Building a W1GHZ-based 3.4 GHz Transverter

23 June 2011

My web page **Building a W1GHZ-based 2.4GHz Transverter (http://www.vk4adc.com/web/index.php/microwave-projects/63-transverters/142-building-a-w1ghz-based-13cm-transverter.html)** tells most of the story about using the W1GHZ boards but a few facts pertinent to using these transverter boards at 3.4 GHz come to mind.

The assembly of the pipecaps onto the board is described in the other article but when you see the images, you may ask why I didn't cut a suitable thread in the top of the pipecap and soldered a nut to the top instead. It is actually quite simple : I didn't have a 5mm tap to cut the thread !

The original article also refers to heating the pipecap, tinning the bottom edge then heating it again with it placed in the correct position on the top of the transverter PCB and waiting for the solder on the pipecap edge and the solder coating on the board to melt and merge. I used a liberal supply of solder externally around the cap to ensure an electrical joint as well as a mechanical one. There is no way I can mechanically knock one of those pipecaps off the board....

The probe length in the pipecap filters is reduced to 11.0mm for this frequency, the 11mm being measured from the bend in the "L' section so that when the probe is inserted into (and through) the PCB, it actually protrudes about 9.5mm into the pipecap's cavity. Once the probe is soldered to the PCB, the horizontal piece soldered to the PCB trace is shortened to about 2mm by being cut off with sharp pliers.

The mounting of the components is the same as for the 2.4 GHz version except for the placement of the 18pF bypass capacitors along the choke segments. The only other exceptions are the use of an ERA-2 in the second stage of the LO chain - instead of the ERA-1 as used at 2.4. The other is the substitution of a GALI-39+ for MMIC A2 in lieu of an ERA-2 as the GALI device has about 4dB more gain at this frequency. A thin strip of tinplate was placed across the PCB earth lands, side to side across the gap and the GALI-39+ soldered to it then to the input and output tracks.

Again, I mounted a 78L05 at the receive preamp voltage feed point so that I could supply it with +8 or +12 without cause for concern about over-voltage. A couple of 1uF SMD capacitors were added at the pins to ensure regulator stability and minimise noise.

My Si4133D synthesiser board was set up to produce 1627.500 MHz on the RF1 port (separate article : **Using The Silicon Laboratories' Si4133 Synthesiser Chip** (http://www.vk4adc.com/web/index.php/general-projects/34-frequency-stabilisation/81-xlocker-si4133.html)) so the LO chain only needs to double this to 3255.000 MHz to work with an IF of 145.0 MHz for 3400.000 MHz operation.

The hardest part of getting the transverter board working part is to get the pipecap tuning close. The physical comparison against the 2.4 GHz version is very interesting too. Note that the dimensions given below are the depth of the screw into the cavity as measured from the upper side of the pipecap - not the inside dimension / length. The physical LO tuning point will be determined by the IF used thus the actual separation of the LO frequency to the actual frequency. Using a 430 MHz IF would mean a much lower LO (nearly 300 MHz) so the screws would be further in the LO chain pipecaps in that case.

In my case, the screws used were 5mm thread x 40mm long (the length is always measured from the threaded side of the head down the length of the screw & not the top of the screw head) so the values tabulated below were the lengths subtracted from 40mm.

The screw lengths for 3.4 should really be 30mm to keep them from protruding too far above the pipecap. A 25mm screw is not quite long enough when using the soldered-nut plus the additional locknut approach with the construction. Tapping the pipecap hole and one locknut would be ok for 25mm though...

Screw Insertion into the Pipecap (mm) :	RF section	LO
2.4 GHz	22 Common - 23.5 Tx	24
3.4 GHz	17.5 Common - 18 Tx	18.5 - 19

This is the screw protrusion using 40mm long screws on the pipecaps at 3.4 GHz. The front two are at RF, the back two are LO.

This is the screw protrusion using 40mm long screws on the pipecaps at 2.4 GHz. Again, the front two are at RF, the back two are LO.

They are obviously inserted further into the pipecap cavity as less is visible externally.

Now side-by-side to make it easier to see how the relative insertion/lengths compare (Note : all are 40mm long screws).

Update 25/6 : A new set of four 30mm long screws were cut down from the original 40mm ones and then replaced one-by-one in the transverter pipecaps while in transmit mode, peaking each screw back to the original RF output reading then locked off. The "new screw" protrusions above the pipecap body(/top) are now about 11mm (LO) to 13mm (RF) to the underside of the screw head.

The reason I have given the physical tuning points is that if you don't have any real test equipment for 3.4 GHz (and not many of us newbies do), how do we get it tuned up on frequency ??

I used my little RF power meter (as described in the 2.4 article, link above) on the LO test port and alternatively / simultaneously screwed the two LO screws out from the "fully-in" position until I saw a slight rise on the power meter. I then peaked each one for a maximum - ending up with about a -1dBm level indicated at the overall peak. I then used my new **4GHz divide-by-prescaler** (http://www.vk4adc.com/web/index.php/microwave-projects/64-test-equipment/145-4ghz-prescaler.html) to measure the frequency : 813.750 MHz. Calculator to multiply by 4 = 3255.000 MHz. I was tuned to the correct harmonic, simple though as I was using a high LO injection frequency. For instance the next harmonic would have been near 4.9 GHz. People using lower actual LO's and higher multiplication are more likely to get it wrong.

The signal source used to test the receive section was my 1GHz signal generator set to 850.025 MHz with the output level set to about -20dBm. (I don't know what the harmonic content of this generator is at 3.4 GHz but was about to find out !). I started tuning out the "common" pipecap screw - the only one used on receive and with +8V into the on-board 5V regulator and the IF output connected to the transceiver set to 145.100 FM. A number of turns later, the sig gen became audible in the receiver. It was duly peaked and locked off. To confirm that the receiver was in fact on 3400.100, I changed the sig gen to 680.020 MHz then 566.683 MHz and finally 485.7285 MHz and each time I could hear the sig gen in the IF receiver. If I could hear it on all of the above frequencies, the receiver had to be on 3400.100 - else I would not have been able to hear the (respectively) 4^{th}, 5^{th}, 6^{th} and 7^{th} harmonics of the sig gen !

The transmitter section was next. The sig gen was connected to the IF port, set to 145.100 and 0dBm output and the +8V connected to the transmit line instead. The small RF power meter was connected to the transmit output port and set to the low range (< 0dBm). The "transmit" pipecap was slowly wound out from full-insertion starting point until the meter started to rise. Once it was peaked, the "common" pipecap was re-peaked as were both LO pipecaps. It is very easy to optimize these settings when you are watching an analogue meter (for RF power) and certainly far easier than watching a signal meter on a receiver or a DMM.

The accuracy of my little power meter at 3.4 GHz is a complete unknown but it showed me a reading equivalent to about +11dBm off my calibration table. Was I sure it was actually 3.4 GHz though ? I held my little pre-scaler board's input near the termination and the counter displayed 850.025 MHz. Yep, multiply that by 4 = 3400.100 MHz. After a little more tuning optimisation work, the output level was indicating around +17dBm at 0dBm IF input.

There is still a lot of work before it is finished off and useable in practice by providing a higher output level (i.e. including an RF power amp and antenna changeover relay) but the basic building block is there. By the way, how long did it take to put all of the components on the board and run the board up (with pipecaps already soldered on it) ? About an hour and a half !!