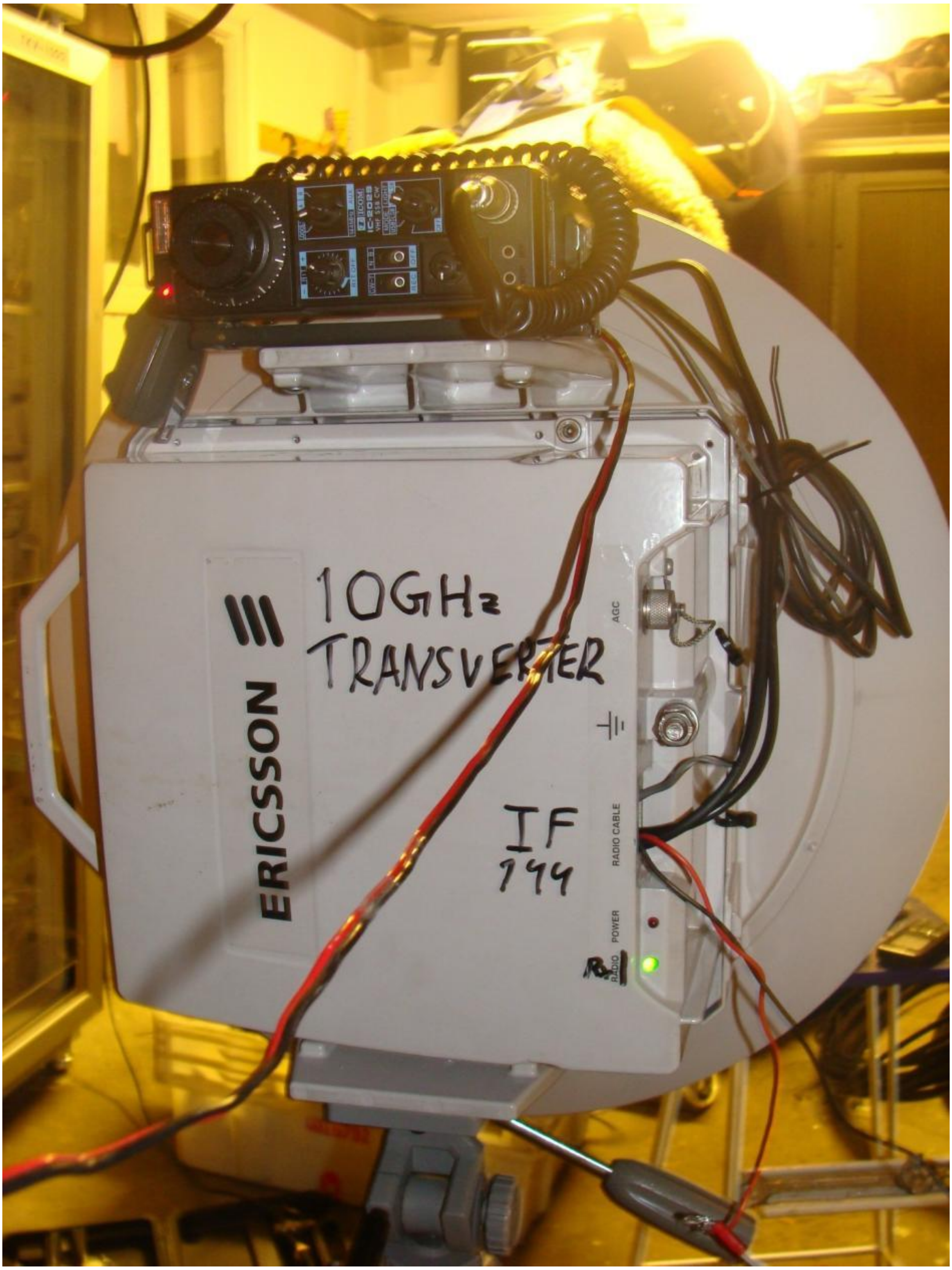
Recycling the Ericsson Minilink 15E for the 10GHz amateur band

By Tomas / OH6NVQ



Foreword.

Due to the fast rise of data communication speeds over the mobile networks, the traditional n*E1 (2Mb/s) communication links for base stations becomes obsolete because the Phone Operators are in favor of Ethernet based high speed products. This in turn leaves us a huge amount of really good equipment for the microwave experimenter! In fact, we are now in a situation where, more or less, forklift upgrades happen. So you should go and ask your local friendly Telco for these! Don't pay a fortune on some auction sites!

This paper focuses on converting the Ericsson Minilink 15E to a 10GHz portable transverter, complete with a 60 cm dish, feed and 150 mW output.

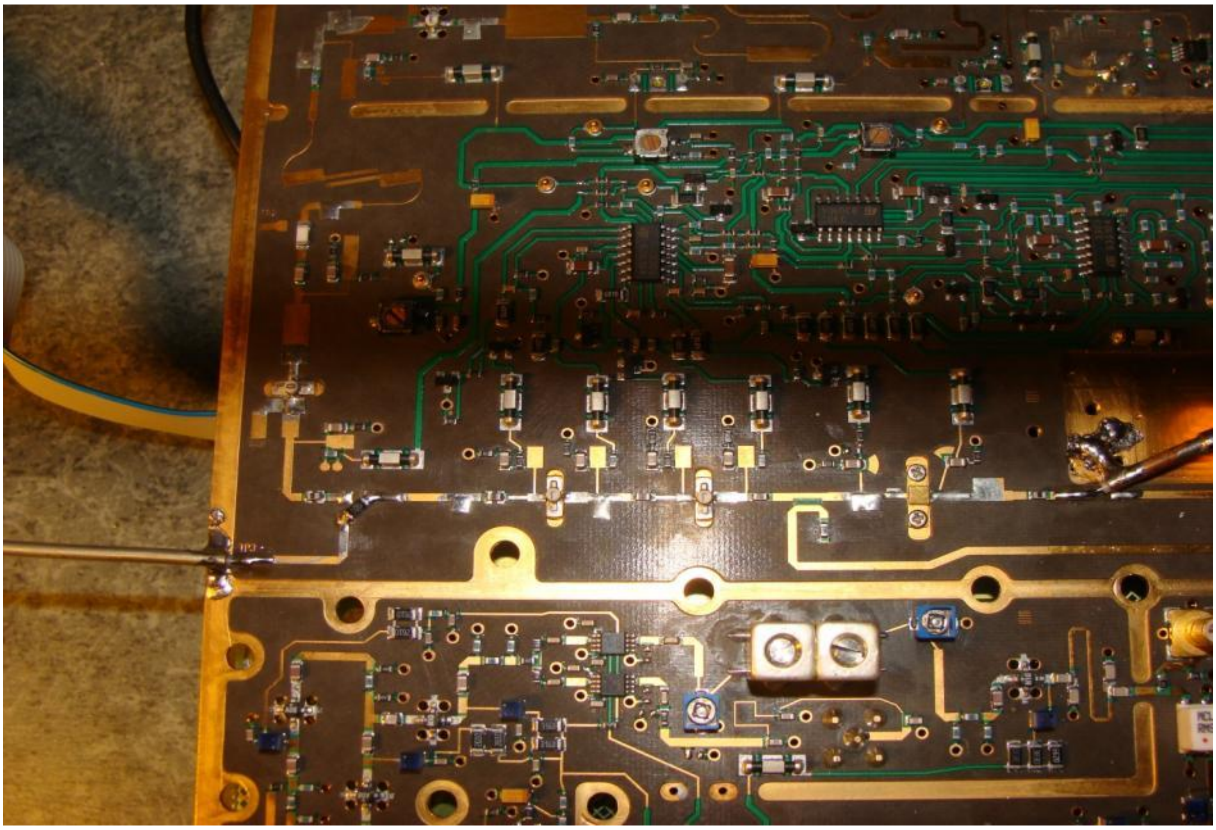
What do you need to do a conversion like this? You'll need:

- Patience.
- Interest in building and modifying equipment.

The start.

The pcb that is attached to the RF unit supply all needed voltages for the RF unit, making it easy for you to use 48VDC feed everything.

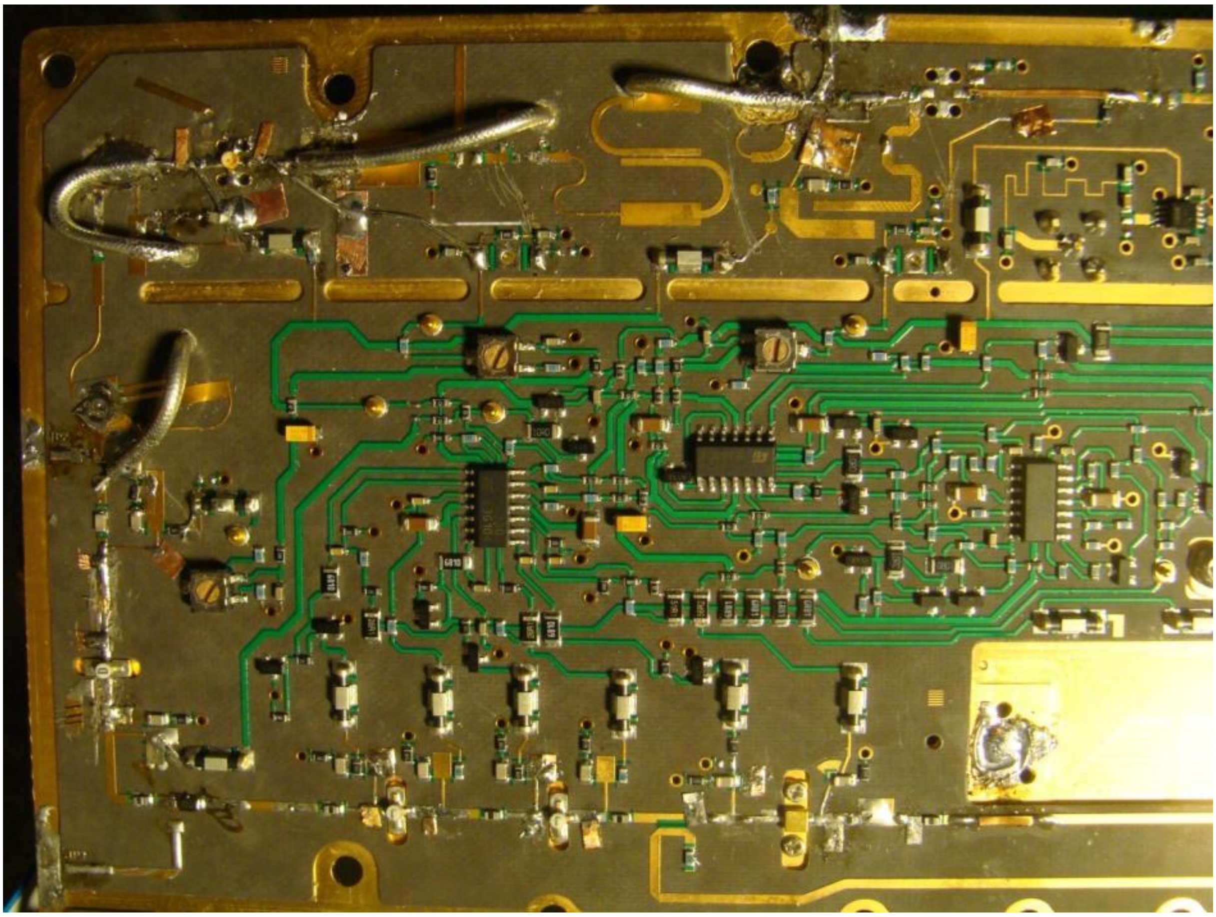
I began investigating the output amplifier chain to see if it was possible to get it working as a power amplifier on 10 GHz. Below a picture of the unmodified three stage PA, first tests done this way.



There are some nice test points on the board that are useful for this purpose.

I attached a SMA output connector through the board so it was possible to connect some measurement equipment at the output. In fact, this model has a nice output power monitor which can be used for tune up, you will see between 1,5-2 VDC at full output. Connect a signal source for the 10368 MHz at the input of the amplifier. Start with about 0dBm input power. Now you need a tuning tool. A small piece 2*4mm of double sided Teflon (ptfe) pcb soldered to a stick of the same material will do the trick. Note that the foil should be removed from the stick upwards from the soldering point. This will serve as a nice test tool.

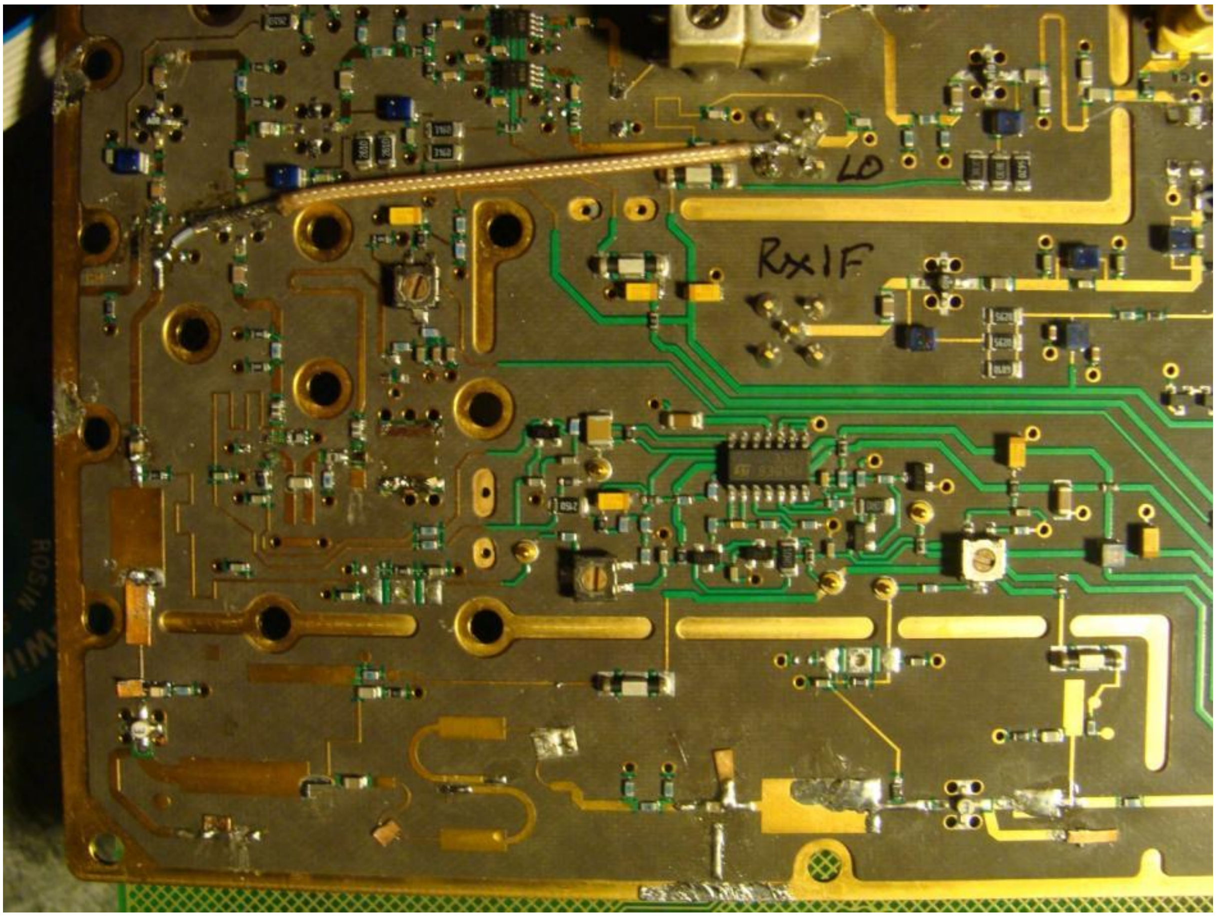
Now you can start to search for sweet spots in the amplifier stages. When you find a sweet spot, cut a suitable piece of copper foil and solder it in place, try again and so on (I used 3M 1181). Remember to cut the power before! Take care to not short the gates to ground when testing. From the pictures below you can see how it turned out in the end. The Gate voltage decoupling capacitances needs to be enlarged as you can see. When tuned for maximum smoke this way, you should see 22-23 dBm output saturated, with 0 dBm drive. In the picture below you can see two additional amplifier stages before the pa-stage, originally an amplifier for 7,5 GHz and a doubling stage 7,5-15 GHz. I cut the foil with a small rotating grinder (Dremel) and tuned with foil. A little re-routing of gate and drain supply was done with some excess resistor leads, and decoupling foils were placed in suitable places. That did the job. Now they serve as post amplifiers after the 3 cm cavity resonators. You see the pieces of ut085 cable going through the brass plate, resonators on the opposite side. Turning the potentiometers searching for most smoke is necessary!



Converting the LO multiplier chain to 2,5-10 GHz multiplier and modifying a double balanced mixer for 15 GHz into two single balanced mixers for 10 GHz. TX mixer with output to filters and RX chain with Two GaAs FET stages and a IF post amplifier.

Here I did a straightforward decision; I did scrapped all three PLL VCO's that where on the board, substituting them with an old G4DDK 2556 MHz source. Originally, the RX LO scheme seems to be 1,8>3,6>7,2>14 GHz multiplication, but I retuned the stages to do 2,5>5>10 GHz. For that I again needed a piece of copper foil and some small cutting! The test points are real handy in this operation. Again tune everything for maximum smoke!

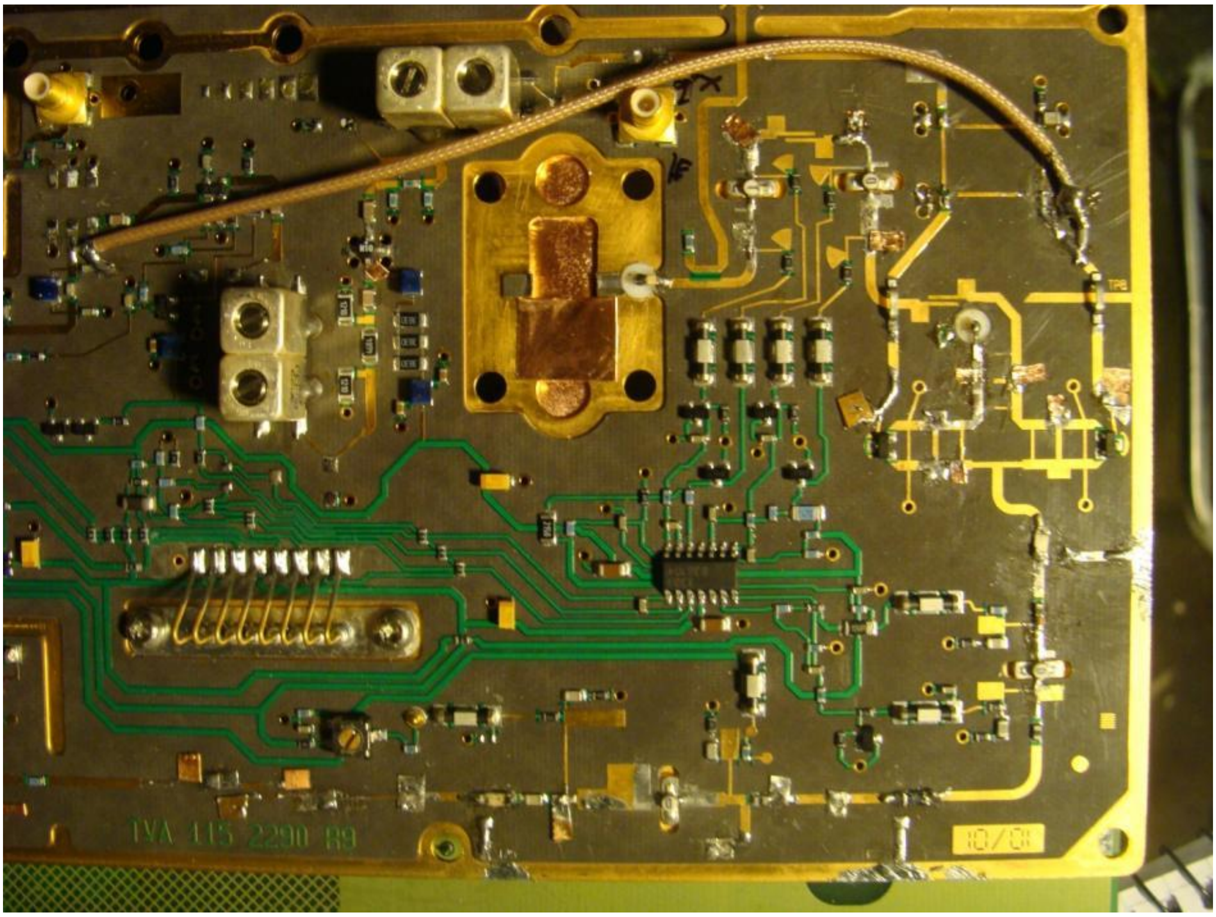
First part of LO multiplier chain modification.



I think it's possible to get much more out of this with some more experimenting, but I got enough LO drive for the divided mixer using the modifications described.

Below a picture of the second part of LO multiplier chain. There you can see the cut in half double balanced mixer. Left side TX mixer, SMA connector through brass plate for 10 GHz RF connection, and 144 MHz IF in line routed to the left SMB connector. RX port, probe to WG cutoff. A SMA connector was installed for 10 GHz RX input +atf 1p chip. The second stage GaAs FET amp retuned with small foil pieces again for maximum gain. I think you get an idea of where the sweet spots on the mixer are to get it going on 10 GHz. The 144 MHz IF line routed through a short piece of coax cable to a mmic post amp (originally 140 MHz) and out through the original RX IF output SMB connector. Nothing in here is intended for impedance purists. Here we only do RF hacking ☺. You will see about 10 dB conversion loss in the mixers when they are modified in this way. But they still are useful in this application. Second picture shows initial test setup.

I reused the SMB connectors on the board to supply LO and IF signals to and from the unit. Of course I did remove some useful components from the board, nice mmic's, small trimmer capacitors, microwave mixer diodes and other useful stuff. Gentle use of a hot air gun on the brass side helps a lot both for soldering and de-soldering!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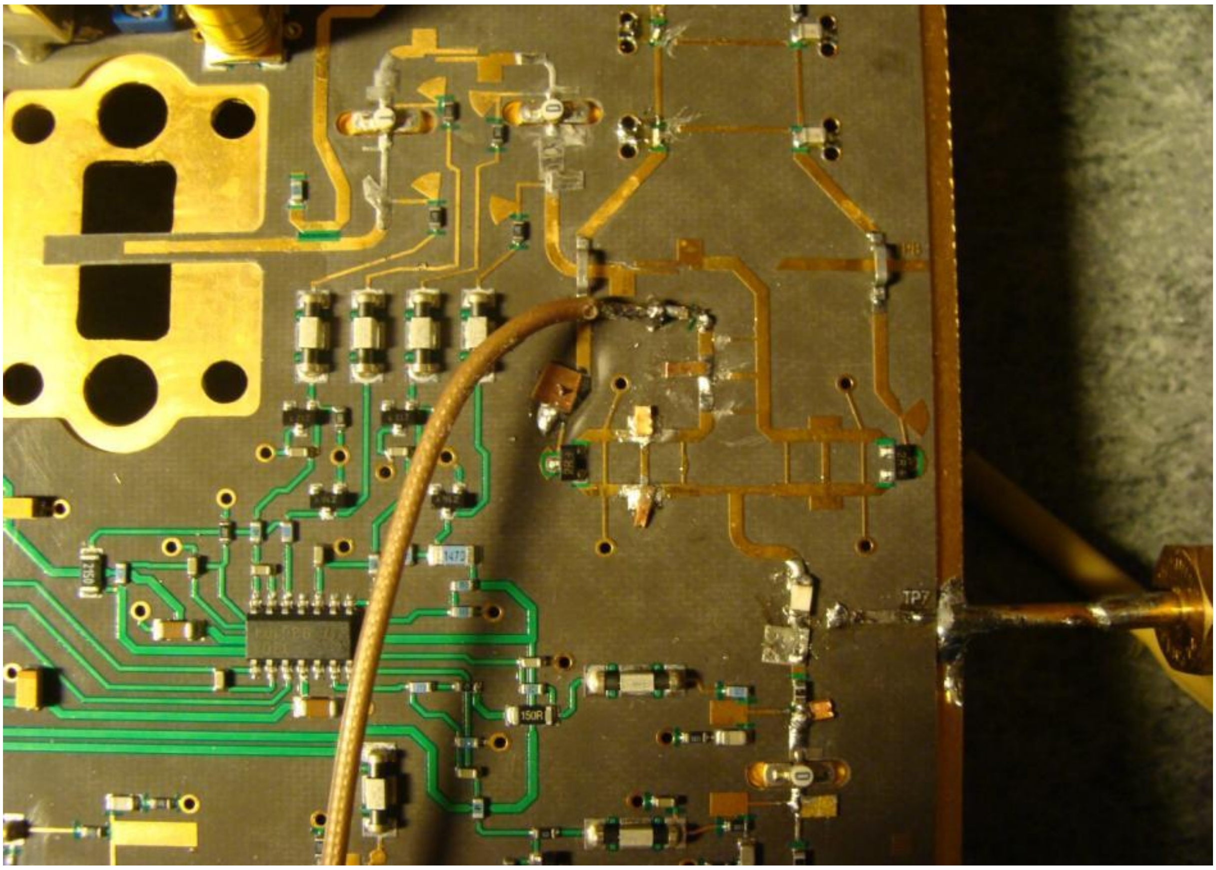
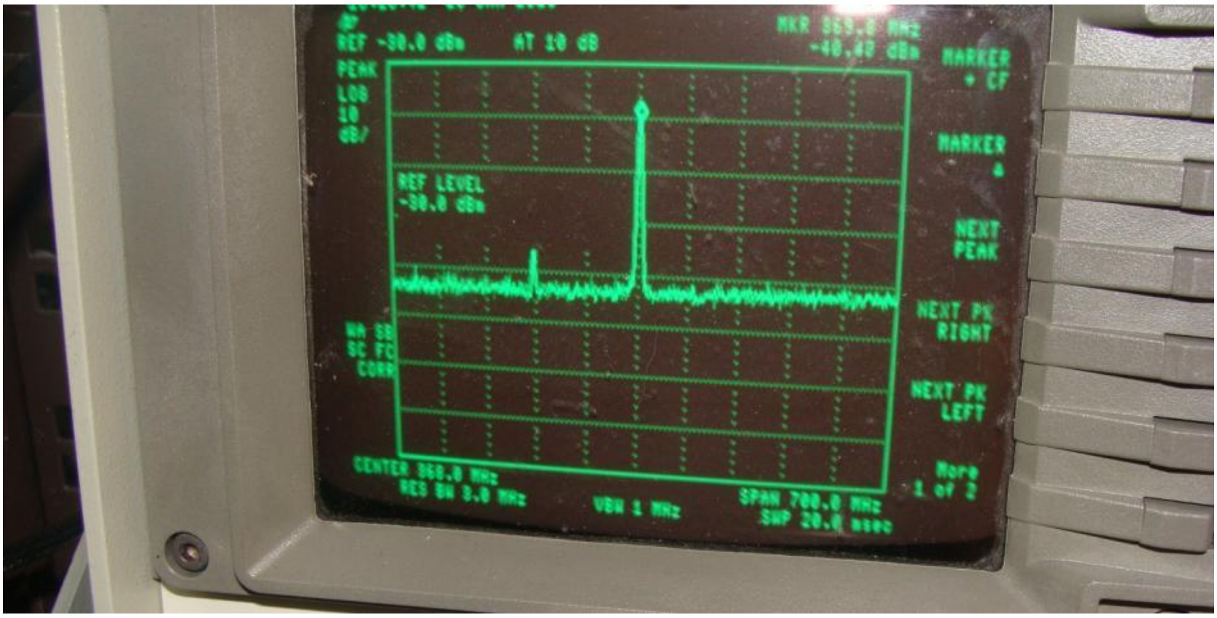

TP7
150R

Filtering of the TX chain.

Three cavity resonators between driver stages are needed to reduce the LO level close to 50 dB compared to RF using 144 MHz as IF. Make the first resonator after mixer, amplifier stage, resonator, amplifier and resonator. Below is the spectrum view **using only two resonators**, main signal 10368 MHz, LO signal only suppressed about 30 dB, image still visible at left. I am a bit limited in dynamic range with my measurement setup, which is a normal up to L band spectrum analyzer with a old LNB in front, where only the mixer and the DRO oscillator are used as down converter.



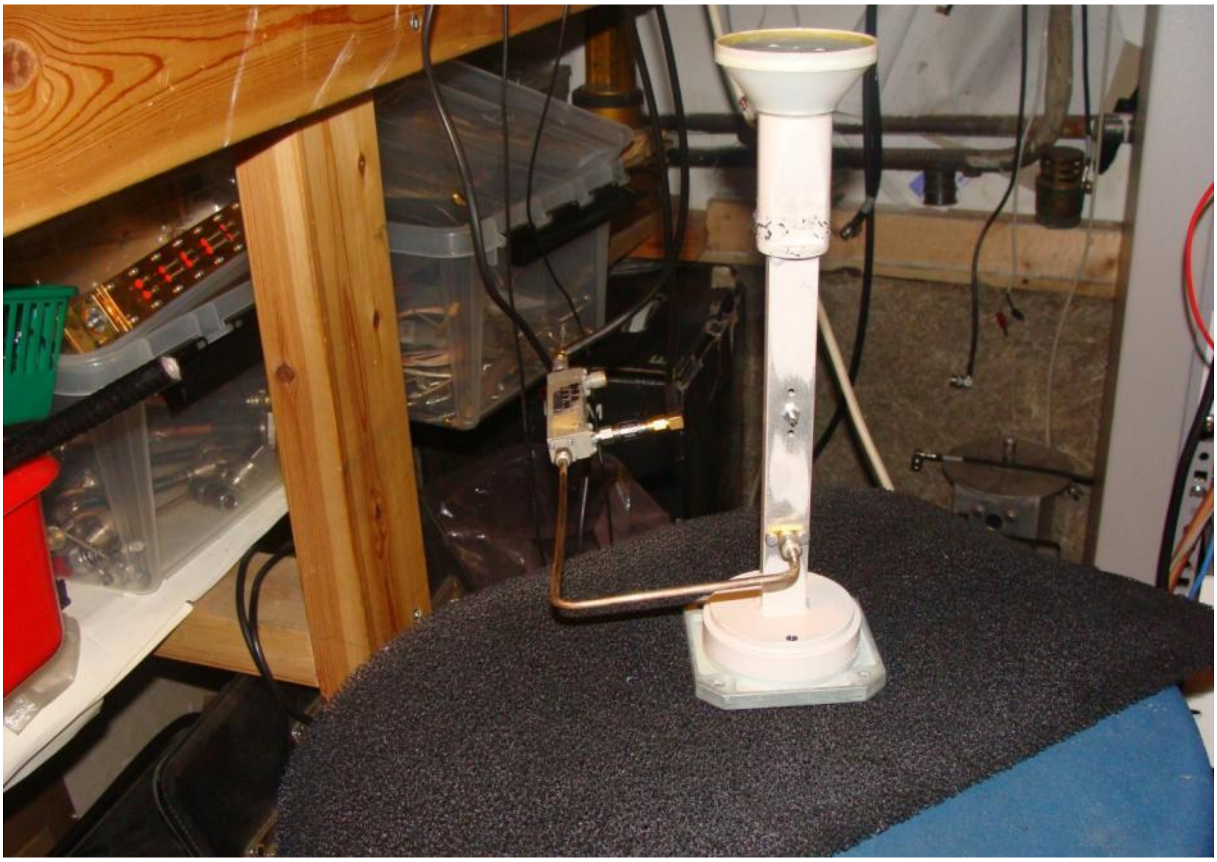
TX-RX interfacing to IF transceiver.

Due to the fact that I have an old trusty ic202 I used that. The radio already had different RX-TX lines, so I routed those two to the board. The RX input straight to the SMB connector after IF post amp, and the TX output through an attenuator made of 50 Ω to ground, 470 Ω in series and a 100 Ω trimmer potentiometer connected to ground, where the slide is connected to the 470 Ω resistor and the 100 Ω pin to the TX mixer input. This can of course be made in a fashion that suits your setup! I had already 12V DC out from the radio on the RX, so I used that directly to power a SMA relay for TX-RX switching on the 10 GHz side. I also connected a small transistor with a series resistor that pulls down pin 6 on the TX side to ground when receiving. In this way you get the TX side shutdown when receiving. It works at least with these power levels. Added a green LED with a series resistor for RX indication. A nice feature is the output on pin 8 from the output detector. I just connected it directly to a red LED for TX output Indication! I used the original 48V dc PSU in this first modification; everything gets powered from the board this way.

The antenna and feed.

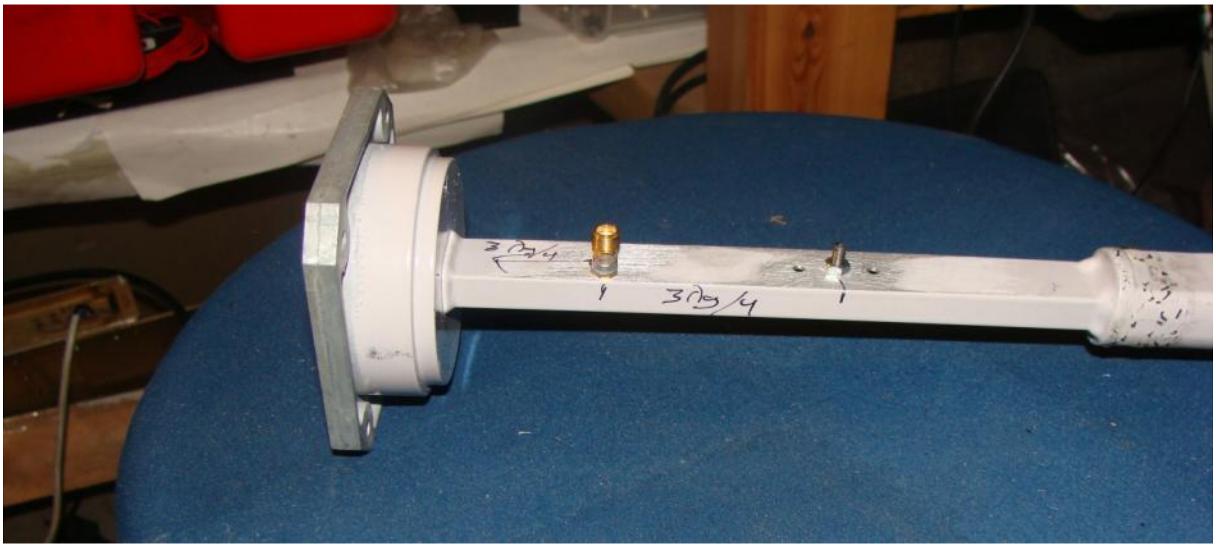
I investigated the feed, and found that 10368 MHz still will propagate in the WG. The inner width is 15,8 mm. Calculated the Guide wavelength for 10368 MHz, and found that it is 72,0 mm. Did a blanking plate to the open WG end, added a SMA connector with a probe protruding 5 mm into the WG exactly ¾ guide wavelengths from the blocked end, 54mm. Added a tuning screw ¾ guide wavelengths 54 mm further along the feed. Initially I had three screws spaced 1/8 guide wavelengths, but when the feed was tuned up, the two other screws where obsolete. And how did I do it? This is a nice feed from the matching point of view! You should see at least 20dB RL if you do make it this way. Using some conductive foam under it did raise the RL to 24dB with my test setup. This should make a feed at least acceptable for this recycling project!

Here a picture of the feed during tune up.

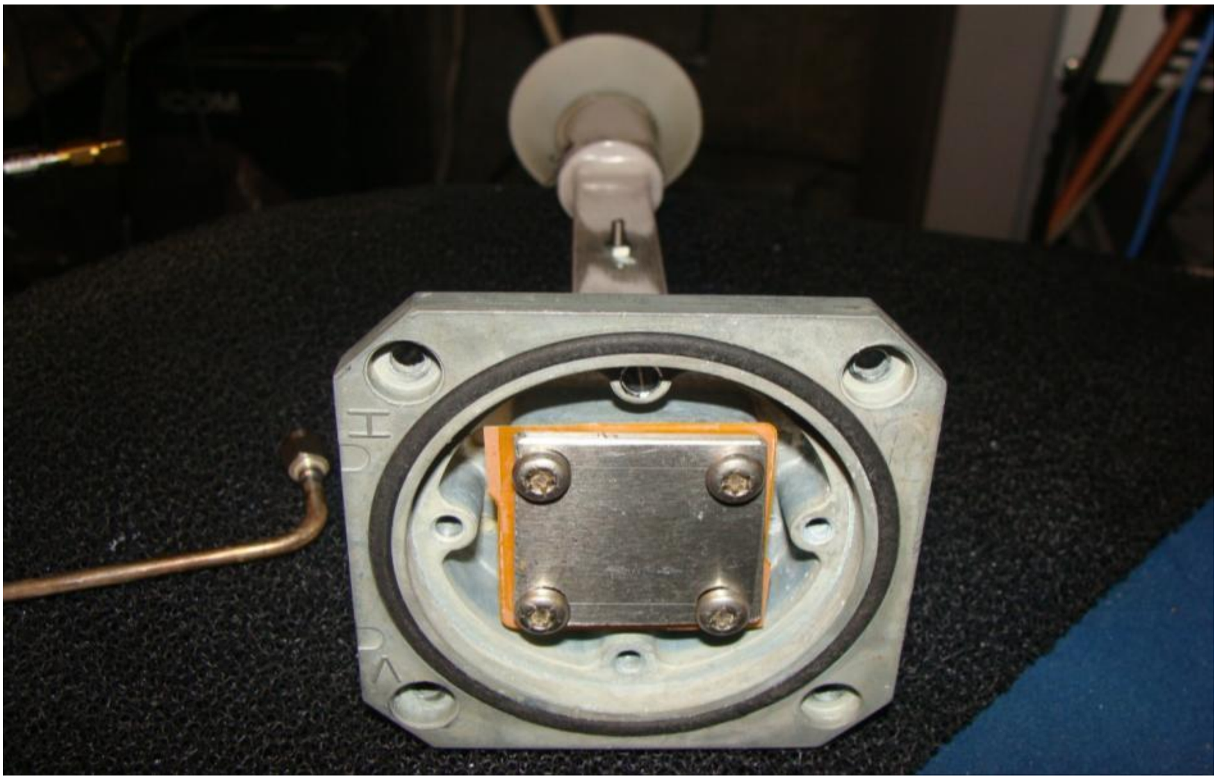


I made the tests using a directional coupler, the signal generator and my LNB converter +SA together with some attenuators.

Here a side view of the feed.

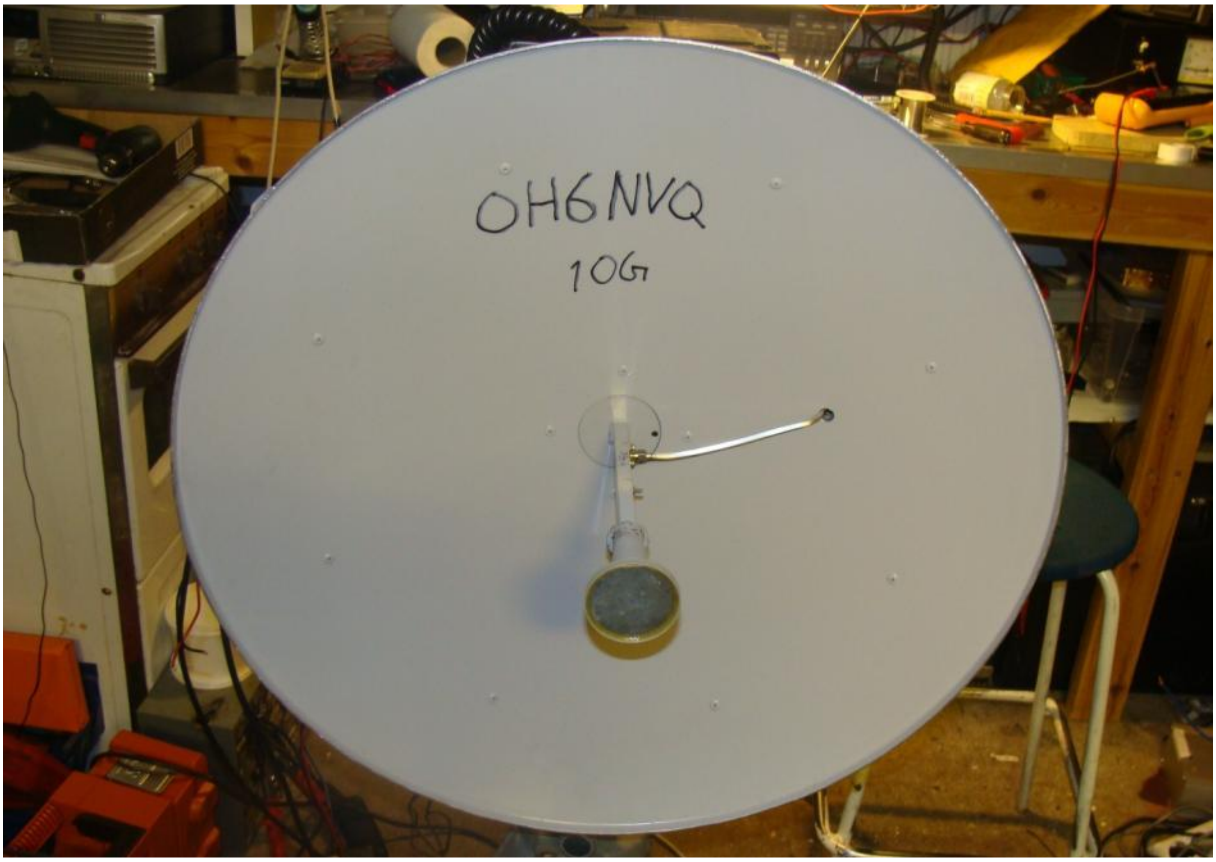


A rear view where the blanking plate is visible.

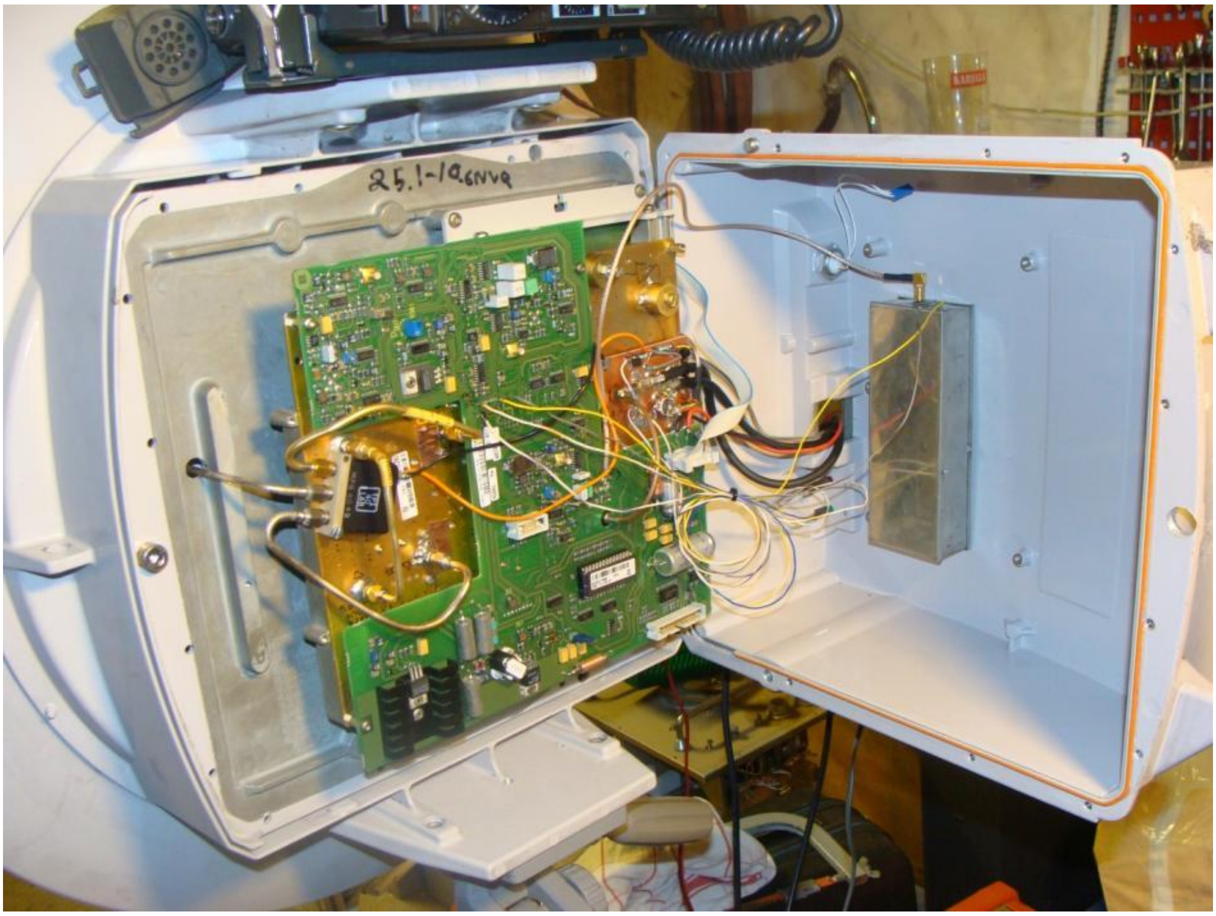


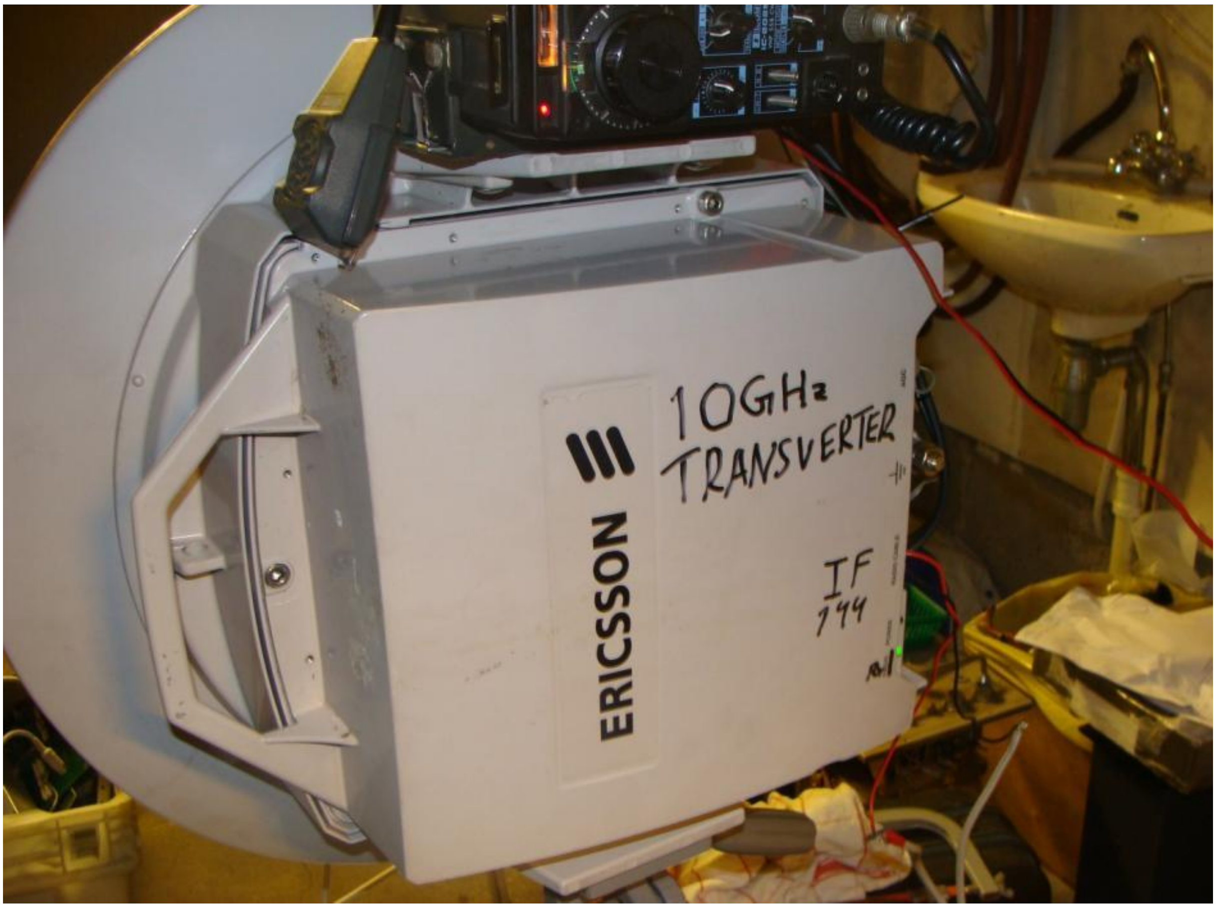
The dish is also recycled.

I did cut of the side lobe screening barrel from the dish assembly to save some weight for portable use. You will also find a nice roll of conductive foam useful in other microwave experiments. Here front view of the completed /P equipment using the 60 cm prime focus dish.



I did turn the assembly 90 degrees to make it easier to attach a camera tripod beneath, another nice feature is the mounting holes that directly can be used for the IF radios mobile mounting bracket. I did mount the bottom plate with electronics to the dish assembly with the upper mounting bolt M8, Recessed with a 13mm hole in the place on the outer cover. The two remaining M8 bolts in the cover holds everything together. This way I did omit the need for the many screws that holds this module together. I did attach two cable wraps to act as hinge for the cover on the right side. Here you can see inside of the completed transverter complete with a G4DDK LO chain in the cover. Note the hole drilled through the dish and bottom plate for the short semi rigid cable from coax relay to the feed. This is one way of making the mechanic side. Enough for my portable use.





Performance.

TX P_{out} 150mW
RX Conversion gain 25dB

RX Cs/G noise difference measured with setup >0,5dB

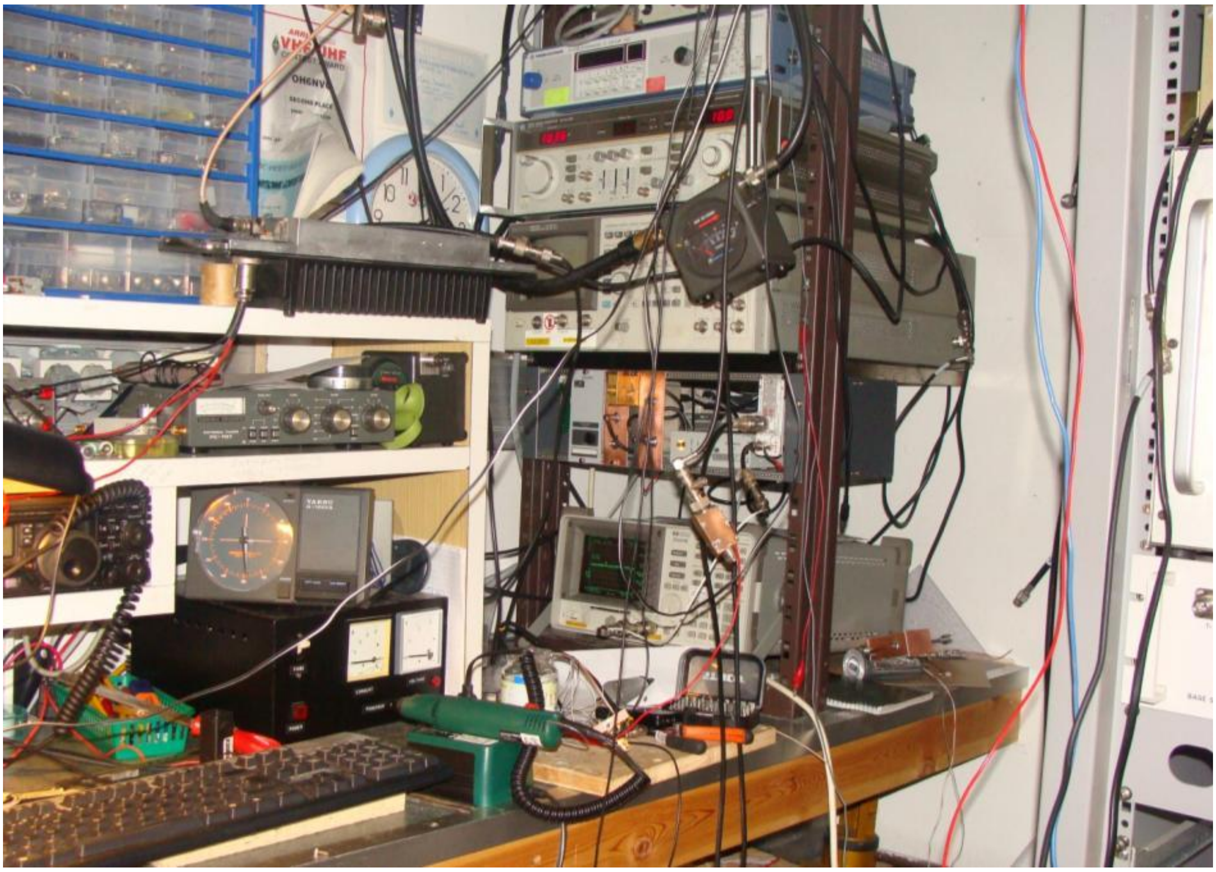
In a second version I would add a Cavity filter between the GaAs FET stages in front of the mixer. Just tuned up with foil pieces, no more than 11dB Image response rejection is achieved.

Future plans:

- Add an 1W PA stage, mount a 12V>48V DC converter.
- Make some QSO's
- Actually modifying a second one to become OH6SHF on 10GHz.
- Start to build a home station from these, also for 6 cm!
- Start modifying a 23 GHz unit for 24 GHz

Here a picture from Cs/G measurements. TG 250K Brrrr. A bunch of laying threes as TG reference.

Equipment used during tune up: Generator 5-12 GHz, 0-2,9 GHz SA. Surplus 2 GHz LO, 2>6 GHz multiplier, surplus 6 GHz mixer, surplus 2 GHz mixer, LNB as down converter, 1 GHz generator and a diode across a BNC connector as harmonic generator. Some SMA attenuators and a DVM.



My shack during the project.

I hope that this short description and picture collection can help someone else to get started making modifications on these Minilinks.

I especially want to send thanks to Michael Fletcher, OH2AUE and Jari Koivurinne, OH3UW for all the technical help and encouraging support they have given me through this journey.

Project time: Started 31-dec-2009 with a pile of this equipment dumped in front of my house, and was a ready to use portable station for 10 GHz 26-Jan-2010.

73's and GL with your modifications!

OH6NVQ Tomas Tallkvist

Jakobstad, 3-Feb-2010