"JOURNAL OF THE CONSTRUCTORS CLUB"

Hot Iron

Summer 2008
Issue 60

Contents

The Walford Electronics web-site is also at www.walfordelectronics.co.uk

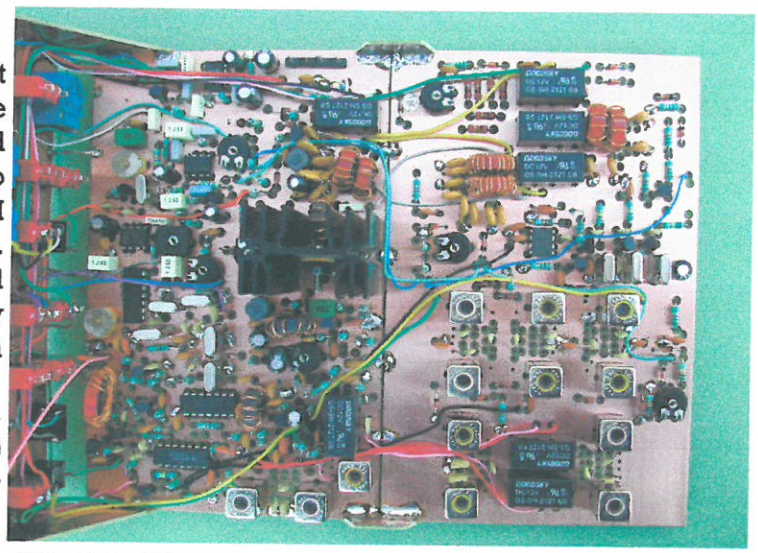
Editorial

We have just spent a week away in Greece with friends where the weather and scenery were magnificent and totally absorbing! Not for a moment did I mull over radio projects much to my wife's surprise and delight! Even the farm was nearly forgotten but arrival back at Bristol airport, where it was as hot as Corfu, brought us back to reality with a bump! While we were away our few ewes had produced most of their lambs, and with a high proportion of triplets too! (Most are growing well now!) The nearest I got to radio was the realisation that the invasion of electronics into practically all aspects of modern life is total. We did a little sailing and notions of taking sun sights etc for navigation are way off in the past - hardly even for emergency use! GPS, VHF comms, weather, WiFI internet and other electronic services reign all around the world. The rate at which these have spread from the familiar HF services of the 1970s is staggering! Even the humble 12 volt battery systems used in modern vessels have to have charge management systems to ensure that engine starting, and the domestic, communication and navigation system batteries get their proper charge in the correct order! Long distance HF communications are hardly used at all except in very remote areas. However the simplicity of much HF QRP equipment still has great appeal - just like the electrics of an Austin 7 car! It is understandable and repairable! Tim G3PCJ

Kit Developments

Again to prove progress since last time, the photo shows my **Minster** with the TX and the extra PCB for the three band version. There is still one minor problem to resolve in the TX but its not far off now! I have also built most of the optional extras. As might be expected, most of these need minor mods but nothing serious! I am pretty confident they will work well with the main rig. More on these aspects later!

Other projects that are well advanced include the Willett DC RX for 20, 40 and 80m; and the Churnside AM TCVR for 6m (and other bands down I hope!). Tim



Hot Iron is a quarterly subscription newsletter for members of the Construction Club. Membership costs £7 per year with the first issue for each year appearing in September. Those people joining later in the year will be sent the earlier issues for that year. Membership is open to all and articles or questions or comments or notes about any aspect of electronics—principally on amateur radio related topics– is very welcome. Notes on member's experience building their own gear, from kits or otherwise is most interesting to other constructors. To keep it interesting, your thoughts and ideas are required please! For membership, I only need your name and address and subscription. Send it or any other suggestions to Tim Walford, Walford Electronics, Upton Bridge Farm, Long Sutton, Langport, Somerset TA10 9NJ © G3PCJ

Whatever happened to the Woodpecker? Part 1 by Richard Booth G0TTL

Tock tock tock it went, for hours at a time. Scanning up and down in frequency over the HF spectrum, this colossal pulsed signal would obliterate most transmissions in its wake. It was soon given the name "woodpecker" and for over 10 years was the subject of many heated debates, complaints and direct electronic action by fed up short wave users. The woodpecker was not choosey in whom it interfered with, be it the Voice of America, radio amateurs, ship to shore telephones and even rather surprisingly overseas broadcasts of Radio Moscow! On an hourly schedule using propagation data the operators would pick the optimum frequency for the woodpecker to rattle at. Our HF bands were a favourite given their relatively quiet signal levels.

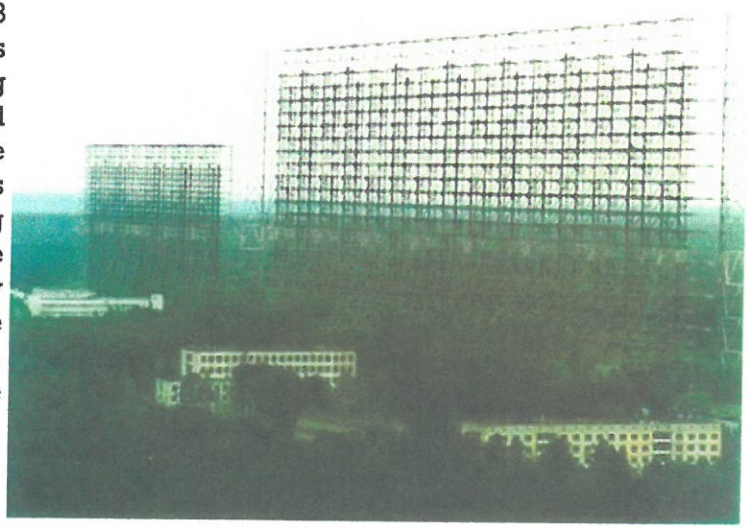
Starting in the early 1970s the Soviet Union were busy building the largest HF antenna arrays in the world, with the intention of being able to detect a missile launch from the USA. Early experimental stations were constructed in Nikolaeyev in the Ukraine. Despite being prototypes the scale of construction was enormous. They were a success and in 1976 the final DUGA-3 over the horizon radar station was put into service (DUGA in Russian means arch). This had two sites in the Ukraine , the receiving array being some 35 miles away from the transmitting site to avoid interference! The CIA chose an apt codename for the DUGA-3 transmitting array "Steel Yard" and when you consider it is 380M high and 900M long, an intricate free standing construction with no guy wires it is an impressive feat of engineering. It weighs an estimated 14,000 tons. The receiving array was much the same. Its no surprise we could hear it!

Now if that isn't staggering enough I need to mention the power levels used. Back then at the height of the cold war the possibility of a nuclear incident was ever apparent. The Soviet engineers speculated that in the event of such the ionosphere would either be severely disrupted or destroyed and in order for DUGA-3 to operate they would need a very high transmit power level. Under normal operation the radar transmitter would run at 15 to 20 MW, that's mega watts - under war conditions assuming the power was available it would run up to 40 MW. Power eh? Then you have to consider the gain of the antenna array. This puts the ERP up at a colossal 180 – 300 MW. Forget your four square on 80 meters; what you want is a DUGA-3!

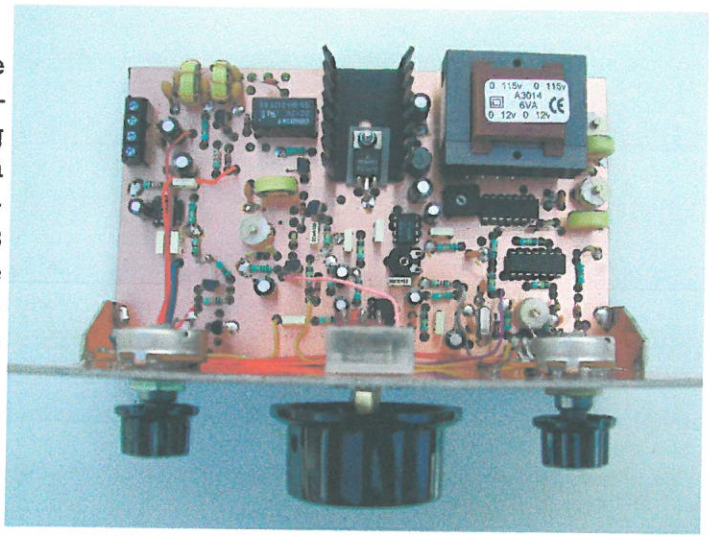
How do you get enough electricity to generate this sort of RF output power? Answer: build your secret radar installation almost next door to a nuclear power plant and have very thick cables. On the 26th of April 1986 the DUGA-3 woodpecker fell silent after 10 years of continuous operation. This date will forever be remembered as the day when reactor 4 of the Chernobyl power station ran out of control following a series of safety failures, causing the reaction chamber to explode and the world's worst nuclear accident to take place. Chernobyl was the main power supply for the woodpecker radar transmitter which was located some 7 miles from the site of the power plant, and within the safety exclusion zone. The woodpecker was resurrected some months later at a much reduced power level when part of Chernobyl was put back into service. However by the end of 1987 DUGA-3 was shut down permanently. A lack of money towards the end of the 1980's and a general move towards satellite detection of missile launch put the final nail in the coffin of brute strength over horizon HF tracking and all the interference it generated.

The last surviving piece of the woodpecker is the large DUGA-3 transmitting array, which despite 22 years of neglect is still intact due mainly to being over engineered in the first place and located in the no go zone. Recently there have been a few intrepid radio amateurs who gained access to the site and strung their own antennas from the top of the construction. The radiation levels are now somewhat safer and there is talk of the whole thing being dismantled for scrap. When the USSR broke up in 1991 the antennas became property of the Ukraine.

Next time - conspiracy theories, and radio amateurs who took on Woody!

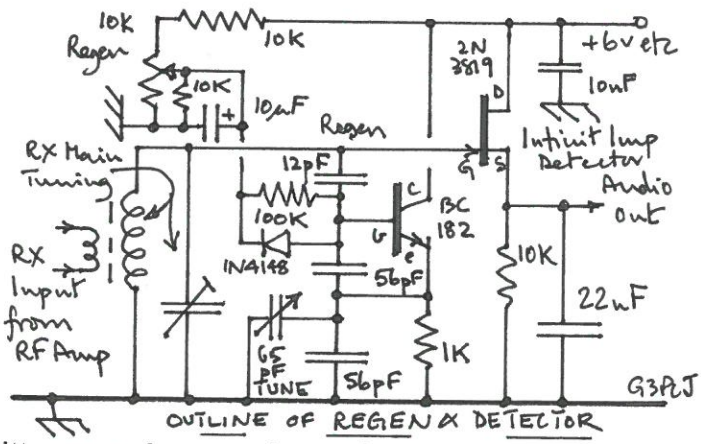


The Chirnside



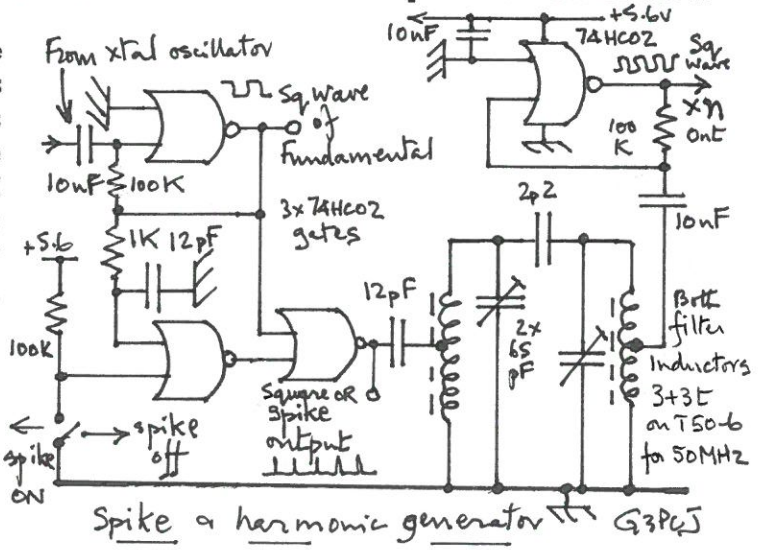
Last time I mentioned my friends wartime bunker and a possible new version of the 17 set – well here is the new 6m **Chirnside** phone AM rig on the right! The RX is a straight regen TRF - not a super-regen. Unfortunately it is not really advisable to do the TCVR with just two active devices like the original 17 set! Anyway, transistors are so cheap that it makes sense to give it better facilities! The RX has a broadband RF amp stage followed by an infinite impedance detector, which in turn is followed by an audio pre-amp, AFG pot and LM380 for deriving a loud speaker.

The regen stage is connected across the single tuned circuit between RF amp and detector. The regen stage is actually connected as an oscillator but with variable bias to control whether it is oscillating or not. I based much of the design on the Knapp HF regen RX but it was soon very obvious that changes in device capacitance with bias were leading to enormous changes in frequency - sufficient to make it unusable! The solution was to change the type of oscillator from Hartley to Colpitts so that the feedback capacitors (of the Colpitts) would swamp the device capacitances - it is now OK for 6m and down but I would not wish to take the principle up to 70 MHz! See circuit right.

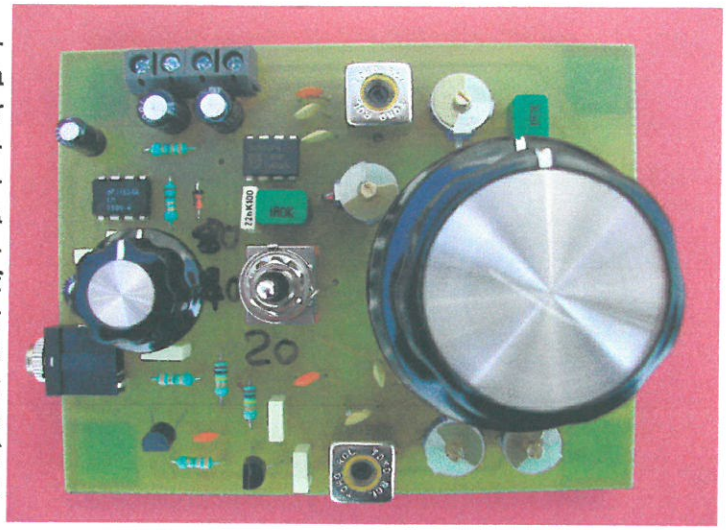


Obtaining adequate stability for the transmitter was always going to be a problem; a frequency mixing scheme would be too complex so it had to be crystal controlled, with a harmonic multiplier. This would be followed by a filter and suitable driving stages for the RD06 MOSFET output stage designed for a 1.5W nominal carrier level on 13.8 volt supplies. Good harmonic filtering is essential on 6m to avoid trouble with domestic Band 2 FM receivers so a double Pi half wave filter is included. Amplitude modulation is achieved with a small 1:2 transformer driven by a second LM380 audio amp, with its own microphone pre-amp and gain preset. Owing to the lack of suitable audio transformers, a small twin winding low voltage mains transformer is the next best alternative. This causes some supply voltage drop and there is also some RF loss in the LPF, so that the actual carrier output level is nearer 1 W on 13.8 volts. The LM380 will achieve about 90 % modulation of this - a transformer with 1:2.5 ratio (10 & 15v windings) would cure this! Of course a higher supply voltage (to 22 volts for short periods!) will enable a carrier nearer 4 W with peaks of 15W or so! Is this still QRP operation?!

I choose to use a readily available (cheap) crystal of 10.24 whose fifth harmonic is 51.2 MHz, with a few KHz tuning range. At this frequency just a small change in capacitance makes it easy to tune to the wrong harmonic! I wished to be able to use any harmonic up to the 5th with other crystals on the lower HF bands - many are suitable! The circuit right is a spike generator that produces only odd harmonics in theory; the spike aspect can be easily turned off for square wave drive which then also includes the even harmonics. A big change in filter output level probably means you are tuning an even harmonic! Tim G3PCJ

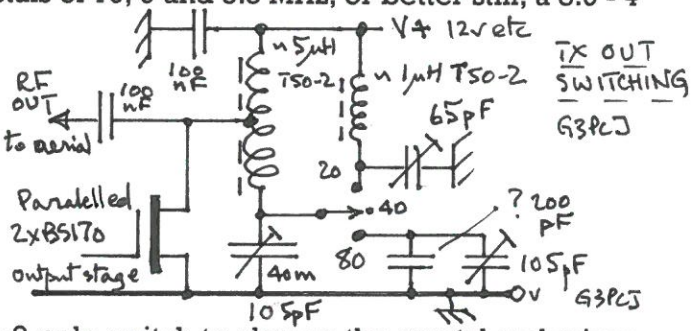


Designing the Washford!

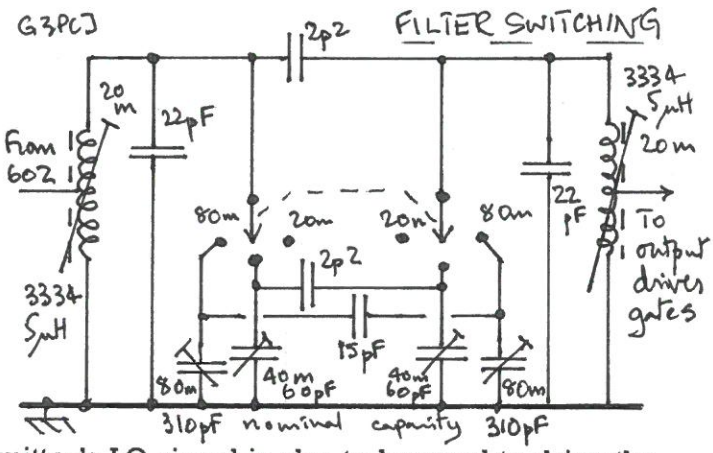


I thought that members might be interested in some of the stages that I go through when hatching a new project - its also another slant on a new rig! Some while back I had decided to do a simple 20, 40 and 80m DC receiver, which has become the **Willett** as shown right. By keeping the tuning and RF filters simple, its possible to use just a two pole centre off toggle as the band switch, with the only other controls being the AF gain and main tuning. The intention was to eventually have a matching simple CW transmitter! I had already given this the name of the **Washford** after the MW TX of that name - both are near the Quantock hills in Somerset. (The Willett is not quite ready yet!)

The need to avoid chirp requires either 'crystal' control or a frequency mixing scheme to avoid the TX output currents getting back into the VFO. Crystal control is cheaper, simpler and easier to set up but is operationally rather limiting, perhaps out of kilter conceptually with a three band rig, and would prohibit transceiver operation. David Proctor G0UTF wants a Mini ABLO for 20, 40 and 80m; this could be a 2 MHz VFO mixed with crystals of 16, 9 and 5.5 MHz, or better still, a 3.9 - 4 MHz VFO with 18,11 & 7.5 MHz xtals. The next topic is the band switching - crystals, mixer filters and TX output filter. Diode switching could be used for the first two but not for the TX filter; but assuming it will be used with a resonant AMU (better harmonic rejection), a single tuned circuit in the TX output might be good enough! This can be done with a single pole centre off switch as shown right for 1.5W Pout.



Although this would allow the other pole of a 2 pole switch to change the crystal and mixer filters, the necessary diode switching would be more complex and need 3 separate conventional double tuned filters. Using 2 poles of a 4p 3W rotary (as shown below) would reduce the parts count/cost and still leave another pole to select the crystals in a Colpitts oscillator! The rest of the LO mixer would be a conventional 602 mixer fed from a regulated 5 volt supply - this being required for the output stage driving logic gate which makes keying of the RF very easy on its way to a pair of BS170 MOSFETs in the output stage. The VFO which provides the other mixer input, could be conventional LC oscillator using a 2N3819, or based on a ceramic resonator. Due to the low frequency stability would be good!.



Although not essential, relay operated semi break-in TR control is easily provided and makes life so much easier with the RX! If the transmitter's LO signal is also to be used to drive the RX, with much improved frequency stability and less hand effects, then RIT will be needed - this can be easily removed during transmission with the spare contact of the TR relay. The last major uncertainty is the physical format! Should it be all flat like the Willet above or provided with a small front panel to take the rotary band-switch and a PolyVaricon? I am unsure at present! Flat would be slightly cheaper as the whole might just fit onto a smaller 80 x 100 mm PCB. One also has to keep an eye on probable costs during the design process, but this feels like a £50ish project which is the sort of figure I had hoped to achieve. The simplifications that could be made would detract appreciably from its convenience; I also think that a complete 3 band rig like this will sell better than the separate rock bound TX and Mini ABLO! Watch out for more news next time! Tim G3PCJ

The G4DCH 80m Mobile Antenna by Chris Tucker

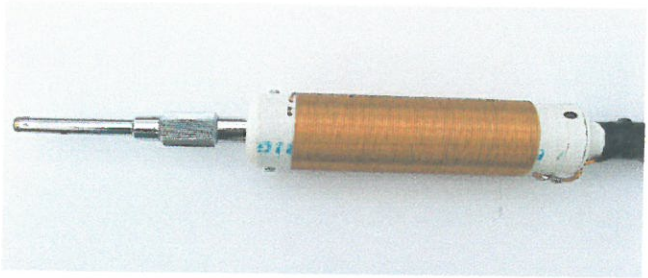
All my antennas are built from readily available components using very simple tools, and have only cost a few pounds. My first effort with a base loaded whip was not successful so I changed to a base matching coil, a short helical section, a centre loading coil and top whip section.

The matching coil is 20 turns of 20swg enamelled wire spaced 2 mm apart between turns, wound on a 42mm OD PVC water pipe. The coil is tapped at 10 turns for 50 R feed point. The bottom of the coil is attached to the vehicle mounting metalwork - I used an old SO 239 (Male) connector, potted into the tube. A wire is attached from the 50 R feeder to the coil tap. By using a 37mm to 13mm pipe adaptor, the middle section can be fitted into the bottom section. The helical section is a 13mm OD plastic overflow tube 940mm long with a helical winding of 14swg enamelled copper wire wound up the tube with 33mm spacing between each turn. This is soldered to the base matching section.

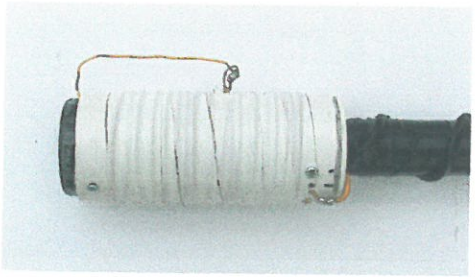
The centre loading coil attaches to the helical section using another 13mm to 37mm pipe adaptor. The coil of 80 turns 20swg is close wound on 42mm OD PVC water pipe, about 200mm long. The top of the coil is attached to the whip using a ferrule and screw arrangement. The top part of the antenna is a standard 1.3m stainless steel whip. I used an old 3/8 2m whip, but stainless steel sections can be picked up from rallies quite cheaply. This will need adjusting to bring the antenna to the frequency area desired.

One piece of essential equipment is the MFJ 259 Antenna analyser – borrow one if necessary to do the tuning. This must be carried out on the vehicle with all the necessary earth bonding wires in place as these will all affect the resonant point. Check the resonant frequency of the plain antenna which needs to be about 4MHz. If it is low e.g. 3.2MHz, then take a few turns off the centre loading coil. Now construct an X shaped capacity hat about 150mm across from two pieces of 16swg tinned copper wire and fix this about 2/3 of the way up the 1.3m whip. This should bring the resonant frequency down to near 3.5MHz. Carefully trim each arm of the capacity hat until the desired operating frequency is reached e.g.3.66MHz. Minor matching adjustments can be made with a suitable ATU – mine covers 3.6 to 3.79MHz using an MFJ mobile ATU.

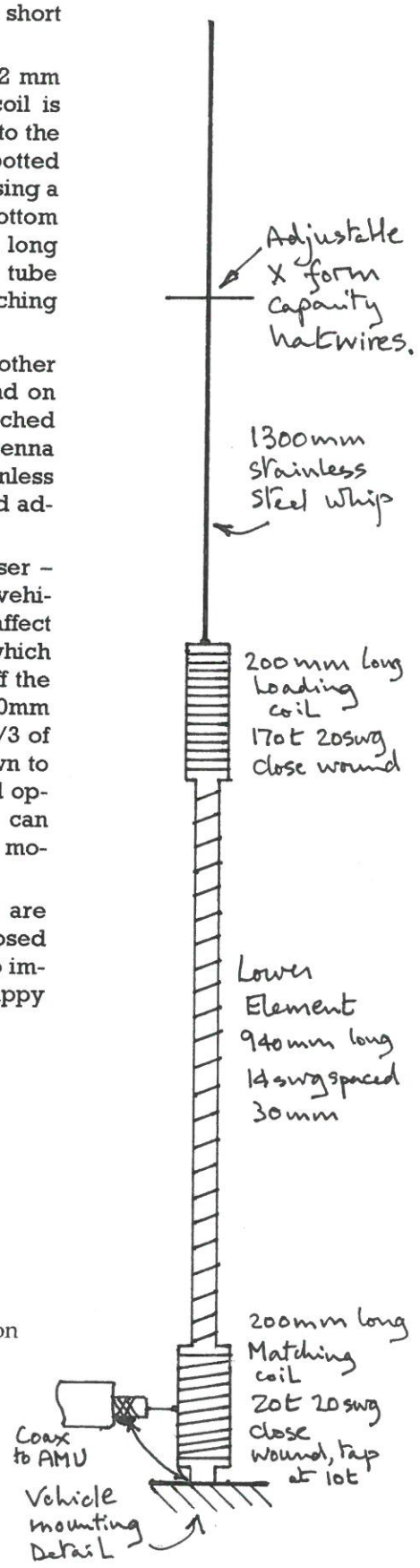
Finally check all the sections are well soldered, that the pipes are glued together and any other fixtures are well secured. Cover the exposed sections of the coils in PVC tape and spray a clear lacquer over the coils to improve the waterproofing. Then your antenna should be complete and happy DXing. Hear you on the band /mobile.



Middle loading section



Base matching coil and tap point



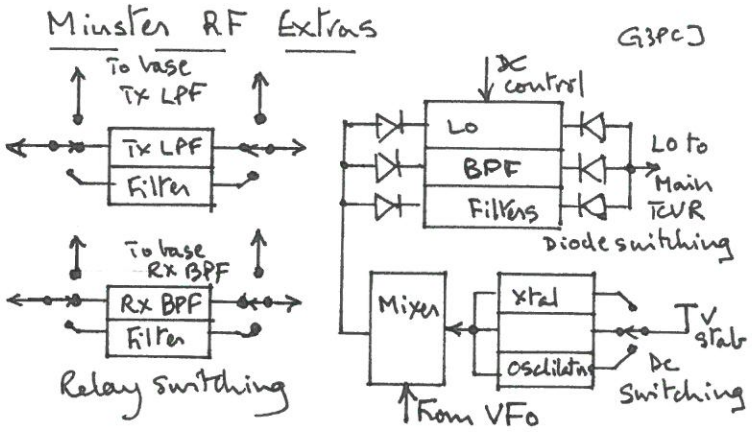
The Minster's Optional Extras

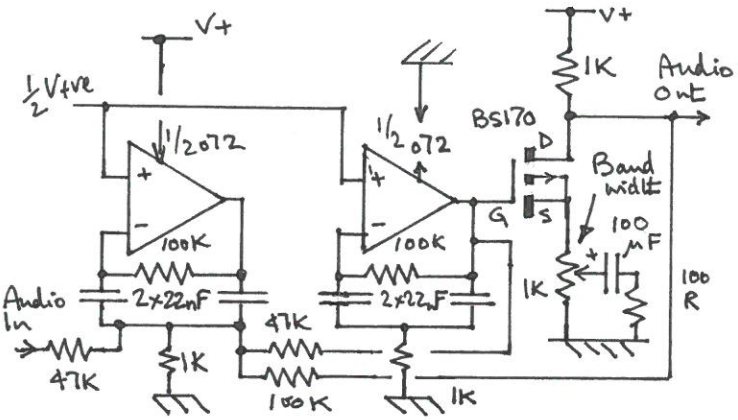
The main rig is a 5W phone TCVR on a double sided 100 x 160 PCB, for any band 20 to 160m with direct injection VFO. It works with any of these! (There is also a new Speech Processor!)

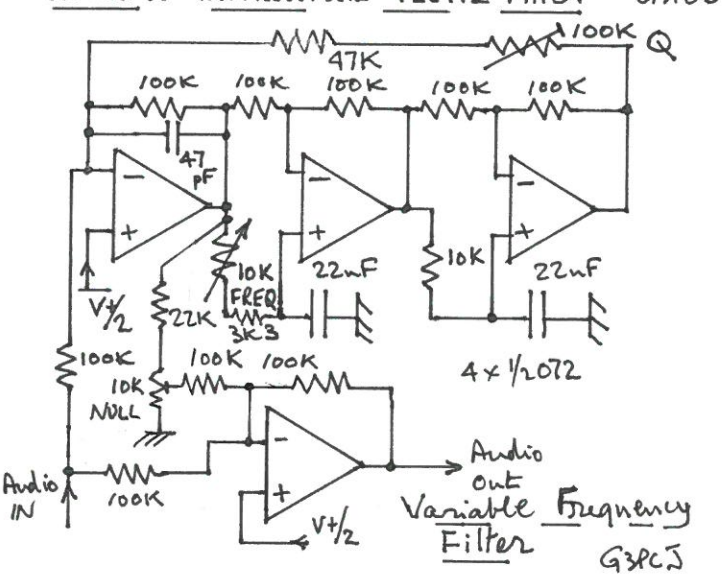
RF Extras This is a 100 x 160 double sided PCB which adds two more bands to the Minster, which, because the rig is also converted to a LO crystal mixing scheme with a common VFO range for all three bands, can be any band up to 10m. Relays are used for the TX LPF and RF BPF band switching due to the excessive losses that would occur with diodes; however diodes are used for the LO BPF switching and the crystal oscillators have their supply switched. A resistive matching bridge drives a LED or external Pout meter. See photo of it with main PCB on Page 1!

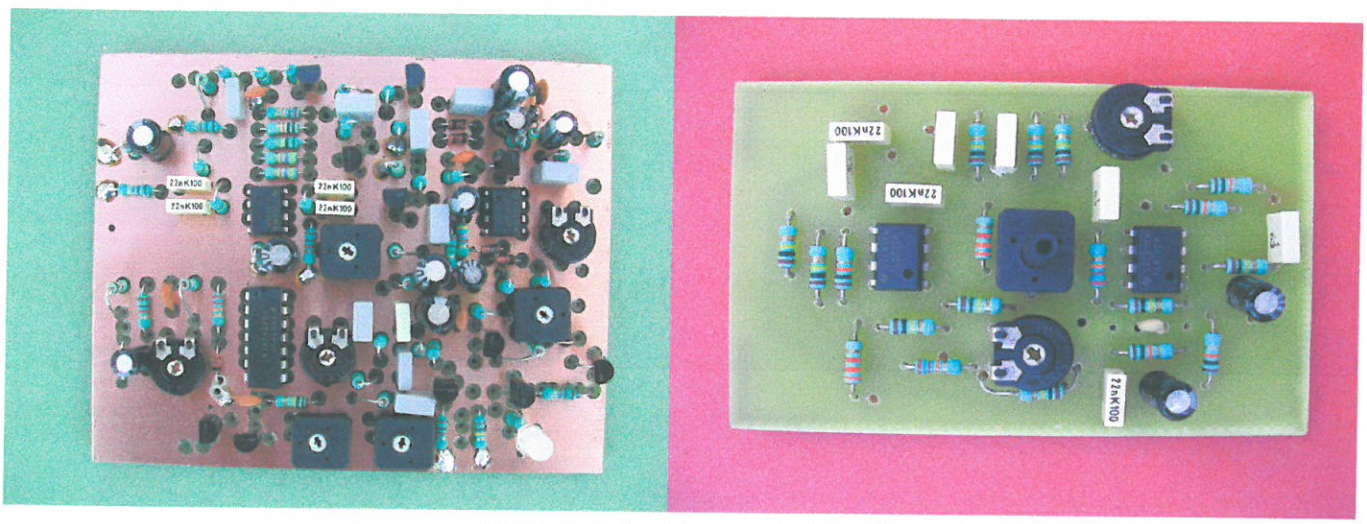
Audio Extras This is a 80 x 100 double sided board (left below) that's adds CW facilities and audio derived Automatic Gain Control. There are two RX audio filters, one to help with SSB under difficult conditions; the other is a *variable bandwidth* bandpass filter centred on 725 Hz for CW, see part circuit right. The selected filter feeds the AGC circuit which also drives a bi-colour LED or external S meter. Semi break in TR control is provided for CW with an adjustable frequency sidetone. Most of the presets can be changed to pots if desired. The kit can be used with other rigs.

Notch Filter This is a single sided 80 x 50 PCB (right below) and provides a *variable frequency* filter that can provide a notch for removing a carrier etc, or a peak to help with CW, or be straight through. Again the kit is intended for general use and the frequency preset can be changed to a front panel *single gang* pot. (NB Most notch filters need two gang pots!) There are three frequency ranges covering 300 to 3000 Hz. The sharpness of the notch is adjustable but since it affects the gain, there has to be a gain preset, so they are not normally altered once set for best notch rejection. The release of these kits is imminent!









Fault finding

This is the approach that I use when faced with what has been a working rig (not mains powered). The first thing is to give it a thorough visual examination with the power off - look for obvious mechanical damage - broken inner leads of coaxes, and other wires broken or grounding when they shouldn't etc. Then get hold of the circuit and block diagrams to give you as much information as possible on how the thing should work. Next connect up the output circuits (RF into dummy load or a load speaker), and then try and produce some sort of output (use signal source or PTT/key as required). If nothing, gently tap around with an insulated tool - you may hear rasping or scratchy noises or even microphony - in which case tap more carefully in the most sensitive area till you can identify the offending part and hunt for a poor solder joint etc! Microphony (from ceramic caps) is not always bad news because it may actually be confirming that the low level audio stages are working. If it's a receiver, you can try doing the screwdriver hum test into low level audio stages or the AFG pot. If that works, its quite likely the problem is earlier in the signal path.

After these simple tests, one needs some test gear! At least check that any internal regulated supply voltages are what they ought to be. (And I have already assumed that the rig supply current is not excessive!) Perhaps the next most easy thing is to check is that any oscillators are actually running and at their intended frequency. Use a counter or scope if available and always with a divide by 10 probe on its input (unless you have reason to believe that the counter is either insensitive or the oscillator signal is very small); if neither of these is to hand drape the aerial of a general coverage receiver over the rig and search for a strong carrier - then check you are actually listening to the problem rig by turning it off etc!

After this, things get appreciably harder but the general principle remains the same; apply some suitable signal source at its input (generally low level audio or RF) and observe the output. Check the control circuits do what they are supposed to do - like put it into transmit when the key is pressed or the PTT switch closed. Listen for relays which should be clicking on/off! If there is any output signal, its nature (voltage, frequency, modulation etc) should give a clue as to what is not happening! If nothing then try to monitor the signal roughly half way along the signal path - if it is present half way, then the first half is working, if not the fault is in that section; again try and divide the faulty section in two until the offending stage is found. If the rig has worked before, then the most likely failure is a semiconductor device - blistered or even shattered maybe! Also look for obviously cooked resistors or other parts! Generally speaking it is distinctly unwise to attempt any frequency realignment until it is working again - most modern rigs do not loose their alignment! Ditto for bias levels generally, but twiddling bias presets (of RF output stages) cautiously while monitoring supply current will tell you if the controlled device is passing DC in the expected manner. Some chips exhibit strange DC levels if they are blown - look for equal voltages (when working correctly) on pins 1 and 2 near 1.25 v for 602 mixers, and also usually pins 4 and 5 equal at about a volt below the supply (but beware this is not always so depending on the circuits attached to the 602 outputs). 4066 switches should exhibit the same DC voltages on the pairs of contacts that are supposed to be on. Logic chips can usually be tested by measuring their in and out voltages and deciding if they are 'logical'! I have skimped a little about what you use to go 'looking for' a signal - the ideal is a scope with divide by 10 probe to avoid capacitive loading of the circuit being investigated. Much can be done with a general coverage receiver and multi-meters, simple signal sources or dip oscillators etc. Scopes are a really good investment, their new price is actually going down and I would much prefer to spend about £190 on a brand new two channel 20 MHz scope than the same amount on a rig! Two Y channels are handy but certainly not essential. Often they can be found at rallies for appreciably less or in the catalogues of second hand dealers. After this I would buy a new modern counter and then the rig of my dreams!

Regens and Super-regens!

Often these two sorts of receivers get confused! Both have an RF stage that is made to 'oscillate' in a controlled manner which will generally improve the Q of the associated tuned circuit and increase sensitivity. In a plain regen, the strength of the oscillation is constant - either not quite or just weakly and usually under operator control. In a super-regen, the oscillatory circuit is made to go in and out of oscillation continuously - this gives it high gain but without the increase in effective Q. Usually the rate at which it goes in and out of oscillation is supersonic - around a hundred KHz, so that it cannot be heard. It was often used for VHF sets - eg the 17 set. Tim G3PCJ

Subscriptions!

I am afraid its that time of year again! If you wish to continue receiving Hot Iron, let me have your cheque for £7 before Sept 1st for the next issue.

Send off your cheques now!

News

I only had one response about a possible electronic form of newsletter. If anyone else is interested and not told me - please let me know.

I have recently opened a Paypal account which is another option for paying for items; purchasers can use their own credit card without them being processed by the trader - me or anybody else.

I still have a few DDS chips surplus to my needs - contact me if of any interest. Free to a deserving home! Tim

Fourth Somerset Supper!

Several Construction Club members were present for the fourth ***Somerset Supper*** held on the eve of the 24th Yeovil QRP 2008 Convention. As ever, there was a wide range of home made electronic projects, exhibited by diners for the informal display and competition. Seventeen items were exhibited ranging from a crystal set, highly adapted kits, whip antennas to complete original design for amplifiers and transceivers. There were also several interesting exhibits from the ladies, of their non-radio hobbies! Construction Club member Stewart Hunt (over from France) very kindly provided the wine!

The judge was Stef Niewiadomski who writes regularly about his electronic projects in Practical Wireless. The range of items on display was so diverse that he found it difficult to compare one item with another! Apart from the obvious electronic content, he also commented on the high standard of mechanical workmanship. He awarded first prize to Steve Hartley G0FUW (left) who exhibited his TCF40 SSB transceiver, which was based on a design by Drew Diamond VK3XU, but using ex-TV crystals for the filters. The 5W output stage uses an IRF510 MOSFET – the whole thing having been configured into a 'shoebox' style case! Other prizes were awarded to Richard Booth G0TTL, Jim Gailer G3RTD and Chris Rees GU3TUX

Make a note in your diaries now!

The 25th QRP Convention will be on April 26th 2008, and the fifth Somerset Supper on April 25th when it is hoped that Rev George Dobbs G3RJV will be the guest of honour.