"JOURNAL OF THE CONSTRUCTORS CLUB"

Hot Iron

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Contents

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

Editorial

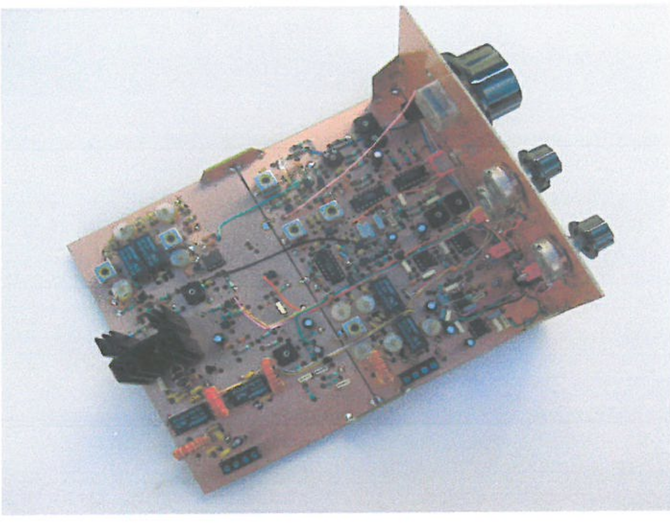
My researches about super-regenerative receivers (see later) has really brought home to me how 'bright' were the early 20th century radio pioneers. Mr Edwin Armstrong is credited with many inventions that he made around 1920 which still provide the fundamental building blocks of modern radio equipment! 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

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

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!

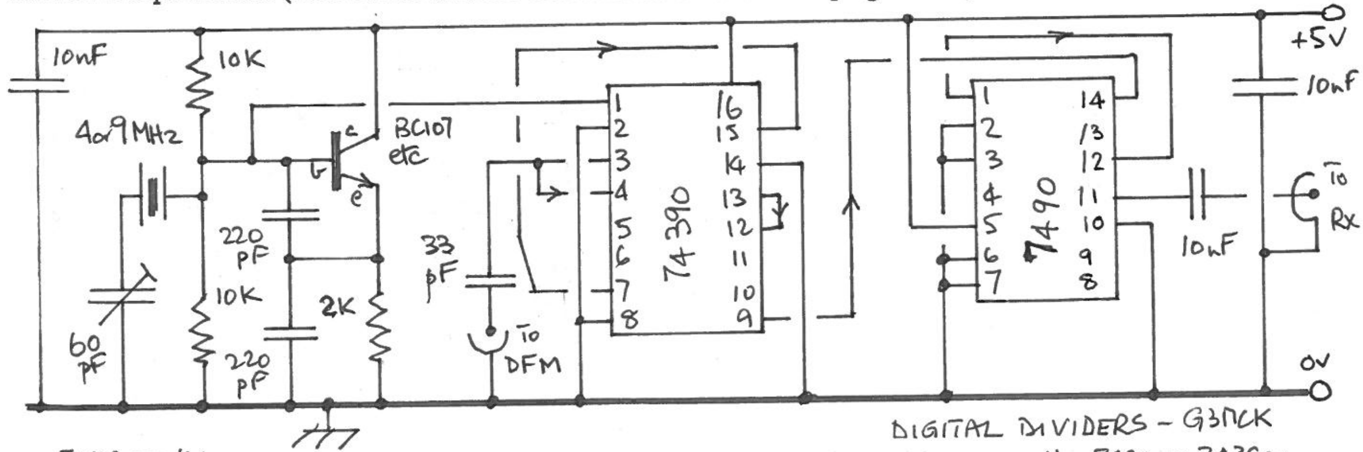
I understand the following standards apply to BBC transmitters:-

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

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

Use 7490 or 74390, as available!

Error probabilities!

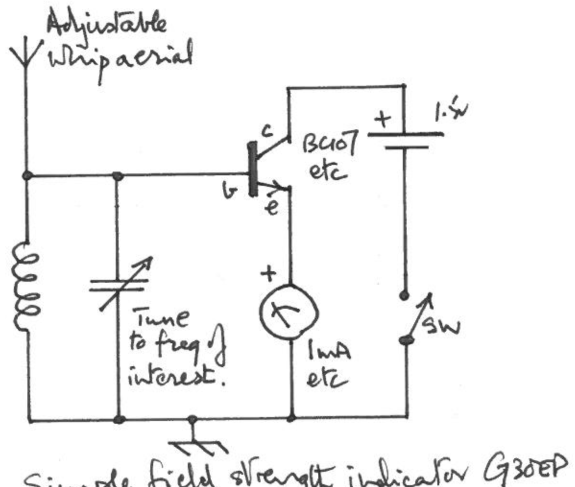
Gerald Stancey also provides a non-radio footnote about the impact of cumulative errors. "DNA is said to be unique to about one in a million. However in a court case you should factor this by the following probabilities: laboratory error, mistakes in collecting samples, mix-ups in storage and retrieval 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 micro-processor 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**

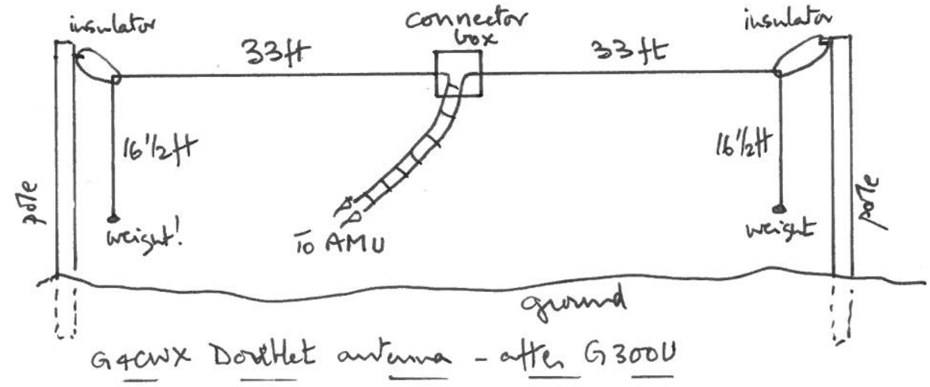
Ok, so in my last article I sounded really smug and self-satisfied having cured the ills of my poor aerials. But I had become a little too complacent and was only achieving QSOs with a handful of other local radio amateurs due to the close proximity of hills. A chance encounter with a fellow victim made 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?"



Super-regenerative Receivers

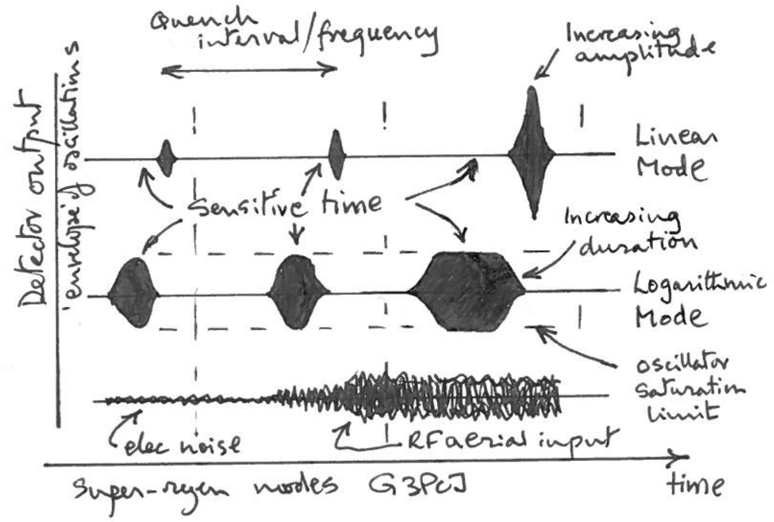
As part of my investigations of the radio installation at my friend's wartime bunker, I have been researching the radio equipment that was used by the Auxiliary Units. (Interestingly, super-regen RX/TXs were also widely used for IFF transponders during World War 2.) Three voice transceivers were used 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.

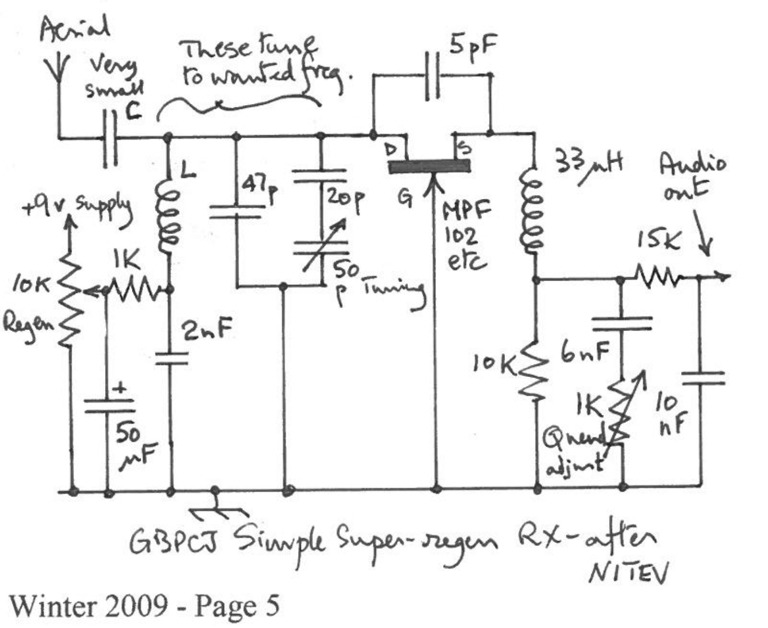
Set 2. This set is known as the TRD and was derived from the Savage set during the early part of the war. It was a great improvement and was used extensively but all records - paper and physical - were put down a coal mine at the end of the war because it was so good! Its probable line up of 5 valves 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.



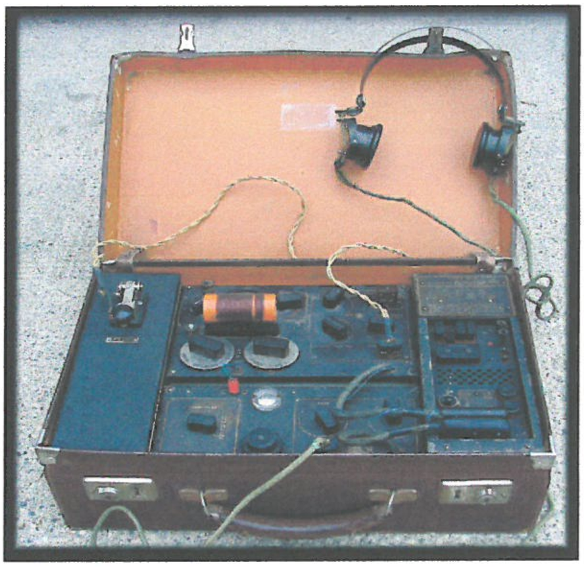
The circuit right is a typical self quenching semiconductor super-regen; they tend to be used only on VHF upwards as the quench frequency needs to be several times the desired audio bandwidth, but if the quench frequency is too high, the RX's RF bandwidth increases too much! The gain of the super-regen 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)

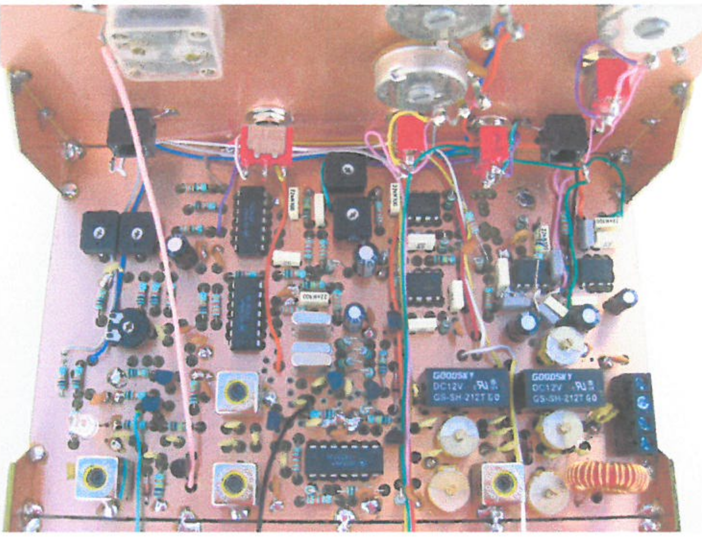
The range of working would necessitate ionospheric propagation and extend from say 150 to 1000 km. Austin postulates Calais and Marseilles as typical of the extremes of range. Most transmissions were made in daytime , and he has researched the sunspot and propagation conditions pertaining in the war 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

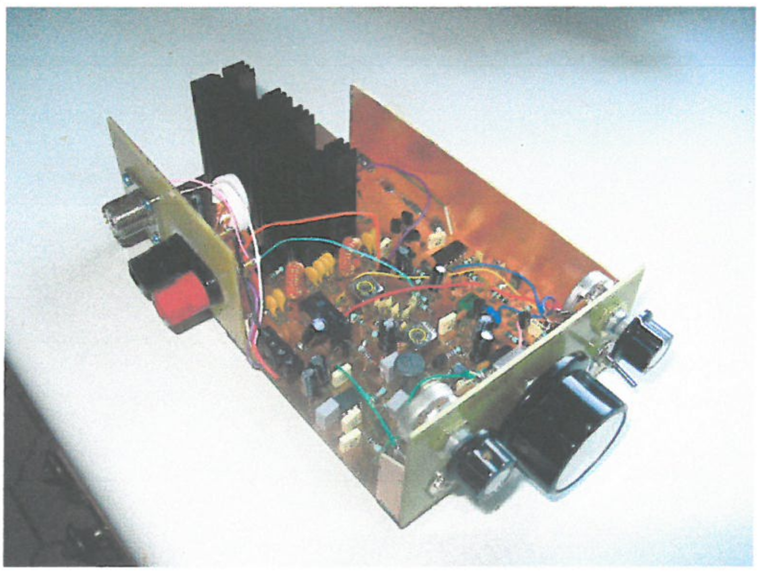


Its been a long time in gestation but I think the wait has been worthwhile! The RX uses a crystal controlled converter (for 20, 40 and 80m) ahead of a phasing single sideband (either) direct conversion receiver operating between 5.4 and 5.5 MHz; this has special switch selectable audio filters for phone 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.