# External reference modification of the
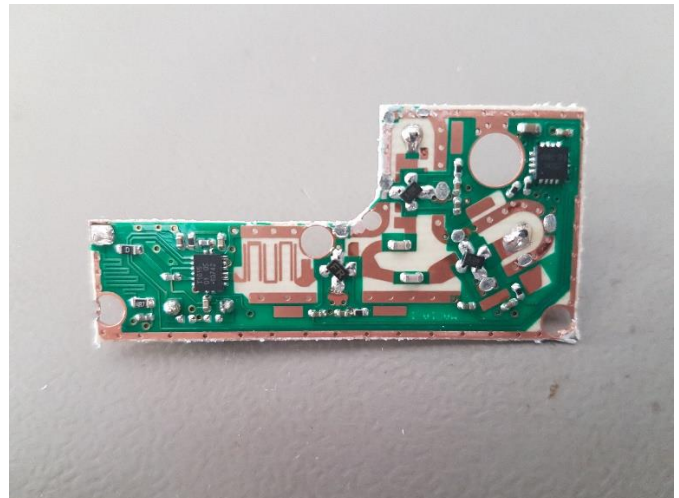# OPTICUM RED „LSP-02G Single LNB" / „Robust Single LNB"

## Introduction

After doing a TCXO modification of the OPTICUM RED „LSP-02G"/"Robust" LNB (which is used at the BaMaTech „DuoBand-Feed 2,4 / 10 GHz LNB", see http://www.dl9sec.de/download/LSP-02G_TCXO_Modification_1V0.pdf) in August 2019, I tried an external reference modification with these LNBs for use with the new AMSAT-DL QO-100 DownConverter V3d (https://amsat-dl.org/der-neue-amsat-dl-qo-100-downconverter-v3d), which can generate a highly accurate reference clock to feed the LNB's PLL circuit.

The basics of this modification can be found in various implementations at the AMSAT-DL forum. This document describes one possible and working variant to feed a **25MHz** reference clock to the OPTICUM RED „LSP-02G"/"Robust" LNB.
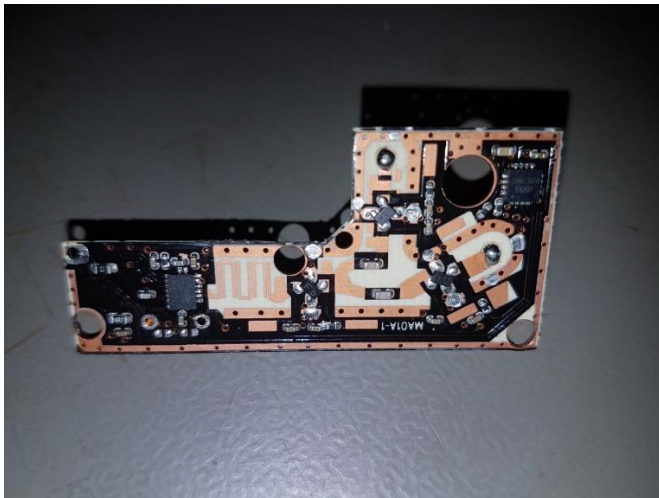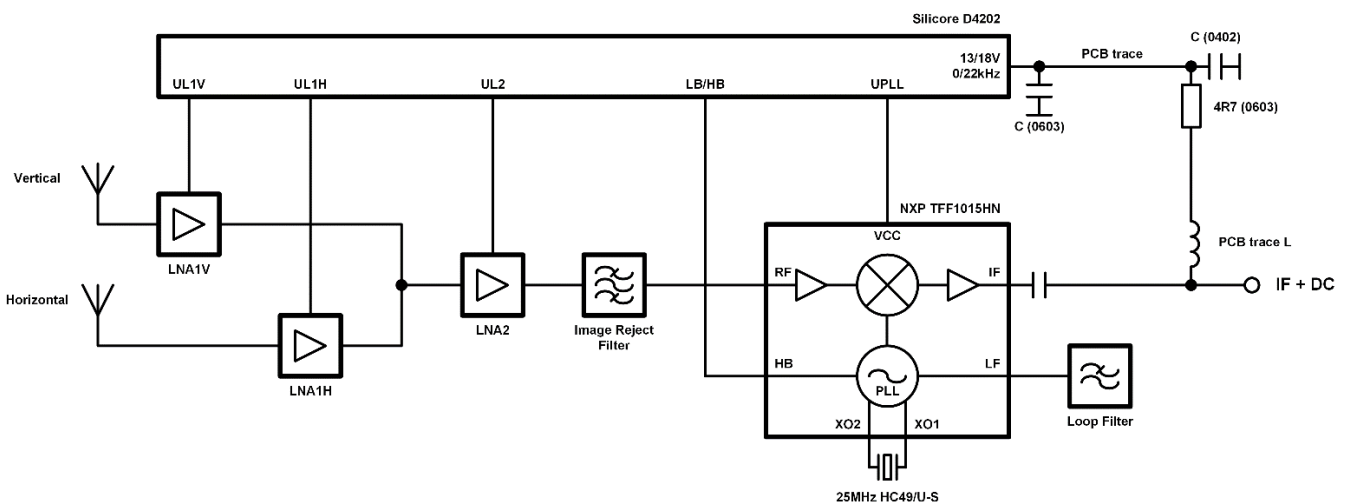


**OPTICUM RED „ROBUST SINGLE LNB"**



**OPTICUM RED „LSP-02G SINGLE LNB"**

Unfortunately this LNB isn't as easy to modify as the „old" LSP-02G. The whole PCB must be removed and there is only a 5x11x4mm cavity for the crystal and about 3mm under the upper shield, where parts can be placed.

I drafted a block diagram of the LNB and gathered some information about the design to understand how to go on with the modification.



**Block diagram of the original OPTICUM RED „LSP-02G SINGLE LNB" / „ROBUST SINGLE LNB"**

The modification is a combination/variation of several descriptions I found. The basic idea is to feed the 25MHz reference signal from the IF output connector through a series resonant circuit (low impedance at resonance

frequency) to the LNB PLL input and block the 25MHz reference signal at the DC bias circuit with a parallel resonant circuit (high impedance at resonance frequency, DC pass), to avoid reference signal loss by the DC/DC converter's input circuitry. The 22kHz signal path is not relevant for me, because I don't need the high band. The modified block diagram looks like this:
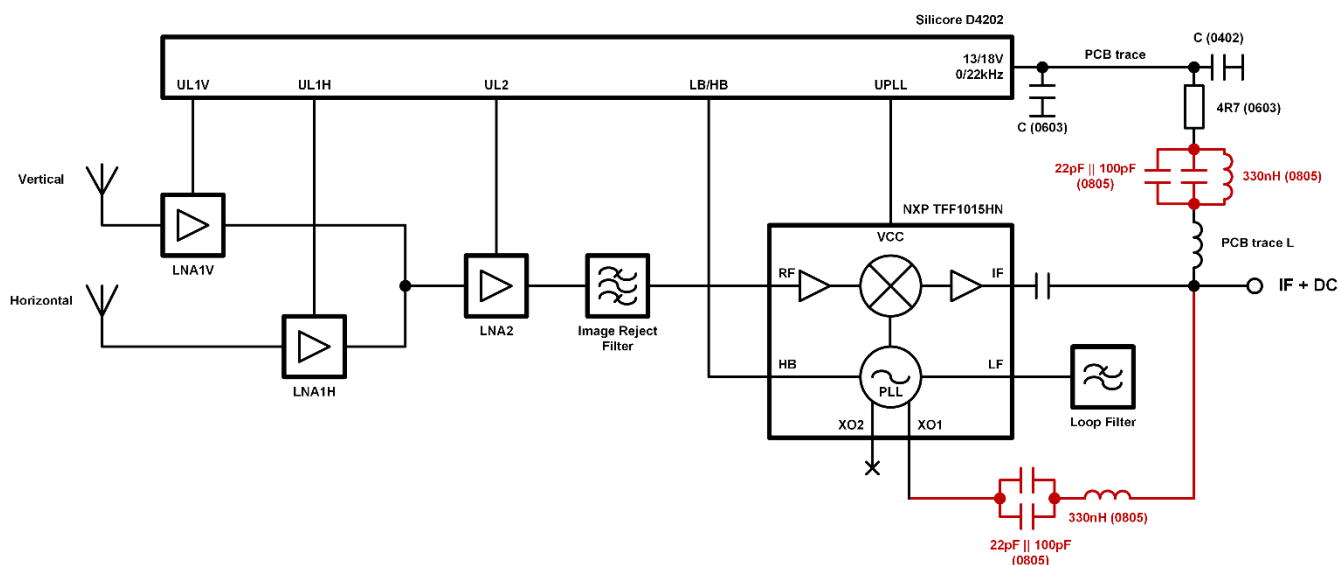


**Block diagram of the modified OPTICUM RED „LSP-02G SINGLE LNB" / „ROBUST SINGLE LNB"**

For the resonant circuits, I used "SIMID 0805" wire wound coils with 330nH (Q~35, R~1,2R) and 0805 NP0 ceramic capacitors with 100pF and 22pF (unfortunately I had no 120pF in the box, but a single capacitor with this value should work too and makes the modification much easier).

The 4R7 series resistor in the DC path is reused, but the resistance will increase to about 5R9. Maybe a 3R3 0603 resistor could be used instead to preserve the DC conditions.

Maybe the parallel resonant circuit isn't really necessary, a simple higher value coil or just no additional part could do the job too, which will make the modification much easier.

So the following detailed description is meant as a support for your own modification efforts, not as a dogma or the only truth. **Do this at your own risk!**

## Step-by-step modification
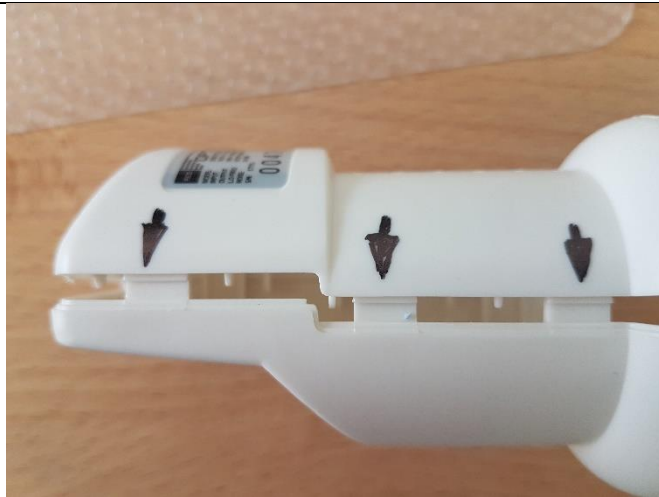


**#1**

Open the outer shell of the LNB at the marked positions and disassemble.



**#2**

Remove the sealing silicone.
I used „SOUDAL Silicone Remover" over several hours and several times. Remove the four screws. Remember their positions, they seems to differ a bit in length.
Be very careful when lifting the top cover. The PCB should left at the bottom and must not stick at the top cover. Then remove again the silicone at the PCB outline.
Be very careful when lifting the PCB not to rip the pad of the F-type RF connector. Heat up the pad and lift the PCB.

Clean, rinse and dry all the parts carefully (ESD). I used „Electrolube Safewash SWA" to clean the housing and the LNB PCB.

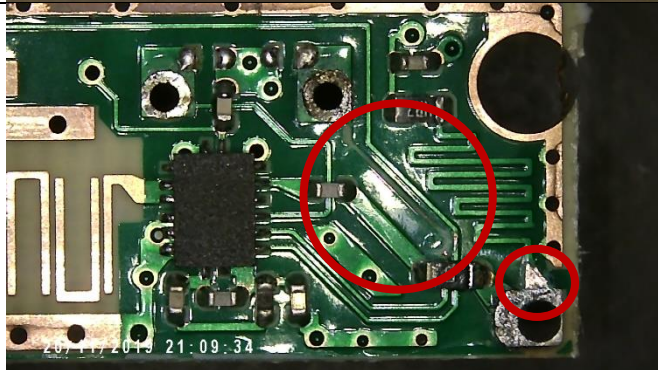This is the cavity of the crystal, where the TCXO must fit into.
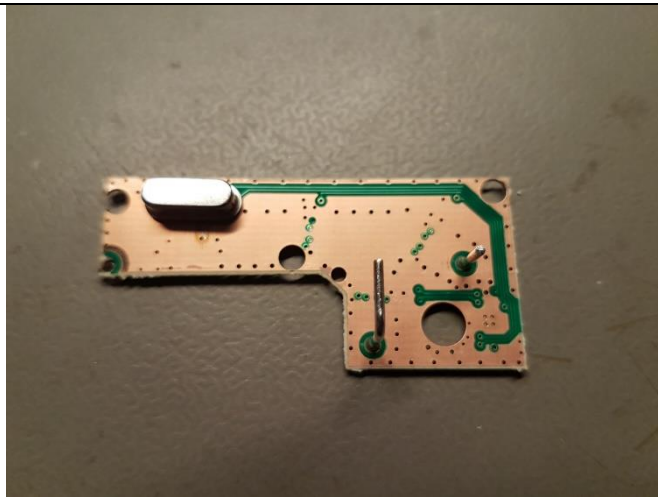
**#3**

This is the bottom side of the LNB PCB.

Be careful with the horizontal and vertical antennas.



**#4**

Carefully remove the crystal and clean the pads.

Cut the shown PCB trace at the right crystal pad and near the 0R chip resistor and remove it.

Scratch off the solder resist at the teardrop trace near the IF connection.



**#5**
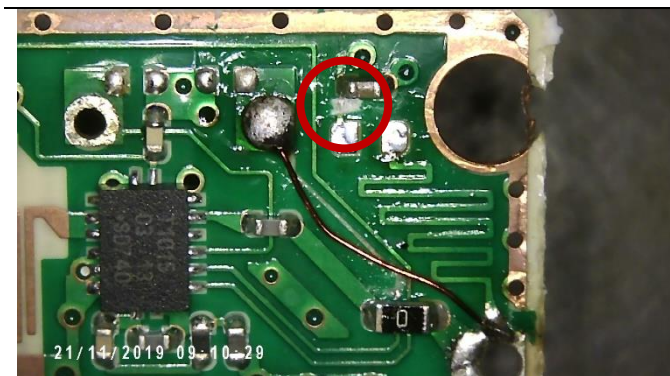
Solder the 100pF and 22pF capacitor together.



**#6**

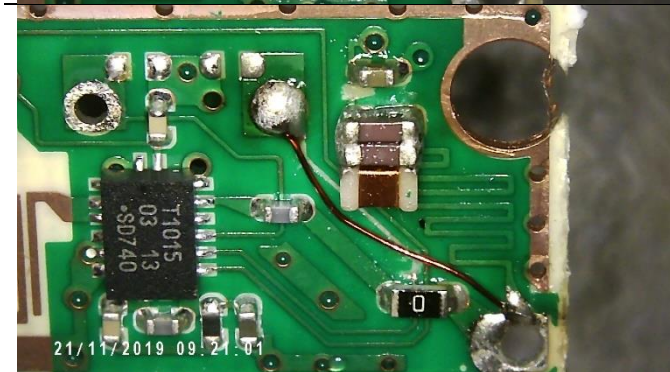Solder the capacitor pack and the inductance together.



**#7**

Connect the right crystal pad with the IF connector pad with a little piece of enamelled wire.

Remove the 4R7 0603 resistor, but keep it (needed again later). Clean the resistor pads.
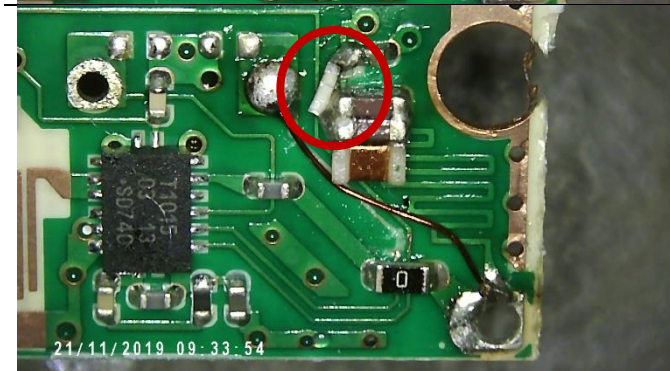
#8

Carefully remove the PCB trace between the left resistor pad and the 0402 capaciotor.



#9

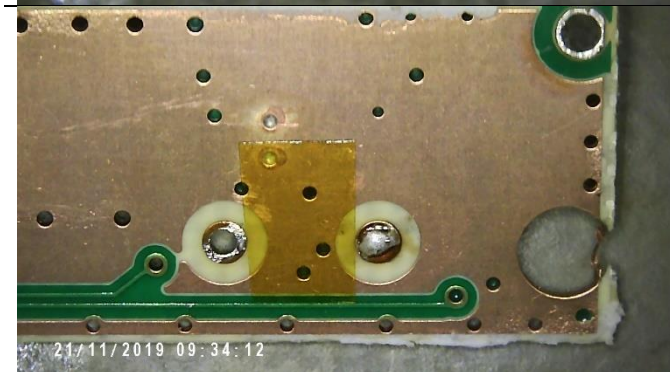Solder the parallel resonant circuit on the pads of the 0603 resistor.

The parts must sit very tight at the PCB to avoid touch and unwanted pressure from the top shield.
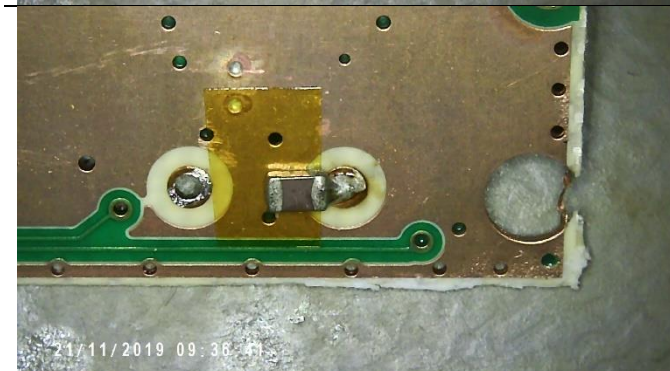


#10

Solder the 4R7 0603 resistor between the resonant circuit and the 0402 blocking capacitor.

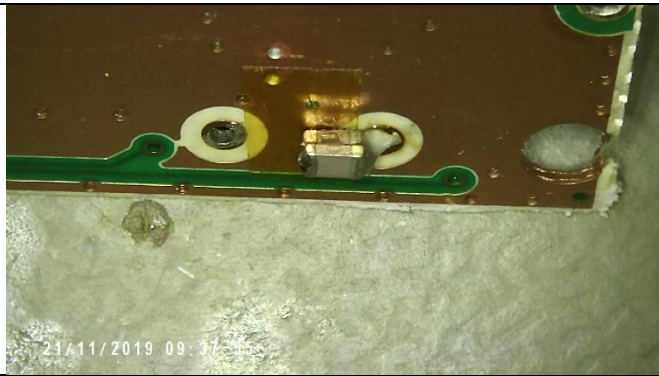(Do not cuss too loud, especially if children are around!)



#11

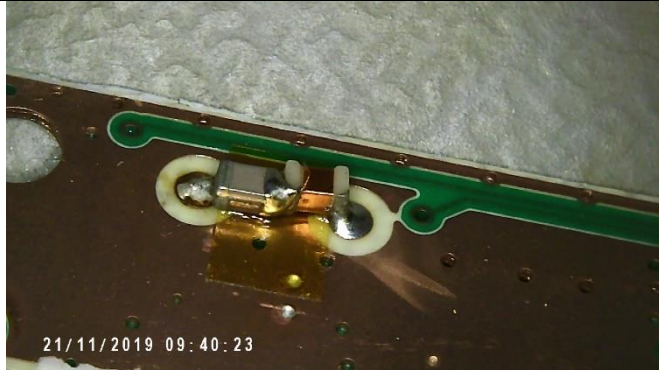Turn around the PCB and put s strip of Kapton tape between the pads of the crystal.



#12

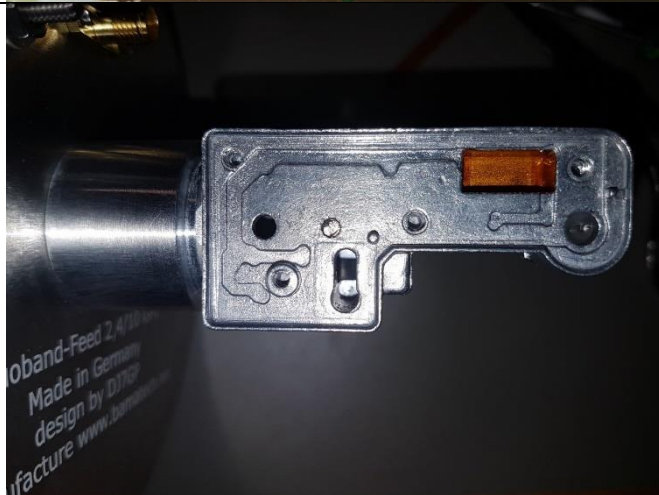Solder one of the series resonant circuit capacitors as shown.

**#13**

Put the second capacitor on top of the first and solder it.



**#14**

Solder the inductance between the capacitor and the other pad of the crystal.



**#15**

To avoid shorts between the parts and the housing (GND), I covered the cavity with some Kapton tape.
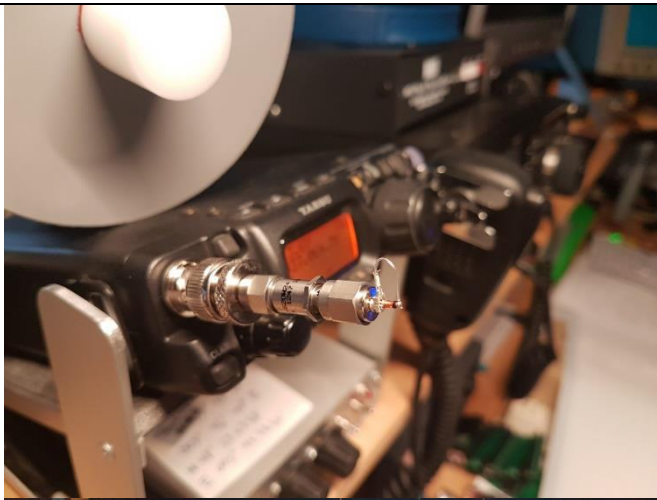


**#16**

Now put the PCB back into the housing and solder the RF/DC feedpoint to the F-connector.

For an intermediate test put the top cover on the housing and fasten the four screws tight.

(Image reused from the TCXO modification, so it differs from the real view).

**#17**

For doing a quick and dirty test, if the modification was successful, I used an idea of EA4OAZ ([https://ea4eoz.blogspot.com/2012/10/24ghz-old-way.html?m=1](https://ea4eoz.blogspot.com/2012/10/24ghz-old-way.html?m=1), tnx to Jochen DG1SFJ for the hint) to generate a 10GHz signal in the wanted frequency range.

I used my FT-817 with 1W output at 437,06979MHz, going through a 20dB/1W attenuator to a LL4148 (1N4148 or similar) connected to GND.

The LNB was supplied with 13V by a Bias-T and fed to a RTL-SDR together with SDR#.

Transmitting a carrier at the given frequency will generate a signal at ~10489.675MHz (23th harmonic) and result in an IF frequency of ~739.675MHz.

If you can see this peek (maybe several kHz above or below the expected frequency), you're done so far and the LNB seems to do its job.

This test is no high sophisticated measurement, but a pragmatic and effective check of the modified LNB before re-sealing it and/or climbing on a roof.
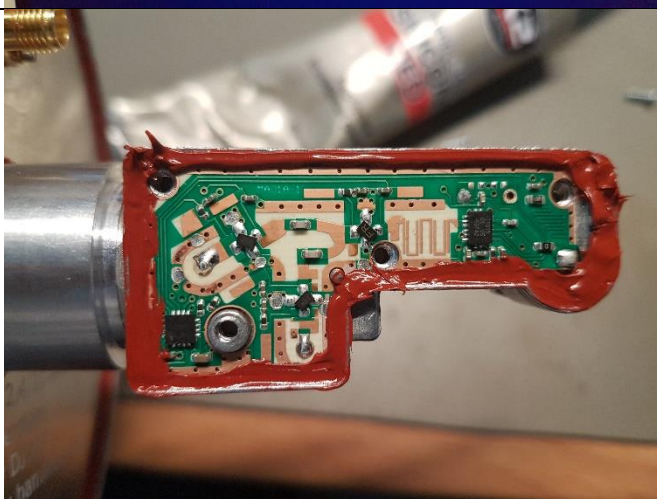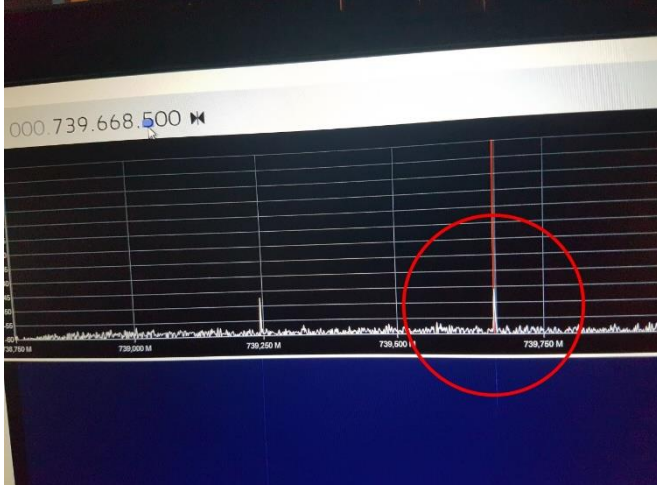


**#18**

Now the LNB can be re-sealed.

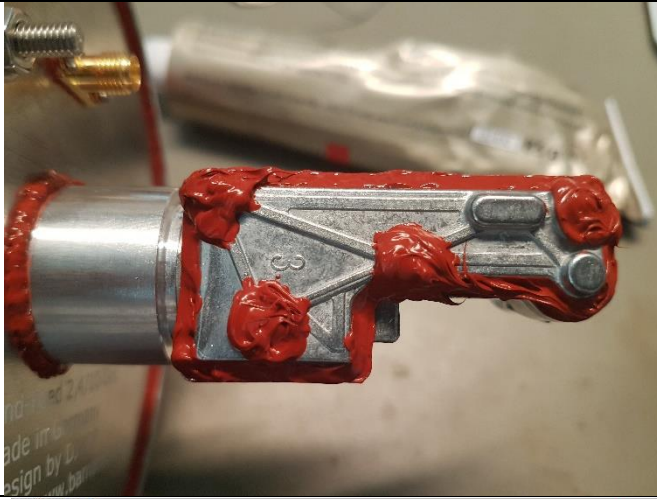I used some „K2 GASKET MAKER HIGH TEMP SILICONE RED".

First I put some silicone around the contour of the PCB.

(Image reused from the TCXO modification, so it differs from the real view).



**#19**

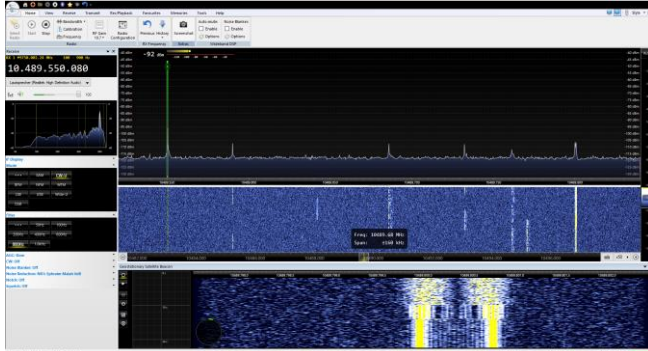Then I put the cover on it and fastened the four screws tight.

**#20**

I applied again some silicone around the touch between housing and cover and on top of the screws.

The silicone I used needs about 24h to solidify completely.

Now the outer shell can be reassembled.

**#21**

At the end the gratification is a stable and solid signal from QO-100.

Have fun and good luck with the modification…

(Screenshot: Signals received with a 30cm camping dish)

Feel free to do some further optimisation or other approaches. I would appreciate to get feedback, if the described modification was helpful and the above mentioned optimisation works.

73, Thorsten DL9SEC