DE KUNSTMAAN

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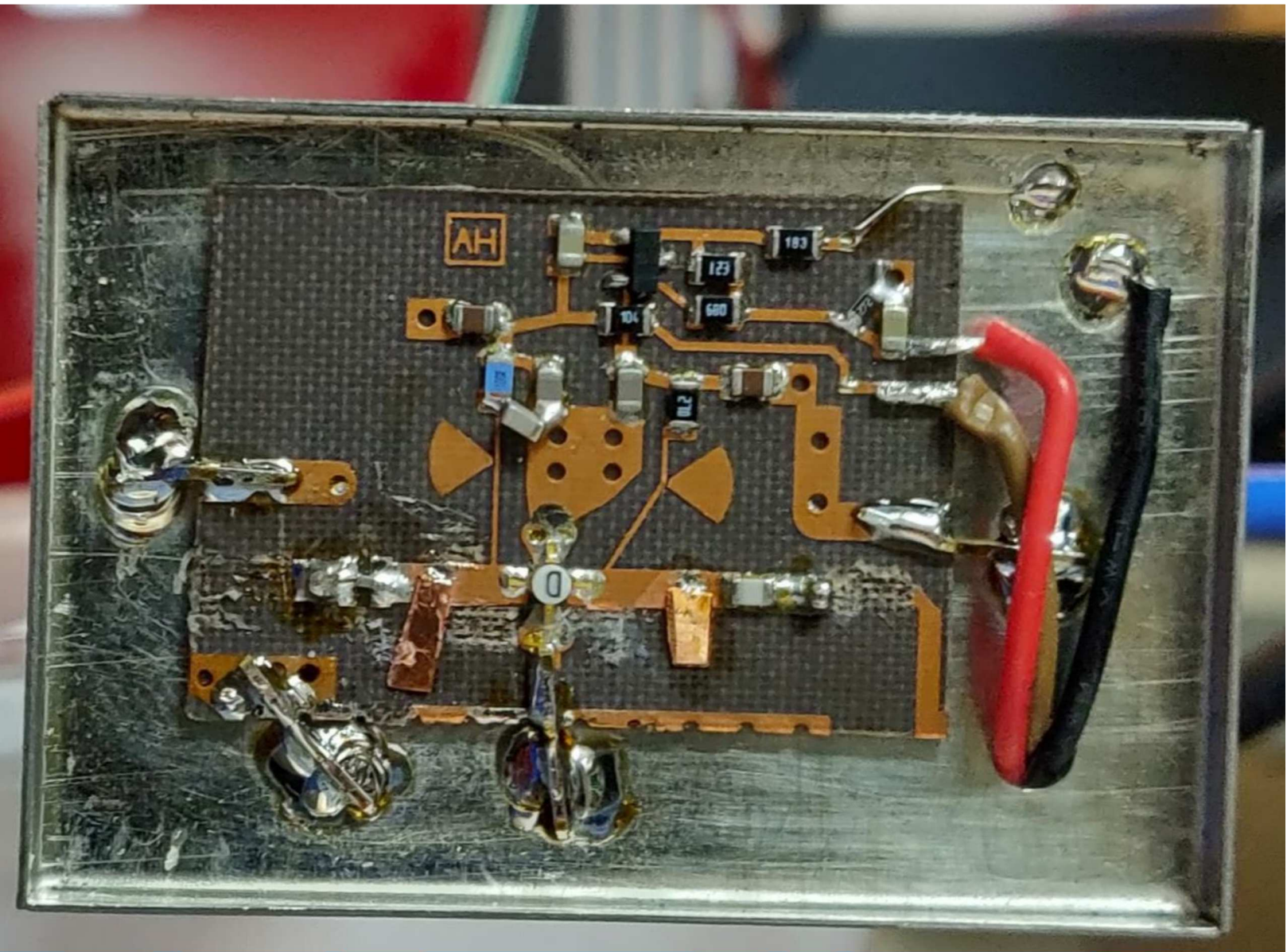
Uitgave van de Werkgroep Kunstmanen



In dit nummer o.a.

ADF5355 VCO met PLL
LNA van RF-microwave
Een bijzondere kunstmaan
en nog veel meer

Dear member,

This pdf contains translated articles of our Dutch magazine “De Kunstmaan”.
Translation for each article is normally done by the author, e.g. using Google Translate (and manual corrections afterwards). But for sure these translations are not perfect! If something isn't clear please let us know.

Formatting is not as perfect as the paper magazine, but figures are all added.

Internet links mentioned in the articles can be found at our website; see under menu 'Weblinks' at:
www.kunstmanen.net

Older magazines, from 2014 to 2019, are now also available in English; see menu “De Kunstmaan”, “Archief”.

I hope these translations will help you to understand the Dutch articles.

Rob Alblas
werkgroep Kunstmanen
kunstmanen@alblas.demon.nl

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Photo front page:
LNA for 8 GHz based on PCB ofRF microwave

Preface

Meetings

Normally the May meeting is dominated by the GMM . Just like last year, the GMM will take place in September this year . Hopefully we can get together then.

During the online meeting of 8 May, French, PE1FOT, gave a very interesting lecture on 5 - 10 GHz design. This in response to a project by Harm, about which more in this Kunstmaan. MMICs can easily be used as a multiplier (3-5x) to generate a signal at 8 - 10 GHz. You do this by overriding the MMICCs . Through optimizing the flow setting can harmonic n generate. With easy-to-calculate microstrip filters, the correct harmonic is selected.

Frans then discussed various LNAs , including that of Rota Franco. I n this Kunstmaan more about this LNA. But also LNAs from the Deep Space Network. The presentation ended with the presentation of 8.4 GHz feeds based on 5, 7 or 10 GHz feeds. To make all this beauty, Frans has a workshop with milling and lathe. It was a fun , inspiring read. We learned a lot from it.

Nimeto

The Nimeto building is undergoing a thorough renovation. The library's four cabinets had to be cleared out and the contents are in moving boxes . In total we have 14 moving boxes that will probably be in storage until October 2022.

The September meeting will likely take place in a classroom. We will report on that in due course.

The Kunstmaan

Many new developments in this Kunstmaan. For example, Harm has made an "artificial satellite" on his kitchen table. This provides an I/Q signal on the 1700 MHz and this is transmitted with a helical . Three meters away is the QPSK receiver and it goes into lock ! Interesting for the 8 G H z experiments because we can now test the higher data rates .

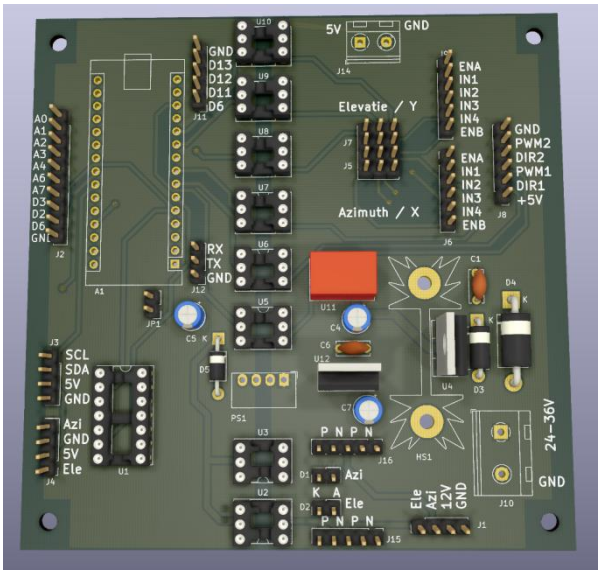
Rob describes new options in xtrack . For example, it is now possible to have the antenna continuously anticipate the satellite within the opening angle . All this to increase tracking accuracy.

Job put the AS5601 magnetic encoder to the test. This could be an alternative to (optical) pulse counters because they transmit the absolute position. One of the advantages is that calibration has to be done once.

Paul has sifted through the UKW - messages and the library for us .

I myself sacrificed my holiday money to buy an ADF5356 board and compare it with a clone board. In the presentation of Frans, the LNA of Franco Rota was mentioned. I tried to " reverse engineer e ren " and for making the 8GHz. In addition, a small look at my workplace where only things go in and not out.

Try to receive some nice pictures from the Metop-A this summer because it will be over at the end of this year ! I myself will be working on the new rotor control PCB this summer. Hopefully we can present it in September.



Happy reading and have a nice summer. And if the omens don't deceive us, we'll see each other again in September.

Ben Schellekens

Chairman of the Kunstmanen Working Group

The ADF5355, a VCO with an integrated PLL

Preface

In the September 2020 Kunstmaan I have written about the AD5355. This is a VCO with an integrated PLL , which can generate a signal up to 13.6 GHz. The VCO runs from 3400 to 6800 MHz and with a doubler you get to 13.6 GHz. I bought a PCB on Amazon , which cost about 100 Euro .

Depending on the intermediate frequency (between 1400 - 1700 MHz), you need an oscillator signal of 6 to 7 GHz for an 8GHz downconverter. At first glance, the ADF5355 seems like a suitable candidate. After some research on the internet were there still some limitations to the above:

- The voltage regulators used (on my board the LT1761-5 and LT1763-5) have a relatively high noise level.

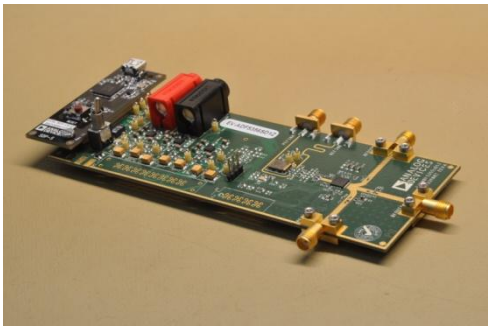
- The SMA connectors are not soldered on the bottom.

- In the described sweeper I had the idea , that the signal level at small frequency changes very varies

To avoid any discussion about the quality of the oscillator in the downconverter, I decided to buy a development board from Analog Devices . Now there are two versions that are very similar: the ADF5355 and the ADF5356. The latter has lower phase noise and fewer spurs . Another advantage is , that the development board cheaper.

The official ADF5355 board

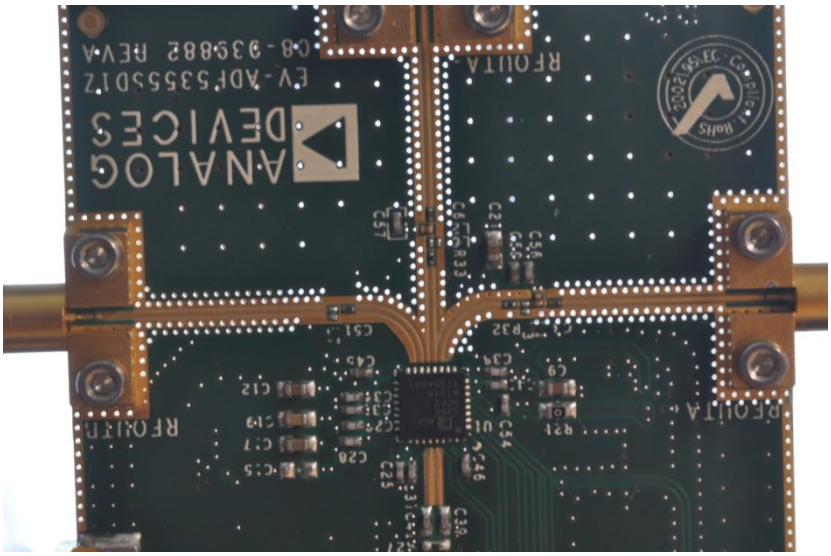
If you only buy the board , you cannot connect a USB cable to it. You have to purchase a separate SDP-S board for this . D hese prick up the ADF5356-board. The SDP-S is not necessary. You could also directly connect the CLK, DATA, LE and CE (max 3.3V!).



On the left is the SDP-S PCB for the USB connection

No manual is included with the ADF5356 board. Reference is made to the datasheet and the software to control the whole can be downloaded free of charge.

The quality is unbelievably high. It is inconceivable that you can reach this level with DIY. The high-frequency print tracks are constructed in coplanar waveguide, they have ground planes next to the print track. Via's are every millimetre!



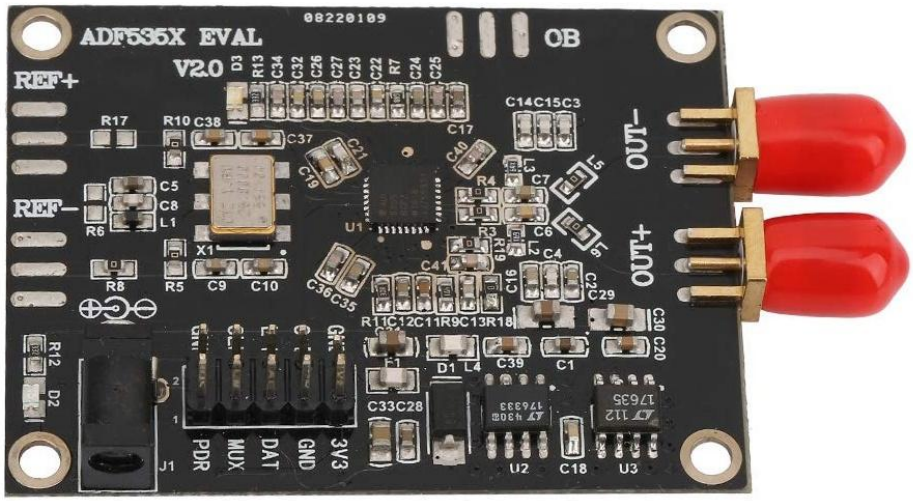
Via's around the RF outputs . Try this yourself.

I do have one point of criticism from the heart. There is no provision to build the board in a box, so there are no mounting holes. It is assumed that the board is loose on the desk. This is undesirable due to possible malfunctions. It is my intention to build the board in a cabinet, but I'm not sure how yet.

On board is a 122.88MHz TCXO. If you don't want to use it , you have to remove a 0 Ohm SMD resistor. This was my s view neater have done .

The clone board

This board I bought on Amazon.



If you want to use the signal from the doubler , you will have to solder an SMA connector in the OB position.

In the September 2017 Kunstmaan I described how you can
simulate an Analog Devices development board with a CYC68013A board . I also did that here to control the cheap board.

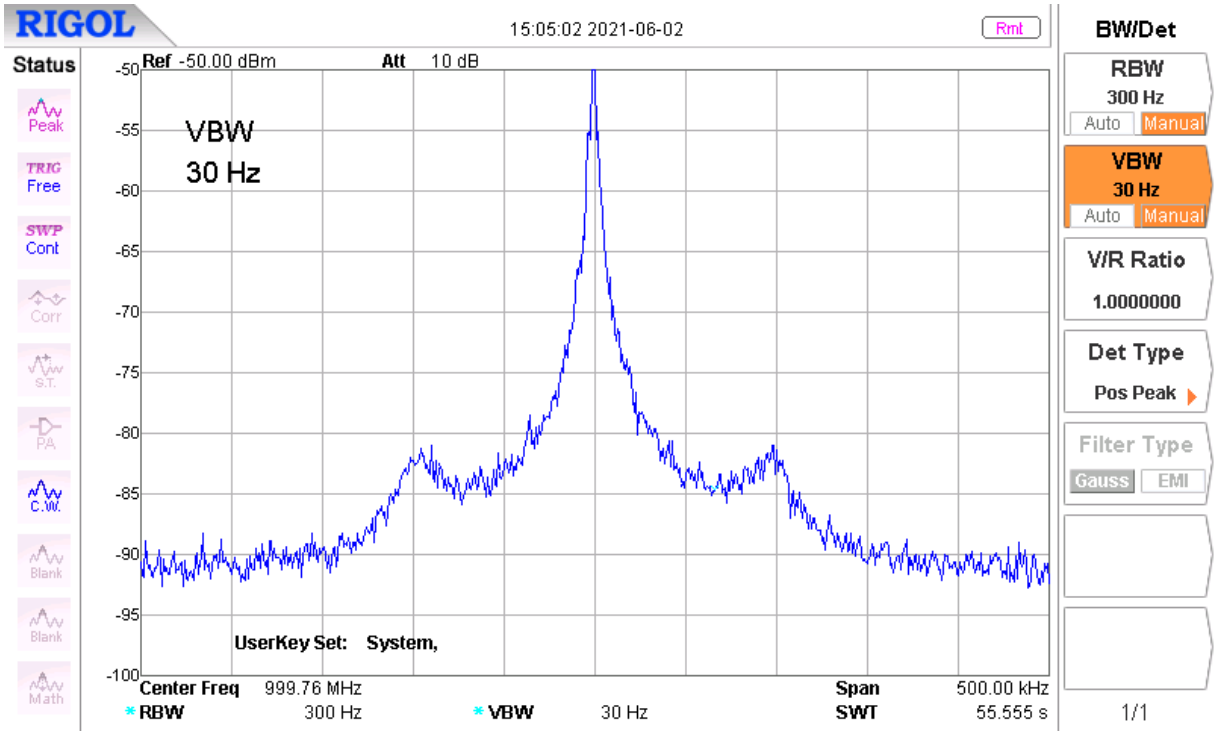
Measurements

What I can't measure is the phase noise. This is a study in itself and you need very specialized measuring equipment to be able to measure this. I can see if I'm on my spectrum analy z there is a difference between the two boards
see. I measured a spectrum of a 1 GHz signal from both boards .

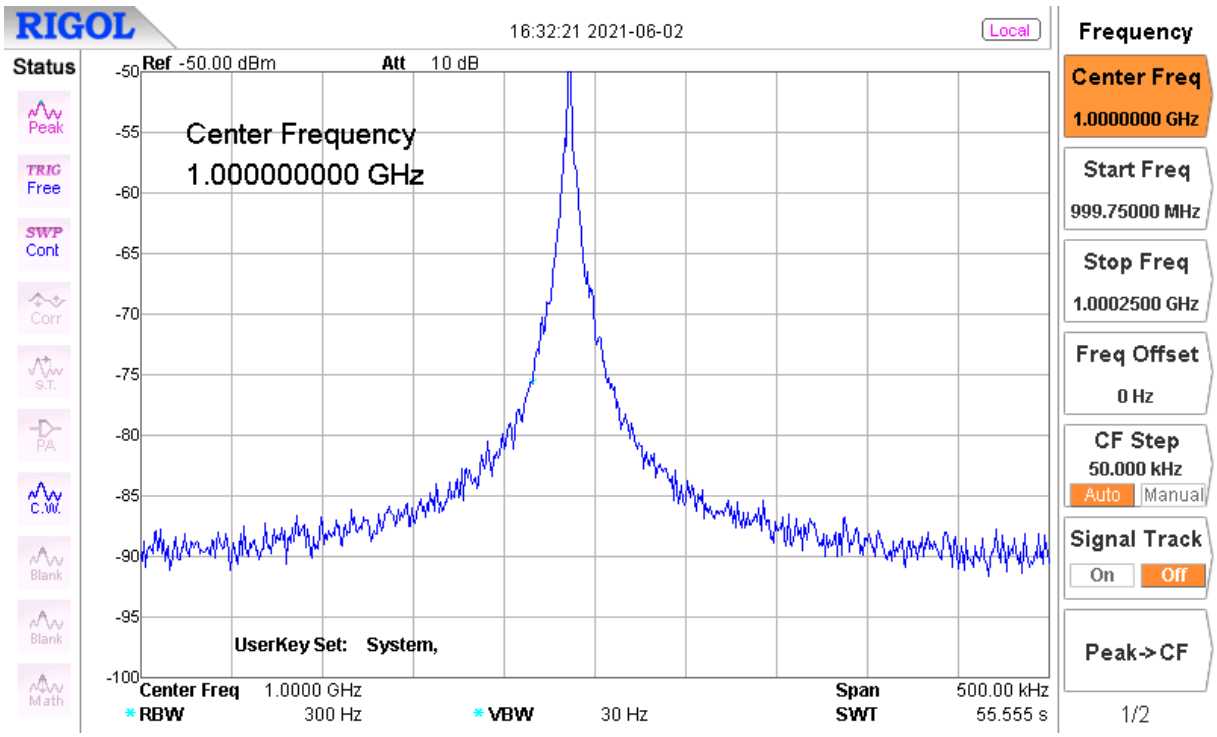
Furthermore, I can measure the output level up to 8 GHz with my power meter , an R&S NRP-Z11, which is suitable for measuring up to 8 GHz.

Both boards were just sitting on my desk and were powered with 6V from
an Agilent U8001A.

Spectrum at 1 GHz



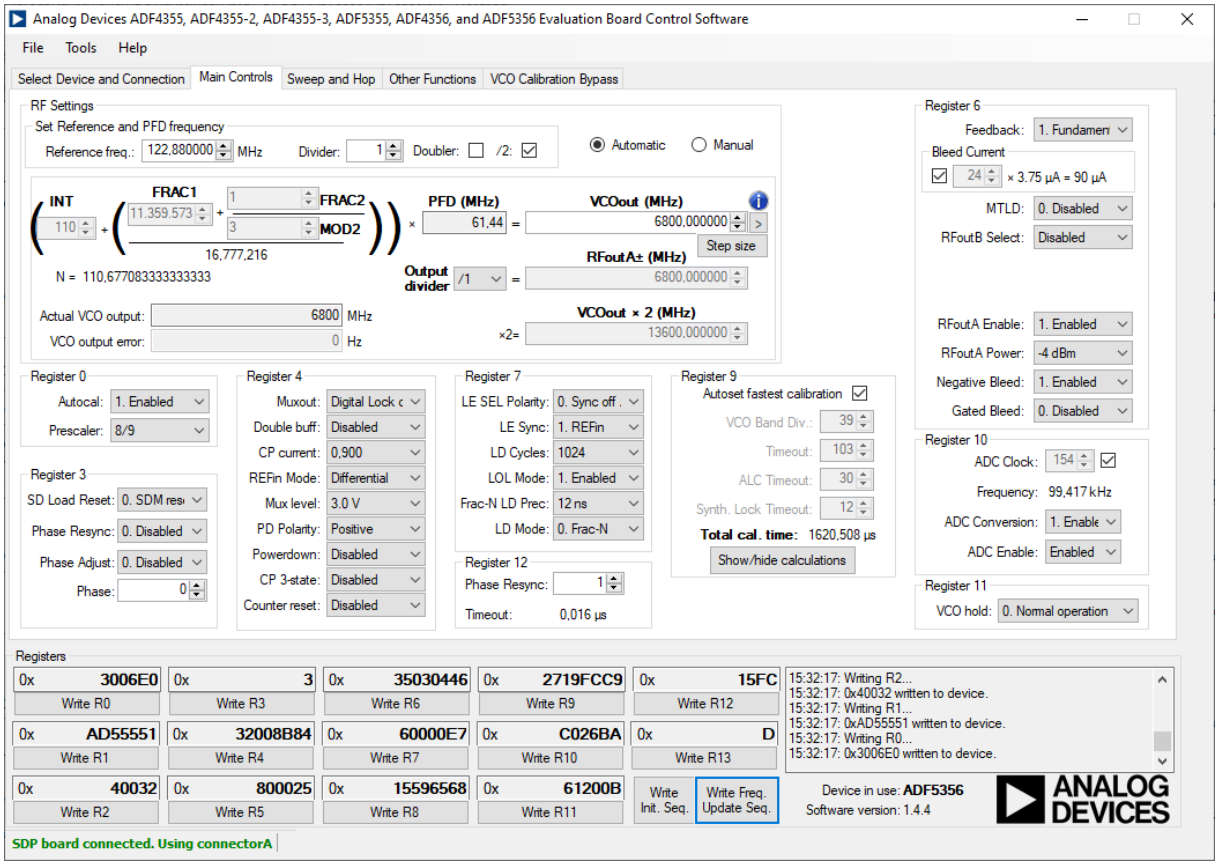
The clone board



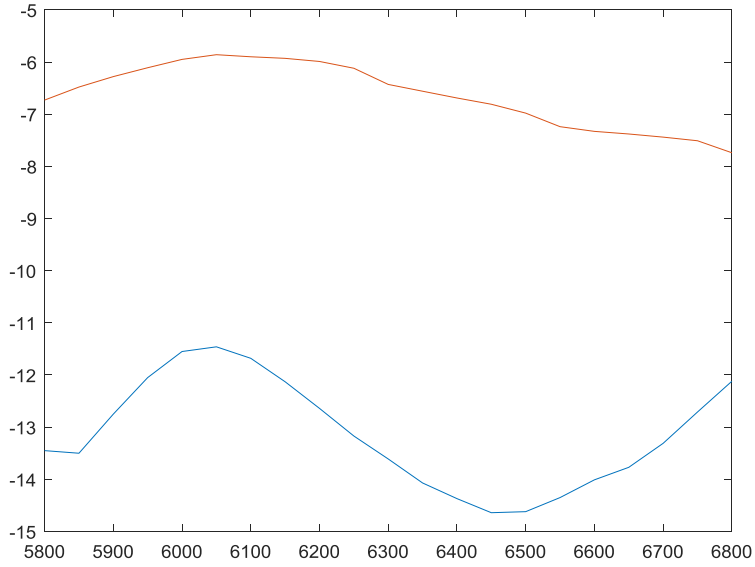
The official board of Analog Devices

Level measurements

I measured the signal level from 5800 to 6800MHz in 50MHz steps. On the Out+ was the power meter and on Out- a frequency counter to see if the AD5355 is on the correct frequency. The output level is set to -4dBm.



The official board settings to generate the 6800 MHz signal.



The Analog Devices board delivers between 5 and 7 dB more power.

Conclusion

If I may draw some tentative conclusions:

- The output level of the official board is much more constant over the frequency range from 5.8 to 6.8GHz

- The output level is much higher . One amplifier stage may be too little for driving a 7dBm mixer. A point of interest.

- The quality of the reference oscillator is better. The signal is better on frequency.

- With the clone board you can clearly see a peak at 100 kHz distance . It's like the signal has been modulated .

The main improvement you see on the internet from the clone boards is that a different power supply is used. An ultra-low noise VCXO was recently described in the Dubus , which serves as a reference for the ADF5356, in order to reduce the phase noise.

To what extent the official or clone board makes a difference in the reception of the 8 GHz satellites I cannot yet judge.

LNA from RFmicrowave / Franco Rota

Summary

This article describes my experiments with a surplus- lnb with four NE32584C . A noise figure of 0.85 dB was obtained .

Preface

Of all the parts in the 8 GHz reception chain , the LNA , which comes directly behind the antenna , is the trickiest. There aren't that many options. So I have to Kuhne Electronic inquired strengthened for a LNA to 60dB. You are immediately ready because the signal can go straight into the mixer. Unfortunately they asked 3000 Euro for this. The 400 Euro alternative with 30dB amplification was not available.

Then try your luck on eBay where you have to pay at least 100 Euros for a used LNA of maybe 30 years old?

Modifying a 10-12 GHz LNB used in TV satellite reception is an option. But you have to adjust them for the 8 GHz. They are not broadband.

And self-build is possible. Many designs are available for the 10 GHz because there is also an amateur band there.

RFmicrowave sells for 3 Euro a 10 GHz amplifier with four NE32584C, this is a super low noise fet . The advantage of this print is that it is generously sized , so that you can easily make adjustments.

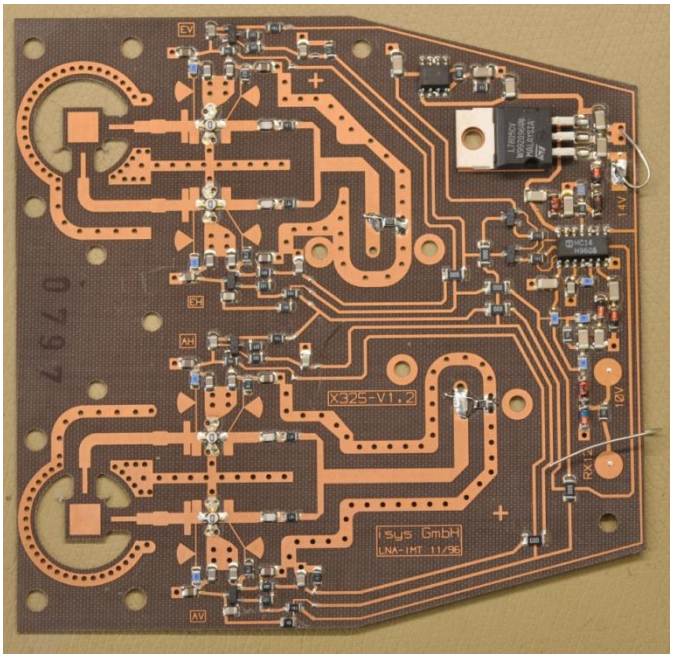
The PCB

The PCB is designed for a dual-head LNB. On the left you can see the antenna probes which to fetjes go .

There are four identical sections around the NE32584C. The outputs of two NE32584C are combined in a 50 Ohm circuit. On the PCB, the four sections are labeled EV, EH, AH and AV. The V and H are , I think , for verti c all e and horizontal e polarization .

The PCB has no connectors.

On the right, see you the power section. The NE32584C has a negative voltage of ron d 2V the necessary gate. If you want to connect a signal generator , you must mount a DC-block capacitor. Incidentally, it is common in TV-SAT LNB ' s for any capacitor to take on at the entrance.



For first time testing I closed the outputs 50R to GND.

The question is how this board to connect to the right fet to Inla iscontrolled, the fets are not on all at the same time. There is documentation in the form of articles in VHF-Communications publications [1] .

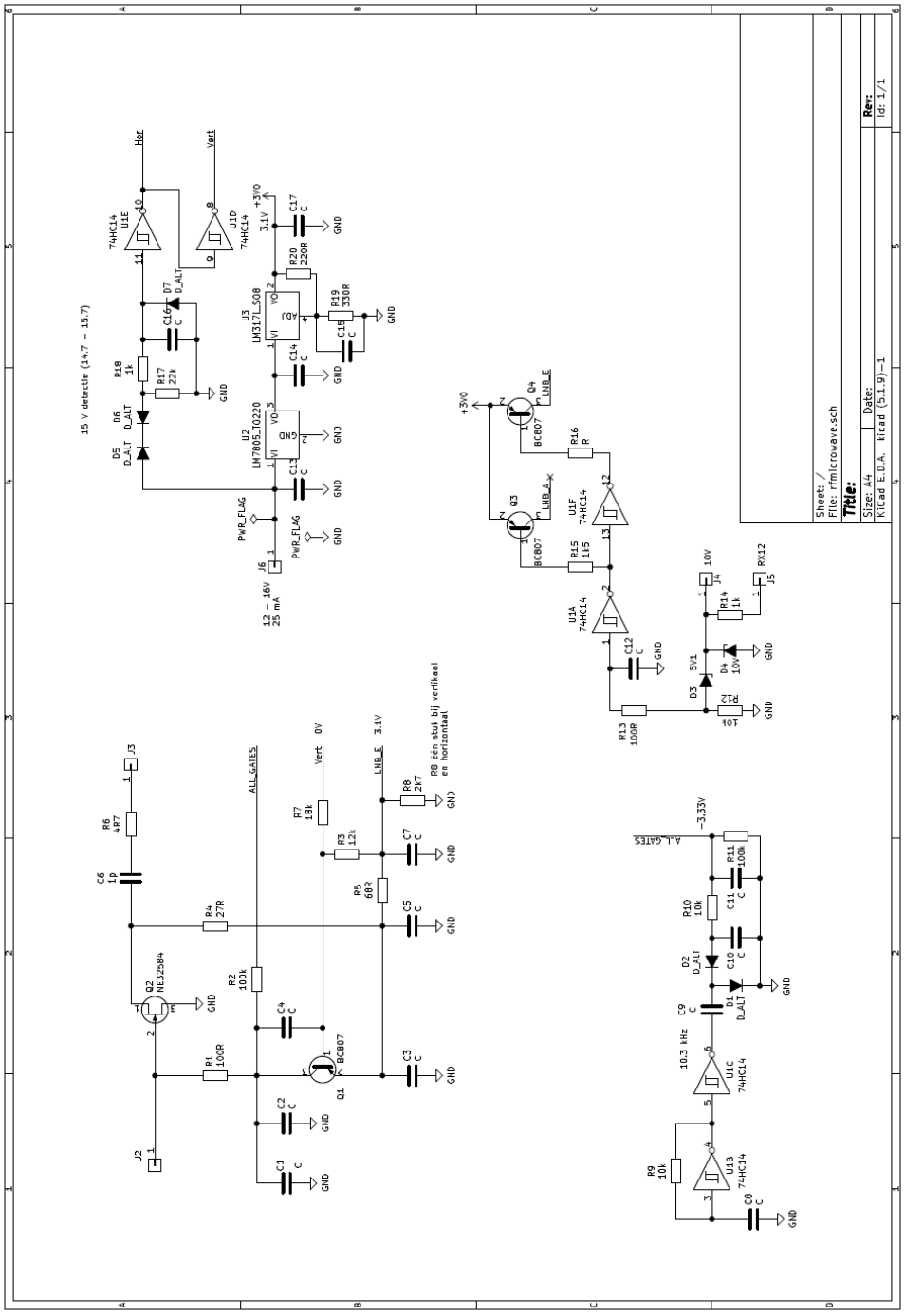
To get more clarity I made a schematic of the PCB.

At the top left of the diagram you see the control of the NE32584C. All four fetjes have the same control. The diagram shows the AV section .

Bottom left shows you the negative voltage of -3.3V to the gates of a 74HC14 wor d excited t. The oscillator has a frequency of around 10 kHz.

To the right of that you see 10V and the RX12 connections. The way I look at it , the 10V is an output. This is because of the 10V zener diode D4.

By putting 12V on the RX12 , the input of U1A goes high and the output goes low. This will cause Q3 , a PNP transistor , to conduct and put 3V on resistor R8.



At the top right you have the 3V power supply and a detection of 15V on the input. Above 15V the horizontal fetjes are switched on. Q1 does not conduct and the -3.3V is on the gate.

Switching between the fetjes is done by applying the correct voltage to the gate and the drain.

Adjustments

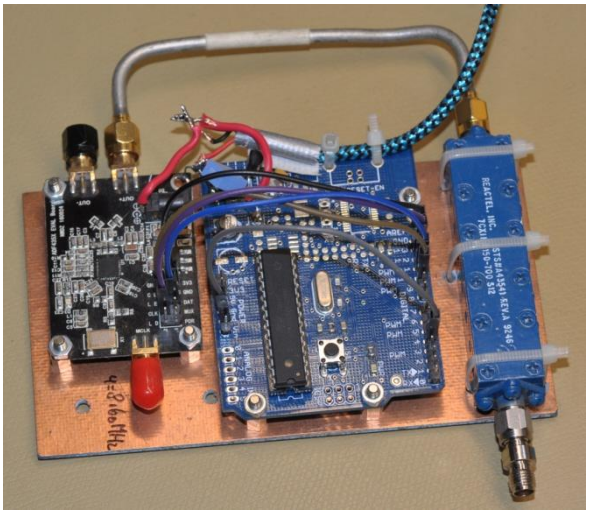
You adjust an LNA to lowest noise and highest gain. Ideally you want to combine both . You will first adjust to maximum gain and within that to the lowest noise.

If you look in the datasheet of the NE32584C , you will see 10mA bias current gives the lowest noise. If the setting current goes up , so does the gain.

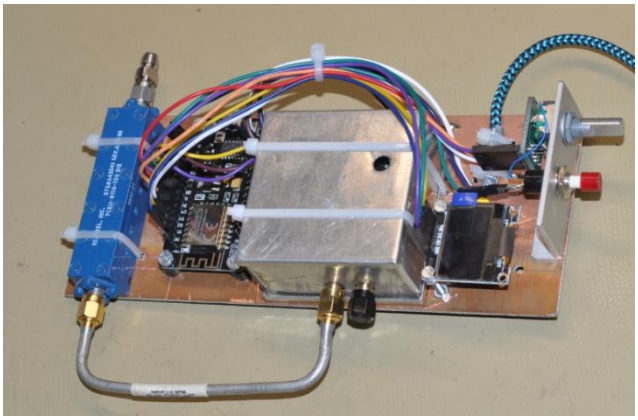
The adjustment is done by banners, they are "in English snowflakes called" post. These are small pieces of copper foil and pieces of Teflon with which you try to achieve the best result experimentally.

Measurement setup

I use a ADF4351 , which third ᴱis put the desired frequency. The signal then passes through a bandpass filter. The signal level is around -30dBm.



The old variant with an Arduino



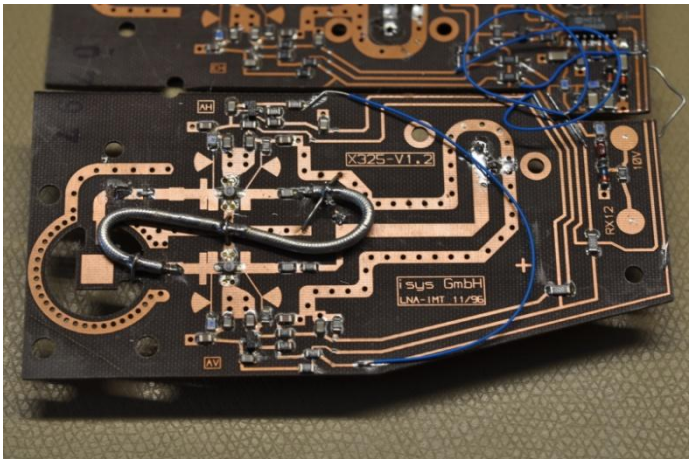
The ADF45351 is canned. The microcontroller is an ESP8266. A frequency can be selected with a rotary encoder.

Trials

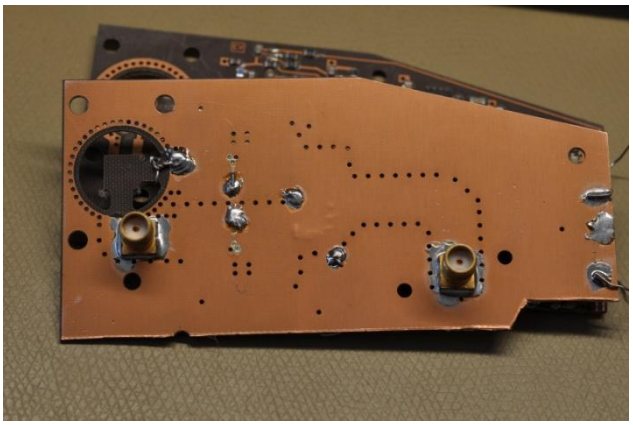
On Twitter is @jclaude this LNA modified to 8 GHz. This was my first try, a 2-stage version. With a piece of semi-rigid (2.1mm Sucoform _86 Huber + Suhner) I connected the output of one fet to the input of the other. With my makeshift measurement setup I measured a gain of 23dB!

The power supply unit I cut loose from the PCB.

Job has measured the LNA. Around 6 GHz , a gain of 25dB, a dip around 8 GHz and 10dB gain at 10GHz. It turned out to d ate there a problem in the measurement setup was . The AD F 4351 , which is broadcasting on 2800 MHz, was not canned and this radiated directly on the LNA!



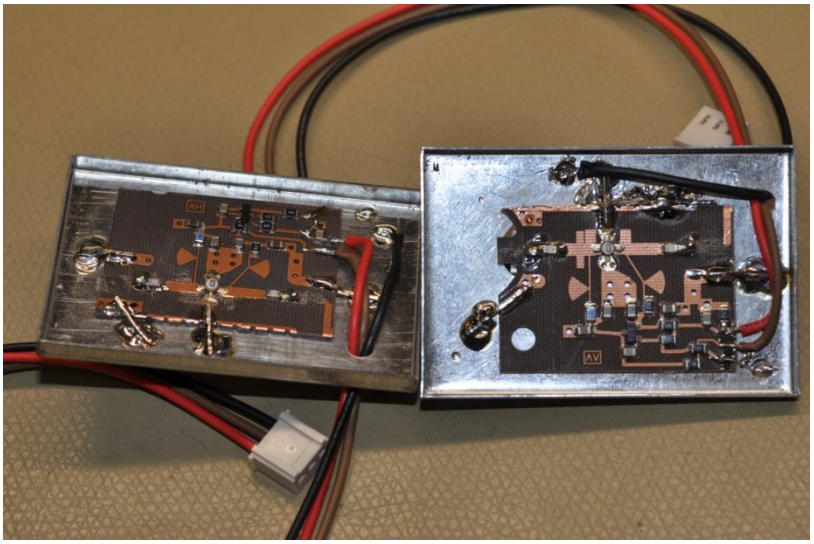
Component side of the 2-stage version



Copper side of the 2-stage version

Second try

I mounted two prints in the lid of a tin can. In one version, I had all the copper surfaces, " stubs ", cut away and the other was non modes f iceerd .



Single stage version , left without stubs and right with.

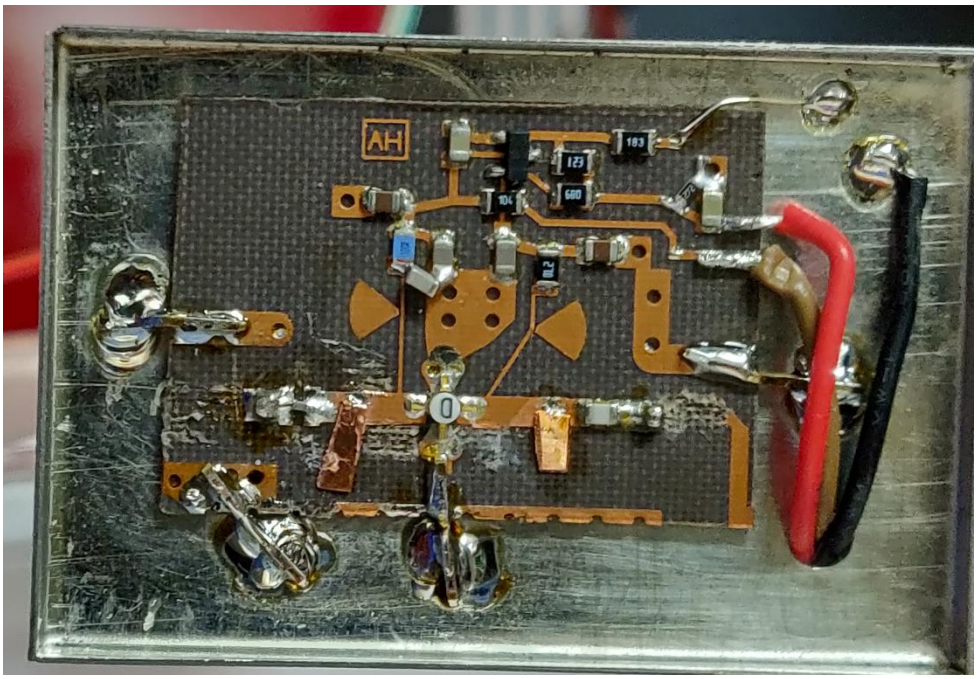
Third try

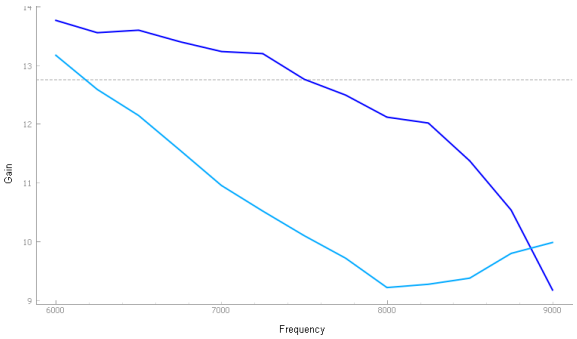
Removing the radial stub . The result is a lot worse. A capacitor to GND must be mounted .

Fourth try

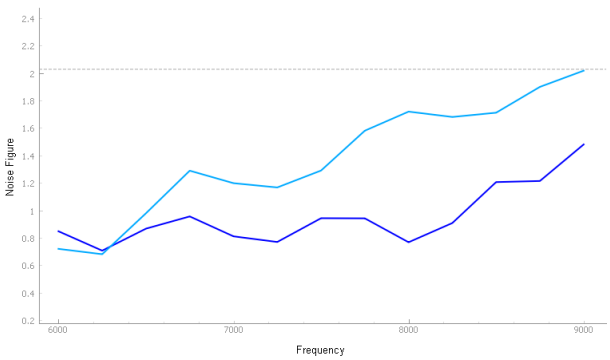
A capacitor s ator in place of the radial stub soldered directly to R 1 to GND. Both at the gate and at the drain vanes.

The result is a lot better, the noise figure is around 0.85dB and gain around 12dB, not bad for a 3 Euro print.





Gain. Dark blue is the fourth try



Noise figure

Closing remarks

First of all I would like to thank Job for measuring and adjusting my tests.

The search for an LNA suitable for the 8GHz is like a search for the " holy grail ". Little has been published about the 8 GHz. In addition, the fetjes are optimized for the 10 GHz because this is a larger market. The experiment content is high and what makes it difficult , is that you must have the proper equipment.

In the next version I want to have the SMA connectors perpendicular to the PCB. It is then easier to connect the measuring equipment. This topic will certainly be continued.

links

VHF Communications

https://worldradiohistory.com/Archive-DX/VHF-Communications/

X-band LNAs of @ jclaude

https://twitter.com/jclaude64503749/status/1354708253477916674

https://twitter.com/jclaude64503749/status/1315559213964328960

My workplace

Preface

It was really necessary to thoroughly reorganize my "workplace" because of a number of problems:

- It was unusual that I ordered parts , which I afterwards been found to have

- Parts, modules, cables were untraceable. While I was sure I had them

- One way or another you always get more parts. From people who quit the hobby or by purchasing an assortment of parts because it is so cheap

- A test setup building takes t eveel time. After you had done was your desk Verande rd in complete chaos in which you again lose everything

- All this takes place in a small room of two by three meters

Components

When storing parts wants to make your structure , so you quickly o find more parts. A chest of drawers provides such a structure. Everyone knows those beautiful red Raaco drawer cabinets . You will then need 60 drawers for the E12 resistor series if you want to store the series from 10R to 820k. Nice , but all drawers are nearly empty because you have a few of each value you . Then what do you do with some resistors from the E24 series ? O f if you have resistors 6.8M or 1R have?

The big problem is , that you can not simply a drawer between sites because you must move all the drawers out. Moreover , these cabinets take up a lot of space, you are not a shop. And you have no overview. You have to open a drawer to see what's inside . I don't think you can get by with drawers.

Resistors wired

The compromise , d ate I have is that the E12 series resistor 1 / 8th watt of 10R to 820K in small drawers of Conrad 's. Bulk quantity is one value in a Raaco drawer , just like the high power resistors . The rest is sorted by value in coin bags. The coin bags are in 45mm high containers from Hünersdorff.

Wired capacitors

Elco’s lend themselves deflators or for drawer cabinets , because there are fewer different values, and the housing is (for larger values) is larger . 12 laa t jes can be cattle l lost. Throw away all used electrolytic capacitors , it's not worth keeping them.

Ordinary capacitors are a different story. So you can have ten variants of one value. A 1nF capacitor is available as ceramic, MKM, multi - layer , grid size 2.5 / 5 / 7.5 or 10mm. So this goes in coin bags. If I buy them from Mouser , the label is included.

Diodes, coils

Can all be in coin bags

Weston boxes

Then you have a lot of parts that don't fit in drawers or coin bags. As far as possible I put these in plastic Weston boxes. This "Peel Off Storage Box" hey eft a dimension of 11 by 25 cm. Last year I purchased directly from the manufacturer in the UK package of 120 pieces. They cost less than a Euro each. At first I thought that 60 pieces were sufficient, just to be sure I ordered double. They are all in use now. I shouldn't need any more!

The advantage is that they are transparent, so you can see what's inside. You stick the sticker on the box and it is visible through the lid. When storing your need then not be sure which cover you in any case put t .

Boxes that I use often , are located to the left of me so I equal to tackle. Boxes where parts in it that I use less , are more backward. Did you get a box then put you this top of the pile again. The boxes that you use more often will automatically be placed on top.

So I have the transistors in two boxes. In one box are the bipolar and in the other the fetjes . Everything in antistatic bags sorted by NPN and PNP and in it by code. If a transistor is added , it can be inserted very quickly. Mouser spare parts pouches go in completely. When the box is full, divide the contents into two boxes. This is a very flexible system.

SMD Parts

I bought very handy boxes on eBay and Amazon , which I assembled 7x7 together. For the resistors, this contains the E12 series. I also store coils and capacitors that I bought for projects here . If the parts come from Mouser , I will list the part number on the label. The labels I make an Excel - sheet to fill out and print an A4 sticker. Then I cut out the sticker. We l laborious , but I have not found an affordable sticker printer that can print such small stickers.

Shelving unit

Then I have a shelving unit in the attic. Here are the parts that I hardly ever use. Like eg housings, who ever builds something in a box? There are also transformers, plug-in power supplies, printed circuit boards from old projects. Everything in handy stackable Samla boxes from Ikea.

Measuring equipment

At first my measuring equipment was on my desk. The desks come from Ikea, the Galant series . Unfortunately no longer available, but very practical because they are modular. For my measuring equipment I have mounted two shelves , which lie on a 30mm aluminium frame from Motedis .

Flexible system. I can heat pipes around

This aluminum frame k a n, I make exactly sizes. I also used this material for my setup to photograph the monitor with print layout . I had Motedis saw the material and measured it carefully . The shelves are 40 cm deep, 19 "ap p Araten apply here also. It is no problem to two meters to be bridged. In the middle there is an additional support.

The support in the middle, this is necessary

ICs

In a few decades you collect some ICs , the whole series of 7400 and 4000, etc. The 23mm high boxes from Hünersdorff are ideal. I prick the ICs in E S D foam (available at Reichelt). I have myself laa d jes made , where these containers fit.

Homemade drawers with 23mm boxes from Hünersdorff

Cables

You can easily store these in (empty) toilet rolls. Make sure all connectors are on the same side and you will quickly have the right cable.

Don't throw away your old toilet rolls!

Hardware

Because you're working with antennas and rotors , did you take some bolts and nuts. Here's the same storage problem as the electronic parts. In the end I ended up with the manufacturer Hünersdorff. Sichtlagerbox.de could supply it. All separate trays in standard sizes , which can be stored in small suitcases.

Tools

My loose tools are in Ikea cutlery trays.

Microscope

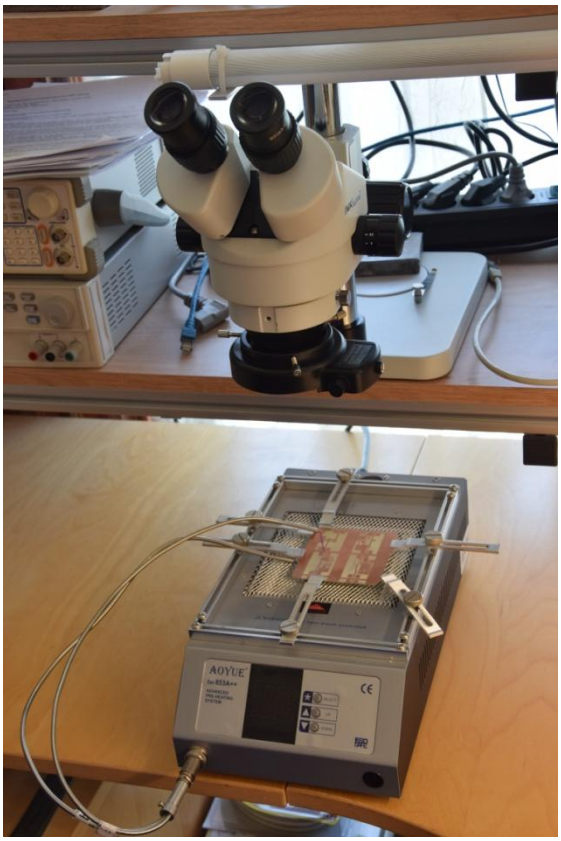
For working with SMD parts , it is useful to have a microscope. Ideal is a stereo microscope with a zoom lens so that you can also see depth. Purchasing a brand microscope from Nikon , Leica and Olympus is unthinkable. So you quickly look at the cheaper Chinese variants.

That's how you come across Amscope or clones of it
on eBay or Amazon . Microscopes are configurations available . I had formulated a number of minimum requirements :

- Stereo - objective

- A magnification of at least 3.5x. In practice this means using a 0.5 Barlow lens with a 0.7 - 4.5 objective and a 10x magnifying eyepiece.

- Built-in LED lighting



The microscope is turned a half turn. The counterweight is a block of lead. You have sufficient working distance to the print heater .

What I deliberately chose not to:

- An extra output for a camera. Photographing through a microscope is a different story. There is little light, you need an extra digital camera and the quality does not seem to be that good.

- A very extended foot. You have microscopes with extendable swivel arms . This takes up a lot of space that I don't have.

Another factor was that I have no experience with a microscope and therefore have a lot to learn. Then it is better to gain experience with a cheap and if it is really necessary, buy a good microscope later. And I don't use the microscope that often anymore.

In the Netherlands / Europe I could not really pay some perch , so I'm
on AliExpress true I a Lucky Please do 3.5X-90X purchased for 236 Euros . D ear

can you not bump attack. A month later, another note came from FedEx for 17 Euro import duties.

Computer

I have a DIY PC with Windows 10 and 8GB internal memory. For years I have been using an SSD instead of the old-fashioned hard disk with spinning disks. This saves so much startup time!

I find two monitors indispensable. A print layout on one screen and the schematic on the other. Still, I'm considering buying a curved monitor to replace these two monitors because they're getting more and more affordable . It saves the black screen edges in the middle.

Lighting

At ledlichtdiscounter.nl I bought 90cm 15Watt LED fluorescent tubes . These can be connected directly to 230V. Two tubes in parallel provide sufficient light. I also mounted a fluorescent tube under the shelf with the measuring equipment .

Closing remarks

Our librarian remarked , something discard is criminal . There 's something in that. This combined with the fact that many people tend collector and have , ensures that we only have to store more items. Another extreme is to buy only what you need and throw away what's left. It saves a lot of space, costs less money in the long run, but it doesn't feel right.

With my storage I work without an index because you d he would not keep going. And it's flexible. If new parts are added, they can easily be added.

The biggest advantage is the time savings because you will find very quickly t what you need.

New features xtrack

Tracking of 8 GHz satellites requires a much greater accuracy than following the old, well-known 1.7 GHz satellites. Fred Jansen has already discussed this in his article (see [1]).
I have now built into xtrack two features he mentioned.

Advanced tracking

Exact tracking of a satellite is not possible. One always has to deal with the limitations of the rotors. Exact tracking is also not necessary as long as the satellite is within the opening angle of the dish. With 8 GHz, also using a larger dish, this angle is smaller than with 1.7 GHz: about 0.9 degrees.
Ideally , the dish is steered in such a way that it is pointed precisely at the satellite at all times. However, during the time necessary for the dish to focus, the satellite is again a little bit further in its course. As long as the aiming error is smaller than half the opening angle , there is still little to worry about, but the leeway is small.
By aiming the dish a bit forward, half the opening angle, it is possible to maximize the use of the opening angle. See fig. 5 in [1].

In Xtrack it is now possible to define this opening angle and activate the new feature 'look ahead'. The calculation is done with elevation/azimuth or X/Y, depending on the rotor type used. From the current and new position, the direction of the next position is determined by means of a simple extrapolation. From determining the dot product of the previous and current position the size of the compound angle between 2 moments follows. That angle is used to determine how far forward the dish should be sent, with a maximum deviation equal to the defined half opening angle.
In the rotor controller, driven by xtrack, the speed of the motor is determined as a function of the deviation from desired and current position. It can be set so that the speed is at it’s maximum as long as the deviation is greater than half the opening angle.

Instead of extrapolation, the time could be advanced one step size. This gives a precise “position-in-the-future” compared to a simple linear extrapolation. Extrapolation was a bit easier to integrate into xtrack, but this can be adjusted if necessary. (Incidentally, with a smaller time interval, extrapolation also becomes more accurate.)
The look-ahead feature described here still has to be tested.

Note: In xtrack it is also possible to let the control run forward a fixed time:
Compensate rotor delay (Rotorconfig tab in Preferences *).* This is more intended to compensate for the delay between calculation and actual control of the rotor. This setting is less suitable for look ahead; the optimal time then depends on the current position/ movement of the dish. With 'Look A head' the dish diameter is used as a parameter instead of a fixed time difference.

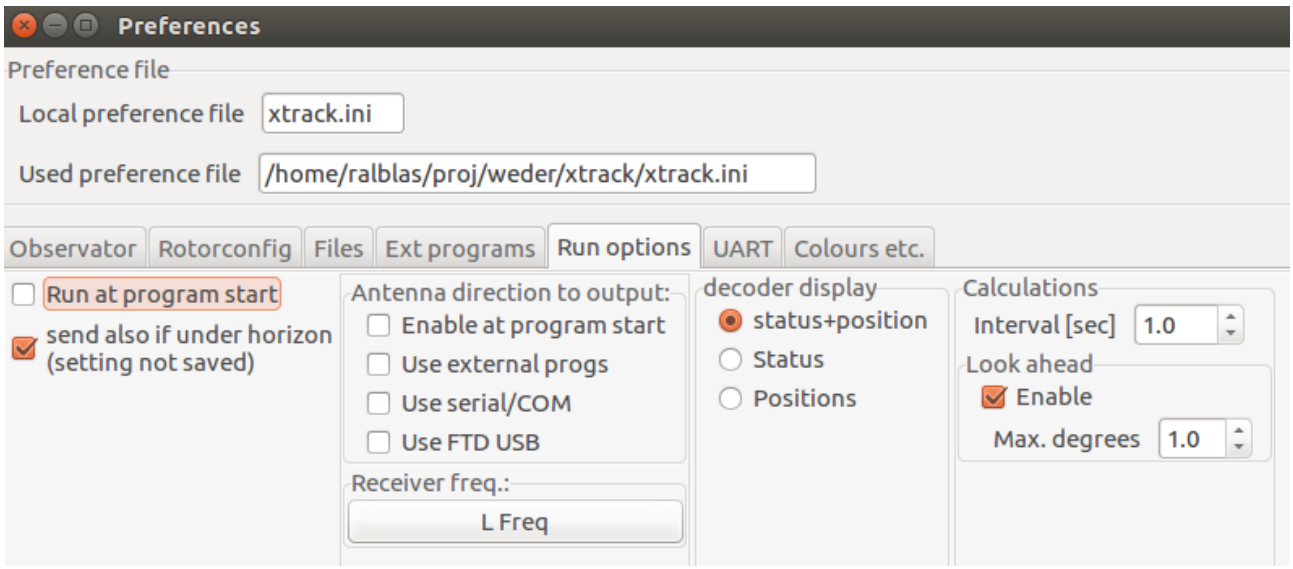
Calibration

A second condition for accurate aiming is good calibration. This is now done mechanically by allowing the rotors to reach their final position and then use that as a calibration point. This method may have a lack of precision; the question is to what extent this way of calibration is reproducable.
Another way of calibration is the use of a geostationary satellite. Kepler data is also available for these satellites. A suitable satellite for 8 GHz is the geostationary Syracuse, a French military communications satellite. (See [1].)
Problem with Xtrack was that just one Kepler -file can be used at a time. However, Syracuse's orbit data is in a different file than the satellites we want to track (eg NOAA20). This could be solved by merging the 2 files and then reading them into xtrack, but that would have to be done every time new Kepler data is retrieved. Not very handy.
Xtrack has now been extended so that a maximum of 4 files can be read. So satellites can be selected from different files.
Furthermore, an offset for both rotors can be set in Preferences. The procedure is then as follows:

1. mechanically calibrate, as usual.
2. Select Syracuse in xtrack, the dish will point to this satellite.
3. In Preferences, adjust the offset so that the received signal is maximum.
4. Optionally Save: save this offset
5. Select the desired satellite to track; the determined offsets are now taken into account.

Remarks:

- ' Save' of offsets can be useful if calibration over Syracuse is not always necessary. eg. as Xtrack is closed and then again started, while the rotors remain under power and are not recalibrated mechanically.
- The offsets also compensate if the entire rotor system is slightly twisted. However, they do not compensate if the axes of the rotor are not perpendicular to each other, except in the period of time in which the satellite to be followed is substantially in the same direction as the satellite used for calibration.
- Furthermore, an automatic calibration would be nice, but then the signal strength must be read by xtrack, and therefore converted via an AD converter.
- The new options have yet to be activated in wsat. Note that this only makes sense if the decoder, used by wsat to process received data, supports the 8 GHz satellites. Currently, only data from 1.7 GHz satellites can be read; a high aiming accuracy (with a dish that is not too large) is not necessary for these satellites.



Preferences. AT the right the settings for 'Look ahead'.

References

[1] Reception of weather satellite data in the X band. De Kunstmaan, December 2020, nr 4

Trip of Fred v.d. Bosch with Francis Bell (2013)

Francis and Nadine were with a cruise and stayed in Nha Trang (Vietnam) for a day and stopped by. Here we leave on 2 motorbikes (Nadine sat on the back of Minh's motorbike) to an old resort from the twenties of the last century to visit. (25-2- 2013)

A special ‘satellite’

Harm de Wit

It seemed like a great challenge to have an artificial moon of your choice on the "kitchen table". If you want to adjust a receiver, you won't have a hassle with waiting for a satellite to come over in order to be able to trim something about your receiving installation like a hare.

After a long road of searching for ideas and building various frills, I succeeded. Note: Everything that follows is subject to improvement/change.

The most effort was needed for generating the I and Q data to get the receiver and decoder in lock.
When I accidentally came across the manual for the GODIL decoder , I saw that in addition to decoders, it also contains generators for the I and Q data of the satellites. Well then, grab them and modulate a carrier with it .

In my search for an I/Q modulator design I found two designs that I liked, namely: BATC , Portsdown Filter-Modulator-board rev2 and the Mini I/Q modulator from Funkamateur FA 1/19.

From the existing diagrams I took what seemed important to me. For both designs I use the filters for 2 Msamples/s (the batc filter is ok, the one from FA leaves something to be desired, so I made something different for this). The carrier comes from a ready synthesizer sign of Chinese make using a ADF4351. The I and Q information goes through a filter to an op-amp (MCP662 or AD8131, depending on the English or German design), for filtering and modification of the level. The I / Q modulator is an AD8346, so all that is important for us to simulate around 1700 MHz (Noaa, Metop, Feng .. etc) is present.

The following situations have been tested indoors:
a) Output AD8346 via 40 dB attenuator to the down converter. This gives a good constellation diagram; the decoder locks, and Wsat gives good test pictures.
b) Output AD8346 connected to a helical antenna, 3 meters further received by a helical antenna connected to the down converter; this gives the same results.

Note: Apply adequate damping when aiming at a parabola with pre-amp .

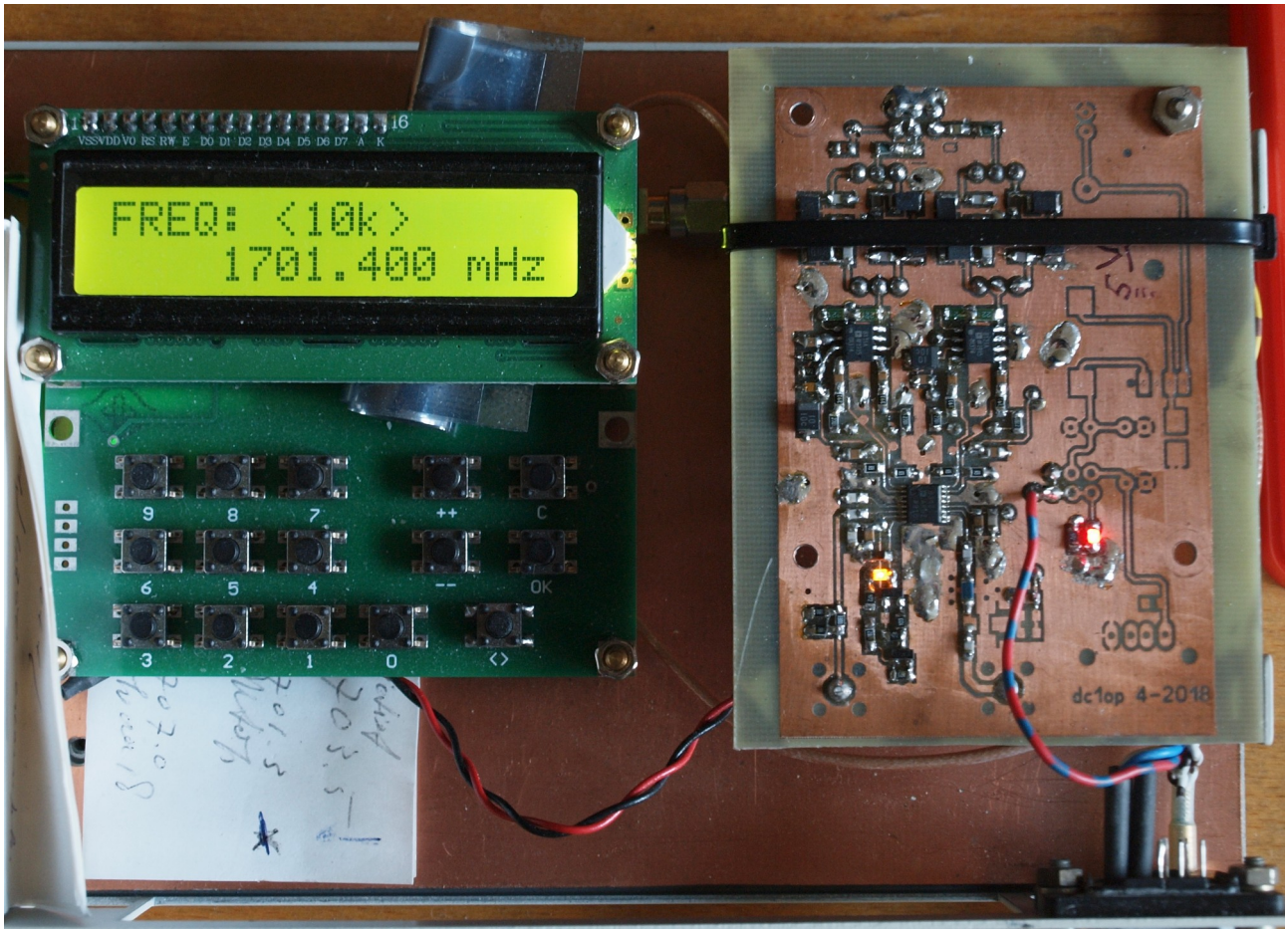
And superfluously : to understand the use and behavior of the Godil decoder : READ THE MANUAL.

Let me conclude with: "long live the artificial moon".

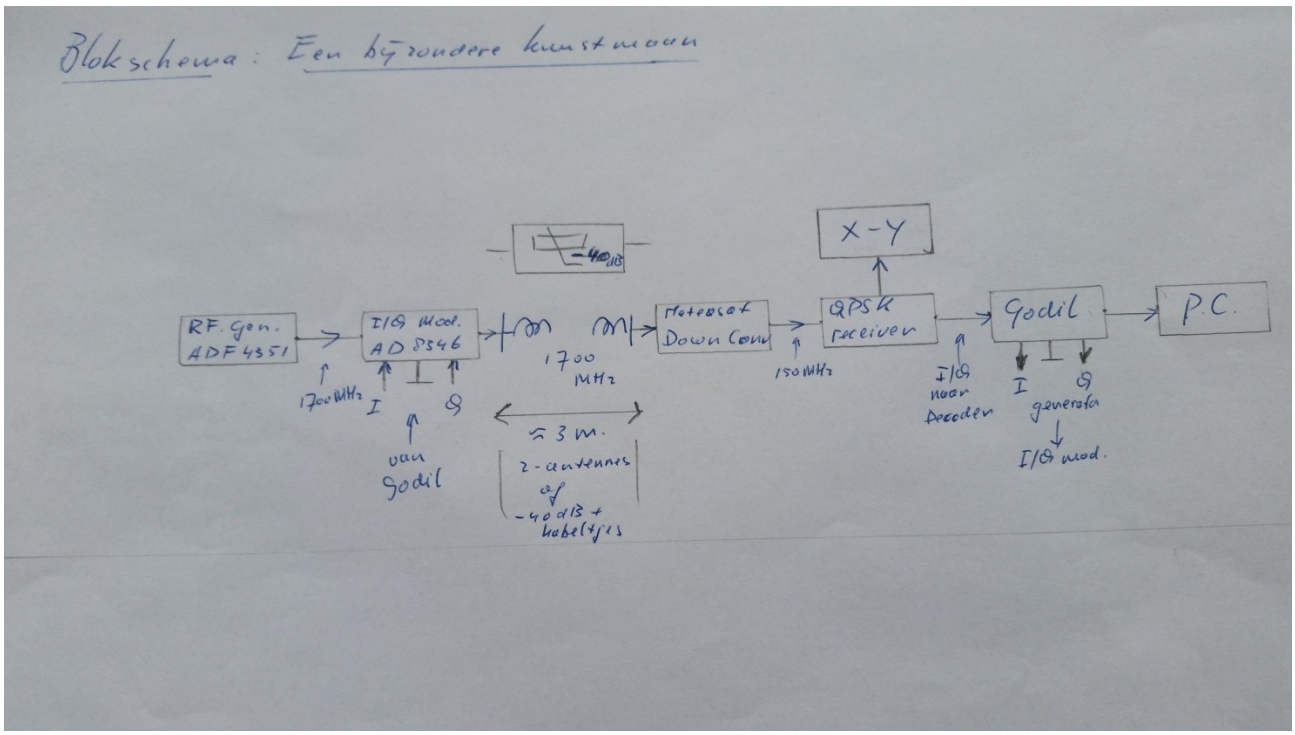
Some technical data:

I/Q modulator AD8346:
Freq. range: 800-2500 MHz , Bandbr. 70MHz
Op-amp MCP662 GBW: 60MHz
Op-amp AD8131 GBW: 400MHz
Rf generator ADF4351:
Freq. range: 50 - 4400 MHz , output +/- 0 dBm i

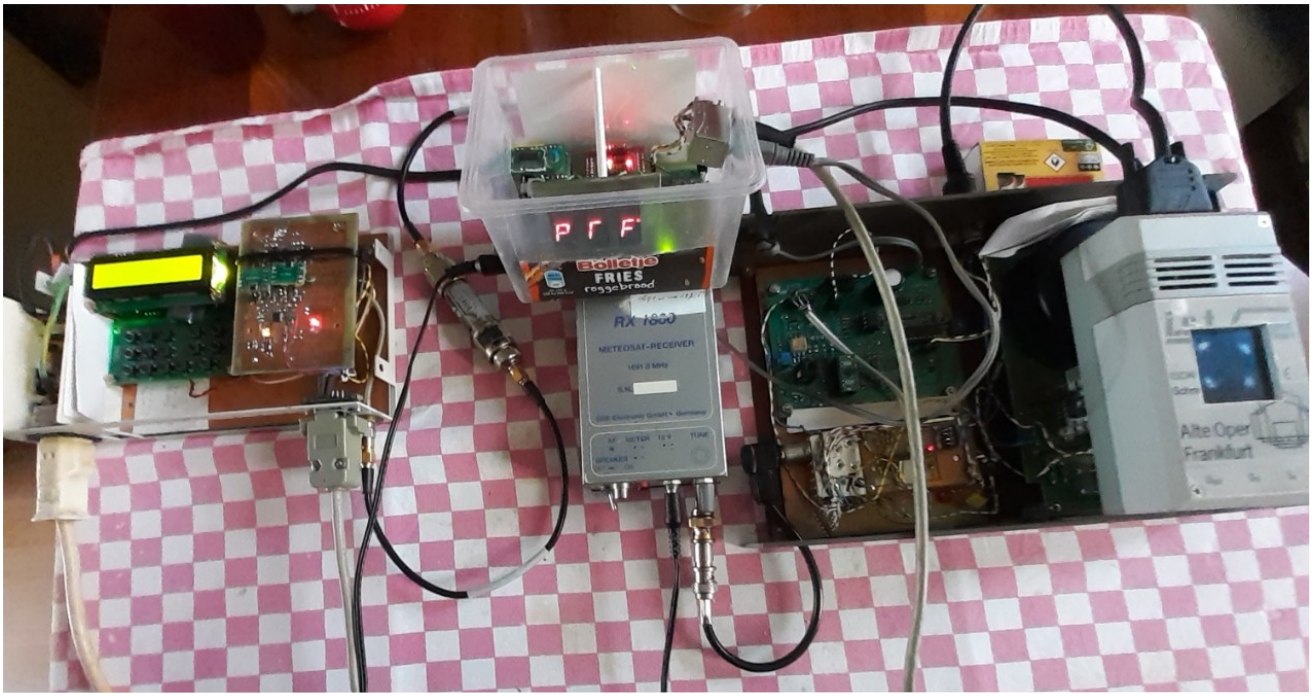
(In the next KM: part 2, now with 8 GHz.)



The special ‘artificial moon’ (synthesizer and IQ modulator)



The block diagram



Setup with transmitter (left) and receiver. In the middle the GODIL, generating dara for transmitter and at the same time decoding data from the receiver.

MAGNETIC ENCODERS FOR POSITIONING

Job de Haas

Summary
The use of magnetic sensors for positioning.

To receive X-band satellites I wanted to be able to control a heavier dish with higher accuracy. To this end I acquired a pan-tilt unit on eBay: a Quickset QPT-90. It turned out to be in good condition, only it was using potentiometers for positioning. They use a small tracking sprocket on the main outgoing sprocket of the worm gear. It has a gear ratio of 50:7 so about 7 turns of the potentiometer for 1 of the rotor axis.

Fig 1. Quickset Pan-Tilt unit

The potentiometers are good quality devices, but using the ADC input in the microcontroller, the reading turned out to be too noise to be sufficiently accurate. My wish is for about 0.1 degree accuracy in controlling the axis; most likely at that point the inaccuracies from mechanical flexibility in the total system will be dominant. An accuracy of 0.1 degree was not doable with the potentiometers despite the gearing ratio.

Fig.2 Principle magnetic sensor

SatNogs rotary encoder
From the build of my previous rotor (see [1, 2]) from SatNogs, I knew that they used a solution with a magnetic rotary position sensor. On the axis of a sprocket a magnet is mounted and opposite that an IC which can be read out.

The manufacturer (AMS [3]) has a whole range of ICs that can deliver angular positions from a magnet in a variety of ways. The magnet is a coin like model with the special property that the north-south division is diametric (diametric magnet [4]) This is logical because otherwise just the north or south side would point at the IC.

The SatNogs rotor encoder uses the AS5601 as shown in Fig. 3. This is an encoder with a 12-bit resolution (so 4096 positions) for 360 degrees or steps of about ~0.09 degrees. Together with the gear ration of 50:7 this is ample to reach a 0.1 degree control of the axis even despite some noise. Reading out the IC is done with I2C in this version ([5]). There are also models with SPI, PWM, AB/ABI (quadrature pulses), UWV (BLDC motor Hall sensor emulation). The AS5601 also has a possibility to use quadrature pulses with a maximum of 2048 pulses per revolution (so 11-bit). Because I still had a couple of this IC, I decided to use this one.

The solution of SatNogs consists of a 3D printed enclosure with a small PCB and some mounting materials (Fig. 4). As I had to replace an existing solution, this design did not fit as is. I still had some PCBs, but the sprocket in the QPT-90 is different and mounts on a 6mm axis. As an alternative axis I found in my parts box old potentiometers. I adapted the design to these components.

Absolute vs relative
The encoders from AMS have an important additional feature compared to regular pulse solutions: the absolute position can be read out because this can be derived directly from the magnetic field. With the AS5601 this can be done over I2C. However, to use this feature there is also a requirement: the magnet must be mounted directly on the outgoing axis of the rotor. Often this is mechanically more challenging than the solution with a tracking gear as in the QPT-90. But if the gear ratio is different from 1:1, the magnet will make multiple revolutions and at startup the absolute position can no longer be known. For this reason I do not use the absolute position and use the end-switches to calibrate the encoders at startup.

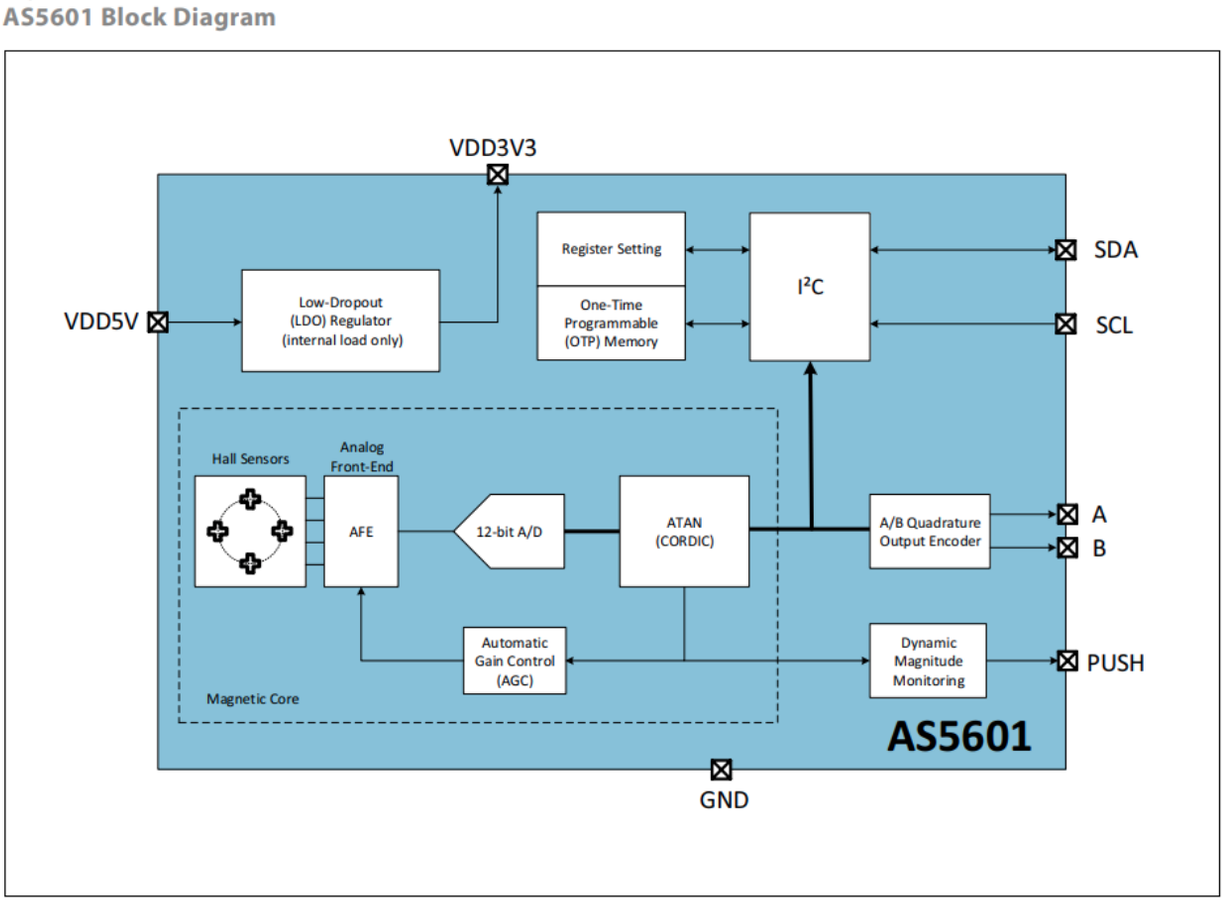
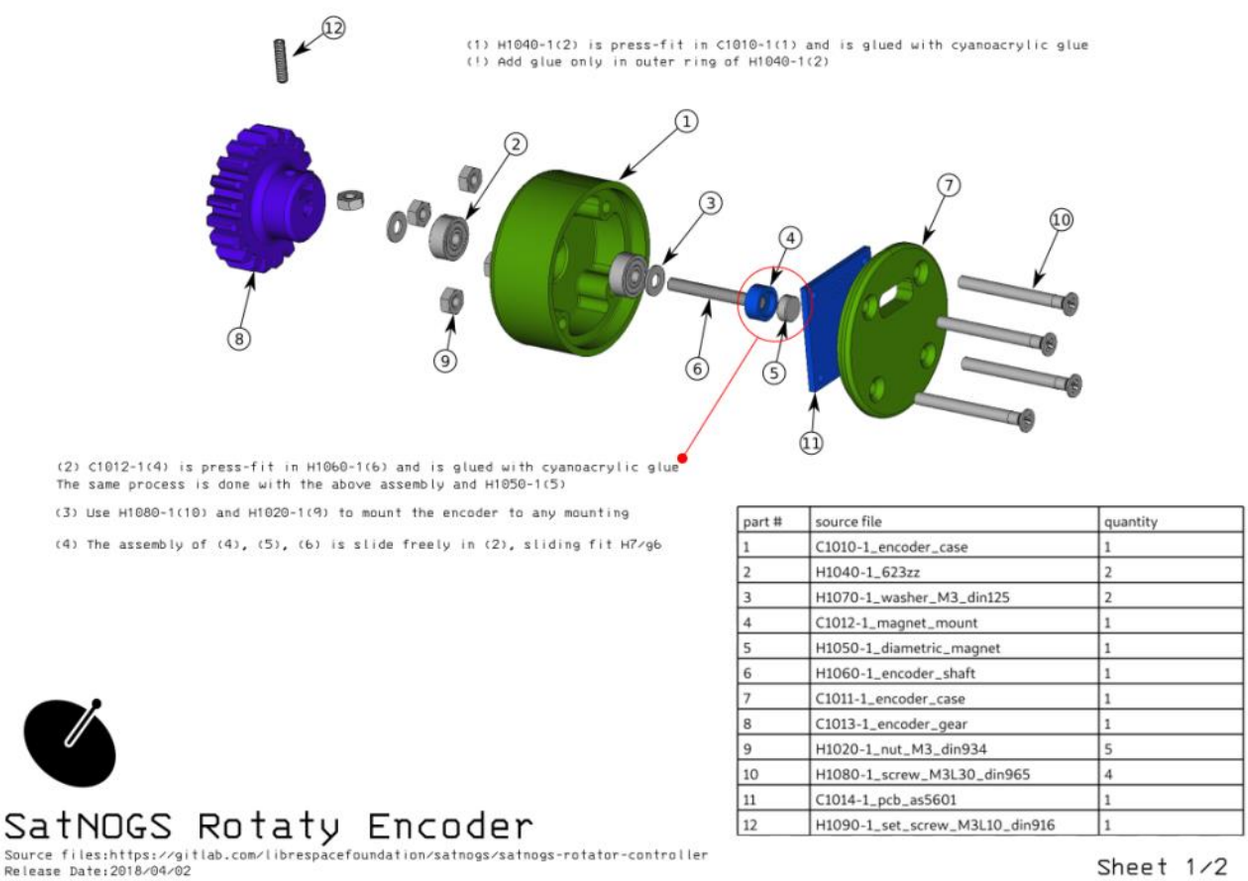


Fig 3. The schematic of the AS5601



part #	source file	quantity
1	C1010-1_encoder_case	1
2	H1040-1_623zz	2
3	H1070-1_washer_M3_din125	2
4	C1012-1_magnet_mount	1
5	H1050-1_diametric_magnet	1
6	H1060-1_encoder_shaft	1
7	C1011-1_encoder_case	1
8	C1013-1_encoder_gear	1
9	H1020-1_nut_M3_din934	5
10	H1080-1_screw_M3L30_din965	4
11	C1014-1_pcb_as5601	1
12	H1090-1_set_screw_M3L10_din916	1

Fig 4. Design of the SatNogs encoder

Encoder adaptations

Figure 5 shows how the potentiometer has been replaced in the rotor. Because the unit is designed to be equipped with encoders, there is enough wiring to carry the power and signals outside. Unfortunately, this makes the path to a microcontroller too long to communicate reliably with I2C. In the SatNogs rotor, that distance is shorter and it works. For this reason I have chosen to use the AB output. This produces quadrature pulses with a programmable number of pulses per revolution. I set this to the maximum 2048 pulses. While there is also a facility to find out absolute position (via an initial pulse train), I don't use it and rely on the end stops for absolute positioning

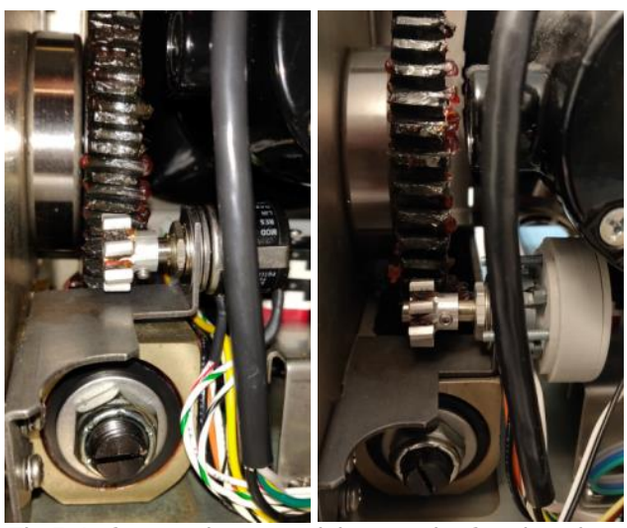


Fig 5. Left potentiometer, right encoder for elevation

Unfortunately, less space was available for the azimuth encoder, so I had to make a whole new PCB and housing. Again based on an old potentiometer shaft (Fig 6 and 7).

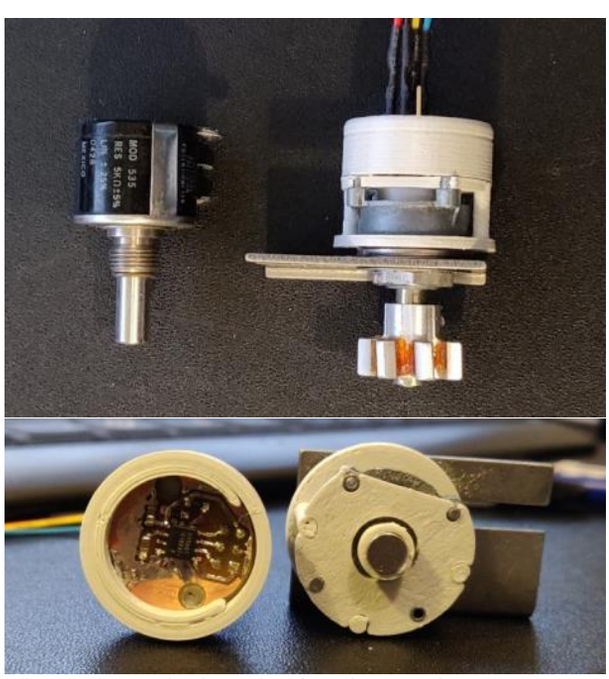


Fig 6. The redesigned azimuth encoder

Use with ESP32 microcontroller

It is worth mentioning that using quadrature pulses (Fig.8) in combination with an ESP32 microcontroller has an advantage. This microcontroller has a very flexible counter mode that can be configured in such a way that quadrature pulses are automatically counted. The only thing that is then needed to know the position is to read the counter register. The software to read the encoder in this way is available as an Arduino library [6]

Fig 7. Azimuth encoder in place.

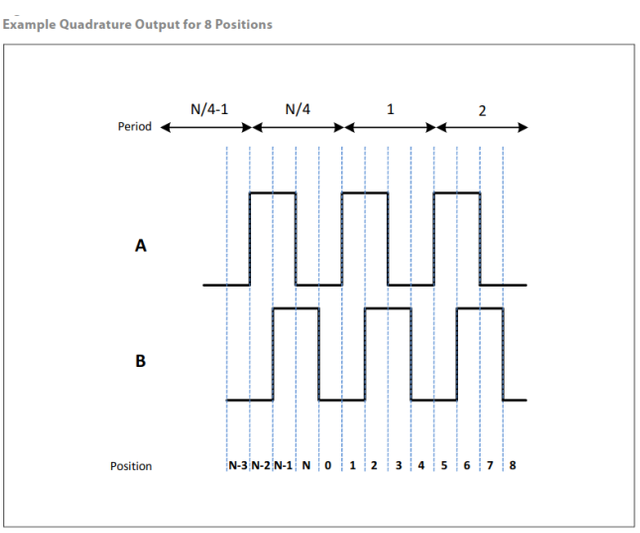


Fig 8. Quadrature pulses from the AS5601

References

[1] SatNogs Rotator v3 wiki
[2] Details of my SatNogs rotor build
[3] AMS position sensor website
[4] Diametric magnet 6x2.5mm
[5] AS5601 source code
[6] ESP32Encoder library

UKW BERICHTE

Paul Baak

Summary
In this article a concise review of articles published in the 1st edition of 2021 of the German magazine UKW-Berichte. We have a subscription to this magazine.

Here is an overview of UKW-Berichte 2021 Heft 1. There we find 4 main articles, and in addition to the 2020 index also two small overviews of useful links and messages. Our club has a subscription to this magazine. Please let us know if you would like to subscribe. The latest issues are available for viewing on the library table during meetings; now that this is not feasible for the time being, please contact the librarian if you wish to read the issues.

Michael Margraf describes the calculation of arbitrary HF lines. This focuses on those cases where usual programs for calculating impedance, losses, shortening factor and the like do not suffice. The cause lies in non-standard sizes or materials, the environment which cannot be properly co-calculated, or a non-standard geometry. The program QucsTransline [1], part of QucsStudio [2], has been extended in version 5.1.0 with a field simulation option based on the Boundary Element Method.

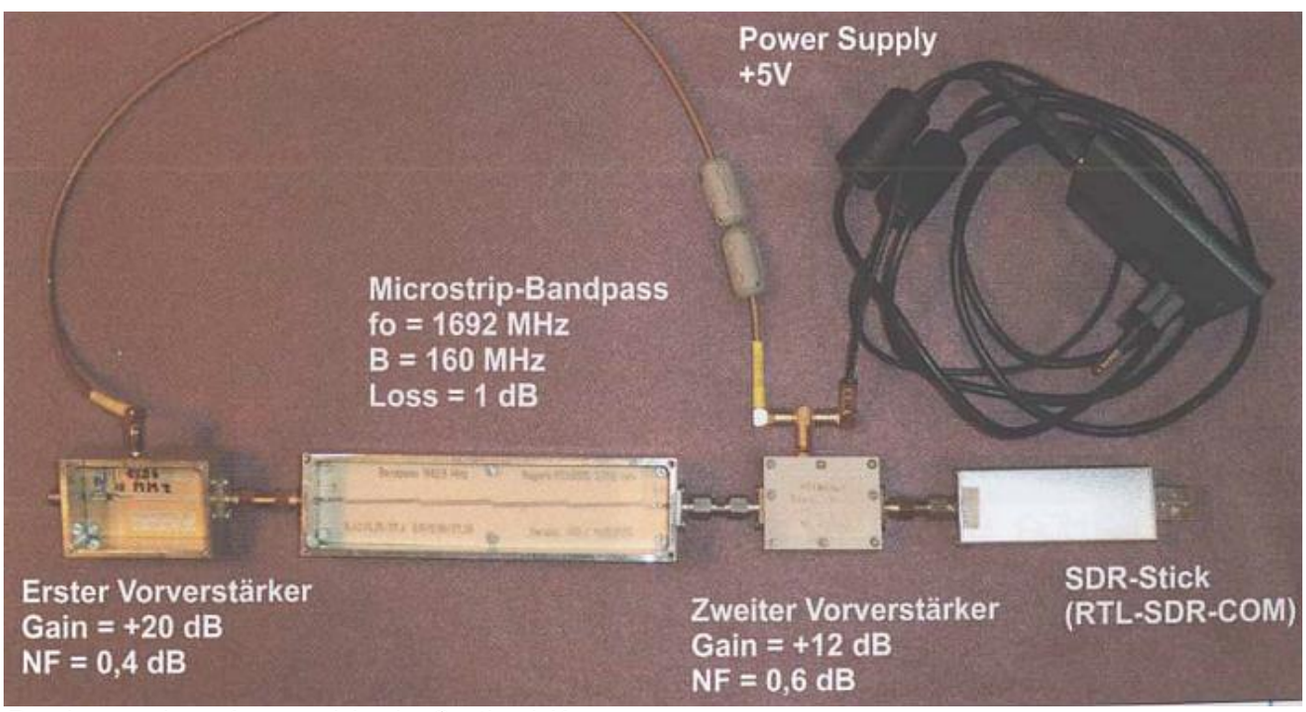
Wolfgang Schneider describes a broadband amplifier with a power of 1 Watt in the range of 50 to 2500 MHz. A single MMIC is used, the PHA-202+ (it costs about 15 euro). Partly for heat dissipation, the amplifier is built in a sturdy aluminium case. Out of the 18 dB, 12 dB

remains at 2500 MHz. For those interested, there are still a few circuit boards available at cost price.

Jochen Jirmann describes a 300 Watt wideband amplifier for shortwave. This amplifier is intended for use with an SDR transceiver. He uses 2 pieces of MRF300, an LDMOSFET. It is actually designed for narrowband use, but the writer is looking at how far it will go in a wideband setup. It is a balance set-up with pre-amplifiers, to be able to steer with 1 mW. Jirmann achieves a power of 300 Watt in Class B.

Gunthard Kraus describes a gainblock receiver for HRPT reception, more specifically: the Meteosat on 1692.5 MHz. This is, of course, a relevant article for us, so here are some more details.

Inspired by some pictures of Meteosat, he builds a setup with modules already available to him. The first amplifier contains an MGA635P8 with a gain of 20dB at 1692 MHz and a noise figure of 0.4 dB. Then follows a stripline bandpass with a bandwidth of 160 MHz and a loss of 1 dB at 1690 MHz. The second pre-amplifier has a gain of 12 dB on 1692 MHz and a noise figure of 0.6 dB. Behind that is an SDR dongle and via a USB connection to a PC.



Receiver made up from modules by Gunthard Kraus

The stripline filter was built specifically for this article, with the help of Ansoft [4] and with Rogers RO4993 as the print material and Micron-20 from Bulgaria [5] as the supplier. Kraus guides us through the design of this filter. He is satisfied with the final measurement results. The article deliberately stops there; no details are given about antenna dish construction or decoding [6] and motor control is not mentioned at all. So, it is a partly theoretical exercise; the amplifier is dealt with, but there is no actual reception. This may have given rise to the following.

Ben Schellekens and Arne van Belle see some flaws: "HRPT is from the NOAA satellites and thus not from Meteosat. Meteosat does have MetOp polar satellites but they do not transmit HRPT. 1692.5 MHz is not a HRPT frequency, this is 1698 or 1707 MHz. This does not make much difference for designed filter and amplifier but it does for reception." Our

chairman brought this to the attention of UKW berichte, but unfortunately did not receive a reply.

We also find as mentioned the table of contents about the year 2020. It is already the 60th volume.

Gunthard Kraus brings us, as always, a series of links in Fundstelle Internet. I limit myself to links that are relevant to us and mention here: mixers in microwave systems, an overview of broadband architectures, technical and scientific software, radar technology, sfdr considerations in broadband digital receivers, homebrew hf test equipment.

The Ultrakurz section shows items from the shop: stainless steel cross clamps for antenna set-ups and gold-plated SMA adapters.

UKW-Berichte [7] is a German-language publication, now without an English version that used to exist under the name VHF communications. The magazine will cost 34 Euro per year from 2021 onwards, including shipping from Germany to The Netherlands. Single copies and volumes (DVD) are also available.

References

[1] version 5.1.0 of QucsLinecalc
[2] QucsStudio
[3] Data sheet of the PHA-202+
[4] Ansoft designer
[5] PCB supplier Micron-20
[6] HRPT decoder
[7] UKW-Berichte subscription

From the library

Summary

Some thoughts from our librarian

Dear people,

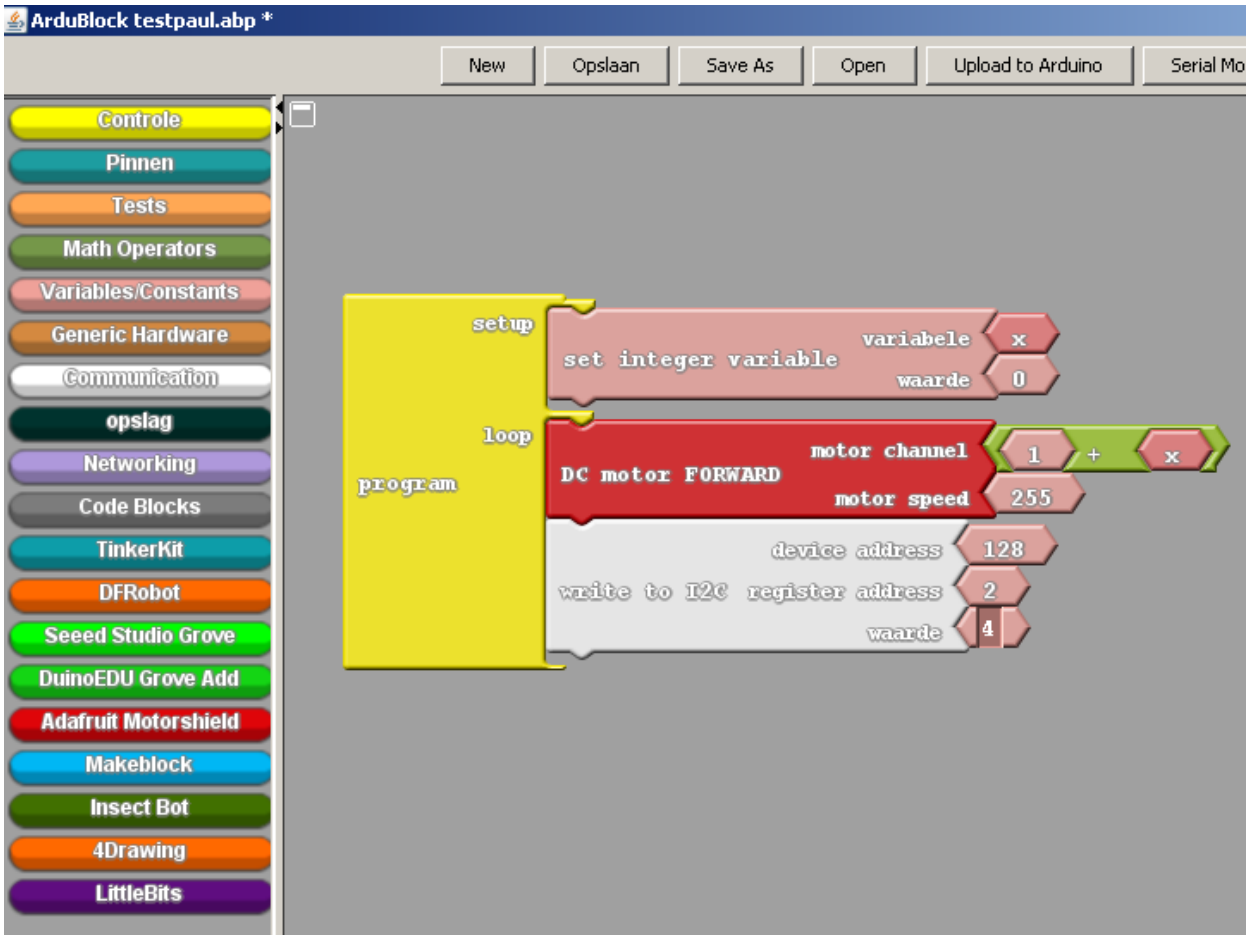
Spring always comes with the story of the suffering. No, not that story. I mean, of course, the Veron's annual April Fool's joke. An early transistor was supposedly found in the ruins of the former German air traffic control center near Arnhem. As false evidence: an old germanium transistor, with that failed German heat sink from the thirties photoshopped on it in a sloppy way. Referring to the Veron site. I expected to find the actual funny part of the joke there. But no. It only says that "nothing else is known". The April Fool's joke this year is that there is no joke. That is also their best joke ever.

The ISS weighs about 400 tons and will be decommissioned at the end of 2028 (current planning). The Russians have already indicated that they will retire earlier, in 2025. They are going to build something themselves, with the pretext that ISS is not safe. The Chinese have never participated with ISS and are also building their own. The Tiangong ("Palace of Heaven") is a bit smaller in size and should weigh 75 tons. In the last few days, the first three astronauts were sent there. Do you know that all their craft have something with "heaven" (tian) in the name? It is not a coincidence, but their government policy. I would like to appeal to them: look down, at the clouds! Get a webcam at Alibahbah (costs not expensive !), stick it on the Palace of Heaven, point it downwards and stick a yagi on it. Small effort, great pleasure. At least as far as the thing gets above the horizon in our area. It never gets more than about 13 degrees.

Business notification from your Librarian! This corona time has made everyone crazy. Everyone is going to remodel their house. Nimeto too is prey to restlessness in the head. The basement has to be completely changed again, and that means our library cabinets will be in an unreachable corner in Nimeto until fall 2022. I can find peace with that, though it will be somewhat impractical if you want to request an old Kunstmaan or other item. Perhaps it is one more reason to focus on electronic data storage where possible.

Searching around for an interesting course to keep the mind sharp in these times, I ended up with a previous training institute of mine. Dirksen Opleidingen, which you may also be familiar with. I was disappointed with the current quality and prices. For a course in Microcontrollers (i.e. Arduino) with exam you can expect to pay a thousand euros, and then there are not even any special topics. I am particularly opposed to the use of ArduBlock [1]. This is a graphical front-end, which lets you glue blocks together and uses them to create the C(++) code we know and then offers it to the Arduino IDE. The worst part is that I immediately ran into a calculation error and an inconsistency and then I fear for the rest. If ArduBlock silently makes a variable you create locally global, sooner

or later trouble will come. I can not find that graphical interface very readable and intuitive either. I look no further. ArduBlock: discouraged from all my heart. Too bad. You better just program your motors in Arduino C.

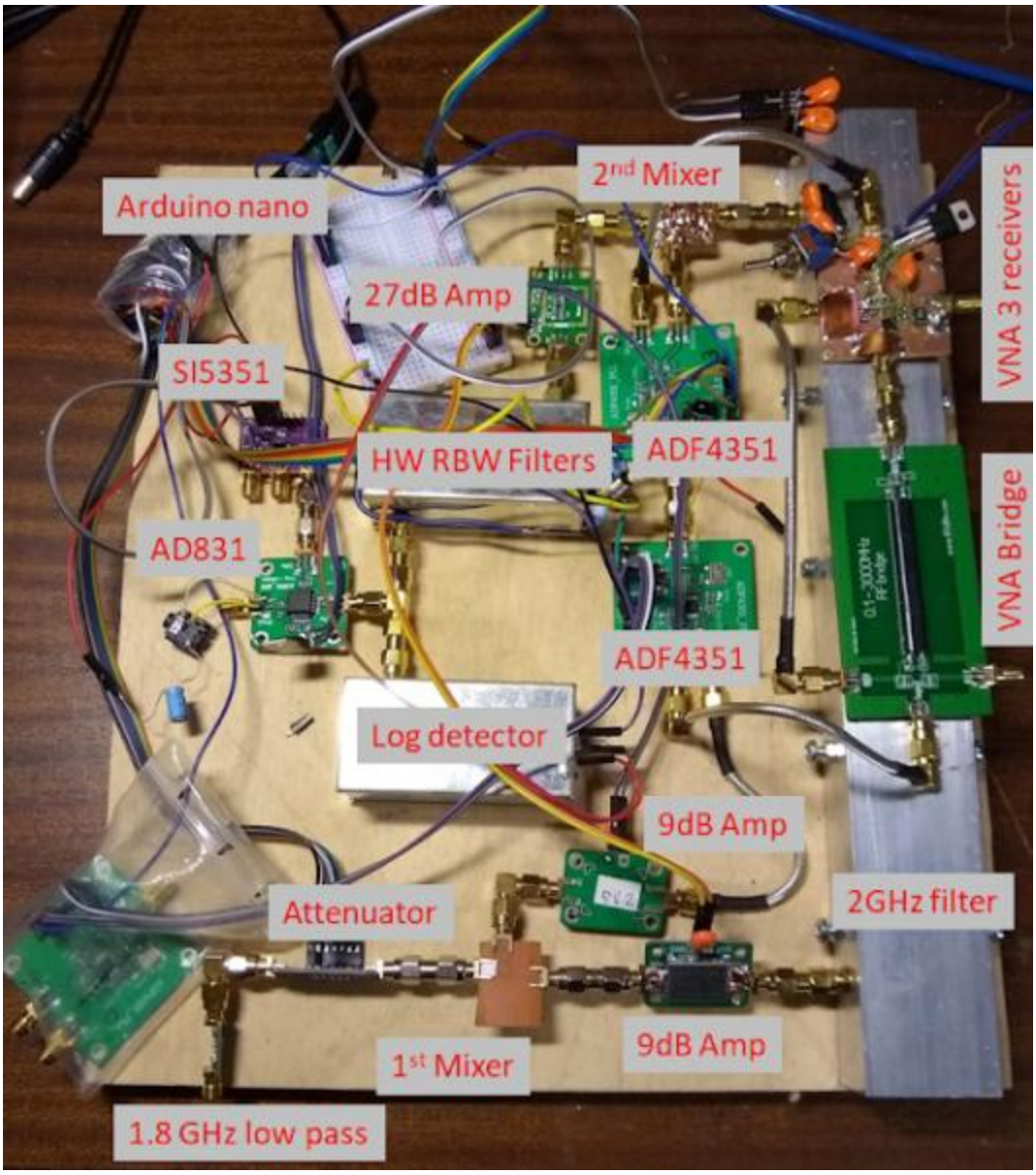


ArduBlock

We had a partial solar eclipse. I missed it, but found a nice little movie made from GOES-East [2]. It struck me again that the core shadow appears so small; it takes an auxiliary arrow to recognize the situation. The half-shadow is hardly noticeable at all.

A department of the Veron in Groningen publishes its own pdf magazine [3]. Hunsotron 42 contains an article on "60 years of satellite communications". From the genesis of telecommunication satellites, a series of underlying principles and events are discussed. Weather satellites are unfortunately only mentioned a few times. Hunsotron is always worth reading, as is Razzie from the Zoetermeer department. In the May issue of the Razzie [4], for example, we find a story about the DIY-construction of a tinySA. The accompanying photo of the setup by author Erik Kaashoek is inspiration for every homebuilder. In our library we have an HP141T, beautiful but a bit heavy. Whether we can or want to trade it in I will not go into here. The tinySa is available for 54 euro ex and

has its own wiki [5] with further information.

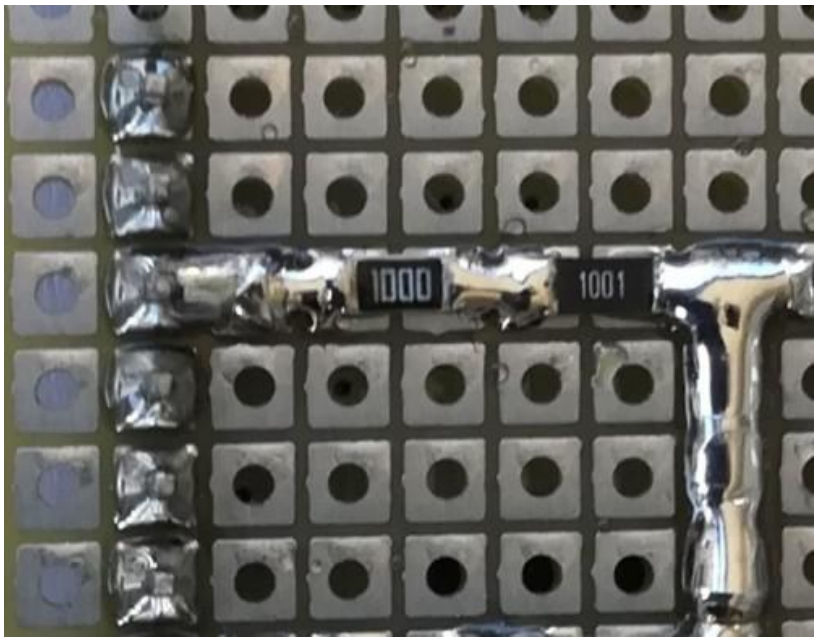


TinySA

In a previous article I have sometimes grumbled at a soldering iron because of the price of 150 euros. You ain't seen nothing yet, boy! At Elektuur they offer a digital soldering station for, believe it or not ... 449 euro [6]. I thought those painful blisters on your fingers were always analogue, but apparently it can now be done digitally. Digital blisters in the wallet that is.

Elektormagazine has a trick for us to get a connector a little firmer fixed to a circuit board. For this purpose via's are used [7]. For the signal path, depending on the circumstances, this is less suitable. Last summer Elektorlabs published a report about

soldering SMD material on a veroboard [8]. Attached is a picture of the better Baking and Roasting. I can understand that in times of need and haste one can glue an SMD component, but to create a conductor with tin like that is going a bit far in my opinion. It will not make it to the 7.8 GHz, I think. And that fine with me. I cannot bear it.



Baking and Roasting

Rob Alblas earlier wrote a item on the speed of the Arduino. I came across the book Arduino Internals by Dale Wheat [9]. Highly recommended for anyone who wants to squeeze the last bit and the last microsecond out of an Arduino. For example, on page 125 there is a reference to the mandatory loop() which is better replaced by a self-built loop consisting of its own while within the mandatory loop: loop() while(1) {...} and everything but everything about the timers is explained. With all these insights come the underlying reasons and calculations. Not an easy read, but it makes this book stand out from the dozens, if not hundreds of books and booklets with simple LEDs and push buttons that have already been published about the Arduino.

Over the past few weeks, I have been nervously sifting through all the minutes of our meetings, annual financial reports, and board agendas. I also spied all the photos of meetings with a magnifying glass. (*mocking dutch politics here, sorry it can not be translated*) Fortunately, I have not seen anywhere that says, "Librarian, occupation elsewhere." That gives me some peace of mind. As we all know by now, you can get worse than that. So next time I can just continue with this column; I see that as the task in the life of

Your Librarian

References

1] ArduBlock
2] Moon shadow, seen from GOES-East
3] Hunsotron
4] Razzie
5] Wiki about tinySA
6] Weller digital soldering station WT1010
7] Connectors support with via's
[8] SMD soldering on a Veroboard
[9] Arduino Internals by Dale Wheat

Report members meeting May 8, 2021.

Opening by the chairman.

Hopefully everyone is safe from Corona and we can attend a real meeting in the Nimeto in September. However, today this would not have been possible because the Nimeto's canteen is being thoroughly renovated. The equipment, books, etc. that we have in Utrecht are temporarily stored; we don't have access to that right now.

The Kunstmaan is now sent in a plastic envelope; that seems to work better than with a paper envelope which is sometimes damaged.

Setting the agenda

No reactions/adjustments have been reported.

Administrative Affairs

No changes. The GMM is held in September; normally that would be today but we have postponed it to the first ‘physical’ meeting.

Satellite status

The Russian Arktika has already been received by Oleg, but it is not easy to do. The orbital period is 12 hours, with a highly elliptical orbit. This satellite is intended for meteorological observation of the northern Russian territory; due to the elliptical orbit, it "hangs" at high latitude for a relatively long time. Fred Jansen reports that this satellite only transmits a useful signal for a very short time (65 sec per half hour high-resolution images, a few minutes of other data; sometimes more often, sometimes not). The carrier wave is continuously present.

Any other business

Fred Jansen will continue to work with 8 GHz reception. He can now receive Terra/Aqua regularly. He shows received signals from Arktika; the bare carrier wave is strong but if useful signal is transmitted then reception is weak. The orbit is strongly elliptical: the distance varies between about 1000 km and 40000 km.

Ben: works with LNA's from RF-microwave; a 10 GHz LNA should be convertible to 8 GHz.

Paul Baak, our librarian, reports that due to a renovation of the Nimeto we have no access to our books and magazines for a while.

Herman ten Grotenhuis reports that a publication can be found in Funk Amateur about a DS815 spectrum analyzer that has been increased from 1.5 GHz to 3 GHz. Still too low for our 8 GHz experiments.

Harm: shows a homemade 8 GHz oscillator, with QPSK modulator. Attention will be paid to this in the lecture by rans PE1FOT, later today.

Hendrik Jalving has made a large worm gear from a (flat) metal disk, which can be used to very accurately control a rotor-with-heavy-antenna-disc.

Wim Bravenboer: An amplifier 50MHz-2 GHz is for sale at Ali Express. Replacing the GaAsfet with an NLB-310 would give you a 10 GHz amplifier; at 8 GHz it gives about 15 dB of amplification.

Job: Tried to make a 3D printed horn with conductive lacquer. The result is disappointing; it doesn't work at all. This will mainly be due to the poor functioning of the conductive lacquer layer.
He shows a self-made rotor, with a smartphone as an angle indicator.
He is also experimenting with Qucs, a simulator for HF circuits. You can also export the entered design (mainly strip lines) to Kicad to make a printout of it.

Rob: has extended xtrack so that multiple Kepler files can be read (important if you want to use satellites from different TLE files). Furthermore, provision has been made for calibration on a geostationary satellite (syracuse in particular is suitable for this).

Lecture: Oscillators 8 GHz by Frans PE1FOT

In next KM you can find a report of this lecture.

Rob Alblas

(secretary AI)

Arne van Belle, June 21, 2021

POLAIR	APT (MHz)	HRPT (MHz)	X-BAND (MHz)	Remark
NOAA 15	137.620	1702.5		Morning/evening, weak/sync problems
NOAA 18	137.9125	1707.0		Early morning/afternoon
NOAA 19	137.100	1698.0		Afternoon/night
FengYun 3A	no	1704.5		AHRPT 2.80 Msym/s
FengYun 3B	no	1704.5	7775	AHRPT 2.80 Msym/s
FengYun 3C	no	1701.3	7780	AHRPT 2.60 Msym/s
FengYun 3D			7820	
Metop-A	off(137.100 LRPT)	1701.3	7800	LRPT/AHRPT 2.33 Msym/s
Metop-B	no	1701.3	7800	Only AHRPT 2.33 Msym/s
Metop-C	no	1701.3	7800	Only AHRPT 2.33 Msym/s
METEOR M N2	137.100 LRPT	1700.0		LRPT/MHRPT
METEOR M N2-2	off(137.100 LRPT)	1700.0	8128	LRPT/MHRPT damaged by meteorite ?
AQUA			8160	7,5 Mbps no FEC
TERRA			8212,5	7,5 Mbps no FEC
SUOMI NPP(jpss)			7812	15 Mbps
NOAA20 (jpss-1)			7812	15 MHz FEC ½
ARKTIKA-M1			7865	BPSK 30.72MS/s
OCEANSAT-2			8300	42,4515 Mbps

GEOSTATIONAIR	LRIT/GRB (MHz)	(SDUS)/PDUS (MHz)	*Orbital position/status*
MET-11 (MSG-4)	no	1695.15 HRIT	0 degree, operational
MET-10	no	1695.15 HRIT	9.5 degree E, RSS
MET-9	no	1695.15 HRIT	3.5 degree E, standby
MET-8	no	1695.15 HRIT	41.5° degree E, IODC
GOES-E (no. 16)	1686.6 GRB	1694.1 HRIT	75.2 degree W via Eumetcast
GOES-W (no. 17)	1686.6 GRB	1694.1 HRIT	137.2 degree W via Eumetcast
GOES 14	1691 LRIT	1685,7 GVAR	105 degree W, Backup
GOES 13 / EWS-G1	1676 SD	1685,7 GVAR	61.5 degree E, Now Space Force
GOES 15	1691 LRIT	1685,7 GVAR	128 degree W parallel with GOES 17
Elektro-L2	1691 LRIT	1693 HRIT	14.5 Degree W, via Eumetcast
Elektro-L3	LRIT	HRIT	76 Degree E, Operational
MTSAT-1R	1691 LRIT	1687.1 HRIT	140 degree E, Backup for MTSAT2
MTSAT-2	1691 LRIT	1687.1 HRIT	145 degree E, via Eumetcast
Himawari-8	no LRIT	no HRIT	140.7 degree E, via HimawariCast
Himawari-9	no LRIT	no HRIT	140.7 degree E, Backup for 8
Feng Yun 2E	-	-	86.5 degree E, Backup
Feng Yun 2F	-	-	112.5 degree E, Backup
Feng Yun 2G	-	-	99.5 degree E
Feng Yun 2H	-	-	79 degree E
Feng Yun 4A	1697 LRIT	1681 HRIT	99.5 degree E, Operational
Feng Yun 4B	LRIT	HRIT	Recently launched
Elektro L2 (goms2)			7500 MHz RHCP 14W, 30,72MS/s
SYRACUSE 3B			7705 MHz LHCP, 5,2W

GOES-13 has been moved, and is handed over to Space Force and renamed to EWS-G1. The GVAR mode can be received and decoded using SDR and a dish antenna of minimal 180cm (look for @ZSztanga on the web).

Meteor M N2-3 launch maybe in Augustus 2021.
Arktika-M1 uses a Molnyia orbit and has been received on 1697, 1703 and 7865 MHz.

GOES-T launch (GOES 18 after successful launch) is scheduled for 7 December 2021.

werkgroep kunstmanen

De werkgroep is opgericht in 1973 en stelt zich tot doel:
Het bevorderen van het waarnemen van kunstmanen
m.b.v. visuele, radiofrequente en andere middelen

www.kunstmanen.net