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Editorial

I am delighted to report that my editorial about 'peak electronic construction' last time did generate several comments! The two publishable contributions (see later) said I was wrong and unduly pessimistic! Spring is on its way so we must be optimistic and the lawn will soon want its first cut! (The earliest I have ever done that was in the middle of January so, based on a huge sample of 1, global warming is definitely not the problem that many would have us believe!) Time soon for some antenna work and in our case, a bit of thinking on where to put them up around our new house that is slowly emerging from the mud! My desire is a balanced (centre fed) dipole of some sort fed by open wire feeders but that is yet fully approved! We had a discussion recently with the electrical contractor and it is more of a potentially nasty EMC scene than I expected! At least these matters are now being given far more thought by equipment manufacturers; but my professional experience years ago taught me that although individual pieces of equipment can be compliant, it is quite easy for the whole to still have problems when there are transmitters of any sort in the vicinity and nowadays all homes have many! Heat pumps with multiple thermostats, induction heating cooking hobs, CCTV with digital communication/storage, solar photo voltaic power inverters, standby generators or UPS for mains failure in a rural area, mobile and portable phone/internet/computers, smart utility meters, broadcast digital TV and radio services, WiFi and even potentially fibre optics in a modern home are quite an interesting mix! And that's without amateur radio! One of the advantages of living in an old Victorian building currently is that nearly everything can be easily taken to pieces – you can lift an upstairs floor board when a new screened cable is needed between two rooms - not so in a modern place where floors are either solid concrete downstairs or large sheets of plywood upstairs! But they will be warmer so I am told!

Personal Data

Under new European Union rules, those of us storing the data on other people, have to be much more careful about protecting it. This applies to Hot Iron readers. The data that I have on you is minimal &, except in special cases, is only an e mail address. For many of you, I don't know a surname and in some cases not even a Christian name! For a vey small proportion, where I do hold a physical address, this is because we have sent each other physical items. Any physical address data is not stored electronically but is an old fashioned address book! I don't accept orders for equipment by credit card so I don't have any of that information – if you do order using Paypal, you card info never gets near me anyway! If this concerns you and you wish to cease getting Hot Iron, all you need to do is send me an e mail saying please un-subscribe and your miniscule amount of e address data will be deleted. I hope you won't! Tim G3PCJ

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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. Just let me know you would like it by e mailing me at electronics@walfords.net Under new rules I have to tell you that I only store your e address so I can send Hot Iron. If you do not like that, tell me & I will remove your data!

Peak Electronic Construction?

Pete Juliano N6QW disagrees with my (G3PCJ's) observations last time:-

So by my assessment, it has never been so easy to build moderately complex electronics and it is likely to get harder in the future – conclusion – we are at 'peak electronics build'!

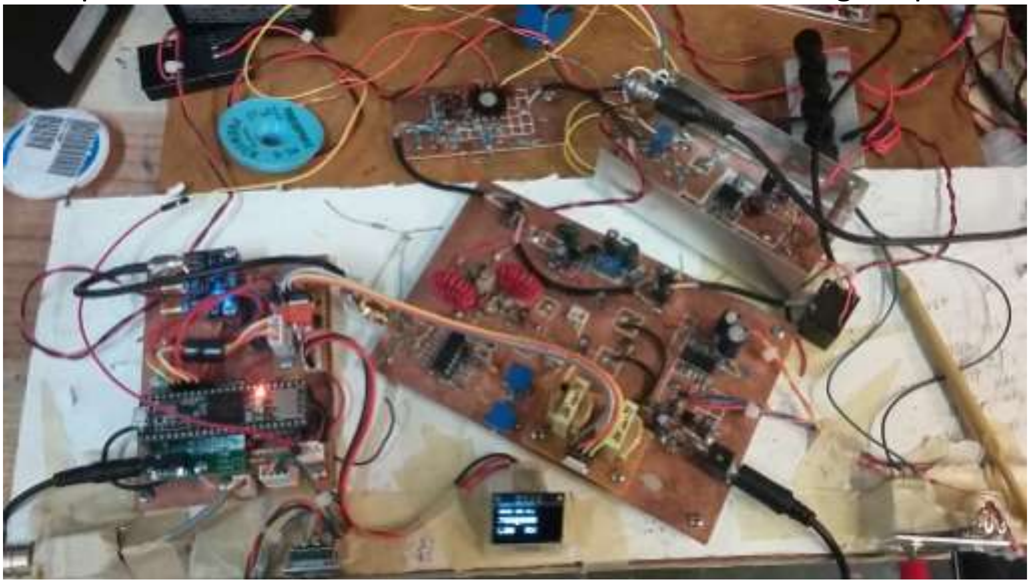
His editorial then proffered a challenge to anyone who would disagree with that position. I am taking up that challenge! Some questions raced through my mind such as the peak is the end and it is all downhill from there. Or is it a peak in the sense it is Mount Everest that can only be climbed by a few hardy souls?

In a completely unrelated event (reading a special edition of Scientific American for 2017/2018) I spotted an article that suggested the perfect premise for my response and that had to do with a chess experiment where the participant's ranged from expert to novice and the intent was to explore the Einstellung theorem. This theory posits a person's predisposition to solve a given problem in a specific manner even though better or more appropriate methods of solving the problem exist. The Einstellung effect is the negative effect of previous experience when solving new problems. Perhaps the real issue is that we are looking at the peak through eyeglasses of the past. [I suspect most hams today need eyeglasses –I do!]

Firstly let us be clear – Tim Walford and I are of the same vintage (we are the same age) so it is not a generational thing. I maintain and frequently state that this an amazing time to be homebrewing all sorts of electronic devices whether it be transceivers or test instruments. The reason this is quite clear and that being the availability of cheap, relatively abundant new technology hardware that can be had for pennies. I believe that G3PCJ clearly acknowledges that point. So let's connect the peak in electronics with the Einstellung effect. If I had a backward time scope on my test bench were there similar comments about a peak when the spark gap gave way to the CW transmitters? Or perhaps a mere 69 years ago, when the transistor was invented. How about the 1960's when there was a widespread shift from AM to SSB. Or perhaps like a recent comment from a Top Band aficionado who was lamenting there are no more DX stations on 160 Meters using SSB or CW –they are all now on FT-8.

But some of these examples are not in the same vein as Tim's comments as it appears his bent was the hardware and not a shift in the modes of communications Thus, let us focus on that aspect. If I read G3PCJ correctly he puts the laser beam on two aspects; one of which is that the parts being used are not simple ¼ watt leaded resistors or 25 VDC leaded 100 nF caps; and two, the devices are complex integrated circuits that must be programmed with the software being the bigger challenge.

Is it these two factors: complex systems on a 64 pin substrate and the need for operational software that drive that peak? Enter Einstellung – we think these two factors put us at the peak when in fact our old paradigm is large size leaded components that require no software to operate. When I once mentioned a Si5351 PLL Clock Generator to a very close friend – his response was "just show me the 2N2222's". The new paradigm is large scale integrated circuit block chips and the specialty software to run them. Recently I built a homebrew SDR transceiver that uses a 64 pin Teensy 3.5 Microcontroller and an Audio Codec Board. These two devices are the heart and soul of the rig. Embedded in the software are Hilbert transforms (I & Q) and a 2800 Hz bandpass filter (in software). I can't spot any 2N2222's in the rig but it sure works well. It is important to mention that I was merely replicating the work of Charlie, ZL2CTM. Yes I did add a dab of "Pete Stuff" but by and large I lifted what he did. For reference purpose this a 5 watt SSB transceiver operating on 40 Meters and the larger PC Board is 4 X 6 inches. Yes it is a prototype and looks like crap but has logged about 3 dozen QSO's in about 2 weeks of operation. Notice the liberal use of masking tape –an old paradigm.



So the real question is not so much have we reached the peak as it is how do we now work with the new components and learn the software? [Einstellung]. We eat the elephant one piece at a time AND we do have help in the form of resources found on the Internet. You Tube videos abound in things like curing water intrusion problems in a 1995 Jeep Wrangler to SDR Transceivers. (Yes both from N6QW – the Jeep one has had 32K views.) The other pieces are ham radio blogs and websites where there is literally tons of info on how to use the new devices along with program examples. We should not also forget User Groups and Forums. There is another aspect and that is those who enjoy are hobby who are ever giving of their time energy and support. I mentioned Charlie ZL2CTM – he spent a lot of time emailing me with help and assistance and support. I am deeply indebted for now I too have a homebrew (not a kit) SDR transceiver.

<u>Perhaps the not so obvious answer to Einstellung is the collaborative effect derived from the Internet. It is no longer a single chess player playing the game – it is a whole group playing the same game.</u>

Earlier I had mentioned the Hilbert Transforms and the 2800 Hz Low Pass Filter Software. Iowa Hills Software provides a free download of programs to design both the transforms and other tools to software build Low Pass, High Pass and Band Pass Filters in the audio range. Their program lets you visually see the filter shape and cutoff frequencies with the final result being a listing of coefficients that define the filter and transforms. The Audio Codec Board [from PJRC and costing about $15 USD] has free design software that will respond to these coefficients. The Teensy 3.5 microcontroller runs at 120 MHz and is programmed using the standard Arduino IDE. Did you all catch the number of times I used "free software".

The new electronic peak also drives the tools we need. I am fortunate in that having spent $250K sending my third son to university to study Mechanical Engineering, in return he designed, built and gave to me a $2500 CNC milling machine. The point here is having a CNC mill is an enabler to address the new hardware and is a step up from tack soldering parts to a copper board ugly style. The boards in the photo above were made on my mill. The really good news is that CNC Mills capable of doing this work are 1/10 the cost of the one I have. [It is OK to check eBay right now and you will find one costing $230 shipped to your door.]

Thus CNC Mills can be put in reach of more hams than those who sent their son's to an expensive university. The real beauty of the mill is that a lot of software needed to generate the cutting patterns are a free download and since it is a stored program when I want another board – all I have to do is load the machine with stock and punch the "Start" button! My major problem now is that I keep running low on PC Board stock.

The biggest problems in facing the pseudo peak are twofold: 1) getting off the couch and turning off the "tele" and 2) taking the time to learn how to use the new hardware/software and tools.

Answered and responded to: It is not a peak but merely an exciting opportunity!

73's
Pete N6QW

David Perry G4YVM also writes about peak electronic construction:-

The advent of DDS / micro processor controlled, rig-on-a-chip kits has certainly changed things as you say. I do agree that with old style components becoming harder to find and new style components becoming harder to work with, things look gloomy. However...the advantages in terms of facilities provided by new methods are undeniably attractive and attracting newcomers. Witness the simple maths of sales: how many of your last TRx did you sell? The little rig-on-a-chip QCX from QRPLabs has sold over a thousand copies! At 40 quid a pop that's a LOT of revenue. Clearly people are buying the facilities of the new digital kits. Another HOWEVER...if a chip fails, as it has on a friends kit, it is almost impossible to fault find. So a £40 kit becomes literally useless and goes in the bin. My friend managed to isolate the issue and buy a spare chip, so all is good. Yes, the kit could be returned but would YOU accept a built but dead kit back for replacement? I doubt it. Fault finding may be provided but it costs...and if it's factory mounted SMD chips it's just not viable.

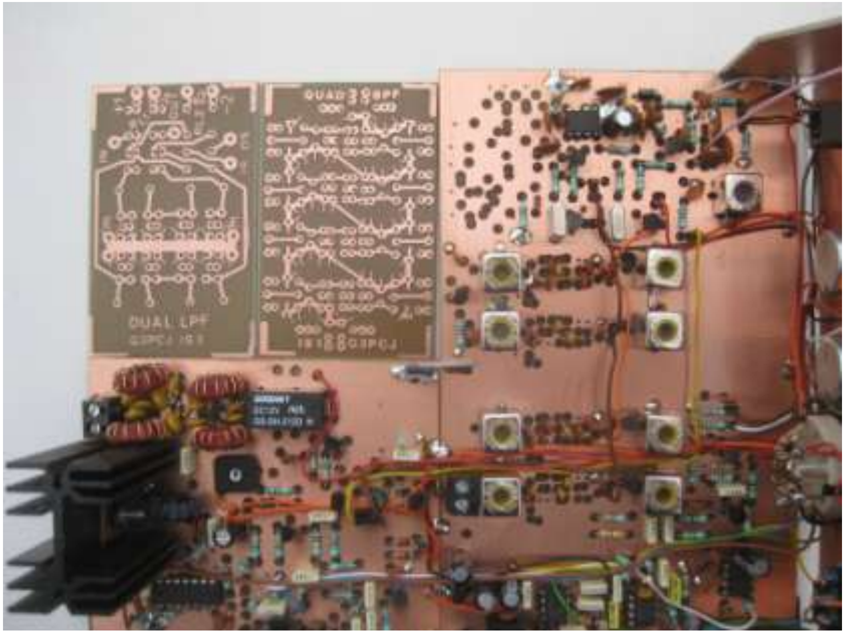
So, on the one hand you are right...we may have peaked. BUT...how long will Kenwood, Yaesu and Icom keep making radios for our market? Sure, they'll all be SDR anyway very soon because these can be programmed for any user but will the amateur market sustain development? Also into the mix goes this: the people running many of our institutions are ageing...the QRP club, FISTS, Waters and Stanton, Lynch and so on and on...in honesty, is there a generation left in these things? I fear not. Which leaves the amateur with no old style kits, no hope with SDR style and no suppliers of commercial gear! I suspect then a resurgence of real old style homebrew, as you say, kitchen table stuff. We will have to build because it's all we can do. And the builders will be using half SDR chips and half wire ended I am sure. Even if wire ended components disappear the ingenuity will continue.

Perhaps, just perhaps, the future of amateur radio is going back to it's roots...fully home brew, cw radio separates with rallies of small scale enthusiasts getting together to swap stories, ideas and spares. The chaps who also sit on 27.555 won't like it and will vanish, but those of us who love radio will thrive and continue to enjoy our hobby.

David
G4YVM

Kit Developments

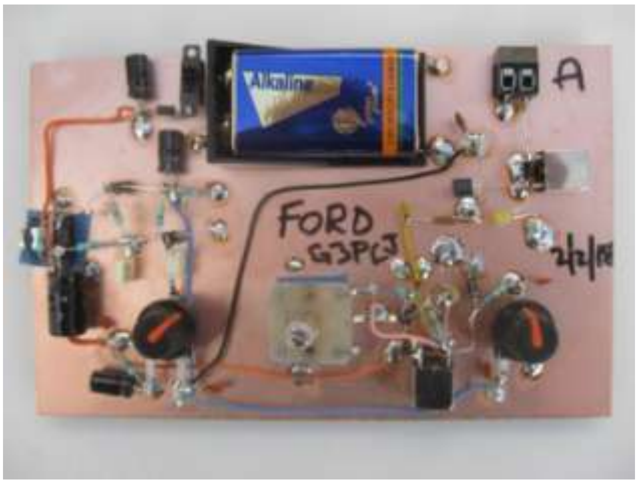
The Beer RX and Stout CW multi-band CW TCVR are now on my website. I am just waiting for the first batch of PCBs to come back from drilling. The photo right shows my two band version ready to take the extra (upside down) PCBs to make it a four band version.

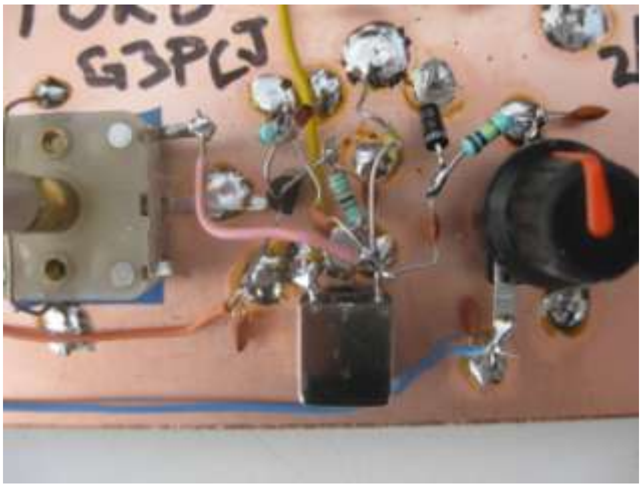


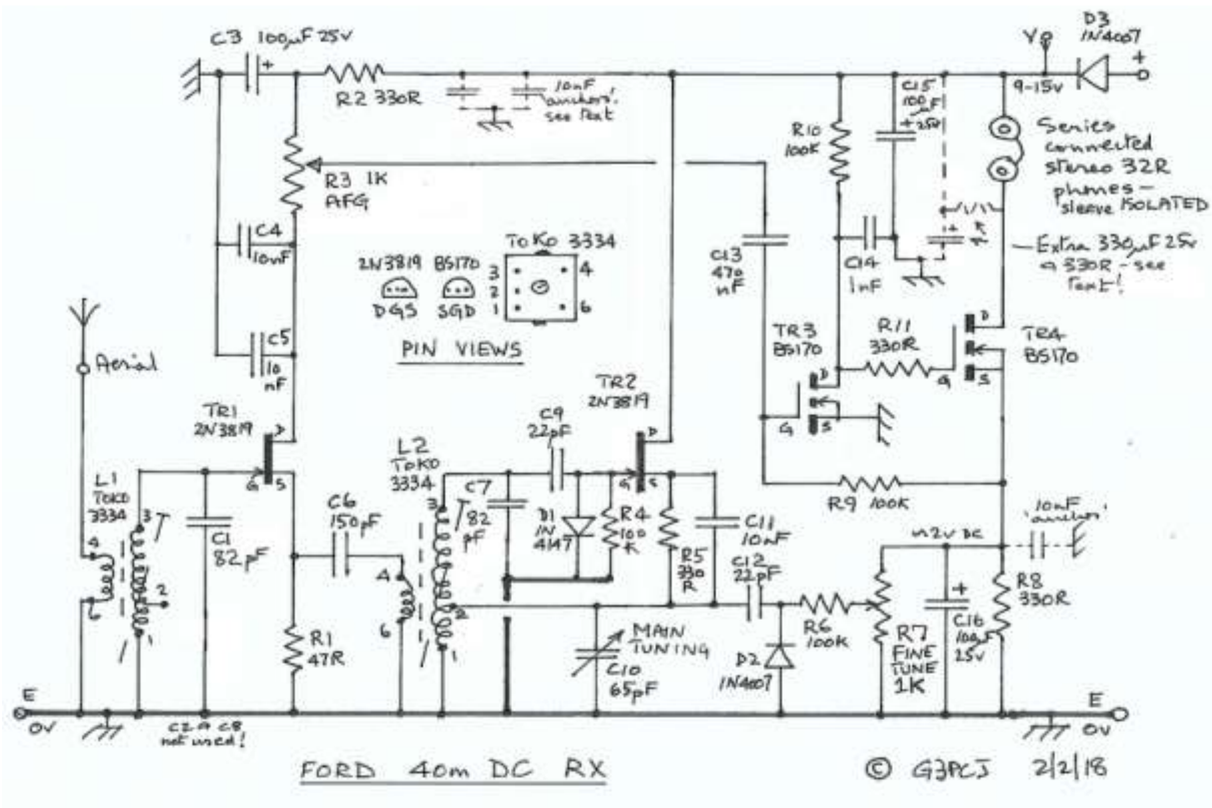
To keep the brain and brawn active, I have been working on a couple of new projects – the Ford and the Culm.

The Ford

I realised recently that I didn't have a very simple direct conversion plain single band receiver – hence the Ford. It is so simple, I built the prototype in an afternoon! It uses just four transistors – two Junction FETs and two MOS FETs. I wanted 40m as a compromise (usually busy) band without frequency stability being too poor from this form of 'in-air' construction without a specially prepared PCB! Plain copper clad board is excellent for circuit 'trials' - like experimenting with the tuning – it has Fine tuning with a power diode instead of an obscure varactor! I added an AF gain control but its hardly needed! Output is to modern 32R stereo phones. Build it yourself! It has a few extra 10 nF discs - not essential but they help with rigidity. Use the extra 330 /uF when optional D3 is included; the 330R is for feeding an external amp.

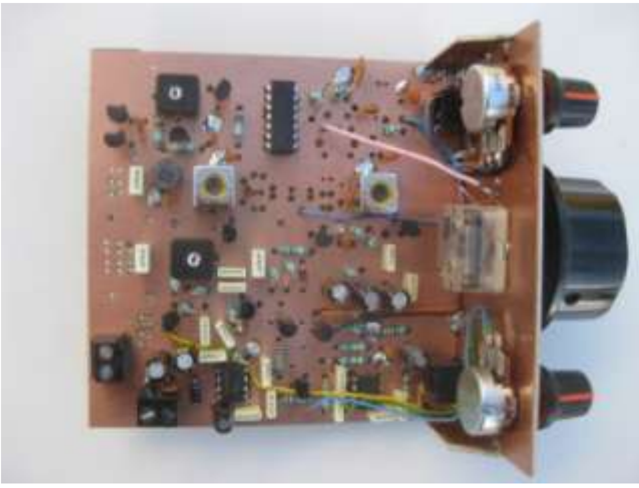


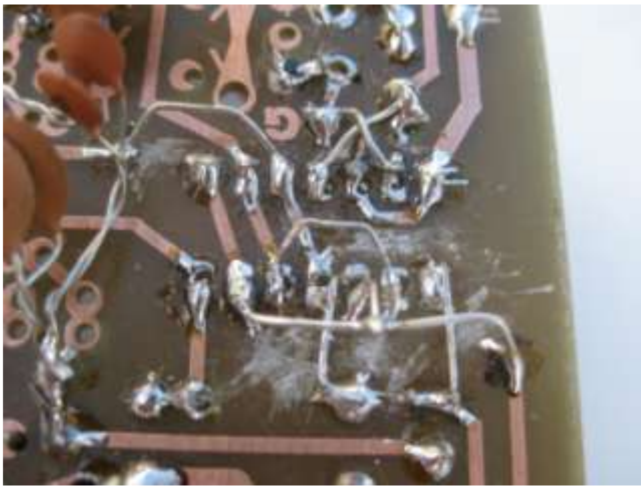




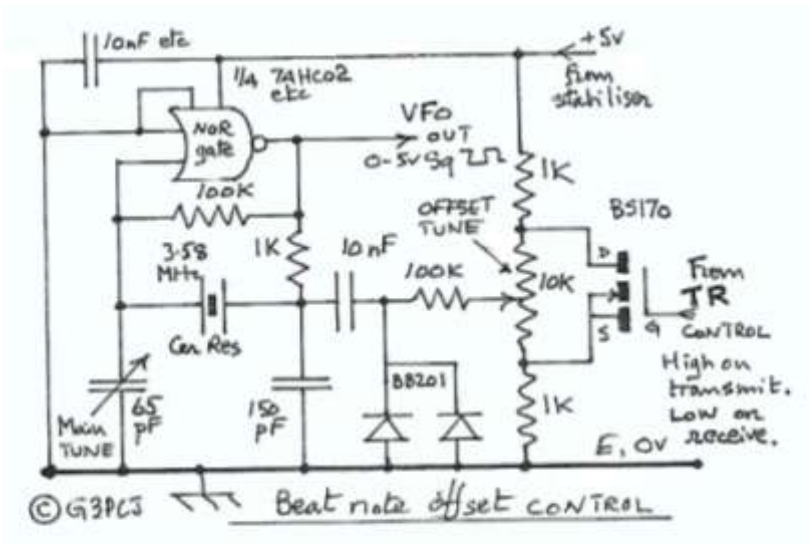
The Culm

This is single band direct conversion CW transceiver & is named after a small river that rises in Somerset but flows into Devon – my small CW rigs are all named after local rivers. It has a ceramic resonator VFO for 80m and is intended to take crystals for higher bands up to 20m. The left-hand photo shows it part way through proving, with the receiving RF filter capacitors not yet fitted properly (underneath temporally) and also missing the transmitter low pass filters (which I have as a piece of test equipment), while I tried it out on different bands. In the early experiments I was not using the RF amp stage and had the antenna fed into the normally unused (in this design) low impedance winding of the first RF filter resonator; but interestingly, the RX had bad microphony and hum problems. Adding the grounded gate RF amp stage, which in effect simulates the impedance step up in the primary to secondary of the filter resonator, made the very nasty noises all disappear. Overall sensitivity from a 50R feeder is similar! It just shows how important it is to minimise LO radiation from the rig into the local environment, which is one of the benefits of adding the RF stage. The right hand photo shows what happens when you mirror image your IC pin layouts by mistake! The rig is working well on 80m, with a ceramic resonator for the VFO. It has main tuning by the PolyVaricon and Fine tuning by a potentiometer acting on a voltage controlled variable capacitance diode. The circuit for this aspect, below,

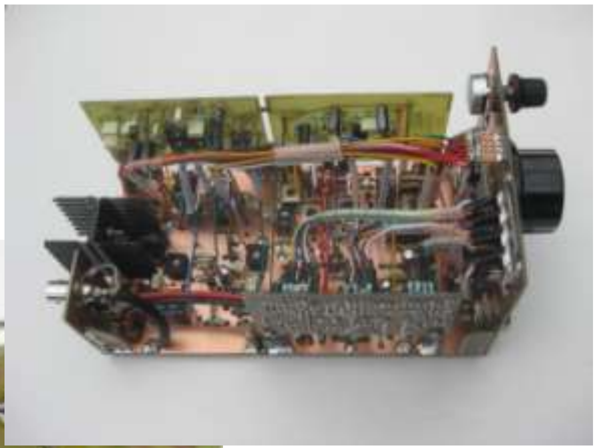




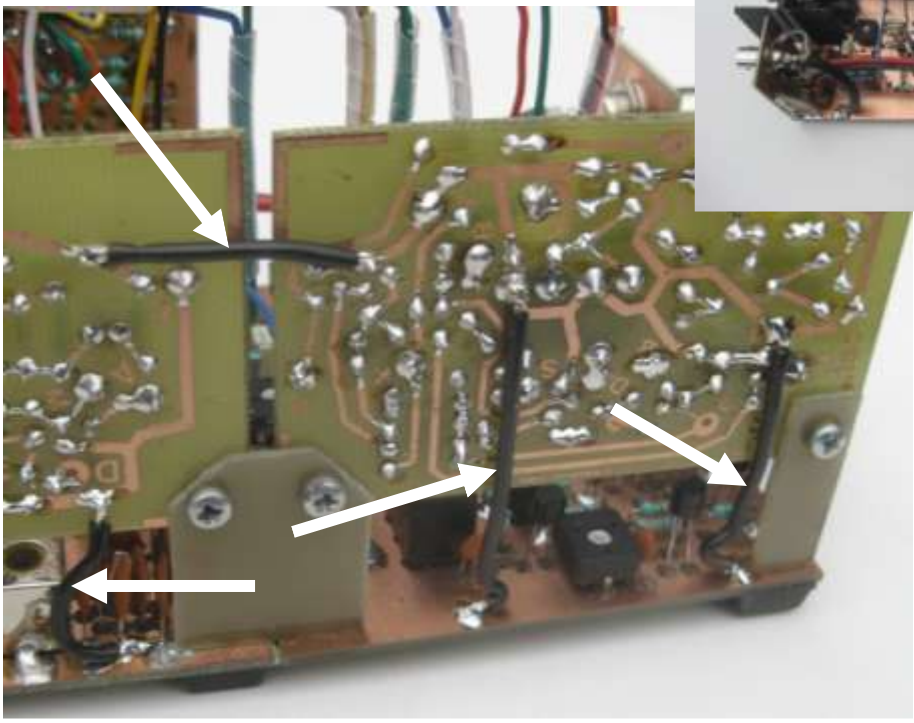
uses a MOSFET under the control of the transmit/receive switching to remove the Fine tuning beat note frequency offset when transmitting: the procedure being to tune the Main tuning for zero beat of the other station with the Fine control centred, and then to use the Fine control for the desired beat note – this can be done either way so you can use whichever sideband has least interference form other stations. When you go to transmit the pot is shorted by the MOSFET, so it is effectively centred, which makes the VFO run on the zero beat frequency. Adapting this scheme for the very limited pulling range of a crystal is proving challenging just now! G3PCJ



The importance of good grounding

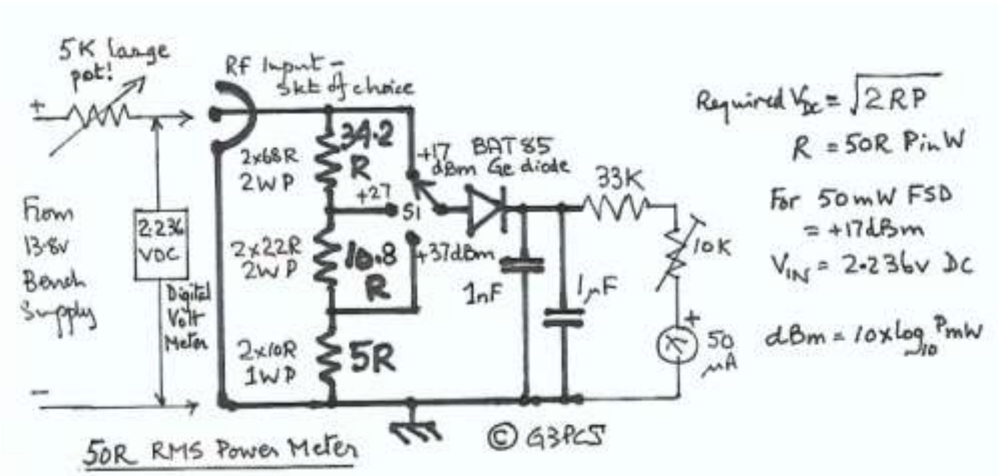


This very well built rig came back for sorting & tweaking up after adding CW & AGC boards; the rig was working well on phone SSB with the original main circuit board, but on CW it was going haywire! The only thing I could see as suspect was the single thin ground or 0 volt supply leads to each of the two extra PCBs. This was easy to improve by adding the four heavy black leads (arrowed) between the main PCB ground plane & 0 volt tracks of the extra PCBs. That cured it completely! Don't skimp on the 'copper in the ground'! G3PCJ



Simple RF RMS Power Meter

This is one of my most used pieces of test equipment! It is so simple I am surprised the circuit does not get more publicity! It presents a load impedance of 50 Ohms from DC up to several hundred MHz depending on how small you make all the RF parts which I have drawn with thick lines. It is peak reading which enables you to calibrate it easily at DC with your most accurate DC meter. Apply 2.236v DC (quickly via 5K pot to 12v), set for highest sensitivity & then adjust preset for full scale. If you work this out in RMS power terms, it is 50 milli-watts into the 50R load, or expressed another way, this is +17 dBm – meaning 17 db above 1 milli-watt into 50R. You can mark the meter with intermediate (non-linear) calibration points in 1 dB power steps down to about 0 dBm. The less sensitive scales add 10 dB or x 10 in power to give a max of 37 dBm or 5 Watts. G3PCJ



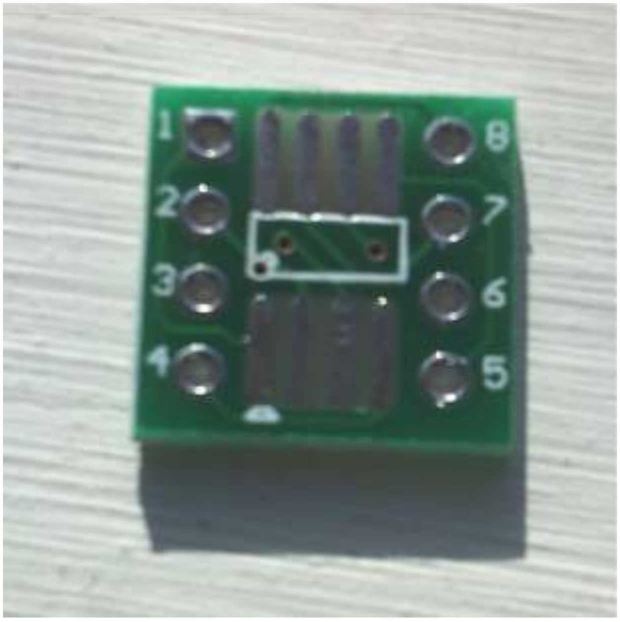
Continuous Improvement – Peter Thornton G6PNR

The Japanese invented this phrase; it meant for us in the UK semiconductor manufacturing industry continuous change and cost reduction in manufacturing silicon chips, transistors and integrated circuits. To make silicon devices, you need 'Process Engineers' to design the chemistry and physics creating the P-N junctions and MOS structures (to name but a couple of the structures Process Engineers use); 'Equipment Engineers' to keep the machinery running, maintain the best performance at the lowest running costs; and Production Engineers to organise the plant's manufacturing and get the maximum throughput for the 'product mix' required, today, tomorrow, next week. Each of these disciplines are involved in 'Continuous Improvement' and a change in any one inevitable creates change (for better OR worse) in either or both the others!

The whole point is to keep competitive. Improvements in manufacturing have to be made every day, every week, every month - if you stop improving, you're a dead duck; competitors will overtake you with technology, manufacturing or lower price. That's why customers always want the latest chips from the production line - they have all the improvements in performance, quality and price. "But," you might ask, "how does that affect me, a radio amateur?" Well.... the chips made a few years ago won't be quite as good as today's products - maybe the balance, gain, leakage, noise factor - as they won't incorporate the latest improvements. Might not be a bother if you're knocking up an 80m 'local natterbox'; but might be vital if you're after digging a signal out of the noise, or wanting the best SSB carrier suppression.

It's tempting to use 'N.O.S.' (New Old Stock) devices; and for an average job, they are cheap, and for any job not too demanding. OK, keep in mind the passivation oxide over the silicon die doesn't stop sodium contamination or water vapour ingress forever; new old stock can be leaky or noisy compared with new devices. It's best to use the latest devices; but it isn't that easy for an amateur - manufacturers responded to customer demand for miniaturisation with surface mount devices, and your chip of choice (like an SA 612) isn't available any more in a DIP-8 package. Here's a trick used by engineers prototyping a circuit, who prefer DIP-8 packages for easy alterations to get the design spec. required. Their solution is an adapter PCB: to convert the SO-8 surface mount package to an 8 pin 'DIP' (Dual-In-Line) package, using component lead off-cuts to substitute the pins of a conventional 8 pin DIP.

Adapter PCB's are available cheaply from the usual auction sources, but beware: not all are manufactured for RF service. Many are not 'lead-free' solder compatible, being tinned with leaded solder; most are not 'through-hole-plated' for best RF impedance. Many don't have screen printed pin identification, and SO-8's are not so easy to get straight without an outline marking. Pictured below are multi-layer adapter PCBs - these take a surface mount 8 pin device and convert it to an 8 pin DIP format, to fit 0.1" pitch circuit boards or sockets. You can/might be able to see the minimal length interconnect tracks, numbered pins, fully plated through holes and the alignment outline screen printed to aid bonding prior to soldering.



SO-8 (0.050" pitch leads) TSO-8 (0.025" pitch leads)

These pictures are of the same adapter PCB - the front and back support different surface mount component profiles. The pads fit 0.050" pitch leads or 0.025" on the obverse. (I am afraid my camera is no good at these really close shots!) They are fully through hole plated, electro-less coated with pure (99.999%) tin for lead-free compatibility and will mount the universal amateur radio chip, the SA612, with ease, as well as any other 8 pin IC of the same pin pitch. You can see the pin numbers on the vertical sides, pin # 1 has a square pad and the chip profile is screen printed to eliminate mounting errors. These PCBs have run SA612's successfully in balanced mixer duty at 450MHz test, and quad FET op-amps in sensitive leakage applications. The easiest way to mount the devices is as follows:

- Fit 8 resistor lead offcuts to the 'DIP' holes, and trim to 6.5mm / ¼" long below the PCB.
- Using Blu-Tack or similar putty, set the PCB horizontally, resistor lead 'pins' down, and 'dry fit' the chip with tweezers to check alignment and leads contacting every pad (use a magnifying glass!).
- Lift the SO-8 chip, and apply a tiny dab of super glue with a cocktail stick to the centre of the screen printed outline on the PCB. Don't apply too much!
- Replace the chip, making sure the leads align with the pads - use a magnifying glass - and press down with the cocktail stick to secure the package to the PCB.
- Using minimal solder, solder each lead with a *temperature controlled soldering iron* and a *clean bit* , *quickly*, (italics = important!) in a diagonal pattern - solder pin 1, then pin 5; pin 2, then pin 6, etc. *DO NOT OVERHEAT* or you'll damage the chip!

The adapter PCBs shown above are available from: Equipment Engineering Co., Manchester, UK. equieng@gmail.com for more information.

Homebrewing a SDR by Jim Gailer G3RTD

Background

Over the past 10 years or so, the use of software defined radio (SDR) has moved from the domain of the 'bleeding edge experimenter' to what will, before long, be commonplace. Other than the need to overcome a fear of surface mount printed circuit assembly, however, the homebrewer can continue to build receivers and transceivers that provide a big improvement on the performance of 'traditional' radios.
In this article I will describe my 'journey' in this technology and describe the basic skills, equipment and techniques that you can use to homebrew in this fascinating technology. I will also describe a fascinating new open source project that will allow you to build a QRP transceiver from scratch, or just to assemble the wire-ended components on a preassembled surface mount PCB. All this for a very reasonable price.

Software Defined Radios

SDRs have been around for a fair time now and people seem either to love them or to hate them. It is true that if you want to dig deep into the fundamental principles of design, you are exposed to quite advanced maths very quickly. Being software defined, someone will clearly need to write digital signal processor software and in most cases, Field Programmable Gate Array (FPGA) code as well! Ah, but don't panic! Your editor has told me not to go there (as if – my teacher put me off maths for life at A-level!). This leaves most of us with a few alternatives amongst which are …Stick with hardware - only radios, 2- buy a SDR radio (shudder) or 3 - build our own SDR and use someone else's software.
I have taken route 3. I do write my own software, but only for utilities, such as to provide links between the SDR and an antenna tuner using the CAT (Computer Aided Tuning?) interface. Don't let me put you off radio programming though. You can generally leave the complicated maths alone and use classical building blocks for mixers, filters and so on. There is even free software (GNU Radio) that will let you design your radio software by connecting building blocks on a computer screen. I was surprised a few years ago that when designing a data averaging circuit (for a bat detector!) I had designed a classical low pass filter and even more amazing, it was the right filter for the job!
So, if you haven't used one before, put aside any preconceptions you have about SDR and find someone who has one that they will lend you to give it a try. It can take a little getting used to at first (unless you are using like an Icom 7300 which is an SDR but looks like a 'normal' radio). The first thing you will likely find is that the radio uses a computer screen and is controlled using a mouse. This usually means using the mouse wheel to tune with, but you can make or buy a tuning knob as a substitute. I did this but I have since bought a Logitech M90 mouse whose mouse wheel can spin free, giving you smooth flywheel-like tuning rather like the old Eddystone tuning drive. Try tuning a SSB station. You know where the stations are because you can see them in the spectrum display on the screen. Look at the 'waterfall' display, which shows the history of the band falling or rising on the screen. You should see the sharp cutoff at the tuned frequency of the SSB signal or the carrier and both sidebands for an AM signal and so on. You can see any splatter and give an accurate report if needed. Because the radio provides bandpass filtering using digital processing, there is no distortion because of misaligned crystal filters, nor filters using low-grade crystals. The filter passband is like we dreamed of in an analogue radio and can be moved or varied in width to help get rid of adjacent channel splatter and so on. Look for an empty frequency on the spectrum display and listen to the noise. I find that it is much less harsh than a conventional radio, again because of the clean filtering. Try a CW signal. Wind down the bandwidth; you should hear hardly any ringing on noise and the CW will be crisp at much narrower bandwidths than with a crystal filter. There's a lot more; give it a couple of hours and enjoy your audio reports too!
Can you tell I'm a convert yet? Enough rant…

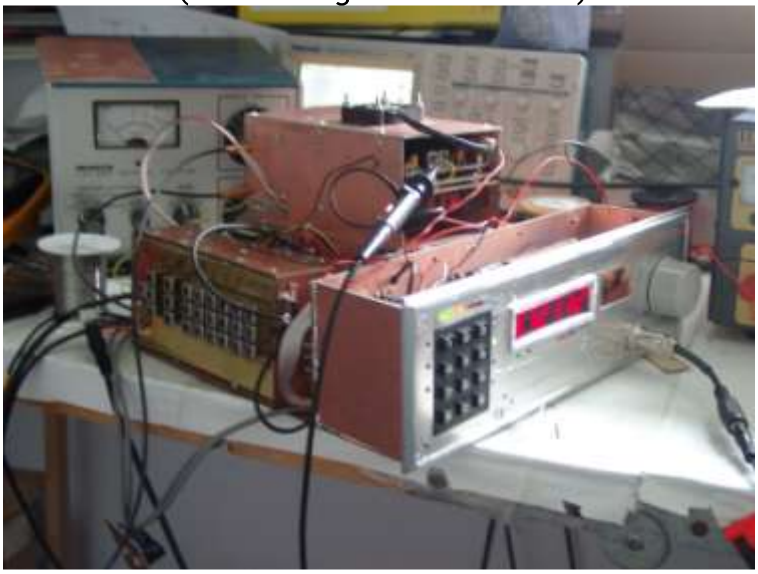
Types of SDR

There are three main types of software defined radio in my mind. Firstly the 'Softrock' type[1], based on the use of a Tayloe mixer and using an audio A/D convertor, often in a computer. These are kit radios and have been available using non-surface-mount technology. A second type uses a conventional superhet design, usually with a very low second IF, so that sound card A/D convertor chips can be used to interface with a computer or a stand-alone digital processor. Finally, designs using an A/D convertor that samples in the 100MHz+ range so as to digitize signals directly without using IF amplifiers, roofing filters and so on. I have built examples of all three, but have settled on the direct sampling design (the last one) which provides a continuous coverage of the HF bands.

Building SDR Radios

I started building my own radios at the age of 9 (one valve TRF kit using a 954 valve) and got my ticket at age 17 (my call sign tells all!) using an 1155L (receiver) and 19 set (as a transmitter), mostly on top band. Then I became a bedsit dweller when I left school and amateur radio was not really possible. After I retired and then my wife died 14 years ago, I bought myself a receiver just to have voices around the house and then joined a local radio club who twisted my arm to get back on air.

My initial thought was to modify my receiver to tap into the frequency synthesizer and add the transmit circuitry. About that time the Pic-A-Star articles[2] by Peter, G3XJP, were running in Radcom and (not showing a morsel of fear!) I decided to give it a go.



My original Pic-A-Star on test

Pic-A-Star is quite an ambitious project, requiring home etching of printed circuits with surface mount assembly of many-legged components. It had been some years since I had used a soldering iron! The project however was well supported (and is still supported though there are a few difficult-to-obtain components) and people have still been starting builds quite recently. The transceiver is a double superhet with a final IF of 15kHz which is then digitized and all of the transceiver modulation, demodulation, filtering and other functions is carried out digitally in a dedicated processor (no PC required!). Nowadays, this might not be considered a 'true' software defined radio since the digital conversion is not close to the antenna – there is a roofing filter in circuit for example. The radio performs very well, however. On both transmit and receive, it sounds much 'cleaner' than a traditional analogue design, probably because of the use of digital filtering.

Open HPSDR

HPSDR in a 'Pandora' enclosure. The 10W PA (Pennywhistle) is at the left of the picture.

My second radio was the original HPSDR[3] which used three pre-built boards on a mother board, further simpler boards (power supply, VCXO frequency reference and power amplifier) being home constructed. HPSDR is an international collaboration, both for the hardware and the software. It is a true SDR in that, other than an A/D convertor driver amplifier, a switchable attenuator, and a low-pass filter, the A/D convertor is very close to the antenna. Likewise, the transmitter which after the D/A convertor is low pass filtered and amplified to about 500 mW. With the OpenHPSDR software, this provides a superb transceiver that is still supported for new firmware and software releases. I came particularly to appreciate the spectrum displays provided.

The Hermes Transceiver

Kevin, M0KHZ, redesigned the transmitter and receiver boards to fit on one PCB (named Hermes).

Hermes, showing both sides of the board

This was used by Apache Labs to build the ANAN 100 radio and who also provided bare 4-layer PCBs for homebrew. I bought one of these for a very reasonable price and built it successfully. I have used it as part of an integrated radio with a 15-inch touch screen intended for a point of sale terminal. The radio has a built-in PC motherboard and despite my initial self-interference concerns, with care this turned out not to be a problem.

Before moving on to the final (Hermes Lite) project, I think its worth setting out what it takes to use surface mount devices, as I know that this is what puts many people off homebrew (other than antennas and of course some kits from Somerset) nowadays.

What You do and Don't Need To do Surface Mount Construction.

You don't need sharp eyesight!
You don't need small fingers.
You don't need steady hands.

1. You need a decent area of clear table or bench, so that you can find components when you drop them! Mine is 2' by 3' and I treated it to an antistatic mat.
2. You need to be able to see the component. There are lots of ways to do this, but you must have stereo vision or you cannot judge whether the soldering iron is about to melt the solder or is hovering above the PCB, for example. I use an illuminated magnifier lens that I can see the component through with both eyes. Head-mounted magnifiers are supposed to work well or even two pairs of glasses!
3. You need a pair of tweezers that are designed for the job. Some steel ones will get magnetized and will not let go of some components. Stainless steel is usually OK.
4. You need a temperature-controlled soldering iron with a very small pointed or flat bit.
5. A good light.
6. If the design is complex, create a colour-coded layout chart or charts with a different colour for each component value
7. You will find plenty of internet instructions for surface mount soldering, for example, google "surface mount soldering 101 – YouTube" (e.g. [4]) but:
   - Use lead-tin solder with a small percentage of silver in it.
   - Rest the heel of your tweezers hand and your soldering iron hand on your worksurface; this will steady them.
   - Apply a small amount of solder to one pad of the component, then melt it with the iron as you slide the component into place. Solder the other pads then re-solder the first one. Use extra flux if the joint is not satisfactory and it has enough solder.
   - If you get shorts between integrated circuit pads, use fine de-soldering braid with a small amount of no-clean flux.
8. Some solder called ChipQuick[5] lets you de-solder the two- or many-legged chip to replace it (or to rotate it 90 degrees!). No connection to me – look for the smallest pack – it's a lifetime supply.
9. If you can't solder a fine pitch or ball grid array chip, there are companies who will do it for you. I have used Allgood Technologies[6] (Peter G8RXJ) for a ball grid array chip. Again, no connection.
10. And a little practice…

The Hermes Lite Project[7]

This is a reaction to the high cost of buying a ready-built radio such as the HPSDR Hermes card, which provides, with no compromise, a low power transceiver on a single board.
Hermes Lite was started a couple of years ago. It has the objectives, amongst others:

1. Low cost. The aim has been to provide a transceiver for about the same cost as a Softrock radio, if the cost of Softrock's sound card is included.
2. Open source. All of the project design files are available freely on the internet[8]. The printed circuit is designed using Kicad[9], free open PCB software. Gerber files are available should you wish to have bare boards made.
3. PCB available with all surface mount components ready fitted. The PCB design files are available so you can have boards made and assemble your own. (I shall!)

It is an open-source development and uses HPSDR design elements and interface, which means it can use the same software. The project has also returned the compliment, HPSDR having incorporated some of Hermes Lite's design improvements.

Hermes Lite 2, beta test PCB, awaiting fitting of through-hole components

Free and open-source software is available: the hardware is compatible with OpenHPSDR compatible programs running on Windows (e.g., OpenHPSDR[3] and SparkSDR[10]) and Linux computers (e.g., Quisk[11] and PiHPSDR). PiHPSDR by John Melton, G0ORX[12], will run (well) on the raspberry Pi2 or 3 with the 'official' 7-inch touch screen. There is a design that integrates the Raspberry Pi and touch screen with a tuning knob and other controls. This provides a stand-alone 5-Watt transceiver (no PC needed).

OpenHPSDR, running under Windows, also supports the amazing 'Pure Signal' software that cleans up the intermodulation distortion in your PA.

The main compromises of Hermes Lite, compared with the OpenHPSDR Hermes board are:

1. The A/D convertor is 12-bit rather than 16-bit. This reduces the overall dynamic range, but will only affect you if you have extremely strong signals (e.g., a broadcast station) nearby. Filtering of the receiver (even your antenna tuner) will generally solve this. I live in a fairly rural location and can see no difference at all here.
2. Maximum frequency is 30MHz rather than 50MHz.
3. No audio input/output is provided on the board – you need to use the computer's sound card and software such as VB-Audio (free).
4. Only two receivers can be run (compared with Hermes, currently with 4) reducing the width of spectrum that can be displayed to 384kHz.

The radio will fit in a small extruded aluminium case, including the 5W PA and a filter board.

The design is currently in beta test prior to issue at version 2, which looks likely to be early this year. The current build is beta 5, for which a batch has been built in China and the cost looks like it will cost about $165. You can get a set of beta 5 boards made today if you wish to make one yourself.

Version 1 was homebrew, including mounting the surface mount components. It used an Altera BeMicro CV FPGA (Field Programmable Gate Array) prototype board, now difficult to obtain, to avoid the need of soldering the FPGA (version 2 has the FPGA on the board). I built versions 1.1 and 1.2 and I could not really see any difference between their performance and that of the OpenHPSDR Hermes board (I live at the edge of a small village, well away from other transmitters). The version 1.2 board can (with special firmware) even run the Pure Signal software which pre-distorts the transmit signal to cancel out transmitter intermodulation distortion.

References:-

1. Softrock radios: http://www.wb5rvz.org/ensemble_rxtx/
2. Pic-A-Star: https://uk.groups.yahoo.com/neo/groups/picaproject
3. HPSDR: https://openhpsdr.org/
4. https://www.youtube.com/watch?v=3NN7UGWYmBY Curious Inventor SMT soldering
5. ChipQuick: http://uk.farnell.com/chip-quik/smd1/removal-kit-smd/dp/1850214
6. Allgood Technologies: https://www.allgoodtechnology.com/
7. Hermes Lite: http://www.hermeslite.com/
8. Hermes-Lite Github: https://github.com/softerhardware/Hermes-Lite2
9. KiCad: http://kicad-pcb.org/
10. SparkSDR: http://www.ihopper.org/radio/
11. Quisk: http://james.ahlstrom.name/quisk/
12. PiHPSDR: http://g0orx.blogspot.co.uk/

When the obvious is not obvious! By Pete Juliano N6QW

When the car won't move and the tire is flat that is an obvious cause and effect! But when your rig does not work – the problem may not be obvious and the cures applied may be totally wrong. I wanted to share a trouble shooting experience in hopes other will take up the charge before applying a 10 stone sledge hammer to your beloved homebrew rig. But let's back up a bit and start from the beginning. I have a large box of rigs that were built perhaps 20 to 25 years ago and somehow didn't work, worked once and died or would never work. Since I am one not to give up, my comment when placing a rig in the box is "someday". Well that was a case with one such rig that was rebuilt over the Christmas 2017 holiday.

The rig was on 20 Meters, had a 9 MHz IF and originally started as a receiver as shown on page 104 of the Solid State Design for the Radio Amateur. Some twenty years ago I figured out how to make that receiver into a transceiver. It "sort of worked" but not too well and my 2017 goal was twofold: 1) fix the rig and 2) update the rig with a digital VFO/BFO and add a super cool color TFT display. All went well with the two goals being met and I had it on the air making contacts. As it turned out, one of my original problems was a bad crystal filter! Suddenly without warning I noticed that the receive function on my rebuilt rig was intermittent. Not that it would die; but that it would periodically lose signal strength and then regain same. The problem appeared only on the receive side but not the transmit side. Now there are many common circuits for both transmit and receive; but some are exclusive solely to the receive end. Thus my concentration was on these receive specific circuits.

I looked for the cold solder joint or perhaps two wires coming in contact and lastly perhaps an intermittent cap or even a device going south. In desperation I rebuilt the whole front end mixer stage which originally had a 3N211 Dual Gate MOSFET. I did find two components that were not the original values specified. So my faulty reasoning was that with age the circuit drifted and now those different values became critical. So the wrong brute force solution was applied where I completely rebuilt that stage with all new components including using a NIB 3N209. That seemed to have cured the problem for a short time; but then it returned again. Next I looked at the homebrew single balanced mixer that followed the MC1350 IF stage. On receive it was a product detector and on transmit it was the transmit mixer stage. I pulled that circuit and replaced it with a packaged TUF-1 reasoning perhaps some bad diodes. Same problem –works and then intermittent. I was running out of things to replace.

At this point I decided to put aside this rig and use another rig to make a few contacts. Boom same problem, different rig. I tried a third rig, and there was that same issue. Then it hit me –something is coming down the antenna. I thought about it overnight and the next day I simply hooked up my DSO (Digital Storage Scope) across the antenna leads and there it was a very strong signal! In fact at one time it was 200 milli-volts pk to pk. All sorts of light bulbs went on when my scope told me that the incoming frequency was 14.07475 MHz. Here it was –a digital station on 20 Meters that was desensitizing my front end. I have a ham directly behind me (maybe 300 meters away) and on my daily walk I noted a new antenna is his yard. To affirm the same I dialled in my rig to 14.07475 while powered on and I could watch the signal on the scope and see my S Meter get pinned and of course a very loud sound from the speaker. The problem was my ham neighbor was running JT-8. There is a you tube video of this discovery.

https://www.youtube.com/watch?v=hRQDWG3tSkI&t=175s

So the lesson is to have a disciplined process for troubleshooting & to also think outside the radio and look at what is coming through the antenna. Smart money would have had me connect the rig to a dummy load and use an RF Oscillator as a signal source – when it was not intermittent that would have been a clue.

Have now added to my process: check signals coming down the antenna! N6QW

The External Variable Frequency Oscillator

Keen constructor Charles Wilson M0CDD, sent along some notes on how he built the VFO for his beautiful replica spy set – on right. He had visited a steam enthusiast who had a single boiler for his many engines and it made Charles realise that one really good external VFO, would be preferable to several mediocre ones! 'Less of the best is better than more of the worst!' (Before you say this is all old hat now we have DDS etc, I must point out this project started many years ago! G3PCJ) The main part of this rig (central box) is a 9 MHz IF superhet so for 40m he included a 2 MHz VFO, and later decided to add 20 and 80m with a separate alternative VFO running 5 to 5.5 MHz; there was not enough space in the main case so he added the small VFO box nearest camera. The furthest box has a loud speaker, another VFO with space for a huff-n-puff stabiliser. (Charles adds the comment that the valves are decorative! I know of another replica spy set where G0HDJ has installed all the transistors in the metal valve cans! Tim)

After taking them out in the field, and much use under arduous conditions, Charles' VFO suggestions are:-

Keep the VFO frequency as low as possible. (Consider crystal mixing for higher frequencies.)

Front panel should have a light colour to reflect heat or sunlight!

Use negative temp coefficient fixed capacitors to compensate for positive tempco inductor.

Have two stages of amplification or buffering after the VFO to avoid pulling by cable changes.

Build it in a metal diecast box for rigidity and screening.

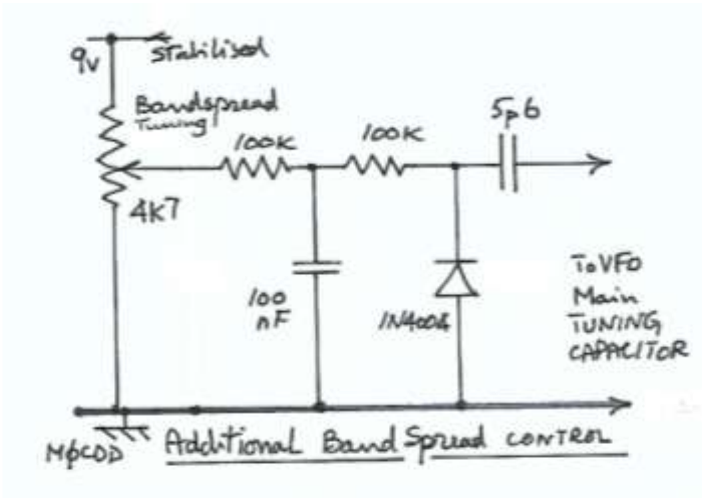
Decouple the power lead heavily at both ends and use good voltage regulators.

Use good quality miniature coax for all leads – RF out, DC power in and any RIT etc.

Check the cable (and any intentional) attenuation produces the right level for your rig's mixer. (NB. SA602/612s only need 150 mV p-p instead of about 1- 2 volts for diode mixers.)

Use good quality air spaced variable capacitors with slow motion drives and large dials. (Mainline Electronics of Leicester are thought to still have stock of Jackson parts.)

Consider adding band-spread capacitor – small air variable or electronic as circuit sketch below.



That's enough for this time – my thanks to all our contributors and keep the material coming please - enjoy the Spring good weather!
Tim G3PCJ