“JOURNAL OF THE CONSTRUCTORS CLUB”

Hot Iron

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Editorial

Recent mails with a couple of good radio friends have suggested a bit of lateral thinking is needed to get new enthusiasts on the air using HF! I quote (almost verbatim) from one Club Chairman who highlighted the hurdles before his newer members like this – ‘We have an issue in our Club. FT817 is now £500!!!! Members cannot all afford £500 to go onto HF. FM 2m handheld £25. But the local area in West Wales is coastal and hilly, so repeater access can be difficult. Many not have CW skills nor much interested in that mode. I got into Ham radio by listening to ‘shortwave’, principally Top Band on Sunday morning. So maybe AM is ideal ...’

This made me get out the doodling notebook! Undoubtedly, generating low or medium power Amplitude Modulated phone signals on HF is very much simpler than attempting Single Sideband phone, particularly if the RF final stage is a MOSFET that will allow modulation at its gate and so avoid a watty power audio modulator that would have been used in years gone by. The receiver might also be somewhat simpler because it only needs an amplitude detector. But after that, choices have to be made for the kit designer! Who are the target customers? Is the objective to interest new Club members who have probably never built a radio before, who might be started with across playing field, or town, contacts; or is it for more experienced builders who will want a small portable ‘unit’ perhaps with good sensitivity and selectivity for DX? If the desire is only short range AM without adjacent strong signals, then a very simple plain Tuned Radio Frequency receiver will do – this can be made quite easily with only four MOSFETs! As soon as you want more selectivity while retaining adjustable tuning, & extra sensitivity, then a classic superhet with amplitude detector has merit. If it has also to receive SSB or CW, then you need to add a Beat Frequency oscillator. A much simpler alternative is to make the plain TRF into a regenerative TRF which will boost the selectivity and sensitivity as well as allowing copy of SSB/CW. This can still be done with four MOSFETs! Phone transmission can then start with a ‘crystal’ controlled RF oscillator followed by an output stage using a MOSFET whose gate bias voltage is driven by a low power speech amplifier. If 9 volt battery operation is desired, one BS170 can produce ¾ of a Watt of peak RF output (implying 3/8 of a Watt carrier for AM). A genuine crystal will have very limited pulling range but luckily there are standard ceramic resonators that can be used for 80 and 160m so being ‘rock’ bound is not quite the drawback of years gone by! Then you also need to decide whether to have a single dense PCB for RX and TX or well spaced out ‘seperates’ for the less experienced! Do they need large aerials – no; loops and loaded whips can be good! See the Gurney Slade later!

For those ‘rolling their own’ rigs, I detail Block 2 of the **Weston** project later on; good to hear that some of you are using these ideas! I am indebted to my contributors and do encourage any of you to write in with a note or to suggest topics that need an airing! 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, distributed by e mail, and is free to those who have asked for it. Just let me know you would like it by e mailing me at electronics@walfords.net

Kit Developments

What with Christmas and my day job, not quite as much development work has been possible as I would wish! I have done a fair bit of doodling about AM on 160m arising from the discussion on the first page but nothing new to report on the kit front YET! Meanwhile I do offer the **Rockwell** Regen TRF which does two bands, each of which has a choice of series or parallel fitting of their inductors so allowing it to be built for any bands of MW, 160, 80 or 40m! For those wanting an AM transmitter, the **Rimpton** is a simple phone transmitter for any of 40, 80 or 160m bands using either a crystal, or a 3.69/2 MHz ceramic resonator for a small tuning range using the trimmer. It produces 1.5W peak (0.35W carrier) on nominal 12v supplies.

I have done a bit more on the Somerton and Dorchester top of the range rig to try and reduce its complexity/cost. This concentrated on starting with a single band 40m design to which could be added 20 and 80m, or possibly 30m. 80m is awkward if the IF is an integer number of MHz, using a crystal mixing LO approach because it will need a less common X500 KHz crystal. One way to avoid this is to divide the LO by 2 for all bands, which does have the added advantage that a more symmetrical drive might be possible to both sides of a first mixer using switching gates; the LO scheme does then get easier but it still needs a double tuned band pass filter in the LO chain for each of the bands with crystal mixing. Add in digital frequency display and it soon gets far too complex compared to a digitally driven VFO using DDS with its own readout! I am afraid this makes the original S and D project unviable for me. However….!

It eventually dawned on me that if the configuration is a changed to a double conversion superhet using crystal driven converters for the first mixer followed by a conventional superhet with 500 KHz of tuning, then one can avoid having LO band pass filters for each band which is a considerable saving. I intend to explore this approach a bit more.

On other fronts I have done a PCB for a more powerful linear RF amp with bigger heatsinks but have yet to build the prototype – I suspect the heatsinks may cost more than the electronic parts which seems illogical for simple extrusions with a few holes drilled in them!

The **Mk 6 AMU**, with the toroids for much easier inductor construction, is now available. Here is another view! The switches each give a binary increase in inductance – it's quite easy to adjust because usually only two adjacent switches will be needed, so you can quickly flick on just any one and then maybe add the one next door for a slightly better match!

Tim G3PCJ

A very simple modular receiver – Peter Thornton

Working in semi-conductor manufacturing I often had to build test equipment, and this was always "modular" design: GHz bandwidth oscilloscopes, spectrum analysers, signal generators and the like had to be used for many different jobs - not possible to buy one for each transistor type to be tested! This influenced me when putting together the simplest possible frequency stable receiver shown below – it's a set of modules to make a "Direct Conversion" receiver.

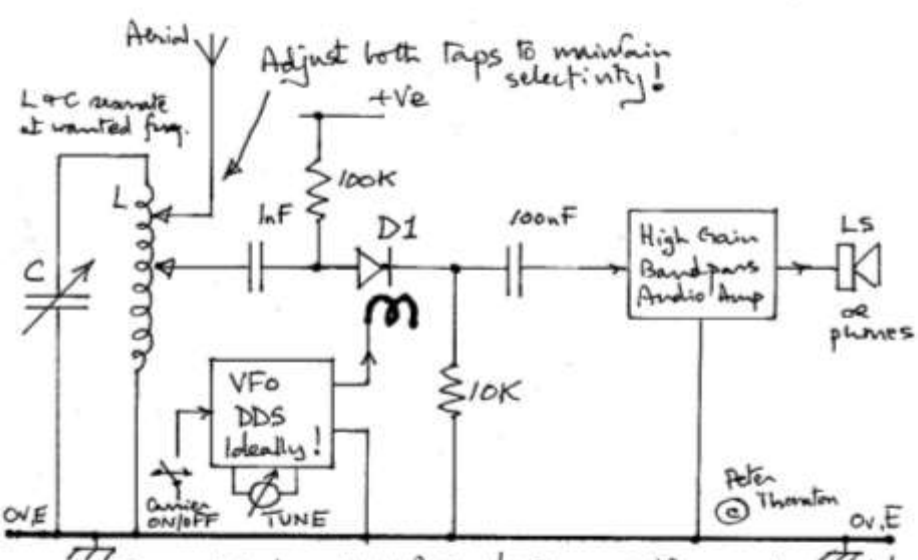
The first module, is the TRF module and detector. This has the tuned circuit for the desired reception frequency which also helps to eliminate broadcast breakthrough. I mounted the L and variable C in a PCB material screened box with a temporary lid. L & C are chosen to resonate to the desired listening frequency. The coil is provided with taps so that both the aerial, and the output to the diode detector, can be adjusted to prevent either of them excessively loading the tuned circuit and hence wrecking its Q or selectivity. Alternatively the aerial can be connected via another variable capacitor to reduce the loading on the resonant circuit. The detector is biased by the 100K resistor form any convenient well smoothed supply. I had three diodes to try: a plain 1N4148, a Schottky 1N5711, and a germanium 1N60. The whole section was built in a PCB material screened box

For the second module, I set up my bench audio amplifier, which has two (bridged tied) LM386's fed by a single stage bipolar transistor pre-amp, to give about 400Hz to 4kHz bandwidth with an overall gain of up to 70dB.

The third module is the VFO, which (in my case) is a DDS unit that is ultra-stable: any clean & stable VFO is suitable; as is a Variable Xtal Oscillator. The VFO signal is coupled to the detector diode by a turn of insulated wire near the diode, *not connected in any way*.

I tried all three diodes - the 1N4148 was noticeably the worst at any bias current. The 1N60 was good; but the 1N5711 had noticeably lower noise.

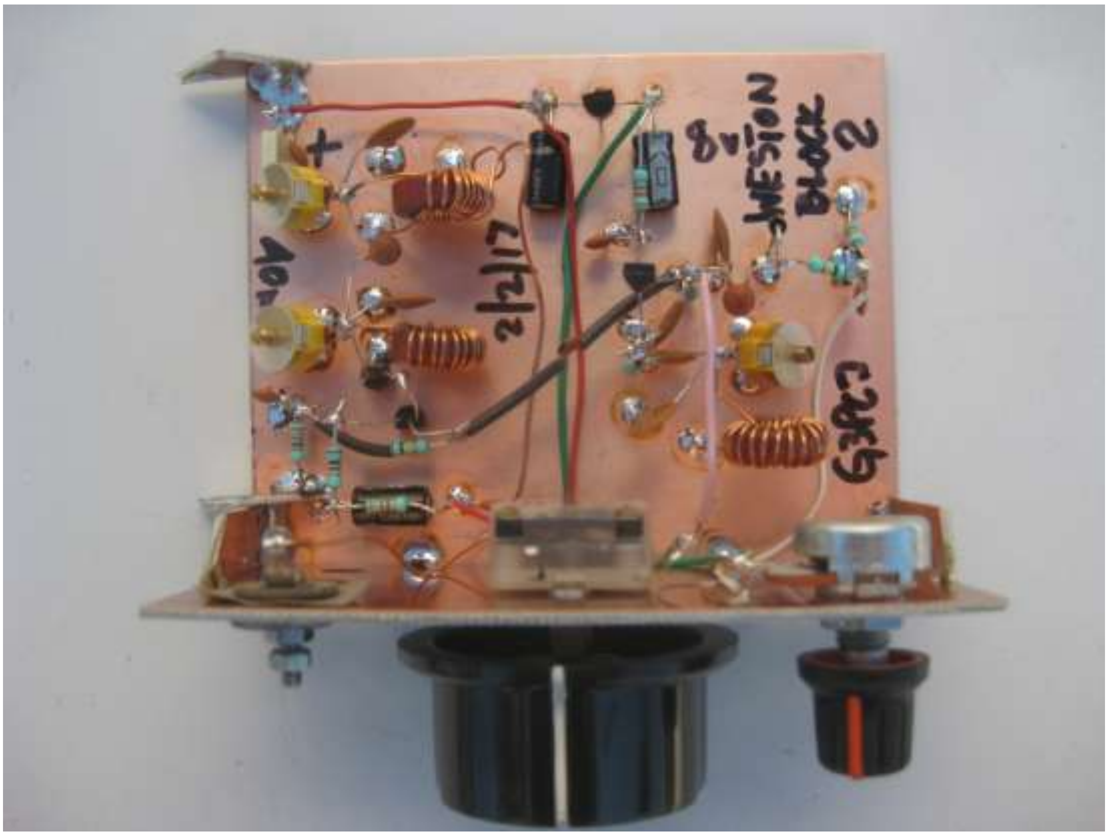
There you have it: a sort of amplified crystal set + VFO = Direct Conversion! Surprisingly sensitive, stable and drift free, it is just about as simple a receiver I can make. No doubt it could be improved with multi-diode mixers, filters, and so on: but it did what I wanted, no fuss, simple, adaptable for virtually any frequency. For HF use, the coil tap was best at ~ 10% up from ground, the low loading of the L/C circuit preserved its Q so eliminating the off-tune broadcast breakthrough. Broadcast short wave stations are a useful indicator of ionospheric conditions and they can be received by zero beating the VFO with their AM carrier.



The original method of CW/SSB reception - modernised!

The Weston Block 2

As explained last time, the aim of this project is to end up with a single band superhet built in easy stages with an interim version as a plain direct conversion receiver. Block 1 was the audio stages described last time. Block 2 adds the RF filters and a mixer (acting as a product detector), which is driven by a VFO operating at the desired band's frequency, for the DC RX. I have built mine for 40m as there is usually something to be heard at any time of the day! As before, my version is built in 'dead bug or ugly' construction style – its so easy and effective! Instead of it all being 'flat', I have added a small ready drilled PCB front panel (salvaged from some unsold kit) which will make operating the tuning controls rather easier. I might later change the AFG preset in Block 1 to a proper pot mounted on this panel after Block 3 (the IF strip) has been added. My Weston Block 2 below is a bit tidier than the other example of 'free construction' later!

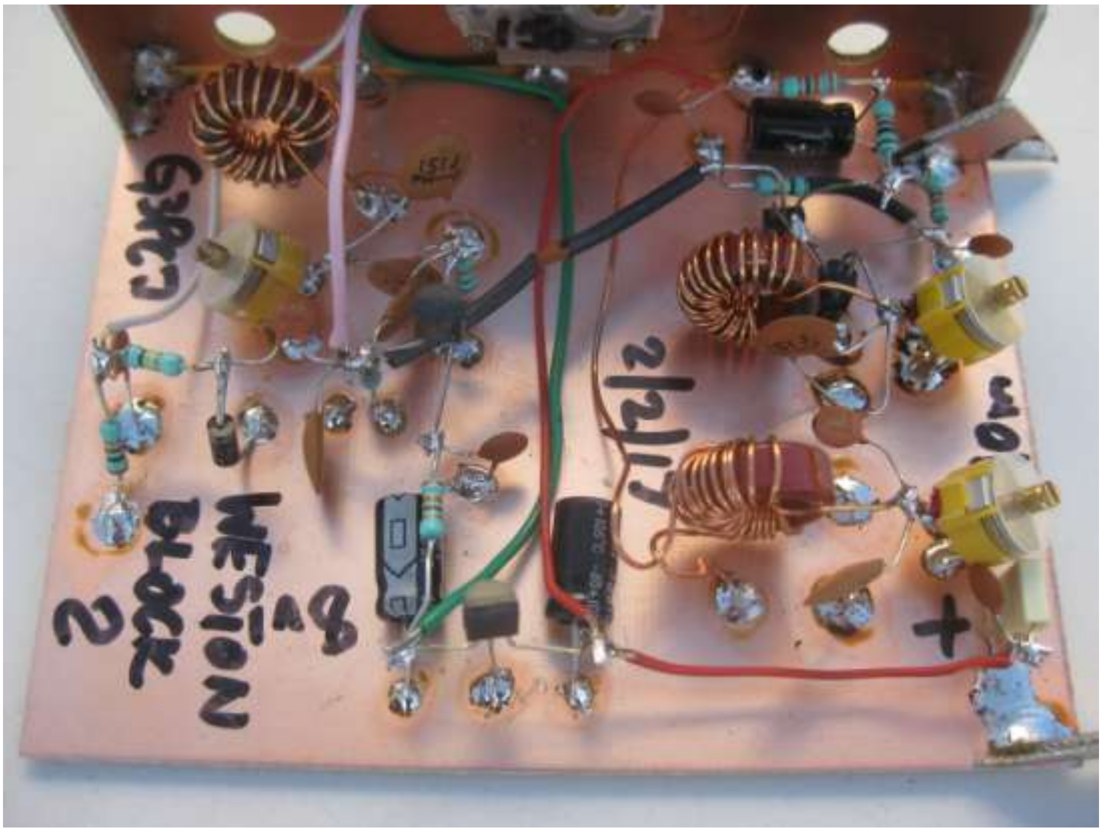


<u>Block 2 circuits</u>
The circuit (Fig. 200) of this block is shown on the next page. The weak signals from the aerial (in block 2A) are first passed through a double tuned parallel resonant top coupled filter whose task is to reject the undesired out of band signals. The first resonant circuit (L250 and C201/251) also acts as a step up transformer by matching the low impedance (typically 50 R) of the aerial feeder to the high impedance (several K) of the parallel tuned circuit. A turns ratio (between primary and secondary of L250) of 5 or 6:1 is a good starting point! The top coupling capacitor C252 is small – typically about one fifteenth (or less) of the main resonating capacitance (C201 plus C251) – make the coupler larger for a desired larger bandwidth, or smaller to reduce the coupling between the resonant circuits and hence a narrower band which might be needed where strong broadcast station signals are present not many kHz away - as on 40m! The second tuned circuit of L251 and C202/253 can directly feed the very high input impedance of the gate of the lower JFET transistor TR201 in the mixer. The other mixer JFET is driven by a large signal from the VFO.

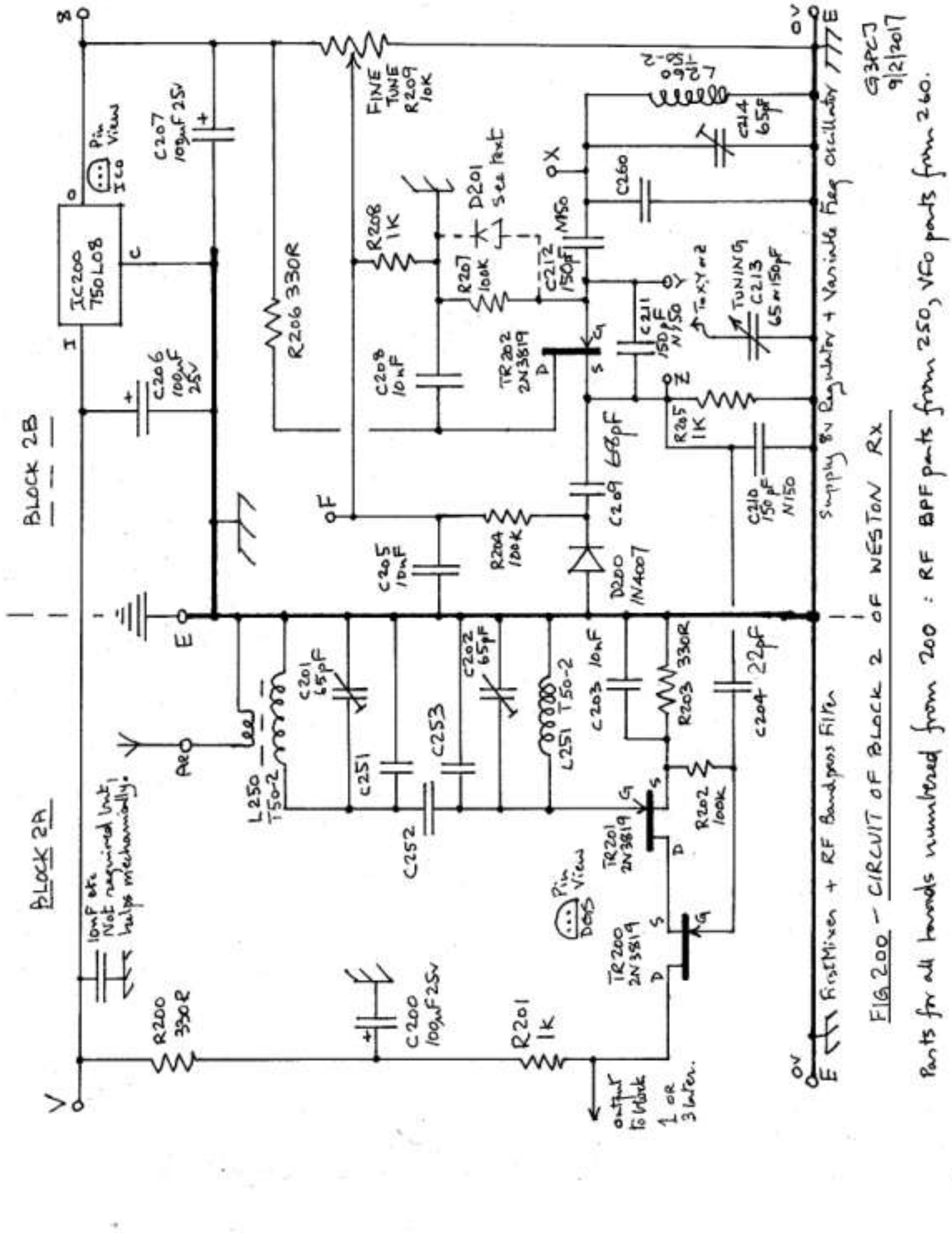
The output of the mixer is developed across the 1K drain load R201 with filtering by the previously omitted C120/121 of Block 1, which is now needed to limit the bandwidth to about 4 KHz. For my ears only one 22 nF was required at C120! I have drawn the circuit with 2N3819 JFETs but you can use other types such as J310 or 2N5459 but beware of their alternative pin-outs! Bear in mind that I have shown C251, 253 and 260 as single capacitors but for some bands they might need to be series or parallel combinations of a pair – see tables later.

In my model, block 2B uses a low drop out 8 volt regulator for IC200 which permits operation with down to a 9 volt supply. You can use the more common 78L08 regulator if you wish but this will need a minimum of 10 volts to the regulator! A stable voltage is particularly needed for the Fine tuning control voltage applied to D200 which is acting as a cheap varactor diode! R208 helps to linearise the action of the Fine control R209 that provides a few KHz of adjustment – this is needed because the main tuning of C213 is often too fierce without a slow motion drive. A Colpitts oscillator is used with N150 temp coefficient capacitors (at C210,211,212,260) for good stability and to provide several points X, Y or Z to which the tuning variable can be connected for alternative tuning ranges. Normally a diode would be fitted at D201 but is best left out here as the mixer TR200 needs a large drive from the VFO.

Resistors	330R R200, 203, 206;1K R201, 205, 208; 100K R202, 204, 207
	Fine Pot R209 – 10K – lin law with knob!
Capacitors	6p8 disc C252; 22 pF C204; 68 pF C209; 150 pF plain C251, 253;
	150 pF N150 C210, 211, 212, 260; 10nF C203, 205, 208;
	100 µF 25v electro C200, 206, 207
	65 pF yellow trimmer C201, 202, 214
	65/150 pF PolyVaricon tuning cap C213 plus hardware and large knob
Inductors	T50-2 Red toroid L250, 251, 260; 1m 24 gauge enam wire
Semicons	1N4007 D200; 2N3819 TR200, 201, 202; IC200 750L08
Hardware	Copper clad fibreglass board – min about 80 x 100 mm plus front panel to suit



Weston Block 2 circuit



Testing Weston Block 2

I suggest start by mounting your tuning capacitor; if you have an air variable of about 50 to 100 pF this will be better than a plastic PolyVaricon for C213 but even if your junk box is lacking the exact value, it does not matter too much because the Colpitts circuit has three points to which it can be connected, depending on the tuning swing that you want. You may also want to add a slow motion drive! (As a bit of general advice, buy any old air variables in reasonable condition whenever you see them at junk sales – new ones cost serious money!) Start building the circuit with the 8 volt regulator IC200, the decoupling capacitors C206/7 and the Fine tuning pot R209 which will discharge the circuit when switched off. Note that the low drop out type of regulator 750L08 does need a much larger capacitor on its output to prevent oscillation, so be generous with a 100 /uF! Check its output and then build/test the VFO section. Bear in mind you will want to alter the inductors and fixed tuning capacitors (L260, C260 most likely) when you change from DC RX to superhet with Block 3 next time, so give yourself a little more room for this part of the circuit. Start with the basic parts of the Colpitts VFO leaving out the Fine tuning parts R208, C205, R204, D200, C209 and the connection to the tuning capacitor. At this stage the VFO is to operate at the desired band frequency – the table below shows the values that I used for 40m with suggestions for the other HF bands.

	L260	C260	L251	C253	L250	C251	C252
	T50-2	pF	T50-2	pF	T50-2	pF	pF
40m	2 uH = 19t	150 single	20t	150 single	20 + 4t	150 single	6p8
20m	1 uH = 14t	75 =2x150S	15t	75 =2x150S	15 + 3T	75 = 2x150S	3p4 =2X6p8S
30m	1.7uH=16t	75 =2x150S	18t	75 =2x150S	18 + 3T	75 = 2x150S	3p4 =2X6p8S
80m	4uH = 30t	300=2x150P	32t	300=2x150P	32+6T	300=2x150P	13.6=2x6p8P

When winding the inductors, it is sensible to leave the ends long enough to add a turn on each just in case more inductance is actually needed – it can always be cut off when you know its not required! Start each winding by sliding the toroid to the middle of the core and then put on the rest of the first half of the turns required – bearing in mind that each time the wires goes through the middle it counts as one turn. Finish the winding off by using the other end to apply the other half of required number of turns. The turns should ideally occupy about ¾ of the circumference – spreading them out or bunching up as required. For the extra primary winding of L250, this can be wound over the earthy end of the larger secondary winding, with the two primary ends twisted together to identify them. If you do not understand the suggested combinations of single, or series/parallel of two capacitors for each of C251, 253 and 260, then ask me or any nearby more experienced person. The VFO inductor has slightly less turns to make up for the increased 'fixed' capacity in its part of the circuit compared to the simpler RF filter resonators.

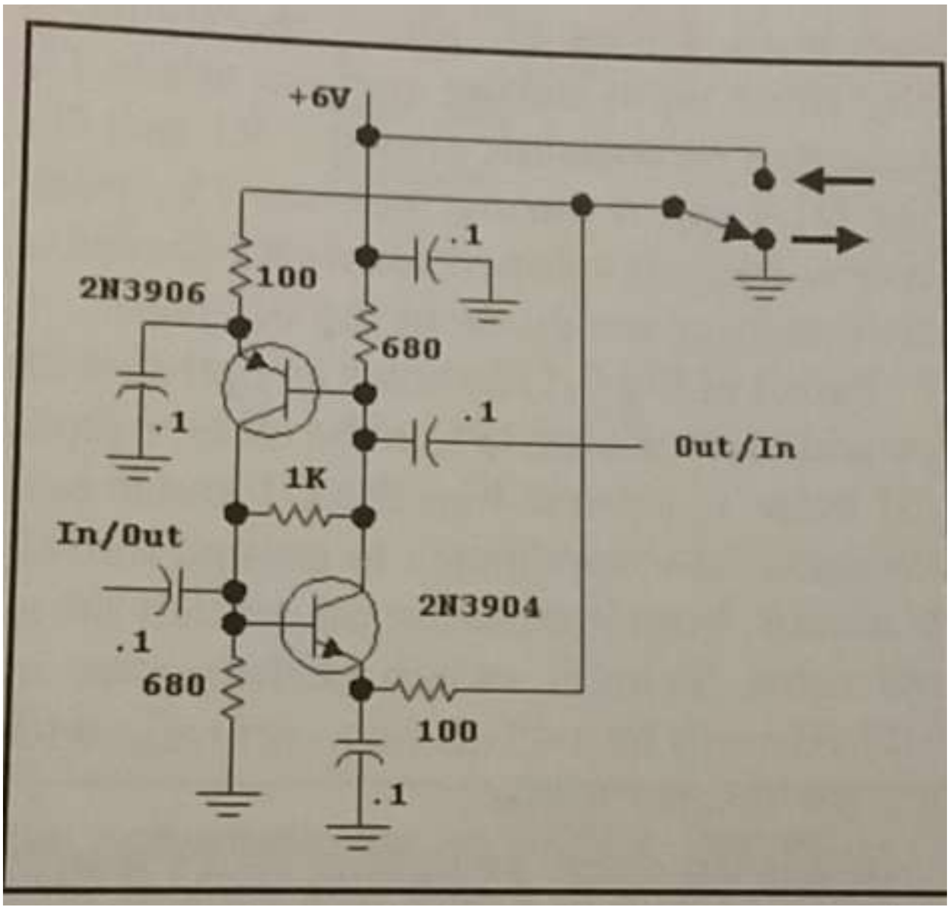
Once the VFO is assembled, you can use a counter connected via divide by 10 probe to point Z or listen for it on a nearby general coverage RX. You can also check it is actually oscillating by temporally grounding point X to stop the oscillator which should make the DC voltage across C208 change very slightly. There is a fixed minimum capacitance of 50 pF from the series value of C210/211/212 which must be added to say 30 pF (half value) from C214 to decide what is needed at C260 to make L260 resonate at band frequency. Use the trimmer C214 to bring the centre of the tuning range to your desired band centre. Once oscillating near band centre, try large or small sections of the tuning capacitor C213 connected to whichever of points X, Y or Z gives you the desired tuning range. X will have the largest swing and Z the least! You can then add the Fine tuning parts R208, C205, R204, D200, & C209. The role of R208 is to help improve the linearity of the Fine Tuning control.

After this, add the RF bandpass filter parts, with the same cautions about winding the toroids L250/251. You will find that when you install C204, the VFO frequency will go down slightly so use C214 to bring it back to band centre. There is nothing to adjust in the mixer, the only items to be adjusted are to bring L250/251 to resonance at band centre by tuning in some signal steady in amplitude and frequency, and then adjusting for maximum signal output from Block 1. See the earlier comments about fitting the Block 1 input filter capacitors C120/121.
As this is a DC RX, you will hear either sideband of signals; next time we change it to a superhet!

My favourite circuit by Pete Juliano N6QW

As I penned this article I almost felt like a school boy some 60 years ago, when a school assignment was to write about a favorite holiday, or a favorite summer vacation. Or like once where the subject I selected was My Favorite Girlfriend. That did not turn out well. But nowadays it is serious electronics projects.

I think we can all relate to a favorite circuit and the favoritism frequently is associated with the simple axiom – it works, it always works and it is my go to circuit. Lurking in our minds is that well if we only use this circuit, we will never learn anything new or we will never advance the state of the art! We have a great word on this side of the pond which I now will express "Baloney"! There are plenty of opportunities to add state of the art features to our rigs and thus the projects do not end up being cookie cutter. But at the heart of the issue is known performance and the favorite circuit acts as the anchor for the project. OK I gassed enough - here is my favorite circuit, which I first came upon in the publication ARRL's Experimental Methods in RF Design (EMRFD) by Hayward and others. Notably the circuit was designed on the other side of the pond by Plessey for use in back pack radios. This circuit is a bilateral amplifier stage that uses but a few parts (cheap parts to boot) and operates in two directions with a simple changing of how the circuit is powered. Put the voltage at one port and it amplifies left to right and reapplying the voltage at another port and the amplification is right to left. The stage gain is about 17 dB both ways.



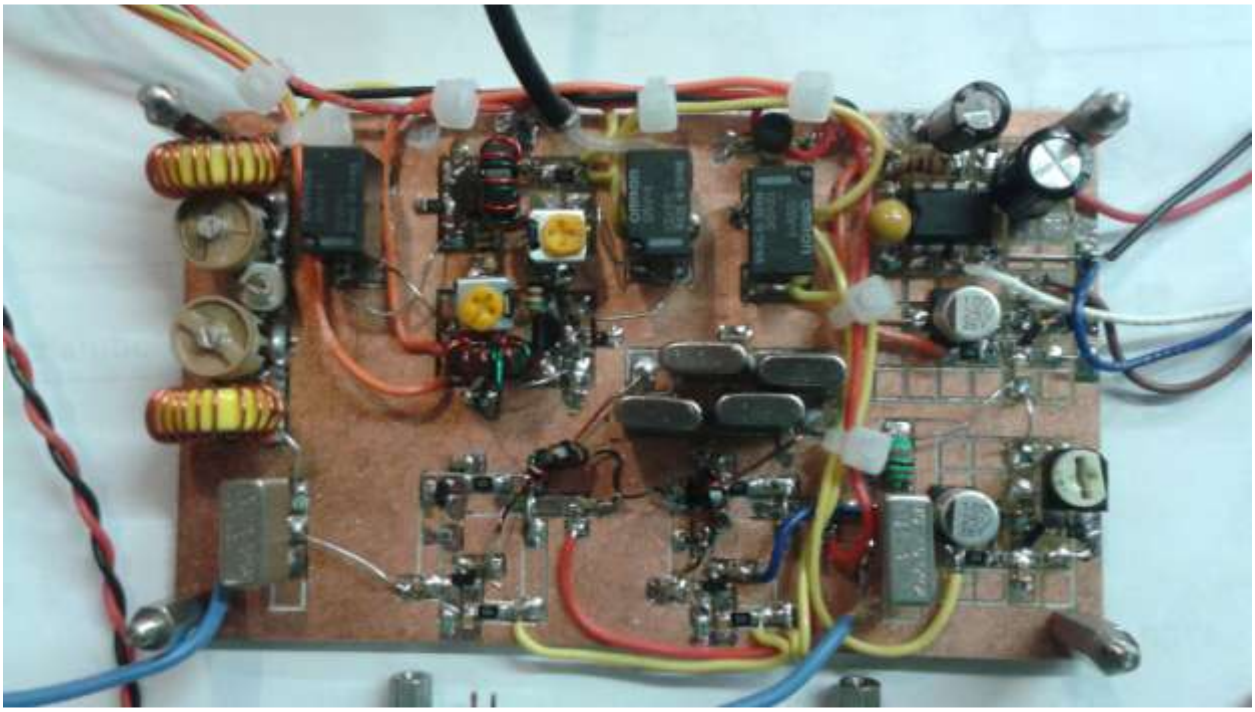
My favorite circuit has become a building block in most of my current crop of SSB transceiver projects. The circuit is basically a pair of complementary transistors that work only at one direction at a time. For those who have EMRFD it is Figure 6.110. This truly must be the worlds' best kept secret. The textual info in EMRFD says this is good through the HF range!

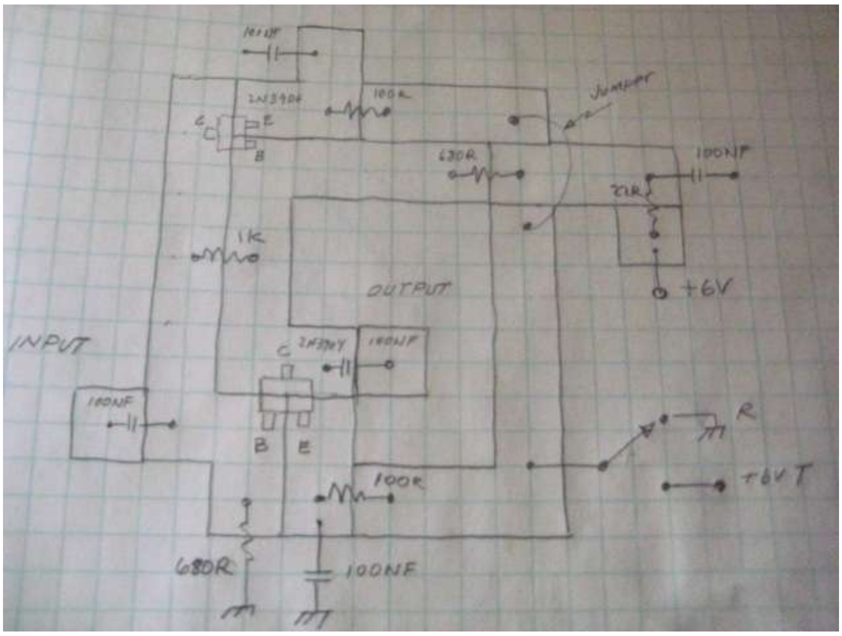
Imagine having one of these stages ahead of and following a crystal filter. Now you will need some matching so for a homebrew filter I match 50 to 200 Ohms and this is done with six bifilar turns which gives a 4:1 match. For a 500 Ohm filter (like the GQRP club filter) I use a single winding of 19 turns tapped at 6 turns (19^2 = 361 and 6^2 = 36, 361/36 = 10:1). Ahead of and following this stage are SBL-1's or TUF-1's which of course, are double balanced mixers (DBM).

The advantage of this architecture is that the 1st DBM takes the LO input so in effect becomes the Rx and Tx mixer stage. With the DBM on the back end it is the Product Detector on Receive and the Balanced Modulator on Transmit. At this DBM port we inject the BFO (Carrier Insertion Oscillator) signals. There is no RF switching of LO and BFO signals with this scheme!

So now think a bit how few components there are in this IF module which forms the heart of a SSB transceiver. Now you perhaps can see the why of my favorite circuit. I have built the circuit with leaded components as seen below in my shirt pocket 20M SSB transceiver (2" X 4" X 2"). Sitting right behind the amp board is a 4 pole 4.9152 MHz Crystal Filter. The signal direction change biasing is done with the small relay shown at the top corner. The two circuits are shielded. At either side are ADE-1L DBM's

I have also built this same circuit using surface mount parts which I found to be even cheaper than the leaded components but SMD is not every one's cup of tea. Here is the info for those with a stout heart (after drinking a lot of stout). This has a lot more circuitry on a board 3 X 5 inches; but shows the amplifiers, the crystal filter (a commercial unit from INRAD at 9.0 MHz), and the two TUF-1 DBM's. Also on board are the microphone amp, and audio amp, the band pass filter ahead of the 1st DBM and a two transistor bi-directional amp that has one leg for the Rx RF amp and the other leg as the Tx Pre-Driver stage.





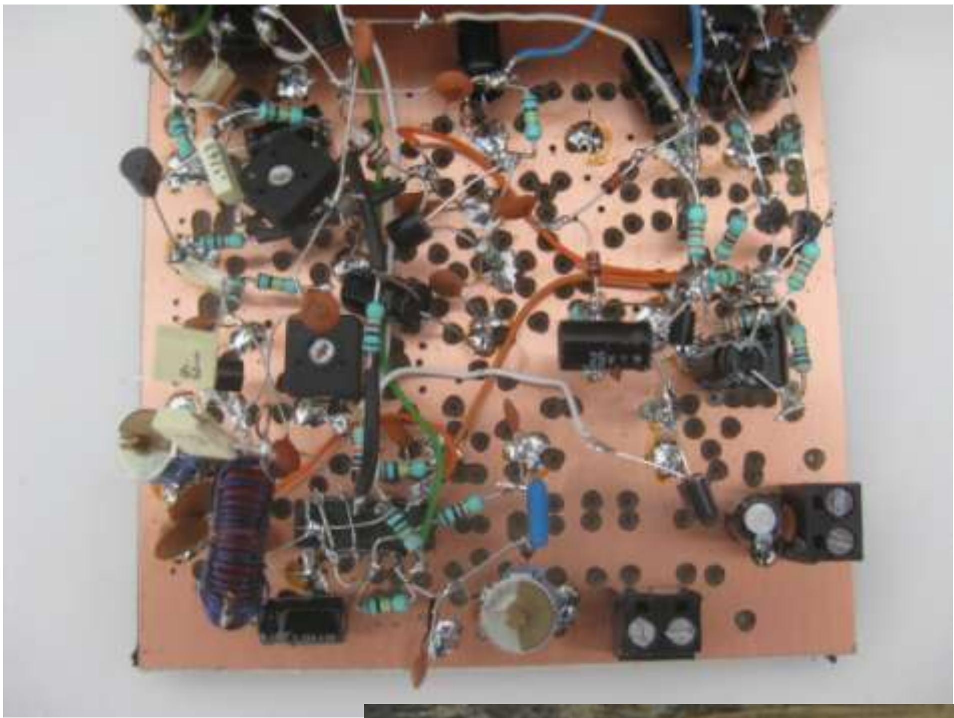
Below that is a sketch of how I initially laid out the amp using SMD parts using graph paper. This sketch was later translated to G Code using the free drawing package G Simple and then, using my CNC Mill, I made the board. No, everyone does not have a CNC mill in their garage; but the sketch above could be translated to a drawing for etching using the Chuck Adams, Muppet Board technique and you are there.

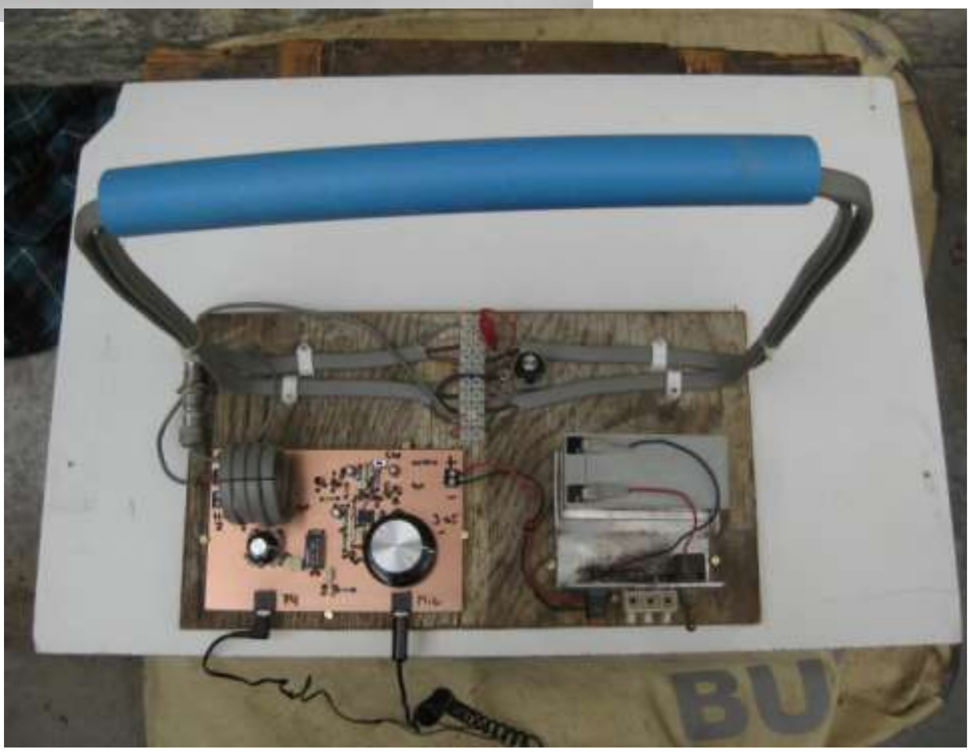
Quite honestly I believe the SMD version works a bit better as everything is tight! There are currently 10 transceivers I built using this circuit –so I guess it does qualify as "My Favorite Circuit"!

73's Pete, N6QW email: n6qwham@gmail.com

Snippets

Here is a shot of my latest 160m AM TCVR rig which I hope will become the Gurney Slade. It is not tidy and would not be any good for taking up a mountain but for development purposes, this style of construction on a copper ground plane is absolutely fine! This one looks a lot worse than it need because I used an old unsold PCB that had been drilled and countersunk – it might just as well have been a plain copper sheet. It is so easy to alter or add to the design, and with a little more care, can actually be made quite tidy and robust! It does not show up so well but the RF output tank in the bottom left corner has multiple taps for long or short top band aerials! This particular version also has an extra two audio output buffer stages in the top right, so that it can drive both sides of stereo phones when their common lead is actually earthed. The RX is mostly in the front right of the picture, with the transmitter RF oscillator and control chip near the trimmer at bottom left, and the speech amplifier in the top left.





Don't be put off the use of 160m because you lack garden space! It is surprising what you can do with a magnetic loop aerial with a single or multiple turns. More on this next time – the carrying handle shown right has up to 8 turns and is resonated (on 80m in this example) by a small variable just above the battery! G3PCJ

Keep the Hot Iron topic suggestions coming please!