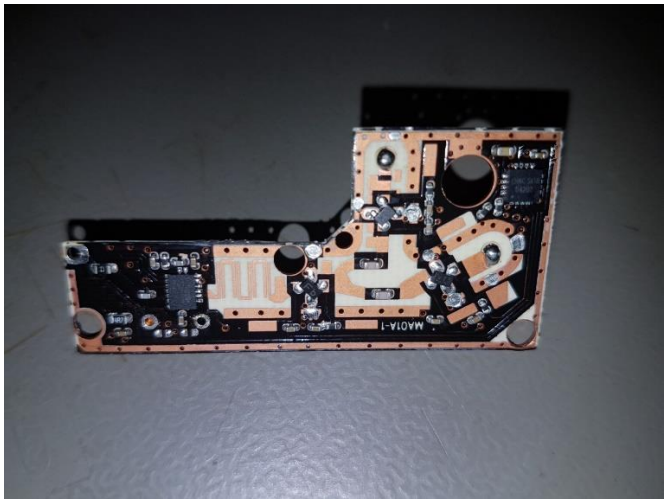
TCXO modification of the OPTICUM RED „LSP-02G Single LNB“ / „Robust Single LNB“

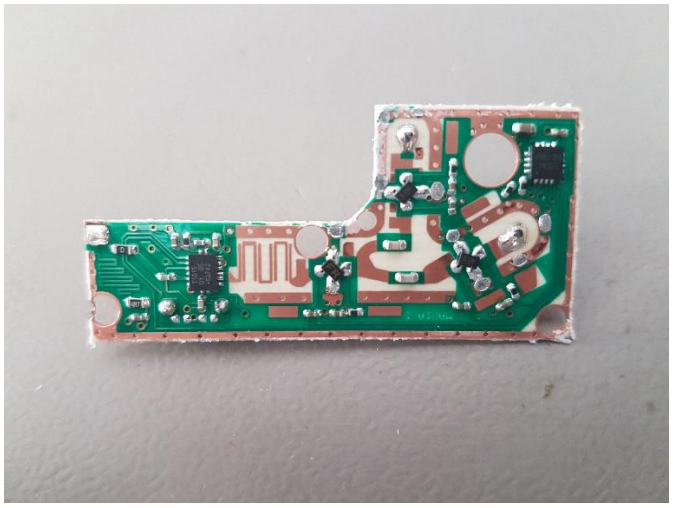
Introduction

In August 2019 I got my BaMaTech „DuoBand-Feed 2,4 / 10 GHz LNB“. In advance I got the information, that an unmodified OPTICUM RED „LSP-02G“ LNB is used for the device. I checked „Ku-band LNB line-up“ (http://www.pabr.org/radio/lnblineup/lnblineup.en.html#LSP-02G) and was happy, because a TCXO modification at this LNB should be easy. All parts are accessible from the top, and the clock input pin of the 3566E PLL is known from similar LNB designs.

After removing the LNB outer shell it didn't seem to be the LSP-02G from the PABR.ORG website. I peeled off the silicone and opened the metal housing. The PCB seems to be the same design as the OPTICUM RED „Robust“ except, that the solder resist is green instead of black and the three LNAs have other SMD markings. I couldn't find differences in the layout.



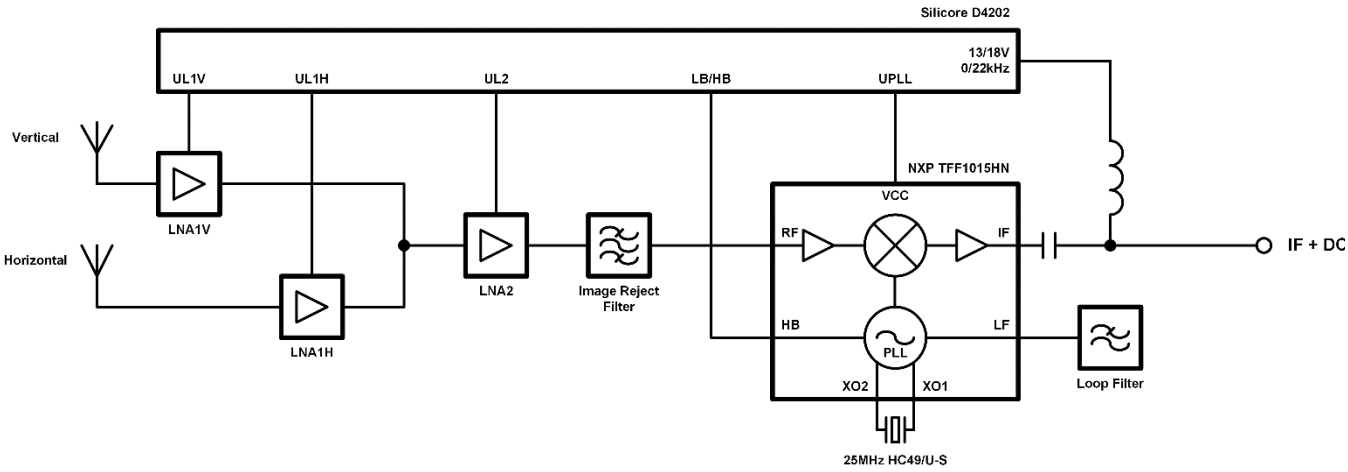
OPTICUM RED „ROBUST SINGLE LNB“



OPTICUM RED „LSP-02G SINGLE LNB“

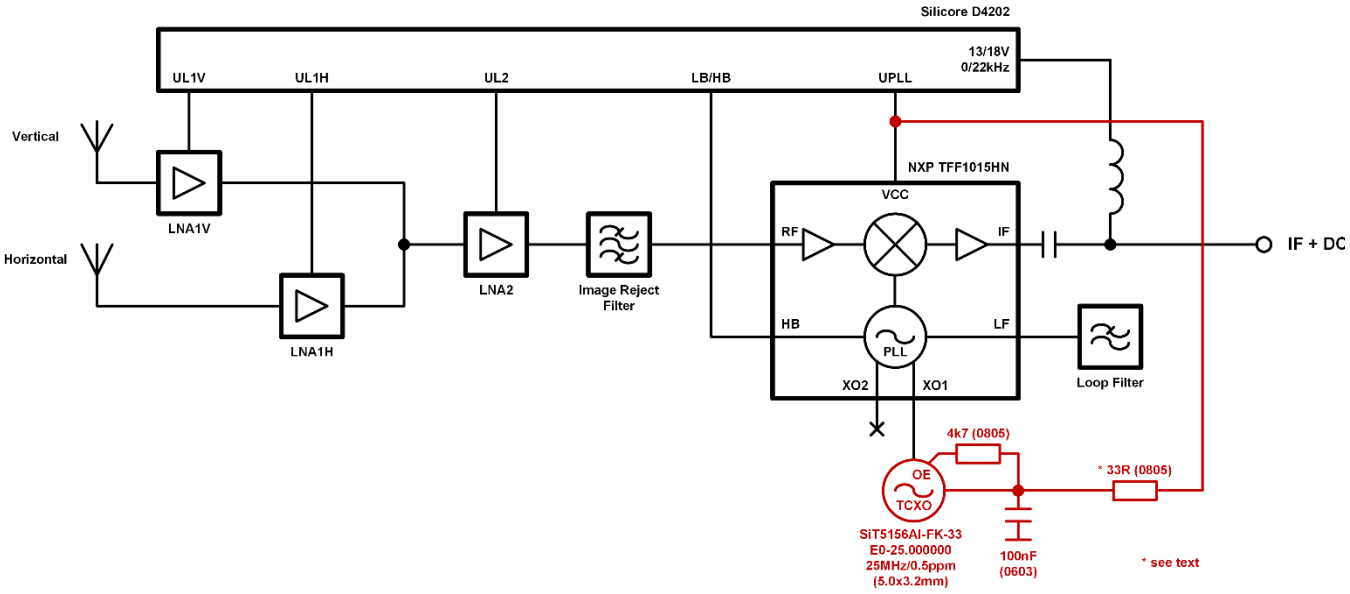
Unfortunately this LNB isn't as easy to modify as the „old“ LSP-02G. The whole PCB must be removed and there is only a 5x11x4mm cavity for the crystal, where a TCXO can be placed.

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“

I did some experiments with the „LSP-02G“ as well as with the „Robust“ and finally used the following solution for the TCXO modification (tnx to Andreas DL5CN for his hints with the Rocket LNB):



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

The Silicore D4202 seems to be a clone of the Zetex ZXNB4202. There are no valuable datasheets for both chips, but it seems, that the D4202 as well as the ZXNB4202 are able to deliver the additional ~50mA for the TCXO and can dissipate the additional heat to the metal housing. The current consumption of the unmodified LNB (both types) is ~70mA.

It seems to be possible to use either XO1 or XO2 to feed the TCXO clock to the PLL.

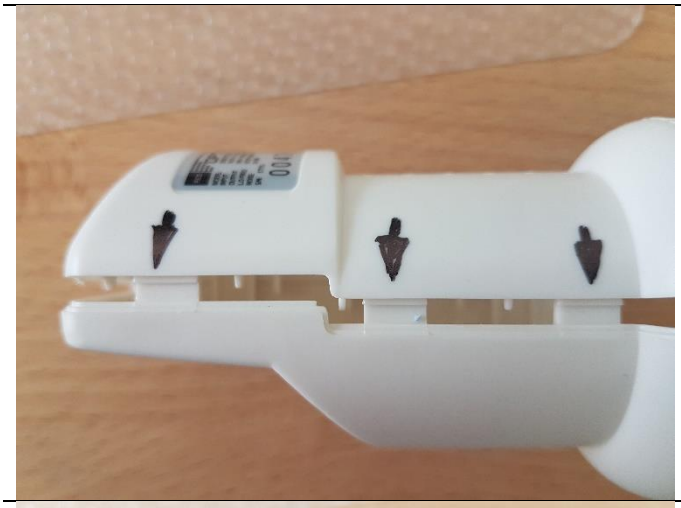
I decided to use a SiT5156 3,3V 25MHz fixed clock TCXO with 0,5ppm, because it was available at Mouser for a „moderate“ price. I think every TCXO can be used which have similar size and parameters. The supplying resistor has to be adapted depending on the current consumption of the TCXO.

I documented the modification on the fly. It works fine, but there is room for optimisation.

Maybe it would be better to turn the TCXO by 180° to omit the supply wire and feed XO2 instead of XO1.

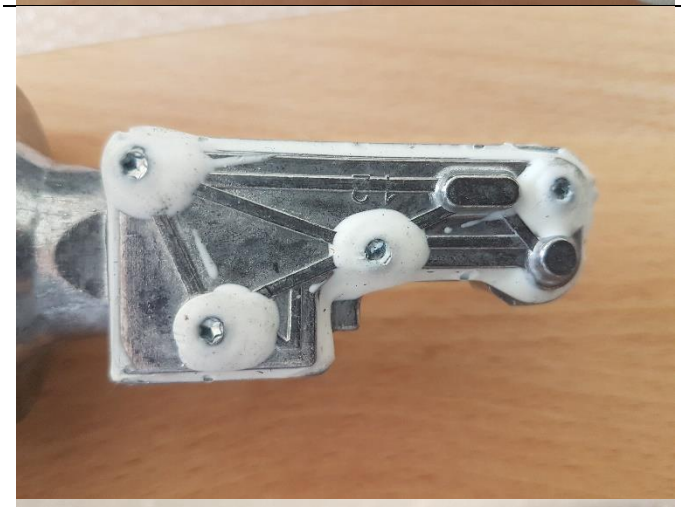
So the following detailed description is meant as a support for your own modification efforts, not as a dogma or the only truth. **Do this at your own risk!**

Step-by-step modification



#1

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

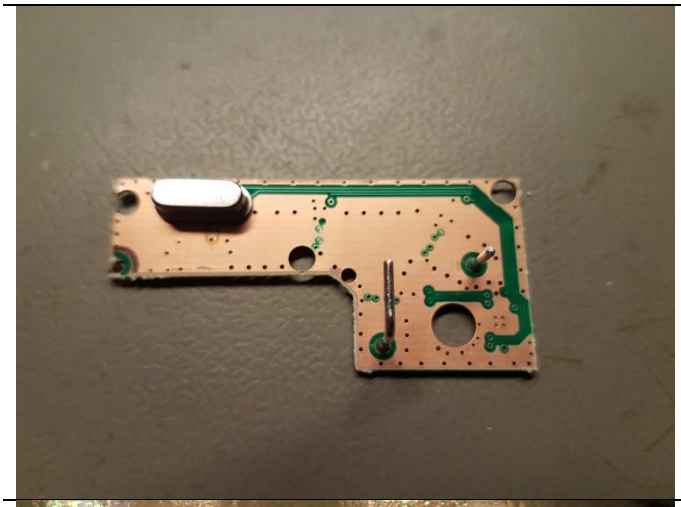


#2

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.

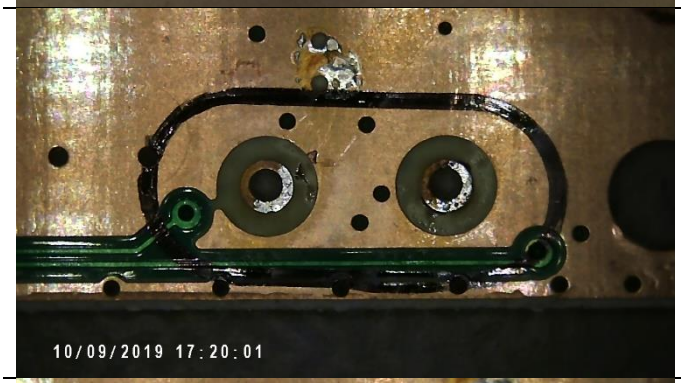


#3

This is the bottom side of the LNB PCB.

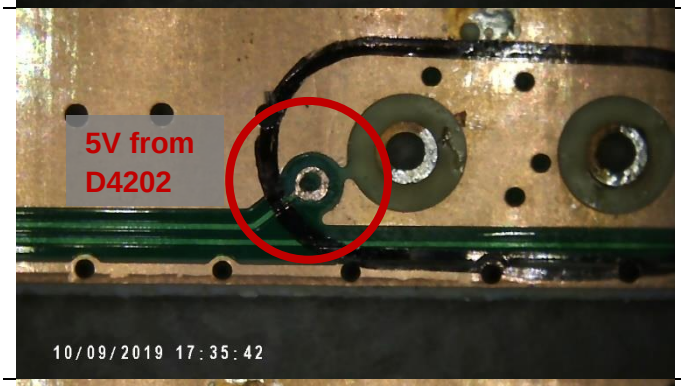
Be careful with the horizontal and vertical antennas.

Before removing the crystal, use a permanent marker and draw around the outline of the crystal.
It is important to know, where to place and solder parts later.



#4

Carefully remove the crystal.



#5

Scratch off the solder resist from the shown via.

It is the 5V supply voltage from the D4202 multi voltage regulator leading to the TFF1015H PLL.

#6

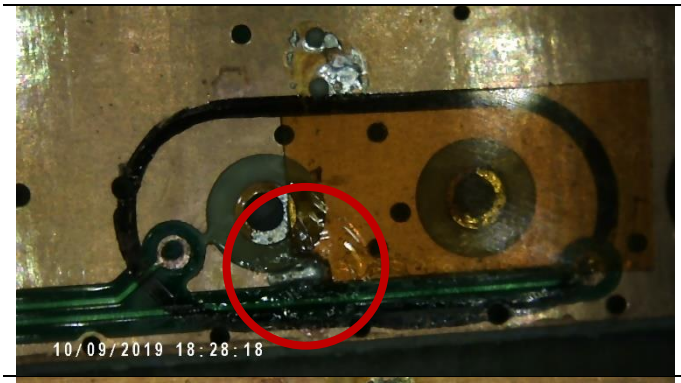
Put a piece of Kapton tape on the PCB as shown.

The Kapton tape resists high temperatures, acts as a solder resist and as an electrical isolator.

#7

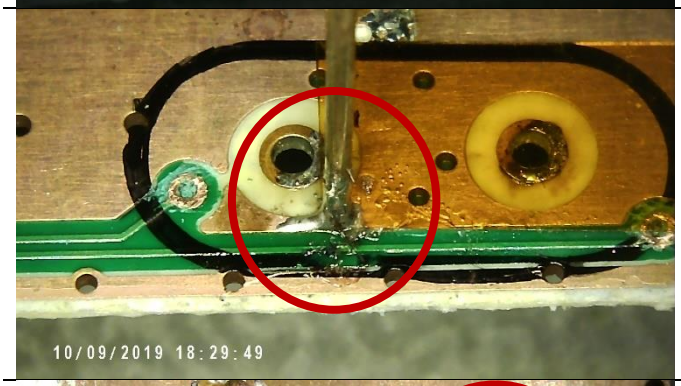
Cut out the lower left corner of the Kapton tape and scratch off the protective varnish from the PCB (the PCB seems to be coated to protect the copper from oxidation).

This is the GND connection point for the TCXO.



#8

Put a bit of tin at the cutout. Do not overheat the copper until it delaminates and peels off.



#9

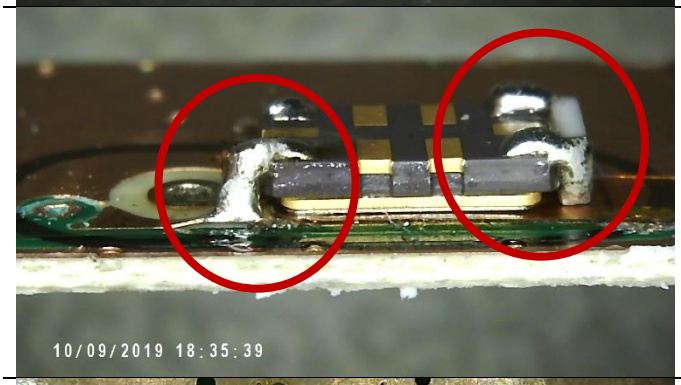
Solder a piece of wire at that corner as shown.

It would be better to use a thinner and more flexible wire, than I used. Bending this wire could peel off the copper from the PCB.

#10

Cut out the upper right corner of the Kapton tape.

This is the connection point for the 100nF 0603 capacitor.

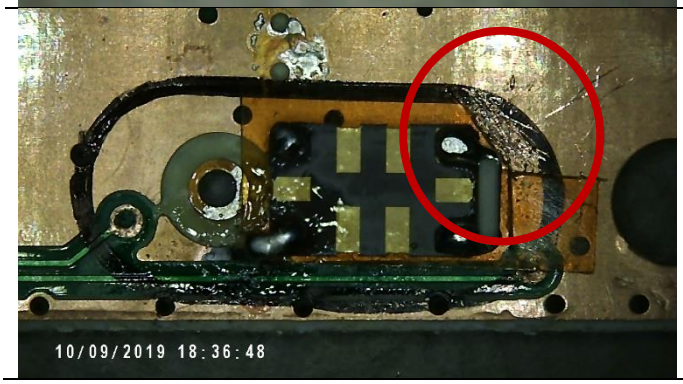


#11

First cut the wire to the final length carefully, position the TCXO and solder the wire to the TCXO (quick and hot!). Be sure to keep inside the crystal contour.

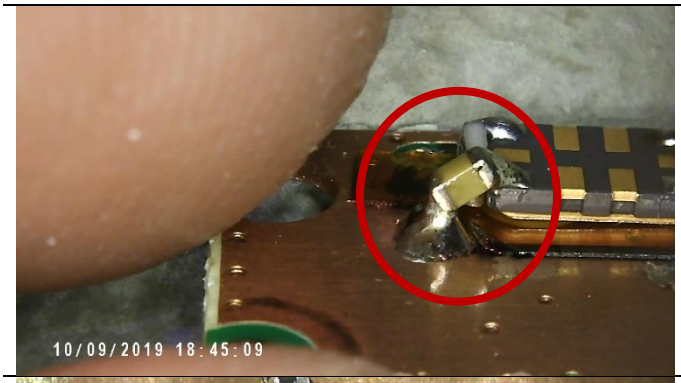
Solder the 4k7 0805 resistor between VCC and OE of the TCXO as shown.

(As you can see, I was not careful enough. The GND copper peeled off because of mechanical stress!)



#12

Cut the upper right corner of the Kapton tape as shown and scratch off the protective varnish from the PCB at the shown position and put some tin on it.



#13

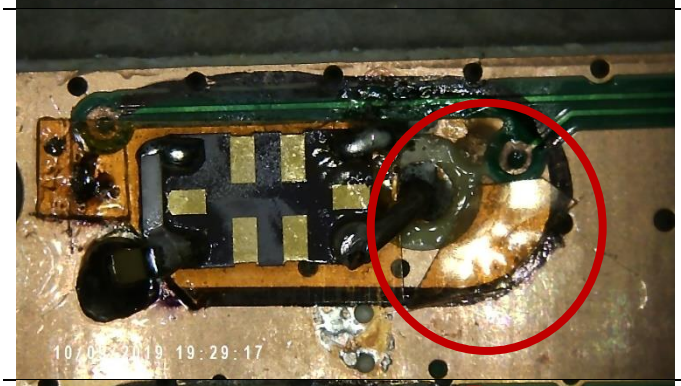
Solder the 100nF 0603 capacitor between VCC and GND as shown.

It is now useful to put the PCB into the housing, to check if it still fits gently and properly.

#14

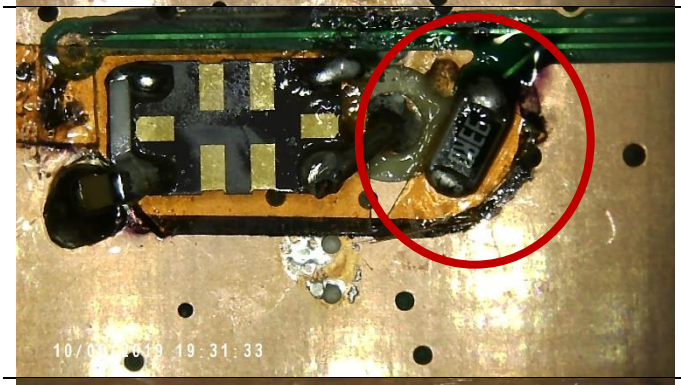
Connect the TCXO clock output with XO1 of the PLL. First solder the wire at the thruhole, then at the TCXO.

Cut the wire before solder it to the TCXO to avoid mechanical stress at the part.



#15

Put a little piece of Kapton tape at the shown position



#16

Put some tin on the via and solder the 33R 0805 resistor there.

#17

Connect the other end of the resistor with VCC of the TCXO by a little piece of wire.

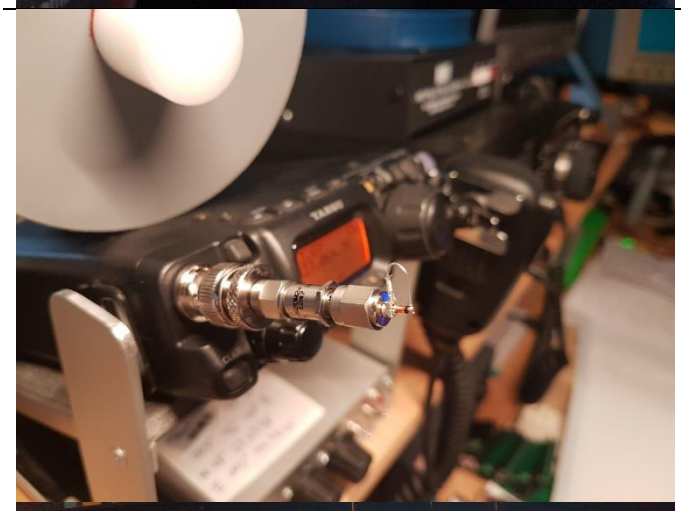
#18

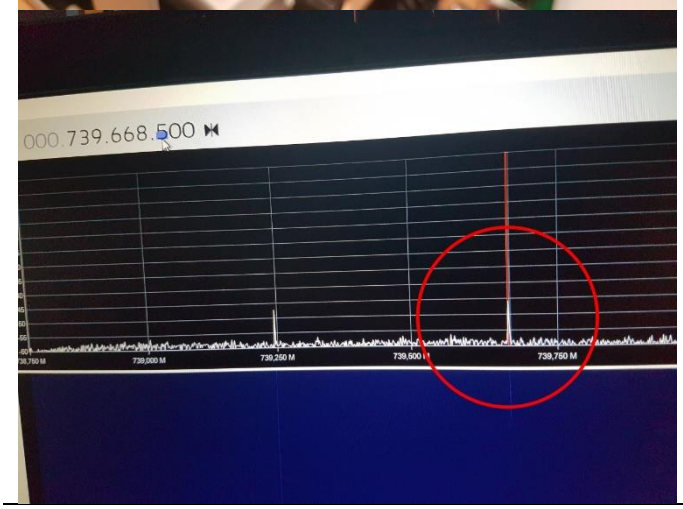
To avoid shorts between the TCXO and the housing (GND), I covered the cavity with some Kapton tape.

#19

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.





#20

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, tnx to Jochen DG1SFJ for the hint) to generate a 10GHz signal in the wanted frequency range.

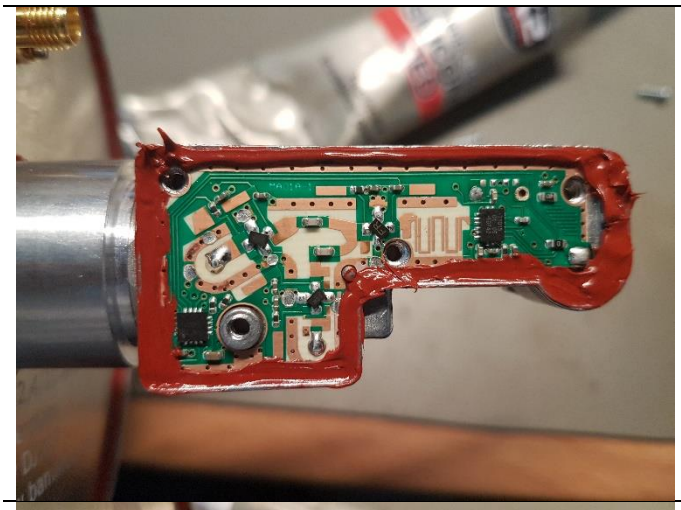
I used my FT-817 with 1W output at 437,06979MHz, going through a 20dB/1W attenuator to a LL4148 (1N4148 or similar) connected to GND.

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.



#21

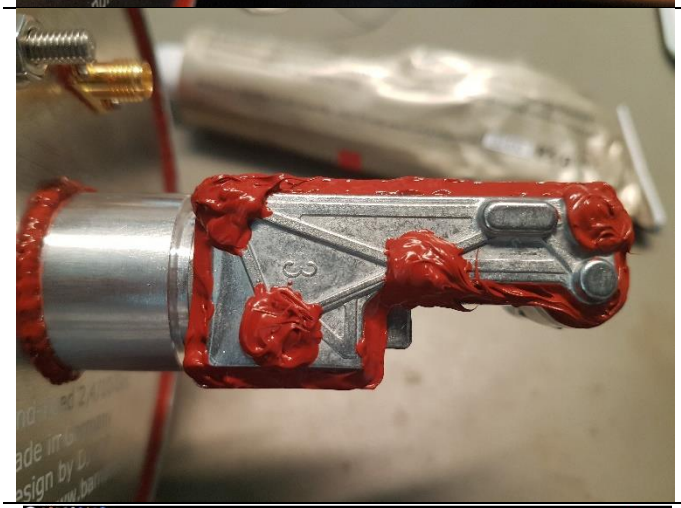
Now the LNB can be re-sealed.

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

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

#22

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

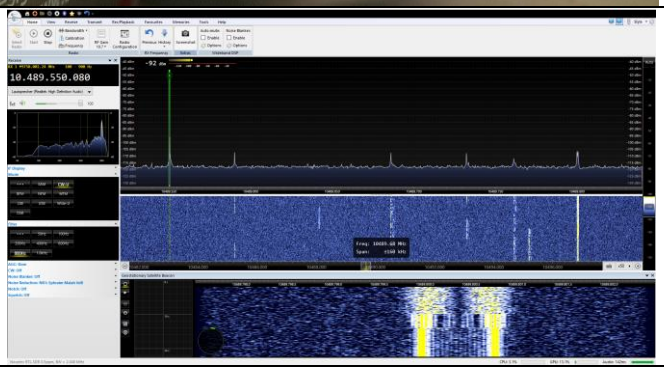


#23

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.



#24

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