“JOURNAL OF THE CONSTRUCTORS CLUB”

Hot Iron

Summer 2018 Issue E100

Editorial – all change!

This is the hundredth issue of Hot Iron and its time for me to stop electronic waffling! A lot has happened in those 25 years and the nature of our hobby has changed a great deal. Perhaps more than anything is the massive invasion of digital techniques into what is actually an analogue world! I have sounded off on this topic before and it is quite obvious now that the larger projects (due to lots of facilities or many operating bands etc) will have digital signal processing at their core. This is a whole new ball or technical game which, for various reasons, I am not able to ‘play’ – certainly not just at this moment – due to house moves and changes in the way we run the farm with our son. Over this last 25 years I have had fantastic support from a very large number of people – technical contributors, publishers and others who have waved their flags publicising this journal; we would not be here now without their generous help and for that I want to say a very big THANK YOU to all of you and them. Some of you have very kindly put up with my arm twisting and your articles lend a most important variety into what can be pretty dense prose! And of course, I must also thank you the readers. Inevitably, it is only a few who actively contribute to any journal, but the mass of readers must also be broadly happy with this sort of rambling, otherwise you would all have asked to be removed from the list! So thank you to all readers as well!

But Hot Iron should definitely not cease! Many of you will have seen regular contributions from Peter Thornton G6NGR who has kindly agreed to take on the role of putting Hot Iron together in future. Decades ago Peter and I both worked for different branches a UK firm that was at the forefront of all sorts of electronic applications – sadly it suffered a financial disaster and no longer exists – but he brings a vigorous alternative view about the technology of the future! Later in this issue he outlines his plans for Hot Iron and you may expect several of our regular authors to continue their offerings; I am not stopping production of radio kits so I will continue to write on my favourite themes for Peter from time to time!

To avoid you all having to re-register your desire to continue receiving Hot Iron, I have passed the distribution lists to Peter Thornton G6NGR on the basis that you are all happy to continue getting it and with ample opportunity to say otherwise earlier. He will be keeping all the data very securely in line with the new EU regulations. If any of you are unhappy with this and do wish to stop any further issues, please e mail either me electronics@walfords.net or Peter equieng@gmail.com and say unsubscribe! Peter has outlined his background and intentions for the future later in this issue. So a big thank you from the first Editor of Hot Iron and I now pass you into the capable hands of the second Editor! Tim G3PCJ

Contents

Hot Iron is published by Tim Walford G3PCJ of Walford Electronics Ltd. for members of the Construction Club. It is a quarterly newsletter, sent by e mail, & free to those who want it. Anybody wishing to receive Hot Iron in future should ask Peter Thornton equieng@gmail.com to add you to his list.

Peter's background and his intentions for Hot Iron!

Tim and I worked for a national electronic, electrical, power distribution and instrumentation company for some years; Tim in digital and analogue design and me in semiconductor manufacturing. As a Technician / Graduate Apprentice I was involved with Research and Development of light emitting diodes, in the late 1960's and early 1970's, building and testing equipment designed by PhD physicists working on sub nano-second pulse gallium arsenide laser LED's and gallium phosphide Shottky barrier LED's.

This brought me into sub-nano second design, which, of course, is the foundation of RF engineering, and the realms of people like Ivor Catt, who propounded radically different principles than Maxwell's equations predicted: this "sideways" R&D view of electrical phenomena has stuck with me all my life. We had superb professional RF engineers working on silicon power RF transistors for Military purposes, who taught me a great deal about RF methods, measurements and test, and Production Department who manufactured devices in quantity. I became a familiar sight around the plant, and soon found a source of unique knowledge in the Maintenance Department: for all-round electronics experience and knowledge, you'll not beat a Maintenance Department!

I was soon applying my newly gained knowledge of RF to high power RF power generators, used in silicon epitaxy (the growing of nano metre single crystal silicon layers). These RF generators fed 500kW of RF to water cooled work coils, mounted beneath a graphite "susceptor" to heat it up – fast. Fast, as from room temperature to 1250°C in less than 5 minutes! The process ran in a hydrogen atmosphere – any air leaks and the process is a bomb! I had already handled cathode ray tubes and their EHT power supplies – safely working with 200kV / 10mA DC supplies every day brings about a steady hand and mind when repairing their Test Gear!

My working with RF soon had plenty of radio amateurs from the plant calling round, as we had esoteric bits like 4CX250B valves (and bases!) by the bucketfull – when the RF output dropped, we changed them out, but they were perfectly adequate for amateur service. We had dozens of vacuum variable capacitors, co-ax by the mile, all sorts of highly prized amateur components as it was very much a "build it yourself" age – commercial equipment was available but very expensive and un-fixable to a great extent – so we built our own in the main.

As Tim mentioned, the Company ran aground financially for various reasons ("lions led by donkeys in my opinion") so I became self employed and worked in any and every opportunity for power electronics, electrical engineering and instrumentation – telecomms in mines, renal dialysis monitors, opto-electronic bottle inspection machines in breweries, to name but a few jobs I was involved with – and loved the working life all over the World, meeting people, different cultures and methods of working.

So that's my background: build it, test it, use it, fix it when it goes "bang" - if it's 12 volts or 12 kilovolts, 20kHz or 20GHz, fA to kA. Modern DDS and associated programming I find personally quite do-able; though I'm no software designer, but I know software designers who have offered to help Hot Iron readers. Similarly, several world class RF designers are willing to publish their ideas in Hot Iron.

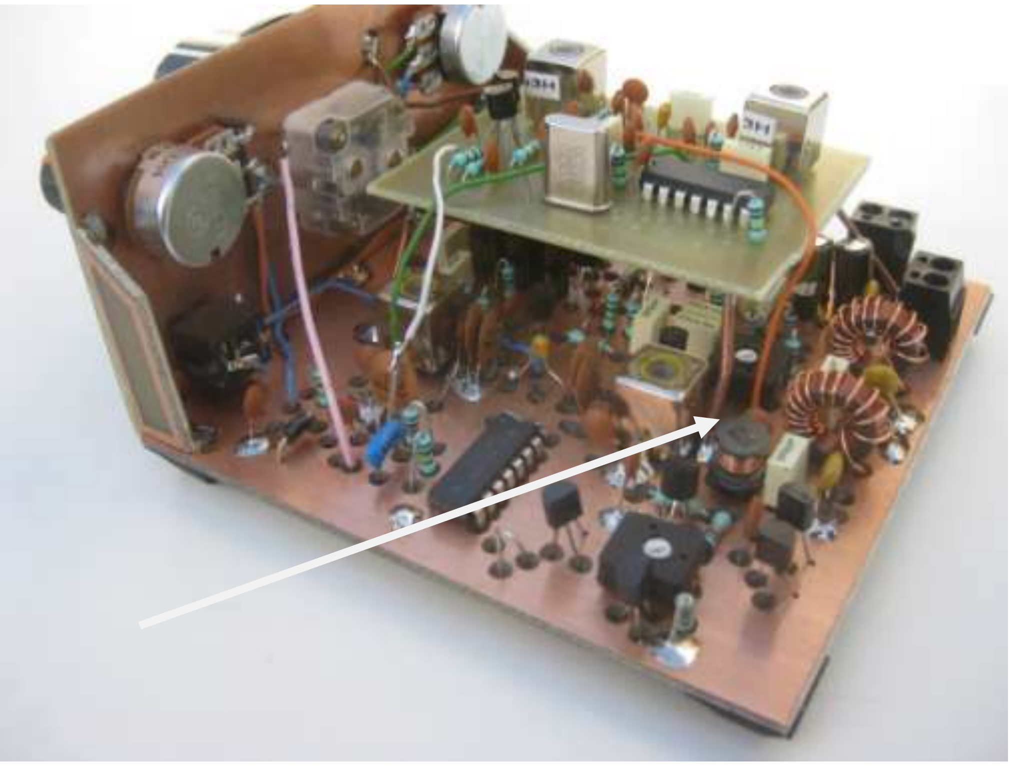
Tim, of course, has a permanent place in Hot Iron. "Tim's Topics" is a regular spot for Tim to keep us up to date with his superb and elegant analogue designs, and his comments on the World of Amateur Radio. I want to keep Hot Iron very much in Tim's mould, "home construction" being the key with "best out of the least" as a guiding principle. Hot Iron has a World-wide readership, and the different "flavour" of Amateur Radio is very much appreciated by all it's readers and offers refreshing alternative views. Please continue to enjoy Hot iron; I welcome any and all comments and ideas. Keep them coming. Hot Iron exists to make amateur radio home construction open to anyone, whatever technical, financial and workshop capabilities.

Hot Iron is for it's readers: feedback, ideas, suggestions are most welcome. Direct them to me please, at equieng@gmail.com on any and every topic relevant to amateur radio. The new EEC directives about data security apply to Hot Iron and in future I will be keeping your e mail addresses suitably securely. I will assume, since you have not asked to be removed from the list that you wish to continue receiving Hot Iron. If you do not want any more Hot Irons, please send a mail to Tim electronics@walfords.net or me Peter equieng@gmail.com saying 'unsubscribe'.

Peter Thornton G6NGR.

Kit Developments

The Culm After the unfortunate PCB layout error that I mentioned last time, it was clear that I had to revise the track pattern quite extensively! This was more annoying than difficult and I am pleased to report there were no further problems! It is working well and being given a through exercise by Geoff G3WZP who writes later about his direction finding experiments for school kids. The basic rig uses a ceramic resonator for 80m, or a crystal on the higher bands, which leads to a very restricted tuning range due to the inability to pull a crystal more than a few KHz owing to their very high Q. There is not a lot you can do about this because ceramic resonators are a bit prone to change their resonant frequency with temperature variations – over about 5 MHz this effect is too bad even if you can find a standard resonator in a suitable part of any band!

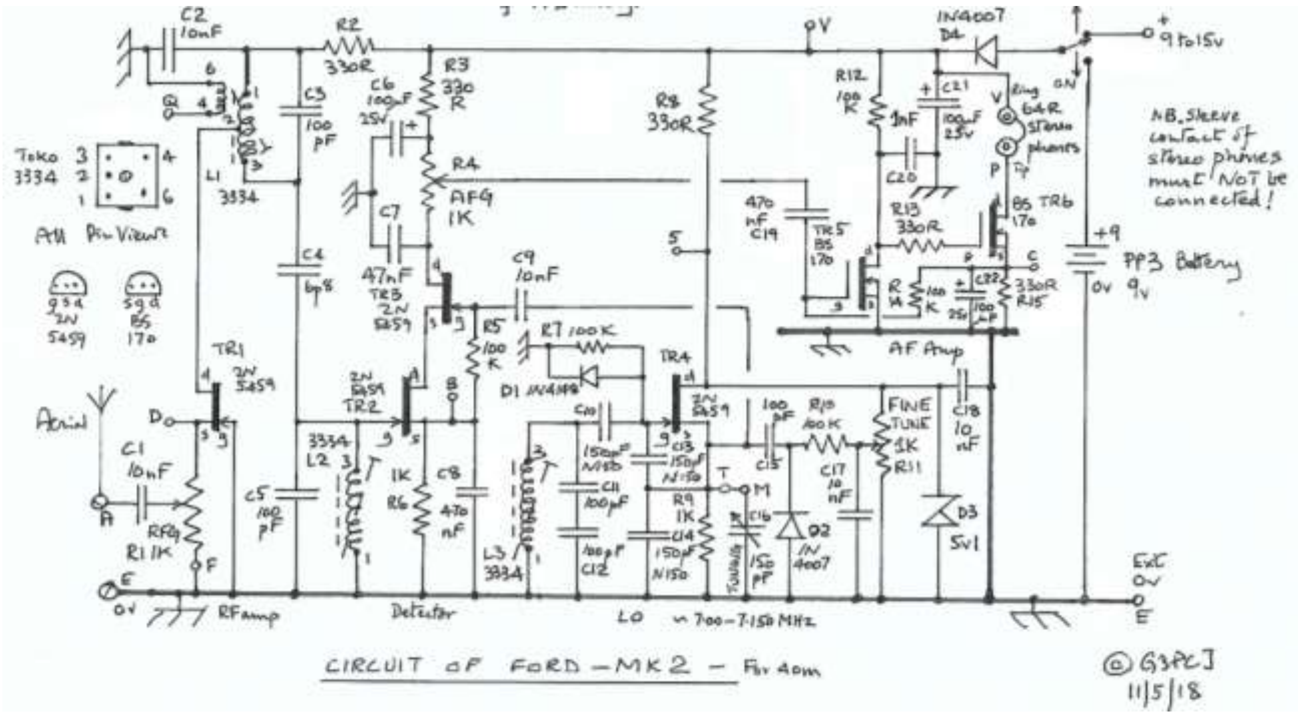


So more head scratching! Crystal mixing using the Mini Mix kit with a conventional VFO is the obvious answer but that would require changing the Culm's oscillator to a LC oscillator and would need quite a lot of track alterations. Instead, fitting a 4 MHz (or 2 MHz) ceramic resonator to the original circuit and then mixing this with a suitable band crystal is a simpler approach. This requires less parts hence the smaller Digi-mix kit which is shown mounted piggy back on the four copper stout wire supports (one arrowed)! The frequency schemes for these higher bands are shown below. G3PCJ

Band	Centre Freq KHz	Variable Oscillator KHz – ceramic resonator	Crystal Oscillator KHz
20m	14060	3940	18000
30m	10120	3940	14060
40m	7030	3970	11000
40m	7030	1970	9000
60m	5262	1986	3276
80m	3560	1940	5500
80m	3560	5440 (LC VFO maybe!)	9000

The Ford – Mk 2

Steve Hartley G0FUV has been in touch, as he has been considering using the very simple Ford for a 40m Buildathon project this summer. It made me try the rig again rather more thoroughly with a view to a reproducible production model. It soon became clear that some improvements would add little to cost while much improving performance! The audio stages were fine and catering for output to modern lightweight 32R phones is much easier than driving a loud speaker which is not as readily available as phones are nowadays – so no changes there! But at night the simplicity of the mixer showed its weakness to the nearby 40m high power AM broadcast stations.



A change to series connected JFETs product detector (simulating a dual gate MOSFET), with a double tuned RF filter instead of single tuned and an RF gain control, much improved its ability to eliminate the BCI! But it was still full of microphony and prone to hum when the aerial was connected! This all points towards unwanted radiation of the Local Oscillator signal which then beats with itself in the product detector and makes the whole RX very tender! The cure is very simple – add an RF amplifier which does not pass the LO signal from the mixer back through it to the aerial and these troubles then disappear! The extra stage can easily be another JFET and the improvement is huge. It was also convenient to change the oscillator to a Colpitts circuit and with coverage of the whole band desired, a Fine tune control becomes necessary. Frequency stability against supply variations then suggest an internal Zener supply is needed! After these modifications the RX is no longer a toy but is capable of some serious listening! Free space wired version right – Pete N6QW calls it ugly construction! I have now laid it out on a single sided PCB with plenty of space etc. Revised circuit above! G3PCJ. Photo by G0FUV.

A New Tool in the Tool Kit!

Pete Juliano n6qwham@gmail.com

For those who perhaps have seen my websites or my blog, you are probably thinking that I now have some new Arduino based “Tool” that completely functionally tests a homebrew transceiver. Sorry to disappoint you but it is not that tool. That said—I am thinking about such a device; but mind you we are just thinking at this point.

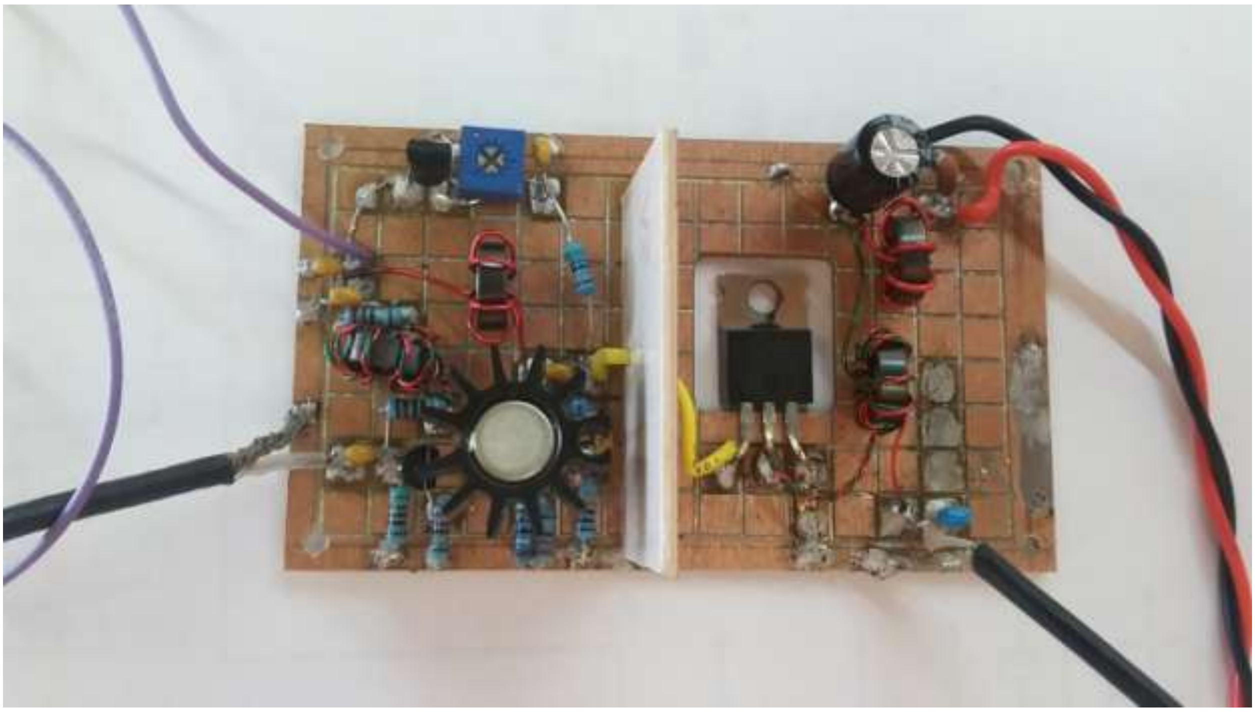
My tool is more fundamental as it involves the making of PC boards using a CNC Milling machine. Remembering back to when I first started homebrewing, one of the most critical skills was metal bashing. Often virtually all of the project time was consumed metal beating and filing out round and square holes. A problem with this approach was that if anything changed –more metal bashing and many more holes in the chassis. With the advent of solid state devices and their widespread use – putting large holes in a metal chassis was like the wearing of brown shoes with a black formal tuxedo.

Enter the era of Manhattan construction and its first cousin "ugly construction". Manhattan for those who may not know is the use of small copper squares that are super glued on to a piece of copper PC Board. Using these isolated pads provided convenient soldering points for connecting wires and components. The term Manhattan reflected that often components would rise from the pads like skyscrapers much like the New York (Manhattan) skyline. Ugly construction just tack solders anything, anywhere. Often 20 Meg Ohm resistors are vertically soldered to the board and provide the anchoring points as not very much of a signal passes through 20 M Ohm.

There are some advantages to both these types of construction and chief among these is rapid prototyping as you just tack solder here and tack solder there and move right along. But there are some issues as well with these methods.

- Circuit interaction –in the haste to "get er done" there are issues of possible feedback paths with the close proximity of components and wiring. Layout is critical but often neglected.
- There are many opportunities for shorts and solder bridges as the random process of ugly construction simple takes the shortest path. Mind you I have seen some very sanitary ugly construction builds that rival a PC board. Then again there are some plain "ugly ones"!
- Circuit tracing becomes problematic especially when "get er done" doesn't "get er to work"
- Repeatability –suppose you want to build an exact second unit?

Enter the modern era table top CNC Milling Machine. Machines capable of building circuit boards such as shown next can be found in the $200 to $300 range.



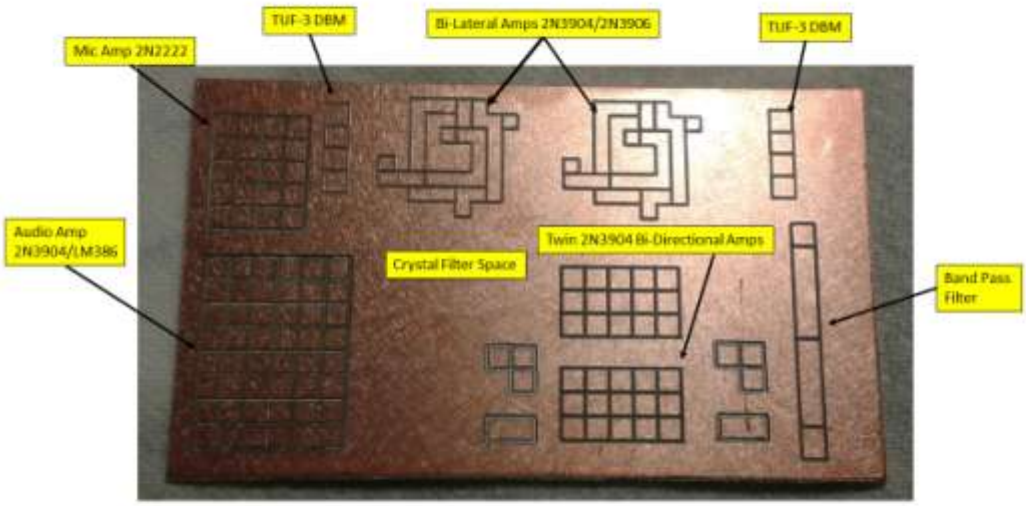
Linear Amp Board for one of my SSB Transceivers.

This linear amp board has the 2N3904 driving a 2N3866 (from EMRFD) and the second half has an IRF510 final amp.

Essentially the outside of the board area is like a picture frame which when bolted to the chassis is a common ground. Using the CNC, I milled out the area where the IRF510 (with a suitable insulator) is bolted to the back of the case where the case becomes the heat sink. The squares are 0.2 inch and thus the board is less than 2 inches wide.

The squares give you the flexibility to make changes without any metal bashing. A piece of PC Board vertically soldered to the board and then grounded to the window frame provides a shielding between sections. The Bias Circuitry for the IRF510 is in the upper left hand corner of the board. Originally I had the LPF on this board (lower right hand corner) but decided to locate it at the antenna terminal so that the LPF would always be in line for both transmit and receive.

One might think of this as an Uptown Manhattan as the squares are cut with a CNC Milling machine and can be any size of an array (4X4 or maybe 6X8 or a complete board). I have these stock arrays in the computer and thus can choose to have a small array at one location on the board interspersed with larger arrays such as shown below.



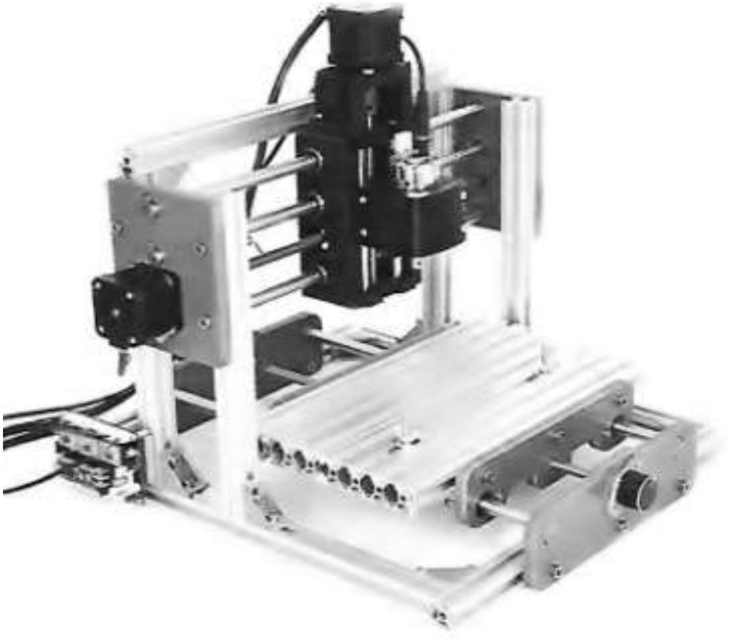
SSB XCVR Main Board ~ 2.5 X 4.5 Inches

N6QW 7/2015

I used my CNC to build my KWM-4 (a solid state version of a Collins KWM-2), as the machine can build more than just circuit boards. The front panel "Collins Look Alike" Escutcheon was made using the CNC Mill and it is important to note that I have just basic skills with the machine and thus if I can do it you can do it! Yes that was a piece of copper PC Board! You have to admit it does look like the Collins gear.

So what does it take to get started using the CNC Mill for your project? There are but a few minimum requirements to start making CNC Milled boards in your lab/shack.

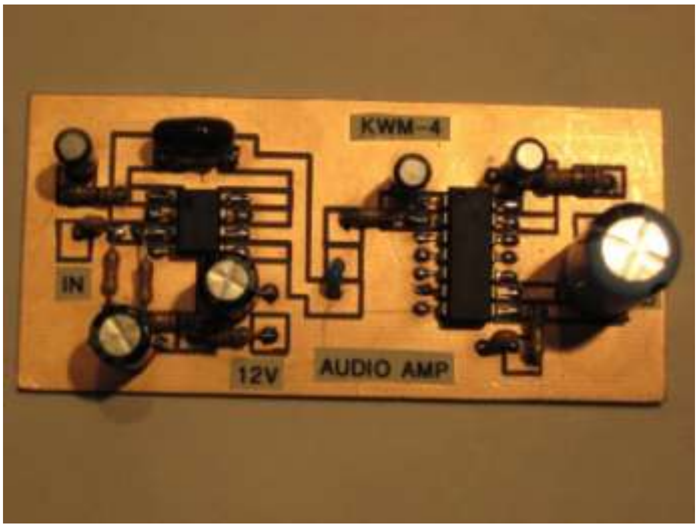
- The first piece is the CNC machine itself. These are sold on eBay and other auction sites and are advertised as CNC Engraving and/or table top milling machines. The low end machines are in the $200 to $300 range; but the most critical item is the work surface area. Look for ones that have a work area of 100 mm by 150 mm. For guys like me, on this side of the pond, that is about 4 X 6 inches. You will likely need to fabricate some hold down clamps which typically fit in the slotted sections of the mill bed. Holding the part secure is paramount to the successful board construction. Don't forget to anchor the mill to your work bench. The machine will move when it is cranking away cutting material, a scary observation indeed! For cutting PC Board I use a 60 degree engraving bit. For other cutting (like milling out the IRF510 hole) I use a four flute 1/16 inch end mill.



This is a typical example of one of the CNC Mills that can be had in the low dollar range. The bed has two posts with wing nuts so that the board can be held in place during the milling. Most of the machines can be used with computers running XP through Windows 10 and some even Linux.

- Next is the design software. I use a free program called G Simple which is not a PC Board specific program. My boards are usually the "island squares" as I can easily call up a rectangle and I know that IC's have 1/10 inch spacing on the pins. You can get pretty good at doing this with nothing more than squares and straight lines. A secret revealed: I use ¼ inch graph paper to first layout the circuit that starts first by drawing an XY axis on the graph paper and then where each square or line is placed, the coordinate of that square or line is noted. I call each square 1/10 inch—keeps it simple. Transferring that into G Simple is a simple matter of using the graph paper coordinates as the input coordinate for G Simple. The output of the completed design is called a .dxf file. This file is the subsequently loaded into another free program called KCAM. This step is need to translate the .dxf file into "G Code". The G Code is what tells the CNC where to cut. There are some other actions taking place in the background where the G Code actually sequences the cuts for the most efficient use of the machine. It is really weird to watch the CNC start cutting at one location and then move to another place and then later on to back where it started – it is all about efficiency. Bottom line –you design it in G Simple and then the "ghost in the machine" takes over from there. There are other design programs which are PC Board Specific and have templates for IC's and transistors. That is too complex for my old and tired brain.

Here is a board design that started with the graph paper and then a cut board. The photo shows the board stuffed with parts. Keep in mind the short comings expressed earlier. I can trace this circuit and have minimized short circuits!



This board is in my computer so when I want another audio amp module I call up the program and cut away. A little labeling makes it look quite professional. This is an LM380 audio amp that uses an NE5534 as a pre-amp stage. I have a similar layout that uses a 2N3904 in place of the NE5534.

- Finally the computer can be almost anything and that might be a good use for that old 300 MHz laptop that is kicking around the junk box. In the case of the new machines that are being sold the actual cutting software comes with the machine so you get a bonus with the purchase. In my case my son built me the machine (it is a little uptown from the eBay ones) and it uses Mach III for the milling software but is running on a windows XP machine.

There is a learning curve here so start really simple with small arrays and as a suggestion go to a tile store that sells vinyl tile squares. Often the store will give you a free stack of obsolete tiles. Tiles make wonderful practice pieces. Often I will test run a design and if all looks good I will then load a piece of PC Board and fire away.

Hopefully this has sparked your interest in CNC Milling your next project.

73's

Pete N6QW

The Culm and Direction Finding

As a volunteer with the Royals Signals Museum visiting schools to talk and demonstrate equipment and seeing how the youngsters like "hands on" exhibits, I suggested that a small transmitter hidden in school grounds and located by DF would show how easy (!) it was to locate SOE radio operators in Occupied Europe by the German authorities …particularly as the exhibition features the short life of the mainly female wireless operators during World War 2. At one stage I looked at getting the Museum's "SOE SPY SET" operational but there was a reluctance to tamper with this set and young students near HT voltages was not deemed acceptable. (Too much paperwork if we electrocuted a student or a teacher!)

Looking around for a reasonably priced and straightforward way to achieve our aim, I contacted Tim and he suggested an ISLE TX and a YEO RX to proof the concept ….and so I ordered a kit of each and waited by the front door for the kits to arrive. To my astonishment there was no sign of an aluminium chassis, International Octal or B9A valve holders just a number of small packets of components and comprehensive instructions. Well after checking out these mysterious looking components out came the 40W pencil bit soldering iron with the 200 Watt soldering iron consigned to the cupboard and the kit building began …(bearing in mind I am a valve man and own an AR88 , BC348 and Sommerkamp valve TX/RX).

Initially I would prove the concept on 3.5MHz before utilising a dedicated freq in the MOD/ Cadet Force allocation in the 4 - 6 MHz (yet to be confirmed). Well the YEO was straightforward apart from my poor eyesight mistaking a Zener for an IN4148 all worked well with plenty of European stations being heard in the early evening. On to the ISLE which again was straightforward except my ignoring some of the "test as you go" stages in Tim's instructions which meant I had to backtrack a couple of times but soon it produced 1W or so of RF on 80mtrs.

Next was a quick DF loop made from 14mm Copper tube and 7 turns of wire tuned with a POLYVARICON variable and a 1 turn tap to the YEO RX. Despite the measured loop inductance I couldn't get it to tune (Probably excess inter-turn capacitance – G3PCJ), so a bit of empirical design work resulted in 5 turns which peaked mid tuning range with variable cap. To increase the amount of signal being received a second loop was made with a 22mm copper tube and a larger loop diameter (right) so this time 4 turns were resonated with the variable capacitor tuning mid range and a separate 1 turn loop to feed the RX. Note - the outer copper pipe loop is a shield which does not form part of the resonant circuit. The results were very good and sharp nulls could be obtained some half a mile away with the ISLE TX feeding a 30 feet wire without any matching and running at 9v input.

So far so good BUT the design parameters from the Museum changed - would it be a good idea to have a remote team hidden sending CW messages to a team based in the school with both being DF ed?

So back to Tim with yet another E mail and he quickly came up with CULM transceiver combining the two on one PCB and after a quick design and prototype build by Tim, which worked well, I ordered 4 CULM and waited the arrival of the new kits. Tim also designed the DIGIMIX simple mixing kit to achieve a wider tuning range on 7MHz.

Well I had learnt my lesson and built the CULM with every stage being tested as per Tim's instructions and soon had the RX receiving CW on 80mtrs in the early evening with my fairly low, end fed wire connected. The TX section quickly followed and yes there it was lots of RF output on 80mtrs with a nice clean keying action. So what about contacts asked Tim? Well a quick change of taps on my lashed together ATU (note to self tidy it up!!) and I managed to get the SWR down to 1.2:1 and RF seemed to be getting into the aerial and not coming back so called F6FAI without too much hope of a reply and yes - you've guessed it a QSO resulted with a creditable report of 559 from Brittany ….haven't been that excited since my first QSO with a CO – PA TX (6C4 and 6CH6) with a 3.55MHz 10XJ Crystal and a R1155 RX back in November 1967!

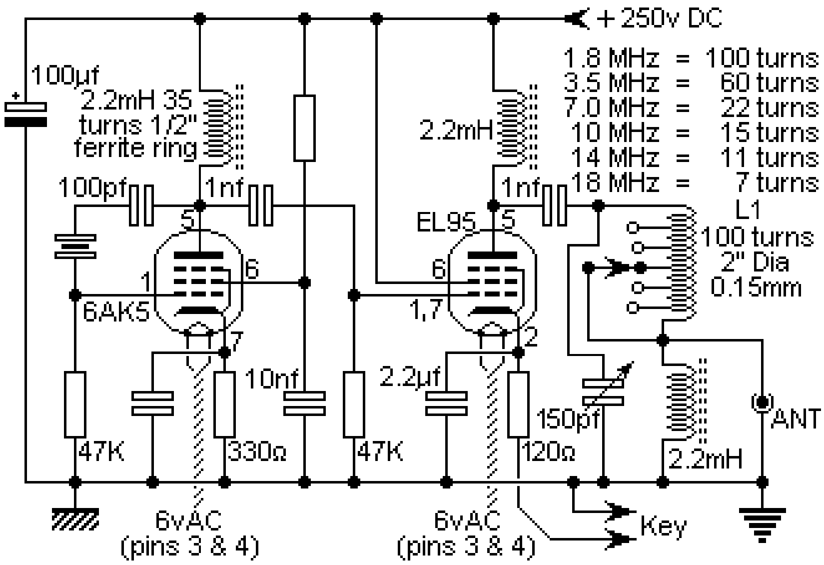
Casting around for a suitable housing, my love of tea drew me to the kitchen for a quick cuppa and I realized a YORKSHIRE TEA TIN was just the right size! A classic dilemma …which would prevail - my love of tea or the need for an enclosure? Well this is where the staff at YORKSHIRE TEA came to my rescue and after an E mail detailing the project, a parcel arrived with 4 tins inside ….. see picture below for the prototype unit now fully operational and just as important the XYL still has a container for the Tea !

Next stage of the project is a demonstration for the Museum Staff and construction of 3 more CULMs with one for personal use on 40mtrs with /P operation to hopefully escape my high urban noise level.

Coming soon … the next installment on the conversion of a G3 valve man to the new fangled semi-conductors ! Geoff Budden G3WZP

Back to the Future? ***A new look at old ideas – Pt 1 - The TX***

Below is a typical circuit diagram for an amateur radio transmitter of 60 years ago (from http://www.sm0vpo.com). Whilst it is "old tech", it's a good reference for an easy project that can be built on the kitchen table. It is fair comment to say that valve days are past for most of us, but stick with me – there are beautiful features you won't find in modern designs using a +12v power supply.



Let's take a look at the circuit: the 6AK5 device is a small signal pentode ideally suited to the oscillator section of this design. If you think of the 6AK5 as a "JFET", you'll recognise a Pierce oscillator, the crystal feeding back from anode to control grid ("drain" to "gate" in JFET terms).

The signal from the oscillator (which runs continuously) is coupled into the control grid of the EL95, an audio pentode, to be amplified to the final output level of typically 5 – 10 watts depending on the frequency. The output power is developed across the 2.2 mH anode choke and fed to the tapped coil and 150pF tank circuit via a 1nF (high voltage ceramic) capacitor. The taps are for impedance matching and the lower 2.2mH choke is for DC safety: if the 1nF anode capacitor fails short circuit, the lower 2.2mH Radio Frequency Choke shorts the anode power supply to ground and blows the fuse, so the antenna never has DC present.

The first thing to note is the frequency range this transmitter covers *without any change of components*. The second is that the output can be *connected to any antenna*. The third is the overall *component count*: it's very low for the power output. Fourth is the Radio Frequency Chokes are non critical; they are simple home-made devices, because the RF power is developed at *high impedances*.

The items above *in italics* are the key: this design is radically different than a typical 12 volt supply transistor or MOSFET design as regards impedance levels. A transistor design for this power, running off a +12 volt supply, would have to have (at least) a 1:4 ratio transformer coupling the collector/drain for impedance matching to 50 ohms: the collector/drain impedance would be estimated from (Supply Voltage)^2 divided by (4 x Power Output) in watts (for class A operation). Therefore for 12 volt supplies, and an output power of 5 watts, the collector impedance is ~ 7.2 ohms! For class C operation, it's roughly double that; 15.2 ohms!

Calculating the value for the valve circuit above, the anode impedance is 4500 ohms for class A operation, and 9000 ohms for class C; a huge difference that simplifies the design parameters, matching and eliminates "lossy" high current components (losses are proportional to i^2R) - and most likely of frequency critical construction. Antenna matching in high-Z circuits is very simple; coil taps or an over-wound link of a couple of turns over the tank inductor can be used. You can't get simplicity with effective harmonic reduction with a 12v supply is a fundamental truth.

There is, of course, a price to pay for simplicity: it's a high voltage anode supply that is (usually) neither portable nor convenient – and not thought safe! To sum up the problems in today's terms:

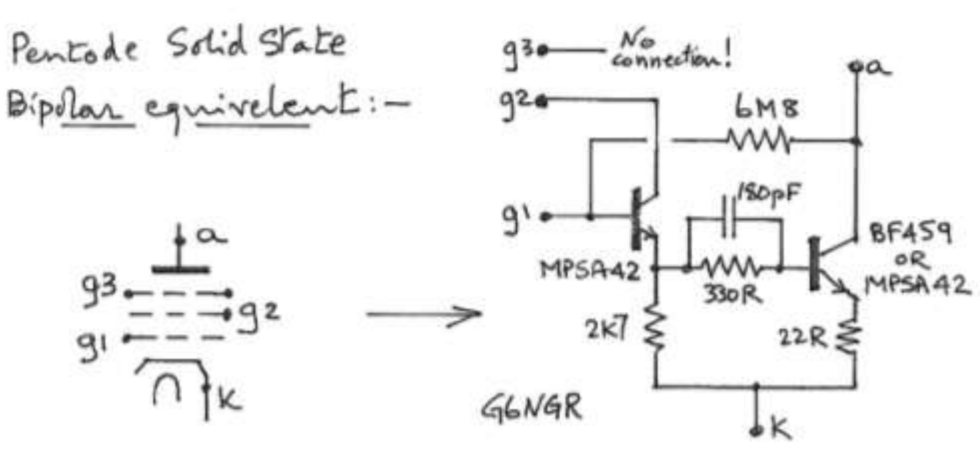
- a high voltage power supply is required
- valve heaters that consume many watts of power
- valves are hot, large and fragile
- are becoming hard (or expensive) to find/buy/scrounge

How to overcome these problems and bring the design, with all its plus points, up to date? A modern design has to be portable and rugged, low volume and weight, and efficient in power terms. The answer is a dose of solid-state!

There are designs for solid state replacements for valves; they were created in the 1960's to replace the fast disappearing valves as transistors began to seize the market, being both cheaper and easier to use than valves, considerably smaller and more robust, too. The transistors then couldn't give high voltage with high frequency capability; but improved modern transistors fit the bill nicely for a "solid state valve".

The need for high voltage supplies is the price to be paid for simplicity. This isn't as serious as it seems: valves don't need more than a few tens of milliamps (for 10 watts RF or so), the design of a power supply is non-critical – it can be a low noise design with an off-the-shelf toroidal transformer (= low cost). That then is the proposal: the problems outlined can be beaten with solid state technology, making the simple "valve" circuits a real contender for rugged, reliable, portable equipment.

The circuit detailed below is designed to "plug into" the valve circuit above, as substitutes for the 6AK5 and the EL95 pentodes.

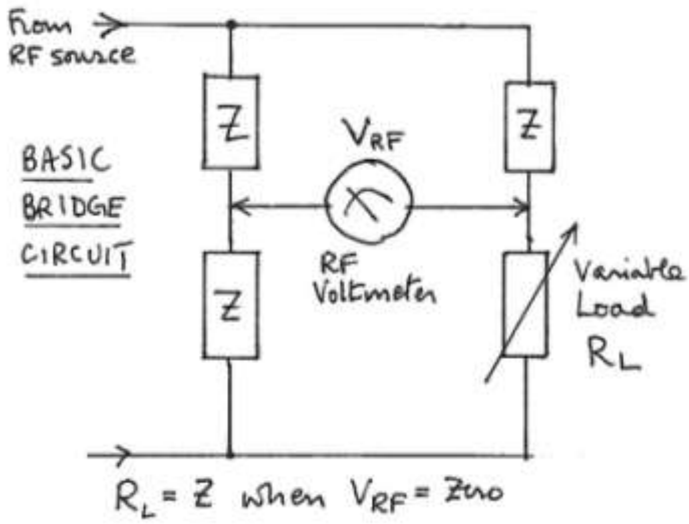


For the oscillator, you can use two MPSA42's, as the stage is low power because the cathode resistor limits the cathode DC current. Try BD129 or BD159 (or similar NPN 350v / 500mA high speed devices) as substitute the BF459 if needs be, all of which require adequate heat sinking. The "g2" voltage must not exceed 300v, to avoid damaging the MPSA42.

For HT rails above 300v, fit a dropper resistor to reduce the MPSA42 "g2" voltage below 300v, and decouple with a 10nF HV ceramic to ground; the BD129/159 will need replacing with a higher voltage device, TV line output transistors such as the BU508 and the super-alpha BU806 would make some very hefty power outputs possible. Peter Thornton G6NGR

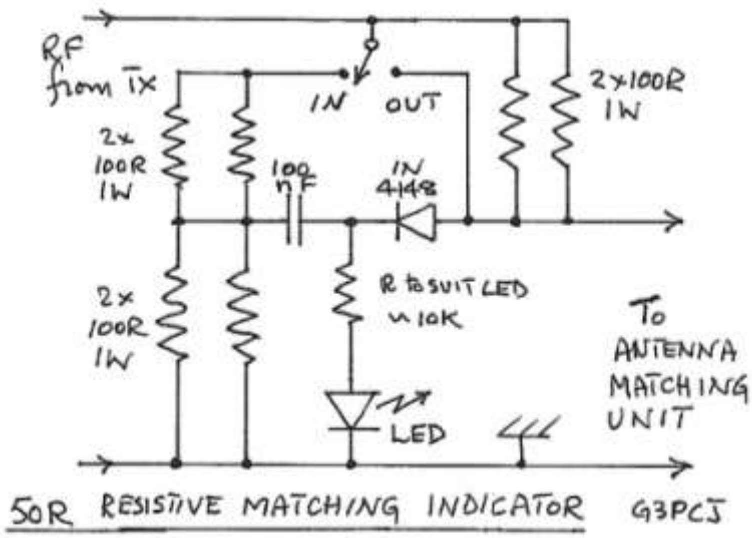
The Resistive Matching Bridge

The ideas behind this circuit are ancient and I do not claim any credit for them, but it is most useful, especially when your transmitter runs only a few Watts of RF output power. The purpose is to protect your transmitter's output stage from unwelcome loads while you adjust your Antenna Matching Unit. The circuit has two arms in a conventional bridge so that when the RF voltage across the 'central points' is zero, you know the bridge is balanced and the matching conditions are those desired. The first diagram right shows this condition for a simplistic bridge made up of three equal impedances of value Z and the unknown load R_L from the antenna matching circuits. When the mid points RF difference voltage is zero, then R_L is equal to Z. Very simple maths will show that the load on the RF source – the transmitter – is then also Z!



Let us assume that you want the matching circuits to present the common 50 Ohm load to the transmitter when in normal use without the matching bridge in circuit. Connect the matching circuits (with antenna connected) as the lower right hand side bridge arm and then make the other three bridge impedances (Z) be 50 Ohm resistors. When the bridge is balanced by the matching circuits creating a load of 50 Ohms, then the load on the transmitter is also 50R as desired. A little bit more simple maths will show that for the extreme cases (pretty unlikely) of the matching circuits presenting either an open circuit, or a short circuit, then the load on the transmitter would be 100 or 33.3 Ohms respectively; these are values that are exceedingly unlikely to trouble your transmitter if designed for a 50R load, so that while normal adjustments are made, the load will always be somewhere between 33.3 and 100 Ohms – hence always safe! Another small advantage is that only a maximum of one quarter of the transmitter's output power is actually radiated, so you will cause less trouble to others when tuning up!

The next aspect is a practical circuit to detect bridge balance. The easiest is a simple RF voltmeter circuit working on the difference between the central points of the two arms. This requires a diode and a capacitor in a rectifier circuit with some sort of variable indicator – this can be a meter or a LED. Bearing in mind that the matching circuit adjustments are correct when the bridge is balanced – ie when there is NO difference in RF voltage between the central points of the two arms – your task is to adjust the matching controls for least glow from the LED. (I say least, because if the transmitter has poor RF filtering and generates some unwanted low level harmonics, the matching circuit will not provide a 50R load for the harmonics as well as the fundamental – so there will be some residual imbalance in the bridge due to the harmonics.) The circuit below shows the practical reality with a switch that puts the bridge IN or OUT of circuit; this particular version uses a single pole switch instead of the common circuit with a 2 pole switch that completely removes the bridge when not wanted. The advantage of this scheme (apart from being simpler/cheaper!) is that the RF indicator remains active when the bridge is switched OUT, giving an indication of full RF output voltage because the left hand side of the bridge has no RF voltage in it. Note that it responds to RF output voltage, so if it is to 'show' output power, then it will need square law power calibration. The circuit's power handling ability is determined by the wattage of the resistors – using six 1 Watt 100R values as shown allows for up to about 15 to 25W output if you are quick in adjusting the matching controls! The resistor in series with the LED controls the brightness at full RF output – it is desirable to be over about 5K. You can see what happens when you apply a short or open circuit to the output, or even a 50R dummy load which will also absorb all the harmonics! Tim G3PCJ



Once again, many thanks to all past contributors and readers – over to you now Peter! Keep the ideas coming please! Best wishes for the future, Tim Walford G3PCJ