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Hot Iron

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Editorial

Further to my last Editorial about encouraging youngsters into the hobby, my thoughts have progressed a fair way! In discussions with Steve Hartley G0FUW, who is a RSGB Board member with a special interest in the topic, I am edging towards the notion that AM reception and later transmission maybe, are the way to go. Not too sure yet about what frequency to use but there is much to be said for using 40m or 160m. The former has the advantage that there is usually quite a lot of amateur CW/SSB activity but unfortunately the standard 7159 KHz crystals that used to be available are now extinct unless ordered in thousands. 160m does have 1834 KHz as a standard crystal which is still available, but it is often used for CW; there are AM nets on 160m and it might just be possible to do a receiver with the high frequency part of the MW and 160m in a single band. 80m also has active AM nets on 3615 KHz which can be done with a 3.58 MHz ceramic resonator but that might be less acceptable to OFCOM if any special permits were required. AM would allow the RX to be simplified, so reducing cost by omitting the regen stage of a rig like the FiveFET but that would eliminate the possibility of receiving CW or SSB, which is an important part of the introduction to amateur radio. As part of this exercise, I have developed the Forton AM TX that can do fractions of a Watt on a 9v supply (see photo below) – it is crystal controlled but can actually do any band 20 – 80m.

I don't now see aerials as the problems that I used in this application! A few metres of throw out wire will bring in the powerful AM broadcast stations on MW and 40m, and would do the same for a nearby low power transmitter using another short wire aerial, such as 'across a school playing field' etc on 160m. Give them both decent external aerials, when their builders are hooked, and the distances possible will leap upwards! There are many things to consider but a very worthwhile objective. Tim G3PCJ

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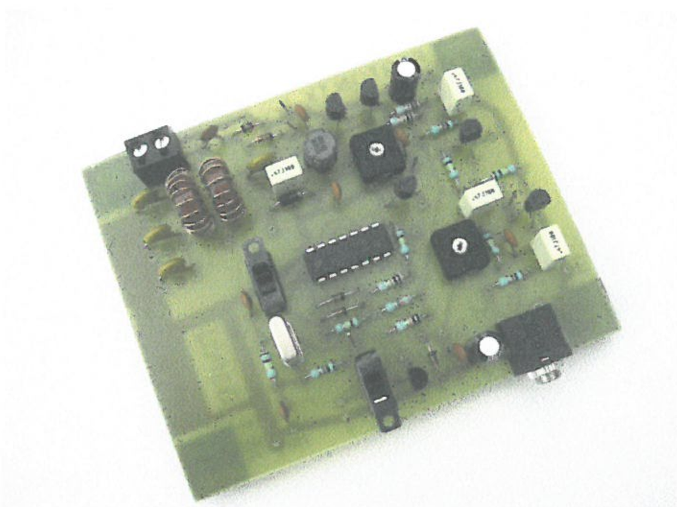

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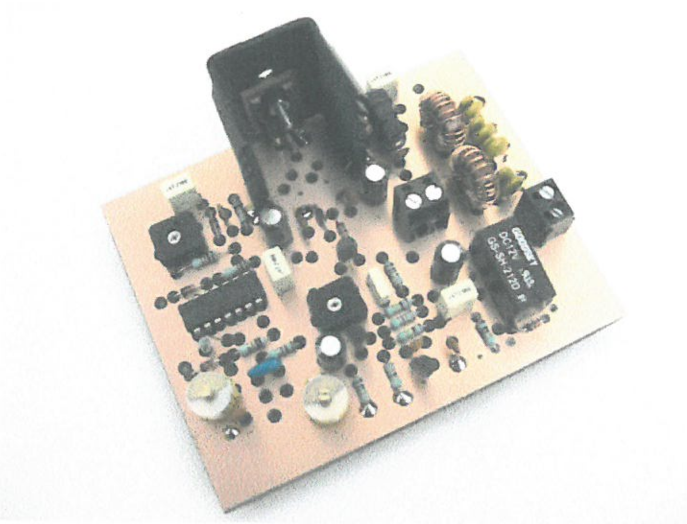
Kit Developments

After much experiment and the building a new prototype called the Star, I regret to say that the idea of using the RF and AF amplifiers for both reception and transmission in a single 80m low cost rig proved just too unreliable. End of the Wick idea!

On a more positive note the new simple superhet phone Rode RX and Rudge TX are working well. Some early High Ham 5W AM transmitters (photo) are being built by the Cheltenham Club; this design can also do CW and has the ability to get on 6m at lower power with an overtone oscillator.

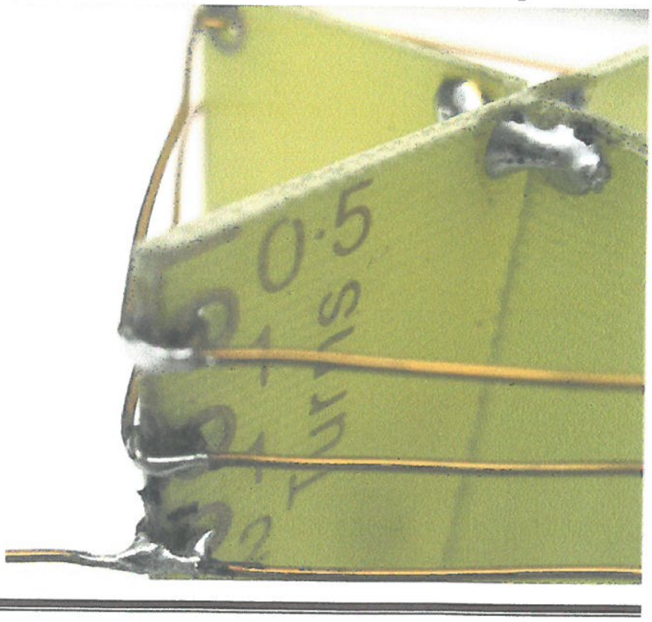


The Forton

This is a derivative of the High Ham described last time. Originally intended primarily for the bands 20 to 80m, with 'crystal' control but no trimmers for ceramic resonators so that it cannot be made (unintentionally of course) to go out of the band which is possible with some 2 MHz and 3.58 MHz ceramic resonators! It has AM as the primary mode but can also do CW. It includes TR control fro either the Yeo with a TR relay mounted on the Yeo, or without a relay for the FiveFET – the latter has had some very minor track modifications to provide the required interface connections but the actual RX circuit is unchanged. The Forton has reverse supply protection and will work with a supply from 9 to 15v but would normally be used with the PP3 battery of the FiveFET. It has a Net switch which turns on just its oscillator stage for netting of RX To the TX frequency. It also has a Transmit switch which is an alternative to the microphones PTT switch – I find the new CB style mics are more expensive than plain hand held 'ordinary' mics, but the switches on these are not able to act as a PTT switch, hence the need for an additional switch to control the rig on the PCB. Such ordinary mics often have ¼ in plugs and are supplied with a mono adapter that would short across any third ring contact of the common 3.5 mm variety, which I usually use for the PTT circuit!

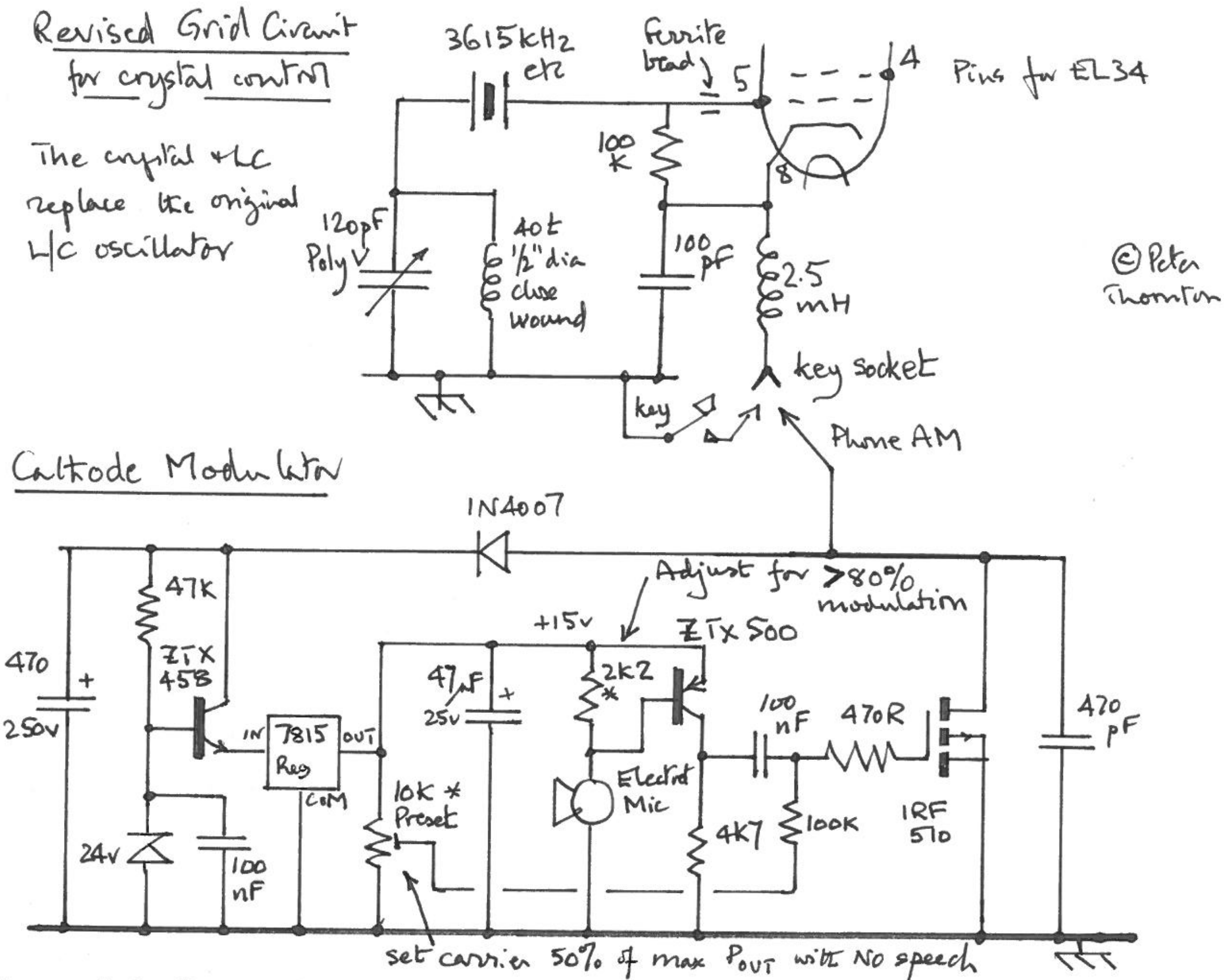
The new Mk 5A Antenna Matching Unit

Finding an alternative to the flexible multi-way PCB strap that I used to use for the coil in the AMU has been a challenge! My last design involved winding about 40 turns with taps onto a length of PVC waste pipe – this was quite challenging and took me several attempts before I had a half reasonable one. Much head scratching has come up with a far easier to make design based on a **X** form of PCB material former that can be packed flat for the post bag easily! The former also has holes along one edge to allow a small loop to be made for each tap; this allows the winding to be completed in stages between the taps without excessive wire lengths. The former material is joined at the middle of the cross and after the first turn has been applied, the arms then become quite rigid! Much better! G3PCJ



Mick Modulator – Simplest ever phone modulator – by Peter Thornton

This approach uses the original anode tuning of a fixed tuning capacitor resonated by a variable inductance. Amplitude modulation is produced by controlling the RF output from the valve's cathode instead of the conventional high power audio amplifier manipulating the main HT supply. The modulator circuit below is simply plugged into the normal key socket and does not even need its own supply! This is a case where semiconductors do work to advantage with valves! I elected to go for crystal control on 80m so bought a 3615 and 3625 KHz crystal from the VMARS suppliers; this needed minor alterations of the grid circuit, so while about it, I added L and C to give a small pulling range.

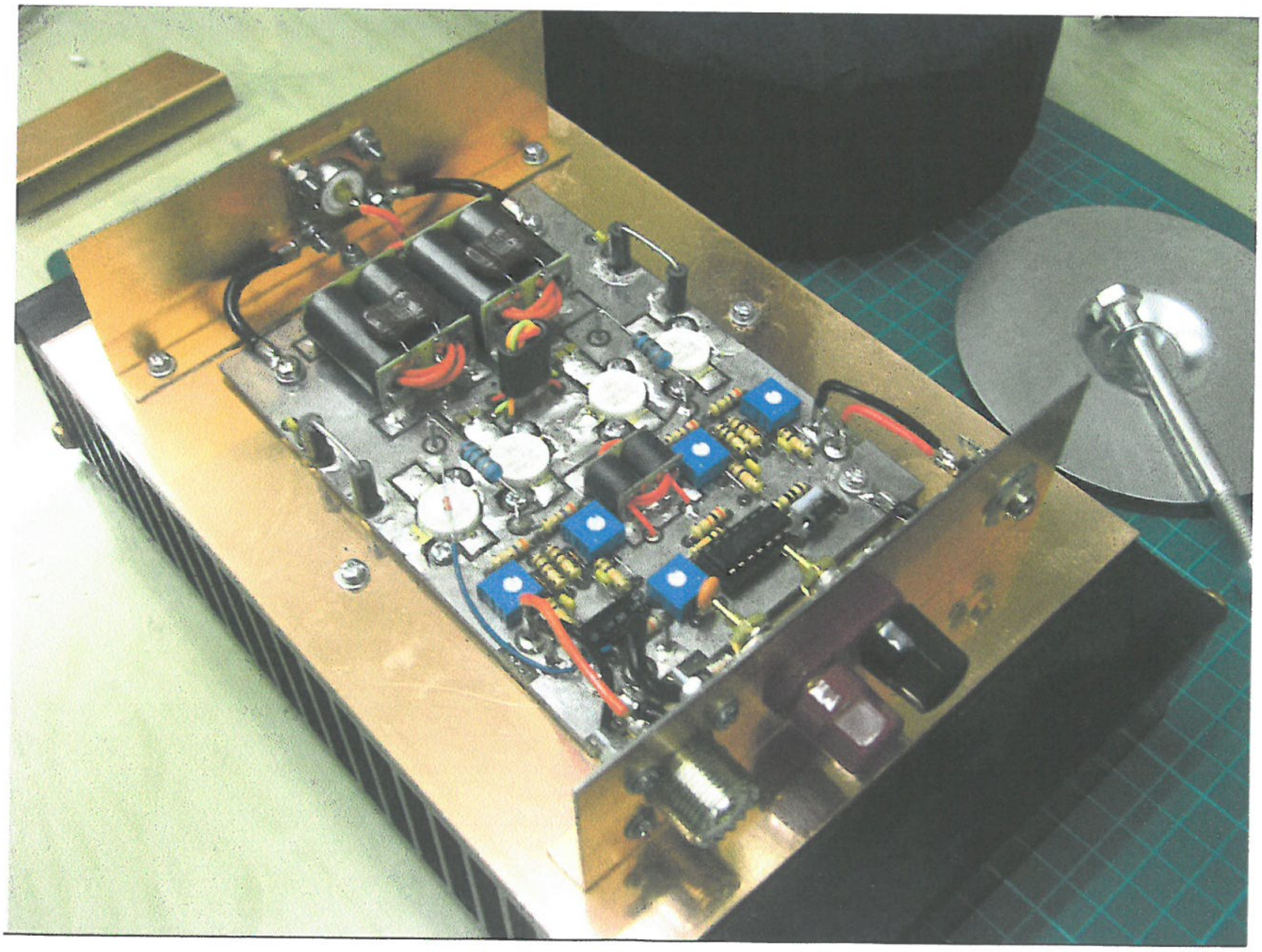


I upped the B+ supply on AM to 630v dc using a mains voltage doubler. The anode current max was around 80mA (max 100mA) so the dc input was about 50w, halve that = 20w in the carrier, 10+w in the sidebands, assuming efficiency is reasonable. The mic circuit capacitors provide good modulation with tight sidebands - a few hundred pF c-b on the ZTX500 clips the higher frequencies if the mic is better quality. You need to tune the anode up a bit quickly or the EL34 will bake bread! The peak AM output is just under the maximum possible with CW. The IRF 510 needs a heat sink - it's a linear regulator and has a few watts to shift.

Valve circuits like this are incredibly tolerant of abuse and "bung anything in" design - the circuits are simple, and to make sure nothing explodes on first power up, I connect B+ via a 40w mains light bulb. They can be very frustrating when they won't go - there's so little to go wrong! It's an old wife's tale that valve TX's blow crystals - just keep the grid/cathode resistor under 270k to keep the crystal's applied voltage down and make certain the cathode choke is a good one!

600 Watt Linear

Dan White and Steve Davies have been busy over the last year building some serious amplifiers! They found some Helge Granburg EB140 amplifiers on the web and set about incorporating them into a fully filtered and controlled multi-band outfit. Sadly Hot Iron is not large enough to be able to do justice to their project and their excellent write-up – if anybody wants to see the full note, I can forward it down the wire. Helge Granburg worked for Motorola for many years and produced several legendary designs of broadband high power semiconductor amplifiers, latterly using Motorola's watty MRF series of MOSFETs. This unit is one of them. The MOSFETs are the four white circular devices across the middle of the board, arranged in a parallel-push pull format; each device having its own preset to adjust its bias current. The challenge with these devices is to arrange the input and output RF transformers so that they overcome the high inter-electrode (not that they are valves!) capacitances. These RF transformers are actually assembled from multiple ferrite toroids on brass tubing to reduce the RF impedance of the primary 'wires'. Producing 600W with a 40v supply implies supply currents in the region of 30A with 50% efficiency – it is probably a bit better than that, but the connections have to be meaty and there is much heat to be dissipated! Dan found that good grounding and heat management was the key to solving most of their technical problems! The heatsink (under the devices) for the main amplifier is actually several times the volume of the amplifier circuit board! The complete unit has multiple inputs and outputs for various input power levels, with extensive switching of many matching indicators and a microprocessor to ensure that any untoward conditions result in immediate shut down! Needless to say, the design has very effective output harmonic filters for each band and extensive PSU arrangements! G3PCJ



From the Pesky Parrett to the Rode & Rudge by Steve Hartley G0FUW

Back in 2010 the Bath Buildathon crew decided to use a 20m version of Tim's Tone receiver for the annual Buildathon in January 2011. The receiver build went really well and everyone ended up with a working 20m superhet receiver. I tried adding a companion transmitter (the Parrett) but having been designed for 80/40m, it did not really have enough 'umph' for 20m and struggled to produce an SSB output above the QRPp level.

Tim did some reworking of the circuit and we managed to get it up to about 1W but the project became known as the 'pesky Parrett' and this radio began to gather dust. Then in issue 84 of Hot Iron I read of Tim's work developing the Rode and the Rudge as replacements for the Tone/Parrett combination. I tried hacking my Parrett to include the Rudge drive/PA circuit and I ended up with a good 3W output and after a weekend of popping on and off the bands I had 12 countries worked with just a city centre dipole; happy days!

Tim then provided the first of the Rode and Rudge kits for us to try. My 40m version went together a treat with a little over 4W output and probably the most stable free-running VFO I have ever built. Dan, M0TGN, built an 80m version of the Rode receiver and Mike, G3VTO, built the 20m version, both reporting good results. It looks like Tim has cracked it with a QRP SSB transceiver for less than £90.

We are using the Rode for the 2015 Bath Buildathon on Saturday 10th of January so there should be many more in use soon. (Get in touch with Steve if any of you wish to partake in his excellent Buildathon guided construction project this coming January – G3PCJ.)

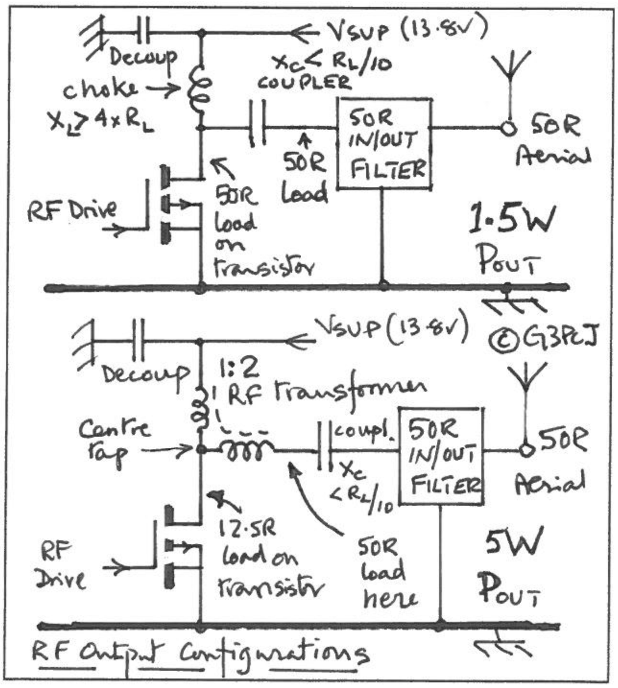
RF Ouput stage power

Often builders ask me if changing the RF output device of some transmitter to a higher power version will increase the RF output. The short answer is that generally it does NOT! It can sometimes make a very small improvement but this is a second order effect, and it can also increase the rig's reliability because the more powerful device will generally run at a slightly lower temperature. The reason that it does NOT materially affect the maximum RF output, is because that is determined primarily by the supply voltage and the load impedance presented to the output device. Steve Hartley, in a comment on some earlier article, reminds me that the power dissipated in a load resistor is given by these three formulas:-

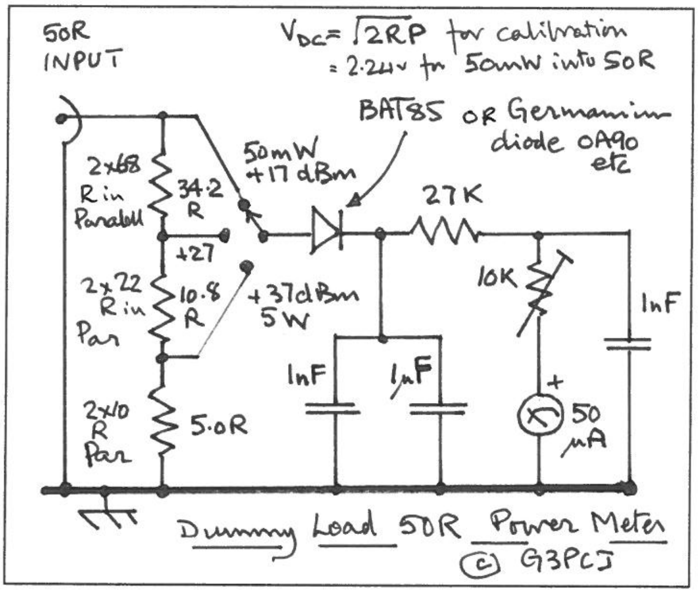
$P = (V_{RMS})^2/R_L = (V_{pk})^2/2R_L = (V_{p\text{-}p})^2/4R_L$ This is because $V_{p\text{-}p} = 2V_p$ and $V_p = \text{Sqrt2} \times V_{RMS}$

For a simple output stage like that shown right, the maximum peak output voltage is equal to the supply voltage and the load impedance is that of the aerial – usually 50R; hence irrespective of the device – bipolar or MOSFET – the maximum output is $(V_{sup})^2/100$; for the common 13.8v supply this comes to about 1.5W every time!!

If you want more out, you have to alter the load (or matching from aerial) to the RF device; the easiest way is to add a 1:2 RF transformer which transforms the load from the aerial to 12.5R presented to the device. Do the maths and this produces 5W as the maximum RF output that the stage can produce! Actual output in both cases is determined by the drive to the device. G3PCJ



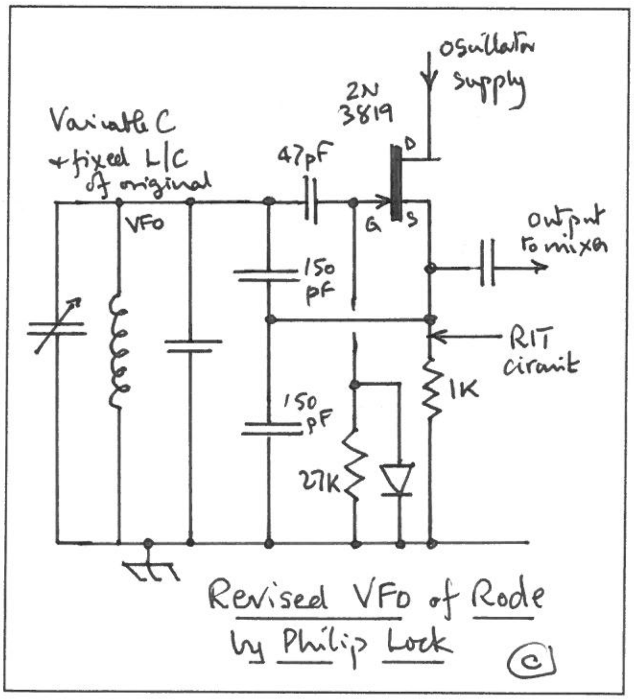
Measuring RF output power



I hardly dare repeat this circuit right since I have put it in Hot Iron before! Its such a simple and convenient circuit that it makes a very easily made and useful piece of test gear. It is a PEAK reading RF voltmeter and 50R dummy load which you calibrate in readings of power – hence it has a square law indication for actual power in milli-Watts which makes it nominally linear in dB terms! It works right down to DC so that it can be calibrated by you with your DC voltmeter! The RF is applied to a 50R attenuator which is arranged for a 0, 10 or 20 dB (power) reduction in the reading. Calibrate it on the most sensitive range with a DC voltage from some adjustable source (that can produce at least 50 mA) when producing 2.24v for full scale; this corresponds to 50 mW or 17 dBm (i.e. +17 dB relative to 1 mW into 50R). Use the maths of the previous note! It can then read up to 5W.

Experience with the Rode

Philip Lock has had an early Rode which he built for 40m – all was well except that he occasionally had a bit of BCI from the adjacent 39m BC band at night. He tried reducing the value of the RF input filter top coupling capacitor from the suggested effective value of 3p4 to 2p2. The values in the kit are compromise of parts for the multiple bands and 40m is often tricky for BCI, so I am not surprised that Philip found that reducing the value to 2p2 did make a small improvement. This helps by reducing the bandwidth of the RF filter, so the out of (desired) band attenuation is higher.

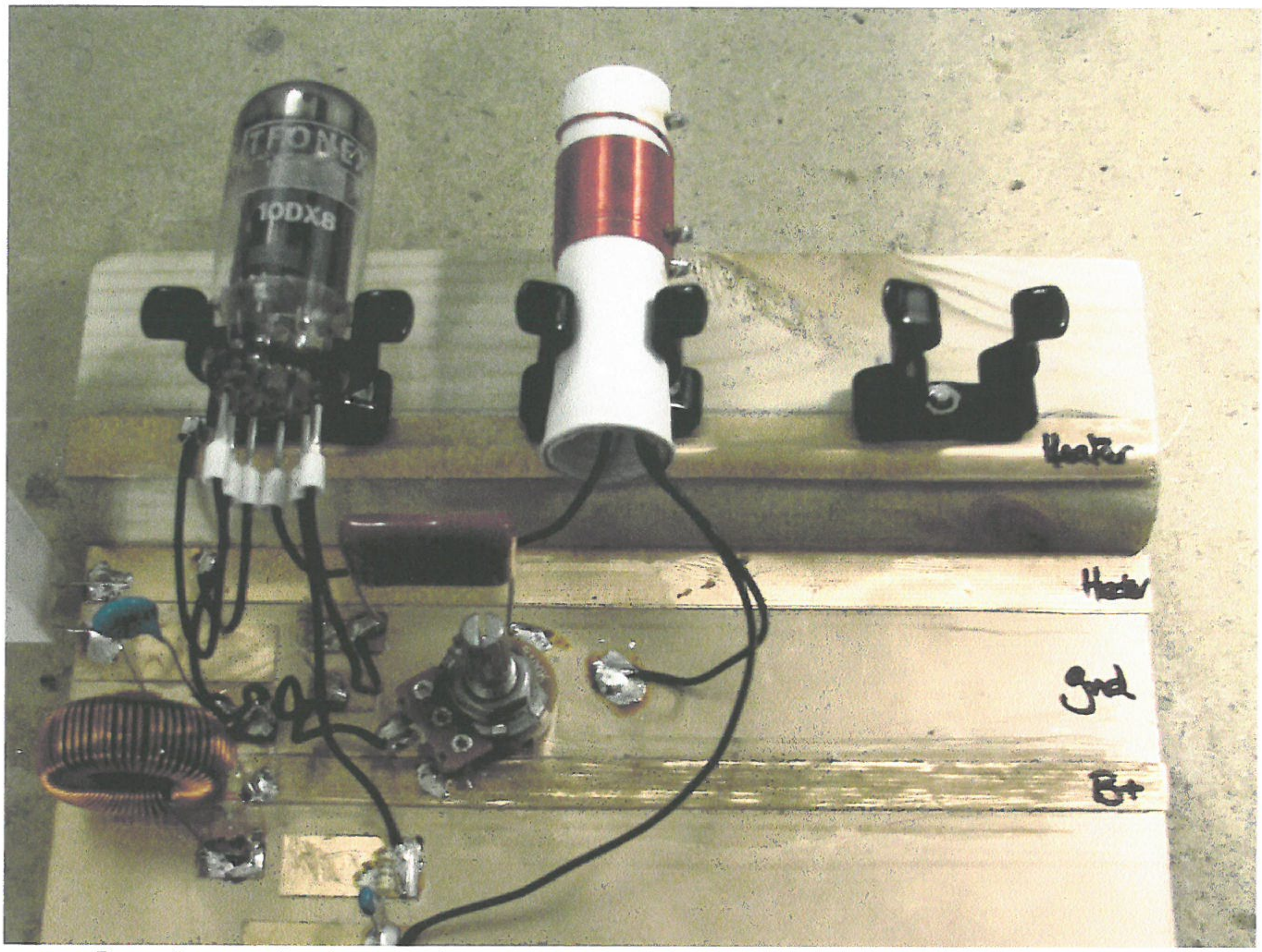


Unfortunately this did not entirely cure the problem! Further investigation led to alterations of the VFO Colpitts capacitor to provide a 'cleaner' output to the first mixer. I sketch right his revised circuit. It has the advantage of reducing the influence of the 2N3819 JFET on the resonant circuit because of the smaller coupling capacitor; he also reduced the JFET gate resistor to reduce the gain of the stage so that it only just oscillated. This cured the BCI!

I don't propose to alter the kit design because it has to work for all its possible bands and hence a wide range of VFO frequencies – I suspect this shows that reducing the LO drive to a 602 mixer also reduces its tendency to be overloaded by BCI. (Steve G0FUW's 40m Rode did not suffer this problem!) G3PCJ

Bread-boarding valve projects

Peter G6GNR sent this photo of some project - it appeals to me for its elegance & originality!



Peter has stuck a length of rectangular softwood near the rear edge of his piece of base copper clad laminate. He has screwed 'Terry' clips to the wood to hold the valve in place with an isolated copper strip under it for the heater supply. The valve overhangs the wood for better cooling! He has also used a Terry clip to hold his inductor in place, which looks as though it is wound on a length of plastic conduit pipe! Connections to the valve pins are by bootlace ferrules crimped onto wires and then slid on the valve pins – the size of ferrule being determined by the size of the pins of your valves. For these B9A valves, he used Rapid Electronics part no 33-1280 ferrules, for octal valves you will need larger ones. Do not worry if you have not got the correct crimping tool – just use the 'wire-cutting jaws' of ordinary pliers squeezed sufficiently to nip but not cut the wire and ferrule in two! Other insulated PCB strips can be used (stuck down) for the main HT supply which is labelled B+ in the photo; smaller isolated off cuts can be used instead of conventional tag boards for the other inter-component connections. As in transistorised bread-boarding, all the earthy connections are soldered directly to the main ground plane on base copper sided plain PCB. One could easily mount a vertical piece of PCB material along one side for the front panel controls – hold it in place with PCB triangular corner braces, soldered to the ground plane and back of the front panel; or use another rectangular piece of wood. Do the wiring tidily and it looks like a professional prototype! (I hope this photo from Peter copies well enough in black and white!) G3PCJ

Snippets

Extremely High Power RF amps You might think 600W peak power is enough but Pete Horrowitz reports in the May QEX on experiments he did with an IGBT AUIRG4045D made by International Rectifier. Its intended for low frequency power control applications in heating systems etc but he found that it had respectable performance on 20m! With 300v on the drain, he observed peak output powers up to 3.35 kW – in short bursts because of lack a large enough heat sink - this is from a D Pak device - about the same size as an ordinary TO220 device!

Paralleling of transformer windings I recall trying to parallel two windings of (apparently) equal voltage from a conventional (E & I laminations) transformer years ago. I got the phasing right by connecting the windings in series then testing the output voltage on no load. One way round = no volts (anti-phase); other way = double volts (in phase), so found the "start" and "finish" of each winding. Then I paralleled them, to get the sum of the winding's current capability, at the voltage of a single winding. BUT.... the transformer got extremely hot on no load. Then somebody explained that just a few mV difference in the winding voltages makes a very high circulating current in the paralleling connection. Modern transformers are (usually, but not always...) bifilar wound so similar windings have virtually identical outputs, so CAN be paralleled; but it always pays to check first by making the correct parallel connection then powering up the primary via a series 20W light bulb and give it a soak test. Any problems and the light bulb limits the current and no damage done. Toroidal transformer windings of equal voltage ratings are perfectly ok to parallel, because of the bifilar winding from the split ring shuttle winding method. G6GNR

Sprat DVD Graham Firth G3MFJ of the GQRP Club has kindly sent along their latest CD which contains all the issues 1 to 160 on it. It is an excellent reference work as Sprat is always full of fascinating ideas and circuits etc. All members of my Construction Club should have this - if you are not already a member of the GQRP Club you should be - its incredibly good value for money! Contact Graham, who looks after their Store at g3mfj@gqrp.com

Contactless Wireless Charging Linear Technology is developing a charger that does not require any complex information feedback path across the gap between transmitter and receiver even when the receiving device has been fully topped up, so they are much simpler devices. As is usual, such chargers depend on resonant loops for both transmitter and receiver with power being transmitted by inductive coupling, in this case at 120 KHz. The new scheme has a transmitter with just sufficient power for the worst case gap and power/time allowed for charging. The clever bit is how to prevent overcharging! This device does this by automatically de-tuning the receiving loop, hence receiving less power, when the job is done!

Happy Christmas

and all the best for

the New Year! Tim