"JOURNAL OF THE CONSTRUCTORS CLUB"

Hot Iron

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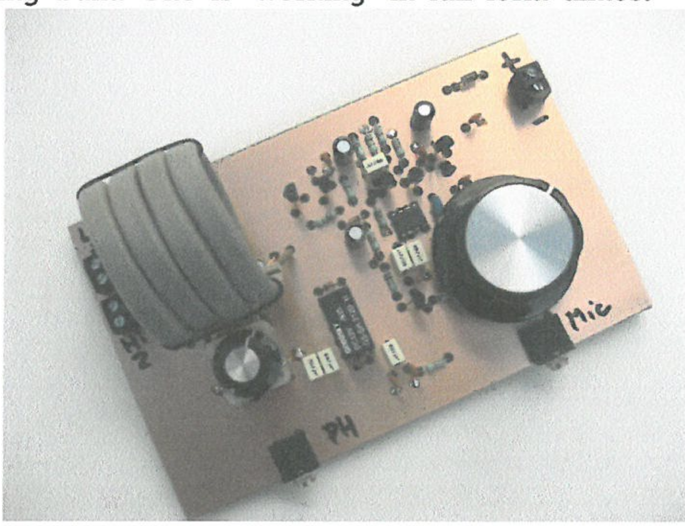
Editorial

Many of you know that my main occupation is farming on the Somerset Levels and have been kind enough to inquire how we are getting on with this terrible winter and all the floods. I am pleased to say that we are fine! As I type (started on Feb 15th) my feet are about 33ft above sea level, while the general flood waters are at about 27ft above sea level. Our house, all the buildings and cattle are dry except when the rain is horizontal! Your concerns are much appreciated. I am pleased to say the forecasts are better now and the EA have just started some huge pumps putting the water back into the rivers and hence to the sea. Tim G3PCJ

After writing the above (it is now Mar 8th), I must apologise for the late despatch of this Hot Iron. One way and another I blame Mr Gates! I was part way through writing it and was forced to change my computer. Unfortunately the new machine did not have MS Publisher (which I was using for writing HI). When I eventually found and installed my old Win95 Publisher software, all was fine for 12 hours till it did an auto update overnight. Publisher got updated and then would not open my old files, nor could anybody else locally for some while. In the meantime we had to go to Amsterdam for a short break booked many months ago! But the good news is that a friend did manage to retrieve the text of the part completed HI while we were away; that is a great step forward – even if I do now have to redo all the diagrams and pictures!

Kit Developments

Five early Minsters Mk 3s are now being built. One is 'working' in full form almost properly and one in its basic form, with a couple more close behind. The usual typos and a few comments that will need minor text alterations but nothing dramatic yet! All will eventually have the multi-band add-ons. Keep an eye on the website for news of its release.



Meanwhile, I have made early prototypes of the Wick and the Mark. The **Wick** (on right) is a very simple starter phone DSB TCVR - see later. Revised versions of the Wick are now working on 80 and 160m. The **Mark** is a 3 band CW regen for 20, 30 and 40 or 80m, which also needs a second prototype which I shall build soon. I have laid out and etched, but not yet built, the matching Meare 3 band CW TX! Tim

Contents Modulation for readability; Home built circuit board techniques; the Mark; Linear experiments; Lydford experiences; Multiband CW TCVR ideas; Dead bug construction; Tape radials; Upton TCVR

Modulation for "readability"? **By Peter Thornton**

If you're trying to communicate over a noisy, fading and QRM riddled path, which modulation is best for "readability"? FM? SSB? CW? No, AM! Not my opinion, but that of Aviation Authorities world-wide. But why, if it's no use for amateur communications nowadays? AM uses twice the bandwidth of SSB; yes, the carrier is (for some receivers) useless. So what are the advantages of AM the professional radio men pursue?

It's simple - AM is far more "readable" than SSB. The voice sounds natural, without the distortion SSB introduces in the crystal filters removing the unwanted sideband. Problems plague FM too - FM receivers suffer "Capture Effect", where a receiver will lock onto a strong signal, over-riding the desired (but weaker) signal.

Traditional AM has a carrier power twice that of the sidebands; since AM has two sidebands, the upper and lower, then each sideband has one quarter of the entire transmitter power. Thus, thought the pro-SSB men, we can get more transmitted power by doing away with the unwanted carrier and sideband, and put all the transmitter power into a single sideband. Pity it doesn't work like that, though! AM produces natural, clear speech; not so SSB!

And - AM is dead easy to produce! "But surely you need huge transformers, and massive power supplies?" No Sir! There are many simple circuits for the production of AM and can even be generated by our old friend, the SA602/612. You can also make perfect AM with CMOS gates, in a Pulse Width Modulator circuit - digital AM! You will find a multitude of AM transmitter circuits on the web, take your pick combined with the contents of your junk box!

Many amateurs running AM are on the bands today. Calling frequencies for AM World-wide are listed below. Hope to hear you on AM soon!

All Frequencies in MHz
160 Metres:
1.885, 1.900, 1.945, 1.985 (USA)
1.850 (W. Europe)
1.933, 1.963 (UK)
1.843 (Australia)
80 Metres:
3.530, 3.650 (South America)
3.615, 3.625 (VMARS, UK)
3.705 (W. Europe)
3.690 (AM Calling Frequency, Australia)
3.825, 3.870 (West Coast), 3.880, 3.885 (USA)
40 Metres:
7.070 (Southern Europe)
7.120, 7.300 (South America)
7.175, 7.290, 7.295 (USA)
7.143 (UK)
7.146 (Australia)
7.195 (Italy)
20 Metres:
14.286

Home built circuit board techniques

With several new Construction Club members, who I would like to very much welcome, I need to address some simpler topics for those who I guess might not be so experienced as old–timers! George Dobbs G3RJV does a grand job with his regular construction column in PW but I wonder if it is really necessary to use any extra parts for the assembling a circuit? I build most of my wilder ideas literally in free air using a copper sheet without any form of mechanical anchoring for connection joints. This makes it extremely simple to alter a circuit but the mechanical rigidity is awful! Generally this does not matter in a protected environment such as your work bench; but there is one major exception! Frequency stability of oscillators is very dependent on mechanical rigidity so when doing long term tests of them, you must use either a proper PCB or some form of anchoring for the joints and other parts; but for most experiments etc, such techniques are not essential except to make it look good!

How can you avoid drawing pins stuck into wooden boards, loads of tedious hacksaw work to make stick on squares, or much 'drilling' to make isolated pads? The first point is to layout the physical circuit in a manner that makes following it easy! Generally, you will be building something from a circuit diagram which is usually drawn with the main ground, or negative supply line, at the bottom; with the main positive supply line at the top of the page. Stick to this in your physical layout! The next stage is to keep input and output parts of the circuit well separated at opposite ends of the 'board' - again following the circuit layout may help. I use 'board' here in its most general meaning; some people like to use ready made pre-drilled boards, with or without tracks on them, that can be cut as required, but a piece of plain copper is fine! You don't need to go to a metal merchant - plain copper clad laminate is available from Maplin & the regular electronics suppliers (Rapid, Farnell & RS) in various sizes that can be cut down as required. I use old scrap double sided PCBs from failed projects but you may not have that source! The benefit of these is that the copper ground plane sheet (even with random holes in it) forms an excellent ground plane or 0 volt supply 'line' for your project.

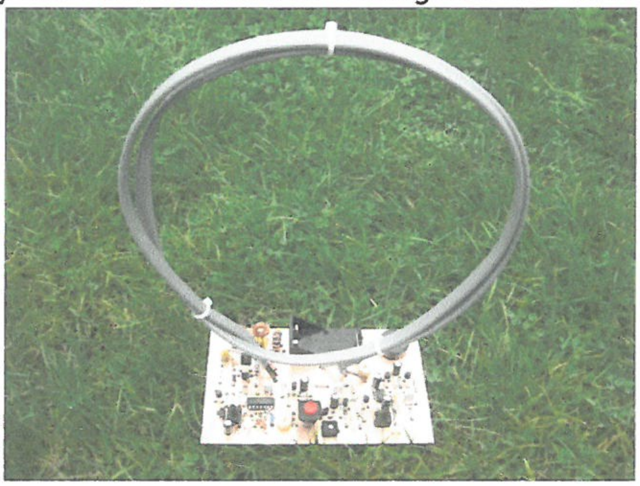
So how do you mount parts? Easy - by soldering their ground leads to the copper plane! (Beware that people like me tend to refer to earth or ground or chassis when they actually are referring to the same 0 volt line!) Cut the ground leads of these earthy parts to about 1/4 inch or 3 mm long and solder them directly to the copper ground plane leaving the other end slightly up in the air so it is not in danger of touching the ground plane. Then add the components from the input towards these earthy parts. Some of these will not have any earthy connections so a bit of support might be needed, fit a high value resistor between that point and the ground plane - use at least 1M resistors (or even 10M) and their value will be many times (> x30 desirable) the circuit impedances at that point, and so will not upset matters. If in doubt, avoid them at high impedance points – associated high value resistors in the circuit are a warning sign!

At the top of the circuit, you probably have a positive supply line; here a bag full of cheap 10 nF disc capacitors are useful! They can be added across the supply lines with gay abandon to give extra rigidity and better decoupling. As before solder one side to the ground plane along the top of the layout, with the other lead up in the air, and then link them with stiff wire to complete the supply rail. If extra rigidity is required at any particular point (say for the incoming supply lead), fit two of them at right angles!

So what do you do about integrated circuits? Consider using a IC socket if you like, but with a published design where you should not need to swap devices, then solder it in permanently. This will also be a good thing for any RF circuit where short leads are desirable, or even essential at UHF etc. If they are being soldered directly in place, they should be mounted upside down. Consider the best orientation, and then mark the copper sheet with a star for pin 1; I also write the part number on the copper for when I come back to the project years later! Then bend down the earthy leads of the device so they can be soldered directly to the ground plane. (Beware about static charges and wear a wrist strap if you work in a hot room with synthetic carpets!) The supply line to integrated circuits can also have their own 10 nF discs between supply pin and ground to help with anchoring. With care one can make quite smart layouts like this – not like my example of Dead Bug Construction on the last page! G3PCJ

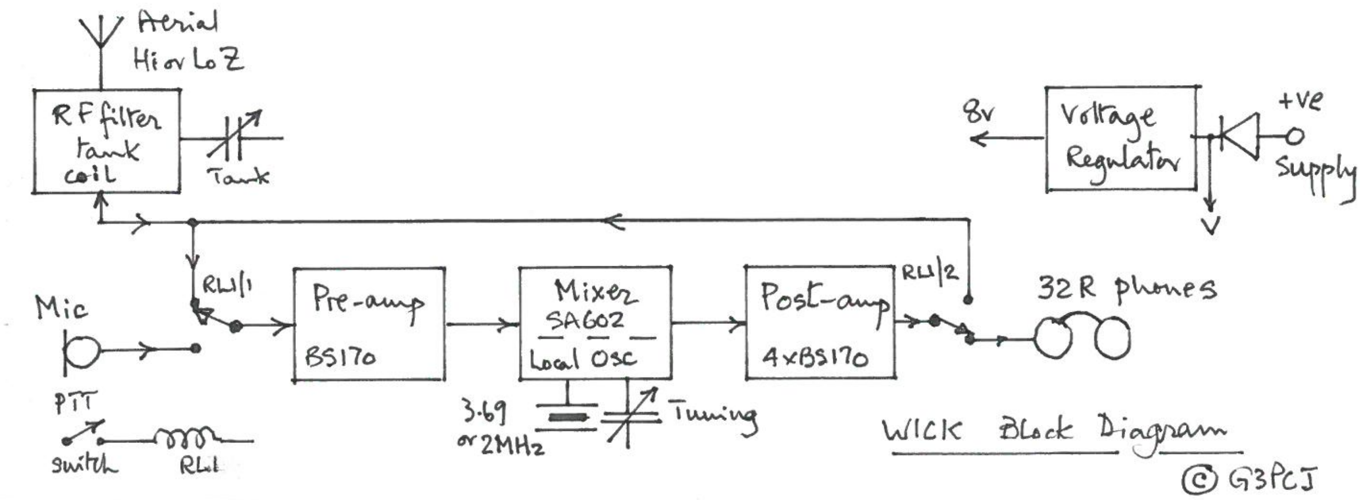
The Mark!

This rig was inspired by a sketch of a Japanese idea kindly sent by Peter Thornton. The key point is that a mixer can perform either as a product detector, or if balanced, as a modulator producing double sideband suppressed carrier phone. The Japanese design used the ubiquitous SA602 mixer chip. (Incidentally, I have been warned that this chip is no longer being made!) The design had almost no other semi-conductor devices, and so lacked sensitivity and transmit output power - but it did set me thinking! Because Peter T had been thinking about 6m operations (portable with the shorter aerials), my first ideas were for something rockbound on 6m possibly with an integral loop antenna like the Radlet (right) of many years ago! But 160m local nets seemed like another potential candidate for a simpler TCVR!



Eventually it has developed into a ceramic resonator based phone TCVR for 80m, (or 160m when ordered). There are standard in band resonators for these bands so it can have 50 KHz or more of tuning range which is far more appealing. The Radlet's loop idea eventually led to the use of semi-rigid mains twin and earth PVC cable for the single RF tuned circuit. As the photo on page 1 shows (of an 80m Wick), it needs a reasonable sized four loops which produces a 12 turn coil by connecting the individual cores in series on the PCB. By a little juggling with the tuned circuit connections, it will work with 'long wire' or a balanced low impedance feeder to a conventional balanced antenna. This approach is an easy way to obtain the high inductance, and robustness, needed for a transmitter tank coil on 80 or 160m!

Another interesting point about the earlier design was that (apart from the 602) one other aspect was used for both transmission and reception. My design uses all active stages for both transmission and reception to get the gain up! See the block diagram below where the switching is done by a single relay. This means that both input and output amplifiers need to work from the RF right down to the low end of the audio range - say 4 MHz down to 300 Hz! That's quite a challenge when inputs and outputs are switched in close proximity, so this is a design that will be a bit more layout dependent than usual! To get most of a Watt of RF output power I decided on a pair of my favourite BS170 MOSFETs working in parallel. On reception their drain load is the series connected 32R phones, so it includes an automatic reduction of their drain current to let them stay cool during long reception sessions! To keep it simple, the only controls are for the main tuning of the local oscillator using the ceramic resonator, and a second PolyVaricon for the RF tuned circuit which is used both for reception and transmission. In view of its simplicity, it will be cheap and should be good for Buildathon type Club construction projects. G3PCJ



Linear Experiments! By Paul Coddington M1BKL

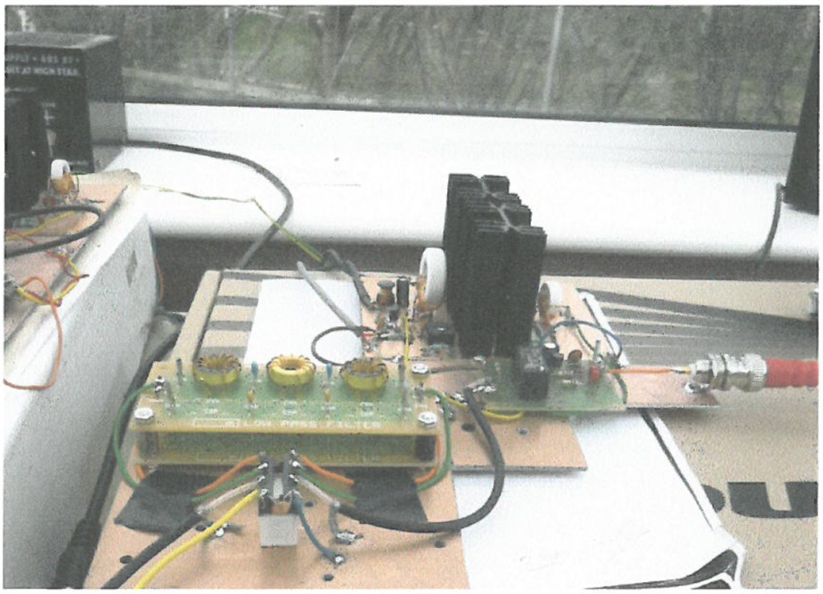
I am new to Tim's kits but I am not new to kit building & have built a number of Softrock Ensemble RX/TX kits. Many of you will know these have a nominal power output of around 1 Watt. I have been using two of these, one with band pass filters for 40, 30 and 20m and one with filters for 17, 15, 12 and 10m for digital (BPSK,QPSK, RTTY etc) contacts over the last 18 months and collected some 60 to 70 countries in the process.

About 6 months ago having obtained an additional external sound card for my PC I decided to configure the SDR software for SSB. The SDR software I use is mostly PowerSDR for SSB supplemented by HDSDR and Rocky for digital. However I quickly realised that for SSB contacts it would be good to have a little more than the 1 watt. I came across Tim's Linear Amplifier so I ordered one (with IRF510s) and got building - it was easy and straight forward. It was then attached to the Softrock with the 40, 30 and 20m band pass filters and it delivered a good clean 10 watts. This Softrock/Linear amplifier combination has been progressively enhanced to include: a PPT aerial change over relay using the switched 12v supply from the Softrock, and two switched LPFs - one with a knee at about 7.5MHz and one at about 14.5 MHz. (They are 7 pole Chebyshev types.)

During building I noted an alternative version was available with RD06HHF1 MOSFETs which might extend the upper usable frequency towards 50 MHz, so I ordered one to give it a try with the other Softrock. The Linear with the RD06HHF1's (for HF use) is identical to the IRF510 version with the exception that since the source is connected to the body of the MOSFET the insulating washer is not absolutely necessary. The one big difference between the two versions came in the setting up.

First following the instructions, the bias was increased until the current rose by about 250 to 300 mA, and the RF input was adjusted until the output stopped increasing.
However this did not produce the expected power out even at a frequency of a nominal 14 MHz, so the bias was increased keeping the RF input constant until the RF output peaked. At this point the standing current was between 0.5 and 1 amp. In the final version the bias was subsequently reduced by a small amount, however the standing current is still more than 0.5 Amp. This Linear with the RD06HHF1s, was then attached to the Softrock together with a PTT aerial changeover relay, driven by the Softrock switched 12v volt supply. Two switched 7 pole Chebyshev LPFs were added to the output – that for 17 and 15 m has a knee at 21.5 MHz and the other for 12 and 10 m has a knee at 29 MHz.

So what about the results? With my simple test equipment - power meter, 50 ohm dummy load and 50 MHz scope, I obtained ~ 10W on 20 and 17m, 5W on 15m, 8W on 12m & 6W on 10 m – all with a nice clean signal. Why there is a dip for 15m I do not know, maybe the output on 10m is being reduced by the LPF. I have now done extensive on-air testing on 17, 15 and 12m with many SSB contacts over the past two months in Europe, USA and Canada, with the best DX being Brazil and Guadalupe. The RD06 Linear and Softrock combination works well!

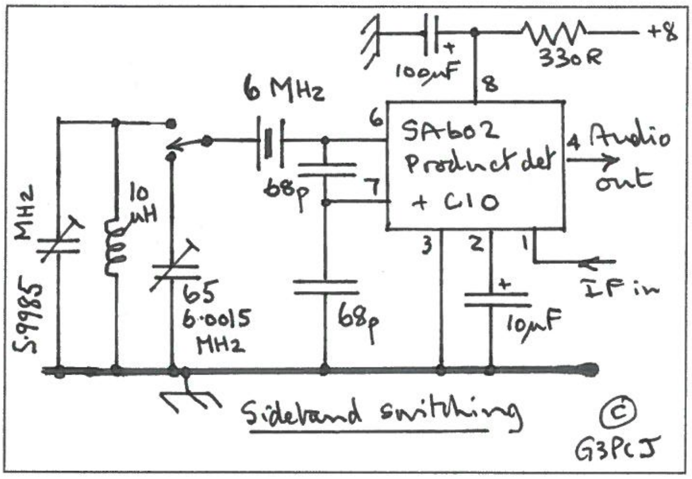


Paul is currently trying out the VHF version of the RD06 devices in another Linear! More news later.

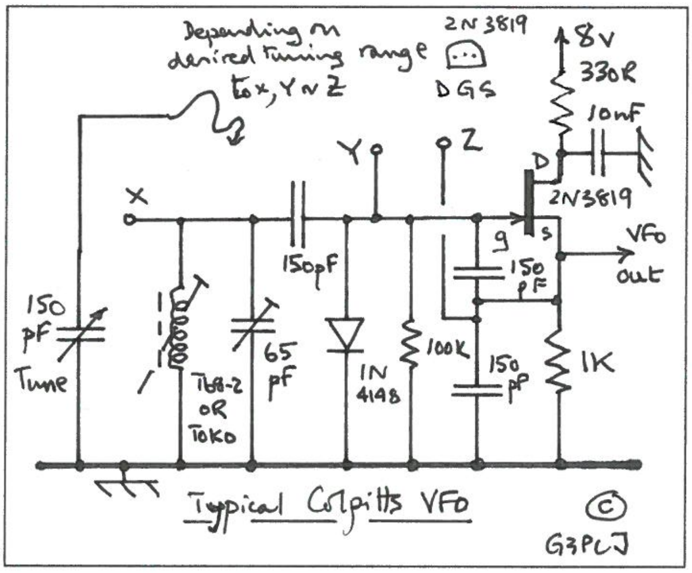
Lydford TCVR Experiences

Several builders have reported their experiences and modifications to this rig! Here are a selection of them:-

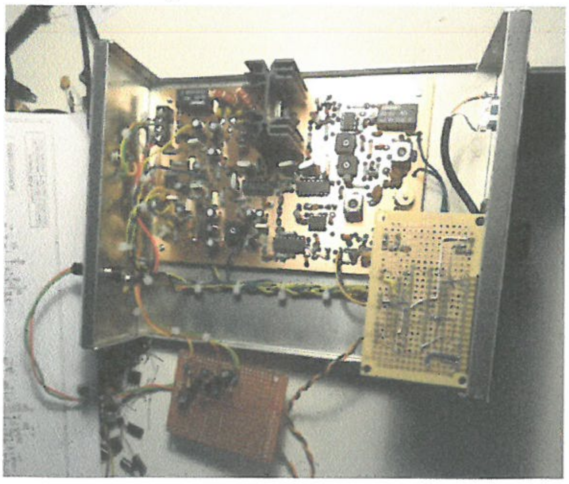
Sideband switching This something I have shied away from because it really needs short leads owing to the Carrier Insertion Oscillator operating at 6 MHz. The normal Lydford CIO can be made to work on either sideband depending on whether its 10 /uH coil is fitted for the lower frequency of 5998.5 KHz, instead of 6001.5 KHz with just the plain trimmer. All that is needed is an extra 65 pF trimmer and a single pole on/off toggle! The leads to the switch should be short and stiff so if you need to have a distant front panel switch use a small single pole relay mounted near the trimmers!

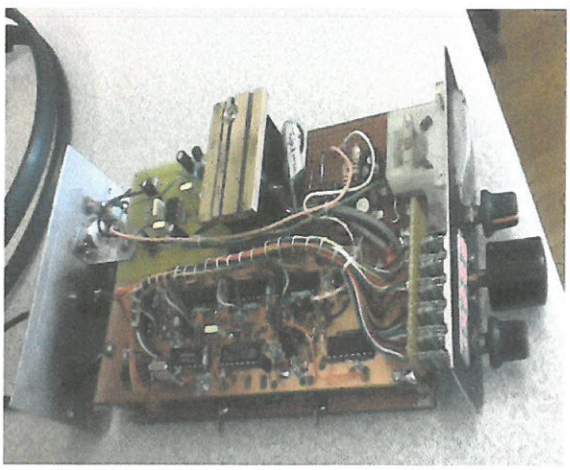


VFO tribulations One builder's VFO refused to work – how was it cured? See the circuit right. This is typical of Colpitts oscillators. If all is well the DC current through the 2N3819 JFET will increase very slightly when the oscillations are stopped. So monitor the DC voltage across the drain supply R and see if this alters when the inductor is temporally shorted out – if not, then its not oscillating! If there is no voltage across the drain R, then the device is not conducting – check its orientation and for bad joints and that the gate resistor is present! It is very unusual but TOKO coils do occasionally go open circuit, so measure their DC resistance – it should be nearly a short circuit! This was the troublesome fault!



Enhancements Many variations have been added or tried - DDS instead of the LO chain, various frequency readout counters, CW and or AGC kits – too many to detail! Thank you to all who have reported back! Judging by the good reports on the basic rig and the many modifications made, it appears to be a very successful kit - DDS version left and with counter right. G3PCJ

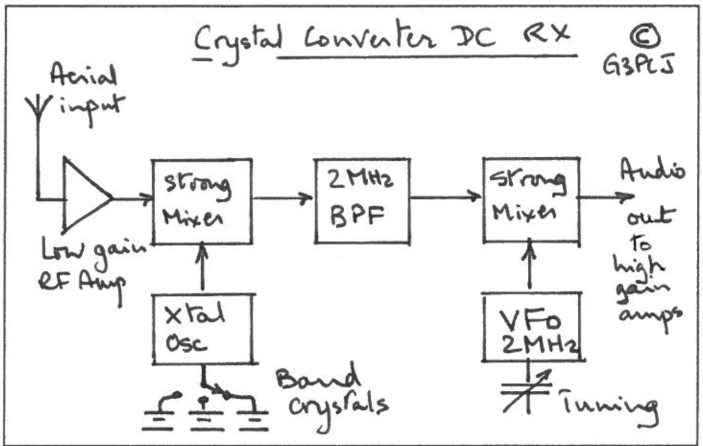


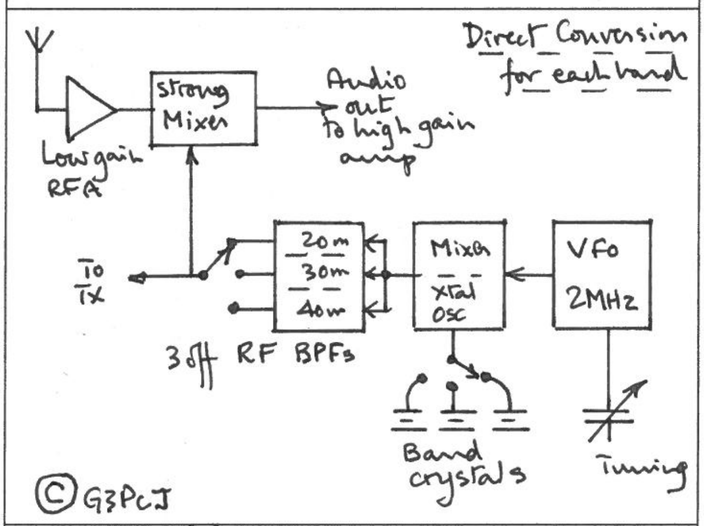


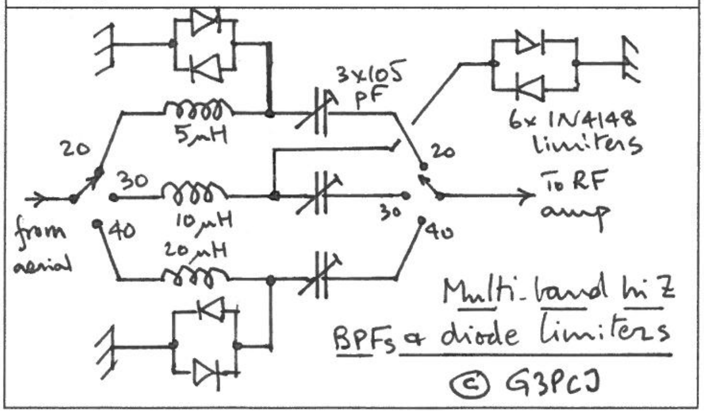
Design ideas for a multiband DC CW TCVR

I have been contemplating a new CW DC rig but the block diagram is challenging if you want to minimise the number of resonant circuits and have full break in operation without TR relays! I hope to simplify/reduce the cost of the earlier 4 band Cadbury design. What frequency scheme is best? To avoid chirp and achieve stability on 20, 30 & 40m bands, a LO crystal mixing scheme is almost essential (unless you fancy computer driven DDS!). A 2 – 2.15 MHZ VFO added to the common 5, 8 & 12 MHz crystals is a good scheme; the only snag is a potential 7th harmonic birdie of the VFO at 14.00 MHz – but to some people, this is a useful band edge marker! A 3 MHz VFO would cure this but that needs more obscure crystals. I hope that a strong commutating HC4066 mixer without RF filters will avoid BCI when a decent AMU is used.

Two approaches for the RX are possible – crystal driven converters ahead of a 2 MHz DC RX (needing two strong mixers), or a LO chain (with the VFO, crystals, mixer and LO filters) driving a single strong mixer for DC operation on each band. The first approach (top right) is probably a bit simpler/cheaper (owing to lack of RF filters for each band) and it also readily adapts to an optional phasing kit for single sideband reception. The second approach has the advantage of needing only a single strong mixer with most of the gain provided at audio. For both approaches a low gain RF amp is desirable to avoid unwanted LO radiation. However the generation of the LO at operating frequency in the second scheme has the strong advantage that it can be directly used to drive the transmitter without further LO filtering. The transmitter for either approach will need low pass harmonic filters.

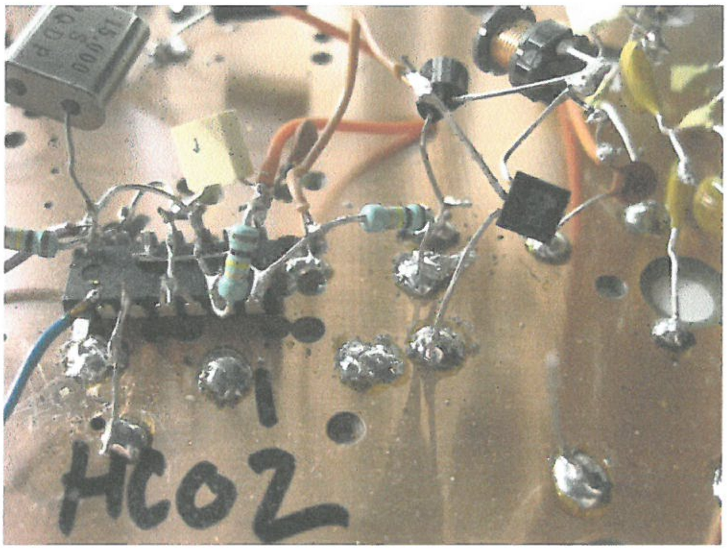






Another challenge is how to obtain full break-in TR switching without burning out the RX front end! The Cadbury used the scheme right but without any RF filters, one can only shut down the RF amp and pray! This may not be good enough for a 5W TX. I would like to avoid diode switches owing to their losses but that maybe acceptable at HF. G3PCJ

Deadbug Construction



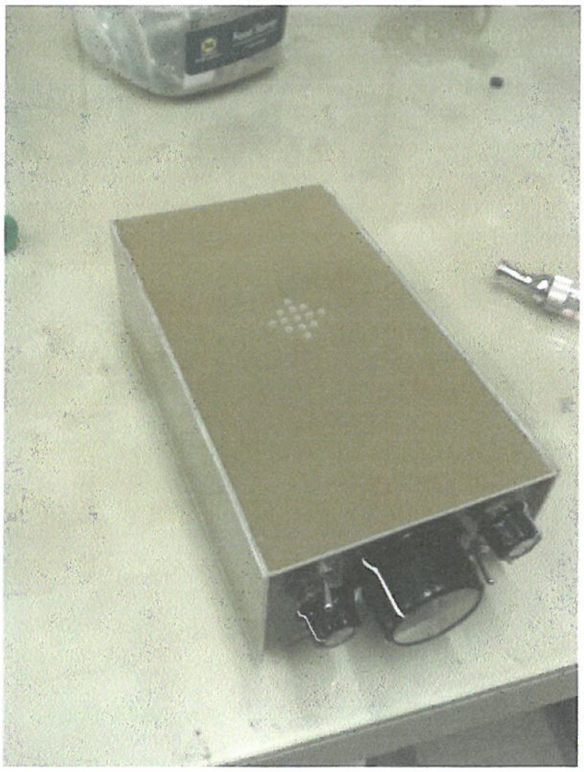
This is an untidy example of how you can mount an integrated circuit upside down. The transistors on right are actually a pair of BS170s in the output stage of an experimental 50 MHz rig! I made many attempts to photograph this but failed to get a decent one! Sorry!

Tape Radials

Craig Douglas G0HDJ sent along an unusual idea for constructing a temporary ground plane antenna. Go to your local tool shop and buy four steel retracting tape measures which can be locked in an extended position. Extend three of them to the same approx quarter wavelength for your band and arrange them in a star shape spaced equally around a central point in the horizontal plane. Make the three ends overlap each other and clamp with a small G type clamp to which you also attach the screen of the antenna coaxial feed cable. The fourth tape measure is similarly extended to a quarter wavelength and held in a vertical position by a suitable 'sky hook' (fishing rod or bamboo pole) attached to the body end of this fourth tape measure. The free end of the extended fourth tape is then attached to the feed coax inner. You will need a little ingenuity to keep this lot in the air! (These 'arms' will have small capacity hats so might need to be slightly shorter than normal.)

I am struck that this concept is much more practical for a high HF band dipole! Two tape measures can be extended equally for the quarter wavelength on the band in use; with their free ends connected to a low impedance feeder. Ideally this would be balanced but if coax is used it can be coiled up just below the tape arms to form a choke balun. The two body ends of the tape measures are then hung between suitable sky hooks. Obviously, a few extra holes and hooks etc will make this much easier to erect! Tim

Upton TCVR



Dan White sent along a photo of his Upton DC TCVR which he acquired un-built from Chris Fleet. The box is made from PCB material and encloses several small kits including multiple low pass TX filters. The design uses a multiband crystal mixing VFO and a doubly balanced strong diode mixer without any receiving RF filters – thus it relies on just the AMU and a strong mixer to avoid BCI! Dan did comment that when originally built, it suffered from many internally generated birdies coming from the digital VFO mixing process. These were cured by extensive use of small coax for most of the sensitive internal RF connections. Unlike the screening of audio circuits where multiple ground loops need to be avoided, in RF circuitry, the screens should be connected to the ground plane at both ends. Originally this design did not have a proper ground plane throughout so it was doubly important to bond together and screen the RF leads to make certain they neither radiated, nor received unwanted signals. G3PCJ