"JOURNAL OF THE CONSTRUCTORS CLUB"

# Hot Iron

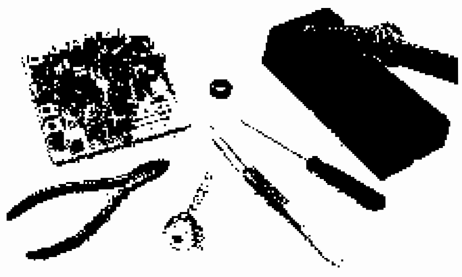
Winter 2005
Issue 50

## Contents



The Walford Electronics website is also at www.walfordelectronics.co.uk

## *Editorial*



Re-reading the last Hot Iron, I see that my mind was in neutral due to the heat; this time is the opposite extreme! Its been below freezing for several days at night and often not thawed out fully out of the sun by day. Blizzards were forecast for last night but it only started snowing just as I left the house this morning to feed the cattle and sheep! Two hours later and the sun is out with a lovely bright day.

Over the years, we have been plagued by 50 Hz mains failures for all sorts of reasons ranging from lightening strikes to collisions by swans on the overhead 11 kV supply lines, so with the warnings about supply shortages, I have invested in standby alternatives. Two days ago, the local 11 kV transformer burnt out a winding so I felt rather pleased when I was able to change to the back up to keep the gas powered/electrically controlled AGA cooker going! Being an old farmhouse and difficult to lag properly, it looses heat pretty quickly so an alternative is rather important. See later for details - but I have to warn that this was not cheap and was partly an interesting experiment! Tim Walford

## *Kit Developments*

Last time I mentioned the new 'K' family! The Kilve RX is available now and will be featured in the Jan 2006 PW, with articles on the DSB phone TX, and how to link them up for transceiver operation later in the year. I have begun thinking about the replacement for the Bristol, which I had to withdraw due to the relay manufacturer ceasing production of the right model. The current idea is for a base CW and SSB phone 5W rig; which would do any single band to 20m with a direct injecting VFO. Then an 'extras' unit could be added to provide two more bands and a crystal mixing scheme for the LO so that it would become an any three band rig up to 10m, with AGC and other accessories like a variable bandwidth CW filter.

In the meanwhile, I have replaced the signal source kit with a new and more capable harmonic marker kit, re-introduced the two tone audio oscillator (both £15 + £2 P and P), laid out a relay selected twin RF bandpass filter unit, laid out a new RF signal generator/twin band VFO, and started on a small static inverter unit. That lot all needs writing up, testing etc., as well as an update to the website!! Looks like a busy run up to Christmas. **Merry Christmas** to you all and may Santa do everything that he is rumoured to do! Tim G3PCJ

*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

## ***The Top Loop*** by Richard Booth G0TTL

For some time now I've been using "magnetic" loop antennas with excellent results on the HF bands. Considering the size of the driven element and the fact that they work well at only a few meters above the ground I've found them to be very useful. Until recently though I've not tried anything on 160M and having an urge to try something different I decided to have a go at building this loop. Conventional magnetic loops use a single turn as the radiator, however at this frequency you would need to make the loop at least 3 meters in diameter, and use a large 1000pF plus tuning capacitor to make it efficient. As you can imagine mechanically things start to get complicated with something of this size and keeping the whole structure upright and in shape would be a challenge. This loop differs in that it is made from 4 complete turns in a coil wound at diameter of just 170cm. It covers the whole 160M band with a very high Q factor which means you need to adjust the variable capacitor to resonance every time you change operating frequency - the bonus here though is that the antenna acts as a band pass filter and gives a tremendous reduction in out of band noise. It is also somewhat directional which gives a useful null that's handy for cutting out local interference sources - a common problem on 160M.

Construction is fairly straightforward. Good quality solder joints are required as the goal is to keep the resistance of the loop as low as possible. You'll need a decent quality tuning capacitor which will go up to 125pF. A standard air spaced broadcast type is OK for power levels up to 10W - above this you need to use a higher voltage component, for instance at 50W the RF voltage across the plates is about 2000V. A cheap solution is to dismantle a 500pF capacitor from an old valve radio and reassemble it with the plates well spaced out. This will bring the total capacitance down, and put the working voltage up. I can help with this!

The main loop is made from "thick" type coaxial cable. If you can get the semi rigid kind that's even better as it will be easier to keep the loop uniform. You need a single length 21.5 meters long to wind it. First of all strip an inch off either end and solder the inner and outer conductors together to make one single conductor. You'll need to make some kind of cross shaped timber or fibre glass frame to support the loop. Each arm of the frame should have a right angled front facing piece at the outer edge to support the separate turns of the coil. You can use a metallic pole for the vertical support but it is essential that this is truly vertical and passes through the centre point of the loop. Wind four turns onto your frame, starting at the bottom end next to one side of the tuning capacitor. Remember to leave enough to make the connection to the capacitor! Fix the cable at each leg, leave a space between each turn equal to the thickness of coax used. Try to keep the loop as circular as possible, but don't worry if it droops a little between the supports. Solder each free end to either side of the tuning capacitor.

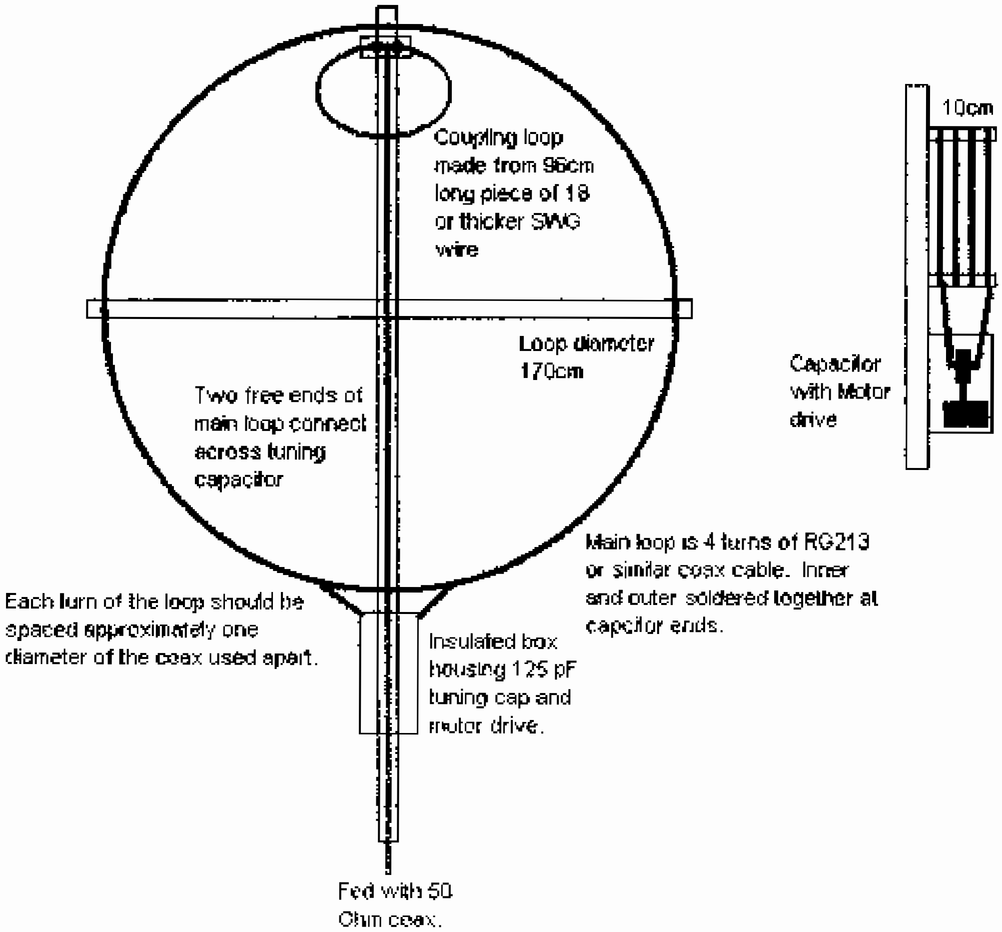
The tuning capacitor really needs to be motorised. I used one of the gearbox reduction types available from Maplin for my prototype and connected through a further 6:1 Jackson type reduction drive to the capacitor. This works reasonably well but does generate a fair bit of interference when making adjustments. Some people might find that useful - when the noise is loudest you should in theory be tuned to resonance! Mount everything in a weatherproof box. A cheapo lunchbox from Tesco and a few blobs of silicone sealant does the trick.

The coupling loop is made from 16 or thicker SWG wire. I used stripped down 30A twin and earth ring main cable. Leave the insulation on. For this you need a piece 96cm long. Bend this into a loop. Each free end connects to either side of the feeder coax. I suggest mounting the two ends of the loop into a plastic box, fit a SO239 socket in the base and then solder the two free ends to the socket. If you drill some holes for a U bolt in the back of the box you can clamp it in place at the top of the main loop (see diagram). The feeder should run vertically down the centre support and away from the antenna. When testing the antenna you may need to slightly alter the shape or location of the coupling loop to achieve the best SWR. I've found that a squashed almost oval shaped coupling often gives the best results. My prototype loop has an SWR of 1:1.4 and a useable bandwidth of about 4KHz before retuning is required. Just enough for a QSO!

(Richard has done such an excellent diagram that I have to repeat it on the next page untouched by my pen! Tim)

The Top Loop continued

If you do have a go at building the Top Loop I'd be happy to hear from you. I'm QTHR or you can email me at richard@pasttimesradio.co.uk Richard Booth, G0TTL




## Antenna Snippets

As a comment, Richard's design above is very similar to my 'heating radiator' loop! That uses 15 mm malleable copper pipe instead of heavy gauge coax, formed into a multi-turn square of side about 0.5 metre. I have always felt that input coupling through a small loop would be a bit less efficient that direct connection of the driving rig so I used a gamma match approach – in effect a tap a small part round the loop from an 'earthy' point. This can have the disadvantage of unbalancing the loop and might also degrade the Q, which in Richards case is very high indeed to achieve such a small bandwidth! I also found out the hard way that using one turn of rubber covered multi-core mains cable (with the cores connected into a multi-turn loop) is no good whatever! It has far too much self capacity between cores so that hardly any external tuning capacity is needed! It was also very lossy! Forget that approach!!

Last time I was unsure who had designed the E P Antenna that Dave Buddery had sent in. I now know that it was Dave himself! Well done.

I also see a correspondence item in Radcom about Windom antennas; there had been an article about what was supposed to be a Windom but the authors opinion was otherwise. Its is really surprising how often new ideas for antennas turn out to have been invented in about 1920!

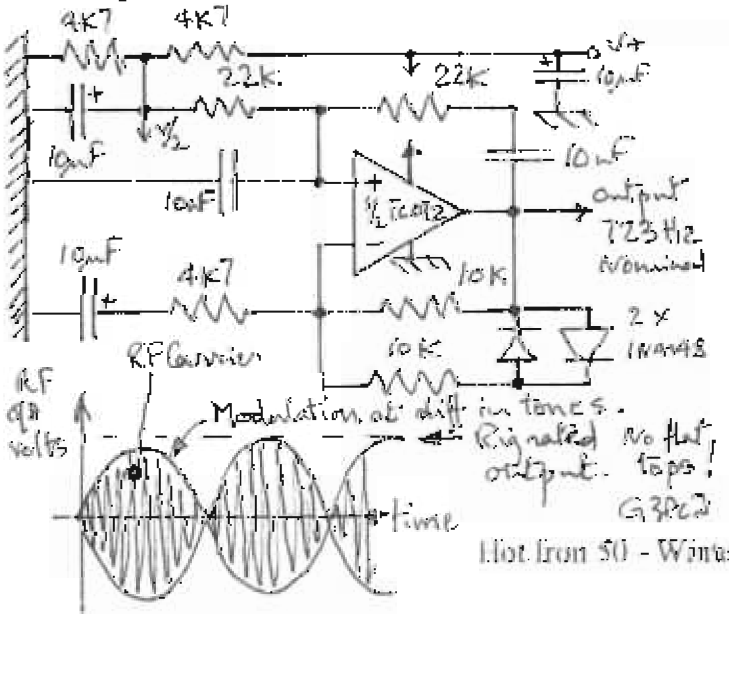
Its hardly an antenna snippet, but I must also report that my good friend and antenna advisor, Eric Godfrey G3GC, has been in hospital for some weeks following a fall. I am pleased to report that he is getting better and was even talking recently about laptops for writing articles in Hot Iron etc!! We all wish you a speedy recovery Eric. Tim G3PCJ

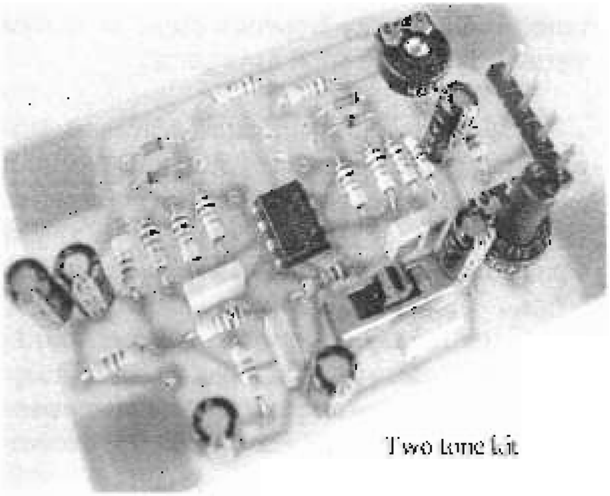
## ***Two Tone Oscillators and setting up a phone rig***

Setting up a phone SSB (or DSB) transmitter should ideally be done with an audio signal source that is based on two equal amplitude audio tones. This sort of transmitter has to have linear RF stages so that the amplitude modulation inherent in the modulation process is maintained all through the transmitter. This is not required when ordinary amplitude modulation is applied to the final stage of a CW transmitter. The SSB (or DSB) transmitter stages should be adjusted so that none of them are limiting on speech peaks. If a stage does 'limit' in either direction, unwanted extra harmonics of the audio are produced which appear as rubbish modulation for a few KHz on both sides of the nominal carrier frequency. Limiting of a particular stage can be due to insufficient signal handling ability in either direction; in a negative sense the output voltage can get too close to 0 volts or to the 'hard on' device output voltage - an effect sometimes known as 'bottoming'. In a positive sense, there maybe insufficient voltage excursion range between the normal device output and the supply rail. When the load or DC feed path is inductive, the signal excursion can exceed the supply voltage so the causes are not always obvious! However the appearance on a scope of this sort of poor signal, is always a flat top and or bottom of the signal at its maximum excursions. Using a modulating signal consisting of two individual tones makes it much easier to observe these defects.

Each of the tones in a Two Tone source should be within the normal audio passband and not harmonically related. The signal from each tone should be sinusoidal and they are added together before input at low level to the rig under test. Generating sinusoidal tones is not as easy as it might seem - especially if a wide adjustable frequency range is needed - thankfully not needed in this application! Standard value capacitors and resistors can be used for nominal frequencies of 723 Hz and near 1590 Hz, with a circuit using a frequency selective feedback network based on the Wien Bridge. The easiest way to control the amplitude of each audio tone is with silicon diodes in the op-amp negative input feedback network. The sketch below shows the circuit for the 723 Hz oscillator. The Two Tone kit (photo - £15 + £2) has two oscillators with a control switch so that each maybe used on its own as a signal source. They are added and output at low level for the rig's mike input.

The transmitter is connected to a dummy load with RF output being monitored on a scope. When correctly adjusted, the picture should look like that below, where the RF envelope is amplitude modulated by a sinewave whose frequency is actually the difference in frequency of the two tones. Note this is NOT the ordinary appearance for amplitude modulation - with no audio input the SSB RF output is also zero and there is a sharp cross-over at 0 volts of the modulating envelope. The procedure is to first make certain that the later stages are not causing a flat top or bottom of the output envelope, due to problems in any stage after the one being adjusted. This is generally done by reducing the RF output to a fraction of its rated figure. The gain or drive level in the earlier stages is increased until a flat top/bottom appears and then eased back a little. This is repeated for the next gain adjustment control(s) until flat topping is just avoided in the output stage. This sounds complicated but is actually quite easy when you have tried it once! The peaks the envelope now should correspond to the rig's rated output. If either tone is now turned off, the plain carrier level due to the remaining steady tone should be half the rig's rated output. It is possible to get near the optimum settings with a single tone, but using two makes it much easier. It will be necessary to adjust the mike gain control for the real mike to produce equivalent levels to the 2 Tone source. Tim



Two tone kit

## ***Retirement to Alderney*** by Chris Rees GU3TUX

Since packing up business last year and our subsequent move to this diminutive island in May, I've had a whole new series of problems to overcome in pursuing my interest in amateur radio. Not least amongst these problems has been a lack of interest! I guess that having had radio as a business has, for me, rather taken the shine off it as a hobby and the progress of technology has taken much of the excitement away as global communication is now cheaply available to the masses. I'm still interested in communication but, like the youngsters, using today's technology in the form of the Internet and its mobile interfaces.

I've redefined amateur radio as a 'heritage activity' – a means of keeping old skills alive. Indeed, I'm convinced that this is the only way to ensure that the hobby survives in the long term, rather like the groups in Oz and the USA who keep the land line telegraph accessible. This new definition means that I shall really only obtain any mileage from the hobby by using homebrew equipment (and QRP CW to boot!). I've brought down here crates of components, kits, aerial materials and just about everything I shall ever need but, for the time being, my shack is limited to a small bureau-like piece of furniture in the corner of the bedroom. We've moved to a small bungalow which has space and potential for expansion, so I'm hoping for a custom built shack later.

Due to the strength of the winds, Alderney is not well endowed with tall trees and I'm deprived of any natural aerial supports. Our corner plot is exposed to the public gaze so the strict planning regulations mean it is unlikely I'd obtain permission for masts, although I might get away with a flagpole and an inverted V disguised as guy wires. At the moment I have dipoles for 20 and 40m in the loft on a single coaxial feeder which I strap at the base end to load on the other bands.

The rig pictured is an FT817 supported by an Elecraft T1 auto ATU which I built within the confines of the bureau flap. My keyer is also a kit – the TiCK4 which offers a couple of memories and my preferred mode A keying. The other accessory is a simple RX audio filter, adapted from a design by G4BJM in 'Radcom'. This has a LPF to cut down the hiss from the 817's AF stage and a gentle peak for CW operation. I must mention the loudspeaker – it is a MFJ281. Not only is it incredibly sensitive but it also has a noticeable response peak at around 700 Hz. It must represent very good value for money, especially for the CW operator.

I don't have any VHF/UHF aerials in the loft – yet. Past experience suggests that quads are relatively unaffected by adjacent objects and a likely candidate for another home-brewing exercise. Indoor aerials have a number of advantages; they're discreet, they don't have to be wind and rain proofed and - usually - they're easy to install and adjust. Radio lore says that the roof tiles account for a loss of 6 dB versus an outdoor slung equivalent, but this can be a fair price to pay. If you're thinking of trying a nest of dipoles on common feeder, start by pruning the highest frequency aerial first and the LF one last.

I do monitor the VHF/UHF channels on a QRP handheld, the little Yaesu VX1R. The local airport and harbour frequencies provide no little entertainment, especially in dirty weather. The island has relatively sophisticated communications for its size. We talk to the outside world via microwave link to Guernsey. This includes 1 Mb broadband access for private subscribers. A communication profile of Alderney could be the subject for a future article.

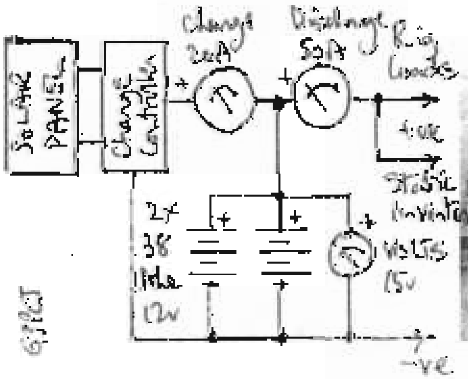
Finally, with our locally generated electricity currently costing 17p per kWh unit, QRP is a definite advantage and I'm planning to use solar power for the station in the New Year.

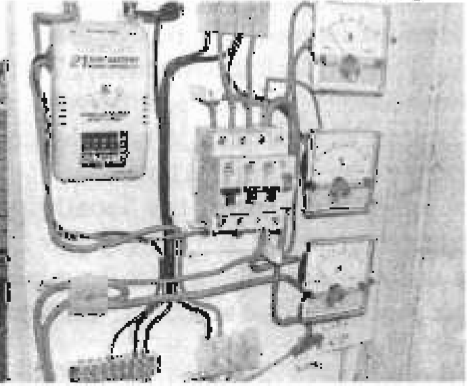
## ***Standby Supplies***

There are several important questions that have to be answered before one can design an alternative to the normal 50 Hz mains. Perhaps the first is to decide what loads one needs to cater for, measured in Watts; bearing in mind that not all need be supplied at the same time. Its also important to distinguish between running consumption and start up consumption. (In the case of many electric motor powered items such as fridges and freezers, the starting load maybe many times the running load and also highly inductive so these are best avoided if possible. Interestingly, central heating pumps do not seem to be a problem - perhaps because they are not genuine induction motors.) My primary concern was to keep a gas powered cooker supplied for its fan and electrically controlled gas valve, with a secondary objective of running the central heating - again gas powered but with electric controls and three pumps. The load of the cooker is about 25W, the central heating controls and boiler about the same and each of the three pumps about 75W. So I was considering a normal load of around 100W rising to perhaps 300W if all were on at the same time.

There is no need for these to have un-interruptible 50 Hz provided by a continuously running inverter. (Computers are very different as they should be turned off in an orderly manner.) The cooling time constant of all these heating loads are of the order of an hour so, giving plenty of time to reconnect to the standby source using ordinary 13A plugs and sockets! I reckoned that having to power all for more than a few hours was unlikely but I might conceivably need 24 hours at the lower 100W level. I wanted 12v lead acid batteries for storage so that I could also run the electronics bench from them. The inverter load of 100W would imply a 12v DC of around 10A allowing for small inverter losses. This suggest that batteries with 240 Amp-hr capability should be provided. That's a lot of battery, especially as the deep cyclic discharge type are advised for this application (not car or tractor types); they are comparatively expensive so I opted for two 38 Ahr ones connected in parallel. I chose a 600 W 12v DC to 240v 50 Hz inverter as there might be uses for it around the farm to power hand tools etc. (As an aside, most commercial static inverters now produce a modified sinewave output that is neither truly sinusoidal nor a square wave - these have a lower harmonic output and are suitable for most domestic loads. They work by producing high frequency AC (to reduce the transformer size) which is then rectified to produce plus/minus 350v DC, which is then chopped for 240v 50 Hz output.) When put to the test recently due to a burnt out local 11 kV substation transformer, the inverter input current was 5A when powering only the cooking stove - fine for at least 16 hours. Beyond that, I can use a 5 kW diesel engine powered generator!

The battery bank is charged from a barn mounted solar panel. This was more convenient (lower) than the house roof and also pointed in the optimum direction but was distant so relatively heavy cables were prudent to minimise IR losses. Again cost dictated the panel size! A nominal 100W panel is about 2 ft by 6 ft and it attempts to charge even in the weak morning frosty sunlight. At midday in bright winter sun it is producing 4 Amps - half its nominal rated output. Depending on cloud cover etc, it will take some days to recharge the batteries when totally discharged but for powering the electronics bench, it is more than enough. A charge controller is used to prevent overcharging. Because this installation was 'experimental' I over egged the panel meters and added MCB trips to protect against the lengthy cables being damaged. The outline circuit is shown below - plus pic! Don't ask what it all cost! The trickiest practical bit is installing the solar panel on a slated or tiled roof. The supplied stainless steel brackets were an unsuitable shape, so flattened 22 mm copper tube was used, suitably solder tinned to avoid corrosion where it touches the aluminium panel frame - as advised by Andy Howgate. The brackets need securing to the roofing battens so they protrude through the roof covering. The metal work was then covered in Waxoyl. G3PCJ



## ***Theory - CR Coupling circuits***

These sums are probably the most often used ones that an analogue circuit designer will require. They relate the size of input and output coupling components to the bandwidth of signals that they will pass.

The top circuit is said to be a high pass coupling network because it will not pass DC and yet, the higher the frequency, the less the attenuation there will be. In between those extremes, the response changes markedly when the reactance of the capacitor is near the value of the resistance. The capacitor might be the input coupling capacitor of an amplifier (to prevent the external circuits altering the device bias conditions), and the resistor might be an actual resistor or, more likely, the parallel combination of the bias resistors and device input impedance. Consider the response for sinusoidal input signals. The C and R form an attenuator, and making the simplifying assumption that the driving device has a negligibly low output impedance and also that the following circuit (amplifier or whatever) has a very high impedance, it is easy to work out the output voltage in terms of the impedance Z of the capacitor:-

$$V_{OUT} = V_{IN} \times \frac{R}{R+Z}$$

From an earlier note on capacitive reactance, you will recall that:-

$$Z = X_C = \frac{1}{2\pi f C}$$

Substituting this into first formula gives the output level in terms of frequency:-

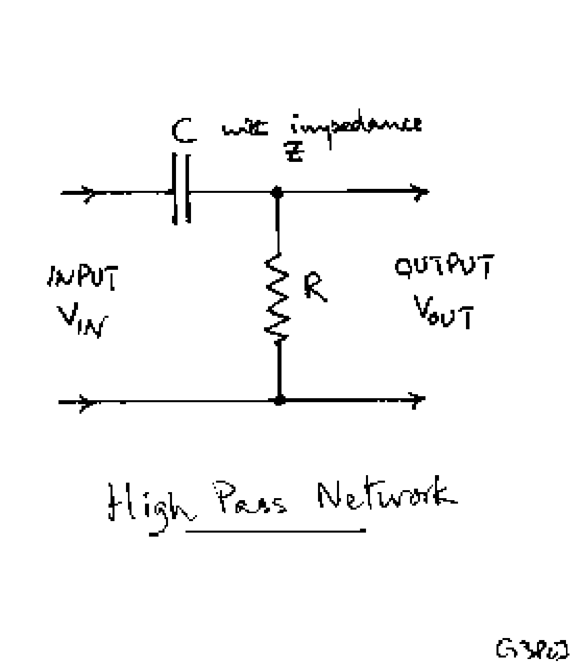
$$V_{OUT} = V_{IN} \times \frac{2\pi f C R}{1 + 2\pi f C R}$$

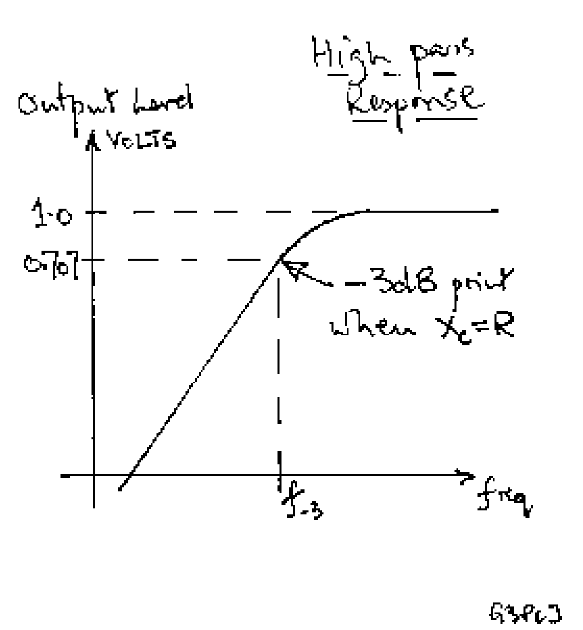
From this it is easy to show the output level is down to 0.707 of the input when the capacitor's reactance is equal numerically to the resistance. This corresponds to the output being 3 dB down (voltage - not power) compared to the input and is the point which is commonly taken as 'the bandwidth' - in this case being the lower limit since it is a high pass network. One can easily turn this around to determine the capacitor size needed to ensure that all signals above a given frequency are passed with less than 3 dB of attenuation:-

$$C > \frac{1}{2\pi f R}$$

C in Farads
f in Hz
R in Ohms

The same formula(s) can be used to determine the size of the required an output coupling capacitor in terms of the lowest frequency to be passed and load of the next stage. Very useful stuff! Tim G3PCJ




$$C > \frac{1}{2\pi f R}$$

with C in Farads
f in Hz
R in Ohms

can be changed to:-

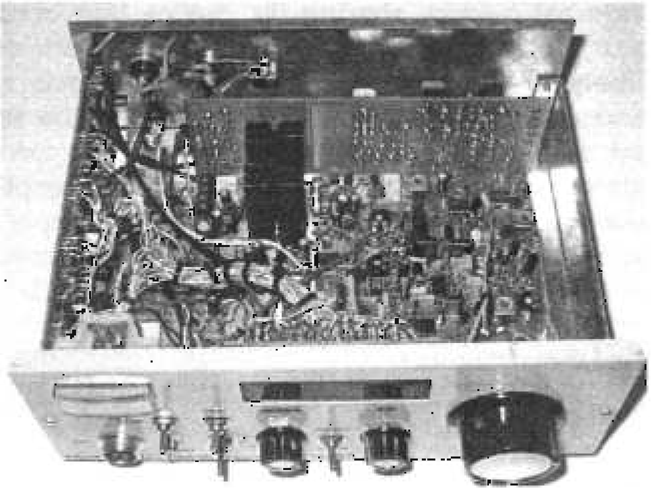
$$C > \frac{1}{2\pi F \Omega}$$

with C in µF
F in MHz
Ω in Ohms

G3PCJ

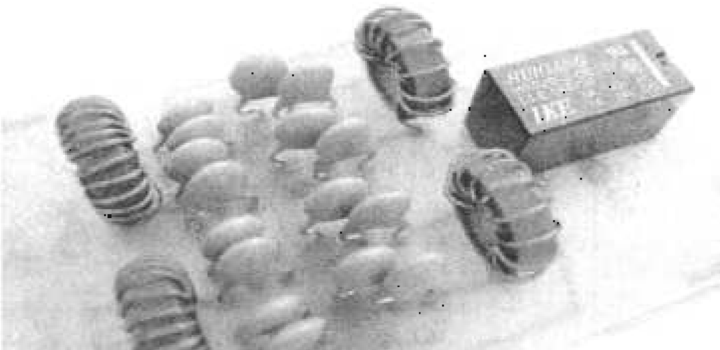
## *Boxed Bristol*

Following my tradition of building things just as they go out of fashion I recently completed my take on the Bristol project. I think the main board layout is a work of art. (What about that cableform then?! Tim) The completed rig has now become my main HF transceiver and I'm very happy with the end result. Just a few modifications were made to the original specification; I replaced the tuning pots with a single 10 turn type and changed the switched filter wires with screened leads. The 5 digit counter uses larger 0.56" displays. I found that add/subtract connection between the counter board and main PCB also needed to be screened due to interference from it on 10 meters. This most likely though is due to my choice of vertical position for the counter PCB. The case used is supplied by CPC. They sell a range of nice looking dark grey/blue powder coated steel cases with plain aluminium front panels and ventilation slots for between £5 and £11 depending on the size of the case. This is the largest version which is 225 x 175 x 89 mm. CPC code EN81242. The front panel after drilling and several hours of filing to make the slots clean was then sprayed with white primer, and a few hours later with the top coat of car aerosol beige. The labels are laser printed onto acetate and stuck in place with a pritstick type of adhesive. This dries transparent and allows you to move the label around a bit before the glue sets. Any excess can be wiped off with a damp rag without spoiling the paint work. The display filter is made from red lighting acetate sheet, to stiffen this up I glue the acetate to a piece cut from the front of a CD jewel case. Hope to hear you sometime on HF! Richard Booth, G0TTL

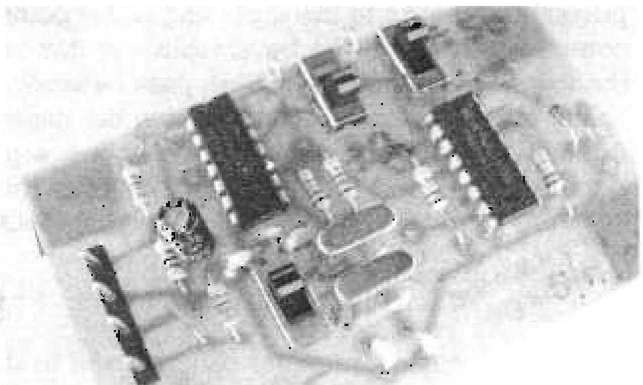


## *The Somerset Supper and Yeovil QRP Convention*

I am planning the second supper to be held on April 8th 2006 in Sherborne for locals and those staying overnight. This is the evening before the Yeovil QRP Convention scheduled for April 9th in the Digby Hall. The convention will have the usual array of interesting talks, trade stands, bring and buy stalls etc., so is well worth while coming - why not make it a weekend! As before there will be a small display of items from each diner's home built radio equipment! Your entry must be different from last years ticket! (Please also bring a QSL card or label.) This will qualify you for a *free* place at the supper table! The competition will this year be judged by Steve Hartley, the well known author of many amateur radio books who writes the Newcomers column for Radcom. He will decide how to judge it and his decision is final! You buy your own drinks. I do plan to a take a photo or two for publicity purposes but this will not intrude into this *social* event where all (including XYLs) will be very welcome. A minimum of formality! Places by advance booking only by Mar 28th so please get in touch soonest via walfor@globalnet.co.uk letting me know names. Places are limited - first booked secures their place! Hope to see it and you! Tim G3PCJ



Dual LPF



Harmonic Mkr

 GU3TUX owns AY5991

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# Hot Iron

Spring 2006
Issue 51

## Contents



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## *Editorial*

My mind is still in neutral due to the cold (again) and colds! I am longing for some warm Spring sunshine to lift our spirits and get out to those outdoor tasks. I am glad to say we have not burnt out any more 11 kV local mains transformers! However the recent energy price rises does make me wonder if I should expand the solar plant and have a 50 Hz inverter running continuously for lighting loads. I just wish the cost of solar voltaic panels would drop significantly, particularly the sort that can be made into the roof's waterproof covering. It cannot be long before most new south facing houses have them a standard. The greatest physical challenge (for existing roofs) is to mount and properly anchor the panels on top of the tiles, slates or whatever without breaking the water barrier. Corrosion and cleaning are further important matters for such long term investments. Fortunately, for most self build radio design projects, total energy consumption is not a major design criteria but it is vital for modern commercially made electronics. Hence the keen interest in improving power supply efficiencies and the resulting desire to move away from 'linear' regulated supplies. See later, Tim

## *Kit Developments*

I seem to have been typing instructions or articles for publication non stop on this machine since the last Hot Iron! The revised website is active and will have a few more extras added shortly. Meanwhile the new relay selected twin BAND pass filter is available - the standard kit does any pair of amateur bands, 20 to 80m, but with other part selections, it can do any 'band' in the HF spectrum. In due course this and other modules can be used to make up a two band RX. I have also built the prototype Mk 2 Signal Generator, its fine but I need to also try out the two band VFO aspects of it.

I have also completed the new Supplies kit; a single set of parts does the timing for two uses - firstly as a Static Inverter, or alternatively a Supply Booster. The Static Inverter will produce 50 or 60 Hz mains from a nominal 12 volt DC supply and the devices are suitable for driving a transformer rated at up to 200 VA. There are many possibilities to use whatever you have to hand so the transformer is not included - apart from its cost & postage! When used as a Supply Booster, it can nominally double a 12 volt supply to 24v (off load), or around 20v delivering 2 Amps. It can alternatively generate a negative 12 volt line giving up to 2 Amps. It has a simple form of maximum voltage regulator and does not need a transformer since it uses a charge pump technique. Tim G3PCJ

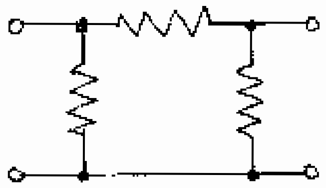
*Hot Iron* is a quarterly subscription newsletter for members of the Construction Club. Membership costs £7 per year with the first issue for each year appearing in September. Those people joining later in the year will be sent the earlier issues for that year. Membership is open to all and articles 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

## ***High Attenuation Attenuators*** by Gerald Stancey G3MCK

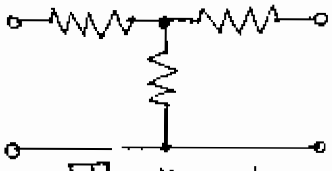
The function of an attenuator is to provide a controlled amount of loss in a matched impedance system. The usual configuration is either a pi or T network, see right. The choice of configuration usually depends on the components that are to hand. These attenuators only introduce loss into the circuit; they do not change any impedances. Consider a signal generator whose output impedance is 50 Ohms and is connected to a 50 Ohm load. Adding an attenuator between the generator and the load will only introduce a loss into the circuit. The generator will still be looking into a 50 Ohm load and the load will still be being fed from a 50 Ohm source.

Attenuators are designed for use in systems of a given impedance. This means that an attenuator that has been designed for use in a 50 Ohm system cannot be used (sensibly/accurately) in a 75 Ohm system. The usual handbooks give values for the resistors that are needed for the most commonly used attenuations and 5% tolerance preferred values are usually satisfactory for amateur use. Attenuations can be simply added, irrespective of the form of the actual circuit - pi or T. If you need a 9 dB attenuator, all you need to do is put a 3 dB attenuator in series with a 6 dB attenuator. It is usual to build them in screened boxes and toggle switches are satisfactory for switching them out at HF and low VHF. Again, good examples of construction are shown in many of the handbooks. (I intend shortly to be offering low cost 50 Ohm attenuators that will do 0 to 20 dB in 1 db steps - Tim.)

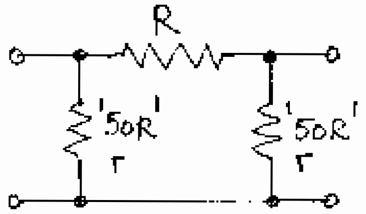
It is customary to limit the attenuation of any one section to no more than 20 dB. This is done to make sure leakage around the attenuator is much less than the intended loss. However there are times when you just want to put more than 20 dB of attenuation into the circuit but are not too bothered about either the exact amount or impedance. In this case a short cut can be used to calculate the main series resistor value - R of the pi form. R is assumed to be appreciably higher than either the load or source impedance and they are matched by the 'fixed' 50 Ohm resistors at each end. The formula right gives the attenuation in terms of R; this can then be turned around to find out what value of R is required for a given attenuation. For example, in this 50 Ohm system, when R is 1K, then the attenuation will be 32 dB. Normally the value of both resistors labelled r, would ideally be just greater than the system impedance; in practice they can be whatever is to hand in the range 47 to 56 Ohms. Such an attenuator can be lashed together on a piece of PCB material as it is not meant to be used in a precision manner.



π attenuator



T attenuator




High Value attenuator where:-

Attenuation (dB)

$A = 20\log(R/25)$

eg. if R = 1k, A = 32dB

OR

$R = 25 \times 10^{A/20}$

eg if A desired = 30dB

$R = 25 \times 10^{30/20}$

$= 25 \times 10^{1.5}$

$= 25 \times 31.6$

$R = 790R$

G3MCK

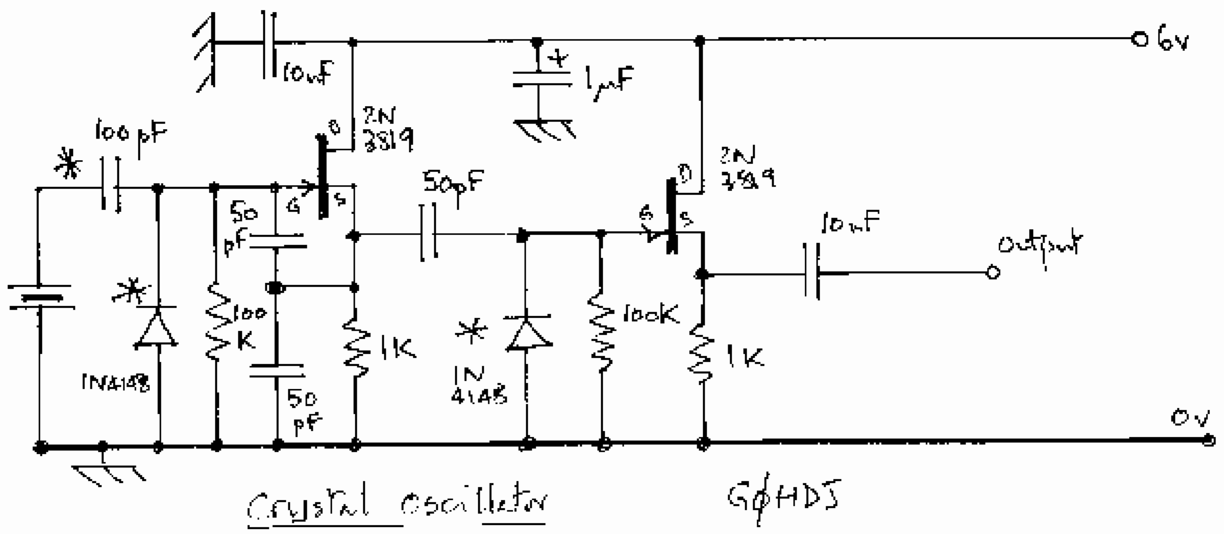
## ***Connectors for RF coaxial cables***

I have been trying to decide what type of connectors to use on the new bits of test gear (attenuators, power meter, amplifiers etc) that I have in mind. As you might guess, these will have an 'open' style of construction to reduce their cost, so PCB mounted connector versions are needed! PL259 types are far too clumsy, relatively expensive when new, and I have yet to see PCB mount females. For preference/quality, I would use 50 Ohm BNC types but they are pricey and not too easy to assemble without special tools. I have long used the standard Belling Lee style UK TV 75 Ohm types, although made for 75 Ohms, they are acceptable for 50 Ohm HF work; but being made of aluminium, they eventually corrode.

The only other possibility that I have found so far, are the RCA phono type. They are cheap, have PCB mount females, and appear to use plated steel rather than aluminium. They are partially screened but without a fully symmetrical coaxial form. Originally intended for audio work, no impedance figure is quoted. They should be quite adequate for most HF amateur use and are my current favourites. I shall be glad to have any other suggestions - but quickly please!! Tim G3PCJ

**_A reluctant oscillator!_** Prompted by Craig Douglas G0HD]

Craig explains that he wished to use the crystal oscillator circuit below to set up a receiver on different bands but was puzzled because it 'didn't want to oscillate at the correct frequency on 10m. Perhaps you could comment on this?' Talk about difficult questions!!




From Craig's words I infer that it works as expected on other frequencies but that when he changes to his 10m crystal, something is wrong. I have no information on the crystal but it might be an overtone type since 28 MHz is relatively high for a fundamental type. Fundamental crystals are certainly possible to 40 MHz but are a relatively recent development over about 25 MHz. If it is an overtone type, which means that its fundamental will be near an odd sub-multiple, mostly likely 3 in this case, implying a fundamental of 9.33 MHz or thereabouts. The circuit has no parts to suppress its fundamental oscillation mode so, if it is a third overtone type, it would run at near 9.33 even if marked as 28 MHz. What is its actual fundamental output frequency? Even if the third harmonic is audible at near 28 MHz, it would not be exactly correct since the fundamental of any overtone crystal is always slightly off the exact sub-multiple. (Crystals marked for even higher frequencies might be third, fifth or even seventh overtone occasionally.) Adding a series trap resonant at the fundamental across the crystal should stop it, but would make the circuit useless for a wide range of crystal frequencies!

The next, but much lower probability, is that something in the circuit does not like running at 28 MHz. There are three slightly suspect items. Firstly, if it is supposed to be a parallel resonant sort at 28 MHz, the commonly used load capacitance should be 30 pF in parallel. (It might be a series resonant sort but this should still work but at a slightly off frequency.) The absence of the normal load capacitance does not mean that it will not work, but that it will not run at the plated frequency. In this circuit the load capacitance is 100 pF in series with two 50 pF in series, which if you do the maths, is 20 pF so it would tend to run at a higher frequency than expected. I would suggested omitting the 100 pF in series with the crystal and up the two Collpits capacitors to 56 or 68 pF. The next oddity is the diode across the crystal - it is there to help stabilise the oscillation amplitude but I think it's the wrong way round! Its presence, when the right way, should be fine. (You could try omitting it to see if it then runs.) The other suspect item is the second diode on the gate of the buffer stage. I cannot see any reason for including it! I doubt that its presence will prevent the oscillator from running! All it does is alter the buffer stage bias when the oscillator is running.

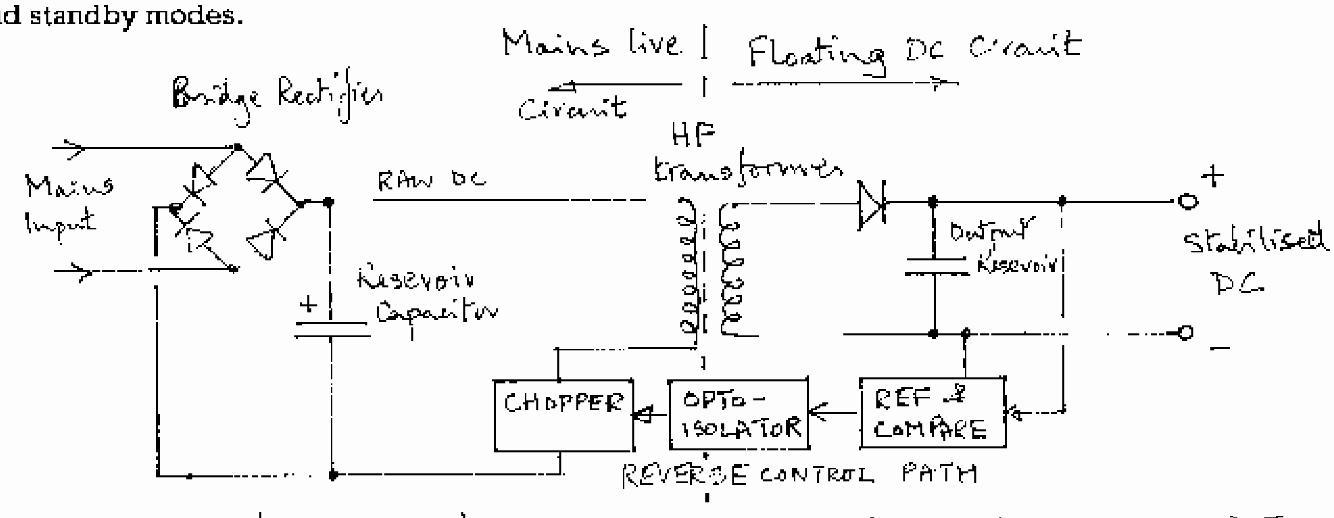
Just to fill the page, I recall that somebody has suggested using low voltage valves as the way to make very stable oscillators - on the basis that there is very little change in inter-electrode capacitance with temperature. The electrode capacitance is of course part of the tuned circuit and would influence frequency. This is a valid comment but usually the amplifying device is loosely coupled to the tuned circuit in any oscillator so the effect of its capacity changing will be diminished. In my opinion it is far more important to make certain that the main tuned circuit L and C are really high quality low temperature coefficient items. That means ceramic formers and air variables! Both are becoming increasingly rare and or expensive! Tim G3PCJ

## *Universal Mains Supplies*

Many modern mains powered electrical gadgets can be used on 'any' type of mains supply! No longer do you have to adjust the tapings on a transformer to cater for American or European voltages, or even frequencies. These items are designed to run on anything between 110 and 250 volts with either 50 or 60 Hz! I suspect they are also quite able to use 400 Hz which is sometimes used on aircraft or ships! They might even be able to use the old 16.67 Hz standard that was used in much of Europe in the 1930's but that is less likely! How do they cater for such a wide input range!

The key is that they generate a high voltage DC supply direct off the incoming mains, without any mains transformer, consequently this voltage might be anywhere between about 150 to 350 VDC. They have a reservoir capacitor large enough to cater for the lowest input frequency without excessive ripple. This DC supply is then chopped at a much higher frequency, often in the tens to hundreds of KHz range, and applied to a small high frequency transformer. The output of the secondary winding(s) are then rectified and smoothed for the desired output supply rails. Clearly without further clever circuits it would have very poor regulation! So the output voltage is compared to a reference and a control signal fed back to modify the chopping process feeding the high frequency transformer. If the output voltage is too high, the chopper is stopped until it gets too low, when it is restarted etc.

Unlike the old valve radios that did not have a mains transformer, with the supply neutral connected directly to the radio's chassis (with potential safety issues), the modern unit depends on the small high frequency transformer for mains safety isolation of the forward power path. The reverse control low power path has its mains safety isolation provided by an optically coupled isolator. In consequence, be very careful when investigating faults in modern PSUs because most of the circuitry is at mains voltages, and with high DC values on top! Furthermore their control loops make it very difficult to decide what stage is faulty - so often the most sensible approach is to buy a new one! The block diagram below shows the principle elements; in reality they are often somewhat more complicated to provide extra facilities such as input power factor correction, shutdown and standby modes.




'UNIVERSAL' SUPPLY BLOCK DIAGRAM G3PCJ

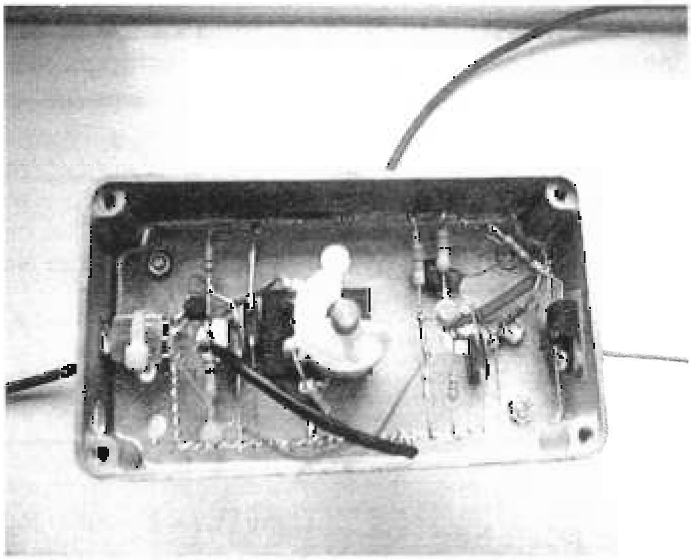
Interestingly, the approach of high frequency chopping an incoming DC supply to generate a much higher DC voltage is widely used in static inverters. The internal high voltage lines are + and - 350v (for a nominal 250v RMS output), which is then chopped at 50 Hz into a pseudo sine wave output - actually positive and negative rectangular pulses with gaps between them so that the RMS voltage is similar to a genuine sine wave but without excessive harmonic content.

In pondering how to better utilise my free solar power (at 12v DC), I contemplate stepping this up to 250v RMS at some much higher frequency than 50 Hz to minimise the transformer size. Ordinary incandescent light bulbs could use this direct but conventional fluorescent lights would not like the higher frequency. I am not sure what the modern long life miniature bulbs would do with a MF input! If they have chokes to limit their current, there is an obvious problem; but they would be alright if the incoming supply is rectified first to generate a high voltage.

Anybody know what is inside a modern long life bulb? Tim G3PCJ

## ***Stable VFO for 20/30/40m*** By David Proctor G0UTF

For years, I built and used VFOs usually for one band at a time. They worked fine, but going above 7 MHz was rather dicey as they were not too stable. After many years I went to crystals and was amazed at their stability. More recently, frustrated by their lack of range, I set my mind back on building a VFO that didn't drift "too much". This effort consists of a 2.0 - 2.2 MHz VFO mixed with 5, 8 & 12 MHz crystals via a Walford mixer to give 7, 10 &14 MHz. Of course you can do other bands with more crystals & filters. The VFO result is quite pleasing, drifting less than 10 Hz in ½ an hour. The VFO circuit is shown below – I haven't got round to the rest yet! Some will say it is too complex but I had all the bits in the junk box, and I don't intend building lots of them. Using a small die cast box there should be few hot spots, and even the KANK coil is strapped to the metal. The total power dissipated is 130 mW and this could be reduced by a remote regulator. The whole transmitter is as yet incomplete but it may sow a few ideas in readers minds. With better components, it could be more stable.



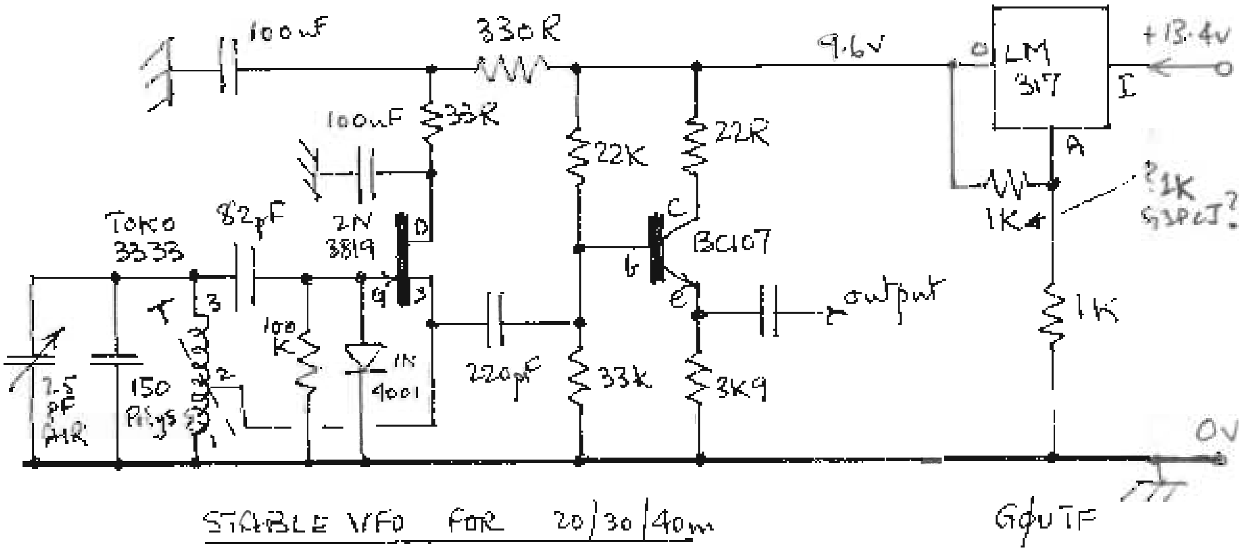
### Run 1

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Mins after on** | 5 | 10 | 15 | 20 | 25 | 30 | 45 | 60 |
| **Drift (Hz)** | 0 | -5 | -2 | -6 | -1 | -9 | -9 | -4 |

### Run 2

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Mins after on** | 5 | 10 | 15 | 20 | 25 | 30 | 35 | 40 | 60 |
| **Drift (Hz)** | 0 | 10 | 17 | 23 | 28 | 33 | 36 | 39 | 43 |

(David explained that both these sets of figures were taken with an initial 5 min warm up period during which drift was ignored. Run 1 was done in a stable temperature condition. Run 2 was done as his central heating was coming on and has convinced him that he should have a water cooled VFO to keep it at constant temperature! Even so, these are good figures! Tim)



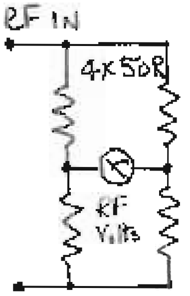

## ***CW and VFOs***

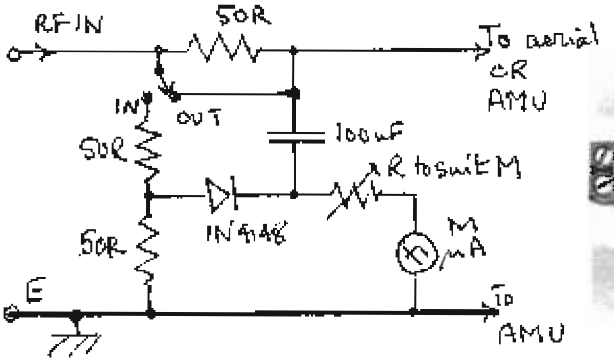
For direct conversion CW rigs, the receive and transmit frequencies of the VFO need to be different in order to generate a received audio beat note. Hence there is usually some form of automatic tuning offset for reception only (RIT). Arranging this tends to degrade the intrinsic stability of the VFO and is seldom compatible with a simple **Huff and Puff** stabiliser - if one is contemplated. Using a single sideband 'phone' type TX superhet with an injected CW tone overcomes the Huff & Puff incompatibility because the VFO frequency does not change. Its no longer essential to have RIT but it's a useful feature in any rig! You can Huff & Puff stability, or RIT, but seldom both! G3PCJ

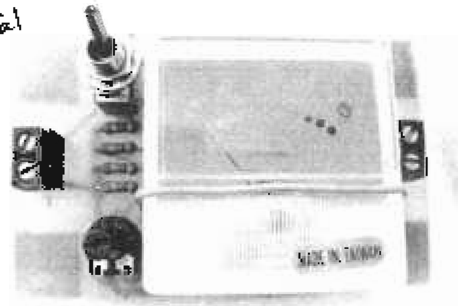
## *Mini Bridge*

The kit designs below are derivatives of the standard AMU. I have split it into two units (matching indicator and antenna matching circuit) so that each fits onto a 50 x 80 mm PCB, to match the **Kilve/Kilmot/Kilton** single band rigs. Each is £19 + £2 P & P, or both £38 inc P & P.

The Mini Bridge is a 50 Ohm resistive bridge where the antenna is connected instead of one of 'four' bridge resistors. If all four were exactly 50R, the bridge is said to be balanced and the voltage across the mid points (as shown left below) would be zero - hence we need a circuit that detects when there is least voltage between these mid points. This can be done with a simple RF voltmeter. After the bridge has been used to indicate the best match obtained by adjusting the AMU controls, the bridge circuit is switched out, but the detector remains connected to the antenna thus showing output RF voltage, or power with a square law scale. The preset is adjusted for full scale deflection with the bridge out of circuit while feeding rated TX power into a 50R dummy load; then with the bridge in circuit, the maximum reading will be half scale for an extreme open or short circuit antenna load. The load on the driving TX has to be between 33R and 100R, so will always be a safe load, irrespective of the actual AMU settings. With the bridge in circuit, you adjust the AMU controls for the lowest indication, (all four 'resistors' equal 50R), and then switch the bridge out. G3PCJ



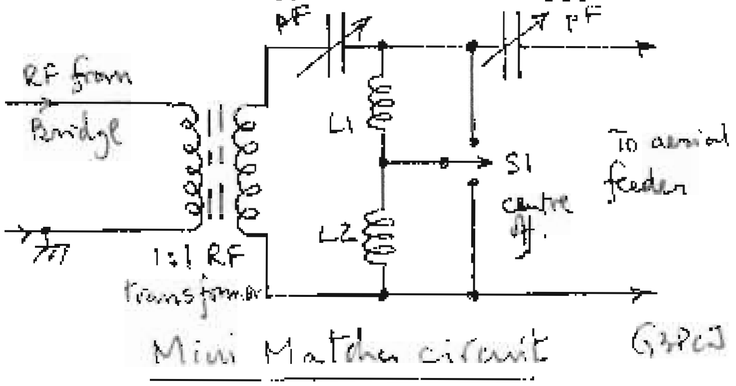



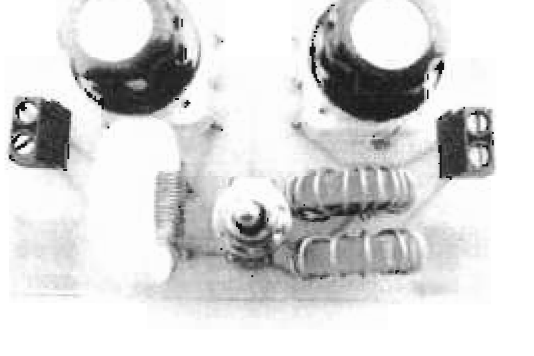



OUTLINE OF BRIDGE CIRCUIT G3PCJ

## *Mini Matcher*

This is a simplified version of the T match part of the AMU, with a restricted inductance range to cater for a single band. The two inductors are wound to suit the chosen band and probable feeder impedance. The standard capacitors should suit all bands 10 to 80m; 160m might need extra fixed C. The T circuit can cope with a wide range of loads, and although not fully balanced, it can drive a balanced feeder/aerial system because the input RF transformer 'isolates' it from the usual unbalanced output of a transmitter. If the aerial is genuinely unbalanced, e.g. quarter wave vertical against RF ground, then the input 1:1 transformer can be omitted. (Beware mains/RF earth isolation aspects.) Because the complete circuit is bi-directional, you can reverse the signal flow through the unit, with the RF transformer on the output driving a genuinely balanced feeder. However, this is not really recommended because the transformer will work better if it has a resistive load - this is less likely with a reversed signal flow unless the *antenna* is actually matched to the *feeder* impedance properly (which is seldom the case!), to prevent there being any reactive component being passed through the RF transformer. The normal, and preferred, signal flow from transmitter through RF transformer to matching circuit, does have the transformer working with a resistive load. The radiation pattern is likely to be disturbed by other metalwork in the near field anyway!

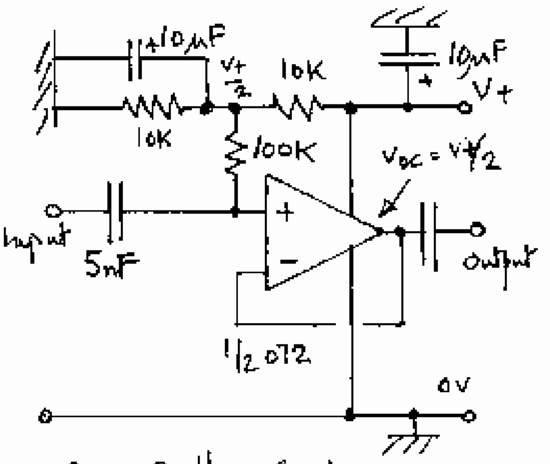


Mini Matcher circuit G3PCJ

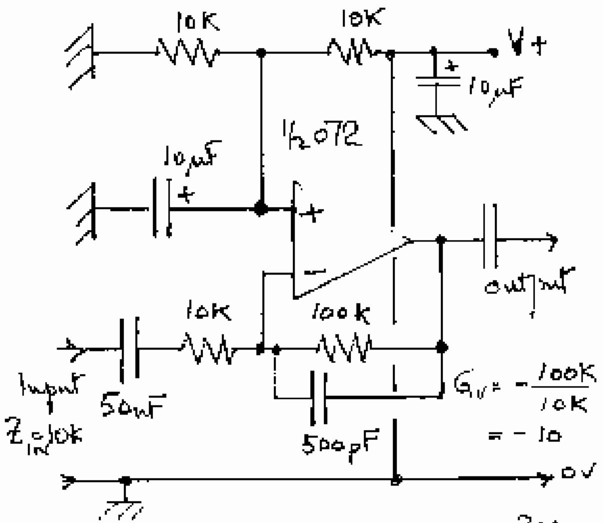
## ***Theory - Using Op amps***

The first thing is to select one that is designed for the anticipated supply voltage. The common TL072 type that I use liberally, is a dual low noise type suited to audio applications and comes in a plastic package with a supply range of about 5 volts to 30 volts. The next point to consider is the biasing, to make the output settle at the desired DC output voltage - often half way between the supply rails. The device will usually have both positive and a negative signal input terminals. A positive going signal on the positive input will make the output go positive; a positive going signal on the negative input will make the output go negative. The actual input bias currents are often so small that they can be ignored. A convenient approach to biasing is to feed the negative input in a DC sense (but not necessarily AC) direct from the output without any form of attenuation; the DC output voltage will then directly follow that applied to the positive input. Where 0 volts is the negative supply rail, then a 'pseudo' mid rail supply is often used to set the out put voltage by applying this mid rail value to the positive input. This leads directly to the very useful *buffer* circuit shown top right. This has a high input impedance and a low output impedance with unity voltage gain. The upper bandwidth limit is hundreds of KHz. The low frequency limit is determined by the input coupling capacitor and the bias resistor - about 300 Hz for the example values shown.



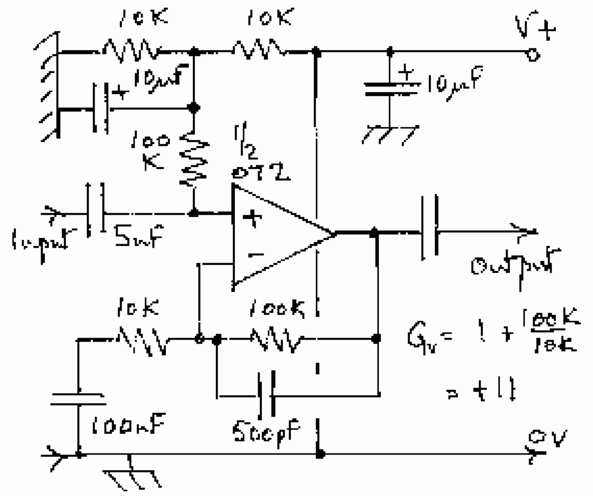

Op-Amp Buffer - Gv=1 G3PCJ

The middle diagram shows a typical AC coupled audio inverting amplifier. It actually has a voltage gain of 10 and a bandwidth of 300 Hz to 3 KHz. The gain is defined by the ratio of the two resistors, literally the feedback one divided by the input one! The output impedance is low (often less than 100 Ohms) and the input impedance is the value of the input resistor! This is because the junction of the resistors at the negative input is a virtual earth, having negligibly small audio signals owing to the very high gain of the internal amplifier. The low end response is determined by the input CR and the upper response by the feedback CR. The negative sign means in and out are out of phase.




Inverting Op-Amp Gv=-10 300-3kHz G3PCJ

The final circuit is a variant of the middle one above, where a higher input impedance is required and it is acceptable for the input and output to be in phase. The gain is now still highly dependent on the resistors at the negative input but to their ratio you must add one! The lower end bandwidth is now dependent on both the negative 'input' decoupling cap and the positive input coupling. (Think about the very first circuit above without negative input resistors, so their ratio was zero but adding 1 for the use of the positive input gave the correct gain of +1. The plus meaning that in and out signals are in phase.)




Inverting Op-Amp with Hi Z, Zin = 100K Gv = +11, 300Hz-3kHz

G3PCJ

Not really much need for fancy maths or the calculator to work out the gains! Bandwidths are all the usual CR sums! Tim G3PCJ

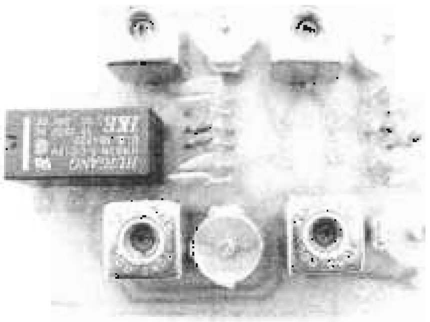
## Snippets

*Lithium batteries* Dave Buddery passes on a tip from his son who is in the oil industry, and hence rather conscious of safety matters, that these batteries are prone to self igniting if allowed to discharge too quickly. I hazard a guess that discharging should be limited to their 1 hour rate max. This would imply a current numerically no greater than their storage capacity in Amp-hrs.

*Huff and Puff stabilisers* David Proctor asks if I ever contemplate a stabiliser kit that could be added to a builder's VFO to improve its frequency stability. This is a project that I have often considered but never tried. An early customer, who is not any longer a member of the Construction Club - otherwise I would get him to write something on it, spent many hours trying to stabilise a varactor tuned VFO and eventually gave up. I think this was because his particular VFO design was prone to small jumps or changes in frequency (but not sufficiently large to hear), due to temp, supply or other variations affecting the tuning diode, which were comparable to the finite size of the control steps of that particular stabiliser design. Since large capacity varactor diodes have become like hen's teeth, leading to the use of PolyVaricon tuning capacitors, I will re-examine this topic.

*40m phone crystals* Several of the new simpler transmitters require an actual crystal for the oscillator on bands above 80m, this is because ceramic resonators are not stable enough as frequency rises. Luckily I have found a low cost source of 'standard' value 7159 KHz crystals so that you can now use them in the extended phone part of the 40m band. £2 +£1 P and P.

*Lead free solder* A messy situation! Many components are going extinct as manufacturers change their processes to cater for the desired abolition of lead products in electronic goods from about now. Solder is the main concern. There are plenty of substitutes but they nearly all require higher temperature soldering irons for the making of satisfactory joints. Interestingly, the military and certain other organisations have obtained exemptions where extreme reliability is demanded. It is also permissible to use normal 60:40 tin-lead solder to repair equipment which was made with that material. It seems likely that 60:40 solder should be available for some time to come.



The photo is a relay selected dual bandpass filter, this one has a 20m filter on the right and an 80m one on the left. The inclusion of trimmers makes adjustment slightly easier and will also allow for toroidal cores when eventually TOKO 333X series are extinct! The relay has two alternative positions, for nominal 50R in & out, OR nominal 1K5 in & 50R out for the in/out impedance of 612 mixers. The filters are actually bi-directional so it can be 50R in and 1K5 out OR 1K5 in and 50R out. Both bands have to use the same impedance setting of the relay. A single set of parts is supplied for the normal amateur bands 20 to 80m but it can do others with alternative parts. G3PCJ

## *The Somerset Supper and Yeovil QRP Convention*

## REMINDER for those who have not yet booked!

I am planning the second supper to be held on April 8th 2006 in Sherborne for locals and those staying overnight. This is the evening before the Yeovil QRP Convention scheduled for April 9th in the Digby Hall. The convention will have the usual array of interesting talks, trade stands, bring and buy stalls etc., so is well worth while coming - why not make it a weekend! As before there will be a small display of items from each diner's home built radio equipment! Your entry must be different from last years ticket! (Please also bring a QSL card or label.) This will qualify you for a *free* place at the supper table! The competition will this year be judged by Steve Hartley, the well known author of many amateur radio books who writes the Newcomers column for Radcom. He will decide how to judge it and his decision is final! You buy your own drinks. I do plan to a take a photo or two for publicity purposes but this will not intrude into this *social* event where all (including XYLs) will be very welcome. A minimum of formality! Places by advance booking **only** by Mar 28th so please get in touch soonest via walfor@globalnet.co.uk letting me know names. Places are limited - first booked secures their place! Hope to see it and you! Tim G3PCJ

"JOURNAL OF THE CONSTRUCTORS CLUB"

# Hot Iron

Summer 2006
Issue 52

## Contents



The Walford Electronics website is also at www. walfordelectronics co uk

## *Editorial*

Last night Tony Blair signalled a push on nuclear power stations supported by extra work on renewable generation and other items designed to save energy. All very sensible! It makes me feel slightly smug that my solar panel is now charging - even on this dark rainy day! Since writing last about it, when I contemplated driving much of the house lighting circuits from a static inverter, I realised that the modern 12 volt AC 'low voltage' lighting and associated fittings is entirely suitable for DC use also. I have now installed a DC supply from my main storage batteries around the central parts of the house, complete with small tungsten halogen light fittings. This works well and will reduce the 50 Hz consumption appreciably from those lights which were often left on for long periods. I have used large section cables from the batteries to the middle of the house, so that I can easily connect a static inverter there to power the TV and heating etc, in the event that the 50 Hz does fail. Maplin Electronics have been selling a 12 volt 600W (1500W surge) inverter for near £50 which makes doing your own uneconomic. The whole 'investment' has a very long payback period but is all good fun! Tim

## *Kit Developments*

Quite a few things going on! The revised signal generator turned out to be too complex and finicky so I have started afresh with a simpler design, without the VFO frills. If all goes according to plan it will have nominal output of about 10 dBm (analogue or digital) over at least 1 to 30 MHz. In a similar vein, and with a fair bit of prompting from a good supporter in Norfolk(!), I have designed a new All Band VFO kit. This does all the traditional bands by crystal mixing with digital dividers but also avoids having an excessive tuning rate or span on any band! See later for the concept. It might even drive an All Band CW TCVR but that is another story!

I am also working on a 1.5W DSB phone TCVR called the Brean. This will be essentially 'crystal' controlled and suitable for any band up to 20m. Either a pullable ceramic resonator for 80m, or for the higher bands, an actual crystal or a wider tuning range with the Mini Mixer kit.

The other major project is the Minster. This is progressing steadily but it is not something to be rushed given the complexity of multi-band operation etc.

None of this helped by my **being away on farming business for most of July!** Sorry about that but I will deal with any queries immediately on my return. Regards, Tim G3PCJ

*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

## ***Diode Abuse!!*** by Richard Booth G0TTL

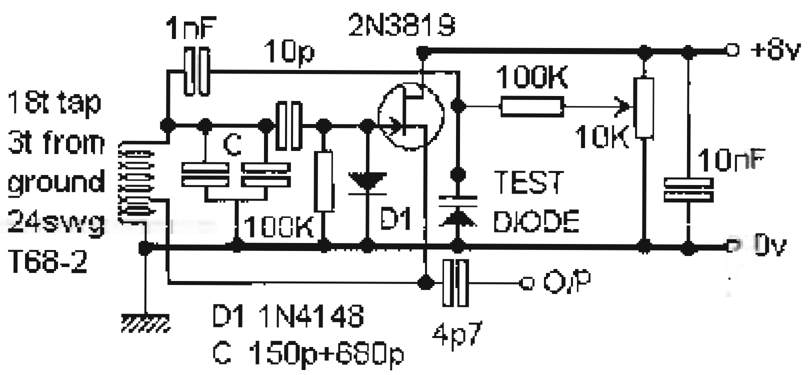
Purpose built high capacity varactors or as I know them varicap diodes are now a thing of the past. Philips stopped making the useful BB212 several years ago with supplies quickly running out, and like everything else in short supply prices for the remaining few are increasing at a rapid rate. The reason for this in much the same way as 10K TOKO coils are now becoming extinct is that very few if any new commercial designs have traditional L/C tuned circuits. Cheap direct digital synthesis IC's and PLL circuits nailed the coffin closed on this chapter of analogue electronics.

However if your thoughts, like mine are about building and maybe designing useful and relatively easy to construct amateur radio projects then you needn't worry too much about that problem. Not all components do just what they say on the packet - take for instance the old trick of scratching the paint from a germanium OC71 and hey presto you have a photo transistor. Or maybe Tim's favourite of using digital logic gates as linear amplifiers or oscillators. It's all about lateral thinking which to my mind makes building your own equipment all the more interesting.

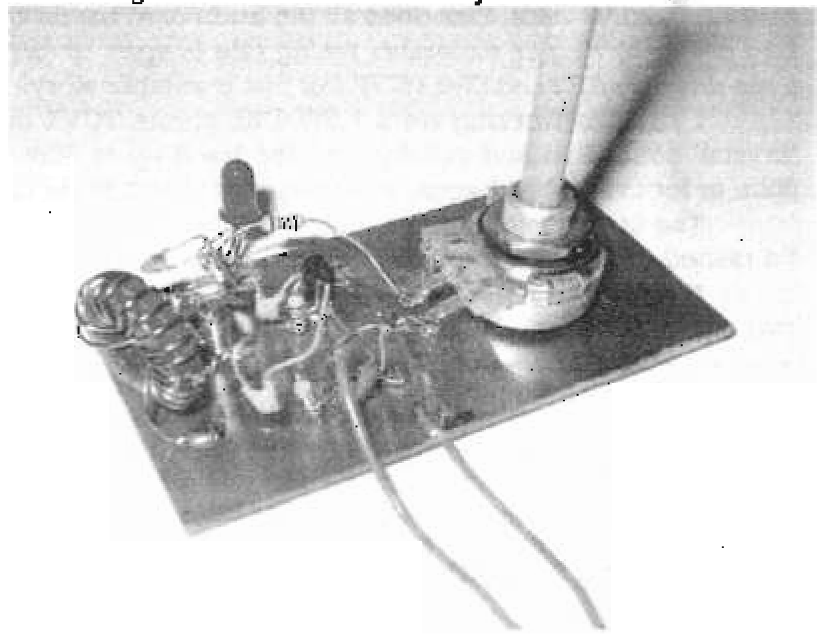
For some time now I've been pondering over a few rig ideas which one day all being well will come to fruition. The VFO has been one of the sticking points, simple mechanical arrangements and only using a variable capacitor as a last resort were my thoughts. So a varicap alternative would need to be found. It's well known that all diodes exhibit some level of variable capacitance when a reversed bias voltage is applied across it. So the plan was to test a selection of readily available diodes and get some meaningful results.

First of all I threw together a simplified version of the Midney VFO circuit, originally designed for the BB212 diode and changed a few things around, to make it run at 4 MHz, substituting the 10K TOKO coil for a tapped toroid and did away with the voltage stabilising components. Running direct from the bench power supply at 8V was good enough for this test.

Simple 4MHz test vfo




The circuit was constructed dead bug style on a small piece of PCB material. 1MΩ resistors were used as standoffs. No frills and definitely not to be repeated in an actual transmitter! As a first test just to make sure that the circuit was working I soldered in a BB212. Just less than 500 KHz of swing was available with the selected component values, with the oscillator running between 4 and 4.480 MHz. I then proceeded to test various diodes including LED's which yielded some odd results!



**How not to build your next VFO!**
This picture shows my quick lash up VFO board. A red LED is being tested.

## Diode Abuse Continued

After reading about success using Zener diodes in this application I was surprised to find the actual results obtained to be so poor - see the Table right. Strangely the LED's however worked quite well as a varicap, although it does seem to be colour dependant! The green types (and I tried several different makes to check this) all seem to have an odd hysteresis effect in that their tuning range is different depending on the direction of the reverse voltage, i.e. going low to high and vice versa.. I expected the larger sized LED's to have a higher total capacitance due to their internal dimensions but again strangely this is not the case. The big surprise though was the 1N54 series of diodes. Rated at up to 1 Kv the 1N5408 turns out to be the winner of best substitute varactor of 2006. Although it's quite a chunky power diode it's not much bigger in PCB space terms than the BB212, especially if mounted up on one end. Tuning across the range seems to be reasonably linear.

So it would appear that several suitable alternatives are available, all of them costing 15p or less. The zener types are probably best suited for RIT or fine tuning control.

| **Diode Type** | **Oscillator Swing at 4 MHz** |
|---|---|
| BB212 dual Varicap | 480 KHz |
| BZY88 5V6 Zener | 10 |
| BZY88 12V2 Zener | 11 |
| BZY88 36V Zener | 13 |
| 1N4007 | 70 |
| 1N645 | 70 |
| 1N4148 | 20 |
| Red HE 5 mm led | 125 |
| Red HE 3 mm led | 135 |
| Green HE 5 mm led | 40 with hysteresis! |
| White 5 mm led | 120 |
| Red 10 mm led | 45 |
| BA148 | 40 |
| BY127 | 25 |
| 1N5401 | 150 |
| 1N5404 | 200 |
| 1N5406 | 245 |
| 1N5408 | 305 KHz |

**A practical example**

Just to prove to myself that this would actually work in practice I removed the BB212 from my 160M Midney superhet receiver and replaced it with a single 1N5408 diode. This is my test bed receiver built on a lump of old timber to make it a bit sturdier with numerous sockets for checking IC's and transistors which I have a habit of killing. Without changing any of the frequency dependent capacitors or inductors I'm pleased to say the results were good. Just a quick tweak of the VFO TOKO coil and an adjustment of the 10K tuning range preset had the receiver tuning 1.8 to 2 MHz with no real difference from its original performance worth noting. For novelty, having never had a receiver tuned with an LED before I also tried fitting a single red 5 mm led. At this frequency 100 KHz of the band was covered - this of course could be increased by altering the capacitors in the oscillator circuit.

Do let me know how you get on if you use any of the diodes I tested, or if you know of any other types worth trying out. 73 Richard Booth, G0TTL

**Caution!!**

Richard's excellent piece of work reminds me of the point that the ordinary 78 series fixed voltage regulators are just NOT good enough to provide the supply for main tuning by a varactor diode. This applies to any device of the 78 series, irrespective of their size! The variation of output voltage with changes in output load current, and with changes in input voltage, is too great for a decent rig. Its frequency will jump about as the volume alters!! The LM317 range of adjustable voltage regulators are almost an order of magnitude better in both key respects! Thus if you do contemplate using a varactor for a wide tuning range (say more than 25 KHz), then use a 317 regulator (L or T type) for the supply feeding the tuning pot. If you only need a small tuning range, such as for Fine tuning or RIT, then the 78 series or other fixed ones maybe adequate.

I am hoping Richard will report soon on the temperature stability of the 1N5408. Tim G3PCJ

## ***Shack Standards*** by Gerald Stancey G3MCK

When using a voltmeter I wonder how many of us stop and think 'I wonder if the meter is correctly calibrated?' In a professional laboratory this problem is, or should be, taken care of by having a procedure where the calibration of all test equipment is regularly checked and recorded to give a certifiable audit trail. The professionals use specialist test–houses for this function and it costs money.

So what can the amateur do? Ignore it and hope that no problem ever occurs or spend big bucks. There is a third way which while not being high precision is better than nothing. You simply measure the voltage of a new Duracell PP3 battery and assume that it is 9.5 volts. Hey I hear you say, this is real simpleton optimism but just think, if the battery is really 9.4 volts your error is only 1% and this is not at all bad. Hence this method while not being of test-house accuracy, will at least show if your meter is really up the pole. Another possibility is to use Zener diodes or voltage regulators but I have not investigated these. Precision voltage standards are also available but these do not seem to offer very much better accuracy.

Readily available frequency standards is an area where we seem to have regressed. In the old days it was simply a matter of checking your 100 KHz standard against MSF on 5 MHz or the BBC on 200 Kc/s, note the use of c/s rather than Hz to keep in sympathy with the times. However all is not lost as the People's Republic of China make standard frequency transmissions on 2.5, 5, 10 and 15 MHz to an accuracy of better than 10 in $10^{10}$ . They identify as BPM in CW at H+29 and H+59. I have used the 5 and 10 MHz transmissions.

Another possibility is to use standard BC stations. In the medium wave they are all channelled at 9 KHz spacing and their frequencies evenly divide by 9 so 900 KHz, 909 KHz etc are all BC channels. The shortwave BC stations are even better as they operate with 5 KHz channel spacing. I do not know how accurately they control their frequencies but the BBC control to 1 in $10^8$ . Checking a number of BC stations in the 40m band suggest that their accuracy is adequate for normal amateur use.

This raises the question ' how accurate do you need a standard to be'? The answer depends on what you want to measure but a rule of thumb is that the standard should be ten times better than the accuracy to which you need to measure. The post war amateur licence required an accuracy of 1 in $10^3$ , ie 1 KHz per MHz. If we assume that BC stations control their frequency to better than 1 in $10^6$ , ie 10 Hz per MHz then it appears that they will make adequate standards for amateur use.

## ***Frequency checking technique***

Its not too easy to check an oscillator against a BC station but this is what I do! Tune in the BC station, preferably on a very stable direct conversion receiver. Adjust the tuning for zero beat of its carrier. Wait and see if either drifts away and no longer remains at zero beat - hopefully not! Then introduce the output of your test oscillator also to the receiver, ideally this would be at about the same signal level as the broadcast station. So it is likely to need quite a lot of attenuation. It might be adequate just to bring the oscillator near the RX input. (The oscillator should have been switched on well in advance so that its temperature has stabilised before the comparison.) When the oscillator signal is introduced to the RX there might be a low audible whistle, or the AGC might pump at a few tens of Hz if it has AGC. Twiddling the oscillator's frequency trimmer might swing it far enough to make the frequency difference audible; but in any case you actually desire that the beat frequency between BC station and test oscillator be zero! You often have to listen exceedingly carefully to detect any 'signal' once the difference in frequency goes sub-audible at roughly 20 Hz. If the RX does have AGC, one can sometimes hear a change in the background noise level as the gain alters at the beat frequency. Failing this, you will have to set the trimmer mid way between the two points at which you can just hear the note with the same frequency. Do this and you wont be far out bearing in mind that the error is in tens of Hz for a carrier of several hundred KHz! Tim G3PCJ

## *Ideas for an All Band VFO!*

Prompted by David Proctor's article last time and Andy Howgate, I have often contemplated how to make an 'all band VFO'. At first sight it is easy! It needs good stability so a crystal mixing scheme is almost obligatory - and it would of course prevent chirp when used to drive a transmitter. So all you have to do is mix a low frequency VFO with a crystal to get 28 MHz, and then divide the output down for all the lower bands. There are two big snags; firstly it needs a tuning range of 28 to 32 MHz to divide by 16 for 1.75 to 2.0 MHz, this is a bit wide for easy tuning/stability and there is a 2:1 change in tuning *rate* for all bands compared to the next above or below! The other problem is that it cannot do 21 MHz as this is not a binary multiple of any band.

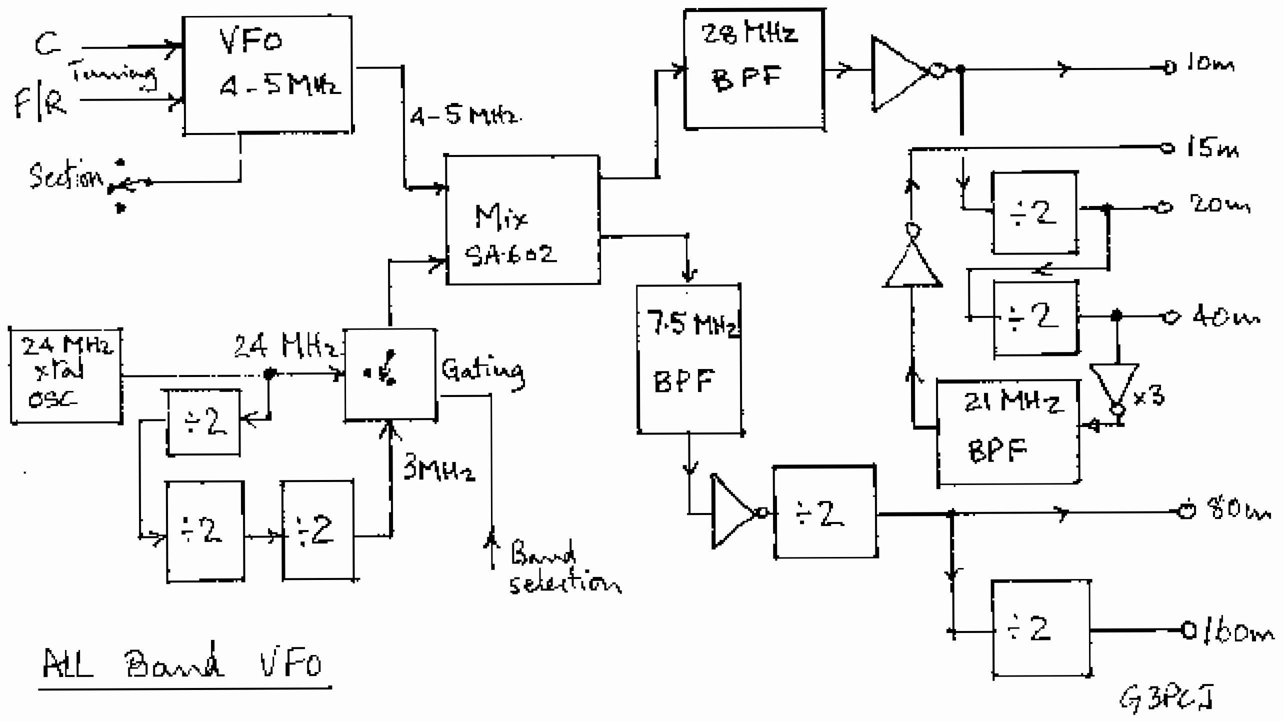
After many doodles and much head scratching, I realised that the two outputs of a SA602 might offer a solution. One could drive a BPF for 28 MHz and then be squared up in a digital gate, followed by two stages of digital division to get down to 7 MHz. The change in tuning rate would be limited to 4:1 overall and a 1 MHz swing at 28 MHz would give coverage of all of 20 and 40m. The other output could drive a second BPF covering 7 to 8 MHz, which with squaring, could again divide down for 3.5 to 4 and 1.75 to 2 MHz. Clearly the inputs to the mixer would have to suit each active BPF. One input could be an actual VFO covering 4 to 5 MHz, the other mixer input being the 602's internal oscillator using crystals of 24 and 3 MHz! A 2 pole 6 way range switch could select the BPF/ divider output and crystal.

How to get to 21 MHz though? This is the third harmonic of 7 MHz and what are square waves rich in? Odd harmonics. We already have 7 MHz square waves divided down from 28 MHz, so feeding this 7 MHz into a 21 MHz BPF should select the desired third harmonic content, which can be squared up afterwards. Easy!

The above scheme would need crystals of 24 and 3 MHz, but 3 MHz is not a standard readily available value. By luck 3 is a binary sub-multiple of 24! So a further divide by 8 stage would get us 3 MHz from a single 24 MHz crystal and then only need gating to select the right output. This would be rather more reliable than actually switching over the crystal directly by the band switch. The resulting block diagram is shown below.

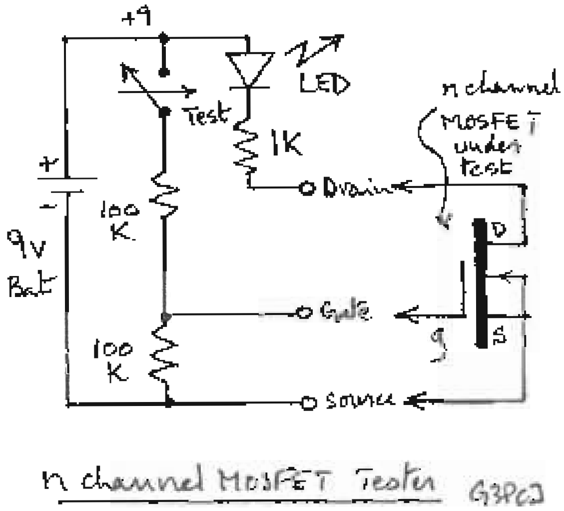
Clearly stability will be important if it is to be used for a rig's VFO, so suitable toroids and capacitors would be best. The 1 MHz tuning range needs dividing into sections with the provision of a further Fine tuning control being desirable. If this Fine control used varactor tuning, then it is easy to make this also double as a RIT control making the VFO directly suitable for a DC CW rig.

I have laid this out as a main PCB with a small upright front panel and will try it out shortly. With some other ideas, it also holds the prospect of an All (traditional) Band CW TCVR! Tim G3PCJ



## *Testing n channel MOSFETS*

Small MOSFETS, like the n channel BS170 are so cheap, that if there is any doubt about them, it is almost the best thing to throw them away and fit a new one! Nevertheless, this little device will test them just as well as the larger n channel types such as the IRF510, which are definitely worth testing. First of all you need to identify the gate lead. The safest thing is to look that up in a data sheet or on a circuit where it should be given. The next thing is to connect the source and drain leads to the circuit with the gate connected also to its test point/button.




Switch on, if the source and drain are the correct way, the LED should not light; but if it is the wrong way round, the LED will light irrespective of the gate voltage/test button - this is because the transistor looks like a diode when the supply is the wrong way round. If the LED does light, change the source and drain around and check that the LED now goes out! If it still stays on, throw it away, because the device is short circuit! This is an uncommon failure mode.

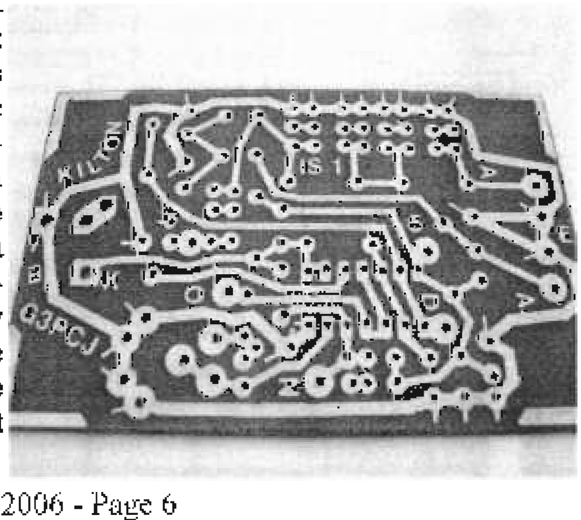
Assuming that it did not light when first connected or went out after changing the source and drain leads, then press the test button; if the LED does now light, all is well with the device. If the LED still does not light, the device is open circuit and no good!

The circuit can also be used to check **diodes**; the LED should light when the diode anode is connected to the drain terminal and cathode to source terminal. The LED should not light when the diode is connected the other way round. If it on both ways the diode is short circuit and fit only for the bin! (This circuit cannot be used for testing p channel MOSFETs.) Tim G3PCJ

## *Laying out PCBs*

If space allows, the best strategy is for the main signal flow to be in a straight line so that there is the largest separation between low and high level signals. If this is unavoidable, then make certain that adjacent low and high level signals are at different frequencies! Next arrange the layout so that all high current stages have good grounding, short leads and are near output RF filters so that the high currents don't go near the sensitive low level circuits. In the example PCB below (the Kilton CW transmitter), the output transistors are on the top left, feeding the TX low pass filter in the top middle, which in turn feeds the output on the right. A common wide earth track links all these stages and the output. In this example, the driver stages are in the middle in the integrated circuit and the VFO components (trimmer and ceramic resonator) are at the front left - as far as possible from the high current part. The control circuits are at the front right. Although this is actually a double sided board with a copper ground plane on the other side of this photo, all the earthy points are also linked together by tracks to minimise the effects of any forgotten top-side solder points, and to help reduce the impedance between any two grounded points. I find that I can lay these circuits out more quickly using a form of rub down tapes than I could do if I were to use software. (I also don't get the square eyes!)

Because I make many samples of the same PCB, I use a photo etching process where the track image is first impressed on the board by an UV sensitive chemical; this is then developed to leave a resist that prevents the ferric chloride from etching away the wanted copper track pattern. The standard drilling process that Brian Purkiss and I have developed, is to first drill the earthy holes - these have hairs on them like a chassis symbol. Then Brian countersinks these holes on the ground plane side to prevent their component leads being accidentally grounded. Finally he drills the non-earthy holes. The copper resist is then rubbed off with wire wool and the board sprayed with a lacquer that prevents oxidation but which can be soldered through. Tim G3PCJ



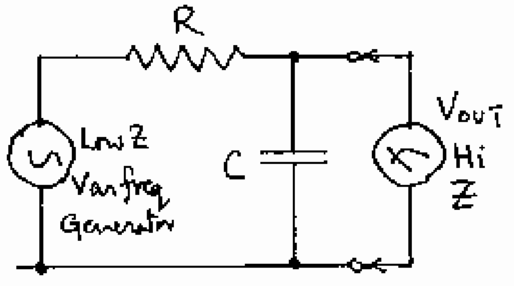
## ***Theory - Low Pass Audio filters***

These are an essential building block of all electronic devices! A sweeping statement you might say - but nevertheless it is true! Even the humble coupling network between two stages of an audio amplifier is potentially a low (or maybe high) pass filter.

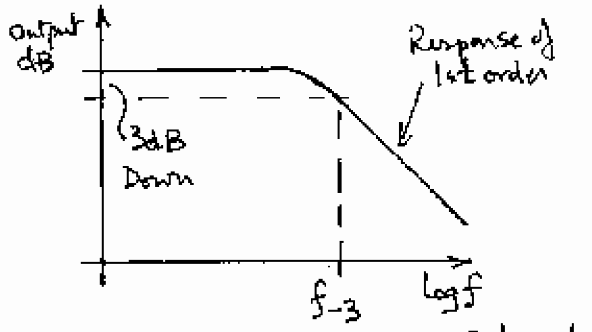
Let first consider the response of the most simple R and C network shown right fed from an ideal low impedance source and with a very high load impedance, so that both those aspects can be ignored. As the generator frequency is increased, initially there is no change in output level, but at some frequency $f_3$ , the output level will begin to reduce and then go on steadily decreasing for ever! The output actually decreases by 6 dB per octave or 10 dB per decade - they are the same slope of the response line. This said to be a first order low pass network as there is only one CR time constant. The frequency where the bend occurs, and the response is actually 3 dB down (voltage) or to 0.707 of its DC value, is actually where the impedance of the capacitor is numerically the same as the resistor. So you can work out that frequency from:-

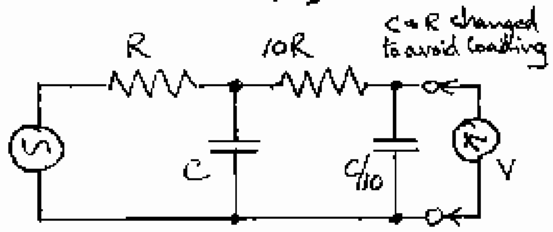
$$f = \frac{1}{2\pi RC}$$

f in Hz
R in Ohms
C in Farads



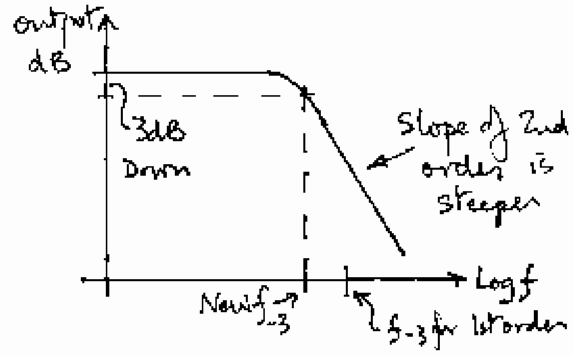

FIRST ORDER LOW PASS

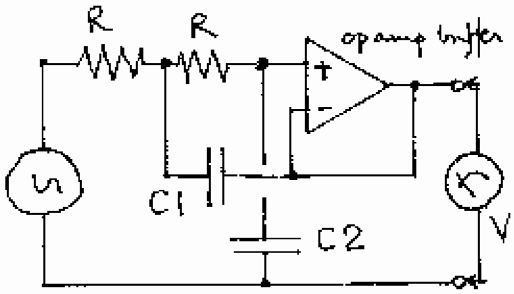



SECOND ORDER LOW PASS

If you now connect two of these CR networks in series to form a second order network as shown right, then the frequency where the response is 3 dB down is slightly lower (for the same CR product values) and the rate at which it falls off as frequency increases to 12 dB per octave or 20 dB per decade. Generally this form of second order filter is *not* often used, but an active one with some feedback mechanism is much more interesting! The third circuit shows one using an op-amp connected as a unity gain buffer. (You can use an emitter or source follower stage instead.) I have omitted the op-amp biasing for clarity. It is now possible to make the response have a peak as shown right where the Q (or sharpness) of the peak depends on the CR values. If the Q is greater than 1, there will also be some voltage gain on the peak! This is the sort of filter that is used to narrow the audio bandwidth of a DC RX to make it suitable for CW purposes. The following formulas apply:-



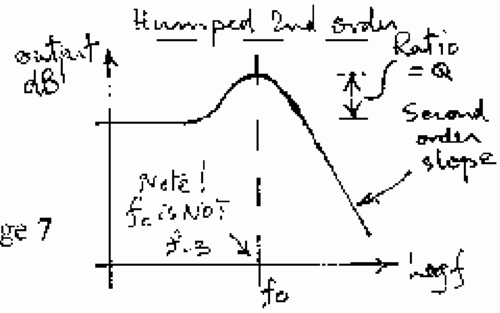




$$f_0 = \frac{1}{2\pi R\sqrt{C1C2}}$$

$f_0$ in Hz
R in Ohms
C in Farads

$$Q = \sqrt{\frac{C1}{C2}}$$

C1 & C2
in same
units.




**Useful stuff! Tim G3PCJ**

## Snippets

*Phono Plugs* Jim Gearey writes of the good suitability of these low cost plugs for RF purposes but warns that, because the central pin is supported by plastic, it is advisable when soldering them to have it installed in a socket to maintain the pin alignment while the plastic is soft. He sometimes also finds it necessary to file their tags to make the solder tin well.

*VFO Enclosures* John Teague comments that he puts his main oscillator resonator parts (L and C) in a die-cast box separate from the rest of the circuitry. This separates the heat source and improves stability. However, do give plenty of space around the coil! I think I have read that the gap between it and any metal work should be at least two coil diameters! If not, any RF currents in the box walls will alter the inductance and hence tuning. Years ago I had a chirpy transmitter, that I eventually traced to output RF currents at same frequency as the VFO getting into the walls of the VFO compartment. Tim G3PCJ

## Somerset Supper

Steve Hartley, the Radcom Newcomers columnist, very kindly came along and took a very keen interest in the diner's entry tickets! For those who haven't been before, diners had to bring an item of home built gear with them as their entry ticket; these were displayed and a couple of prizes awarded. This year the standard was very high and there was a tremendous range of 'items' on display. Bob Woolridge G7LNJ was presented with the first prize – an appropriate bottle of Somerset cider brandy for his masterpiece - an oscilloscope made from a World War 2 surplus radar tube surrounded by lots of glowing valves! Although Bob was willing to demonstrate it, no suitable power source could be found for any of the signal sources also on display! Jim Gailer G3RTD earned high praise, and the runners up prize, for his surface mount DDS based signal source for 2m satellite working.


The provisional date for the 23rd QRP Convention is April 15th 2007 and I am expecting that Ben Nock of PW fame will be our

# Subscriptions!

I am afraid its that time again! If you wish to continue receiving Hot Iron, let me have your cheque for £7 before Sept 1st for the next issue. I still have loads of crystals which I am unlikely to make any use of, so let me know if you would like any of the following frequencies - free apart from the packing & postage - as many as you like within reason! I will send these out (when I am here - see front page) on receipt of your sub so please add two first class stamps for the packing/postage of the crystals or increase the sub figure to £8. The following are available:-

Parallel Resonant – MHz - 5.0688, 5.6914, 5.752, 6.0177, 7.20, 9.30, 9.60, 10.2775, 10.44, 11.0258, 12.73819, 14.84830, 15.375, 16.5888, 16.623333, 17.9, 18.26, 20.105, 20.78

Series Resonant – MHz - 15.0, 18.0, 20.0, 21.0, 24.0

I have some TTL oscillators (sq wave output) £2 for P & P please - MHz 24.0, 30.0, 32.0

# Send off your cheques now!

But don't forget I am out of circulation for most of July!

"JOURNAL OF THE CONSTRUCTORS CLUB"

# Hot Iron

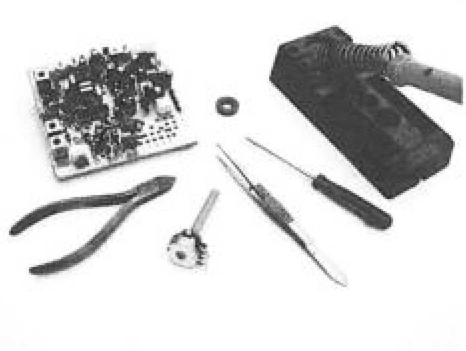
Autumn 2006
Issue 53

## Contents



The Walford Electronics website is also at www.walfordelectronics.co.uk

## *Editorial*



Back from work temporally abroad at a farming Conference in Canada (with a little bit of a holiday there as well!), I am finding it very hard to get going again on any serious work! I was not pleased to find that back here, my solar charged batteries were completely flat (due to a light being left on) and not accepting any charge from the panel. After several hours on a powerful mains charger they have crept back to life! It remains to be seen what permanent damage will have been done and if anybody knows about resuscitating deep discharge gel cells I would be pleased to know.

The batteries did however come into their own (powering our AGA cooker) a few days ago, when lightening stuck our local 11 kV overhead lines and took out one phase. All the alarms went off for miles around - I was certainly not going out to turn mine off! Our Post Office still had at least one modem dead 7 days later! We had just had a lightening conductor installed (before the storm) on our 500 year old church, which has never been struck, so perhaps there is a lesson to be learnt there! Tim Walford

## *Kit Developments*

I regret that I have done very little except get the three items of test gear working and written up for PW since I was last typing for Hot Iron! The very next development job is the Brean and then the All Band VFO and Signal Generator. (Please don't give me any more new rig suggestions before Christmas!!) The Test gear items are all for use in 50 Ohm systems - a 20 dB switched Attenuator with 1 dB steps, a Dummy load indicating Power meter (with ranges of 50, 500 mW and 5W FSD), and a PCB with two separate wideband 10 dB RF amps. £19 each or all three for £57 P& P free.

After that I am less certain, as ideas for the Pylle CW TX are beginning to crystallise, possibly using the All band VFO; this might also be a suitable test bed to try out some ideas for the Minster.

Meanwhile the sky is looking distinctly threatening - I ought really to be outside installing some land drains out in the field where a tractor nearly got stuck back in the Spring! Doing a little of Hot Iron looks to be somewhat easier!!

Regards, Tim G3PCJ

***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 

## ***More Diode Abuse!!*** by Richard Booth G0TTL

Since the last edition of Hot Iron, my experiments using standard diodes as varactors have continued. Previously I concluded that red LED's and the 1N54 series of rectifier diodes had the best potential for use in VFO circuits. With this in mind the next thing I wanted to look at was the frequency stability of such devices when used in a standard Hartley oscillator.

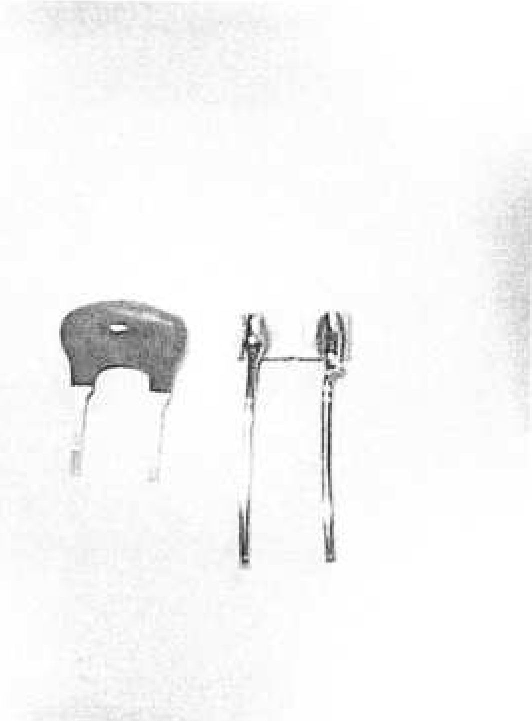
A well regulated and filtered supply is essential for any kind of frequency stability when working with genuine varactors or substitutes. Being able to deal with temperature changes is the other big problem, luckily though there are quite a few different types of capacitor which can be used in the oscillator to counteract changes in diode capacitance due to temperature fluctuations. The theory is that by using a capacitor with the opposite temperature coefficient to the tuning diode and inductor you can attempt to cancel most of any frequency drift out. Negative coefficient ceramic N150 capacitors, and polystyrene ones are good for counteracting positive drift, which normally occurs in resistors or inductors. COG and NPO ceramics are the other useful types for stabilising oscillators, having negligible changes in value over a wide temperature range.

My latest project which is half built now, is a direct conversion receiver that uses a varactor tuned oscillator running at 6 MHz, this in turn is mixed with cheap ready cut computer crystals and filtered to generate the local oscillator frequency. This scheme covers all the traditional HF bands and a couple of the WARC allocations too. The prototype hopefully will cover 4 bands. More on this later! My specifications were a 6 MHz VFO with a minimum 300 KHz bandwidth. Using much the same circuit as described last time for test purposes, I constructed another oscillator complete with the extra supply filter and regulating components. Fourteen turns on a T68-2 toroid makes up the oscillator coil together with a tap at three turns from earth. This had it running at 6 MHz in no time at all. For starters I used a 5 mm red LED as the tuning diode. It turned out to be a good choice as I managed to get about 300 KHz swing out of the circuit without too many capacitor value changes. Using a combination of COG and N150 ceramics as the VFO resonators I was surprised just how stable this little circuit could be. After allowing the board to settle down for a few hours any drift, according to my counter, was in the region of 10's of hertz! From switch on as expected the oscillator drifted about 2.5 KHz over the first few minutes, after being on for 15 minutes you could adjust the frequency and after a moment settling down a high level of stability was achieved. The acid test that I like to perform is to listen to the output on a good communications receiver. Over a one hour period once tuned in I did not have to adjust the tuning control on the RX at all - to my ears listening in CW mode I didn't notice any change in pitch either, which backs up the previous findings of the frequency counter. Blowing on the tuning LED caused the output frequency to increase slightly - this is quite an extreme test though! The experiment was then repeated using a 1N5406 diode which I had to hand. This produced a wider frequency swing than the LED, although slightly less linear at the extremes of tuning. To keep things comparative I used exactly the same resonating components. The results here were not quite as impressive as the LED, however still quite acceptable. Initial drift at switch on was about 4 KHz. After 15 minutes this settled down to around 400 Hz over a 10 minute period, and much the same after changing frequency. After 1 hour of operation this improved to around 150 Hz over 10 minutes. Blowing on the diode made a big shift though, I think possibly due to the physical size of the component more than anything else.

The construction of LED's makes them almost double glazed and quite well thermally protected. Based on these tests I've built my 6 MHz VFO using standard high efficiency red LED from Maplin. It's working a treat - more on this project next time.

Richard, that looks very promising and we look forward to hearing more. Could you also see what the oscillator does when you change the supply voltage, and or change the load on the regulated supply line due to some other circuit that might be sharing the regulated supply? My experience suggests, that for an ambitious project like yours, you need better regulators than the 78L0X series - something like the 317L. Tim G3PCJ

## *Ceramic Resonators for 80M Phone*



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Where it is essential to maintain mains supplies, such as to emergency operating equipment in hospitals etc, the available solutions are becoming more high tech! Often a standby diesel engine powered alternator is provided to carry the main load some minutes after the normal mains fails but what is best to keep the gear going during that transition? Traditionally the load would have been powered by a bank of lead acid batteries feeding a rotary, or nowadays, a static inverter. This might have been kept on line all the time, ready to supply power instantly, with the batteries being trickle charged from the mains. But lead acid batteries are bulky and not very friendly items in our environmentally concerned world! Super-capacitors, featuring many Farads (yes - whole farads!) of capacity are now available and are used in all sorts of applications where high integrity short term supplies or energy storage are needed. They can be used as direct replacements for the lead acid battery in standby supplies to bridge the gap while an engine is started.

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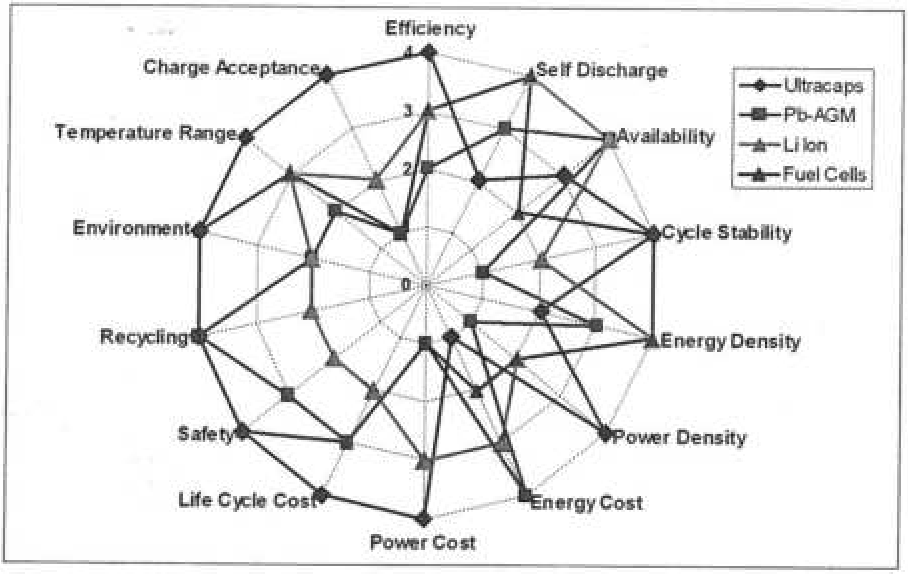


## ***Resistor selection for the Home Constructor*** by Gerald Stancey G3MCK

Resistors come in many forms but for the home constructor there are really only two characteristics that matter; these are resistance and wattage. Lets look at each in turn.

The resistance is usually written on the resistor or coded onto it by different coloured bands. The former method of identification usually gives very few problems but the latter can cause difficulty, For example which end of the resistor do you start to read the bands and what are the colours - not just what do they mean but can you tell the red from brown in any light? Apart from enabling you to determine its resistance the colour coding may also give data such as the tolerance. Oh for the old days when the body, tip spot system was used and life was simpler.

Tolerance means how close to the marked value the resistance will be. In general modern resistors are usually within 5% of their marked value and a good circuit diagram should give the tolerance of the resistors that are used.

I find that the best way of handling resistors is to measure their value on my DVM (digital voltmeter). This avoids having to decide whether it is a brown or red band and from which end to start. Lets look at a practical example, the circuit diagram specifies a 47K 20% resistor. This means that any value between 37.6K and 56.4K can be used. Hence all you have to do is to look in the junk box for a resistor in that range. A word of caution, resistors can change their value with age/use so it may be a little 'iffy' if the marking says that it is 33K and measures 38K, but for the junk box king taking risks like that is part of life's rich tapestry.

Wattage is a difficult parameter to establish. I know of no way that this can be established by visual inspection or non-destructive testing. You may be able to get an indication by comparing it with contemporary resistors of a known wattage. If you know anything better then please tell me. Happily needing to know the wattage is a problem that does not often arise for the modern home constructor. The reason for this is as follows. For the modern constructor the highest voltage that he is likely to encounter will be 13.8 volts. The lowest wattage resistor that you are likely to come across is 1/8 Watt. Now let us look at Ohm's Law and similar things. The wattage dissipated by a resistor can be written as:-

$$W = \frac{V^2}{R}$$

Substituting V = 13.8, and W = 1/8, allowing a 50% safety factor and rounding shows that resistors greater than 3K3 need not have a wattage greater than 1/8 Watt. For resistors of less than 3K3 you will have to do a little circuit analysis to see if 1/8 Watt will be enough. Lets look at a 100 Ohm resistor that is used as part of a decoupling circuit in a 13.8 volt feed line. If this resistor is to dissipate 1/16 W (note the 50% safety factor) then it will pass 25 mA of current so if the stage is drawing less than 25 mA it will be suitable for use. Other examples can easily be calculated.

In the above examples, I have left you to do the detailed calculations for practice. Don't worry if if you do not get exactly the same values as me, remember that I have rounded and used a safety factor of about 50% and then chosen a close preferred value. For those who wish to have more rules of thumb, the following table maybe helpful:-

| Wattage | Ohms |
|---|---|
| 1/8 | 3K3 |
| 1/4 | 1K6 |
| 1/2 | 1K |
| 1 | 470R |

This shows that all 1/2 Watt resistors whose values are greater than 1K can be safely used in 13.8 volt circuits.

## *Tolerance and how many resistor bands?!!*

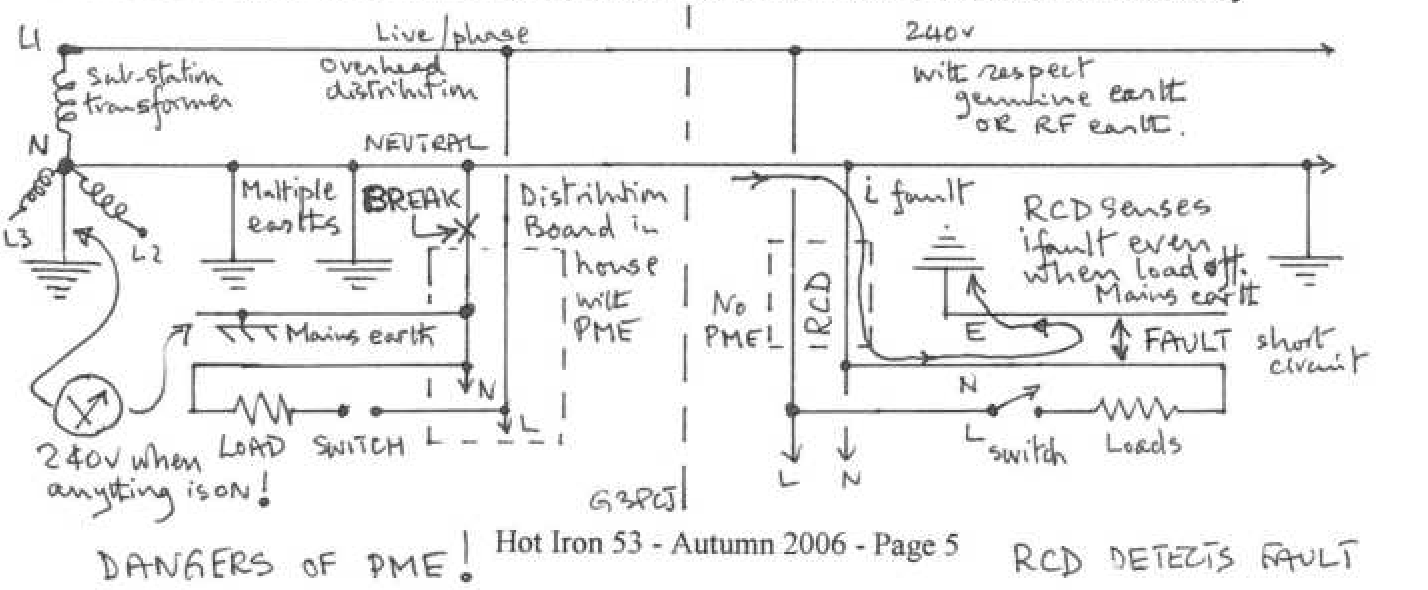
Modern resistors with only **four** colour bands will probably have a tolerance of at least 5% whose value will be in the sequence 1, 1.2, 1.5, 1.8, 2.2, 2.7, 3.3, 3.9, 4.7, 5.6, 6.8, 8.6, 10 ..... etc. Starting from the colour ring nearest one end, the ring sequence will equate to body, tip, and spot - the value is a.b times $10^c$ with the fourth ring signifying the actual tolerance. If it has **five** colour bands then it is likely to be 1% tolerance with markings that mean a value of ab.c times $10^d$ plus the fifth ring for tolerance which is very confusing! I try to avoid five ring types!! G3PCJ

## ***Another reason for using RCDs!***

Members may recall that I have long advocated the use of Residual Current Devices on your incoming main 50 Hz distribution board, especially where the mains earthing is provided by PME (protective multiple earthing). This is especially important for installations with radio equipment that have genuine low impedance connections to the real earth through the radio installation 'earths'. Using a RCD, which detects small differences between the current in the live/phase wire and the return neutral wire, allows the mains earth to be provided by a suitable local earthing rod or spike. Under normal circumstances, the phase and neutral currents are equal so that the RCD is unable to detect any difference and the circuit stays powered. If there is a small difference, due to poor insulation/leakage or short to something else, then the RCD turns off the circuit. RCDs are available to detect differences of 30 mA where there is a risk of electrocution — typically on 13A socket outlets, or of 100 mA where the concern is fire. 300 mA RCDs (often with delayed tripping characteristics) are used to give further protection to a whole 3 phase installation. Using a RCD, with the mains earth provided by a suitable spike, means that there is unlikely to be any chance of a significant 50 Hz voltage being developed between the enclosures of mains earthed equipment and anything connected to the genuine earth via the station's RF earth system. However it is advisable to not directly connect RF and mains earths even if an RCD is used.

Where PME mains earthing is used, the mains earth is provided by a direct connection of the house earth wires to the incoming neutral, on the assumption that this is very unlikely to ever become 'live' (due to its multiple actual earthing). It is normal practice anyway to bond all metalwork that might become live (through a breakdown of insulation, eg in a central heating pump) to the mains earth terminal block; the purpose of this is to ensure that all exposed metal work in the house will be at the same potential and hence there is a much reduced risk if a person touches a mains earthed cabinet and the central heating pipes. The drawback to this scheme is what happens if the incoming neutral, that is providing the PME earth, happens to get broken or is accidentally switched with the live phase wire! The consequence is that everything becomes live with respect to genuine or RF earth!! Hence the warning that one should not be able to simultaneously touch mains earth and RF earths in a PME installation!! Failure of the incoming neutral is not unknown (especially with overhead rural distribution) and I have had direct experience of the incoming neutral/phase live line being reversed (thankfully there was a spike and RCD protection)! If you are unsure what sort of mains protection you have, make certain that mains and RF earths are separate and well insulated! This is a point for Antenna Matching Units!! The diagram left shows how things can go wrong! Take care and consult a good electrician if in any doubt!

After the recent thunder and lightening, in one local property the RCD would NOT switch on even when all the individual circuit breakers were off! Previous experience told me this would be due to a short between an un-switched, or not isolated, neutral wire somewhere in the whole installation and the mains earth . Disconnecting the neutral leads of all circuits together then allowed the RCD to stay on (but with northing working!). Only disconnecting and testing the circuits one by one eventually revealed which had the neutral to earth fault - in fact the lightening had caused an insulation failure in old hidden perished rubber covered wires which had 'fused' together - see right. Without the RCD, this short caused by the lightening would not have been detected! G3PCJ




DANGERS OF PME!  RCD DETECTS FAULT

## *Alderney's Electrics and Communications* by Chris Rees GU3TUX

Living on a small island emphasizes one's reliance on effective communications. Barring some dairy products, Alderney imports all of its needs by sea and air. Not infrequent fog can disrupt flights and the flow of mail, newspapers and perishables. Prolonged gales can delay delivery by sea of just about everything else. A well stocked larder is reassuring when the weather turns nasty.

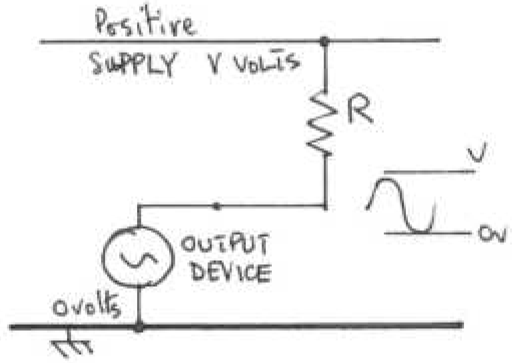
Moving on to the sort of communications which interest readers of 'Hot Iron', we start with the electricity supply. This is locally generated by diesel driven alternators. The price reflects movements in the cost of oil and is currently around 18p per kWh. QRP operation definitely pays! There is a long term project to harness the power of the strong local tides, but in the meantime I use solar where I can and have invested in low energy lighting. Mains voltage routinely fluctuates +/-5V from nominal 235V – I discovered this when investigating the reason for my FT817 constantly switching to half power TX, which was due to lack of volts from a poorly regulated DC supply. Mains frequency can also vary as witnessed by poor timekeeping of mains-locked clocks. Supply interruptions are, thankfully, rare.

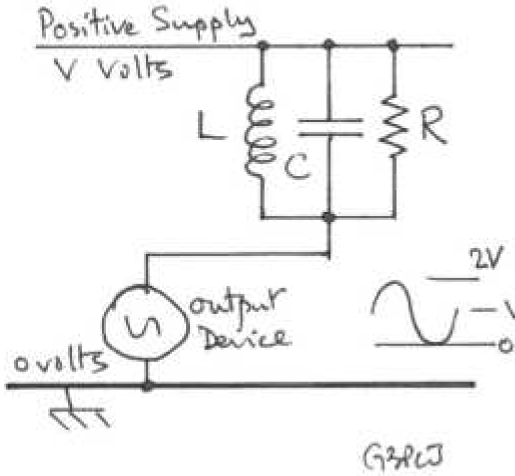
Being surrounded by the sea, the island is particularly subject to disturbances to VHF and UHF propagation. I'm no more than a mile or so from the local TV repeater and Band 2 BBC Radio Guernsey TX, but both are often subject to severe co-channel interference from French mainland stations. Best band 2 FM reception is usually had from West Country transmitters, rather than Jersey. 'Sky' satellite installations seem to be favoured by the majority of the viewing population. Interestingly, on 2m, the GB3ANG Dundee beacon is frequently a better signal than GB3VHF in Kent.

The telephone service is supplied by Cable and Wireless based in Guernsey. The link is by microwaves to that island and thence by undersea cable to the UK mainland. Alderney has broadband, most likely driven by the presence on the island of several on-line gaming operations which benefit from the favourable tax regime. 2.5G mobile phone coverage is offered by both C&W and Jersey Telecom (Wave). The only hiccough here is that at certain points on the island my mobile finds a stronger signal from France and QSYs accordingly! Unless you pay attention, you can end up inadvertently paying roaming charges for local calls.

Before the microwave telephone link was installed, an 80 MHz system was in use. This used 4 stacked wire rhombic aerials of multiple wavelengths. The gain must have been pretty staggering. I've recently rented the old equipment hut as an alternative shack for my VHF/UHF operations. The site is excellent with a sea path to everywhere except the South West.

## ***Theory - Rig Output Power***



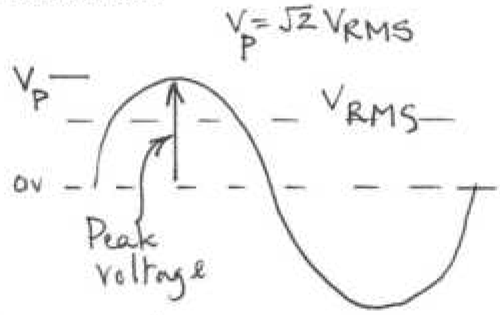




A customer recently commented (before purchase!) that the Brent, with its 1.5 Watt twin BS170 output stage, would be a good candidate for an upgrade with much higher output, by changing to an IRF510. So what determines a rig's maximum output?

Consider the simple circuit top right. An output device, bipolar or MOS is driving a plain resistive load R Ohms in series with the positive supply of V volts. The lowest voltage that the output can achieve is 0 volts when the device is hard on; the highest output voltage is just V when the device is turned fully off.

What happens if we now add a parallel tuned circuit across the load resistor as shown in the next circuit? If the signal from the driving device is turned off quickly, the presence of the inductance will cause the output circuit to ring at its resonant frequency. In a practical transmitter output stage the driver will operate at the desired radio frequency; and the tuned circuit will usually be resonant at the same frequency. At maximum output, the device will cause the output voltage to just reach 0 volts on each half cycle, and on the other half of the cycle the voltage will go above the supply rail by the same extent as it went below. The output voltage thus swings actually between 0 volts and twice the supply rail, so that it has a peak ac output voltage equal to the supply voltage V, which is sitting on a DC pedestal of V volts also! Practical output networks remove the DC aspect by capacitive coupling so that the we are now only concerned with an ac signal of amplitude V volts peak into the load resistance R.

We all know (or should!) that the power dissipated in a resistor is the product of the voltage times the current, but the current is voltage divided by the load resistance so that the power can alternatively be expressed as voltage squared divided by the load resistance.




In an ac circuit, one uses the RMS values of current and voltage to work out power, so what is the RMS voltage for our signal whose peak voltage is V? The peak voltage of a sinusoid is square root of 2 times the RMS value (see right), so the RMS figure is the peak divided by root 2. Substituting, the power then becomes the peak voltage squared divided by (load resistance times root 2 squared). This of course simplifies down to the well known formula:-

$$P = \frac{(V_{RMS})^2}{R} = \left(\frac{V_P}{\sqrt{2}}\right)^2 \times \frac{1}{R} = \frac{V_P^2}{2R} = \frac{V^2}{2R}$$

where the supply is V volts. G3PCJ

What this tells us is that the maximum output from any particular stage is highly dependent on the supply voltage, and to a lesser extent on load resistance. The device power rating does NOT have a direct effect as long as it can make the signal swing to the full extent of the supply voltage. Thus just changing the device to a beefier type will NOT alter the output, unless you also either increase the supply voltage or reduce the effective load resistance! If you put the actual numbers into the above expression you will find that any suitable device(s) with a 50 Ohm direct antenna load on a 12.5 volt supply will produce about 1.5 Watts, or that a beefier device on 12 volts will need a 12.5 Ohm load to produce 5 Watts of output. This lower load can be achieved by using a 1:2 RF transformer or a tuned matching network like the LCC one used in most of my 5 Watt rigs. (While the above is written in terms of a resonant circuit at the output stage, the ringing effect is equally true when a broad-band stage directly drives a low pass filter which is intended to remove harmonics.)

So the conclusion is that just changing the Brent output to an IRF510 will not increase its output, even if all the other considerations like bias conditions had been catered for! Tim G3PCJ

## *Snippets*

*Coherers* The Yeovil ARC has long had an interest in very simple rigs that go with QRP activity generally; and this has included simple diode type detectors. At a recent crystal set event, I recently inquired of one of our elder members about the rectification characteristics of coherers. He wasn't too sure but thought they might just begin to turn on when the applied voltage was over a volt. No wonder radio communication distances were so short in the early days! Even now actually getting over a volt out of your receiver antenna system, and through a tuned circuit, into any form of detector is quite an achievement! And that's with transmitters that might actually be putting a steady carrier of hundreds of kW or even a Megawatt of RF into their aerial, as opposed to a spark making an RF circuit oscillate! So does anybody know what actually are the characteristics of iron filings as rectifiers? Their ears or actual signal low frequency information detectors must have been seriously sensitive! Of course that is why mirror galvanometers were invented (actually a lot earlier than radio) because of the high sensitivity that could be obtained by a very long projection distance for the light beam, between the mirror/magnet hanging on the pivot threat and the scale on which the reading was observed. Anybody fancy making a coherer and measuring it?! Tim G3PCJ

## *Design Challenge!* From Chris Rees GU3TUX

I've recently been coerced into joining the Alderney Railway Society and have even driven the train up and down the line a couple of times, complete with passengers on board! The loco does have dual controls, though. The operation is push-pull with a guard in the leading coach when the loco is pushing the coaches. The guard has control of the brakes which he can apply in emergencies. There are several un-gated level crossings at which the guard uses a bell communication system to signal to the driver when it is safe to cross. There used to be loco to guard telephone communication, but this failed and the 3 wires of this system are now used for the bell circuit.

The Problem. They'd like to restore guard to loco cab voice communications whilst retaining the bell signalling system. This has to be achieved with the existing three conductors (no earth return available), including powering the loco end of the circuit from a 12V battery located in the guard's compartment. The battery is solar charged and the system should not consume any power when inactive. The bells operate satisfactorily from the 12V battery supply - they are (and need to be) loud! It should also be capable of construction by yours truly. PMR radio is not a viable option.

Chris offers an appropriate prize of railway related items - tickets, first day stamp covers etc. I have copied Chris's words direct from his e mail so I can't directly answer any questions; however it seems to me that the key is to somehow liberate one of the conductors from the present 3 wire bell circuit. So Chris, we all need to know how these bells are connected and used. I also wonder why a return path (perhaps of poor quality but good enough for fail safe bells) is not available through the engine/carriage wheels and track/couplings? Tim G3PCJ

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Whilst doing some component research I've come across a useful ceramic resonator available from Farnell. It's nominal frequency is 3.840 MHz however using a 150 pF variable capacitor it will pull right down to 3.710 MHz without any problems at all. I've tested this component in both the Sutton and Compton kits with superb results. The only slight snag is that it's a surface mount part, however it's actually the same size as the standard component - minus it's resin dip coating. It has three pads which are all plenty big enough to solder wires to, the two outer pads being the ones to use. Ignore the centre pad. I bought quite a lot in to get the overall cost down so if anyone would like one to try out then please send 5 second class stamps to Richard Booth, School House, Old School Lane, Wadworth, Doncaster, DN11 9BW and I will pop you one well packed in the post by return. I'm more than happy to solder you on a pair of legs for PCB mounting - just ask. The FEC part code is 117-0427

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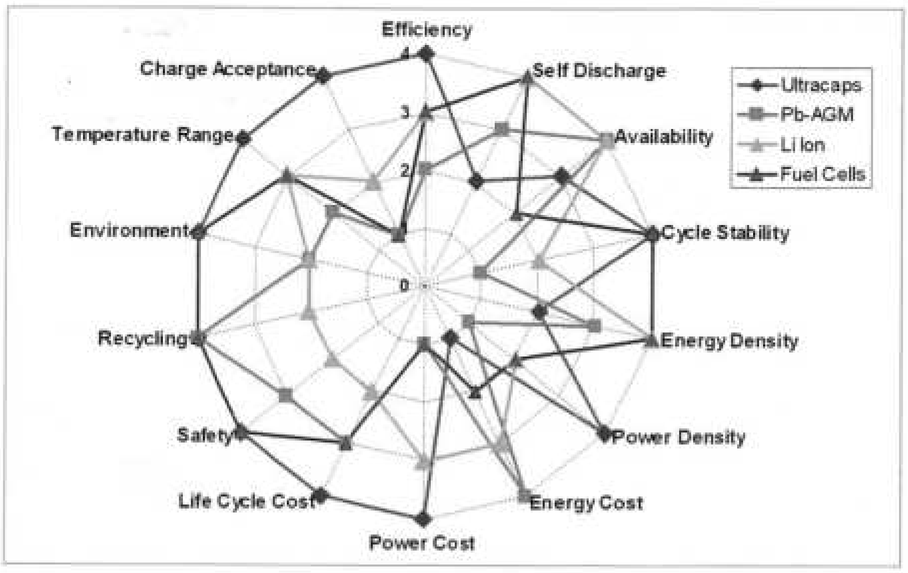


"JOURNAL OF THE CONSTRUCTORS CLUB"

# Hot Iron

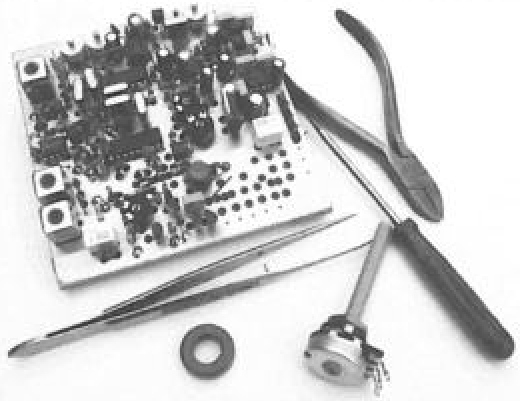
Winter 2006
Issue 54

## *Contents*



The Walford Electronics website is also at www.walfordelectronics.c

## *Editorial*



Here we are at the start of the 14th year of Hot Iron - I would never have guessed that we could keep it going that long! Two long time supporters Andy Howgate and Richard Booth felt we ought to celebrate in some manner, and had themselves not seen all the early issues, so they hatched the idea of an 'anniversary edition' containing all back issues. This paper version of HI54 is not that but the special will come to you on CD! It should be despatched before Christmas!

Richard has done a really splendid job putting together all the material, which has involved scanning all earlier issues, sorting a collection of photographs of my rigs - ancient and modern, as well as some most welcome ones from other builders, getting some old material from PW (as I have worked with them), writing some software and getting it all produced on CDs for all current members. Thank you very much Richard. Tim Walford

(A word of warning! My early writings in HI 3 on measuring SSB RF power were wrong - so don't take everything as gospel - it was corrected later!)

## *Kit Developments*

The **Brean** is now out and available, with an article in the Dec PW. It is a small double sideband suppressed carrier phone *transceiver.* It can be used on any single band 20 to 80m and produces 1.5 Watts peak on a 13.8 volt supply. It costs £44 plus £3 P and P. For the higher bands, you can either use a crystal with a very limited tuning range, or add the Mini Mixer kit which transfers the normal 80m tuning range up to the higher band. I have also now got a few early All Band VFOs (**ABLO**) ready. This provides a digital output, suitable for driving the LO of a direct conversion RX (diode or 602/1496 types) for all the traditional harmonically related bands. I explained the concept in Hot Iron 52. It can be used to drive an all band CW TCVR such as the forthcoming Pylle. It costs £49 plus £3 P and P. It can also be used with CW and phone phasing receivers! See later.

After that, I am preparing a signal generator, the Pylle CW TX and Minster. I am also working up ideas for a good DC RX to replace the Sutton (which has been retired); this is to be called the Knole and would be any single band 20 to 80m but with a better performance than the Kilve.

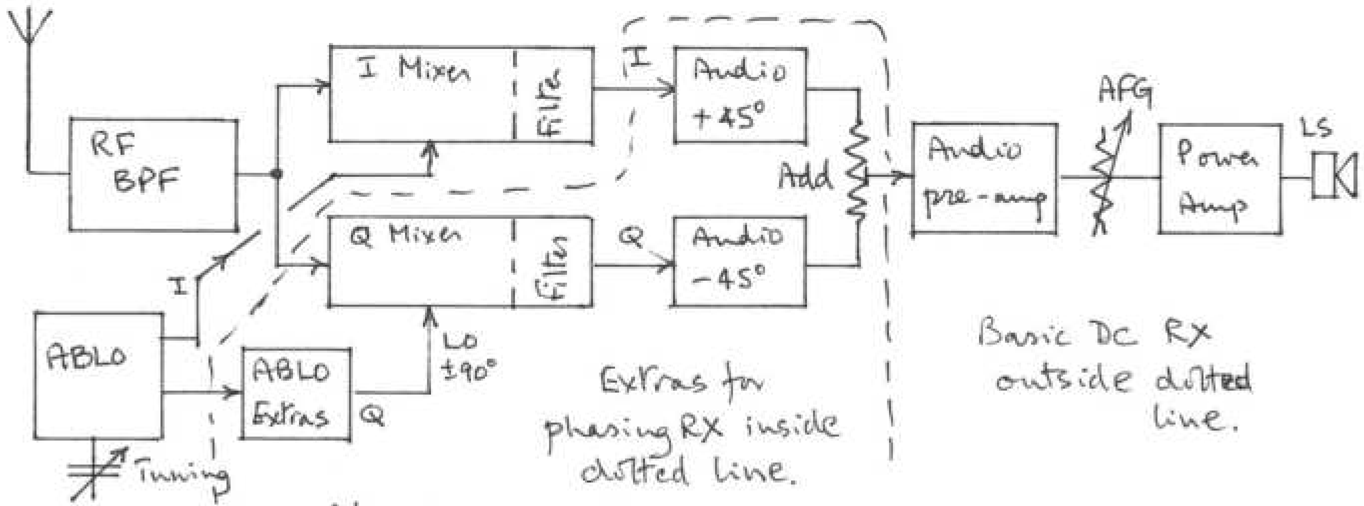
Meanwhile it is still raining and I ought to be outside sorting our ewes and lambs! Christmas is not far off, so **I wish you all a very happy Christmas and the very best of health,** Tim G3PCJ

*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

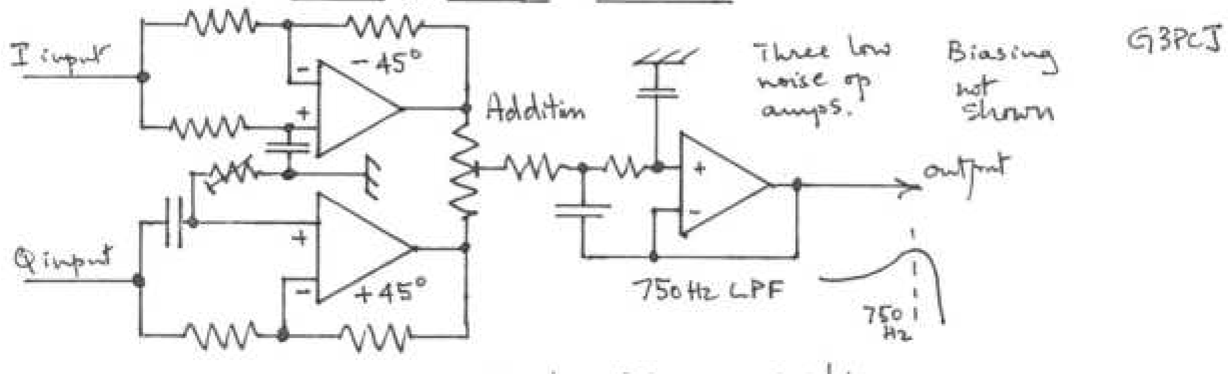
## ***Phasing Receivers***

The phasing approach is another method of removing the unwanted sideband when an incoming wanted signal is mixed with a local oscillator. It is normally used in conjunction with direct conversion receivers, because superhet receivers usually have a narrow filter which automatically removes the unwanted sideband. The phasing approach avoids this expensive & complex filter, while the DC RX approach can now be made multi-band without too much difficulty.

The phasing scheme involves using two mixers which feed into two audio phase shifting networks, followed by a combining stage that outputs into the rest of a conventional DC receiver. The two mixer channels are often referred to as the I and Q 'channels'. The basic block diagram is shown below. The mixers need their LO signals (at the same frequency) to have a phase difference of 90 degrees. This will cause their heterodyne outputs (the difference between the LO and wanted RF signal) to also have a 90 degree difference in phase. These outputs are then applied to two separate audio phase shift networks which introduce a further 90 degree relative phase shift; the two audio signals are then added together. The sideband which had a relative RF 90 degree lag (say) and then a further relative audio 90 degree lag will be 180 degrees out compared to the other channel, thus when added they actually cancel each other out instantaneously. Conversely, the other two audio sidebands will be in phase and will add enhancing the wanted output. In the design shown below (which is suited to narrow CW audio signals), the audio phase shifting is done by making one channel lag by 45 degrees and the other advance by 45 degrees at the centre of the CW audio filter, thus producing the desired 90 degree relative shift. Audio phase shifters for phone signals can be designed but are much more complex. Only a few extra mixer and audio parts are needed to implement this scheme for CW. It also retains that signal clarity for which DC RXs are renown! I am contemplating a small audio phase shift kit for use with any type of mixer, but my own approach would use two of my standard diode mixer kits. Hitherto, the main difficulty has been to produce LO signals with a 90 degree phase difference. However, the digital approach used in the All Band LO (ABLO) kit makes this quite easy - see the next page. Tim G3PCJ

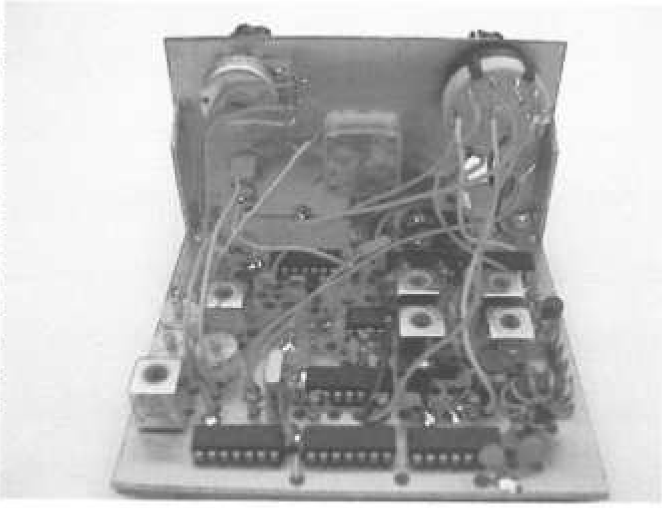



Phasing DC Receiver



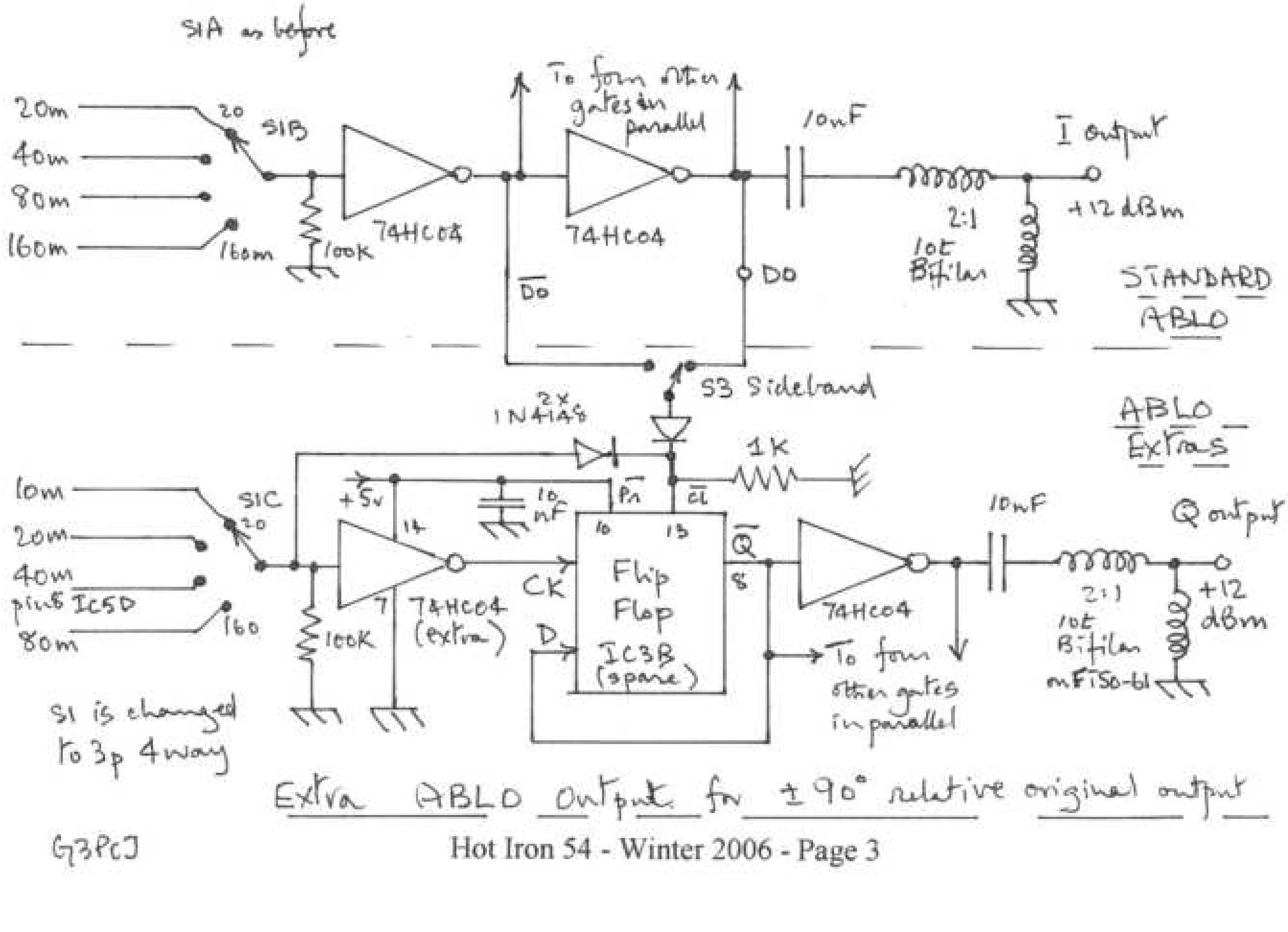

Audio Phase shifters

## ***ABLO outputs with 90° phase difference***



The All Band LO was outlined in Hot Iron 52; it uses a VFO and crystal mixing scheme to produce stable signals at 28 - 29 MHz and 7 - 8 MHz; which are then squared up in digital gates and divided down using digital flip-flops to obtain square wave outputs on 10, 20, 40, 80 and 160m. There is also a 15m output but it cannot be used for driving a phasing RX as we have to start with twice the wanted LO output frequency. For this reason, it also not possible to use the ABLO on 10m with a phasing RX. Hence the ABLO can only be used to produce the required 90 degree different outputs on 20, 40, 80 and 160m. The photo on the right is the prototype ABLO but without any phasing additions.

One output can use the normal signals from the bandswitch, which drive paralleled inverter gates connected to the 2:1 output transformer; this enables it to directly drive a diode mixer if required. The other extra 90 degree output comes from an extra flip flop (actually the spare one in the ABLO) that is clocked with the twice the desired LO frequency, but with an inverted clock to introduce the desired 90 degree difference at the output. (The flip flop divides the frequency by two.) The extra circuits are shown below. The extra flip flop drives paralleled gates and a 2:1 transformer just like the original output. This approach is multi-band, provided the second channel has its two times input frequency also altered to match the main channel - this is most easily done by using a 3 pole 4 way bandswitch instead of the original 2p 6w one. Without further arrangements, the flip flops would have a random relative phase at switch on, hence the pair of diodes driving the reset input of the additional flip-flop - this ensures the same sideband will be selected each time it is switched on. By adding a SPCO toggle to select the alternative phase of the main signal for the reset circuit, it is easy to change sidebands too! I intend to use this ABLO scheme to make a multiband CW transceiver using two diode mixers, the audio phase shifter and the standard audio amp kit in conjunction with the Pylle CW transmitter. More about this on another occasion! Tim G3PCJ



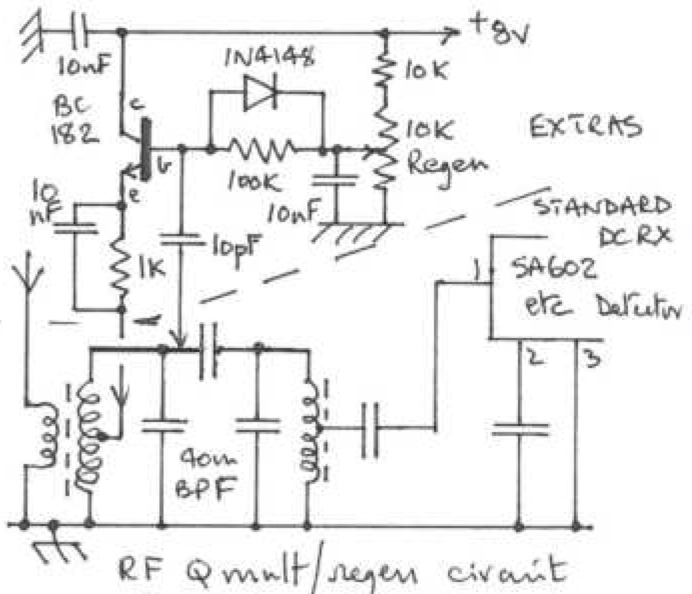

Extra ABLO Output for ± 90° relative original output

G3PCJ

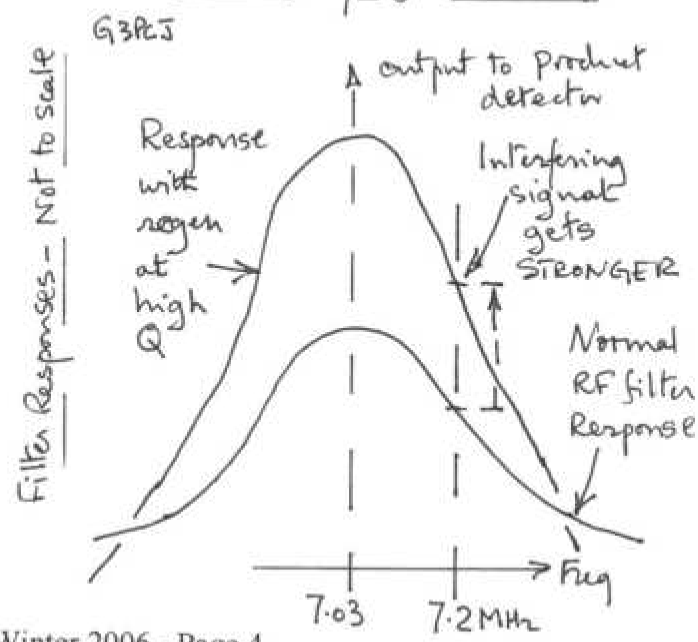
## ***BCI and Q Mulipliers***

Simple receivers (of the DC type) can be prone to overloading of their detector stage from very strong signals just outside the amateur band. This is the classic problem on 40m which can lead to un-tuneable mushy signals all over 40m - particularly at night when the broadcast stations at about 7.2 MHz get going! There are two solutions - firstly use a stronger mixer that is better able to handle the big unwanted signals, or secondly to improve the rejection by the RF bandpass filter of the adjacent unwanted signals. The former approach often requires diode mixers with their high local oscillator drive requirement. Improving the RF filter out of band rejection is not easy either!

However, I thought that incorporating the RF filter into a regenerative or Q multiplier stage might be the solution! Its quite easy to make a parallel tuned circuit regenerate by adding a few CRDs and a transistor. The technique is to introduce a little positive feedback so that the stage is just below the point of oscillation. This needs to be very carefully controlled for the best effect, otherwise there is likely to be either no advantage, or it will be actually oscillating! This must not happen because it might radiate and will certainly introduce extra heterodyne whistles! Luckily the point of oscillation can be carefully controlled by adjusting the bias of the extra regen (oscillator) stage. Only very small changes in bias (or other circuit/load) conditions can lead to dramatic changes in the effective Q of the tuned circuit that is on the point of oscillation. As the positive feedback is increased, the Q (or sharpness of the tuned circuit's response) also increases dramatically. It is quite common for a plain tuned circuit, say with a Q of 30 on 7 MHz, to have the Q increased so much that the reduced RF bandwidth then limits the audio sidebands, implying a Q of nearer 3000! I thought this ought to also get rid of the BC signals which would be over 100 KHz away! So I lashed together the circuit right on the front end of a standard 40m DC RX.




It certainly raised the Q alright! But it did NOT get rid of the BCI! This puzzled me for some time until it eventually dawned on me what the real effect of the regen stage actually is! The regeneration was certainly raising the Q and by so doing it was markedly increasing the wanted signal right on the nose of the filter; but crucially, it was also always raising the strength of the off-nose signals - but not so much as for those on the nose because that would imply no change in Q. This is shown in the lower diagram which shows the change in filter response as Q is increased.




Thus the interfering signals presented to the following product detector were not getting any weaker - the opposite in fact; the wanted signals were much stronger but the BCI was still there because the unwanted was not made any weaker! One would have been able to reduce the gain of the following receiver audio stages but the BCI would just have been less noticeable!

The proper solution has to reduce the level of the unwanted signals presented to the product detector. Often this is done by attenuating all input signals, when a small reduction, totally removes the BCI leaving the wanted in the clear. Thus we come back to improving the out of band rejection of the RF filter. One approach is to add a third resonator to the RF filter and this is what I propose for the forthcoming Knole single band good DC RX. G3PCJ

## ***Mains earthing and RCDs (again!)***

Steve Hartley took me to task about my earthing suggestions last time! He observed that there is an official advice group who has looked at this for the RSGB. ***For all readers of Hot Iron, I must bow to the advice of the legal experts and insist that you consult and take the advice of the relevant electrical professionals — not me.*** I write the following notes in the hope that it will help you to closely question any person who you do consult. In some particular circumstances (and I am specifically avoiding stating which circumstances!), their advice is to is to bond RF earths to the mains earth with suitably stout cables. For my own uses (and you must not copy me but just closely question any professional and form your own decision based on their advice), I shall not bond my RF earths to the incoming PME earth terminal. The reason is that I don't want all the local neutral current (potentially many 10s of Amps) zipping down my RF earth if the neutral to this house is broken - it is carried overhead on poles and might get broken by a hedge trimmer or whatever! I much prefer to have my mains earthing done by my own RCD and local earth spike. I doubt there are many RF earths that could safely take even 10 amps of 50 Hz, let alone 100A!

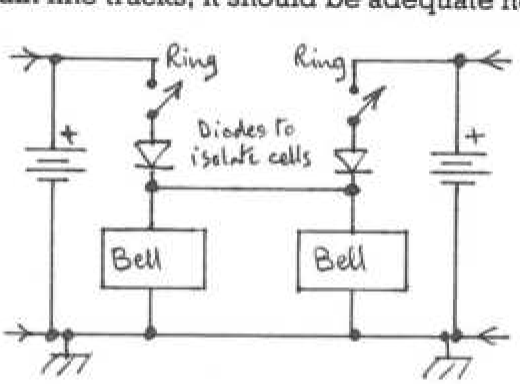
I remain convinced there is some confusion in these matters! Steve recounts that recently 3 students followed the industry advice about bonding of RF earths and found that the protective devices kept tripping - I am not sure what they were in these installations. They were professionally checked by electricians; eventually it was found that in all 3 cases there were several volts (at 50 Hz) in difference between the local mains neutral providing the PME, and genuine RF earth. (This is not surprising on a heavily loaded local mains distribution transformer.) I don't understand why completing the bonding should cause the RCD (residual current device) to trip because the current flowing between the 'few volt high' neutral and RF earth should not flow through the RCD anyway; nor should it flow in any MCB (miniature circuit breaker) that is in the outgoing live (or phase wire) to any particular load. The MCB is there as a modern equivalent of a fuse, and only fitted in the live or phase wire, which is intended to protect the wiring (and maybe the load) from excessively high currents flowing via the correct path back to the supply neutral. If some of that current escapes to earth, the missing difference should be detected by the RCD if fitted (and maybe the MCB if its sufficiently high), which then causes the RCD to disconnect the circuit. In the cases mentioned by Steve there are some unexplained funnies - possibly some unwanted and irregular leakage path between a circuit neutral (ie after the RCD if it was fitted) and the associated circuit mains earth. (This is the difficult scenario that I mentioned last time, where lightning broke down the insulation between a load circuit neutral and mains earth, causing my RCD to trip! This fault can only be found by disconnecting the individual circuit neutrals until the fault is removed.) Enough - take the advice of others! G3PCJ

## ***GU3TUX's Design Challenge!***

I regret that nobody really rose to Chris's challenge - only David Rowlands made any comment, and that was not too complimentary about using old London Underground stock in Alderney. He commented on their unreliability but I suspect this referred to their own traction arrangements, which are of course irrelevant when being pulled or pushed by a smart green diesel monster!

Chris did explain to me that they use a system of multiple 'rings' with the existing bells to signal different driving or stopping conditions. This uses all three of the available conductors. Ideally two of them needs to be liberated and I cannot see why the rails/wheels and couplings cannot provide a return for a bell circuit. If wheel to rail contact is sufficiently good for detecting the presence of a rail vehicle on main line tracks, it should be adequate here for bells.

Here is a scheme but it does need two batteries. It might be possible to use the engine battery for the cab end? Perhaps easier than running an extra pair of wires through the carriages! G3PCJ



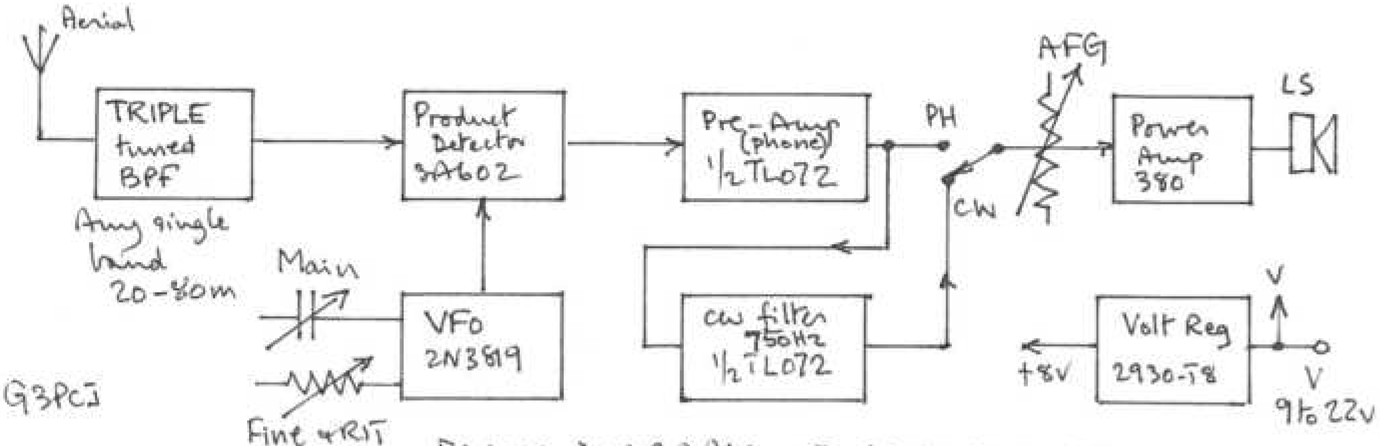

## ***The design basis for kits***

It has been suggested that I explain what goes into designing a kit! My fundamental objective is to utilise technology that is easily 'buildable' (ie not use surface mounted parts normally). The next point is to provide a performance which is good for whatever a particular customer decides he can afford - high or low. Often this involves many re-iterative stages of scribbling in my notebook to devise a block diagram that meets the task and is efficient in terms of parts that are required. I specifically avoid using any part whose cost is way above the general run of parts for that type or class of kits - for example, a filter costing me £15 would be totally out of place in a kit having a target selling price of £30! I also use parts in as many kits as possible for better purchase discounts. I have to use new parts, ordered from reputable suppliers who I can go back to time and again; this makes it impossible to source them from rallies or other non-professional sources. I tend to use the major distributors Farnell, RS and Rapid, with specialist things from a few other firms.

Deciding what the target rig spec should be is the first hurdle. Obviously, there needs to be a range of kits having different complexity so that builders can select projects to match their skills. They also need to address the differing interests of the hobby like phone or Morse methods of communication. Others will be more interested in test gear if their interest is in building projects rather than just operating the equipment. Some will only wish to natter on 160m while others will be avid contesters on 10m only so the question of single or multi-band rigs is relevant! These different 'axes' of interest all cross in different ways and can lead to a gap in any logical sequence along one axis. As a general rule, the higher the frequency of operation, the more challenging it will be to make a satisfactory rig with good frequency stability. This is why I do not currently offer anything over 10m because most builders ability to fault find in the low VHF (and upwards) region is pretty limited. I once did a 2m design which worked as a lash up on plain copper sheet built dead bug style, but it took me ages to get it working properly after transferring to proper PCBs, because my test gear was not adequate for the job.

As an example, I decided earlier this year that I needed a simple direct conversion receiver costing about £20; to provide an alternative and lower cost starter kit to the ubiquitous regen TRF (the Catcott). At this price one has to give up quite a bit so I decided the Kilve RX should only cater for driving phones, not load speakers, and to omit an audio gain control, and to have a simpler RF input filter. By adding a few extra holes to allow alternative part connections, it was not too difficult to make this design suitable for any single band 20 to 80m with just one set of parts - important for minimising my time spent picking the parts to make up kits and to reduce the total quantity needing to be held in store to meet my aim of despatching kits the same or next day. Designing a reasonable receiver is always harder than doing most transmitters - especially for CW TXs. Hence the CW Kilton TX works very well and provides better performance for money than does the Kilve RX!

This has led me to realise that a better receiver is needed for serious use with the K series transmitters. By coincidence the Sutton RX has been around for long enough and should be retired soon, so it became clear that a new good DC RX is required. It needs to be slightly different to anything before and hopefully have some improvements that don't add too much cost! Its going to be called the Knole and its block diagram is sketched below. It will be any single band 20 to 80m design for CW and phone with a proper VFO giving full band coverage and improved RF filters for better BCI rejection.

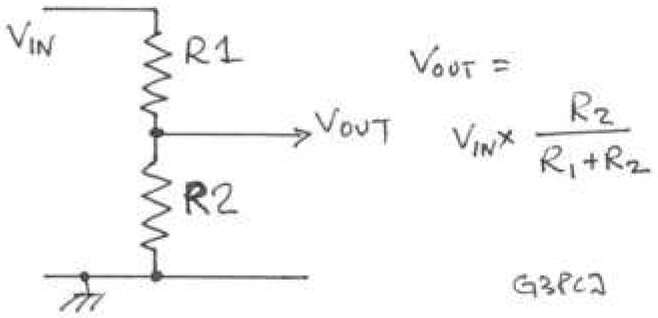



BLOCK DIAGRAM OF KNOLE DC RX

## *Theory - Resistive dividers*

Here is a handy aid to picking resistors from your junk box to achieve a desired output voltage using a resistive divider. It saves having to punch a calculator through the many combinations that you might have available in your junk box! The complete table is based on standard 1% resistors for best accuracy but you can use it with wider tolerance types. The standard 1% series are actually logarithmically spaced in increments of 1/96th of a decade. The complete series of values are shown in the table below for one complete decade - this can of course be for any decade, say from 10R to 100R, 1K to 10K, or from 100K to 1M etc.. The commonly available 1% resistor values are shown in italic bold underlined, but if you have not got these in your junk box, you just search on for another pair that you do have because there are masses of combinations that will achieve your desired voltage reduction.

The first step is to work out a small sum which gives you the number of steps (in the table) between the two resistors that will give you the desired output voltage for your input voltage. See the circuit right where it is assumed that the voltage comes from an ideal zero impedance source and there is no loading from any following circuits. This sum is based on the formula in the box, but you don't have to work that out!.




You need to work out on your calculator, N, the number of steps separating the two values in the table below:-

$$N = 96 \times \log_{10}\left(\frac{V_{IN}}{V_{OUT}} - 1\right)$$

Having done this, round the answer to the nearest whole value; pick a value (in your junk box) for R1 and count N steps through the table and see if you have the R2 value listed at the Nth step - if not try another value for R1 that you do have and try again until you find two values that you have which are separated by the required number of steps! For example, suppose the input voltage is 1.5 and you want 0.6 volts out, the number of steps is 16.9 which rounds (up in this case) to 17. Thus if you stick to the more common values, you could use 1K and 1.5K, or 1.21K and 1.82K, or 1.62K and 2.43K, or 4.99K and 7.50K. Or if N were to calculate to 15.2,that rounds down to 15 and you could use 47.5K and 68.1K etc. I am indebted to the Maxim Engineering Journal for this interesting aid! G3PCJ

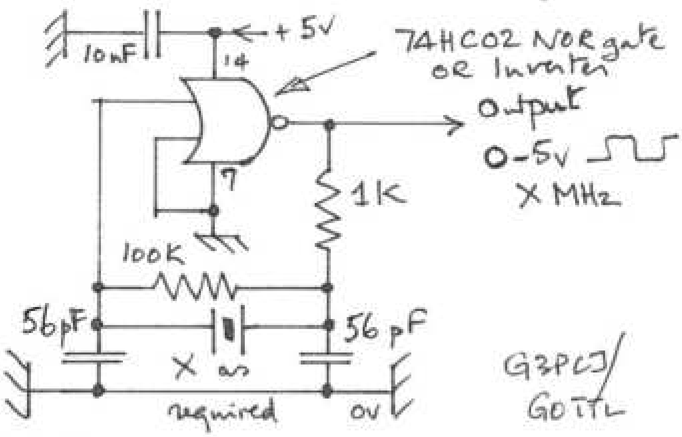
| Steps in table | 0 | 16 | 32 | 48 | 64 | 80 |
|---|---|---|---|---|---|---|
| 0 | ***1.00*** | 1.47 | 2.15 | 3.16 | 4.64 | ***6.81*** |
| 1 | 1.02 | ***1.50*** | ***2.21*** | 3.24 | ***4.75*** | 6.98 |
| 2 | 1.05 | 1.54 | 2.26 | ***3.32*** | 4.87 | 7.15 |
| 3 | 1.07 | 1.58 | 2.32 | 3.40 | ***4.99*** | 7.32 |
| 4 | ***1.10*** | ***1.62*** | 2.37 | 3.48 | ***5.11*** | ***7.50*** |
| 5 | 1.13 | 1.65 | ***2.43*** | ***3.57*** | 5.23 | 7.68 |
| 6 | 1.15 | 1.69 | ***2.49*** | 3.65 | 5.36 | 7.87 |
| 7 | 1.18 | 1.74 | 2.55 | 3.74 | 5.49 | 8.06 |
| 8 | ***1.12*** | 1.78 | 2.61 | 3.83 | ***5.62*** | ***8.25*** |
| 9 | 1.24 | ***1.82*** | 2.67 | ***3.92*** | 5.76 | 8.45 |
| 10 | 1.27 | 1.87 | ***2.74*** | 4.02 | 5.90 | 8.66 |
| 11 | ***1.30*** | 1.91 | 2.80 | 4.12 | 6.04 | 8.87 |
| 12 | 1.33 | 1.96 | 2.87 | 4.22 | ***6.09*** | ***9.09*** |
| 13 | 1.37 | ***2.00*** | 2.94 | ***4.32*** | 6.34 | 9.31 |
| 14 | ***1.40*** | 2.05 | ***3.01*** | 4.42 | 6.49 | 9.53 |
| 15 | 1.43 | 2.10 | 3.09 | 4.53 | 6.65 | 9.76 |

***Sutton Band Cards*** I have recently decided to withdraw the Sutton RX and Montis/Mallet transmitters. I do still have various band cards for that project (3 x 10m, 1 x 15m, 1 x 40m, 1 x 160m, and 4 band card PCBs awaiting any band's parts – except WARC). £10 each, two or more £8 each, plus £3 P and P! Also, four Montis DSB phone TX PCBs! Anybody want them? Stand alone TX? G3PCJ

***Crystal Conundrum*** by Richard Booth G0TTL

Whilst constructing one of the prototype ABLO kits I ran into a puzzling problem. After assembling the 5V supply regulator the first real stage of digital electronics to build is the crystal reference oscillator. This uses a 74HC02 NOR gate arranged as a 24MHz square wave generator - see below. A well proven building block, with a minimum of components it's about the simplest crystal oscillator there is. (You can use just a single inverter! G3PCJ) Not much to go wrong there you might think. It didn't work. If the oscillator is running you would expect there to be 2.5V DC present at the output of the gate - this being the average of a 0 to 5V square wave and of course a whopping great 24MHz signal to listen to on a RX. Not a peep. The output was stuck up at 5V which didn't seem right at all. My first thought was that the logic IC was faulty. Not having a spare one to hand and after discussing this with Tim, the general opinion was it's very unlikely to be the case. Check the gates manually was the reply. So this I did, by removing a couple of resistors on the PCB I carefully applied 5V to the "crystal" input of the NOR gate - whilst watching the output on a multi-meter. As soon as 5V hit the input pin the output went low – nothing wrong with that then. The next thought was to check the biasing resistors, not just by sight but actually test them with a meter. Both were fine, but still no output from the oscillator. Next thought "Give it a bit more persuasion by reducing the value of the feed resistor to 470 ohms". Still nothing. Between the three of us (Andy Howgate had now joined in the quest for oscillations) we were stumped. Surely the crystal was OK. They don't go wrong do they? I didn't have another 24MHz crystal to try so I dug out a new 18MHz type. Soldered it in place but didn't bother to ground the can. I wasn't expecting much to happen when I plugged the power supply in and looked up at the frequency counter. However a glorious sight awaited me. It started oscillating quite happily and just to be sure I tuned into the carrier on my receiver. So it looks like the original crystal is faulty after all. Once again I fitted the 24MHz component back in place, for a final test. I didn't bother to solder the can to the ground plane. To my surprise it was working. What was going on?

Taking a screwdriver and shorting the can of the crystal to ground killed the output, and also solved the puzzle. Out of circuit I measured the resistance between the crystal can and it's two leads. One measured 62Ω, the other several MΩ. Both should really have been at least 20MΩ. In a conventional analogue oscillator circuit this component might have been OK for use, assuming you had the low resistance end connected to ground. However in this crystal oscillator circuit it's useless as both ends should be isolated. The final question to answer is why there was 5V present at the output of the gate when the oscillator wasn't running. It's simple really; as the oscillator wasn't running the gate was operating as a standard NOR. Both inputs were effectively grounded, therefore the output of a NOR in this state is 1 or in other words 5V. Just in case you are wondering, this looks like a one off manufacturing fault. Between us we've tested several more from the same batch of crystals and they all work fine in the ABLO exhibiting excellent insulation properties! G0TTL




## The Somerset Supper and Yeovil QRP Convention

The third supper will be held on April 14th 2007 in Sherborne for locals and those staying overnight. This is the evening before the Yeovil QRP Convention. As before there will be a small display of items from each diner's home built radio equipment! This will qualify you for a ***free*** place at the supper table! The display will be judged by **Ben Nock**, the well known contributor to PW who specialises in World War 2 radio equipment, who is also staying for the Convention. Places by advance booking **only** by Mar 31st so please tell me if want to come. Hope to see it and you! Tim G3PCJ

"JOURNAL OF THE CONSTRUCTORS CLUB"

# Hot Iron

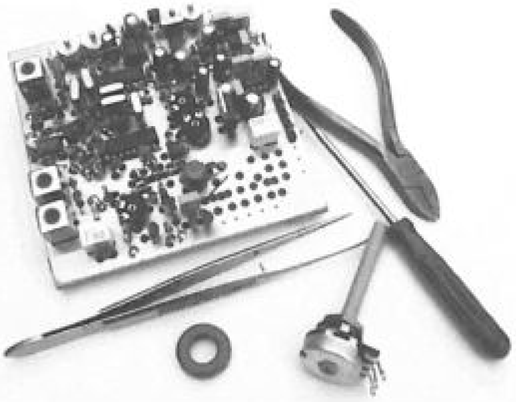
Spring 2007
Issue 55

## Contents



The Walford Electronics website is also at www.walfordelectronics.co.uk

## *Editorial*



Some of you have been kind enough to compliment Richard Booth on his efforts in putting together the CD which all current members should have received by now. Thank you for those comments which I have passed onto Richard. He is a busy fellow with a young daughter, and not all that much time to spare on his several interest, so a big 'thank you Richard'

Recently I have been re-reading some of the excellent books published by the ARRL on technical and construction topics. They are thoroughly recommended. There is a different approach in the US. They go for superior technical performance despite an apparent increase in complexity; whereas most European designers strive for the best performance that can be obtained with a smaller number of parts - in effect seeking the best performance for a lower complexity generally. I have always tended towards the latter because often the extra performance (of US designs) is hardly ever put to the test! But see later about mixers!! Tim Walford

## *Kit Developments*

The All Band VFO (ABLO) is available and will shortly appear in PW. I have been pleasantly surprised how stable it is, and of course, that applies to all bands! It has been invaluable on my bench already. I have also designed (and is available now) a new wide range (200 KHz - 30 MHz) Signal Generator in the small upright format for those wishing to sweep filters etc. The preparations for an all band CW rig using the ABLO have necessitated revisiting my mixers, so I have a new Product Detector with low noise audio amplifiers and filter for CW. This will go with the Pylle CW TX to form a TCVR, but the many LPFs that are necessary, have required small alterations to the normal dual LPF kit for cascaded control. I have also laid out a small single band Regen TRF called the Knapp (derived from the Catcott). The PCBs for the Knole are back but not yet assembled! Both the **Knole** and the **Knapp** can be used with either K series transmitters. The circuits for audio phase shifting (for a phasing RX) are also etched but not tried out! Details on all these kits will be on the website when they are available.

Meanwhile don't forget to let me know if you wish to come to the **Somerset Supper** - see the last page! First come first reserved and places are limited! Tim G3PCJ

*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 

## *Germanium Transistor Troubles* by Richard Booth G0TTL

As some of the readers of Hot Iron may be aware my day to day job is the running of "Past Times Radio" which amongst other things means I am regularly involved with restoration and repair work with what is now classed as vintage radio. Wood or Bakelite cabinets fitted with those funny glass things that glow and give you such a warm and cosy feeling. Transistor radios from the late 50's and 60's are becoming more popular again too, most likely due to their compact dimensions and many recent appearances on TV programmes.

Here in the UK, transistors found their way into the first portable radios in 1957. One of the earliest pioneers of this new technology was Roberts Radio as they launched the RT1. The early Mullard germanium transistors such as OC44, OC45, OC71 and 81 series were used by all the manufacturers to good effect and even to this day 99% of them are still operating to their original specifications. Nothing much apart from incorrect battery polarity or biasing faults will stop an OC44 transistor working. I have even had radios in for repair where direct ac mains had been applied to the 9V battery connections and some of the OC71 transistors survived! However not all things made from germanium turned out to be this reliable.

Around 1961 Mullard developed their new range of high frequency RF and IF transistors which were named the AF114 – 7, and OC171 series. Designed to have higher gain and lower noise than the OC44 series they soon became the industry standard transistor from 1963 until the late 60's when silicon devices started to appear. Just about all portable radios and early transistor communication receivers were fitted with them. So what was the problem? Well at the time nothing was apparent but 20 years into their life and many just stopped working for no obvious reason. 40 years on and this is even more of a common place problem.

How this happens could be due to impurities in the manufacturing process. Microscopic whiskers grow on the germanium wafer which eventually given enough time will either short the collector or base connection to the outer metal can or short the collector and base together. On an AF117 or OC171 transistor the can is usually grounded via the screen connection. This of course stops the transistor working. The same is true for other metal can germanium transistors to a lesser extent, such as the AC127, 128, 177, 178 which although lacking a direct screen connection, they are audio output devices and more often than not clipped into a grounded heat sink.

There is a temporary fix which sometimes works for AF117 or alike. Once you have located the suspect device (if you don't have a multi-meter to hand try tapping the metal can of each transistor with a screwdriver until you find the one that causes a crackle in the speaker - that will be the faulty item!) Snip the screen lead which really isn't required for anything other than VHF use and if you are lucky it will burst back into life. Make sure that no part of the transistor can touches any other metal work on the chassis. This is only a temporary repair though as sooner or later another whisker will grow and shut the transistor down permanently. Another thing you might find happens is that whilst tapping away at the transistor cans, the radio starts to work again. The impact shock quite often fractures the internal whiskers giving another few months of service before a repair is necessary.

The best option is to replace the faulty device or better still replace all of the AF117 or similar transistors. There are several good alternatives that are still available - don't be tempted to use "new old stock" 117's as they are just as likely to be faulty, either new or used. My favourites are the germanium AF124, 125 and 127 which have identical properties to the original devices, without any of the unreliability. AF200's also work well and are especially suited to "factory sealed IF modules" which were common in the 1960's. The pin outs are slightly different so care will be needed when fitting them. Unfortunately though like so many other semiconductors recently this series has been made obsolete. However you can still get them from many component sources including CPC.

Continued on the next page.

## ***Germanium Transistor Troubles*** continued

Here's a trade secret! The repair mans friend, BF450. It's pnp silicon, very cheap and in many cases, assuming a fresh battery is used, will quite happily work in your transistor portable with absolutely no bias adjustments. Yes I know it's hard to believe but this odd transistor does work with germanium voltages. Some re-alignment is to be expected and won't work in everything but I found just about all of the popular portable radios of the 1960's will run on BF450's. One notable exception are the high quality, high gain Hacker radios which will burst into self oscillation without any resistor changes. Better to stick to using AF125's in this unless you really know what you are doing!

Audio stage transistors. As mentioned earlier, AC128's and their derivatives also suffer from the whisker syndrome. It's also worth noting that this type of transistor was fitted well into the 1970's or later whilst the rest of the radio will be silicon based. If you have a radio to look at, and the power connections and switch (and headphone socket) seem ok, but there is no noise out of the speaker try popping the output transistor pair out of their heat sink. If this makes the amplifier work, its time to get the soldering iron out and replace them. Luckily there are no problems getting new components at present and the best thing to do is replace the pair. Remember to put a smear of high temp grease on the new transistors before fitting back into the heat sink.

Finally I am certain that impurities in manufacture are to blame in the AF117 series as I have never come across a single faulty US made RCA germanium transistor of the same type. German made transistors also fair well in comparison.

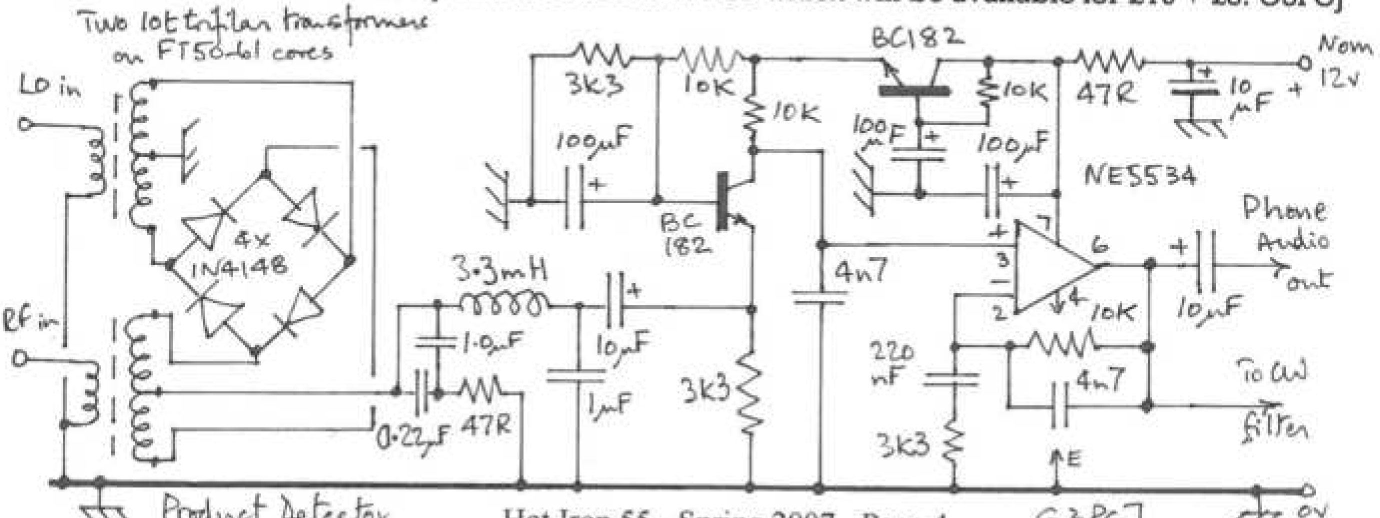
**Memories are made of .....** (I just couldn't resist this - found in the Snailbeach District News! Tim)
According to today's regulators & bureaucrats, those of us who were kids in the 1950/60/70s and even the early '80s probably shouldn't have survived, because our baby cots were covered with brightly coloured lead-based paint which was promptly chewed and licked. We had no child proof lids on medicine bottles, or latches on doors or cabinets and it was fine to play with pots and pans. When we rode our bikes we wore no helmets, just flip-flops and fluorescent 'spokey-dokey's' on our wheels. As children, we would ride in cars with no seat belts or air bags - riding in the passenger seat was a treat. We drank water from the garden hose and not from a bottle and it tasted the same - strange how water tastes just like ...well ...water! We ate chips, bread and butter pudding and drank fizzy juice with sugar in it, but we were never overweight because we were always outside playing. Your Mother MADE ice pops out of dilutable orange drinks. We shared one drink with four friends, from one bottle or can, and no one actually died from this. We would spend hours building go-carts out of scraps and then went top speed down the hill, only to find we had forgotten the brakes. After running into stinging nettles a few times we learned to solve the problem (dock leaves). We would leave home in the morning and could play all day, as long as we were back before it got dark. No one was able to reach us and no one minded. We did not have Play stations or X-Boxes, no video games at all. No 99 channels on TV, no video movies, no surround sound, no mobile phones, no personal computers, no DVDs and no Internet chat rooms. We had friends - we went outside and found them. We played football and rounders every summer - sometimes that ball really hurt. We fell out of trees, got cut, and broke bones but there were no lawsuits. We had full on fistfights but no prosecution followed from other parents. We played knock-on-the-door-and-run-away and were actually afraid of the owners catching us. We WALKED, yes, walked to friends' homes. We also believe it or not, WALKED to school; we didn't rely on mummy or daddy to drive us to school - which was just around the corner. We made up games with sticks and tennis balls. We rode bikes in packs of 7 and wore our coats by only the hood (kind of like a cape - looked cool when you went really fast). The idea of a parent bailing us out if we broke the law was unheard of. They actually sided with the law. This generation has produced some of then best risk takers and problem solvers and inventors, ever. The past 50 years have seen an explosion of innovation and new ideas. We had freedom, failure, success and responsibility, and we learned how to deal with all of it. And if you are one of them Congratulations! (Well done living this long!) The majority of students in universities today were born in 1986, for them, there has always been only one Germany and one Vietnam. AIDS and CDs has existed since they were born. Michael Jackson has always been white. To them John Travolta has always been round in shape and they cant imagine how this fat guy could be a god of dance. They believe that Charlie's Angels and Mission Impossible are only movies. They can never imagine life before computers. They'll never have applied to be on 'Jim'll Fix It'. They cant believe a black and white television ever existed and they will never understand how we could leave the house without a mobile phone. If you smile when you read this, your probably over 40 years, but remember - you are not old - just very fortunate!

## *Mixer Experiments*

I have been hatching a scheme for an all band CW DC rig for some while. The major problem of the LO has been solved by using the ABLO. The receiver product detector and audio stages are shared by all bands so no nasty switching there. However, conventional wisdom suggests that you cannot do without RF bandpass filters for each band - hence there is a big switching problem for a 'many band' rig. The concern behind this is that good filtering is needed to remove the unwanted signals that might cause either BCI or cross modulation. BCI is well known as 'un-tunable mushy noises'! Cross modulation makes itself known as whistles or spurious signals appearing at regular intervals across the tuning scale, often near a pair of huge AM carriers. Both effects are often found on 40m at night. An approach to minimise these effects, is to use a 'strong' mixer as the product detector. This means that it is less likely to suffer overloading from the strong signals which causes both nasty effects. My hope was that with a strong mixer, it might be possible to avoid having switched RF bandpass filters ahead of the receiver's product detector, relying just on the station's Aerial Matching unit to give sufficient out of band rejection.

I was prodded by Richard Booth into investigating the 'strength' of SA602 and MC1496 mixers, both of which use Gilbert Cells internally. I set up both with 1K loads, paralleled by 22 nF, and ran them on an 8 volt supply. I fed them with two signal generators near 3.7 MHz (without input matching) and wound up their inputs for 'maximum audio' signal out. The 1496 produced 2 v p-p for 0.3 v p-p of RF and LO of 0.15v p-p; giving a conversion gain of about 7. The 602 produced 0.8v p-p for an RF input of 0.4 v p-p and LO of 0.4 v p-p; giving a conversion gain of about 2. Hence the 1496 is roughly 2.5 times better on output overload aspects and 3.5 times better on gain! This is a very simplistic assessment and the actual circuit matching will alter these numbers. I also tried Richard's Clara design (more about this on another occasion) on 40m using a 1496 but heavily modified to avoid the RF filter - but it was overwhelmed nearly all the time. Hence that approach would not meet my multi-band rig objective - it needs an even stronger mixer! (After these experiments, my new **Knole** DC RX which uses the 1496, is to have triple tuned RF bandpass filters!)

Quad diode mixers are known to be strong, especially the form known as H mode, but that is complex and needs extra LO circuits. How would a conventional quad diode ring doubly balanced mixer do? The answer is very much better in terms of overload but it does attenuate the signal! Adding extra RF gain ***ahead*** of ***any*** mixer will aggravate its overload performance so the diode mixer has to have more gain ***after*** it. Because the signal levels are so low after a diode mixer, it is necessary to use low noise amplifiers to avoid them producing noise on all but the strongest signals. The mixer in/out impedances are usually 50R on all ports and poor matching to these will degrade its performance. Also, because the mixer output potentially contains a very wide range of signals - all the RF mixed down to baseband as 'audio' on either side of the LO's frequency, there is a very strong chance of overload of the first stage of the low noise audio amplifier. The cure for this is a diplexer which maintains a 50R impedance over a very wide frequency range while passing only the wanted audio frequencies into the next stage. All of this seems very complex and rather American, but if you want performance then you cant do without it! Using this approach, I find that for a very large part of the time, reception on 40m is untroubled by BCI using my 160m dipole and just the AMU for RF filtering! Adding a good CW audio filter completes this little project - most of the circuit is below. It fits nicely onto a 50 x 80 mm PCB which will be available for £19 + £3. G3PCJ



## ***A good 'BRENT' at bedtime*** - by Victor Brand G3JNB

After a busy day, a CW QSO or two before bed is a sovereign remedy for insomnia, blocking out all those quirky items that can trouble your mental software when you need to zizz. Nothing too taxing, just a chat with a station or two before you pull the big switch. For a sensible conversation, 80m late at night is good but, at 100 watts, there is little sense of accomplishment. However, 1.5 watts to your bit of best bent wire, adds a lovely glow to your sense of well being as you QRT after working round EU.

The little BRENT rig is a real joy! It has a sensitive receiver, sidetone and optional full or semi break-in. Don't you just love the extraordinary clear sound of a DX RX? This one is great and I found no problem with the direct drive of the little Poly Varicon tuning capacitor and Tim's 750 Hz audio filter really peaks up the incoming CW above the QRM. The Walford kit arrived as my Christmas present from the XYL and I resolved to enjoy a leisurely build tempo. Having been quite spoiled years ago by David Howes and his PCBs with a printed component layout, I was a little worried to see the plain board with a veritable sea of holes. Once I got started though, the accompanying sketch layout proved excellent. To combat ageing eyes it was only necessary to poke a bit of wire through the board to check that the location was the right one and did connect to the appropriate point in the circuit.

Construction is divided into a dozen stages each with its appropriate testing of volts or sounds. Things went well and, somewhat to my surprise, there was no sign of Murphy. The little board was croc clipped to volts, key, phones and aerial tuner and a measured output of just under 2 watts loaded the wire. Now the real thing I liked about this rig is the VXO. I got a swing across much of the CW section of 80m and, for a couple of weeks, enjoyed bedtime Qs all round EU with many a two way QRP session as well as attracting the big boys. Only one station has reported my drifting and he has a very narrow filter but I think it was because I had just switched on as he reported that I moved back again ..HI! The keying characteristics are great for low power DXing with FB comments on the sound of the signal.

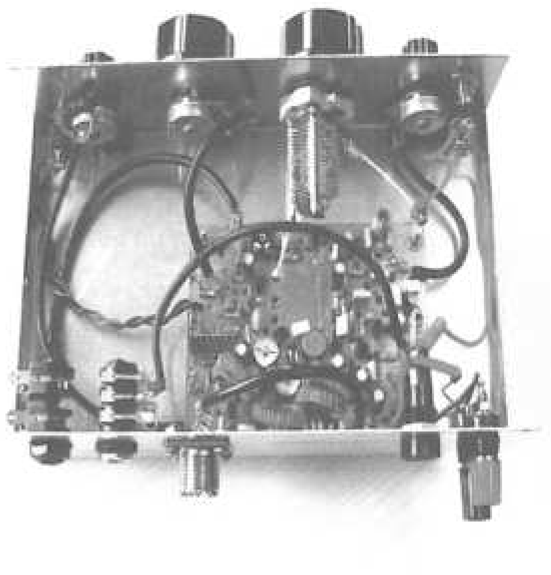
Now to pretty it up and put it into a box. You are all familiar with the golden rule the 'it won't work when you box it up'? Well, in my case it did actually work once I had drilled, reamed out and mounted the full size pots and terminals and bolted in the board. Except, that is, for the fact that I had sound in only one earphone. It was at this point that I lost my presence of mind! It was late and I just connected the braid of the screened audio lead to the phones jack to the spare terminal. Up came the full sound...that's great. I did wonder why the ear-pads seemed to be getting rather warm so I switched off. Turning on again, I could hear nowt! "I told you I would get you...so I did" chortled a familiar voice behind me. Yes, there lounging against the shack wall was our old friend and adversary Mr Murphy. With glass in hand and a fag dangling from lower lip, he gleefully pointed out that I had ignored Tim's specific instructions not to ground the headset and, "and to be sure, you have killed the audio output transistor!" How stupid can you get?

As it happened, Tim had popped in some reserve BS170s when supplying the extra components for the boxed model. So I gingerly lifted the PCB with its connecting leads and swapped the transistor. No heavy breathing from 'you know who', so I switched on. Bingo!

Continued ........

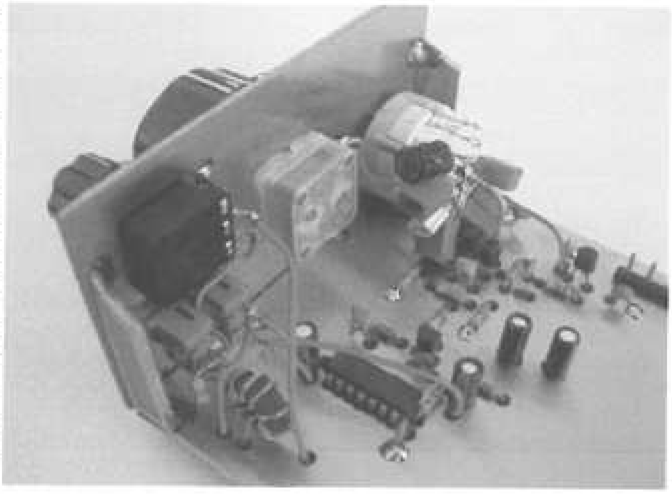
## *A good 'BRENT' at bedtime* continued

Now things were back on track. I have had a beautiful, pristine Jackson 150 pF air spaced variable in the junk box for donkey's years. This now gives me a swing from 3502 to 3615 Khz. Instead of a slow motion drive, I am tuning it directly with the supplied big knob and have added a similar one to the IRT pot, which doubles as bandspread. Works great. The full break in was a bit too much so I simply paralleled a 2.2uF capacitor beneath the board cross the existing C. This gives me near semi break-in with just sufficient listen through to notice if that kilowatt station is continuing with his endless CQing ...HI! The sidetone was blowing my head off but I was reluctant to take the board out again. So, I carefully cut the lead to the appropriate resistor and 'stood it up beside an extra series 390 ohms, covering the botch with a piece of sleeve. The Brent is giving me a lot of fun and the sheer delight when you reveal to the big guns that you are working them with torch power.



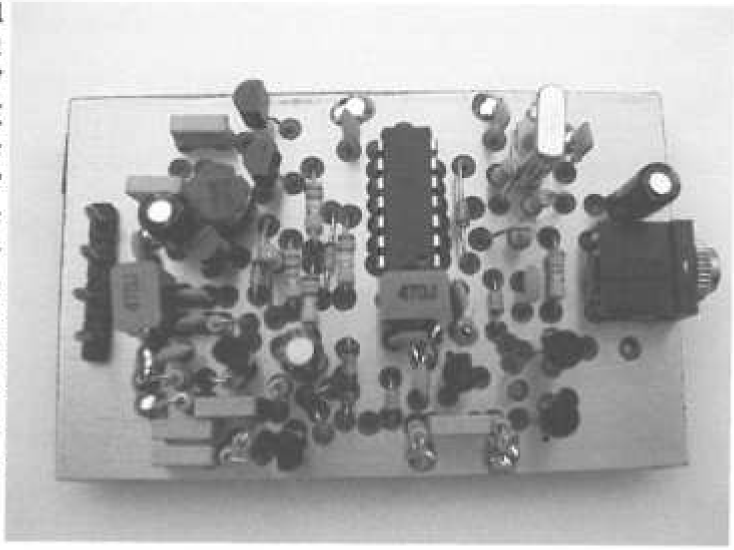
## *Signal Generator*

At last the new Mk2 version is available! Development of the ABLO has allowed simplifications to concentrate on obtaining a wide frequency coverage. It now has at least 8 overlapping tuning ranges that cover about 200 KHz to over 30 MHz. The prototype does 180 KHz to 33 MHz but this will vary depending on your physical layout. It has an output for a counter as well as a variable output from a potiometer. The variable signal is switch selected from the nominal sinewave output, or a squared up version obtained from high speed CMOS inverter gates. It can drive 50R loads up to about +12 dBm or 2.25 volts p-p. Another switch can further attenuate the output by 100 times. Price £34 + £3 P & P.



## *Pylle*

I made the prototype last weekend and didn't find any cause to alter the PCB!! (Almost a first!) This is the many band 1.5W CW transmitter that includes sidetone, RX muting and RIT, with diode TR switching (for full break in operation) and a receiving RF amplifier! It is intended to be part of a larger multi-band CW TCVR. It would normally take its local oscillator from the ABLO but it can also be used on a single band with its own crystal or ceramic resonator. It does not include any transmitter Low Pass Filters - use the new relay controlled dual band filters, which can be selected by the ABLO's bandswitch! Price £24 + £3 P & P. G3PCJ



## ***How to make a circuit work on another band***—by Gerald Stancey G3MCK

(I have included this in the 'theory' slot as its all about the simple maths of reactance! Tim)

You may often see a circuit that has been designed for one band and thought wouldn't it be nice if it had been designed for another band. This article gives some advice on how to do this by using a technique called scaling. Assume that you have the circuit for an 80m transmitter which you wish had been designed for 40m; what changes in component values do you have to make? Let us consider the components under a few headings.

*Resistors.* It is unlikely that any of these will have to be changed in value. However it is possible that one or two may have to be changed to alter a bias to get the right level of drive so bear this in mind.

*Output filter.* This will need completely redesigning and the simplest way is to replace it with one of the designs that is shown in a standard handbook.

*By-pass capacitors.* No changes should be necessary as there is usually wide tolerance regarding the values of the components that are used. The junk box king may take advantage of this and be able to use what is to hand. For example, if 0.1 /uF has been specified, then 0.047 or 0.68 /uF should be satisfactory. How we get to these figures will be dealt with next.

*Tuned circuits.* Here component values will have to be changed but the calculation needed is ridiculously simple. Going from 80m to 40m you are doubling the frequency, so you will need to half the values of all the inductors and capacitors that are directly involved with the tuned circuits. Yes, it is that easy! This is scaling. If you had been designing a 40m transmitter to work on 80m, you would have doubled the component values.

You will now see why 0.047 or 0.068 /uF can be substituted for 0.1 /uF in the previous section. You are aiming to get about the same value of reactance for the by-pass capacitor. This technique can also be used to redesign the output LPF but you may well get some funny values so it is better, as previously suggested, to replace it with a standard design as this will use preferred values.

*Coupling capacitors.* These are treated in the same manner as the capacitors in tuned circuits. When the frequency goes up by a factor of two, the capacitors should be halved; when going down, the values should be doubled. Usually their value is not critical and if in doubt err towards larger values rather than small ones. Do make certain that they are not actually part of the tuned circuit though!

*Transistors.* It is unlikely that an changes will be needed. (Except perhaps if the transistor is working near its high frequency 'practical' limit, when its gain is likely to decrease when going up in frequency. Such affects maybe masked by negative feedback in some circuits too! It's a bit more complex but worth a try!)

As with all things there are exceptions and simple scaling is unlikely to be applicable when the scaling factor is large. For example, scaling a 1.8 MHz rig for 144 MHz is definitely not on but scaling between near HF bands should not give any severe problems.

To summarise: the scaling factor is the ratio of the two frequencies. If you are going from LF to HF, component values get smaller and vice versa. Keep your wits about you and you shouldn't go wrong.

(The above approach is fine for 'straight' rigs, typically TRF, regens and DC receivers; and 'crystal controlled' transmitters. But do NOT change the frequencies of all stages in superhet receivers or transmitters because of the frequency addition/subtraction that takes place in their mixers. Gerald is also working on a note about transistor substitution. We look forward to it! G3PCJ)

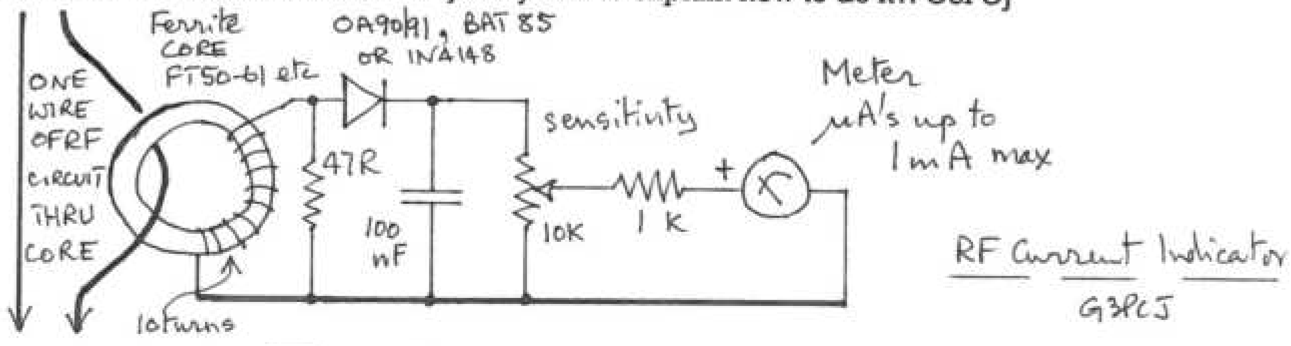
***Sutton Band Cards*** I still have a few band cards which I would like to clear! £10 each, two or more £8 each, plus £3 P and P! G3PCJ

***DDS chips*** I have the following surface mount sample devices surplus to my needs:-
AD9857AST, AD9283BRS, AD9835BRU. I think they are all direct digital synthesizer chips needing control from a micro-processor. I also have a 50 MHz xtal oscillator to drive them. Anybody like to have a play? Free to a deserving home! G3PCJ

## ***Antenna current indicator***

Dave Buddery G3OEP writes that an antenna current 'meter' is a very useful piece of gear for adjusting AMUs and helping with antenna trials etc. In days when battlefield communication was mainly by HF instead of satellites, it was widely used by the military. (Many old timers like me, will have made their first DC mutli-meter using a moving coil micro-ammeter salvaged from a RF ammeter as used in many WWII transmitters.) I say 'meter' because calibrating such an instrument is notoriously difficult but it is excellent for giving relative indications - RF current increasing, or not, as adjustments are made. The modern version uses a broadband ferrite transformer to produce a small RF voltage that is proportional to the current flowing in the primary of the transformer. This primary is usually just the antenna 'lead', or one side of the feeder, or some other lead of an RF circuit, that is passed through the centre of the toroid! Very simple! The secondary winding feeds a small RF rectifier and DC volt meter. Such a circuit is sketched below. If you are working with RF currents below about 0.1 Amps, then you can thread the primary wire through the ring twice but this will have a more disturbing effect on the circuit under measurement. Note that it uses a *ferrite* toroid and not a powdered iron one! The latter just does not have enough inductance for HF work like this.

Recently, Sprat had a variation of this circuit that fed the resulting DC voltage down the antenna feeder back to the main operating position. This is an alternative to using field glasses out of the shack window! Another variation is to make the device 'clip-on-able'! This is done using exactly the same circuit but with the ferrite ring very carefully cut in half; the two faces of the core are then carefully ground for best fit against each other and glued to the arms of a clamp device rather like a clothes peg! The secondary winding is permanently wound onto one half of the core and connected to the indicator mounted on the clamp handle. I have not tried this myself and suspect that cutting a ferrite ring in half is much easier said than done - anybody like to explain how to do it?! G3PCJ




# ***The Somerset Supper and Yeovil QRP Convention***

The third supper will be held on April 14th 2007 in Sherborne for locals and those staying overnight. This is the evening before the Yeovil QRP Convention. I will be having a stand with most of the new projects mentioned recently in Hot Iron on display/for sale. This year the **Somerset Supper** is being held in the **Antelope Hotel** at the top of Sherborne's High Street - 7:00 for 7:30 pm sit-down. Their dinning room has a far more convenient layout and is smoke free! A three course meal, without choices will make it rather easier and quicker to serve! (Alternatives are available for those who have special dietary needs.) There will be a small display of items from each diner's home built radio equipment! This qualifies you for a ***free*** place at the table! The display will be judged by **Ben Nock G4BXD**, the well known contributor to PW who specialises in World War 2 radio equipment, who will award a small prize. He is also staying for the Convention. Places by advance booking **only** by Mar 31st so please tell me if you want to come, how many, and any special dietary needs. Hope to see your item of gear (anything that you can transport easily!) with brief description and you! Tim G3PCJ

"JOURNAL OF THE CONSTRUCTORS CLUB"

# Hot Iron

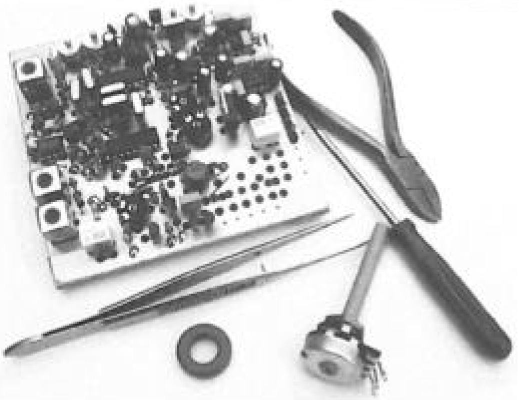
Summer 2007
Issue 56

## Contents



The Walford Electronics website is also at www.walfordelectronics.co.uk

## *Editorial*



I am delighted to welcome another contributor of articles for Hot Iron. Dave Buddery Jnr G3SEP is, I am told, one of those very capable CW operators who can copy about three high speed CW signals simultaneously! He is the son of another Hot Iron contributor with the same names who is G3OEP - talk about things running in the family! As you will see, G3SEP was using his amateur radio experience to good effect for his work in the oil industry in the remoter parts of the world.

I am sure there are other Members of the Construction Club who have interesting tales to tell or who can raise topics that will be of interest to readers. We all have our own interests within different parts of the hobby, so please do come forward and pen something. I don't really mind what the topic is as long as its radio related. Don't forget that I am also very glad to have questions or other thought provoking topics raised, on which I will try to obtain a reasonable response! You don't want my musings all the time - I need other contributors please! Tim G3PCJ

## *Kit Developments*

The new Mk 2 Signal Generator is now available and compliments the ABLO. The former is for wide range coverage (200 KHz to 30 MHz) whereas the latter has the emphasis on stability and use as a rig's Local Oscillator. They cost £34 for the Sig Gen and £49 for the ABLO; £3 P & P and both have small optional upright PCB front panels. The all (traditional) band CW rig that I mentioned last time is now called the **Upton**. It uses the new Pylle CW TX, several twin LPF kits, Product Detector and the Audio Amplifier kit, with the ABLO acting as LO. Its quite a large assembly, especially if you add a 5 digit counter! See later! It did not work first time due to grounding problems which has necessitated minor track revisions to a couple of the audio kits. Cured now I think!

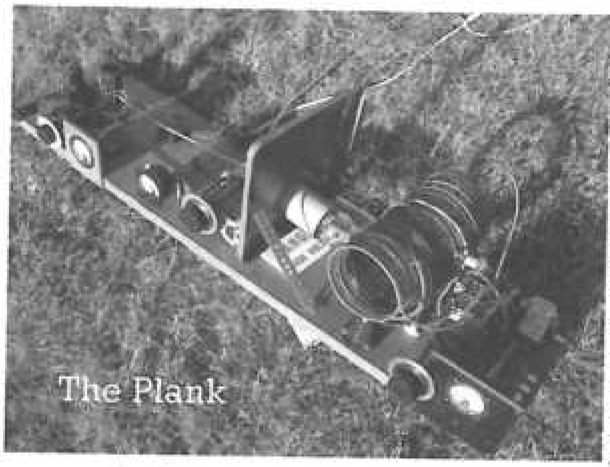
Meanwhile both the **Knole** and the **Knapp** have had to wait because of pressure from other farming type activities; I long also to get started on laying out the Minster but that is a major exercise which needs a clean sweep of many evenings - sadly this is not too likely in the immediate future! In addition, Steve Hartley G0FUW is planning some construction courses and has tried a Brean DSB phone TCVR; but we fear this is too dense for novice constructors - so we might need a new version called the **Brendon** with a small PCB front panel instead! No time to think! Tim G3PCJ

*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 

## *Eric Godfrey G3GC*

I am very sad to report that poor Eric died on Mar 15th after various trips to hospital, following falls etc, and other longer term complications. Eric was born in the 1920s and was brought up in West London, showing a very early interest in electronic technology. He obtained an experimental transmitting licence in his teens, about 1936/7, and spent all his working life in the research labs of EMI at Hayes. During the war, he assisted professionally with many military projects. When not working, he was an ARP Warden and also a 'secret listener' for the intelligence services, regularly forwarding CW traffic to his handler. He eventually became EMI's expert on aerial systems and was heavily involved with the early very tall TV transmitter masts.

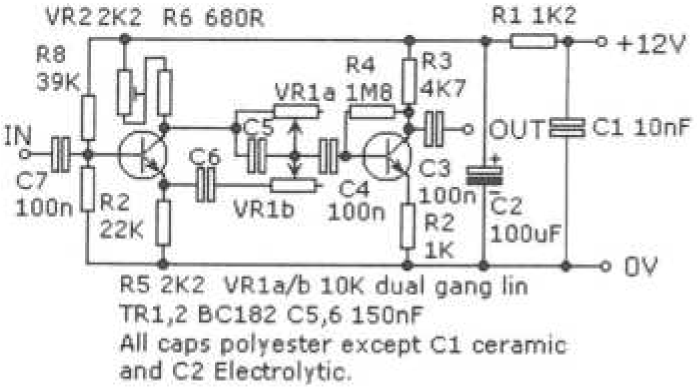
Eric retired in about 1982, moving to Yeovil and joining Yeovil ARC. At that time, YARC had its base right next door to Eric and it was there that I first met him. There was much interest in home construction, and Eric presented a challenge cup for the winner of a Construction Contest, which bears his call and is still presented annually. I recall some consternation when I entered an SSB rig (my first) made entirely in tobacco tins; he was not impressed because it looked a mess but was kind enough to remark on some measly little strips of aluminium acting as knobs on very small Polyvaricons in the RF filter tin! He was very keen to promote both understanding of the technology, and for things to be well made, perform well and be durable. He decided that entries should be left with, examined and evaluated by an external adjudicator, who would then provide a critique on each entry and announce the winner to a Club meeting. He was always a keen CW man and was soon doing the local slow morse transmissions, with talkback and help for struggling students like me! He was able to send immaculate manual CW at different speeds, in sessions straight one after another. He has my only CW contact in his log book - hardly a long or high speed QSO! At about this time, Eric also took on the job of founding Editor of YARC News, which he produced on his BBC computer for over a decade. He was also a keen supporter of the Yeovil QRP Convention; regularly exhibiting and operating his replica 1938 CW TX (see below - crystal oscillator and 807 PA ), which I would like to donate to a suitable museum. (Any suggestions?)

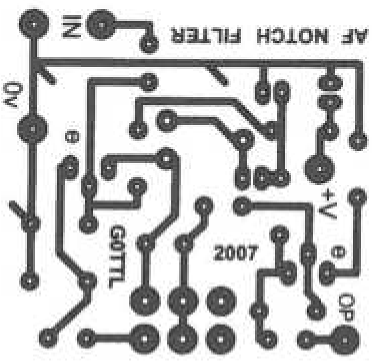



When I started designing kits, one of the early projects was the Yeovil CW and SSB 20/80m TCVR; Eric built the Club's version and helped to correct and improve the Manual for it. I have his version of the rig here now and it is a splendid example of how one can, or should build a rig. I used often to get him to evaluate the technical aspects of the instructions for new rigs; and his wife Catherine, would improve my English! He often gave talks to YARC, and other local Clubs, on his main interests – aerials, matching techniques, and CW operation. He organised the YARC RSGB Field Day entry here on the farm in May 1990 - see photo - with Peter G3CQR (now also silent key). He set up a centrally supported half wave dipole for 160m fed by open wire line connected via a KW (E-ZEE) Match to his own Drake TR7, which I now have awaiting a suitable space to set it up properly. I recall that a little amber fluid, as he referred to whisky, helped to keep the station on air into the early hours of the morning! In later years, Eric's health was a little fragile, and he spent considerable periods in hospital. When at home, he continued his regular Saturday morning 'sked', with members of his 'home' radio Club at Edgeware. He will be sadly missed by all those that knew him personally, or for his writings in various journals, including many in Hot Iron; he also leaves a strong and lasting impression on YARC and my own radio activities. Tim Walford G3PCJ

## *Simple Audio Notch Filter* by Richard Booth G0TTL

A tuneable audio notch filter is a useful tool in the battle against interference on the crowded HF bands. This simple project, despite only having two active devices, does a good job of phasing out unwanted audio noises leaving the signal that you are listening to relatively unscathed. It is particularly useful in direct conversion phone receivers.




The audio input is coupled by C7 to the base of TR1 which operates as a phase splitter with two out of phase signals being produced at the collector and emitter. The collector output is applied to the phase shift network comprising of C5 and VR1a whilst at the same time the emitter output is applied to the other phase shift network comprising of C6 and VR1b. At one particular frequency (controlled by the position of VR1) both these signals will undergo the same degree of phase shift. Both phase shift outputs are mixed together at the slider junction of VR1. Therefore the result is, when you have an input signal at the same frequency where the two shifters produce the same phase change that particular input signal is cancelled out to a great degree. All other frequencies are allowed to pass with little or no attenuation. The filter tuning range is 100 Hz up to about 5 KHz. The preset VR2 is used to optimise the filtering null by adjusting the output level at the collector of TR1. TR2 is configured as a buffer amplifier to overcome losses in the filtering process, and also to provide high load impedance for TR1. Output is coupled by C3 which isolates the wanted AF from the dc voltage at the collector of TR2. Although this is an active filter there is no overall gain. R1, C1, 2 are used for power supply decoupling.

Construction is straight forward and you can either build it using my PCB layout or on Veroboard. The dual gang 10K linear pot is available from Maplin - part number JM81C and at just over £1 is not going to break the bank! The audio input is best taken from the wiper of your receiver volume control and I suggest you arrange a double pole switch so that you can switch the filter in and out of circuit as required. Feed the output of the filter back to the audio pre-amplifier of your receiver. Various NPN bipolar transistors were tested in this circuit and most general purpose types worked well. You can use BC108/9 types if available. In theory you should use 5% tolerance or better polyester capacitors for the phase shift capacitors C5 and C6. In practice I had good results with standard 7mm block types but the tolerance is worth bearing in mind.

There is nothing much to adjust other than the preset resistor VR2. Connect the filter in circuit and adjust the preset to its centre position. Arrange some interference from your signal generator if you cannot find anything on air! First of all adjust the main filter tune control VR1 until the best null of the offending heterodyne is obtained. Then carefully optimise this by adjusting the preset VR2. Once set there should be no reason to adjust VR2 again. The small PCB can be mounted by leaving it on the back of the pot when it is fitted to a control panel.

I hope you enjoy building this little project and it proves to be a worthwhile addition to your receiver. As ever I would be most pleased to hear from you.

## ***HF Radio experiences in the oil industry – Aerials in the Wet.***

I started work in the oil industry more years ago than I care to remember. By that time, I had been licensed (the old pre-Class A/B etc. licence) for 8 years. After a short spell training in the UK I found myself in the jungles of West Africa, living and working from a houseboat in the river systems of that country. We used HF SSB to keep in touch with the town office, report daily activities etc. The transceiver at our operation (on the houseboat and in town) was an excellent little hybrid American unit made by Stoner. I had not heard of them before and never since, which is a shame because this little transceiver was an excellent piece of kit. It was a true hybrid with a single "quick heat" version of the 6146 in the PA and it ran about 50 watts, crystal controlled, anywhere between 2 and about 24 MHz, if I recall. The antenna when I arrived was a fibreglass helical whip antenna with a screw base, the base bolted to a length of thin wall drill pipe.

It was clear to me that we did not have a good signal and once when in town and listening from the "other end" we were noticeably weak but I left things alone, being the new boy. Things came to a head towards the end of the dry season when the first of the seasonal rains started and we began to have real problems, the town office could hardly hear us. The company knew I was a radio ham and soon the boss said, "Take a look at our set-up and see if you can improve things." The Stoner was producing RF although the SWR was pretty dreadful. I thought the problem lay with the exterior termination, as I found out the antenna had been up in the tropics for over 2 years and the coax never looked at. I got a bit of help and took it down. It was fed with RG58 and no effort had been made to waterproof the top end, nor to make a good earth connection at the feed point. I unsoldered the SO239 plug and there were sizzling noises of water boiling as I unsoldered the braid, then I stripped back a couple of feet of the outer jacket to find that it was heavily corroded. Fortunately we had some spare, dry coax so I re-connected the plug, ran a new length, waterproofed the whole thing with self amalgamating tape and made a decent earth connection between the mounting bracket and the steel pipe with read lead applied to the metal joint after it was tightened (you could still get red lead paint in those days). Firing up the rig again, the SWR was better so I took the top cover off the Stoner and retuned the PA for "maximum smoke". I called town and was rewarded by an immediate reply. The town operator when asked reported better signals and the morning scheduled calls started going through sometimes without repeats, so things were looking up.

Things carried on OK for a bit longer but within a couple of months we had moved (relatively) quite a long way from town (from about 40 Km. to over 100 Km.) and outside the ground wave range (we were using a frequency just HF of 5 MHz and ground wave doesn't do too well up there even in a swampy area). We found it hard to be heard at all during daylight hours but it was OK at dawn and dusk. I had measured up the houseboat and figured that we had enough space for a bottom fed inverted L strung between short poles at each end of the houseboat and fed against the steel hull – the houseboat wasn't not long enough for a dipole and the construction ruled out putting up any kind of mast amidships for an inverted V which would otherwise have just fitted. The boss was irritated at our radio problems so I went to him with the idea. He was receptive and within a twinkling I had the antenna up and running. The SWR was much better than the whip and we could be heard at all times.

By this time we were so far from town that a journey between town and the houseboat was quite a risky undertaking through the river and creek system in our 12 foot aluminium dinghy.

Continued overleaf

## *Aerials in the wet* — continued

The boss had a nasty experience when one of the 2 outboard engines broke down just past the half way point and he arrived back from town after dark, fortunately on a night with enough moon and not fully clouded-over. He asked me if we could rig up the spare transceiver in the dinghy with the whip bolted to the hull now that we were no longer using the whip on the houseboat.

The dinghy (built by Freezer of Mill Rythe Lane, Hayling Island – I spent hours looking at that little maker's plate) - had a tiny aluminium forward deck, very thin and flimsy – it couldn't have been more than 18 SWG, so I made a doubler plate, explained the arrangement to him and got the go ahead. We had to put the radio and microphone in two thick plastic bags as a precaution against tropical deluges (the battery too). But it worked and we all felt a bit safer during those 5 to 6 hour trips.

But this state of affairs resulted in weekend breaks only once ever 4 or 5 weeks, whereas we had usually managed a couple of evenings in town every fortnight when the trip was shorter. So we began a rotational system whereby a certain number of key personnel would stay on the houseboat at weekends and one at a time go to town. When you are stuck out in the middle of an equatorial swamp with not much light relief, a night in town is most welcome. No doubt many of you have read "Animal Farm" and are aware that "all animals are equal but some animals are more equal than others", well, as the new boy I was one of the "others," coupled to which was the fact that I didn't need to go to Lodge meetings, then or now, so I got the short straw.

I was stuck out there one weekend, the Sunday finding me working on some equipment in my little workshop. I had a remote speaker in the workshop connected to the Stoner (which was in the manager's office) so that if there was a call, I would hear it and deal with it. I heard a weak call from an unknown but identifiable company operation, so I went to the office and said, "This is Houseboat XYZ, who is calling?" The unknown operation identified themselves and the voice said, "Dave, is that you?" I replied "yes" and then realised I recognised his voice and said, "Is that 'John Smith'", to be answered in the affirmative. It turned out that they were about 700 or 800 miles away in another West African country. We were talking about this and that when the town office, to my surprise, broke in to ask if I was in contact with 'John'. "Of course," I admitted (expecting trouble) and asked "Can't you hear him?" A round robin ensued, during which I established I was the only station in contact with the other two (one up for the inverted 'L' and Ham Radio!) As a result of this 'net' we got some urgently needed spares to John's operation. This cross-border contact was illegal of course, but we didn't get caught, so who cares? In the early 70's, in remote areas, HF radio was the only means of rapid communication and it brought a bit of fun into life out there.

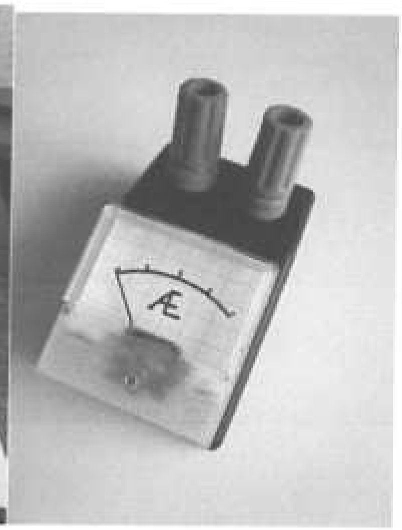


## *Counter ideas!*

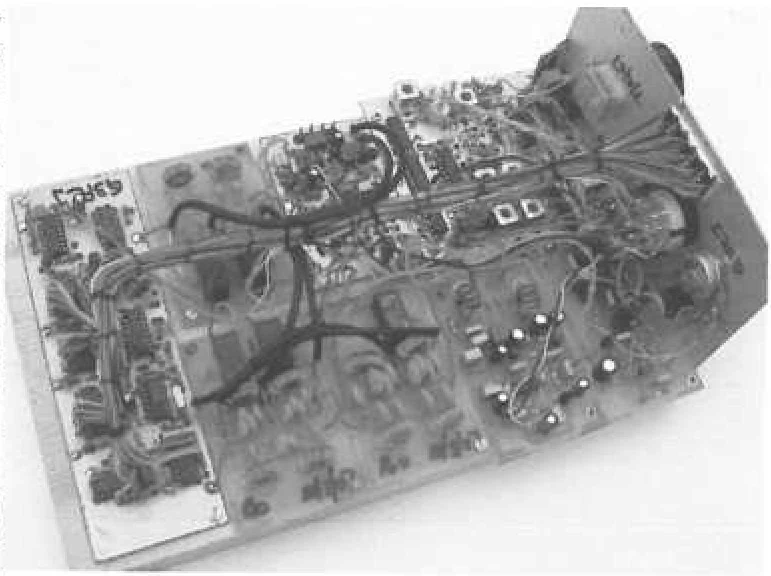
After a few years (actually a couple of decades!) of designing kits, it gets harder to think of something slightly different that looks as though it might be worth developing with a chance of reasonable sales. A digital frequency readout is probably the best 'extra' that can be added to a rig but I have recently sensed that my counter designs are not too price competitive, having originated in the days before micro-processors or PICs became widely available!! The primary objective then, was to avoid the horrible radiation from multi-plexed LEDs that plague receivers in cheap designs! Hence my current designs use dedicated CMOS logic, with very little radiation from the chips themselves, but with many wires to the displays that carry DC, and only change when frequency is altered, so obviating radiation from the wiring. While using a single PIC instead of several chips can reduce the cost of the kit, I don't like the fact that few people will be able to alter, or fully understand the workings of the software - even if I had the inclination to learn the skills for writing the software myself! That approach does little for helping the builder to understand the technology he is using! I need an alternative approach to reduce the cost! Announcing the frequency in CW does not appeal for reasons that maybe deduced from another page! What else can be done? How about a scrolling display with two or three actual digits to display the MHz and KHz numbers in turn? Each actual LED display omitted saves at least one chip and 7 wires! Any other suggestions please! Tim W G3PCJ

## *Antenna Current Meters*

Chris Rees, GU3TUX, who many of you will know from his earlier days of selling keys and other CW related gear, took up the notes on building antenna current indicators. Here is a pictorial sequence of his creations! See the previous Hot Iron Issue 55 for the circuits.



## *The Upton*



This is a multi-band CW TCVR using several different kits. The heart of it is the ABLO which provides the Local Oscillator for all the traditional bands 10 to 160m. It has coarse and fine tuning; the latter also acts as RIT when linked to the transmitter. The receiver uses the Product detector kit with a strong broad-band quad diode mixer (to avoid BCI), followed by diplexer, low noise amplifier and switchable low pass CW filter. Audio output is by the (nearly!) standard Audio amp kit for phones or LS. Receiving RF selectivity is provided by the AMU! The transmitter is the broadband 1.5W Pylle CW kit which is driven by the ABLO, and has diode TR switching for full break in TR control, with sidetone and muting for the receiver. It also includes a receiving broadband RF amplifier to make up for the losses in the diode TR switch. Because the Pylle does not include transmitter low pass filters to remove TX harmonics, you will need external filters - in this case I have used the Dual LPF kits, three of which can be cascaded to cover all six bands. The last unit in the photo, extreme left, is a standard 5 digit counter linked by the cable-form to the 7 segment LED displays which are mounted, with the other controls on a 100 x 160 mm single sided PCB front panel.

This has been quite a challenging project and is not for the novice constructor! I chose to mount all the PCBs by small screws onto a wooden plank behind the front PCB panel. This has the drawback that arranging the ground or earthing is more complex! In fact mine oscillated at audio when the AFG was turned up due to the LS currents getting back into the early audio stages. Eventually I realised that the audio stages needed something nearer 'single point' earthing while the transmitter and low pass filters needed 'ground plane' type earthing arrangements! Despite many ground wire links, I found that using miniature 50R coax between TX and filters lifted the 10m output to just on 1W! I am not offering this as a formal kit because of all the options, but I do have a note on how to connect them all together. If you are interested, please discuss options with me. G3PCJ

## ***Miser's Micro-Henry Meter*** - by Gerald Stancey G3MCK

"An engineer is a man who can do for a shilling what any fool can do for ten quid."

My philosophy with measurements is that if you have to do a lot of the same type to a high level of accuracy, then it is best to buy the right instrument and ignore the cost. However there are times when one needs to do just a few measurements and there is no way the expense can be justified, and none of your friends have suitable test gear that can be borrowed. This was the position I found myself in when I needed to measure the inductance of a few small, about 1.5 /uH, inductors to better than 5%.

The solution went back to first principles and used equipment that is readily available in most shacks. The one thing that we can all measure very accurately is frequency. Even if you don't have a frequency counter, a 100 KHz crystal will calibrate a receiver at 10 MHz to much better than 1%. The connection between inductance and frequency is given by the equation:-

$$f_{MHz}^2 \times L_{\mu H} \times C_{pF} = 25330$$

If we use the unknown inductor as the coil in an oscillator and measure the frequency, then we are part way to finding its inductance. If we now increase the capacity across the coil by a <u>known</u> amount and then measure the frequency again, we can easily derive the inductance. Assume that the unknown coil has an inductance L and resonates with the circuit's basic capacitance C at a frequency of $F_1$. When the capacity in the circuit is increased by 47 pF, the circuit now oscillates at a lower frequency $F_2$. The frequencies $F_1$ and $F_2$ are related to C by:-

$$\left[\frac{F_1}{F_2}\right]^2 = 1 + \frac{47}{C}$$

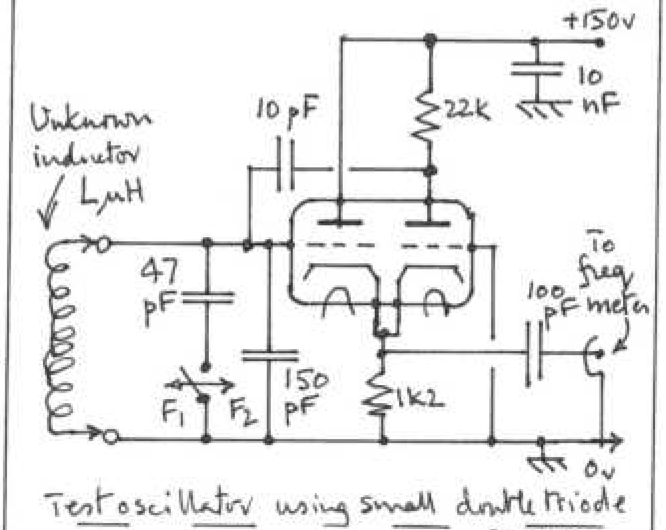
Rearranging this gives:-

$$C = \frac{47}{\left(F_1/F_2\right)^2 - 1}$$

Then substituting back into the first equation gives:-

$$L = 539\left(\frac{1}{F_2^2} - \frac{1}{F_1^2}\right) \mu H$$

where $F_1$ & $F_2$ in MHz.



Test oscillator using small double triode G3MCK

The circuit that I used is shown on the right. I made it with a valve because I had one to hand and felt like doing something with valves! Keep the leads in the oscillating circuit short to minimise stray inductance, otherwise construction is straight forward. Doubtless a transistor circuit, say two FETs, would work just as well. The 47 pF 0.5% capacitor is temporarily soldered into place. I used a frequency counter to measure the frequencies - a calibrated receiver would do just as well. Many modern rigs provide full HF coverage and some domestic short wave receivers have very accurate digital readouts too. If you don't have either of these, then an old clunker like the CR100 and a 100 KHz crystal oscillator, with interpolation of the logging scale will do just fine.

How accurate are my measurements? Well I don't really know as I don't have any precision inductors with which to check them. All I can say is that I get consistent results. To be really accurate an allowance should be made for the other inductances that are present; however, I believe these are small and can be ignored for inductors that are likely to be used in HF projects.

The same circuit could be sued for measuring small capacitors but I have not tried it.

# Subscriptions!

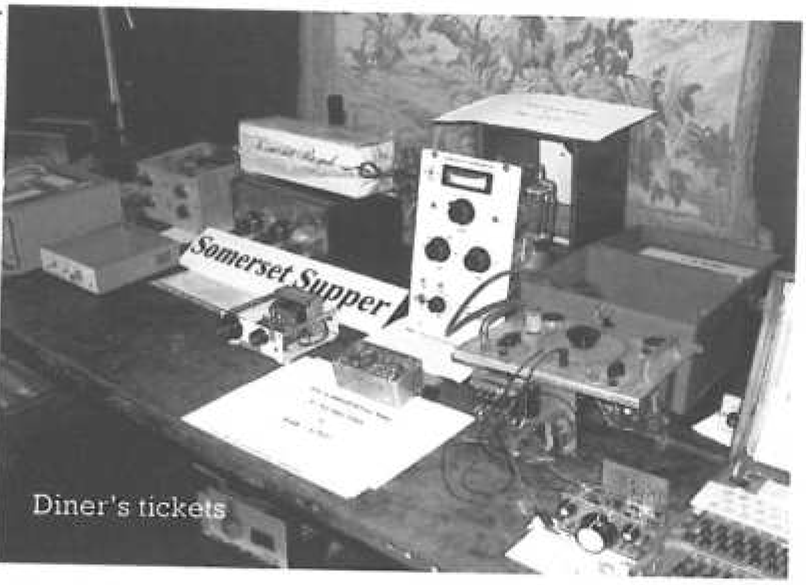
I am afraid its that time of year again! If you wish to continue receiving Hot Iron, let me have your cheque for £7 before Sept 1st for the next issue.

# Send off your cheques now!

**DDS chips** - I have the following surface mount sample devices surplus to my needs:- AD9857AST, AD9283BRS, AD9835BRU. They are all direct digital synthesizer chips needing control from a micro-processor. I also have a 50 MHz xtal oscillator to drive them. Free to a deserving home! G3PCJ

# Supper in Somerset!

A few Construction Club members were present at the third ***Somerset Supper*** on the eve of the 23rd Yeovil QRP 2007 Convention which was a most convivial evening. A wide range of home made electronic projects were exhibited by mainly local diners for the informal display and competition. Seventeen items were exhibited at the Antelope Hotel, Sherborne, with a wide range of building skills being evident – from novice constructors to almost professionally made equipment. The items ranged from simple AMUs to high powered valved linear amplifiers.




Ben Nock G4BXD, regular contributor to PW and collector of World War II military equipment, had the difficult task of choosing the winners; he awarded the first prize - a bottle of Somerset Royal Cider Brandy - to Tony Marriot G0GFL for his modern version of an Enigma coding machine. Second prize went to Andy Howgate G7WHM for his 160m AM transmitter. Ben commented that 'It was great to see such a diversity of projects and skills but it made my task all that much more difficult!' Tim Walford G3PCJ, who hosted the event, commented that 'He was delighted that the number of entries was greater than last year and the standard of construction was even higher.'


The exhibits created much lively discussion, and it was agreed by all to have been an excellent event with plenty of evidence of original ideas and much fun!

## Make a note in your diaries now!

The 24th QRP Convention will be on April 27th 2008, and the fourth Somerset Supper on April 26th.

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My apologies for this issue being a little late, I am always heavily involved with the Bath and West Show: this year there was even more to do!

"JOURNAL OF THE CONSTRUCTORS CLUB"

# Hot Iron

Autumn 2007
Issue 57

## *Contents*



The Walford Electronics website is also at www.walfordelectronics.co.uk

## *Editorial*

Here we are at the start of another Construction Club year, and for once this year, the sun is out and we have a settled spell of good weather which has enabled us to catch up a bit on the farm - thank heavens - many activities are two months behind normal! Hence time for a little electronics work on Hot Iron! Time for a different picture - can you identify what rig I am working on at the bench? The photo was taken a little time back and I suspect was associated with development of a phase lock VFO that never got past this stage! I would love to have some other Member's photos for you all to enjoy - be glad to give them an airing if you care to send them down the wire! Tim G3PCJ

## *Kit Developments*

The **Upton** is now available but is not really a single kit since it is made up of several standard kits allowing potential builders to pick and choose what they need. It is about to appear in PW. Several **Knole** DC Rx's have now been built - this is intended to be a better receiver to replace the Kilve and has several aspects that will improve out of (amateur) band BCI. The K series transmitters can be used with it. I have also just got the first **Brendon** working - this is a development of the Brean; it is a DSB phone TCVR but with a more robust IRF510 RF output stage, LS drive and a PCB front panel to allow a more spaced out layout suitable for novice constructors. See later.

After completing this issue of Hot Iron I shall be writing up the **Knapp** which is a single band regen TRF RX. It is small at only 50 x 80 mm! It uses essentially the same circuits as the Catcott but without the multi-band aspects. Then I *will (!)* be starting on the **Minster** unless I get distracted by a revision of my counter designs. At present I am dithering over how to lay out the Minster - whether as a base single band (20 to 80m) TCVR on the main PCB, with another PCB for any two extra bands with other optional extras like AGC etc; or to go for a RX PCB and separate TX PCB - both having spaces for the extra bands. Any views are very welcome! Tim G3PCJ

*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 

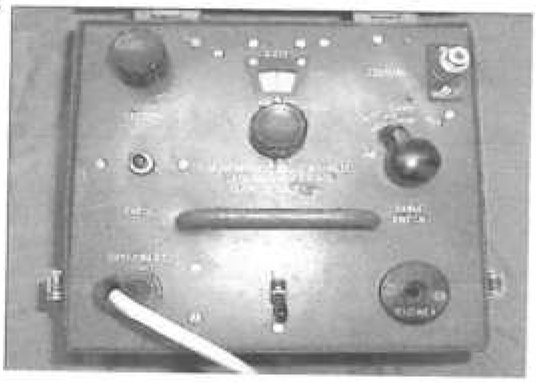
## ***Army Signals Cadets in the 50s*** - by David Proctor G0UTF

I still have a memo from the Ministry of Labour telling me that I would not be called up for service in H.M. forces after June 1960. I left university in 1961 so I avoided my two years in National Service: however, whilst at school I did join the Combined Cadet Force – because they had a signals section! The corporal in charge was not to my liking, but when he left, I got the job of running the section. I think that some Construction Club members may also have been in the Army Cadets – so let me remind you of the gear we used (as I remember).

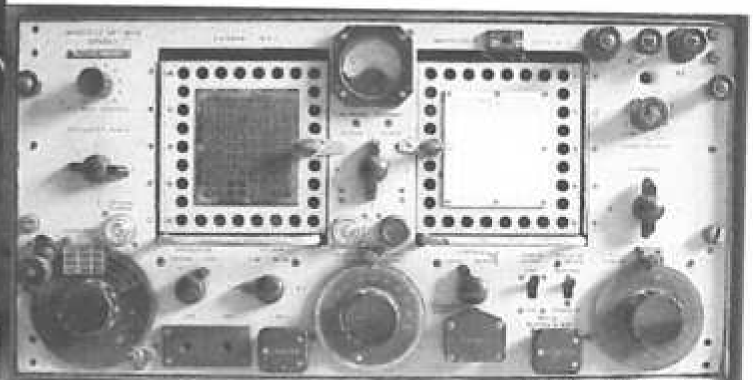
The base station was cubicle, about 6 x 5 feet crammed into a prefabricated army store. The RX was an army **R107** and the TX was a **"12 set"**. Frequency checks were by a **"type D"** wave-meter. I ran the aerial via a large army issue copper knife switch (to earth it) via a flag pole on the parade ground to a higher building. The wire was VIR covered multi strand copper and one steel (for strength). With 25 Watts of double sideband AM from the **"12 set"** transmitter, there was a national network on three single frequency allocations (between 4 & 6Mc/s) and I managed to work other cadet stations across the UK during the daytime. Of course, we had less attractive manoeuvres in the field, staggering through wet fields with **18 sets** which were worn on the back like a rucksack and another cadet was needed to operate it. A much lighter rig was the **38 set** which was held by a strap over the shoulder. Both these rigs were valved (IO types) and so the batteries needed for HT and heaters were quite heavy.

If you remember, they looked like this:-

**18 set** – RX at top & TX below **38 set** - transceiver - 5 valves 4 x ARP12 1 x ATP4 (PA) Po 0.2W. Whip ant to 12 feet. 7.4 – 9.2MHz



**Type D Wavemeter** spot frequencies 1.9 - 8.0Mc/s in two ranges. The gaps filled by VFO (centre knob) with 1 MHz pips to 25Mc/s. Worked off 6Volt cell



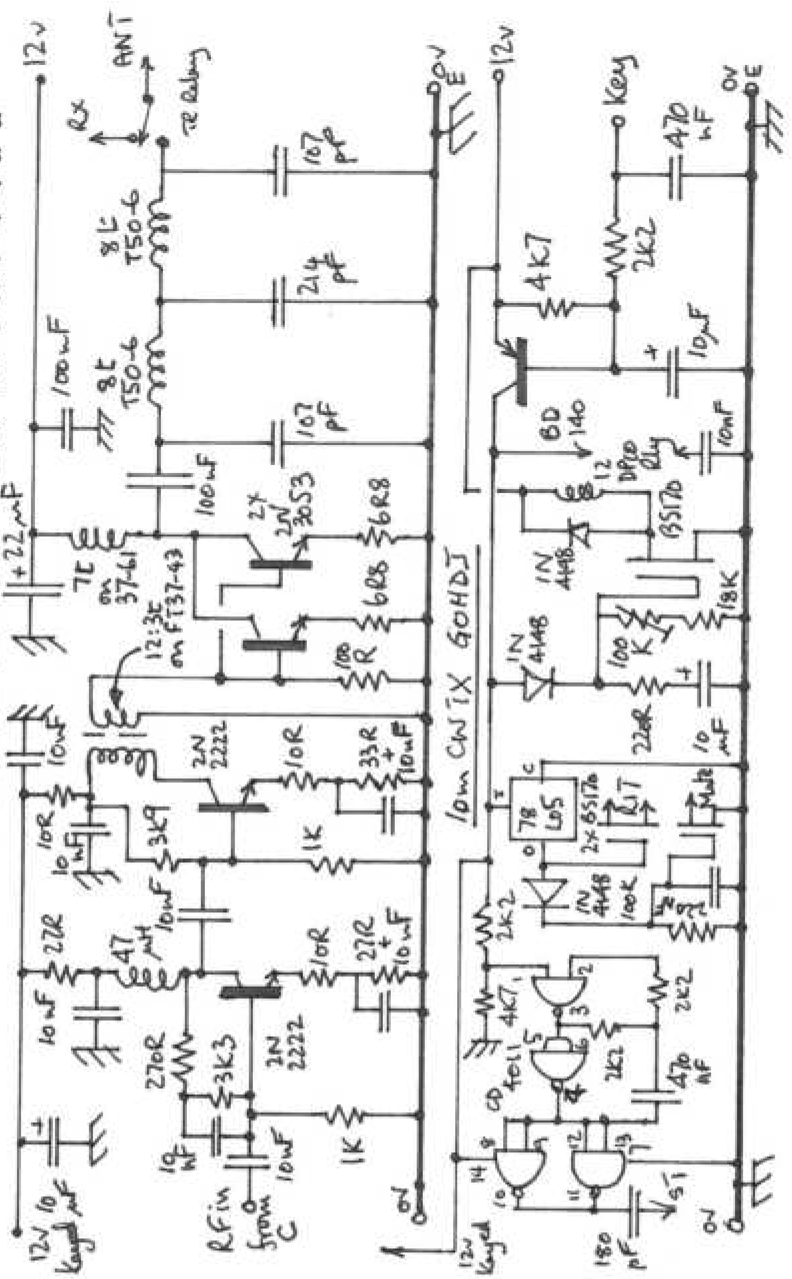
**R107** (left above) in steel case and cast iron knobs (very tough ) single conversion superhet with 1 RF and 2 IF stages: range 1.2 – 17.4 Mc/s in three bands.

**12 set** (right above) – built in steel cabinet – front panel perforated to see a pair of glowing PA bottles! It produces 25Watts of double side band AM from 1.2 – 17.5 MHz. Hand held carbon microphones were used – they were rugged.

## *G0HDJ's Sutton CW TX for 10m*

Craig decided that he would build his own 10m CW TX to go with his Sutton and has used a mix of circuits from NB6M's homebrew page of suggestions and mine from earlier rigs. He built it physically with a mix of isolated 6mm square pads stuck down onto sheet copper clad PCB for the RF parts, and Vero board for the control circuits. The resulting assembly was attached to the back of his Sutton RX. At the time of writing in June, it was producing a comfortable 2 W without chirp and he was just waiting for the band to open! Craig's circuit is shown right.

For those unfamiliar with the Sutton design, it was a simple form of multi-band DC rig. The basic rig had ceramic resonators for 80m, with the mixing resonant circuits for other bands on a plug-in card that interfaced with a VFO mixer on the main PCB. This mixer used the 80m VFO input and a specific crystal for each plugged in band - in this case for 10m, the crystal is 24.5 MHz. This scheme avoids the problem of chirp and provides a stable adequately large coverage of each band. For those who would like to explore the arrangement, I have plenty of crystals for the higher bands - 10.5, 17.5 and 24.5 MHz. The Sutton VFO mixer circuit fed into the rig's product detector so that a buffered output for driving a transmitter was available from its point C, which forms the RF input to this circuit. G3PCJ




## *More Snippets!*

*High power chips* I recently spotted that Freescale Semiconductor claims to have the highest power laterally diffused metal oxide semiconductor (LDMOS) RF power transistor. These are relatives of my trusty BS170 and IRF510 FETs!! It gives a pulsed peak output of 1 kW at 130 MHz with 65% drain efficiency. I wonder if that could be made to open your local 2m repeater?!

*Narrow band TV* Dave Buddery Snr G3OEP reports that he is a member of the Narrow Band TV Association and they are looking at Baird's work. He suggests the BBC were unwise to drop his experiments as their best members are now achieving good three colour moving images needing only 9 KHz of bandwidth! Dave asserts that a single high powered medium wave transmitter could cover the whole of the UK! I must admit that I don't understand how the many so called digital TV signals (with their digital sharp modulation edges - which imply 'wide' bandwidth) can be more spectrum efficient than the existing FM modulated analogue signals - perhaps a reader can explain!

*Ultra capacitors* I am fascinated by this technology as it wont be long (I hope) before we can stick these in our electric vehicles and forget about lead acid or Lithium battery technologies! I see that Maxwell Technologies have developed a unit that can deliver over 58 kW of power! Although individual cells operate at about 2.5 volts, higher voltage 'stacks' can be obtained to over 1100 volts. The continuous discharge current can be up to 150 Amps! No mention of price so don't order them from Walford Electronics just yet! G3PCJ

## ***HF Radio experiences in the oil industry –*** - HF Radio in the bush

The area where I was working in West Africa was a hive of activity in the early 70's. One of the problems we had was "conflicting operations" whereby things one crew did would interfere with the operations of another crew and vice-versa. All the crews had a common HF channel no matter who you worked for and we made arrangements to make radio contact if we thought "conflict" was going to happen or if we found it happening unexpectedly (a very common state of affairs). It got so bad at one time, that we held a meeting in town at which we talked about our areas of operation, their extent and duration etc. and we thought of ways of "deconflicting". Eventually all the interested parties admitted they had a spare transceiver and we decided to take one to the bush every day with the operation, rig up a dipole, make contact and conduct our affairs in a manner such that the conflict ceased to be a problem. This worked like a charm. I very much admired the performance of a dipole slung amongst the trees in the jungle as a result! Needless to say, management and our clients were very happy with this state of affairs.

Later on during this first trip to West Africa, my operation found itself having to let off moderate size explosive charges in the big rivers where we worked. The rule was that if the river crossing in the line of progress (not the actual river width) exceeded 600 metres, we had to make these "water shots". There was one shot for every 50 metres of the river crossing. Each shot used 15 to 20 pounds of explosive and on a good day we might make 2 sets of river crossings. It could amount to about 100 shots a day or a bit more, so around a ton of explosives might be used, quite an undertaking (dangerous too – NB for the environmentalists, these practices are a thing of the past, there are better and safer methods used today). Inevitably, at the time we killed a lot of fish.

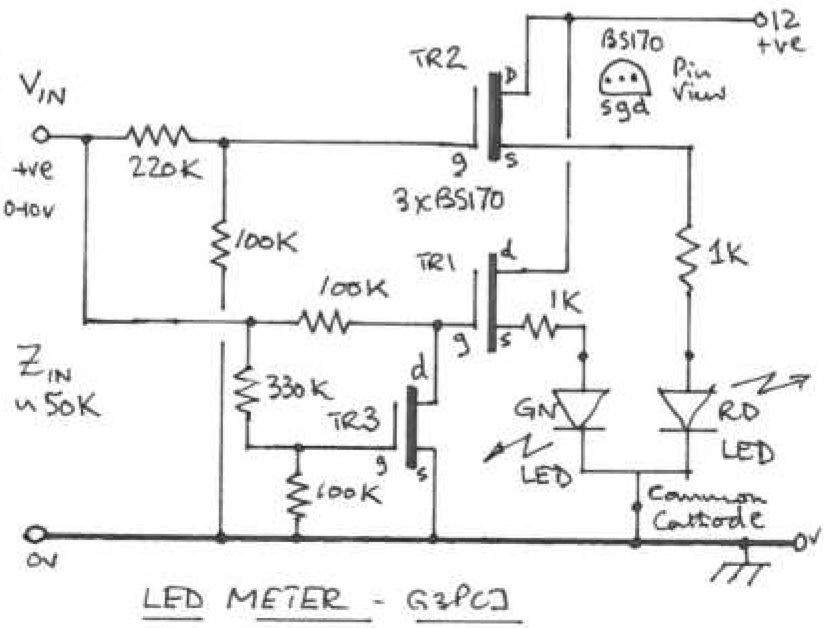
The shot firing was carried out by radio and so was the shot positioning (charge supported beneath heavy duty plastic bag, towed behind dinghy, yours truly driving). This was before the days of modern, mass produced VHF transceivers (by only a few years) and we used 3 sets of hybrid AM Motorola taxi radios, with some valves used on the transmitter side but with a solid state receiver. They ran on a frequency around 58 MHz if I recall, just HF of "6 metres" (why?? – I never found out – I was too fly too ask!). The valves in the RF side of the TX meant that these beasts ate batteries, you needed 2 good 12 volt car batteries per set – one for the heater and one for the HT (rotary converter if I remember), if you wanted a reliable day's work to be carried out. The gear came with a set of antennas – a whip for the dinghy from which the shot firing was carried out and a couple of others for the two fixed stations. The whip bases were pretty hopeless for work in the mangrove bush plus the unbalanced RF got into all the other gear and so I rigged up dipoles for the two fixed units and hung them in the mangrove. They worked fine.

My crew carried out several of these operations and a few times I heard music on the channel and once or twice weak voices speaking in what I thought might be Italian or Spanish (neither of which I spoke at the time). One day, in the late afternoon, the music was stronger than normal and so was one of these voices. I noticed a kind of interrogative tone to the voice from time to time after we had been transmitting and words like 'Que?' being used. I thought we had a listener, so I said, "This is Crew XYZ working in (West Africa), who is calling?" I think I repeated it a few times. There was a silence and finally a voice came back "This Taxi in Buenos Aires". I had a rather poor chat with the guy who spoke just a little English and he said, "I hear you before, today you very loud, what you do?" I can't really remember much of what I said, but I know told him not to worry because we would soon be gone!! I reported it "off the record" to our management and they laughed. I think Ham Radio and in particular NFD experiences helped to get me through those operations, perhaps when it came to making sure all the batteries were ready and the antennas. It was certainly useful in explaining to those not familiar with radio operations in what to do to reduce consumption from the HT supply battery by taking one of the croc clips off between times when we were not actively using the gear etc. I often wonder if I would have got through all that without amateur radio.

## *Meter Miscellany and CD4066s!*

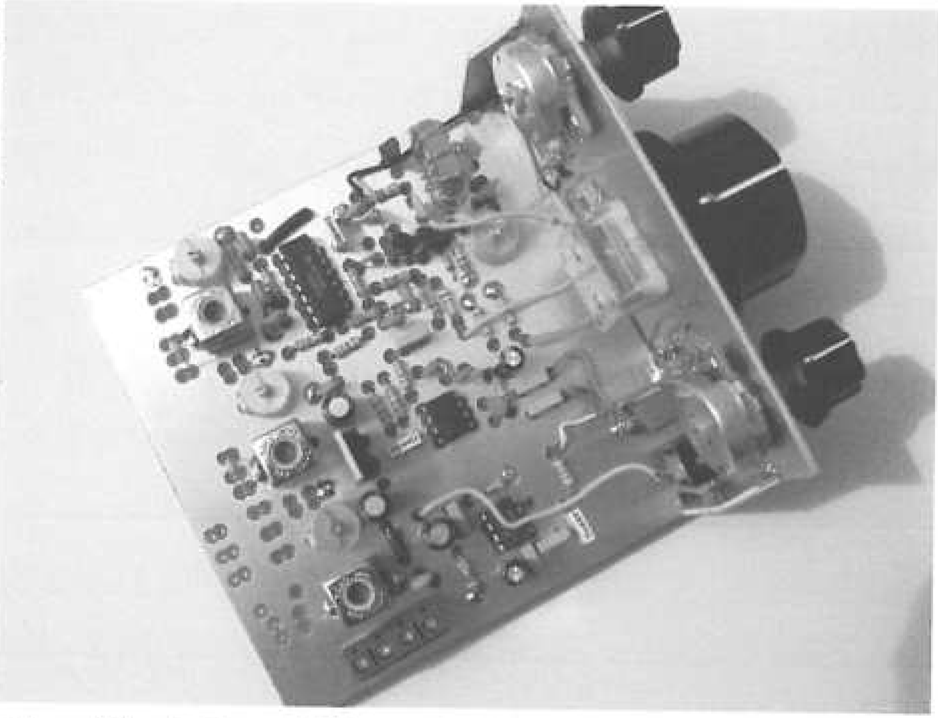
Andy Howgate tells me that he had fitted a LED 'meter' to Eric (G3GC's) partially finished Taunton. When clearing Eric's shack I found this rig and Andy expressed an interest in completing it - which he now has, but not without considerable difficulties. Although a retired design now, it is worth recounting the difficulties in case any members have had similar problems (and not told me!). The symptoms were that it would work for a while and then blow one of the CD4066 switching chips, which it did repeatedly! This was not doing the PCB, or Andy's temper, any good whatever! Andy eventually did find the problem himself and this then prompted my memory to confirm that there had been a design problem which had led to a PCB modification on later models. The problem was an unused section in one of the CMOS mixer switches, where the recommendation is to tie the unused or unconnected inputs to a supply rail. Owing to the complex track pattern, it was much more convenient to tie the inputs to the 8 volt supply than to 0 volts, and this was eventually causing the chip to blow. The modification was to connect the unused inputs to 0 volts; so I am now pleased to report that this Taunton is now working properly! Andy fitted two LEDs instead of a normal edge meter (see right) which set me thinking about tri-colour LEDs as an alternative to expensive moving coil meters.


Tri colour LEDs are cheap and easily fitted devices - they are usually just a pair of red and green diodes in one package with three leads, the central one being their common cathode. The driving circuit is intended to simulate a nominal 0 to 10 volt FSD voltmeter; it relies on the BS170 needing just over two volts between gate and source to make it conduct. Because the gate is like a capacitor, you can use resistive potential dividers on their inputs to select the threshold at which they will begin to conduct. TR1 and 2 are arranged to come on with voltages above 3 (brings on the green LED) and above 6 which also brings on the red LED for a combined orange colour. TR3 then comes on at about 8 volts, acting as a switch across the input to TR1 so that only the red LED is left on! I have to admit that I have not tried this out but I am reasonably confident it will work - maybe with some resistor value alterations!



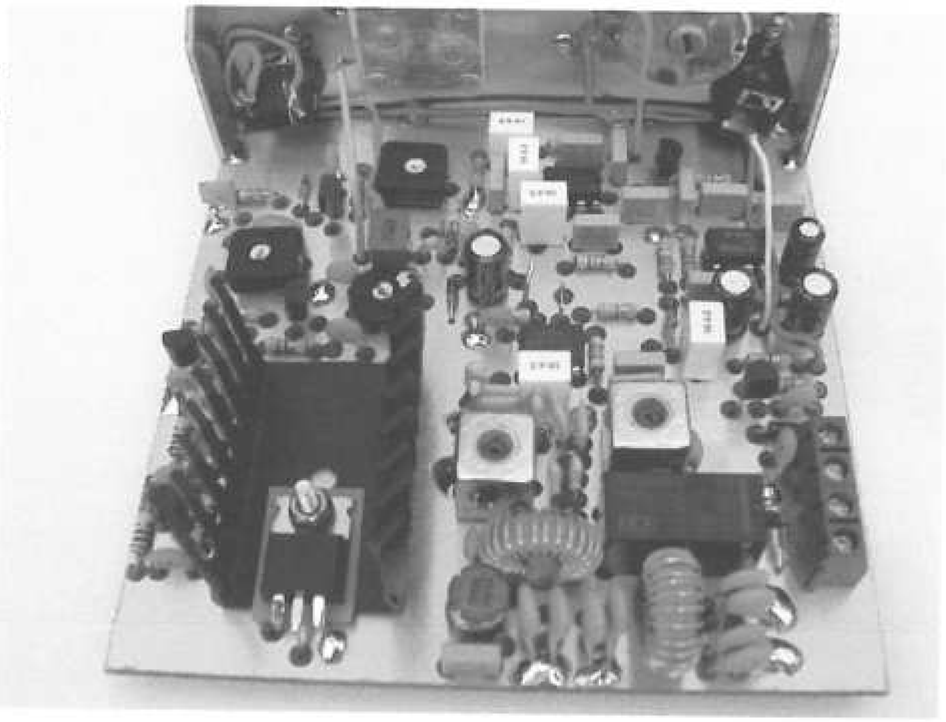

For those who like to stick with **conventional** meters, I recently purchased a quantity of good quality 50 micro-amp moving coil brand new boxed meters with 6 x 7 cm faces. **I can offer these to members at the very low price (one third of (not off!) normal) of three meters for £10, plus £3 for P & P.** Tim

## *The Knole*



This is a DC RX for any single band 20, 40 or 80m. It can do other bands but the single set of normal parts covers those common bands. You can see the set of three inductors and trimmers on the left hand side which are the RF input bandpass filter. The use of three resonators gives extra rejection to out of amateur band broadcast stations. A further feature to improve its BCI rejecting performance, is the use of an MC1496 Gilbert cell mixer (middle top left) - this is like the SA602 but is 'stronger' and hence better able to deal with overload problems caused by BCI. The VFO uses a powdered iron toroid for better stability on the higher bands than could be obtained from TOKO inductors. I am afraid you do have to wind the toroid yourself! Main tuning is by the PolyVaricon with Fine tuning by potentiometer; the latter can be converted to RIT when used with a CW transmitter. The MC1496 feeds an audio pre-amp (in middle of the PCB) having a bandwidth suited to speech reception; the other half of this chip is a low pass filter for CW. Their output, selected by a front panel switch, feeds the AFG pot and the LM380-8 output stage (bottom middle right) which can drive a LS or phones. There is also provision for mounting a TR relay when used with either the Kilton CW, or the Kilmot DSB phone transmitters. Plenty of space! **£44 + £3 P & P.**

## *The Brendon*



This is 'builder friendly' DSB phone TCVR producing 1.5W of RF on nom 12 volt supplies. It is laid out with a lot more space than the earlier Brean and includes a front panel etc! The audio output stage has been changed to an LM380-8 so it can now drive phones or LS. The low level RX and speech amp audio stages now use a TL072 dual op-amp. The RF output stage now uses a more robust IFR510 and heatsink instead of three BS170s! The VFO remains a 2N3819 using a ceramic resonator for 80m. For other bands (up to 20m), you can use a crystal - this avoids the drift associated with higher frequency ceramic resonators but has the drawback of very limited tuning range. This is solved by using a crystal mixed VFO with the Mini Mix kit. **The Brendon is normally £49, but is reduced to £44 + £3 P and P for Construction Club members.**

## ***A guide to Bi-polar Transistor selection*** - by Gerald Stancey G3MCK

How many times do you read in a constructional article the phrase 'a 2NXXX or anything similar will do'? This is fine if you know which transistors are similar or have a book which lists them, but what can the normal amateur do? The following notes are intended as a guide and if you have followed them but the project does NOT work, at least you will know where to start to find the problem.

Firstly the no-brainers. If a **PNP** type is specified, then a **PNP** it must be. An **NPN** just will not do and vice versa.

The next thing to consider is the order in which the leads come from the transistor. Are they **ecb** or **bce** or whatever? This may or my not matter. If you are using a ready made PCB then unless you can fiddle the connections it will be a show-stopper. On the other hand, if you are using ugly construction or something similar then it probably does not matter.

In a similar vein is the type of package. If the specified transistor is in a TO1 case then trying to substitute something in a TO3 case may not be a good idea.

We now come to the voltage, current and power dissipation figures. By and large, if the proposed substitute equals or exceeds those of the one which was specified then you wont have a problem. Even if it doesn't you may still be alright but in this case you will have to analyse the circuit to see exactly what voltages and currents are involved.

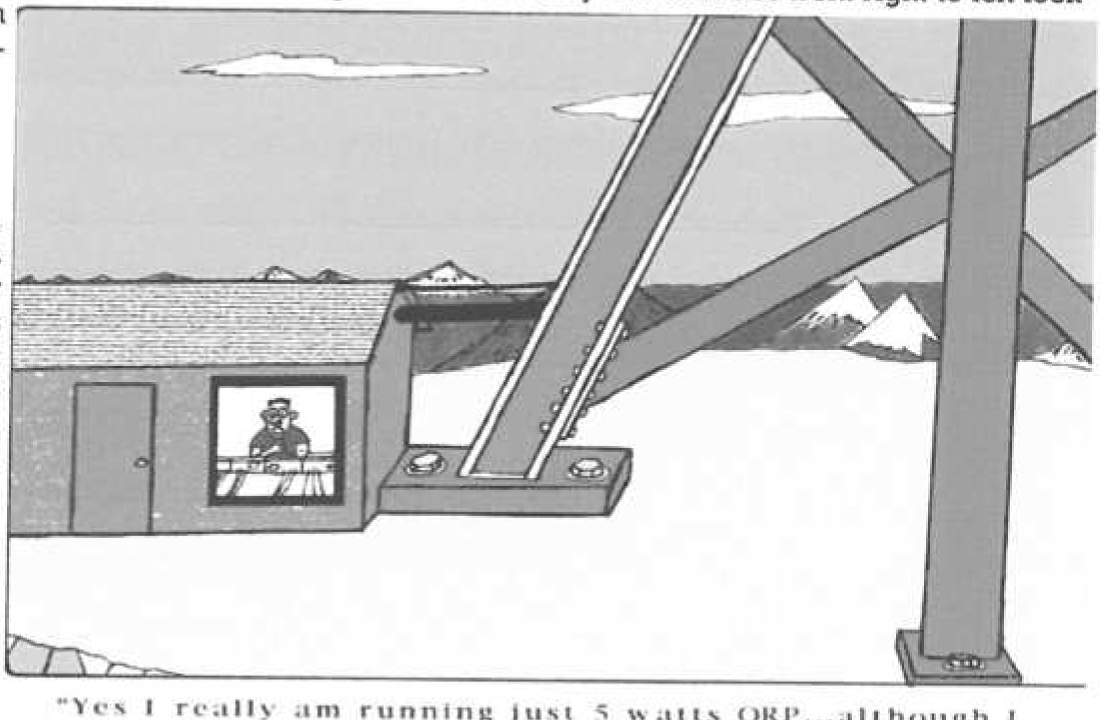
The **Hfe** (current gain - ratio of emitter/collector to base current) and **Ft** (frequency where gain drops to unity) are other parameters that need to be considered but usually they are of little importance provided they are over a certain minimum.

Two subtleties: it is usually unwise to use VHF transistors (having very high Ft) where an HF device has been specified, instability may result; also check to see if the specified transistor has some special characteristic, for example, is it low noise?

Suppliers catalogues (and websites of Farnell and RS) can be used to find the basic data to which I have referred. The above is not an exhaustive list but should be good enough to put the home constructor on the right lines as I said before - if it does NOT work, then you know where to start looking!

As a comment, I (G3PCJ) offer the following quick fix solutions! Use TO92 plastic BC182s for any HF (or lower frequency) NPN task! They are 50 volt, 300 mW, 100 mA (all max) devices with min Hfe of over 100 and typical Ft of 200 MHz. Noise figure is 10 dB. For HF PNP tasks use the complimentary BC212s - they have the same spec numbers! They are both ebc from right to left looking at pins with the flat side pointing down!

Finally, Richard Booth kindly drew my attention to this cartoon! I expect he has about 15 BC182s in parallel for his 160m output stage!



"Yes I really am running just 5 watts QRP...although I suppose I do have an above average antenna system..."

# Snippets!

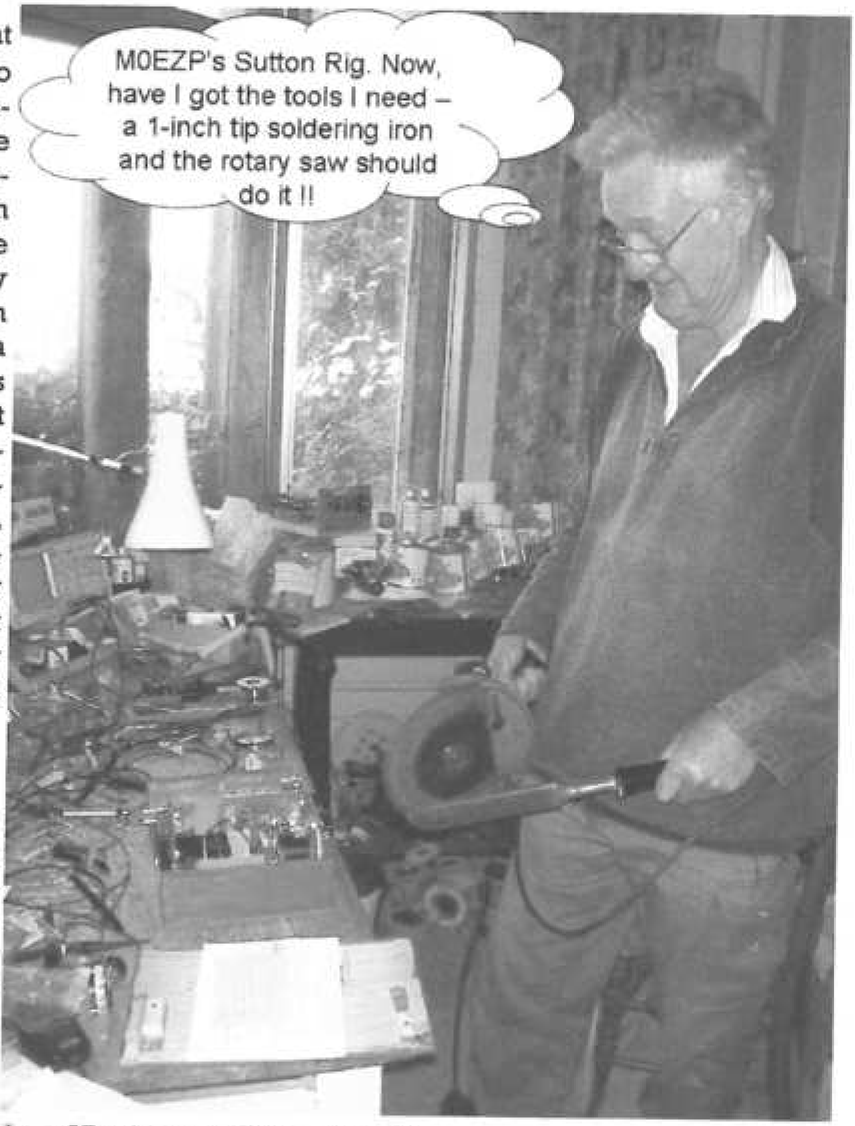
***DDS chips*** - I have the following surface mount sample devices surplus to my needs:- AD9857AST, AD9283BRS, AD9835BRU. They are all direct digital synthesizer chips needing control from a microprocessor. I also have a 50 MHz xtal oscillator to drive them. Free to a deserving home! G3PCJ

***Tolerances!*** Craig Douglas G0HDJ has built the diode tester which Godfrey Manning wrote about in an earlier Hot Iron but he had a spot of bother about the voltage thresholds. Craig eventually contacted Godfrey and the trouble was soon spotted - Craig had used 5% resistors in a critical part of the circuit where 1% ones were actually required. (I hope this vital aspect was not a problem of editing!) If so my apologies - but it does show that occasionally 'tolerancing' does actually matter as parts can be on the edge of their specified value.

***Counter ideas!*** Gerald Stancey G3MCK kindly wrote about his needs following my pleas for suggestions: he would like the readout to 100 Hz. However he knows the band he is on so XXX.X KHz would meet his need but this could be reduced further by accepting a resolution of 1 KHz instead. As a CW man, he also knows that he is in the bottom part of the band and therefore has no need for the hundreds of KHz digit which brings the need back to XX.X or XX KHz. He could live with a set of plain LED indicators - nothing on for first 10 KHz, red for 10 - 20, green for 20 - 30 KHz, etc. In fact his 'essential' needs are met by a display of just XX KHz. As a comment, I had concluded that just two digits are adequate but have found that the extra circuits to make it into a scrolling five digit display using just two actual displays does not need many extra parts or chips. This is what I hope to offer soon. Tim

***LCD Voltmeters*** Craig G0HDJ sent me a note about his recent move into making furniture and the need to measure the moisture content of wood! He tried adapting a soil moisture measuring circuit but lacked the information relating electrical resistance to moisture content for many species of timber. By the time he obtained this, he was given a commercial wood moisture meter as a Christmas present! However he does recommend the ICL7106 chip as a most useful voltage measuring device. It contains an A to D converter, 3 1/2 digit display driver for LCDs, voltage reference, decoders etc all running off a 9 volt battery and consuming just 2 mAmps! They are available from Farnell for about £3.20 and the matching LCD display costs about £6. The A/D input range can be 0 - 2v or 0 - 200 mV FSD.

***Finally - a lighter note!*** Both David M0EZP and his Sutton have been recent visitors here. David kindly sent me this picture that he took while I was contemplating what to do - I did want to delete his call sign from the picture but was unable to make my software do it - sorry David! Note Upton in background. Tim



"JOURNAL OF THE CONSTRUCTORS CLUB"

# Hot Iron

Winter 2007
Issue 58

## Contents



The Walford Electronics website is also at www.walfordelectronics.co.uk

## *Editorial*

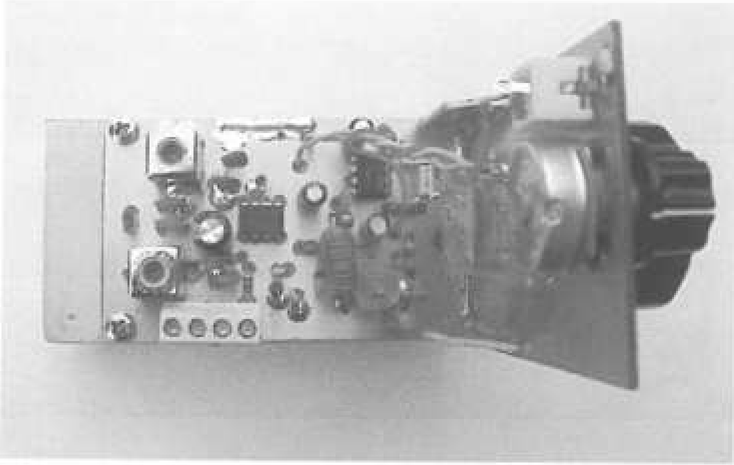
Here is something slightly more inspiring and tidy than my bench! It's the operating position of Chris GU3TUX who many will know from his former life selling keys and other radio related bits and pieces. Chris moved to Alderney a few years back and now has a bit more time for using his gear. I note a couple of items that should be easily recognised by readers! The boxed TCVR on the middle shelf is a Highbridge in disguise; currently undergoing some modifications for better filtering etc. Chris uses these items with a long W3EDP antenna. Keep the pics coming please - much more interesting! Tim G3PCJ

## *Kit Developments*

The **Knapp** is now available! It's a single band regen TRF on a small 50 x 80 mm single sided PCB! A few **Brendon** phone DSB TCVRs are now operating too; Steve Hartley (late of Radcom fame) is going to use them as the basis of a one day building course for novice constructors in Bath during January 2008. (If you want to participate I can put you in touch.) I hope some of those rigs will be exhibited at next years Somerset Supper - see later. I have now at long last etched a **Minster** but am awaiting its return from drilling. Assuming the basic rig works as intended on any single band 20 to 80m, then I shall start on the 'extras' package which will give it any two more bands and several extras. I have also lately realised that retiring the Kilve has left a gap in the range at the low end - I hope to plug this with the **Willett** - a three band (20/40/80m) simple DC RX. I have laid this out with a LM380-8 audio output stage in the flat 80 x 100 mm format. The target price is about £25 - I awaiting the return of the first PCB from drilling and must then check that it works well enough to be a viable receiver. I have also been doing several technically interesting experiments (see later) that might be incorporated into rigs in the future.
As Christmas is not all that far off, so I wish you all a very Merry Christmas, Tim Walford G3PCJ

*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

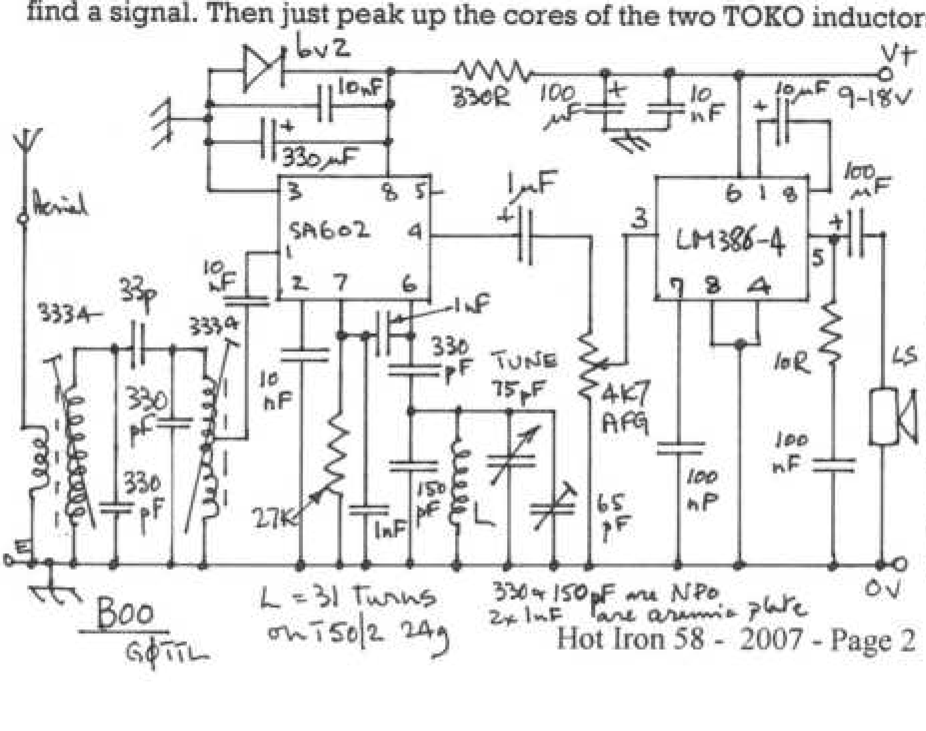
## ***Boo!*** By Richard Booth G0TTL



This little project came about during the development of a superhet transceiver that I am working on. The plan is to design it using a minimum of components to keep cost and complexity down. I must be one of a few people who makes his own equipment and has never used an LM386 audio amplifier! So I wanted to try one out and by using this particular device which has a voltage gain of up to 200, the theory is that you can do away with an audio preamplifier stage; this fits my design plan perfectly. That fact in mind, I also wanted to try out the possibilities of using the internal oscillator of the SA602 mixer as a Colpitts style VFO with a single winding toroid (no taps) and variable capacitor as frequency control. Again this approach would save an extra transistor oscillator stage in my eventual superhet project. Rather than muck about with breadboards testing ideas I prefer to build something more substantial, especially when testing VFO circuits. This gave me an excuse to put together a little direct conversion receiver for 80M.

Construction is straightforward, the layout not being particularly critical although care needs to be taken around the audio stage due to the high single stage gain. You can build it on my 80x50 mm double sided PCB or ugly bug style. Use ceramic plate capacitors for the RF input band pass filter which uses a pair of TOKO 3334. The Colpitts VFO around pins 6 & 7 of the SA602 uses two types of capacitor. The 1nF types need to be N150 ceramic plate (orange tips) and the 330pF and 150pF are NPO types. This helps to improve temperature and frequency stability so worth fitting the correct variety. The toroid "L" is made up from 31 turns of 24 SWG, close wound on a red T50-2 core. There is just enough room for this winding in a single layer. Make the turns tight. My prototype covered the whole of 80M using the 75pf section of a Polyvaricon variable capacitor - use the 65pf trimmer in parallel to adjust the operating frequency range. The audio stage uses a LM386N-4, I chose the "4" version as this is the higher operating voltage type, which will stand up to 18V. All electrolytic capacitors are rated at 35V, the 100nF components are miniature polyester. The rest of the other capacitors are ceramic disc. You can either use a 9V battery or your 13.8V supply. Do check the polarity before switching on.

When complete, set the operating frequency of the VFO using a counter, you can temporally hook it up via a divide by ten probe to pin 7 of the SA602. Otherwise use another receiver to listen for the VFO in the usual manner and adjust. If you use the suggested values it should be very close to the 80M band and need little adjustment. Now connect up your antenna, tune to mid band and find a signal. Then just peak up the cores of the two TOKO inductors for best signal to noise ratio.

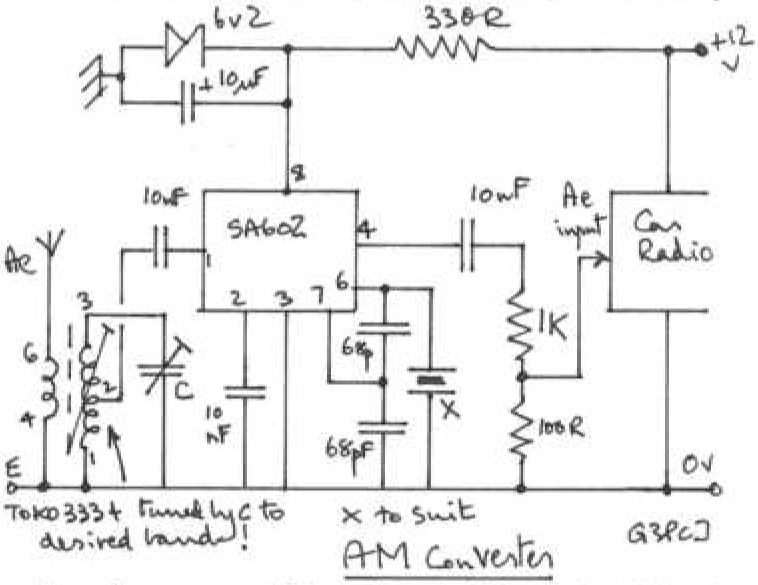



After completing this receiver I realised the original concept of strapping a 602 and 386 together had already been developed by a certain George Dobbs, G3RJV in the "Sudden". Some may say great minds think alike! I will now get on with making a superhet version of this, the next job is to build and test a home made 9MHz SSB crystal ladder filter. If you want a PCB, I can supply them; give me a call - Tel 01302 858468. Happy Christmas, Richard G0TTL

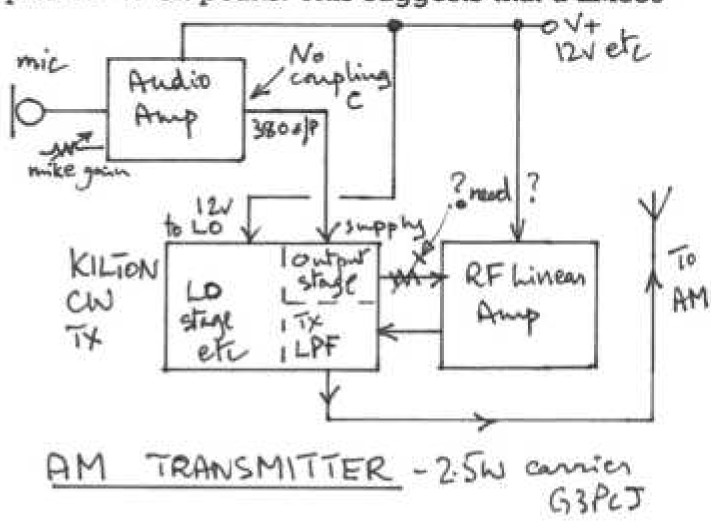
## ***Amplitude Modulation techniques***

There is quite a lot of activity and interest in Amplitude Modulation, with regular nets on 160m and, I am told, also on 40m. Prior to very narrow IF filters becoming cheap, making single sideband economically feasible, AM was THE mode of phone operation.

*AM Receivers* TRF receivers (often with regeneration) were common the before superhets - the TRFs had amplitude detectors after the RF amplifiers to detect the peaks of the RF envelope, which were then passed to following audio amplifiers. While this was originally done with valves, it is now much easier with FETs and bi-polar transistors as in the Knapp regenerative TRF RX. This uses an infinite impedance FET detector to rectify or detect the peaks of the RF signal. A plain diode could be used instead but this will load down the RF tuned circuit and reduce its Q and or the sensitivity, whereas the infinite impedance detector works like a perfect diode that does not load the driving tuned circuit! Unfortunately it is not possible to make the product detector of a normal direct conversion receiver work as an amplitude detector while still retaining its selectivity - AM really requires a different approach. One of the easiest ways is to use an old AM broadcast band car radio which can often be picked up at rallies for a £1 or so, working in conjunction with a simple converter. The converter just shifts the received signals down to a convenient section of the medium (or long wave) band with the car radio acting as a tuneable IF, detector and audio output. This scheme is easily done with a SA602 mixer oscillator chip as shown right. You need a crystal whose frequency is about 750 KHz to 1 MHz either above or below the band you wish to listen to - the exact figure is not important as you just adjust the car radio's tuning to suit! 5.5 MHz suits 40m and 2.5 MHz does 160m.

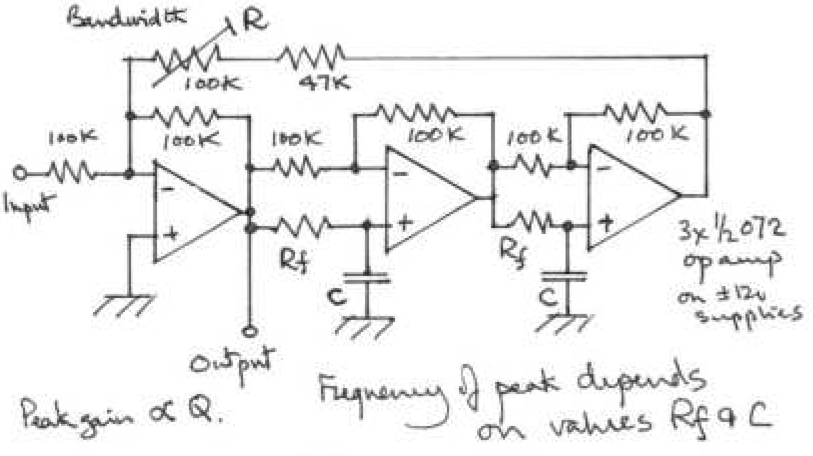



*AM Transmitters* Traditionally this was done by using a powerful audio amplifier to 'modulate' the HT supply of the output stage of a CW transmitter. This approach does have the advantage that an existing CW simple transmitter can be used because it does not have to be linear through all the RF stages as in an SSB transmitter. It is certainly possible to do this with transistorised equipment but the major drawback is that it often needs an expensive special audio transformer. Another approach is to modulate at rather lower level and use a linear amplifier to obtain the desired output level. The RF amplifier operates continuously at the desired carrier power, going up to peaks of four times that on speech peaks and down to zero on the troughs. This means that a 10W peak RF amp, like my linear kit (on 13.8 supplies), can run a 2.5W carrier on AM. Its gain is about 8 dB so it would need around 300 mW carrier input going up to 1.2 W on peaks. This suggests that a LM380 audio amp chip can directly modulate a lower power RF amp as a driver to the Linear. This is done by using the audio amp's normal DC output of half the supply voltage to feed the RF amp final stage without any coupling capacitor. The **Kilton,** normally 1.5W of CW on 13.8v, is ideal if its output stage is powered at 6 volts by an LM380 from my **Audio Amp** kit! The oscillator section of the Kilton is run on 13.8 volts as normal. This is an easy alteration to make! What's more, there are 2 MHz ceramic resonators that can be directly used on 160m in the Kilton provided the output low pass filters are also altered for 160m! Worth a try! Tim G3PCJ



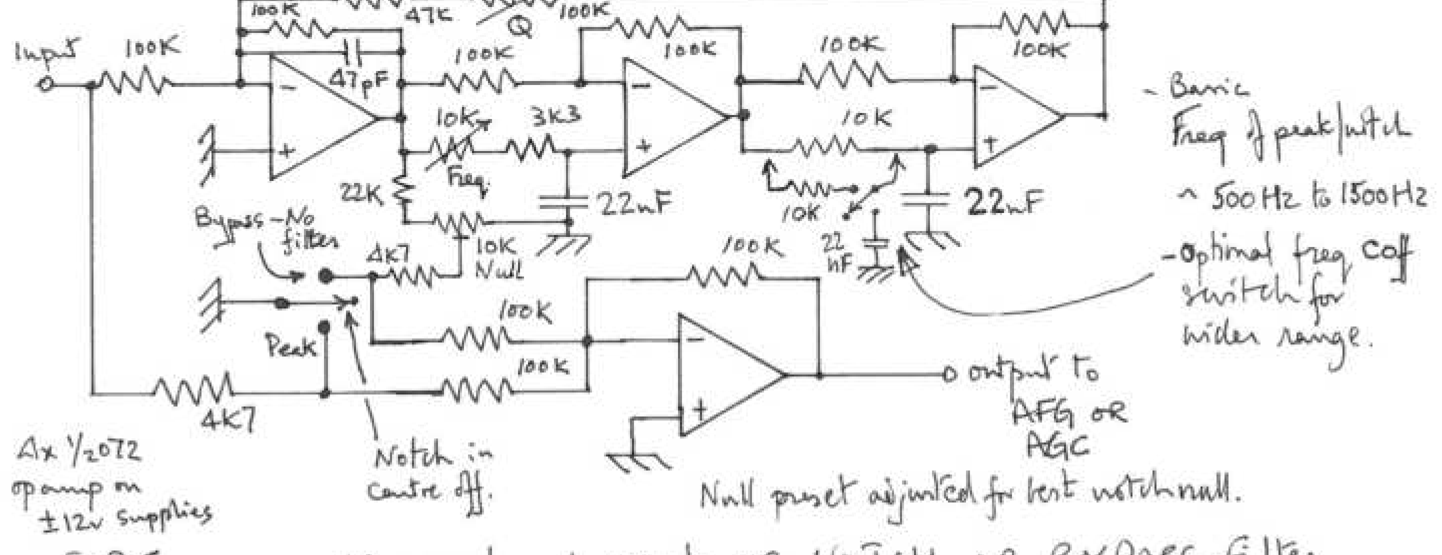
## ***Ideas for CW filters!***

While considering what filters to put into the Minster for CW, I went wild and contemplated variable bandwidth, variable centre frequency, choice of peak or null or direct etc!! Variable bandwidth with fixed centre frequency is relatively easy and I have had a kit for this for some years using adjustable coupling between two filters, but a 'simple' variable frequency design had eluded me - I particularly wanted to avoid having to use two gang pots. For CW it is also important that although one might want a narrow bandwidth implying high Q, the filter should not ring. After playing with most of the common op-amp filter networks, including the 'state variable' filter that uses two integrators and an inverter, I hit on the idea of using two *all pass* phase shifters to provide the 180 degree shift required for near oscillation instead of the state variable's integrators. The *all pass* filter has unity gain but just alters the phase delay (or advance) as the signal passes through it, hence it would be possible to change the delay, and thus frequency, without altering the overall gain or Q of the whole circuit. The box right shows the scheme. The simple arrangement shown is a peaking bandpass filter, where, as the variable R element is decreased, it gets nearer to oscillation with a decreasing bandwidth or higher Q. In this simple scheme the overall gain does alter with Q but there are ways round that if bandwidth has to be a front panel control!




Bandpass Filter

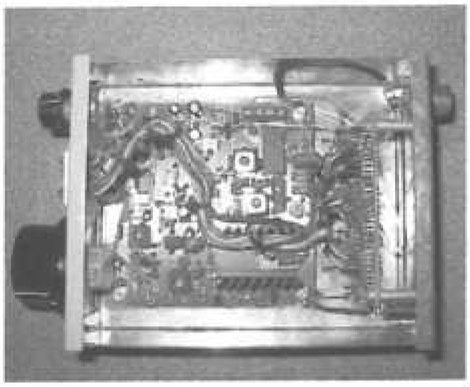
It then dawned on me that the two phase shift stages need not have the same delay as long as their combined shift comes to 180 degrees. This means that by varying just one of them, with a single pot, one could alter the centre frequency! This worked excellently and I even managed to devise a version (with an extra op-amp) that had constant gain irrespective of the Q! By adding yet another op-amp to subtract the filter output from the original input signal one can turn it into a notch filter too! With a centre off toggle one could have straight through, notch or peak outputs! In the basic version there was some evidence of very HF instability so I added a couple of CR's to reduce the HF gain. However by this time it was looking like at least 5 op-amps and getting far too complicated, but it was an interesting exercise and might encourage readers to explore the ideas! The circuit below uses ground referenced biasing for + and - 12v supplies; a single supply design will need mid-supply biasing. I still have to decide exactly what I will put for CW in the Minster! Tim




Narrow band peak OR NOTCH OR BYPASS filter

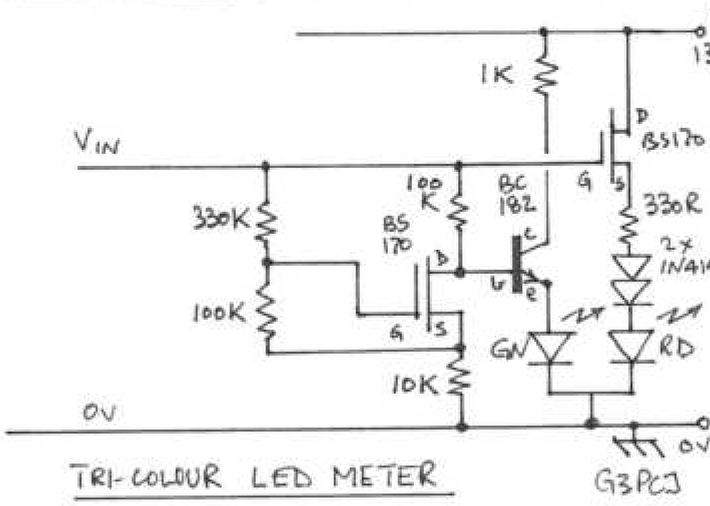
## *Smart Brendons!*

Here are a pair of very smart Brendons built by Paul G0VHT and Richard G0TTL. Paul is working on adding a linear RF amp that was salvaged from an earlier project. Richard has added a 3 digit counter to his (right).



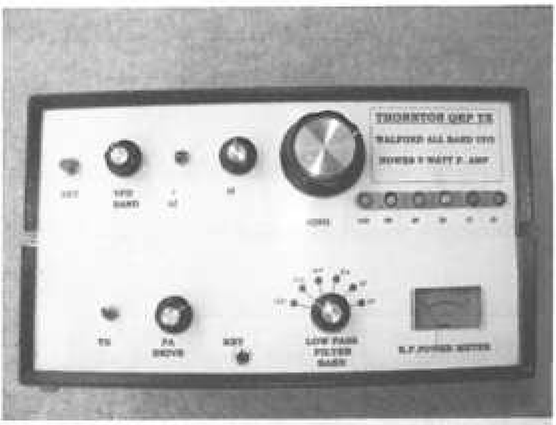
## *Tri-colour LED meter*

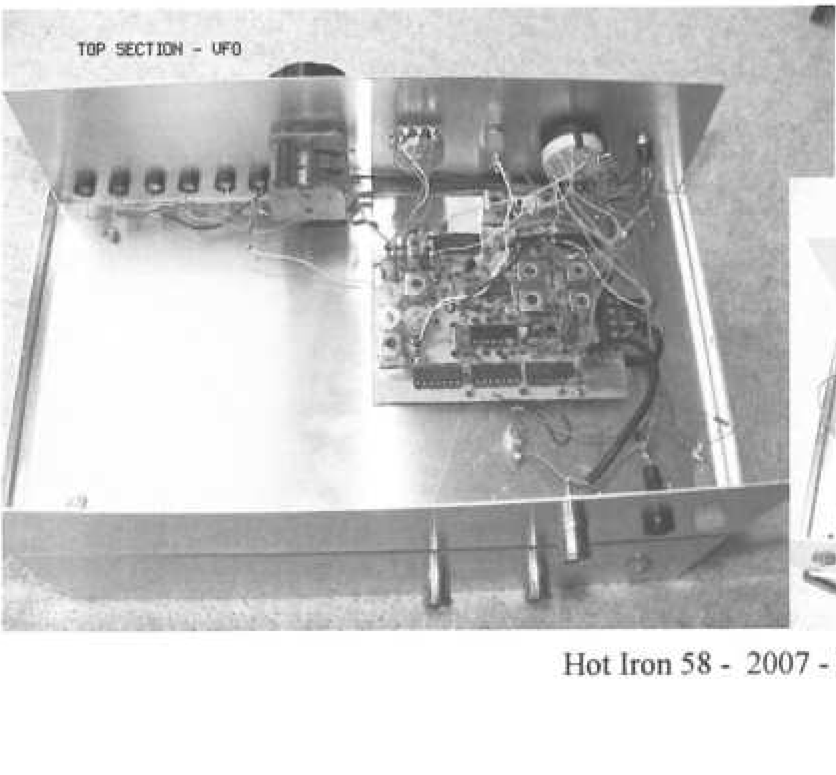
After floating this idea last time with an untried circuit, I did eventually get round to seeing if it worked - it did but not quite as well as it could! The circuit right is much better, with the colour changing gradually from nothing (up to 2 volts) rising to full green at about 5 volts, to orange at 8 volts, then progressively brighter red for over 8 volts. The loading on the driving circuit is about 80K min. It is a viable low cost and low space alternative to expensive moving coil meters - but see the back page! G3PCJ

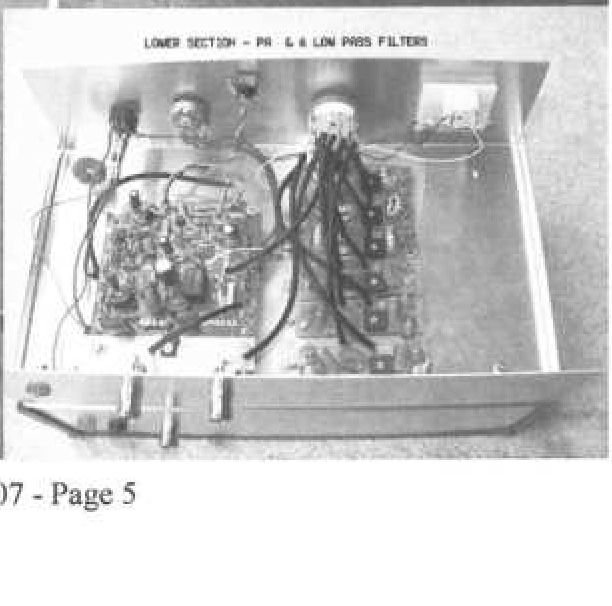



## *The ABLO*

David Proctor G0UTF has been using an ABLO to drive his CW TX which I think had its origins from another kit supplier (Dave Howes). It should eventually do all the HF bands that the ABLO can do, but so far he reports good results on 40m. It also has a LED digital frequency readout. The TX, with its low pass filters, is mounted in the bottom section below the ABLO. As an aside he commented on the excellent filtering qualities of his Howes CW filter which had made several contacts to Europe possible when the lack of a filter would have prevented them. Dave H's design used double twin T bandpass filters for CW after sharp cut-off SSB filters.



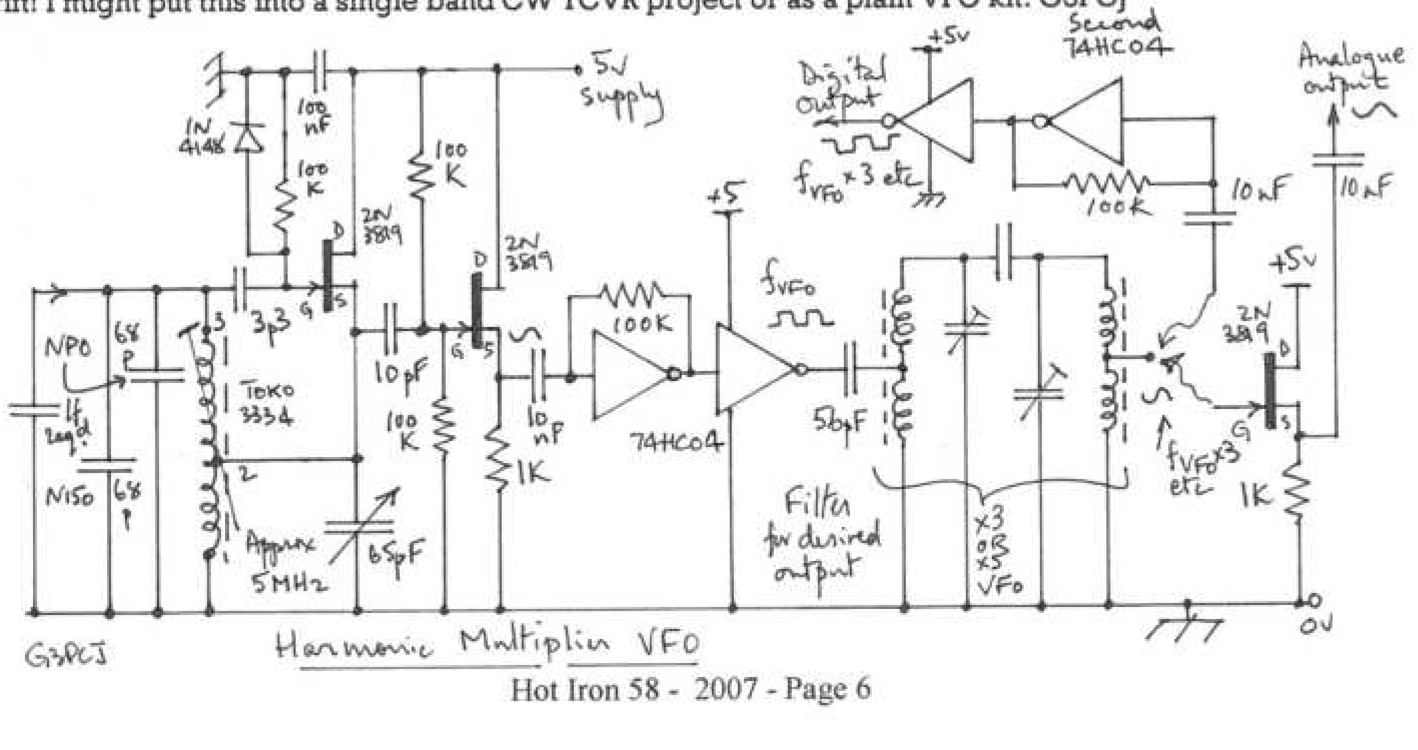



## ***Harmonic VFO possibilities!***

Many of my simpler rigs successfully use ceramic resonators as a low cost method of controlling the Local Oscillator; nevertheless it would be nice to get away from the associated drawbacks of a restricted tuning range and 80m operation. Plain conventionally tuned VFOs are not practical for the higher frequencies due to frequency instability, and without exceptional screening are also likely to suffer from chirp/FMing. The cure for these problems is to have the VFO run at some low frequency and not that of the TX output stage. Using a crystal mixing scheme is very effective and also permits the stability of a low frequency VFO to be transferred unaltered up to a higher output frequency, but it does need a different crystal for each band. Another approach is to use a multiplier and or dividers. Conventionally, multiplication would be done with doublers, or occasionally a tripler, as part of an essentially analogue LO scheme (as opposed to one using digital circuits). Yet another approach is to use the harmonics that are inherently present within a rectangular waveform. Fourier theory shows that a square wave comprises not only the fundamental, but slowly decreasing levels of all odd harmonics of that fundamental. Hence by filtering, one of the low harmonics (3, 5 or 7 possibly) can be extracted and used as the LO output signal. This is the approach used in the ABLO to generate the 15m output from a normal 7 MHz square wave signal.

I have recently investigated this approach of harmonic multiplication (with or without digital division) as the possible basis of an 'any single band VFO'. The aim was to get to 28 MHz with a tuneable VFO for use either directly on that band, or with digital division to provide the two LO signals (90 degrees apart) that are required by a phasing single sideband receiver on 20m. The snag is that not only does the fundamental frequency get multiplied but so does the drift!! Reckoning that a VFO near 9 MHz (using the third harmonic to get 28 MHz) might be a bit drifty, I elected to try a VFO on 5.6 MHz with the fifth harmonic. Initial experiments using the simplistic approach of a VFO with a digital gate as the active amplifying element, had to be abandoned because of excessive drift due to changes in capacitance within the chip as it warmed etc. Further trials with a 2N3819 conventional VFO, followed by a buffer to provide isolation prior to the squaring stages in a hex inverter digital chip, were successful. (It did take quite a while to find that film trimmers are not too good for stability, nor are too many pFs of N150 temp compensating capacitors!) The 5.6 MHz square wave is then passed to a 28 MHz double tuned filter that extracts the fifth harmonic before being again squared up by further digital inverters that provide the desired output or can drive the dividers of the phasing LO circuit. If you wanted a sinusoidal output instead, one could use a conventional linear buffer stage after the filter. I did find that it was not wise to use a single chip for all the inverters as this led to unwelcome modulation of the signal. The main part of the circuit is shown below. The parts count is comparable to a crystal mixing scheme; but the advantages are that all bands can be done without too much trouble by selecting the VFO frequency and harmonic multiplication and/or division, it avoids many special expensive crystals, and it does facilitate 90° apart digital outputs. The drawback is the need for a very stable VFO but any division will also reduce the drift! I might put this into a single band CW TCVR project or as a plain VFO kit. G3PCJ



## ***Improving an HF Radio Station*** - by Dave Buddery G3OEP

(I have shortened this from some longer notes that Dave kindly sent me - G3PCJ)

*The transceiver* Does a rig that is only 15 years old really need realignment? Probably not unless it has suffered physically, or has been used /P. Regularly used rigs seldom need tuning re-alignment - they might need checks of bias voltages, sticking relays & higher value capacitors.

*Power leads* Are they heavy enough to avoid a significant voltage drop (less than few %) under full output? Are they and the RF leads, aerial wires etc in good condition? Good RF insulators can be made from plastic chain link fencing!

*QRP Operation* Need to make certain that every milliWatt of RF gets radiated hence put max effort into obtaining a good aerial and earth system, with low loss feeders and an efficient AMU.

*Earth system* Remember its half the aerial! Is it in good condition? Is the local soil a good conductor, and is there enough rod etc to make a good ground contact? Consider using a counterpoise. Note that an 'artificial earth' is often a short length of wire tuned or loaded by its own AMU to make it look like a quarter wave.

*Aerial poles* Difficult! Use heavy duty 16ft long bamboo if available, fibreglass 'rods' or lash shorter ones together with an overlap of about 18 inches. Lash to a strong supporting post sunk in the ground, and guy it if it bends! Use three equi-spaced guy wires from about two thirds its full height if the pole is supporting the middle of the aerial and NOT pulled sideways by it. If it is on the end of aerial, then one guy wire must be directly opposite the aerial wire and right at the top.

*Aerial wires* The thinner and lighter, with less windage, the better but thin aerials have narrow bandwidth. Steel wire is OK but hard drawn (split BT 'drop-wire' figure of 8 pair) or plain copper wire is better. Generally get as high as possible and ideally half a wavelength long (total) on your lowest band; does not matter if the ends hang down but make sure not touchable - to avoid shocks!

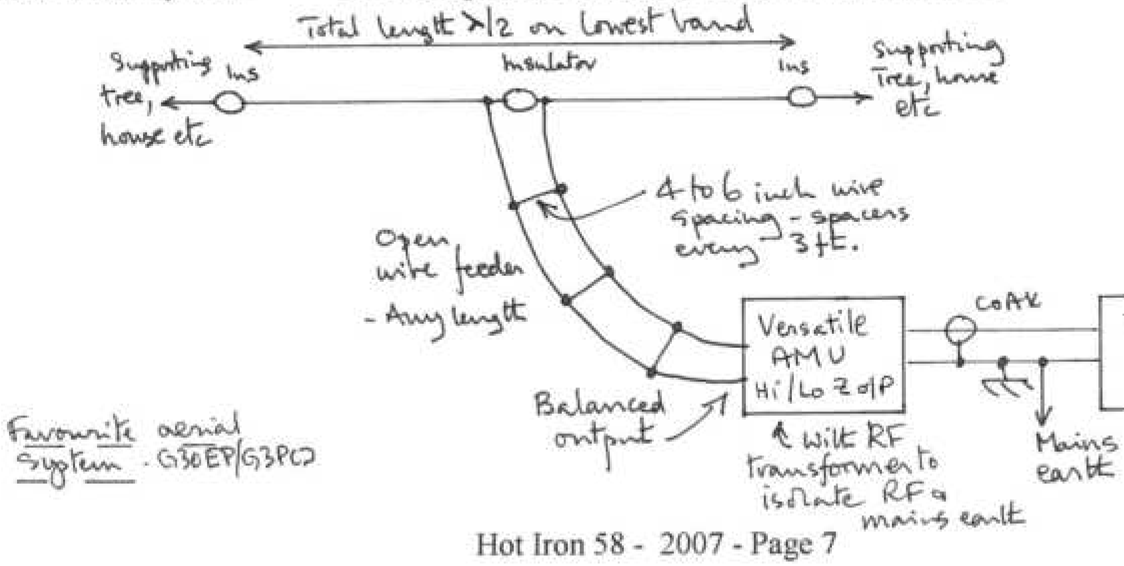
*Aerial feeders* Open wire ladder line to a versatile balanced output AMU is probably the least lossy. Even when the line impedance (which is high - often 300 to 600 R) is NOT matched to the antenna's feed point impedance, the losses will be negligible at HF. Can be easily made with two copper wires using spacers about 4 inches long made of plastic strip material, about 3 ft apart.

*Aerial halyards* Using a ring or pulley attached to top of pole/tree/house etc, through which the halyard is threaded will enable you to raise/lower the aerial without use of ladder etc. One end of halyard attached to aerial insulator, other end over pulley down to ground level and is attached to a cleat to secure it, or a suitably heavy suspended weight to allow some give. Some prefer the halyard to be continuous, connected end to end, so that it cannot be lost up the tree!

*Baluns* Theory suggests these should always be fitted at the junction of aerial and feeder, to make sure the inherent balance of the aerial (assuming it has symmetrical length arms) is maintained. Practical experience suggests their main value is helping to reduce TVI.

*RF Ammeters* Used to be available from Air Ministry! Tend to be a bit fragile. Low voltage (hence low resistance) filament bulbs in series with aerial conductor are another cheap option. Better to thread aerial lead through centre of a small ferrite toroid RF transformer, made from a few turns on toroid feeding a sensitive RF voltmeter. Use a small diode (ideally germanium or Schotky), 100 nF smoothing cap and a sensitive meter - moving coil 50 or 100 micro-amps FSD.

*Versatile aerial system* This design is favoured by many for all band use:-



# Snippets!

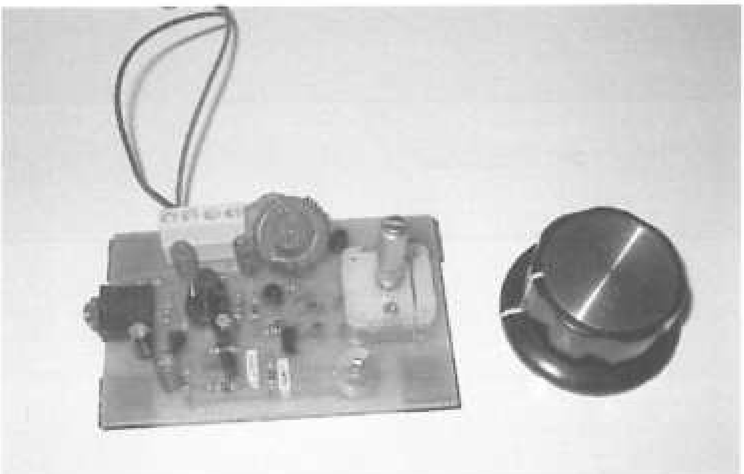
***Moving coil meters*** I have some excellent brand new 50 uAmp meters with rectangular 2.25 x 2.75 inch faces. Because I got these cheap I can offer them at three for £10 plus £3 P and P. G3PCJ

***Aerials and SWR*** There is an excellent summary of what is important for aerials, feeders, AMUs and the like in the December 2007 Radcom as part of Pat Hawkers G3VA's Technical Topics article. His regular column alone makes it worth being a member of the RSGB! Pat has been writing this column for decades and has an excellent gift for bringing forward new developments while setting them in the context of what was found out by the early radio pioneers - he does a grand job and will be a hard act to follow when he eventually puts down his pen. If you read this, please Pat, don't do that for a long time yet! One should support the National society anyway since non-members have no means of influencing Gov policy etc; the RSGB generally does a generally good job for us even if some aspects do cause annoyance. Its no good moaning if the message cannot be delivered!

***M0EZP's Sutton*** After that slightly embarrassing photo of his rig under threat from me with an angle grinder, I can now report that it is working as intended! David's rig has many additions of which the most important was a Linear RF amp. When the linear was connected after the normal output stage but before the TX output low pass filters as advised, the rig appeared to be unstable with very unpredictable readings on most bands. The trouble was traced to the LO input to the transmitter's balanced modulator - this being fed from a medium impedance source in the RX's Local Oscillator chain. Examination with the scope showed that this waveform was triangular rather than sinusoidal and hence full of harmonics. These harmonics were upsetting the TX and following Linear. Why was the LO drive triangular? This did not take long to explain and cure. The signal was derived from the RX's LO SA602 mixer chip LO input buffer transistor; this runs at a bias of a fraction of a milli-amp (even with an extra 10K external emitter resistor), consequently it is able to pull up the load capacitance rather more quickly than the emitter resistor can pull it down! Hence the triangular waveform. The cure had to be to reduced the capacitive load on this buffer stage - it turned out that David had wired it with miniature coax which represented a capacitive load of several tens of pF! The cure was to change this coax to a short single core plain wire run close to the PCB - simple! Waveform became sinusoidal, no harmonics and the rig was stable!

In general it is often better to use short direct wires between signal points in RF circuits if the distances are only small fractions of a wavelength, particularly if the source is not low impedance. The capacitance of the wire will be much less; while running it close against the ground plane(s), so as to minimise the area enclosed by the wire and the current return path, will reduce the inductance so that there is less reactance overall on the driving device.

***Knapp*** Here is a photo of what this little Regen TRF Rx looks like - built by G0TTL



## The Somerset Supper and Yeovil QRP Convention

The fourth supper will be held on Saturday April 26th 2008 at the Antelope Hotel, Sherborne (as last year) area for locals and those staying overnight. This is the evening before the Yeovil QRP Convention. As before there will be a small display of items from each diner's home built radio equipment! This will qualify you for a ***free*** place at the supper table! The display will be judged by **Steve Niewiadomski**, who contributes interesting construction articles to PW; he is also speaking at the Convention. Places by advance booking **only** by April 19th so please tell me if want to come. Hope to see it and you! Tim G3PCJ

"JOURNAL OF THE CONSTRUCTORS CLUB"

# Hot Iron

Spring 2008
Issue 59

## Contents



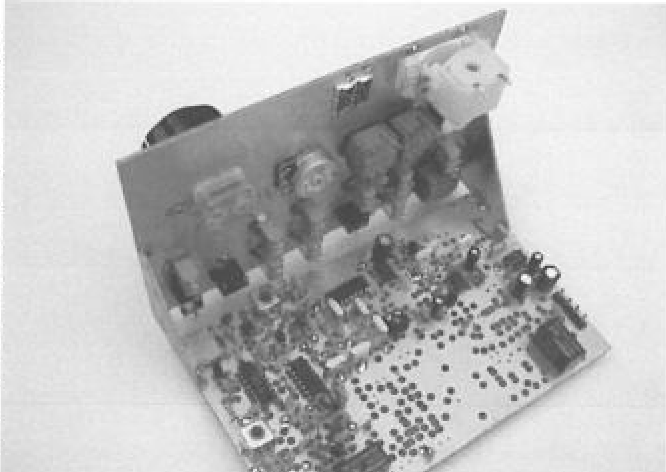
The Walford Electronics web-site is also at www.walfordelectronics.co.uk

## *Editorial*

Many of the notes in this Hot Iron are connected with Amplitude Modulation in one form or another; this is because I am always keen to explore ideas for rigs that put a slightly different complexion on the standard rig concepts - after a while one needs to deviate from yet another standard direct conversion rig! Why AM then? Somewhat to my surprise a couple of Construction Club Members have expressed a keen interest in the topic and it happens to coincide with another 'historic' development! A good friend of mine has a site that was used by the Auxiliary Services during World War 2 and it appears that a 17 set was the normal equipment fit. This had just two valves which provided a regen TRF receiver and an AM phone transmitter with a nominal output of about 1/3 Watt; the frequency coverage being about 45 to 65 MHz. My friend would like to put the site back on air for a special event which made me think about a modern version of the 17 set. I would not wish to do it with just two transistors as I feel certain that the RX and TX frequencies (both derived form the regen stage) might be several KHz apart and very prone to frequency pulling as the aerial moves in the wind! The operators of the original 17 set must have been pretty good to undertake two way messages! But it has made me think about AM as another approach for relatively simple phone operation. See later and watch out for the Churnside rig - this was the name of the wartime net in my friend's area! Tim G3PCJ

## *Kit Developments*

Just to prove that I am making progress with the **Minster**, the photo on the right is the partly built prototype fitted with a front panel that has the controls for several of the optional extras. The rig is now working well on 40m after several niggles have been cured. The main problem has been that I gave it too much gain in the TX strip requiring some re-balancing between stages in both the receiver and transmitter. Some decoupling electrolytics were not large enough - needing many minor track alterations. I also changed the output stage to a broadband transformer and conventional LPFs - much simpler! The next task is to add the RF extras for two more bands to 10m! 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

## *CW in Oman* by David Buddery G3SEP

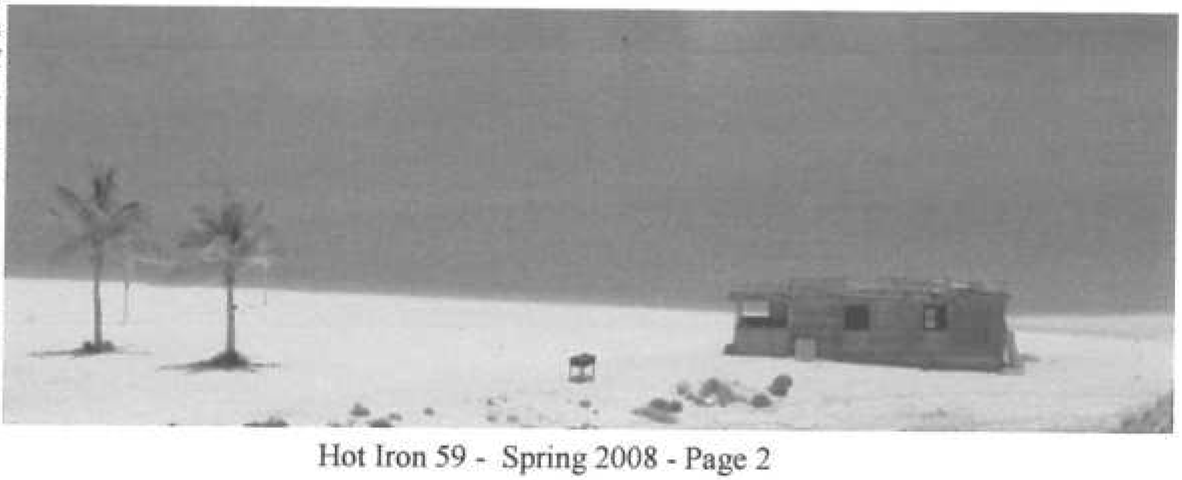
I had a great ham radio year in Oman from mid '85 to mid '86 when I had to come back to the UK. It took me 6 months to get my license and another month to get my gear out there. I built a 30 foot wooden antenna mast whilst I waited and got the antennas up, so once the gear arrived, it was "plug in and go". I put up a 14 MHz quad loop hung from the mast erected on the villa flat roof. It could see the sea and the path to Europe, the USA, South America etc. which worked fine on 14 and 21 and better than it should on 28Mhz. For 3.5 and 7 MHz I put up 66 feet of sloping wire at about 45 degrees to the vertical and fed it at the base against a couple of 66 feet length insulated radials which ran around the garden of the villa, tucked in at the base of walls. Both of these aerials were fed with BOFA slotted 300 ohm twin, what magic stuff it is.

My old trusty KW2000A worked a load of stuff barefoot from there. I had a separate Drake R4C receiver and I had modified the 2000A to give me a separate receiver antenna output for the R4C. It was close to the bottom of the sunspot cycle, but the sub-tropical location of Oman improves propagation and I was surprised how often 28 MHz was open to Europe. I could not believe how quiet it was out there – very little noise on 3.5 and 7 MHz. I spent most of my time on the air on CW but did use SSB a bit often on request. Most days I would get 1 to 2 hours on air from about 1630 to 1800 or 1830 then maybe a bit more time later on. I always looked first at 21 MHz. If it was lively with good signals to Europe, I make maybe a 100 QSOs (usually all on CW, quick as I could!), let the band know I was about to QSY up to 28 MHz and maybe 8 times out of 10, 28 MHz would magically open, often to Europe and even to the UK. People would say I was the only signal on there, which goes to show!

There was often the most amazing grey line propagation from Oman. Ahead of the CQ WW CW contest in 1985, I looked at the grey line for the date and figured that it would be worth looking on 7 MHz at around dusk for stations in the central Pacific. Lo and Behold, this KH6 appeared at well over S9 with a few others and I worked them. It was just before dawn there and normally no-one would be on the air at that time, but of course, it was a contest weekend. There were other strange openings like this. It was dusk one day and 28 MHz was going out. I was just looking round to see if there was anyone left when I heard a call and it was a CE3 from Santiago in Chile. I worked him, only to be called in succession by 4 of his pals!" I sent all 5 QSLs the next day to one of them who promised to pass them round.

Much to my annoyance I had to go back to the UK in mid '86 when the oil price crash occurred (the first one). I wrote the radio club a letter thanking them for helping me to get the license, which I enclosed for cancellation. Apparently I was about the only person who ever did this in their history and it went down very well. I went back out to Oman on a visit in '87 and the evening of the day I arrived, I went back to the Radio Club where I was welcomed with open arms. I was more than welcome because I had a big Toyota Land Cruiser and they were putting up a special event station in an open area and designed around a traditional Omani "Barusti" (reed and thatch, split palm tree trunks) house. My Land Cruiser and its roof rack were that very evening pressed into use carrying gear, masts etc down to the site. It was a bit like NFD. I knew I would enjoy it and thought a bit wistfully it was going to be sad for me not being able to operate because I no longer had a license.

But then something happened. Salim the Chairman came up to me and said "Dave, can you operate this weekend please?" I of course had to remind him gently that I no longer had a license. He replied, "No problem, can you be here at 8 pm tomorrow night? The Minister will be here and I'm going to get him to give you verbal approval to operate this weekend, but please, can you do an all-night session and work us lots of DX.?" The word HAD got around and they hadn't forgotten! Of course I agreed right away and was on tenterhooks all the next day hoping and praying this was going to work out. But the next evening I got this approval from the Minister who was charming. He turned up again on the day of the event when I was in a truly massive pile-up banging out CW at 35 WPM ++. He just stared at me and said, "You know, I always wanted to learn how to use one of those bug keys!" I remember sitting there in the early hours of the next morning, on the air, alone apart from a security guard, thinking "NFD at the Great Yarmouth Radio Club trained me well for this sort of thing." I'm sure it was the fact that the club there recognised me as a CW operator that swung it for me!



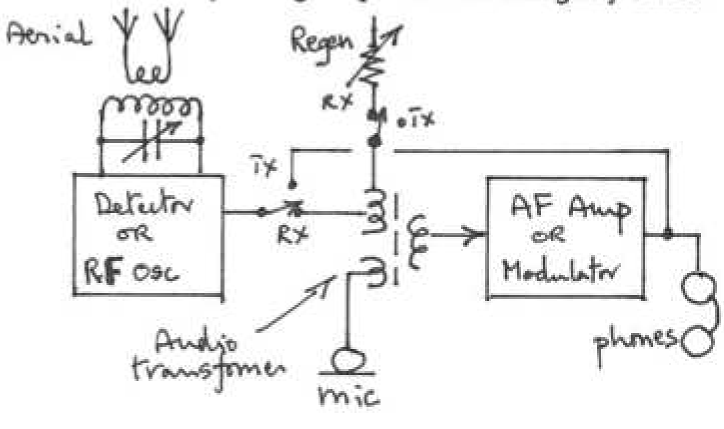
## ***Amplitude Modulation*** continued from HI 58........

Following my remarks on this mode of operation last time, a couple of members expressed a strong interest in the subject; John Teague G3GTJ sent me the following helpful information about nets etc.. I quote verbatim.... "I was interested in your page in Hot Iron about AM - "Ancient Modulation" to the aficionados like me. I like the idea of using the Kilton. Concerning nets - there are AM activities on most bands, I believe, if you know where to look. At HF these are mainly US driven. In UK the most popular AM band is 80m, in particular on 3615 MHz. On Saturday mornings from 0830 - 0930 VMARS (Vintage & Military Amateur Radio Society) run a net which usually has a dozen participants and has had as many as 20. People who are retired like me use this frequency a lot during the week too, around 1230 and often in the afternoons from 1430 or thereabouts. All users of AM are welcome on these occasions whatever equipment they use. One or two enthusiasts monitor the channel and respond immediately to a CQ AM call. Tony G8AQN is one and Mervyn GW8TBG.another. Another net on Saturday mornings from 1030 operates on 3625. Led by Gerald, G3LEO, this net is much smaller with three or four regular takers mainly in the north of England with plenty of technical talk.

The equipment used can be modern, old, or ex-military. The Codar AT5, designed for the amateur market in the fifties is popular and gives remarkable results for 5 watt output. For QRO oomph the Heathkit DX100 of the same period is a good choice The Rolls Royce of AM transmitters is the Labgear LG300 of the late fifties, beautifully engineered with an 813 in the final. These radios are all "hollow state" and can be bought at rallies but prices of good quality vintage and military gear are rising fast. There are plenty of cheaper restoration projects: replacement valves are not usually problem although a few can be difficult including the 7360 beam deflection tubes. VMARS has an extensive archive of technical data.

There is a plethora of second world war items available and Racal produced a series of QRP manpacks in the 1965 - 1975 era which was the transition period between AM and SSB for the military. All these radios generate DSB+carrier AM as an option to SSB by contrast with amateur transceivers which almost universally opted for A3E - single sideband full carrier."

John's letter and my friends desire to have, or resurrect, a 17 set for his Auxiliary Services site set me thinking about a modern version of the 17 set and other 'Paraset' type ideas that are of interest to many. The 17 set is very economical in its 'active devices' with just two valves! These were 2 volt heater types using an HT of 120 volts. One is a regenerative detector whose tuned circuit is directly coupled to the balanced aerial by a link winding. The regen control is in the anode supply to the detector's audio transformer which feeds the second valve as a conventional audio amplifier for the phones. On transmit, a carbon mic feeds the same audio transformer driving the second valve as a modulator of the RF valve which now has full supply, to ensure oscillation with about 1/3 Watt RF carrier output! See the block diagram below. All done at 50 MHz with no obvious precautions to ensure frequency stability, or the same RX and TX frequencies! The wider bandwidth, & tuning insensitivity, of AM is essential for such techniques. A modern version would need good stability and avoid radiation during reception. In Hot Iron 58, I suggested a method by which a Kilton could be amplitude modulated - it works well but Andy Howgate preferred a slightly different approach - see the next page. AM can be done easily at low level but for use at 50 MHz I think crystal mixing from a low frequency VFO will be essential and the challenge is to make this suitable for many bands. For reception I think that a regen TRF is adequate and in keeping with the theme. (A Knapp fitted with a suitable toroid as in HI 58 photo could be pressed into service on any HF or low VHF band easily.) I am uncertain whether the complications of providing CW as well are sensible - any views on whether this is best left to a dedicated CW set for most of the normal HF bands? G3PCJ




SIMPLIFIED BLOCK DIAGRAM OF 17 SET

G3PCJ

## ***More AM topics!***

Paul Tuton writes ..."Today, if you want to build a 10watt, solid state, AM transmitter, then (a) is there an easy 'plate & screen' modulation equivalent or (b) is the low power AM driver/linear a better approach? I first started tinkering with AM about 40 years ago. With valve transmitters of around 10w, it was extremely easy to choke modulate the final via a standard speaker output transformer driven by a basic audio amplifier. With a bit of care, the quality and depth of modulation could be very good.

Moving up to higher RF powers demanded corresponding increases in modulator output and a transformer of the Woden UM type, which I didn't have and couldn't afford. I wanted more RF but without the cost penalty of a powerful audio amplifier, the associated PSU and a hefty modulation transformer. The answer seemed easy. Forget about anode modulation and use e.g. grid modulation as found in some of the cheaper commercial AM transmitters of the time. Of the various alternatives that I tried, most of them worked, to a degree. I discovered that controlled-carrier modulation could be quite effective, though it was tricky to set up and often sounded odd at the receiving end. I even tried NBFM, long before the mode was commonly available on receivers. With slope detection and a half decent RX, it seemed the most promising of all. But nothing that I tried could compete with plate (& screen) or even choke mod.

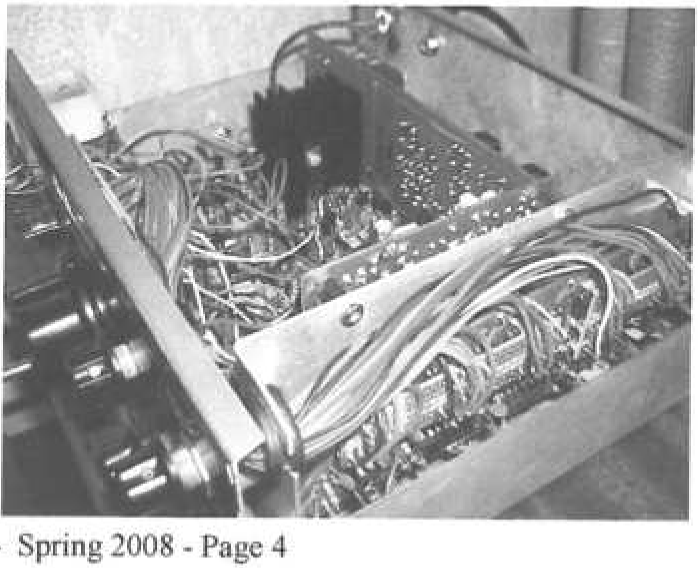
Even today, many AM signals are poorly modulated (listen on 80m around 3600 to 3630). S7 carrier levels with barely-discernable audio are fairly common. There are not many fully modulated, punchy signals. When you do hear them, they really stand out. (Almost) invariably, they are using muscular modulators of the plate & screen variety. I've occasionally heard perfectly readable AM signals as low as S3.

A few years back, I picked up a 1979 PW containing a construction article for an AM top band TX. About 8 watts output from a VMOS PA and high level modulation applied via an audio choke - again, a speaker transformer but this time, using the secondary (speaker) winding. The only awkward part was that it required a 15ohm tap. I copied the concept and built an AM 160 / 80 transmitter based on Tim's Dundon kit, but with an IRF510 PA. (A little later, I described it briefly, in Hot Iron). I didn't have a suitable speaker transformer, but soon discovered that Maplin stock an audio Line Transformer that does the job. For the modulator, I used a standard 5 watt module and preamp. The results have been very good, with Q5 reports at S5 signal strength and with an upward kick on mod peaks. With an 18Volt supply, the TX output is around 8watts.

While ambitions remain around the 10watt level, my experience is that good modulation can be achieved easily with a simple choke/transformer. If you have to buy one, Maplin's line transformer will cost you around £14, though I expect there are plenty of alternatives that will work just as well. But the question remains; will a driver/linear produce results that are as good or better? Most that I have heard - mainly on top band at the 5 watt level - have not been impressive. However, I can think of one in particular that is good, so it can be done. Being conditioned by early experience, I have yet to try, so I'm hoping that one day, Tim will come up with something.

Amongst the very best of AM signals that I have ever heard was on 80 meters several years ago. It was astoundingly good, and came (as I recall) from a modified FT101 - a low power AM driver followed by linear. It belonged to Peter Chadwick G3RZP and clearly, he knows what he's doing. Maybe that's the secret.

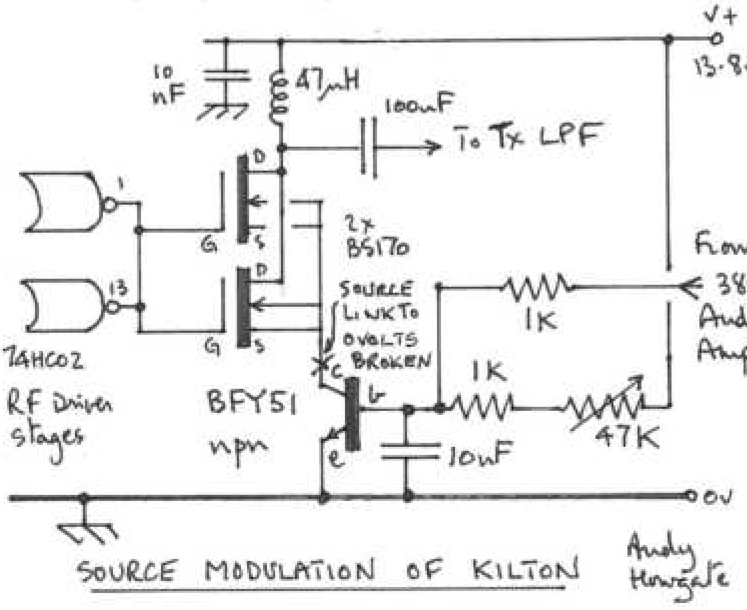
Nothing to do with AM - but this is Simon Burgess' very smart Bristol!



## *Yet more on AM!*

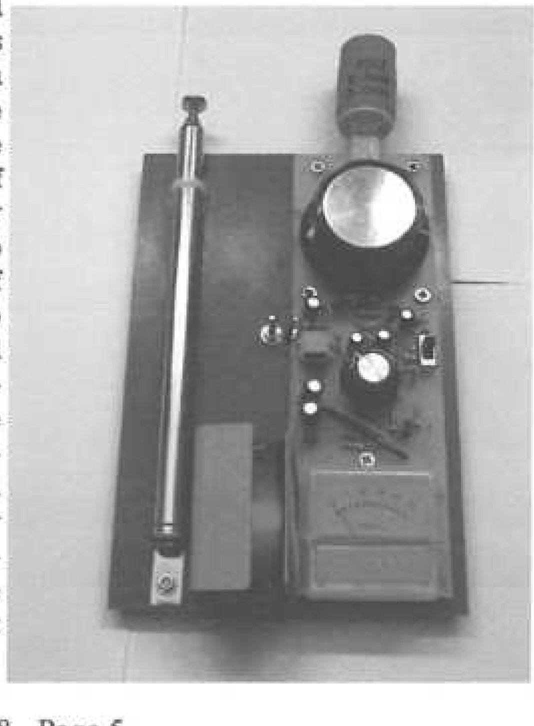
Andy Howgate has reported on his experiments with a Kilton 1.5W CW transmitter modulated by a LM380-8 as part of a standard Audio Amplifier kit. The latter has a twin BS170 low level stage that feeds an AFG type preset that then feeds the 380 output stage. Because the DC output of the 380 chip is at half supply voltage with the wanted audio superimposed on it, and potential output current of fractions of an Amp, the chip can be used directly to power the output stage of a low power CW transmitter like the Kilton. (See the last HI 58.) If used this way, the AFG preset then becomes a mic gain or modulation level control. When I tried this combination I found that it worked very well with excellent modulation waveforms. The carrier power was just over a third of a Watt peaking up to four times that as expected. (I have since found several very similar approaches expounded in SPRAT and PW over the years - one just last Autumn!)

However Andy experienced some problems with the common tendency of the 380 amplifier to oscillate at around 2 MHz!! It then draws much current and gets very hot! (I don't think this method of oscillation can be used as the source of the desired RF!!) After curing this tendency of unwanted oscillation, he was still uneasy about the quality and depth of the modulation; he then tried *source* modulation by separating the sources of both BS170 RF output transistors from 0 volts. Keeping them (RF output) supplied with 13.8 volts he used a BFY51 between BS170 and 0 volts acting as the modulator. See circuit right. With no audio signal the 47K preset from the supply is adjusted to provide a quarter of max RF output, and then the audio drive from the 380 is adjusted to achieve full modulation. He found this worked rather better than my original suggestion. Some readjustments of the carrier power level and audio drive may achieve a slightly more punchy signal. He was actually using the Kilton to drive a 10 Watt Linear amplifier but I don't see why that should make either modulation method better than the other.




## **Dipper Coils** by Andy Howgate

I hit on a super easy idea for making good air cored coils. Fluorescent starters is the thing - remove the innards and you have a super plastic former. Drill two 1 mm holes in the end that line up with the pins of the connector you are using. Then super-glue the connector body to the end of the starter. The next bit is winding the coil; two further holes of 1mm are drilled in the end alongside the pins, and another one on the outer body of the tube where the winding is to start. Feed the copper wire through this hole and then one of the holes by the connector pins – use long nosed pliers to reach inside! The wire is cleaned, tinned, wrapped around the connector pin and quickly soldered to prevent the connection moulding melting! Now wind your coil onto the outer of the starter tube; at the end of the winding drill another 1 mm hole through the starter body to bring this end inside the tube; then thread it through the other hole already drilled next to the other connector pin. Clean off the insulation, wrap and quickly solder to the pin. That is it! Superglue top and bottom to secure the coil. When dry, apply heat shrink sleeving or insulation tape, & mark frequency range.



## ***Brendon Buildathon!*** by Brian Jones, G1ZEZ

I recently attended the Bath Buildathon where a group of amateurs got together for a day to build a transceiver each. The design chosen was Tim Walford's Brendon and so I volunteered to write a few words about the day for Hot Iron. First a little about my background in amateur radio. I took the RAE and got my licence while at sixth form college in the late 80s. Being a student meant that I couldn't afford fancy transceivers and so I started out by converting a low band FM Pye Westminster to run on 70MHz. I tinkered and tweaked but didn't build any complete projects other than a few aerials from scrap metal (the 1987 storm provided a rich source). I dabbled in amateur radio while at university but aerials were always difficult when staying in digs and so I became less and less involved in the hobby.

A new burst of enthusiasm came when I heard the news that HF would be available to Class B holders. It took me a while to get organised but eventually I renewed my licence and rejoined the RSGB. In one of the first RadCom issues I received as part of my new membership I saw the news item announcing the Bath Buildathon which had the aim of getting a group of new constructors together and building a complete sideband transceiver in just one day. This sounded like the perfect project to get me back into the hobby and so I contacted the organiser, Steve Hartley G0FUW, and luckily got the last available place. Having paid the £60 fee it was not necessary to turn up with anything beyond a packed lunch - the Brendon transceiver kits, tools and test equipment were all provided.

After brief introductions and some tips on soldering we set to work. There were 12 constructors working 4 to a table but remarkably little chatter: everyone had their heads down checking component locations, soldering (sometimes re-checking component locations and de-soldering...) Tim's staged construction process was rigidly enforced with instructions for each step only being provided once the tests for the previous step had been passed. It was remarkable how many of the electrical tests were passed first time for many of the people present - a good sign of a robust and well debugged design.

After lunch Tim turned up with a completed Brendon Transceiver and set up a small station. Shortly afterwards some of our receiver stages were completed and we were able to pick up our first signals. An hour or two later we also had some completed transmitters and could make our first (very non-DX) contacts. I suppose many people reading this will know exactly how it feels to build a transceiver and make that first contact, and now thanks to the Buildathon there are a few more people who have found that thrill.

I had thought about getting a transceiver kit several times in the past and while I was confident that I could get one to work I always worried that I would hit some hurdle such as a hard-to-find bad joint or misaligned circuit element that would frustrate me and leave me with just an unfinished project. But, working with a group of others gave an extra feeling of confidence that everything would be working by the end of the day and seeing that happen has really fired me up to get into more construction.

Since getting home with my completed transceiver I have ordered a few more kits from Tim and now have a working dipper oscillator and frequency counter as well as an aerial matching unit that will be getting built when I next have a free evening. My next steps are to plan out the best way to get an 80m aerial system up without annoying the neighbours and then work out how to stealthily drill the holes for the aerial/earth feeds in what was our spare bedroom but is now my new shack.

Slightly perversely, having waited until Class Bs could operate on HF I now have an urge to learn Morse code - I very much like the simplicity of CW transmitters and quite fancy a crack at building one with some ugly/dead bug construction. So the combination of a nicely thought out kit and a well organised event definitely fired my enthusiasm and I am sure that I was not the only one. Many thanks to Tim and Steve.

## ***Capacitor Selection*** by Gerald Stancey G3MCK

In the old days there were very few types of capacitor in common use (paper, silver mica, electrolytic and disc ceramic) so deciding which type to use in a particular circuit was pretty easy. Now there is a plethora of types, many beginning with poly from which to choose and the correct decision is often by no means clear. The professional designer has detailed knowledge of the characteristics of each type and having made the best technical choice then gets the purchasing department to buy what he wants. The amateur is often uncertain what can be used and even if he does know he may have a problem getting them. This article approaches capacitor selection from the point of view of the home constructor who wants to know if something that he has in his junk box can be used.

The most critical application area for capacitors is in RF tuned circuits and filters. In these applications silver mica, polystyrene, COG type (also known as NPO) ceramics and negative temperature coefficient ceramics are the types most commonly used. A word of caution, be sure when using ceramics that they are suitable for RF tuned circuits; I have had a bad experience in this area.

In RF decoupling, the ceramic now seems to be the material of choice. However other types maybe used such as paper, silver mica and many of the poly types.

For AF decoupling, practically any type of capacitor can be used and the same goes for smoothing capacitors in power supplies but the high values of capacity that are needed usually drive you to using electrolytic capacitors.

It is always possible to use a higher quality than is necessary, for example using a 1000 pF silver mica in an AF circuit. This may appear to be unwise considering the cost of silver mica capacitors but if you need one of a certain value to finish the job, and that is all there is in the junk box then use it. A professional friend tells me that at his company, when making one-offs, they are encouraged to use anything from redundant stock provided that it meets the technical requirements.

When choosing a capacitor there are other considerations such as size and working voltage and these must be met before thinking about the type of capacitor that should be used.

### *Some additional comments!*

Identifying the type of an unknown capacitor is very difficult but some clues maybe deduced from its shape. First the easy ones; silver mica are usually very thin and rectangular while polystyrene are usually cylindrical with either clear plastic for the common low voltage types, or a metal casing for the higher voltage specimens - for all of these types the tolerances are quite small - often +/- 2.5 % and they are expensive - typically 75 - 100p each when new. Silver mica tend to have a nominal zero tempco but with quite a wide tolerance of the actual tempco; polystyrene generally have a N150 tempco. I must admit to not liking either of these types in oscillator tuned circuits as I find they lead to wandering up and down in the VFO frequency. Ceramic capacitors come in many shapes and are usually much cheaper and more suitable for VFO resonators; the modern ceramic plate types are usually small light green rectangles about the size of a match-head, their tolerances are often +/- 2% and for 22 pF to 150 pF have a N150 tempco - meaning their capacitance goes down by 150 parts per million for each degree C rise in temperature. Hence their main use is in VFO resonators to counter the positive tempco of the resonator inductor. Their use is not necessary, nor the extra cost justified, for other inter-stage tuned or filter circuits. Close tolerance round ceramic discs are also available with the NPO (= COG) characteristic meaning nominal zero tempco which is indicated by a black tip or flash. Less common now but still available are round N150 ceramic discs, these have an orange tip or flash. Larger value ceramic caps can also have a X7R or Z5U characteristic which is definitely not suitable for VFOs, nor for tuned circuits owing to very much higher tolerances (+/- 20%) & tempco (they are said to be medium K or high K), but they are cheap and often used for RF coupling/decoupling purposes where exact capacity is not important. For HF decoupling purposes it is common to find a 10 nF medium K disc in parallel with a 10 uF electrolytic; similar approaches are used for much higher frequencies. No form of ceramic capacitor should be used in audio stages as they are micro-phonic - use polyester ones which are rectangular blocks - sometimes moulded, or dipped, or with exposed metallic connections down their sides. Disc ceramics are also available with higher working voltages up to about 5 kV but their Q is poor and they are not suitable for filter resonators where a high Q is desired.

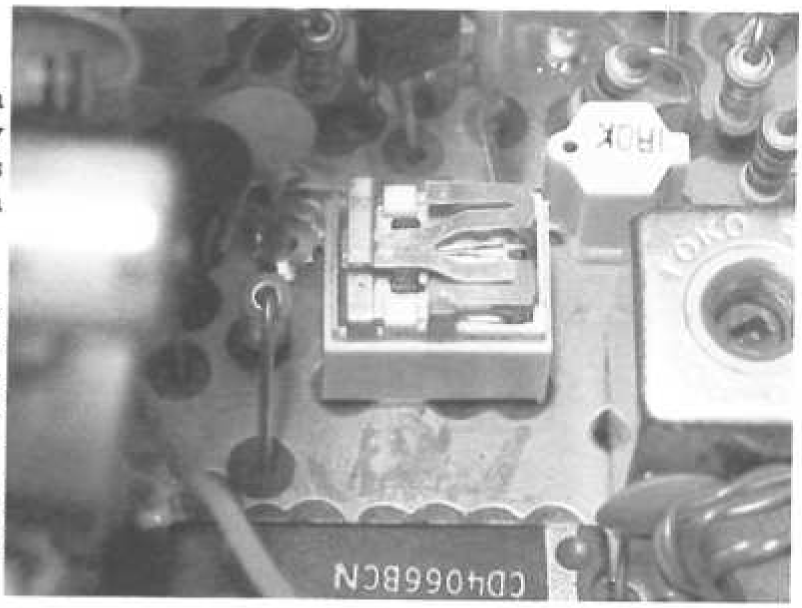
I am afraid Gerald has touched on a veritable minefield!! Tim G3PCJ

## *Moving coil meters*

I still have some excellent brand new 50 uAmp meters with rectangular 2.25 x 2.75 inch faces. Because I got these cheap I can offer them at three for £10 plus £3 P and P. G3PCJ

## *Cleaning relay contacts*

Paul Tuton writes ...




Tim, here's a picture of the relay, Taunton RL102, in situ, lid off. Easily removed by careful winkling with a watchmaker's screwdriver & gently pulling/twisting with medium-nosed pliers.

Was fine on RX, but dodgy contact on TX. Switch to TX activates the relay and snaps the common connection to the upper contact. Inserted a piece of thin card, switched to TX and scrubbed lightly, to & fro. Wouldn't dare risk wet & dry - much too fierce. Then repeated with a blob of electrolube on the card. Seems 100% again. Lost the lid but who cares!

By the way, years ago we used newsprint (avoiding the ink!) to clean the gold plated edge connectors of PDP-11 plug-in modules. It was amazing how much black appeared on the newsprint and how shiny the connectors became. From time to time, still do the same with PC boards. Very effective and does no damage.

## *Electronic news*

One Construction Club member has suggested that it would be nice to have an e mail 'news' service from Walford Electronics; I am wondering what others think about the suggestion? Owing to the way I do diagrams it is not practical to distribute Hot Iron down the wire but I could certainly send out electronically a short e news-sheet with advance warnings of new kits and other matters that do not involve hand drawn diagrams. If you would like this, send me an e mail at walfor@globalnet.co.uk with your suggestions for what ought to go in it! Tim G3PCJ

# *The Somerset Supper*

***and***

# *Yeovil QRP Convention*

The fourth supper will be held on Saturday April 26th 2008 at the Antelope Hotel, Sherborne (as last year) area for locals and those staying overnight. This is the evening before the Yeovil QRP Convention. As before there will be a small display of items from each diner's home built radio equipment! This will qualify you for a ***free*** place at the supper table! The display will be judged by **Steve Niewiadomski**, who contributes interesting construction articles to PW. *Places by advance booking **only** by April 19th so please tell me if want to come.* Hope to see it and you! The QRP Convention will have the usual programme of radio related lectures including one by Stef, trade stands, bring and buy stall, and other excitements! I shall be there and am always pleased to see and display if appropriate any of my customers 'constructions'. Tim G3PCJ

"JOURNAL OF THE CONSTRUCTORS CLUB"

# Hot Iron

Summer 2008
Issue 60

## Contents



The Walford Electronics website 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.

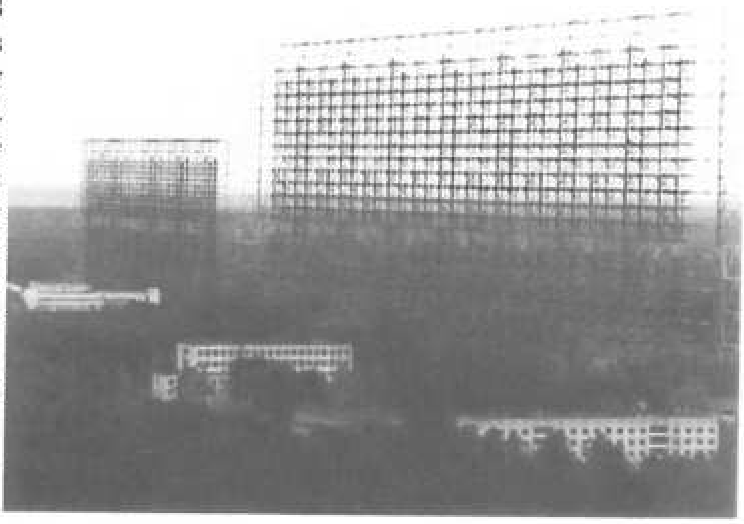
Starting in the early 1970s the Soviet Union were busy building the largest HF antenna arrays in the world, with the intention of being able to detect a missile launch from the USA. Early experimental stations were constructed in Nikolaeyev in the Ukraine. Despite being prototypes the scale of construction 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!

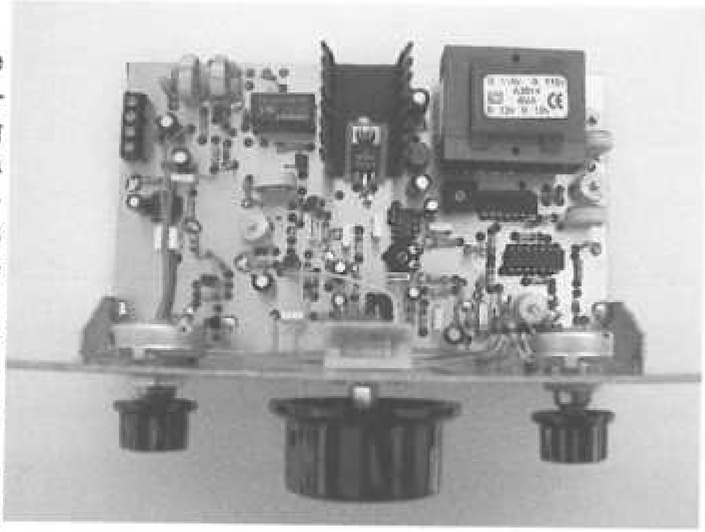
How do you get enough electricity to generate this sort of RF output power? Answer: build your secret radar installation almost next door to a nuclear power plant and have very thick cables. On the 26th of April 1986 the DUGA-3 woodpecker fell silent after 10 years of continuous operation. This date 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!

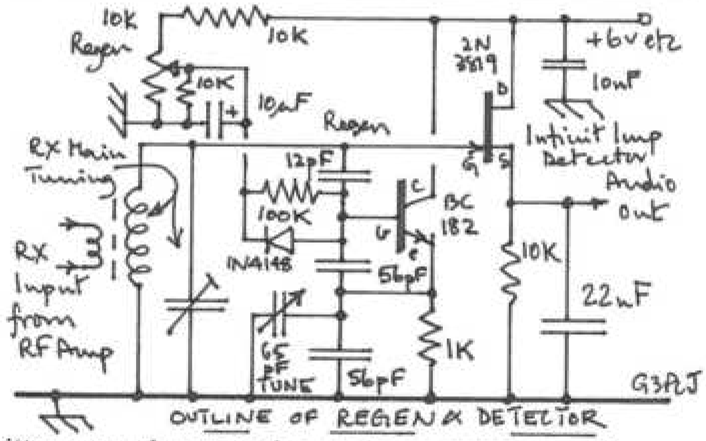


## ***The Chirnside***



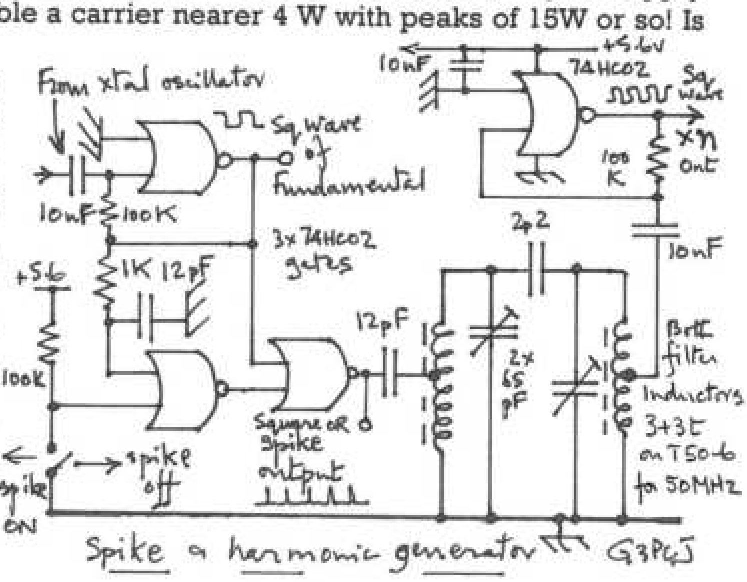
Last time I mentioned my friends wartime bunker and a possible new version of the 17 set – well here is the new 6m **Chirnside** phone AM rig on the right! The RX is a straight regen TRF - not a super-regen. Unfortunately it is not really advisable to do the TCVR with just two active devices like the 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.

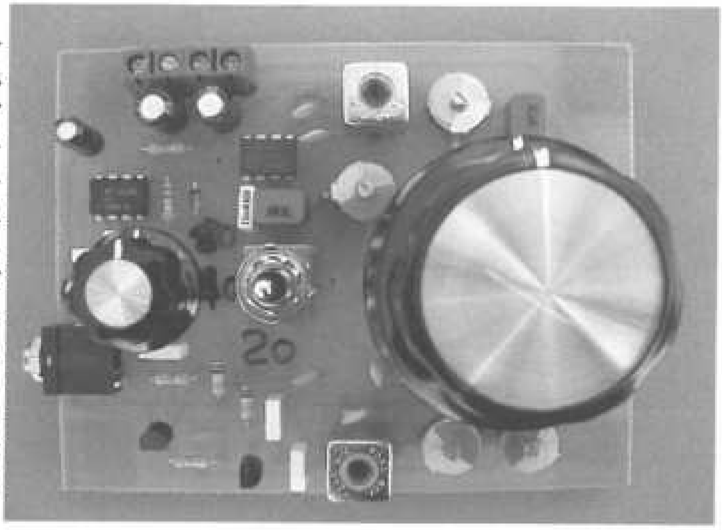



Obtaining adequate stability for the transmitter was always going to be a problem; a frequency mixing scheme would be too complex so it had to be crystal controlled, with a harmonic multiplier. This would be followed by a filter and suitable driving stages for the RD06 MOSFET output stage designed for 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

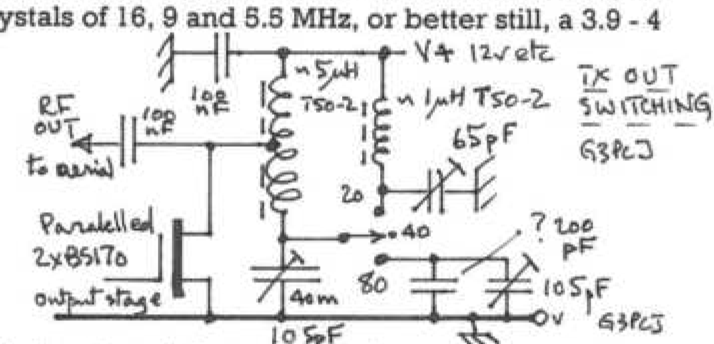


## ***Designing the Washford!***

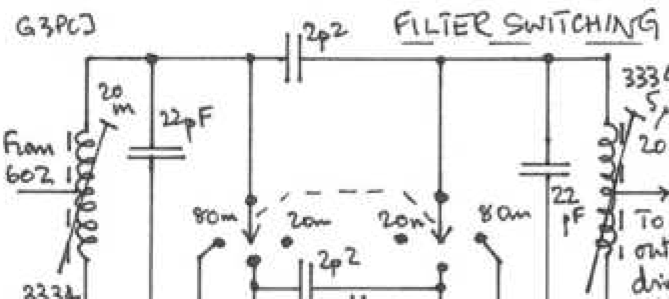


I thought that members might be interested in some of the stages that I go through when hatching a new project - its also another slant on a new rig! Some while back I had decided to do a simple 20, 40 and 80m DC receiver, which has become the **Willett** as shown right. By keeping the tuning and RF 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.

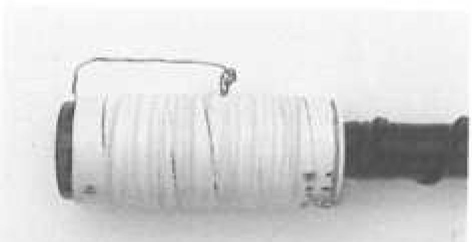
The matching coil is 20 turns of 20swg enamelled wire spaced 2 mm apart between turns, wound on a 42mm OD PVC water pipe. The coil is tapped at 10 turns for 50 R feed point. The bottom of the coil is attached to the vehicle mounting metalwork - I used an old SO 239 (Male) connector, potted into the tube. 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.

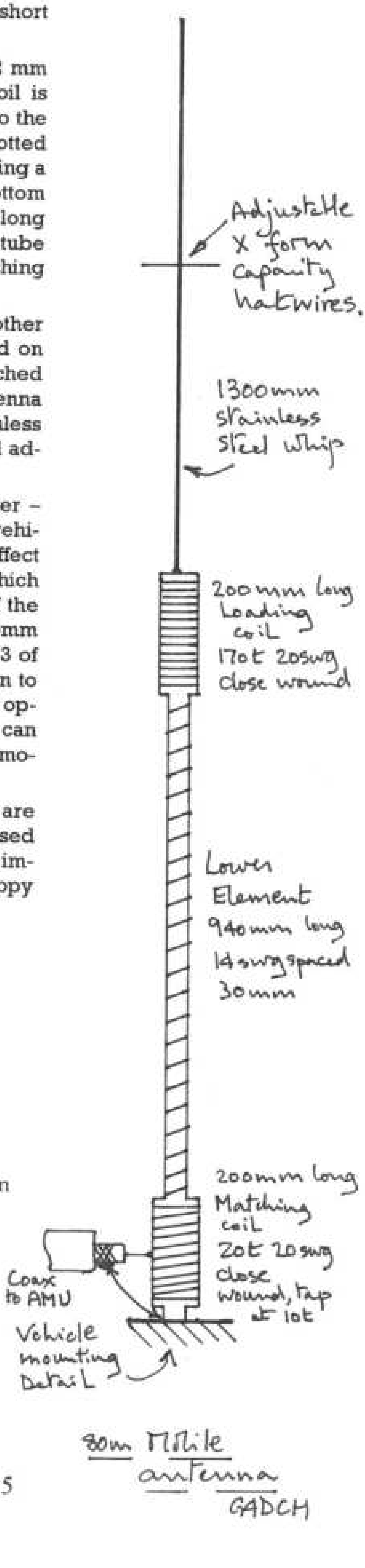
One piece of essential equipment is the MFJ 259 Antenna analyser - borrow one if necessary to do the tuning. This must be carried out on the vehicle with all the necessary earth bonding wires in place as these will all affect the resonant point. Check the resonant frequency of the plain antenna which 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



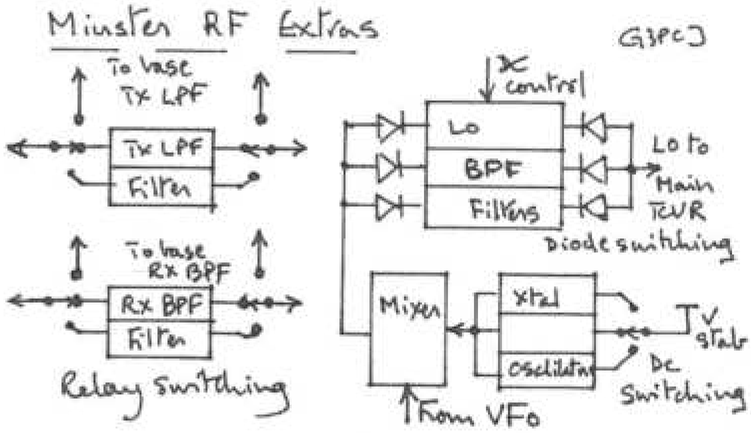
## The Minster's Optional Extras

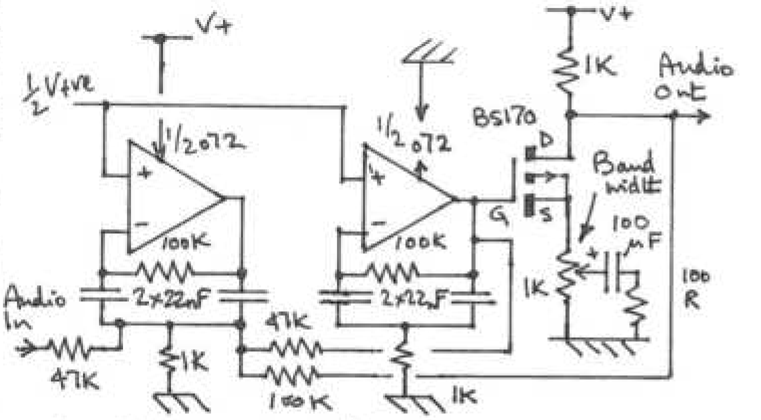
The main rig is a 5W phone TCVR on a double sided 100 x 160 PCB, for any band 20 to 160m with direct injection VFO. It works with any of these! (There is also a new Speech Processor!)

***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!

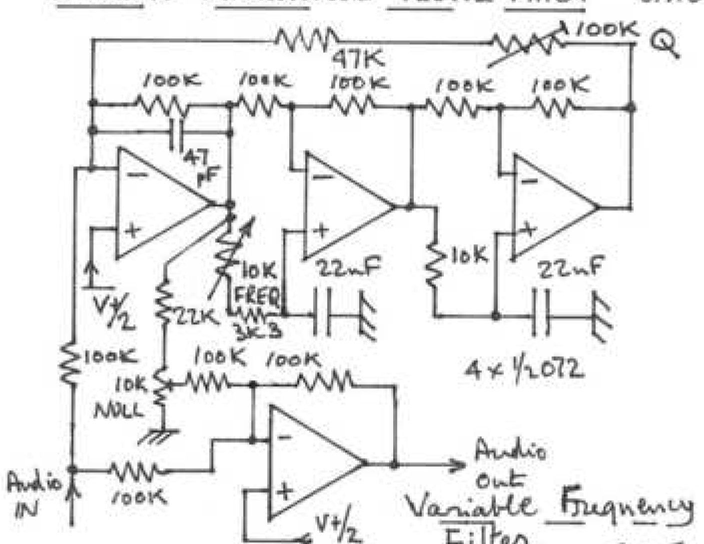
***Audio Extras*** This is a 80 x 100 double sided board (left below) that's adds CW facilities and audio derived Automatic Gain Control. There are two RX audio filters, one to help with SSB under difficult conditions; the other is a *variable bandwidth* bandpass filter centred on 725 Hz for CW, see 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.

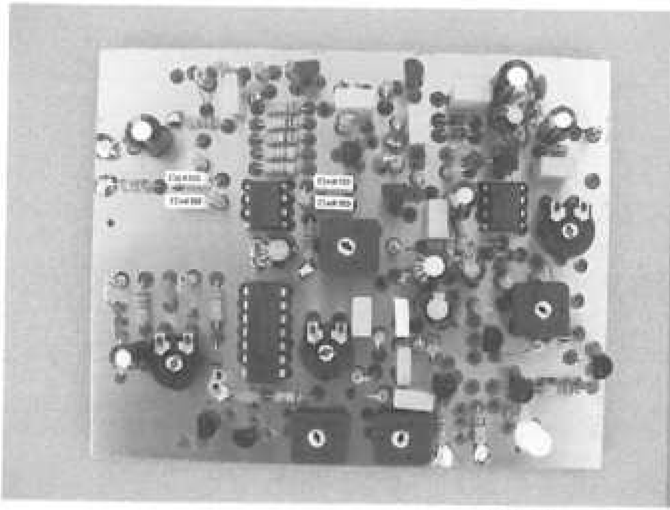
***Notch Filter*** This is a single sided 80 x 50 PCB (right below) and provides a *variable frequency* filter that can provide a notch for removing a carrier etc, or a peak to help with CW, or be straight through. Again the kit is intended for general use and the frequency preset can be changed to a 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!

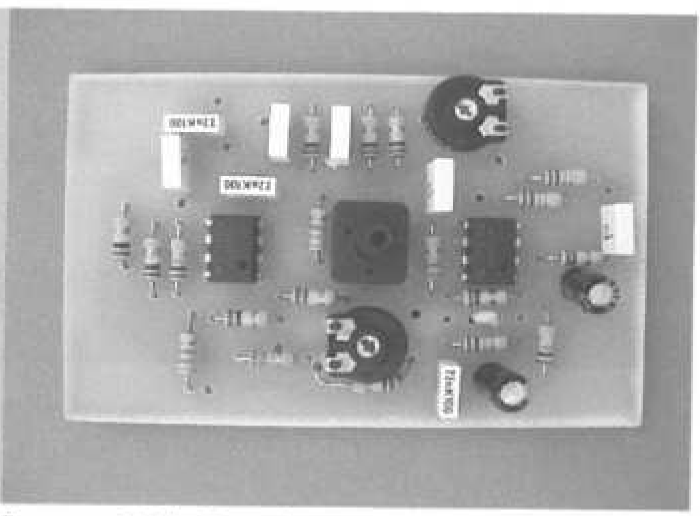



Variable Bandwidth 725Hz Filter G3PCJ





## *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 the17 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.

"JOURNAL OF THE CONSTRUCTORS CLUB"

# Hot Iron

Autumn 2008
Issue 61

## Contents



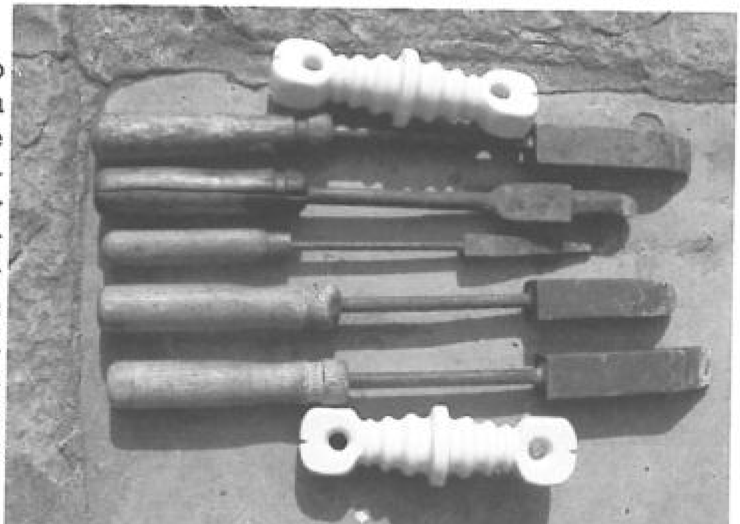
The Walford Electronics website is also at www.walfordelectronics.co.uk

## Editorial

How time flies - here we are at the start of the 16th year for Construction Club members and I ponder what to put in this time! I could drone on about this lovely Summer that we are enjoying on the farm; or I could be a real boring old whatnot and decry the trends in modern electronics where everything has to be 'digital' with embedded microprocessors. Instead I wonder how (when somewhat younger) I ever managed to do anything out of normal working hours like decorating, gardening, rewiring the house, and occasionally play with a radio! After a day's work, a quick check of the electronic mail, some food and there is now not sufficient time left for radio! I have a list of potential new projects or upgrades that just does not get any shorter despite my good intentions! I swear that Einstein should be doing an experiment on time running faster nowadays. I fear there is a more mundane explanation which I don't want to know! Inevitably social and community activities take up an increasing amount of time because one's circle of friends grows with age - especially if one has lived in the same place for a long time. (Next year it will be six decades since I first came to this house!) The place still has surprises up its sleeve though - we have had a damp problem in a bedroom wall (for many years) that I am now told is probably condensation in a concealed old chimney sealed top and bottom. I have found its bottom but not yet the top - I wish electronics could help with this but not enough time......... Tim

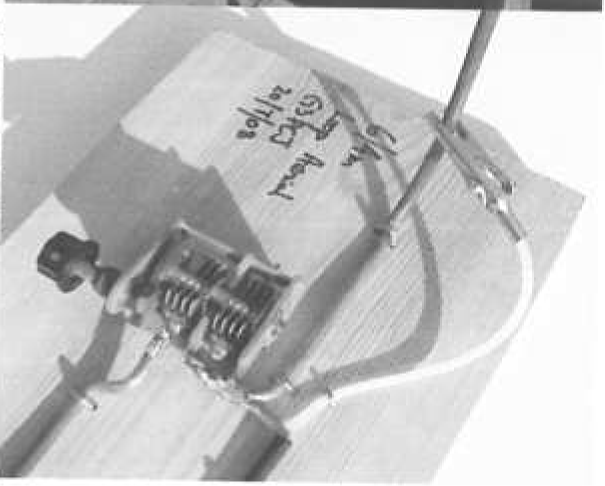
## Kit Developments

I am pleased to report that the Audio Extra and Notch filter kits have just been proven by Richard Booth and Andy Howgate and will be available shortly - see later. Although these have been designed primarily for the Minster they can be used with other rigs as well. The Minster is not yet ready for release as its performance on 10 and 15m is not really good enough. I have been troubled by a variable gain amplifier, which is used on reception and transmission, that was more like an attenuator on 10m!! Meanwhile here are some handy aerial tools!! Tim



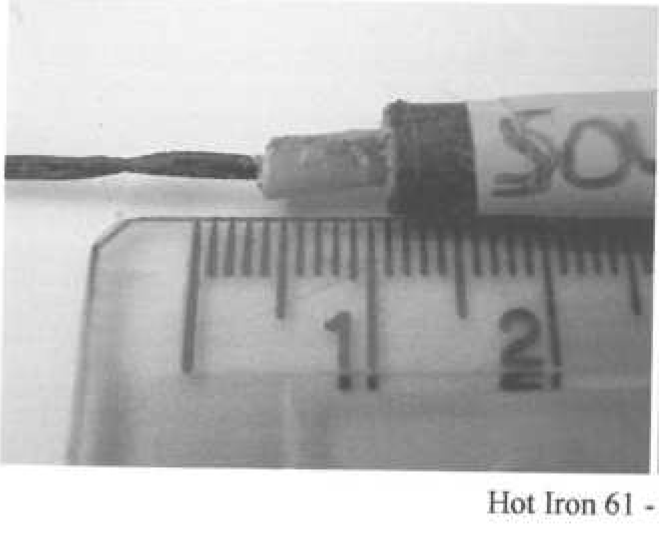
*Hot Iron* is a quarterly subscription newsletter for members of the Construction Club. Membership costs £7 per year with the first issue for each year appearing in September. Those people joining later in the year will be sent the earlier issues for that year. Membership is open to all and articles 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

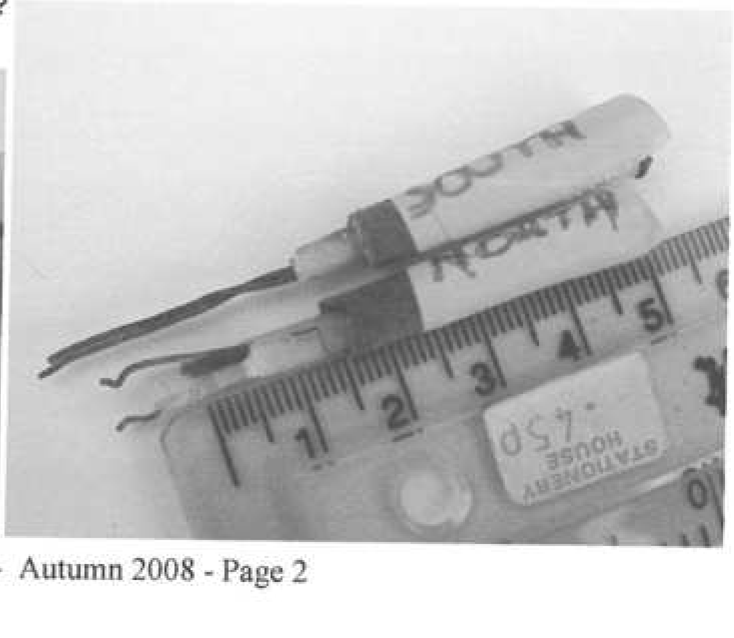
## ***Chirnside, 6m and a conundrum!***



Since I wrote last time about my friends wartime bunker, I have been able to get his WS17 set working on battery supplies; I used a NiCd powering switch mode regulators to produce 2.5v (dropped by a diode) for the 2 volt heater, and a 9v regulator driving a 50 Hz static inverter feeding a 6-0-6v to 115v mains transformer for the 120v HT. These modern parts conveniently fit inside the original battery compartments of the 17 set. Not having any other 6m gear (apart from my Heathkit GDO) I had to test the 17 against my prototype Chirnside TCVR. At least I knew the Chirnside's transmit frequency as it is rock bound, multiplied up from 10.24 MHz! Both seemed to work alright on dummy loads so I then needed two 'aerials' which I could eventually take to his house and at least have a QSO across his garden! The 17 set was often used with vertical aluminium rod dipoles, with or without a reflector, but even at 6m a half wave is not too good for fitting in a small car! I needed something much smaller or collapsible like a vertical wire half wave, fed at its centre by coax threaded up inside the screen of a larger coax acting as the bottom half of the dipole. This could then be coiled up for transport. This was not difficult to make and is easily installed in a tree with the aid of a thrown weight and string. Strictly this ought to have a choke balun fitted in the feed coax just below the bottom of the lower radiator, but for informal trials where the radiation pattern is not too important, I skipped that. For the Chirnside's aerial I used a small loop with gamma matching - they both worked well!

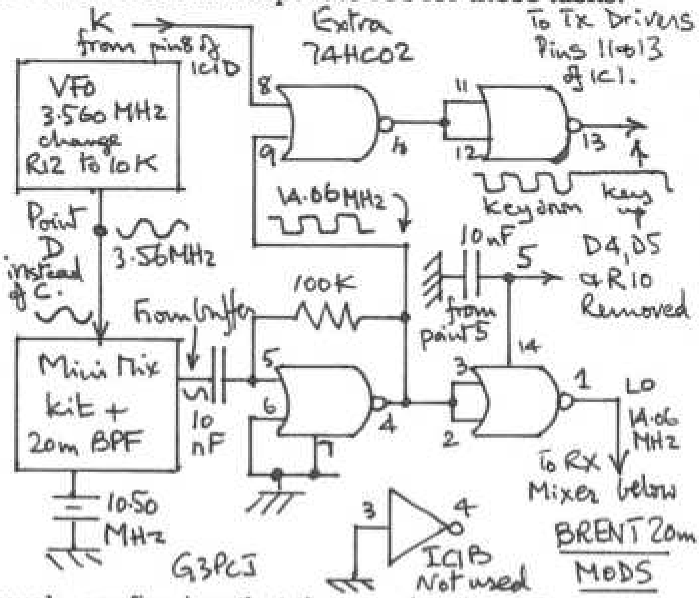
However, we have so far been unable to properly explain the aerial and feeder arrangements that were installed at my friends house during the war. One dipole aerial definitely used a plain twin low impedance feeder without any overall screen - this is the Northern specimen below. The other aerial appears to have been 'fed' by a single conductor (without screen) prior to going up a tree to its radiating elements whose details are unknown - the southern cable. Both cables were buried directly in the earth for a significant distances. Their construction is similar (and definitely for RF) except for one being twin and the other a single. Both have a cloudy plastic (? polythene) main insulation within an overall plastic outer. The twin feeder is well explained but the other single RF wire is a mystery. No evidence has yet been found for a second similar cable alongside it either. Its unlikely to be a Windom type feed with so much of it below ground, nor a counterpoise at 50 MHz - so what was its purpose?
Any suggestions are very welcome! Tim



## *The Brent on 20m*

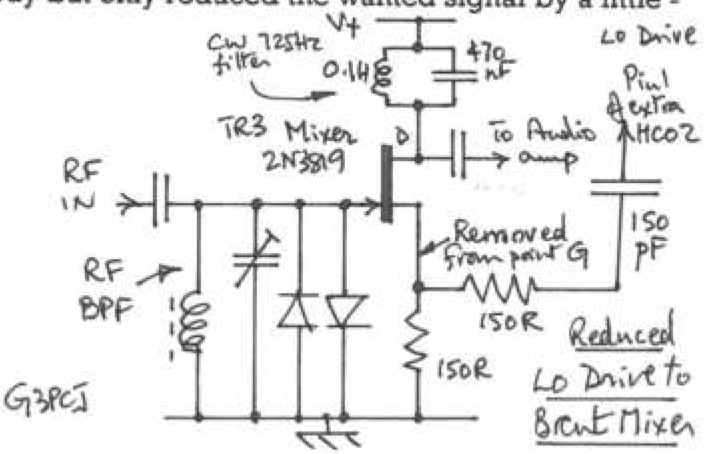
Recently a customer asked me to investigate his Brent, fitted with a Mini mixer for 20m. His main complaint was 'too many birdies'! I have to admit that there were rather too many. He had also had difficulty with severe audio instability which had been cured by adding 1000 uF across the incoming supply. This was I think due to some quirk in his power supply, as I was not able to replicate that problem. There were other minor snags such as an intermittent short between the Poly-Varicon bolt heads and the ground plane which were easily cured by a little insulating tape! But the birdies had me foxed for a while. The basic frequency scheme is to mix the normal 80m VFO, which has a square wave LO (using a digital gate and a ceramic resonator), with a 10.5 MHz crystal. The LO mixer is a SA602 and this feeds a double tuned LO filter tuned to 14.05 MHz, which is then squared up for the RX mixer by further gates. With such a simple scheme there is inevitably a strong birdie on the band edge at 14.0 where the VFO is on 3.50 MHz, and its fourth harmonic comes through strongly into the RX front end. However there were many high order (with fast tuning rate), and very much weaker, birdies near to 14 MHz. After trials with an external VFO I concluded these had to be leakage (or capacitive coupling) from the square wave VFO into the mixer driver gate within their single integrated circuit. The cure was to use separate ICs for these tasks.

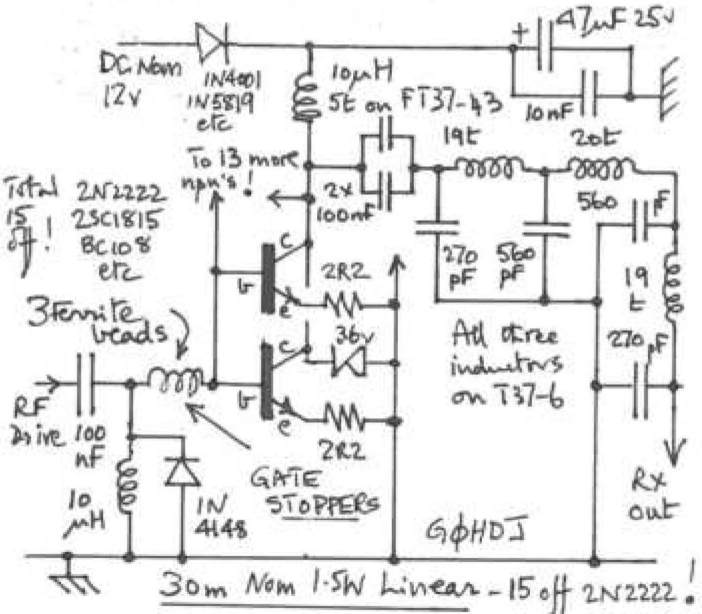



Adding an extra digital IC to cure the birdies also allows one of the other known design compromises of the Brent to be removed; that is the rather crude form of keying the transmitted signal using a diode gate with a pull down resistor. To obtain the necessary fall time at 14 MHz requires an uncomfortably small pull down resistor, which often leads to an un-symmetrical drive to the output stage and less RF output. The solution is to use an extra 2 input NOR gate without the diodes and pull down resistor, and use the other NOR gates for the birdie solution. This is shown right.

Having just acquired a new set of phones, to replace my tired 'Walkman' style ones, I was a bit disappointed with the level of audio hash or noise coming from this RX. Removing the LO drive to the receiver's mixer stopped most of this mush, confirming that the receiver's early audio stage was not to blame! So why was the mixer noisy? A fair bit of web trawling didn't produce an answer but an old ARRL handbook suggested that driving the JFET into the pinch-off region is unwise. I had specifically aimed to do this by connecting the mixer FET source direct to the output of the LO driving gate, with its 5v LO signal. I was confident that using a square drive was not the problem as all the potential harmonic products would be well above the operating band. A little experimentation with reduced injection levels into the mixer FET source soon showed that the audio hash was hugely dependent on LO level, but that conversion gain was far less critical. Halving the LO drive signal chopped most of the mush away but only reduced the wanted signal by a little - leading to a significant improvement in signal to noise ratio and plenty of off-air signals!.

I would expect this mush improvement to apply to all Brents, whether for 80m or higher bands. It can be easily altered by adding the two resistors and capacitor as 'free-standing' items as shown right. The first modification mentioned above, to cure birdie problems and improve the TX keying, is not necessary for 80m Brents. If anybody needs these extra parts, please let me know. Tim G3PCJ





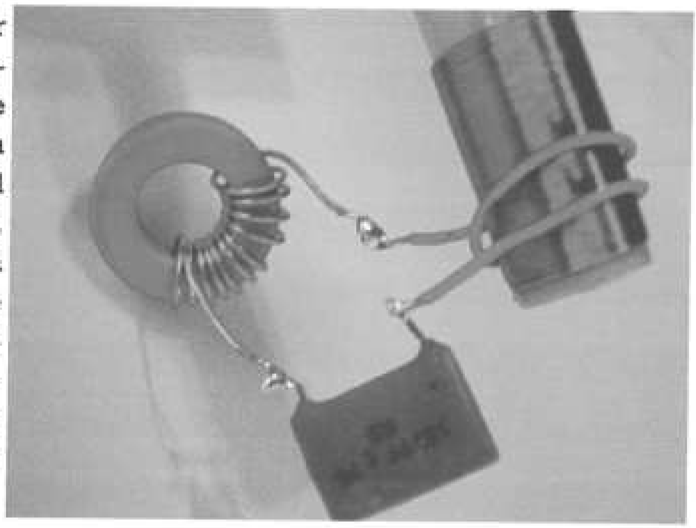

## *Gate stoppers and ferrites*

Craig Douglas sent me the circuit right asking for advice as to why he could not obtain the expected output from the version that he had built. I was a bit busy at the time and as it appeared to be a perfectly good circuit, I delayed my response pending further thought. I am pleased to report that Craig solved it before I did! He had used some ferrite beads for the gate stoppers and in desperation had tried it without these in the drive to the output devices - lo and behold it burst into life as expected! Clearly the 'gate stoppers' were stopping the wanted signal!

So why are gate stoppers often included in circuits? They tend to be more common in power FET circuits but nearly all common drain or common collector (unity voltage gain buffers) circuits can lead to VHF or higher oscillation, particularly when the device is feeding a high capacitance load. Years ago I had this problem with the audio CW filter in the Midney RX! The clue was that all the birdies (oscillation) stopped when I connected a scope probe or even put a finger on the filter FET - in that case the unwanted oscillation was over 50 MHz! The inclusion of a small amount of attenuation at VHF is often sufficient to reduce the VHF gain below that required for oscillation. Often an inductor is used, or ferrite beads, or a few turns of wire on a low value resistor so that the impedance increases with frequency; so giving a higher impedance/reduced gain at VHF while still presenting a negligible attenuation to the wanted signal at HF or lower. As the Midney was an audio circuit, where the gate impedance is all capacitance, it was easily cured by adding 1K (for commonality with other resistors) in series with the buffer's gate - its quite likely that just 10R would have been sufficient!

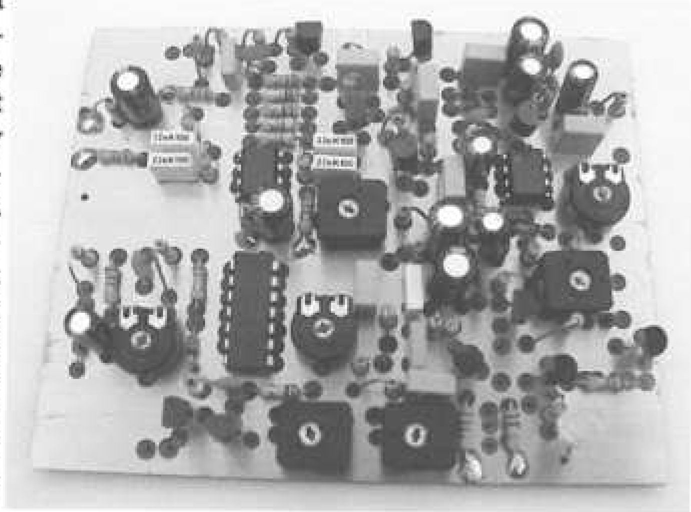
The lesson of Craig's experience is that the impedance at the operating frequency of his ferrite beads was far too high, but why? Obviously the inductance was far higher than it should have been, given that he had only threaded them on without multiple turns; this suggested that the ferrite beads had a very high inductance per 'turn'. This is often the case for ferrite materials which are intended for low frequency or power supply work, and although I don't know it, I suspect these beads had been salvaged from the hash filter of a switched mode mains PSU. Ferrite materials are usually a dull black and notoriously difficult to identify by visual inspection (unlike powdered iron toroids which are coloured); the real answer has to be to measure the inductance of a turn or two and see if its suitable for the intended circuit.

The easiest way to do this is with a gate or grid dip oscillator. I don't have a picture of a ferrite bead being investigated but the technique shown right can be used with any inductor. In this case, the toroid has such a low external field that it will not satisfactorily couple to a GDO, hence the two turns around the GDO coil. Try a few different value capacitors in series with the ferrite bead inductor and GDO turns and be prepared for resonant frequencies that are somewhat lower than normal. Knowing the resonant frequency and the value of the capacitor will let you calculate the inductor value. G3PCJ



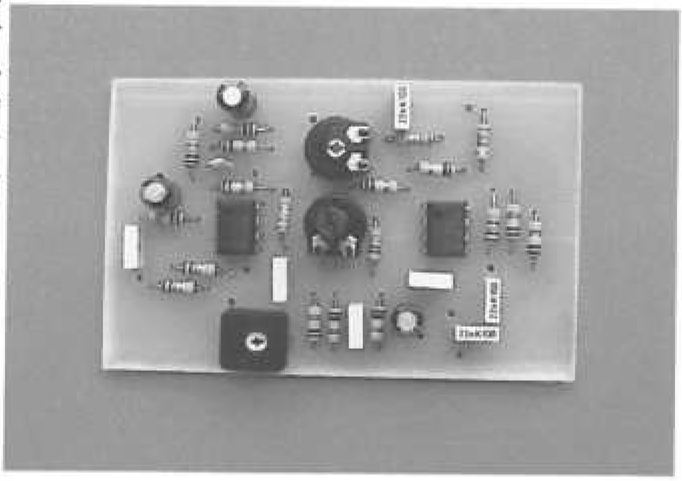
## *The new Audio kits*

*Audio Extras* This kit provides CW and AGC facilities for a phone TCVR; it has been designed for the Minster but also suits other phone TCVRs. For reception, there is a choice of straight through, an intermediate LPF (1.2 KHz) or narrow audio filtering; the narrow audio filter has an **adjustable bandwidth** of about 40 to 300 Hz with a centre frequency of nominally 725 Hz. The selected filter feeds the AGC system (either direct or via the Notch filter kit) and provides a constant output of 250 mV p-p, for audio input signals that are above 15 mV p-p. There is a choice of Long or Medium AGC time constants, or off altogether. The AGC control voltage also drives the green section of a bi-colour LED whose intensity alters with received signal level.



For CW transmission, a keyed audio tone is injected into the phone transmitter's speech amplifier to produce the desired carrier, with adjustable frequency and level presets for TX and RX. The TR control system provides semi-break in operation with another preset to set the delay time. The red section of the LED is driven by the rig's antenna matching bridge circuits to give an indication of RF power output. The LED circuits can also drive a conventional meter scaled for 10v FSD. The PCB is double sided needing a 9 – 22 volt supply. Apart from the optional bandwidth pot and meter (see below), the other front panel items are the key socket, filter toggle switch, AGC toggle switch, and the LED. The Audio extras kit costs £28.

*Notch Filter* This kit provides a **variable frequency** Notch or Peak filter to clean up receiver audio. Although designed for the Minster, it can be used with most receivers. The filter can be switched out when not required. It has an adjustable frequency bandpass filter with an additional op-amp to provide the peak or notch facility. The frequency of the Notch/Peak is altered with a single variable resistor (unlike most designs) and can be changed to a front panel pot. The filter has three tuning ranges; the middle one covers the normal range of CW beat notes, with additional high and low ranges for the rest of the audio band. The bandwidth of the filter can also be adjusted, but is not usually altered after setting up.



The kit is normally connected immediately before the rig's main audio gain control stage – either automatic or manual. It can also be used as a separate receiving accessory outboard of an existing rig to drive medium Z phones. Apart from the optional frequency control, the other front panel items are the frequency range and notch/peak toggle switches. The PCB is single sided (50 x 80 mm) and needs a 9 to 22 volt supply. Cost is £18.

*Meter and pots* A horizontal edge meter (for signal strength and RF Pout), with two pots for front panel variable frequency and variable bandwidth controls are available for £9.

## *Hot Iron 62*

It is probable that the next issue of Hot Iron will be delayed till about mid December as I have some important farming business that will take me away for most of November. Please bear with me; if you are able to send me any contributions so that I don't have to write quite so much, it will hasten its production! As ever I shall be delighted to have any articles or suggested topics etc, up to about a page or thereabouts. In the meantime my apologies in advance. Tim G3PCJ

## ***Building and de-bugging an 'old' project*** by Steve Hartley, G0FUW

Way back in the mists of time, well twenty four years ago to be precise, I saw a project in RadCom and thought 'one day I will build that'. The project was the G2DXK multi-band SSB/CW transceiver and I was but a young whipper-snapper with a fresh RAE pass slip and a VHF call. The project ran over several months and I kept the articles ready for the day when I had the time and money to make a start.

I cannot remember exactly when I started building but I can report that I never got very far, even in several bursts of activity. However, earlier this year, realising that the project was approaching its silver anniversary, I decided that it was about time I knuckled down to getting the 'DXK on the air.

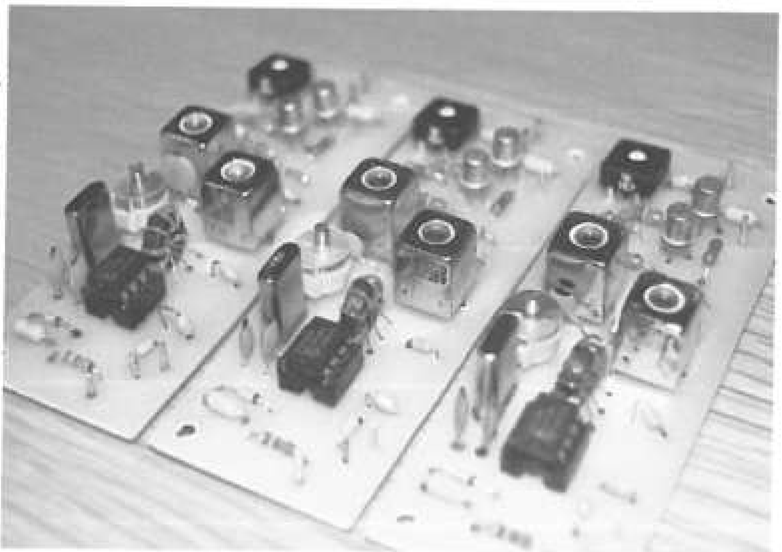
Co-incidentally, Richard Witney G4ICP, posted a noted on the G-QRP reflector to say he was in a similar position and we have been comparing notes and had a couple of meetings since then.

Some projects go together at the first attempt, all very pleasing, especially for the designer. Others have you delving into textbooks and trying all kinds of modifications and fixes to get them going, much more frustrating but a great source of 'self-development'. My 'DXK belongs to the latter - I have even learned how to use the mighty fine LTSpice to try to understand what is going on with some of the circuits.

In brief, here are some of the 'highlights'. First off the LM380 audio amp was getting very hot and making some horrible noises. Tim pointed me in the right direction by suggesting a 100uF cap across the DC input. The original design had one, but not on the AF board, hence my problem in testing the amp on its own!

Next the VFO refused to oscillate. I had never built a Vackar circuit before and I did not realise how critical the coil was. Richard Booth, G0TTL, came to the rescue with a recycled coil former and a very stable oscillator was had. Then I found that the VFO crystal mixer converter boards were producing some odd frequencies that were definitely not the sum, or the difference. Despite some recommended fixes with added feedback in the buffer amps the spurious emissions remained; I decided a different circuit was the answer. Several SPRAT circuits were researched, band pass filters designed using the software that came with 'Experimental Methods in RF Design', and a prototype board tested for 24MHz. This turned out to be much cleaner and controllable. Phew!

The latest set back was to find that the receiver was as deaf as a post with the BPF feeding straight into an SBL-1 mixer. I am now in the throws of redesigning the IF and maybe even adding some pre and post crystal filter amplification...



I am determined to complete the radio in time for the silver anniversary (1 May 09) and whilst the G2DXK transceiver architecture may be intact, the individual circuit building blocks will far from the original design. That said, I am sure that Lorin Knight, G2DXK (SK), would have been thrilled to know that he had spurred at least one amateur to expand his knowledge and skills in the home brew department.

(This reminds me of my tobacco tin project! Tim)

## ***Whatever happened to the Woodpecker?*** - Part 2 by Richard Booth, G0TTL

Twenty years ago, the woodpecker made its last transmission and short wave radio enthusiasts could once again enjoy a little peace and quiet on the bands. Unfortunately that was to be short lived due to the advent of cheap domestic electronics products, with their noisy power supplies and poor RF screening. In 2008 the woodpecker would seem quite a minor irritation compared with the modern menaces like mains cable computer networking devices and equally a good number of plasma televisions. Rather than being several thousand miles away in the Soviet Union they are literally next door, and telling your neighbours will most likely generate the same response as Leonid Brezhnev gave in the late 1970's - "It's nothing to do with us" or words to that effect. Yes the USSR never actually admitted to generating that colossal carrier or made any effort to explain what it was.

Of course now we know the sole purpose of DUGA-3 was a brute force, over the horizon radar that needed a nuclear power plant as a battery and several ships worth of steel airborne as an antenna. However during the cold war years many theories existed as to what the real purpose of this strange radio signal was. I would take many if not all of them with a wry smile and large pinch of imagination! Outside official intelligence reports the most common idea was that the woodpecker was some kind of subversive scalar electromagnetic weapon, based loosely on the experiments of Nicola Tesla in the 1890's. Apparently the woodpecker carrier could be modulated at 10Hz or thereabouts and given its huge signal levels at the target areas, the ELF modulation phase locked into the radar transmission would affect our brain waves which naturally occur near this frequency. Supposedly causing psychological and physical disabilities - some go as far as to say death. Stories of this alleged property gave DUGA-3 a new identity in the Ukraine, namely the Brain Scorcher!

The weather. Yes the woodpecker could apparently interfere with that too by altering the jet streams! There are physics defying conspiracy theories by the bucket full on this topic, the main gist being that an extremely high power radio transmission, again using low frequency modulation beamed along the earth's magnetic field would in theory cause the charged electrons in the radiation belts to become excited. In effect generating artificial Aurora Borealis! Working rather like a microwave oven the kinetic energy build up in the excited electrons would increase their temperature significantly having the result of introducing new stratospheric winds and thus creating new high and low pressure weather cells. By using multiple transmitters these new artificial weather patterns could be steered to its destination and then wind or rain dumped on target. I for one do not believe a word of it.

If you could get even less plausible, the woodpecker was blamed by the tinfoil hat brigade for all kinds of other incidents, including various structural failures. Apparently it caused no end of bridges to collapse through induced metal fatigue. The same bunch suggested DUGA-3 shot down the Space Shuttle Challenger by swamping it with RF and a number of other military and civil aircraft were lost whist the Soviets practiced shooting their EM weapon. Honest!

**The Amateur strikes back**

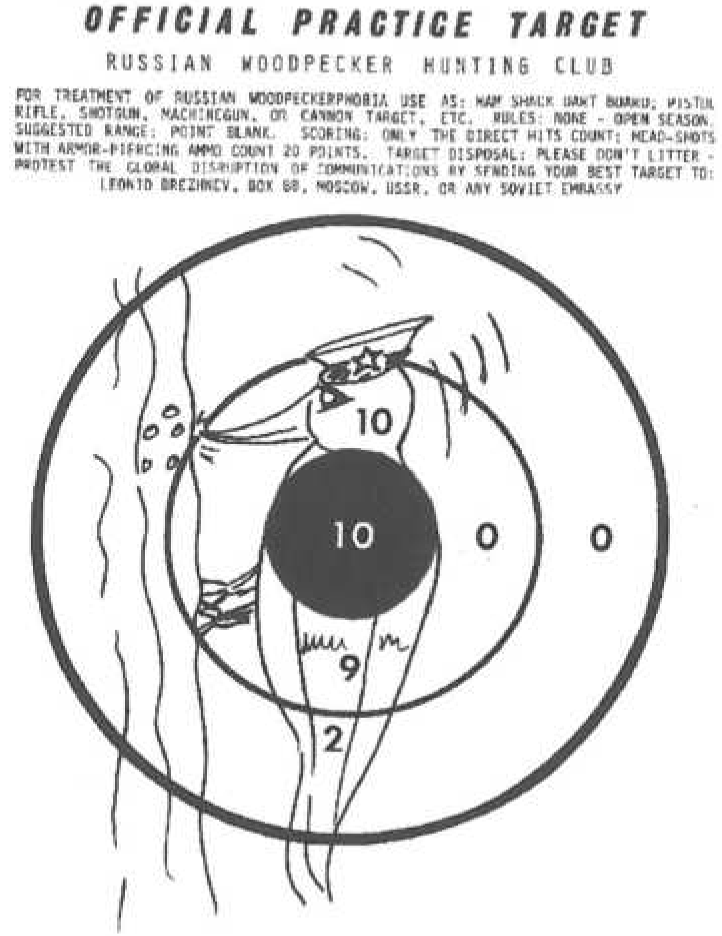
It would seem at the time other than causing general annoyance to users of shortwave radio which included long haul commercial airlines, broadcasters and the military the only people to actually have a go at fighting the woodpecker were disgruntled radio amateurs. Governments made official complaints but this made little difference, and there would appear to have been little if any interest in the USA or NATO in developing an official electronic counter measure to defeat the system. So it was left to a bunch of amateurs to try their hand at making a bit of deliberate interference.

Radar which ever way you look at it is a system that generates an RF pulse and then listens out for reflected energy. If you could generate your own pulse at the correct time and as such fill in the gaps with a fake echo you might just be able to confuse the system. This is exactly what happened. The Russian Woodpecker Hunting Club was formed in the USA and resources gathered together to track the common frequencies of operation. When woody strayed into an amateur band they would get together and engage in a bit of electronic warfare. Despite using simple antennas and low power (compared to the MW coming out of the Chernobyl installation) the amateurs had some success. Maybe this was due in part to the massive receive array antenna set up as part of the DUGA-3 system. .........

*Continued next page with hunting club poster!!*

## *Woodpecker Pt 2 continued*

Chasing the signal up and down the bands, sending fake echo CW bursts back to the USSR the most difficult problem to overcome was getting the critical timing right. Practice was the key quite literally; there were more than enough opportunities. However it worked in a crude small man against the might of the Soviet military way and sometimes it almost appeared that the woodpecker operators gave up and switched off for a break. Maybe the radar personnel thought the ionosphere conditions were just too unstable or more likely they threw the switch due to sheer frustration. Whatever happened though, the Soviet electricity meter would soon be busy again and the tock tock tock would return.




# The Fifth Somerset Supper!

Next year the 25th Yeovil QRP Convention takes place on Sunday April 26th 2009. As usual I plan to hold a **Somerset Supper** the evening before on April 25th. I have in mind a slightly less formal style buffet supper to give people a better chance to mingle and discuss the exhibits. The previous venue is no longer available and as there is nothing else suitable in Sherborne, I plan to hold it at Lower Farm, Kingweston, near Somerton. My friends Jane and David Sedgman, who farm there, have a suitable meeting room (actually the old Court house); Jane also does B and B/catering for a limited number of guests. They are 'four star' members of Farmstay UK and will do us proud! David is also a very keen model railway enthusiast who might be persuaded to demonstrate his huge layout which adjoins the Court room. I am delighted to confirm that our guest of honour and judge for our informal radio construction show, will be Rev George Dobbs G3RJV - very well known as the Editor of the Journal of the QRP Club - SPRAT.

**Make a note** in your diaries now, and let me know if you are interested as places will be limited - the Sedgeman's website can be seen at lowerfarm.net If you wish to stay overnight with them please contact them direct. I hope you all have new projects to exhibit! Tim

"JOURNAL OF THE CONSTRUCTORS CLUB"

# Hot Iron

Winter 2008
Issue 62

## Contents



The Walford Electronics website is also at www.walfordelectronics.co.uk

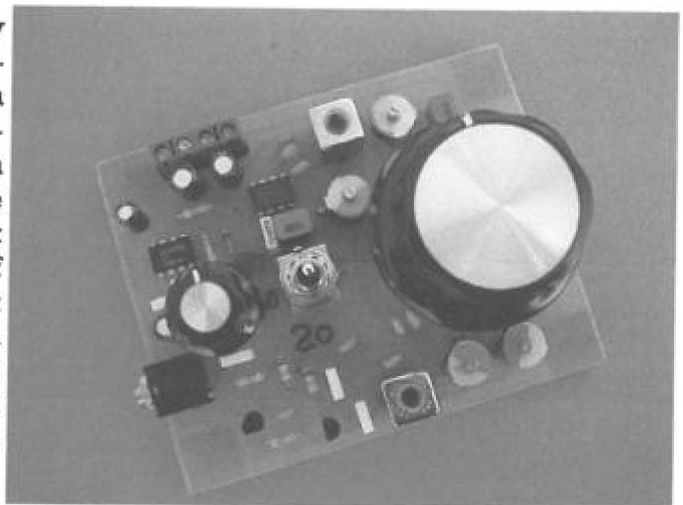
## *Editorial*

As I forewarned last time, I was rather occupied with other things during the last 6 weeks, so firstly my apologies for this late issue of Hot Iron. We were actually away in New Zealand and Australia for most of the time attending an agricultural Conference and doing farm visits and tours - we got back just on a week ago. They are both staggeringly beautiful countries and we had a most excellent time - everybody is so positive and helpful too! Suspecting that many of you may also have an interest in elderly machinery (apart from radio etc), I plan a little colour supplement to this issue taken from the 500+ photos that I took! My apologies to those who don't share these interests and I promise a bit more radio related topics next time!

One can only marvel at how modern electronics makes life so much easier now. We must have flown about 35,000 miles on 10 flights with only one slight hitch (due to a failed weather radar on an incoming plane). Even a few years ago, one would not easily contemplate such a complex and tight itinery involving six countries and four airlines. Where would we be without modern aircraft flight control systems and mobile phones etc? All of this has its origins in the very early radio systems described later in this issue - in view of its importance I make no apology for devoting 3 sides to it - especially as I didn't have to type it!. Tim

## *Kit Developments*

I have now taken the 'busy' sign off my website and Notch and Audio kits are now available from stock. I have also written up the Notch (and peaking) filter up for PW which should appear after Christmas. Although these have been designed primarily for the Minster they can be used with other rigs as well. While away I took the opportunity to contemplate the structure of my range of kits and have decided that I must press on very quickly with the Minster and then get stuck into some simpler projects - like the 3 band Willet RX on the right! One that also appeals to me is a 2 or 3 band phasing single sideband CW rig. More on that later! Tim G3PCJ



*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

## ***Pulling Ceramic Resonators Higher in Frequency*** – David Brewerton M0EZP

You've built your simple rig based on a ceramic resonator VFO but then you think "if only I could pull the band spread HF a bit, I'd be able to join in that net!" Here's something to consider...

Ceramic Resonators are stable, small, and inexpensive but have a 0.5% tolerance in their resonant frequency. You might also have more stray capacitance in to the circuit than expected, so your band spread might be different to intended (probably lower in frequency). Remembering that adding capacitance lowers the frequency of a tuned circuit, you can adjust your band spread LF by adding more capacitance. However, if you want to adjust your band spread HF you might be stuck because you might not be have any capacitance you can get rid of (remember your tuning/ trimming capacitors are adding 30-50pF at minimum). An interesting characteristic of Ceramic Resonators is that when they are connected in parallel, they have a higher resonant frequency than either of them connected on their own.

In my tests using 3.69 MHz resonators, remembering each will vary in frequency slightly, this is what I got in the Sutton:-

1 resonator on its own = max 3680 kHz with a -70 kHz span
2 resonators in parallel = max 3735 kHz with a -68 kHz span
3 resonators in parallel = max 3755 kHz with a -61 kHz span

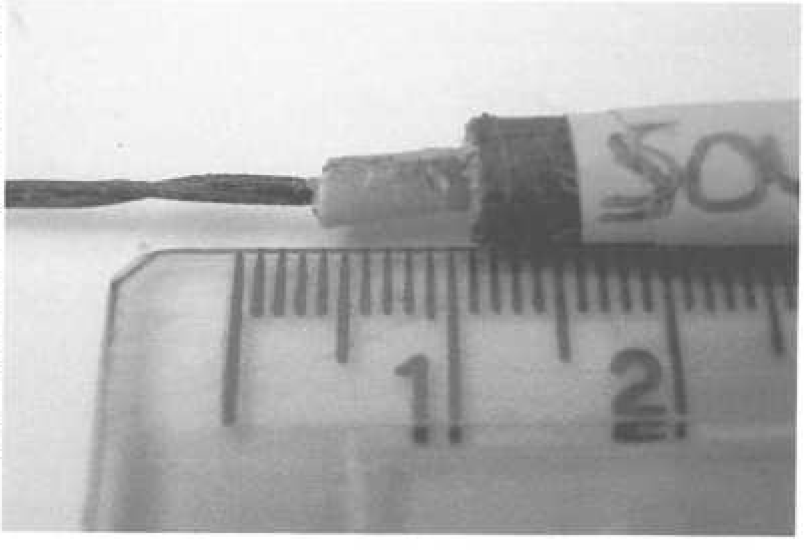
As you add more resonators in parallel it appears there is a law of diminishing returns in the increment to the resonant frequency and in their frequency span before oscillation stops. In my Sutton transceiver, I originally tried using a panel switch to connect in the 3 resonators in parallel but found that the wiring associated with it added much capacitance and the max frequency was around 3730. So to reduce the capacitance, I now use a small plug-in board with 2 x 3.69 resonators on it which connects in parallel with the existing 3.69 resonator and my max frequency is now 3755 kHz!

*With thanks to Jack Ponton's (GM0RWU) article on Parallel Ceramic Resonators http://eweb.chemeng.ed.ac.uk/jack/radio/projects/resonator.html*

It is also widely suggested that resonators can be pulled slightly HF by adding series inductance - try a few micro-henries. Never tried it myself so cannot be more definitive! Tim G3PCJ

## ***The aerial feeder conundrum!***

Nobody has yet offered any explanation for the single core RF cable (with two plain twisted wires) that we have unearthed at my friend's war time dug-out. Further excavation has now revealed that the original dug-out was just a single 'room' accessed by lifting up the whole seat box of his garden privy. The concealed radio room, which is next door to the original room, was evidently added later in the war when the radio equipment was added. This is thought to have included at least a 17 set and probably a TRD set. A buried duct for the aerial feeders has been found but no known examples of the TRD set have been found as they were all 'put beyond further use' at the end of the war. A mock-up of the TRD has recently been made but very few details are known.



This radio installation undoubtedly had a twisted twin core balanced feeder connected to one vertical dipole hung in the nearby trees; but how was the other single conductor RF feeder (shown right) used? There appears to have been a second vertical 'dipole' several wavelengths from the first but no suggestion of any operation other than the low VHF band around 50 MHz - so what was its purpose? Someone please help us solve this puzzle! Tim

## ***The Story of Portishead Radio - Long Range Maritime Radio 1920 - 2000***

Broadcasting to ships had been taking place since the early days of radio; the General Post Office (GPO) long wave stations at Poldhu and Caernarfon had been conducting two way traffic with ships within a few hundred miles of the United Kingdom prior to the First World War. However, no long range system existed until 1919 when the GPO and the Marconi Wireless Telegraph Company agreed to convert a redundant Imperial Wireless Chain receiving station at Devizes in Wiltshire for long range maritime use. Comprising a receiver and a 6 kilowatt valve transmitter, station GKT was opened for service early in 1920, with a guaranteed range of 1,500 miles. The radio officers at GKT were housed in old army huts, with radio telegrams being sent to and received from ships up to 5 days from any British port at the rate of 11d (just less than 5p) per word. Radio traffic was keyed to and from the London Central Telegraph office from the operating station.

This two way "long range" service proved to be immensely popular, and by 1924 it became necessary to expand the station at Devizes to cope with the increased demand. The GPO constructed a second long wave transmitter and built a new receiving station at Highbridge (near Burnham-on-Sea) in Somerset, to which most of the radio officers transferred. Ex Station Manager Don Mulholland recalls: "The old building was originally a bungalow, and it housed an engineer, handyman, kitchen, writing room and the office of the OC. In addition it had very large long wave receivers, some nine feet in length (guessing). The receiving positions operated on 143 Kc/s, answering and calling frequency, and on working frequencies of 121 and 129 Kc/s. As you can see they were extremely long waves. 143 was GKU (the familiar name of the station to R/O's). I worked long wave from wing C in the first half of the 50's but was done away with then. In the heyday it was only large liners who had long waves. Other ships did a QSP on MF to the liners. This system was also used when short wave was introduced. Eventually short wave tests were conducted. I think it was with the Esperance Bay on a trip to Adelaide.

As a result of the success the bungalow had a top floor put on and PEY was built in 1928. Operating on 8, 12 and 16 Kc/s, with call signs GKL GKG and GKS, and working calls of GKN (I think) GKF and GKJ. The familiar name of the station was then GKL. It was Nick Carter (the OC previous to me) who thought up the more recent set of call signs GKA GKB GKC etc. So it was mainly LF downstairs with HF upstairs. GKL had a four poster rotating device operated from inside the station (upstairs ). As a kid I operated it, as a ship was tuned in, so it was rotated for the best signal. At the same time a similar contraption at Portishead was rotated - a simple dipole with reflector. By 1926, experiments on short wavelengths had established that world-wide communication could take place. The GPO installed the first maritime short wave transmitter at Devizes, keyed by operators with receiving equipment at Highbridge that same year. Initials tests proved outstandingly successful, and it became necessary to construct a brand new transmitting station. This station was to be located at Portishead, near Bristol, and thus in July 1928 Portishead Radio was born. Three long wave transmitters were installed, followed in 1929 by a new short wave transmitter, ultimately resulting in the closure of the Devizes station.

Throughout the 1930s this long range service expanded greatly, with a gradual decline in the use of the long wave (short range) service, However, new markets were being discovered, including the use of Portishead by the morse code operators on the flying boats, passing traffic from as far as South America and India. The great liners were also making heavy use of this new service, and by 1936 Portishead Radio, now with 4 short wave transmitters, was handling over 3 million words of radio traffic with a staff of 60 radio officers.

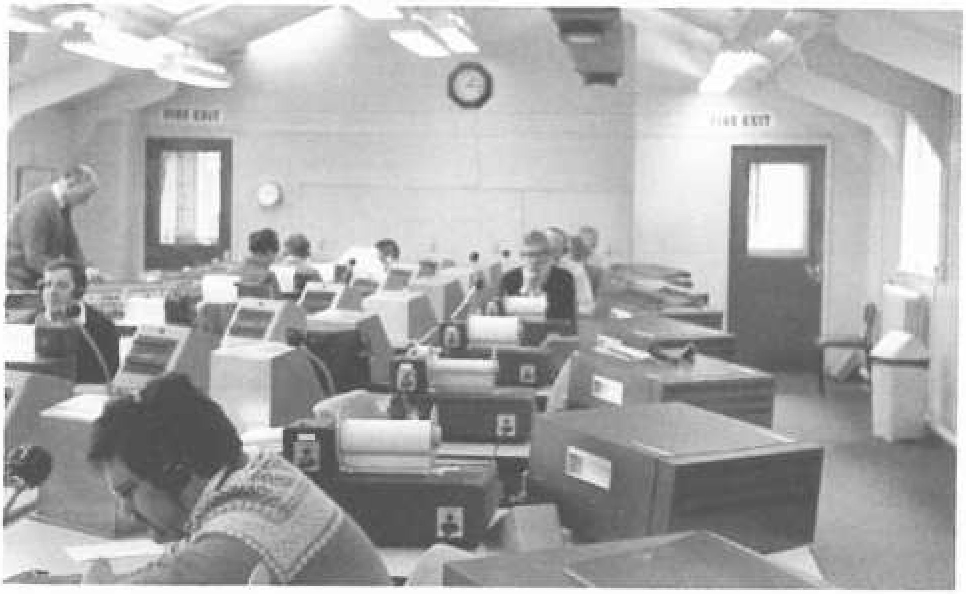
## ***Portishead Radio*** Contd. Pt2

The war years between 1939 and 1945 saw great changes in the role of Portishead Radio, two way communication with ships changed to a broadcast of traffic without any acknowledgment of receipt. For obvious reasons, transmissions from ships were kept to a minimum so as not to release their positions and destinations. However, distress calls, enemy sighting reports, news of the North Africa landings and clandestine signals from Europe ensured the station was kept busy. Early in 1943, the workload had increased to such levels that Portishead's civilian staff were augmented by naval operators from HMS Flowerdown. Many of the civilian staff were seconded to Government services at home and abroad, not only to man radio stations but to train the many new radio officers needed for convoy work. A special aircraft section was constructed to maintain communications with patrol aircraft in the North Atlantic.

Peacetime brought a return to commercial activities, and with it a vastly increased demand for long range communications. An "area scheme" was established in 1946 to enable British and Colonial registered vessels to use naval stations around the world to relay their traffic to Portishead. 1948 saw the opening of two new operating rooms with 32 operating positions, a broadcasting and landline room, and a central control room with a steel plotting map of the world measuring 36 by 16 feet. A bureau file of both ship and aircraft positions was maintained, and many were plotted with magnetic indicators. During the late 1940s and early 1950s transatlantic liners provided a high volume of traffic, all using radiotelegraphy (morse code) transmissions. The development of the landline telex service enabled customers to deposit and receive traffic directly from Portishead, with high traffic users installing their own private wires. The Suez crisis in 1956 brought high levels of telegraph traffic in both the to-ship and from-ship directions, leading to increased staffing levels towards the end of the decade.

The 1960s saw the station continue to expand, with increased traffic levels and the development of a telex over radio (TOR) system. A press transmission of news was transmitted by morse to enable ships to produce their own news sheets. By 1965, 86 radio officers were handling over 11 million words of traffic per year, and communicating with over 1,000 ships each day. The introduction of the Daily Telegraph transmissions to the QE2 in 1968 by radiotelex was another first for the station. April 1970 saw the transfer of the radiotelephone service from Baldock to Portishead. This necessitated the use of extra transmitters at Rugby and Portishead, and the temporary use of an additional control centre at Somerton (Somerset). Further transmitters at Ongar, Leafield and Dorchester were transferred from the International point-to-point network were brought into service to cater for the increased traffic levels.

The area scheme previously mentioned was terminated in 1972, and with it the Naval presence at Portishead. However, traffic figures continued to rise, with the developing oil market and the deepwater fishing industry all providing work for the station. The leisure market continued to expand, with the early round-the-world yacht races providing valuable publicity for Portishead Radio and its services. By 1974, traffic levels had increased to over 20 million words per year, now handled by 154 radio officers. To-ship traffic was housed in a 'carousel' in call sign order (British and Foreign), and was interrogated by numerous R/Os performing traffic list, WTC (Wireless Telegraphy Control), Circulation and Bureau functions.



***Portishead Radio*** Contd. Pt3

Further expansion of the existing operating area was impossible, so in 1976 work commenced on a purpose-built building to house the various services then available to ships. A new computer based message handling system was installed, and the manual radiotelex service became more popular, resulting in the development of an automatic system. The Portishead transmitting site was closed in 1978 followed by the Dorchester site in 1979, leaving the sites at Leafield and Ongar operating alongside the main transmitting site at Rugby. However, the famous name of Portishead Radio was maintained to provide the maritime community with a familiar and well known service. The advent of satellite communications in the early 1980s had little initial impact, and in 1983 the new control centre was opened, providing new radiotelephone and radiotelegraphy consoles, with automatic radiotelex being installed later that year. Remotely controlled receivers and receiving aerials, located at Somerton, were utilized for all services, resulting in the dismantling of the receiving aerials at Highbridge. The old operating rooms were demolished, creating space for administration offices and stores. Automation of the W/T service by necessity caused a reduction in operational staff numbers, although management (overseer) posts were maintained. 1985 saw the opening of a new aircraft service, providing world-wide "phone patch" and flight information services. This service proved so popular that many land based industries based in remote locations in Africa used the aero frequencies, culminating in the opening of the Gateway service. Relief agencies, military units, embassies, and industries used the service, which acted as a lifeline to those located in countries where normal landline links were poor or non-existent.

By the end of the 1980s, satellite communications were making significant inroads into Portishead's traffic figures. It became clear that a severe rationalization program was necessary in order for the station to remain viable, which resulted in the closure of the transmitter sites at Leafield and Ongar. The number of operating consoles was reduced in line with the decline in radio traffic, and the number of staff employed fell proportionally. In 1995, the 75th year of the UK's Long-Range maritime radio service, BT's Satellite Services opened a Customer Support office at the Highbridge site, staffed by 12 ex-GKA Radio Officers, leaving the terrestrial radio station manned by less than 20. As the station began to die, more staff transferred to the Satellite Services side, and in early 2000 the decision was made to close down Portishead Radio for good.

So it was that on 30th April 2000 Portishead Radio went off the air for the final time. (After a final 24 hours of cross band operation with many lucky amateurs! G3PCJ.) The Satellite Services office however continued to thrive, but in early 2001 BT surprisingly decided to sell the whole Aeronautical and Maritime department to Stratos of Canada, resulting in the closure of the Customer Support Office and the redundancy of the staff. At the time of writing there are no inhabitants at the station - it remains empty and unloved. An ignominious end to what was once a bustling and efficient station. No trace of radio equipment remains - the final aerial mast has gone, the maritime radio display in the reception area has been removed, and all maritime photographs and pictures have disappeared. Only the microwave link tower and the building sign (which still bears the legend 'Portishead Radio Station') serve to remind anyone that a maritime radio station once occupied the site.

The Local Council are now (Dec 2008) trying to establish a suitably active and dynamic exhibition aimed at reminding youngsters and others in the locality of the importance of what used to be a world famous radio operation.

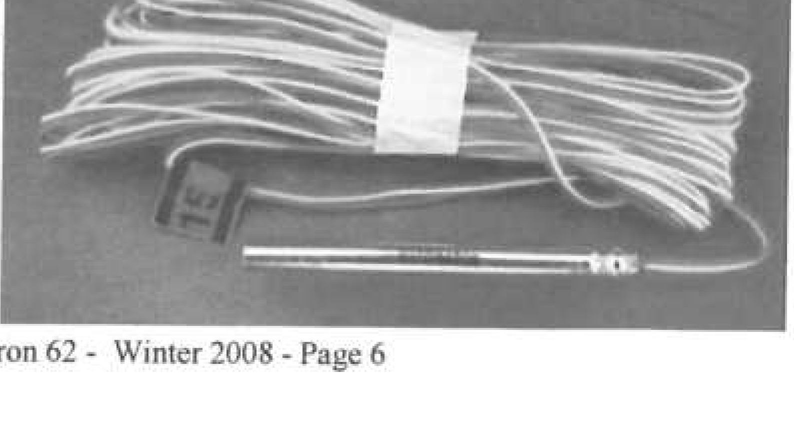
The above most excellent article and photos have been very kindly provided by Larry Bennett G4HLN, and Brian Lea - both late of BT. Larry has also provided me with another article that appeared in the May 1975 Lloyds List about long range maritime comms in the 1970s - if anybody is interested, I will be delighted to forward it by e mail. Tim G3PCJ

## ***The Varnished Detonator – only an Englishman!*** - Dave Buddery Jnr G3SEP

Whilst at University, I was secretary of the Amateur Radio Club - we had a shack in a wonderful location, on top of the Electrical Engineering Building, about 240 feet up, in central London. It was so far from any residential property that TVI wasn't going to be an issue, those were wonderful times and it was close to the Sunspot Maximum too. There was one drawback to the location. We were close to the outlet of the main college boiler chimney. The college had centralised water heating and needed a massive boiler, which burned fuel oil – this clearly had a considerable sulphur content and there must have been rather a lot of sulphur dioxide in the flue gases. We were lucky enough to have a 35 foot lattice mast bolted to the side of the lift housing and this was topped-off by a HAM M rotator (we WERE VERY EXPOSED at 275 feet of antenna elevation!!), a wide spaced Hy-Gain full size 20 metre beam and a Mosley Elan (if I recall) for 10 and 15 metres. By the end of my second year, these aerials had been up about three years and had not really been looked at since. We were becoming concerned by what we thought was a lack of signal from the Elan and erratic SWR with the Hy-Gain. I, the Chairman and a few of the better end of our little gang decided to take a look for problems, so we borrowed the chain hoist from college maintenance and lowered the mast. When we got it down, we were horrified by the state of the connections to the Hy-Gain and by deterioration of the coax plastic outer cover, partly due to the sulphur and partly by a few years of the sun. There was also very considerable corrosion to the beam elements. I remember us all standing there, covered in soot, hot, tired and a bit sun-burnt (it was midsummer after end of term exams). We decided that the Union Bar was a good place to ruminate on our predicament so we cleaned up best we could and went down there.

As about the third pint went down, I thought of something and said "Did any of you ever read "Slide Rule" by Neville Shute"? One or two of them had and one said "Why, does it relate to our problem?" I replied, "It may, do you remember what they did when the R-100 [she flew to Canada and back and did not crash!] which had been hanging in a big damp shed near the Humber at Howden for over a year, was beginning to show signs of corrosion in its Barnes Wallis designed geodetic spars? They varnished the whole thing and years later just before it was broken up Neville Shute reported it was still in excellent condition as a result. Maybe we could varnish our beams!" There was a stunned silence. Then one of them said "Do you know how to go about it?" "Yes," I said, "I've done a few boats in my time." We had another beer or so (!) and figured out what sort of varnish, when, what who, how, how much etc etc. Things were looking up! A week later it was ALL DONE and the beams were back up, new coax and all. The Hy-Gain SWR problem was fixed and on 10 metres in particular, the band sounded a lot livelier. The aerials looked wonderful, gleaming in the sunshine. I recall the Head of Electrical Engineering, Professor Brown, asking me later how they seemed to look so shiny and he was smiled when I told him what we had done! He hadn't come across that before and he was a keen antenna man.

Many, too many moons later, I found myself "somewhere in Asia" troubleshooting the reason(s) for a 5% misfire rate on an explosives energy source survey. 5% is far too high, it ought never go over 2%. The incumbents had been at it for a while but to no avail with our advice going to them by e-mail. Finally, they swallowed pride and asked for a visit from one of the London technical hit squad (i.e. yours truly). The "misfire" was of the "no-fire" variety. The explosive (some 20 metres underground) in a back-filled but "wet" hole, below the water table, was failing to detonate. One problem was that sometimes the charges were in the hole for 4 to 6 weeks. It was unavoidable given the nature of the work. I'm not going into detail about why we were sure it was not related to the explosive itself, it has no bearing on this story. It had to be the detonator. Anyway, I arrived out there and looked at the electric detonators in use, which were of the generic type found in that line of exploration anywhere in the world (like that right). I was aware that the work was going on in a very heavily farmed and irrigated area. I asked a few questions about the chemical content of the groundwater.



## ***The Varnished Detonator*** Contd.

No-one present on the operation knew but one of the local advisers who was attached to the project said they would know at the hydrology department of the Local Government Office in a town about 20 miles away. So we booked an appointment and went to see them. Sufficient English was spoken at the level of Government Officer that we were meeting with and they produced analyses of various groundwater locations throughout the area. One thing was clear – it had a high Nitrate concentration due to the leaching out of fertiliser. The light came on – the Nitrates were corroding the aluminium tube of the detonator! I didn't say anything at the time, but let the meeting go on to its conclusion. There was no need to hurry in front of these rather charming folk, so I invited them to Supper. After Supper, we bade them goodnight and our small group minus the officers adjourned to the bar of our hotel (the officers 'didn't drink' – say no more).

In the bar, I told our guys what I thought and why, talking about my experiences with the aluminium aerials at University. I suggested we got hold of some blank detonator tubes as a matter of urgency, drilled a test hole in the camp, cased it with plastic casing to keep it open and lowered maybe 10 of them threaded on a plastic cord with a non-electrolytic weight to take it down. Incredibly we had all this done within 72 hours. I asked them to let me go back to London and return 3 weeks later. They were to leave the detonator shells ALONE in the hole while I was away. I was closely quizzed about why and explained that I thought it would take the low concentration of nitrates (in chemical terms) a while to attack the aluminium and after all it was the charges which had been in the ground for 4 to 6 weeks which had the problems. If we saw corrosion then we would try varnishing the detonator shells (or rather, the manufacturer would have to do it – it was ruled too dangerous for us to do it ourselves – wrongly so, I thought but never mind).

I went home and came back out to Asia 3 weeks later as planned. That afternoon we pulled the plastic cord out of the test hole and the detonator shells looked like lace work. Now we knew for sure – and my suggestion to varnish the detonator shells was taken up immediately. We flew up to see the detonator manufacturers, taking the corroded shells with us. The next batch of detonators were varnished and we persuaded them to do a rush job on 1000 detonators for ready use. Within the next month, it was clear our problems were over; the misfire rate was below 1%. Neville Shute plus an obscure corner of amateur radio experience had gone to the rescue! The varnished detonator for exploration use in irrigated farming areas is now a standard product from the manufacturer in question.

NB you can check on the R100 spar varnishing story in "Slide Rule." It's there! OR go to Google – type in 'R100 varnish corrosion' and see what comes up in Wikipedia.

In a separate e mail Dave comments '*The area was hypersensitive as one side of the block boundary was the international border and it was a sensitive one. We were warned not to take cameras and we had to hide GPS receivers in our luggage. We had the border marked on the GPS in memory. A local driver got me stuck twice in one afternoon out on an area of mud/sand flats which were a bit soft in places. It was about 120 F and 105% humid. After the second time, I drove and we got stuck no more. I kept driving until we got back on to hard ground then I let him drive again! I had a personal army bodyguard at all times outside the protected camp. He was armed with an M16 and I was a bit of a hit because I used to go down to his mess with him and eat their food which I thought was a lot better than the stuff they gave us!*' G3PCJ

## ***VFO Stability?***

One of our regular contributors has sent along this photo of a most important element in stabilising his simple ceramic resonator based VFOs! Who is he?! G3PCJ

## *The Brendon with linear, or on 15m!* - David Rowlands G6UEB

Whilst I was waiting for my Brendon to arrive I built a miniature DSB transceiver based on ideas in SPRAT. Once my Brendon kit arrived, I duly set to on the construction of it. I managed to get a maximum of almost 2 watts out however I've backed off the potentiometers to give a max 1.5 Watts into a dummy load.

I had an 80 m Ramsey linear that I'd picked up on Ebay some time ago so decided to build the two units into one case. The case is from Maplins cat # N81AL. To fit the Brendon into the case, I had to turn the connector blocks around. I also had to be mindful of all of the earthed components most of which are on the opposite side of the circuit board from the block connectors. With solder both on top and under the PCB great care was needed to ensure that when finished the PCB would slide into the case. It really IS a tight fit, but I have done it with care. The Ramsey board after a slight trim was an excellent fit – the on/off switch on that linear was removed and replaced with a wire link. Another wire link was removed and made way for a rear-panel mounted toggle switch. The other toggle switch turns the Brendon on and off. Both Brendon and its built-in linear can be used separately as I have provided the Brendon with a separate RF output socket. The linear can therefore also be used with a small 80m AM transmitter that I have. To use the linear with the Brendon, connection is made as if to an external transmitter/transceiver. Both the linear and the Brendon are powered through the linear's power socket.

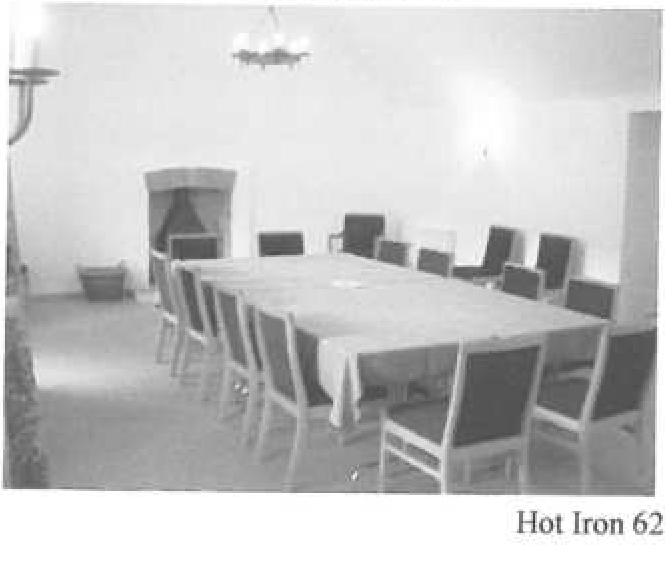
Before I fitted the TX low pass filter into my Brendon I substituted a RD16HHFI for the IRF510 PA stage and found that the set was able to transmit on 15 metres. The output power was the same as usual and with this transistor the Brendon would work up to 10 metres judging by the data sheet. With the sunspot peak coming around again this might be worth considering. Meanwhile now I've built it I need to get a few contacts on my completed Brendon! I shall be interested to know how others have got on with this set especially when running it "barefoot" on 1.5 Watts.

*Comment from G3PCJ. The driver and output stages of the Brendon's TX are not really intended to run seriously above 80m so I am somewhat surprised that David had this success on 15/10m with this higher speed power MOSFET that is used in some CB rigs! It is the output stage of my 6m Chirnside AM TCVR that is in development. It was David's note introduced me to this useful device. Tim*

# The Fifth Somerset Supper!

Next year the 25th Yeovil QRP Convention takes place on Sunday April 26th 2009. The Fifth **Somerset Supper** is to be held the evening before on April 25th. The format will be a buffet style supper for better discussion of the exhibits etc. It will be at Lower Farm, Kingweston, near Somerton in the Old Court Room. Jane and David Sedgman also do limited B and B/catering. They are 'four star' members of Farmstay UK and will do us proud! David may might be persuaded to show us his large model railway installation. Our guest of honour and judge for our informal radio construction show, will be Rev George Dobbs G3RJV - very well known as the Editor of the Journal of the QRP Club - SPRAT.

Get building your equipment for entry tickets now and make a note in your diaries; places will be limited - the Sedgeman's website can be seen at lowerfarm.net If you wish to stay overnight with them please contact them direct. Tim



"JOURNAL OF THE CONSTRUCTORS CLUB"

# Hot Iron

Spring 2009
Issue 63

## Contents



The Walford Electronics website is also at www.walfordelectronics.co.uk

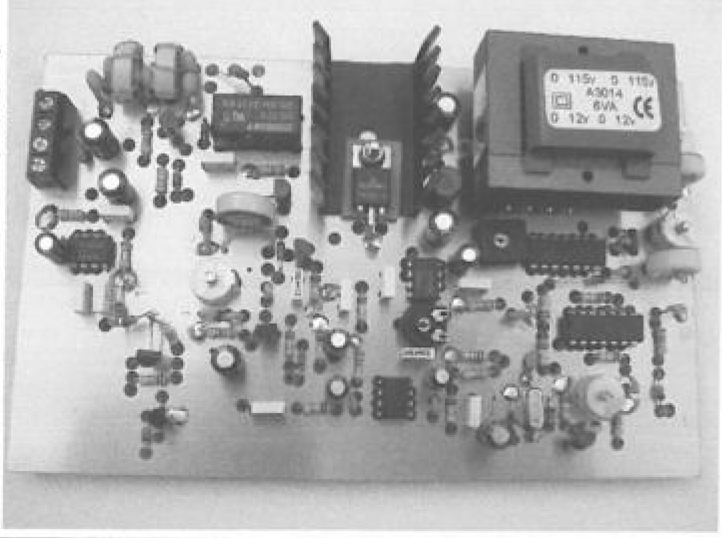
## *Editorial*

Altering the information to the left to say 'Spring' seems strange when we had an inch of driving rain and drizzle last night, with continuous heavy frosts forecast for the next few days! But the sun is now out and things are getting better - I just hope they were never going to be as bad as the pundits had suggested! Trade in this little business has been better than I feared it might be over the last month - for which I am very grateful - the orders from satisfied customer wanting something else are especially pleasing. But commercial life is strange - I note that one of my competitors says he sell lots of accessories but few complete rigs, whereas my experience is exactly the opposite!

The turn of another year shows the challenges ahead - in my case to drive down the sale prices while still providing good value for whatever customers have available to spend. I see a recent comparable product where the price can hardly cover the material costs, let alone the overheads of running the business so it's a real challenge! Often start up businesses supplying hobby type products fail to appreciate the overheads like insurance, stock finance, promotional costs etc and soon prices have to creep up! Time is often not properly costed and it makes it very challenging for those who are doing it as a living. I run Walford Electronics as a business but thank heavens I am not totally dependent on it! Tim

## *Kit Developments*

My assessment of the prospects for solving the snags in the Minster shows there to be a fair risk that it will become too complex and expensive. The target spec for the Minster remains but it is going to need several major revisions. Accordingly, I have pressed on with the **Willet** (simple DC receiver for 20, 40 and 80m) which is now available for £34 + £3 P&P; and I have just done the final PCB modifications of the **Chirnside** (early 6m version right). I have also drawn out the **Trull**, a MW TRF with optional regen stage and parts to make it also do 80 and 160m. This is aimed at novice constructors. Tim G3PCJ



***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

## ***Brief Report on VP8YLE*** - by Nicky Marriot M5YLO

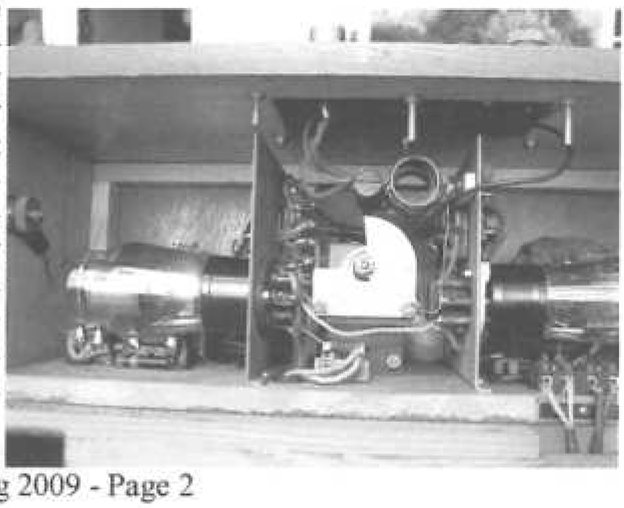
This was my first experience of flying ..the long flight (Madrid to Santiago 13hrs) seemed endless. Three of us travelled together, staying in the same Santiago hotel & later joined by three more of the party. The WX was very hot - 30C. We took a tour around Santiago, with its many new buildings - I enjoyed that very much, and then dined together on Friday evening. We had to be up at 5am on Saturday, to catch the only plane to the Falklands. We met up with 3 more at Punta Arenas. From here it took 2 hours to fly to the Falklands, arriving at 13:30 local and were meet by Bob and Janet who took us back in a mini bus. The roads were very bumpy and made from loose grit... also very dusty! Our accommodation "Shorty's Diner" was a row of connected huts each occupied by one of the YLs.

We had a nice meal at Bob and Janet's and got to know each other. On Sunday we walked around Stanley to find our bearings. In the morning I had to go to the hospital as my ears were ringing & my balance was not right, I had some tablets to settle them down. I started my first shift at noon on Monday and was pleased to make contact with the UK. Ruth and I were on a very early shift 4:30am the next day and worked Japan, which was great for me as I have not worked JA from my home QTH yet. At the end of the day I had made 329 contacts (more than I expected), later in the week I was pleased to make a sked contact with my local radio club Blackmore Vale ARS. It was good to hear the lads 5 & 5; the pile ups were quite mad calling all the time (with the best operators being Americans & Japanese). Most days we did 3 shifts of 3 hours each. With 2 hours off in between, I felt quite tired by the end of the week. The WX kept very good for the two weeks, with one day of rain & one very windy cold day - the rest of the time we had sun & we were in "T" shirts. On the second Wednesday we took a trip to San Carlos cemetery, Goose Green, Gypsy Cove, which took most of the day - it was 270 kilometres. We were very pleased to see the penguins. During the two weeks I gained much confidence in working the pile ups... we operated both numbers and split depending on conditions. I made a total of 270 QSOs of the 25,000 total (& 150 countries) with the VP8YLE call sign. I thank both Bob and Janet for the help given and making this YL trip a great success. Nicky.

## ***The aerial feeder conundrum*** - contd.

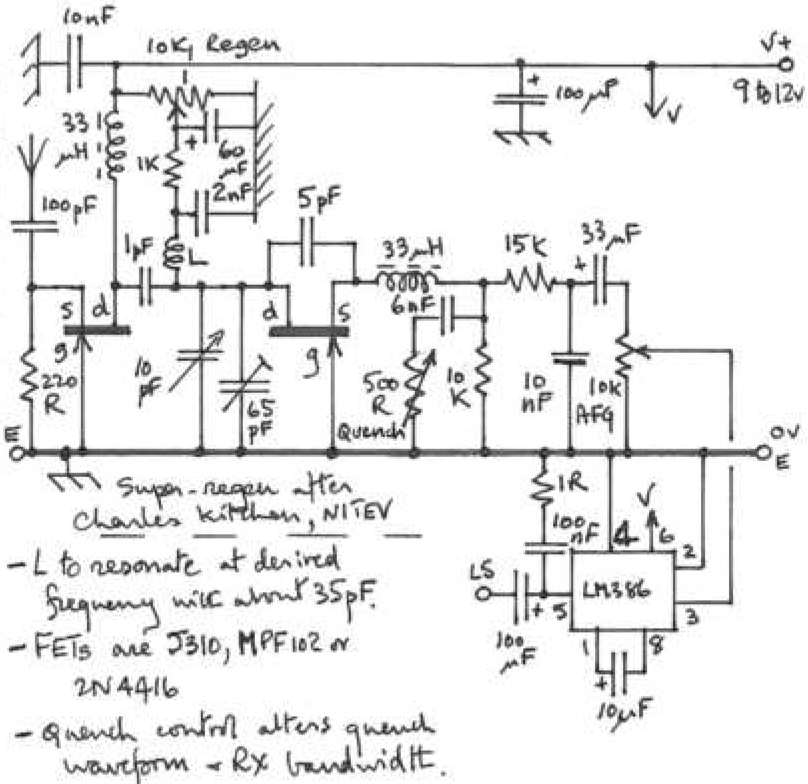
Nobody has come up with a really good explanation yet for the single conductor RF feeder that I have mentioned before (at my friend's wartime dug-out). The best suggestion so far, is that it was for a general purpose long wire aerial for medium or long wave domestic type sets; such a receiver might well have been used in a bunker to keep abreast of the national situation, but this explanation is not entirely satisfactory! Its seems surprising that a specialist, scarce and expensive RF cable would have been developed and used for such a task that could possibly have been done with a simpler cable. The cable was buried in the ground for about 10 yards so something would have been needed to reduce losses and unwanted stray capacitance from the earth. When the weather improves I intend to examine what remains of the feeders and aerials in the trees.

One puzzle about a network of the simple WD17 sets (right) operating together has been explained satisfactorily. I was concerned that a net using such simple sets would be prone to marching up or down the band due to differences between transmit and receive frequencies. However the super – regenerative receiver has an inherently wide bandwidth - theoretically up to half the regen quench frequency which is usually many tens of KHz - hence they can all hear each other easily even if their transmit frequencies are appreciably different - see next page. My own 6m project - the Chirnside - is performing well; it has a Regen RX and AM transmitter. G3PCJ



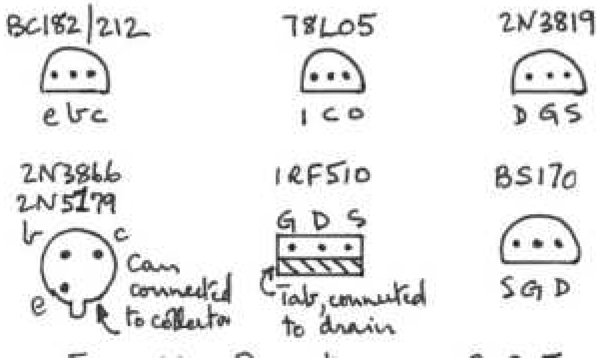
## *Simple Super - regen Receiver*

In the USA, Charles Kitchen N1TEV has generated many very effective and simple sup-regen circuits. That on the right is an anglicised version which I have adapted from one of Charles'. I have not actually tried it but I am confident the changes that I have made to his well tested circuits will work! This particular one has a grounded gate broadband RF amplifier feeding into a ground gate second stage. This is actually arranged as a form of Collpits oscillator but has two extra parts (labelled R and C) in the source circuit that turn it into a super - regen stage. Charles has also used grounded source RF amplifiers instead of the one shown here - whatever their form, their purpose is to prevent any of the oscillator signals feeding back to and radiating from the antenna. This particular version has been tuned in the VHF region but there is no reason why they cannot be used at lower frequencies. The advantage of the super - regen is that the adjustment of the regen control is not rather 'tender' like the conventional regen because the circuit action continually takes it into and out of oscillation at the quench frequency. (But modern regens are much better anyway!) This gives it very high gain and because the quenching takes place at supersonic frequencies, that effect is not audible. The drawback is that this is effectively a sampled data system, with a bandwidth of half the quenching frequency - typically a few 10 KHz. Thus the RX bandwidth is large enough to copy stations spread over a few KHz. G3PCJ



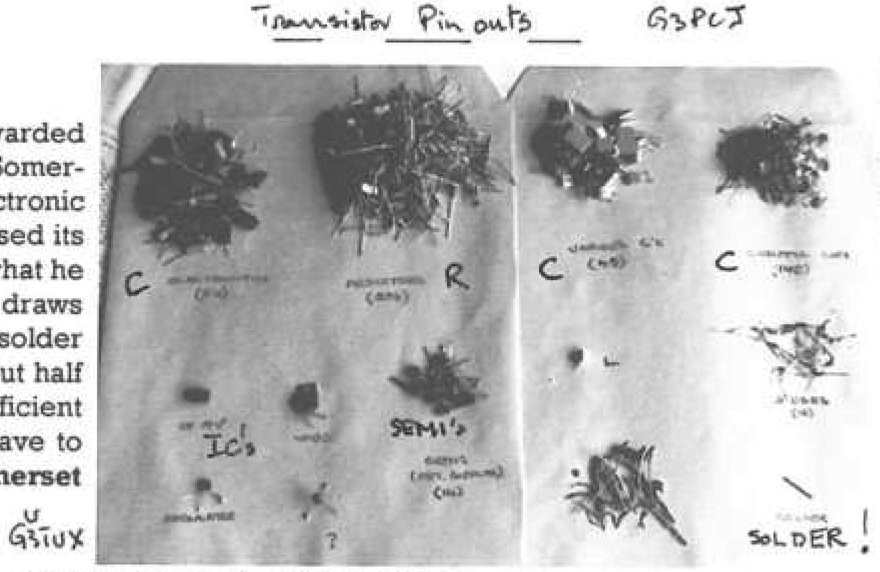

## *Useful pin-outs*

I have sketched on the right, the pin views of many devices that are commonly used in QRP projects. Note that JFETS like the 2N3819 can work equally well with their source and drain reversed - beware there are also two versions from different manufacturers that have the same 2N3819 number but do have different pin-outs - I have shown the more common version. G3PCJ




## *What to do?*

Chris Rees GU3TUX was awarded the consolation prize at last year's Somerset Supper, it was a collection of electronic goodies off my bench. He has analysed its contents (right) and wants to know what he should build with these parts but draws attention to the low quantity of solder (bottom right) that is available - about half an inch! Plenty of Rs and Cs, sufficient transistors and some wire! I shall have to rectify this for the forthcoming **Somerset Supper** - see back page. G3PCJ



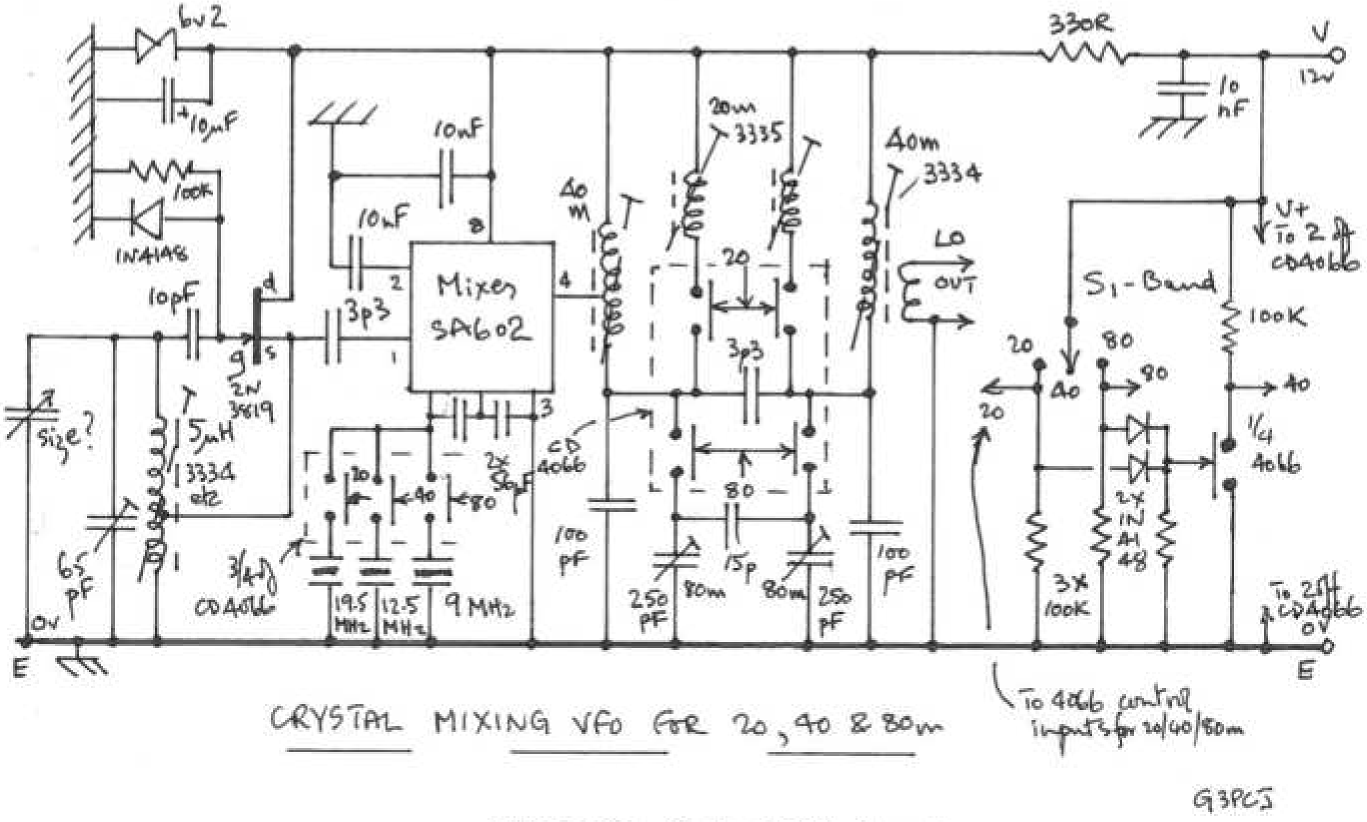
## *The TRIBLO!*

This 'project' is for a restricted version of the earlier All Band LO kit, providing for the three most used bands - 20, 40 and 80m. The aim is to have good stability, a common incremental tuning 'scale' and no transmit problem with chirp! It might form the heart of a three band direct conversion rig - most likely to be for CW. The easiest way for only three bands is a crystal mixing approach; this avoids the change in tuning scale when the lower bands are derived by digital division. It can also be an all analogue design which appeals to some people! That may have a benefit in less harmonics, unwanted mixer products and associated spurs! The choice of crystals can allow a lower VFO frequency which will improve stability. Because I happen to have these crystals my preference is indicated below, but it could be altered to suit whatever is to hand.

| Band | LO Freq range | Crystal freq | VFO freq |
|---|---|---|---|
| 20m | 14.0 - 14.1 | 19.5 | 5.5 - 5.4 |
| 40m | 7.0 - 7.05 (7.1) | 12.5 | 5.5 - 5.4 |
| 80m | 3.5 - 3.6 | 9.0 | 5.5 - 5.4 |

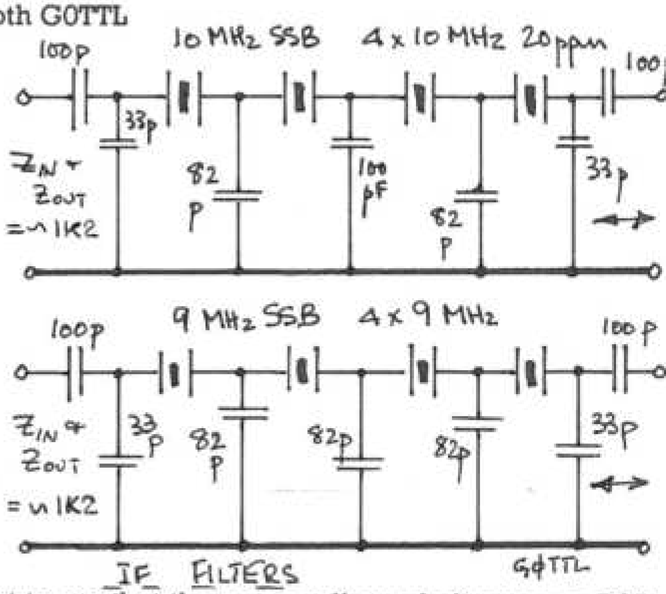
In this example, all bands actually tune backwards and the unwanted sum product is out of the way well above the listening band. The VFO harmonics are also out of any band. Ideally all bands need to all tune the same way, and subtraction of frequencies will generally be best owing to the very low VFO that would be needed to get below 80m; also, low frequency crystals such as 1 MHz are becoming like hens teeth at reasonable prices!

Band changing would appear to be possible with CD4066 electronic switches for these low power analogue circuits. Three of the four switches in one chip could be in series with the crystals to select them for the oscillator section of a Colpitts SA602 mixer; with the fourth switch doing the 'logic' inversion required to control them from a single pole centre off band toggle switch. A second CD4066 could alter the output double tuned band pass filter, by applying capacitors or inductors in parallel with the normal resonators for 40m, to give operation on 80 and 20m respectively. The 5.5 MHz VFO would be quite standard with normal tuning controls - coarse, fine/RIT as required. The circuits are sketched below without part values as it has not been tried out! I can supply the crystals if anybody wants to experiment. Tim G3PCJ



## ***Doodles from Doncaster*** - from Richard Booth G0TTL

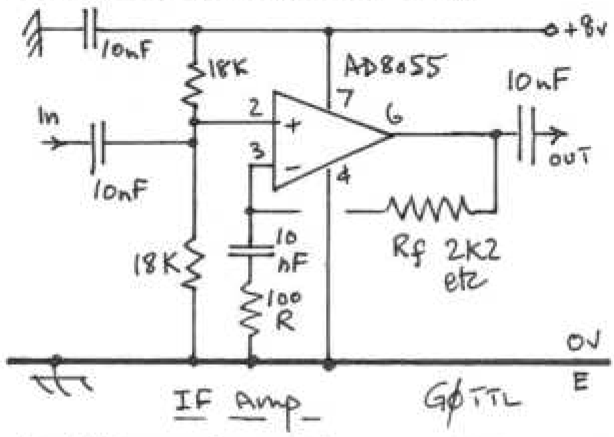
*Crystal Filters* Manufacturing processes in crystals continue to improve and there are now a good number of 20 ppm resonant frequency types available off the shelf for little cost. Bearing this in mind the good news is that testing crystals to get a reasonably matched set is no longer a necessity. Recently I developed a filter using four 10MHz (Rapid Electronics) types for use in SSB phone transceivers. The input / output impedance is about 1K which suits active mixers such as the SA602 and my personal favourite the 1496. Bandwidth is about 2.7 KHz and I have had no complaints on air so far! A similar filter was also developed for 9MHz this time to be used in a traditional 20/80M superhet, with a 5 MHz VFO. 9MHz crystal are custom made but I have plenty.




*Cheap PCB accessories* Several folk pointed out to me that they use ordinary hairspray as PCB solder through lacquer, rather than shelling out £6 a can for the proper stuff. I was a bit sceptical however if you are anything like me and only need to look at your shiny just etched board for it to start turning black, you ought to try this out. I am not recommending you use hairspray on your latest valve linear power supply or anything other than low voltage QRP projects, and only use it as a pre-construction lacquer. It is there to protect the copper clad from the atmosphere and finger prints, and not to improve electrical insulation! Do not go spraying it all over the components once they are soldered in place! To use, simply remove the etch resist either by polishing with wire wool or as I prefer to do wipe it off with standard car paint thinners. If the board is to be drilled I suggest you do that before removing the etch resist. Then give it a blast with your favourite brand, best buy I have found is Tesco's value spray at about 40p for a large can - yes it really does work. Smells like the hairdressers when you put the iron on it, my 18W Antex burns through it in no time at all. One of my efforts that I assembled over six months ago which is open plan still looks as it did the day I plugged the antenna in.

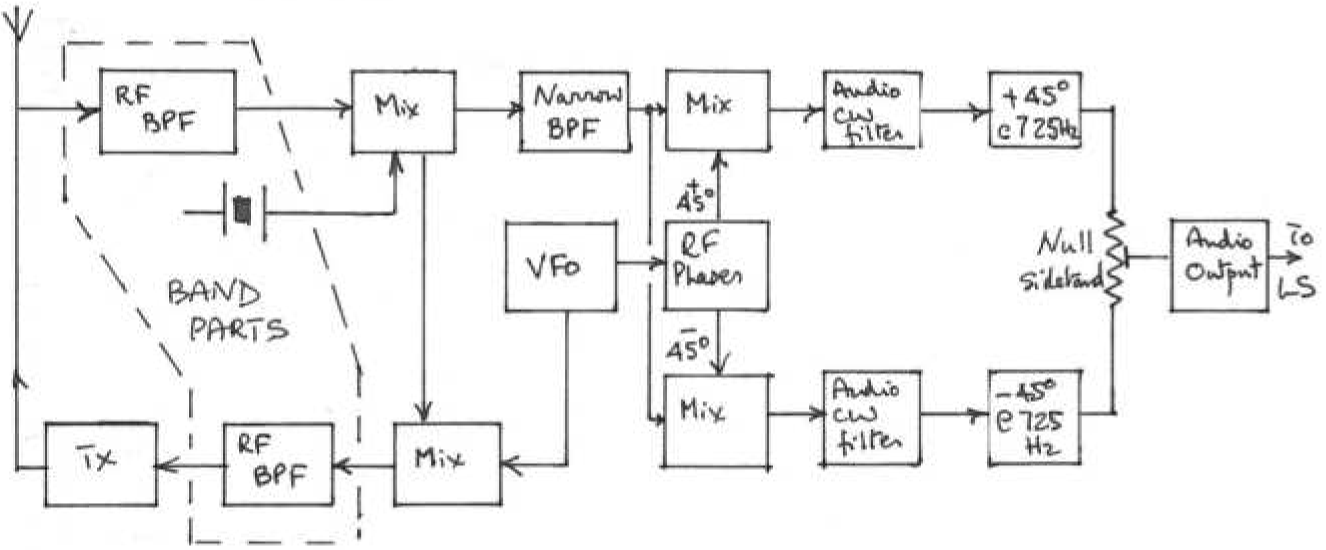
On the subject of PCB manufacturing another discovery I have made is that "Black Light" fluorescent lamps which are used in light displays etc to make white objects (especially clothes washed in fabric conditioner) highly illuminated have enough UV in their output to be used as exposure lamps with photo etch board. This is despite the main visible light output being right at the violet end of the spectrum. You can now buy the black light lamps in a 15W energy saving format which means a simple light box built out of MDF with a sheet of thin glass on top is a straightforward task. I have built such an item using a single lamp, the box is lined with silver foil. Exposure on my rough looking unit is about 5 minutes; you will need to experiment depending on the photo board type and the distance between it and the light source. A lid on your box lined with foam padding is a good idea so that some pressure can be exerted between the PCB material & UV mask.

*Ultra simple IF amplifier* There are still several standard package wide band Op Amps available, one which is particularly good / cheap is the Analogue Devices AD8055A. With it's operating bandwidth high up the HF region, using it as an IF amplifier at say 10 MHz hardly has it breaking into a sweat. Simply configure it as a non inverting amplifier, no tuned stages are required as the input is straight out of your crystal ladder filter and the output impedance is sufficient to drive into a 602 product detector. The feedback resistor Rf should be something like 2K2 or 3K3 if you are brave and want maximum gain. Although I have not tried it at an IF of 6MHz this simple circuit could be easily added to WE superhets - it is essential though to keep any connections short and rigid. I will leave you to ponder over adding AGC!



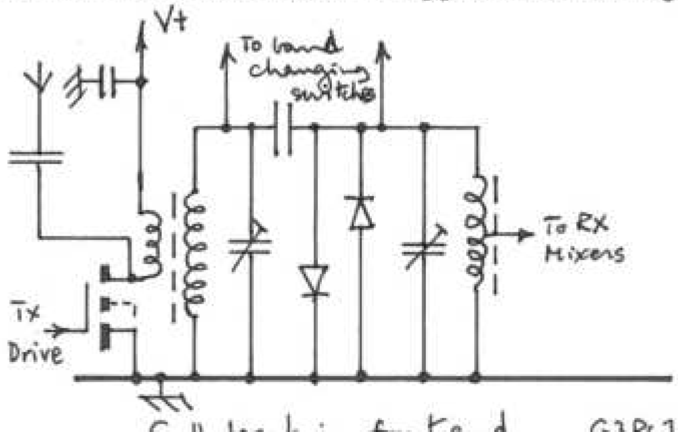
## ***Concepts for a 20/40/80m CW phasing TCVR***

Over the years I have toyed with a 3 band CW TCVR project, a bit like a modern HW9! To make it different from other rigs in my current range, I had envisaged a 5W RF output and a decent single sideband receiver possibly of the filter superhet type. But these are a bit boring now! Another option was use the TRIBLO (see earlier) to drive a good direct conversion rig; however to make this have single sideband reception, it would have to be a phasing type design which is awkward for a such large LO range unless there is a digital VFO source running at four times the required LO - all of which is complex, risky and expensive! Another approach is to use a crystal controlled converter ahead of a simple narrow band DC RX with phasing type rejection of the unwanted sideband. This is the scheme sketched below - receive aspects in the top part of the diagram and transmit below. The crystal frequencies change for each band but the phasing receiver does not alter. Interestingly, the same crystal and VFO frequencies can be used as in the TRIBLO earlier! The necessary RF phase shifting (+/- 45 degrees at LO) can be done with simple CR networks as the LO range would only need to be 100 KHz in a few MHz for the LO. The two phasing mixers then feed conventional audio stages with narrow audio filtering for CW, followed by audio phase shifters (+/- 45 degrees at 750 Hz); the two audio channels are then subtracted to eliminate the unwanted sideband just before the AF gain control and conventional audio output stage.




OUTLINE OF PHASING TCVR G3PCJ

For transmission, the crystal and LO need to be mixed and filtered to drive the RF output stage. It is probably easiest to duplicate the mixing/filtering for transmission rather than share the circuits for reception. I would want full break in operation with no TR relays! This creates an interesting challenge for band changing without losses in a diode TR switch! The approach on the right has been used in the Brent very satisfactorily and would appear to allow multi-band operation (by relays) without too many complications; it gives low reception losses and low harmonic output provided a proper resonant AMU is used. I also think it possible to use a similar band changing approach for the other low power band filters, using 4066 electronic switches instead of power hungry relays. Another 4066 can switch the crystals in their oscillator - see earlier article about the TRIBLO If anybody thinks this a worthwhile project let me know - costs are likely to be near £90. Tim

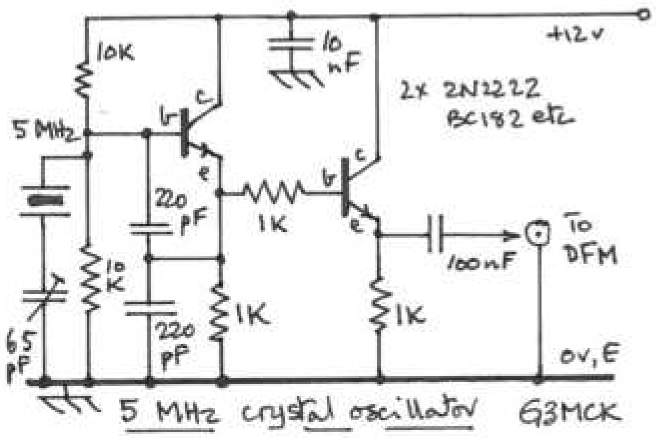



Full break in front end. G3PCJ

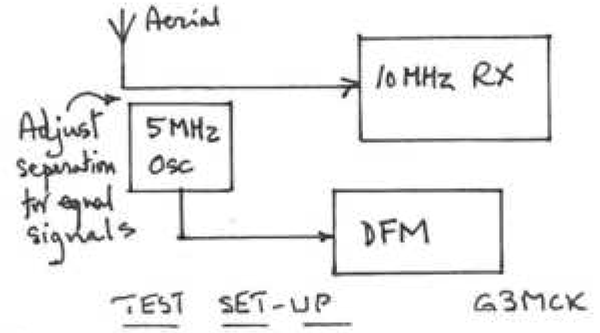
## ***How accurate is your Digital Frequency Meter?*** By Gerald Stancey G3MCK

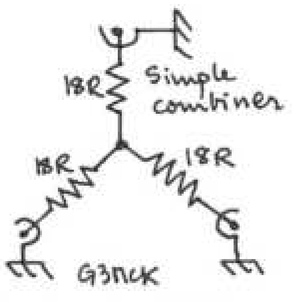
These days a simple DFM is a common piece of test gear in many constructors' shacks but how accurate is it? First of all let us be clear about accuracy and resolution. Just because a DFM has eight digits, it does not mean that it is accurate to nearly one part in one hundred million. The number of digits is a measure of its resolution not its accuracy. The accuracy of a DFM is controlled by the accuracy of the oscillator that clocks it and for really high accuracy the home constructor has to use an off-air standard. This article is aimed at those who own a DFM, that is one that does not contain an 'ovened' crystal nor uses an off-air standard. According to professional friends, it is reasonable to expect a long term accuracy of about 10 parts per million (ppm) for an 'ovened' crystal and this is the standard for which I aimed.

The easiest way of checking out a DFM is to measure a known frequency and then compare the readout. I used several different methods of establishing an accurate local frequency and will describe the one that is easiest to implement. A future article maybe written describing the other techniques which I used out of interest and as a cross check. HF transmissions from MSF have long ceased along with other European standard but, happily, the Chinese Government provide transmissions on 2.5, 5, 10 and 15 MHz to an accuracy of about 1 in $10^{12}$ - that is by my standard they can be called exactly right! These identify with the call sign BPM at H+29 and H+59 minutes. The 10 MHz transmission is easily received on most receivers that have a 10 MHz band. Experiments with a number of el-cheapo 10 MHz crystals showed that they drifted, however this defect was not found with a similar 5 MHz crystal. Using a 5 MHz crystal in the standard oscillator (box) also allows you to check against BPM on 5 and 15 MHz.




The test procedure is quite simple: set up the oscillator and DFM as shown right. By trial and error adjust the coupling between the test rig and receiver until the signals are at about the same level, then adjust the 5 MHz oscillator to zero beat with the BPM. When you get to the sub-audible area you will have to adjust by listening to the rise and fall of background noise. I found that this took a little practice but that I could get repeatable figures to better than 5 Hz, ie much better than 1 ppm. A better set up for comparing the two signals is to use a hybrid combiner. I used a version with a toroidal transformer but the simpler resistive star-match (right) should do for this application. At this stage you can either: be happy with what you have, or adjust your DFM clock (if possible) so it reads the correct frequency, or apply a correction to all future readings! The choice is yours and will depend on how accurate you wish to have your DFM. Note that it maybe impossible to adjust the DFM clock, so you will have to live with it and make corrections when necessary!




Lets looked at a worked example. Assume the DFM reads 5,000,015 Hz when the 5 MHz oscillator has been zeroed with BPM on 10 MHz. This means that all readings are high by 3 Hz per MHz or 3 ppm. If you have decided that your required accuracy is 10 ppm then you need do nothing else. On the other hand, you may wish to allow for this on all future readings. However, be warned, your DFM clock may well drift over time so that expecting to measure to this standard of accuracy should only be done immediately after checking against BPM. It is instructive to check a DFM over a period of time and you maybe pleasantly surprised at how stable it is. Finally, if you are happy with 10 ppm, then you only need to get agreement with BPM to 100 Hz - this is very easy.

***Items for sale*** as at 13/2/09

This equipment is for sale on behalf of a severely ill friend of our Club member Tony:-
Spectrum Analyzer 141T & 8555A (5 Ghz to 18 Ghz Module), LF Oscillator Advance Model H1E,
Power supply Thander TS 3022s, Digital Storage Adapter Thurlby DSA 524,
Function Generator Farnell FG1 upto2Mhz, Eprom Eraser Stag SE15,
Eprom Eraser UV140, Monitor Panasonic WV5370, CRO Iso Tech ISR620 2Channel 20MHz,
CRO Gould OS4000 Digital Storage 2Channel, CRO Farnell DVT20 2Channel 20Mhz,
CRO Telonie 121 (Very large display), BP/BS Filter Barr & Stroud EF4-C1 1Hz - 100KHz,
Function Generator Jupiter 500 0.1Hz -500Khz, Universal Bridge Marconi TF2700,
Counter Universal 5001, Frequency Meter Black Star Meteor 1000 5Hz- 1GHz,
Mini Scope Comonedex RS232 (data monitor), Modem Tester Wandel & Goltermann 750/02,
Interface Analyzer Convex 682 V24/RS232, Fluke Multimeter,
RF Power Analyst Bird 4385 (19 in Rack) (2 off inserts 200-500Mhz), also many technical books

Please contact Tony Marriot G0GFL Tel 01258860741 or tm@io80vv.freeserve.co.uk)

I also have a 4m Transverter unit (Andover Club project about 1980) built by Jim Geary - complete with documentation. Free to a good home! Contact me - Tim G3PCJ

# The Somerset Supper

## and

# Yeovil QRP Convention

The Fifth **Somerset Supper** is to be held on the evening of Sat April 25th, the day before 25th Yeovil QRP Convention. The format will be a buffet style supper at Lower Farm, Kingweston, near Somerton TA11 6BA in the Old Court Room. As before, there will be a small display of items from each diner's home built radio equipment! This will qualify you for a ***free*** place at the supper table! Our guest of honour and judge for our informal radio construction display, will be Rev George Dobbs G3RJV - very well known as the Editor of the Journal of the QRP Club - SPRAT. *Places by advance booking **only** by April 19th so please tell me if want to come.* I hope to see it and you!

Jane and David Sedgman also do limited B and B/catering. The Sedgeman's website can be seen at lowerfarm.net If you wish to stay overnight with them please contact them direct. They are 'four star' members of Farmstay UK and will do us proud! David may might also be persuaded to show us his large model railway installation, which is loosely modelled on aspects of the nearby Somerset and Dorset Railway.

The QRP Convention will have the usual programme of radio related lectures including one by George G3RJV, trade stands, bring and buy stall, and other excitements! I shall be there and am always pleased to see and display as appropriate any of my customers 'constructions'. Tim G3PCJ

"JOURNAL OF THE CONSTRUCTORS CLUB"

# Hot Iron

Summer 2009
Issue 64

## Contents



The Walford Electronics website is also at www.walfordelectronics.co.uk

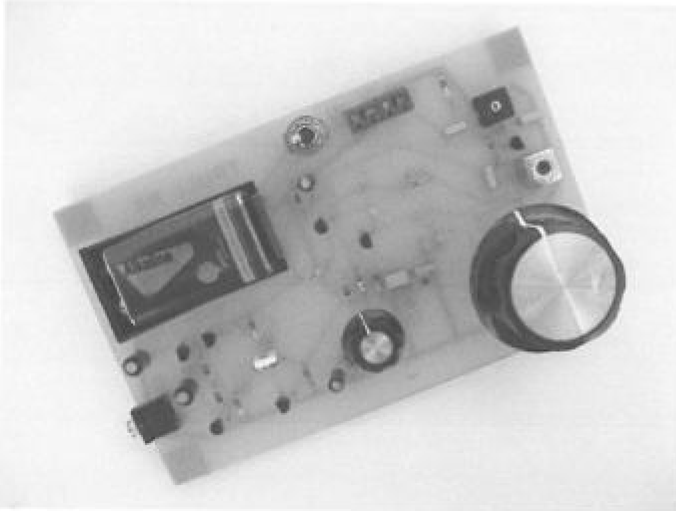
## *Editorial*

I had sat down to tell you about the Plank (see later)! But its a typical Sunday morning (or was) on the farm! Raining cats and dogs and the phone rings. Neighbour thinks one of our cattle is in the river! (This is the Yeo which is about 10ft deep in the middle and 30 ft wide with very steep banks covered in weeds and nettles.) Another neighbour calls and we set off to investigate which is a 5 mile round trip as there are few bridges here - find it has swum down stream about half mile and then back up again to be near his mates who are still in their field. Luckily it is able to walk along the bank edge most of the time, with water nearly over its back; it is a quiet and strong South Devon, but the bank is too steep for it to be able to climb out. It goes further upstream where the vegetation is very high and not possible to get any sort of vehicle nearby to pull it out! Two of the rescue team return to other side and await instructions. After two hours shouting in the rain from the far side we get it to turn around so it half swims back alongside its mates; it is just about within reach of being lassoed with a rope and hauled by the truck! I am stuck on the other side unable to do much except offer wet encouragement! Tension goes on and it slides half up the bank with its hind legs still in the river when the rope snaps! Luckily it does not slide back in, and after a 15 min rest it is encouraged to climb out and ambles off with its mates. All six of us retreat home to dry off. 5 hours later I cant tell which one it was! That's farm life. Tim

## *Kit Developments*

I have just added the **Trull, Chirnside, Willet** and **Washford** to the website. The Trull (right) is the MW regen TRF for novice constructors, with variable gain RF amp and LS drive that I mentioned last time. See later article too. The Willet is the simple DC RX for 20, 40 and 80m while the Washford is the matching 3 band crystal controlled 1 Watt CW TX.

I am about to build the first **Brue** - this is a single band (normally 80m) 1.5W CW TCVR; with several improvements over the Brent - LS drive and separate VFO. I am also actively designing what I think will become the Mendip - 3 band phasing CW TCVR! Tim G3PCJ



*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

## ***Doodles from Doncaster*** - by Richard Booth G0TTL

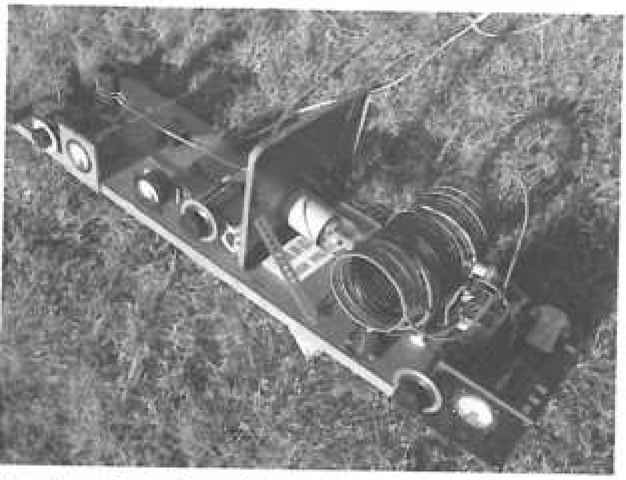
*More PCB accessories.* Last time I reported using hairspray as a cheap alternative to PCB lacquer. Andy Howgate G7WHM has now got me to try floor polish! No ordinary floor polish though, this stuff is called "Klear", intended for wooden floors and is manufactured by Johnson and Johnson. One coat wiped over the PCB with a soft cloth is ample and having now used it, I will never buy another can of "proper" PCB lacquer. Solder through is a breeze, with no spluttering or nasty smells and the board retains a glossy look and texture even after several attacks of the iron. It dries in 10 mins, is water resistant, cheap and without waste.

If like me you were born with the drawing ability of an arthritic crab, you will need some computer software for your PCB layouts and circuits. I use the simple, easy to learn "Design Works Express". The free version is more than adequate; it has the same libraries and functions as the professional version but is limited to 1000 connections. Most of the component symbols are included, even valves and many RF bits. You can create your own symbols and save them in a library for use later. To develop PCB artwork I use "PCB Wizard 3" which has a small price tag and is designed for use by students. Again this is easy to use, I never bother with the auto routing preferring to do everything manually. I use the software as a drawing package only, but with the big advantage of component layouts and pads to hand to drag and drop as you please. Just remember the golden rules of making boards for RF work. Short tracks, minimal parallel signal paths and plenty of copper for the ground connections. Have a look and I am sure you will find it useful.

*All QRP'ers should have a magnetic loop antenna!* There are many reasons why I favour compact loop antennas, but recently I have been using my loops as a spectrum analyser. Given their very high Q or narrow bandwidth you can use it to test the output of your transmitter for spurious signals. All you need is a reliable clean transmitter on the frequency that you wish to test your suspect. Tune the loop for the best SWR with that transmitter and take note of the reading, which ought to be near unity if you have a well made antenna. Then simply plug in the transmitter and repeat the test. If the SWR now reads a good deal higher than previously the likelihood is that your transmission is dirty; the unwanted out of band signals are being reflected by the high Q loop and heating up the capacitors in your transmitter low pass filter (if it has one!). This came in very useful recently as I have been working on a DSB transceiver that uses a diode ring as the receiver and transmit mixer. Problems occurred on speech peaks or whistles - the mixer appeared to go a little berserk, making a lot of hash and general rubbish into the transmit PA. The SWR meter was flicking up and down quite a bit so investigation was in order. The culprit case was my Op-Amp microphone amplifier stage. The 50 ohm input port of the ring mixer is much too low impedance for the output of the TL071 device to drive directly. The cure for this problem was to add a series resistor in the signal path to give the Op Amp something to drive, and to increase the overall gain to compensate. Adding 1K in series with the amplifier stage worked well. No more noisy signals on the scope and the output spectrum is clean enough to maintain a 1:1 SWR on my 80M loop (which has a useable bandwidth of about 10 KHz without adjustment).

*Interesting Signals.* After living here 10 years I have finally installed a few antenna feeds into my office. I wondering what transmissions are about on HF apart from broadcast, Volnet and amateur signals. I was very pleasantly surprised! Ever since the "good old days" of the cold war I have been fascinated by signals that we are not supposed to hear. I thought all this sort of thing had gone digital or transponded by satellite and had not listened away from the established bands. Happily that is not the case and a tune around 4 MHz during the late evening yielded many things of interest. There is a lot of analogue HF still in use for shipping, espionage - yes even number stations, beacons, news relays, military, air sea rescue, over horizon radar (baby woodpeckers?) even ship to shore communications in Russian! Have a tune around on 2,4,5,10,13 and 16 MHz and you might just drop on something intended for a much smaller audience. Most nights around 4.725 MHz USB at 2330 hrs BST there is a number station to listen to - go down another 100 KHz and several days of the week around the same time I have picked up a very English AM mechanical female voice droning out strings of numbers and cipher keys - not quite as scary as the old East German transmissions of the 1970's but it still managed to give me a thrill! Also on the 4 MHz band there is an 80 KHz wide OTH radar signal that sounds very strange, have a listen on 4.510 after dark and see what you make of it. Around 4.100 there are shipping and trawlers to be heard using USB, also air sea rescue and the oil / gas platforms. I could fill a whole edition of Hot Iron with times and frequencies but have a listen yourself; they are there! Until we meet again, agent 00X...

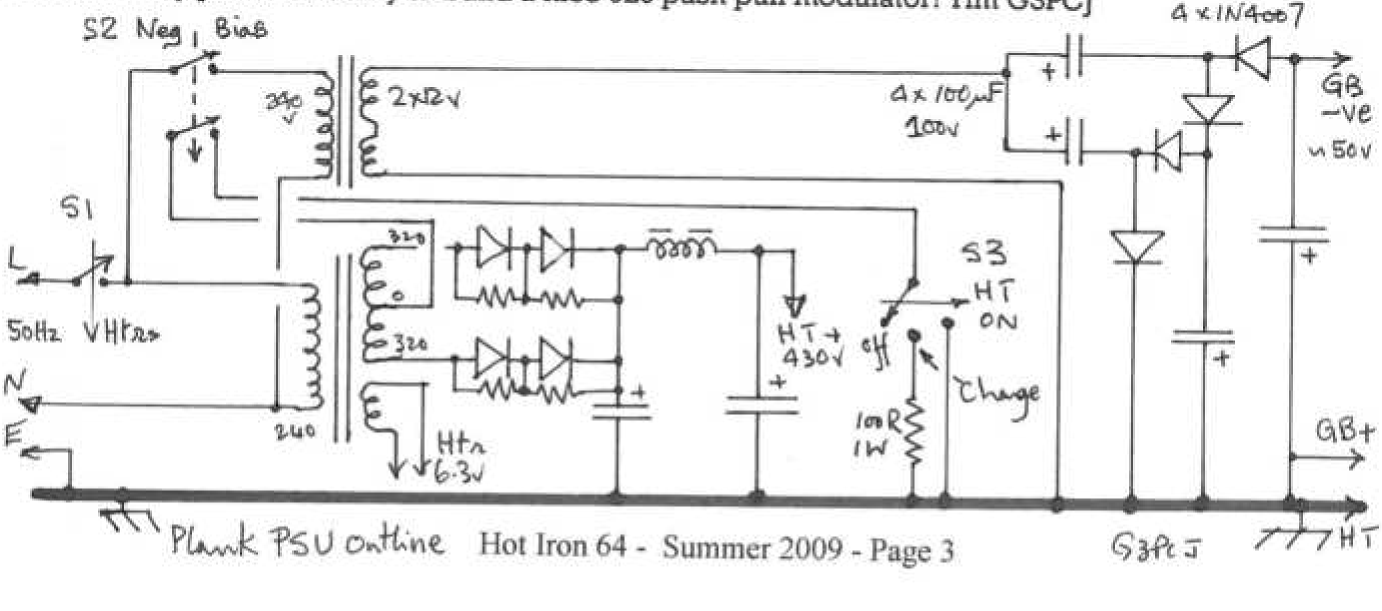
## *Refurbishing the Plank*



I know that many amateurs are very interested in valved projects and many years ago, I had the pleasure of seeing the late Eric Godfrey G3GC demonstrating his replica late 1930's transmitter. It lay in his attic for many years and I was able to salvage it for future demos - seen as recovered on right. It consists of a 6K7 crystal oscillator driving an 807 PA with keying of the oscillator and manual TR changeover. As can be seen, the PA tank coil is small bore copper tuning in a balanced form with link output coupling, all with plenty of tuning knobs and metering! One end of the tank coil connects to the 807 anode and there is a stiff wire 'gimmick' capacitor in the biscuit tin lid screen to adjust the neutralisation from the other end of the PA tank.

When clearing Eric's attic I collected up all the old valve type PSUs that I though might have gone with the plank. Examining these, I came to the conclusion that it might need all three that I had found - to provide 6.3v for the heaters, +250v for the oscillator, –50v bias and +350v or more for the 807 anode! After gingerly applying low mains volts to these PSUs to 'reform' their electrolytics, I was at least able to fire up the oscillator stage! I recalled last seeing it operate on 40m but to my surprise the tanks all resonated on 80m for which I only have one crystal which is not in the CW part of the band. So I think I shall change it all back to 40m for which it was originally built as all the coils have had sections added. The photo alongside shows it lashed up to some of the PSUs on my bench to get the oscillator going!

Next task was to tidy up the PSUs for easier demonstrations! My aim was to have one unit provide the heater supply off the main transformer which would also provide the main HT at over 400v. The 807 is rated at 100 mA and 700v max on the anode to give about 50W out. But I didn't have anything for the –50v bias supply. The easiest way to obtain that was with a voltage doubler from a small modern mains 2 x 12 volt transformer. The circuit below shows how I have arranged the switches so that the HT cannot be on without the bias supply - to protect the 807. I have also added a resistor in the HT negative line to limit inrush currents at switch on - this is shorted for full power. The bias supply will also power a manually controlled 48v 4 pole relay used for applying power to the 807 during transmission and to operate the aerial change over circuit. I also have a 40m crystal that might suit AM operation, but I don't have any plans currently to build a nice 6L6 push pull modulator! Tim G3PCJ




Plank PSU outline  G3PCJ HT

## ***Mulit-band Trull*** by Andy Howgate G7WHM

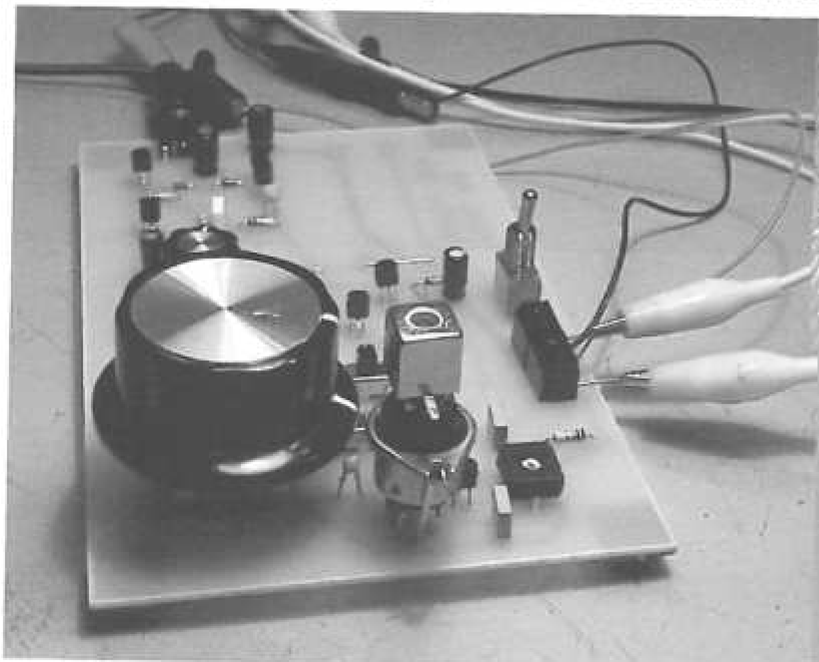
No sooner had Andy received his Trull than he said it needs some variants! He writes:-

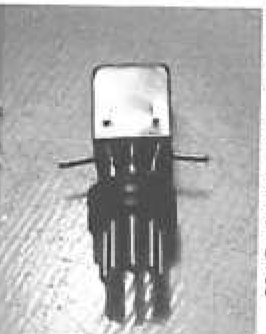
"Having just assembled the Trull regenerative receiver, and having read the notes in the manual and comments from another Construction Club member Richard Booth G0TTL about its use on the HF bands, it made me realise that a pluggable inductor could be deployed to use other TOKO coils, thus making this little receiver a multi-bander. As ever using what is at hand, I removed the 3336 TOKO coil carefully so as not to damage any tracking and fitted 5 single wires to a chassis mount DIN socket of the type which has 5 connections. With the use of a pair of pliers, the DIN plug tags can be bent to match those of the TOKO coil. After fitting wires to the DIN socket, these wires were pulled down to the existing TOKO drilling holes and soldered into place. Then some stiff copper wire was stripped out of some mains house wiring and used to connect the earth tracks of the TOKO pads to the mounting 'ears' of the DIN socket so providing a bit more rigidity. The whole was then checked so that when the din plug is pushed into the din socket the correct connections are made.

Points T and S then had a miniature slide switches fitted by enlarging the holes and breaking the tracks so that the switch makes or breaks the T and S connections allowing capacitor variations for the desired tuning range. The slide switch has an extra connection so that through experimentation another pair of capacitors can be fitted giving yet more variations on tuning range. The TOKO coil on its DIN plug could also have some suitable value of capacitor fitted across the secondary winding to aid with finding a particular frequency; so with the TOKO inductor core being adjustable I would expect it possible to have the radio working on most of the interesting parts of the spectrum. I used a TOKO 3334 for initial tests on 40 and 80m but I dare say a TOKO 3335 could also be added with another DIN plug for higher frequencies. As yet, and this is perhaps the more time consuming part, the next stage is to play with capacitor values to get the very best and useable frequency coverage for the TOKO coil used. A point worth mentioning is that the DIN plug shroud can be positioned over the TOKO coil tightly so that the cable exit tube can now be used to change the tuning coil.

The rest is down to the experimenter to have the radio working as many frequencies as he chooses!"

Andy sent along these photos of his multi-band Trull:-

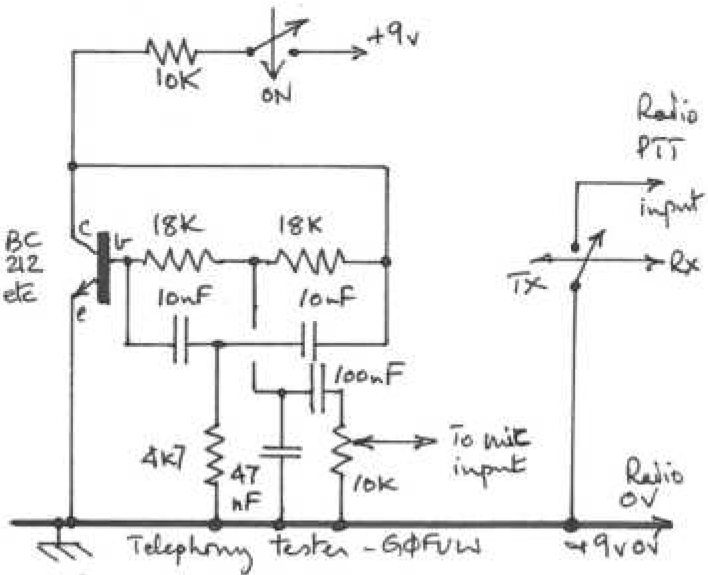




Left - Coil assembly before sliding the DIN plug cabling cover over the TOKO can.
Below - Four coil assemblies giving coverage from 1 to 20 MHz!

Above - Early Trulling trials!

## ***A Simple Telephony Transmitter Tester*** by Steve Hartley G0FUW




Most voice transmitters require a steady audio signal to be fed into the microphone socket during testing. This can be achieved by whistling or saying 'aaaahh' but I find that I run out of breath just as I am making the final adjustment of a preset or trimmer. Most annoying. This little circuit was devised for use at the first Bath Buildathon where we had twelve first-time transceiver builders and we needed some consistency for multiple transmitter testing.

The tester is based on a simple 'twin-T' audio oscillator that is often promoted for Morse code practice (e.g. see RSGB Cookbook p284). Using the component values shown produces a signal of around 600Hz. The pre-set resistor allows the output to be set to emulate your microphone of choice. Typical CB type dynamic microphones develop 20-40mV peak to peak, some ex-PMR models slightly more. A quick check into an oscilloscope allows the tester to be set to the correct level – alternatively use with a power meter and a known transmitter/microphone to compare.

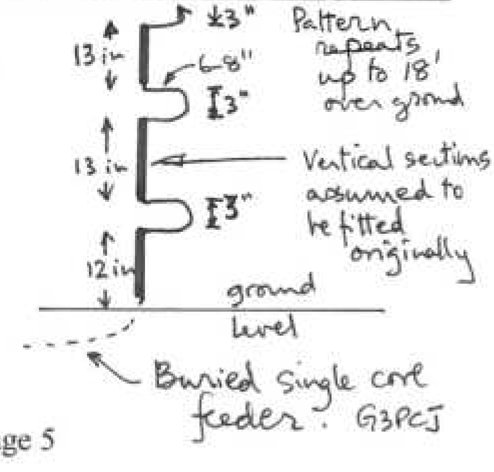
A switch is included to activate the push-to-talk control and to switch the audio oscillator on and off to prolong battery life. My original used a double pole double throw switch but in retrospect two separate single pole switches would provide more flexible switching options. Whilst this circuit lacks the sophistication to provide proper two-tone peak envelope power measurements it is ideal for setting up homebrew voice transmitters. You could build one into a sideband transmitter to provide a steady carrier for antenna tuning or even key the audio for CW transmissions.

## ***The Wartime aerial Conundrum!***

The radio installation at my friends wartime bunker continues to be a mystery! With better weather I have now had the opportunity to properly examine what remains in the two remaining aerial trees. The Northern one has a twin conductor cable running up a crack in the bark of the tree and then does a dog-leg around to the opposite side of where we suspect the aerial to have been suspended. It was for near 50 MHz operation and all is entirely logical!

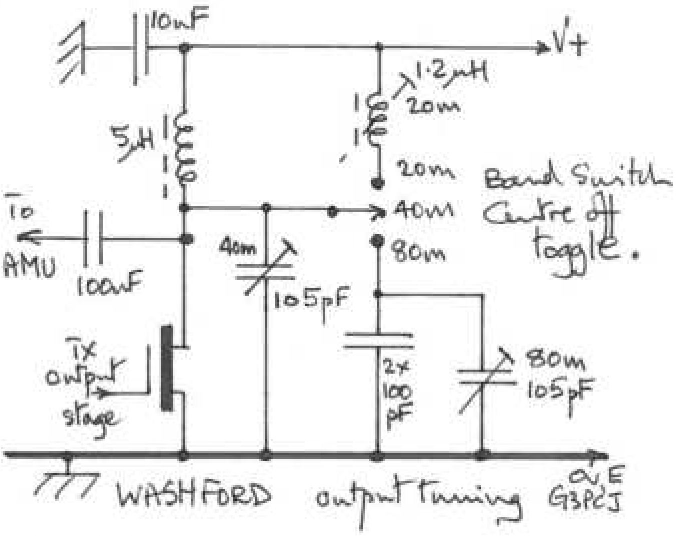
The South aerial tree has many remnants of single, but also some twin, conductor RF unscreened cable protruding horizontally from the trunk of the tree. The lowest of these is about 12 inch off the ground and the highest at about 18 ft up. In between, there are many pieces of protruding cable as in the photo above. A couple of these have been excavated in the tree's trunk and found to be in the form of loops or hairpins. They are spaced about 13 inches apart, and that pattern (of hairpins 3 in wide and 13 in apart) MAYBE repeated all the way up the trunk! There is no evidence of any remaining vertical elements and the longest of the extant cable protrusions is about 4 in outside the trunk. The diagram is what it MIGHT have been like electrically. The nearby feeder cable is the single core RF cable that I have shown in earlier issues!

What sort of aerial is it and for what frequency? G3PCJ

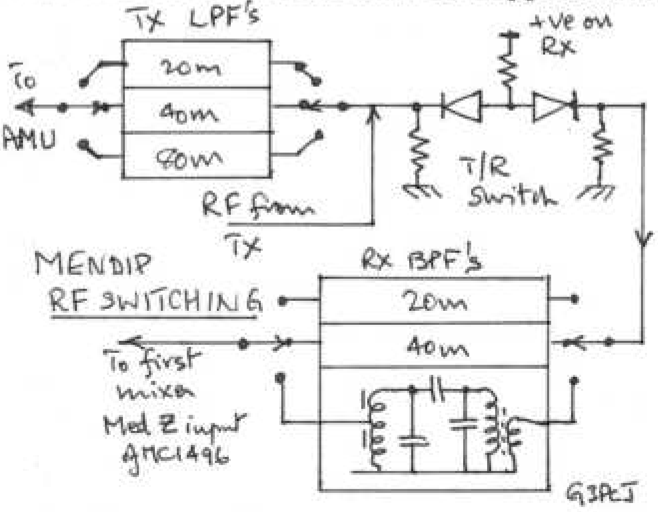


## ***Output design options for the Mendip***

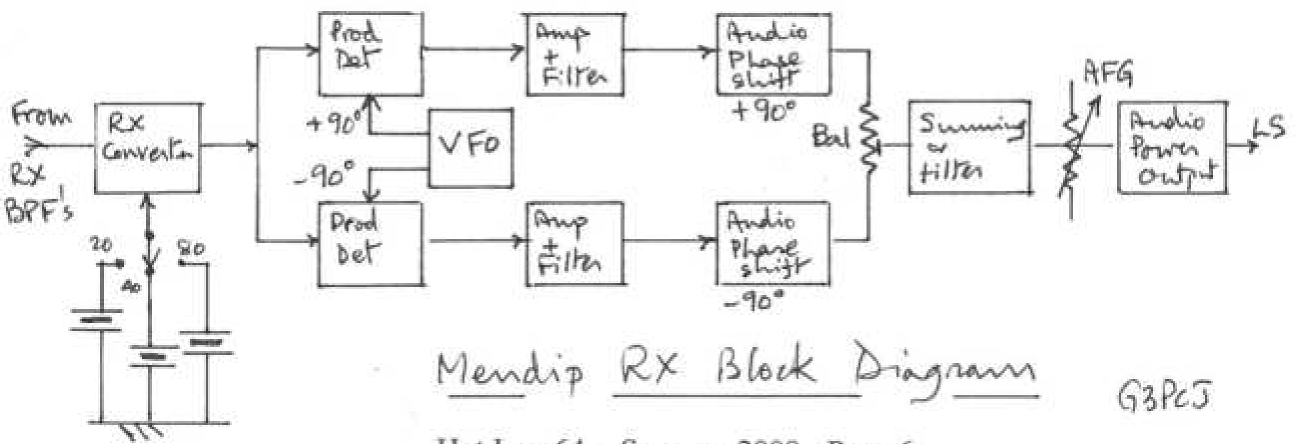
The Mendip is the probable name for the 20, 40 and 80m phasing 5W TCVR. It needs to have full break in operation and the minimum of relays and resonant circuits to be a viable kit. I have toyed with the idea of a parallel resonant TX output stage tank like that in the Washford; but at the 5 W level it might be a little awkward to wind the toroid and also to tune up. A single resonant circuit would hardly give enough attenuation to harmonics which becomes more important as the output power is raised; hence the decision to use relay switched dual half wave filters for harmonic filtering and a broadband 1:2 transformer to obtain the desired 5W on 13.8 volts supply.




The next consideration for full break in operation is how to connect the aerial to the receiver input circuits. In the simpler 1.5W rigs like the Brent, it is feasible to have the first resonator of the RX band pass filter directly connected by a low Z winding to the aerial, with the top coupling capacitor to the second RX resonator limiting the RF current through clipping diodes across the second resonator during transmission. But at 5W this scheme is a bit more risky due to the higher RF voltages! High speed relays could be used but they would chatter and not last so well as an electronic TR switch. The next best approach seems to be a double diode TR switch but its drawback is the 6 dB or so loss of incoming signal. Atmospheric noise levels on these HF bands are such that this 6dB loss could be tolerated if the following stages don't introduce any more loss! That tends to rule out a diode first mixer because they usually have a further loss of about 6 dB. I did consider using CD4066 electronic switches in the RX band pass filters but fear there might be further losses so propose to stick with more relays for band switching. Hence we come to the scheme shown left. This does at least have the advantages of being able to optimise the bandpass filters for each band, with much less chance of overloading or unwanted signal losses!




The rest of the RX can be fairly conventional for a phasing rig! Band changing is by switching the crystal oscillator into the first mixer above, which is likely to be a 1496 for better signal handling ability than the 602. The signal emerges at about 5.5 MHz into the two phasing detectors driven by the VFO RF phasing networks. The audio stages have filtering for CW bandwidths followed by audio phase shifters and subtraction to obtain only the wanted sideband. Tim G3PCJ



## ***Sundials*** - by Gerald Stancey G3MCK

For thousands of years man has used the sun to indicate time. They used a vertical stick or pillar which indicated the direction of the sun or, from the length of the shadow, the altitude of the sun. This simple device showed midday, ie when the sun was due south, and the by the length of the shadow the time of year was indicated. Of course the 'dial' had to be calibrated by observations over a few years but they had plenty of time to do this.

The snag with such a simple dial is that it will not indicate hours as we know them. To explain this let assume that Tim and I agree to meet for a coffee when the sun is due east. We both have shadow sticks so we will make the appointment. We agree to meet again in one month when the sun is due south east and again we make the appointment in a timely manner. However because the sun's movement is not uniform we will not be meeting at the same time as indicated by a clock.

In the fourteenth century the modern sundial was invented which gets around this problem. The key to its operation is that the edge of the gnomon - the triangular bit of metal that sticks up from the dial plate, or out of the wall in the case of a vertical dial - is parallel to the earth's axis of rotation. In other words it points due north and its inclination to the horizontal (in degrees) is the same as the latitude for which it was made. This means that a dial is made for use at one latitude. However if you have purchased a dial when on holiday in Italy (latitude 42 degrees) and want to use it in Somerset (latitude 51degrees), there is a simple fix. Just jack up the dial plate so that the edge of the gnomon slopes at 51 degrees to the horizontal.

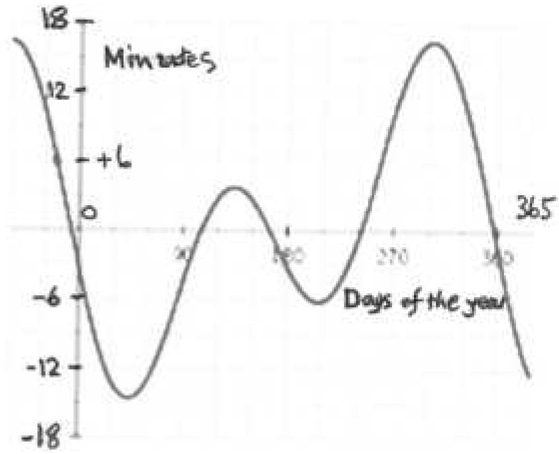
This one is at Hampton Court

The effect can often be seen with south vertical dials when the wall on which it is mounted does not face due south. Here the dial is often canted out from the wall so that the dial plate does face due south. Another solution is to allow for the direction of the wall when designing the dial markers but this gives the dial a lopsided look as the six o'clock line now slopes instead of being horizontal.

If you compare the time shown by your watch and a sundial, it is unlikely they will be the same. To get agreement you have to make up to three corrections. Firstly, during summer months you must correct for the change from GMT to BST. Secondly, you may have to correct for your longitude. In the UK, time is measured with respect to the Greenwich meridian of zero degrees longitude. Yeovil being west of Greenwich is therefore slow in terms of sun time. A correction of four minutes of time for each degree of longitude has to be made so for those in Somerset a correction of 12 minutes is needed. For those living on Greenwich meridian no correction is required.

Finally you have to correct for 'The Equation of Time'. The earth moves in an elliptical orbit round the sun and the earth's axis of rotation is inclined at about 66 degrees to its orbital plane. The effect of this is that the sun is rarely due south at midday.

The graph shows that this is not a minor correction. Above the horizontal axis the dial appears fast and below it, the dial is slow. Many dials gives this data either as a graph or as a table on or near to the dial. If they don't, you will have to consult either a book on dialling, astronomy or Whittaker's Almanac. But beware! Some are calibrated for BST assuming there is more sun in summer - they need correction in the winter. There are dials where the plate can be rotated or changed for this correction! On some modern dials, the longitude correction has either been built in or allowed for in the Equation of Time.




This is just a short intro to a fascinating hobby!

## *Solder Smoke!*

Steve Hartley first drew my attention to Bill Mears who runs a monthly web blog on radio matters. Each bulletin lasts about half an hour and is full of topical chat about radio matters, both on his own experiences and of those sent in by his listeners. Currently he is based in Rome but he covers radio topics from all over the world. The most recent talk included quite a bit about listening to extremely weak signals from milliWatt transmitters over trans-oceanic distances! Real QRP! I have much enjoyed his talks over recent months and am pleased to hear that he enjoyed Steve's report on the Fifth Somerset Supper - see my notes below!

Its well worth a listen! The web address is :- www.soldersmoke.com

# Radio and Trains!

This year, the Somerset Supper had the added attraction of the Somerset and Dorset railway! Diners brought their electronic construction projects for an informal display and the competition was judged by George Dobbs G3RJV. Apart from members of the local Yeovil and Blackmore Vale radio clubs, several radio personalities were present - Steve Hartley G0FUW, Rob Mannion G3XFD, Robert van de Zaal PA9RZ, Chris Rees GU3TUX. Stewart Hunt F5VJJ kindly brought over some wine from France!

The supper was held in the old Court Room at Lower Farm near Somerton, and afterwards George had the difficult task of judging and presenting the prizes. Commenting that it was like judging a gardening show because he was bound to both make and loose friends, he awarded first prize to Richard Booth G0TTL for his dual band transceiver. Runners up were Gerald Stancey G3MCK with his valved CO/PA CW transmitter, and Chris Rees GU3TUX with his portable AMU. Unfortunately Chris's entry did not feature the parts from last year's consolation prize - Gerald promises to put his sweepings off my bench to better use next year! Later David Sedgman demonstrated his very extensive 0 gauge model railway layout which is based on the nearby Evercreech Junction of the Somerset and Dorset railway. Below left is Rob Mannion playing trains and right is Richard Booth receiving his Somerset Cider Brandy from George Dobbs (holding the rig).


"JOURNAL OF THE CONSTRUCTORS CLUB"

# Hot Iron

Autumn 2009
Issue 65

## Contents



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

## *Editorial*

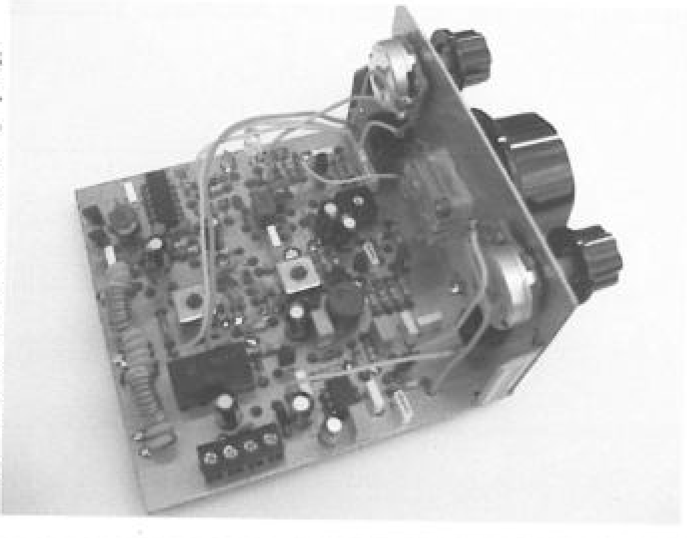
To take my mind off a most frustrating summer on the farm, I have been messing about with valved projects! I mentioned last time that I was re-furbishing Eric G3GC's plank mid 1930s CW transmitter - well, it was not long before I realised that it needed a companion receiver. To keep in the spirit of simplicity (and using what was to hand or relatively easy to obtain) this had to be a regen TRF! Then of course the transmitter which was originally rock bound, needed a bit more flexibility for modern conditions - hence a VFO module. More on these later! It has been great fun and I am indebted to Richard Booth for assistance with some of the parts as they are more in his line of expertise.

Neither of these Plank projects was conceived as kits but as fun 'one offs' using whatever parts I had available. Things like Muirhead slow motion tuning drives would be horrifically expensive if one had to buy them but luckily there were some in the spares which came originally from Eric. The good news is that Richard G0TTL is investigating the possibility of selling kits based on B9A valves (instead of octal valves which I wanted to match the Plank TX); the PSU and its transformer are one of the main obstacles but it is not insuperable! No doubt we will hear more on this from Richard in a later Hot Iron.

Meanwhile back to the transistors and chips! Tim G3PCJ

## *Kit Developments*

The Brue prototype CW TCVR (right) is now working well; it is a builder friendly version of the Brent with several minor improvements to make it more versatile & easier to use. I have just recently added it to my website. The price is £44 + £3 P&P.



I have also drawn out the circuit for a new single 7 segment display 5 digit scanning counter. This should be rather easier to build than the old one and cheaper - target price about £25! I am also actively working on the Mendip 3 band phasing TCVR but have just realised that its transmitter ought also to suit the Knole! I must make certain it can do both! 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

## ***Audio amplifiers in a chip*** - by Richard Booth G0TTL

These are monolithic integrated circuits to give them their posh name. We all use and abuse them, be it in their intended role as an audio amplifier on the output of a receiver. Or you can connect one up to a transformer and use it to modulate an AM transmitter. I have even used a pair of LM380N in the past with a MW tuned circuit up front, coupled together with a 1N4148 diode detector (not germanium as the potential voltages on strong signals are too high) as a MW TRF receiver. Yes, they are good up to a few MHz! Recently I have built a complete AF stage out of four logic gates and a LT700 transformer to match the Hi Z output to 8 ohms. Surprisingly loud it is too and more on this in a future edition. Presented here is what I hope is a useful reference sheet, for my favourite five devices. All are 8 pin DIL packages and cost less than £1 each.

TDA7052 No external components required. The power supply filter capacitors are optional; this has to be the simplest of all amplifiers currently available. The voltage gain is set internally at just short of 100 which is ample enough to be driven directly from an active mixer such as the SA602. The only disadvantage here is that both speaker connections are isolated from ground. It is happy operating from 12V and has a maximum supply of 18V. 1W output.

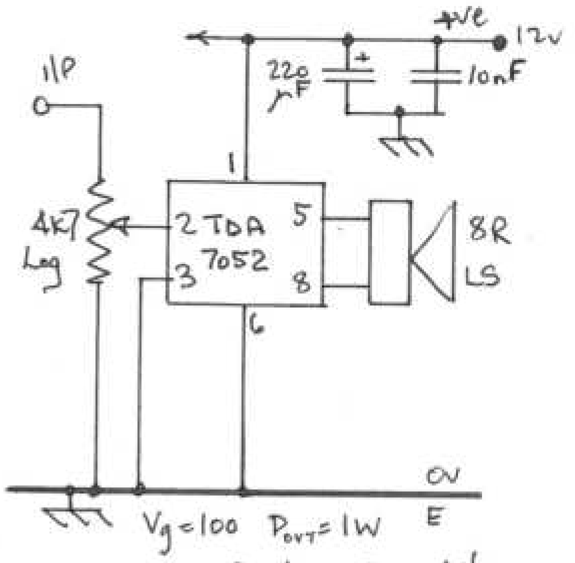
TBA820M Well this one has been around since the 1970's and well proven in a number of projects. Needs slightly more external components than the LM380 but has a number of advantages. The main one being variable gain control, which is calculated by $R_{IN}$ / $R_G$. I like to use 8K2 as the input resistor value. This keeps the gain under control when the 10K log AFG pot is turned down towards ground. 22nF shunts any RF at the input to ground and prevents self destruct mode oscillation! Maximum supply voltage of 16V and develops 1.2W into 8 ohms.

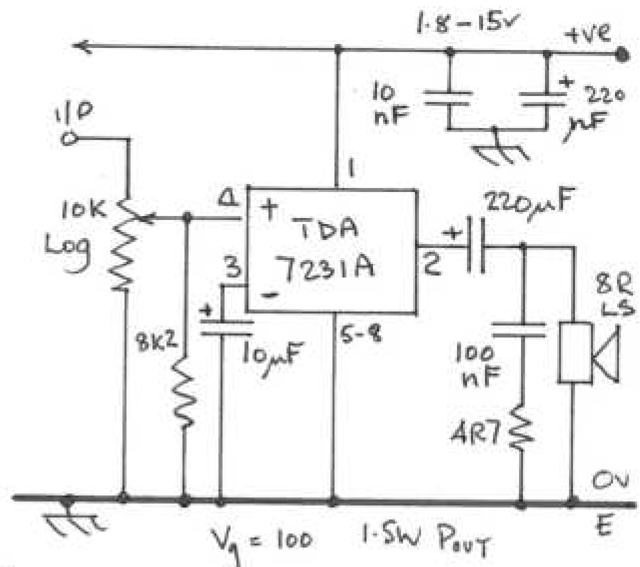
LM386-4 There are several versions of the LM386 all of which have different operating voltages. The LM386-4 is the highest of all and can manage up to 18V. Has adjustable gain of sorts, removing the 10uF electrolytic between pins 1 and 8 drops the voltage gain to its internal set value of 20. With the capacitor fitted it is allegedly 200. This can be limited by adding a resistor in series with it, or in parallel there is the possibility of some audio filtering. Not my favourite device, the 386 tends to be a bit on the noisy side.

TDA7231A This is every bit as easy to use as the venerable LM380N-8 but with a few distinct advantages. The supply voltage can be anywhere from 1.8 to 15V and at 12V this little chip develops 1.5W output. Less distortion and the internal gain is set at 100. As used to good effect in the current range of Roberts Radio portables. Pins 5 - 8 are all ground connections and should be soldered to a thick pad of copper for heat sinking.

LM380/N-8 No list would be complete without it. I very much doubt you need to read anything from me about this performer, remember this one can handle up to 22V without breaking into a sweat. It can become an uncontrolled 2 MHz power oscillator! Internal voltage gain is set at 50.

(Richard has provided circuits for all but with space tight, I include the two least often seen. Tim)




Audio Amplifiers G0TTL

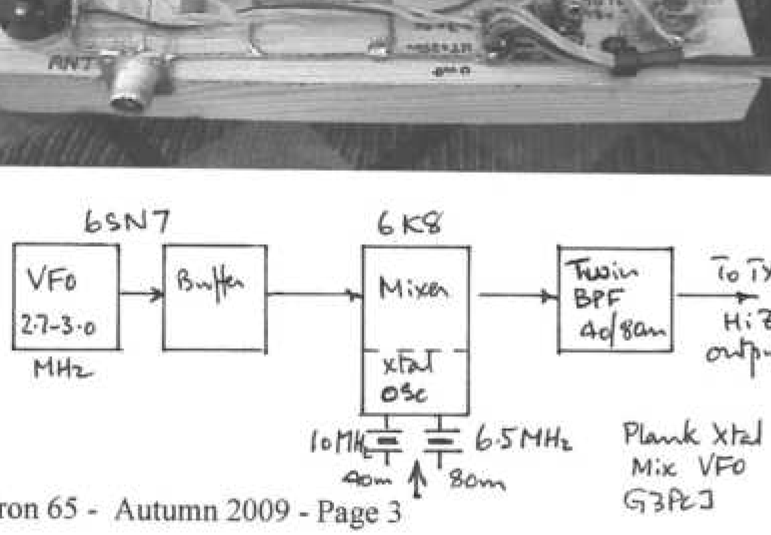
## ***Plank Project Developments!***

It did not take long to get the Plank TX working again - I removed the extra turns on the inductors to revert to 40m and altered the TR switching to suit the planned RX and it was away! I did have one funny that eluded me for a while - the output power was initially about 16W on the 400v supply but drooped over the next half minute to nearer 12W every time you went to transmit! All the usual culprits in the PSU were soon eliminated; eventually I found that the 807 was tired! The final improvement was to make it do either 40 or 80m by adding slide switches with extra fixed capacitors for 80m across all the inductors - they were all tuned by air variables so no need for trimming.

The companion RX was to use octal valves as I had some and plenty of valve-holders. A twin triode for the audio amp seemed a good idea, with one half being able to drive a small speaker transformer for low Z phones or an actual LS. Choice was either a 6SN7 or 6SL7, the former proving to have a little bit more gain. The regenerative detector needed to be an RF pentode with a pot controlling the screen grid voltage to control whether it actually oscillated or not - a 6K7 being chosen as it was to hand. 47v Zeners were used to stabilise the regen screen supply for ease of operation and frequency stability. I wanted to cover at least 40 and 80m, so plug in coils were mounted on old British 4 pin valve holders. The main tuning capacitor is a vintage air spaced unit with a nominal max capacity of 700 pF and was fitted with one of Eric's Muirhead drives; one coil covers 20 and 40, another does 80 and 160m, and a third the medium waveband for ease of demonstration. A small Jackson 802 capacitor gives band-spread. To prevent changes in aerial size and loading altering the frequency, and to prevent LO radiation, I added a grounded grid 6K7 RF amp stage and RFG pot. It copies CW, SSB and AM well for such a simple approach. The last RX item was a mains PSU!

The Plank format was used to match the transmitter with a thick plastic rigid front panel braced by the air variable capacitor mountings. The lack of a metal chassis is easily made up for by using plenty of thick copper interlinked wires! The frequency stability has pleasantly surprised me - maybe because I used silver mica resonating caps. The circuits are very standard - I can supply them if anybody wants them.

The crystal mixing VFO is to drive what was normally a 6K7 crystal oscillator in the TX. This approach avoids any chance of frequency pulling or chirp. The Hartley VFO (at 3 - 2.7 MHz) and its buffer are a 6SN7 twin triode feeding a 6K8 frequency changer; the triode section being a xtal oscillator at 10 or 6.5 MHz with the mixer having a double tuned tank for 40/80m with high Z hence high RF voltage output to replace the TX crystal. The final item is planned to be a twin 6L6 modulator for AM if I can find a suitable transformer! Tim



## *Aerial Antics and Tips* by **Andrew Atkinson, G4CWX**

This past winter has not been kind to me. First, the storms took down my vertical aerial, then corrosion set in to my G5RV and that came down, then to cap it all I slipped on the icy decking at the back of the house and ... well that is another story. With the last of the snow beginning to thaw out it became been time to think about putting on a woolly jumper and braving the cold outside.

The first job to tackle was the G5RV. On closer inspection it was clear to me that the core of the flexweave main sections were completely corroded. Water had been sucked in from the connectors for a length of about two metres, no doubt due to capillary action. The solution was simple: buy a length of replacement flexweave, a bunch of new connectors and put it all back together again. The only difference was that this time I sealed everything in a product that I had not come across before. It is called Liquid Electrical Tape and is available from www.plastidip.com at a very reasonable price. Once you have joined the connectors securely together, take the brush out of the can and cover everything in a coat of the black gunk. Wait an hour or so for it to go off and then give it another liberal coating – making sure that quite literally everything (including the connectors and wire) is covered in the stuff. Leave it overnight to dry properly and you are ready to erect your aerial. This stuff really works and will give you a weather tight seal for years to come.

The next job was on my vertical - replacing it promised to be an expensive business, until I came across some useful articles on the internet – not the least of which was from G4NSJ, which prompted me to try a homebrew approach. Sandpiper aerials (www.sandpiper.entadsl.com) market a 10 metre long fibreglass fishing pole for about seventeen pounds. The real problem was working out how to mount the darn thing, but the solution was simplicity itself. Cut off the plastic retaining cup from the base of the largest section of the telescopic pole. It will now slide snugly inside a standard two inch aluminium aerial mast. Push the handle end of the pole down inside your aluminium pole so that about three feet are exposed. Wrap electrical insulating tape around the fishing pole until you can only just manage to push it into the aluminium pole and then use self-amalgamating tape around both poles to join them together and make them truly secure.

So what about the aerial? I had a reel of Watson enamelled copper wire laying around, so I straightened it, covered the top two feet in Araldite epoxy resin and then pushed it inside the smallest section of the fishing pole. One of my neighbours had previously complained about the noise my aerial feeder was making when it was rattling around inside an aluminium support pole. My solution on that occasion was to fill the pole with expanding foam – the sort that builders use to fill in large holes and cracks, as well as around door and window frames. This had been so successful that I decided to use it on my new fishing pole. As I fed out each section of pole with its inner core of copper wire, I squirted a liberal amount of expanding foam inside the fibreglass pole. I continued doing this until all of the sections of the pole were extended and then taped off the end to prevent any foam from escaping. It took a couple of days to dry, but the wire is now held firmly in the centre of the fishing pole and has also added some extra stiffness to stop the thing swaying about in high winds. For an extra couple of pounds I also bought a pair of guying attachments and that has reduced the sway even further. This proved reasonably reliable – until the first high wind, after which I realised that the fishing pole needed to be guyed in at least two places. I terminated the copper wire in the back of an SO259 socket which was screwed to the aluminium support pole and then covered the lot in liquid electrical tape for good measure. All that I had to do now was mount the support shaft on the top of my existing pole and I was in business.

This might sound a bit over the top, but down here in deepest darkest Somerset, between the Mendips and in the valleys, we suffer extremes of weather and I am really hoping that this will be the last time that I have to set foot on a ladder for some years to come. Roll on the DX !

In the next issue of Hot Iron, I will include Andrew's assessment of how it worked! G3PCJ

## ***30m Midney-Kingsdon with 5 digit counter*** by Mark Bywater M0DFF

This project consisted of the construction of the Midney receiver, matching Kingsdon transmitter and five digit counter. These are mono band kits, and as the Walford Bristol had previously been constructed, I decided to build these for a band not covered by my Bristol - 30 metres. The Kingsdon also produced a nominal 5 watts output which matched the same level of power from the Bristol, both rigs would be switched to the input of a home brew linear amplifier giving the grand output of 25 watts.

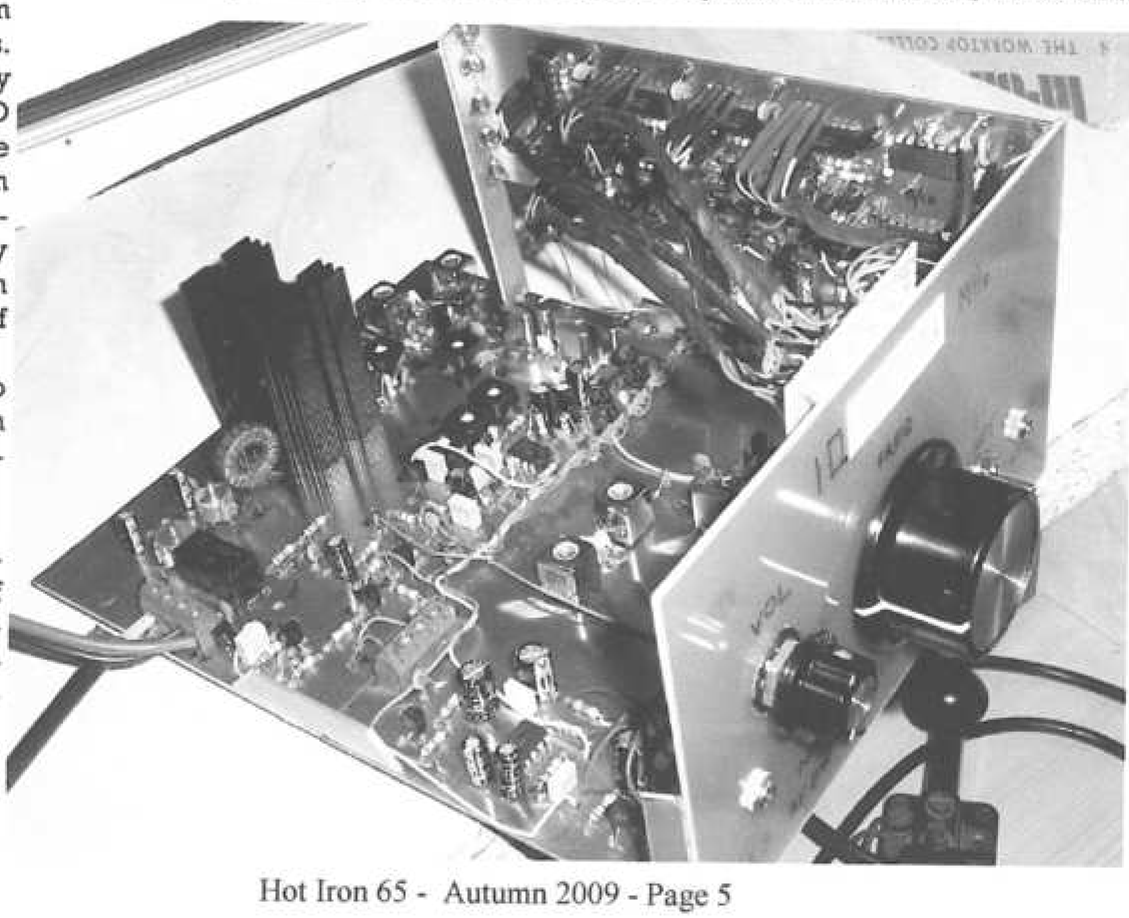
This project would also be constructed open chassis style unlike the Bristol which was boxed. After checking all the components the receiver was the first kit to be built. This was carried out section by section with testing along the way as described in the notes that come with each kit. A multi turn pot was used for the main VFO as the counter was to be used for exact frequency display. Everything progressed well and initial tests on the completed receiver were encouraging. Next the Kingsdon - again section by section with testing meant that this was completed without any major problems. Now the Midney and Kingsdon were linked together. A minor modification was to include a fixed resistor with the multi turn pot to restrict the tuning range, this meant that the ten turns of the pot covered just over 50kHz when the inductor and pre-set were adjusted correctly. No microphone socket was fitted for the Kingsdon, but the mike amplifier was built for completeness. The fixed capacitors on the output matching stage were replaced by pre-sets to make matching a little easier.

Now for the counter. Again step by step construction and testing as per the instructions meant that any minor problems were quickly overcome. The resistors for the display were mounted on the PCB end on, then wires were soldered to the other end of the resistors. Heat shrink sleeving was placed over the resistors and the end connection to make a nice tidy insulated joint. The wires were then methodically soldered to the display. The counter was connected to the rig and worked first time! Now for the counter clock modification. The clock was divided by a further 100 by passing it through two 4017 decade counters. This now causes the display to read 10s of Hz as the least significant digit, at the price of loosing the MHz digits. As the rig is a mono band rig the loss of MHz digits is of little consequence The two 4017 counters were mounted "spider like" just below the counter PCB on a couple of earth wires as can just be seen on one of the photographs. 4017 were used simply as they were already in my spares box.

Initial results have been promising and the audio out is very smooth on the ear, unlike a lot of modern black box rigs. It is a real joy to have a QSO on a home brew rig with the other operator usually commenting on the quality of the tone.

Now to get started on the 6m Chirnside rig........

(Mark is building a pair of Chirnsides - we look forward to a report! Tim)

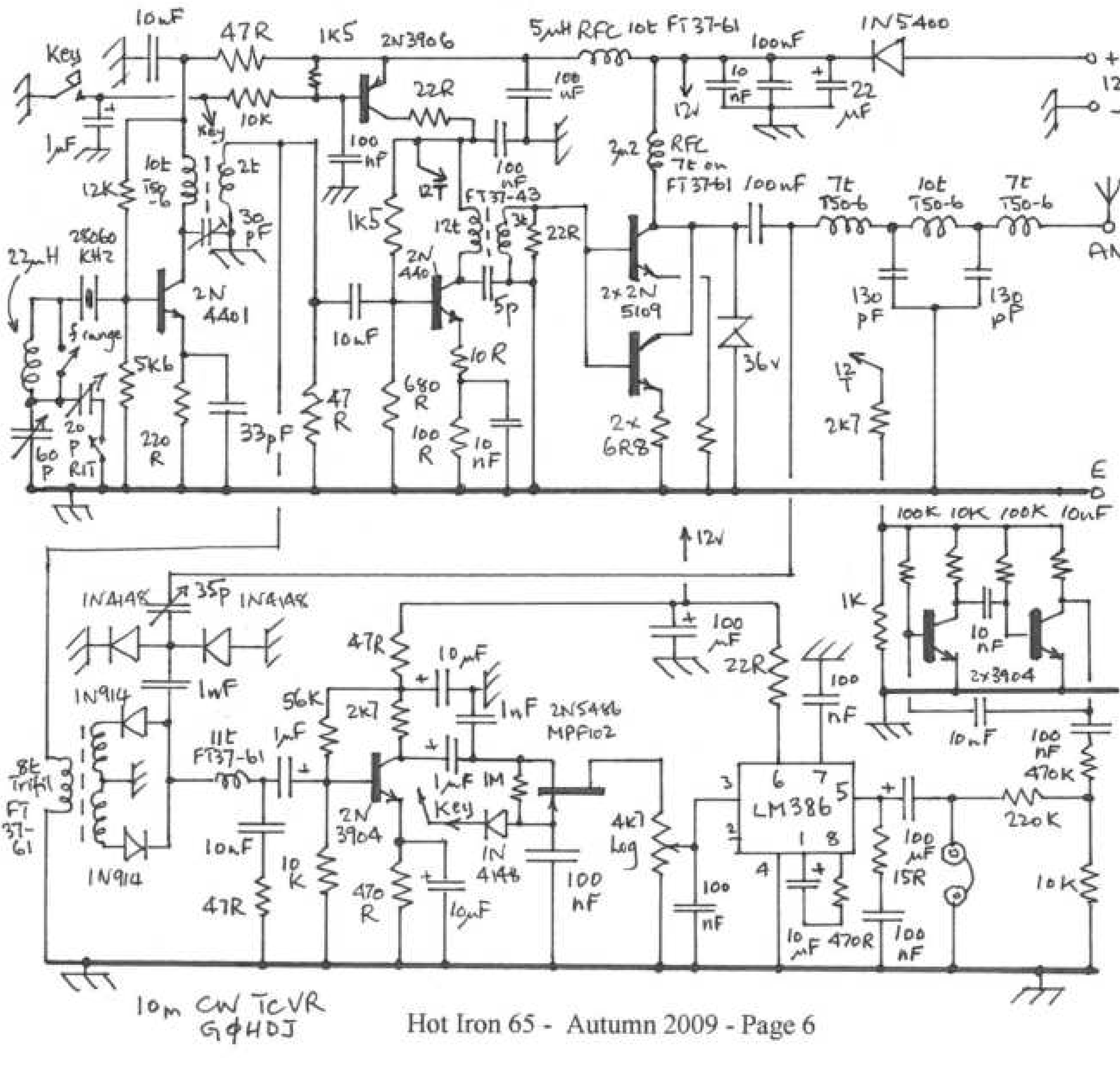


## *10m CW Transceiver* by Craig Douglas G0HDJ

Craig has been working this design up for portable use over a number of months and has it now packed up ready with a portable aerial, table/chair, flask of tea etc ready for an opening! As a parting comment on the weather, he says that he is working on a design for a new ark having just taken up carpentry!

The circuits are derived from previously published circuits in Sprat, ARRL and RSGB handbooks. He uses a 2N5109 in the TX output in preference to the often seen 2N3553 as it is better suited to a 12 volt supply. The 2N3924 would be an alternative. (Ref ARRL 'QRP Power'). The TX output as configured, is 1.2w using a 12.4v gel cell (RX 28 mA and TX 184 mA) but this increases to 1.8W (32/320 mA) when used on a 13.8v supply. The two switches in the oscillator circuit provide a small change in frequency for RIT and for pulling the crystal; the nominal fundamental mode 28060 KHz crystal actually covers 28058 to 28077 KHz by using the optional 22 uH in series with the crystal. Craig warns that you do need to remember to turn off the RIT manually when transmitting, otherwise TR changeover is automatic! An earlier version did not include the RX muting stage nor a sidetone oscillator as there was some 'feed through', but the final version has these added with direct injection of the sidetone into the phones. He used double sided PCB material with one side as a continuous ground sheet, the other side having the circuits etched and wired together by point to point wiring.

As a comment, I have no doubt that this basic design could be adapted for any of the HF bands. I happen also to have a selection of crystals for 10, 15 and 20m that are near the X.060 KHz nominal QRP CW calling frequencies - e mail me if you want details. Tim

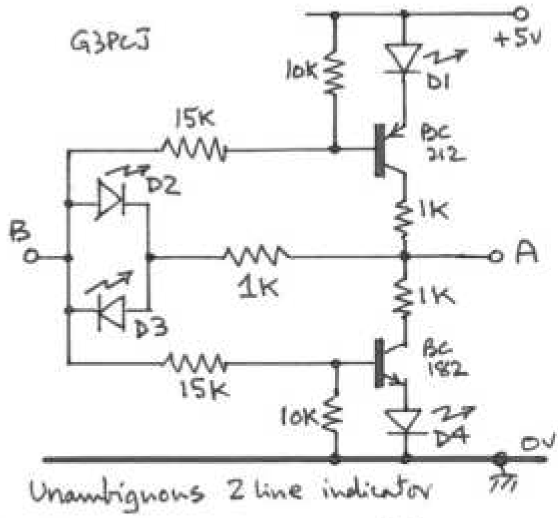



10m CW TCVR G0HDJ

## ***Snippets!***

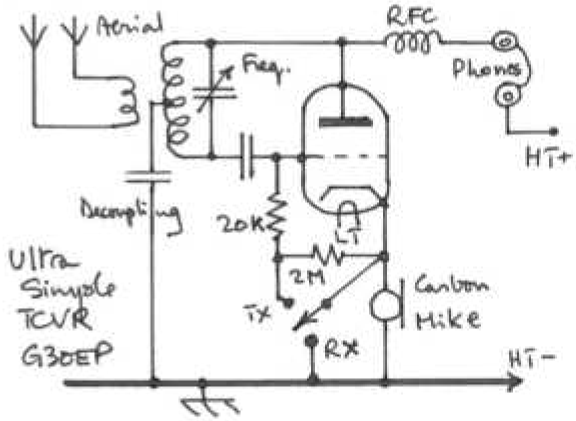
*Unambiguous 2 line logic indicator*

The circuit right always shows only one LED on for any the four normal combinations (high or low) of the two logic inputs A and B - no LEDs on or more than one denotes an error condition! Hence the display is unambiguous. The two logic inputs need to be fed from sources that can source or sink the nominal LED current of about 3 mA using 5 volt supplies. Use high efficiency LEDs! A and B inputs low lights D1, input A low and B high lights D2, input B high and A low lights D3, and inputs A and B both high lights D4. Transistors can be any common complimentary devices like BC182/212 etc..



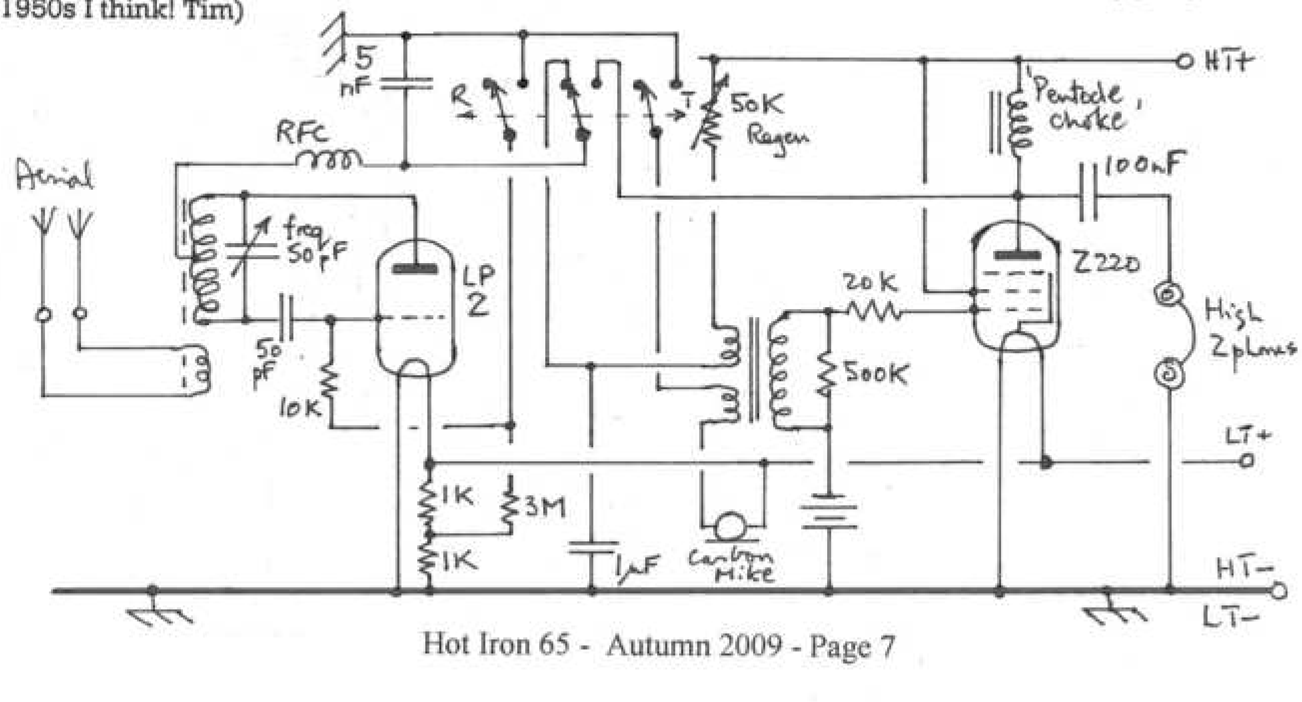

*Ultra simple TCVR!*

Dave Buddery G3OEP sent along this circuit which he thinks first appeared in an ARRL publication in 1937 or 1938. I don't think Dave has ever used it but suggests it would be fun on 6m!! But I bet its very tender and prone to frequency shifts with the wind! I imagine it would not be too difficult to make it into a regen on reception by controlling (reducing) the HT with a pot that is shorted out on transmission. Anybody like to try it out?




*Two valve UHF transceiver*

Dave also sent along an extract from one of the T and R Bulletin wartime handbooks books outlining what had been used for portable work pre-war UHF work. This circuit is actually remarkably similar to that of the 17 set that was used extensively for communication to searchlight batteries - I suspect a common designer. The article suggest that for reception, the first stage is a self quenching detector, which implies to me that it is a super-regen as in 17 set; the second stage being a conventional audio amplifier. For transmission the audio amp becomes a choke modulator for the triode acting as a power RF oscillator. Undoubtedly changes in the aerial circuit will pull its frequency! The note goes on to suggest that for serious work this form of self excited transmitter is not satisfactory. Modulation cannot be above 50%, and the writer suggests that when transmitting is again permitted after the war, this form of self excited UHF equipment will become as obsolete as spark was in 1939! (500 KHz spark emergency maritime transmitters were still rescuing people into the 1950s I think! Tim)



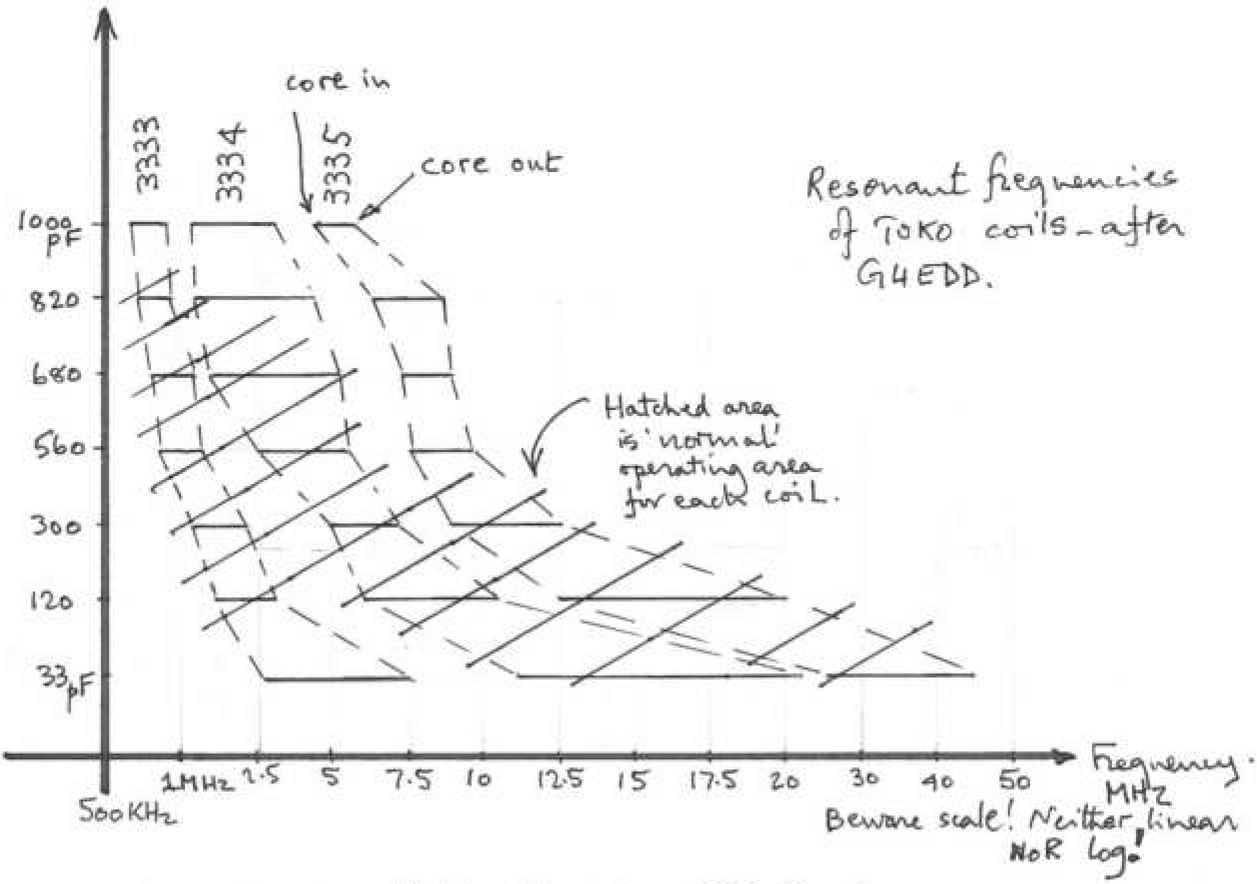
## ***Discounted kit sale!***

I have the following kits which I would prefer to sell cheap rather than break up for spares:- 4 off 50R attenuator kits; 0 - 20 dB in switched 1 dB steps. PCB is single sided 50 x 80 with 5 DPCO toggles. £10 each. Also 2 off Pylle CW transmitters for the Upton project - 1.5W 'crystal' or external drive, broadband TX with diode TR switching and 10 dB receiving RF amp, with muting & sidetone oscillator. Double sided PCB 50 x 80 mm. Does not include any TX LPFs - but see next item! £15 each. I also have 3 off relay switched two band cascadable transmitting low pass filter kits - £10 each. P and P £3.

I am always happy to supply Construction Club members with any spares - just e mail me about your needs and I will give you a price. Tim W G3PCJ

## ***TOKO Coil Ranges***

I came across this useful information in the Autumn 2008 SPRAT, the Journal of the GQRP Club. The information was originally compiled by G4EDD who measured the range of resonant frequencies of the three most common adjustable TOKO coils (commonly known as 3333, 3334 and 3335) with their adjusting cores 'in and out'. The core was deemed to be in when its top surface was flush with the top of the coil's can; core out is literally what it says! Although this range of TOKO coils is no longer made, they are in common use and it will be some time before my stocks are exhausted. The potential frequency/capacitance range for each type is the area bounded by each lozenge. The original data was compiled with a grid dip oscillator. Beware the scales – they are neither linear nor logarithmic! I have left the extreme capacity/frequency points unchanged. You can use the diagram to determine what capacity should resonate with a chosen coil for a particular frequency or vice-versa. I have added a hatched area to suggest the normal operating range for each coil - the higher inductance 3333 being suited to higher capacitance and hence low frequency, while at the other extreme, the 3335 is best with low capacity for high frequencies. This data is a graphical form of the common parallel resonant circuit formula applied to the adjusting range of their nominal inductances. The manufacturer's published nominal inductance values (with core in) are 1.2 µH for the 3335, 5 µH for the 3334 and 45 µH for the 3333. Tim G3PCJ



"JOURNAL OF THE CONSTRUCTORS CLUB"

# Hot Iron

Winter 2009
Issue 66

## Contents



The Walford Electronics website is also at www.walfordelectronics.co.uk

## *Editorial*

My researches about super-regenerative receivers (see later) has really brought home to me how 'bright' were the early 20th century radio pioneers. Mr Edwin Armstrong is credited with many inventions that he made around 1920 which still provide the fundamental building blocks of modern radio equipment! When one considers how simple the test equipment was that he had at his disposal (not a lot more than galvanometers, torch bulbs and Letcher lines), and the very limited capabilities of the early valves, the achievements of those pioneers is remarkable!

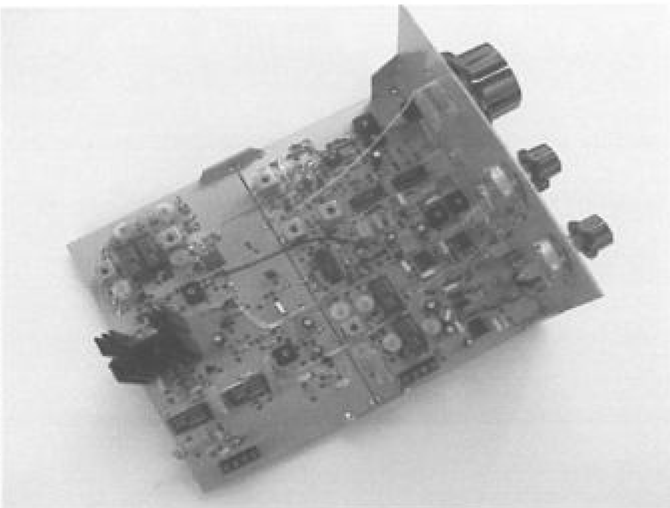
It is also intriguing that in those days the active devices (valves) were very expensive compared to the passive components and it was not unusual for there to be complex switching to avoid using another valve - for example in what we would now call a transceiver, the very early 1940s WS17 uses just two valves for a VHF phone RX and TX but the TR switch has six poles! Nowadays commercial chip designers don't even bother to count the number of transistors they use! However I find that the cost of kits is directly related to the number of circuit blocks and the most costly item is often the PCB! I have long held the view that the cost of mechanical items in electronic projects is unduly high compared to transistors - pots and knobs especially! Enclosures are another overpriced item!

**Happy Christmas all!** Tim G3PCJ

## *Kit Developments*

Initial reports on the **Brue** are very favourable. I am about to withdraw the Brent - two PCBs left! The Brue is better, particularly its performance on the higher bands - with or without a Mini mix kit, and is much easier to build.

The scanning counter design has progressed to a second version which I shall try out shortly - it is intended for DC rigs. Meanwhile the prototype **Mendip** 3 band phasing CW receiver, with the 5 Watt **Polden** transmitter (on right) are both working well - see later. Their prices will normally be £75 and £40 respectively but Construction Club members can buy them for £110 post paid. Check the website! Tim



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## ***More shack frequency standards*** - by Gerald Stancey G3MCK

In Hot Iron 63 I described a method of checking a Digital Frequency Meter (DFM) by establishing an accurate local frequency standard which was set against BPM on 10 MHz. This article describes how other transmissions may be used for this purpose.

At my QTH, BPM is not the strongest signal and I have often looked with interest and envy at the very strong signals on 4996 and 9996 KHz that come from RWM, the Russian frequency standard agency, whose accuracy is better than 1 in 10^10. My first thought was to pull a 10 MHz crystal to 9996 KHz but this did not seem to be a good idea as my 10 MHz crystals exhibited poor frequency stability; however you may have better luck. Finally the penny dropped when I realised that as 9996 is 4 less than 10,000 it must be divisible by 4. The same also applied to 4996 and 5000. A 4 MHz crystal oscillator was divided down to produce 4 KHz pips which could be checked against RWM. The circuit, below, is that used in crystal calibrators. The DFM is connected to the 2 MHz output to give a measure of buffering between the 4 MHz oscillator and the DFM. The 74390 could be replaced by two 7490, similarly half a 74390 could be used instead of the 7490.

In the old days, it was common practice to set a 100 KHz standard against the BBC transmission on 200 KHz. Unfortunately that is no longer possible as the BBC have changed to the less than helpful frequency 198 KHz. However all is not lost, for example some writers have advocated extending a classic crystal calibrator to give 2 KHz pips which can be checked against 198 KHz. Having already built a crystal oscillator driving a divide by one thousand TTL chain it was easy to change the 4 MHz crystal for one of 9 MHz and use the 22nd harmonic of the 9 KHz pip. All MW broadcast stations operate on multiples of 9 KHz so any MW station can be used as a standard but first a warning. Much to my surprise I discovered that there is no ITU regulation that covers the accuracy of the carrier frequency for medium and long wave transmitters. It is left to each national authority to specify the required accuracy and this probably rules out many apart from the BBC. It is very annoying that the transmission on 900 KHz appears to be slightly off frequency!

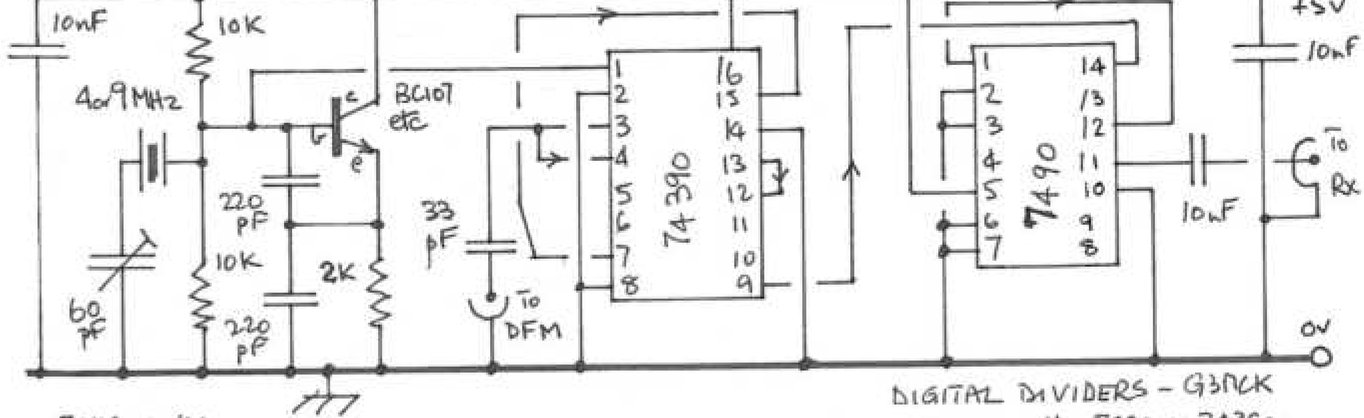
I understand the following standards apply to BBC transmitters:-

| | | |
|---|---|---|
| 198 KHz | Droitwich | 1 in 10^11 |
| 198 KHz | Other | 1 in 10^10 |
| Networked transmitters, e.g. 909 KHz, | | +/- 0.05 Hz |

Local radio, various but usually better than 5 Hz off the nominal carrier frequency.

Let us now look into the techniques of setting the 9 KHz pip to frequency. For many years I had wondered how it was possible to zero beat accurately to a modulated carrier. Happily the RSGB Handbook of 1961 gives chapter and verse. Start with the 9 KHz pip a few hundred Hertz off tune, bring it down to zero beat as normal and continue into the sub-audible area until there is no degradation in the quality of the voice. I find that its best to do this on a man's voice. Unless you are within 1 Hz of zero beat there is a noticeable degradation of the audio. Like all things it requires a bit of practice and judicious use of the oscillator on/of switch is helpful. Certain people have claimed that they can set to a higher accuracy but to date this has eluded me.

For many of us the choice will be between using 198 KHz and 909 KHz and it may surprise some people to learn that 909 KHz is the better frequency. The accuracy with which you have set the 9 KHz pip is a combination of the accuracy of the BC station and your netting accuracy. Let us assume that we can set to 1 Hz. At 198 KHz this is an accuracy of nearly 5 ppm. However at 909 KHz it is an accuracy of nearly 1 ppm so the zero beating error swamps the different accuracies of the carrier frequencies. (See some further comments on the next page! Tim)




DIGITAL DIVIDERS – G3MCK
Use 7490 or 74390, as available!

74HC series chips could be used instead of 74390 or 7490!

## *Error probabilities!*

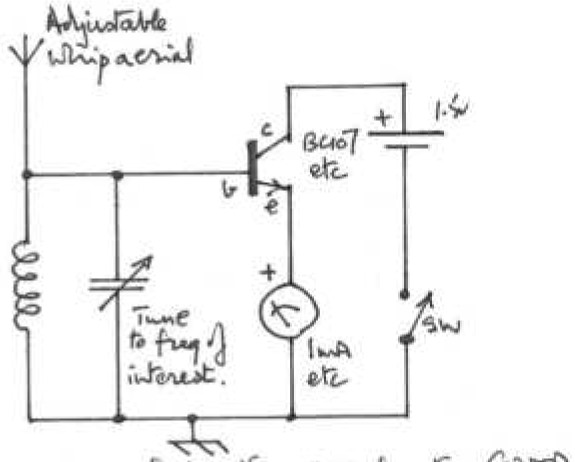
Gerald Stancey also provides a non-radio footnote about the impact of cumulative errors. "DNA is said to be unique to about one in a million. However in a court case you should factor this by the following probabilities: laboratory error, mistakes in collecting samples, mix-ups in storage and retrieval etc. If the cumulative errors of these are say 0.1% then the chance of the DNA match being unique is one in a thousand. This means that in the UK alone there are 600,000 suspects! Makes you think doesn't it?"

## *Digital Britain*

Our Government has already announced plans to change all ordinary radio broadcasting to a digital format, in much the same way as all analogue TV transmissions are being progressively closed down - we have already lost our analogue TV in the west country! I understand that not only will the analogue FM Band 2 transmissions (from about 88 to 106 MHz) cease in a matter of a few years time, but so will all the existing AM broadcast stations in the medium and long wave bands (very roughly 150 KHz to 1.5 MHz). This means that the most suitable of the conventional AM transmitters that Gerald has used as frequency standards (see previous page) will not be available in a few years time (2015 is suggested). I do not have any details of what the vacated frequencies will be used for, but whatever the service, they are unlikely to be free! If anybody has any details please let me know. I suspect there is also an intention to do similar things to most AM short wave broadcasting but due to the need for widespread inter-national agreement, it is likely to take much longer to get that agreement and eventual transfer to Radio Mondiale or whatever. I suspect the relative simplicity and low power consumption of ordinary AM receivers, compared to microprocessor based devices, will keep them in use for many decades yet, especially in the developing world! One hopes that the short wave standards like WWV and WWVH will remain!G3PCJ

## *Simple Field strength indicator*

Dave Buddery G3OEP sent me this some while back and its been waiting for a suitable space - my apologies for the delay! A short aerial rod is attached to the top end of the resonant circuit which obviously has to be tuned to the frequency of interest. When the power switch is open, the base emitter junction of the transistor acts as a diode; when its closed it then also amplifies the DC signal for higher sensitivity. Sensitivity can be adjusted by altering the aerial rod length (telescopic easiest) and then re-tuning the signal for maximum indication. While it is not calibrated it can give most useful relative strength indications when adjusting aerials, investigating polar diagrams etc.




Simple field strength indicator G3OEP

## *Testing MOSFETs*

Don't bother to test the likes of BS170s if they are suspect - they are so cheap they should be replaced with new! More expensive devices like IR510 can be tested **with care** and suitable anti-static precautions! You need to know the lead identities and the following is for the common N types. First discharge all pins by pinching all three legs simultaneously in your fingers and then place it carefully on a non-conducting surface. You must follow this sequence:-

1. With a digital multi-meter set for diode testing, connect the gate to the black lead and the source to the red lead to test the gate source 'junction'. It should show an open circuit - scrap if not.
2. Next put red to the drain and black to the source to test the drain source diode when device is off - it should still be open circuit - scrap if not. Then reverse the leads and it should show one diode drop - typically 250 to 500 mV from the internal diode (they often read volts on the diode range).
3. Now turn the device on by connecting gate to red and black to source, it should still show an open circuit. Then transfer leads to drain and source - either way round it should show a very low resistance because it should be on for either polarity of small voltages. Lastly pinch all leads again.

Anything departing from this sequence of events indicates a duff one! Tim

## *Not More Aerial Antics?* by **Andrew Atkinson, G4CWX**

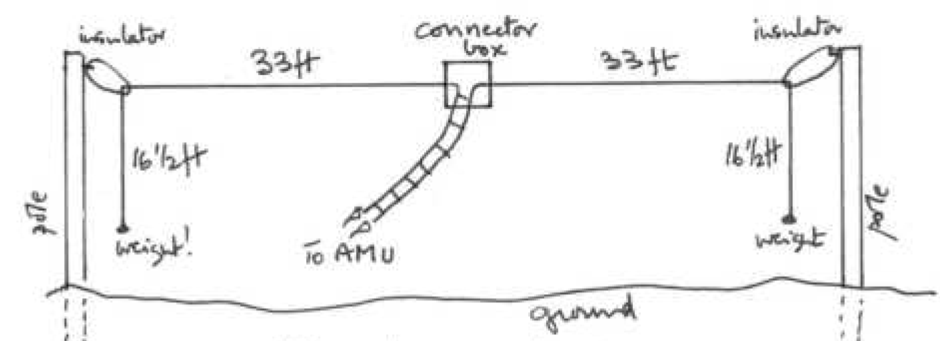
Ok, so in my last article I sounded really smug and self-satisfied having cured the ills of my poor aerials. But I had become a little too complacent and was only achieving QSOs with a handful of other local radio amateurs due to the close proximity of hills. A chance encounter with a fellow victim made me spend some time and effort researching alternative aerial solutions, so that I might actually achieve my DX Nirvana. So we have established that I am gullible, but what the heck, it was worth a try. In the ensuing months I read everything that I could find on aerial design and filled notebook after notebook with jottings and diagrams. I joined list servers and Yahoo groups; I exchanged email with dozens of amateurs around the world. I surfed the internet like a thing possessed and – finally – came up with two designs that were both feasible and affordable.

From all that I had gathered, a vertical aerial was just not going to work at my location. Apart from anything else, I was never going to get permission from the XYL to dig up the lawn and lay the necessary radials. On top of that, my long suffering neighbours would doubtless object to the sight of a multi-guyed mast and pole that reached to the heavens. I suspect that I might also have been accused of causing danger to low flying aircraft as they approached nearby Bristol International Airport. Thus, my solution, in whatever form, had to be a wire aerial. The first choice was to be a Windom; truly a classic offset centre fed dipole. The commercial versions were way beyond my shallow pockets. I also felt that they did not really represent very good value for money. Instead, I invested in a pair of new 2" diameter masts, complete with pulleys; one for the side of the house and another for the rear of the garage. The distance between the two worked out to be just a little over 66': a miracle, if ever there was one. Why a miracle? It just so happens that both of my chosen designs required exactly this distance for them to work at their best.

The *Windom* has one leg 21 feet long and the other is 45 feet. The central ends of each leg feed into a 4:1 balun. You can buy a commercial balun for between £30 and £40, make one yourself, or take my route and find a new one on EBay for about ten quid. The balun is fed by standard 50 ohm coax straight off to your transceiver via the ATU. So, how did it fair? To be honest, not badly at all. It knocked spots of my previous attempts at a vertical and was noticeably better than the old G5RV. The VSWR between 40 and 10 metres was acceptable, although on eighty it was a touch on the high side. I left this aerial up for about a month and gave it a really good workout.

Then it was time for plan B. In the course of my researching, I had come across all manner of centre-fed designs. Each of which had virtues extolled by either designers or users. The one that I settled on came courtesy of G3OOU. The layout it given below. It is simplicity itself – and again fits neatly into my 66 foot long gap. Each top section is 33 feet in length and the sides which drop down are 16.5 feet. The connector box in the middle is just that; not a balun, just a straightforward connection of each leg to the 300 ohm feeder. For those with more space, you can double these distances for an even better performing aerial. Although the designer feeds his aerial into a 'Z Match', I decided on experimenting and found that the best results (for me) were to be found with a 1:1 balun just before the ATU. You need to be aware that some of these baluns – even the expensive commercial variety can be a bit lossy, but I was prepared to accept the limitation.

So, what about the results? *'Outstanding'* is about the only word to describe it. For the first time I have been able to hear and work distant stations on all HF bands from 80 metres to 10. I have tried changing the main conductors from solid hard-drawn copper wire to flexweave, as well as experimenting with differing lengths of feeder, but none of it made any significant difference. This very basic design just works to perfection and, unsurprisingly, I am now one very happy bunny. The only question which now remains is "What shall I do with my time, now that I have found my perfect aerial?"




G4CWX Doublet antenna - after G3OOU

## ***Super-regenerative Receivers***

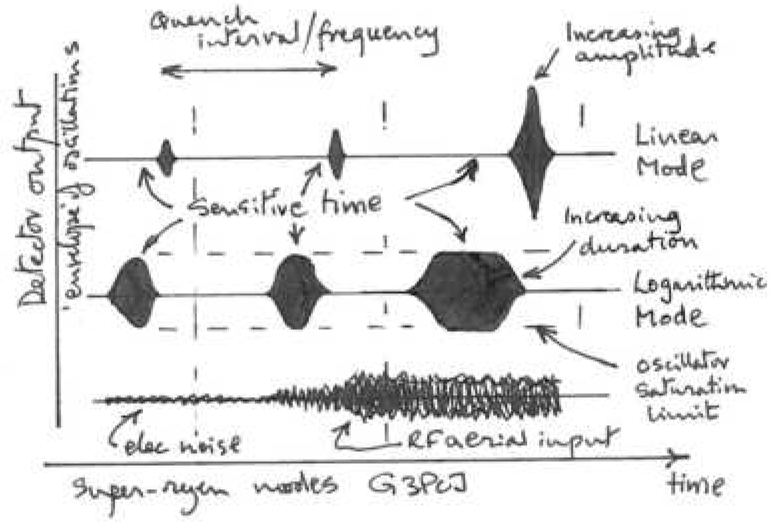
As part of my investigations of the radio installation at my friend's wartime bunker, I have been researching the radio equipment that was used by the Auxiliary Units. (Interestingly, super-regen RX/TXs were also widely used for IFF transponders during World War 2.) Three voice trans-ceivers were used by the Auxiliaries, all operating with a carrier frequency of about 50 - 60 MHz:-

Set 1. Designed in the mid 1930s, this was manufactured by Messrs Savage & Co, hence is known as the Savage set! Circuits do exist (but I have yet to see them) and I am uncertain about its modulation method - it probably used conventional amplitude modulation. The set was not reliable and about 50 were made. The receiver was super-regenerative and drove headphones.

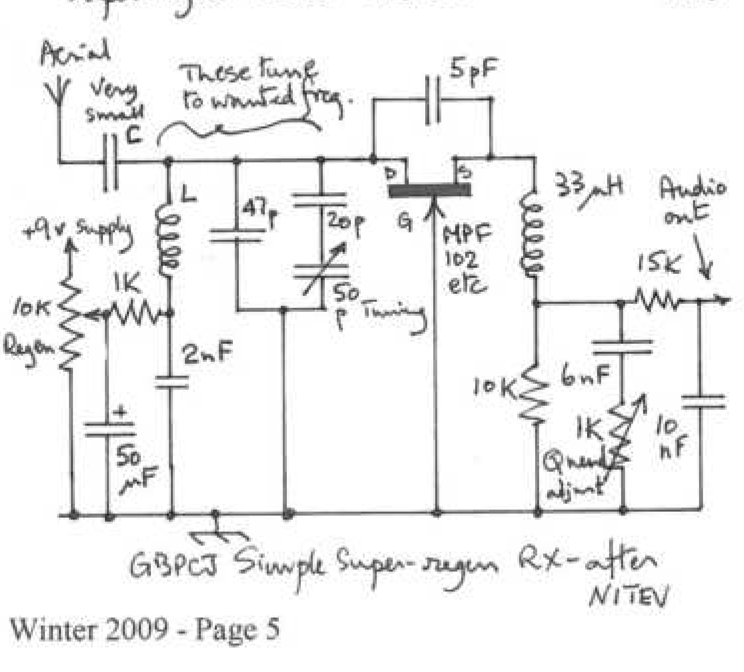
Set 2. This set is known as the TRD and was derived from the Savage set during the early part of the war. It was a great improvement and was used extensively but all records - paper and physical - were put down a coal mine at the end of the war because it was so good! Its probable line up of 5 valves is known. It had a super–regen RX and produced a watt or two of RF. But the modulation technique is very unclear. It was not conventional AM, but possibly some form of pulse modulation that is thought to have been the basis of its special secure speech facility. It is another enigma!

Set 3. The final set is the well known WS17 of which many were made. This has two valves producing conventional AM and also had a super-regen RX.

A super-regen differs from the plain regen in that the RF oscillations are interrupted at a high rate - usually supersonic. This is achieved by altering the device gain to just permit oscillation or not - either under control from an external quenching signal or due to extra parts added to the super-regen stage. When the stage gain is increased to permit oscillation, the RF waveform builds up slowly from electrical noise in the circuit; however if a wanted aerial signal is also present in this sensitive phase, the time to reach a given amplitude is much reduced, which in turn leads to a larger pulse of RF oscillation. The frequency of oscillation is that of the tuned circuit, but the build up can be triggered by any signal within the RX's bandwidth. Similarly, when the time comes for the gain to be reduced, the larger RF oscillation pulse takes a longer time to die away. When the pulse size is **not** limited by the oscillator saturating, the operation is said to be linear and the pulse size can be used to recover any conventional amplitude modulation. If the RF pulse builds up to the point where saturation **does** occur, then the area within the RF pulse envelope increases with increasing aerial signal and the operation is said to be logarithmic; this also has the effect of providing a form of automatic gain control. The diagram above shows the difference.




The circuit right is a typical self quenching semiconductor super-regen; they tend to be used only on VHF upwards as the quench frequency needs to be several times the desired audio bandwidth, but if the quench frequency is too high, the RX's RF bandwidth increases too much! The gain of the super-regen stage is phenomenal (perhaps to a million or more which is why the wartime RXs had so few parts), it has very few parts to achieve such high gain, and it is consequently simple and cheap. Normally they are used to demodulate conventional AM but can also be set to read FM. They are widely used key fobs with on-off keying and for other short range data exchanges. Their drawback is a relatively wide RF bandwidth. Tim G3PCJ



## ***Life or Death: QRP radio in World War II*** by John Teague, G3GTJ.

The following is a digest of an article by Dr Brian Austin, G0GSF, entitled "HF propagation and Clandestine Communications During the Second World War" which was published in the August/September issue of "Radio Bygones". Brian Austin is a retired academic, whom I know and who has written numerous papers on radio propagation and related subjects. It occurred to me that his latest work would be of interest to Hot Iron readers who may not see Radio Bygones.

The equipment used by resistance groups in France for communications with the UK used contemporary radio amateur technology and components. A Foreign Office Radio Service wartime development engineer told me that John Brown, a leading designer of wartime clandestine radio equipment "worked with a soldering iron in one hand and an ARRL handbook in the other."

At the UK end of these CW links powerful transmitters, rhombic antennae and National HRO or RCA AR88 receivers were the norm. At best the agents end would probably be a single 6V6/6L6 valve crystal oscillator transmitter with an output of 5 or 6 watts coupled to a short random length antenna at no more than eves height. The receiver might be a TRF one or at best a one RF/two If stage super-heterodyne, both covering the 3 to 16 MHz frequency range. (The B2 spy set shown right was typical of this technology - G3PCJ)

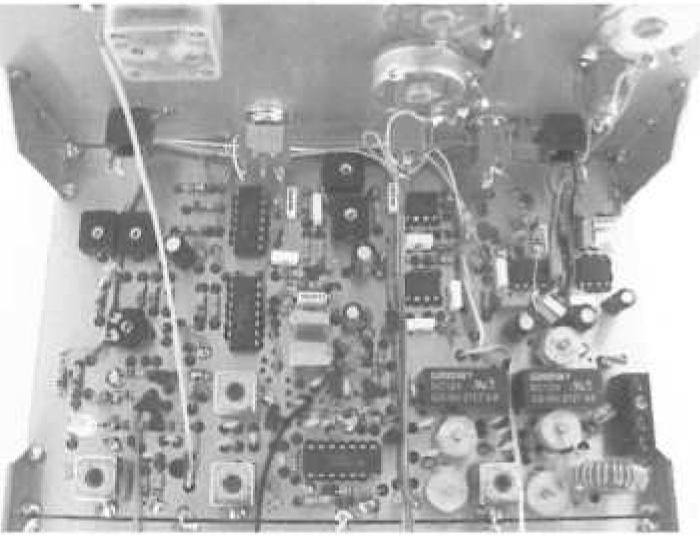
The range of working would necessitate ionospheric propagation and extend from say 150 to 1000 km. Austin postulates Calais and Marseilles as typical of the extremes of range. Most transmissions were made in daytime , and he has researched the sunspot and propagation conditions pertaining in the war years making assumptions about galactic and atmospheric noise levels at that time. Discussing all the factors contributing to the viability of the radio channel and taking them into account he concludes that the optimum frequency for the Calais link would be around 4.7 MHz and for Marseiles 10.3 MHz. Making further assumptions about antenna performance and propagation losses the author presents a graph relating antenna efficiency to received signal-to-noise ratio and concludes "Clandestine radio operation using extremely simple low powered equipment and highly compromised antennas was indeed capable of providing the vital link between agents in occupied France and their headquarters in England" which is, of course, what happened. Incidentally he also shows that the signal-to-noise ratio on the long distance link was 10 to 12 dB up on that of the short distance one.

Brian Austin has kindly agreed that I might publish this abstract of his article in Radio Bygones - my thanks to him. Of course this short summary does not do justice to the original illustrated seven page article. For anyone interested in further details please contact me at Perrotts, Lydford on Fosse, Somerton, Somerset TA11 7HA.

## *Update on Craig's 10m project*

Bench experiments had shown an unduly large shift in frequency when the key is down. This has since been greatly reduced by powering the crystal oscillator from its own 8 volt regulated supply from a 78L08 regulator - a wise precaution in any transmitter! There is still a small key down shift but this is probably due to transmitter output RF getting back into the crystal's resonant circuit - the very high crystal Q helps tremendously and does allow a viable transmitter when the oscillator is on the same frequency as the TX output, but increasing frequency does aggravate matters! Craig also experimented with inductors in series with the crystal to increase the tuning range. Some theoretical suggestions for an appropriate value of inductance actually killed the oscillator - I suspect because the crystal's series resistance was rather higher than assumed - this is a characteristic of crystals that does vary tremendously and cheap ones do often have high series resistance!

## *Mendip and Polden* - prototype RX on right

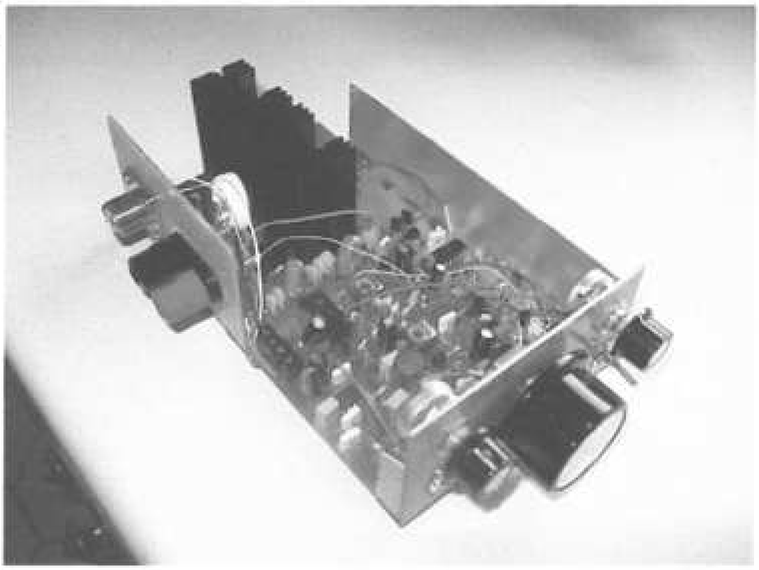


Its been a long time in gestation but I think the wait has been worthwhile! The RX uses a crystal controlled converter (for 20, 40 and 80m) ahead of a phasing single sideband (either) direct conversion receiver operating between 5.4 and 5.5 MHz; this has special switch selectable audio filters for phone or CW. 1496 mixers give better strong signal handling than the usual 602s mixers. The RX has coarse and fine tuning, and adjustable RIT when the TX is fitted. The RF bandpass filters are mostly set with trimmers, nor is it difficult to adjust the phasing aspects - just go for least unwanted sideband. When the audio filter is set for CW, the unwanted sideband is better than 30 dB down on the wanted one over the whole of the audio bandwidth. When set for phone, there is still a useful rejection of the unwanted sideband.

The associated Polden transmitter can work on all three bands producing 5W on a 13.8 v supply. It uses a crystal mixing scheme to avoid chirp and provide proper VFO coverage using the receiver's oscillators. The TX has low pass harmonic filters with further rejection of unwanted harmonics provided by the receiver's RF input filters (which have to have protection against the RF voltages). This allows full break in operation if wanted but there is also provision for semi-break in with a antenna changeover relay. Sidetone and muting are also included. A single band version can be used with the Knole RX! There is plenty of scope for personalising these kits!

In principle 30m could be fitted in place of 20m but it will require a non-standard crystal and several other detail alterations! Please consult me about the practicalities of these!
Tim G3PCJ

## *Super Brue!*



Larry Manderson initially had a plain Brue but was so pleased with it that he decided to add a Linear for 10W PEP output so it became a Super-Brue!

The sheet of PCB material on the right hand side is to give added mechanical strength between the main PCB and that of the Linear.

## ***Discounted kit sale!***

I have the following useful kits, now selling at a discount! 4 off 50R attenuator kits; 0 - 20 dB in switched 1 dB steps. PCB is single sided 50 x 80 with 5 DPCO toggles. £10 each. I also have 3 off relay switched two band cascadable transmitting low pass filter kits - £10 each. P and P £3. I also have some All Band LO PCBs - free to anybody who can use them! Also last two Brent PCBs at £5. G3PCJ

## ***Aerial Question!***

Craig G0HDJ has a doublet (2 x 10.7m) in his attic fed by 17m of twin 300 Ohm feeder from a semi-balanced AMU. Will he get any benefit by fitting a current balun, and if so where to fit it, and also how to make it? I suggested coiling the feeder up with several turns at the centre of the two arms but doubt that it is really going to help much. Anybody like to tell us what he ought really to do? Tim

# ***QRP in the Country***

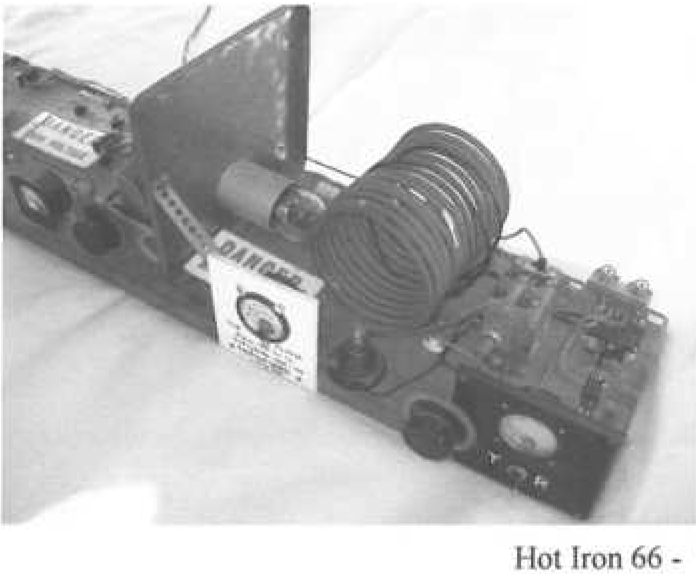
Put **July 18th** 2010 into your diaries now please! Instead of having a Somerset Supper this year, I am working up a new QRP event to be held here on the farm in the field (and or the barn) shown right! The sheep will not be present!

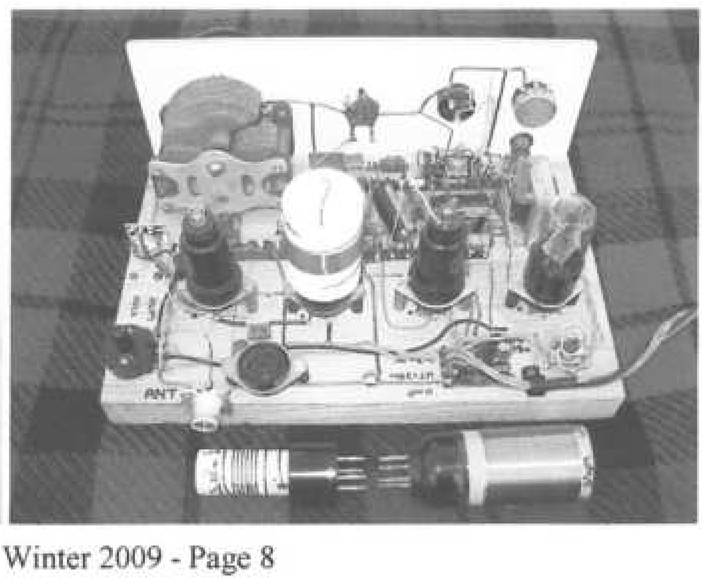
A wide range of radio attractions is planned, including:-

Opportunity to operate the replica 1930s TX (below left) built by G3GC, together with my modern valved TRF (below right).
Construction advice clinic
Informal home construction competition judged by a radio personality
Somerset Range kits to operate (and even buy!)
Transformer throwing competition
Bring and buy sale
Special event station probably operated by Yeovil ARC
Tables for displays etc by any west country radio club who would like to attend

Simple food and drink - beer from the Long Sutton brewery and barbequed meats - possibly our own home produced beef or lamb.
Farm tours led by my wife Janet - a walk of about one mile down to the hay meadows and back for those partners not so keen on radio all day!

The event is open to all (with free entry) but I especially hope that all Construction Club members in the South and West will be able to attend.





"JOURNAL OF THE CONSTRUCTORS CLUB"

# Hot Iron

Spring 2010
Issue 67

## Contents



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

## Editorial

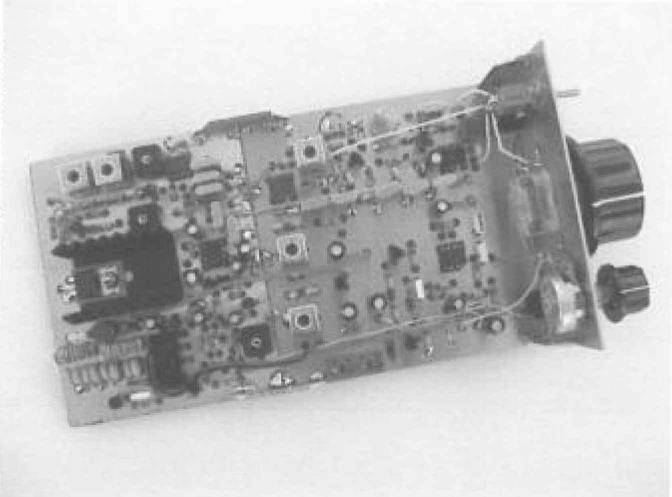
How time flies! I must apologise for being a little late in production of this issue of Hot Iron. Its been a long and cold winter down in Somerset so I have spent quite a bit of time on farm and electronic paperwork in the house! The result is some new projects (see later) that were so engrossing that I have hardly noticed that we are now in another month! However the good news is that it is at last beginning to dry up and the sun has been out leading to a more positive attitude on many fronts! Soon I shall have to start thinking about how to erect some extra aerials for QRP in the Country. There is plenty of space but too few sky hooks! For these occasions, where multi-band operation is wanted, my good friend Eric Godfrey G3GC, used always to say that there is nothing to beat a half wave for 160m, supported at the middle and ideally at the ends also; fed by open wire line with a good balanced resonant AMU. I recall him spending hours making such a feed line with glass spacers and hard drawn copper wire; but I shall be resorting to BT style twin 'drop wire' which can be split for the arms!

I mentioned the price of mechanical items last time - imagine my surprise when I contemplated re-ordering the upright heatsinks that I use for the 5W rigs. My usual distributor had upped the price to nearly £4 each! That called for some hard bargaining! Tim G3PCJ

## Kit Developments

The Mendip and Polden are being tested by Eric Bowell and Richard Booth. This has thrown up a few small errors in the instructions but no significant problems with the circuit or track! By the time you read this I shall be ready to take orders at £110 post paid. (In case you have forgotten, it's a specialist 3 band 20/40/80m 5W CW TCVR with phasing RX - see website.)

The other new projects are the **Digit** scanning counter (see later) and the Tone/Parrett combination (right). This pair are an entry level 80m single sideband receiver and separate 1.5W SSB TX which together form a TCVR, & can take the 10W Linear. I need some early builders! 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

## ***Simple antennas for Low VHF*** by Andy Howgate

Some years ago I made several J pole antennas; they are a super antenna and work ever so well. It is made from plumbers copper pipe so it takes some time to make one, and mounting it is not so easy because you have to make up an insulating section and the engineering takes a hell of a lot of effort. I searched the web for something simple and found a few ideas on the DX zone website - how some chap got his 4m antenna working I will never know because I tried it without any success! Eventually I settled on an idea I have used time and again over the years, either in wire form for horizontal or a more sturdy fixed structure for vertical polarisation - but always its the hardware and making the antenna fit to some location that is the problem.

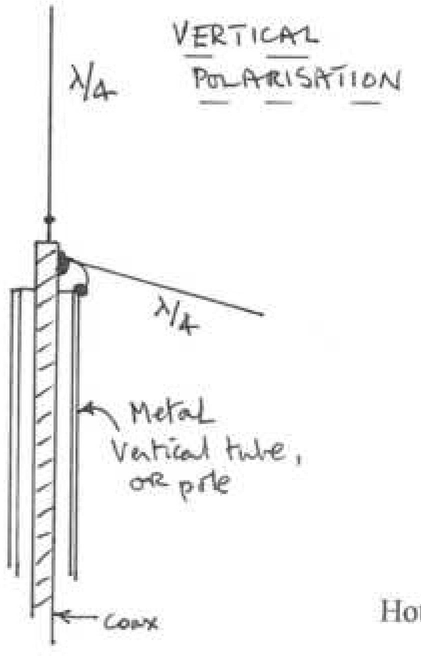
I had a very aged 2m/70cm Colinea so that came apart and the inner radiator, which is inside the glass fibre tube, was removed and in its place I used one of those pull up whips (a long one) used on some VHF BC radios. I had a pair of them which was handy - the whip is fully adjustable from 6 inches to 1.2m so I set it for 101.5 cms which is a 1/4 wave right in the middle of the 4 m band. For the element lengths, I find if one uses the usual formula for an HF dipole it is not far out for VHF up to 2m. Even if the match is not good immediately, you can play with the angles till it come right.

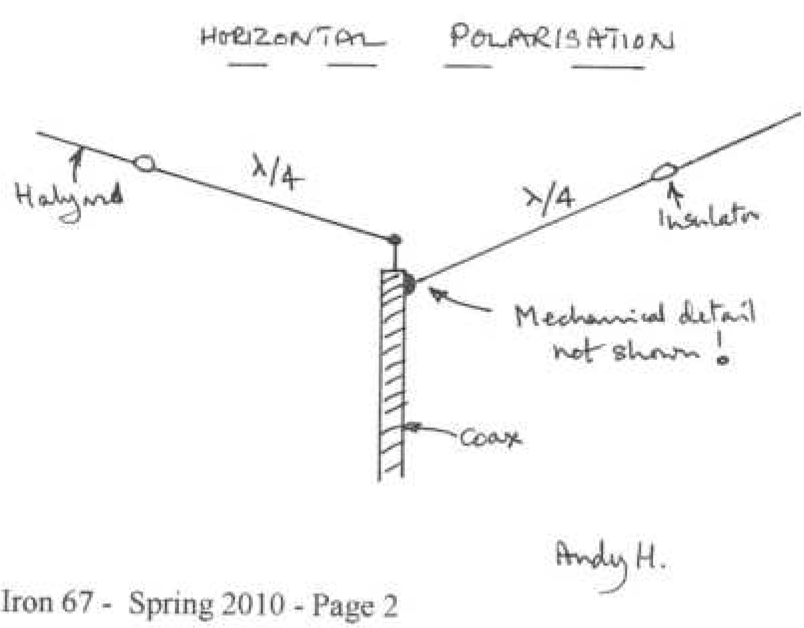
I put the antenna back together and then used the other pull up whip as the counterpoise or other half of a dipole; but the difference is to get a perfect match this is angled at about 100 degrees from the vertical radiator - this gives a 50R match from previous experience; if it were arranged as a normal vertical dipole the match would be nearer 70R and thus offer an SWR a little way off - its probably OK but angling the ground side element so it looks like a drooping L shape, you can get a full flat match - I suppose its a bit like a 3 radial ground plane with two ground planes missing however I have found this makes an excellent antenna.

Now you would think this vertical will be OK till you bolt it to another structure like a pole but oddly adding much metal to the antenna does not affect it at all; it appears to be the dipole radiator length set at an angle that has the affect on bringing the antenna to a match. Satisfied with my efforts once it was up, I rechecked the match and it is flat across the whole of the 4m band. Great! So put out a call on 70.450 FM, and low and behold I worked a station up the coast from here - some 28 miles with 4 watts so I reckon that was darned good with the antenna only 20ft off the deck, so at no great height, the other station was using 15 watts.

You can use the same approach of altering the line up of the two elements for a nominally horizontal VHF antenna. My 6m dipole is like this but with less than 180 degrees between the arms so it resembles a shallow V dipole, but set nominally horizontal for SSB working - again one can get an excellent match.

Like I said - a simple antenna, without major matching networks and hours of engineering!

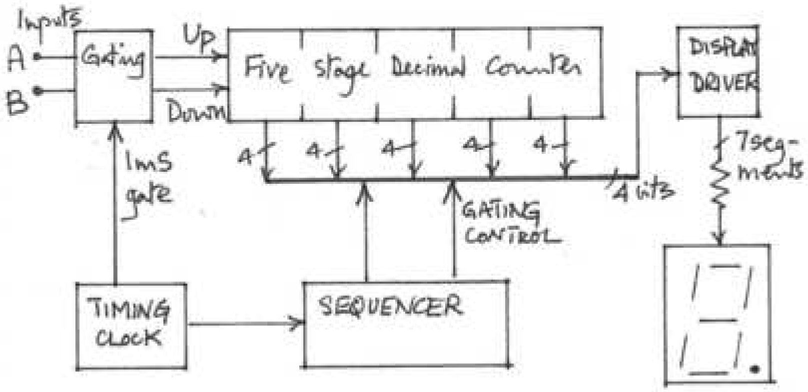


## ***The Digit***

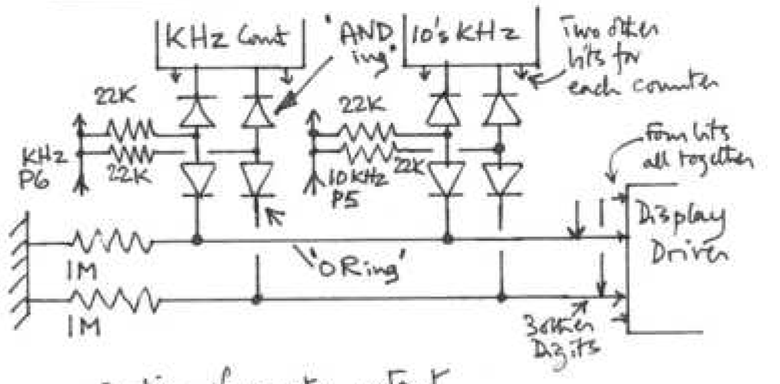
The counter was given this strange name by Andy Howgate when we were discussing an earlier version! The intention is to reduce the cost (and ease of wiring to the display) by sequentially scanning and showing the numbers to be displayed on a single 7 segment display. This cuts down the number of wires to the display to just nine; and this new design allows the display to be mounted on the counter PCB, or for that end to be cut off and connected by a ribbon cable.

The challenge was to find a discrete logic approach that builders would be able to understand, would permit construction and testing in stages, and which could be repaired in the event of failures! (Undoubtedly a micro-processor approach would have less parts and be cheaper, but the designer is then the only person who understands how it and the software works, and its unlikely to be repairable - so no good for us!) CMOS decade up/down counters are needed to minimise the supply current and electrical noise. The 74HC192 is suitable and can be cascaded directly for use up to over 40 MHz. By using an accurate 1 mS duration for its counting period, the least significant counter stage will then show the KHz number so that five stages will allow a maximum reading of 99.999 KHz (not actually achievable due to the chip max frequency limit.) Each chip has a four bit digital output for its decimal count number; so these five 4 bit numbers have to be sequentially input to a suitable driver chip that will also decode the display segments to be activated. I choose a large 7 segment LED because it is far cheaper than any liquid crystal display! This leads to the simplified block diagram right.




BLOCK DIAGRAM OF THE DIGIT

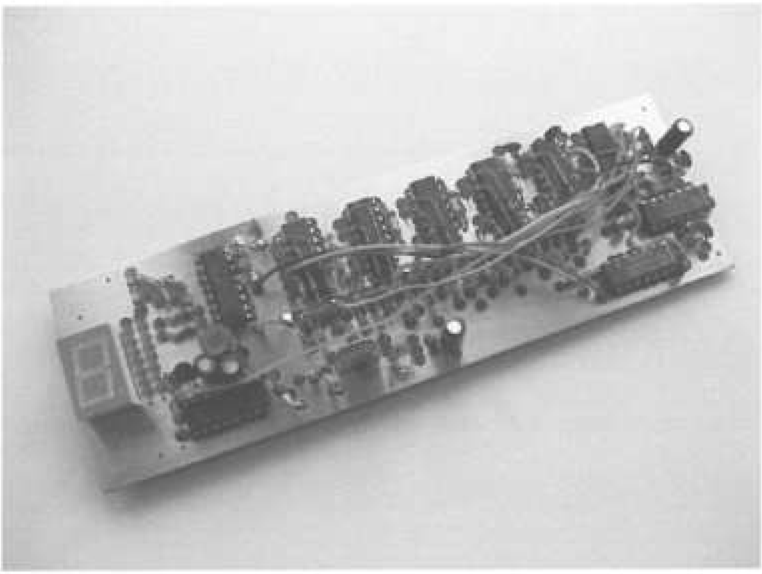
The reading of the counter outputs sequentially leads to a quite complex gating task, which if it were to be done with integrated circuits, would add many more chips; luckily it can be done with diodes as there is no requirement for high speed! Each 4 bit count number has to be first ANDed with the particular display digit period signal, and then ORed onto the four display driver input lines. This (simple!) logical task needs 40 diodes and 24 resistors so is relatively very cheap! The partial circuit right shows how it is done when speed is not an issue, by increasing the resistance values of successive stages to avoid loading the earlier one.




Section of counter output gating.

G3PCJ

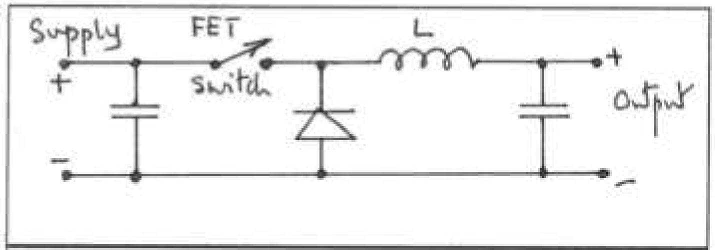
One other trick is to alter the control of a 74HC4060 clock divider so that it provides accurate 1 mS pulses repeating about every 0.2 seconds for timing and sequencing the displayed number! Add in the two input channels for up or down counting so that it can suit additive or subtractive superhets, or rigs with converters like the Mendip, with either input up to about 45 MHz and one has a very versatile low cost unit. Just £24 & some care! G3PCJ



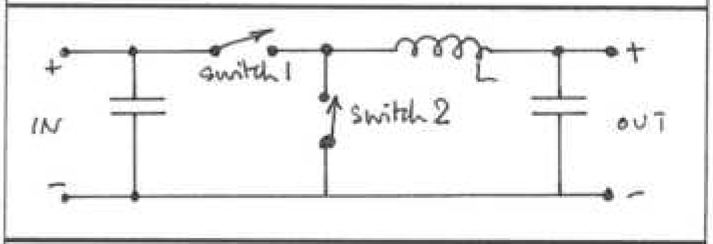
## ***Switched Mode PSU Configurations***

I have always been intrigued by the different topologies that are used in modern switch mode PSUs - there are many whose merits for different applications I have never properly understood! Because they have a reputation for being electrically noisy, I have always stuck with (wasteful) linear regulators within my rigs. However, with the increasing emphasis on design for reduced power consumption in modern commercial electronics, you cannot ignore the advantages which come from using switching technology. In addition, with decades of experience, the methods to tame the electrical noise problem are now also better understood. The diagrams down the right show five of the more common approaches with some brief comments on their uses.

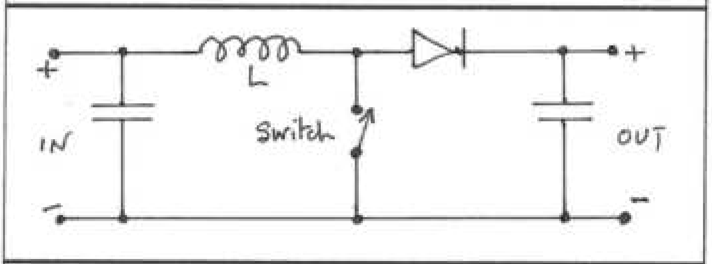
**Buck.** Step down. Typically Vin is 3 to 5 times Vout. Up to 5A. Good efficiency.



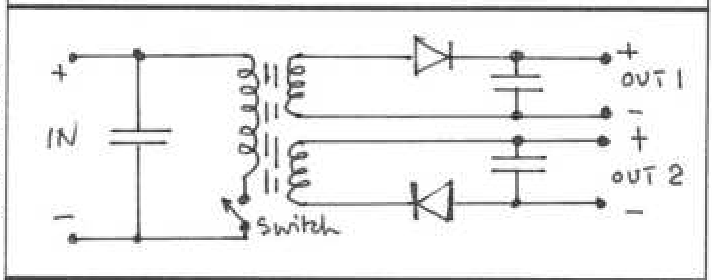

**Synchronous Buck.** Step Down. Vout nearer Vin. Better efficiency under high output over 5A.



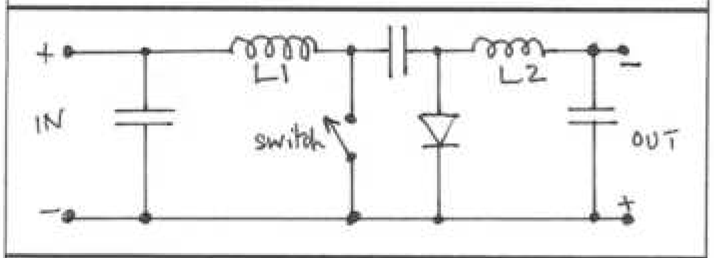

**Boost.** Step up. Transformerless design suitable for more than 200 mA up to about 20W and output less than 7 times input voltage.



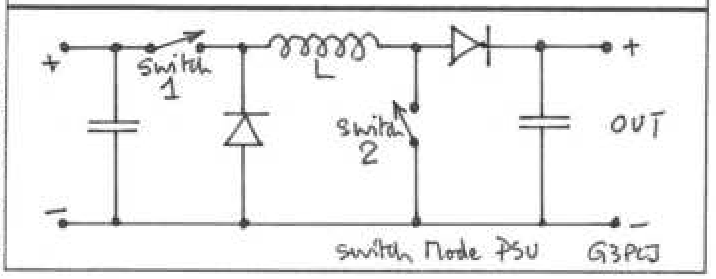

**Flyback.** Step up or down due to transformer which also gives isolation and potentially many voltage lines of either polarity. Suits higher output voltage ratio than Boost configuration. To 100W. Can use higher switching frequency than raw AC mains hence small transformer.




**CUK** Can invert for negative Vout with positive Vin without a transformer.

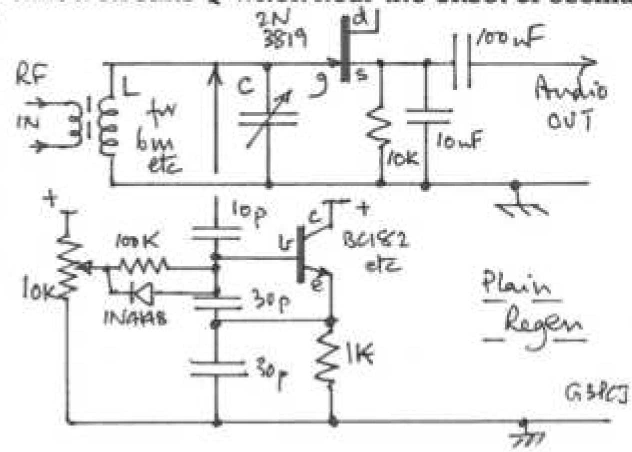



**Comment!** I see that one manufacturer advocates a combination of Buck and Boost (right) for automobiles where Vout is say 5 volts but under cold cranking the battery input may be down to nearer 4 volts instead of normal 13.8v! In practice the switches are mostly watty FETs driven hard on or off with much thought about the actual current paths to reduce radiation (avoid loops) and plenty of decoupling for noise reduction. G3PCJ



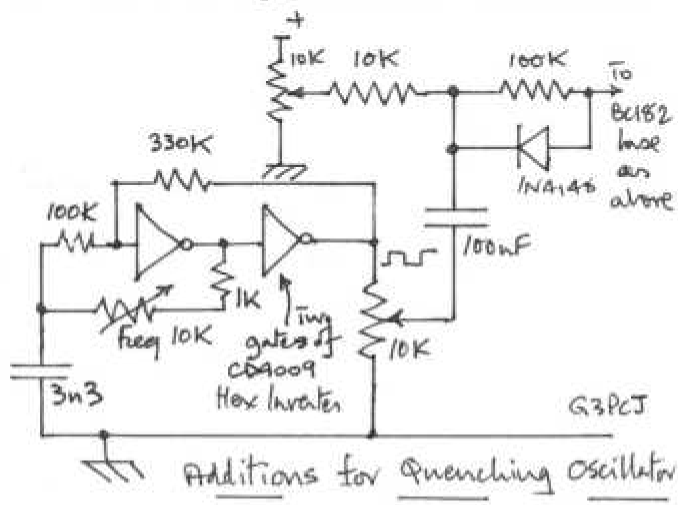
## ***Regens into Super-Regens?***

I have been asked recently if the Chirnside, which is a normally a plain regen, can be turned into a super-regen RX. This answer is yes and no! Yes, it can but then its unlikely to be all that good for modern amateur use! First a word of explanation! The characteristic of a regen that makes it so appealing is that it greatly increases the tuned circuits Q when near the onset of oscillation - this has two desirable consequences. Firstly the RF bandwidth goes down increasing the selectivity markedly and this leads also to a big increase in gain. The bandwidth can get so small (for HF circuits) that it will cause clipping of the sidebands and so reduce the received audio bandwidth of conventional AM (and also of DSB/SSB). Hence it has much merit in a crowded band! The box right shows the RF part a typical plain regen. Note that I add a diode compared to many designers because this will stabilise the oscillation amplitude for those conditions when oscillation is required (CW and SSB/DSB). The oscillatory circuit can be a Colpitts (as shown) or the Hartley configuration, but the former has more discrete capacitance which helps to swamp changes in device capacitance with bias voltage and temperature.




For the super-regen, the oscillations are allowed to build up and then killed off on a regular basis which is called quenching. This can be self controlled or directed by an external quenching oscillator whose output is applied to the regen's bias input. For my experiments about wartime super-regens, I wanted external control of the quenching frequency and bias changes. I modified a 6m Chirnside circuit as shown below so that it could in effect be either. When detector output is viewed with a scope triggered of the quenching oscillator, it is lovely to see the effect that introducing an RF signal has! The normal detector output is the pulse envelope of the build up of the regen's RF signal. In my case I let this RF envelope hit a bias limit so that it was the *earlier* rising edge of the envelope that indicated the presence of the incoming RF signal. Without any RF input, the envelope peaked about 5 /uS after the bias change, and the introduction of the RF carrier (from a GDO on the next bench set to 50 MHz) made that rising edge occur about 1 /uS earlier. It is this change in timing (and hence area of the pulse envelope) which can be used to demodulate the audio modulation of the incoming conventional AM signal.

The consequence of making the 'detector' super-regenerative is that it becomes a sampled data system where Mr Shannon's famous sampling theorem comes into play. He pointed out that to recreate a signal, the sampling rate had to be at least twice the inverse of the signal's bandwidth. A consequence of this is that the RF bandwidth of the regen circuit is now affected by the frequency at which it is quenched. A low quenching rate will lead to less change in bandwidth and vice-versa. It is however inevitable that the RF bandwidth is appreciably greater than for the plain regen. It's a complex relationship and because the quenching rate needs to be super-sonic, the bandwidth increase is significant. This means that for a crowded modern band with large signals, the receiver is likely to be swamped and unable to distinguish one signal from another. Because these conditions did not apply in the 1940s as there were so few signals, the advantage of extremely high gain was far more important than the loss of selectivity. In fact the wider bandwidth was actually required on reception to ignore the jump in RF frequency when the other set went to transmit. (These sets often used a single RF circuit to determine the frequency for reception and transmission.)



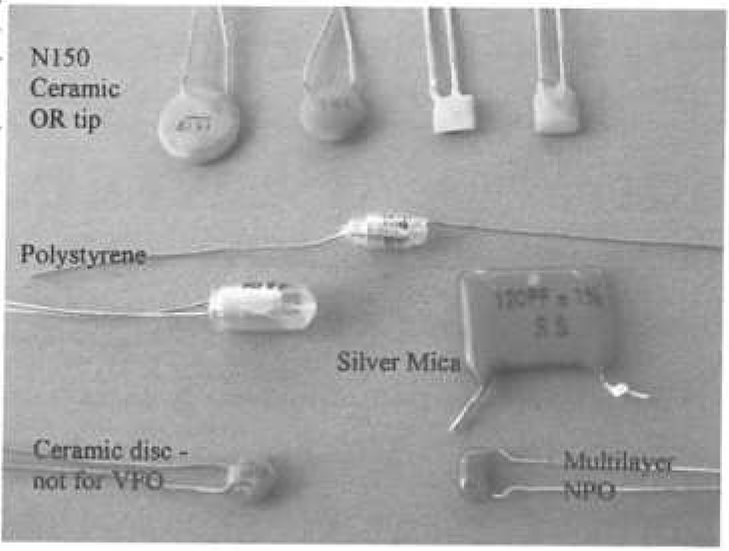

Hence it is best to alter a regen to super-regen with care so that it can be either! Tim G3PCJ

## ***Low Value Capacitors***

Recently I realised my stock of 150 pF ceramic plate capacitors was uncomfortably low and I went to order some more. Imagine my annoyance when I found that none of Farnell, RS, Rapid, Maplin or CPC had any of them! These are the small rectangular thin yellow jobs with almost indecipherable markings! It eventually emerged that they are no longer made - I suspect it has something to do with the fire in the factory that the manufacturer BCE-Sud had about 2 years ago!

This is really rather worrisome as negative temperature coefficient capacitors are needed for VFO circuits to counter the positive tempco which most inductors exhibit - including most of the (no longer made) TOKOs that are commonly seen in home built amateur HF equipment! Without these negative tempco compensating capacitors the VFO will be unstable; the inductance increases in value as it warms up, and hence the frequency of the VFO goes down. The yellow 150 pF ceramic plate caps had a N150 tempco meaning that their value decreased by 150 parts per million for each degree Celcius rise in temperature to compensate for the change in inductance.

For 18 pF and below, the yellow ceramic plate range had a tempco of zero +/- 30 ppm/°C , for 22 pF to 150 pF it was –150 +/_ 30 ppm/°C and over 150 pF it was –750 +/- 120 ppm/°C. Hence anything larger then 150 pF was useless for VFO purposes as the compensation was too great. Many years ago similar capacitors were made with a grey body and had a coloured flash to indicate the tempco, black for the nominal zero tempco - this is also known as COG or NPO - the latter meaning negative positive zero! The N150 type had an orange flash and the N750 was purple.




I have failed to find any source of a complete range of N150 types but I did eventually find that some values of the yellow type were still in stock and I have bought quite a lot of them, but there are gaps in my inventory. Sorting through my old stocks I found that I did have quite a lot of 150 pF with the desired orange N150 flash (see right) made by other manufacturers and I shall supply these only where they are used for VFOs. For general use in tuned circuits such as RX input filters then it is not necessary to have the N150 types and I will supply COG or NPO versions. So for all future kits, I shall identify the ones that need to be temperature compensating types! It's a complication that I would prefer to avoid but we will have to live with it! I guess the reason that none are made any more is that nobody makes HF VFOs commercially any more - they use microprocessor controlled DDS chips instead! By the way, those round yellow 65 pF film trimmers that I use are also no longer made!

The good news is that COG or NPO ceramic disc types with values suitable for tuned circuits are available but beware - their tolerance is often +/- 5 or even +/- 10% compared to the +/- 2 % of the yellow ceramic plate types. We shall have to get used to using these instead!

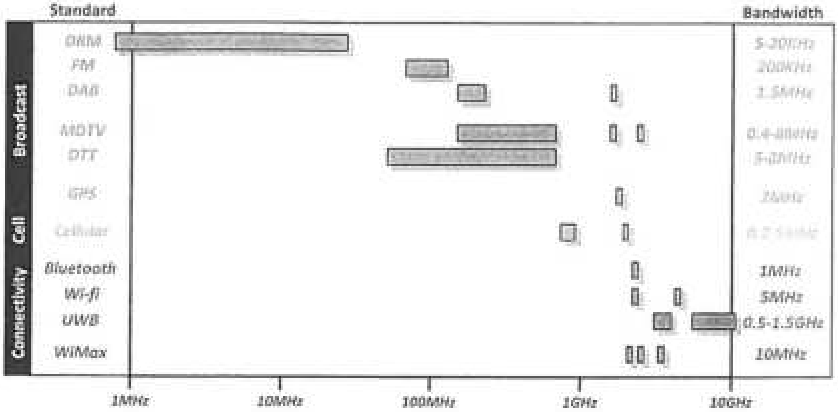
You can also still buy silver mica low value caps (usually small positive tempco but wide variation); they are expensive often starting at nearly £1 (for small quantities) for small values and rising to £20 for 47 nF!! You can also still get the small cylindrical polystyrene variety (usually N150) but the value range is often limited and they start at about £1.25 each 1 off!

As an aside, do not use types radial multi layer types with X7R or Y5V dielectrics for tuned circuits. The former has a tolerance of +/- 10% but a tempco of +/- 20%. The Y5V sort has a tolerance of –20 or +80% and tempco of +22% or –82%. Both of these sorts can be used for decoupling supplies but they can be micro-phonic, so are not good as coupling capacitors in audio applications. It is better to stick with polyester for audio work, or ordinary aluminium electrolytics. I am afraid the supply of nearly all through PCB components is getting distinctly awkward! Tim G3PCJ

## *Snippets!*

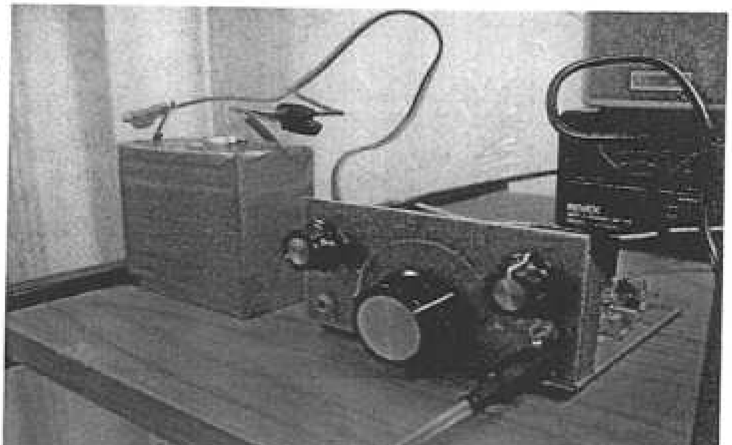
*Very High Speed!* Toshiba have recently announced the ability in their silicon foundries to offer 180 GHz RF devices using 40 nm CMOS. These devices can be integrated with other circuits on their 'system-in-package' devices. The F(t) of these transistors can be 90, 140 or 180 GHz! Makes the BC182 @ below 300 MHz look a bit slow! Passive elements both capacitive and resistive can be added, as well as varactors and half turn differential or symmetrical inductors. Many of these parts have zero tempco! (What a relief - see previous page!) All you need to do is send them a net-list and Spice models etc and away you go!

*Standards* I came across this diagram right showing the bandwidth and frequency of various radio services recently. I must admit to being puzzled as to how many of the modern 'digital' formats are supposed to use less bandwidth than the earlier versions. (What happened to Mr Shannon's opinion?) I suppose that the digital encoding can be more efficient (so reducing the bandwidth required) but the increase in data content brings the bandwidth numbers back up again. I am struck strongly by the increase in power consumption of many domestic receivers that is required to decode these modern formats compared to plain conventional AM or FM. This cannot be good for the environment - especially in the less developed parts of the world where simplicity, repairability and long life are more important than in so called advanced western societies.




## Rechargeable batteries in laptop computers by Paul Tuton

It's been my experience that these can appear to be discharged / worn out when the cells are actually fine. I've been through all the usual procedures - recalibrating and so on and seen that these have no effect. The computer constantly reports 'low battery' and most recently, an Asus laptop would run for only about 1 minute following a full charge. The battery was only about 15 months old. However, on dismantling the plastic case and removing a Heath Robinson arrangement of battery management electronics (probably the source of the problem), a quick test with a 12v headlamp bulb indicated that the cells were healthy. I reassembled them into a convenient, compact package and connected it to my Maha charger / conditioner. Sure enough, it reported that the battery was already fully charged.



I've included a digital snap of my 80m Highbridge showing the reconfigured Asus battery (Samsung cells). It provides 17v and the TX output is almost 10 watts. The battery capacity is about 3 amp hour so it lasts and lasts. Every couple of weeks, I give it boost with the Maha. If you have a laptop battery that seems to be expired after only a short life you might find that the cells are fine. They are an excellent basis for a compact, high capacity battery. I now have several and they give a few more volts than you normally get from a gel cell. Just a note of caution; handle the cells with care. They contain a lot of energy.

## *Old items wanted!*

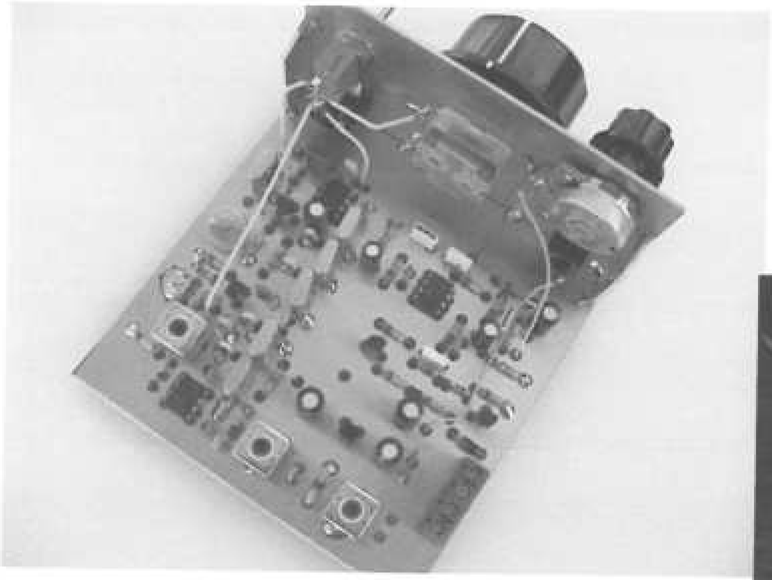
Godfrey Manning G4GLM writes saying that he operates a spares service for old transistors. He is delighted to take good old specimens when you next have a clearout! If you need an obscure old one he is also very happy to supply if he has them. He also wants useable lengths of the old style PVC 240v permanent mains installation cable that had red and black cores with or without an earth wire, (and the three core versions with red, blue and yellow). These are for restoration jobs - it is the old colours that he wants not the old sizes of wire! For those of you living in large old houses, he is also on the look out for the wood and brass electric bell indicator 'boards' that were used in the 1920/30s to tell the staff which room wanted service! If anybody can help, then I can put you in touch. Tim

# *QRP in the Country*

Don't forget that its all going to happen here on **July 18th!** I hope that those of you in West Country already have it in your diaries! The arrangements are coming along well. There will be several threads and some of the local west country clubs are likely to have their own tables or stands. The full line up of G3GC Plank items (right) will be among the attractions!

The other attractions include:-
Construction advice clinic,
Informal home construction competition judged by our member Gerald Stancey G3MCK (who can also tell you about sundials if the sun is out!),
Somerset Range kits to operate (and even buy!), like the Tone superhet below,
Transformer throwing competition,
Bring and buy sale,
Food and drink from local sources. The Long Sutton brewery and local organic hog roast are planned!

And then you can do a farm tour led by my wife Janet. If your local Club would like a table for displays or Club items, then get them to get in touch with me. The event is open to all with free entry!



You might even see a Brent like that built by Ryan Pike! He had a good selection of 20m crystals and with a switch was able to make a compact 20m rig.

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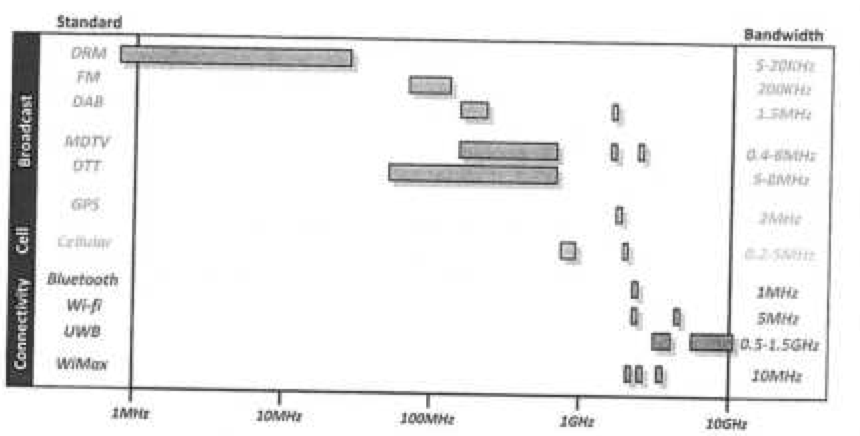


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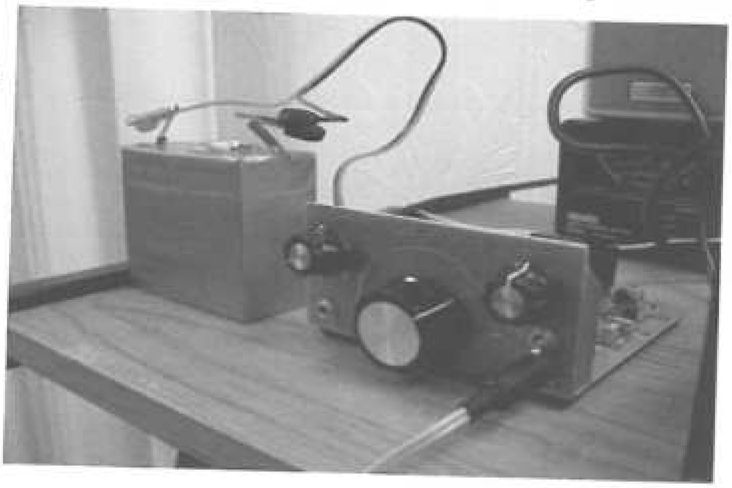

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# Multi-standard RF front end

requirements for the RF circuitry are principally the same, namely:

- Supporting a large frequency band of operation and wide range of channel bandwidths
- Supporting a high input signal dynamic range (low noise, high linearity)
- Co-existence with other RF functions and immunity to 'real world' interferers
- Accommodate antenna limitations i.e. size, antenna sharing, antenna isolation etc
- Low power to maximise battery life
- Enable low system cost
- Deliver a small solution size

Of course these considerations are typical to the system integration of any RF front-end, but the challenges become even more acute when co-location of multiple radios is attempted due to the aggregation of disparate requirements.

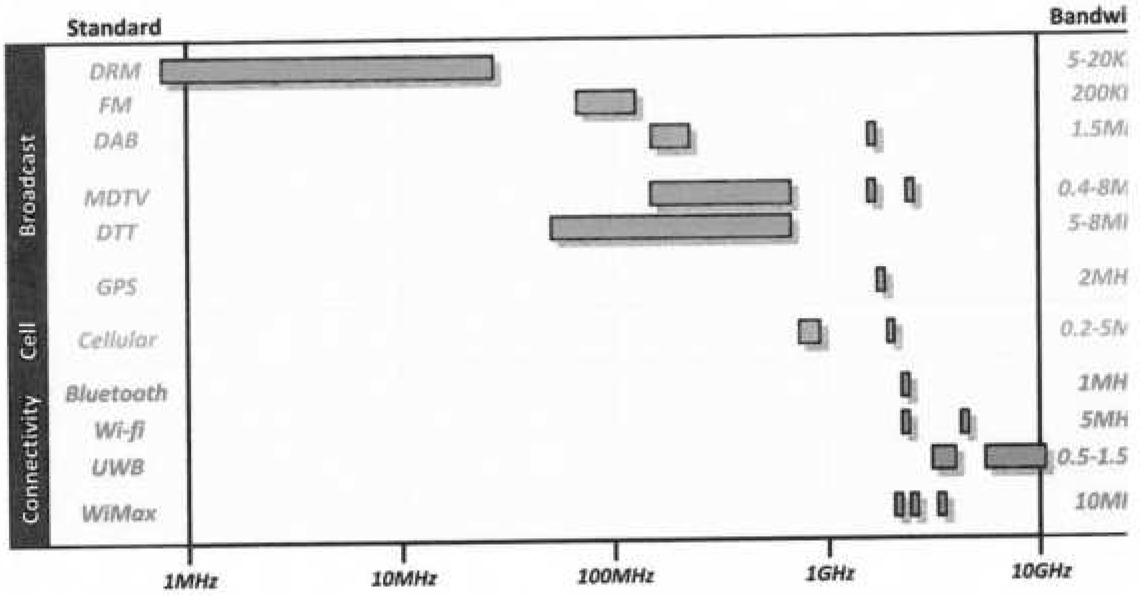
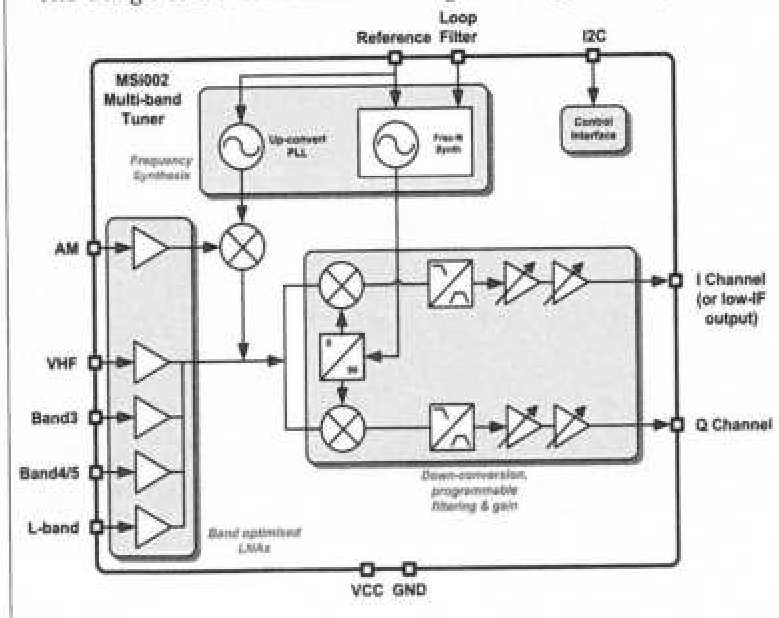



Figure 3: Spectral allocation (log scale) and channel bandwidth of various radio standards.

Figure 3 depicts the spectral allocation for various broadcast, cellular and connectivity standards. Even if the market requirement for an all encompassing product existed, a single front-end could not realistically enable support for the listed radio standards; the vast operational frequency range, various channel bandwidths and differing dynamic range requirements are simply beyond cost-effective implementation today.

### A Multi-standard front-end example

The design of a multi-standard front-end that 'only' delivers broadcast TV and radio reception in a portable device covering FM, DAB and DVB-T (for EU market) is challenging in its own right. The receiver's synthesizer must cover one decade in frequency from 88MHz (FM) to over 800MHz (DVB-T), support frequency step sizes down to single digit kilohertz (FM), deliver low integrated phase noise to support 64 QAM modulation (DVB-T), and also feature low single-side band noise to mitigate blocking effects. Additionally, the receiver's RF input stage must support a large dynamic range enabling reception of signal levels from as low as -105dBm (FM) to as high as 0dBm (DAB) often in the presence of interferers, whilst the baseband section must support channel bandwidths from 200KHz (FM) to 8MHz (DVB-T).




The design of a multi-standard receiver from Mirics.

One method to address these distinct requirements would be to design multiple RF chains interfacing into multiple corresponding baseband circuits. However, such an approach would result in a die size so large as to be commercially uncompetitive if only one or two application standards were to be supported. A better approach is to employ a reconfigurable receiver architecture.

Robust performance in the presence of unwanted interferers is vital to ensuring a good user experience in the 'real world'. In the case of this broadcast receiver example, typical sources of on-channel interference include high power FM signals, whose second harmonics may fall onto the wanted DAB signal, or harmonics of DAB signals falling onto the wanted DVB-T channel.

Additionally, harmonic mixing products of the wanted signal and oscillator may also fall in-band. Other interference scenarios which result in blocking of the wanted signal include the presence of strong adjacent channels, or reciprocal mixing of wideband interfering signals due to inadequate phase n Careful choice of down-conve architecture (heterodyne versu modyne), use of harmonic reje mixing, and on-chip filtering help to alleviate these problem

As Figure 2 illustrated, ant integration must be conside any multi-standard system. I case of broadcast reception plexing, tri-plexing and even c plexing techniques can be us reduce the physical number o tennas that must be integrate a CE device. However, wideban tenna frequency response and tiplexing insertion loss must al considered.

There are also significant p and size trade-offs between op partitioning of signal processi tween the RF front-end and th ital demodulator. Analog filt is a good example of this poi an RF front-end provides too analogue channel selectivit die size is negatively impacted versely if insufficient analog lectivity is delivered, the demc tor's analogue-to-digital con faces unreasonable dynamic requirements. Such carefully sidered system trade-offs ca liver significant technical and mercial benefits.

Chet Babla is director of marketing a Mirics Semiconductor

"JOURNAL OF THE CONSTRUCTORS CLUB"

# Hot Iron

Summer 2010
Issue 68

## Contents



The Walford Electronics website is also at www.walfordelectronics.co.uk

## Editorial

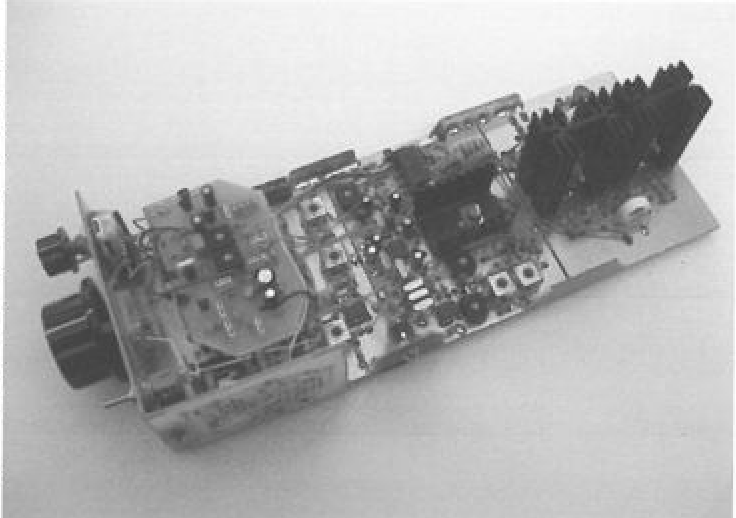
We are hearing more now in the media about Digital Britain and it makes me feel distinctly nervous - especially the bit about the closing down of our current analogue radio services. I refer particularly to the proposed demise of Band 2 FM analogue transmissions and the AM ones in the medium and long wave LF bands. Apparently we will have to equip ourselves with so called 'Digital' receivers more properly known as DAB receivers. I think I have also heard that our DAB is not a world standard either. I am delighted that Rob Mannion G3XFD, Editor of PW, has been leading a national campaign to continue with the analogue services. There is a good note by him on the Southgate ARC website.

We are urged to become more green but the change to DAB is certainly not that! The radios consume about twice as much power as their predecessors, and of course considerable resources are used to build the new radios - much more than building an analogue one. DAB radios are prone to aerial problems and are not liked by the motor manufacturers. And where will students learn about the analogue fundamental building blocks of radios? This is a real problem - a student at a recent Bath Buildathon had never built anything electronic despite studying for an MSc in advanced radio techniques. Can one home build a DAB radio? I think not! But some amateur radio kit gear will still be analogue! Tim G3PCJ

## Kit Developments

No fully new kits since last time, but I have been trying out a number of the latest versions of replacement accessory kits. My version of the basic Tone and Parrett 1.5W SSB 80m phone TCVR now has a Linear for 10W, the new Mini CW kit, and the new Mini AGC. The latter is especially useful with the Tone as its simple audio output stage can't deal with really big signals, that crop up suddenly as you tune across 80m! The picture right has all these extras hung onto my favourite open style of construction!

I am pleased to report that a couple of builders now have their Digits working too!



*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 

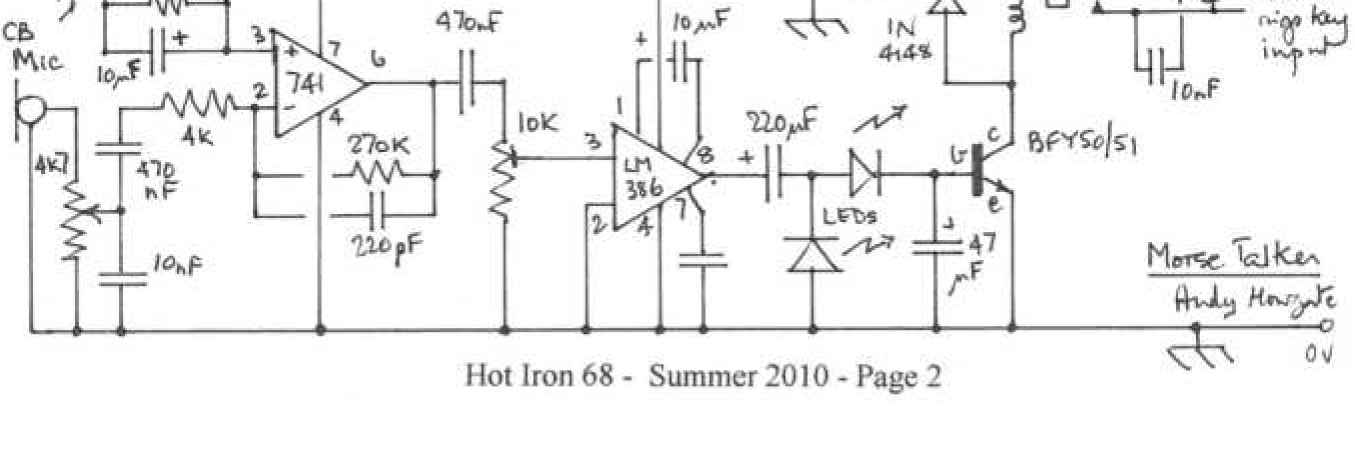
## *Morse Talker* by Andy Howgate

The article in Sprat 141 by Michael Rainey AA1TJ set me thinking about those people who had lost the ability to use a morse key due to arthritis or some other affliction. Morse is often taught by the sound of the characters ie C may be written and spoken as Dah di Dah dit so one could use the voice to send morse by talking it. A few hours on the bench yielded the circuit below. The Morse Talker as I have called it, was used initially to key the side tone of a rig without transmitting; however I used a morse decoder which was listening to the side tone - the result I am pleased to say had the morse decoder reading what I was sending thru the morse talker circuit, now I figure if the morse decoder can read it then on air it should be read OK by another operator.

The circuit is rather crude and basic stuff using components likely to be in your junk bin or parts drawers. A standard CB mike can be used - the circuit is a high gain amplifier driving a pair of LEDs which will illuminate and rectify the audio from the amplifier stages, which when smoothed, turns on the BFY 51 transistor operating the small relay that keys the transmitter. When using your voice to talk morse in Dahs dis and dits, you don't even need a side tone. Another advantage is that there is no conversion from thinking morse to a movement of the hand, and you are less likely to get cramp or be stiff or tired, hi hi!

There are other uses for this circuit. One may use it to send pre-recorded morse tones either from a computer's sound card output or a tape or digital recorder. To test the Morse talker circuit I used an old Datong morse tutor with the output fed to the morse talker simply because I wanted to test the reliability of the relay so it was left running at something close to 20 wpm for several hours without any problems. Another very amusing moment was to place the microphone close to a rig's speaker with the rig tuned to a morse signal, the morse talker's relay now keying the Datong's inbuilt oscillator and then wearing a pair of headphones to listen to the morse tones coming not from the rig but from the tutor's oscillator. The thing is one has the almost perfect audio filter but that is not true in a real sense, the tutor's in built oscillator is producing morse tones which is a facsimile of the original as taken from the rig - inevitably one needs a filter ahead of the morse talker circuit and whilst this use is not perfect for morse reception, I am sure it could be developed further.

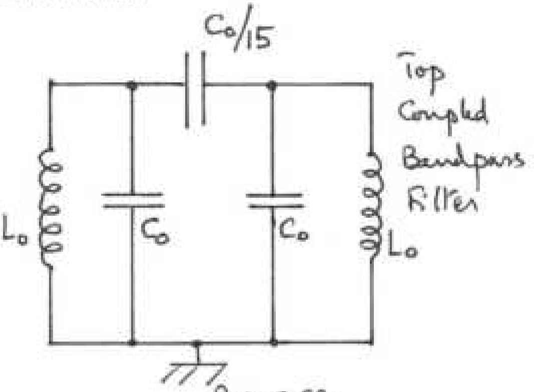
There is a few things that needs to be observed for the keying wires from the relay to a rig - I used mini 50R coax and the relay and all associated wires needs to be kept well away from the amplifier especially the preamp and it maybe prudent to put it in a cheap alloy box. Setting up is easy - the 10K preset is adjusted for the suitable sensitivity required and the 4.7K pot is taken into consideration allowing for adjustable gain when the device its completed and lid is on. A standard inexpensive CB type dynamic microphone is used with an impedance of 500 R. Although not shown on the circuit the microphone line can be switched inside the CB mike but one must be aware switch noise may trip the relay and or a noisy PTT button may also cause a pip to be transmitted. The Hyperbright LEDs can be mounted thru the box and will give an indication when the morse talker is keying nicely, one may also send morse using the light display pretty much as we may have done as children with a torch but if no illumination is wanted, then a pair of IN4148 diodes will do in place of the LEDs. All one has to do now is talk in normal voice the rhythmic morse sounds of Dahs dis and dits, it does not take much effort and you may find you can run away with the lip and tongue a bit to quickly till you get tongue tied hi hi. But at the end of the day it can be good fun using it. One final thought, one may have to assemble a Morse Talker before an affliction happens or get a friendly constructor to assemble it for you after the misfortune.



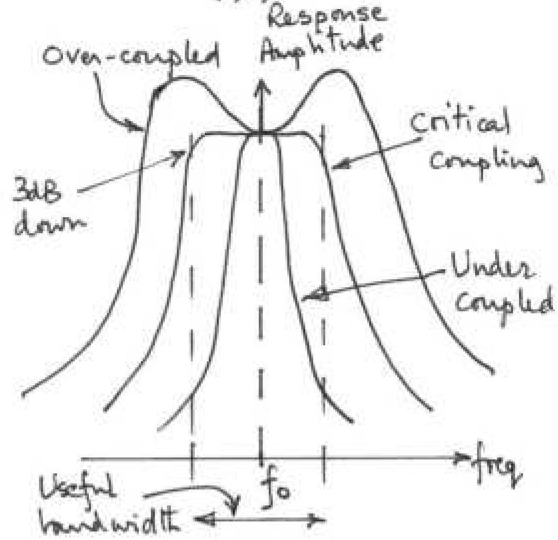
## ***Bandpass RF Filters***

Craig Douglas G0HDJ sent me outline details of his proposed 'VFO' for his new 15m rig and explained that he had spent some time considering what filters to provide. The basic design of the LO chain is a 5 MHz actual VFO mixed with a 16 MHz crystal oscillator to produce 21 MHz for the RX and TX. This needed a filter on the output of the SA602 to select 21 MHz and reject the other main mixer product at 11 MHz. Initially he considered a high pass filter which would reject everything below about 18 MHz, but the snag with this is that the higher unwanted order products above 21 MHz would still get through and might cause a spurious response in the RX.

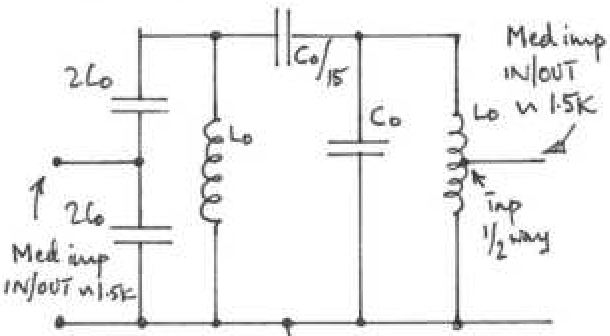
My own preference would be for a bandpass design centred on 21 MHz. Often a pair of top coupled parallel resonators as shown right is sufficient. Ignoring the input and output aspects just for the present, the question is how to size the top coupling capacitor. (There is also an inductively coupled version but most people prefer using Cs to Ls, so it is not often used!) If the coupling capacitor is very small, little signal will go from one resonator to the other, leading to a peaky response that can be imagined by superimposing the humped response of one tuned circuit on top of another identical one!

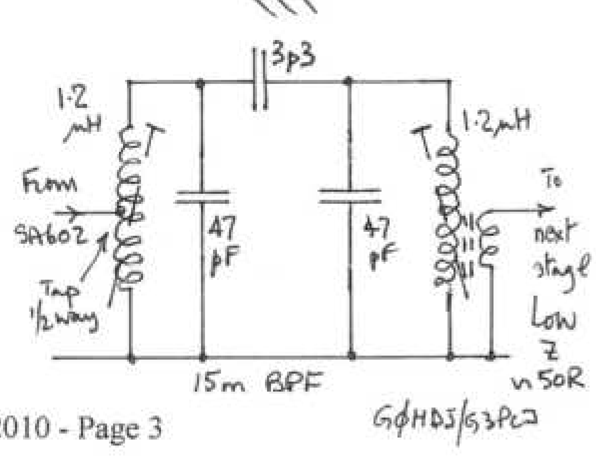



Alternatively, if the coupling capacitor is 'large', then they become 'over-coupled' which leads to twin peaks separated by a slight trough. In most situations the ideal response is a near flat top with the shoulders being just large enough to encompass the desired operating band - this is called critical coupling. In practice, small deviations from this ideal shape are not too serious as changes in propagation conditions or other factors are often much more significant in determining the effectiveness of the filter. Often a good slope on the sides of the response is more important for high rejection outside the pass-band. You can do some maths to get an exact size related to the wanted bandwidth, but you will often not be far out if the coupling capacitor is roughly one fifteenth of the value of the resonating capacitors.




Coupling in and out can be done either by capacitive or inductive tapping. In both cases, the aim is to prevent the external impedances (from the driving or load circuit) causing a severe reduction in the effective Q (or tuning sharpness) of the resonant circuits. In many applications, the Q will be sufficiently high if the 'transformed' external impedances equate to over roughly 5KOhm across the whole of each resonator. If capacitors are used then two equal double value capacitors in series will retain the same resonant frequency, but allow a load of one quarter of that 5K, or 1.25K for source or load impedance. Similarly, a mid inductor tap will have the same 1:4 impedance transformation effect. (Think of turns squared ratio for transformer impedance transformations!) You can also use a separate winding with half the number of turns. Taps nearer ground (or smaller input windings) will suit lower impedances, or taps nearer the top for high impedance. In Craig's case, for matching to the 1K5 output impedance of the SA602, this leads to the design right if using TOKO 3335 inductors of nominally 1.25 uH. The purists might object but this approach but it's a jolly good starting point if you don't like maths! G3PCJ



## *Radio in World War II*

As part of my researches associated with my friend's war time bunker, I have recently read three books that I can thoroughly recommend:-

1. Between Silk and Cyanide - A Code makers War - Leo Marks - ISBN 978-0-7509-4835-7
2. The Secret Wireless War - Story of MI6 Comms - Geoffrey Pidgeon - ISBN 1-84375-252-2
3. Colossus - Bletchley Park's Greatest Secret - Paul Gannon - ISBN 978-1-84354-331-2

Most people will now be aware of the immense contribution made by all the teams that came together under the general heading of code breaking at Bletchley but these books brought out several new aspects for me. The involvement of radio amateurs is well recognised, in many spheres and I already knew of the role of Voluntary Interceptors, which had been explained to me by my late good friend Eric Godfrey G3GC who was one, and who managed to combine this with working for Alan Blumlein in the EMI research labs at Hayes. Often much of the HF morse traffic that they logged was received on very simple regenerative TRF receivers - often with only 2 valves. This logged CW traffic was sent by post originally to Box 25, Barnet, where it was analysed and passed to Bletchley for breaking of the coded messages into clear text. Encryption by the German Enigma machine was eventually understood sufficiently well for a very large proportion of these manual morse messages to be fully readable. As the war developed, the value of this intelligence required a quicker response and several dedicated HF receiving stations were built, and connected by land line to Bletchley for quicker analysis.

As the German armed services spread over Europe, the traffic became too large for plain manual morse and automatic methods were developed. Telex type services using typewriter style direct entry keyboards to paper tape were widely used but these also had to be made secure. These transmissions used high speed tone modulation of an HF carrier, and highly directional large aerials with relatively low transmitter power. A special receiving station was built at Knockholt in Kent to capture these signals which were relayed by land line to Bletchley. The German firms Lorenze and Siemens made coding machines that used a form of automatic rotor wheel encyphering - a bit like a more complex version of the Enigma manual machine! These non morse messages proved extremely hard to decipher and required far greater specialist processing power at Bletchley, where statistical text analysis methods became more important. The Post Office research station was heavily involved and eventually, with the development of suitable valved circuits instead of relays, produced Colussus. This staggering machine was the fore-runner of the European computer industry and was many years ahead of what was being done in the USA. At the end of the war several of these were in use, together with many other forms of 'processors'.

Of course, enemy transmissions were just one type of HF traffic; there was also a large listening and transmitting operation associated with our underground agents in occupied territory. The establishment at Whaddon, near to Bletchley, made very large numbers of so called 'spy' sets throughout the war that were used for this purpose, and also in our embassies abroad. Examples of the common models (like the Mk III) are still in use at special events. There seems to have been a very strong dependence on American receivers where portability was not important - HROs and AR88s being almost universal. The UK designed and made transmitters were all crystal controlled and seldom more than a crystal oscillator followed by a power output stage, that could also often double the frequency. The familiar 6V6, 6L6 and 807 beam tetrode valves feature strongly!

Having decoded and assessed the overheard information this had often to be sent back to Allied forces without revealing how the information had been obtained! This again called for an elaborate system of dedicated HF transmitters and receivers. As the Allied forces began to move into Europe, the pace of movement was often such that further specialist mobile HF cars or vans were provided for important commanders. Many of these vehicles were equipped at Whaddon with much the same equipment that was used for communication with agents in the occupied territories. Many famous people were involved in all these operations - too many to list in this article!

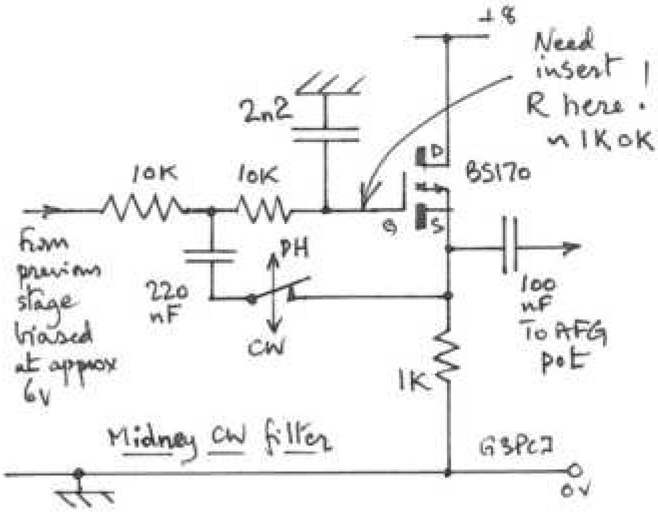
Another radio aspect was propaganda broadcasting to the German Services and their wider population. In the second half of the war, this had been developed to a fine art and used the Aspidistra transmitters at Crowborough in Sussex; the first installation needed a labour force of 600 men and was completed in about 9 months. American transmitters were purchased that could produce 600 kW on Medium Wave; the site also had at least two 100 kW short wave units.

Fascinating as this is, it has not yet explained the workings of Auxiliary Unit's TRD! G3PCJ

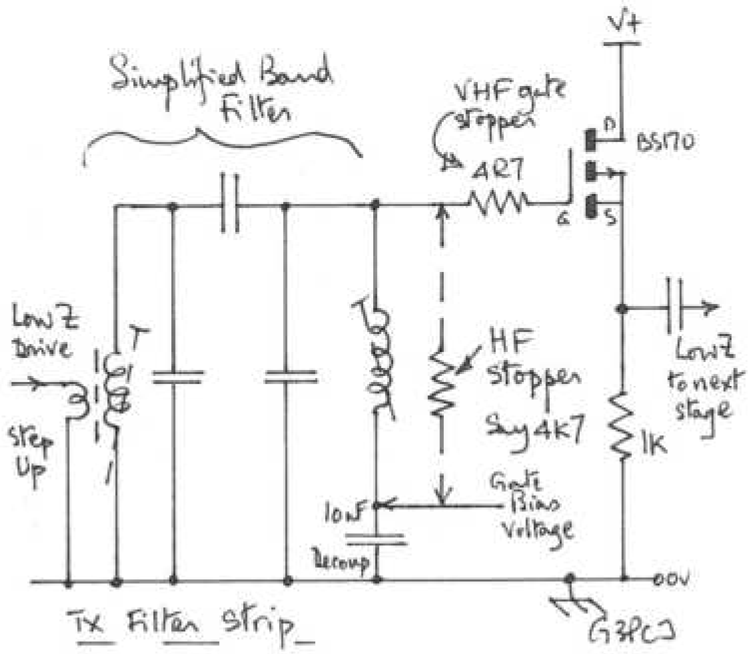
## ***Beware of 'buffers'***

No - I am not branching into railway matters, despite I K Brunel being one of my heroes! This warning is about emitter or source follower buffer stages. Valuable as they are for driving a lower impedance load than the existing source can stand (with near unity voltage gain); they can lead to unexpected results, as I have found out to my cost on a number of occasions!

Many years ago, I had a problem with the audio CW filter in the Midney. It is a single BS170 stage arranged as a common source follower, in a Sallen and Key low pass filter; it had a toggle switch to open the feedback path for the wider phone bandwidth - see circuit on the right. This circuit has an appealing simplicity for changing the audio bandwidth! Initial listening tests showed that it was not passing the audio signals smoothly. Investigations with a signal generator and scope (equipped with normal divide by 10 probe) showing it working exactly as expected! Eventually, I found that it failed the finger test - ie prodding around with ones fingers - initially hoping to find a poor joint! In fact the extra damping from my finger (resistive and or capacitive) was curing the problem. My test gear didn't (and could not) show it up, but the stage was actually oscillating at VHF! Applying the scope probe stopped the oscillation! The source follower had sufficient output capacitive loading (from source to ground) so that it was forming a crude Colpitts oscillator using its internal gate to source capacitance! The cure is simple when you have deduced the problem - add a low value gate stopper resistor in series with the gate input to the MOSFET - at the point marked R in the above circuit! In MOSFET audio stages this can be any convenient value up to a few K as it will not affect the audio bandwidth - I used 1K. The same problem can also occur with bipolar transistor emitter followers; but this time the base current requires a low value resistor to avoid altering the bias conditions, so add a few tens of Ohms to reduce the gain at VHF to below that required for oscillation.



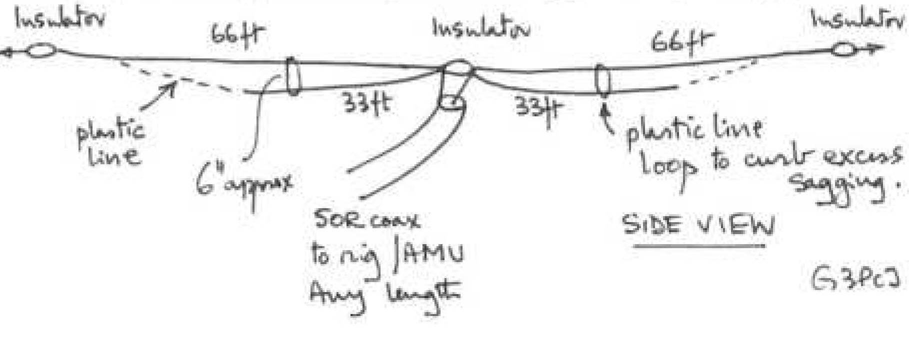

One can also fall into a similar trap with RF circuits. In a linear transmitter RF output line up needing a bandpass filter, one approach for achieving the desired gain is to use the inductive voltage step up possibilities of the filter input 'inductor'. One then has a higher RF voltage which needs 'buffering' so that it can drive the following lower impedance output stage - hence a source or emitter follower is needed. The threat of VHF oscillation is still there but there is another problem from the resonant circuit at the input to the buffer stage. Give this too much Q and it will oscillate at the wanted signal frequency!! Much the same oscillator circuit is at work (the darn Mr Colpitts again!), but because it is active at the intended operating frequency, you cannot just add a gate stopper as above! You need to reduce the Q of the tuned circuit. This needs to be done with care as its there to reject unwanted signals and heavily flattening its response will ruin that effect. Parallel tuned circuits still exhibit useful Q when they are loaded by about 5 K, and often a few K across the output resonator will kill any oscillation at the signal frequency but not totally ruin the response. G3PCJ

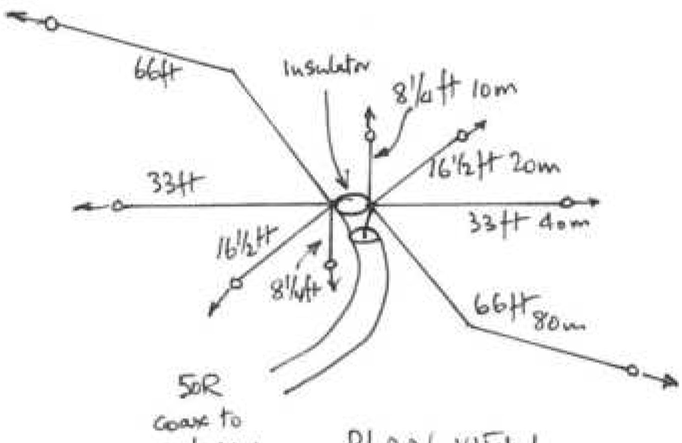


## ***Nested Dipole antennas***

Charles Wilson kindly sent along some notes based on articles that originally came from QST. The first is for a multi-band dipole antenna. It is actually the 'nested' form of dipoles connected to a common coaxial feeder. The authors version had four dipoles for 80, 40, 20 and 10m; but the 40m will also work (and match) well on its third harmonic so this array will also do 15m. Coincidentally, I had decided to use nested dipoles for the main HF antenna on Jul 18th for QRP in the Country. I wanted only 40 and 80m operation and had started with salvaged BT telephone 'drop' wire which is hard drawn copper in a twin split-able figure of 8 PVC configuration. I intended to have each arm 65ft 6 inches long for 80m, and to cut one conductor at 33 ft and remove the outer section for 40m. But I wondered what effect the high capacitance between the two wires would have - would it be lossy or ruin the resonances hence needing changes in lengths? To avoid any chance of problems, I thought it best to separate the wires of each dipole by a few inches. How to do this and keep everything light? Searches in long abandoned cupboards produced some thin plastic line originally intended for an electric strimmer head. Nice and light but strong enough to pull the shorter dipole up to a few inches below the main 80m one. After splitting the wires, I found this did droop a little too much, so a couple of loops of this plastic string part way along (and secured in plastic with PVC tape) cured that! As a warning, if this is to be a permanent installation, you need to find a way of securing the ends of the plastic string because it will eventually undo and slip along. Lots of clove hitches help but a judicious melting of the plastic might secure one turn to another!

The QST version with four dipoles got over the inter-wire capacitance problem by laying them out horizontally over all points of the compass! The author had trees or buildings suitably dotted around his garden and even bent some of the wires to make them fit. Its very simple - all the wires on one side are joined to the coax inner, and all the wires on the other side to the coax screen. Given the good match between dipoles and feeder you might even get away without the need for an AMU! G3PCJ




## ***Very Smart Brendon!***

Many Brendons have been built but not too many like this which will even go into the US 75m band by using a 4 MHz ceramic resonator!! Built by Jim N7JS.

## Snippets!

***Rechargeable Batteries*** A couple of interesting notes recently. Firstly in Radcom May 2010, where Richard Newstead G3CWI extols the virtues of Lithium Polymer batteries. Their price has come down in recent years making them now an attractive alternative to lead-acid gel cells, especially for portable use. A quirk is that the single cell voltage is 3.7 volts, so a common pack is of 3 cells producing 11.1 volts nominal. Many nominal 12v rigs that are favoured for portable operations like the FT817, will run comfortably on this, albeit with slightly less RF output power. You can also use four cells for 14.8 volts and reduce this with a silicon diode or two, which you can short out when the cells get a bit low. The main advantage of LIPO cells is their higher energy density - such that the same energy is held in about one third the weight and nearer a quarter of the volume! But beware - they can deliver (or accept!) seriously high currents if allowed to do so! Consequently it is suggested that they should be charged using the specialist chargers and the actual battery be in a fire proof box or be outside!

The second note in Technology First (from Farnell) explains that Lithium is the lightest solid metal and has an intrinsic negative potential larger than all other metals, so that depending on the other electrode, the cell voltage is between 1.5 and 3.6 volts. As explained above, the energy density in weight and volume terms is unrivalled currently. Lithium based cells include poly carbon mono-fluoride (Li/CFx), manganese diode ($Li/MnO_2$) and lithium thionyl chloride ($Li/SOCl_2$) often abbreviated to LTC. Cell construction is important - spiral wound cells are used to reduce their impedance owing to the higher surface area of the anode. Typically spiral LTC cells have an energy density of 800 Wh/litre and service life of about 8 years. In contrast bobbin wound ones have an energy density of about 1420 Wh/l and a lower self discharge rate such that service life can be up to 25 years theoretically! This makes them very attractive for low consumption applications such as domestic meters for gas supply. Apparently over 3 million have been deployed worldwide! A recent development is a hybrid construction that can take or deliver extremely large currents;100s of Amps to over 1000A!

## Customer Feedback

Ted Williams G4NUA writes: 'I built the 20 metre version of the "Fivehead". As you suggested in your write up, tuning can be a bit tricky on SSB, being of an age where the hand is not so steady, this was very much the case. Having been in the TV trade many years ago I remembered about varicap diodes, and decided to have a go. I decided to start by connecting a 100K pot to the 8 volt supply and standing the earthy end off with a 56k resistor, this in turn gave me a voltage swing of approximately 5 volts, 8v to 3 volts. During a discussion with G3XBM he suggested the use of a red LED as the varicap, with a suitable RFC and a couple of decoupling capacitors this seems to work well. I placed the LED and the RFC as close to the variable capacitor as possible and was then able to mount the pot on the from panel (see photo). Each of the 3 sub-bands when switched give me a swing of approx 60 KHz per switch position, the varicap diode give me an additional swing of about 1 KHz. In passing I removed C150 the fixed value for a variable cap, this allowed me greater control of the frequency spread, so I now have a nice overlap between 14.125 and 14.340 KHz. Many thanks for a great project TED G4NUA best 73'

# QRP in the Country

This is going to be a ***real radio field day***! To be held here at Upton Bridge Farm, Long Sutton, Langport, Somerset TA10 9NJ on July 18th and all radio enthusiasts are welcome. Entry is free! Homebrew radios is the theme! Gate opens at 10 am. I hope that all west country members of the Construction Club will be able to come!

There will be many attractions, including:-

Special event station GX3CMH/P operating SSB, CW and AM on 40 and 80m
G3GC replica 1935 CO/PA 807 TX and associated RX, VFO, modulator etc
WS 19 HF sets and WS17 VHF 6m operational on phone/CW
Informal home built competition – bring your entries please!
Construction and advice clinic
Displays of Walford Electronic kits
Display of antique domestic radios
Award of Bath Buildathon Competition prize by Rob Mannion G3XFD - editor PW
Competitions, with Bring and Buy stalls
Several West Country Club stalls with PW and the RSGB in attendance
Farm tours (1 mile walk) led by my wife Janet
Local food (barbeque) and beer for sale

In the event of poor weather, all will be under cover in the cattle sheds! For further information please contact me Tim G3PCJ at walfor@globalnet.co.uk. Here is some of the kit that will be on air (I hope!).

# Subscriptions!

I regret it is that time of year again! How time passes more quickly as you get older. The next issue of Hot Iron is the first of the membership year and I need to receive your payment of £7 for UK members by Sept 1 2010. Overseas membership costs £9. The price remains unchanged despite the threat of a rise in VAT! If you wish to pay via Paypal this is fine, but please add an extra £1 for their fee. All I need is your fee and name/address. To keep it interesting your contributions are essential! You will get bored of me writing it all each time! Any article or note, about your experiences, hints and tips etc. are especially welcome. Allow for about one side of A4 ideally with some sort of picture or diagram. And I am very happy to attempt to answer member's questions. If you don't feel too confident about producing material that is fit for publication I will do my best to turn it into reproducible form! Hope to see you July 18th! Tim G3PCJ

"JOURNAL OF THE CONSTRUCTORS CLUB"

# Hot Iron

Autumn 2010
Issue 69

## Contents



The Walford Electronics website is also at www.walfordelectronics.co.uk

## *Editorial*

The start of another Construction Club year and the sun is out for the Bank holiday weekend, the harvest is in and it has also rained enough to get the countryside green again! Thankfully our clay ground held enough moisture for the corn yields to be reasonable despite the very dry spring/summer here. I also sense the economic climate is beginning to look up very slightly. The new Government has also had the good sense to put the Digital Britain plans on hold - by waiting for demand to be very much higher before deciding whether and when to shut down Band 2 analogue FM broadcasts. No doubt that the public campaign run by Rob Mannion in PW and the national press has had a significant impact - well done!

Yet another positive thing is that my file of raw material (from others) for this issue of Hot Iron is rather fuller than normal! Thank you to all who have contributed notes - it makes my life much easier and makes it so much more interesting for members to read! Keep it up please!

Some of you kindly came for QRP in the Country here this year - and since I have not got a suitable new rig photo to put below, I will give the rest of you a glimpse of what you missed! The 'Planks' are being earnestly discussed by Gerald G3MCK and others! Note the date for next year now - QRPiC 2011 Jul 17th! Tim G3PCJ

## *Kit Developments*

Farming has been a pesky intrusion this last few months so not much time for radio - but the new Mini CW and Mini AGC kits are now available as accessories for most rigs. In the last month, I have been trying out a very early version of a new 'CW trainer' kit called the **Radlet** which then becomes a complete CW TCVR! See later.

A recent talk to the Yeovil Club about the **Tone** also brought home the need for a low cost entry level DC RX - I am currently working on concepts for this which will hopefully get the price down to the sub £30 region. It will be called the **Yeo.** Tim G3PCJ

*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

## ***QRSS – The Real QRP*** - **Doing more – with less** - by Andrew Atkinson

I first started getting interested in QRSS about eighteen months ago, and I have to tell you, it is one of the most fascinating and enjoyable aspects of our hobby that can be found. Well, for me at least, it certainly is. So, what is QRSS? Quite simply, it is the sending of a morse signal very, very slowly using no more than a fraction of a watt. How slow is 'slow'? The QRSS10 standard equates to a dot length of ten seconds and a dash length of thirty seconds. How do you hear it? Strangely, you don't, you hook up the audio output of your receiver to the soundcard of your computer and let some very sophisticated (and free) software do the rest for you. Perhaps I have made this all sound a bit complicated thus far, so I'll slow down a bit and go through all of the steps in more detail. I should also add that it is almost impossible to convey all of the information you need in the space of a short article such as this, so take the time to visit **www.g4cwx.com** and select the QRSS link on the right hand side of the screen for useful links, contacts and a lot more besides.

**Why do it?** I suppose the real question is "Why not do it?" To start with, QRSS is not hungry on bandwidth. Typically we only use a 100 Hertz segment of the lower end of the 30 metre band. With such a narrow window in which to work, we each limit ourselves to only a few Hertz of that allocation. Less output power also means less input power required. Hence I run my transmitter from a gel cell battery hooked up to a small solar panel for recharging.

Surprisingly QRSS has been going from strength to strength since it first started about 8 years ago. Initially the tests were conducted over relatively short distances, but as time passed the power levels have decreased and the distances over which signals have been heard has increased significantly. On 30 metres, for example, it is fairly common to be received in the USA on a lot less that 100 milliwatts - many people use much less power than that – even microwatts. This often equates to something approaching 8 million miles per watt – not bad performance for such a mode of operation. As each month passes we see a steady increase in the number of amateurs around the world both transmitting and also setting up "grabbers" to receive QRSS signals and display live digitised feeds on the internet. It has now become incredibly easy to set up a small station and some companies are even selling specially designed kits specifically for this emerging market.

**Receiving QRSS** This is, without doubt, the easiest bit. I am going to make an assumption that you have an HF amateur bands receiver of some sort. Connect the output of the audio to your computer soundcard input. I use a commercial interface to save the possibility of blowing something up, but it is easy to construct a small opto-isolator circuit. Now download the free "Argo" software, tune your receiver to 30 metres and you are ready to start receiving QRSS signals.

Although the easiest mode to transmit is plain CW, you will also find examples of DFCW, FSCW, Slowfeld and lots more besides. The Argo screen on your computer will display a form of waterfall which makes the QRSS signals stand out as white dots and dashes against a dark blue background. Whilst Argo is, without doubt, the easiest to get up and running, it is by no means the best tool in the box. Spectran and Spectrum Lab are excellent tools, but they do take time to learn. This might sound a bit like cheating, but if you do not want to go to the trouble of setting up your own receiving station, you could always have a look at Claudio's (I2NDT) web site **http://digilander.libero.it/i2ndt**. Then select "Knights QRSS Compendium Grabber". This is where many of us have our grabbers showing live received data on line updated every minute or so.

**Transmitting QRSS** Frequency stability is essential. Simplicity is the best approach - a crystal ('ovened' ideally) controlled transmitter with a small amount of frequency shift from a varicap or LED diode is sufficient. The only other requirements are a stable power source and a keyer. The latter can be purchased from one of the "Knights" - check my web site for more information. I suggest initially connecting the transmitter to a dummy load first and watching the output from an Argo screen on your computer. This will show you very clearly exactly how stable your transmitter is – and also whether it is in band. So, if all is well, you can now connect your aerial and start watching the other grabbers around the world to see if you can identify your signal.

**More information** One of the really enjoyable aspects of QRSS is that you suddenly become a member of a very exclusive club. Everyone involved is incredibly supportive and more than willing to help newcomers. There is a truly first-rate mailing list (reflector) which shows what is going on. There are details about propagation, bands in use, and much else. So, the first thing to do is visit my website. (Andrew sent some screen shots but they don't photocopy well - photos of some kit on next page! Tim) Then start receiving some QRSS signals yourself, get your TX out and I hope to see your signal! If I can help in any way, please email me at andrew_atkinson@hotmail.com

## *Invisable Aerials* by David Proctor

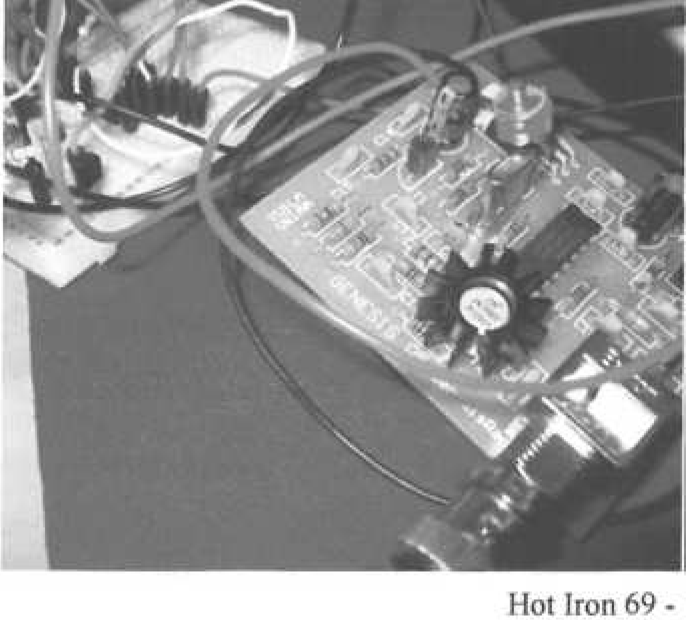
Back in the 50s when I was an SWL I always had room to put up a decent long wire, or dipole. Now, somewhat older, we have moved to a nice house but with a small garden. The front is open plan (no aerials) and the rear garden is 35 feet wide and 35 feet long, where it meets a 10 foot wide stream, beyond which are 60 foot chestnut trees. This is in the North York Moors National Park, so any new aerial needs approval by a committee that probably don't understand what amateur radio is all about.

A hidden aerial was therefore needed – but what? I considered all sorts – thin long wires – and dipoles that would have to be bent. Then I thought of a loop - why not wind it round the house as high as possible? Then the plastic gutter came to mind. Loops are inherently balanced (depending in their symmetry) so no earth is required. The house is 25 feet wide, and the side gables 27 feet long: this gives a loop of 104 feet, or 31.7m. I ran a plastic covered 24swg wire round the house, but looped out into the back garden to get the total length up to 40m. One neighbour asked what the "strings" were in the garden! The diameter of the wire with plastic is over 1mm, so I am about to use 0.56mm bare copper wire in the garden bit of the loop to reduce visibility.

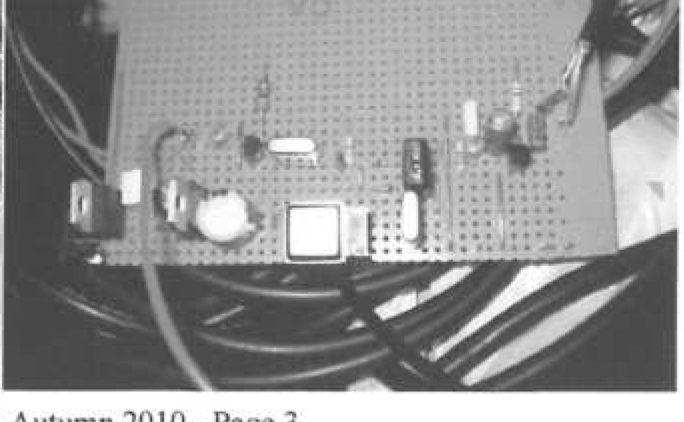
My present shack is in an upstairs bedroom (not far from the gutter!) so a very short length of 300R feeder into a 4:1 impedance transformer feeds the ATU and into the rig. As to results:- being a QRP CW person, and when compared with a 40m dipole, the loop seems to do well. It loads up OK on 20, 30, 40 & 80m and I have worked round Europe with 5 Watts. Durability of the wire is my only concern. The wire in the gutters is stationary and has shown no deterioration in two years, but the wire in the garden is sometimes brought down by flying mallard ducks that fly over the stream – so I am raising the fixing point (they do not fly so high!).

I would recommend the plastic gutter loop to anyone with space restrictions, because you can't see it, it is balanced, and it works!

Comment by G3PCJ. I understand that David has his wire laid mostly in the gutter, so it is immersed in water when its raining! I just wonder if it might be less lossy if it was below the actual gutter - some gutter support brackets have a small gap between them and the half round of the gutter itself which might allow the wire to be held pretty close to the bottom of the gutter to keep it concealed. If this is not too important it could be allowed to sag a little between the brackets (or even alternate ones) to further separate it from the water! It would be interesting to know what the house's internal pipe-work does to the radiation pattern!! David - something to evaluate and report in Hot Iron??!!

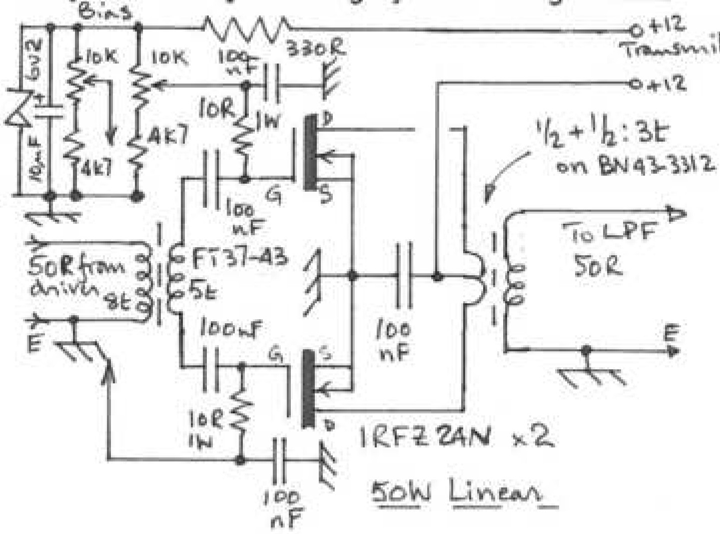


This is some of the kit that Andrew Atkinson uses for QRSS - on left is the 30m Genesis transmitter with bread-boarded keyer, and below is a Poliakov design RX for 30m.



## *50 Watt Linear suggestions*

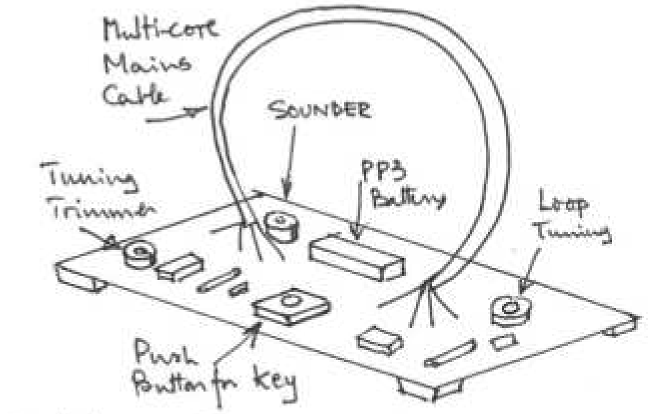
Charles Wilson kindly sent along some ideas for a 50W Linear to run off a nominal 12 volt supply on 40m. It uses a pair of IRFZ24N MOSFETs in a push pull configuration. The original scheme had temperature sensed bias circuitry but with careful use I doubt this should be necessary - a stable DC voltage should be OK for MOSFETs as the idling current should decrease as they get warmer. When running at full power they will dissipate roughly 50W so generous heatsinks will be needed, or smaller ones with a blower. The nominal 5W input (50R) drives a broadband transformer that feeds the two device gates. To deal with the high gate capacitance, the transformer is loaded by 10R 1W resistors on each side. Given the lack of anything to force driving symmetry, individual bias presets are desirable so that each device has an idling current of about 120 mA, which can be tweaked for least harmonic output. The output transformer has a centre tapped primary and should feed a low pass filter to remove unwanted harmonics. These devices could take higher supply voltage for more output!G3PCJ



50W Linear

## *The Radlet*

This is a novel design that starts life as a CW trainer and turns into a full blown CW TCVR! It had its origins in something for Morse code practice between two people. Initial ideas were a squeaker with connecting wires. Andy Howgate thought it would be a much better if the students could practice adjusting a receiver and work from room to room without wires! His idea was for two very simple TCVRs with short aerials. Back to drawing board with much head scratching - short aerials are OK at VHF but would these students be able to build a simple VHF rig - NO! (Nor would it be cheap!) Consider using HF loop aerials - but how to make them a practical size - that needs multiple turns. How about multi-core mains fixed installation electrical cables which might just be stiff enough? This possibility seems viable so how to make a rig that has a very low parts count, and yet is worthy of the name of TCVR and not 'toy'? I eventually hit on a TX output stage that can also act as a strong receiving mixer - and it is fundamentally broadband too! The builder can start with the sidetone for one-on-one sessions and then add the RX, and eventually the TX/ loop. I anticipate that even on a 9v battery they will work over half mile or so. With a full sized aerial it should be pretty good and ought to do any single band 20 to 80m with a crystal or ceramic resonator. It will of course be compatible with a normal TCVR. I have yet to try it out properly and make certain that chirp and the like are not a problem - so no orders just yet! Target price for a single kit is under £30 or two for about £55! The basic kit will have a (very) small LS, PP3 battery holder and push button for key, in a flat open format, but an optional extra kit will provide full sized controls for serious use. The sketch right shows the concept! Keep your fingers crossed!



Radlet CW Trainer © G3PCJ

## *The Yeo*

This new DC RX is for entry level Club Construction projects. (The Knole is too complex/ expensive for this.) The aim is to have a decent DC RX that can eventually work with a TX if required rather than a toy which is built and then neglected. I hope to get the price down to £29 (including PP3 holder and LS) with full sized AFG pot and PolyVaricon main tuning of 3 sub-bands selected by a toggle switch. The operating band to be builder's choice of 20, 30, 40 or 80m. This will be open style in the small upright PCB front panel format. The devices will be the ubiquitous SA602 and an 072 dual op-amp plus an output buffer stage. Watch website for progress! G3PCJ

*Three Books* - reviewed by John Teague G3GTJ.

In my opinion the paramount book on amateur radio to be published for decades is the ARRL's "Experimental Methods in RF Design." It has set a standard against which I measure other books - not that I buy many - but I find that as middle age begins to be overtaken by old age the inclination to read about what one might be doing in the workshop tends to displace actually picking up the soldering iron and making hardware. Thus less money is spent on kits and more on books and I always happy to find companions for Experimental Methods in my "Shopping Book" category. These are books always ready to be snatched up when my wife tells me as we set off for somewhere "I just want to pop into Tesco on the way" and are dipped into while she combs the store. There is always something interesting to read or re-read; shopping books have to have plenty of circuit diagrams, technical discussion and related equipment photographs to qualify.

The books, all published by the RSGB within the last twelvemonths, are "HF Antennas for Everyone" 330 pages compiled by Giles Read, G1MFG; "International QRP Collection." 174 pages edited by George Dobbs G3RJV and Steve Telenius-Lowe 9M6DXX and lastly "Homebrew Cookbook" by Eamon Skelton EI9GQ. None of these books is expensive and all are fair value for money. The disc is George Dobbs' "Regenerative Receivers" which I will leave until last.

I will start with the most recent publication, **Homebrew Cookbook.** Despite being an enthusiastic reader with a file of clippings from Eamon Skelton's regular articles in Radcom this book proved to be a surprise. Although all the material has appeared already, it is two years old and a really excellent editing job has been done in rearranging it under topic headings - "Building a Receiver, Frequency Measurement, Transmitting Projects and Aerials." There is also an introductory chapter "Construction Methods." Time and the good editing add up to a refreshingly different presentation of the original material and I enjoyed it very much. Skelton's writing is authoritative, clear and all is related to recently built equipment. I have no serious quibbles but I would have liked more advice on component sources.

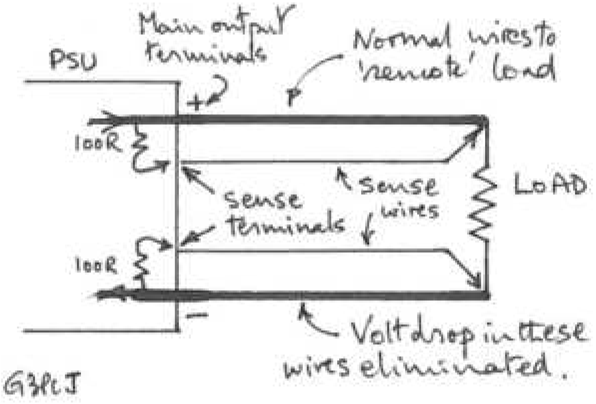
**Internatiional QRP Collection** is also very good and meets the shopping criteria well. It is assembled from a wide range of sources including QST, Sprat, Practical Wireless and Radcom. Rick Campbell, a principal contributor to Experimental Melthods has a two part paper "Designing and Building Transistor Linear Power Amplifiers which is well up to his usual high standard. There are also several papers on pedestrian and bicycle mobile which interested me, mainly because the techniques are often profitable at the home station.

Lastly we have **HF Antennas for Everyone** published in April. Drawn exclusively from Radcom, this book provides discussion of about 100 different amateur antennae with constructional details. The text is divided into sections "Horizontal, Vertical, Loop and Stealth" with as final chapter on feeders. A few off beat aerials are included - toroidal, HF slot and helical but the Hatley and other Poynting vector synthesis proposals are ignored. It is full of practical and useful information but not quite in the shopping class in my view.

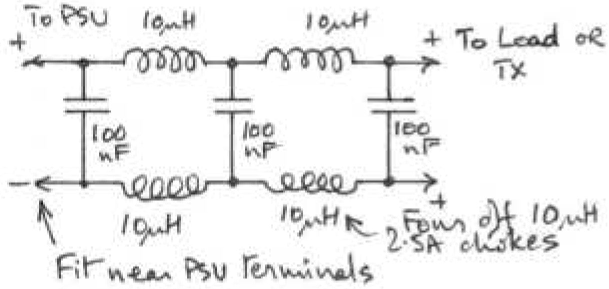
So there we are - **good reading** !

## ***Power Supply Miscellany***

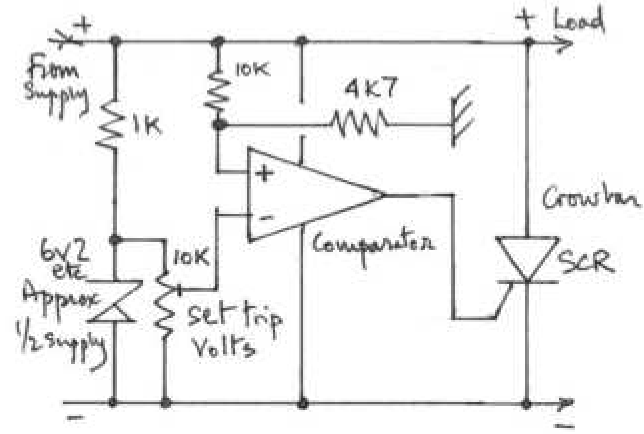
*Remote Sensing* Most relatively modern PSUs will have a voltage regulator to ensure that the output does not change appreciably as a load is applied. While not quite so common nowadays, the open style of rack mounted supplies that are often found at rallies, often have four output terminals. Two are for the load proper and two are for feeding back the actual load voltage to the regulator circuits; in this way the load voltage can be kept constant even with long leads where their resistance is high enough to cause a significant voltage drop under full load. Quite often, there is a low value resistor (about 100R) between each pair of terminals, for the separate output leads. Their inclusion will allow the regulator to work even if the separate sense wires are absent or broken - but IR losses in the main leads will not be compensated!



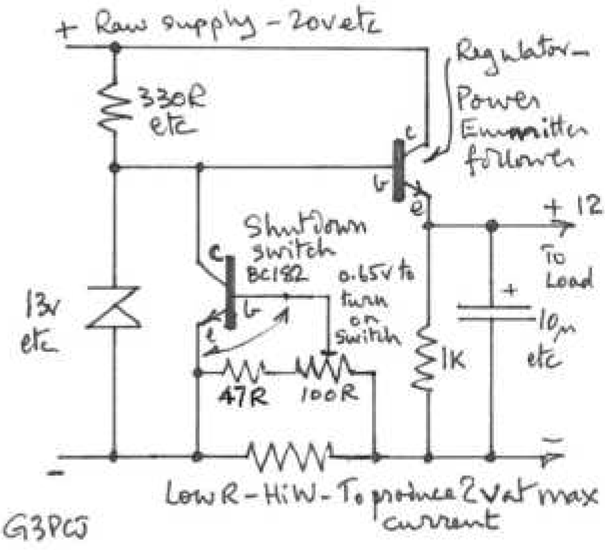

*RF wrecks regulation!* The regulator circuits often have a wide bandwidth (hundreds of KHz) to ensure that the regulator acts swiftly when the load changes very quickly - either coming on or off. This transient performance is hardly ever specified but is an important aspect of the design. This means that the regulator can be a bit prone to RF getting in from transmitters. I have one supply where I found it was very sensitive to RF just after it went out of warranty! Go to transmit and the output voltage rises appreciably! Not the effect you would expect! I have found that low pass filters made with high current inductor chokes will often effect a cure. Try the circuit right!




*Over voltage protection* The purpose of this is to prevent damage when the output voltage suddenly rises above some set limit that might damage the load circuits. It is usually only fitted to fixed voltage supplies as it can be tricky to set the turn off level for variable supplies without complex circuits. It is not the same function as that provided by the regulator. The load voltage is compared with the set trip voltage, so that when it is excessive, the regulator is shut down. Alternatively, it can fire a 'crow-bar' SCR across the PSU output to blow the fuses or shut it down until switched off.




*Over current protection* This is very useful on bench supplies when experimenting with a new rig! Often an excessive current may indicate a short on a supply line or some circuit malfunction such as a bipolar transistor cooking with thermal runaway. If in doubt about what current to expect set the trip level low. The very simple regulator shown right depends on the load current flowing through a low value resistor, that is used to turn on a second transistor which shuts down the regulator. Max current through the low value R needs to produce about 0.65v to turn on the bipolar transistor. If the setting is to be adjustable, then use a higher value resistor with a low value pot across it. The low R sense resistor must be high wattage! Tim G3PCJ



## *Snippets and Customer Feedback!*

Hello Tim from Fred G3TWN on Anglsey. Just to let you know how the builds are getting on. The Brent I bought in May was completed in September and works very well. I have worked OK, DK LA and G's and I am very pleased with the rig. Due to building the Brue 40 I have not operated much. The Brue was much easier to build than the cramped Brent but having said that I engaged on a difficult mechanical build. Fitting a slow motion drive involved extra time and I had to fit the mixer above the main board separated with one sided board to avoid spongy transmissions. Noise is problem here and I have fitted a RF gain control at the rear. 7 MHz is poor at the moment but good for testing on WW CW contest weekend. I have been using the Digipan waterfall to check the audio out. The filter shows up well and I can see that the VFO/Mixer is stable. It has helped me choose pot levels correctly to avoid noise. PSK31 decodes ok too!!!. I tuned the mixer trimmers with my trustee Heathkit GDO and weeks later they proved to be correct in practise. I hope to get operating with Brue now I have declared it finished. Congratulations on your kits and thank you. Cheers. *Thank you Fred - very pleased to hear that PSK31 works - I have often been asked! Tim*

## *20w output on 160m* (aka. How to be heard above domestic QRM on topband!)

With mounting frustration that most amateurs I talk to on topband couldn't hear me above their 8 s-points of local QRM, I determined to do something about it! A few years ago I built the Walford Sutton Montis, a multi-band Double-Sideband rig with 1.5w output. I added all sorts of features and in particular Tim's 10w linear with everything all connected together as one rig. A reasonable output on all bands was a compromise though and on 160m I was only able to put out 4.5w! My objective was to raise the output to at least 15w and for the rig to cope with long waffle overs. Being a thermo-neurotic, I had visions of IRF510s going up in smoke and so I planned to site a fan on the top of the linear heat-sink from the start (with rubber washers) and to site another fan behind the transmit board heat-sink. There are many quiet fans available now aimed providing PCs with quiet cooling. The two I chose were Fractal Designs 12v 50mm 'silent' PC fans and with a 2w 50 ohm resistor in series with 13.8v they were running quietly at around 11v. For the linear power supply, I bought a 24v 6A switch mode supply which was ex-rack equipment to a high spec and six 50v 6A Silicon Diodes. My thought was that the power supply would tweak down to 21.5v and the diodes in series would potentially bring the voltage down perhaps to 17v. The diodes only dropped 0.3v each however, so a bit of a non-starter!

The rig continues to have a 13.8v supply for everything other than the linear and I wanted to optionally run the linear either on 13.8v or the higher voltage linear supply. The easy solution was to use 3 pin10A mains extension lead connectors. The idea being that 24v nominal could be passed to the rig through one of these for normal running and a 'dongle' could be made out of another connector to feed the 13.8v back in to the linear if lower voltage running was required. I started tests at 19.5v but quickly brought the volts up to 24.0v to produce up to 20w output on 160m. At 24v on long waffle overs it produced around 20w output on 160m, the heat-sink warms up only mildly. It could take a bit more but 24v is enough for me and I'm more than happy with the results! Here is the Sutton with the fan on top! David Brewerton M0EZP



# QRP in the Country –2010

On Saturday, the weather forecast suggested Sunday would be dry. So plans for Sunday were based on everything being outside, which was a great help. It allowed all those staying here on Saturday evening to join us at a Summer Party run by the Friends of Long Sutton church - this was a great diversion as it was near compulsory fancy dress with a 1940s theme! We even had Winston Churchill turn up in a suitably old chauffeur driven car and there were numerous spivs in attendance!

Sunday started cold and windy but at least it was dry. The kite and huge Union Jack, tethered by an 80m vertical dipole and feeder, promptly rose to 180 ft - the flag's attachment lines lasted less than an hour and it had to be recovered from our garden! The rest of us spread our stalls around the field using three farm trailers, gazebo tents, tables etc. We had visitors from far and wide, as well as good support from 'our locals' in the south west of England. My thanks to all who came and especially the many helpers - local Clubs, individual 'stall' holders, without whom it would have been impossible to put on this event. The list is too long to include here but I must highlight the role of all The Ladies who provided the most excellent support service (food) - they did a grand job despite the wind trying to extinguish the barbeque! As the day progressed, the wind died, the sun came out and a great time was had by all. With so many positive reports afterwards, we have to hold it again - Jul 17th 2011!

If any readers of this note are able to encourage your local Clubs etc or individuals to attend and put on any sort of interesting display, then please do so and get them to drop me a line at walfor@globalnet.co.uk. Here is a selection of the sights! Thanks to Tex Swann for some of these pictures.


Giving the thanks to helpers and my wife Janet leads the returning farm excursion! G3PCJ

"JOURNAL OF THE CONSTRUCTORS CLUB"

# Hot Iron

Winter 2010
Issue 70

## Contents



The Walford Electronics website is also at www.walfordelectronics.co.uk

## *Editorial*

For a while now I have been sending Hot Iron to Bill Meara N2CQR - he produces a regular blog which goes under the name of Soldersmoke - Global Adventures in Wireless Electronics. Every month or so he recounts his amateur radio activities and thoughts in an audio report lasting up to an hour - he has been kind enough to give Hot Iron several mentions and I can thoroughly recommend listening to his soothing tones, especially while hunting for some vital microscopic part that has fallen on the floor! Apart from his regular blog, there are now all sorts of subsidiary groups and items of interest - well worth a visit http://www.soldersmoke.com

Imagine my concern though when listening to the latest, to find that Bill nearly had an incident on the New York subway, when the lady sitting next to him on the train, noticed what he was reading and thought that Hot Iron was some sort of very different magazine! I just hope that the name is not putting off people on this side of the pond!

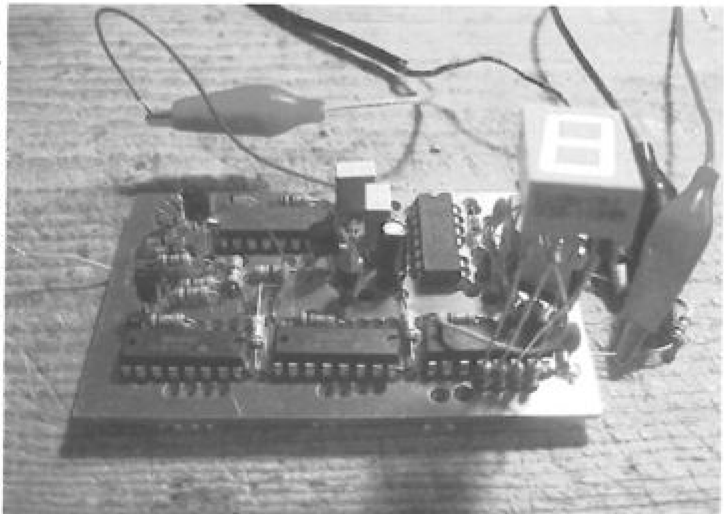
A reminder - note the date for next year now - QRPiC 2011 here at the farm on Jul 17th! I have some special guests coming! Do encourage your local Clubs to bring a stand.

Meanwhile, I wish you all a very Happy Christmas and good luck with whatever radio project takes your fancy! Tim G3PCJ

## *Kit Developments*

The **Yeo** entry level DC RX is now available after a positive reception by Yeovil ARS. It does any band 20 - 80m with its own PP3 holder and a small LS! Much more than a toy! The **Radlet** unique CW trainer is also now available after trials by Andy Howgate. Details of both these kits are now on the website. The **Tone** 80m phone superhet and its associated **Parrett** TX have been reviewed in PW.

The most recent addition is a new **3 Digit** Kilohertz counter - the MHz numbers disappear left out of sight. Up or down to 60MHz. Suits my superhets. Undergoing tests right with just one of the 3 displays! G3PCJ



*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

***Saturn DC Receiver*** by Richard Booth G0TTL

Once you have finished eating all the mince pies, watched the Doctor Who special and completed building your latest Walford Electronics kit what you need is an excuse to go and find the radio bench. That way you can avoid watching more repeats on the telly or worse still, the omnibus edition of East Enders. DIY dentistry with a Dremel and Stillson wrench appeals more to me than that prospect...

Saturn. It has rings. Well this little receiver does too! A double balanced diode ring mixer is the heart of this project, which is a direct conversion receiver for the lower HF bands. It will work quite well up to 20M and you only need to alter the VFO and RF amplifier resonating components to make it work on your band of choice. The version presented here is for 80M which is always a good starting point. In recent years the prices for SBL-1 and the clone HPF505-X ring mixer have dropped dramatically and they can often be found for a few pounds on eBay. So having bought a load of them I thought it would be a good idea to make use of a few and hence the Saturn project came about.

To follow the norm, here is the circuit description. The antenna input is coupled to Q1, a grounded gate FET amplifier which is tuned to the band in use by the resonant circuit of C2, C13 and L2. The inductor is an off the shelf, ready made RF type of the sort that looks like a fat resistor. This gives good front end gain with a relatively high Q factor which helps to reject out of band signals. Q2 is set up as a unity gain buffer so that the low impedance input of the diode ring mixer does not load the RF amplifier stage. The VFO needs to develop a hefty sine wave of around 2V PP to drive a ring mixer of this type effectively. So in order to do this and maintain stability a two stage Colpitts style oscillator is used. The first part Q3 is a traditional 2N3819 oscillator with course and fine tuning (using a reverse biased red LED) as a varactor. Main tuning is by the variable 75pf capacitor connected in parallel with L1, the only hand wound inductor used in the Saturn. A T68-2 core is used for this purpose. Q4 is a voltage amplifier, using a J310 FET. This type was chosen over the 2N3819 as it has higher operating parameters and in practice just seemed to work better. Certainly looking at the VFO output on the oscilloscope it appears far cleaner with a J310 - 2V PP easily achieved. The VFO carrier is mixed with the RF input in the SBL1, with the resulting very low level audio frequency product generated at the output ports of the mixer. In order for the product detector to operate efficiently it needs to be terminated at an impedance of 50R in the audio spectrum. R11, C20 and C19 achieve this and help to reduce the audio bandwidth to something better suited to SSB reception. Q5 and Q6 operate as a bipolar variable gain voltage amplifier. Dynamic range is the key here, and hence the reason why a dual gang pot is used for the volume control. This avoids overloading of the audio stage with strong signals, due to the amplifier gain being lowered as the volume control is turned down. In practice this is much smoother and gives a big reduction in AF noise which you would normally get with such a potentially high gain stage. If a single gang pot is used the amplifier stage would have to be at full gain all the time, and under strong signal conditions this makes the receiver very noisy. The final audio amplifier is the plug it in and forget it LM380N-8 which needs no explanation. DC supplies to the VFO are regulated by an LM317LZ.

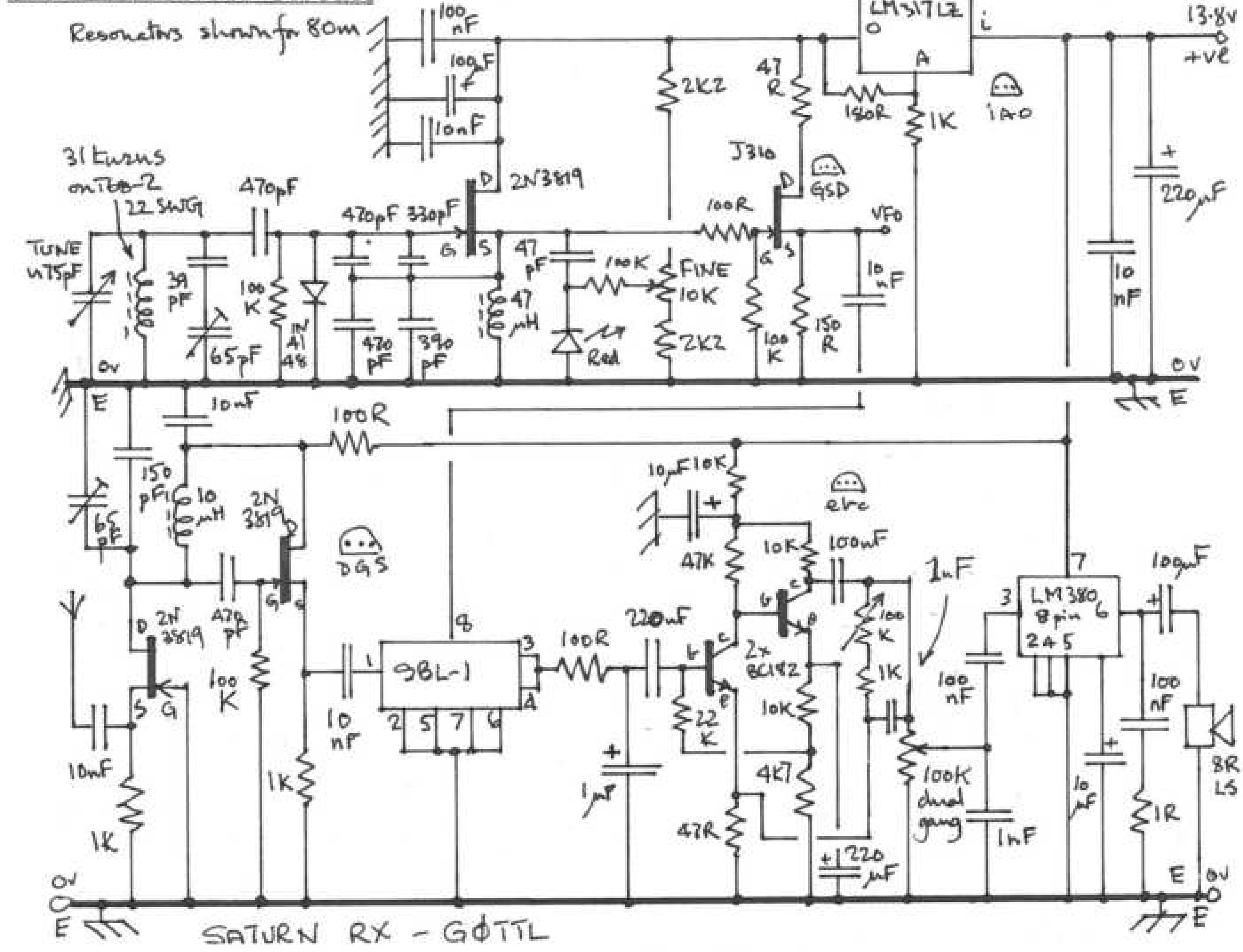
Construction is straightforward and the layout non critical, although I would take care with the audio amplifier stages and use screened connecting wires to the volume control pot. The dual gang 100K is available from Maplin. Everything else is available from Rapid Electronics bar the diode mixer which you will need to hunt around for. For the grand total of two 1st class "Large" stamps I will send you complete construction details including PCB layouts and artwork for the Saturn. This also includes details for operation on other bands. Ready made PCB's and components are also available on request.

There you go, a proper Christmas project. I hope you decide to have a go at building this little receiver which I think gives excellent audio quality coupled with a robust front end. I hope you have a very happy Christmas and all the best for 2011!

Richard Booth G0TTL School House, Old School Lane, Wadworth, Doncaster DN11 9BW

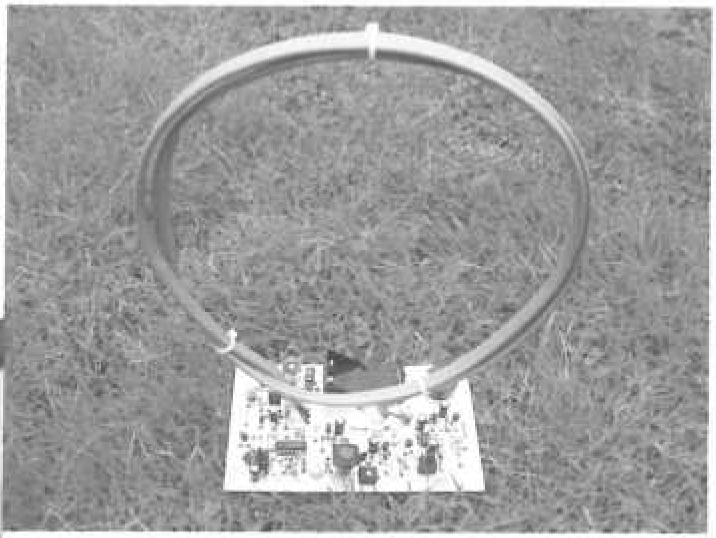
Circuit details for 80m on next page - G3PCJ

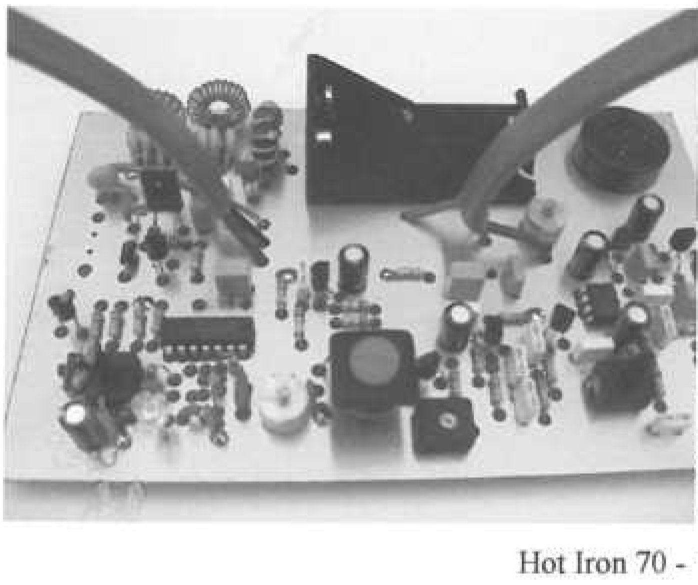
## *Saturn Receiver Circuit*

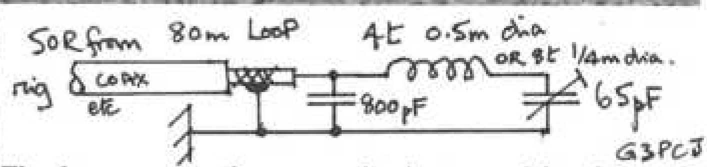



## *The Radlet*

Here is what the final version looks like with its 80m loop aerial when extra small! The actual loop is made from four core mains (fixed) wiring cable, with the four wires connected in series. The loop makes a convenient carrying handle and should be good for local contacts! It is better when arranged as a single loop of 0.5 metre wide.








The loop resonating capacity is tapped for the normal 50R feed from TCVR. The PCB has a small speaker, push button for key, with presets for AFG and RIT. Normally 80m but with xtal to 20m. G3PCJ

## *My Ideal RX*

Andrew wants help in achieving his ideal RX! (I regret I had to edit this down a bit - Tim):-
In a few months time I am hoping be on my travels again and this time the planned destination is Dubai. Hitherto I have had little time for amateur radio whilst on the move, but this time things will be different. The one thing that I do not possess (and would dearly like to make for myself) is a small portable receiver covering the entire HF region. Providing that I have AM, SSB and CW reception, then I would be perfectly happy. Ideally, this will be powered from either a 9v battery, with excellent selectivity & sensitivity, and sufficient output for a small pair of headphones.

I have a redundant DDS VFO that does 1 Hz steps to over 40 MHz. What about having this drive a low parts count NE602 DC RX with an LM386 audio stage? (Snag - no Am capability!) Most of my earlier projects have been single band but I have not tackled anything as potentially complex – and I am beginning to feel a little out of my depth.
Any design has to be a compromise, but I want a receiver that will allow me to make a few QSO's whilst the XYL is busy at work. What does the Hot Iron readership say?!! Comments and suggestions to me at **andrew_atkinson@hotmail.com** please.

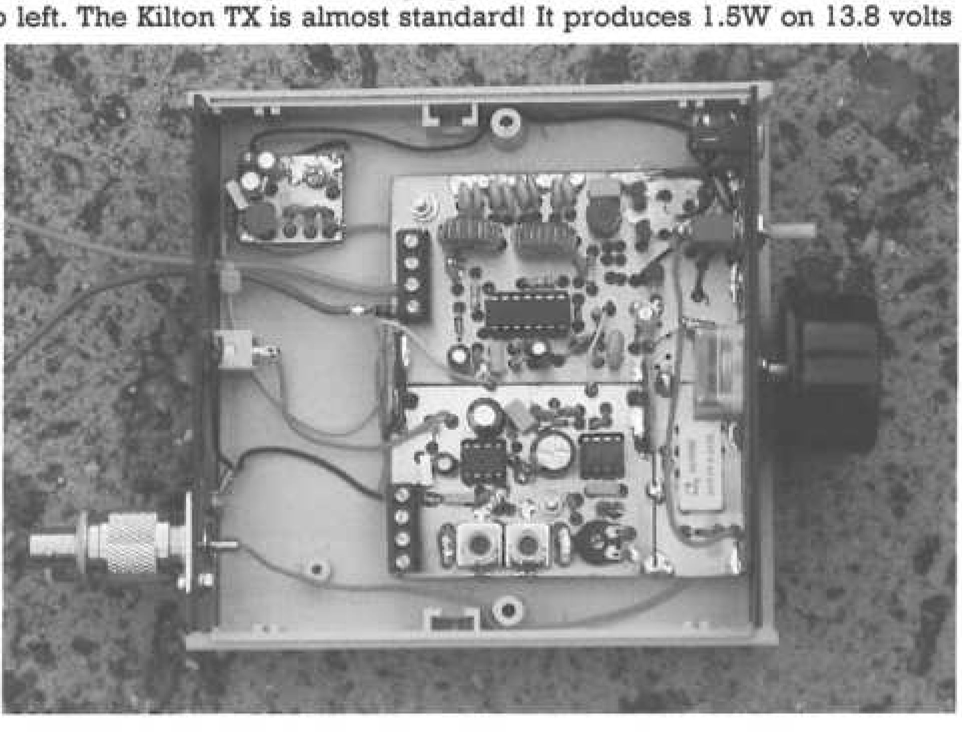
G3PCJ Comments - this is challenging territory for which one normally expects to pay many hundreds of £s!! I would suggest starting with a regen TRF as its easy to change bands (single resonator) has excellent selectivity for the number of parts, is simple and can provide excellent fun certainly up to 20m or even higher with good quality tuning parts. It can also do AM easily and has a very low consumption usually. What's more, it does not need a computer of any form to drive it! If a TX is also wanted, then perhaps the DDS does have a role driving a conventional CW TX. But consider the 'tuning of the filters' required to remove TX harmonics over that wide frequency range! This might need a linear TX to keep harmonics low and hope the AMU removes the rest. If AM reception can be sacrificed, then consider a RX with the DDS driving a strong diode mixer (with very little RF filtering for simplicity - perhaps only that of the AMU) followed by loads of audio gain. Tell us all how you get on Andrew - please!!

## *Howlette's Heinz 57 TCVR*

Andy has been devising a new project which has come to be known as the Heinz 57 rig owing to the many sources from which circuits and ideas have been lifted! The bottom PCB is the DC RX which uses a twin tuned 80m RF BPF followed by a NE602 mixer. The RX PCB is a Howgate special layout. I cant see the VFO but I suspect it is derived from the 80m ceramic resonator in the Kilton TX but with tuning by the PolyVaricon instead of a trimmer. I think the switch operates the preset RIT. The RX audio stage is a LM386 arranged for high gain, with facilities to inject sidetone from the audio oscillator top left. The Kilton TX is almost standard! It produces 1.5W on 13.8 volts and has the circuits for semi-break in TR control of the TR relay bottom right.

Note the reversed supply protective diode in the lower of the two incoming supply wires!

A very neat little project which has given Andy much pleasure in devising.

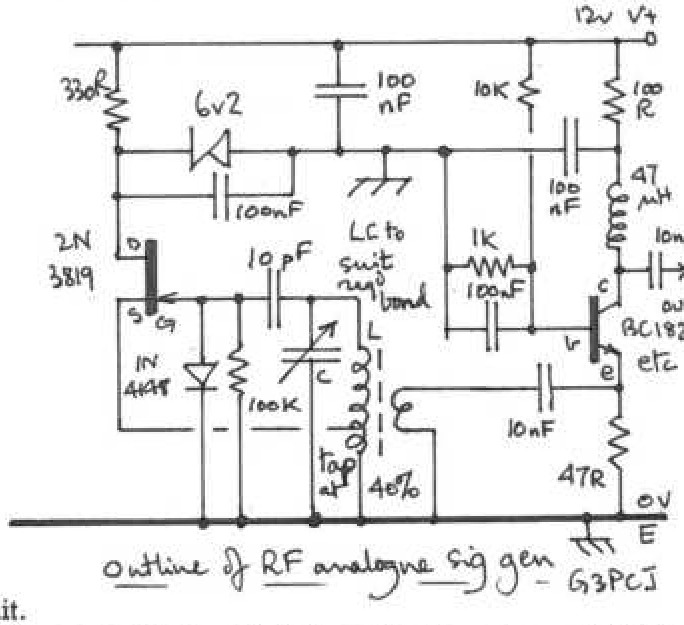


## *Ideas for Signal Generators*

Steve Hartley G0FUV sparked this train of thought by saying he needed a source suitable for testing and setting up rigs at his forthcoming Buildathon; this is expected to be based on the Tone superhet RX (with 6 MHz IF) RX but adapted for 20m. The important thing is to understand what the 'source' is to be used for - at one extreme you might need an output level of a few volts into 50R for driving diode mixers, maybe with very high frequency stability for extensive tests over any frequency from say 100 KHz up to low UHF! That sort of spec is the realm of professional test gear which can sometimes be bought second hand but the drawback is that it often weighs half a hundred-weight! For Steve's purpose something much simpler can be used; restricted in frequency range to perhaps 10 or 20 MHz on the fundamental, with much lower level outputs that would suit direct connection to a working typical kit RX say 50 µV RMS (or about S9 or –73 dBm). Good stability is desirable but a wander of 50 or even 500 Hz in 10 minutes is not going to matter because the tuning controls are often being readjusted for different tests.

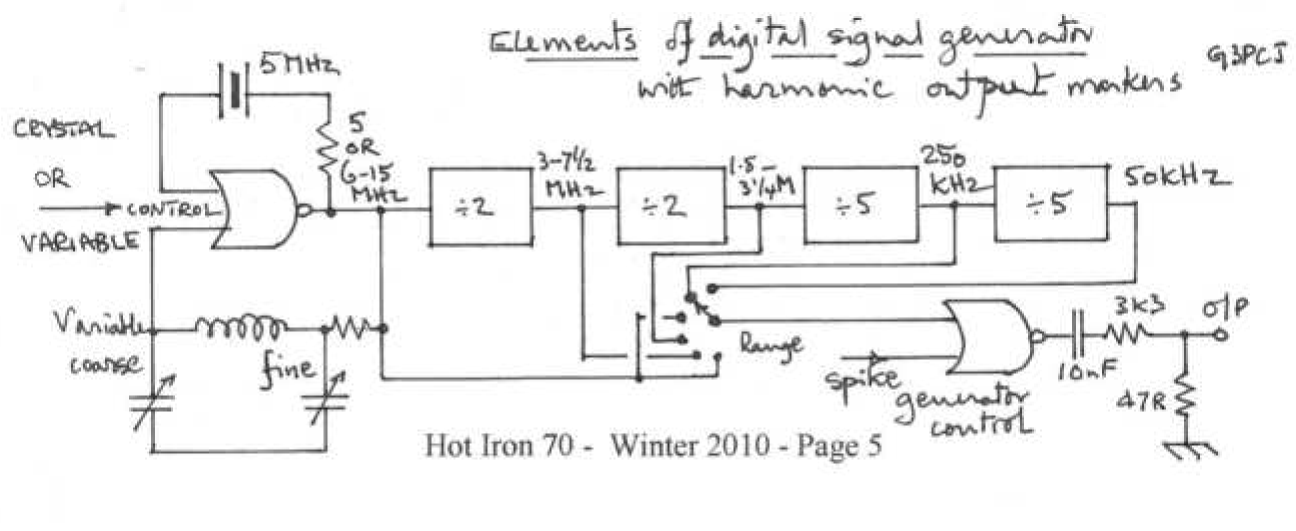
Traditionally the oscillator would be analogue. It is desirable to keep the number of frequency ranges to a minimum to keep the switching simple, which implies a wide range on each setting leading to the need for a second FINE tuning control. A Hartley configuration for the oscillator is usually best as this does not require any feedback capacitors that would add appreciably to the minimum tuning capacitance. So with luck you can achieve about 2.5:1 frequency change on a single range; but if you need more than one range, then at least two wires to the inductor have to be switched!

To avoid pulling by load changes, it is best to follow the oscillator by a grounded base stage with its high reverse isolation; and this can often be fed by a small low Z winding on the inductor. But this is another connection that might need switching! See the above outline circuit.




If high stability is not quite so important, then consider a digital oscillator using a CMOS gate. They can work to beyond 50 MHz but for Steve's purpose, an upper limit of 15 MHz is adequate. Such an oscillator will produce a square wave that is rich in odd harmonics so signals would be available for all of the HF bands and higher. Digital dividers can easily be used to provide fundamentals on any lower band. Buffering for load isolation is easy with another gate, and if even harmonics are wanted as well as odd ones, then a spike generator is easily added.

The digital dividers of such a device can also be used to produce accurate RX frequency scale calibration markers - traditionally every 100 KHz. Add a 5 MHz crystal oscillator to the digital Sig Gen, and then it can produce 250 and 50 KHz markers! Very useful! Add a counter and it becomes a serious piece of test gear! I have laid out a PCB based on this approach and will report next time on its success! I have included holes etc for the MHz chips to be controlled by the 3D counter for a 5 digit readout. Prices - about £25 +£25 for the counter. Something like this:- G3PCJ



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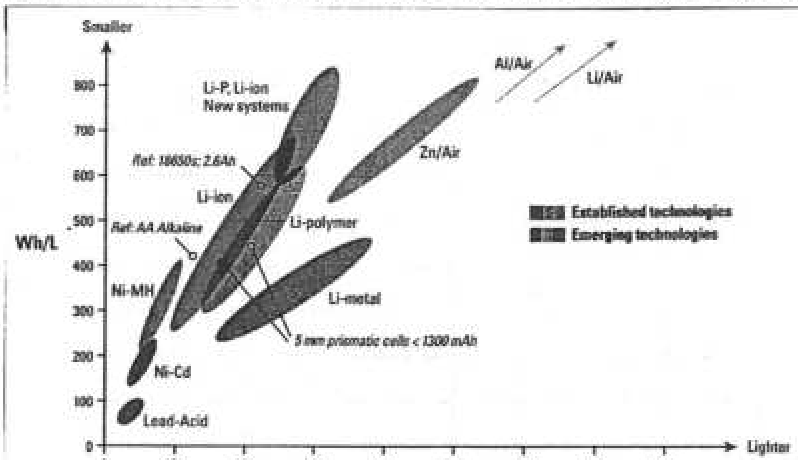


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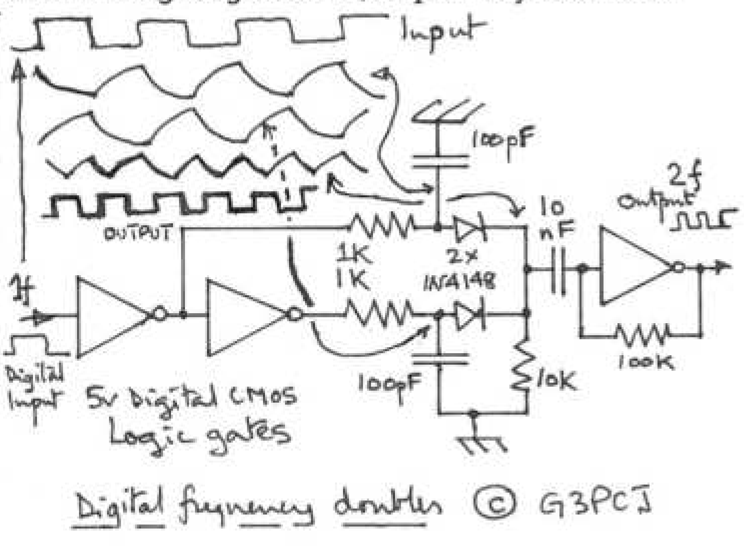
## *Snippets!*

*Digital Frequency Doubler* This idea might be useful in a signal generator, or possibly in a transmitter chain to avoid chirp caused by pulling of a VFO by TX currents at the same frequency. The intention was to avoid having to wind transformers, which are often used to obtain an anti-phase signal that is then rectified to give two output pulses per input cycle or twice the frequency. If a digital square wave is inverted it looks the same so you need to do something else! If you feed both square waves into an RC circuit to delay their peaks, you can then 'rectify' or 'add' them in a full wave rectifier circuit and pass the output into a further gate for squaring up again. The circuit right works over at least 3:1 frequency range from about 2 MHz up. The output does not always have 1:1 mark space but is at twice the frequency!




*Walter Farrer G3ESP* Walter was very nearly 91 but died following a fall at his home. He was a very keen radio constructor and experimenter, often making gadgets for demonstration at the Yeovil QRP Convention. I recall that he was one of the first people to realise the potential of ceramic resonators for variable HF oscillators which followed his earlier work on using multiple crystals in parallel to obtain a wider pulling range. Walter always loved explaining his thoughts and was very keen for all to benefit form his ideas - a sad loss for us all.

*Capacitor Information* Recently I have been searching for 150 pF ceramic capacitors with N150 temperature coefficient that are suitable for use in VFOs. I don't like having to pay about £1 each at the 100 off rate for polystyrene types, instead of the few pence that used to apply when you could obtain the ceramic plate types made by BCE –Sud. My search continues but I found a fascinating website devoted to capacitors http://my.execpc.com/~endlr/index.html Worth a look as there is a wealth of useful information - sadly I cant find the name of the author so I cant credit him with the work! Another site that's useful is from the RF Part Co http://www.rfparts.com/caps.html

*Small magnetic loops* When devising the loop aerial for the Radlet, I came across this website from Steve Yates AA5TB http://www.aa5tb.com/loop.html Its full of useful information and formulas for designing your own. As ever with any loop aerial, he emphasizes the importance of minimising the losses in the loop itself and the tuning capacitor. Usually it is the sliding contacts of a conventional air variable capacitor that is the worse culprit - a partial solution to this is to use a dual section air variable whose nominal max capacity is twice the value that you expect to need. You then connect one side of the loop to one of the fixed vane terminals, and the other end of the loop to the other fixed vane terminal. By leaving the frame and moving vane shaft contacts electrically floating , you are not including them in the loop because only the more electrically conducting solid shaft forms the link between the two halves of the overall capacitor.

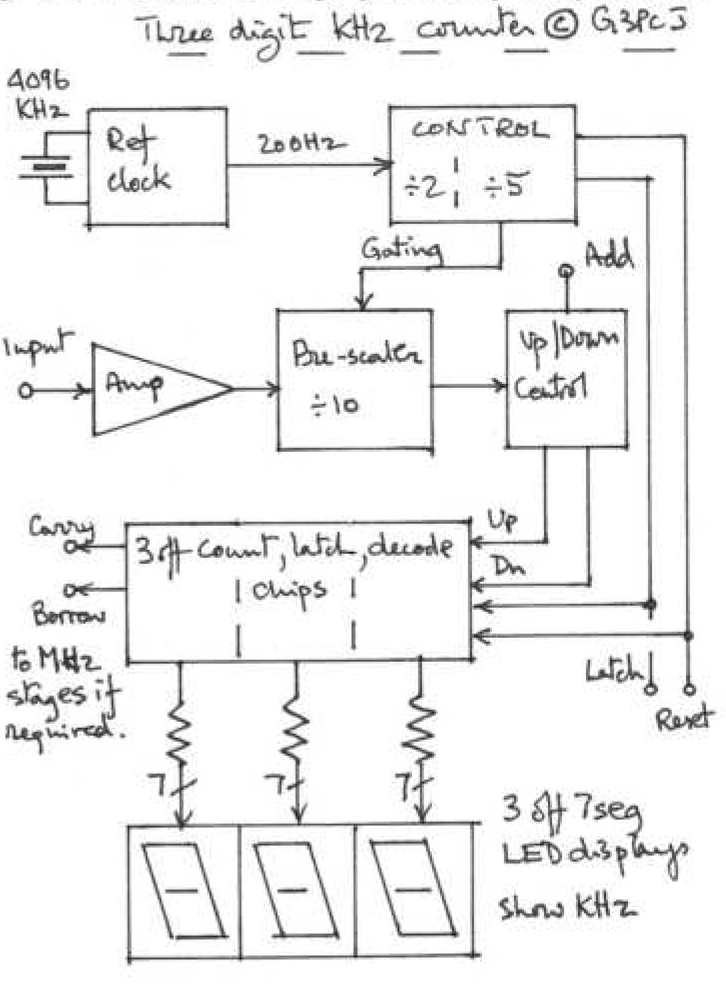
Most authors strongly advise checking the resistance of all loop joints, especially when using lengths of copper pipe joined by solder (or even compression) fittings. The resistance is usually pretty low even when poor, so a heavy current (ten amps or more - use a 12v battery with high wattage headlamp in series to limit current!) will be required to get a volt drop reading across each joint that will enable you to see the difference between the many (hopefully) good joints and the poor high resistance one!

Opinions vary about how best to feed the loop. Often a small coupling loop is positioned inside the main loop in the same plane but I suspect these are not easy to adjust nor keep in position! Much simpler is the 'gamma match' approach, where the low Z feeder is connected at a tap point part way round the loop away from the earthy point. The tap can be inductive, or capacitive as in the Radlet. For that rig, the losses caused by using mains cable are not important! G3PCJ

## ***The new Three Digit Counter***

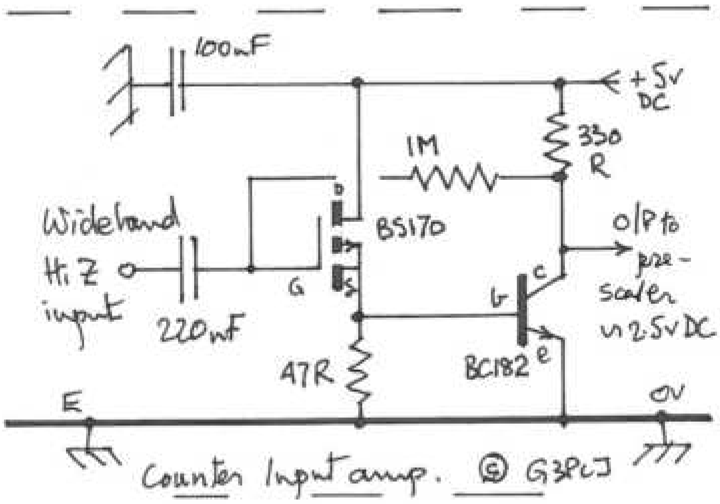
A digital frequency readout is about the most useful accessory that you can add to any rig! There are many offerings from kit suppliers and most modern ones are based on a micro-processor. However I think most readers will know of my dislike of such devices when in close proximity to a receiver. Computers, and their smaller microprocessor cousins, inevitably have a nasty electromagnetic signature owing to the use of digital signals which are inherently full of harmonics. Often the cyclic nature of the software programmes will lead to continuous interference which tends to escape down the connecting leads - for supplies, or to/from the displays etc. It was the cyclic repeating of multiplexed (and relatively high current) display driving of 7 segment LED displays that gave such arrangements a very bad name. Although my designs have LED displays, the special counting chips that I use (CD40110), do not employ multiplexing - the wires to the displays actually carry DC and only change when the frequency is changed.

A full 5 digit readout has 35 wires and needs 7 or 8 chips for a counter that can take in the rig's VFO and 'do' the offset - rather a lot! My five digit design does the offset by also taking in the CIO and then adding or subtracting the frequencies. However if the IF is an integer number of MHz then the KHz numbers will be correct based only on the VFO or LO input. Luckily my rigs generally use a 6 MHz IF, so a somewhat cheaper 3 digit design is feasible. The block diagram is shown right; to make it suitable for additive or subtractive superhets, it has to be able to count up or down - preferably under remote control for use with a future multi-band superhet (The Minster!).




This design only needs 5 chips and a few discrete devices for the input amplifier; hence I have been able to get it all on a 50 x 80 mm as shown on the first page of this issue. In most situations the MHz figures can be ignored, but if wanted for a full frequency readout for something like a signal generator, then the two extra counting chips and displays can be controlled from the 3D logic. For a single band rig, the MHz displays can be hard wired using just the segment resistors. Such an approach can also be used for multi-band control but it tends to need a diode matrix to drive all the segments correctly.

I wanted to avoid using a digital gate as the input amplifier because there was no other need for gates. The amplifier needed to have high input impedance, a voltage gain of over 10, bandwidth of DC to several tens of MHz with the output biased to near 2.5v DC so that it could interface directly to the input of the first counter stage, which uses the 5 volt CMOS dual biquinary counter 74HC390 chip. The combination of a MOS input buffer (BS170) followed by the bipolar amp (BC182),when arranged as a feedback pair, automatically makes the output stabilise at near 2.5v - owing to their turn on voltages of roughly 2 and 0.6 volts adding together. This little circuit (as on right) works very well.G3PCJ




**Happy Christmas!!**

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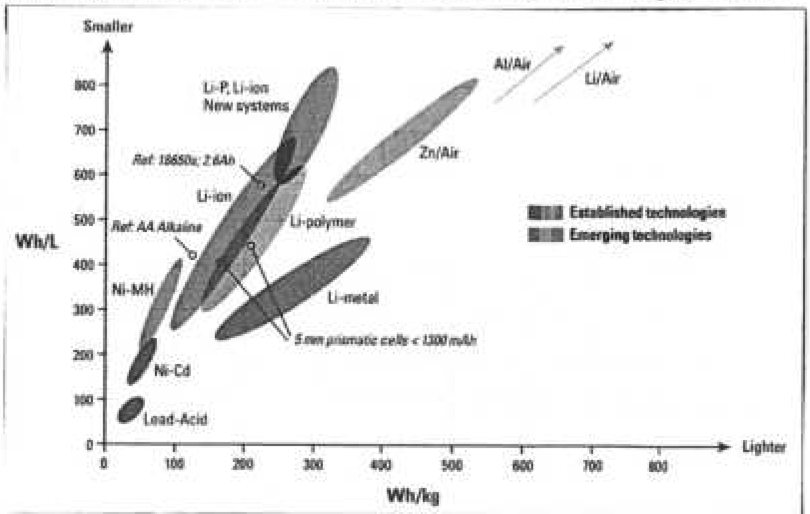


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"JOURNAL OF THE CONSTRUCTORS CLUB"

# Hot Iron

Spring 2011
Issue 71

## *Contents*



The Walford Electronics website is also at www.walfordelectronics.co.uk

## *Editorial*

Firstly - my apologies for being a bit late getting this issue of Hot Iron out. In truth I have been exceedingly busy with this darn computer writing up the radio aspects of the near-by wartime bunker, and latterly buying a new tractor. I would not have guessed how time consuming the latter might be! I contacted several dealers locally and was after a young second hand machine. Three did not bother to respond, 2 said they did not have anything that met the spec, one offered a slightly bigger machine than I wanted but, although made by a major manufacturer, it had several design features which were decidedly poor after-thoughts! One said wait two weeks till his rep was back, then nothing. The last offered a new machine that met the spec pretty well, had 3 yr warranty and came with low cost finance, at the same price as the only other second hand candidate! A no brainer - you can guess which continent it came from!

On more 'relevant' matters, the local radio clubs down here continue to flourish - I had the pleasure of talking to the Bristol RSGB Group recently. A good crowd turned up and from the questions etc afterwards, I knew they were thriving and interested in all sorts of different aspects of the hobby. Also a good mix of ages too which bodes well for the future! All Bristol's traffic lights were stuck at red on the way there but at least they had changed to green by the time I left! Tim G3PCJ

## *Kit Developments*

Reports from those who have added a **Kilton** to the **Yeo** DC RX are very encouraging. Both can do any band 20 - 80m. I also have good reports on the **Tone/Parrett** phone TCVR. Steve G0FUV has also used a special 20m **Tone** variant for his latest Buildathon.

Meanwhile I have got the **Cam** AM TX under way which will eventually go with the new **Cary** Regen TRF. The new **Digital Signal Generator** will be available by the time you get this, 1.5 - 16 MHz on fundamentals and higher on harmonics, with crystal maker 'pips' down to 250 and 50 KHz. It goes extremely well with the new 3/5D counter (right). G3PCJ


*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

## ***The Compton-Twofer*** by Steve Hartley G0FUW

For this year's QRP ARCI Pet Rock Sprint (3 hours of rock bound activity) I decided to put something on 20m. I happened to have been messing about with some simple crystal controlled transmitters and found the Twofer a nice compromise between complexity and output; 2W out from three junk box transistors, four if you count the keying transistor (see p129 of the RSGB book, International QRP Collection). Mine uses a BD139 for the PA, which is much cheaper than a 2N3866 or similar, and appears more tolerant of the odd shorted output socket, etc!

So what to use as a receiver? I had been having a tidy up in the shack and came across an old Walford Electronics 'Compton' receiver for 80m. I recalled it being quite a nice sounding receiver with a CW filter onboard. So, the band pass filter was changed to suit 20m and the 80m ceramic resonator was replaced with a 14.060MHz crystal and the conversion was complete. I now had TX and RX but how to link them?

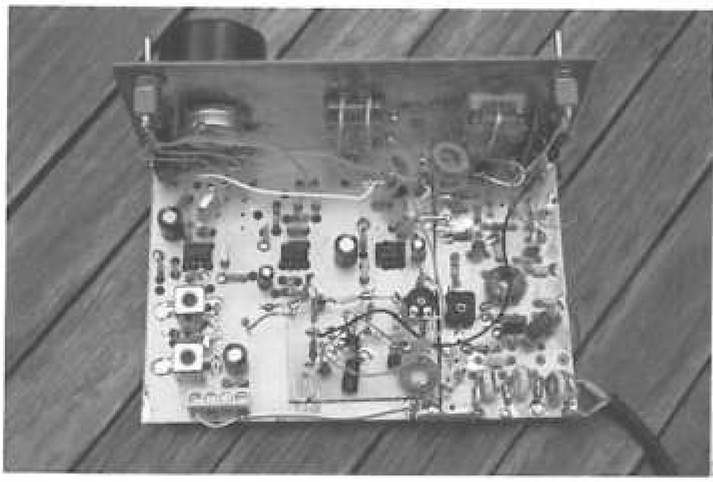
I tried relay switching but the 'pop' in the headphones was just too loud. Tim suggested muting the AF amp, which was better, but there was still quite a 'pop' on return to receive. I decided to try electronic switching and borrowed a few bits from the Micro-mountaineer Revisited and a very pleasant delayed mute and sidetone was in place (see p2-10 in the ARRL book, More QRP Power).

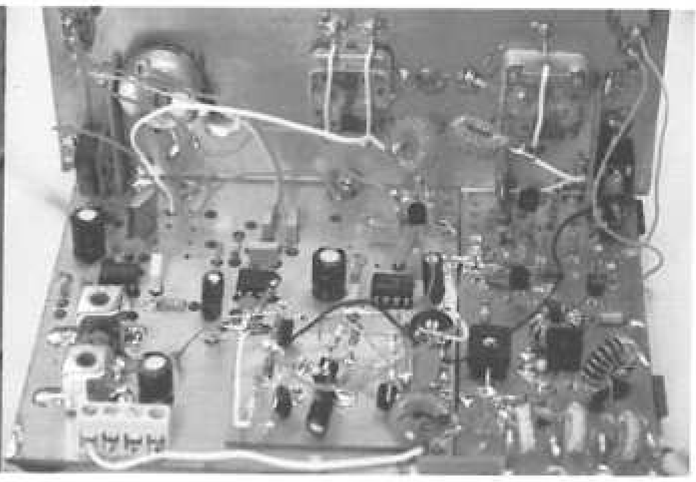
My next quest was to have a single VXO to drive both RX & TX. That proved to be a step too far! I got close but the day before the contest the RIT was still not behaving so it was back to basics with two independent VXOs and a 'net' switch.

First try on air with the shack CobbWeb dipole brought a report of 579 from IV3ZJJ in Udine, which was encouraging.

Using my portable NorCal doublet and homebrew BLT tuner first contact in the contest was EA6UN on the Balearic Islands which boded well, but then the band closed and I had to QSY to 40m. Lots of effort for not many contest points? Well, being rock bound on TX & RX gains 5000 bonus points per band in the Pet Rock contest, so not too bad!

My 2011 resolution is to build a reliable VXO to drive both and provide RIT for next year's contest. I will report progress in due course (suggestions welcome!).





Comment by G3PCJ! I am delighted to see these pictures because this is just the sort of construction that I love! I am not sure the difference between these two pictures from Steve but they illustrate just how easy it is to alter things when partially built dead bug style. Printed circuit boards are a wonderful material for simple chassis construction and I have often built whole rigs without any etched tracks; everything supported by the ground connections and the supply rail decoupling capacitors.

## *Competition Time!*

Here is a little challenge - who is the gentleman on the right? I am told he developed the Knack at a very early age and is seen here giving lessons in electronics to anybody willing to listen! In later years his shack has developed a very full array of test gear and other useful apparatus!

Rumour has it that feeding this antique heating appliance keeps him busy for much of the daylight hours and has also led to a delay in Government announcements about the renewable heat feed-in tariffs.

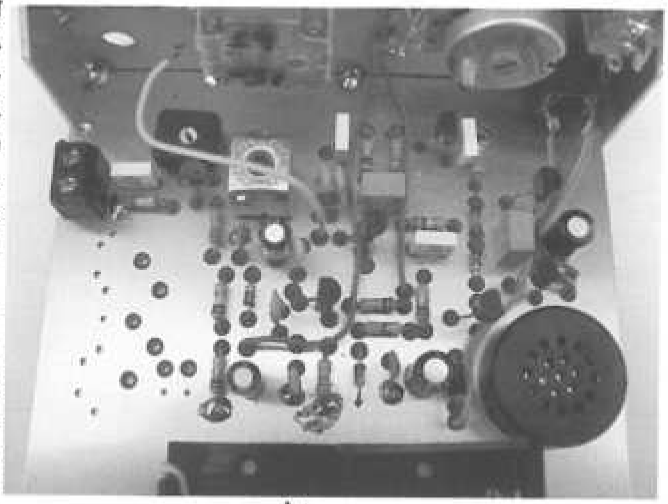
Entries on a post card to me by April 1st, when the winner will be picked by my wife and will receive a token gift! G3PCJ

## *Slow scan TV*

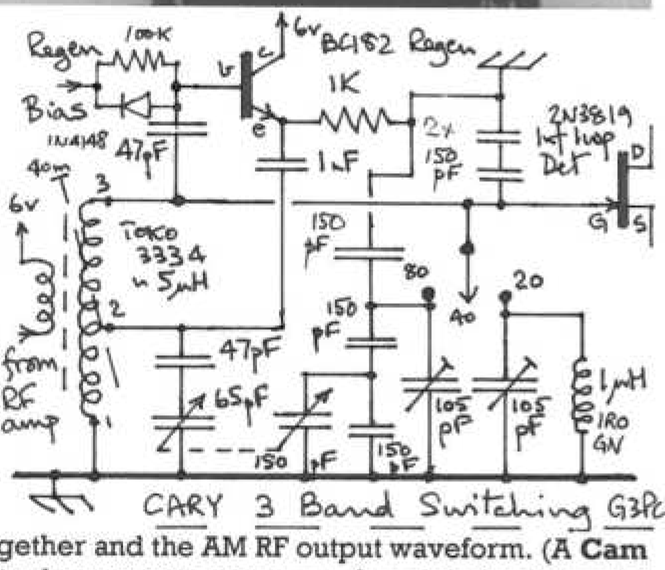
These are thought to be the first pictures received by a Tone on 20m, courtesy Dave M0SXZ.


## ***Ideal RX - Cary and Cam***

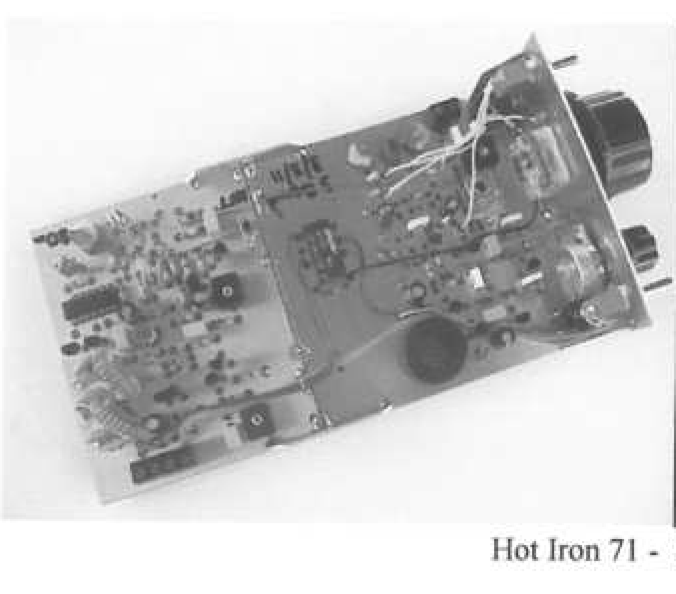
Andrew Atkinson asked for some help in the last Hot Iron to achieve his ideal portable rig! I offered the comment that a regen TRF has the huge advantage that band changing is relatively easy due to the limited number of signals that have to be switched. It made me re-examine my regen TRF designs and see whether they could be improved - answer yes! I concluded that many serious operators don't like my very cheap flat form of construction, exemplified by the current Trull. I have decided to re-engineer it in the small upright format. I wish to keep something simple for very first time building youngsters, who will value the low end of the Medium Wave where Absolute Radio is still to be found as a very strong signal. So the **Cary** is a regenerative TRF which can do any one of 80m or 160m or MW in its simplest form (right). It retains audio output for a small L:S or phones, with an infinite impedance detector and an RF amp with adjustable gain. Changing to the small upright format allows space for a very tiny sounder as LS, with it all running off the on board PP3 9v battery.

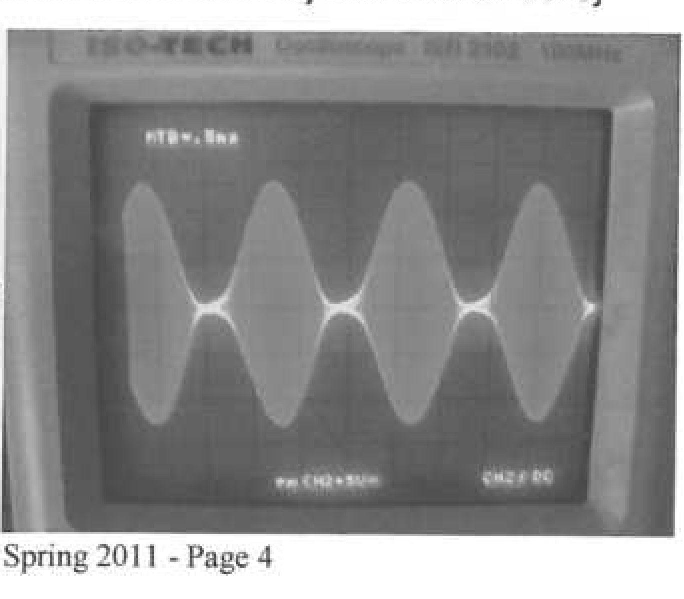


Given the potential ease of band changing, I decided to add the holes/tracks for an optional 3 band version using the 3334 TOKO. This allows it now to do all three of 20, 40 or 80m! The hardest part was to obtain a reasonable tuning rate on each band without employing too many different capacitor values. Although I know what the values are because of the labelling on their bags, their markings are useless so have to be marked separately by me hence I don't want any more values than absolutely necessary! Out of interest I show the resonant circuits of the **Cary** right for this 3 band version.



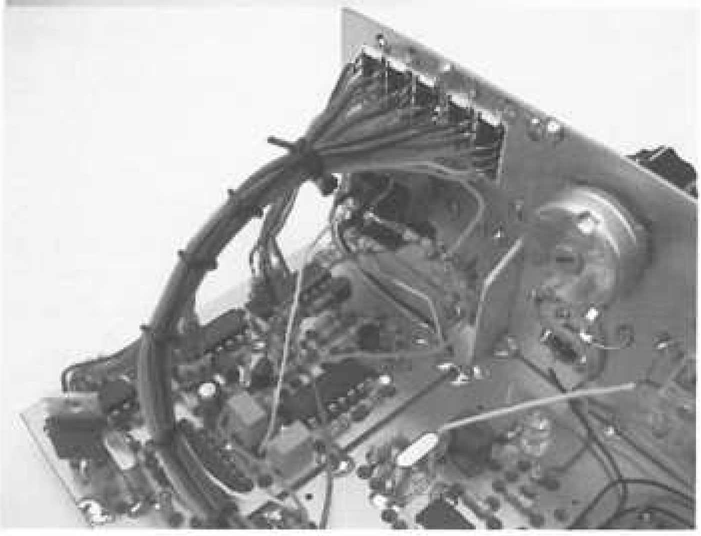

The matching transmitter is the simple amplitude modulated **Cam kit** based on ceramic resonators - there are ones suitable for 80 and 160m with a bit of care! The actual frequency being adjusted with a trimmer when the net facility is employed. This afternoon I loaded them up into my 160m half-wave on 3615 KHz and was given good reports by stations in the Isle of Wight and South Wales. Relief! Below is the pair together and the AM RF output waveform. (A **Cam** is going to Bletchley for the RSGB's radio displays to demonstrate one type of modulation.) Special price for Con Club Members - £70 inclusive of P&P for both on 80m only! See website! G3PCJ





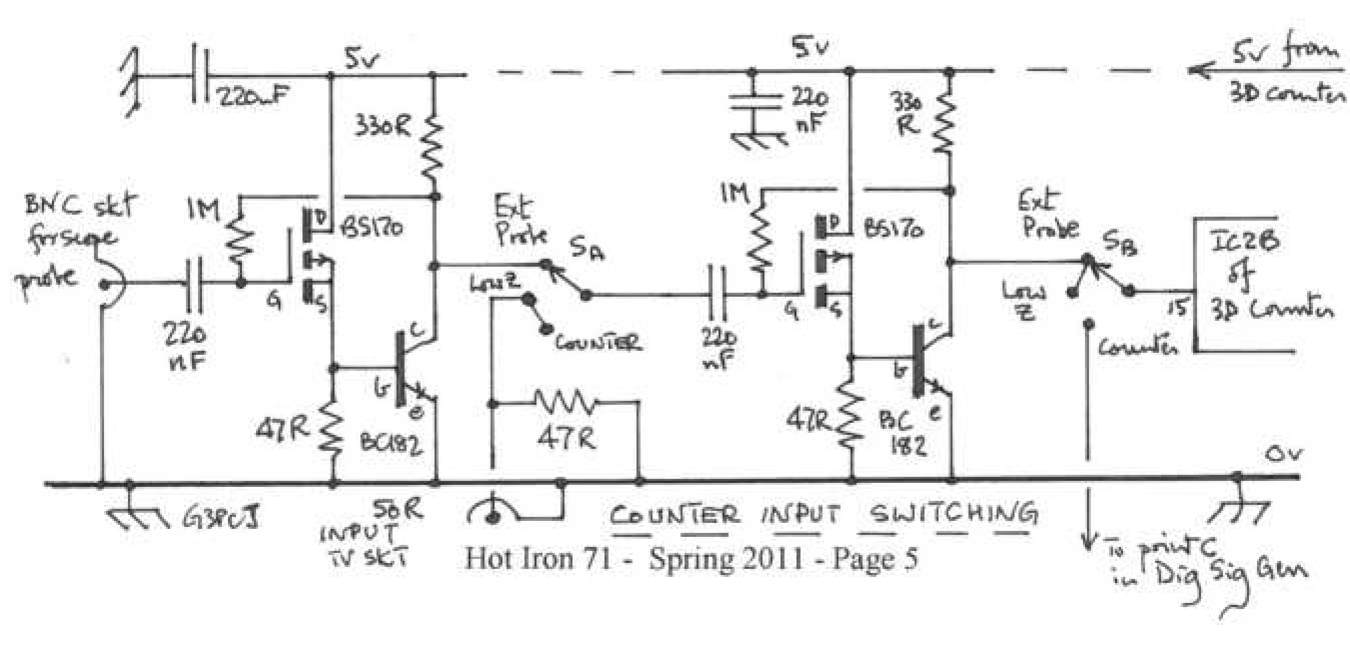
## ***Digital Signal Generator***

Last time I floated some ideas for a new digital signal generator which has developed into the kit shown on the first page. (This is not strictly true as the final version has two extra switches.) I have been pleasantly surprised by the stability of the main digital variable frequency oscillator which runs between about 6.5 to 16 MHz. The alternative main oscillator uses a crystal at 5 MHz for the receiver tuning calibration marker pips. Either oscillator can drive the dual bi-quinary dividers for variable fundamental outputs down to 1.5 MHz, or marker pips with a spacing of 250 or 50 KHz. Other switches are for power and the output level.



Adding a counter to this kit makes a really useful piece of test gear. I have arranged my own so that a further 3 way toggle can select the counter, a low impedance nominal 50R external source, or a 1M source and extra amplifier for use with a scope type probe. The photo right shows the front panel and the full 5 digits display - the normal 3 digit counter shows the KHz part of the frequency, and the Dig Sig Gen has space for the 2 extra MHz counting stages. If you are happy with the normal counter input sensitivity, and will not be using a scope probe, then an extra amplifier stage is not required. Its easy enough to add one, being only two transistors and I built mine dead-bug style on the back of the front panel (lower photo). The whole lot can run off the PP3 battery (or an external supply) so makes a very handy portable unit for setting up VFO's and rigs.

I have added a centre off toggle for output level selection; this is a bit of a compromise but it does have a low Z output with nominal levels of 200, 20 and 1mV p-p open circuit. For the variable frequency outputs, these are actually square waves and even the lowest would represent a strong signal at the input of a receiver! If the spike or 'pip' outputs are selected, although the last digital gate output has the same levels as above, the very narrow pulse spreads the energy over a much wider spectrum so that the actual level of any particular harmonic is very much lower. Input switching shown below. G3PCJ



## ***Fault finding!***

One of my regular customers recently pointed out that my kit instructions are all about building the rigs, but are not so good at explaining how to repair them when they fail! It's a fair observation so here are some general notes about bringing a dead rig back to life! Obviously not all of these suggestions will be relevant in all cases so amend them as relevant! In nearly all cases, you will be stuck without the circuits ultimately.

I always start with a good physical examination! Broken wires, and or for my kits, missed topside ground solder points. This is still the most common fault despite strengthening the standard warnings about that! Giving it a good firm tap while held upside down often removes blobs of solder or swarf! Then look for burnt or broken tracks and any signs of dry solder joints. Often inexperienced builders do not use enough heat so that the solder forms round teardrops rather than smoother well tinned rounded curves! My experience with modern lead free solder is not great but it needs more heat than conventional 60:40 tin:lead solder. Do not be afraid of cooking electronic parts, modern ones are much more tolerant of heat than they used to be! It is much more likely that the PCB tracks will lift off the fibre-glass (or SRBP) board before any part gets damaged.

The next task is to apply power. Use an adjustable current limited and voltage regulated power supply. (I used to make these myself but in recent years they have become much cheaper and hardly worth the effort, especially as they often now include current and volt meters, so a commercially made one is a sound investment.) Set the voltage to the specified figure and then (assuming it does have over-current protection), set that to a little more than the anticipated load. Its not always easy to set the current turn off level but you should be OK to short the PSU output and then adjust the resulting current to the desired figure - try this with caution if you have not done it before! What do you set it for, if there is no guidance in the instructions or circuit? I would suggest about 100 mA for a simple RX, and perhaps 2-300 mA initially for a TCVR. If it has loads of relays, then this figure might need upping. And of course, when going to transmit, the draw might be very much higher than this - but most QRP type rigs will not draw more than an Amp or two at worst. Having connected and powered it up, wait for a little while and see if any smoke arises or if the current increases. If yes, this indicates that some stages is suffering thermal runaway and is most likely to be a power stage - audio or RF! Then check the internal supply rails are close to the nominal values. After this, one does really need to know the detail of the rig's circuits.

I find that the next easiest area to test are the rig's oscillators. Direct conversion rigs tend to have only one and you can often use a general coverage RX to listen around for it near to where it ought to be. Superhets will also have a carrier oscillator which should be very close to the nominal IF frequency. So far you don't need any fancy gear! But if you do need to set the frequencies, then a counter or the general coverage RX with digital readout are invaluable.

If the oscillators are working, then test the audio stages. If it's a RX, you should not need a special source - just yourself! Apply your finger to the shaft of a metallic screwdriver and dab this on to the audio signal path, starting at the output stage. If you get a click or a rough sounding hum, its likely to be working and will probably get louder as you advance towards the low level stages nearer the aerial. If you are working on a transmitter, you can listen to the speech amp stages with an external audio amplifier (with high Z input) turned well up initially.

After this you are into less easily tested stages like mixers and RF amplifiers. Having formed an opinion about the faulty area, it is always wise to measure the DC operating voltages with a high impedance voltmeter. Any transistor whose drain or collector is sitting at either 0 volts or the supply rail is suspicious until you have satisfied yourself that it should be like that! A transmitter output stage fed via a low value RF choke would be one of the few cases where the full supply volts on the drain/collector would be normal! But any at 0 volts indicates potential trouble (a shorted device!), but watch out for the open circuit device which might also make the supply volts appear on the drain/collector! If the bias voltages seem plausible try injecting RF signals into a RX from a sig gen; or for a TX, listen with the general coverage RX aerial near to individual stages.

It is most satisfying when you find the single dud joint in the rig that cost you £5! G3PCJ

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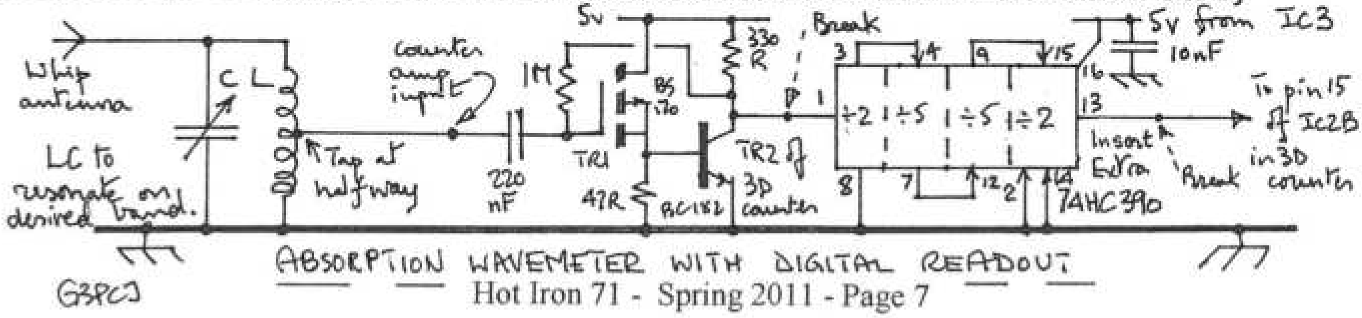


ABSORPTION WAVEMETER WITH DIGITAL READOUT

G3PCJ

## ***Yeovil QRP Convention***

20th March 2011 at the Digby Hall, Sherborne, Dorset

Doors open 09:30 am to 4:00pm
Supported by the RSGB & RAFFA
Traders, Bring & Buy, Club Stalls
Contact Derek Bowden M0WOB email yarc-contact@tiscali.co.uk
Talks by Rob Micklewright G3MYM and Peter Chadwick G3RZP

I will be having a stall there. If you want any kits and are coming please let me know in advance so they can be prepared. Note the date is early this year!!


## ***QRP in the Country 2011***

I hope all of you living in Southern England already have the date in your diary! Just in case:-

July 17th 2011 at Upton Bridge Farm, Long Sutton, Somerset TA10 9NJ

I am working on several new attractions and will be welcoming several radio personalities including Rob Mannion G3XFD, Editor of Practical Wireless, and Rev George Dobbs G3RJV, Editor of Sprat. Please do encourage your local Club to come along with any sort of radio related stand that explains some of its activities and which will be of interest to others. No charges! Just send me an e mail to walfor@globalnet.co.uk

Keep your fingers crossed for good weather - if necessary we will move into the cattle sheds!


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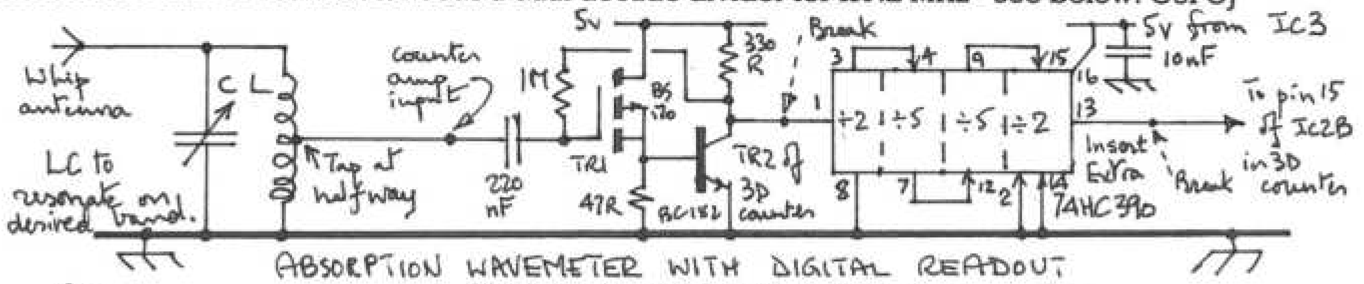


ABSORPTION WAVEMETER WITH DIGITAL READOUT

G3PCJ

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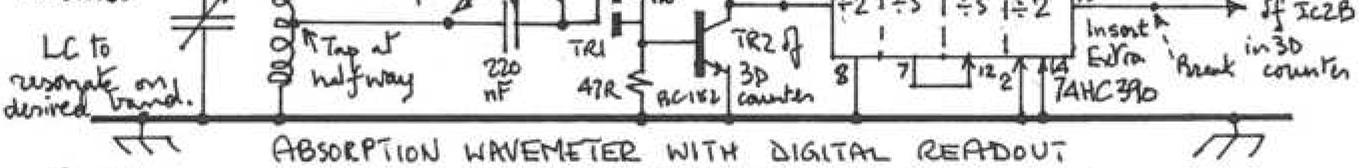



ABSORPTION WAVEMETER WITH DIGITAL READOUT

G3PCJ

"JOURNAL OF THE CONSTRUCTORS CLUB"

# Hot Iron

Summer 2011
Issue 72

## Contents



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

## *Editorial*

Last Hot Iron for the fourteenth subscription year! How time flies. I used to think that it was almost impossible to re-invent the sort of radios that amateurs want. But fashions change and new devices or 'components' allow a slightly different approach; so what one might think is always a direct conversion rig can actually take many different forms. Of course complexity is one of the major variations and of late there does not seem to be much appetite for interesting but more complicated designs. Inevitably they are more expensive, and the poor economic climate keeps buyer's hands in their pockets! But soon there will be a little more fun and money in the economy! The doom cant go on for ever and then you will all be wanting something different. Do tell me what I ought to be working on for the longer term please! I am happy to consider any suggestions provided they do not depend upon a computer to drive the gadget! There are even rumoured to be some 'doodlings' for low VHF rigs on my pad!

So as to make certain you see it, I make no apologies for mentioning QRPiC 2011 on the first and last pages! All Construction Club members (within reasonable reach of here) are invited to come and join us here on the farm for QRPiC 2011. There is loads of space for individuals or Clubs to put on displays or any form of stall that will be of interest to others. It will not be a rally full of black box or computer traders! Tim G3PCJ

## *Kit Developments*

Much of the last three months has been taken up with non-radio matters so not quite as much to report as I would have liked. The **Cary** is now available after quite extensive development (see later) - the wide range of bands proved to be rather more of a challenge than I anticipated!


I have even started on building the revised **Minster** Mk 2 (right)! I hear some faint signal in the noise ... 'about time to'! The RX text is mostly written and I will soon finish building it; & then add the TX. It will use the earlier RF Extras kit to convert it to any 3 bands, with options for AGC, CW etc. G3PCJ

*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

## ***Supply Miscellany!***

It is some while since we mentioned power supply aspects, so some general background info!

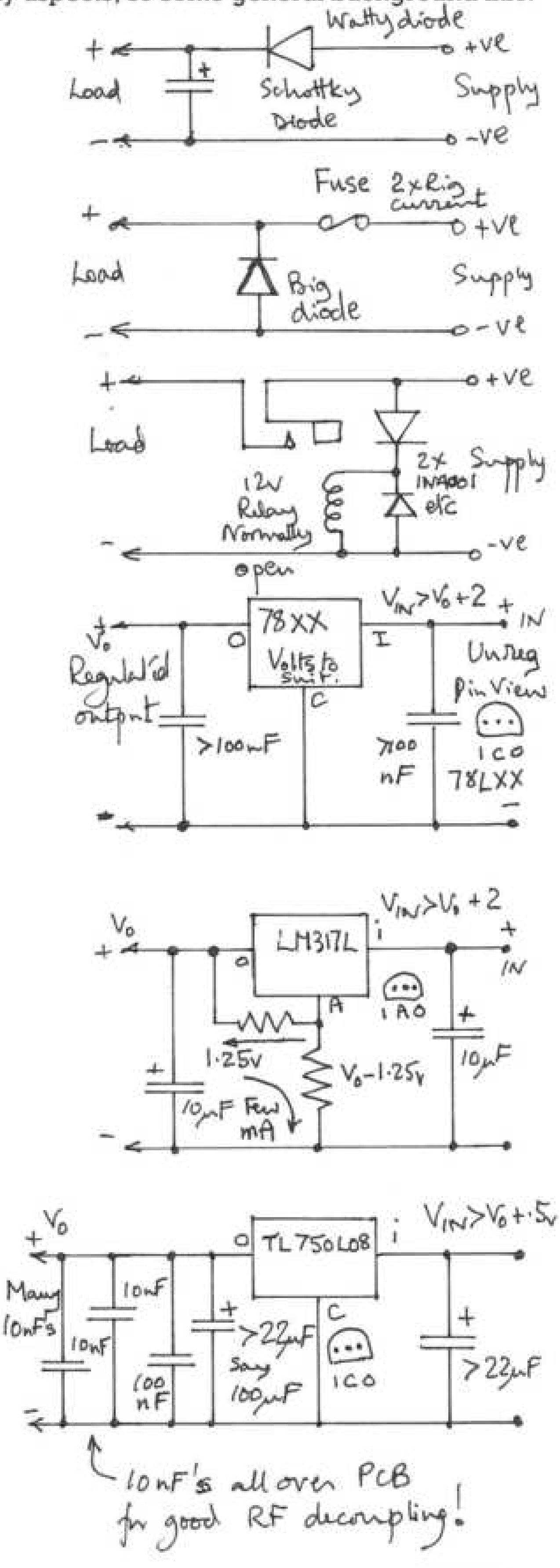
*Reverse Supply Protection* There three basic approaches as shown on the right. Firstly a diode in series with the incoming supply line. Gives full protection but drops between about 0.4 and 0.8 volts depending on type. Ordinary Si diodes (1N4000 series) drop about 0.6v up depending on current. Better are Schottky diodes which are down at the 0.3 v up level. I use 21DQ06 or SB330 devices, the 1N5817 series are also suitable but a bit physically larger. If heavy transitory load currents (power audio) can occur, needs heavy decoupling! The next scheme is a big power diode across the supply (after a fuse) - the diode conducts when the supply is reversed and blows the fuse! Correctly installed MOSFET RF power output stages like an IRF510 can act as a diode so you don't need an extra one! Problem - this scheme is not sufficiently quick to always prevent damage. The best solution is a relay which only turns on when the supply is the right way round!

*Fixed Regulators* The common and cheap 78 series devices are excellent for general purpose use. The TO220 style devices are usually rated at 1Amp with the small ones at 100 mA. There are many fixed voltages available - commonly 5, 8, 9,12 and 15v in both positive and negative versions. They are supposed to need decoupling by at least 100 nF on both input and output but I have not yet had a problem when omitted on a bench test lash-up! The input range is usually from 2 volts above the desired output up to about 35v. The need for 2 volts more than you want is their main drawback unless you need very high regulation against variation in load or incoming volts.

*Adjustable regulators* The LM317 series provide better regulation (change in output voltage) as either the load or the incoming volts are varied. This makes them especially suitable (or even mandatory!) as the source for tuning voltages used with varactor tuning diodes. Again there are high power T versions rated at an Amp but the small ones are 100 mA. They also need an incoming supply at least 2 volts (up to 35v) above the desired output. They need 2 resistors to set the internal feedback voltage to 1.25v.

*Low drop out regulators* These devices do NOT need the 2 volts headroom between in and out voltages. Often the difference can be down to 0.3 volts at full load. The LM2930-T8 devices are now expensive so I am using the 100 mA 8v TL750L08 in small rigs. These must have at least 22 uF of output decoupling otherwise they oscillate!

*Decoupling* If in any doubt, add plenty! Almost all circuits will benefit from too much! Use 10 nF disc caps spread all over an RF board, then parallel with 100 nF polyester somewhere and maybe up to 100 uF electrolytic if feeding an audio output device. G3PCJ



## *'Widebanding' a 40m Kilmot* by Steve Davies MW0KST

I thoroughly enjoy building, testing, modifying and generally tinkering with Tim's kits. After getting them working, experimenting is probably the most fun. In fact several extra mysterious holes can often be found in the kit PCBs – maybe just for this purpose?

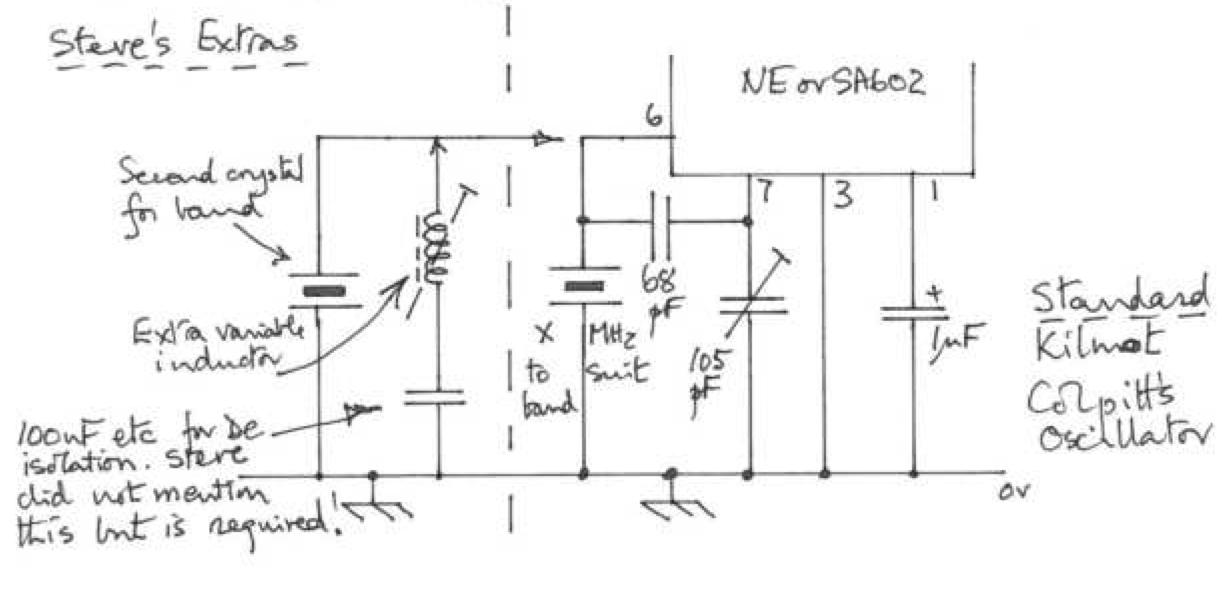
My most recent 'build' is the little Kilmot VXO DSB transmitter for 40m. From the start I planned to adapt it for use on both 40m and 80m. The idea was to simply switch the 40m crystal over to the 80m ceramic resonator, at the same time switching in an 80m low pass filter.
However, probably like a lot of people, I wanted a little more coverage on 40m than could be achieved using the single crystal. I'd read about the "super VXO" and various articles in publications such as 'Sprat' about how to increase the pulling range of a crystal VFO. This would retain the advance of excellent stability while providing much more useful band coverage.

I started my little experiment by adding a parallel 40m crystal the same frequency as the original in the kit. The result was disappointing, with only an extra 2 or so KHz more bandwidth. I then added an inductor between the pair of crystals and earth. The inductor used was a Toko 3336 left over from a previous kit. This seemed to work surprisingly well. With adjustment of the inductor, I was able to tune the VFO from the crystal frequency down about 30 or more KHz.

A bit more playing with the new 'widebanded' version of my Kilmot revealed that the oscillator would not start when switching on if the VFO was set near the crystal frequency. I also noted that on some (but not all) occasions, going into transmit near the crystal frequency caused the oscillator to stop.

Adjusting the inductor partly cured the problem. I set the VFO frequency near the crystal frequency and adjusted the inductor while switching on an off, soon finding the point at which the VFO reliably started on each occasion. The downside of this adjustment was that the usable bandwidth was reduced to about 10 kHz. Still, not bad for a very simple mod. involving the addition of two junkbox components.

If anyone knows how to achieve the larger VXO range whilst maintaining VFO stability near the crystal frequency, I'd be very grateful to hear from them!

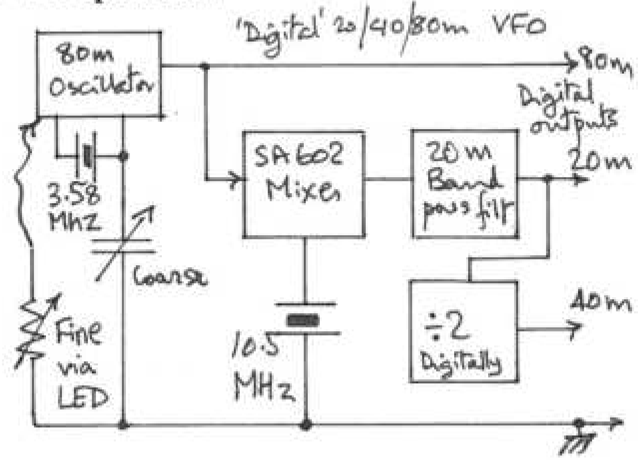



Comment from G3PCJ. The nominal inductance of the 3336 TOKO is about 45 uH; my impression is this is a bit large for pulling most HF crystals - I think 10 uH is more typical. I don't have much experience except at 6 MHz (for a Colpitts CIO), where adding 10 uH directly across the crystal allows it be pulled down easily to 5998.5 KHz. Without the 10 uH, it will easily go up to 6001.5 KHz.

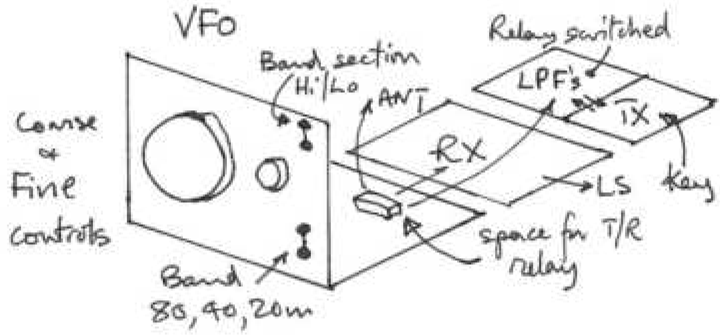
## *Ideas for 3 band rigs*

The ease with which the Cary regen (see next page) can be made into a 3 band RX has made me ponder different approaches for a 3 band CW transmitter. I started by considering 80m using a ceramic resonator for the CW section to give limited VFO operation without the problems of chirp when a 'normal' VFO and TX output stage are on same frequency. How to get up to 40 and 20m? Doubling (twice) would magnify any drift, so no good. Mix with a 3.5 MHz crystal source for 40m is possible but does not solve 20m! That needs a 10.5 MHZ crystal - maybe use third harmonic of the 3.5 one - no, too complex. Consider separate crystals for each band - however soundings of potential customers indicated they wanted proper VFO operation!

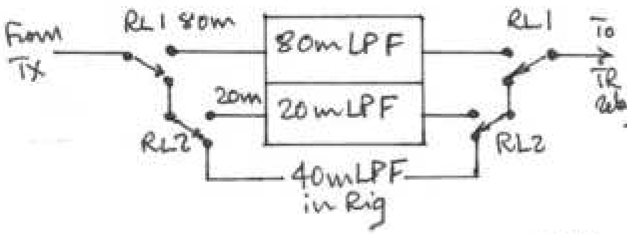
So back to a scheme that I had used in the Locking some years ago (right). This uses an 80m ceramic resonator as the basic VFO. For 20m this is mixed with a 10.5 MHz crystal (I have plenty), passed through a 20m BPF and then digitised into a 5 volt logic signal. This can then be easily divided by two for 40m. This arrangement would provide 0-5v logic output signals for 20, 40 or 80m with all three bands sharing the same bottom band edge tuning spot. A single tuning spot would also be shared by all three nominal CW QRP 'frequencies' - 3.56, 7.03 and 14.06 MHz!



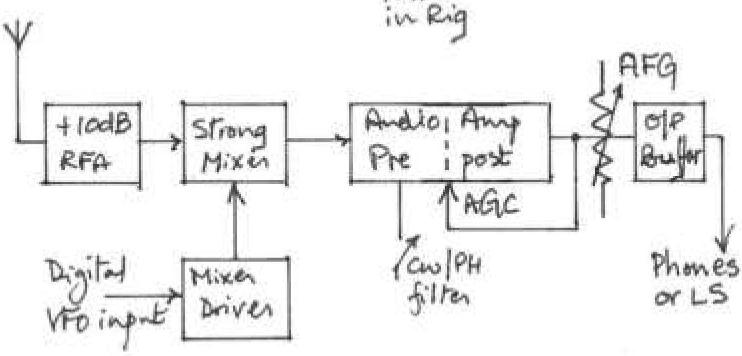

What sort of physical format should this be given? Somebody had suggested a 'universal' VFO which led to the idea of this gadget being used to drive a TX and/or a direct conversion RX. The VFO section could be in the small upright format (like Yeo or Cary), with TX and or RX behind. See rough outline on right! Band selection would be done by DC signals from a centre off toggle switch.




As it happens the existing Kilton CW TX, will work on any of these three bands provided the low pass filters are suitable. It can also be easily driven with logic signals from an external VFO. The existing design allows for connection of a Linear and these pads can be used to add a pair of relay controlled low pass filters for 20 and 80m with the Kilton's normal LPF set for 40m as shown right. (This broad approach might also work for the DSB phone Kilmot.)



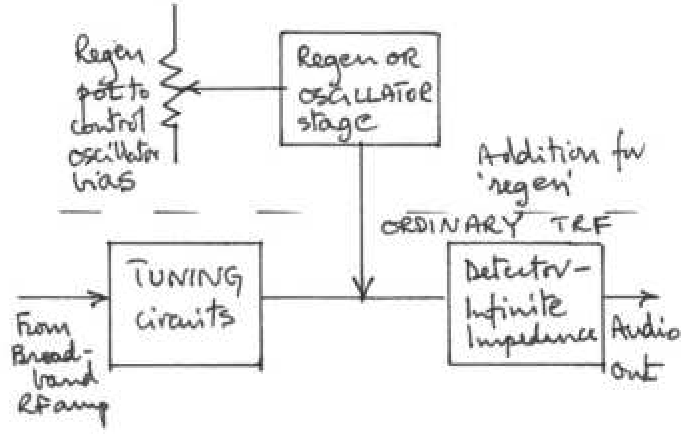

The last element is a wide band DC RX using the same VFO! It would need RIT but that can be applied to a Fine tuning pot easily. I plan to try out a 'strong' partially balanced mixer that might avoid the considerable complication of RF band pass filters for each band. Hopefully the use of a resonant AMU might just provide enough out of band rejection. A low gain broadband RF amp might be a sensible addition to stop unwanted LO radiation. The mixer would be followed by a grounded base audio amp, filtering for phone or CW and further audio stages for driving phones or a small speaker. It might be worth considering AGC for this rig too. Any comments? Tim




Wide band RX Concept ©G3PCJ

## *Development of the Cary*

I had thought that it was all sorted! However, the thorough testing by the two Steves (MW0KST and G0FUW) showed it needed more work! The problem is the desired wide frequency range - MW (single band) for novices to 20m in its 3 band form - 1 MHz to15 MHz! The diagram right shows the heart of a TRF set with a resonant circuit feeding a detector. It is turned into a regenerative TRF by making it capable of oscillation, and because transistors are so cheap compared to valves, it is now best to use a separate oscillator stage. The frequency of oscillation is determined by the main tuned circuit. The stage is controlled to be either just NOT quite oscillating for AM, or to be JUST oscillating to provide the LO for CW or SSB use, by careful adjustment of its bias conditions.



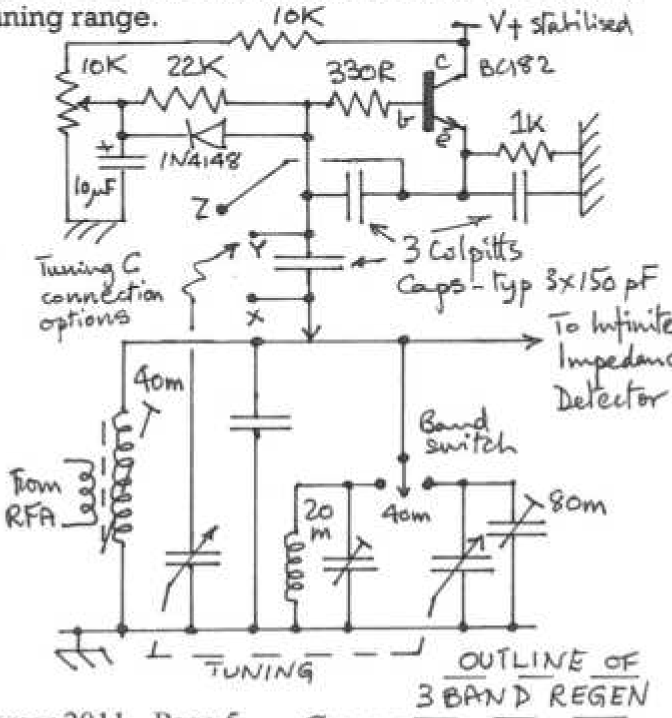

Having a separate oscillator (or regen stage) works well and gives less interaction between the controls for tuning and regen than was typical with a single valve for both functions. At the very low frequency end, I found it necessary to keep the impedances high, otherwise the regen stage would not oscillate. But this then led to squegging when the resonator was altered for 40m! Squegging is what happens intentionally in a super-regen detector where oscillations build up repetitively to some level and then cease, which usually causes a rough sounding hash in the audio. Not good for CW/SSB where a steady condition is needed, with it just into oscillation! This was eventually cured by a change to the Colpitts oscillator configuration (with lower emitter resistor for HF) instead of the earlier Hartley arrangement. This also has the benefit of swamping the regen transistor device capacitance, which changes with bias, by the Colpitts capacitors; this leads to less shift in frequency as the regen pot is altered.

The final hurdle was an unexpected VHF oscillation! This is quite a common problem in emitter follower circuits because they can look like a Colpitts oscillator if they are feeding a capacitive load! The cure is a base stopper resistor which reduces the gain at VHF but is transparent at HF! Finally, the resonating capacitor values needed manipulation to minimise the number of different values in the kit! The circuit right is a simplified (owing to lack of space) but shows the principal of how a single inductor is used to provide three band operation. To avoid a second adjustable inductor for 20m, it is easier to parallel a smaller fixed L and then bring the resonant frequency back down with added capacitance from a trimmer. Extra capacitance for 80m is easy and the 150 pF section of the PolyV gives a reasonable tuning range.

I had some comment from a customer who thought the Trull (from which the Cary is closely derived) to be unduly complex compared to his old valved RX regen that seemed to do all this with much less fuss! I had to point out that:-

An RF stage is needed to prevent radiation
High Z phones are no longer obtainable
Customers want it to drive low Z loud speakers
Plug in inductors for bands are complex
Single tuning caps need slow motion for wide freq range, or extra band spread capacitor
Air variables are lovely but very expensive
Air variables are much harder to mount
Higher sensitivity is desirable nowadays

Unfortunately what he could do nicely from his well stocked junk box is not the basis of a viable kit design! G3PCJ



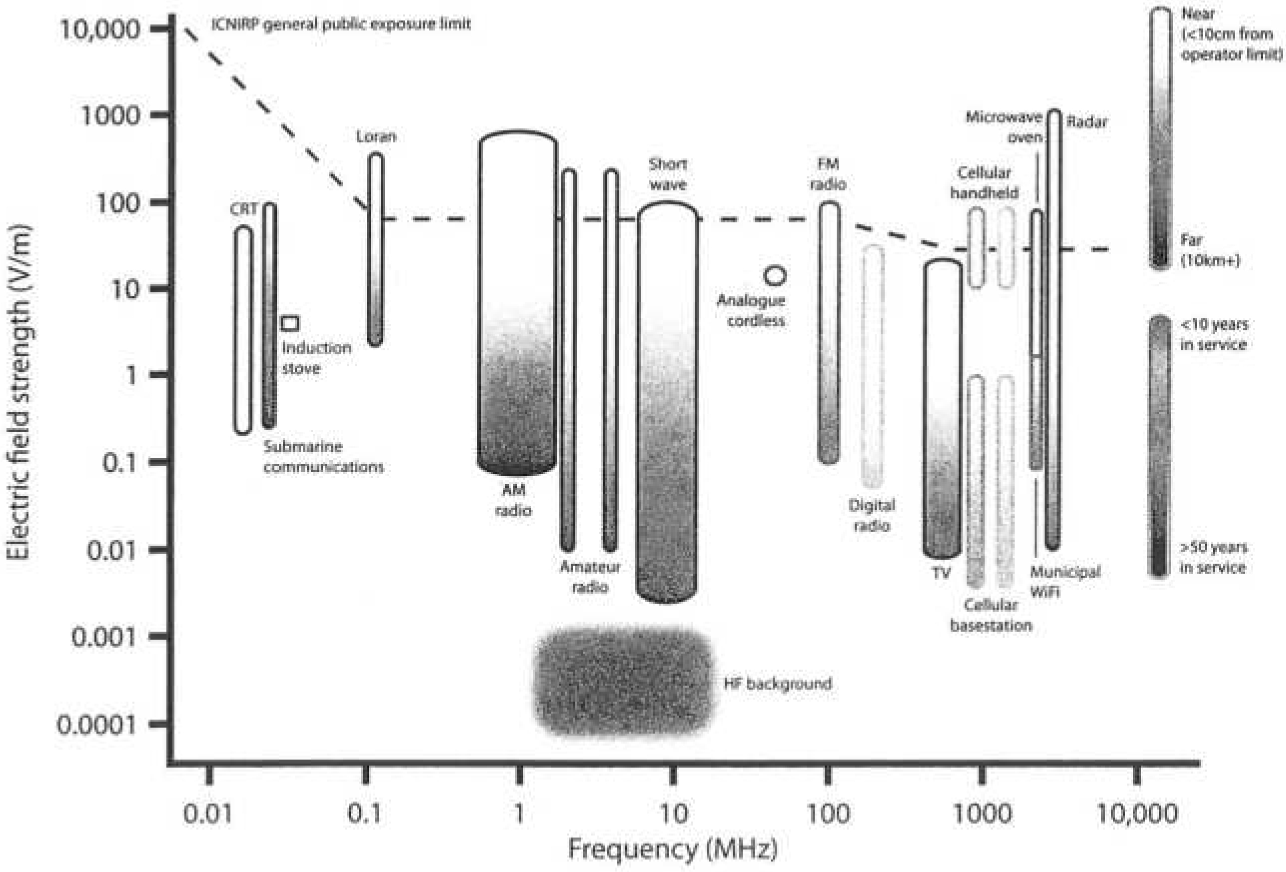
## ***The RF soup!***

This is nothing to do with food but is about exposure to RF radiation. An article in the E & T magazine published by the IET in Sept last year discussed what we are all subjected to in our everyday lives. In recent years there have been two areas of possible concern - low frequency exposure from power lines (especially high voltage ones), and that from mobile phones. Much has been written on both subjects and there are entrenched views on both sides - that there is a problem with long exposure to weak EM fields, or that the only limits to worry about are those due to heating effects in the body. I am no expert and do not offer any opinion! People do get worried by the proximity of mobile base stations to children's playgrounds etc but the field levels from these are much lower than that from a handset transmitting right next to your head! There have been experiments to boil eggs with mobile phones etc but without success! Despite large amounts of money being spent to identify genuine problems, there is very little hard evidence which is able to be replicated in a scientific manner. It is easy to believe that we are being bathed in an increasing soup of RF radiation from Wi-Fi etc but recent studies suggest the RF levels in a metropolitan environment are below 1% of the suggested ICNIRP levels, and are well below that of leakage from a typical microwave oven at a distance of 1m.

The article concludes:-

'Levels of ambient RF have clearly increased since the 20th century began—the few milliwatts per square metre of black body radiation are now supplemented by a variety of sources operating in the microwatt to milliwatt per square metre range, representing a relative increase of five or more orders of magnitude, though from very low levels. But some of these sources have been operating for most of a century - a far longer period in which to recognise any potential health effects than the working lifetime of relative newcomers such as cellular radio and Wi-Fi. That has yet to be reflected in public perception of the risks of RF radiation - if there are any.'

Accompanying the article was a most interesting table (copied below) which confirms my suspicion that the peak power of many MW used by AM broadcasters are some of the highest! Tim



## ***Snippets!***

*Last time's competition* Who was the owner of this useful set of test gear with a very tidy corner in his workshop? The answer was Richard Booth G0TTL and Chris Fleet was the lucky winner. His prize was a transmitter low pass filter kit.

*Magnetism?* A recent letter from David Buddery G3OEP says he recently dropped a 4W metal film resistor and was amazed to find that his telescopic pocket magnet attracted it! Was there magnetic material in the end wires? 'When I removed them, the resistor was still magnetic. Where is the magnetic material? Is the metal film magnetic? I seem to have read somewhere that Nickel can be magnetic or is it the substrate that has these properties? I understand that many small permanent magnets, such as those used in low power dynamos or electric motors are often of special material.'

I too have noticed that off-cut wire ends from some resistors or capacitors are magnetic but I suspect this is plain iron. By chance I happened to spot an article in a recent Electronics Weekly which reported a development combining traditional in-organic semiconductors with organic spintronics in a novel device. The polymer is vanadium tetracyanoethylene and is a ferromagnet - just like iron or cobalt. A gallium arsenide LED device was used to observe the spin coupling effects. I am not sure what the potential application of this device might be but I think Nickel and Cobalt are in the same group of the atomic table and hence might share magnetic properties!

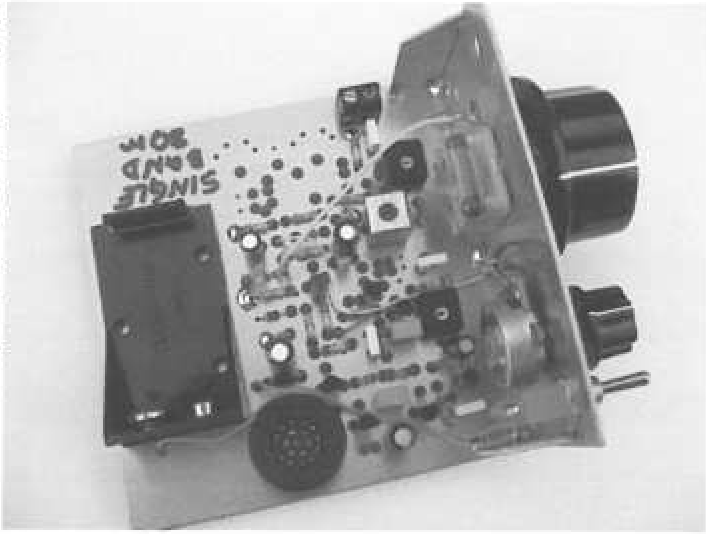
*Goobledegook!* Another EW article began '4GLTE or WiMax networks are now just in the process of being deployed and integrating them with existing CDMA and EV-DO networks is a venture into new territory. In the meantime, GSM/WCDMA network operators are deploying HSPA and HSPA+ technologies, and it is becoming difficult to maintain a competitive position with the speeds offered by HSPA networks while staying within the 3GPP2 ecosystem. To tackle this EV-DO Revision B, and extension of the concept of EV-DO Revision A combines multiple Revision A carriers together to offer faster speeds. In a typical three-carrier deployment, Revision B can achieve speeds up to 9.3 mbps on the forward link. .......' Can anybody understand or explain this please?!

*How loud is it?* I spotted this useful table of Sound Pressure Levels in db recently:-

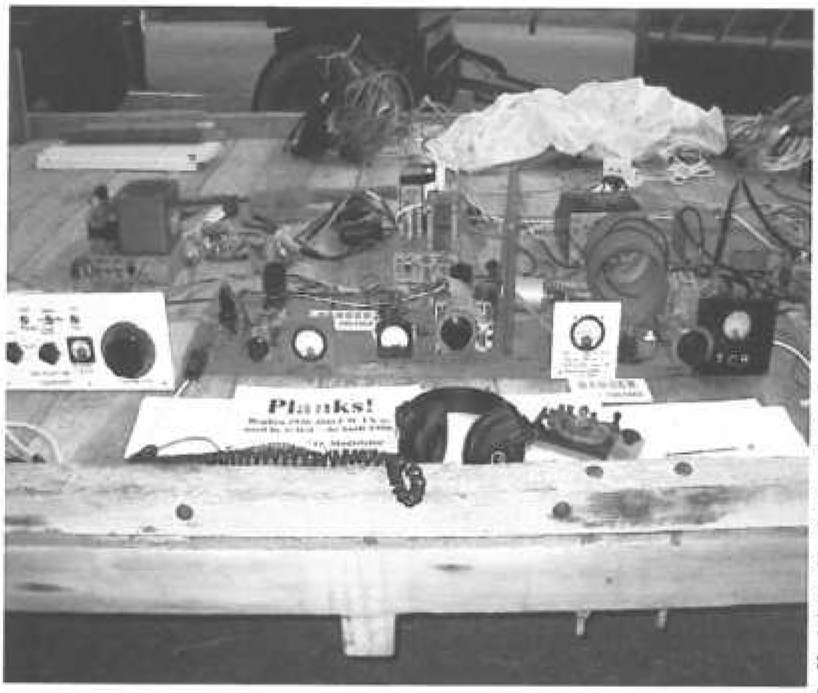
| | |
|---|---|
| Jet engine at 3m | 140 |
| Threshold of pain | 130 |
| Rock Concert | 120 |
| Accelerating motorcycle at 5m | 110 |
| Pneumatic hammer at 2m | 100 |
| Noisy factory | 90 |
| Vacuum cleaner | 80 |
| Busy traffic | 70 |
| Quiet restaurant | 50 |
| Residential area at night | 40 |
| Empty movie house | 30 |
| Rustling of leaves | 20 |
| Human breathing at 3m | 10 |
| Threshold of audibility (for good ears) | 0 |

So now you know!! Tim G3PCJ PS Where does an S9 + 60 dB signal come in this table?!!

## *QRP in the Country 2011*



The renowned Bath Buildathon team led by Steve Hartley G0FUW will be running a construction project at QRPiC2011 on July 17th 2011 here at the farm - TA10 9NJ. The project will be a basic Cary Regen receiver as photo right. This is a single band RX for MW, 160 or 80m; but parts will be provided for builders to change it to 3 band on 20, 40 & 80m in their own time later. Those wishing to take part should send payment by cheque or Paypal to Walford Electronics. The cost is £40 and construction of the basic RX is expected to take 3 to 4 hours, so there will be time for you to see the other attractions! The closing date for entries is July 4th. Places are limited so book early!




The Rev George Dobbs G3RJV will be attending and commenting on a 'Show & Tell' display – please bring along lots of homebrew things for all to see! Rob Mannion G3XFD Editor of PW, the RSGB and other QRP personalities will be there! There will be working demonstrations of the G3GC replica 1930's Plank equipment, vintage wartime gear, several Club displays and individual stalls with a full range of Walford Electronics kits. There will also be a construction clinic for those needing advice or a little help to get something working. There is still plenty of space for more Club stalls or displays – I am very keen for more of them - let me know if you can bring a display of any sort! There is no charge for attendance. Gates open 10 am.

Local food and drink from the farm and the next door brewery will help lighten the day! My wife Janet will lead a short farm walk for those wishing to see the Somerset countryside. The radio event will be held outside but if the necessary will be moved into the farm barns.

# *Subscriptions!*

I regret it is that time of year again! The next issue of Hot Iron is the first of the membership year and I need to receive your payment of £7 for UK members by Sept 1 2011. Overseas membership costs £9. The price remains unchanged despite the rise in VAT! If you wish to pay via Paypal this is fine, but please add an extra £1 for their fee. All I need is your fee and name/address. To keep it interesting your contributions are essential! You will get bored of me writing it all each time! Any article or note, about your experiences, hints and tips etc. are especially welcome. Allow for about one side of A4 ideally with some sort of picture or diagram. And I am very happy to attempt to answer member's questions. If you don't feel too confident about producing material that is fit for publication I will do my best to turn it into reproducible form! Hope to see you July 17th! Tim G3PCJ

"JOURNAL OF THE CONSTRUCTORS CLUB"

# Hot Iron

Autumn 2011
Issue 73

## Contents



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

## *Editorial*

The start of yet another year! So to be different I invited Nick Tile to write something for this slot. He writes:-

As an Environmentalist, the QRP movement is inspirational. Over the last few years, I've watched the radio amateur go from being a very capable and competent artisan who could turn his hand to building or repairing his radios, capable of adapting what he had to hand, often improving it, re-using parts and sharing knowledge and components with other amateurs, to a completely different breed. Arguably, they are still technically very competent, but they are people who buy expensive equipment who wouldn't dream of opening it up, it's too expensive, too complex and anyway, it isn't repairable or adaptable.

Through the good offices of people like Tim, G3PCJ, George, G3RJV, Eamon, EI9GQ, Bill N2CQR over at Soldersmoke, and the army of unsung heroes who have participated in, and driven forward, a sort of "grass roots" movement, we have seen a new version of the old fashioned amateur rising slowly, typified by the QRP'ers. People who do more for less, use greatly reduced component counts, every part there for a purpose, simplicity a virtue and performance not compromised, or better still, appropriate. These are people who have adopted QRP as a philosophy, people who have looked at technology, and seen its limitations, or simply tinkerers and "Makers".

From my perspective as someone who is concerned about the Environment, these are the people who are setting the blueprint for the way that society is going to have to live. We have all heard the arguments about Carbon Dioxide and climate change, and we all stand in a slightly different place, but in truth, that really isn't the issue. The real issue that we all need to address is consumption, we use too much of everything, we have forgotten how to adapt, repair and re-use the way that you, the QRP movement, does. `Society has to recognise that we can no longer simply rely on technology, we have to start re-learning the process of using our ingenuity, to use fewer resources because they are all limited and therefore precious, so we should be squeezing every last drop from them. We have to learn to start our own "junk-box" of parts that might be useful one day, and how to utilise it in everyday life. Every aspect of the way that you conduct yourself as a QRP enthusiast is relevant to society, and a lesson that it has to learn if it is to survive. You may not appreciate it, but you are brave new pioneers, teaching society how it SHOULD be living from the bottom up, you are demonstrating that you can achieve just as much without the burden of what isn't needed. You have the courage to experiment and fail because you know that trying something that doesn't work is a successful experiment demonstrating what won't work and why. You have the social responsibility to re-use and to share parts, components, and most importantly of all, knowledge. You are helping to write the blueprint for a new society, and you are doing the experiments that prove it can, and must work, and maybe most powerfully of all, your chosen medium is one that ignores all the usual boundaries and constraints, so that your philosophy can be shared to reproduce and grow as new ideas.

Gentlemen, and ladies of course, you might not appreciate it, but you might just be the future.

*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

## ***Developments and the Minster 2***

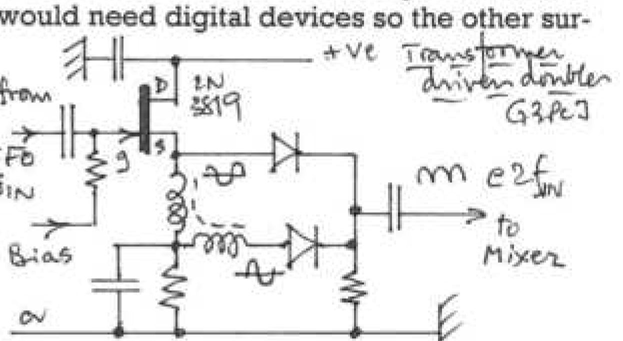
Firstly my apologies for the small sized type on the front page but I didn't want to cut a guest editorial down! It has been mighty hectic here all summer, farm and kit supplies have been busy, and oragnising QRPiC 2011 took up much time too! I had difficulty getting Clubs to come and show what they are up to, so if any of you, have any influence over you local Clubs who might attend next year, then please start lobbying them to come along and show us all the interesting things you get up to!

As for new projects, I have not been able to do much except press on slowly with the Minster 2. When away I had a rethink about the frequency scheme with, I think, a little improvement! To remind you, the basic rig is intended to be a builders choice any band 20 - 80m superhet with a single set of parts. The IF is to be 6 MHz so this leads to these local oscillator frequencies (MHz):-

| | | | | |
|---|---|---|---|---|
| Band | 3.5 | 7.0 | 10.1 | 14.0 |
| LO freq | 2.5 or 9.5 | 1 or 13 | 4.1 | 8 |

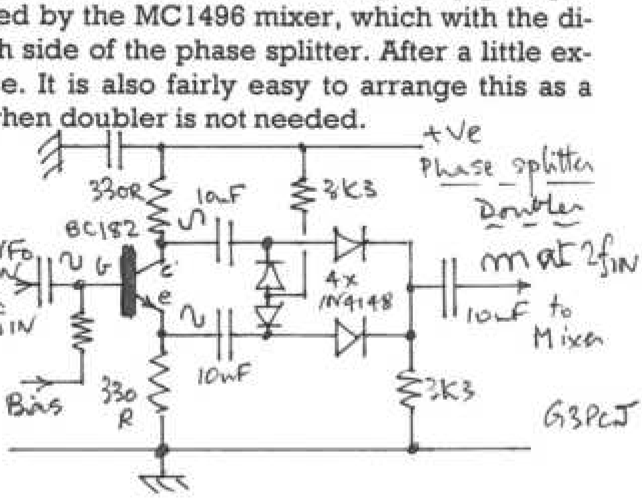
Additive or subtractive LO mixing is possible in the basic rig as the CIO can be easily placed on either side of the 6 MHz IF. However, THE problem band is 40m; at 13 MHz the VFO would be too high to be sufficiently stable & 8 MHz is plenty high enough for 20m! The 40m alternative of 1 MHz is challenging for the VFO inductor!! I planned to use a T50-2 toroid with the number of turns being adjusted to suit each band so avoiding different types of TOKOs for the different bands. But it is impractical to use a T50-2 for a 1 MHz VFO because it would need about 80 turns to get sufficient inductance and none of you would like winding on that many turns!

This problem has caused me much head scratching over the years. One alternative would have been a digital VFO producing square waves for the LO signal and to make the mixer work on the LO third harmonic. I tried this out and it certainly works but the mixer voltage gain drops from about x10 down to nearer unity. It also needs quite high LO drive levels which could feed through into subsequent stages. Apart from that, few other aspects of the rig would need digital devices so the other surplus gates within a single chip might well be wasted!




But I then thought of using a frequency multiplier in the VFO chain. The Minster is to have a VFO buffer stage anyway and this could be adapted as a doubler for some bands. The obvious approach is a full-wave rectifier driven by a toroid transformer producing anti-phase signals. The drawback is it needs quite low impedances if one is to not have masses of turns on yet another awkward toroid! This approach is sketched right.

Another scheme for a full wave doubler is to make the buffer stage into what is often called a phase splitter; this is essentially a buffer but with equal resistances in emitter and collector (if a bipolar device). This causes equal amplitude signals in anti-phase to be available at the emitter and collector. Because they carry DC bias voltages one cannot just input those into the full wave rectifier - some form of DC restoration is required to make the AC signals to sit on the same DC voltage. A p-p amplitude at the doubled frequency of about 0.3 volts is required by the MC1496 mixer, which with the diode drops leads to about 2 v p-p being needed from each side of the phase splitter. After a little experimentation the circuit right seems a good compromise. It is also fairly easy to arrange this as a plain buffer and attenuator to give 0.3v p-p for the mixer when doubler is not needed.



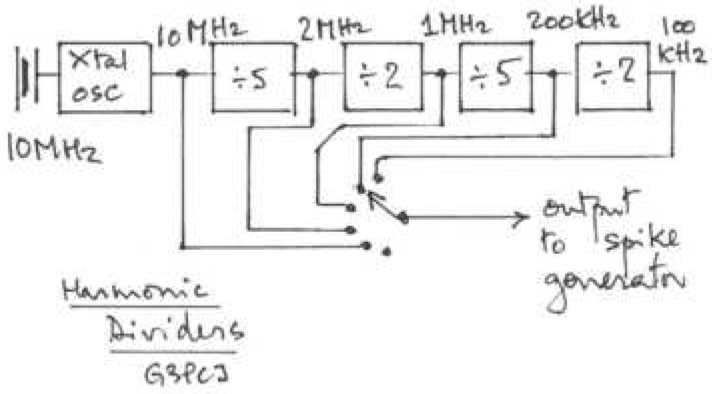

Having got a doubler for 40m, it is also sensible to use it for 20 and 80m so that the VFO now only has to be altered to run between 4 and 6.5 MHz for any of the bands. When the RF extra kit is to be added with crystal mixing for any 3 bands, the VFO also needs 4 MHz! This small range is easily catered for by capacitor changes and a fixed inductor - another TOKO 3334 can be used instead of the unwelcome T50-2 toroid!

I think I might also use this scheme in a proposed new low cost single band TCVR - more later! Tim G3PCJ

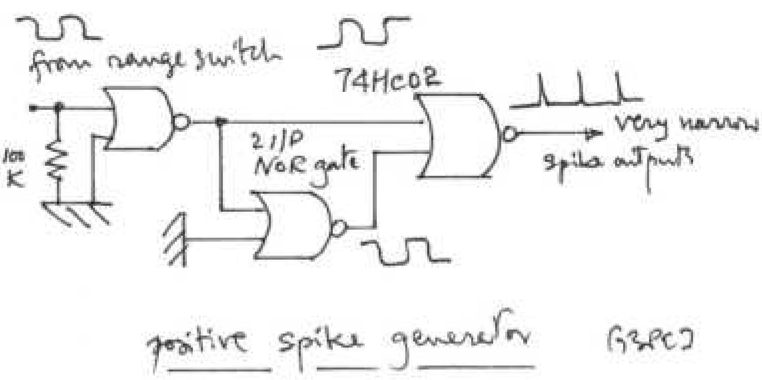
## ***Harmonic Markers***

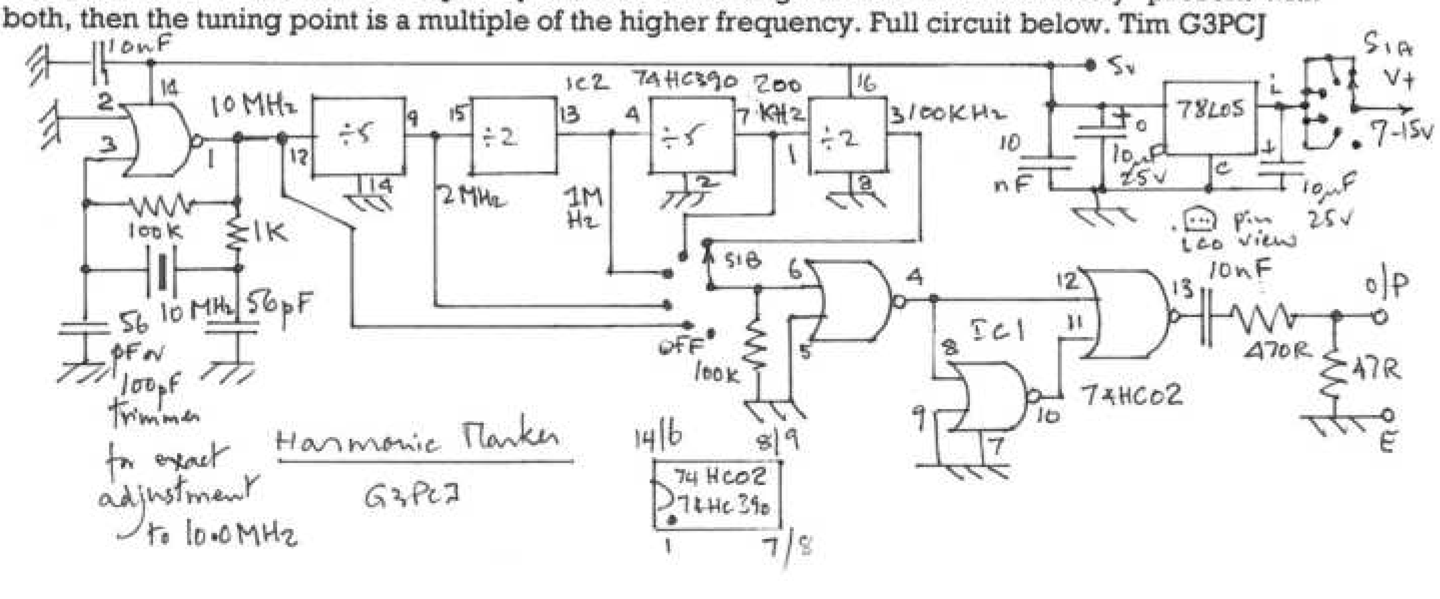
These are most useful pieces of equipment - their main use being to calibrate a receiver's tuning dial and to provide stable test signals for aligning a rig's RF filters etc. It was one of the first 'test' items that I made and I have had several variants over the years. Essentially they comprise a crystal oscillator that provides the accurate source or fundamental frequency; with the advent of cheap and fast digital circuits they now also incorporate digital dividers.

In years gone by they were based on large and expensive 100 KHz crystals arranged in an oscillator that was not very sinusoidal so that the output contained loads of harmonics! This tended to be a bit hit and miss and it was not unusual for the device to be ineffective in the higher HF range towards 30 MHz as this would need the 300th harmonic, and the higher the number, the weaker they get! Modern ones use cheap computer crystals - often starting at 8 or 10 MHz. The oscillator element can use one section of a quad NOR gate. The oscillator is followed by a digital counter acting as a frequency divider - these come in straight binary forms or in bi-quinary/decimal forms. I favour the 74HC390 device which has two bi-quinary dividers that can each be configured to divide by 5 and then by 2. With a suitable switch (1p 6w) you can then have outputs based on 10, 2, 1 MHz, 200 and 100 KHz; the sixth position can then be OFF by using a second pole for the battery supply!




While a square wave output does have uses - to assist in identifying the harmonic being listened to because theoretically it only has odd number harmonics, more generally 'all' harmonics are wanted; these should be present right up into the VHF region when the output is derived from a very narrow spike type pulse. Again this is easily done with the other gates of the quad NOR package - see right! In use, one listens to a harmonic and its absence when switched to a higher frequency tells you that it must be a harmonic of the lower frequency and not of the higher one. If its 'definitely' present with both, then the tuning point is a multiple of the higher frequency. Full circuit below. Tim G3PCJ



## *UK Amateur Radio Exams* by Steve Hartley, G0FUW

Following a number of letters in RadCom and Practical Wireless and enquiries at QRP in the Country, Tim asked me to pen a few words on the current state of play with the UK exams for Hot Iron. For those that are not aware, I have been a member of the RSGB's Development Committee for the last nine years and was involved when the current systems was developed.

There are now three levels of examination, Foundation, Intermediate and Advanced, all run by the RSGB on behalf of the examination body, the Radio Communications Foundation. The exams line up with the three UK amateur radio licenses; Foundation, Intermediate and Full which all provide access to the HF, VHF and some UHF bands. The power levels increase as you learn more (particularly about EMC). In broad terms, the three levels give up to 10W, 50W and 400W on most bands. Intermediate and Advanced holders have less restrictions on homebrew transmitters.

The system is progressive, in that you must pass them in order, but there is no time limit on progression and successful candidates can stick at any level if they so wish. The logic behind the progression was to prevent examining the same material at all three levels. For example, the phonetic alphabet is part of the Foundation syllabus but does not feature in the other two.

One of the questions that keeps cropping up is 'why do I have to do all three levels?' The answer is quite simple, the Advanced exam alone does not satisfy international requirements. Only taken together do the three exams cover all the topics in the Harmonised Amateur Radio Examination Certificate (HAREC) syllabus, which is recognised around the world. Not everyone knows that if you hold a UK Full Licence you can apply for a HAREC from Ofcom but some countries demand sight of your HAREC before issuing host country licenses.

There is absolutely nothing to stop a competent candidate from sitting all three exams in a single day, indeed there are six occasions every year when that can be done. The reality is that only one or two a year do so, usually at the RSGB Convention in October.

Is the system working? Well before it was introduced the numbers sitting the old City & Guilds exams had dwindled to a few hundred each year. Since the change there have been thousands taking the Foundation every year and hundreds are now progressing to Intermediate and Advanced. The decline in numbers has been reversed but it is unlikely that we will ever get back to the numbers seen in the 1980s when CB was a fashion accessory and ham radio was a logical next step.

## *John Teague G3GTJ*

I am sorry to have to report the death of John, who lived not far from us here in Somerset. He was a keen supporter of home construction and was also very interested in World War 2 equipment. He was a keen member of VMARS and of the Taunton ARC. I did not know him properly then, but it transpires that he worked for Westland Helicopters at the same time as myself! John kindly helped me with some of my inquiries about the wartime equipment that was likely to have been used at my friends Special Duties bunker in Devon. Members may recall that he was also an occasional contributor to this journal.

## *Contributors Please!*

John's demise reduces yet again that small faith-full band of people who I can call on for contributions to Hot Iron. You are all too polite to tell me that you have had enough of my prose but I am quite sure some more authors would go down well! So please do let me know if you have a topic up your sleeve! Even if you feel unable to write something yourself, please tell me what you would like written about and I will endeavour to find somebody who might be willing to tackle it! Even plain questions are helpful to me!! Get writing please!! Tim G3PCJ

## ***Test Gear***

What are the instruments which are most valued by constructors? Clearly the Mark 1 eyeball comes out top! Hotly followed by a pair of surgical tweezers!

Of course it depends on what you are trying to do - often when trying to repair something that has worked previously, this may be all that you need! Hold the item upside down and giving it a good tap may dislodge swarf etc that can cause unwelcome shorts etc.. Then a thorough visual examination to look for bad solder joints, other mechanical defects or broken/cooked PCB tracks. After that I often start with any oscillators and check they are operating on the right frequency. Then one has to dig into the signal flow and that will depend on what the item is supposed to do. For audio purposes, the finger screwdriver hum test can be revealing. Apply your finger to the shaft of a metal screwdriver and gingerly apply it to the signal inputs of audio stages with a LS or phones on the output. RF gear is always more challenging as you often need a source and some means of detecting RF - often over quite large signal level ranges.

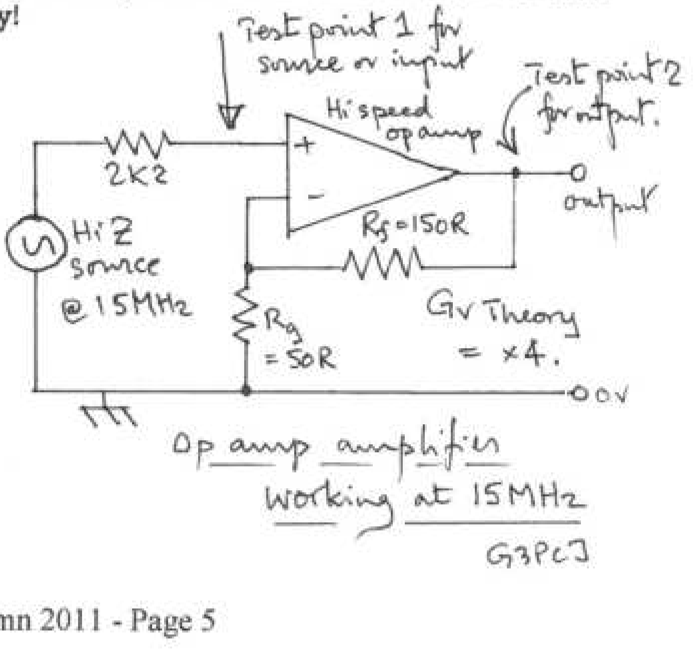
If the gadget under evaluation has not worked before but is a kit of (hopefully!) proven design, then you must follow the designer's test procedure, which if he is logical, will entail testing sections or functional blocks in stages as the item is built so that a second fault is not concealed by a previous one. Throwing it all together and hoping it will work is not really recommended!

What other items ought one to have on the shelf? Clearly a general purpose multi-meter is a thoroughly useful item - the higher the 'Ohms per volt' the better to reduce the loading on the subject. Ranges - Volts AC and DC, milli-Amps and Ohms. Digital ones are now cheap and sometimes also have a capacitance and or frequency range, but if one is observing a trend as you adjust some preset etc then an analogue meter is easier to follow - so have both types if you can! Don't bother with more than three and half digits in a digital meter.

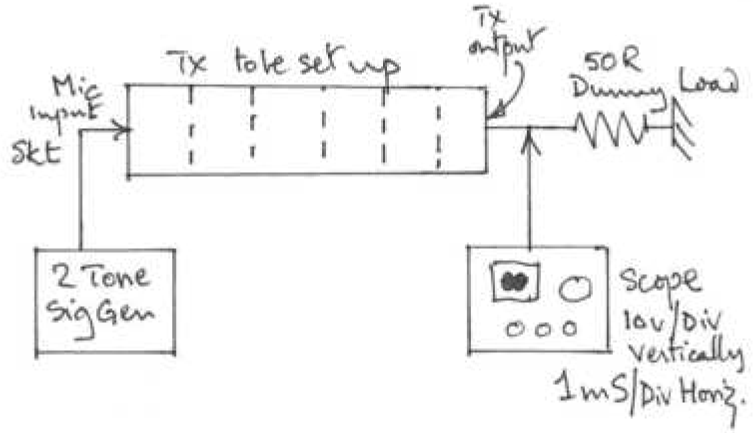
Perhaps the next most useful item is a counter for measuring frequency (and checking that an oscillator is working). Modern commercial ones are now quite cheap. Unless you are into development of new circuits and worried about VFO frequency stability, 3 or 4 digits are usually enough. Some rig counters with 5 digits for MHz and KHz readout can be used as general test gear. In years past, a grid dip oscillator (GDO) was considered an almost essential item but they do require a certain amount of skill to be used effectively. I bought mine from Heathkit over 45 years ago but it has never been used more than once or twice a year - but when you do need it, it can be very handy! Their special use is to measure the resonant frequency of a simple passive LC circuit.

If you can afford it, then a 'scope is really very useful indeed because it has so many uses! Measuring voltage, frequency/time, signal presence and changes in a waveshape etc... the list is almost endless! Second hand ones can be good buys too. As for what spec to aim for, it's a bit like buying computers - go for the best you can afford! A single Y channel is quite enough to start with and a bandwidth of 20 MHz is OK for much HF work. The price of new ones has come down in real terms in recent years and about £300 ought to buy a good one. Do make certain you also have 'divide by 10' probes to go with it. These are essential items not luxuries. They contain an attenuator that greatly reduces the loading (resistive and capacitive) on the circuit under test. The latter point is most important as I was reminded just recently!

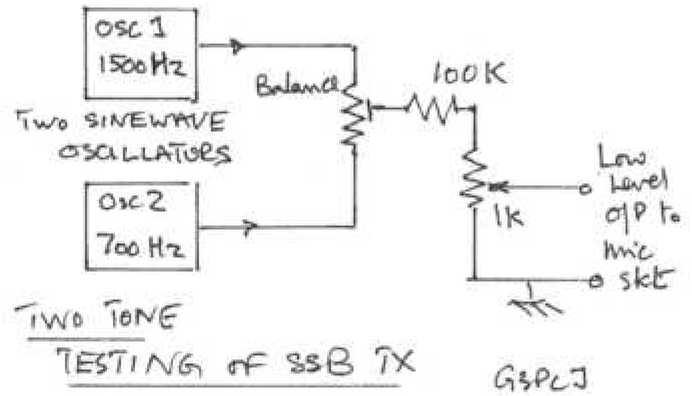
I was investigating the gain of this op-amp circuit which ought to have had a voltage gain of x 4. But repeated tests with a scope (!) showed the gain at between 6 and 7! The circuit is so simple that something had to be wrong. The theoretical gain is $1 + R_f/R_g$ . I was making the measurements at about 15 MHz with a single channel of the scope transferring between the 'source' and the op-amp output. Eventually I tried using both channels of the scope and found the gain was x 4 exactly as predicted! What was my mistake? Answer - not allowing for the extra capacitive loading of the scope probe! Just a few pF of the scope probe working with the 2K2 source impedance was enough to reduce the input signal so that without it, the level rose giving a false impression! Take care! G3PCJ



## ***Two Tone Testing***

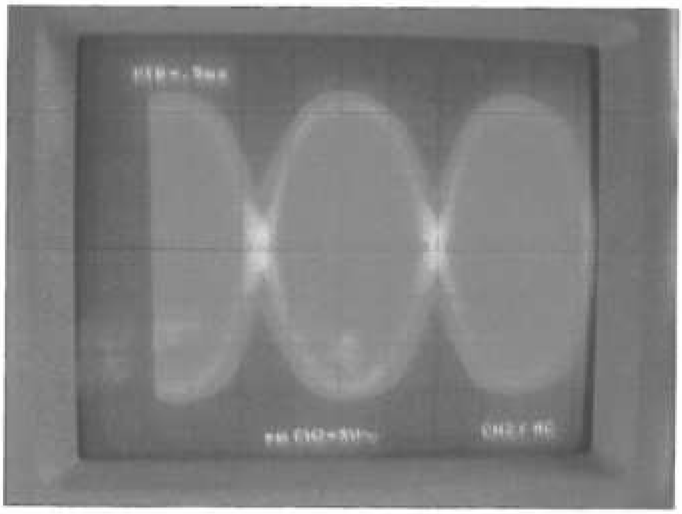


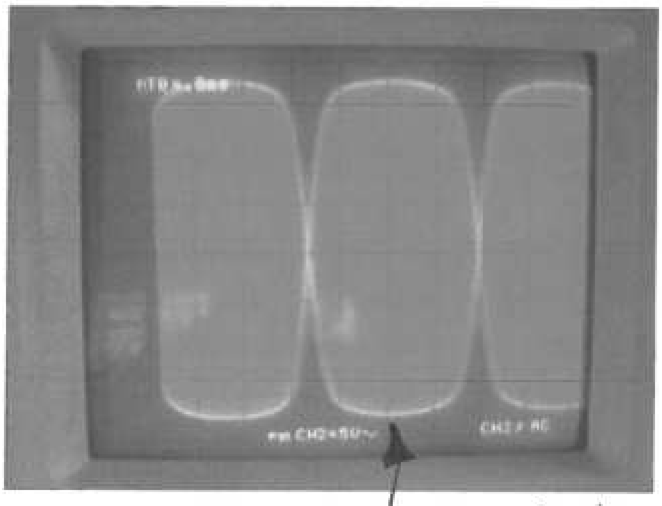

This is something that is done when properly setting up a single sideband phone transmitter. The whole purpose is to ensure that all stages of the rig are linear - ie that they do NOT introduce distortion into the signal that would make the transmitted audio sound peculiar. The set up is shown right - a two tone audio oscillator feeds low level signals into the rig's mic socket; the transmitter output feeds a dummy load and observations are made with a scope at appropriate stages through the rig to see what is going on.




A two tone audio source is used to make it much easier to see when undesired limiting is occurring. It is this limiting which causes the unwelcome distortion - it results from one (or more) stages having an insufficiently large maximum available signal swing. The two audio generators should not be harmonically related and need to be of equal amplitude. Their difference in frequency is what appears on the scope and should also be within the normal audio bandwidth of the rig. So one might use oscillators on 1500 and 700 Hz for example - the exact frequencies are not important. Each individual audio tone should be free of harmonics, otherwise the scope RF envelope will be a little fuzzy like that on the left below! The combined tones should have a level control so that it can replicate the low level output of your microphone.

You need to examine the signal as it progresses through the rig, adjusting signal levels so that peak signal excursions do not cause the unwanted flat topping. It is not possible to see the two audio tones together as the scope will not be able to show one if it is triggered by the other; but after modulation, the signal should appear as an RF envelope like that on the left below. The difference frequency shows up as the overall envelope which is filled by the RF excursions at frequency for the point of testing. If the signal swing is limited, then the unwanted flap topping occurs as right below! This would sound bad! The signal swing in all early stages is kept below the flat topping level and the final drive level is increased so that it is the final output stage that is just driven to its limits on signal peaks. Turn off one of the tones, the output signal from the other should be a steady CW signal whose level can be easily measured (it is not the rigs max output); then peak or max undistorted output level with mic or both tones will be twice that of either single tone. (This is the origin of the INCORECT confusing belief that the SSB rig max output is twice the CW one!) Tim







Bad flattened region!

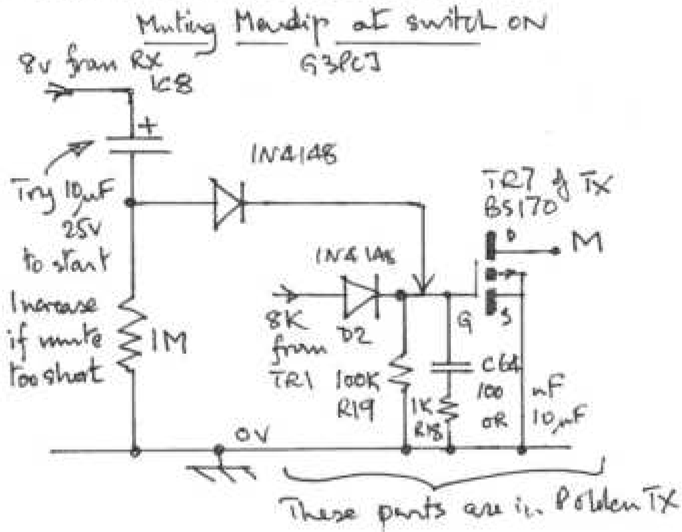
## ***Snippets!***

*Goobledegook!* In the last Hot Iron I quoted some rubbish about compatibility of mobile phone techniques and future developments. Its not worth repeating but Paul Tuton kindly provided a translation:-

"These things are incompatible. Making them communicate with each other is almost impossible. Some people will go out of business".

Of course, the telecoms marketing men cannot bear to say that. Hence the incomprehensible hype.

*Squealing Mendips!* Unfortunately, the Mendip RX makes an unwelcome noise for a second or so after switch on until the bias levels in the audio stages settle down. I have been unable to find proper explanation for this feedback mechanism and there is no suspicion of trouble once the bias levels have stabilised. A possible solution is to activate the receiver's muting during this switch on time. A 'large' capacitor charging up slowly can turn on the mute transistor while it charges up - unfortunately the muting device is in the transmitter, so this is not a solution where the TX has not been built.




*Kingsdon Transmitter* Recently one of our members was having difficulty obtaining full 5W output on 40m from his rig and returned it to me for investigation. He had tried all the obvious things and was stuck! After a while it appeared that the AD8055 op-amp in the transmitter was not giving enough output to fully drive the IRF510 output stage. Normally the 8055 uses the regulated +8 supply from the RX - it transpired that this particular sample needed more supply volts to generate enough drive. Luckily the Kingsdon can use the main incoming V+ instead of +8 and a swift change over cured the problem. In the early stages of building V+ is suggested and the link LK100 can just be left in place. If your Kingsdon is a bit low on RF output, despite high drive and bias current settings, then try changing the +8 to V+.

*SAQ Grimetown in Sweden*

Gerald G3MCK managed to make a trip over there during 2010 and reports that it is well worth a visit! The station had its origins in normal commercial traffic to the US and was built in 1925. The Swedes had found that a link via the UK during the 1914-18 war was not entirely satisfactory so they set up a direct 'over sea' link to the USA. Low frequencies were all the rage then and 17.2 KHz was chosen! This was generated by a huge alternator producing about 100 kW of 17.2 KHz directly, driven by a steam or oil engine - my information does not say which! The alternator fed a magnetic amplifier which did the 'keying' and combined the outputs from several separate stator coils, before being fed to a variometer for matching to the huge aerial array. The aerial consists of four vertical base loaded radiators connected in parallel and hung from six masts over 400 ft high with 120 ft cross beams! As technology progressed the commercial traffic moved to other HF routes and the station was latterly used for communication with submarines by the Swedish Navy. It ceased normal operations in 1996 but is now regularly 'spun-up' by volunteers and put on air.

*Coax feed to dipoles* Charles Wilson sends me an old RSGB Bulletin article by G3HZP pointing out the benefits of feeding a dipole via a balun at its centre which in turn is fed by coax. The author claims a gain improvement of 10 dB but I suspect this is highly subjective and site or distant station dependent! Nevertheless, it is clear that an simple unbalanced feed to a dipole by coax is far from ideal and it likely to make the radiation pattern unpredictable. The author suggested a Mullard FX1588 toroid wound with a 10 turn primary and a split 5 + 5 secondary, centre tap to the feeder screen, and the other two ends to the dipole arms. For QRP work one can use a ferrite toroid using the 61 mix or even an old domestic radio ferrite rod aerial. An alternative (but heavier) scheme is to wind the coax into choke balun of 10 turns immediately below the dipole centre feed point.

## ***QRP in the Country 2011***

I haven't managed to get down to QRP in the Country before, being based in Essex, but decided to make a weekend of it this time, and was very pleased that I did. Whilst not an especially large rally, the venue was wonderful. Tim had made a great job of ensuring that everything was under cover, with space to move about and see everything.

It was very much an amateur radio event, so there were few computers in evidence, rather, there were a lot of people with pieces of radio gear and aerials, much of it home brewed, pieces of valved equipment and some wonderful examples of equipment that went back to the mid 20s right through to modern data based systems and a big display of Tim's kits too, with Tim in attendance to button hole and ask for technical advice!! The emphasis was very much on the amateur operator / builder so the normal commercial stands were absent, but I was very pleased to see the G-QRP club admirably represented by George G3RJV, and his wife Jo, BYLARA were represented too as were the RAIBC. Rob Mannion, G3XFD, and "Tex" Swann, G1TEX from "Practical Wireless" were very much in evidence, Rob sporting a new camera and interviewing anyone who would stand still for a moment.

It was particularly interesting to see kit that wasn't for sale, but was there to look at, and to be able to talk to the people who built it. As people who home build become a somewhat rarer breed, that physical contact is missing, so actual face to face time to look at what people have done, and talk about how they have done it becomes so much more valuable. It would be unfair to single out individuals, but I did have very interesting conversations about a beautifully built K3, and a rather unusual bicycle wheel antenna. I was interested to see the show and tell "stand" too next to George, and to see some physical examples of circuits that I read about. I was very much impressed that what I was seeing was the work of artisans of the highest calibre, who were capable of producing minimal, and not so minimal solutions to problems that in many instances, simply re-used what they had rather than grabbing for something new.

Catering on the site was of a very high standard with some really good burgers and a choice of local beer or cider (highly recommended by George), both of which were excellent as well as the usual soft drinks – and bales to sit on whilst you consumed them and surveyed the busy scene adding to the delightfully bucolic feeling of the event. Everything was under cover as the weather so rather than the usual tables, some of the exhibits, including the now famous "Plank" had been set up and were operational on farm trailers – had it have been dry, all would have been towed outside!

One of the highlights of the day for me was a walk around the farm with Tim's XYL, Janet, and a chance to enjoy both the local scenery, and the farm which is a wonderful example of a mixed farm that works in sympathy with its location. The herd of cattle that viewed us with considerable interest looked to be in very good condition, but hopefully couldn't hear Janet extolling their virtues as beef sausages !! Nick Tile

See Rob G3XFD's three videos at:-
http://www.youtube.com/watch?v=PqJf-7JWqRs
(with close links)

"JOURNAL OF THE CONSTRUCTORS CLUB"

# Hot Iron

Winter 2011
Issue 74

## Contents



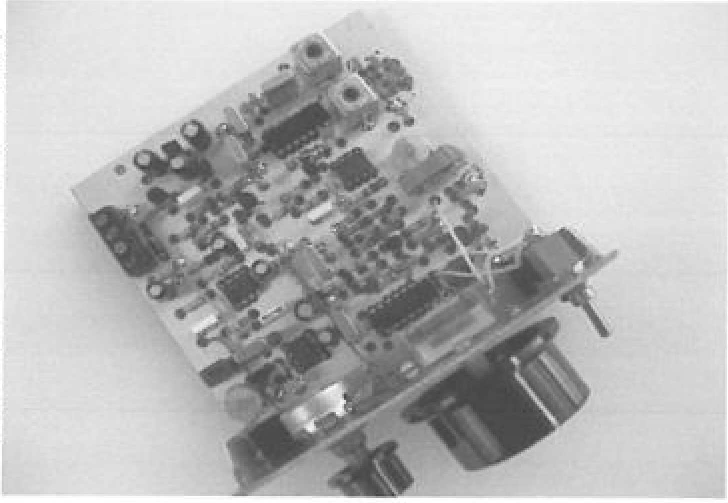
The Walford Electronics web-site is also at www.walfordelectronics.co.uk

## Editorial

A nasty grey day outside so time for a little radio 'work'! I have been playing with the VFO of the Bridgwater for much of the day and now need a break from trying to get it more stable and avoid a tendency to wander. It did start jumping by very small changes in frequency but light tapping with a plastic tool eventually led me to a poorly soldered joint. Listening to a VFO on a stable general coverage RX over a long time is very revealing! I have already put in negative tempco capacitors and it now stays at approximately the right frequency so suspect that the inductance is now the cause of this wandering. Later I will try a T50-2 instead of the TOKO but this means a trimmer is needed to adjust the frequency. Unfortunately all these traditional VFO frequency determining parts are getting hard to source. Its all down to the use of DDS chips in ready made rigs! Nobody uses free running VFOs in commercial designs nowadays. I think I have enough N150 caps to see me out but my stock of the original TOKOs is low - Spectrum Communications do have some modern versions but they are not identical. Luckily many TOKOs can be replaced by powdered iron toroids, whose supply is OK for present, with trimmers - these were also off the distributors lists a while back but seem to have reappeared. Builders don't like winding toroids but this unease is misplaced! Its just another part that needs a little sub-assembly work. If nothing else, this all keeps the grey cells active on a dull afternoon! (Have just found that what I thought were N150 types have different dielectric!) Tim G3PCJ

## Kit Developments

Firstly an alert for **Polden** builders! If yours is fine on 20m ignore the note later, but I have felt it wise to alter subsequent versions to overcome snags found on one particular model. The Minster 3 is on hold again too - sorry but it is not right yet and needs a re-think!



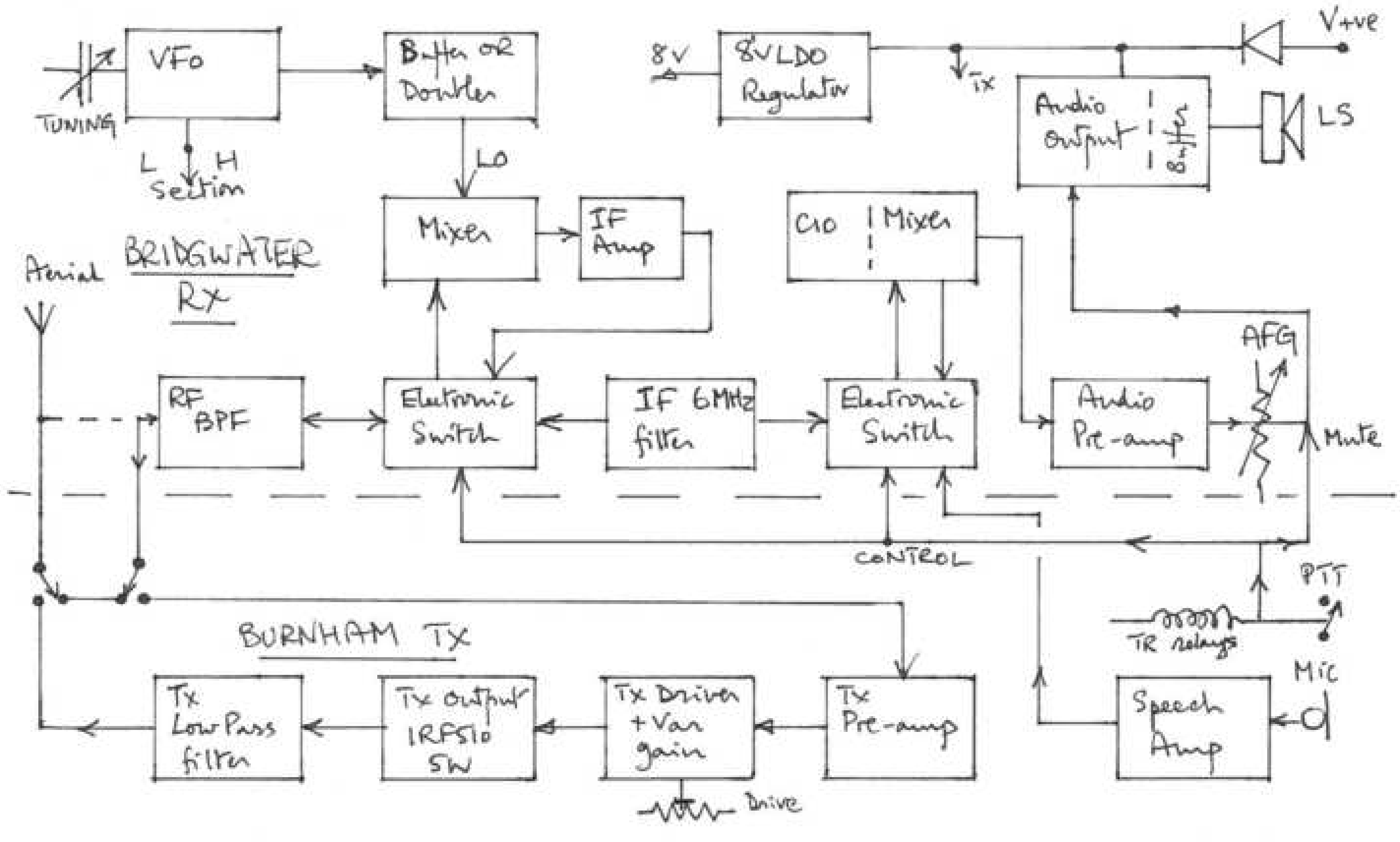
Meanwhile the **Bridgwater RX** (right) and **Burnham TX** are progressing well. Together they make a 5W phone superhet TCVR for any single band 20 - 80m - see later. I will soon be able to take some early orders - let me know if you are interested. Tim

*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

## ***Bridgwater and Burnham***

I have taken this new project up again because the Minster 2 was getting too complex - I just could not get the 1496 mixer to stay adequately balanced without lots of extra components! This was injecting a large second harmonic of the VFO everywhere! So needed to have a pause and a rethink!

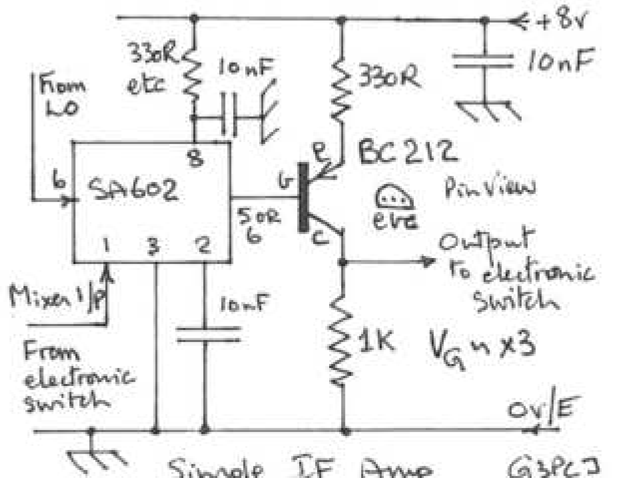
To explain - this new design is for an any single band 20 - 80m RX and TX in the small upright format. It uses a 6 MHz IF and, as indicated last time in the context of the basic Minster 2, the VFO has a doubler so that for most bands, the LO is above the IF. This reduces the range of frequencies over which the VFO has to be made to work and so eases its design and minimises the range/number of parts required. The RX also has a simple IF amp. Compared to the Tone RX and its associated Parrett TX, the Bridgwater has a bi-directional IF strip using CD4066 switches at the inputs and outputs of the mixers. This means that on transmit, the RX actually generates an SSB signal out of its aerial terminal for driving the transmitter! Hence the TX is much simpler without an IF strip like the Parrett. The TX only has an RF amp, LPFs and a speech amplifier, which makes the whole TCVR appreciably cheaper! The TX uses an IRF510 giving 5W peak on a 13.8v supply. Block diagram of RX and TX below:-




BLOCK DIAGRAM OF BRIDGWATER & BURNHAM

The VFO doubler needs to be broadband and operate with inputs from about 4 to 6.5 MHz - as ever, its 40m that is hardest, needing a LO of 13 MHz after doubling! The basic circuit was given in the last Hot Iron so no need to repeat here. It needs a capacitive attenuator (6p8 and 22 pF) on the input to reduce the VFO output from about 4v p-p down to nearer 1v p-p so that the phase splitter does not run out of available signal swing.

I think you might be more interested in the simple IF amp (right) that can be added with a BC212 to a 602 first mixer stage and still be correctly impedance matched to the IF and RF input filters when switched by a CD4066! G3PCJ




Simple IF Amp

## ***Radio Magic*** by Richard Booth G0TTL

Whatever you think you must agree that there is something magical about radio. A bunch of excited electrons forced down a wire suspended above ground creates an invisible electromagnetic wave. This wave can span the globe or given the right conditions escape into deep space. Speech, music or pictures can be hidden within it. Or you can just switch it on and off and send Morse code. The waves are fast too, travelling at the speed of light no less. At the receiving end the same thing in reverse happens, the aerial grabs the wave out of thin air. Electrons get excited in the wire and your radio reproduces the original transmission in your ears. Of course there is a lot more to it than that, but as a six year old it was magic to me and I have been well and truly hooked ever since. To this day I am fascinated by the idea that something as small as a PP3 9V battery contains enough energy to excite yet more electrons and send a radio transmission maybe a thousand miles or further. How can that be possible? A crystal diode, a coil of wire and capacitor to tune the circuit, coupled to a high impedance headphone and you have an am receiver. No batteries required. Now that has to be magic.

Hours were spent back in the late 1970's making crystal sets and three transistor reflex receivers with help from my dad; soldered together on bits of wood using copper nails and OC44 / 71 transistors. I would take our creations into school to show the teaching staff, which in turn worked well for me as seemed to get an never ending supply of old transistor radios donated for spare parts from them. My school report one year stated "Richard is a strange child, he seems very uninterested in school work but excels in making radios and taking things to pieces in class". The time I spent sitting in the garden shed thumbing through 1960's copies of Practical Wireless in search of the next project was priceless. I still do that today! By the early 1980's I had progressed to building EF91 valve based projects and mains power supplies to suit. Yes, I survived to tell the tale.

Well what got me thinking about all the fun of 30 years ago was a recent discovery. Whilst helping to sort out my parents loft I came across a long lost old friend. My first proper 8 valve communications receiver, a Heathkit RA-1. My dad (G8BIW) built this in the 1960's and officially passed it to me on my 8th birthday. I think the plan was I would stop messing about with his AR88 or whatever else I could get my hands into at the time. A lot of fun was had with it and many new experiences - the pink glowing voltage stabilizer for one was mesmerising and I would sit there in the dark, listening to SSB on 40M with the lid removed just so I could get a good view of the valves. Yes that is where I also experienced my first proper mains electric shock. "Don't touch that resistor" my dad would tell me. Of course eventually I did whilst wiggling a valve or gazing at the heaters. Never looked back since! The RA-1 is an amateur bands only receiver with crystal filter, AVC, noise limiting and quite good performance for its time. Or so I remember.

So the RA-1 is back in my workshop. Last time it was used must have been about 1985. Many modifications and some suspect capacitor "repairs" by yours truly back then mean that the radio will need an overhaul, re-alignment and serious going over. So this Christmas break I have a radio project to look forward to. By the next issue of Hot Iron it should be all finished and back in regular use. Then of course more electrons will be excited, this time inside the little B9A valves. The cathodes warm up and the invisible magic starts all over again.

Happy Christmas and all the best for 2012

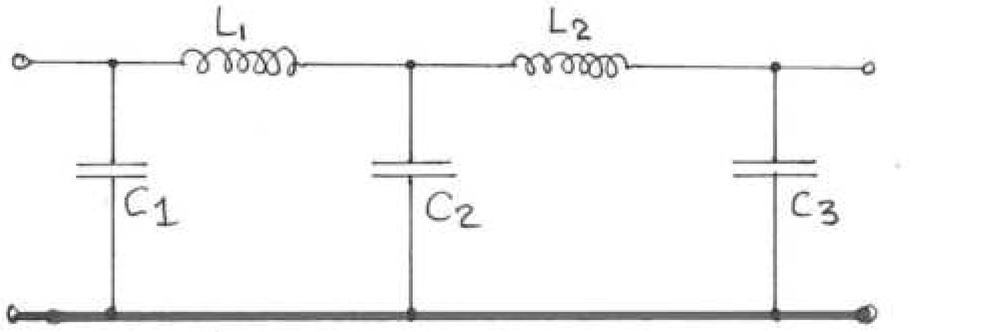
## ***Low Pass Filtering for QRP TXs*** - How much do you really need?

The cut-off frequency of a low pass filter (LPF) is a term that is often loosely used. The author is aware of three definitions: firstly the obvious one which is where the filter starts to attenuate, this can be hard to measure; secondly where the signal is 3 dB down on strength in the passband, this is easy to measure but we would not consider using such a filter in a QRP rig at close to its cut-off frequency; and thirdly a more complex definition which has to do with ripple in the passband. In this article the author uses the first and intuitively correct (!) definition.

The emission of unnecessarily strong harmonics is against the licence conditions and is anti-social. The conventional way of expressing the strength of a harmonic is to say it is so many dB weaker than the carrier and this is referred to as dBc. However what really matters is the absolute strength of the harmonic.

It is instructive to look at the USA amateur licence to see what absolute harmonic power can be legally radiated in the USA. For an output of 1.5 kW, the US maximum, you must have at least 43 dBc suppression which means that you can radiate 75 mW which is about 18 dB down on 5W. It is reasonable to assume that a single ended PA will have a second harmonic that is 10-15 dBc, say 13 dBc. A pi-filter will provide an extra 10 dB giving a total attenuation of 23 dBc of the second harmonic. This means that a simple QRP rig with a pi-filter will radiate less second harmonic than a very QRO American TX. The author therefore feels that using anything more than a simple pi-filter is overkill. A five element half wave filter gives about 24 dB of second harmonic attenuation so the radiated second harmonic will be 37 dBc which is more than adequate.

In practice the attenuation of the second harmonic may be much better as the above assumes that the TX is feeding a trap dipole which may also have a feed impedance of 50 Ohms at the second harmonic. If you are using a mono-band dipole this will not be the case and you can expect to pick up a further 15 dB or more of second harmonic attenuation. The attenuation through a half wave filter does not reach 0.1 dB until the frequency is 15% greater than the cut-off frequency. This means that you can design the filter and operate it somewhat over the cut-off frequency with impunity which may enable you to use parts that are to hand. Suitable values for the half wave filter, and other five element filters, can be found in many books such as the ARRL and RSGB Handbooks.




Half Wave Filter

For use with 50 Ohm coax at the cut off frequency:-

$X_{L1} = X_{L2} = 50$ Ohms, $X_{C1} = X_{C3} = 50$ Ohms, $X_{C2} = 25$ Ohms

Contributed by Gerald Stancey G3MCK

Note from G3PCJ! It just so happens that the value of two end capacitors then become approximately10 times the nominal wavelength of the amateur band, and the centre capacitor is double that! Thus for the 80m band, $C_1 = C_3 = 800$ pF and $C_2 = 1600$ pF. $C_1$ can be conveniently made up of 330 pf in parallel with 470 pF so the whole filter needs 4 x 330 pF and 4 x 470 pF. These values of capacitors can also be used for all the higher bands to 20m - 470 pF for 40m, 330 pF for 30m and 330 pF in series with 470 pF for 20m! The inductors can be conveniently wound on T50-2 powered iron toroids with turns adjusted for band in use - 20t for 80m, 14t for 40m,12t for 30m, & 10t for 20m

## *Circuit construction without etched PCBs!*

I suspect that most readers of this journal would like to dabble with their own circuits but do not always have etched PCBs for all the interconnections. There are many ways that you can assemble a project and for it to be mechanically stable and hence able to stand normal use in the shack. I will assume that you have access to un-etched PCB material in plain copper clad sheet form - not necessarily in large pieces though! It nearly always is an advantage to have a continuous copper sheet for a ground plane, either on the top side or, less easily managed, it can be underneath. The ground plane makes it easy to do all the numerous connections to 0 volts which nearly always dominate all circuits, as well as providing a very low impedance 0 volts everywhere. The challenging bit is how to make the connection points that need to isolated from 0 volts, sufficiently rigid.

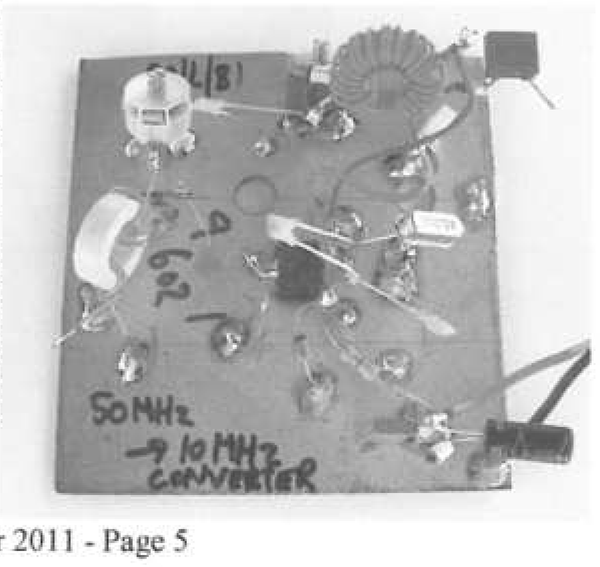
One approach is to carefully cut isolating grooves in the copper foil across the top side ground plane at say 3 mm or 1/8th inch intervals; do this one way several times and then do it again but at right angles so as to make rectangular isolated patches of copper. They will then need 'cleaning' up with wire wool to remove the rough edges and also a check between adjacent squares to make sure they are isolated from one another! I have never liked this method as it is hard to get just the right depth of cut if the laminate is more than an inch or two wide!

The next approach is similar but this time, you cut the PCB sheet right through into small squares! You end up with small rectangles of copper isolated by their backing material (fibre glass or cheaper alternatives) which are then stuck down onto the rest of the uncut sheet. You can use either single or double sided copper clad board. A dab of superglue is placed where you need an isolated pad and then you just plop a rectangle down on-top! The electronic parts are then soldered on the top of these pads (after checking for whiskers etc!). This is much easier to do and can provide an excellent mechanical framework for a circuit. You can even make up the outlines of typical circuit patterns and make yourself some blank development boards!

My own preferred method avoids the hacksaw work but at the expense of lots of 10 nF disc capacitors and maybe a few 1M resistors! As before single or double sided copper clad PCB sheet is used for the main base plate and for all 0 volt connections. You can then arrange a series of 10 nF discs, with one side soldered to the copper, all along the topside; these can be linked together by a rigid (maybe insulated) wire that will form the positive supply rail. If needed, repeat at the bottom of the sheet for a negative rail. Add a few electrolytic caps (say 10 μF) at the ends of these supply lines - making sure their polarity is correct! You might even wish to break or amend these rails to fit a voltage regulator part way along. If it is of the 78XX series, then its middle common leg is just soldered direct to the ground plane with in and out leads to the now heavily decoupled in and out supply wires. Extra 10 nF discs, with one end soldered to 0 volts, can be used wherever extra rigidity is required on any supply rail - you can never have too many of them!

The 1M resistors are used if there is any doubt about the mechanical rigidity of signal or other isolated points in the circuit. This does need a little bit of thought just to make sure that the circuit impedances at this proposed anchor point are appreciably less than 1M. Ideally one would not add 1M across any point where the impedance is of the order of 100K or higher - such places might be the gate inputs of any type of FET, or op-amp inputs. These are not always high impedance points and if all the associated resistors are well below 100K you are probably all right.

How to mount integrated circuits? Easy - on their backs, legs in air - hence the name 'Dead bug construction'. A useful tip is to write the pin numbers of the four corner pins on the sheet before it is soldered in place (so you can check easily!) The ground legs of the chip are just bent out flat and soldered direct to the ground plane. The supply pin(s) are mechanically attached with a 10 nF disc between the pin and 0 volts. Resistors and capacitors that have to be mounted between chip pins and other nodes, have their leads shortened as required and then soldered one to another - ideally in a rectangular grid that makes it look smarter. Something like a tidier version of one of my bird's nests right! G3PCJ

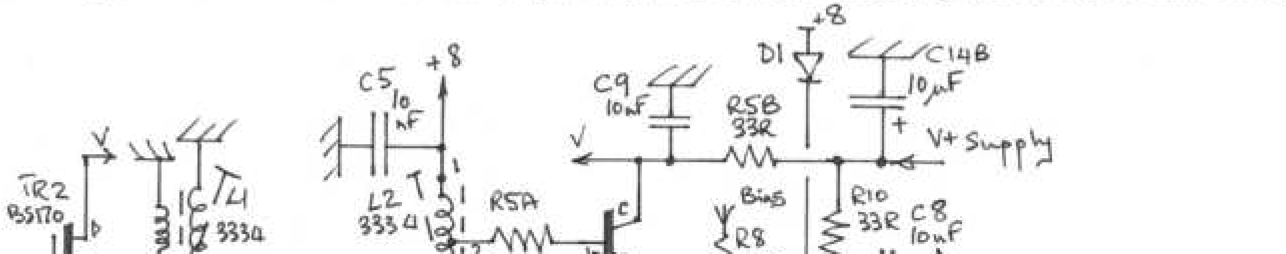


## *Polden TX Mk 2*

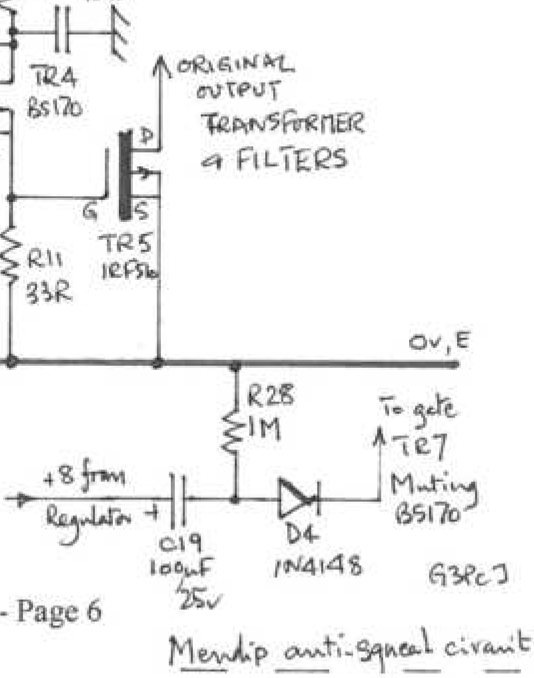
I have decided to do a MK 2 version because one customer had trouble on 20m which took quite a bit of curing! My own Polden shows no sign of these troubles so if yours is fine then ignore these suggested changes. The problematical rig was fine on 40 and 80m but on 20m it went 'awol' above a few milli-watts of output with an apparently significant amount of unwanted output at 7 MHz as well as 14 MHz! Although I have changed the associated Mendip RX also to Mk 2 version, the circuit is identical - I have just altered the instructions so that it can be sold as a basic 3 band DC TCVR for £99, with an optional extra kit to suppress either unwanted sideband for £11 bringing the whole back to the original £110. The Mendip Mk 1 is fine with either version of the TX.

It was fairly easy to establish that the problematical Polden on 20m was producing 7 MHz when it should not, but finding out why had me stumped for a while. I eventually found some SPRAT articles (Numbers 91 & 107) about this effect by Ha-jo Brandt DJ1ZB which provided some clues although my own explanation of the causes is slightly different. I eventually concluded that the high gate capacity of the IRF510 output FET needed a much lower driving source impedance than I had originally provided. I am guessing that this did not show up in the early versions because the gate capacitance does vary widely between specimens. I think my pull down resistors in the gate drive circuit were just not low enough to discharge the gate capacity properly before the next positive peak came along! This is because the source follower diving stage has a much higher negative going impedance than it does going positively; this is because the driver DC standing current is the maximum that can be *extracted out* of the following stage's gate capacitance - the current that can be *injected into the gate capacitance* from the source follower is much higher.

Altering the driver stage to do this enabled a few other changes which have reduced the chances of the original source follower stages self oscillating! These circuit details are sketched out below. One of the consequences of these alterations is higher dissipation in TR4 - on normal 13.8 volt supplies this is of no consequence but do be careful if you think about using a higher supply for a larger RF output - hence my advice is to keep below 16 volts. It was convenient to make the track alterations by adding a little extra decoupling by adding what has become R5B and C14B but this is only needed for layout purposes really! I also found that the transmitter RF BPF filter driver stage TR2 could do with more standing current so R3B is reduced to 150R. I have also included the 3 extra parts to mask the problem of switch-on squealing in the Mendip! It is not difficult to alter an existing PCB to the revised circuit. If anybody needs the altered parts for their Polden, please let me know. But I do emphasize, if all is well on 20m, ignore this note! Tim G3PCJ




MK2 Polden Output stages G3PCJ



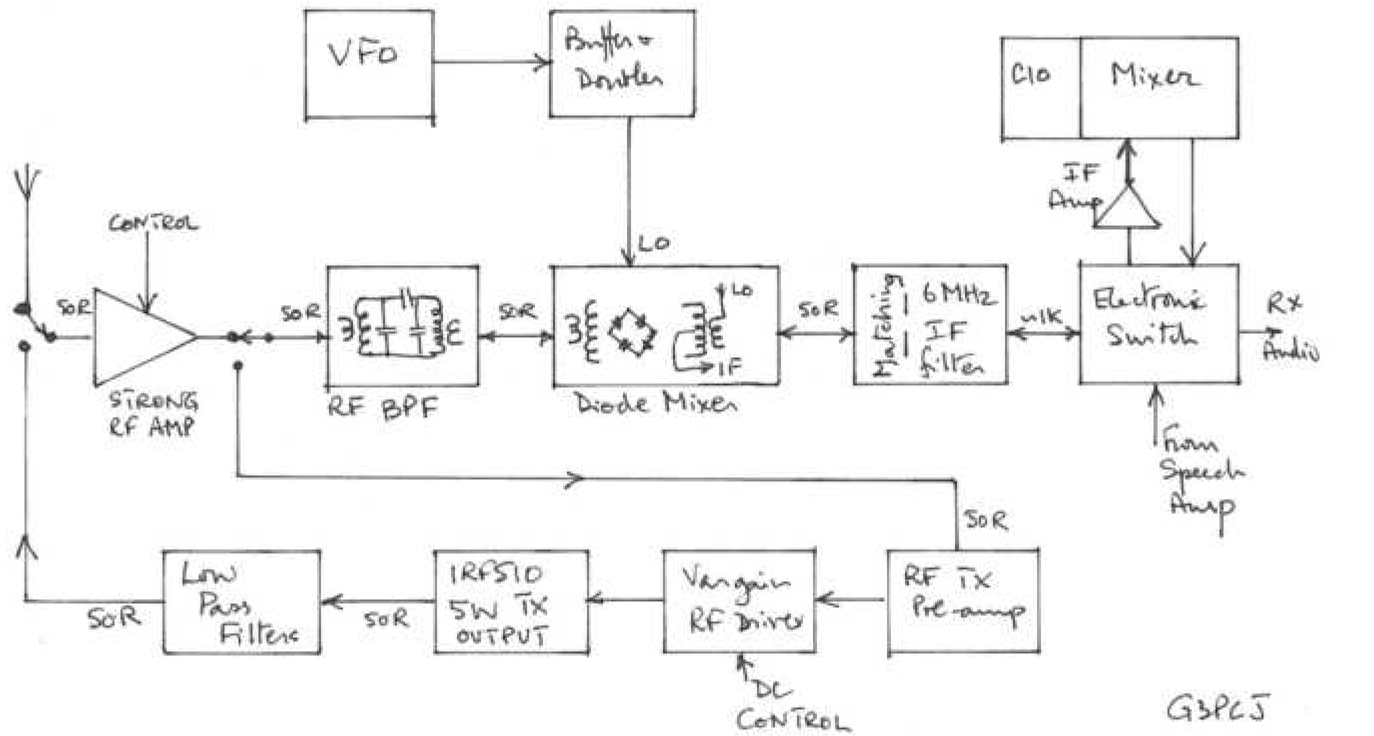

Mendip anti-squeal circuit

## Snippets!

*TCVR schemes!* With Minster 2 on hold, I have been doing a bit of doodling on alternatives for the first mixer, which converts the received signals to the 6 MHz IF. I want a stronger mixer than the SA602 which probably means using a diode mixer. It needs to be doubly balanced as in the conventional 'quad diode plus two centre tapped transformers'. These mixers can be bi-directional between their RF in and IF out points. Two other blocks of a superhet can also be bi-directional - RF input and IF filters! So in principle, it could be bi-directional between RX aerial and IF output! This might simplify the transmitter!

A diode mixer is lossy so the RX will be deaf unless there is extra gain to make up for this loss and the missing gain of a Gilbert cell mixer (often about 10 dB). An obvious approach is to put a strong RF amp in the 'aerial' lead after TR switching but just before the RF BPF. This gain can be shut down during transmission to prevent instability. It would be better to put the RF amp after the BPF but this needs another set of relay contacts and makes the transmit RF path a bit convoluted.

The rest of the rig would be fairly conventional! It would start life as an any single band 20 - 80m rig using the VFO buffer/doubler approach of the Bridgwater. A 5W output using an RD06 FET (for up to 10m) driven by a variable gain RF amp to set the gain for each band remotely. Maybe add CW and then try to get the lot below £100 for the single band base TCVR! Pretty dense on a single 80 x 100 mm PCB but an interesting concept that I will consider a bit more. The potential block diagram is something like below. G3PCJ




POSSIBLE TCVR SCHEME WITH BI-DIRECTIONAL FRONT END

*Happy Birthday 4000 Series!*

A recent note points out that it is 40 years since Intel introduced the world's first commercially successful micro-processor the Intel 4004! It had 2300 transistors and was first made in 1971 using 10 /um processes, which are of course huge by modern standards. From this came the 8008 and then the x86 processors that are still Intel's bread and butter today, and of course includes the hugely influential 8080 and Z80 processors. They were initially designed by a team including Frederico Faggin, Ted Hoff and Stanley Mazor with considerable input by the Japanese from Matatoshi Shima of Busicom. The fact that really grabbed my attention was that Intel are still shipping Z80s at the rate of about 40 million per year 20 years after their introduction! Faggin's 8080 architecture still dominates the world's computer industry via the Pentium Pro series of processors!

## *More Snippets!*

*'Loss-less' power diode* When large groups of solar PV panels are connected in series to drive mains connected inverters, there is a problem when one cell is in shade but the rest are producing useful output. The solution is to put a normally reversed diode across each panel; but even the normal Schottky diode drop of about 0.4 volts wastes too much power. The solution is a so called 'active diode' with a forward voltage drop of only 50 mV when passing up to 20A! I guess that it has a watty MOSFET which is turned hard on by the reverse voltage working in conjunction with a charge pump - all done without an external supply so it is still a 2 terminal device! Pretty clever!

*LDMOS up to 3.8 GHz!* Semiconductor firm NXP has been in the market for high power LDMOS (Laterally Diffused MOS) devices for use in avionics and cell phone base stations for many years. In 2000, their devices used a gate length of about 800 /um but by 2010 this had dropped to about 200. Meanwhile, the gain has risen from about 7 dB to nearer 14 dB when using a 28 volt supply at 3.6 GHz. These advances have enabled increased power density (in Watts/mm$^2$) to rise from about 0.6 to over 1. This translates into single devices able to produce 600W! Ought to make a good Linear amp for 10 or 2m if you can afford one!!

## *QRP in the Country 2012*

The date is fixed! Make a note now of **July 15th 2012** for those of you who can come. All Construction Club members are especially welcome. As before it will be here at Upton Bridge Farm, Long Sutton, Somerset TA10 9NJ. If anybody coming from afar would like help with accommodation overnight let me know.

To make things a little more interesting next year, I thought we ought to have an informal **Construction Challenge**. Steve Hartley G0FUW has kindly agreed to be the judge and there will be a small prize. The detailed rules have not been decided yet but are likely to be based on the following task and I will put it into the National press for anybody to have a go. You lucky fellows get a sneaky pre-view opportunity to put your thinking caps on! The task is likely to be to build a RX for any MF or HF amateur band using no more than 10 discrete components and optionally, one integrated circuit and one power supply regulator if you wish. They are to be demonstrated here using a long wire aerial or signal generator in conjunction with the builder's own, or a provided PSU and LS/phones as appropriate. Steve will set his own judgement criteria but will obviously include the three S's - sensitivity, selectivity and stability! Lets hope we can be outside again like 2009 above rather than inside as last year!

# ***Happy Christmas to you all!***

"JOURNAL OF THE CONSTRUCTORS CLUB"

# Hot Iron

Spring 2011
Issue 75

## Contents



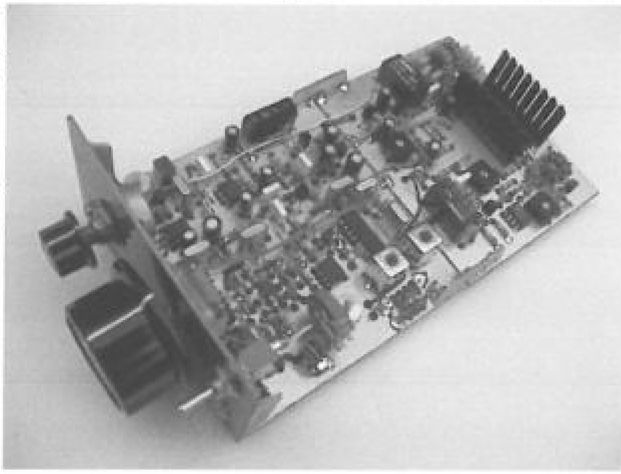
The Walford Electronics web-site is also at www.walfordelectronics.co.uk

## *Editorial*

The extremely cold WX has just finished and I ought really to be outside doing some farming but need to get started on Hot Iron! Continuing with my theme of VFO matters in my last editorial, further testing and observation over a long time showed that although it (the Bridgwater's VFO) was basically stable, and was not running gently out of the band, it was not really useable due to short term wandering both up and down in frequency. Not really believing that this was likely to be due to the inductor changing value that quickly because of its greater thermal mass, it had to be the resonating capacitor (only one at this stage) that was suspect! Experiments with other types soon showed this to be correct! They cured the short term wandering but not the long term drift! I had to find some N150 types (-150 ppm/°C temperature coefficient) that did not exhibit the short term wandering effects! Years ago I had two sorts of round N150 ceramic discs (about 5 mm across with an orange flash) that were good but my stock is now effectively exhausted and no longer obtainable. I considered silver mica and polystyrene types (but they don't really have the right tempco) and they are fiendishly expensive at not less than £1 each in quantity. After much searching, I found that Anglia Components had some non compliant old stock of 150 pF ceramic N150 types. I bought a thousand and they proved excellent, so I have now bought the rest of their stock - enough to keep me and any successors in this business for a century! In future all my VFOs will use only 150 pF parts!! My latest tests on the small pale yellow rectangular ceramic plate types showed them to be poor - they are slightly smaller than they used to be and I suspect have a different dielectric that is not N150. If doing your own VFO work, beware that different types do have markedly different performance! Tim G3PCJ.

## *Kit Developments*

The **Bridgwater** and **Burnham** (right) are now ready for release - 1.5W SSB on any single band 20 to 80m. An early one is happily driving a Linear on 20m. The normal price for RX and TX will be £83.



My most recent thoughts have been about a new rig christened the **Burtle**. Specialist 1.5W CW TCVR for any single band 10 to 160m if all goes according to plan. Full VFO + xtal mixing. £50 ish! 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 

## *Testing Transistors and Class C amplifiers* by Peter Thornton G6NGR

No doubt many of you have tested a transistor with a multi-meter, and are completely familiar with the 'two diodes' idea, but here is a different approach.

We all know the scenario; yes, I measure two diodes with a common connection at the base lead. But which is the collector and which the emitter? A simple multi-meter 'ohms' test cannot distinguish between them.

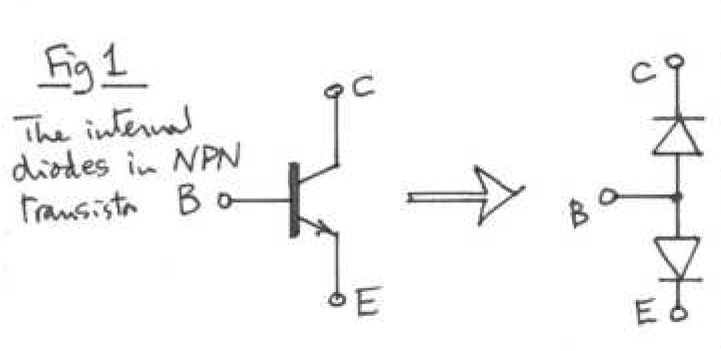
Here is a little gem that will help. The collector to base diode ahs to withstand large voltages when the transistor is off; its this high voltage ability that gives the bipolar its power handling capabilities. Not so the base to emitter junction however. The base to emitter diode is very heavily doped to inject carriers into the collector region to turn 'on' the transistor when a base to emitter current is fed in. In fact it is so heavily doped that it acts as a *Zener diode* when reversed biased - see Fig 1.

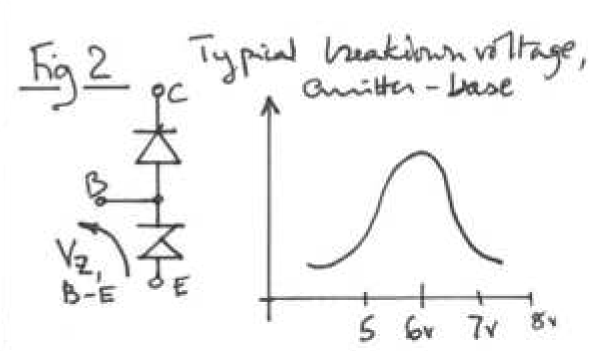
Fig 2 shows the typical spread of voltages that you will find - 6 volts or so is typical. That's the reason your multi-meter will not find these Zeners because it uses a low(ish) voltage for ohms testing, even on the diode range of super whiz band modern meter. Its back to back to basics and some old fashioned test gear - a test lamp!

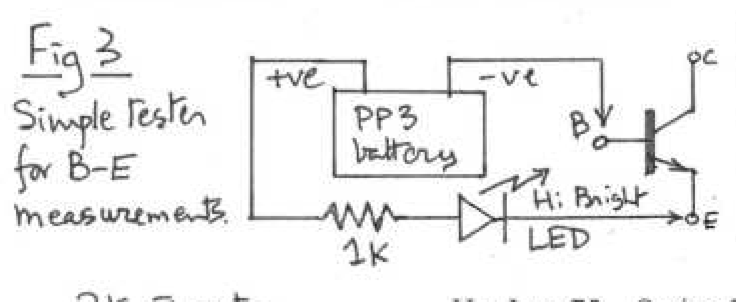
The way to differentiate collector and emitter is to see which junction will break over with a bias of say 9 volts dc; easily obtained from a PP9 9 volt battery. You will need a resistor in series with the battery to limit the current - see Fig 3. The high brightness LED needs only a sniff of current top light, so when testing the emitter to base junction (reverse bias, the emitter to the positive lead, base to negative lead) will light the LED dimly. The other way round and the LED will be very bright and you will soon own a flat battery!

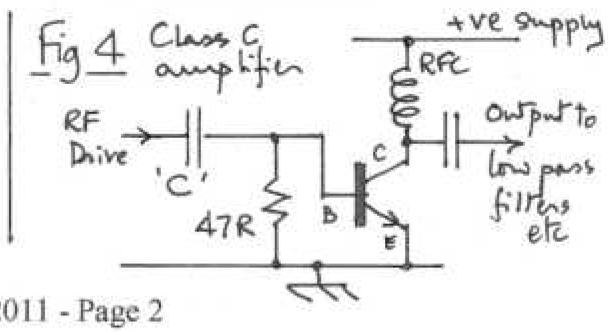
Now lets consider the Class C amplifier. The typical circuit (Fig 4) has the base grounded via a low value resistor, often about 47R, with the drive applied via a capacitor to the base. On the positive half cycle of the drive all is well; the drive pushes the current through the base and emitter to earth and through the 47R resistor in parallel. The 47R is selected to ensure that on negative half cycles the drive never applies more than –6v to the emitter. If the emitter base diode is driven into Zener breakdown do not expect your final stage device to last very long!

As ever the 47R resistor is a compromise - increase it and you get more drive and more output, but don't go too high or the emitter-base diode will Zener on the negative halve cycles and you can watch that final plop its clogs!




Peter Thornton
G4NGR

## ***Valves Revisited*** by Craig G0HDJ

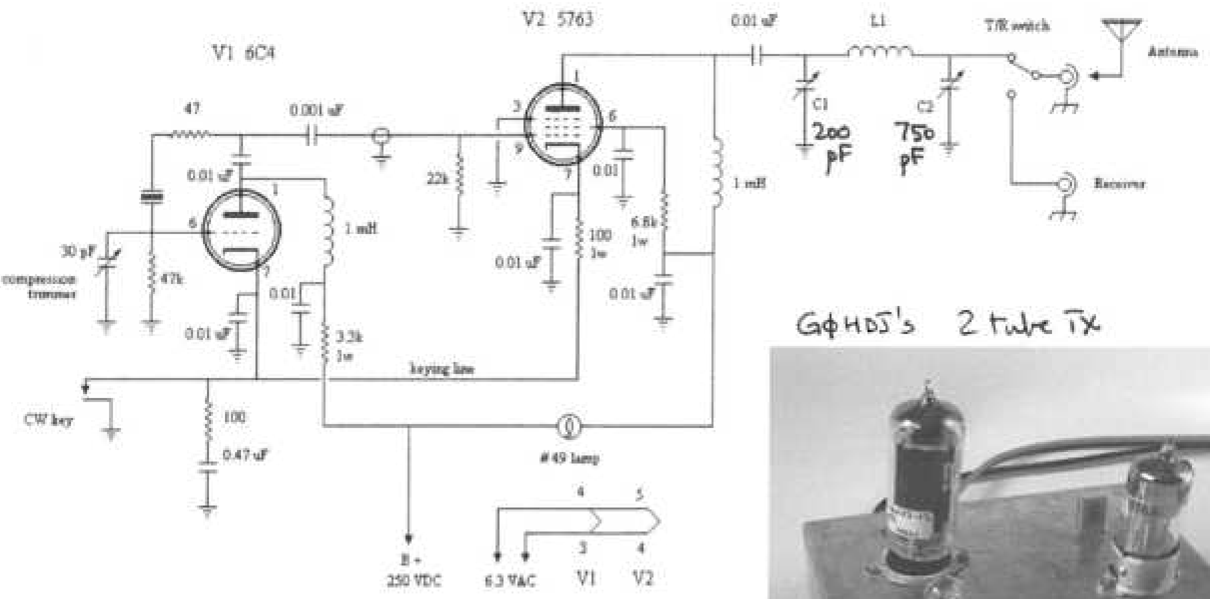
For a change of diet I thought I would try some valve based equipment construction. I have had moderate success with the building of 1 or 2 valve MF and SW receivers. There is also the necessary multiple PP3 battery box for HT and the 240V/6.3V LT supply. So I thought a simple crystal controlled transmitter was the next challenge. But for me this was a different ball game and 'Plate Loading' turned out to have a new meaning! (It is what I normally do with my wife's cooking). A steep learning curve was undertaken – difficult when your brain is fossilizing. Eventually I managed to build something that sort of works. A few facts I discovered:-

- Old books like the 1951 'The Radio Handbook' are better replaced by the likes of the RSGB 'Valves Revisited'.
- Not all valve circuits found on the internet are necessarily reproducible or work according to the author's write-up.
- Geoff Davis (Radio) is a good source of valves but not always the ones you may need.
- Valves off the internet are nearly always from USA, Russia or Hong Kong.
- Valve equivalents are not necessarily so.
- There are no local radio shops that test valves.
- High voltage non-active parts are available from some suppliers but sources are getting fewer.
- Tag strips replace PCB's.
- 'Old junk' stalls at radio rallies may require some investigation.

All is great fun and keeps the soldering iron hot. I tried two projects:

- Simple one 'tube' CW TX by WA2NTK using the power pentode valve 6AQ5 output about 0.5W (author claims 7W!)
- 'Two Tube Tuna Tin Transmitter (5T)' by WD8DAS using triode 6C4 as an oscillator and power pentode 5763 as pa. Output about 1.3W (author claims 8W!)

I would be grateful for any advice/suggestions/thoughts re the power output variance. (In words of one syllable or less and on the back of a post card!!) The circuit of the WD8DAS Two tube Tuna tin TX and my version are shown below. Craig G0HDJ




L1 32 turns @16tpi
2" long on 1" dia former

G0HDJ's 2 tube TX

## ***Fun in Far Flung Places*** by Dave Buddery Jnr

A few years have passed, I had changed employer and moved along in my career. The new company where I had been working for 2 years was doing a lot of work in a certain Middle East country with the likelihood of a lot more and it needs to modernise its ways. I was at the time very busy in the UK office, supporting local and international operations when one morning, the USA-based International division MD walks into my workshop area. "Dave," he says, "We need to go for lunch today, can you be ready for 1200?" "Yes", I replied, wondering what this was about. At about 1200 he came and picked me up, we went off to a good pub restaurant and a quiet table in an alcove with the UK MD and the group chief engineer there too. I knew this was way out of the ordinary and wondered even more what it was all about.

There was not a lot of time wasted, "Dave", he says, "You know there is a large amount of work going on down 'there"?" "Sure," I replied, "I've been down there for start-ups and I know about most of the current activity." He looked at me and said, "OK good, but we are looking at a big expansion down there plus upgrades of all the existing operations." The former I did know but the latter I didn't know right then, but I wasn't surprised. He went on, "We have looked at our personnel list worldwide and considered hiring but we have figured out that you are first choice for the main technical support job. Will you go please?" I WAS surprised but delighted too, nothing like this had been on the radar screen. "Yes," I said, never being one to hesitate, "I'll go." There was a look of relief all round - we had a very good and rather liquid lunch.

I knew there was amateur radio down there and looked up the local radio club details. I wrote the secretary a letter letting him know that I was coming out and asking what the gen was about shipping gear out, getting licensed etc. He telexed me back [before the days of the internet and e-mail] and warned me not to carry or ship any gear without getting a license first or it would be confiscated. Accordingly I boxed-up my UK station and resolved to get moving on formalities on arrival.

About 3 weeks later I had flown out and was sitting in the local head office, being checked out by the local MD. He had been going through my CV, which at my level in the Company on transfer was sent to the local MD and then he said, "You say here you know about radios, you are a Radio Amateur, is that any use to us?" I was amazed! I knew of course we used HF communications to keep in touch with field operations and that UHF and VHF were de rigueur on all the operations, in fact we could not operate without all that. I replied, "You know that without HF you can't talk from here to the field operations and that most ops have around 60 to 100 VHF and UHF units without which you can't operate. These keep running at least in part because you have a number of amateur radio enthusiasts in the workforce who do it as a side line?" This was absolutely true; radio maintenance wasn't catered-for as a listed job skill. His jaw dropped and I could see he didn't know what to say. I had him cold. Anyway, he calmed down and eventually replied "OK, OK, but did you know that we are out to tender for an operation in the mountainous area in the east here and we are quoting to use a radio telemetry system?" That I didn't know because the individual offices of decent size worked as semi-autonomous units in an independent and competitive manner within the company (a management technique ahead of its time in those days). "No," I said truthfully, "That news hadn't arrived at my level in London." "OK, you had better get up to speed with the tender but it will be at least 6 months before we start because there will be a lot of work to be done to prepare for it". "For certain," I said, "No doubt there will be a huge amount to do with approvals, licencing etc." His eyebrows shot up when I said the word "licencing". I thought, "What's up now?" He said nothing for a minute then looked at me and said "How about a beer tonight at your hotel?" "Yes, that's a good idea," I replied. We finished the interview and I went off to the operations office and got out the tender for the radio telemetry system and all its accompanying documents. I spent a couple of hours going through it and talking to the local operations guys. It was so far in the future they hadn't really got much into it at the time.

Finally I went back the hotel and waited for the evening meeting. I had been in the place a few days and had put my toe into the water regarding getting an amateur radio license which was off to a fair start. The local MD arrived as agreed and we had a beer in a quiet part of the bar. To paraphrase, "Dave, we got a problem," he said. I replied, "Tell me please." He looked around, probably to make sure no-one was listening and said, "We haven't paid any of our radio license fees for 2 years and year 3 is coming up. Please think about what we might do about it, I'm open to suggestions. I could try to fix it on my own but I need some help regarding the paperwork, "transmission modes" etc., I'm just not into that." Continued on next page.....

***Fun in Far Flung Places*** continued>

We talked about a few more things affecting the matter but I was horrified and began to think quickly about how we got into the jam, it might show me the way out of the situation. I asked, "What happened before the problem started, who looked after it in the more distant past while it was being paid?" He sank his pride a long way and said "We had a guy like you out here and he filled up the paperwork and the accountant submitted it." I carried on, "Well, how did it take nearly 3 years before we figured we had a problem?" (Makes you think doesn't it?) I could see him visibly stiffen, then he replied, "The accountant asked why certain regular payments had stopped, we looked into all of them and of course it came to light. Otherwise, it would probably have gone unnoticed." I thought about the Ministry responsible for radio licensing and wondered why they had not come after the company and asked the question. He replied that he thought they were pretty inefficient and just relied on companies like ours doing the right thing. I moved around the edges a bit more and asked why we could not carry on in a like manner. The MD looked in his brief case and pulled out a clipping from the local Government "Gazette" newspaper. It was a recent warning to companies to make sure their radio licensing formalities were up to date as they could be subject to inspection and audit etc. The game was up, we had to fix it. If we got found out and they closed down all our radio systems we would be totally unable to work – a disaster. The MD went home not long after and I went for a walk to think about things. I had a small entertainment budget as part of the job and resolved to call the secretary of the local radio club and to spend a bit of it sounding him out, I didn't yet have any contacts with local radio licensing experience [apart from the MD!]. I was very worried too about "guilt by association", because if my company got found out before things were rectified, bang would go my hopes of an amateur radio license.

So a couple of nights later I invited the radio club secretary out for a meal and over it I told him all about this mythical company which had not paid radio license fees etc. etc. He smiled and said, "You will need to offer them three times the unpaid frees if you don't want real bad problems." Fair enough I thought, and wise in the ways of indifferent management, I went to work and told my MD that four times the unpaid fee was the going rate. He argued, so very, very reluctantly (to his face) and after some argument, I agreed that we would open the batting at three times the unpaid fee, mentally keeping my fingers crossed. To cut this short, it worked. I filled out the paperwork (designed for licensing a radar or satellite communications system – I imagine it had been copied out by a clerk from the sub-continent and then generally applied, but I'm used to that sort of thing, fortunately). We went to the ministry, the MD did the talking, after all he had got us into the jam. They were pleased with three times the fee, I think it came out close to the equivalent of £100,000 if my memory serves me well.

The moral of this story is – amateur radio to the rescue again and the MD of course, never knew about the radio club secretary. I eventually got a bit of recognition for having sorted out the problem.

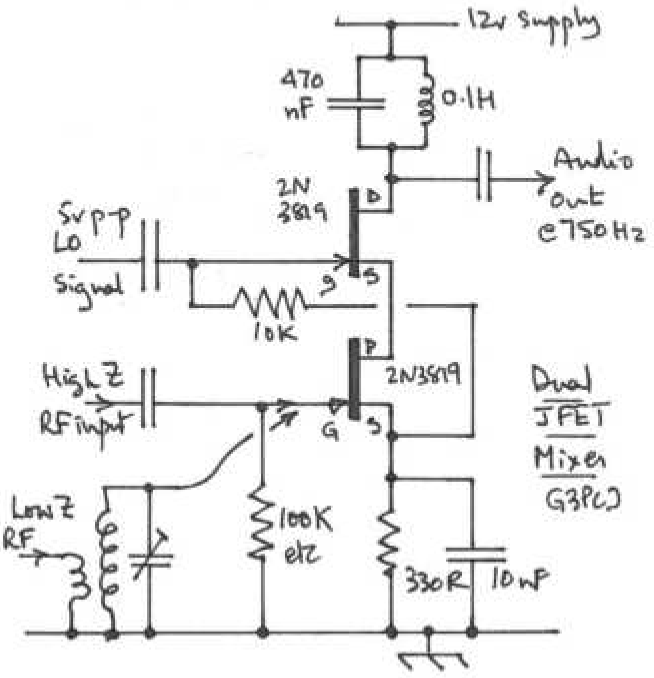
## Bath Buildathon winner

Nothing to do with the above but Zoe Thomas (right) M6ZOE did her famous project (a Tone 20m special) which won the RADARC Constructors' Trophy. Well done Zoe!

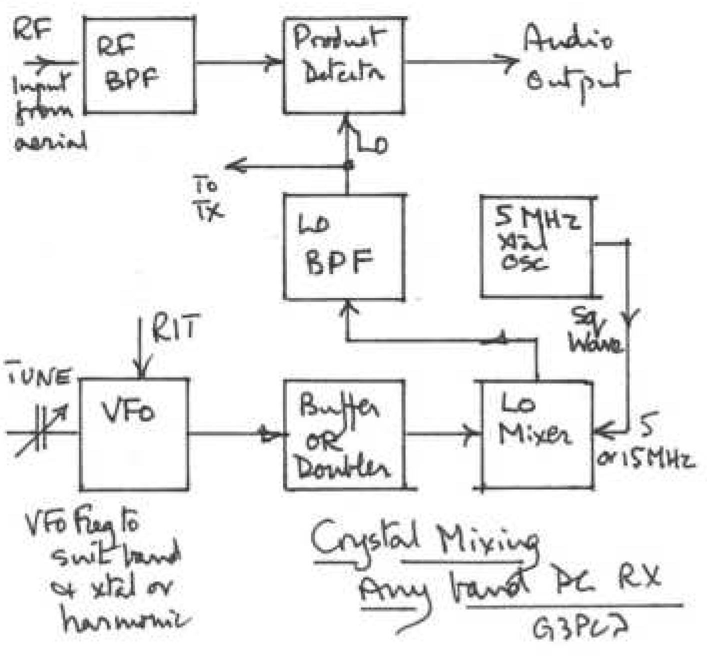
## *Jottings from my notebook!*

The two topics that I mentioned last time, have stimulated a few subsequent scribbles and experiments. Firstly - alternative mixer approaches or devices.

Doubly balanced quad diode mixers have a big attraction - high signal handling ability - but do have a number of significant drawbacks. They are either expensive to buy readymade at near £6 each, or are fiddle-some to make - needing two tri-filar transformers, which often lead to indifferent performance; they also need high LO drive levels at 10 dBm or more. Something made me consider the dual gate MOSFET approach that used to be popular when these devices (40673 etc) were readily available; but they can however be made up by using two ordinary JFETs such as the 2N3819 in series. Both RF (lower) and LO (upper) gates are high impedance points and signal conversion gain is possible with high impedance drain loads at the desired output frequency; this is in addition to any voltage step up that might be possible from a 50R source to the high impedance RF gate. Experiments soon showed that a conversion voltage gain of about x2-3 is feasible with a LO drive of about 5 volts p-p biased at about 1 v DC. At the time I was thinking of a CW DC RX with a drain load resonant at 750 Hz formed by 0.1H with 470 nF as shown right. This agreed well with notes from bygone ARRL publications! A 5v p-p LO signal might easily come from a CMOS digital driving gate producing square waves - it turns out (as might be expected) that its response from the LO odd harmonics is also viable; with the third giving a RF signal conversion voltage gain of about x0.8.




This triggered the second doodling topic! Could this property of useful responses from the fundamental and third harmonic of the LO be used in a crystal mixing rig intended for use on any single band - builder's choice from 160 to 10m? Transmitters using the same frequency for a VFO and the RF output stage are notoriously difficult to stop chirping, especially when getting beyond the useable range of ceramic resonators; hence the necessity of a crystal mixing scheme for a decent rig with VFO that can cover the higher HF bands. This also help considerably with frequency stability! It turns out that a 5 MHz crystal mixed with a VFO set appropriately in the range 3.8 to 6.5 MHz (with buffer/doubler) can do all bands 160 to 10m for a DC rig! You could also do it with a 6 MHz crystal but then 17m is troublesome! Bands below 15m would use the 5 MHz signal; 15m and up would use the 15 MHz third harmonic mixed with the VFO. The rough outline of a possible mixer and LO chain is shown right. Obviously, with such a wide frequency range, it is not practical to use a single type of ready wound TOKO inductor so it would have to have toroids and trimmers for all resonators. Give the rig full break in and narrow CW filters and it begins to look interesting! I have named it the **Burtle** provisionally! I might even start laying out the PCB soon later today! Tim G3PCJ (Done & etched - it *is* a tight PCB!)



# *The Oscilloscope Probe* by David Proctor G0UTF

Oscilloscopes are wonderful test instruments as they can measure time (and hence frequency), P.D. both D.C. and A.C, and a double beam scope can measure relative phase of two similar frequency signals.

Of course, the range of HF frequencies is limited by the scope itself, but more often by the input impedance of the scope. This will be typically 1 MOhm in parallel with about 30pF – furthermore the test lead may add another 30pF in parallel.

To decrease the input capacitance we can use a "probe", which is an R & C in parallel, in series with the input of the scope. It is not just any old R & C: they are calculated for a particular scope.

This is how it works:-

$Z_p$ = probe impedance
$Z_{in}$ = input impedance
$Z_s$ = scope impedance

$V_s$ = scope input PD
$V_{in}$ = input PD
$C_s$ = capacitance of scope

$V_s/V_{in} = Z_s/(Z_p+Z_s) = 1/K$ (K = attenuation)

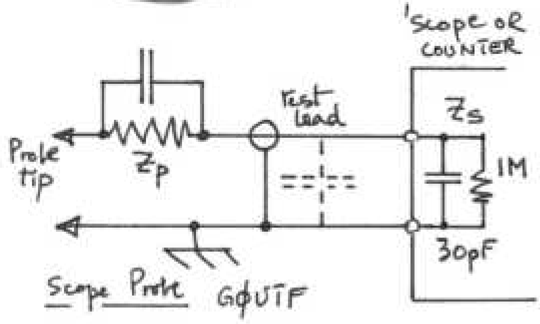
Which gives $Z_p = (K - 1)Z_s$

So, the probe input impedance = $Z_{in} = Z_p + Z_s$

$$Z_{in} = (K-1)Z_s + Z_s$$

$$Z_{in} = KZ_s$$

The purpose of the probe is to make $Z_{in}$ much greater than $Z_s$ so K must be high, which means that the input impedance rises by K times but the overall gain is down by a factor of K (don't panic – scopes usually have lots of gain).




**QUESTION:-** A scope with input resistance 1 MOhm and 30pF is fed by a probe whose cable has 30pF capacitance. You need a voltage reduction factor of 10 at all frequencies. Find the value of the probe resistor and capacitor

**ANSWER:-** Consider DC only, $R_p$ = 9 MOhm (9 times scope resistance).

Now considering AC: the phase angle of the scope must be the same as the phase angle of the probe. $C_p$ = 6.7pF (one ninth of the scope capacitance)

You could build the probe with a higher attenuation and lower the input capacitance even further, increasing the RF response and increasing the attenuation.

I hope you get the gist of the design – a full treatment is a bit too mathematical.

Comment by G3PCJ - David rightly mentions the capacitance of a typical length of coax used as the connection lead - often 30 pF or more. So if this were to be used without the attenuator at the tip or test point end, it would add 30 pF directly in parallel to the circuit at the point being investigated. Whether the test is being done with a scope or a counter, the effect can be very 'disturbing'! Imagine trying to read the frequency of a relatively high frequency VFO with a counter and then adding 30 pF to the resonating capacitors - the frequency will show appreciably lower than without the probe! It is actually much better to just use a single plain piece of short wire direct to the instrument input socket if you don't have a divide by 10 probe! G3PCJ

## *Snippets!*

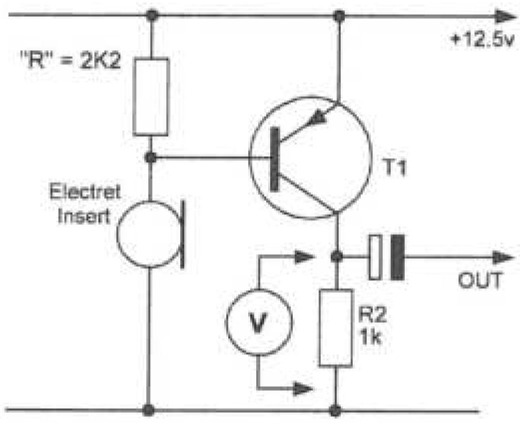
*Old Age ICs!* Two of the most famous chips are now over 30 years old and still going strong!

The 741 op-amp was designed by Dave Fullager when he was working for Fairchild Semiconductors in 1967. It was the bed-rock of analogue signal processing for more than a decade. It gained a huge following because of its inclusion of parts that made it unconditionally stable in most of the common configurations. Previously Dave had worked for Ferranti in Edinburgh for a couple of years. Dave went on to found Maxim Integrated Products in 1983 and retired in 1999.

The 555 timer chip was designed a little later by Hans Camenzind while working for Signetics which later became part of the Phillips empire now known as NXP. This chip (his 10th design) could also be used in a host of applications where timing was an element. Hans went on to design several chips - among them being the Intersil 8038 waveform generator. He too started his own company Iterdesign which he eventually sold to Ferranti in 1978. By the mid 1990s he had done 135 designs.

*Electret speech amp*

Recently I think one of our members asked about electret mic amps and I was a bit unsure of my info! But Peter Thornton has kindly sent this circuit on the right along - hope the relevant person is reading this - I have no record of who he was! I think I recall Peter suggesting that R needed a little trial and error adjustment in order to get a few volts across the output 1K R2, and that one might start with a value for R of about 2K2.



KISS ELECTRET PRE-AMP G6NGR

## *QRP in the Country 2012*

I trust you all have **July 15th 2012** entered into your diaries for a visit here - TA10 9NJ in Somerset! Construction Club members are especially welcome. If anybody coming from afar would like help with accommodation overnight let me know.

I already have quite a few stalls booked by local clubs but there is loads of space more for either Club or individual stalls. Provided its broadly related to radio, then its likely to be very suitable; please do encourage your local club to put on something - don't forget that if you all assume somebody else will be doing it, there will not be anything to see. No entry fees to worry about either! If you have any other ideas or suggestions for things that would be of interest then please do let me know. Lets hope we can be outside this time!

As mentioned last time Steve Hartley G0FUW has kindly agreed to consider the entries for an informal **Construction Challenge**. The task is to build a receiver for any MF or HF amateur band using no more than 10 discrete components and if you wish to, also one integrated circuit and one supply regulator. Your choice of types! So this should make it possible to provide a quite useful RX! I will be putting out a national press release soon but Construction Club members have advance warning! Get thinking! Steve will set his own judgement criteria but expect consideration of the three S's - sensitivity, selectivity and stability. A long wire aerial or signal generator will be available for assessment with the builder's own, or a provided PSU and LS/phones.