Hot Iron

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Editorial

Welcome to the start of a new Construction Club year which is now our fifth - without the active support and encouragement of you I could not have kept it going this far - thank you and please keep sending in your contributions. For those who have hesitated to contribute so far, please don't be worry about writing/drawing tidily - I can 'adjust' most contributions without too much difficulty. I should love to have some new contributors and many members would find it interesting to hear about other member's rigs, test equipment and homebrew projects, including those that are not too successful!

We had a weeks holiday in Cornwall just before the harvest on a farm (where else!) where all the old buildings had been converted into holiday accommodation. I took the prototype Langport (see below), AMU and a reel of wire with me. With plenty of space here for antennas, I normally use a 160m dipole fed by open wire feeders and a versatile matching unit, which obtains a good 'grip' on the aether and performs well. When on holiday, being close to others and not wishing to intrude too much, I started by erecting my end fed wire along the plastic guttering of the old barn; despite a total length of nearly 50 ft which produced quite adequate reception, I failed to even raise the locals on 80m! Messing around with alternative RF 'earths' made no difference so I eventually strung the same wire across the yard (out in the open) at about 15 ft minimum height. I called the first person who I heard calling CQ - it turned out to be Rob Mannion G3XFD in Hampshire who is Editor of PW - neither of us recognised each other despite many conversations by other means! All of which goes to show that when operating QRP, you have to have an efficient antenna in reasonably clear surroundings.

Kit Developments

Last time I mentioned the **Wellington** TCVR, CW for any 1 or 2 bands to 10m; this is now available after helpful trials by early builders. The mark 3 **Booster** is now out incorporating several improvements aimed at portable operation where antenna efficiency is often poor - I could have used it on holiday! On transmit it produces 20 W on a 13.8 volt supply from about 1 to 1.5 Watts drive over the frequency range 1.8 to 15 MHz. For reception there is a 10 dB RF amplifier. Control is direct or by RF sensing with the option to separately control the receive and transmit amplifiers.

The **Langport** is a 5 Watt CW & phone SSB superhet TCVR for 20 and 80m. It is a Yeovil derivative with an IF amp, better RF and AF filtering and many simplifications. I have managed to squeeze it onto a single 100 x 160 mm PCB so it is pretty full! The VFO runs at 2 to 2.5 MHz for 80m, for 20m this is mixed with an 18 MHz crystal so stability is excellent. Price will be about £115 - a couple of early builders are needed - please let me know if you are interested. The same PCB could do 20 and 160m phone & CW **OR** 160m CW plus any other band phone & CW to 10m! A £10 discount for the first correct explanation received for this odd set of possibilities! Tim Walford G3PCJ

Hot Iron is a quarterly newsletter for radio amateurs interested in building equipment. It is published by Tim Walford G3PCJ for members of the **Construction Club**. Articles on simple theory, construction, testing, updates on kits, questions and suggested topics are always wanted. Please send correspondence and membership inquiries to Upton Bridge Farm, Long Sutton, Langport, Somerset, TA10 9NJ. Tel 01458 241224 E mail walfor@globalnet.co.uk The Copyright of all material published in Hot Iron is retained by TRN Walford. ©. Subscriptions are £6 per year for the UK (£8 overseas) from Sept 1st.

Effective Radiated Power

Jim Geary GW8HKY asked about erp and our licenses - Eric Godfrey G3GC kindly came to my rescue:-

'The Amateur Radio Booklet BR68 which accompanies the Amateur Radio Licence (A) and (B) contains a schedule of the maximum powers that may be used for different bands. It specifies the power which may be supplied to the aerial in dBW except in the case of the band 431.0 to 432.0 MHz where the specification is in dBW erp. This specification of erp power also applies to the licence variation order for 73 KHz. So what are the implications of these two different specifications?

In the majority of bands where the power is specified as so many dBW to the aerial this is the power at the aerial terminals. This means that if there is any loss in the feeder then the power from the transmitter into the feeder may be higher so as to give the specified power at the actual aerial terminals. It is of no consequence as to what type of aerial is used. This means that if a beam with a power gain of say 10 dB over a dipole in the direction of maximum radiation is used then the power actually radiated in this direction will be 10 dB greater. 10 dB is a power gain of 10 and therefore, if the power at the aerial terminals is 100 W, then in the direction of the main beam the remote field strength and therefore received signal strength (compared with a dipole) will be as though the power was 10 x 100 Watts or 1 KW. This is the effective radiated power normally abbreviated to erp. So when the power is specified in absolute terms it is possible to effectively radiate, in a particular direction, power far in excess of the transmitter power.

When the power is specified as an erp then this implies that this is the maximum power that may be radiated in any direction. Therefore the aerial gain has to be taken into consideration and the transmitter power, after allowing for any feeder losses, adjusted accordingly so as not to exceed the specified erp. This means that if one is using a beam with a gain over a dipole then in the 431 to 432 MHz band the transmitter power will be less than the erp power so as to not exceed the specified 16 dBW erp (39.8 W). In the case of 73 KHz where the erp is specified at 0 dBW (1 Watt) the opposite will usually apply since most aerials are unlikely to be anything approaching a half wave long which is 2055 metres. Since the aerial is likely to be considerably shorter than a half wave dipole the resultant effective gain will be less than unity i.e. a loss with respect to the dipole (indicated by negative dBs) and therefore a larger transmitter power than 0 dBW will be required to achieve the 0 dBW erp. If the aerial shows a loss of 10 to 1 (-10 dB) over a half wave dipole then the transmitter power will have to be increased by the same factor of 10 to 10 dBW or 10 Watts.' Eric Godfrey G3GC

Tips and comments

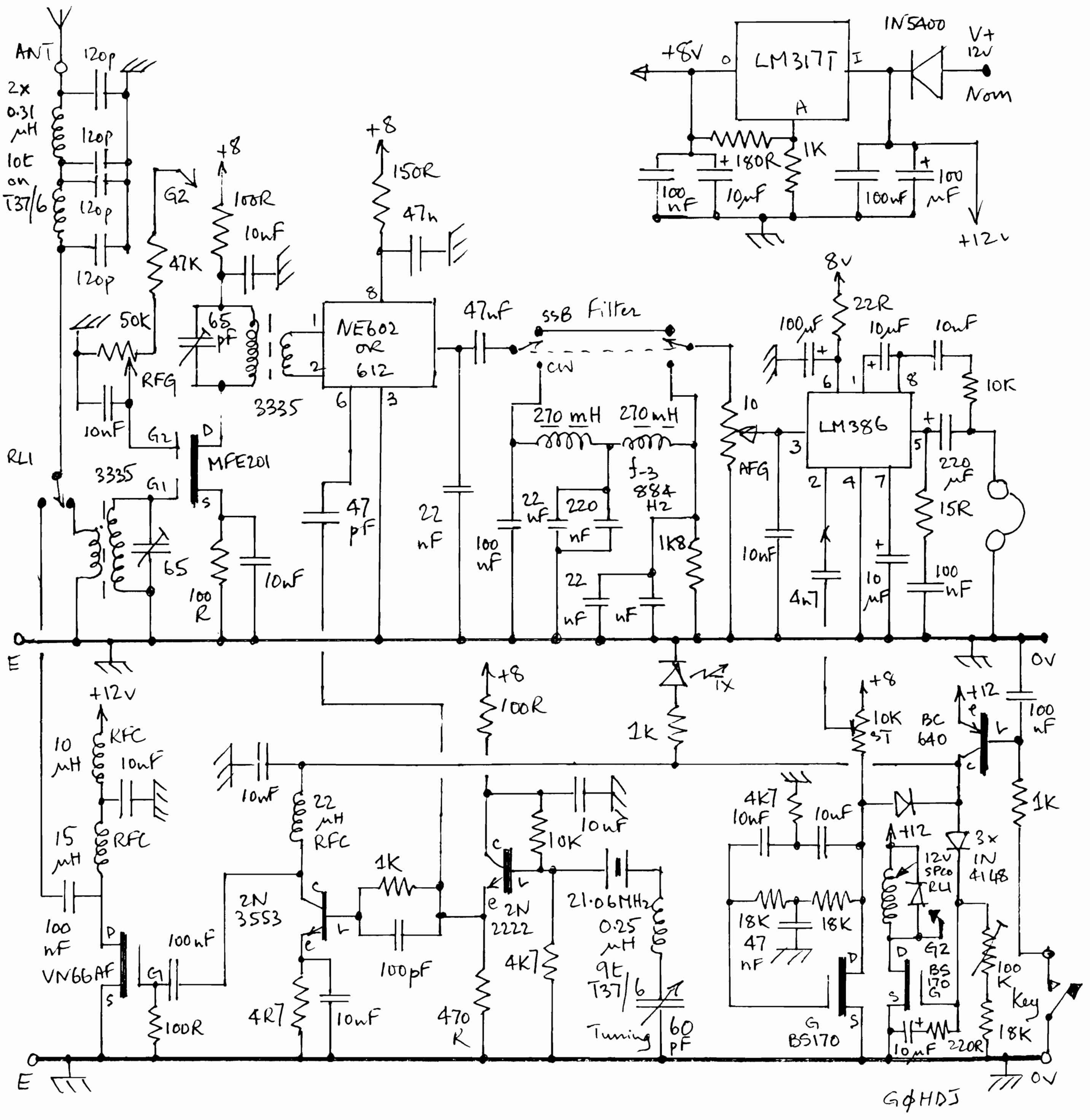
Norman Hixson M0ALB suggests that taking reverse tracings of parts layout diagrams by photocopying greatly eases finding the position of individual parts - if you want, the magnification can also be adjusted on the photocopier. Norman also comments that using preset controls as normal front panel controls (as in the Sparkford) may lead to premature failure as they were never intended for such extensive use. True if heavily used but in defence I would point out that *you* can go to a rally and buy full size replacement pots/knobs for far lower prices than I can supply them new and it avoids the initial cost/mechanical complexity of a front panel as part of the kit while allowing you to get it on air quicker! I think it also adds distinction to the rig but do appreciate that point is debatable!!!!

Austin Muir (ex ZS5KH) also comments on controls, preferring a large wooden (for cost/ease of building) front panel, with protective wire mesh, so that the circuit PCB can also be mounted on it. He hankers after designs with more options for experiment, particularly by changing inductors for coverage of other bands. I hope he will forgive any implied comment but his experience derives from a much earlier age when all coils had to be home wound and were large by modern standards; nowadays builders are much more weary of inductors and small size is highly valued - which is why I squeezed the Langport onto one PCB. Superhet rigs usually contain many more inductors than a simple regenerative RX so band changing is also impossible if not designed in from the start.

Cases! I normally include a blank single sided 100 x 160 mm PCB in the more complex kits for builders to use as a front panel. For my own purposes, I hardly ever box anything because it does not allow demonstration so easily; furthermore it aggravates fault finding or testing during construction because a box invariably prevents access to the PCB underside. I am aware of at least one person who builds like me but would love to have some wider feedback. Nearly every rig that gets returned here has been cased. Do builders want PCB front panels? Omitting them would save about £3. I have considered offering a U shaped aluminium cover to match the PCB panels, attaching directly to the main PCB. They would cost about £6 extra with a rear blank PCB panel. Any interest? G3PCJ

15m CW transceiver

Craig Douglas G0HDJ has been developing this little rig over the last 18 months and now reports good success. He wanted a small rig for portable use using a 12 volt battery. It produces 1.5 Watts and is a classic of fitness for purpose. It incorporates circuit ideas from a number of different contributors. When I first saw this rig, it was laid out over quite a large area with undesirable long signal leads darting back and forth but Craig now reports that the final tidy version performs well and is stable in an oscillatory and drift sense. Craig has sent it in for Sprat but I have taken the liberty of altering the control circuit very slightly so that a single pole antenna relay can be used. I would also comment that all three RF chokes in the transmitter could have any value from about 5 to 20 µH. Apart from using the specified inductors in the RF amp, audio filter and RF low pass filter, there is very little that is critical. It should be laid out in the normal sequential manner to minimise the chance of unwanted feedback. Why not try building it 'ugly' style on a sheet of copper clad board? The scheme can be used on other bands near 21 MHz quite easily. In the RX, only the RF amp Toko coils/trimmers and crystal have to be changed. In the TX, only the RF low pass filter needs altering.



Broadcast Station Interference

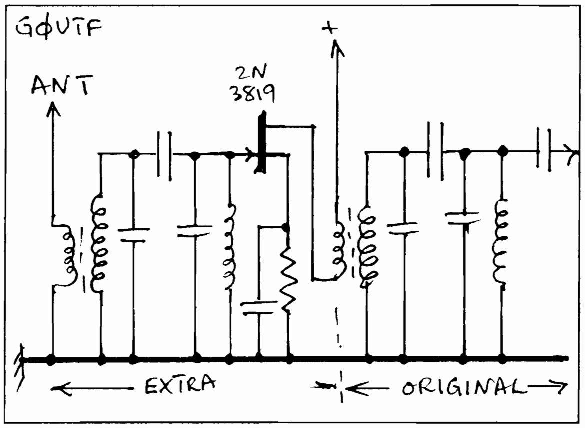
David Proctor G0UTF and Mark Worsfold have both had problems with BCI which is more likely to affect direct conversion receivers than superhets. The root of the trouble is that the mixer, which in a DC rig coverts the RF down to audio directly, is unable to reject the very large RF signals emanating from broadcast stations close in frequency (and maybe physically); this overloading of the mixer causes it to act as a poor envelope detector (not as the desired product detector) hence partially recovering the broadcast station's modulating audio. The real solution is to use a 'strong' mixer, meaning one which can handle large signals without overloading; most of us however, are stuck with NE602 or 612 mixers which cannot easily be changed - their replacement is another story! Because the mixer of a DC rig is followed by audio amplification stages, these 'noises' are passed to the output - typical symptoms are weakish mushy sounding audio which is independent of the rig's tuning. Quite often, a small reduction in the BC signal will cure the problem. In a superhet, the first mixer, which is the one prone to BCI overload, is followed by the IF strip which does not pass the BC station's audio so superhets seldom exhibit this particular trouble. (Superhets can still suffer overload from other in-band signals but this is a different problem which seldom lasts for more than one operating session.)

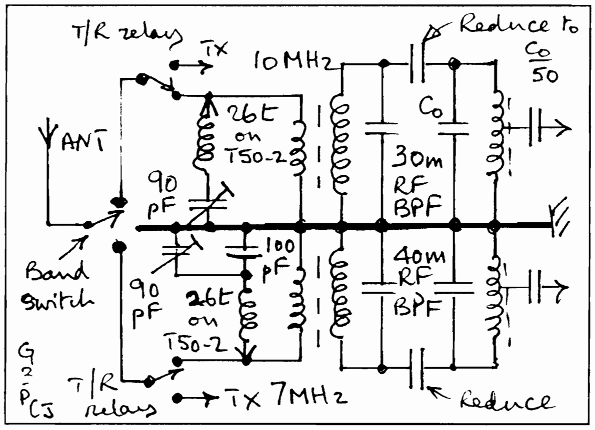
Some amateur bands are more likely to suffer BCI than others due to the proximity of broadcast stations; the worst offenders are 40m, with the BC stations only a few KHz away from the top end of the band making it a stiff test for any rig, and 30m which can be nearly as bad. In principle any desired band can be affected by any strong RF source but due to the rig's RF filtering, trouble is most likely to come from BC stations who frequency is near to the wanted signals. People also have trouble with 160m but the cause is usually slightly different; this is because 160m antennas are often long wires (giving large BC signals) and matched to the rig with an L network matching unit. The 160m antenna is high impedance so the L network has a low pass response which fails to attenuate the lower frequency signals from the powerful BC stations in the HF end of the medium wave band.

There are two main approaches to overcoming BCI, the first is better RF filtering to allow only the wanted signals into the receiver. If this does not effect a cure, then attenuation specifically of the unwanted signal is necessary. Do not do anything which *increases* RF gain, this will only aggravate it! Filtering to allow in only wanted signals should start with the antenna matching unit; link coupling and a parallel tuned circuit will provide the best out of band rejection on both the high and low frequency side of the wanted signal. Changing to this style of AMU is often sufficient to cure problems on 160m where the interference is not that close in a frequency sense, which allows the low Q found in AMUs to be effective in attenuating the unwanted. The next step is to reduce the bandwidth of the rig's RF filter - if it uses a double (or triple) tuned circuits with capacitive top coupling, try reducing the small coupling capacitor until sensitivity begins to fall noticeably. A typical value of top coupling capacitor might be one fifteenth of the resonating capacitance but reducing it towards one fiftieth may help. (This is all right for narrow HF bands but may not be sensible for the wide LF bands where the whole band has to be received - these will require more resonant circuits. The maths of such filters is beyond most of us!) Make certain that the coupling into and out of the resonant circuits is sufficiently light to not degrade the Q of the individual circuits. This is especially important if there is only a single tuned circuit. Use a small number of turns, on the low impedance antenna RF input primary, compared to the main resonant winding to give a high turns ratio. Unless the tuned circuit feeds directly into the high impedance gate of an FET, make certain that the next stage is either inductively or capacitively coupled down the main resonant winding. Occasionally BCI can enter the rig after the RF filters, so see if it is present while shorting out the RF bandpass filter, this is a clue to look elsewhere. Longish RF leads (e.g. to plug in band cards) can pick unwanted signals which is why the Taunton has provision for a trap to suck out BC interference near to the 6 MHz IF. It is also worth remembering that overall screening may help.

If improved RF filtering fails to effect a cure then the unwanted signals have to be directly attenuated. Broadband resistive attenuation certainly works well (this is why many rigs have an RF attenuator control), but it affects all signals equally so will also reduce sensitivity to wanted signals. A better solution is to use an extra selective tuned circuit to suck out the interfering signal(s). A series tuned resonant circuit is connected across the low impedance antenna input to the RF bandpass filters. Assuming the offending station is near to the wanted band, this trap should be designed to resonate on the wanted band. Use a 'fixed' inductor wound on a powdered iron T50-2 toroid with sufficient turns to resonate at roughly half mesh of a 90 pF trimmer. Tuning of the trap is checked by using it to first attenuate the wanted signals and then tuning off on whichever side best reduces the interference while causing least wanted signal reduction. The trap should have as high Q as possible (high L to C ratio) so that the steep slope of its response causes least reduction in wanted signal away from its actual resonant frequency. Experiment with the tuning of the trap, on the opposite side of the offending station to the wanted band, so that it provides just sufficient attenuation of the unwanted signal to cure the problem and hence least reduction in wanted signal.

David Proctor found that with his Frome, there was some improvement from adding a single resonant circuit with a buffering FET RF amplifier prior to the existing RF filters; but the best solution came from an extra double tuned RF filter with the buffering RF amplifier and an input attenuator to reduce the gain back to what it was previously! His solution is really the first approach of keeping out the unwanted without attenuating the wanted. He is actually using four resonant circuits in his ‘RF’ filter. I have sketched it below left. For Mike’s rig, reducing the top coupling capacitors of the existing double tuned RF filters helped on both 30 and 40m but fitting a series trap for each band was most effective. This approach also allows some adjustment to cater for use with different antennas which might have alternative BCI consequences. The diagram right shows values for both bands. G3PCJ





Replacements for the NE602/612

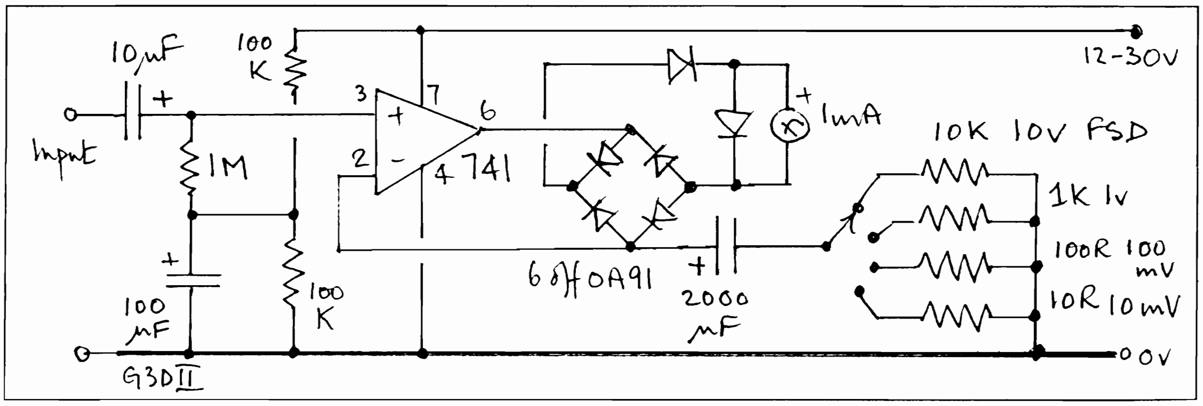
Although these are not being made in pinned dual in line format any more, the surface mount version SA612AD ***is definitely*** available. Poor Craig G0HDJ ordered some and could barley see them! With patience, you could mount one on an 8 pin header by wire extensions from the surface mount pads. Soon we will have to build like this as new devices are made in only in surface mount format. The hunt for a replacement continues, perhaps with a better strong signal performance!

Cirkit Electronics

Several people have asked if they are still trading. The answer is yes. I ordered bits last week without any difficulty but possibly they are concentrating on account or non-retail customers.

An audio milliVoltmeter by Joseph Bell G3DII

Not a device that is used every day but nevertheless very useful for audio projects. The circuit shown below is simple, cheap and accurate over not less than 8 Hz to 50 KHz on all ranges covering 10 mV to 10 volts FSD. It can use any DC supply between 12 and 30 volts drawing about 2 mAmps in the quiescent state. The input resistors bias the op-amp input and hence output normally to mid supply; when a signal is applied to the input capacitor, the output AC load current flowing through the scale resistor selected by the range switch, is full wave rectified by the diode bridge to show on the meter. The two diodes across and in series with the meter are for protection purposes. Z_{IN} is 1 MOhm.



High Power Linears

Peter Thus from Oslo wrote to me regarding his experiments with watty MOSFETs of the BUK445-200A type. Using a 24 to 30v supply he obtained about 100 Watts on 80m from a 3 Watt QRP driving rig. He had all four FETs in a single ended parallel arrangement with suitable matching input and output transformers. I have not included any circuit because the details he gave me were incomplete and his experiments on other bands were continuing. However, his remarks set me thinking about high output devices. MOSFETs specifically intended for RF radio service are still very expensive (£20+ whatever the power!) but there are now many (hundreds) of different types of watty MOSFETs intended for low frequency use; their price is low and they are inherently high speed devices but with significant drawbacks! The worst aspect is the high input capacitance but modern designs are improving with several application notes describing fixed frequency (non radio) uses up to 50+ MHz with powers of 2-300 Watts. I spent one afternoon searching the data sheets, on CD and the web, to find the best performing low cost device that might produce about 100 Watts of RF. Supply voltage is crucial - while nominal 12 volts has many advantages for amateurs, not many suitable devices have low input capacitance, so I then wondered if something working off 100 to perhaps 250 volts might be feasible. A single ended device directly coupled to a 50 Ohm load and using a 125 volt supply would have the potential to generate around 100 Watts easily. No nasty output matching transformers and plenty of devices able to take the voltage and power - looks interesting! Double the supply to 250 volts and 400 Watts looks possible! Achieving a sufficiently low harmonic output would suggest that a push pull arrangement might be better - still quite promising. Typical devices have an input capacity of around 1 nF and might cost a pound or two. Using input step down transformers to match gate resistors of 10 Ohms or less would need a few watts of driving RF on 80m for a few volts of gate swing. Going up to 20m would need lower impedance at the gate and hence more input power for the same gate AC voltage. Not impossible! I was about to order some devices to play with when I remembered the power supply!

Experiments years ago using VN88AFDs on a 35 volt supply had highlighted the problems of higher voltage ampy supplies; poor regulation of the mains input with simple transformer, rectifier, smoothing capacitor circuits can lead to large output voltage variations over time, and with load, making a linear regulated PSU design quite difficult. There are also new EC regulations to worry about concerning current harmonics on the mains caused by simple rectifier & reservoir capacitor circuits. A simple half wave choke input filter direct off the mains would solve this aspect and produce around 125 volts but where does one buy ampy 'Henry' sized chokes nowadays? This arrangement would not be safe without a mains isolating transformer - these are available but cost at least £30 plus VAT new! Add a smoothing capacitor at say £5 - £10 and allow £10 for the choke and it is quickly apparent that the PSU will cost at least £65. An alternative approach might be to modify the cheap computer switch mode PSUs but this also has its drawbacks.

Even allowing for the extra costs of heatsinks, RF transformers, decoupling and bias parts etc., it is clear that the amplifier cost will be well below half that of the PSU. Conclusion - concentrate on the design of the PSU and not the amplifier!! What a disappointment that we cannot get away from 50 Hz! The situation has not changed from years ago when the PSU powering early computers cost more than the calculating bit! (As a footnote, the first computer that I helped design back in the sixties used so much power that it had to have a chilled water supply for each cabinet to keep it cool!) G3PCJ

After all that heavy text, we need a little humour:-

" LIONEL IS A RACK AND PANEL ENTHUSIAST "