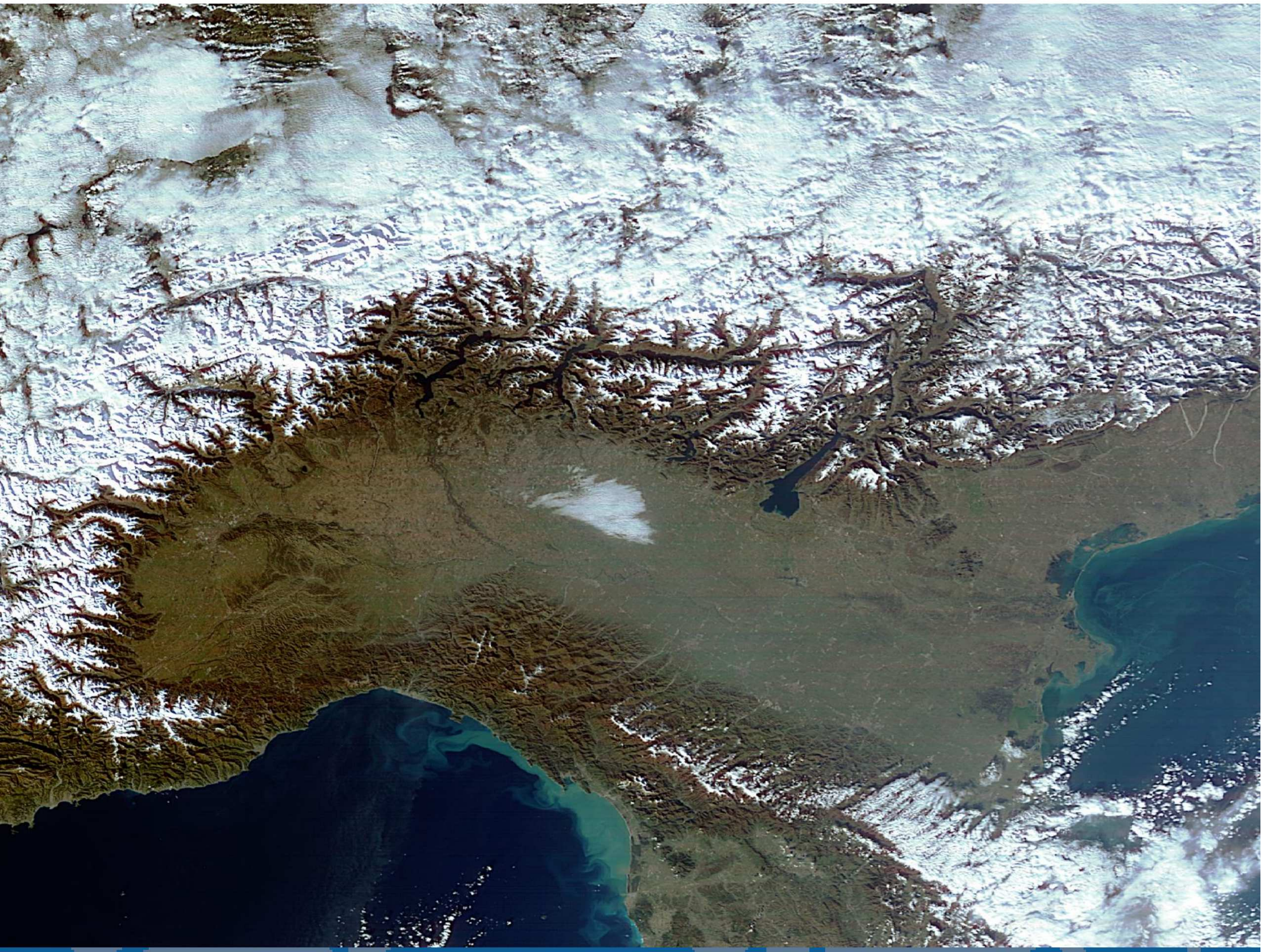
DE KUNSTMAAN

December 2021 – 48e jaargang nr. 4
Uitgave van de Werkgroep Kunstmanen



In dit nummer o.a.
- Zelfbouw ‘slotted line’
- Een IQ Modulator
- Interdigital filter voor 1420MHz
- 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
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kunstmanen@alblas.demon.nl

Content

Photo front page:

FY3D X-band by Fred Jansen 6-12-2021 12:49Z

Physical meeting
We got back together! There is a fixed group that comes to the meeting and another group that follows the meeting via Zoom. I still find it quite difficult to ensure that both a physical meeting and a Zoom run smoothly at the same time. Every time we try to do a little better but apologies if it is not yet optimal.
While many associations are having a hard time during this period, we are getting through it well. Of course we hope that the restrictive measures will disappear soon and that everyone will have confidence again to be able to go to the meetings safely.

De Kunstmaan
Our body magazine De Kunstmaan is an important binding factor for our working group. In this we publish articles about our beautiful hobby. The aim is to make every Kunstmaan 28 pages thick. Due to layout & printing, the number of pages is always a multiple of four. Now it is not always easy to fill all these pages and it is sometimes stressful to finish the copy on time. It worked again!

So at the end of the year is the time to publish overviews.
In total we had 96 editorial pages in 2020 (excluding front and back cover and colophon). This year we are at 100 with editorial pages, a nice round number. The pages were written by the following authors:

	2020	**2021**
ben	34	48
Fred vd B	2	-
Rob A	28	19
Paul	11	11
Arne	7	6
Fred J	10	
Ger	4	
harm	-	8
Job	-	6
Rob H	-	2
	96	100

Half of the copy of the Kunstmanen in 2021 comes from me. And that is unfortunately not because articles from others had to be left on the shelf.
My stories are often the result of projects that I am working on. But it's not a good thing that there's such a heavy reliance on one author, and it's also much nicer to have more variety. Therefore a request to everyone to submit a copy. Small messages are also nice. And also tell us about what didn't work out, we learn from that and you don't see this approach from practice very often in magazines.

The Kunstmaan in front of you is an example of many practical experiences. I started with "slotted lines". Harm started working with IQ modulator. His schematic has been

translated into a printout and it actually works. Rob has worked the higher data rate from the Godil to have a signal generator, with which we can design receivers for the 8 GHz. We'd rather have one "special satellite" on the table than ten in the sky.
Arne describes Jean Claude's experiences with reception on the 8 GHz. Track by hand using an 80cm offset dish! If you don't have room for an antenna at home, it's easy to make a mobile receiving station. The 8 GHz is also accessible to everyone!
If you still want to get started with rotors, Job describes the ESP32 with which he controls his rotor via WiFi.
Rob Hollander has built a chic housing for the QPSK receiver, his experiences can also be found in this Kunstmaan. I myself have been behind the milling machine for the construction of an interdigital filter for the 1420 MHz.

Contribution

From this place we ask you to pay the contribution. We will keep the rates the same for next year:
€10 membership for PDF only (both in the Netherlands and abroad)
€ 28 membership for paper Kunstmaan (as it was) and PDF
€ 33 membership for the paper abroad membership and PDF

It remains for me to wish everyone a Merry Christmas and a very happy and healthy New Year. The first meeting of the new year will most likely be on January 15. At the moment it is unclear how we will shape it, at least also digitally. According to the regulations, we fall under the schools and they should be open....
Keep an eye on your mailbox.

Ben Schellekens
Chairman of the Kunstmanen Working Group

DIY slotted line

Vector network analyzer

Several workgroup members already have a spectrum analyzer, in many cases equipped with a tracking generator. This makes it possible to look at the spectrum: the strength of the signal compared to the frequency. Very useful if you want to adjust filters, for example.

You cannot measure phase shifts of the signal with a spectrum analyzer. This brings you into the field of network analysers.

Network analyzers are often used to measure components, spectrum analyzers to view a signal.

When a signal enters a component, part of the signal will reflect, depending on the impedance. A vector network analyzer is able to measure this reflected signal and determine its phase.

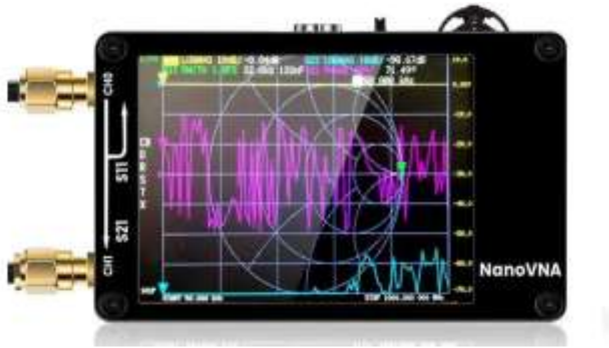
Based on the phase information, it is possible to create an adaptive network so that a component performs optimally at a certain frequency. A Smith chart is an important tool to help you do this.

As with spectrum analyzers, the price goes up with frequency.

For sale for 69,000 U$. Age unknown, but with a floppy disk! Up to 65GHz.

A four port VNA from R&S for sale for 179,000 U$. It goes up to 67 GHz.

There are also cheap alternatives, such as the NanoVNA, which is for sale for 55 Euros and can measure up to 1.5GHz.



The NanoVNA

The only "affordable" VNA suitable for the 8 GHz VNA is the SNA5012A from Siglent, only around 18 thousand euros.

How were measurements taken in the past when there were no VNAs or when they were unaffordable? Since the Second World War, so-called "slotted lines" have been used. They are often mechanical feats of a piece of waveguide in which a slot has been made for placing a probe. With this probe, peaks and knots can be observed in the reflected signal.

A slotted line of waveguide. In the middle you see the detector.

DIY

These slotted lines are difficult to obtain second hand. Sometimes parts are missing, such as the detector, or they are not suitable for the 8 GHz because the waveguide is too small. Then find out if you can do it yourself.

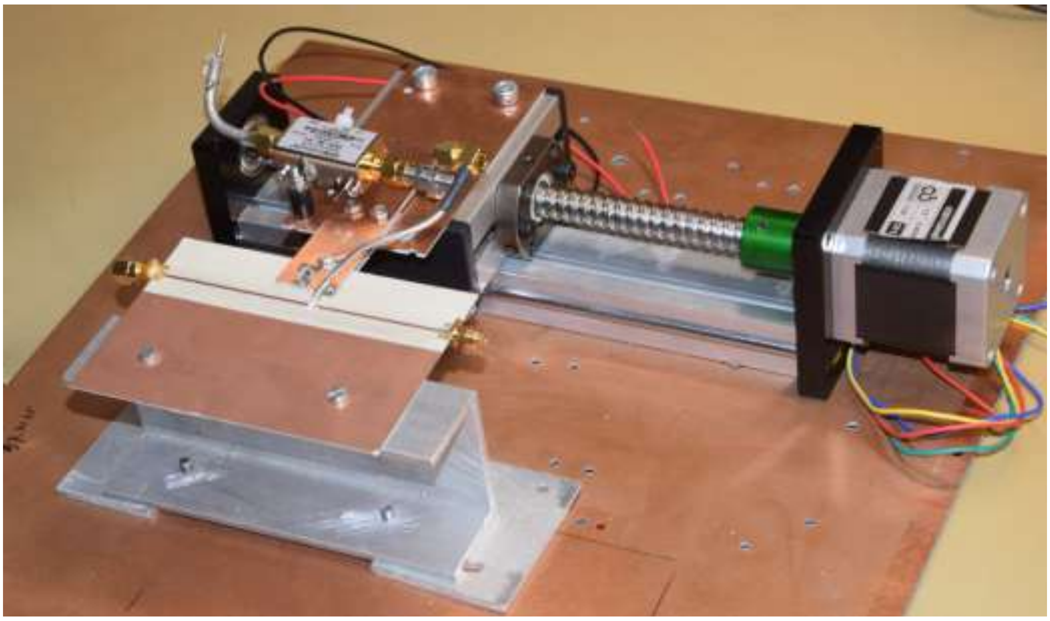
Due to the temporary move from the Werkgroep's library to moving boxes, I had brought home some old VHF Communications. The summer 2013 issue featured an article about an automated slotted waveguide that can take measurements for the X-band (8 - 12 GHz).

I also found a description of a microstrip slotted line in the book "Planar Microwave Engineering" by Thomas Lee.

I went to see if I could put together something workable myself.

setup

I made the slotted line of printed circuit board with a 50 Ohm track. This saves a lot of hassle with waveguide on which you also have to mount SMA connectors.



The “slotted line” as described in this article

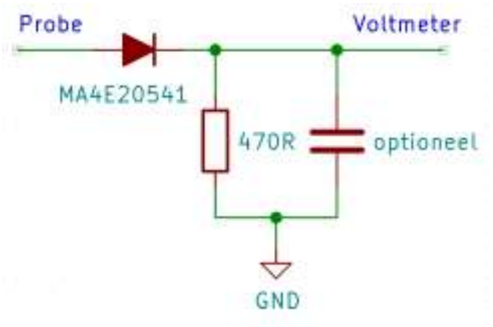
For me, the starting point was that it had to be a reasonably automated system, because I don't feel like taking and processing hundreds of measurements manually. My slotted line consists of the following parts:

- The circuit board is from IS680 from Isola. I had some sample material from this. I cut out the print track with a Stanley knife.

- A linear guide driven by a stepper motor. These are often used in 3D printers. This moves the probe along the print path. This way you can position the probe very accurately. Found on Amazon for 65 euros, you don't mess around for this yourself.

- The stepper motor is controlled with an Arduino and a MotorShield from Adafruit.

- The probe was a tricky one. Lee recommends the diode MA4E2054, but I haven't been able to get this to work. No idea what's going on. Too much or too little signal. I've tried with a 1kHz modulation, but nothing comes out. In the end I resorted to a power detector from MiniCircuits, the ZX47-60-S+. It can measure signals down to -60dBm.

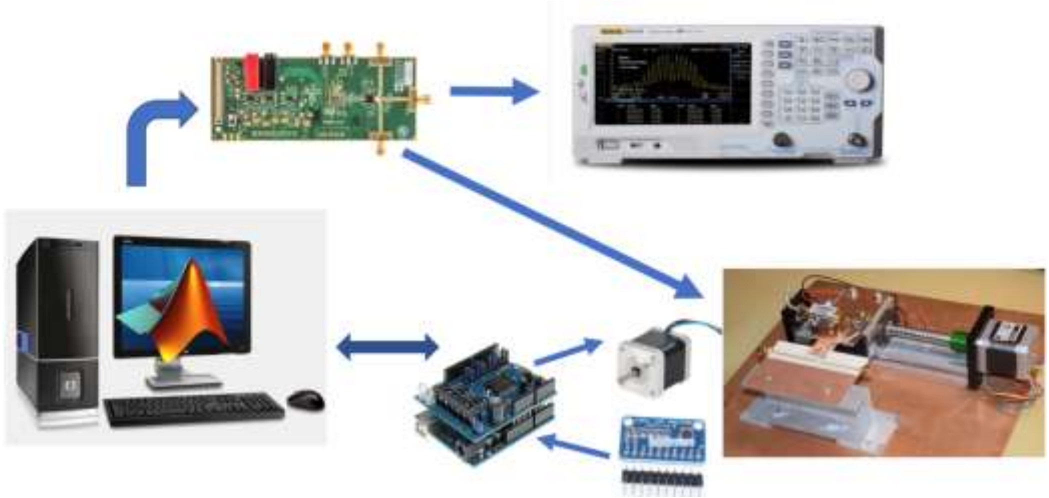


Diode detector that I didn't get to work

- I measure the voltage on the power sensor with a 16-bit ADC, the ADS1115

- As a signal source I use the evaluation board of the ADF5356 from Analog Devices. At 8 GHz, the output level is -3dBm. The ADF5356 is set to frequency with the Analog Devices software.

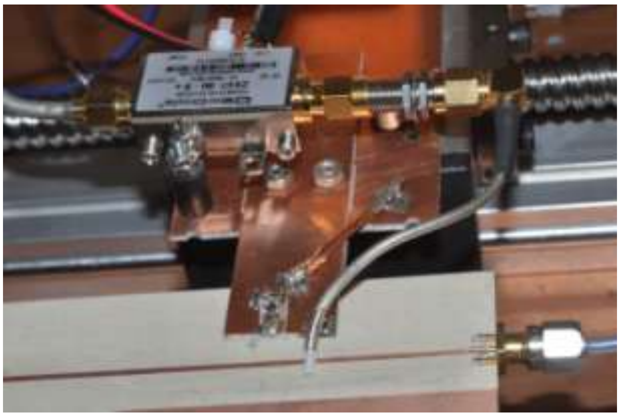
- Software-wise I control everything with Matlab.



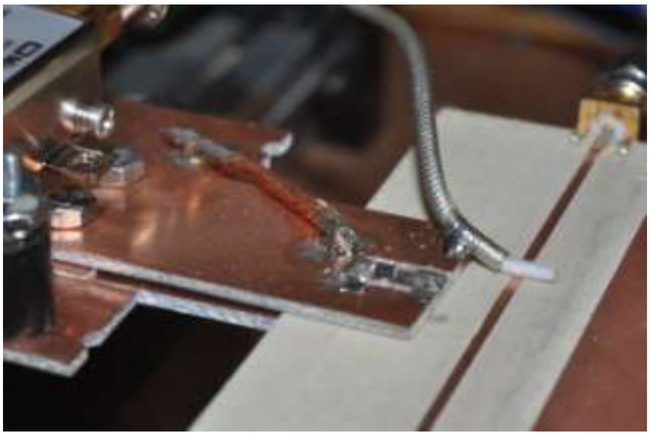
The total measurement setup.

Probe

A piece of semi-rigid coax is connected to the input of the power detector, from which the jacket has been removed at the end.



The probe made of a small piece of semi-rigid coax



You can clearly see that the underside of the probe print makes contact with the measurement print

Arduino

The Arduino is controlled directly via the USB port from Matlab running on the PC. So you don't write an Arduino program, everything is done from Matlab. The Arduino runs software that is the link between the Matlab control on the PC and the extensions connected to the Arduino.

Because the interface goes through the USB port, you cannot achieve high speeds. But for this purpose it is more than sufficient.

The Adafruit MotorShield is mounted on the Arduino. The motor supply is 5V with a current limitation at 500mA.

Matlab

In the past I wrote something about Scilab, the open source alternative of Matlab. I still had a problem with Scilab because the toolboxes are hardly updated. You must then work on a low version of Scilab.

Nowadays Matlab has become very accessible for the hobbyist. For 119 Euro you have a home license that you can install on two computers, this includes one year of maintenance (free upgrades). Any necessary toolboxes are added on top of this. The Arduino toolbox is free.

With the Matlab script, see the end of this article, I do a few things:

- Driving the stepper motor connected to the Arduino

- Reading the ADS1115 connected to the Arduino

- Save the read values in a csv file

- Generate a chart

At first I wanted to control the ADF5356 via SPI, but I couldn't get this to work. When initializing the SPI on the Arduino, unwanted signals came on the SPI bus, causing the ADF5356 to no longer work properly. So now I use the USB interface of the evaluation board.

ADS1115

I chose an external ADC because the Arduino / ATmega328 has a 10 bit resolution. The ADS1115 is a 16-bit ADC that is controlled with I2C from the Arduino with Matlab.

When using the ADS1115, you have to make a number of choices:

- Which entrance are you going to read, there are four

- What is the measuring range

- How many measurements should be taken per second

Since I couldn't use Arduino libraries, I had to figure out the I2C communication myself.

First you write a byte with the value 0x01, this points to the configuration register. Then you write two bytes to the configuration registry. Then you write a byte with the value 0x00. This points to the conversion register. Here are the measured values. You can then retrieve the measured values per two bytes.

This is well explained in "10.1.7 Quickstart guide" from the datasheet.

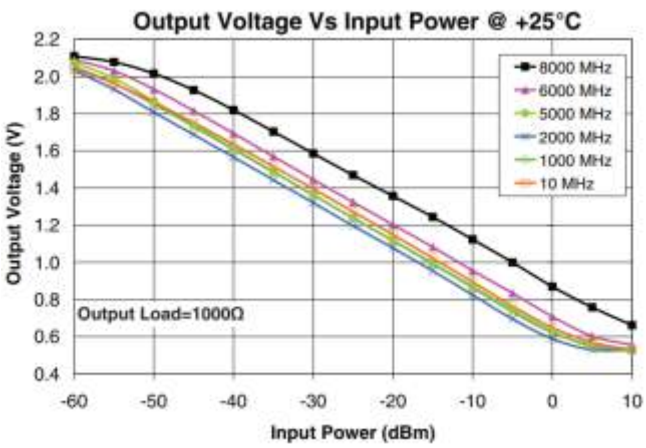
Evaluation board of the ADF5356

8 GHz comes from the RefB output. The RefA output is connected to my spectrum analyzer. The VCO of the ADF5356 is set to 4 GHz. The RefB output shows the frequency doubled and the RefA output shows the VCO frequency divided by four. Very handy to see if there is a signal.

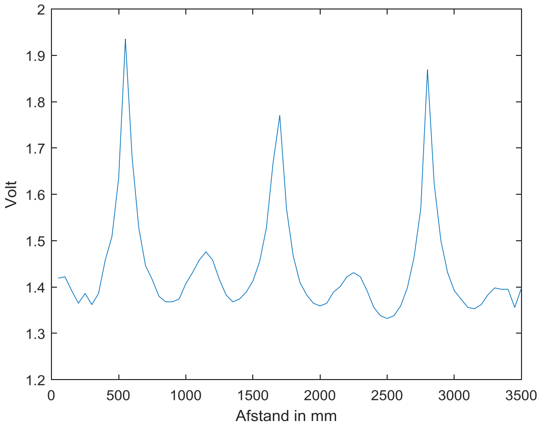
Measurements

I have done several measurements. The goal was to see if I can measure standing waves. As mentioned, a standing wave is created when there is an impedance transition, then reflection occurs. The sum of the incident and reflected wave produces a standing wave.

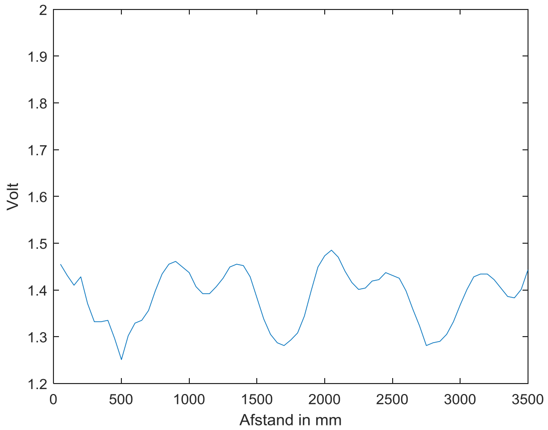
When interpreting the pictures keep in mind that on the vertical axis is the voltage as it comes out of the power meter. The higher the level, the lower the voltage.



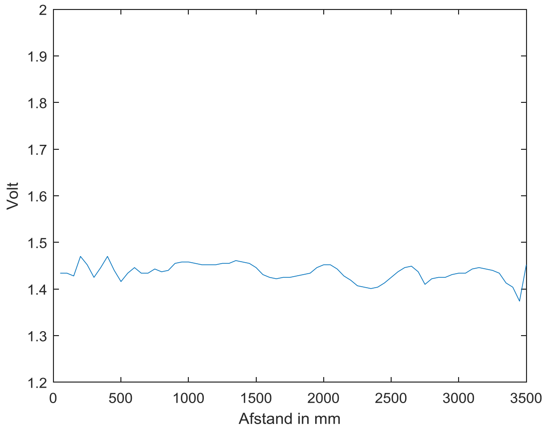
Relationship between voltage and the level of the ZX47-60+



A measurement with a short circuit. The impedance is zero.



An open-ended measurement. The impedance is infinite.



A measurement with a 50 Ohm terminating resistor. If all is well there is no reflection because the print path must also be 50 Ohm.

You should be able to calculate the frequency based on these measurements.

Improvements

- Still see if I can get a diode detector to work.

- The above measurements are in power (dBm). SWR measurements are often in voltage.

- Mount the circuit board better. Accurately tailor the print track (which one?). The sma connectors are now not perfectly mounted because they are only soldered on the underside.

- I had the idea that the measurements of the ADS1115 are not really stable / constant. Maybe I should make a PCB and not build it on a breadboard.

Conclusion

The setup seems to work. I don't think it's an accurate measuring device in this setup. But it is very nice that you can still take measurements on the 8 GHz with simple means.

Using Matlab made control very easy.

IQ Modulator.

Harm de Wit

As a result of my contribution in “ de Kunstmaan”, June 2021, about "A special satellite", Ben wanted a schematic and a PCB design of the I/Q-Modulator.

Ben drew the schematic and designed the PCB (chapeau). I assembled this PCB with the things I still had lying around; I demonstrated the result at the November meeting.

The original design is called “Mini IQ-mod” and was published in Funkamateur magazine, FA 1/19. I made some changes in this design to be able to get a better result for Metop-like signals, among other things.

The data stream for I and Q from the Godil *) is used as source. These signals pass through filters, a 5-pole Butterworth LP filter, with the correct bandwidth (calculated with RF-Tools). The filters are placed on a separate plug-in board (with the size of a 14-pin DIL socket). So that, depending on the satellite and the associated bandwidth, the correct filter can be placed.
The op-amps ensure that the I and Q signals are at the correct strength and are converted to balanced signals; furthermore, the signals are set to the correct DC level and presented to the I/Q-Modulator.

The carrier, for the L-band, is generated using a synthesizer chip ADF4351; I attenuated this signal by 10 dB.

The modulator is activated with Q1; either place a jumper to the 5 V, or use a P(ress)T(o)T(alk) line to 5 V.

The output signal of the "bare" I/Q-Modulator chip AD8346 is too strong for a LNC 1700 etc. downconverter, so it needs to be attenuated, in my case with 40 dB. The board has the option to place a fixed attenuator. I made R27 = 0 Ohms and did not put R26 = R28; I prefer to work with "separate attenuators", as needed.

Well, this must be it. Success in replicating and/or improving.

The table below gives the filter values for METOP (L-band) and NOAA-20 (X-band); the latter has yet to be tested with the simulation data.

	METOP: 2x2.33 Mb/s, BW=2.5 MHz	NOAA20: 2x15Mb/s, BW=15MHz
L1,L2,L3,L4	22 uH	3.9 uH
C3,C4,C7,C8	180 pF	30 pF
C5, C6	560 pF	100 pF

*) GODIL is the module used to make the decoder/generator for (A)HRPT.

Note Rob Alblas:
In a next Kunstmaan we will try to give a complete description of this project. The GODIL can generate and decode I/Q signals, but it remains to be seen whether the NOAA20 speed can be reached. It's 15 Mb/s on both I and Q. I don't think this will cause a problem for the generator; otherwise it is for NOAA20 decoder.

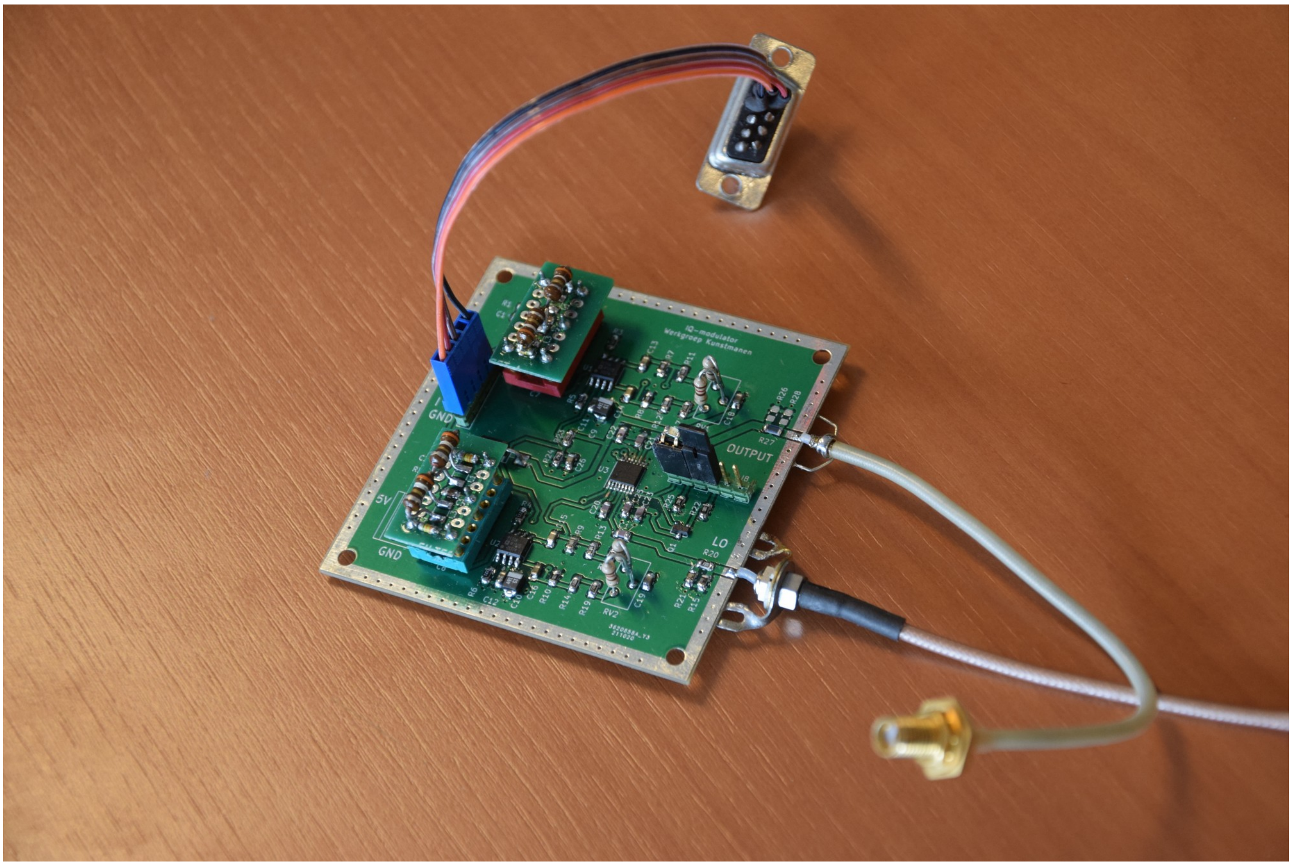


Fig. 1. The built I/Q modulator. On the left the I/Q inputs, on the right the input for the local oscillator and the RF output.

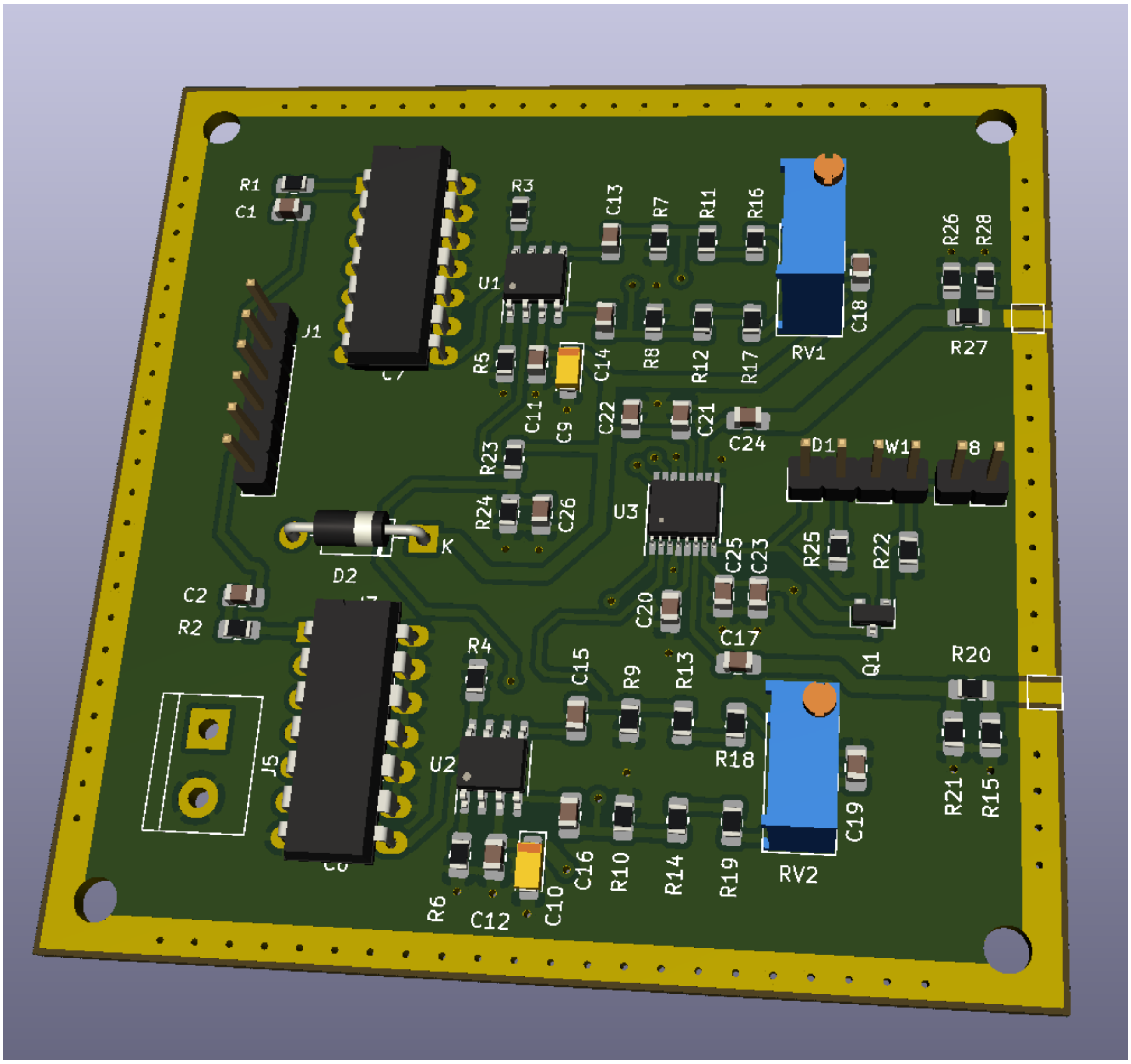
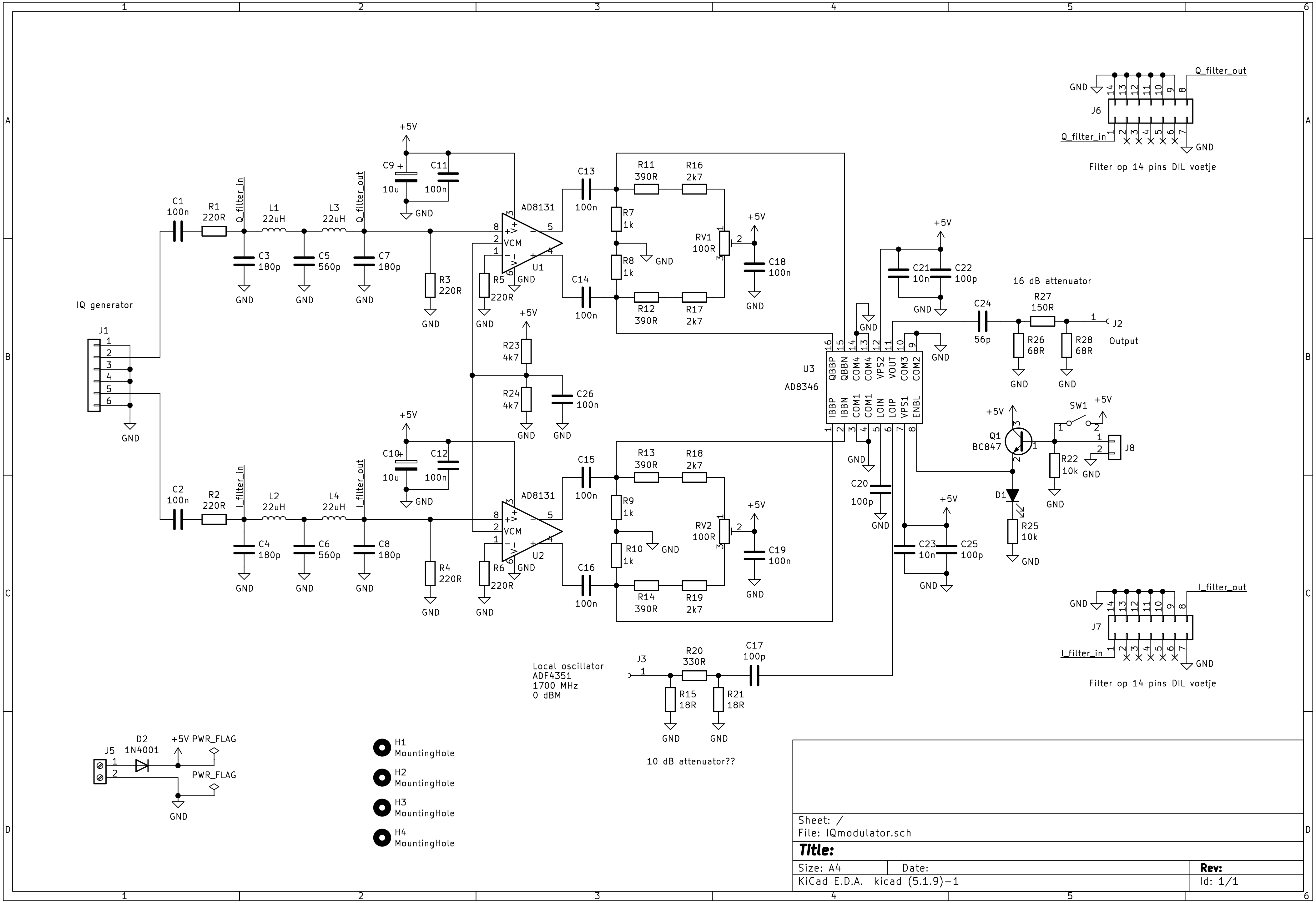


Fig. 2. The printed circuit board



IQ generator
J1
GND
C1
100n
R1
220R
Q_filter_in
L1
22uH
L3
22uH
Q_filter_out
C3
180p
C5
560p
C7
180p
R3
220R
C2
100n
R2
220R
I_filter_in
L2
22uH
L4
22uH
I_filter_out
C4
180p
C6
560p
C8
180p
R4
220R
+5V
C9
10u
C11
100n
C10
10u
C12
100n
AD8131
U1
U2
VCM
R5
220R
R6
220R
R23
4k7
R24
4k7
C26
100n
C13
100n
C14
100n
C15
100n
C16
100n
R7
1k
R8
1k
R9
1k
R10
1k
R11
390R
R12
390R
R13
390R
R14
390R
R16
2k7
R17
2k7
R18
2k7
R19
2k7
RV1
100R
RV2
100R
C18
100n
C19
100n
U3
AD8346
QBBP
QBBN
COM4
VPS2
VOUT
COM3
COM2
IBBP
IBBN
COM1
LOIN
LOIP
VPS1
ENBL
C20
100p
C21
10n
C22
100p
C23
10n
C25
100p
16 dB attenuator
C24
56p
R27
150R
R26
68R
R28
68R
J2
Output
Q1
BC847
SW1
R22
10k
J8
D1
R25
10k
J6
J7
Filter op 14 pins DIL voetje
Local oscillator
ADF4351
1700 MHz
0 dBM
J3
R20
330R
C17
100p
R15
18R
R21
18R
10 dB attenuator??
J5
D2
1N4001
PWR_FLAG
H1
MountingHole
H2
MountingHole
H3
MountingHole
H4
MountingHole
Sheet: /
File: IQmodulator.sch
Title:
Size: A4
Date:
Rev:
KiCad E.D.A. kicad (5.1.9)-1
Id: 1/1

Interdigital filter for the 1420 MHz

Introduction

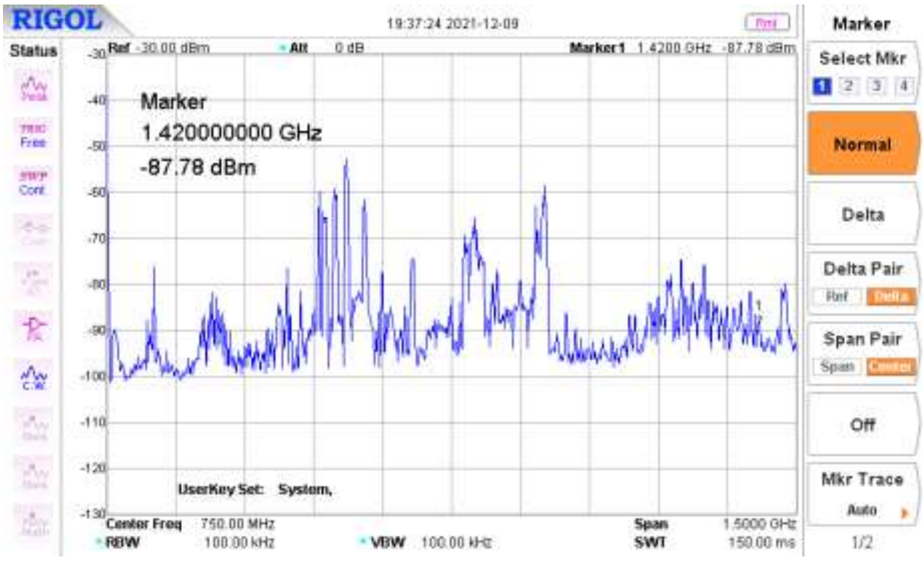
A few things have been written about interdigital filters in the past. Arne, for example, described a 1700 MHz interdigital filter in the February 2002 issue of Kunstmaan. The calculations were performed with a GWBASIC program. In the September 2016 issue I wrote something myself about a filter made by Hendrik from a block of aluminium.

Through Job I came up with the idea to use rectangular aluminium tube because this saves quite a bit of milling work.

1420MHz

Why 1420MHz? I want to use the filter as an intermediate frequency filter for an 8 GHz down converter. It is important to block as many interference signals as possible. Major sources of interference are the GSM bands on the 900 and 1800 MHz. The 1420 MHz is neatly in between. This frequency is also known as the hydrogen emission line. Radio observations of the universe therefore also take place on this important frequency. It is a "quiet" part of the radio spectrum.

Another (small) advantage is that my spectrum analyzer only goes up to 1.5GHz and that I can do measurements without the band converter.



Spectrum visible on the 1.5GHz spectrum analyzer with 20dB gain and without attenuator. There is a small wire at the entrance.

Dimensions

One of the parameters that you must specify for the calculation of the filter is the bandwidth. For myself I made an overview of the different bandwidths of the 8 GHz satellites. At the bottom is the Aqua with 15 MHz and at the top the FengYun 3D with 45 MHz. I have decided to take a bandwidth of 50 MHz as a starting point.

A side note: I don't know yet what the influence of the intermediate frequency bandwidth is on the reception.

The height of an interdigital filter is a 1/4 wavelength and at 1420 MHz is 52.78mm. An aluminium tube, which comes close, is 60mm with a wall thickness of 3mm. I chose 3mm as the wall thickness because I also want to tap threads into it.

I chose 24mm as the depth, I could also have chosen 19mm (tube of 30 or 25mm minus 6mm wall thickness).

For the round rods I chose 8mm brass rod.

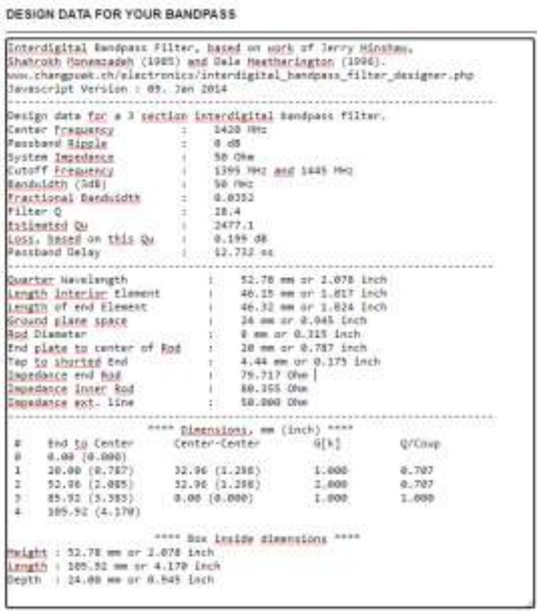
Incidentally, Jos Disselhorst (van de Veron) advises to take 2:1 as the ratio between depth and diameter. Maybe as a next experiment.

I want to keep the side of the filter open, because this saves a lot of work. When the distance from the side is greater than 20 mm, it no longer makes much difference to the impedance matching.

There is a nice page on the Changpuak website where you enter these parameters and the required dimensions will then be rolled out.

Entering the parameters

Calculated transmittance curve as my spectrum analyzer should show



DESIGN DATA FOR YOUR BANDPASS

```
Interdigital Bandpass Filter, based on work of Jerry Hinshaw,
Shahrokh Monemzadeh (1985) and Dale Heatherington (1996).
www.changpuak.ch/electronics/interdigital_bandpass_filter_designer.php
Javascript Version : 09. Jan 2014
---------------------------------------------------------------------------
Design data for a 3 section interdigital Bandpass filter.
Center Frequency          :    1420 MHz
Passband Ripple           :    0 dB
System Impedance          :    50 Ohm
Cutoff Frequency          :    1395 MHz and 1445 MHz
Bandwidth (3dB)           :    50 MHz
Fractional Bandwidth      :    0.0352
Filter Q                  :    28.4
Estimated Qu              :    2477.1
Loss, based on this Qu    :    0.199 dB
Passband Delay            :    12.732 ns
---------------------------------------------------------------------------
Quarter Wavelength            :    52.78 mm or 2.078 inch
Length interior Element       :    46.15 mm or 1.817 inch
Length of end Element         :    46.32 mm or 1.824 inch
Ground plane space            :    24 mm or 0.945 inch
Rod Diameter                  :    8 mm or 0.315 inch
End plate to center of Rod    :    20 mm or 0.787 inch
Tap to shorted End            :    4.44 mm or 0.175 inch
Impedance end Rod             :    79.717 Ohm
Impedance inner Rod           :    80.355 Ohm
Impedance ext. line           :    50.000 Ohm
---------------------------------------------------------------------------
              **** Dimensions, mm (inch) ****
 #    End to Center     Center-Center      G[k]        Q/Coup
 0    0.00 (0.000)
 1    20.00 (0.787)     32.96 (1.298)      1.000       0.707
 2    52.96 (2.085)     32.96 (1.298)      1.000       0.707
 3    85.92 (3.383)     0.00 (0.000)       1.000       1.000
 4    105.92 (4.170)

               **** Box inside dimensions ****
Height : 52.78 mm or 2.078 inch
Length : 105.92 mm or 4.170 inch
Depth  : 24.00 mm or 0.945 inch
```

The dimensions of the resonance rods, housing and the distances

Construction

In the previous Kunstmaan I had already written about my milling machine. So I put it to work.

With the edge finder (described in the previous Kunstmaan) you will determine the zero point of the fixed part of the machine clamp. This is the reference because you will loosen and replace the piece of aluminium tubing several times.

An edge finder against the fixed part of the machine vice. The lower part has shifted slightly, so you are right on the edge. The edge finder also rotates at 500 rpm, by using a flash to take the picture, it seems to stand still.

The problem was that my edge finder no longer worked. The lubrication between the two parts had become too thick. I think the problem was the low temperature, which made the lube more viscous. With a piece of paper you rub off the old lubricating oil and lubricate again with thin oil. After that, the edge finder worked perfectly again.

With the metal band saw I cut a piece of the 60mm tube, a few mm longer than necessary.

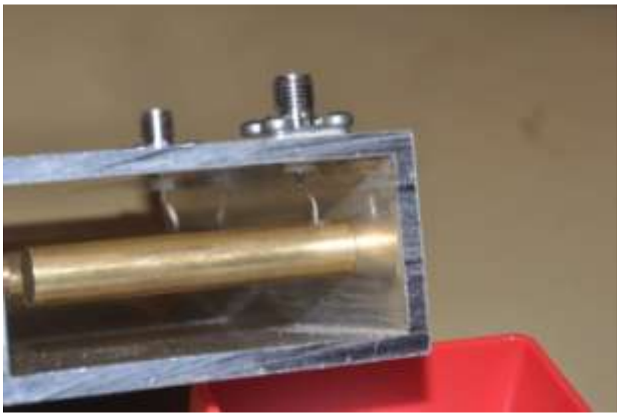
I flattened one side with a 40mm long cutter. Then you can easily mill the other side to length using the digital ruler.

Then we drill the holes for the resonance rods and set screws. For the attachment of the resonance rods I had 4mm brass bolts in mind (expensive, next time just steel). The set screws are M6 fine metric thread. This needs to be drilled with 5.5mm.

M4 thread must be tapped in the resonance rods so that they can be secured in the housing. How do you find the center of the bars? I mounted a rod in the chuck and manoeuvred the cross table with the machine clamp until the rod goes into the machine clamp. Then the rod is removed from the drill chuck and secured in the machine clamp and drilled. It's not super accurate. The best thing is to drill a hole with a lathe.

The hardest part was getting the rods to the right length. I miss a narrow machine clamp with which you can mill the right length exactly to size. Now I had to measure the length with a caliper and to know how much should be removed. Measurements with a caliper seem to be more inaccurate, because it bends, the object to be measured is not perfectly perpendicular between the jaws, etc.

The SMA connectors come above the outer bars on the ground side. I mounted them slightly off the edge. A short wire runs from the SMA connector to the rod.



Connecting the sma connector

Make a small hole in the resonance rod with a center point where the wire should come. Then drill a hole with a 0.5mm. Then you have to solder the wire in the rod. What I did is set my soldering iron to 450°C and insert it into the mounting hole. After about 5 minutes the stick was hot enough to melt the solder. With a burner it will go faster but I didn't feel like going into the cold garage. You can then easily solder the wire to the SMA connector.

The adjusting screws were a story. I wanted fine metric thread because the pitch is smaller. The advantage is that you can adjust more accurately and the adjusting screw is slightly tighter in the thin wall of 3 mm.

I've looked everywhere, but I couldn't find a supplier of bolts with fine metric M6 threads in their range. Then make it yourself.

M6x0.5 tap and insert

At Herman Buitelaar I bought a Völkel machine tap M6x0.50 and the corresponding cutting plate. Cutting the bolt from 6mm brass rod is no problem. Then saw off the required lengths (20mm). Before cutting, carefully secure the threaded rod in a vice. It might even be better to put it between two blocks of wood so as not to damage the screw thread.

I simply tap the screw thread in the aluminum housing with my cordless drill. Make sure you do the tapping at right angles.

The tuned 1420 MHz interdigital filter

Accuracy

If you see the results of the calculations accurate to the hundredth of a millimeter, that makes you suspect the worst if you are going to build a filter: it will have to be super accurate. How did it go for me:

- Distances of the bars is I think accurate to 2/100 mm.

- The height is wrong. This is 54mm instead of 52.78mm, this would be a frequency of 1339MHz.

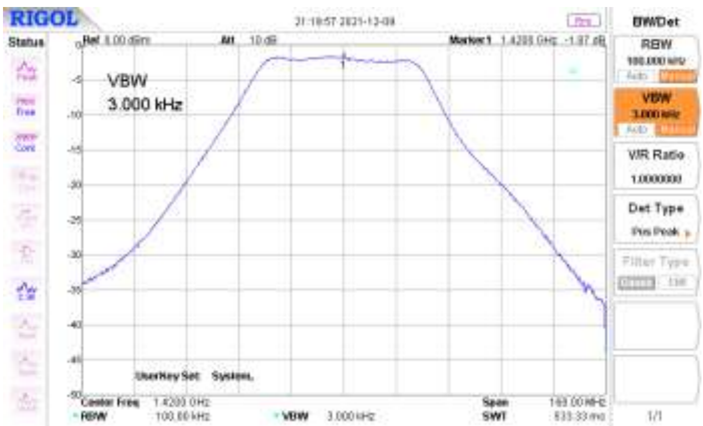
- The length of the outer bars is too short. Instead of 46.3mm they are 46.1mm.

Measurements

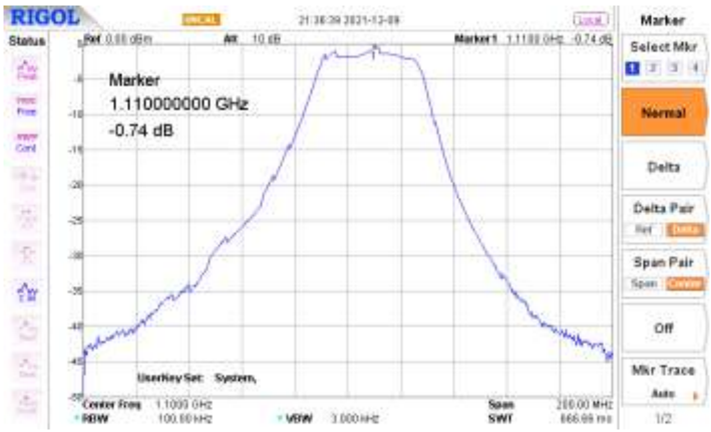
I have made several measurements:

- What frequency is the filter on when the adjusting screws are turned out to the side.
- What does the transmission curve look like at 1420 MHz.
- What is the lowest frequency at which we can adjust the filter.

Without any adjustment, with the adjusting screws on the side. The center frequency is 1460MHz.



Pass at 1420 MHz. The curve is steeper than in the simulation.



The filter can be adjusted up to 1110 MHz. That the curve is somewhat crumbly is because the spectrum analyzer was not "normalized". You must do this with every adjustment of frequency or bandwidth.

What does a filter with a depth of 19mm do?

What changes in the dimensions of the filter when the depth of the filter becomes 19mm instead of 24mm and we go from 8mm to 10mm in rod thickness?

According to the simulation, the filter is 96mm long, so a bit shorter than this filter. And the bars are 0.4 millimeters longer. So the filter becomes a bit more compact.

Improvements

There are some hardware improvements that can be made:

- Center the drill hole of the resonance rods with a lathe.

- Make a thin edge on the resonance rods on the side where they are screwed against the housing.

- Does silvering the resonance rods matter?

- A more accurate length of the resonance rods.

More important is what it functions electrically. The transmission curve should be as flat as possible within the bandwidth. And then you have the "group delay". At different frequencies you can have different phase shifts. I have no idea how to measure this or if it is a big problem.

The fact that we have some signal loss is not so important at this point in the reception chain. The antenna signal is already amplified 40dB at this point.

Conclusion

It has become quite a story about metalworking again. Is this our destiny if we want to go higher in frequency?

If you use an aluminium tube, the construction is relatively simple. The interdigital filter can be made in an afternoon, provided you have the right tools. A milling machine with a digital ruler has proved indispensable.

It is not necessary to work accurately to the hundredth of a millimeter because the filter can still be adjusted over a large range.

I still want to make brass nuts to secure the adjusting bolts. Practice will also have to show whether this filter does its job properly.

Metop in front of the main entrance at Eumetsat

Recording of Metop-A May 5, 2013

Metop-A 2006 - 2021

The Metop-A was launched on October 19, 2006 from a launch site in Baikanur / Kazakhstan, the first of a series of three satellites. The latest in this series is the Metop-C launched on November 7, 2018. The expected lifespan was 5 years. When the Metop-A was turned off last November, its lifespan was exceeded by more than 10 years.

The Metops fly in a sun-synchronous orbit. This means that they happen every day at about the same time for every location.

It was one of the first satellites to broadcast with QPSK modulation. This has presented our Working Group with major challenges. It was only in December 2016 that we were able to present a receiver that was suitable for the reception of QPSK signals.

In addition to direct reception, it was possible to receive the pictures via Eumetcast.

On November 15, the Metop-A started to move from its 817 km high orbit around the earth and to an altitude of 530 km. At that time, the HRPT is also switched off. Eventually, the Metop-A will burn up in the atmosphere. This is expected to be 25 more! take years.

The last signals were received on 30 November.

THE ESP32 MICRO-CONTROLLER

Job de Haas

When developing my rotor controller I switched from an Arduino based AVR to an ESP32 microcontroller. In two articles I want to explain why I chose this and what I have achieved with it. The second article will follow early next year. This article mainly deals with the properties of an ESP32 and the differences with the traditional Arduino with an AVR chip.

Just to give you a sneak peek: with my new controller I can now remotely control the rotor via WiFi with a test version of xtrack. In addition, I can also remotely load new firmware. Finally, the ESP32 is powerful enough to experiment with more advanced motor controller algorithms or even complete trajectory planning based on TLEs.

The Arduino

The Arduino microcontroller has become an indispensable part of our hobby projects. We can deploy them wherever we need small-scale automation. Especially after the arrival of miniature variants such as the Arduino Nano.

Originally, an Arduino was based on the AVR microcontroller. An 8-bit processor from the manufacturer Atmel with various useful features for embedded use. For our use these are in particular:

- Various digital input and output pins
- PWM output for motor control
- Interrupt handling on pin inputs for pulse counters
- UART, I2C and SPI communication

In addition to these hardware features, another strong feature is Arduino's software and development environment (IDE). This has resulted in a more or less standardized way of programming. This makes it possible to load and use code without (or with limited adjustments) on different variants of an Arduino board.

Based on the above ingredients, Rob Alblas (building on work by Harry Arends) has made a rotor control system for both stepper motors and DC motors. And both for Azimuth-Elevation and X-Y versions. Peter Smits has various variants of such rotors at his disposal and has tested them with the Arduino controller.

Why change?

The first reason to look at an alternative is the desire to use a wireless connection to send the commands. Until now, a data cable was always needed between the PC with the tracking program and the rotor. For example a USB cable or RS232. These only have a limited maximum length. For greater distances, further adjustment must be made with for example RS485. Or the wiring for motors and sensors should be extended and the controller placed next to the PC. Via WIFI (or possibly other wireless protocols) there is no need for such longer wiring (except for the antenna signal).

A second reason is the desire to also be able to load and update the firmware via the WIFI connection. Especially if a controller is built into an outside rotor, it is nice if you can easily test changes. Programming almost always requires a USB cable, so you have to open the controller outside and load new code into the Arduino with a laptop or similar. Wireless would greatly simplify this.

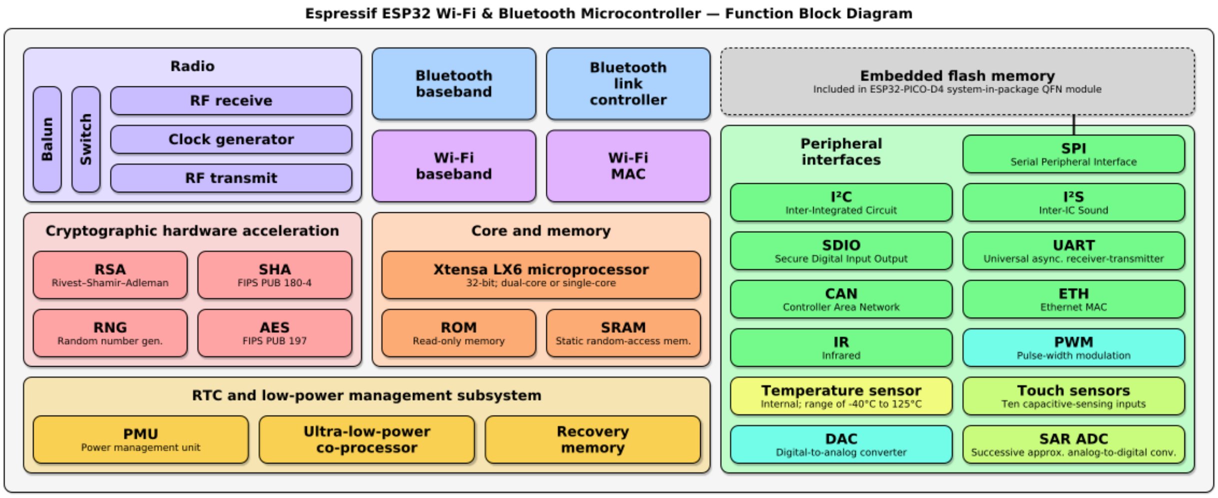
Wireless Arduino

When investigating the possibility of making an Arduino wireless, all kinds of "shields" initially appear that you can put on an Arduino board. The advantage is that you can continue to use the existing Arduino. However, the shield also needs pins and if they conflict with what you already had in use, you still need to make changes. Wifi-Shields also often cost an extra 15 euros; sometimes more than the Arduino.

An alternative are Arduino compatible boards with a different CPU that support built-in WIFI. Here are several of them:

- ESP8266 (eg WeMOS D1, NoceMCU)
- ESP32 (eg LOLIN D32)
- Cypress BCM43362/STM32 (eg Particle Photon)
- Atmel ATSAMW25 (eg Arduino MKR1000)

While this is by no means an exhaustive list of possibilities, I certainly haven't tried and compared them all. As is often the case, you choose something based on availability, price and what else you know about it at the time. The ESP8266 are the cheapest (sometimes only a few euros) while official Arduinos quickly cost over 25 euros. The ESP32 appealed to me because it has a 32-bit CPU and is therefore easier to program and yet is available for less than 10 euros.



Features ESP32

The ESP32 is made by the company Espressif [1] and is based on a so-called Xtensa CPU.[2] This is a relatively new architecture and therefore different from AVR (from Atmel) or the ARM CPUs. It is a so-called RISC processor that is relatively fast.

As mentioned, the ESP32 is primarily a processor with wireless communication capabilities (Wifi and Bluetooth). It lends itself well to projects where wireless communication is desired.

Another very nice feature of the ESP32 is the great flexibility in the use of the pins. Many functions can be used on a large part of the pins. There are 16 PWM channels that can be connected to 34 different GPIO pins. However, not all pins are available on every development board. The ESP32-DevKitC in Figs 2 and 3 is missing 4.

- Xtensa LX CPU (RISC, no ARM) 32-bit 160-240MHz
- 320KB RAM, 448KB ROM
- Peripherals:
  - 34 GPIO / 4 GPI (input only)
  - 18 Analog-to-Digital Converter (ADC) channels
  - 3 SPI interfaces
  - 3 UART interfaces
  - 2 I2C interfaces
  - 16 PWM output channels
  - 8 Counter modules
  - 2 Digital-to-Analog Converters (DAC)
  - 2 I2S interfaces
  - 10 Capacitive sensing GPIOs
- Wi-Fi
- Bluetooth
- Hall sensor
- SD/MMC i/f
- Ethernet MAC
- CAN bus

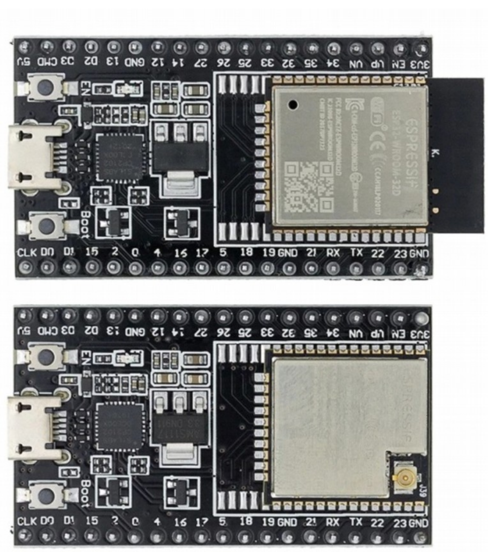


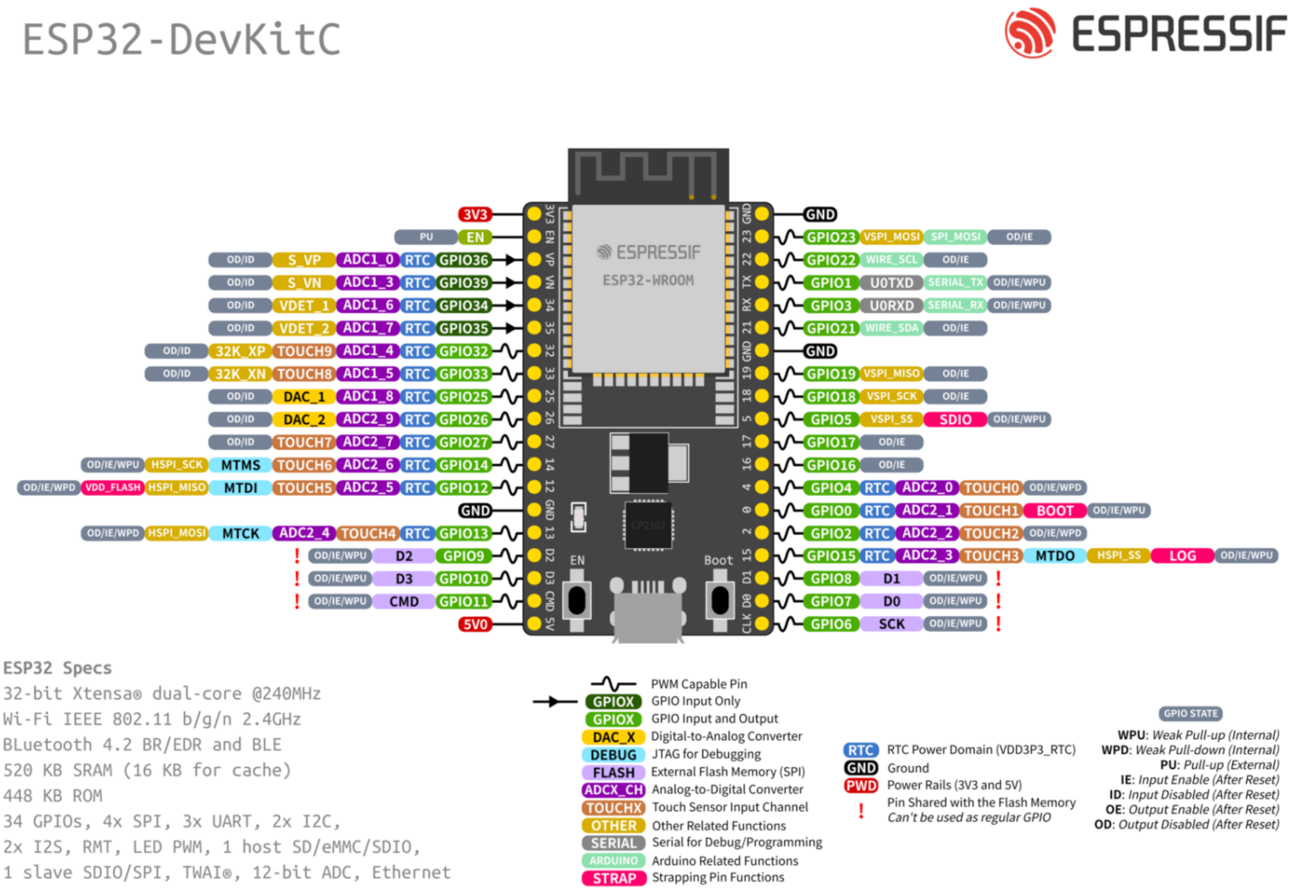
Fig 2. ESP32-DevKitC with PCB or External Antenna

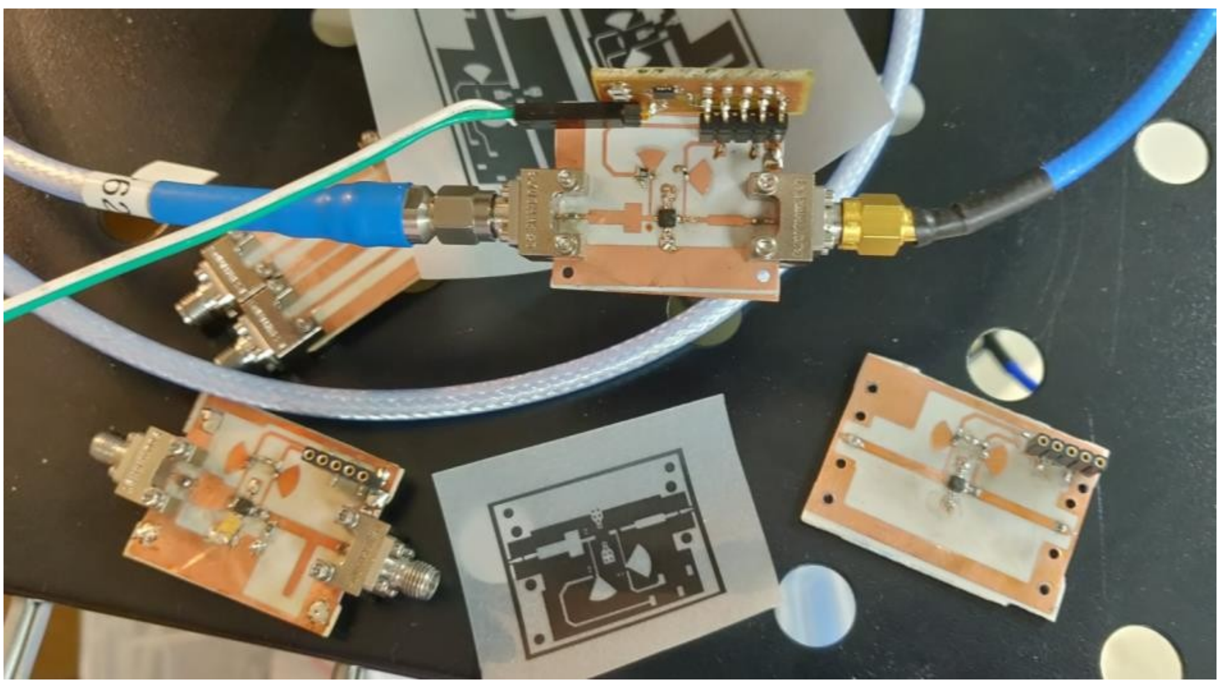
A final big advantage that I discovered when working with the ESP32 is the broad support with libraries to make use of all the bells and whistles. There are ready-to-use libraries to update the firmware remotely (eg .ElegantOTA) or to flexibly integrate the ESP32 into a WiFi network (ESP_WifiManager). The ESP32 can itself be its own Access Point or a client in an existing WiFi network. And you can choose that at startup. Finally I also found a library to read a quadrature pulse encoder (ESP32Encoder). I needed this for the encoders as I described in an earlier Kunstmaan [3]. This can be done by smart programming of the counter module, but the library takes all this difficult work off your hands.

For many examples of how to use the ESP32 I look at the website of Random Nerd Tutorials [4] and if I want to understand a little deeper how something works I can go to the website of Espressif itself where extensive detailed information can be found [5]

References

[1] Espressif ESP32
[2] Xtensa CPU
[3] Kunstmaan 2021-2:Magnetische encoders
[4] Random Nerd Tutorials ESP32
[5] ESP32 documentation



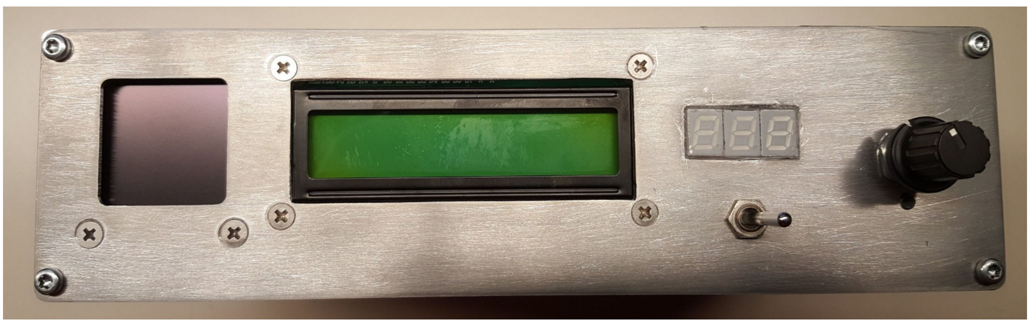


Experiments with an LNA for 8GHz. Due to unforeseen circumstances, unfortunately stopped for a while, but in the next Kunstmaan an article about designing and measuring

A case for the QPSK satellite receiver of the Werkgroep Kunstmanen.

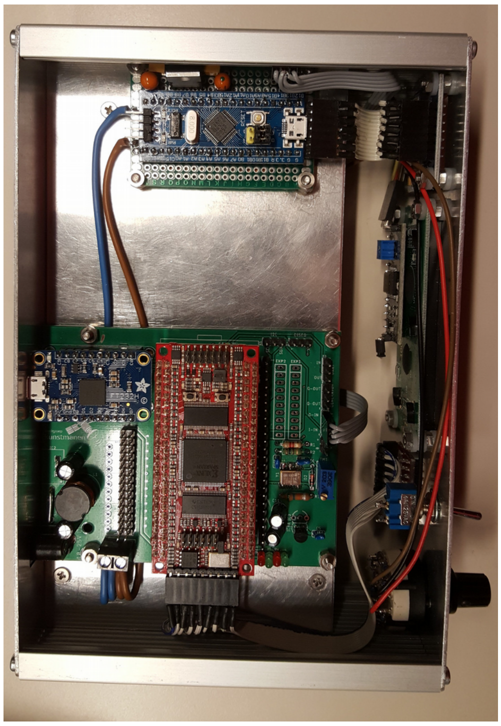
Rob Hollander

Probably, as one of the last members of our Werkgroep, I started to assemble the QPSK receiver. I had the advantage, that I could use the (probably) final versions of the PCB’s. My first advice is: Don’t start immediately with a mounting case for a new project. Forget this advice if you already did so.
I had looked at the constructions of the QPSK receiver of other members of our group. To my opinion, there was room for some improvement. Most cases were rather large in order to enable extensions and adjustments of the design without the need to make a new case. My second advice is: wait for the final design and collect all parts that have to fit in the case.
At first I mounted the parts onto the PCB’s (with the help of Ben for the SMD parts; I can’t see parts these anymore). I put a new version of the USB as a piggy-back on the Godil- unit, soldered the resistors onto the rotary switch, bought the displays (also for the constellation viewer), a ‘blue-pil’ STM32 board for the constellation viewer, in short, everything that had to fit in the case was on the table. For me, the challenge was to make a compact receiver. Via Ben I could get an aluminium profile with a width of 5,5cm for the sides of the case, defining the total height. I wanted as little as possible connections between PCB’s and the outside world (antenna cable, USB cable, 5V power). I mounted the PCB’s against the back of the case and used the existing connectors on the PCB’s to ‘peep’ through the back plate. The dimensions of the PCB’s and the room, needed for the rotary switch and the displays on the front defined the depth of the case. I ‘ve chosen 15 cm to be sure that there was ample room. The minimal width of the front is defined by the room needed for the displays and the rotary switch. A width of 20 cm is enough. Everything fitted in this 20 x 15 x 5,5 cm, however I had to mount the receiver in two stages on top of each other. Now I encountered the problem that I ignored my own advice two. Advice three: the aluminium profile could have been better 6,5 cm is stead of 5,5 cm. I had to change the 7-segment display connector on the Godil to a 90 degree version (I just bended the pins, which is possible only once).
Now I was sure that the dimensions were OK, I could go to the metal shop. I bought anodised aluminium plates, 1,5 mm thick, for the case and a not anodised plate for the mounting of the PCB’s (better electrical contact).
I used my milling machine for the drilling of the holes and the milling of the openings for the displays. Make a plan for these actions! With the precise displacements of the XY-table you can do all the machining in one round. Exchange the drilling head for the milling head without removing the work from the XY-table. Advice four: do the machining not at once; sleep on it!



Advice five: Look at the holes for the screws of the 2-line display and the hole for the display. They are not symmetric!
Advice six: are you right-handed, position the rotary switch at the right on the front. Left-handed people could better position the switch on the left to avoid blocking of the displays with your hand.
I have mounted the display of the constellation viewer 'upside down' in order to get a 'nicer' position on the front. Rob Alblas included an option in the program to show the text correctly in this 'upside-down' mode.
I made the aluminium profiles to the proper length with my milling machine as well.
After completion of the receiver it turned out that I had taken the depth of 15 cm much too large. I had enough profile the make a 13 cm deep case. So, I went to the metal shop for new plates. Front, back and mounting plate could be reused.
The PCB's can be approached easily for adjustments and re-programming. The whole construction can be dismounted easily.

Success, it was fun to do the project.



Top side

Bottom side

BREAKING NEWS ABOUT X-BAND RECEPTION

Arne van Belle

A few amateurs receive images from polar satellites on X-band 8 GHz. Jean-Luc Milette in Canada was one of the first and reported this in GEO Quarterly 61 [1]

But Jean-Luc uses a large prime focus dish antenne with diameter of 1.7 and later even 2.4 meter. But these dishes are made for 4 GHz TV satellite reception and don't work optimal on 8 GHz and hard to get in Europe. He tracks the satellite by hand, rather difficult because a dish this size has a tiny openings angle and catches a lot of wind. Hence hand tracking needs practice, good weather but often fails with high overhead passes.

Since September Jean Claude, a French HAM F1AIA shows on twitter that he successfully receives Feng Yun and Aqua on X-band using only a 80 cm offset dish (standard type that is used for satellite TV reception on 10-12 GHz).
He tracks by hand but using a 80 cm dish with larger beamwidth this is a lot easier. He uses an old surveyor tripod and SDR readout on a laptop to aim for maximum signal level. All images and photos can be seen on his Twitter account [2]

Fig. 1 80cm dish with feedhorn on tripod

He has built his low noise preamp form surplus LNB PCB's and modified an older type TV satellite LNB for down conversion. Signal is decoded and processed using a moderate HackRF SDR and a i5 2.5 GHz laptop with 16 GB ram.

Software HDSDR and/or SATdump is used to interface the HackRF SDR.
His complete setup fits in a Peugeot 206 and he is able to work without mains connection!

Jean Claude drives to a location that offers free sight at horizon and does manage to capture a X-band pass of Feng Yun from Morocco to Iceland ! (see fig. 2)

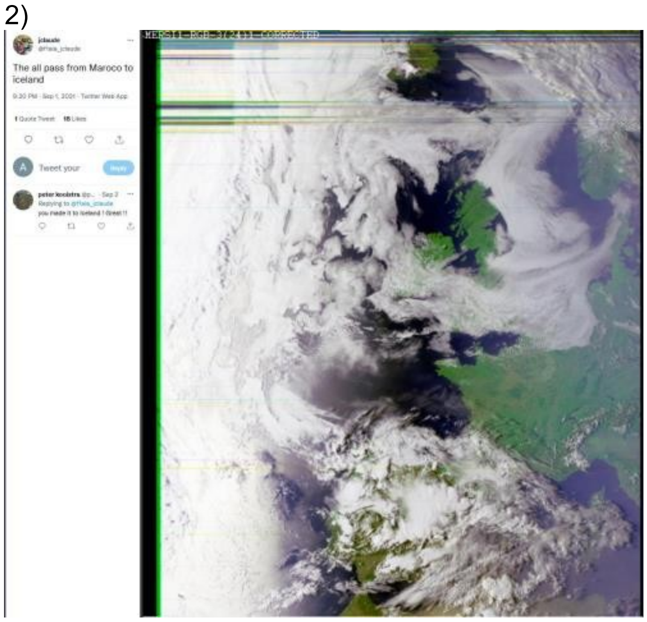


Fig. 2 Feng Yun pass received on X-band.

The feedhorn that Jean Claude uses consists of a conical part in front of a circular septum waveguide. This septum feed is very popular, it is built from a round tube with a stepped plate soldered inside. This stepped plate, called septum, converts the circular polarized signal onto a horizontal monopole without losses. There is a monopole for RHCP and opposite the plate is one for LHCP (Fig. 3.)

Fig. 3. Feedhorn with septum for LHCP and RHCP

As Low Noise Amplifier he build one from two Teflon PCB cutouts from a surplus TV satellite LNB. This LNB frontend is designed for 10.7 to 12.5 GHz so he used small copper foil patches in certain places to improve performance on 8 GHz. In later designs he replaced the dated FET with a better one for more gain and even lower noise figure. (Fig. 4.)

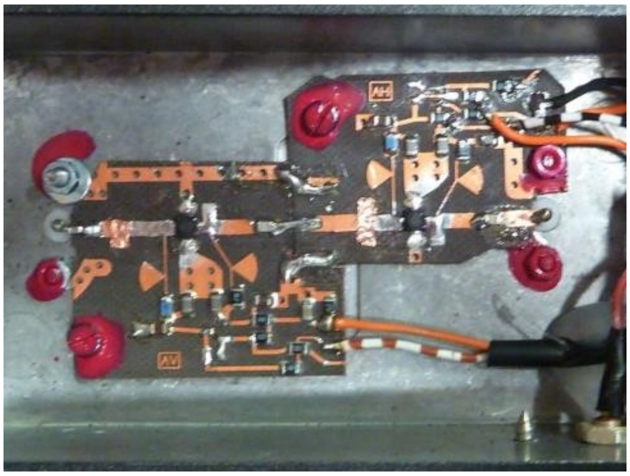


Fig. 4. LNA.

This feedhorn still fits in the standard 40 mm LNB clamp. The LNA is mounted close to the feed horn to limit cable losses (Fig 5).

Fig. 5. Feed and LNA mounting

At first he used a conventional downconverter setup composed of ADF oscillator, filter, amplifier and ring diode mixer, see fig. 6. Later on he uses the oscillator and mixer from an old type LNB.

In his most recent experiment he soldered a single stage LNA directly to the septum feedhorn to minimize connector and cable losses. Important is also that he omitted the input series capacitor here as these are known to cause noise.
This is standard practice in all TV satellite LNB's, The monopoles are concealed in the waveguide so the negative Gate voltage on the monopole is no issue here.

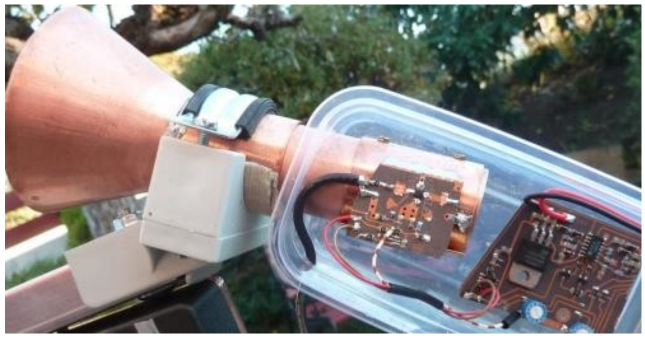


Fig. 7 Latest LNA feed setup

So Jean Claude has proven that you can receive X-band satellites using a standard 80 cm TV satellite offset dish and use surplus LNB parts to build your own LNA and downconverter !

Follow Jean Claude on twitter for his latest developments and images https://twitter.com/f1aia_jclaude

References

[1] http://www.geo-web.org.uk/quarterly/geoq61.pdf
[2] https://twitter.com/f1aia_jclaude

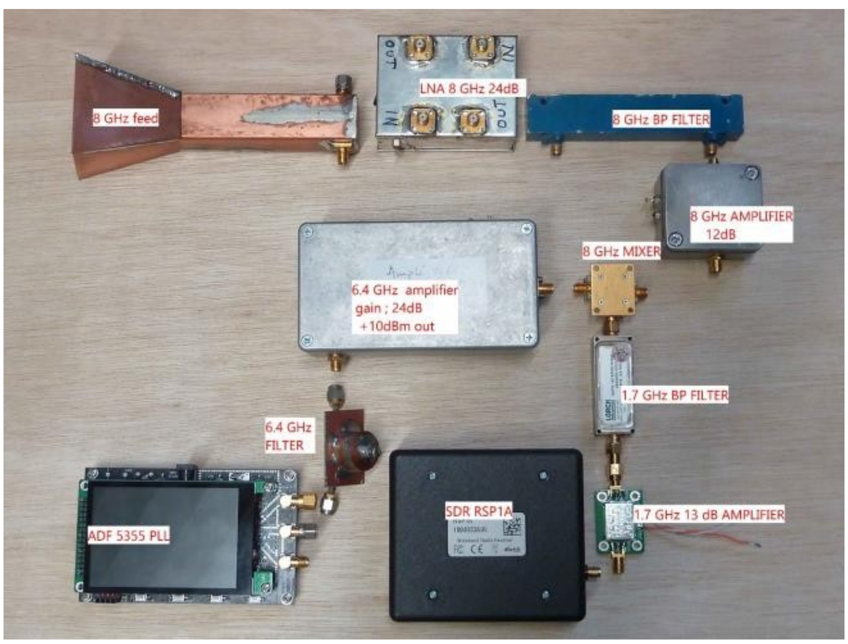


Fig. 6. Used setup at first

Report meeting November 13, 2013 in Nimeto

Remark
This report was written by your chairman because Rob was unable to attend. To improve the sound quality for our zoom members, we entered the room with a Jabra (a separate speaker-microphone combination) during the survey. Arne had also brought speakers on tripods and a microphone.

1 Opening
In total there are 11 attendees. Five more members participate via the zoom. We are back in the room made available to us by Nimeto. Restrictive corona measures also apply here.

2 Set agenda
No additions or changes

3 Administrative matters
Paul has indicated that he is retiring from his position as librarian. Since 2011, he has fulfilled the role of librarian with gusto. He took over this position from Herman Vijlbrief and Hans de Jong. In December 2013, the first "From the library" was published in which Paul manages to connect the contemporary world, electronics and our beautiful hobby with a joke. "From the Library" has come out 23 times. This year was a low point when, due to the renovation of the Nimeto, everything from the library had to be packed in moving boxes.
The chairman thanks Paul with the obligatory bottle of wine and a bunch of flowers.

Paul receives a bunch of flowers and a bottle of wine. Thank you for the many years of dedication to the Working Group.

4 Satellite status
Harrie is also present via Zoom and indicates that he can receive all 1700 MHz satellites.
Fred Jansen gives the status of the X-band satellites. The FengYun 3E is now in the commissioning phase. The Aqua and Terra are still available. All Metop's also broadcast in the X-band (Metop-A no longer). The data that is broadcast is the same as in the 1700MHz band. The Aura satellite broadcasts on 8160MHz.

5 Any other business
Hendrik showed various constructions. Including a worm gear. To make this, the tap (for tapping the screw thread) must be inserted into the lathe chuck.

Rob Hollander showed his neatly finished QPSK receiver. The receiver, HRPT decoder and constellation display are mounted in a small housing.

Wim Bravenboer showed a PCB with which a quadrifiliar antenna for the 1700 MHz can be built. The question is whether this is a suitable antenna. Only this as an antenna is too insensitive. It could be used as an illuminator for a parabolic antenna. The radiation diagram has a large angle, this must match the dish.

Peter Smits complimented Rob Alblas because the rotor control program works very well with DC and stepper motors.

Harm showed his "Art Moon" with which the transmitter was equipped with a helical antenna and the QPSK receiver with a patch antenna. The receiver actually locks. As a modulator, he used a PCB newly developed by the chairman.

Harry Arends asked if we can start on time. Of course we try this, but we have to rebuild / connect everything every time. It would also be useful to appoint a host so that the speaker only has to concentrate on the text.

Rob Alblas indicates that the code for the rotor control works well. It now also has a double calibration.

Peter Kuiper asks if there is a Chinese geostrative satellite. This is the FY2H or G. It hangs very low to the east. There is also the Elektro L2 with LHCP modulation. Problem is the signal.

Harrie van Deursen is present at a distance. He has his 1700 MHz installation working and can receive all NOAA, Metop's and FY's.

Fred Jansen has a much better reception with a wider tube (inner size 32 mm). Its illuminator is a Kumar feed with a septum baffle. Dish diameter is 150cm. Reception with a standard offset dish should be possible.

6 Closing

It is not yet known when the first meeting will be in the new year. The canteen will most likely be open again by then. The question is whether we still want to go there because we like the current locale.

Postscript: At the time of the meeting, the lockdown had not yet been announced. Keep an eye on your email / website if we can meet via zoom or physically.

Presentation

Your chairman gave a presentation on measurements on the 8GHz. I have tried to make a very educational video of John Shive of Bell Telephone Laboratories from 1959 entitled "Similarities in wave behavior".

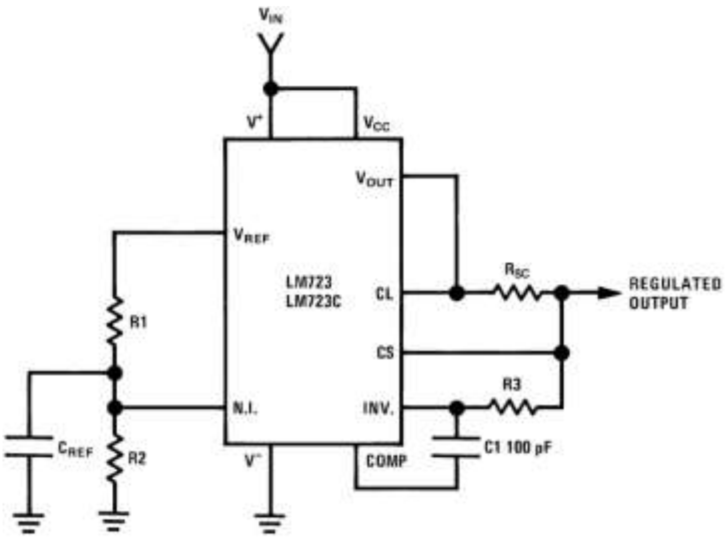
https://www.youtube.com/watch?v=DovunOxlY1k&t=152s

The content of this presentation is elaborated in the article “Slotted lines” in this Kunstmaan.

UKW-Berichte

The summary of the UKW-message comes from me this time because Paul has resigned from his work as a librarian. In the third edition are four main articles that I would like to briefly describe. You also have the "Fundstelle Internet" section where interesting websites are discussed. You can quickly navigate to it with the QR code. Point the camera of your smartphone at the code and you're on the website where you need to go. Maybe we should experiment with it too.
Our association has a subscription to the UKW messages. Please indicate whether you would like this subscription. The latest editions are available for inspection at meetings on the library table; if this is not for you due to the current circumstances can be reached, you can contact the chairman.

Bernd Kaa does noise measurements on modern low-noise voltage regulators. In addition, he includes the low-noise LM723 in the comparison. The following voltage regulators are included in the comparison: LT3045-1, NCP163 / NCP167, TPS7A92 and the LF33CZ. The measurements were performed with a 60dB low-noise amplifier (design by Bernd Kaa) and the AudioMeter by Prof. dr. Thomas Bayer DG8SAQ. Best in the test is the LT3045-1 which has an RMS noise of 0.55uV. The LM723 is slightly higher at 1.29uV. The "standard" 3V3 regulator LF33CZ has an RMS noise of 82uV.



The LM723 is still doing well. 1967! it was marketed by Fairchild.

The second article is by Wolfgang Schneider. He describes a 2 Watt amplifier for the 9 cm band (3.4 GHz). With only one chip, the TC3341 from Transcom, a gain of 27dB is achieved. He has used a double-sided print of Rogers RT4350B, see also the front plate of the UKW message.

Heiko Leutbecher compares two MMICs for the 70cm band with a maximum power of 1 Watt. It concerns the TQP7M9103 and the HMC453T89.

Jochen Jirman describes the design of low-pass filters to be used in an output stage of transmitters to suppress harmonics. He discusses the theory: what does an ideal filter look like and how does it work in practice. Also attention for winding coils yourself and which capacitors are suitable. He uses QUCS257 and LTSpice for the simulations. By the way, I couldn't find QUCS257, but I did find QUCS and QucsStudio. With 23 pages it is a large and complete article.

satellietstatus

Arne van Belle, December 22, 2021

POLAR	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	no	?	7820	
FengYun 3E	no	?	7860	38.4M QPSK
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(137.900 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)	HRIT/GVAR (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, 7500 MHz & via Eumetcast
Elektro-L3	1691 LRIT	?	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 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	1697 LRIT	1681 HRIT	7500 MHz X-band
SYRACUSE 3B	Test signal	7705MHz LHCP	Only for test signals 5,2W

- GOES-13 was renamed to EWS-G1. GVAR mode can be decoded using SDR and a dish antenna of minimal 180cm (look for @ZSztanga on the web).
- Meteor M N2-3 launch date is delayed.
- Arktika-M1 uses a Molnyia orbit and images have been received on 7865 MHz.
- GOES-T launch (GOES 18 after successful launch) is now scheduled for January 8, 2022.
- Since 23 September Meteor M-N2 is transmitting LRPT images on 137.100 MHz again !
- Aqua is low on fuel and will leave the afternoon orbit (A-train) in January 2022 but will be continuing at lower orbit until 2026 !
- The second transponder used for EUMETCast Europe High Volume Service 2 will migrate from 11388 MHz H to 11263 MHz V in 2022.

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