ZL2BMI SSB Transceiver 160 – 40m or more   July 2019

How it happened

For more than 30 years I have built DSB transceivers for “tramping” (backpacking, hiking, depending on your country!) in New Zealand – and two of these have appeared in Sprat.

Recently I wanted to build another one using the new DDS from OzQrp, which is the smallest DDS I have been able to find. But having bought it, I wondered how hard it would be to do SSB instead, so I drew up a block diagram. It turned out that I needed to add just one NE602, a homemade filter and a DPDT relay to my DSB rig to achieve SSB. How hard can that be!? While I did it from a block diagram – others have done similar designs.

The circuit

The heart of this radio is the DDS from OzQrp – capable of both a variable frequency output (vfo) and a single fixed frequency (bfo), both in the range 100kHz to 100Mhz. Rather than trying to switch the inputs and outputs of the mixers as some have done, it is easier to switch the bfo and vfo frequencies with a simple relay. Solid state switching (eg 4066) can be used but turns out to be a bit more complicated and only saves a few mA.

The rf and af amps are basically the same as in my previous DSB rigs.

In essence, on receive the first 602 mixes with the incoming signal to produce the IF. This passes through the filter and is demodulated by the bfo frequency to produce the audio.

On transmit the bfo and vfo are swapped so the the first 602 produces the DSB signal which is passed through the filter, then mixed in the second 602 to produce the wanted frequency.

Purists will immediately want to question the lack of filtering in the rig, and I understand this. I have done some tests with other close hams, to check particularly on image or mixer frequencies, and they could hear none (but read on!).

Let's just consider the transmit path. The NE602 is a balanced mixer (not double balanced the way I use it). Whatever is injected into pin6 is very reduced at the output.

For the first 602 all that comes out of pin 4 is two sidebands (12Mhz in my case). Any audio present is unimportant – and would be shunted to ground by T1. One sideband is removed by the filter. To produce an 80m signal, the 12Mhz sideband is mixed with 15.5Mhz (in the second 602) to produce 3.5Mhz for example. The 15.5 Mhz is balanced out.

Presumably this leaves 3.5Mhz, 12Mhz and 27.5 Mhz. Because I am using a tuned aerial, and the amplifier does not work well above about 15Mhz, very little signal above this frequency would get out. Tests done with a simple plug-in external LP filter for 80m (just one inductor and two caps) shows that it reduces the 12Mhz IF signal from 20dB down without, to about 40dB down with the filter. The 27Mhz frequency, already very low, is further reduced. An aerial tuner further reduces any unwanted signals

At the times when the band is open for qrp at 80m, its usually not really open at the higher frequencies anyway. Using such a rig in the bush with a simple filter, 5 watts and a dipole cut for 80m is unlikely to cause any problems with mixer products or harmonics.

Shortly after finishing the prototype I had a 5/9 report from Eastern Australia on 80m (about 2000km path), so I have been pleased with it. But its not really for rag-chewing, its a communicator for when I am away in the bush!

Extra switched or plug-in filtering before the rf amp might be desirable in busier locations than NZ, and a better filter on the end would be useful. This is just a bare bones circuit.

Notes:

1. The DDS – these are available from Leon, who I have found good to deal with. Extremely simple to assemble – basically just adding hardware. If a future version enables another fixed output – it could have selectable LSB/USB. (More further on). The 22R resistor in the power supply can be lowered to about 10R, but there is some “noise” from the DDS which comes back along this line. A larger cap also helps – or larger on the NE602 power supply.
2. L1 – about 40t with 6t link to aerial as used in DSB. Combined with C it is the front end tuning. If you only want 80 or 40m, just switch capacitors. With 50 turns and a plastic broadcast cap I cover about 3 – 10Mhz as a preselector.
3. Tr1 is any NPN transistor (eg BC338 etc.), which shorts the input of the receiver to ground during transmit.
4. Mic – Originally a carbon mic (simplicity!!), but now superseded by a simple electret mic circuit. Some electret insert don't work well. I found the slightly dearer ones sold in lots of 18, from China are very good.
5. The filter – this took many hours of measurements to achieve. The DDS was used to check the passband.If the filter does not matched the impedance reasonably, the passband with suffer. I ended up using the low profile 12Mhz crystals from Aliexpress suppliers. It started as a Cohn filter, but needed extra capacitance in the middle to narrow the passband (about 2.7khz at 3dB). Matching with resistors seemed rather lossy, so the small transformers are tiny ferrite beads with fine wire and 10 turns tapped at 4. Suppression of the unwanted sideband is about 35dB – which is fine for me. To listen to USB (for mountain radio forecasts in NZ), I have a switch which shorts the output and input of the filter – DSB! Simple! Or just change the bfo freq in the DDS. The books say the crystals should be withing about 50Hz of each other - but other info was that it is not all that critical. +/-100Hz will probably do.
6. Audio Amp – Note that I have replaced the 3V9 zener previously used with 22R, though lowering it to 10R may be better. Note also that the 5R on pin1 adjusts the gain, and sometimes needs a higher value to prevent oscillation. Some cheap Chinese 386's need a much higher value! This circuit has about 70dB gain.
7. RF Amp – as used in the revised circuit for the DSB rigs. T2 is about 18turns of fine (34-38swg) wire tapped at 4 turns on a small ferrite bead. T3 and T4 are wound on a larger ferrite bead (these also from China and very good), about 6mmx4mm with 3mm hole. T3 is 24 turns tapped at 8. T4 is 8 turns bifilar. TR2- the best I have found is MSP6531 but 2N2222 works reasonably or some other transistor with high Ft. TR3 -this is the hard part! I use some good 2SC1971 from China (these were original parts – some were ex-equipment with short leads). You will need to find the best rf transistor you can get. Others like 2SC2166, or some of the good MRF types will be ok. I get 5watts or more with the 1971. Or you can use your best version of an IRF510 amp. I left some of the beads with Graham Firth when I visited UK recently.
8. There are various other small addenda - eg there are 100ohm load resistors from output to gnd for the two DDS outputs. Also there is a 470uF bypass across the

power supply at the T/R switch.

This circuit will be “too simple” for some – and I know improvements can be made – but my needs are for small, lightweight (140gm) for backpacking. Plug-in filters are needed for each band and I have not actually tried it much above 40m. I know it does about 2 watts at 20m – except that the filtering is then more of a problem. Note also that with the mixing arrangement I am using there is then sideband reversal. You will need to experiment for other bands.

The final outcome was:

Case size - 80mm x 80mm x 37mm

5 watts PEP

Transmit - 160, 80, 40 metres

Receive – continuous from broadcast to above 15 mHz (needs better front end tuning).

Also receives AM broadcast band for weather forecasts (but only 10Hz tuning steps!)

Could be easily adapted to your own vfo/bfo arrangement.

12Mhz IF was an attempt to separate the image – could go higher. I have built a 16Mhz filter from low profile crystals that seems fine. With the DDS its a doddle to change filters.

A lower IF frequency would make it easier to use a straight LC vfo – but probably best just for 80m – though with the current sunspot cycle that's mostly fine.

All best wishes with the building.

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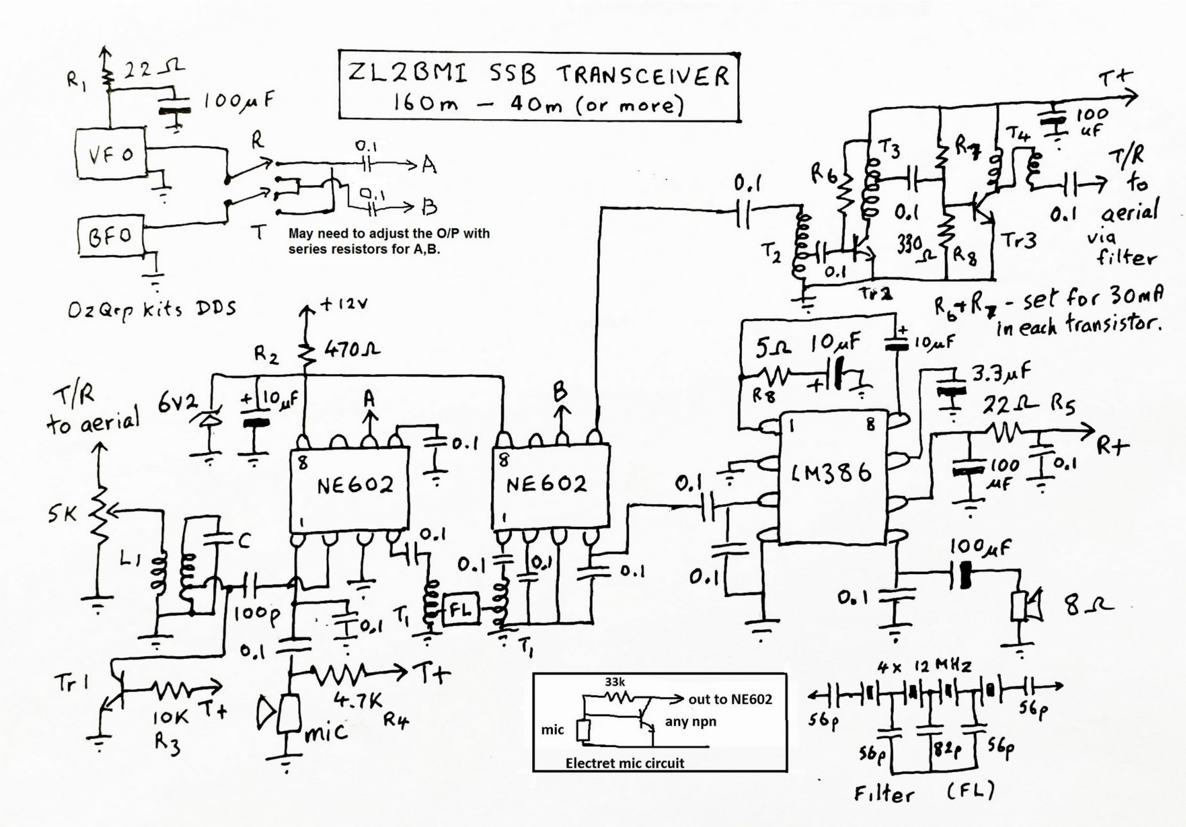
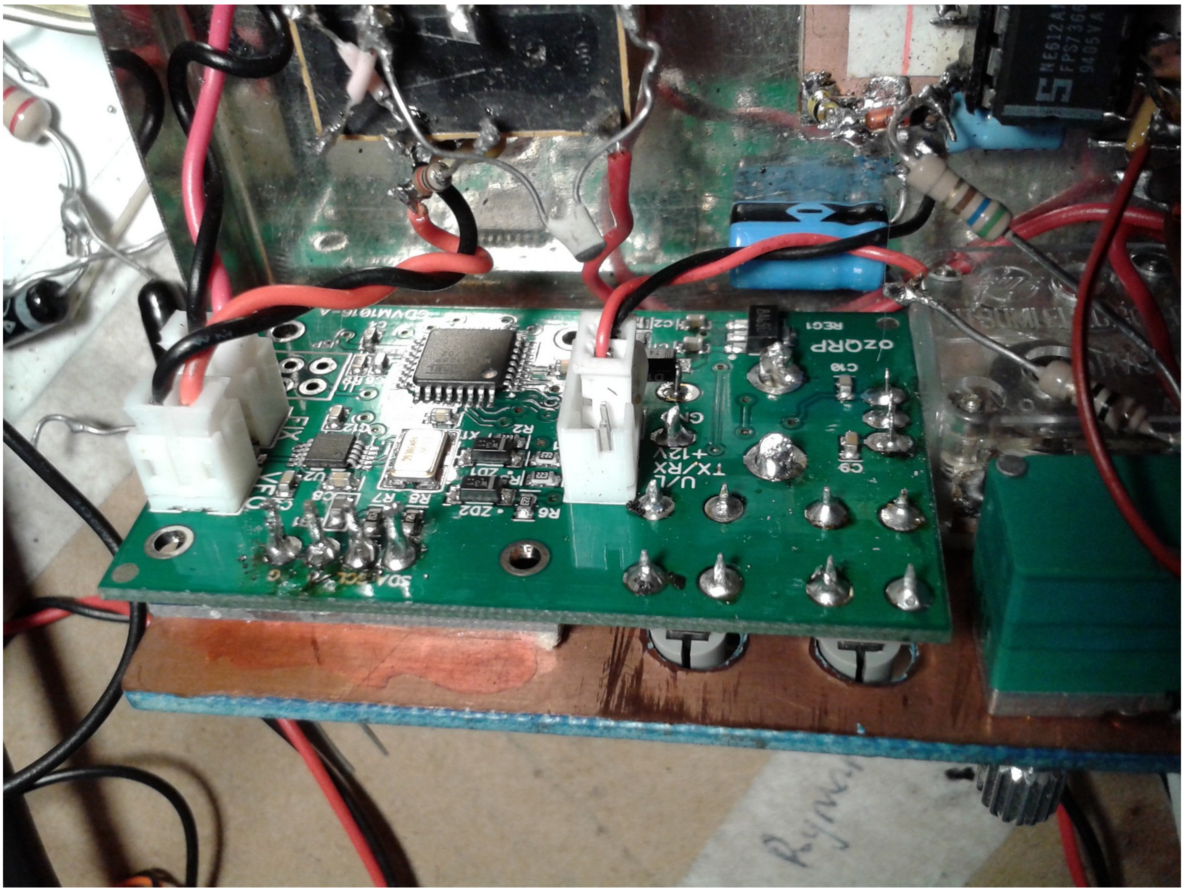
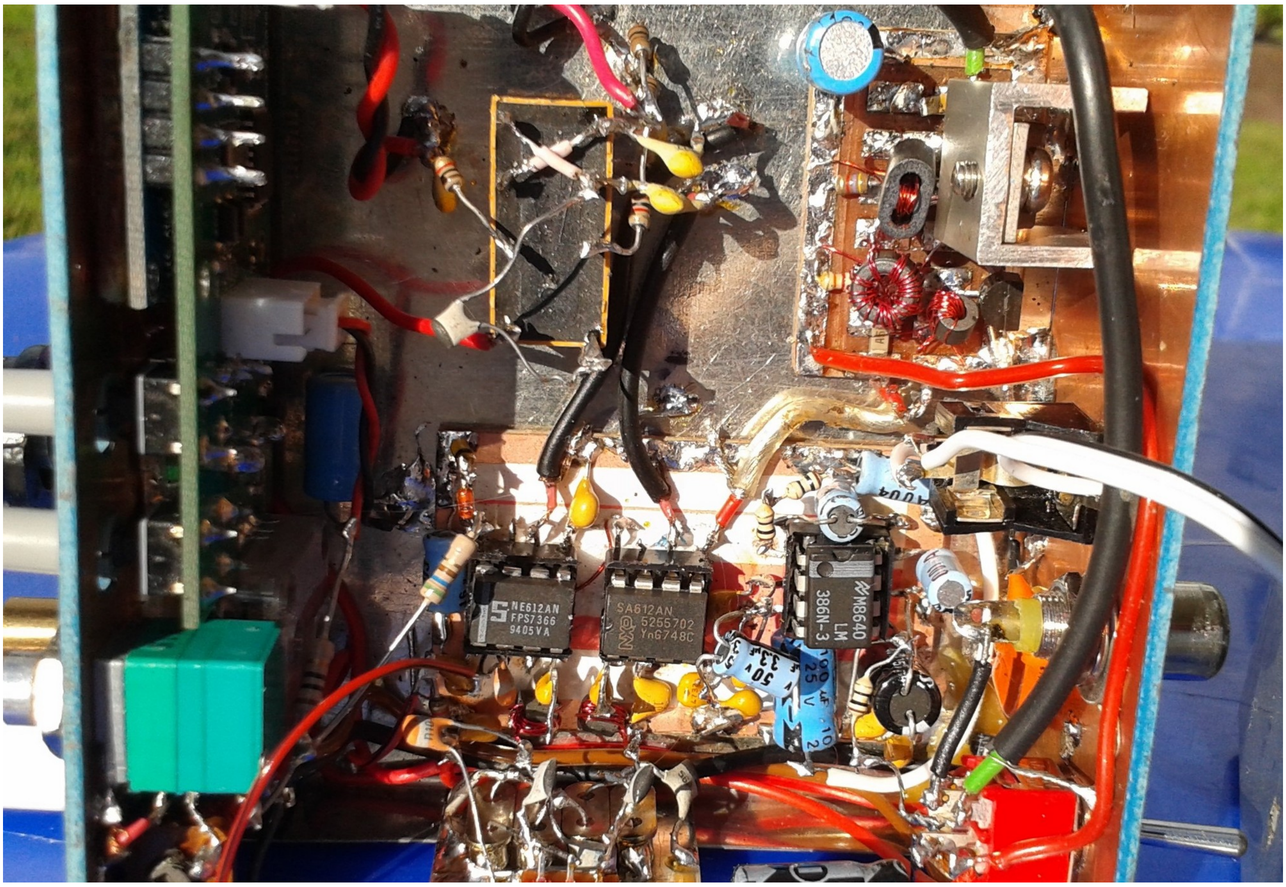


Filter with shorting switch at the top.



The OzQRP DDS board.

Front view with Mic



Inside layout