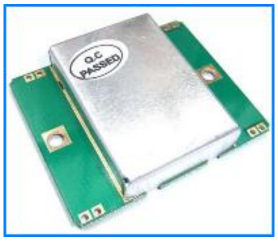
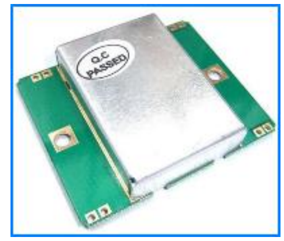


QRV for €3 on the 3cm band with the "HB100" motion detection device!



To become active on the 3 cm band, an investment of about €3 for a transmitter and €12 for a PLL stabilized LNB will go a long way. This means that you must already have a computer or tablet plus an RTL SDR dongle or, for example, a Yaesu FRG9600 as a receiver. Furthermore, of course, some cables, a power supply and some hand tools and a lot of motivation :-)

If the HB100 transmits at 10.369 GHz, and the LNB has an Lo of 9.750 GHz, then the signal comes from the LNB at 619 MHz. You connect a receiver via a Bias-Tee that can receive in the range around 619 MHz, such as an RTl SDR dongle or an FRG9600.

Of course you have to buy an HB100 first :-) You can get one for just under €3 on E-bay. Search for "HB100 microwave" or click here -> CLICK

You can buy a PLL LNB for around €12, including shipping. For example this -> CLICK

Before you go any further, I would also take a look at this document DROplexer.pdf . It was the source of inspiration for me to also purchase the HB100 motion detection device and to conduct experiments with it.

A datasheet of the HB100 can be found here: http://www.limpkin.fr/public/HB100/HB100_Microwave_Sensor_Application_Note.pdf

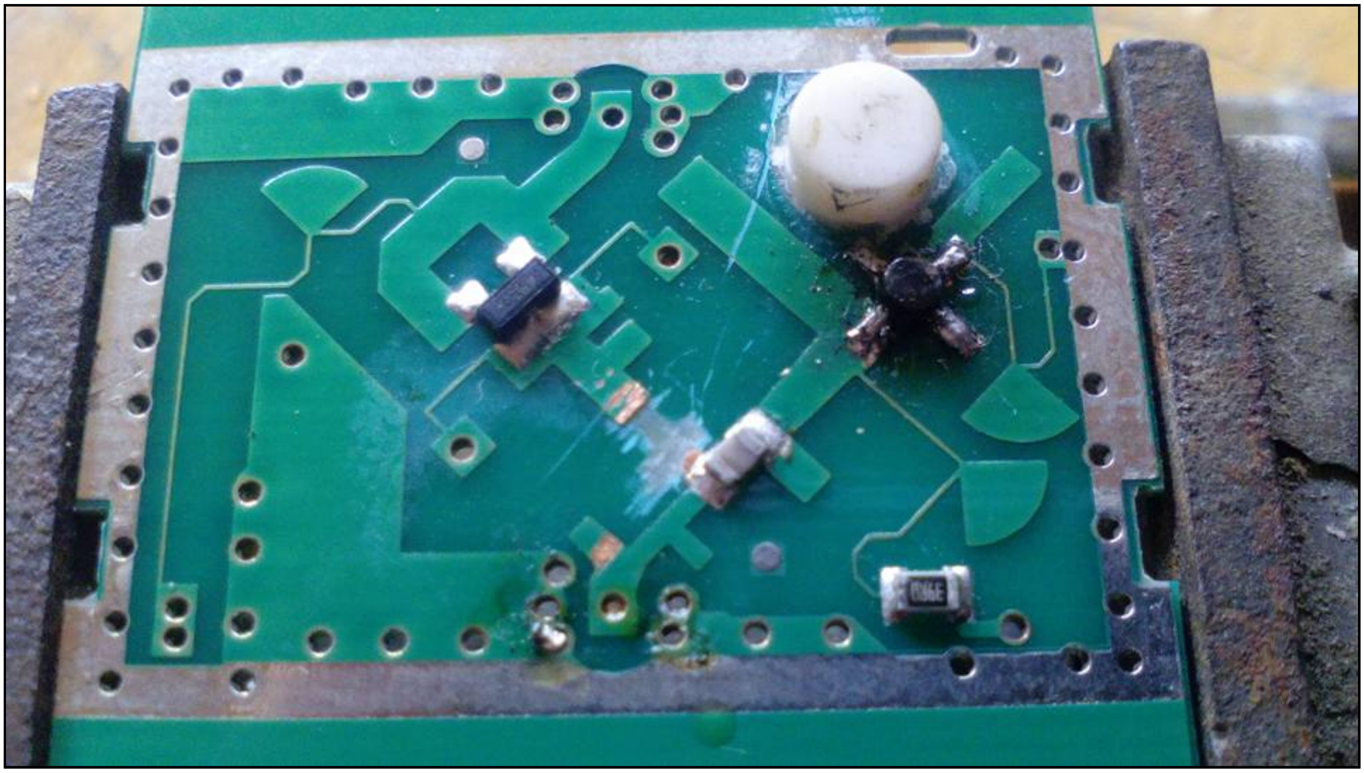
Unlike the example in the DROplexer.pdf, I am not using the IF output of the HB100. For reception I use an LNB as used in satellite TV reception installations. Therefore we can cut the mixer loose from the oscillator. This makes the transmission frequency of the HB100 more stable and less sensitive to environmental influences.

Modification A :

Open the aluminum cover by carefully bending the tabs open. Do not bend further than strictly necessary. There is a chance that they will break off. Cut or mill the print path next to the SMD capacitor and partially remove it as shown in the photo below.

Modification B :

There is an Allen screw in the aluminum cap. This allows you to adjust the frequency by turning this bolt closer or further from the DRO pill. Replace this with a longer screw and also install a lock nut. The standard Allen screw will rattle, but you can fix it nicely with a lock nut. Replace the aluminum cap and bend the tabs firmly around the print again.



The HB100 has 4 antennas. 2 of them are intended for sending. The other two are for reception, but that has now been closed. In fact, you can already supply the HB100 with 5 volts and transmit with it. I bridged a distance of 5 km between Winschoten and Koos, PD0SBS in Scheemda, with a bare HB100 at a height of 12 meters.

To make more gain, I placed an HB100 with the two transmitting antennas in the focus of a dish. Please note that the PCB is not exactly in the center of the dish because the antennas are on the edge of the HB100 PCB. I found the maximum radiation, the focus point, by measuring the field strength at a distance of 8 m with a 1N23c diode detector (see elsewhere on this page).

This photo below shows how the HB100 is mounted in a plastic tray in the dish. The saucer is a 42 cm Ikea lampshade that happened to be very parabolic.

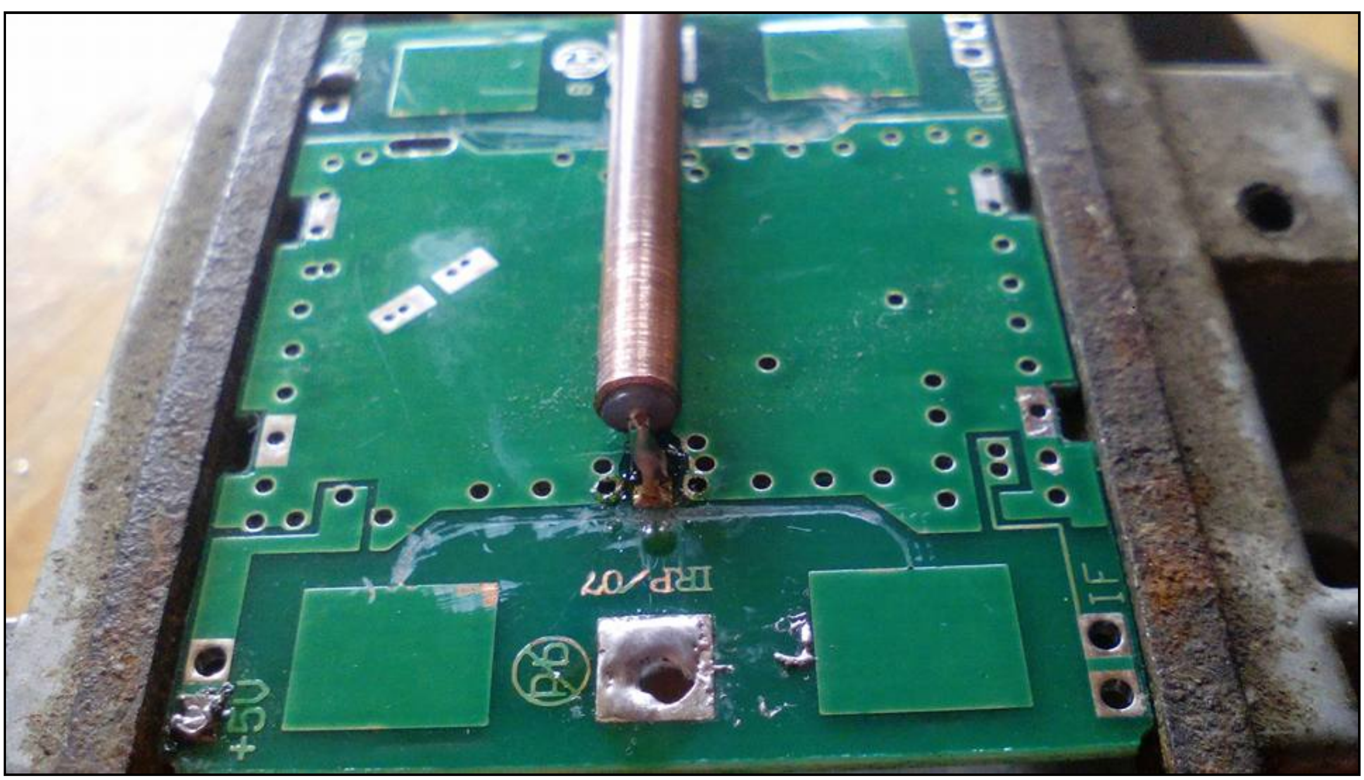
Once again the details photo of the HB100 in a plastic container to protect the HB100 against water and wind. The HB100 is very sensitive to temperature influences and must be protected against them as much as possible. Variable gusts or drafts cause the frequency to drift back and forth. On a partly cloudy day with alternating sun and clouds, you also see the frequency drifting up and down as a result of heating and cooling of the plastic container in which the HB100 is mounted.

With this configuration (HB100 in the 42 cm Ikea dish) the mode 'OPERA op05' is bridged about 32 km between Uithuizermeeden at a height of about 25 meters agl (a TX site made available thanks to Gerrie the PA4GB) and the RX station in Scheemda near Koos the PD0SBS on 18 m agl with a 50 cm offset dish. Incidentally, a connection was also successful that day between Uithuizermeeden and Nieuwolda, with Berend using the PA3ARK/p on 3 m agl.

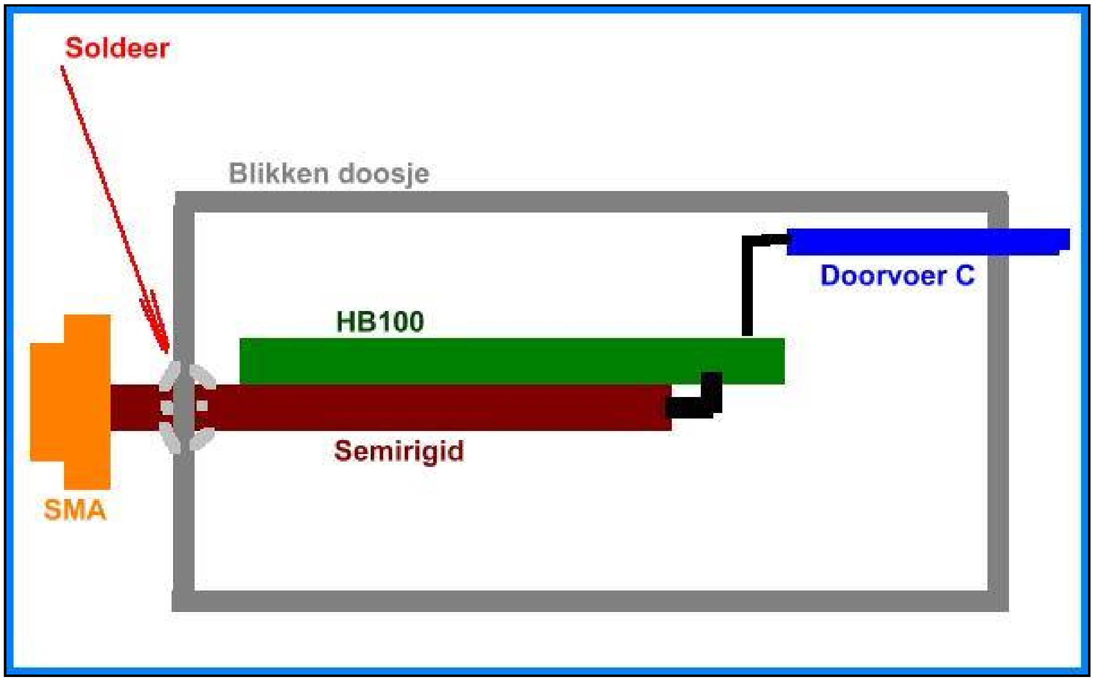
To modulate the HB100 you can keep it very simple. Only a transformer in line with the power supply. On the other side of the transformer you connect an audio source such as a PC or an MP3 player. You will have to increase the input voltage before the transformer to compensate for the voltage drop across the transformer. When finding a transformer you have to be lucky that there is a suitable type in the junk box. I also used an LM317 voltage regulator on the Adj. pin of the LM317 to inject the audio from the MP3 player via some resistors and an electrolytic capacitor.

The amplitude that this creates on the 5 volt power supply ensures that the HB100 FM is modulated. The generated frequency is sensitive to variations in the power supply. This creates FM modulation. We didn't do that in the past with 3 meter tube transmitters ;-) However, the MP3 player does not contain Pirate polka music, but an MP3 or WAV file with CW ID that is played in a loop. I have recorded an "OPERA op05" cycle myself and have played it in a loop through the MP3 player.

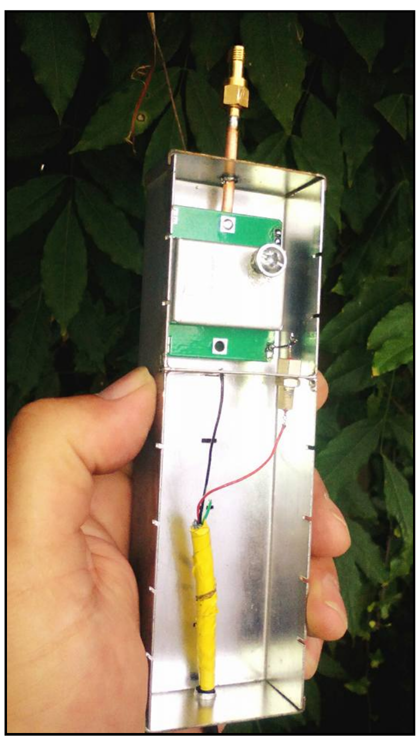
It is also possible to make an SMA connector on the HB100. The thin print paths to the two Patch transmitting antennas are then scratched away. At the point where these two print paths come together you can solder the core of a coaxial cable. See example in the image below. The outer sheath of the semirigid coax has not yet been soldered to the PCB in the image below, but you should do that!



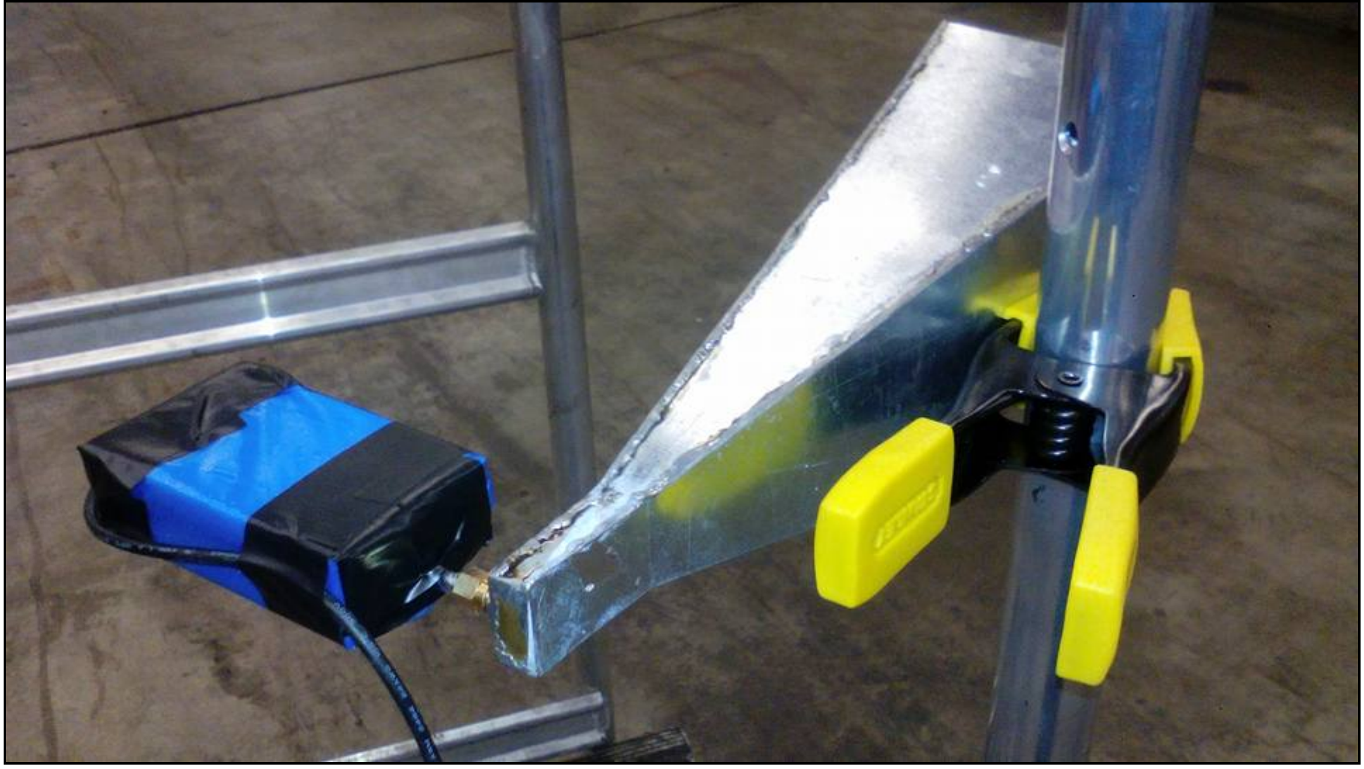
In the illustration below you can see how I further assembled it. Just a note regarding the HB100 print. It should not experience mechanical stress. A slightly variable mechanical load on the print causes the frequency to vary. Initially I made the connection to transit C very rigid. A seesaw is created where the semirigid passes through the can. The rigid lead-through C connection provided back pressure, causing the PCB to bend slightly. After I replaced this connection with a thin wire with some loops, the stress on the print was resolved. In the meantime, I also received the advice from two amateurs to place a choke with the necessary uH in front of the lead-through C to suppress influences picked up in the power cable.



This is a practical example of the modified HB100 in a tin box. The passage C (bottom right corner of the compartment) is still provided with a stiff piece of wire, with the associated problems I wrote about above. Also note the modified adjusting screw + lock nut to adjust the frequency.

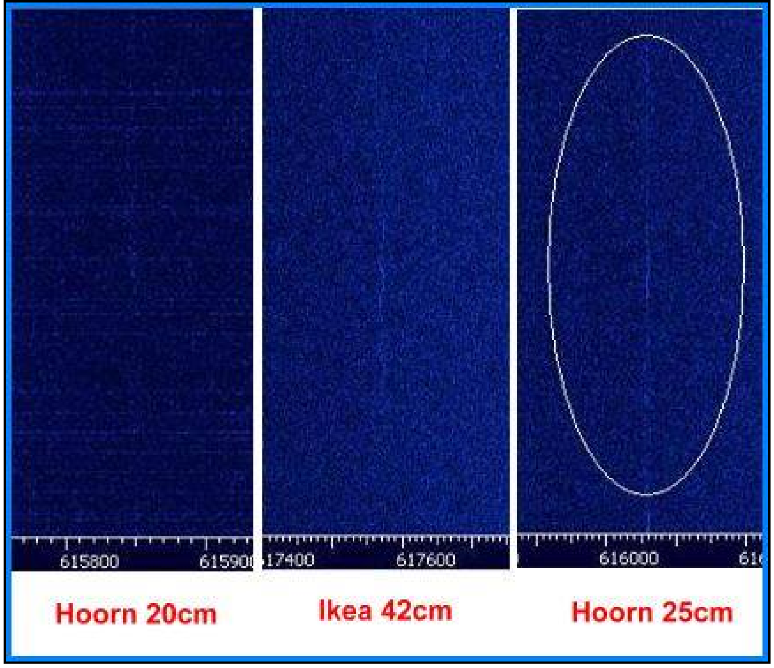


I will come back to the horn later, but again a practical example of how the HB100 is connected to a horn. The frequency stability of the HB100 partly depends on the mechanical rest you can give the PCB, but thermal rest is also important. That is why the tin box in this case is wrapped with bubbles of foil and finished with a blue freezer bag. This is to counteract the influences of wind and rain.

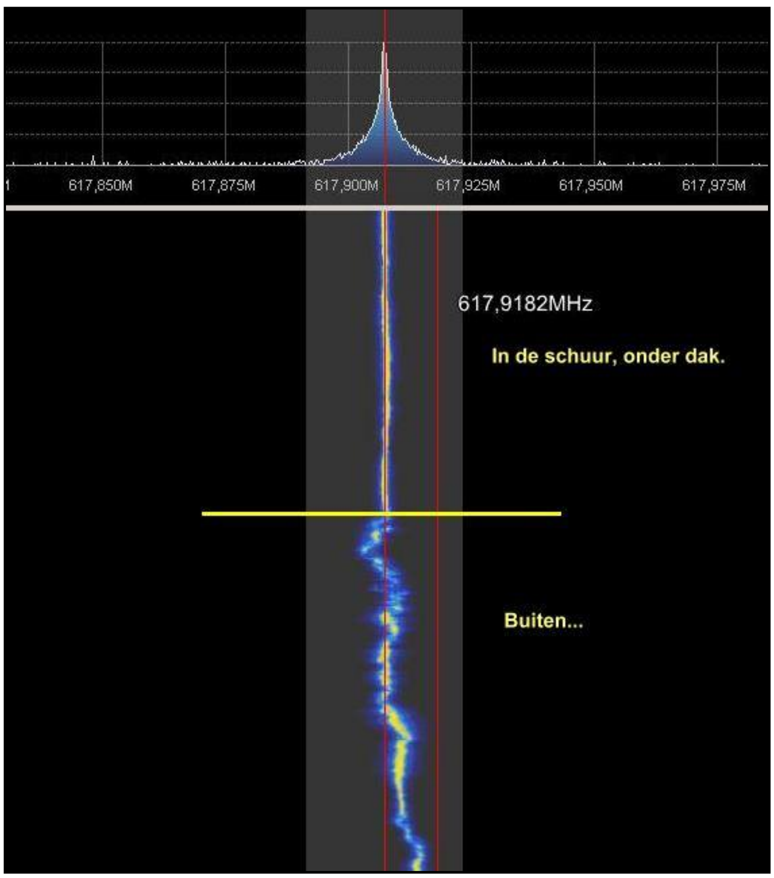


In this way I have the modified, canned HB100 + cone at 8 meters agl. The modulator is on the ground floor. From this 8 meter height I did some tests between Appingedam and Scheemda and the signal has also been decoded in OPERA op05.

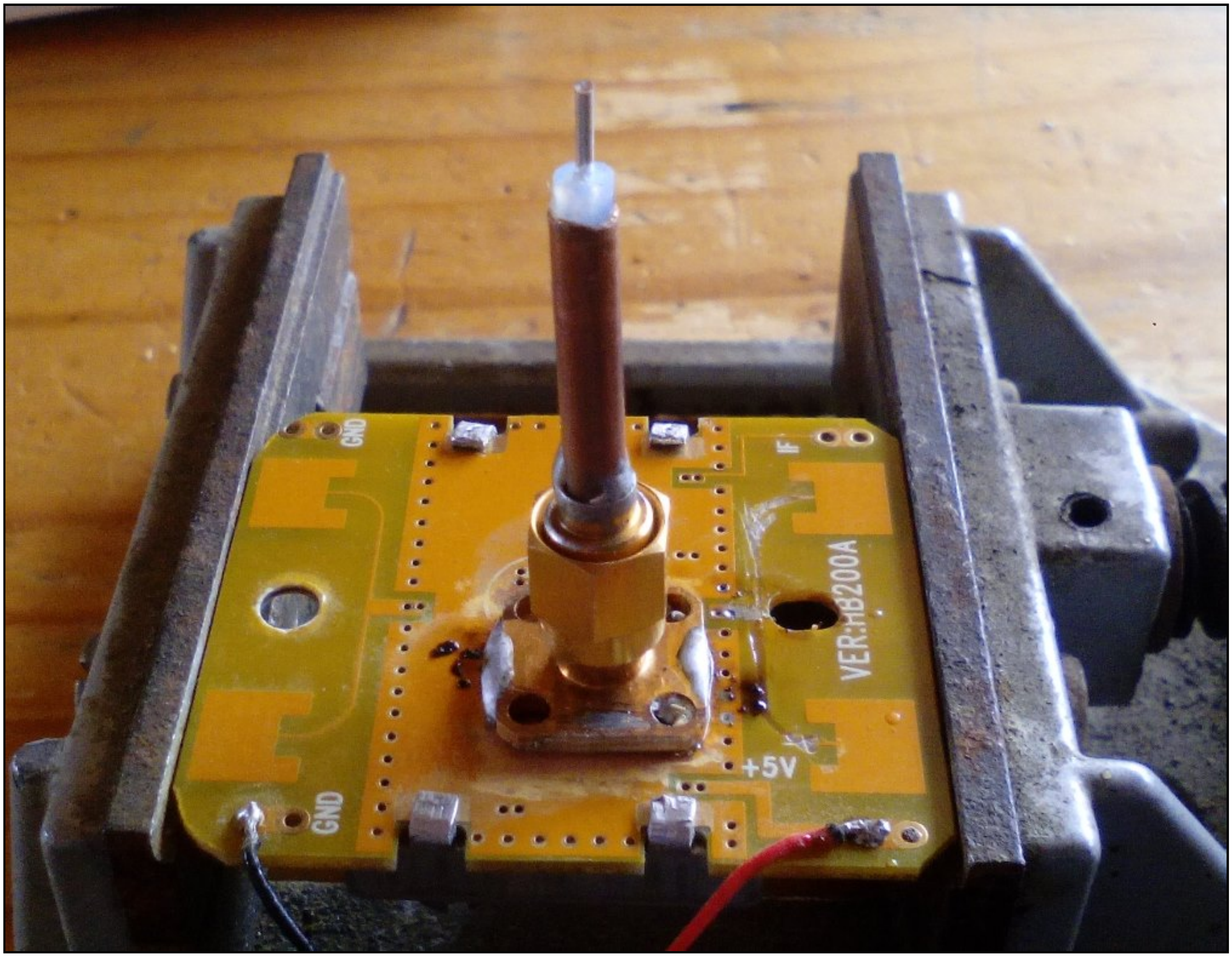
Below are some results from different antennas. A very thin vertical line is visible in these spectrograms. These measurements show that the entire HB100 in the focus of an Ikea lampshade and the HB100 with SMA connection and 25 cm long horn produce comparable results. Of course the signals are extremely weak. But we are talking about a 15 mW transmitter on 10.369 GHz over a distance of 18 km. In Scheemda at PD0SBS we listened with a 50 cm offset dish and LNB at 18 meters agl. My transmitter was at 8 meters agl.



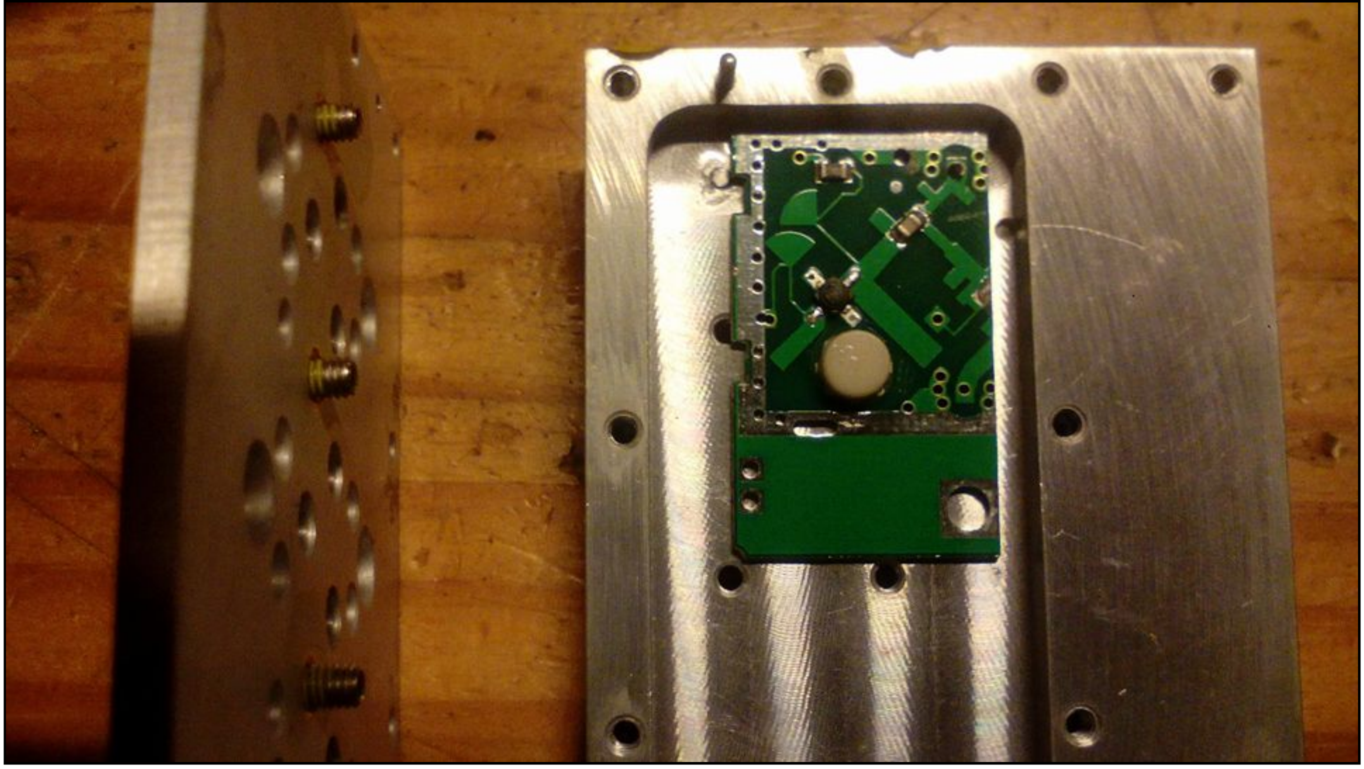
I just wrote about thermal packing the HB100. Below are the results of an open HB100 that was first set up in the shed and later outside. The frequency stability clearly shows that drafts and environmental influences significantly influence the frequency stability. The drift is about 12 KHz in this case.



In addition to the HB100, there is also an HB200. My impression is that HB200 is less stable than HB100. It is also more difficult to modulate in FM. It needs a lot more amplitude on the 5 volt line. Not an objection in itself, but in my opinion it offers no advantages compared to the HB100. Nevertheless, for test purposes I equipped this HB200 with an SMA chassis part directly on the PCB instead of using semirigid as a connection. An SMA male connector with a leftover semirigid + blade serves as a test antenna for back yard experiments.



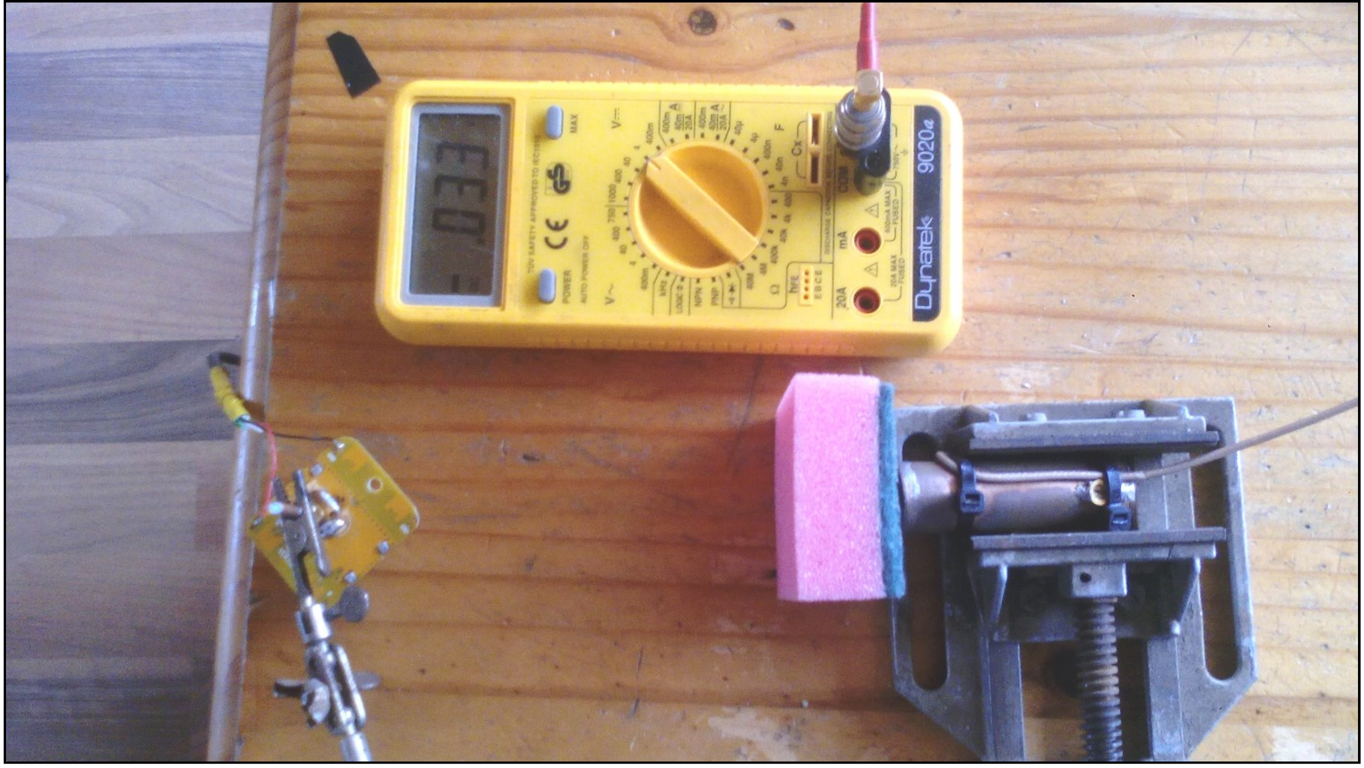
Here is another example of a successful experiment to counteract mechanical stress on the print. The HB100 was stripped to such an extent that only the transmitter circuit remained. Otherwise it wouldn't fit in the milled aluminum block I happened to have lying around. The HB100 is firmly screwed into the 1cm thick aluminum block, creating good mechanical rest. The lid (left) is equipped with the adjustment screw to regulate the frequency and falls into place just above the DRO pill. There is an SMA chassis part at the bottom of the aluminum block. The output of the HB100 is soldered directly to the core of the SMA chassis part. In this case in the top right corner of the stripped HB100 print.The aluminum cover that normally covers the HB100



To measure 10 GHz signals, I equipped a 22 mm copper tube with a 1N23c diode. The diode is located 8 mm from the back wall. The back wall is closed with a 5 Euro cent. The top of the diode is led out through a hole in the tube. There is still a C of 10 nf about this. I measure the voltage with a universal meter. Just above the HB100 patch antennas I measured about 2.5 volts. At about 8 meters away you should expect voltages of about 20 mV if you point a horn at it. The voltage at the top of the diode is negative.


00.0
200
250
OFF
250
200
V~
A
200µ
2000µ
20m
200m
5
hFE
5A MAX
MAX 10SEC
EACH 15MIN
FUSED
VΩmA
250V MAX
250V~MAX
500mA
FUSED
COM
250V MAX
Plus

I was curious about the damping of various materials. I made a measuring setup with the aforementioned HB200 and the 1N23c diode measuring head about 20 cm away from the transmitter. I then held various materials in front of the diode measuring head and recorded the measured field strength. The results can be read below the photo. What did surprise me is that glass blocks a lot of signal.



With no obstruction between HB200 and the 1N23C diode detector, the signal was 31 mV!

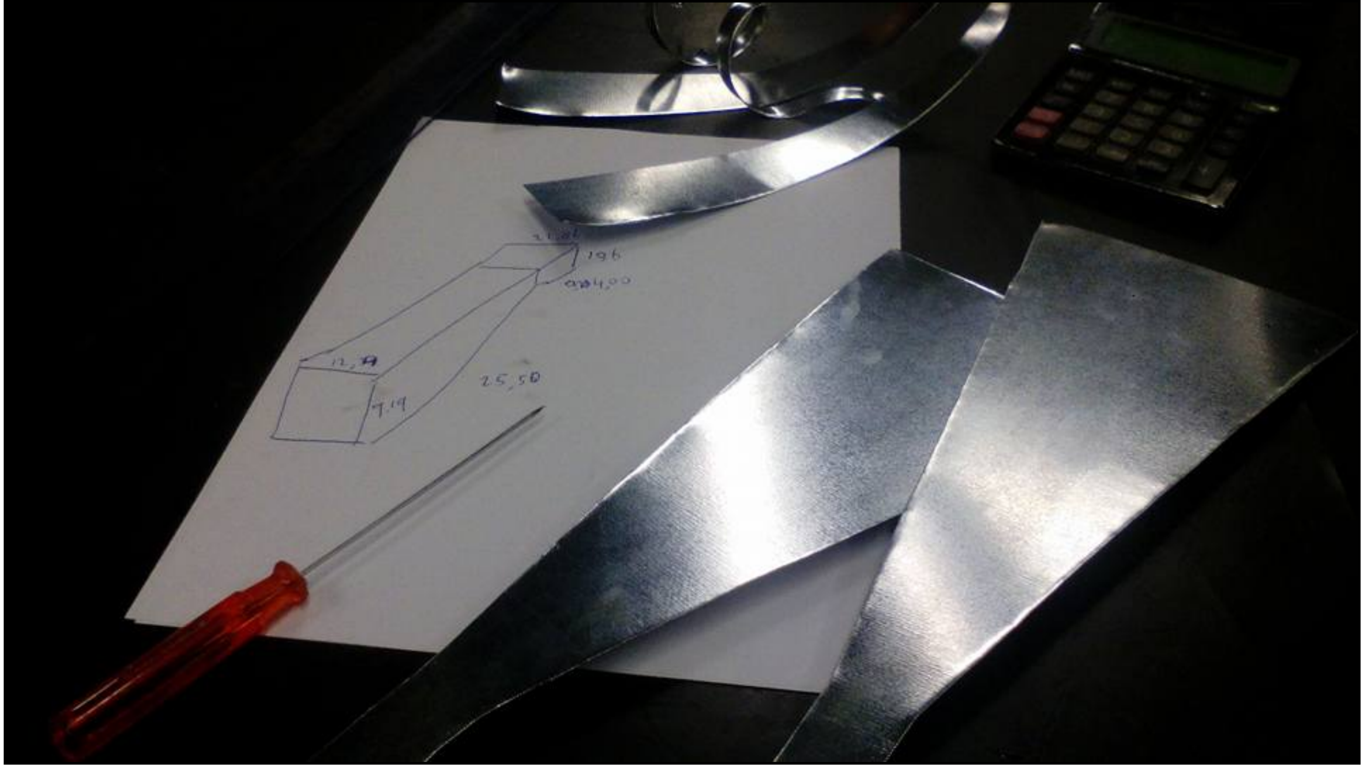
Sponge (see photo) - 31 mV
Brown Sanding wool - 31 mV
Freezer bag 4x double (rustle) - 31 mV
PE adhesive tape - 31 mV
9v battery blister - 31 mV
Glasses plastic - 31mV
PP drinking cup - 31 mV
Tupperware container - 31 mV
Blister packaging Cheese - 31 mV
Cutting board plastic - 31 mV
Lid Gamma screw blister - 31 mV
White Teflon tape - 31 mV
Cap of lighter gas can - 31 mV
Eemsbode, double - 29 mV
Rice waffle - 29 mV
Plexiglass 2mm - 28 mV
Paint can cap - 27 mV
Ceramic cake dish - 26 mV
PP drinking cup - 23 mV
Plexiglass 5mm - 22 mV
Ceramic pastry dish - 19 mV
Giant African snail shell - 17 mV
Jar of 4 seasons pepper - 16 mV
Bag of wood fiber/sawdust - 15 mV
Wooden cutting board 15 mV
AH All kinds - 13mV
Green Welding cap glass - 12 mV
Book 550 pages - 12 mV
Highball glass - 11 mV
Glass coffee cup - 11 mV
Slice of bread - 9 mV
Wine glass - 9 mV
Slice of space cake - 7 mV
Spanish dictionary 380 Page - 7 mV
Shot glass - 3 mV
Cherry tomato - 0 mV
Copper - 0 mV
A hand - 0 mV
Cucumber - 0 mV
Sugar bite - 0 mV

In the meantime I have made 2 cones from 0.5 mm tin, including the SMA to waveguide transition. You can find the links to those cones here:

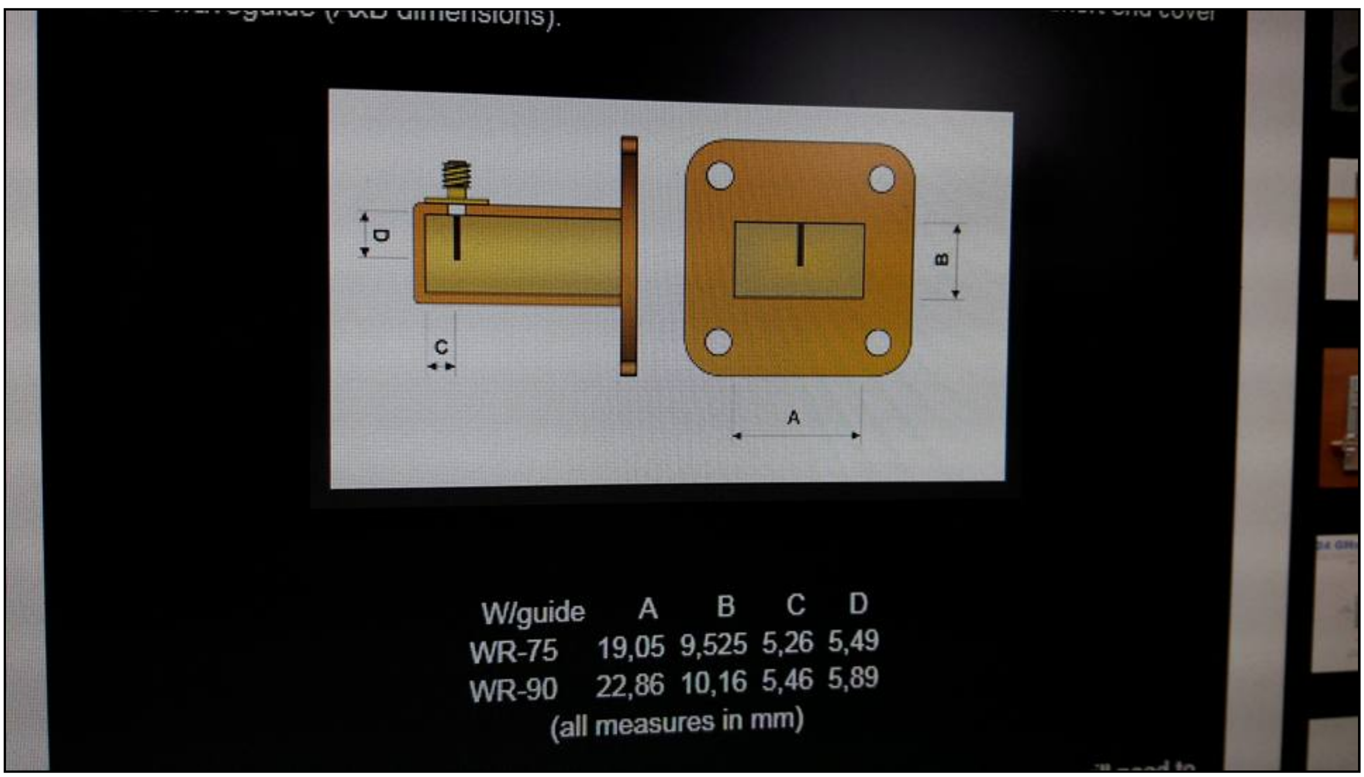
http://www.wipl-d.com/getting_started.php?cont=benchmarks/wipl-d-pro-examples/antennas/20-db-horn-antenna

http://projects-web.engr.colostate.edu/ece-sr-design/AY11/antenna/Images/Final_Paper.pdf

I cut the 4 sides of the horn from a piece of sheet metal and soldered them together. I made a mold from wood that has the correct dimensions of a WR90 waveguide. This way, the 4 sides of the waveguide can be soldered together with the greatest possible accuracy and it will ultimately approximate the correct size of waveguide, size WR90.



The dimensions for a WG16 / WR90 waveguide to SMA transition are shown in the image below...



In the meantime I have purchased a [DB0VE](DB0VE) output stage . The control of the HB100 is sufficient to control PA3-2-400mW. In the picture below, the HB100 is encapsulated in a milled aluminum block (right). This is then connected to the 400 mW output stage. A circulator follows the output stage. This is a particularly nice asset to reduce environmental influences. The HB100 drifts without a circulator at 400 KHz when you wave your hand in front of the horn. With the circulator only 40 KHz. The circulator is then connected to the 25cm long 20dB horn.

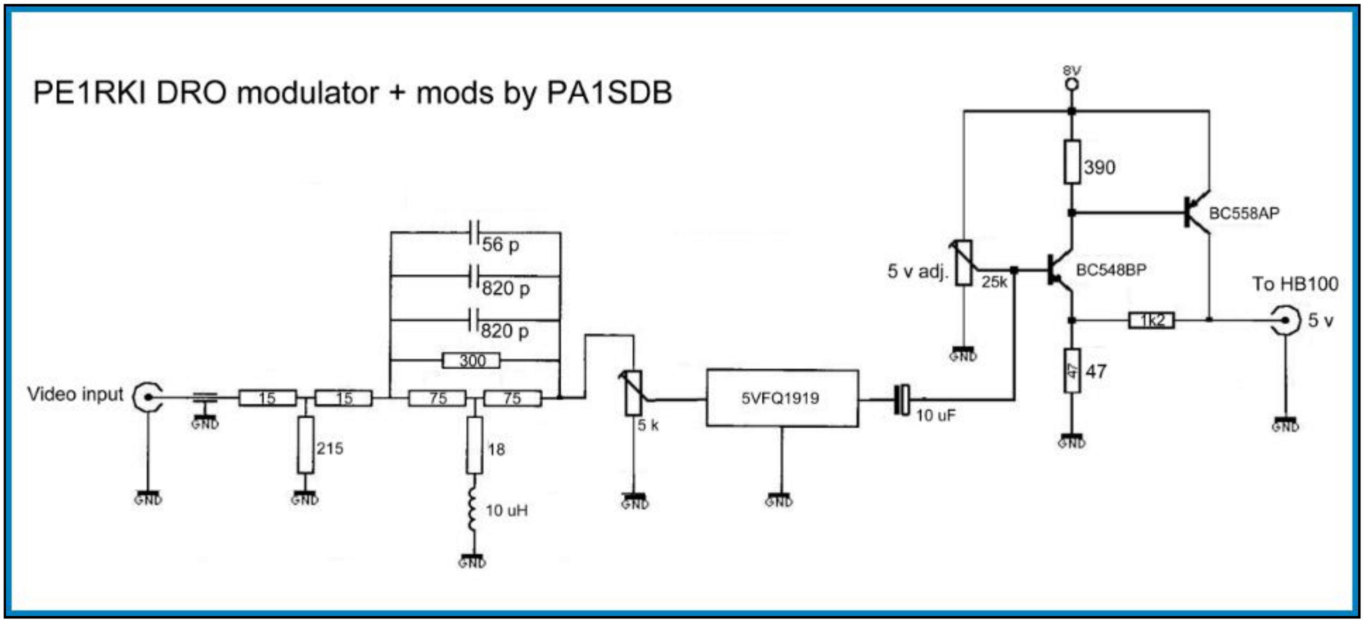
ATV with the HB100

In January 2017 we managed to successfully use the HB100 as an ATV transmitter. In January we conducted a test in the open field between PA1SDB/p and PD0SBS. Over a distance of 6 km it was possible to transmit a B5 image between both stations. The HB100 was connected to a 40 cm dish with Pennyfeed at a height of 3 meters agl in an open field. On the reception side at Koos, PD0SBS was viewed with a 50 cm offset dish at a height of 18 meters. Naturally, when receiving ATV, a satellite receiver + LNB with 9GHz lo must be used.

The video below made by Koos, PD0SBS shows the result of these field experiments in January. Both PA3ARK and PA1SDB/p were simultaneously QRV at 10 GHz. At the time of this video there was quite a bit of echo/shadow visible in the image. This was later almost resolved by better shielding of cables between the modulator and the HB100.

Also look here for the photo report made by Berend, PA3ARK from the PA1SDB/p TX site: [CLICK]

I combined the PE1RKI modulator (right after the filter) with input from some other baseband modulator circuits. This ultimately resulted in the design below. The connection between the modulator and HB100 must be made with a shielded cable. If you do not have a 5VFQ1919 filter lying around, it is possible to leave it out and connect the 5k potentiometer to the 10uF electrolytic capacitor.



A photo taken of the TV screen during an indoor experiment.

And one more, with unfortunately still slight shadow weakening....

Finally, some links regarding HB100 related experiments or applications:

https://www.facebook.com/groups/1076244799116326/

https://www.facebook.com/groups/603514236508122/

https://youtu.be/lCSHqsmzSyw

https://youtu.be/qURK54i_vKo

http://www.arrl.org/files/file/QEX_Next_Issue/2015/May-Jun_2015/Wadsworth.pdf

http://f6hcc.free.fr/10ghz.htm

http://www.kh-gps.de/hb100.htm

73's, Peter - the PA1SDB