Updating a 2.4GHz DEMI Transverter Local Oscillator

29 July 2011

Recently I was approached by a local amateur about drift in the LO in his 2.4GHz DEMI (Down East MIcrowave (http://www.downeastmicrowave.com/)) transverter, a Model 2401-144. Could I stabilize it with one of my X-Locker designs ??? I thought I could so accepted the challenge.

My original thoughts were along the lines of adding one of the early-ish X-Locker versions to lock the existing oscillator to an external 10MHz reference but a "by the way, could you shift it so that 2403.1 is actually 144.1 instead of 147.1 while you are doing it" request made that option impossible. Fortunately, DEMI has a PDF of this series device on their website so, after a bit of examination, it appeared that the current MicroLO PCB started off with a crystal oscillator at 188 MHz and multiplied it up to 1128 MHz and then the transverter board frequency-doubled that to 2256 MHz.

My next thought was to remove the existing 188.000 crystal and effectively replace it with an external oscillator board running at 188.250 MHz. That would certainly work but if I was replacing the crystal, why not replace the whole MicroLO board with one of the Si4133-based synthesisers set up to 1159 MHz and simplify the whole modification process.

My latest version of the Si4133 PCB (/~vk4adc/web/index.php/general-projects/34-frequency-stabilisation/81-xlocker-si4133.html) layout incorporates BGA2709 MMIC amplifiers on each output port (I have lots of these devices and they are rated to 2.6GHz !) and with these in circuit, the raw RF output power available is around +13 to +14dBm value. A nominal 6dB attenuator (6.7dB actually) was then added by using the pads on the PCB that I put there for this purpose. The final output level is thus between +6 and +7dBm, just right for feeding into a typical microwave mixer device (eg ADE11, ADE35X) or, in this case, the DEMI transverter board. The original MicroLO board output was measured at +7dBm at 1128 MHz so the drive levels are compatible. The board used a PICAXE-08M so only one alternate set of frequencies is available by changing the logic state on PCB terminal #1 : no jumper = 144 IF, jumper to ground = 145 IF.

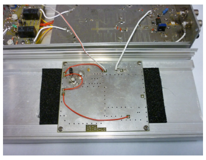
Before I did anything major to the transverter, I set about measuring the receiver and transmitter section performance and documenting them for later on. The captions on the photos below tell most of the story of how it was accomplished and the outcome was pleasing. The tests after the physical implementation was complete was done like this...

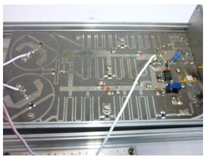
- Measure the receiver sensitivity with the original MicroLO wired in place - in my case, I used a SINAD measurement on FM as I have a SINADDER in my workshop test equipment lineup. The RF signal level was set for 6dB SINAD.
- The new synthesiser was then wired/fitted in place of the MicroLO board - this provided 5dB SINAD - a 1dB difference - although a 1dB variation in SINAD set around 6dB is really very small..
- Comparative tests were also made on SSB where with the "minimum detectable signal" I could hear (by ear) from the signal generator, the variation was only around 2dB between the original LO and the new one.
- The transmitter power was also checked using my homebrew microwave RF power meter plus a 20dB commercial in-line SMA power attenuator. Original power was "measured" at around +34dBm (or 4 watts) at the output of the Kuhne 5 watt power amplifier, the "after-mod power" was almost identical.

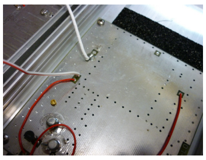
By the way, the original LO's frequency stability was initially checked with my frequency counter (GPSDO locked) and it started off at the equivalent of +7KHz at 2256 and was still around +4 KHz after 45 minutes although the drift rate was almost nothing by then. That still meant that it was off by 4 KHz at 2403 so if you were expecting to hear a signal on 2403.150, well, it would be out of the receiver's passband ! The new LO's accuracy and drift is determined only by the accuracy of the 10.000 MHz reference frequency fed into it....

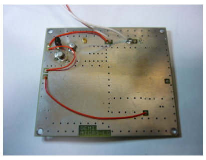
The outcome was that the overall characteristics are basically unchanged, frequency stability excepted. The receiver sensitivity is almost identical, as is the transmitter power. You can't ask for much more than that...

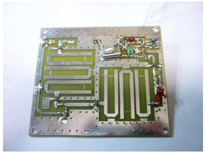
Photos... Scroll over the images to see more detail. Position the mouse carefully to avoid flash-blur.

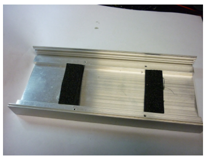

This is the original MicroLO board mounted on the "lid" of the DEMI transverter. The small white coax is the RF out to the main transverter and the red/white wire is the +9V from the regulator on the sequencer board.

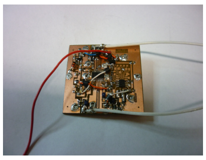

This image shows the layout of the DEMI board a little better. The receiver side is on the upper side of the image with the actual receiver input at top RHS, the LO in the middle with the signal path going right to left, and the transmitter at the bottom with signal path going left to right. The two circular track sections at the LHS are the two diode mixers.

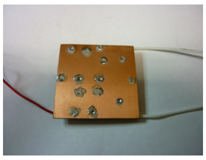

The black "blocks" at either end are RF absorb material and the board is screwed down to the aluminium extrusion's channel in 4 places with threaded screws.

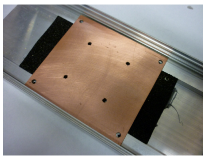

The top view of the MicroLO board after removal. Not much to see on the top of it...


The under-view of the MicroLO PCB shows the crystal with attached heater plus the various tuned line segments.

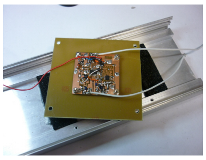

The two RF absorbs are left glued into place on the channel.


The new Si4133 synthesiser PCB ready to go. The white coax is from the RF1/RF2 port and the red wire goes to the +9V regulator on the sequencer.
The "through-rivets" are easily seen in this image and connect the top to bottom layers of the PCB material.
The various power feeds across the board all have ferrite beads fitted.

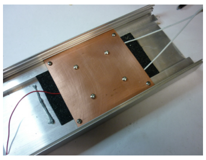

The under view shows that this time around, I used through-hole rivets to provide the "via connections". previously I have used thin wire as the vias but this should provide a lower inductance between the layers - hopefully.



The new synth board is smaller than the original so a mounting "plate" was made from some single sided PCB material, mounted copper-out so that any tuning (/de-tuning) effects on the main board from the proximity would be minimised, simply because it was the same size and position as the original board.

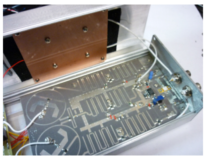


The new synth board is screwed into place by 4 x 3mm screws, nuts and spring washers.

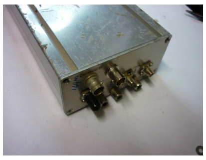


The whole assembly is then screwed back into the "channel" and re-attached using the original screws in the original holes.

The 3 wiring connections are "clamped" into place against the RF absorb blocks by the PCB edges.

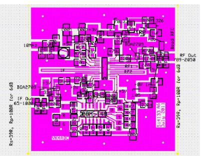


The two miniature coax cables are shown here, one to the LO input point on the main PCB while the other goes to an additional BNC socket mounted onto the "rear" panel of the transverter assembly - the 10MHz reference oscillator input.



The extra (bright and shiny) BNC socket is next to the IF output port near top centre.

The front panel of the DEMI unit, in case you see one of these in your travels... and need to identify it.



The Si4133 PCB layout used for this modification.

Note that either the 78L33 or the 3.6V zener / series pass 3V regulator transistor TR2 is required - not both. The two regulator options were created on the layout because SOT89-style 3V regulators can be hard to find at times.

The trimpot on the output of the LPF for the 10MHz reference input was not fitted, as were many of the 4K7 resistors near the PICAXE.