Hot Iron

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Editorial

Feeling rather lazy yesterday afternoon, I decided to reread the April 1999 edition of Electronics and Communication, published by the Institution of Electrical Engineers for their members. I had put it aside previously because the issue is devoted to futuristic radio techniques. Of particular interest was an article about 'Software Radio' which I touched on briefly in a previous Hot Iron. Nearly all future development in radio matters is being devoted to 'mobile' or similar highly portable uses. The basic principle of a software radio is to use digital signal processing techniques for as much as possible of the radio transmitter and receiver. The performance of very high speed analogue to digital converters (& D/A) is such that practically everything of a UHF receiver, apart from the very first low noise amplifier, can be done in a programmable general purpose computer like block following the A to D converters. This makes it possible to change the modulation formats, and other pretty fundamental aspects, purely by changing the software of the processor. This would be a very major advantage because the same hardware unit could be used in many different parts of the world (where formats are not yet standardised) and would lead to much larger production runs and lower prices. Even the 'RF' filtering would be done in software and so band changing no longer requires different circuits tuned to the working frequencies! Most of these techniques are equally applicable to the transmitter. Interestingly, because full duplex operation is essential, the TR switch becomes one of the most challenging items. If you are interested in where radio is progressing, this article is well worth obtaining. Needles to say, I shan't be offering software radio kits! While I used to do some programming, I don't enjoy it much and I don't think most current kit builders are too keen on any technique which is not readily understood. Hence my avoidance of microprocessor controlled gizmos etc.. Tell me if I am wrong!

Kit Developments

The **Radstock** is at last available after considerable help by several early builders for which I most grateful. Any two bands 5 Watt CW TCVR but with a phasing receiver for single sideband reception. Full break-in, £79. Recent attention has been devoted to updating and improving my rigs at the lower and middle part of the range. Shortly the Radio Today **Chedzoy** will be launched in that magazine; this is a regenerative TRF RX for first time builders covering MW and a short wave band near either 80m or the 4 MHz broadcast band. Very detailed instructions and costing £19. Next up the revised range comes the **Priddy** as a suggested first serious construction project, it is a DC receiver covering 20, 40 and 80m with filtering for CW and SSB. It can be used with the three band 'crystal' controlled **Godney** 1.5 Watt CW TX. Price £39 or £64 with the Godney. The last new rig is the **Minehead**, this is a 5 Watt CW transceiver for any band up to 20m. Again not too dense and easy to set up. It has a crystal mixing VFO scheme covering the whole of the CW section of each band and costs £49. I could do with some early builders for these rigs to help prove the instructions, so drop me a line if they are of interest. I have also re-jigged my catalogue if you wish to see the whole range.

This is the end of our sixth year of Hot Iron so it is time to ask you to renew subscriptions before Sept. 1st 1999 if you wish to carry on. There will be no reminders! Tim Walford G3PCJ Editor

Send £6 now to secure Hot Iron for next year please!

Aerial Impedance Matching Networks - part 2 by Eric Godfrey G3GC

In the last issue of Hot Iron I dealt with matching units for balanced aerial systems. In this issue I shall be considering unbalanced systems which includes aerials such as end fed quarter waves, end fed half waves and wires of random length. The last category of aerials are often mistakenly referred to as long wires but this is only really true if they are more than a wavelength or so long. Consider 100 feet of wire on 10 metres, it is about 3 wavelengths long and therefore may be called a long wire (with respect to wavelength) but on top band it is only about 0.2 of a wavelength and thus is no longer a long wire but is often referred to as such. All these aerials come under the general heading of end fed wires that may or may not be of resonant length.

If the length of the wire is such that the aerial is resonant then the input impedance will look like a pure resistance, either low (say 25 to 75 Ohms) or high (thousands of Ohms) depending upon whether the aerial is an odd or even number of quarter waves long. If it is odd, then the impedance is low and if it is even it is high. However if the aerial is not resonant then by definition there must also be some reactance which, depending upon the length of the aerial, will be capacitive if the aerial is shorter than a quarter wave and inductive and if it is longer. If on the other hand the aerial is nearer a half wave long then the inductive and capacitive reactances will be reversed.

One way to match different impedances is by using an inductance and capacitance connected in the form of an "L" as shown in Figs. 1 and 2.

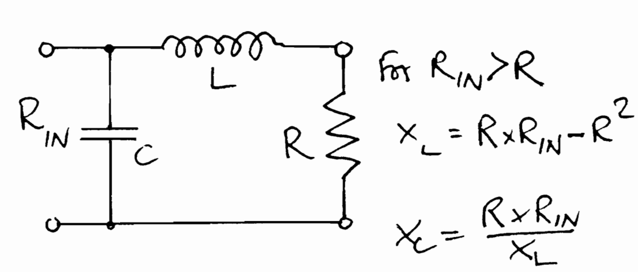


Fig. 1

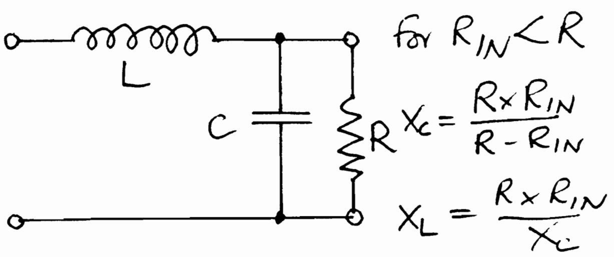


Fig. 2

The formulae for calculating the values of inductance and capacitance assume that "R" is a pure resistance. In practice it is more than likely that there will be some reactance associated with it which will modify the values of inductance and capacitance required. This is accommodated for by making them variable, using a variable capacitor and either a tapped coil or a "roller coaster" for the inductance. These arrangements are shown in Figs. 3 and 4.

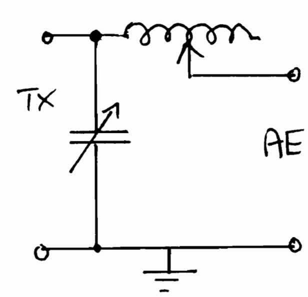


Fig. 3

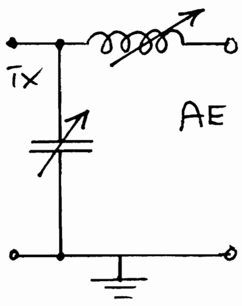


Fig. 4

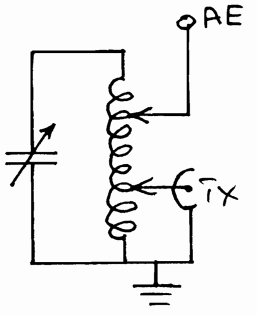


Fig. 5

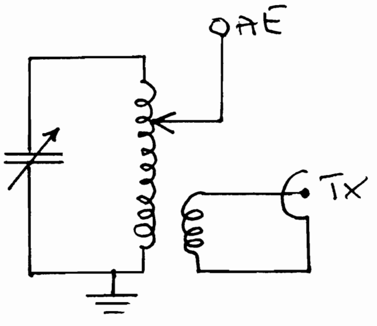


Fig. 6

G3GC

The simple LC circuit is a series resonant circuit and has the frequency response of a low pass filter. If the L and C components are transposed, as is permissible, then the circuit becomes a high pass filter. A better arrangement is to use parallel resonant circuits such as those shown in Fig. 5 and Fig. 6. The frequency response is now that of a band pass filter and as such attenuates frequencies both above and below the resonant frequency. For best results the circuit shown in Fig. 5 requires a tapped coil for both the input and output connections. However the input connection, instead of using taps, may be linked coupled to the coil by a small number of turns depending upon the frequency as shown in Fig. 6.

An important point with unbalanced systems is the RF earth connection. It is unsatisfactory to rely on the earth wire of the AC mains. It is not uncommon for shacks to be in the spare bedroom or the loft area, in which case it the earth wire will be very long, meandering around the house before being taken to ground. It is far better to create your own virtual earth by connecting a counterpoise, preferably an odd number of quarter waves long (usually one) at the operating frequency, to the matching circuit's earth connection. A number of different lengths will be required to cover all bands but a quarter wave cut for 7 MHz will be satisfactory on 21 MHz where it is three quarters of a wavelength long which is an odd number of quarter waves.

These two articles only touch on the surface of the subject of impedance matching and the circuits described are only of use up to about 30 MHz or possibly 50 MHz. The use of lumped circuit components is not feasible at VHF / UHF and therefore impedance matching techniques at these frequencies usually employ coaxial lines in some form or another.

Hints and tips from Derek Alexander G4GVM

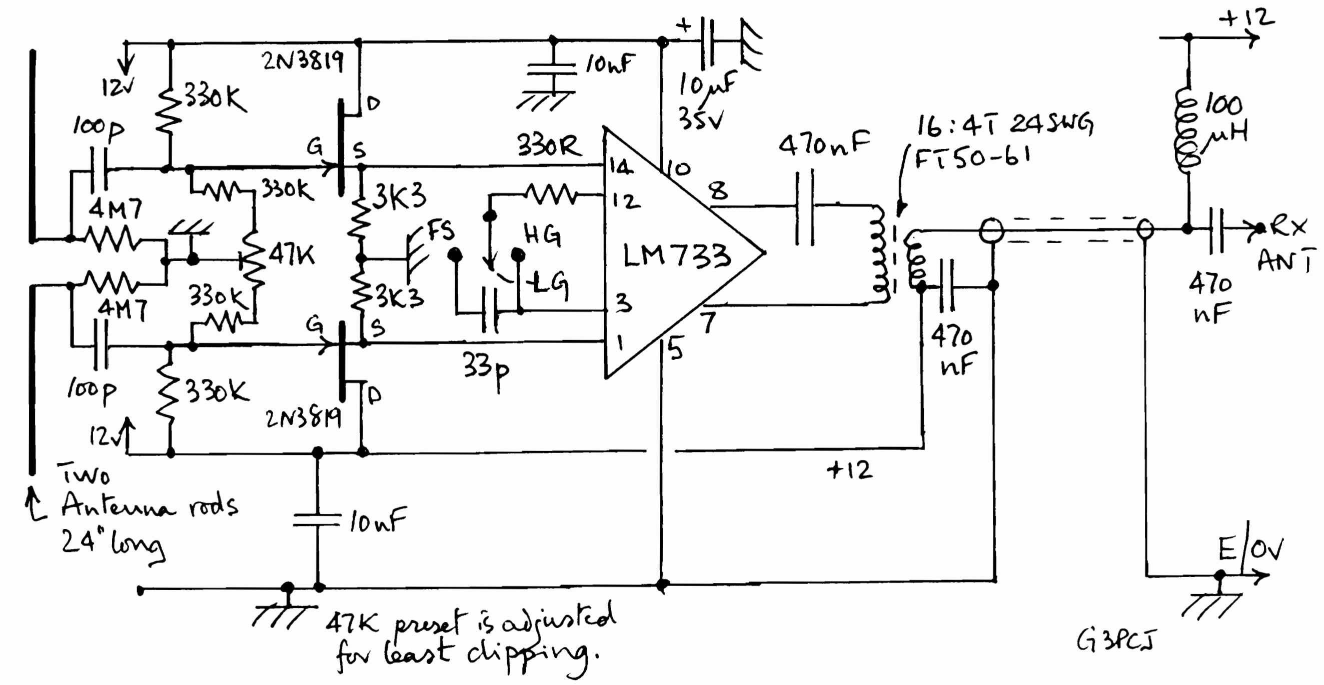
I purchased a couple of large silver plated capacitors and a roller coaster at last year's Longleat rally. They were black! I tried dipping them in 'silver dip' for about 30 seconds, agitating them in the solution. I then quickly ran them under the tap to remove all trace of surplus dip solution. (Beware of stainless steel sinks!) I was very pleased with the result for not only were the plates cleaned but so were the ceramic ends and frame. I have also similarly cleaned all my Jackson 804 type capacitors.

Speaking of these, they are about £10 new (and the rest! - G3PCJ) or about £2.50 second hand. However, the trimmer type 804 can be had at rallies for as little as 50p. They can be modified by aralditing a length of ¼ inch brass tubing - obtainable at any good model shop. Some have a 1/8 inch stub of spindle with a screwdriver slot in the end, others a nut formation with the slot. The latter type will need filing down. The brass rod can be cut to the desired length when fixed.

An old potentiometer can provide a bush for mounting on a panel to steady the extended spindle of a capacitor, switch or potentiometer.

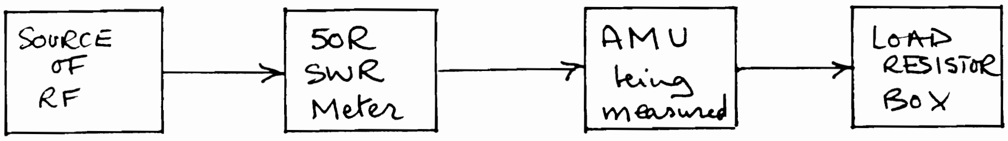
Active Antennas

The common problem with relatively simple active antennas is overload of the internal amplifier and or the receiver front end from high power broadcast signals in the medium wave band. A recent article suggested using an op amp whose gain is reduced at the lower frequencies of the medium wave band. The original article had several extra features and complications which are incidental so I have altered it slightly as something to experiment with! I have not tried this out but am fairly confident it should provide quite useful results for a receive only portable antenna. It is a balanced design with two rods for the antenna - it was suggested these be 24 inches long but their actual length is not critical as long as they are equal. The centre-off toggle switch provides three gain settings; in the middle position with it open circuit (the low gain setting), the response is flat from 200 KHz to over 30 MHz with a stated gain of 9 dB. In the high gain position, the response is nominally flat over the same frequency range but with about 19 dB gain. In the *frequency selective* position, the gain slopes from about 9 dB below 1.6 MHz to 19 dB at 25 MHz so you get the high short wave gain without strong MW signals. Being an electrically short balanced dipole, the radiation pattern allows you to rotate it to further null out unwanted signals. The circuit also shows power being fed up the antenna coax. G3PCJ.



Aerial Matching Unit Losses by John Teague G3GTJ

The losses in matching units should be of particular interest to QRP operators. Frank Witt, AI1H, in the original highly recommended April/May 1955 QST articles found some surprisingly lossy commercial units which were also able to match open and short circuited outputs! His technique is potentially capable of 0.5 dB accuracy. The underlying principle is that the indicated SWR measured between a transmitter and AMU, when the latter is matched, will depend on the degree of mismatch of the load and any losses present in the AMU. Thus if the mismatch is known, the AMU losses can be found. You need a source of RF for the chosen operating frequency (your QRP rig adjusted low so as to not burn out the resistors), a matching indicator which shows the SWR with respect to 50 Ohms and a 'resistor box' going up by a factor of 2 in value from say 6.25R to 1600R (see later). Connect them up thus:-



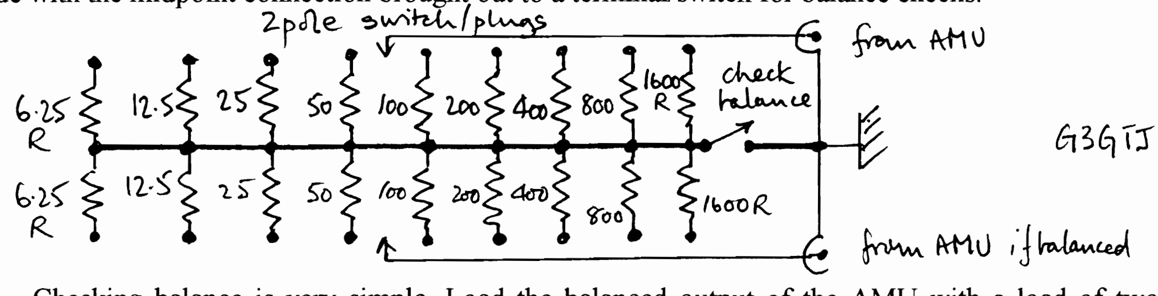
The procedure is to select a typical load resistance which you think your antenna/feeder presents to the AMU, say 200R and adjust the AMU for 1:1 SWR. Without altering the AMU settings, the load resistor is changed to *half* the previous value (100R) and the new SWR noted. If there are no losses in the AMU the SWR should now be 2:1. You can repeat the test by *doubling* the load resistor to 400R, again the new SWR should be 2:1 if the AMU has no losses. The original article has a complex formula to calculate losses from the indicated SWR following a 2:1 load change but a small simplification leads to quite useful results (with slightly less accuracy) from the following table:-

SWR	2	1.9	1.8	1.7	1.6	1.5	1.4
Loss, dB	0	0.3	0.7	1.1	1.6	2.2	3.0

This illustrates the well known fact that once aerial coupler losses are more than a 8 to 9 dB such a system will always present negligible SWR to a transmitter. These methods can provide useful insights into the factors underlying a successful - or unsatisfactory - AMU design and reveal immediately which of a range of AMU settings is optimum. In my own case, I abandoned my pi coupler in favour of a Z-match, finding, incidentally that:-

- Losses, load matching and balance over the HF range are largely independent of the number of turns used for coupling links over the range 2 to 12 turns,
- Coils (not toroids) can be mounted very close to metalwork or in small screening cans without causes losses,
- The Z-match provides excellent balance on all bands. (See last Hot Iron!)

A simple load box can be made using ¼ watt resistors so that a wide range of loads can be selected by a multi-turn switch. Each load resistor in the chain should be in the ratio 2:1 in adjacent switch positions as below. Non standard values can be made by paralleling standard values. All leads should be kept as short as possible. If your AMU output is balanced, then a balanced load box can be made with the midpoint connection brought out to a terminal/switch for balance checks.

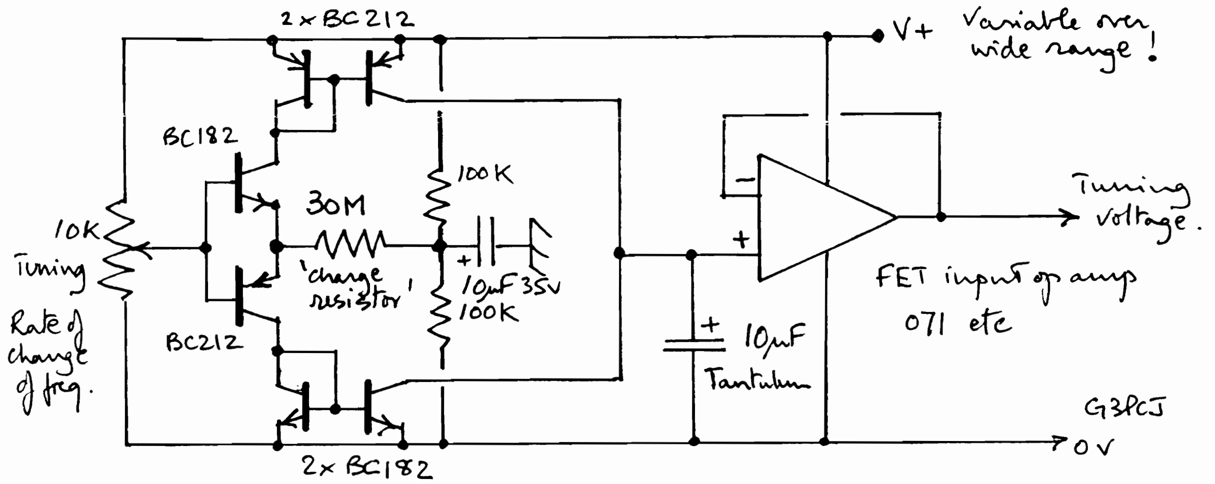


Checking balance is very simple. Load the balanced output of the AMU with a load of two equal resistors in series (balance switch open). Adjust the AMU for 1:1 SWR at the AMU input and then connect the mid point to ground by closing the balance switch. Any change in SWR will indicate unbalance within the AMU. Baluns can also be checked this way and their losses established using the AMU test procedure.

Single Knob Tuning

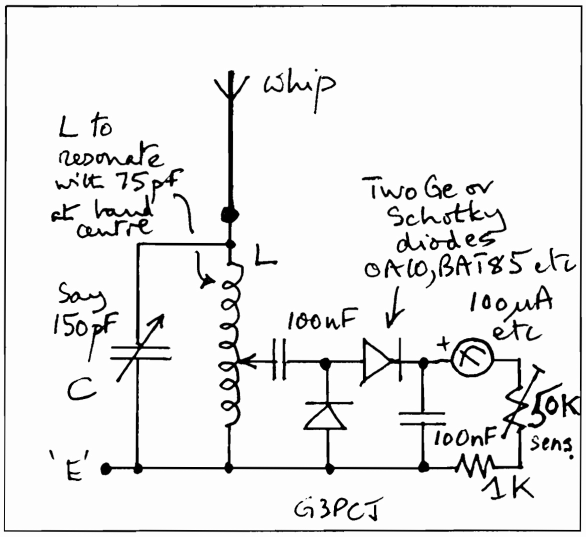
Those of you lucky enough to have air variable tuning capacitors driven by slow motion drives need not read this! The rest of us stuck with varactor diodes probably have a coarse and fine tuning controls where the tuning range is more than 100 KHz or so. While doodling one day about how to improve tuning arrangements with 'huff and puff' stabilisers or synthesisers, I hit on the idea of deriving the normal varactor tuning voltage from that stored on a capacitor and injecting/extracting charge to change the tuning voltage. The first snag is how to 'buffer' the capacitor voltage so that it can drive the varactor diode without altering the capacitor's charge - this is fairly easy using a low leakage tantalum electrolytic capacitor feeding a FET input op-amp like the TL071. The major advantage of this scheme is that you do NOT need a stable supply any longer! The op-amp's supply voltage can change quite dramatically if it has typical supply change rejection figures.

To inject or extract charge from the capacitor some form of rotary control is desirable; hence the idea of a pot whose central position corresponds to no change, and where movements on either side control the rate of frequency change up or down. I very quickly found that minute currents are required in or out of the capacitor to change its voltage so a driving circuit without any current gain is essential! This all boils down to two current mirror circuits for each polarity driven by a pair of 'common emitter' transistor biased at the control potentiometer's mid voltage. Only when their bases depart from the mid supply voltage does one of them inject current into the associated mirror and hence into or out of the capacitor. The finite turn-on base to emitter voltage of the two 'common emitter' transistors means there is a small (wanted) dead band at the central position of the pot. The size of this dead band can be varied by altering the pot supply voltage and it does not affect the tuning either! I tried this scheme out on my Langport and it worked quite well - you might find other charging resistor values better for your rig! 30M is pretty large so a pulsing scheme might be indicated but this adds complication. It takes a little while to get used to a tuning control which alters rate of change of frequency (and you do need a digital readout) but one control and being able to change the supply voltage from 8 to 30 without affecting the tuning is quite something! G3PCJ



Absorption Wave meters

Prompted by a note from David Roper who asked about 6m wave meters, I reproduce alongside the general circuit of such gadgets. The tap on the inductor is to avoid the diode detector from spoiling the Q of the tuned circuit. It should be about ¼ to ½ of the turns up from the ground end. The whip antenna, made from a couple of feet of stiff brazing rod, can be connected direct to the hot end of the coil. The more sensitive the meter, the more sensitive will be the whole instrument. The L and C need obviously to resonate over the bands of interest; the L can be made plug-in for several bands. Calibrate the tuning dial by connecting the whip input and earth in series with your RX antenna; it should attenuate off-air signals when tuned to the same frequency as the RX. G3PCJ



Five Questions Prize Draw!

Several members eventually answered my questions; I am most grateful to them because it is very difficult to obtain market research data of a positive nature. Here is a synopsis of the answers:-

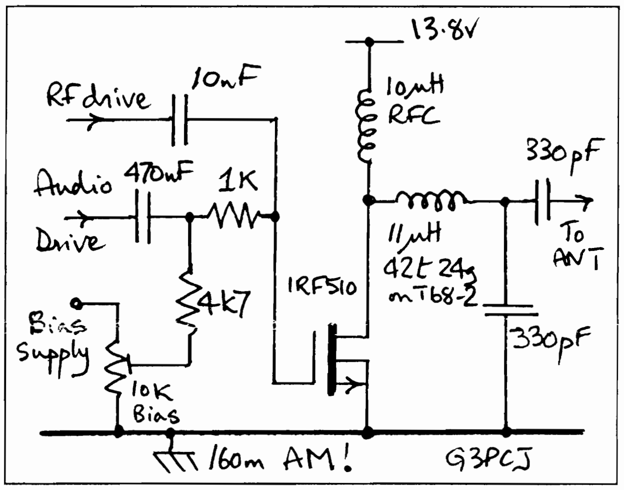
1. Desired rig. Large variety - tubed rigs to 2m multimode (phew!), high spec CW, no drift VFO, etc.!!
2. Experience. Taunton, Street, Oscilloscopes, 23 cm transverter, 40 Watt 6 to 160m CW/SSB TCVR.
3. Other topics. More practical things, simple test gear, /P antennas, humour, more feedback (please!!)
4. Strengths. Value for money, interesting solutions, step by step tests/instructions, they work!
5. Weaknesses. Range too extensive, none, lack of enclosures, 612s, transistor lead/holes.

I have already made good use of a number of these points but the one that haunts me is enclosures! I have been searching for what I think is a good value solution for two years or more without success. You can obtain good quality cases where you can remove any single side or end without it collapsing (for tests etc.) but they are expensive at around £25 each and then they need drilling and some sort of labelling scheme. Another problem is that of accommodating options like digital readouts, plug-in cards and other extras etc. without having a large inventory of expensive cases waiting in stock for customers. I would very much welcome some suggestions on how to solve this.

My son Charles, who some of you have met at the QRP Convention, is open to influence but on this occasion claims to be acting independently, has chosen G3YCC at random as the winner of the £25 voucher - well done Frank. Its on its way separately. My thanks to all of you for your help. G3PCJ

Top Band AM

Paul Tuton wanted an AM TX but I can't find the circuit that I used many years ago. It used gate modulation of the TX output stage IRF510 FET. Try this: design the drain load to produce a maximum of say 5 Watts on 13.8 volts which actually needs a drain load of 12.5 Ohms easily obtained by a LCC network. Apply gate bias/RF drive to obtain ¼ of this (1.5 Watts) as carrier with no modulation, then apply audio to the gate to just achieve 100 % modulation. Since the gate circuit is very high impedance for DC and audio signals it can be driven from a speech amplifier. I certainly had several contacts using this approach. Write it up for us Paul! G3PCJ

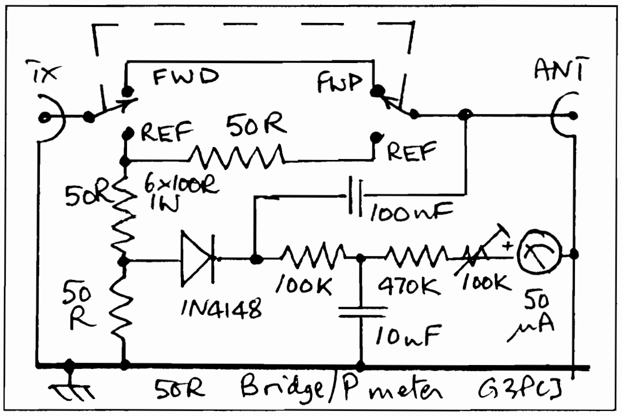


High Current Batteries

Lead acid batteries have now been fabricated like capacitors (Swiss Rolls) so that they have very large area cells with very low lead inductance. Experimental devices can now pack a huge punch - 6 off cells each 23 mm in diameter and 70 mm long connected in series for a 12 volt battery could start between 15 and 20 V8 engines on a single charge!! Even more impressive is their rapid response - a single cell discharged at over 1000 Amps just 1 microsecond after switch on (including a 700 A switch bounce spike after just 500 nS!) and had risen to 1500 Amps by 6 microseconds! Makes the cranking of my tractor diesel engines by conventional lead acid batteries sound very tired! Can't find where to buy them! G3PCJ

Most Often Used Gadget!

Filling the last few lines is always tricky! This QRP matching bridge is the unit that I use most frequently. It indicates forward and reflected voltages but after the AMU has been adjusted for a 50 Ohm load it can be calibrated in power. In the reflected position, it also protects against any AMU load. Very handy - G3PCJ



Finally - don't forget your subs!
£6 for UK, £8 for overseas