend more time every day on it and to increase BT's bill. (No cable out here in the sticks yet!) Many of you readers have experience in this field and I would love to have some comment from you - am I being old fashioned, lazy, or missing out on a splendid opportunity? For publication or not as you wish.

The onset of Spring, at long last, reminds me that the Yeovil ARC is actively preparing for the QRP Convention on May 18th; to be held in Sherborne at the Digby Hall. The festivities start with an open Dinner on Saturday night (booking essential) attended by this year's VIP who is Ian Keyser G3ROO and his wife. Sunday has a full program of lectures, competitions and demonstrations etc., together with on-demand morse tests for those equipped with photos etc.. The Construction Challenge is open to anyone and the task is to produce a 'useful piece of gear'. This gives a very wide scope! For serious entries, I suggest you contact Peter G3CQR (whose is QTHR) about the actual rules and other Convention details. The judges will certainly have a difficult task comparing vastly different entries but their decision will be final! A must for keen constructors.

Kit Developments

It has been a busy quarter; these are now available! The Wedmore is a specialist 5 Watt CW DC TCVR for 80m using a pullable ceramic resonator VFO; it has 9th order bandpass filtering and can be used on either RX sideband at will. It is especially easy to set up! Just £49. The Lopen is a 1.5 Watt CW TX to go with the Martock; it can be used on any of the Martock's bands and gives VFO coverage over the whole CW section - again either RX sideband at will. Alternatively it can be used with another RX, either on 80m with the ceramic resonator supplied, or your own crystal up to 15 MHz. £29. The Coxley is a regenerative TRF RX for 20, 40 and 80m derived from the Pitney but with tuning limited to the amateur bands. The companion CW TX is the 1.5 Watt Godney; this can work on any 3 frequencies to 15 MHz. A pullable 80m ceramic resonator is supplied for one with space for your crystals for the others - normally for 20 and 40m, but all 3 can be in any band. Coxley & Godney £29 each or £55 for both. The signal generator design is now much simpler. 400 Khz to 50 MHz approximately for £29. Do not forget the **Somerset Homebrew Contest** on Mar 28th - see Sprat issues 89 & 88 for details.

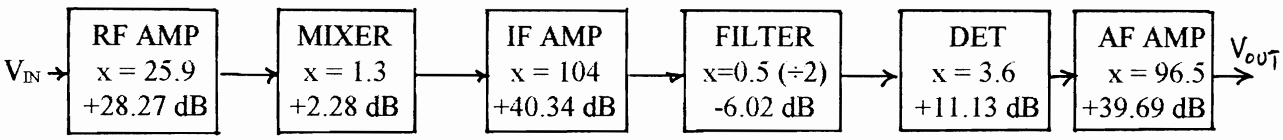
Hot Iron is a quarterly newsletter for radio amateurs interested in building equipment. It is published by Tim Walford G3PCJ for members of the **Construction Club**. Articles on simple theory, construction, testing, updates on kits, questions and suggested topics are always wanted. Please send correspondence and membership inquiries to Upton Bridge Farm, Long Sutton, Langport, Somerset, TA10 9NJ. Tel & Fax 01458 241224 Subscriptions are £6 per year for the UK (£8 overseas) from Sept 1st in each year. 1/9/96.

Decibels - by Eric Godfrey G3GC

The one thing that seems to cause more confusion to Amateurs than anything else is the decibel. This has no doubt been made worse by the indiscriminate use by the media of decibels when talking about the loudness of sound. Who has not seen or heard a remark such as "The noise from the aircraft was 140 dB(s)". This is quite meaningless as the decibel is a ratio expressed in a logarithmic form and ratios do not have any dimensions of their own. When expressing a quantity it is essential that the value in decibels is always expressed relative to some specific value of the unit to which the decibels apply. For instance to say that a transmitter has an output power of 20 dB is quite meaningless. However it could have a power gain of 20 dB which would be meaningful being equal to a power gain of 100 times. However if the output power is stated to be 20 dBW, then this is meaningful since the "W" means relative to 1 Watt. Since positive dBs represent gains, and negative figures represent losses, the 20 dBW is a gain of 100 and the output power is 100 x 1 = 100 Watts. A power of 20 dBmW would be with respect to 1 milliwatt and equal to a power of 100 mW. (20 dBmW may be written just as 20 dBm as the "W" is implied in the use of power. The same applies when referring to voltages, the "V" of dBmV may be dropped when referring to voltages with respect to 1 millivolt). Before going any further perhaps we should state the formula for calculating dBs:-

POWER GAIN dBs = $10 \times \log (P_1 / P_2)$ VOLTAGE GAIN dBs = $20 \times \log (V_1 / V_2)$

The calculation for power and voltage differ because P is proportional to V^2 ($P = V^2 / R$) and to square a logarithm one multiplies the value by 2, i.e. $10\log(x^2) = 2 \times 10\log(x) = 20\log(x)$. Why do we bother to use dBs, why not just use the ratios? Well the answer is that dBs are much more convenient as will be illustrated by the following example.



This represents the block diagram of the signal path in a receiver but the values given for the voltage gain (x) of each block are for illustration purposes only and may not be those that would pertain in a practical receiver. The third line are the gains / losses converted to dBs. A gain factor less than one, or negative dBs, indicate a loss in the block.

Overall voltage gain (using gain figures) = 25.9 x 1.3 x 104 ÷ 2 x 3.6 x 96.5 = 608,241.8

Overall voltage gain (using dB figures) = 28.27 + 2.28 + 40.34 - 6.02 + 11.13 + 39.69 = 115.7 dB

The first calculation involves multiplication and division finishing up with a very large number whereas the use of dBs only involves addition and subtraction and uses figures which are easier to handle. The gain figure above of 608,241.8 to 1 when converted to dBs is, as expected, also 115.7 dB, a less clumsy figure.

An amplifier with a power input of 3 Watts and an output of 12 Watts has a power gain of 12/3 = 4:1. Expressed in decibels this, in common parlance, is 6 dB but more precisely 6.0206 dB. If both the input and output impedances of this amplifier are the same at say 50 Ω then:-

The input voltage (3 Watts) $V_{IN} = \sqrt{P_{IN} \times R} = \sqrt{3 \times 50} = 12.25$ Volts

The output voltage (12 Watts) $V_{OUT} = \sqrt{P_{OUT} \times R} = \sqrt{12 \times 50} = 24.49$ Volts

Ratio of output voltage to input voltage is 24.49 / 12.25 = 2:1.

Expressed in dBs this is 20log 2 = 6 dB or to be more precise 6.0206 dB.

Provided that the input and output impedances are the same then this voltage ratio will be maintained irrespective of the value "R". From this it can be seen that a four to one increase in power leads to only a two to one increase in the output voltage. This is why that an increase of four to one in transmitter power is required to get an increase of one "S" point (6dB - 2 × Volts) at the receiving end.

For an amplifier, power and voltage gains, expressed in dBs, are only the same if the input and output impedances are the same. However, even in a passive circuit, voltage gain is possible without there being a power gain. This is illustated in Figs 2 and 3 which show two ideal lossless transformers.

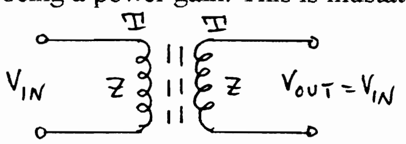


FIG. 2

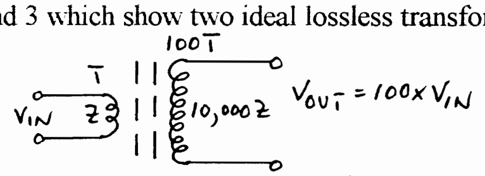


FIG. 3

In Fig 2 the transformer has equal turns on the primary and secondary and therefore both the output voltage and impedance must be the same as the input voltage and impedance. Since the transformer is lossless the input power must be equal to the output power. Therefore both the power and voltage gains are equal at unity. Since the logarithm of 1 is zero both 10log1 (power) and 20log1 (voltage) are zero, i.e. 0dB. In Fig 3 however the lossless transformer now has one hundred times as many turns on the secondary as on the primary. This means that the output voltage will also be 100 times the input voltage and the voltage gain is 40 dBs (20log100). However since the transformer is a passive component the output power must still be equal to the input power. This accounted for by the fact that the output impedance has also increased but by the turns ratio squared $(T2 / T1)^2$ which in this case is $100^2 = 10{,}000$. Therefore the output impedance across which the output voltage is developed is ten thousand times the input impedance. Expressing this mathematically in Fig 2, $P = V^2/Z$. In Fig 3, $P = (100V)^2/10{,}000Z = 10{,}000V^2/10{,}000Z = V^2/Z$, which is the same power as in the one to one transformer of Fig 2. Therefore the voltage gain in Fig 3 is 40 dB whereas the power gain is 0 dB.

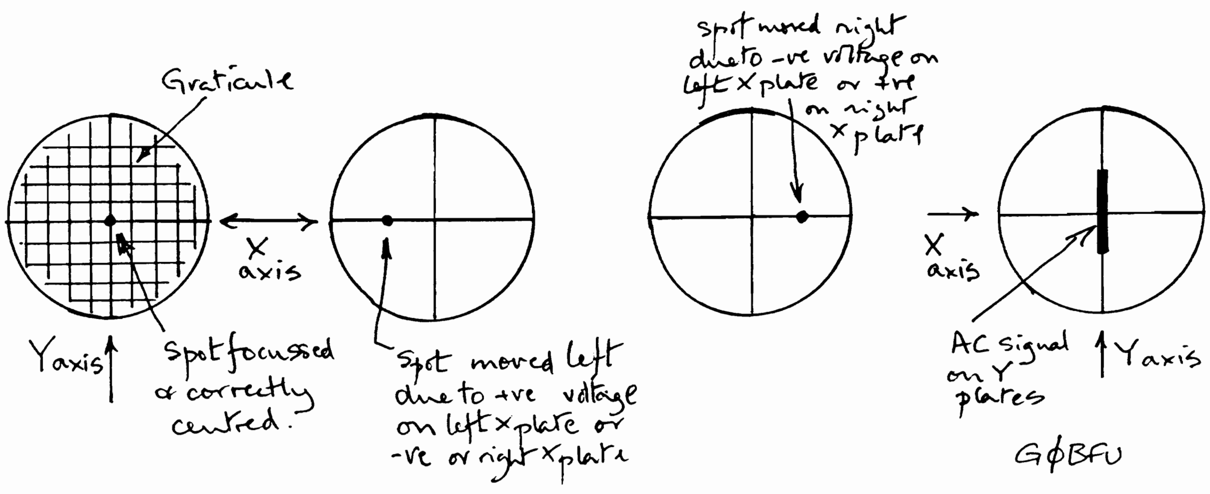
Thus when one is dealing with dBs one must be very clear about what the impedance is and whether the dB values used are for power or voltage.

Using an Oscilloscope by Dick Turpin G0BFU - Part 1

The oscilloscope is one of the most interesting instruments available to the radio amateur/constructor but its real value is only determined by the operator's skill. Most amateurs fail to obtain this skill due to a lack of understanding in its mode of operation and controls. So, if you have one but have not yet used the instrument:-

1. Check that it is set to the correct line voltage and frequency to suit your supply.
2. Before switching 'on' be sure you have made yourself familiar with the positions of all controls, even to the extent of drawing a copy of the control panel with all controls clearly marked, then test your knowledge.
3. Turn the 'Intensifier' or 'Brilliance' control fully anit-clockwise so as to prevent a trace or spot from burning the fluorescent screen inside the tube face. Develop a good habit of doing this after each observation.
4. Before making any observations, allow it to reach normal operating temperature; this is more important for older scopes whose circuitry is more prone to temperature effects.
5. To make 'observations' on any item, a 'probe' will be necessary, plugged into the input.
6. Advance the 'brilliance' control to about halfway (hopefully), when a spot (or line if the timebase is working) should appear near the screen centre. If the spot is badly focused or fuzzy, try adjusting the 'focus' control. It may need resetting for different brightness settings. Make certain that you can centre the spot using the 'X shift' and 'Y shift' controls- sometimes called 'X and Y position' controls.

Now one must review the basic operation of the scope to enable the operator to make primary observations. The spot is formed by a beam of electrons which pass between two pairs of deflector plates - one pair are vertical and these are the X plates. If either plate is charged positively by a positive voltage, the negatively charged electron beam will be attracted towards it. If the other plate is made negative, it will repel the electron beam. So the spot will move from its central position to a position which will depend upon the applied voltage on the plates. See diagrams below.



Similarly, if the two Y plates are charged instead of the X plates, the spot will either move up along the Y axis or, on a change of polarity, down the Y axis. Now one has a simile with a centre-zero meter, single range and no calibration but useable with its needle moving either sideways or up and down. If an alternating voltage is applied to the Y plates, then at very low frequencies (say 1 Hz), the spot will move up and down the Y axis equidistant from the X axis. As the frequency is increases, the spot will plot out a luminous vertical trace, or line, equal in length above and below the centre of the X and Y axes. How the signal is applied to the plates is the subject for another time, so do not forget the diagram and to zero the brilliance control before you switch off. Oh, don't lock away the multimeter yet, you might need it again!

Kit Updates

Adjustable CW filter. Gerrit PA0FOY and Ed EI7DV, both observed that the CW sidetone was just audible all the time when the kit was added to their Tauntons. The cause of this is failure of the switching or keying transistor (TR4, a BS170) to act as a perfect switch! When off, its effective impedance was sufficiently low for there to be still some signal passed to the output filter and buffer TR5. The cure is to lower the impedance after the switch so as to increase the attenuation when the switch is off. This is done by reducing R21 and R22 to 22K. The on resistance of TR4 is a few Ohms when the key is down, so reducing these resistors will cause a slight decrease in output level but there is plenty of signal available and only RT5 and RT6 should need resetting afterwards. More significantly, they also noted that the first burst of RF in a CW sequence, after going to transmit, had a very slow rise time. This was due to a slow rise in the standing current of the TX's output stage IRF510; Gerrit tracked this down to excessive decoupling of the FET bias line. This cure is to replace the yellow bead 10 µF tantalum capacitors in the Taunton (C304) and in the Bruton (C302) with 100 nF disc ceramics. These components are now included in the Adjustable filter kit. My thanks, gentlemen!

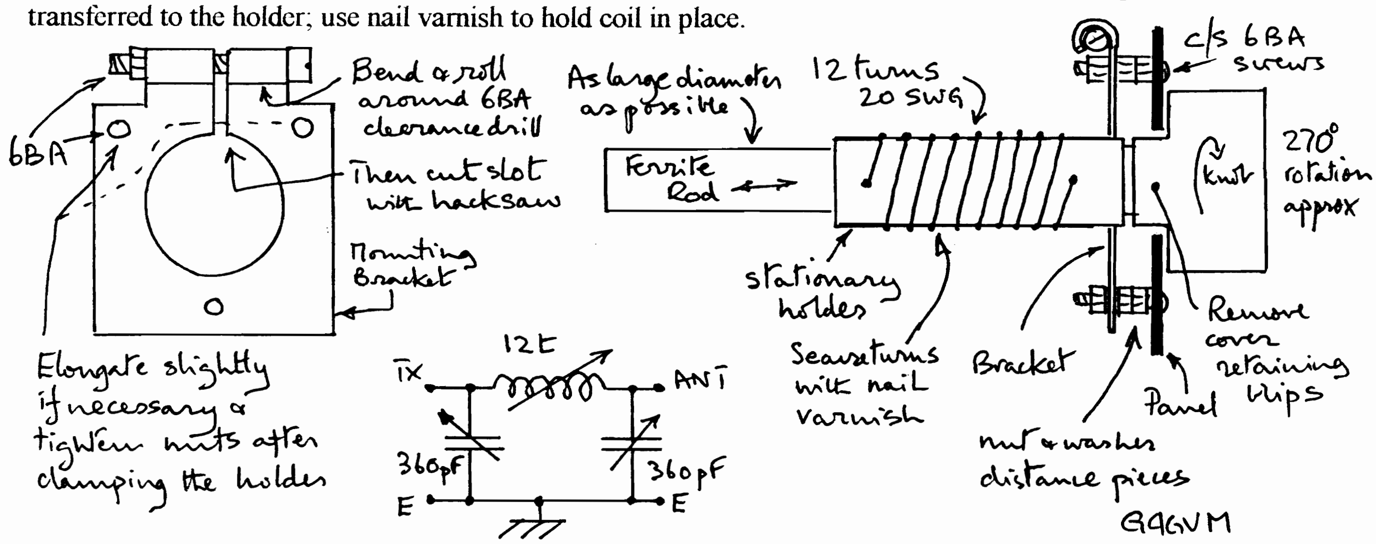
Taunton - unused section of 4066. Ed EI7DV also had another strange symptom. After switching on, the RX worked fine but after going to transmit, it failed to fully revert to receive with the TR relays still just held on. It was eventually traced to a damaged 4066 IC105 which was holding the RXC line to 8 volts after transmitting, this was sufficient to partly turn on TR305 and hence hold the relays. The damage appeared to be associated with the unused section of the 4066, so if you have problems, it is best to connect all pins of this unused transmission gate to 0 volts. Cut the RXC track between pins 12 and 13 of IC105 and put a wire link from the track linking pins 10, 11 & 12 to 0 volts.

Bruton and Taunton. Dave, G7BTX/2E0AMS, experienced a nuisance hunting of the AGC in his Bruton between two widely separated received levels when the actual signal was somewhere in between. The data sheet for the SL6270 suggests that when it is used with a single ended input, the 'unused' input (of pins 4 or 5) should be connected to 0 volts by 22K and heavily decoupled at audio. This is to stop a nasty control type oscillation at about 0.5 Hz. My experience is that often a lower resistance is needed hence these two rigs have 10K/10 µF specified for this. Dave found that his worked best without any resistance. I presume that it didn't oscillate either. Let me know what your does!

White Rose/Taunton. Fred Maddison, from Australia, mentions that he tried making his White Rose rig into a switched multi-band version and fitted one of my 5 digit counters. There was breakthrough problems from BC stations and other sources so he eventually abandoned the idea. Ray Donno also tried it with his Taunton using a bank of interlocking push button switches. It was too complicated and subject to breakthrough. As the wires to the parts that change on each band get longer, all these problems becomes increasingly severe. Switched multi-banding has to be designed in right from the start and not added afterwards! G3PCJ.

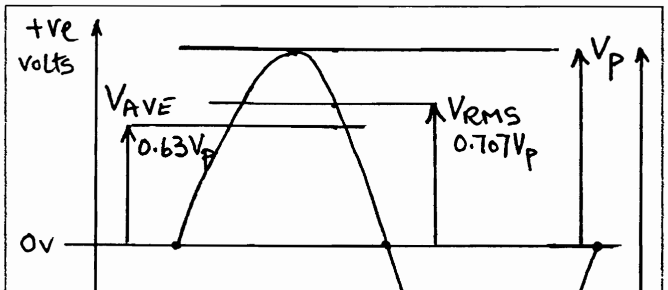
Simple and effective AMU by Derek Alexander G4GVM

For a couple of years now, I have been using G4LDY's design, as illustrated in the G-QRP Club Circuit Book, when /P with my Yeovil rig. The design is a simple π circuit using two transistor radio type tuning capacitors and an inductance, varied by the position of a ferrite rod within it. It is this last item that makes it somewhat clumsy and so I was delighted to note G4UEL's idea in Sprat No 89 which made use of a used lipstick holder to move the rod in or out of the coil. Many lipstick holders are made of metal but fortunately whilst on holiday, I discovered a 'lip-salve stick' which is identical but made entirely of plastic. This meant the coil could be wound on the holder thus reducing the total depth and obviating the need for a separately mounted coil and former. The tricky bit was how to fix the whole set-up to the panel so that the control is presented as just another knob. After some thought, I decided on the method illustrated. Helpful tips - use the bracket as a template to cut the panel holes as this will make it sit true. Use nuts and washers as distance pieces to place the bracket on the edge of the holder static piece. wind the coil on a slightly smaller diameter former so that it hold tight when transferred to the holder; use nail varnish to hold coil in place.



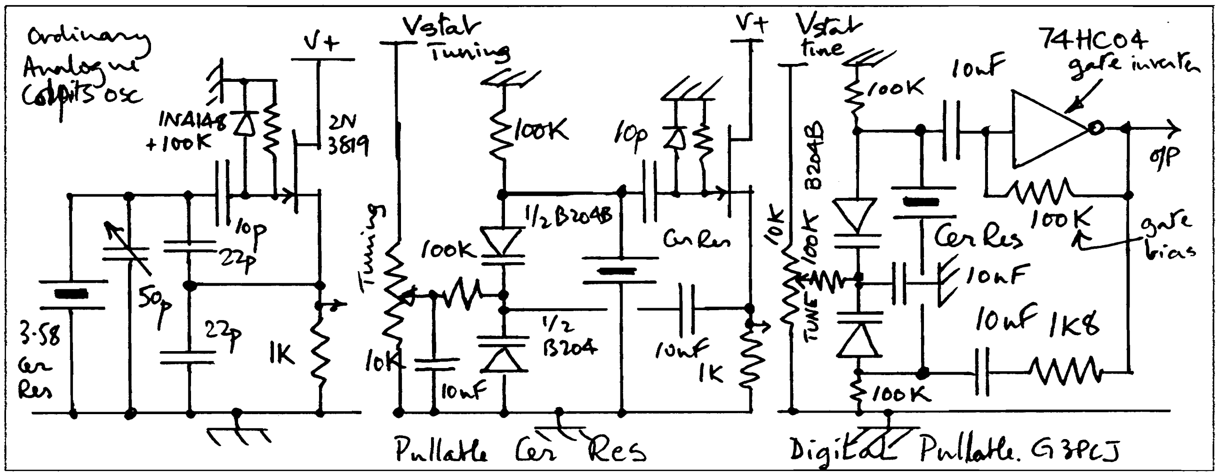
More about Power Measurement by Eric Godfrey G3GC

This note is in response to a letter sent to Tim G3PCJ by Stephen Melling, G8FUH. The fundamental definition of power is related to the heat dissipated in a resistive load when a certain voltage is applied across it. The power dissipated in a circuit is given by $P = E \times I$ or E^2/R. This presents no problem at DC where the voltage is constant. However with AC, independent of the frequency, the voltage is varying through the cycle but for the same nominal power the heating effect over the period of each cycle must be the same as for DC. The fundamental alternating voltage is a sine wave as shown in the diagram. The different voltages, i.e. peak, peak to peak, average and RMS, applicable to a sine wave are also indicated on the diagram. Since the voltage is varying during the cycle the power dissipated in the load will also be varying during the cycle. It is therefore necessary to sum up all the varying powers during the cycle which in turn requires knowing what the voltages are which are directly related to the sine of the angle in the sine wave. This can be done mathematically or by taking samples at regular intervals throughout the cycle. If one does this every 5 degrees from 0 to 180 degrees, then summing these and then finding the average or mean by dividing by the number of samples then one gets that the average voltage is 0.63 times the peak voltage. However using this in the V^2/R formula yields an incorrect result since the average power is the sum of all the individual powers. What has to be done is to take each of the sample voltages, square it, add them altogether, average them and then find the square root. This is what RMS voltage is compared to average voltage, i.e. the root of the mean (average) of all the voltages squared. This results in the familiar value that $V_{RMS} = 0.707 \times V_{PEAK}$. Using average voltage instead of RMS voltage to calculate power will result in a difference of 1.002 dB. Some of the confusion around this has I believe been brought about by the use of the expression "RMS" power, meaning the power calculated by using RMS voltages but which in fact is the average power. The use of the term "RMS" power is in my opinion quite incorrect and one should always use average power. Our licences use the term average power and defines the peak envelope power as the power averaged over one cycle at the peak of the envelope. Thus the $P = 0.707 \times (V_{PEAK})^2/R$.



More on Ceramic Resonator VFOs

Since I last wrote about these last Autumn, I have devised more useful circuits. As their Q is roughly midway between a crystal and a good inductance, they tend to have the advantages of both! I have already mentioned the commonly available 3.582 MHz types which can be pulled down to cover most of the CW section of 80m. I have been developing various varactor diode tuned versions of the Collpits oscillator configuration. The usual analogue circuit (left) suffers from having fixed 'Colpits' capacitors so reducing the pulling range, but the middle diagram below shows how they can be made variable with twin varactor diodes; the right diagram shows the conventional digital 'Colpits' oscillator modified for varactor control. In both circuits, the labelled 100Ks are to apply DC bias to the varactor diodes only; their value is not critical. Although the digital circuit is biased into its linear region, the output is digital. A word of warning! Any digital oscillator (without a very high Q resonator like a ceramic resonator/crystal) is quite likely to suffer from phase noise due to jitter on the switching action of the gate. This is why you don't find a digital VFO oscillator directly driving a RX mixer.



Most ceramic resonators have a tolerance of 0.5% which can be significant. For fixed frequency use, their nominal load capacitance should be 30 pF reducing to nearer 20 pF over 15 MHz or so. The load C is made up from the series value of the two Colpits capacitors which are usually equal. If the Colpits Cs are varactor diodes, then strays will mean that it is unlikely to be possible to get it operating at a frequency higher than the nominal value, so they should always be considered as going down only. With care, it is possible to go down up to about 2% of their nominal frequency. They are available in quite a wide range of standard frequencies, but so far 80/160m are the only bands where they are within the band; the others are on the LF edge and hence not directly useful. Frequencies can be mixed with a 612, eg. a fixed 20 MHz less a pulled 6 MHz for 20m. The 5.6 MHz value might also be useful when doubled to 11 MHz. I have found sources for the following MHz frequencies:- 0.455, 0.5,0.56,1,2,2.45,3.58,3.69,4,4.19,4.91,5,5.5,5.6,6,7.3728,8,10,11,12,16,20,32,33.86,40! G3PCJ

Progress on the Minehead

This is the new rig for 10, 6 and 4m. The major problem to overcome is VFO stability, so a mixing scheme is inevitable. In the interests of overall simplicity, it will be a double sideband phone or CW rig with a DC RX. I want it to do any single band by changing the coils/capacitors/ceramic resonator(!); the oscillator plan will also do any of the major HF bands but I am not sure that I can obtain all the inductances for 15m to 160m in the same TOKO can size required for a common footprint! No problems with the three above bands though. I hope to have a lash up working soon!

Free Yeovil 40m Converter!

Jim Geary, GW8HKY, has returned his built 40m converter because he decided against altering the main rig. He has asked that I offer it free to anyone who has a good home for it. If anyone who has a Yeovil without 40m and would like it, please get in touch with me. He has also made up his signal generator, with a three digit counter, into a smart instrument using a Maplin box type PC25.

Cleaning PCBs

When I had Ed, EI7DV's, Taunton back for investigation, its PCB was immaculate! After a little prodding, he told me the secret. After loading the PCB, the flux residue can be scrubbed of with a toothbrush and cellulose paint thinners - obtainable at your local paint spraying garage or paint shop.