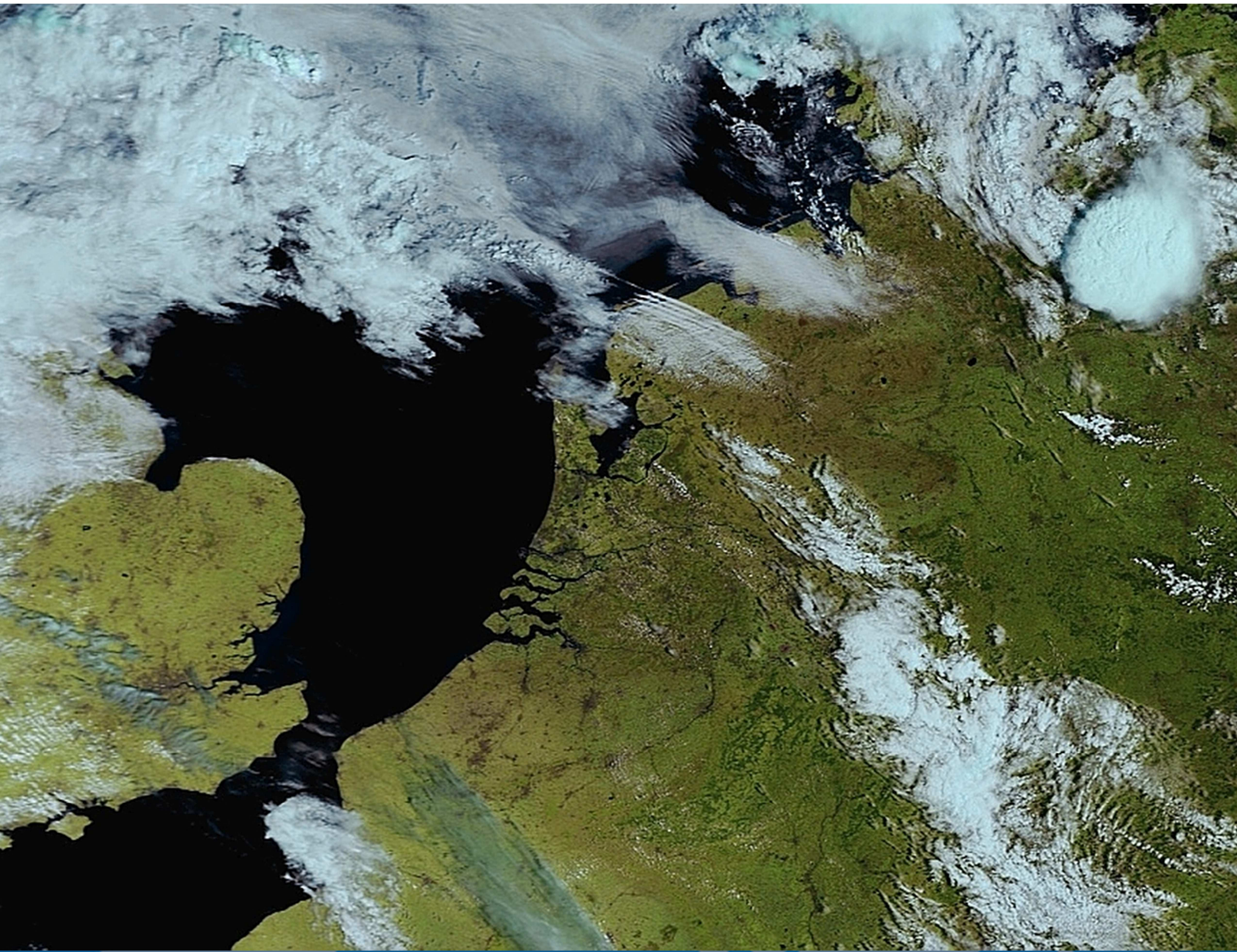
DE KUNSTMAAN

Juni 2020 – 47e jaargang nr. 2
Uitgave van de Werkgroep Kunstmanen



In dit nummer o.a.

Geo referenties met satelliet data
Versterker met de Gali-2
Nauwkeurige satelliet tracking
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, 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 2018, 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

Content

Photo front page:

NOAA18, record of June 13 by Peter Kooistra using home-made antenna, and using SDR and XSD software

Preface

These are special times. After the poorly attended meeting on March 14, the Netherlands entered a lock-down . Because of this, it was not possible to let the GMM continue on May 9.

We had the meeting as a “ zoom meeting ” for the first time! For the first time was the Netherlands (and the rest of the world) from home to work and everyone learned quickly Please, Skype , Teams, etc. After a short practice session came anyway so ' n 12 members in the Zoom meeting . It is very nice that Fred from Vietnam and Peter from Curacao were present.

Such a zoom meeting is not ideal, because you want to be able to show things, consult one on one with someone. But it is better than doing nothing. The big advantage is that you can reach members who are not able to come to Utrecht. We need to see how we can fit this into a regular meeting.

The virtual May meeting

For me personally, working from home means a time saving of more than 10 hours per week. Time to better spent for the hobby. So I got busy with the 8 GHz down converter. In this Kunstmaan my experiences to run a Gali-2 on the 8 GHz. It is difficult, however, self-construction becomes a major challenge on these types of frequencies.

Circuit board manufacturer Isola was kind enough to donate a 40 x 50 cm circuit board to the Werkgroep. If there are members who are interested in a piece of circuit board let us know. The printed circuit board IS680, suitable up to 75 GHz, has a dielectric constant of 3.45 with a thickness of 0.508mm and has no light-sensitive layer.

Circuit board, enough to build something for the 8 GHz

Visit Eumetsat

Unsurprisingly, we had to cancel the visit to Eumetsat. Both sides expressed the wish to have the visit take place at a later time, but this will not be before summer 2021. Hopefully the corona problems will be over.

De Kunstmaan

Fred writes his last column about his experiences with the reception of weather satellites in Vietnam. It has been more than 9 years since we organized a farewell dinner for Fred. It feels like a few years ago, it seems like time is moving faster and faster. After 36 articles for the Kunstmaan, Fred puts an end to it. He concludes with the remark ".... clumsy ....", this does not do justice to his very readable articles. From this place I want to thank you for your nice contributions and we hope to receive something from you a little bit in the future. Incidentally, if you can receive 11 GHz television satellites, then 8 GHz also succeeds ....

Fred Jansen wrote an article about correcting the bow tie effect which can arise if you "just" place the scan lines next to each other. Very nice article, we are curious about the sequel ...

Paul went through the UKW report for us . Hopefully we can take this up in September.

Rob also writes about adjustments in xtrack to increase the accuracy of the satellite orbit calculation. The new version takes into account , among other things, the flattening of the earth.

These accurate calculations are of no use to you if you do not have a good rotor. During the previous meeting we discussed extensively about rotors . In this Kunstmaan an article about everything that has been discussed, expanded with the experiences of Harrie and Arne, among others .

Peter Smits has built a rotor himself, including Smolka motors. Maybe we will read more about this in a next Kunstmaan.

At the time of this writing, it is not yet known when the September meeting / ALV will take place. According to the rules (at the moment), a meeting can take place, but we must be comfortable with it.

It remains for me to wish everyone a lot of reading pleasure at this Kunstmaan, a good summer holiday and stay healthy!

Weather satellites in Vietnam (36) Fred van den Bosch

Summary
My experiences with weather satellites etc. in Vietnam.

General
Exactly nine years have been completed with this version. And this is the (provisional?) latest version. The reason is simple: I don't know much more to tell. I think it's already very clever of myself - and especially of everyone who helped me with that - that I managed to make it to 1.7 GHz. I never dared to dream that before.

The beginning
A similar article [1] about crystal radio (foxhole radio) in a youth magazine was the beginning of the electronics hobby for me. It must have been around my tenth birthday. No, I never built such a receiver (with razor-sharp tuning). The cost of parts far exceeded my pocket money (ehh, what pocket money) at that time. A few years later it really started with two Philips building boxes for a receiver and an amplifier, both with tubes.

And tubes turned out to appeal to me: they got nice and warm, spread a nice glow and could tolerate some overload if you did something wrong again (as long as you didn't put the anode voltage on the filaments). For me troubleshooting was also relatively easy. Even troubleshooting U-tube receivers survived (the well-known Driehuis-Westerveld circuit, named to a Dutch graveyard).

At that time I also built quite a few things: short wave receivers, tube voltmeter, signal tracker, amplifiers, even a simple scoop. My limit for receivers was about 30 MHz. Above that, I had a bit of trouble and wasn't really that interesting to experience. At a TV store in the neighborhood I was allowed to take some old TV's out of the garden (first poured the water out) and a series of loose tubes, which were lying on a pile next to it. I actually got a few of them working again, so I had my own TV very cheaply.

The sequel
That was a lot less successful. The era of transistors and later ICs began. I did build a few circuits with transistors, but if something went wrong I had a huge problem. Finding faults and especially fixing them didn't go very well for me. And the hobby watered down...

Weather satellites
... and only began to live again when Radio Electronica came up with the famous series by Jansen en Schimmel about the reception of weather satellites. And yes, with tubes! A modified BC-624 as converter and a BC-603 as rear seat. I already had a working BC-603. A BC-624 was also quickly found. Enough dumps in and around Rotterdam. And then the for me almost physical limit of 30 MHz played up again. I couldn't get the converter to work. In the end, a transistor converter was tuned by a colleague. After that I also worked on an image drum and glow modulator, more than a few sync lines I never got on paper.

MSG
When I once visited Wim van Gaalen somewhere in the far north after a consultancy day in Friesland and saw 12 globules building up at once in MSG manager there, I really wanted to do the same. But, help, 12 GHz. But when complete receivers became available for this band, I took this leap into the deep end as well. At the back of the house I placed a dish on a pole that could just look over the house and with adjustment help from Arne I received MSG. Unbelievable!

HRPT

Again "scary", 1.7 GHz. And with additional complications: another receiver and a dish. Anyway, that story is known from the past 35 episodes. Because APT and weather station are automated, I only have to start HRPT or QPSK manually every now and then. Well, I can't fill an article with that.

Future
I will keep a close eye on the developments around the rotor. That's the weak point here. 8 GHz I don't even think about. You mustn't defy fate. Of course I'll keep up to date, but do it myself? No way.

If there are any new developments, I'll be sure to report them. For the rest, I thank everyone who read my stuff over and over again. I hope that some of them have had some use for it as well.

References, See website
[1] Bizarre labs, Crystal radio

Using geo-referenced satellite data

“Bow-tie” corrections

Introduction

In order to use self received weather satellite data it often is necessary to correct the data for instrumental effects or to provide geo-references to the data in order to compare with maps and coastline data as well as to combine with other satellite data or photo’s.

Geo-referencing

This project started with processing HRPT-data received from weather satellites transmitting in the L-band (NOAA, Metop, FengYun, Meteor). The primary objective was to produce (false) colour pictures as well as making it possible to combine data from multiple weather satellite passes. This can be achieved in different ways, but one of the more obvious ones is to use geo-referencing – essentially providing a per pixel geographic location. In order to achieve this an accurate timestamp per scanline is required. This is combined with a TLE (Two-Line Elements) based accurate orbit prediction of the satellite (better than 1 km required for L-band data, and better than 250 m for X-band satellite data). Especially the requirement to have an accurate and valid timestamp creates quite stringent requirements on the quality of the data received as the average timestamp contains a lot of bits and thus vulnerable to inadequate reception quality.

The first step in processing the data received is to sort the timestamps and filter out data with unsorted and/or otherwise wrong timestamps.

The connection to the geo-location of an image pixel is created using:

- Time
- Position in orbit at this time
- Direction of the satellite velocity at this time
- Scan angle per pixel

This is all combined, and by using some high school mathematics to calculate the intersection of the WGS84 ellipsoid (describing the shape of the Earth) and the plane containing the satellite image scan line. This plane is mathematically defined by the satellite velocity vector, which is orthogonal to this plane, and the fact that it needs to contain the satellite’s current position. Especially the assumption to use the velocity vector to define the plane containing the image scan line is one which, in a subtle way, appears to be not quite correct for all weather satellites – however, you can work around this problem in a way that later enabled the implementation of the so-called Bow-tie correction.

The implementation of these equations in software is reasonably complex and a computationally intensive task requiring lots of CPU time. In principle the starting point for the calculations is the sub-satellite point. This is the place on Earth (longitude, latitude) where at the reference time the satellite is located exactly at the zenith. Starting from that location one of the axes is traversed in small steps and the other two coordinates are derived from the aforementioned equations – this way you slowly ‘walk along’ the line on the Earth’s surface as scanned by the satellite. Every time the distance traversed (or rather the angle as seen from the satellite when compared with the known angular pixel size) is an exact multiple of the size of 1 pixel these values are stored and this way to boundaries of all pixels are calculated.

With this information all observed pixels can be placed onto a projection of the Earth's surface and borders, boundaries and latitude/longitude grids can be added (Fig. 1).

Fig. 1. Image derived from a Metop-B satellite pass on 7 Februari 2020 at 08:43 UT.

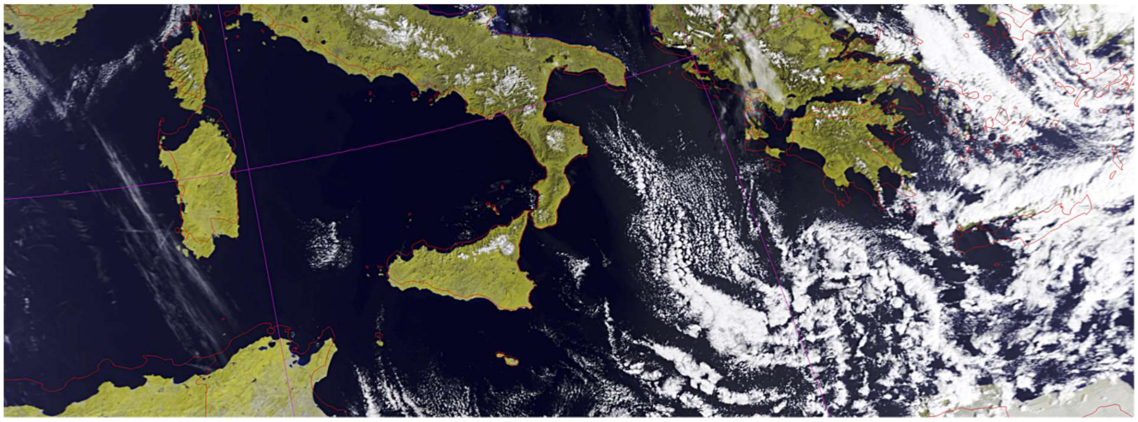
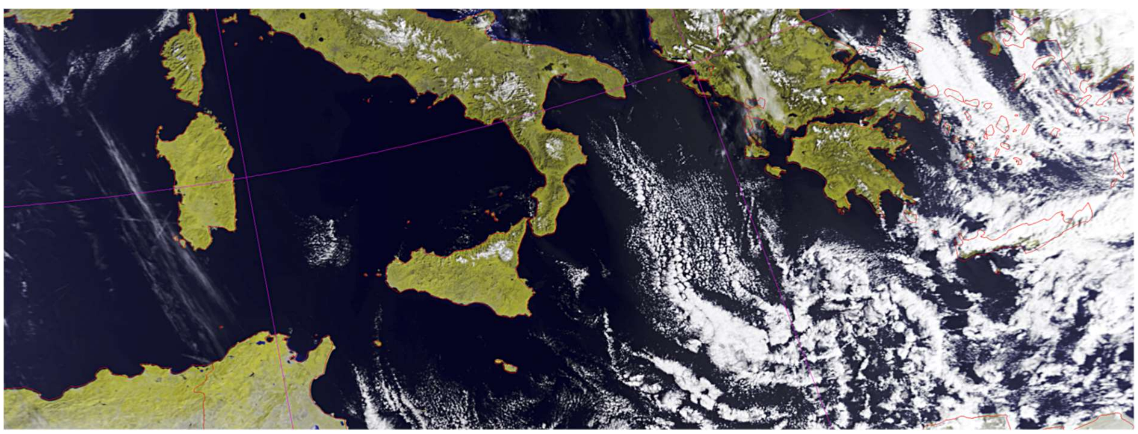


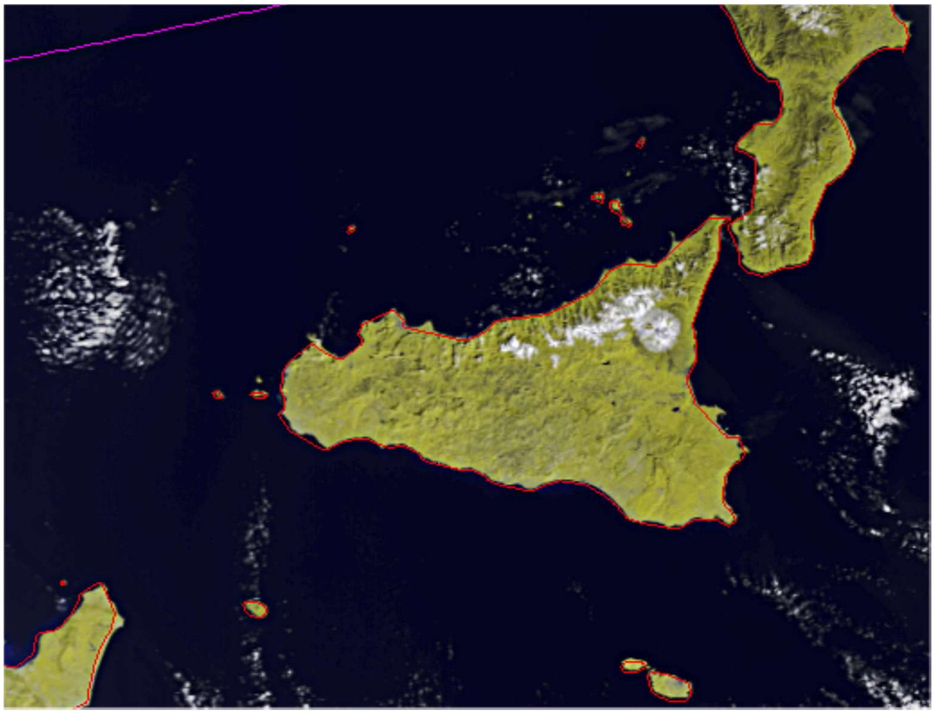
Fig. 2. The same Metop-B image but with the scanline direction rotated by -2.9 degrees around the vector from satellite to sub-satellite point.



From this image it is immediately clear that the borders drawn are at the completely wrong position and only are correct in the middle of a scanline. This led to a lengthy search for a coding error and the idea behind it, but once I realised this effect is not present in the data received from the FengYun and NOAA satellites but only in the data received from the Metop satellites, it was clear that the method and the code in principle worked OK. On close inspection of figure 1 one can see that on the left side of the image the borders are too high and on the right side of the image too low. This suggests a slight rotation of the scan direction of the camera around the imaginary axis from the satellite to the sub-satellite point. This was included into the geo-projection algorithm, by rotating the satellite's velocity vector – which defines the intersection of the scan plane and the Earth – around this imaginary axis. The result shown in figure 2 and the detailed zoom in figure 3 clearly shows this works quite well[1].

[1] It is important to remember that the country boundaries come from separate files and are independently placed on the polar-stereographically projected image, thus they always stay at the same location, independently from the rotation used.

Fig. 3. Zoom of the Metop-B image of the region around Sicily. The improved alignment of the borders/boundaries with the satellite image is clearly visible.



The AQUA MODIS instrument

While the APT and HRPT instruments only scan the Earth 1 line at a time by using a detector looking at Earth through a mirror at a 45 degree inclined angle, the NOAA AQUA and Terra satellites (which transmit in X-band around 8 GHz) do this with up to 40 lines at a time (for the 250 m/pixel bands, less lines for the other bands). Figure 4, taken from the AQUA telemetry manual, illustrates this principle. As a result of the optical implementation of this principle the scanlines fan out towards the edge of the scan (the pixels get bigger in size in 2 directions) and the same place on Earth is observed multiple times over subsequent rotations of the scanning mirror. Consequently, if you create an image by just putting the scanlines next to each other, you get a very confusing picture (Fig. 5). This is called the Bow-Tie effect, after the shape of the curvature of the scan lines. In this image one can also clearly see the striping and banding structure caused by the way the camera works with 40 detectors in parallel – also this has to be corrected in software later.

The curvature of the scanline towards the edge of the image is strongest for the outer detectors (for 250 m/pixel detectors 1 and 40) and gradually reduced towards the middle detectors (detectors 20 and 21) to almost zero. This requires an image correction that makes use of which detector is used for which scanline in the MODIS data. I quickly realised that the corrections necessary to get rid of the Bow-Tie effect are essentially the same as the scan line rotation technique I developed for Metop (see above), with the difference that the Bow-Tie correction required a slightly increasing scan angle rotation per scan line (see also Fig. 6). The effect also was required to be symmetrical around the center of a scan line. Through experimenting with the implementation of these corrections I quickly found out that a linear increase of the Bow-Tie correction angle per scan line, starting with a minimum in the center of the scan line to a maximum at the edge did not work very well and only gave satisfying results for a limited part of the scan line. An experiment, using a non-linear increase of the rotation angle from the middle towards the edge, worked much better.

Fig. 4. Figure taken from the AQUA telemetry manual where the simultaneous readout of multiple scanlines (in multiple wavelength bands) is illustrated.

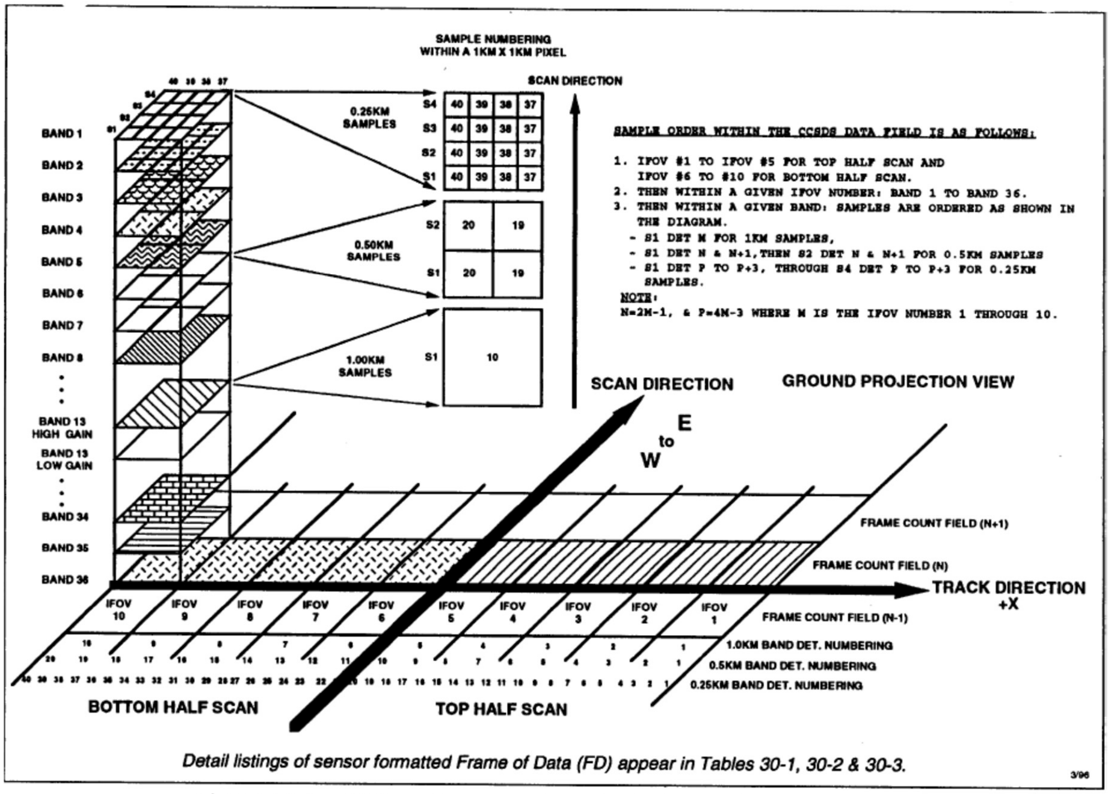


Figure 30-9. MODIS FPA Sensors Formatted Frame of Data Structure

Fig. 5. Direct scan line based image from the MODIS instrument on AQUA. The repeated presence of the same imaged area near the edge of the image is clearly visible in this zoomed area around Long Island. Telemetry data courtesy of J.-L. Millette (Twitter: @LucMillette).

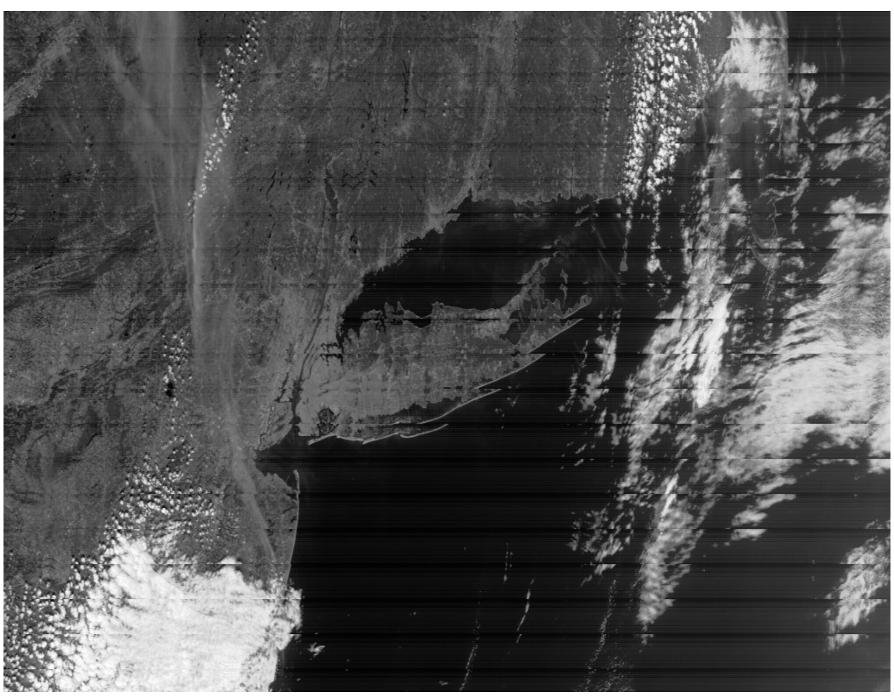
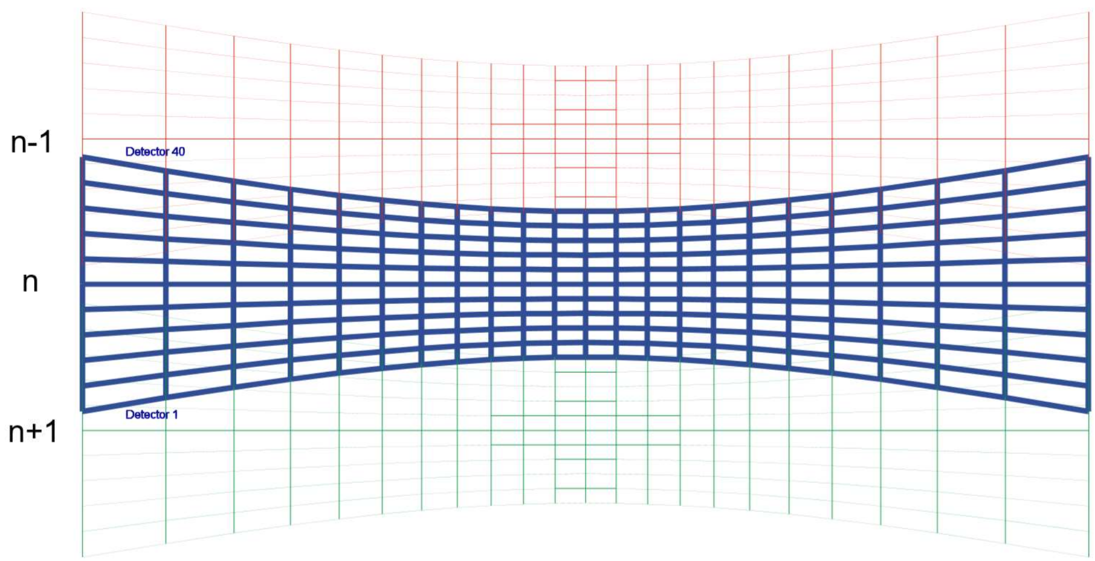


Fig. 6. Explanation of the Bow-Tie effect over successive rotations of the scanning mirror (Source: DLR). The detector numbering for the case of 40 detectors (Band 1 and 2 – 250 m per pixel) is indicated.



Bow-Tie correctie: an implementation

The final Bow-Tie correction used a rotation correction with a minimum of 0 degrees in the middle of the scan line, to a maximum of 0.42 degrees at the edge, with the maximum linearly increasing from zero to this value from detector 21 to 40 and from detector 20 to 1. Within a scan line I use a relative position parameter (in FORTRAN notation):

```
rpos = abs((dble(2 * k) / dble(nsat_pix)) - 1.0D0)
```

where nsat_pix is the number of pixels per scan line and k runs from 1 to nsat_pix. The local rotation angle is calculated using a gamma-like correction where aqmtheta1 is the value for the angle in the middle of the scanline and aqmtheta2 the value at the edge. The value of the rotation angle for an individual pixel can then be derived from:

```
aqmtheta1 + (aqmtheta2 – aqmtheta1) * (rpos ** (1./gamma) )
```

with rpos from the formula above and gamma=1.6. Results obtained using these formulas in the Bow-Tie correction are shown in figure 7.

This correction has been implemented in my software, available on GitHub:

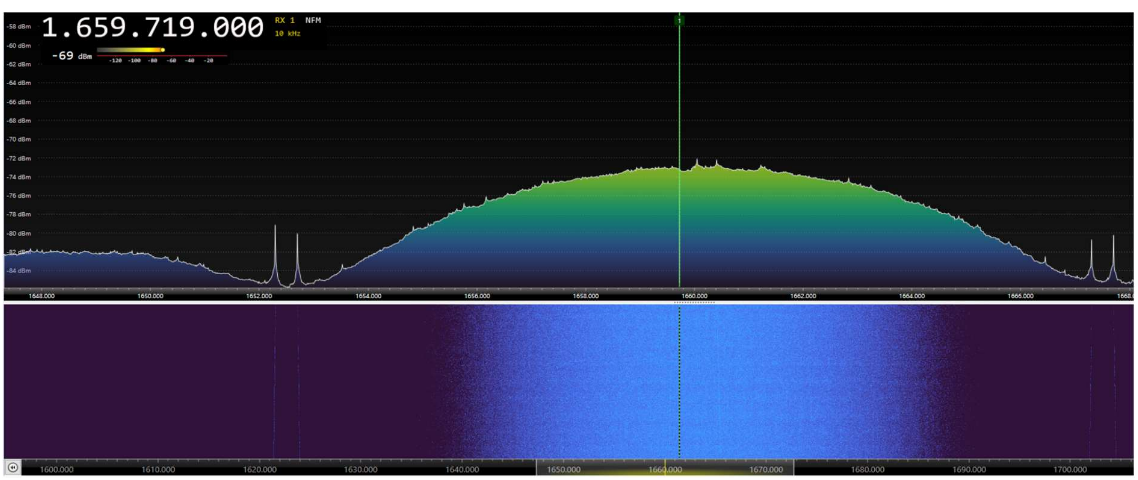
https://github.com/rocketscientist-fred/weathersat

When geo-referencing is not required the Bow-Tie correction can be implemented in a similar way for a scanline by scanline organized image. This has the advantage that removing the calculation of latitude/longitude per pixel greatly reduces the computing time needed.

I intend to implement this in my own code, together with the necessary colour corrections to take care of the atmospheric effects caused by Rayleigh scattering and the solar illumination angle of Earth and the atmosphere. This unfortunately requires quite some work and at the moment I am focusing on trying to receive the X-band weather satellite data myself (Fig. 8).

Fig. 7. True-colour image using the Bow-Tie correction and overlaid with land-water boundaries – the image covers the same area as figure 5. The change in aspect ratio of the image (when compared to figure 5) is caused by the removal of repeated observations of the same area on Earth. The green-blue hue of the image is (amongst others) caused by light scattering in the Earth's atmosphere. Central Park can be clearly seen in the image. Telemetry data courtesy of J.-L. Millette (Twitter: @LucMillette).

Fig 8. AQUA signal received using my own signal chain using a feed built by Fons Buitelaar (Twitter: @pa4fb)



Accuracy of satellite tracking software

In this year's KM No. 1, Ben described calculating a satellite orbit using a program for Scilab. When compared with the results of xtrack, the results turned out to be quite different. Xtrack is good enough if you do not have to aim too accurately at an approaching polar satellite, as is the case with the satellites on the 1.7 GHz band, but for 8 GHz the deviation seems to be too great.

In Ben's story, xtrack, wxtrack (by David Taylor) and Scilab are compared; results of wxtrack and Scilab match well, but my xtrack gave some more deviations.

I made xtrack a long time ago (20 years or so) based on an existing basic program for the calculation part. So that is apparently not so accurate. Time to tackle this xtrack-problem.

Available codes, structure

For the calculation of satellite paths often the so-called SGP4 algorithm (Simplified General Perturbation Version 4) is used. Parameters in this algorithm are available in the " two-line element mean" (TLE) files, for weather satellites 'weather.txt'. (See [1]) On the Internet you can find several codes that all amount to the same thing. I used the codes on the " Project Pluto " website [2] . This code is written in C / C ++ and can therefore easily be placed in xtrack (written in C).

The function "SGP4" determines the position of the satellite in a so-called "True Equator Mean Equinox coordinate system". This is a coordinate system which is fixed relative to the "stars". To determine the position on Earth, the rotation of that Earth must be calculated and combined with the SGP4 calculated data. The position can then be determined from this at a specific time on Earth. For this I have used codes that can be found on the Celestrak website [3] . Here you can also find an explanation of the coordinate system.

Finally, by means of the location where it is located, the elevation and azimut can be determined. For an X/Y-system, the desired angles for the X and Y rotor can be calculated from elevation and azimuth.

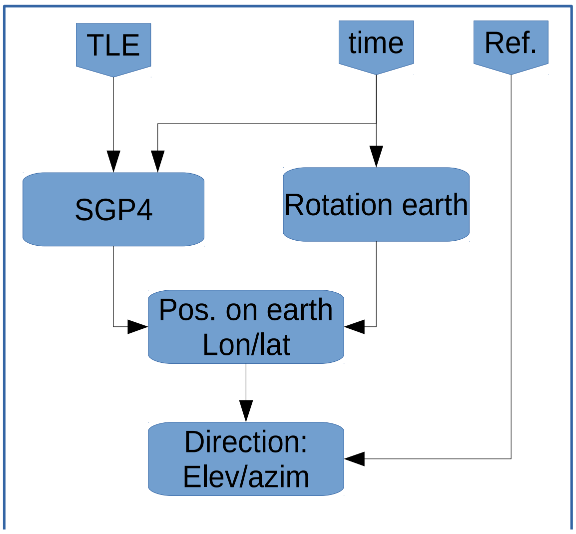


Fig. 1. Overview how the elevation / azimut is calculated from Kepler-data (TLE), time and position of the observer.

Comparison

In xtrack I added the improved code and made a comparison between the old and new xtrack on the one hand and the results of the Scilab code on the other. Using Scilab as a reference. For Scilab I have adapted the code Ben used, in such a case that a whole passage of a satellite can be calculated and written to a file. I used 2 passages of NOAA18: a high passage (approx. 70 degrees elevation) and a low one (approx. 25 degrees).

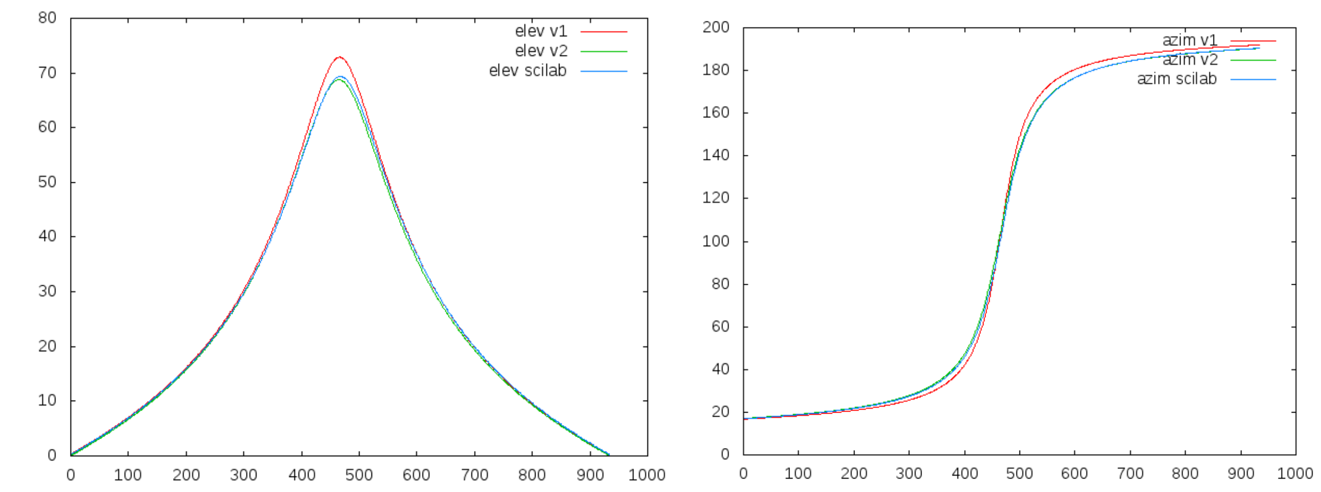


Fig. 2 a, b. Course of elevation and azimuth for xtrack version v1, v2 and scilab

In the figures above, elevation and azimuth are shown for the old version v1, the new v2 and the Scilab calculation. With some effort, it can be seen that v2 and scilab match well, while v1 differs slightly. This can be better seen by plotting the difference:

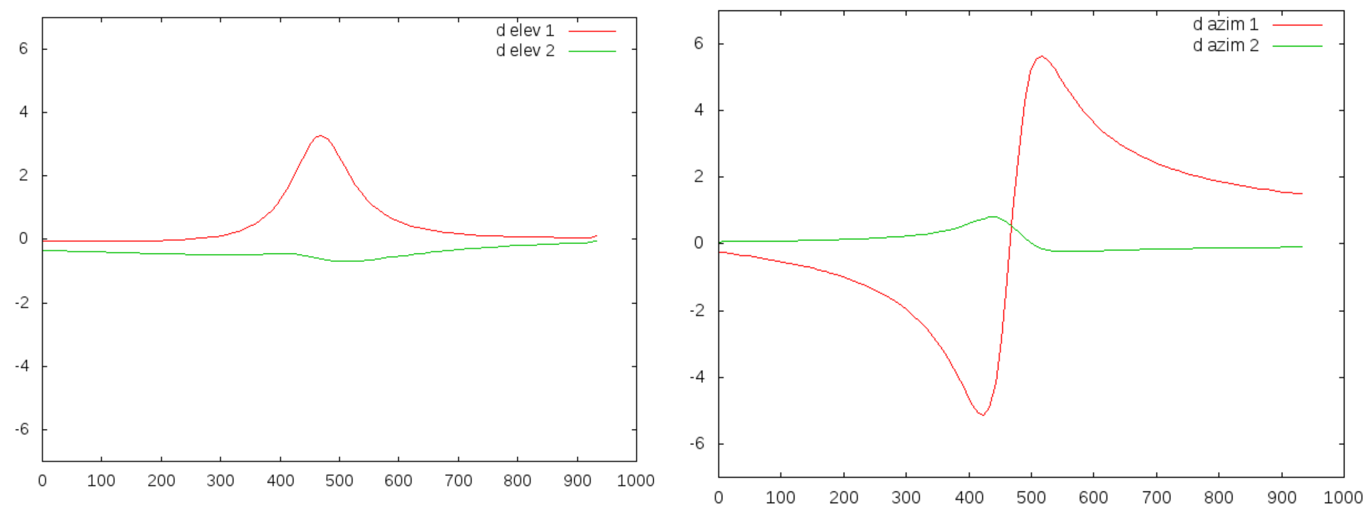


Fig. 3 a, b. Difference (error) of elevation and azimuth for xtrack v1 and v2 compared to Scilab results

In numbers, the maximum deviations from scilab are:

- v1: Elevation 3.6 degrees, azimt 7.6 degrees
- v2: elevation 1.3 degrees, azimuth 3.4 degrees

For a low pass, the results are:

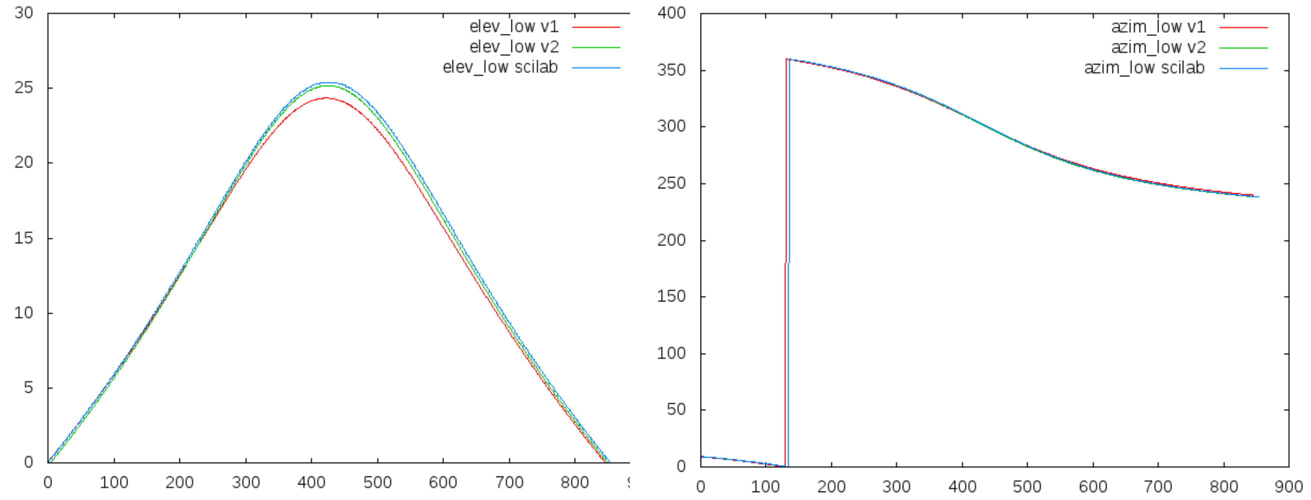


Fig. 4a, b. Course of elevation and azimuth (low transfer)

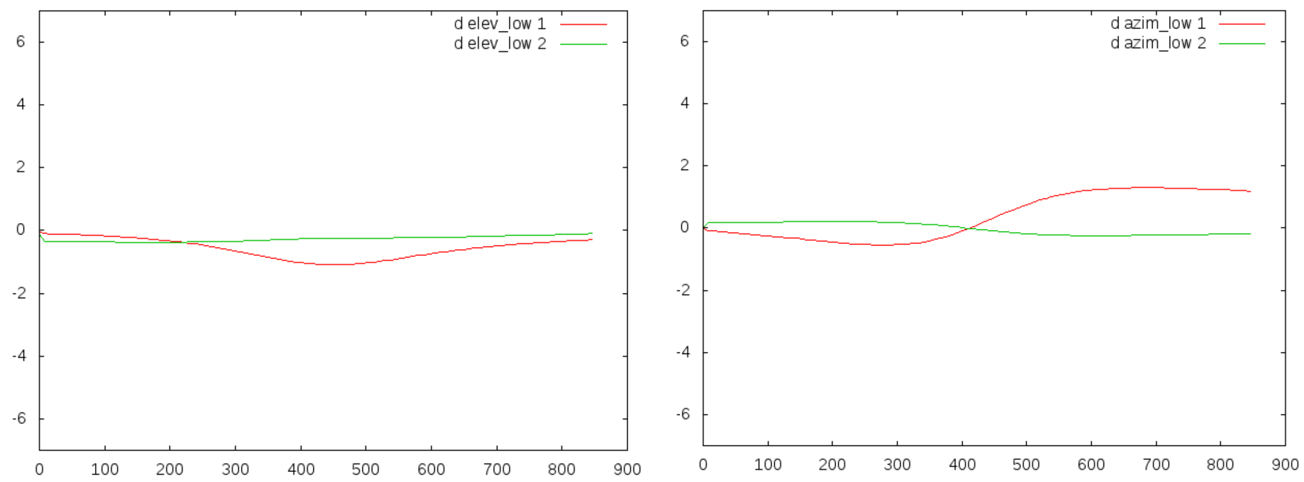


Fig. 5a, b Difference (error) of elevation and azimuth for xtrack v1 and v2 (low pass) compared to Scilab results

In numbers, the maximum deviations compared to scilab are:

- v1: elevation 1, 2 degrees azim you t 1, first degree
- v2: elevation 0, 4 degrees, azimuth 0, 7 degrees

So the results of v2 are much closer to the results of Scilab. One possible explanation for a not exact match is that Scilab-code takes into account the fact that the earth is not perfectly spherical, but is flattened at the poles. Then an observation point on the equator should give a better match; currently the position is 5 degrees longitude / 52 degrees latitude (position between the places Ijsselstein and Lopik). And that indeed appears to be the case. With an observation point at 0 longitude and 0 latitude we get the following deviations:

- v1: elevation 4 , 37 degrees, azim you t 4 , 0 degrees
- v 2: elevation 0.08 degrees, azimuth 0.15 degrees

Sufficient reason to build in the correction for the flattening of the earth in xtrack : v3. The results, along with those without correction, are shown in the table below: (position on earth: 52 latitude, 5 longitude)

	max. elev.	v1	v2	v3
elevation	69	3.58	1.30	0.06
azimuth	69	7.56	3.41	0.24
elevation	25	1.16	0.38	0.02
azimuth	25	1.12	0.69	0.05

Table 1. Max. deviation xtrack versions w.r.t. Scilab code.

Only the azimuth has a slightly larger deviation in v3. Applying a small offset in time does not decrease this, but with an error of only 0.24 degrees this will not cause any problems.

The error course for the 3 versions:

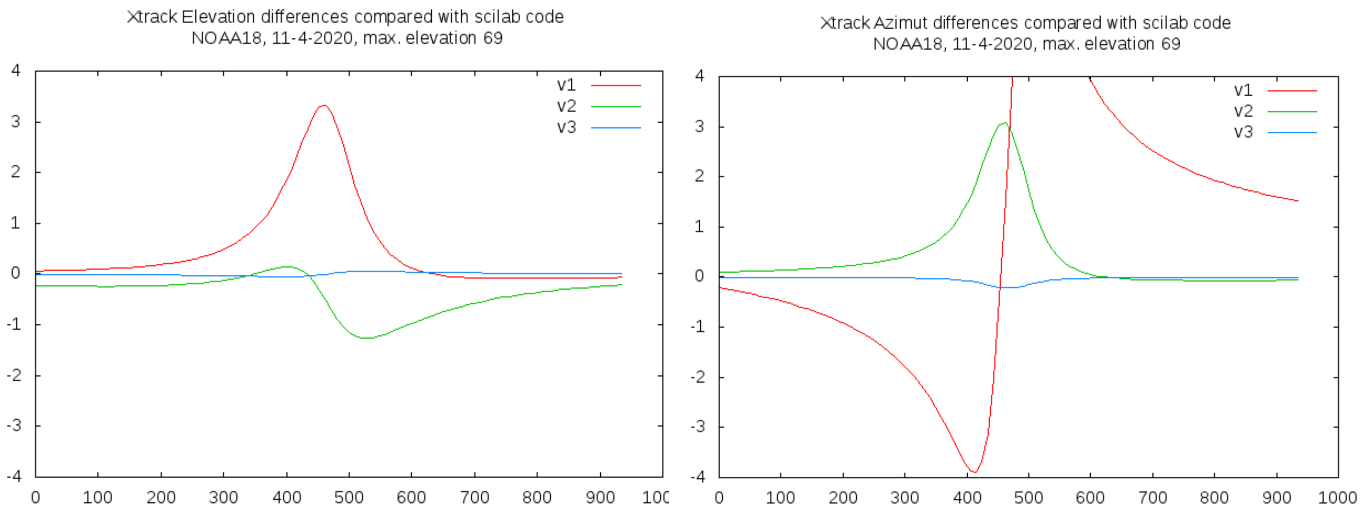
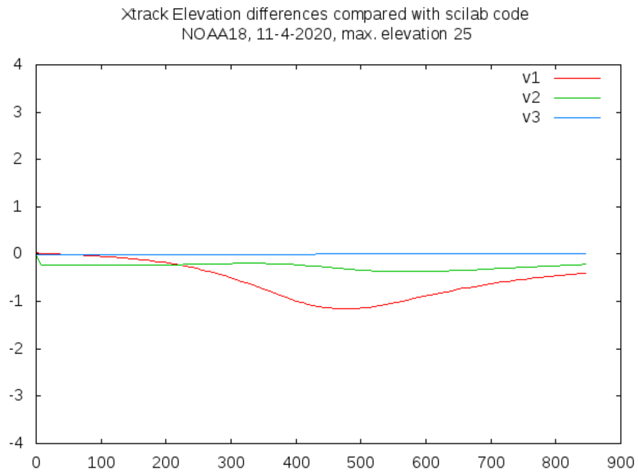


Fig. 6a, b. Errors for xtrack v1, v2 and v3; high pass.



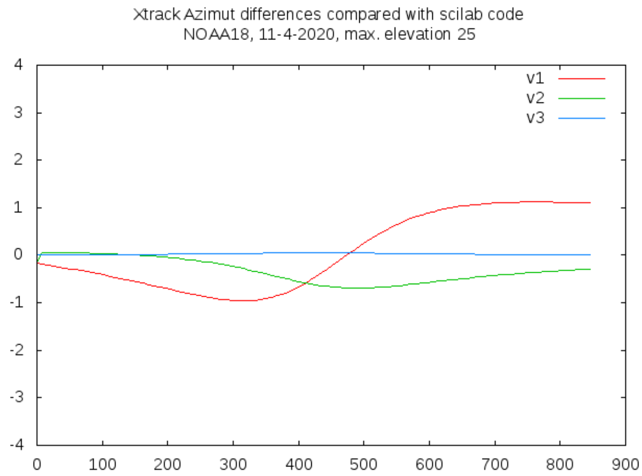


Fig. 7a, b. Errors for xtrack v1, v2 and v3; low pass.

The formulas for calculating the Earth's flattening can be found in [4].

References

[1] Website Celestrak with TLEs

[2] Project pluto: code SGP4

[3] Explanation and formulas coordinate system.

[4] Explanation and formulas for flattening the earth.

An amplifier with the Gali-2

Preface

For some time now I have been designing a down converter for the 8 GHz. The heart of the down-converter is a ADF4356, which the local oscillator (LO) signal between 6400 and 6800 MHz, the generation t, followed by a 7 dBm mixer. The intermediate frequency will be around 1420 MHz.

The problem is, that the ADF4356 has an output level of -2 dBm at a frequency of 6800 MHz. This is far too low for controlling a level 7 mixer (I have the MCA1-12G + in mind). The LO signal will therefore have to be amplified.

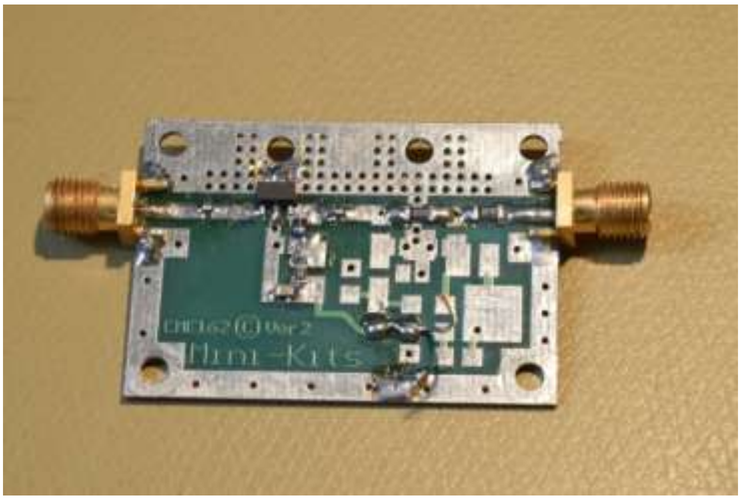
After some puzzling in the Mini-Circuits datasheets I decided to use the Gali-2, which according to the datasheets at 8 GHz delivers a gain of 15 dB.

Gali-2

The Gali-2 comes in a SOT-89 housing and making it "normal" to be soldered is . Internally, the inputs and outputs have been adjusted to 50 ohms, so no adjustment network is required. The power consumption is around 40 mA. Another advantage is that the Gali-2 is reasonably available.

First experiment

I had a print of Minikits [1] . I mounted the Gali 2 thereon with a few C's, a coil in the supply line and ready. I still had a signal generator for the 8 GHz and a power meter from Rohde & Schwarz [2]. So measure it. The 15 dB gain was actually around 1 dB! . I took another Gali-2, but this did not improve. Where such a print may still work around 1 GHz, this is a completely different story at 8 GHz.



Gali-2 mounted on an experimental board

I could think of some problems :

- FR4 print material delivers higher losses at high frequencies

- The dielectric constant of FR4, which among others determines the track width of 50 Ohm, it is not so constant. It differs per supplier, frequency, direction on the printed circuit board, etc. Therefore, they advise (depending on who you ask) not to use the FR4 above 1 - 10 GHz. Often said circuit board which is suitable is the manufacturer Rogers . For this amplifier I use circuit board from Isola [3] . They were kind enough to give a sample of their IS680 circuit board to the workgroup. This material has a very low loss and is suitable up to 75 GHz!

- The DC-blocking capacitors may no longer be C's at 8 GHz but coils because the self - resonant frequency (SRF in English) is much lower.

- Signal is also lost via the coil at the output.

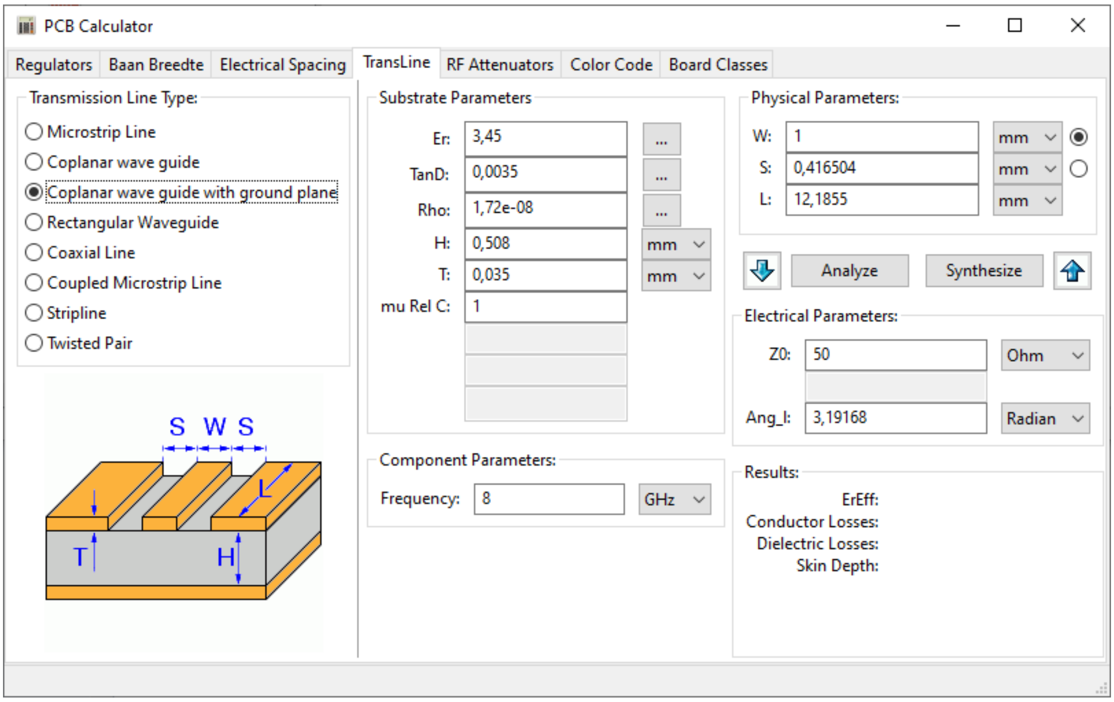
- I included some 0 ohm resistors in the signal path . How do they work on 8 GHz?

Own print

Because I want to know how far you can get with DIY, I made my own print design. The problem is that the Chinese board houses they only supply FR4 prints. Other materials are tens of times more expensive. So then again etch yourself. This is a topic for another article.

The traces, over which the 8 GHz signal runs, must have an impedance of 50 ohms. This translates into a certain track width. Ideally, you want transitions from print path to capacitor or the Gali-2 to be as small as possible. I chose a track width of 1 mm. This means that the track must become a so-called "coplanar wave guide", in plain Dutch: an earth plane next to the track.

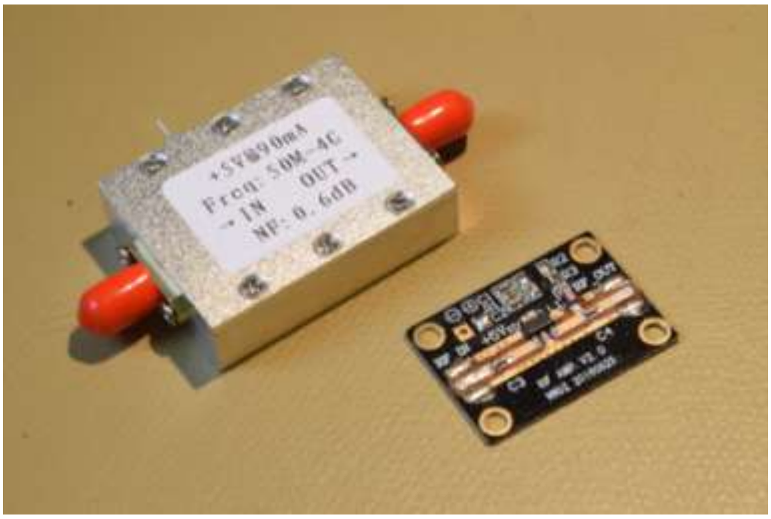
There are useful tools for calculating track widths : AppCAD [4] and KiC ad [5] .



Calculation of a coplanar wave guide in KiCad

Housing

On the internet I saw an LNA suitable up to 4 GHz, including housing. I ordered this with the idea to reuse the housing. The pcb could fit in here.



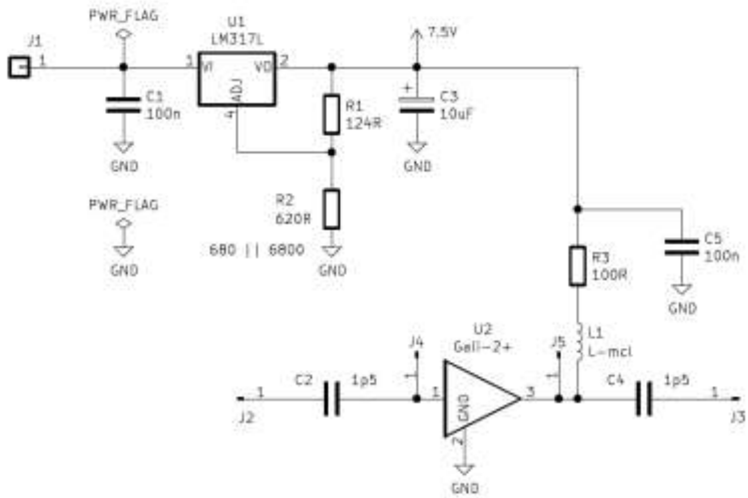
The housing is quite low. The lid did not fit because the elco is too high!

LNA up to 8 GHz as you can find it on eBay . The chip used is the SPF5189Z. Maybe this LNA is also suitable for the 1.7GHz? This is another project.

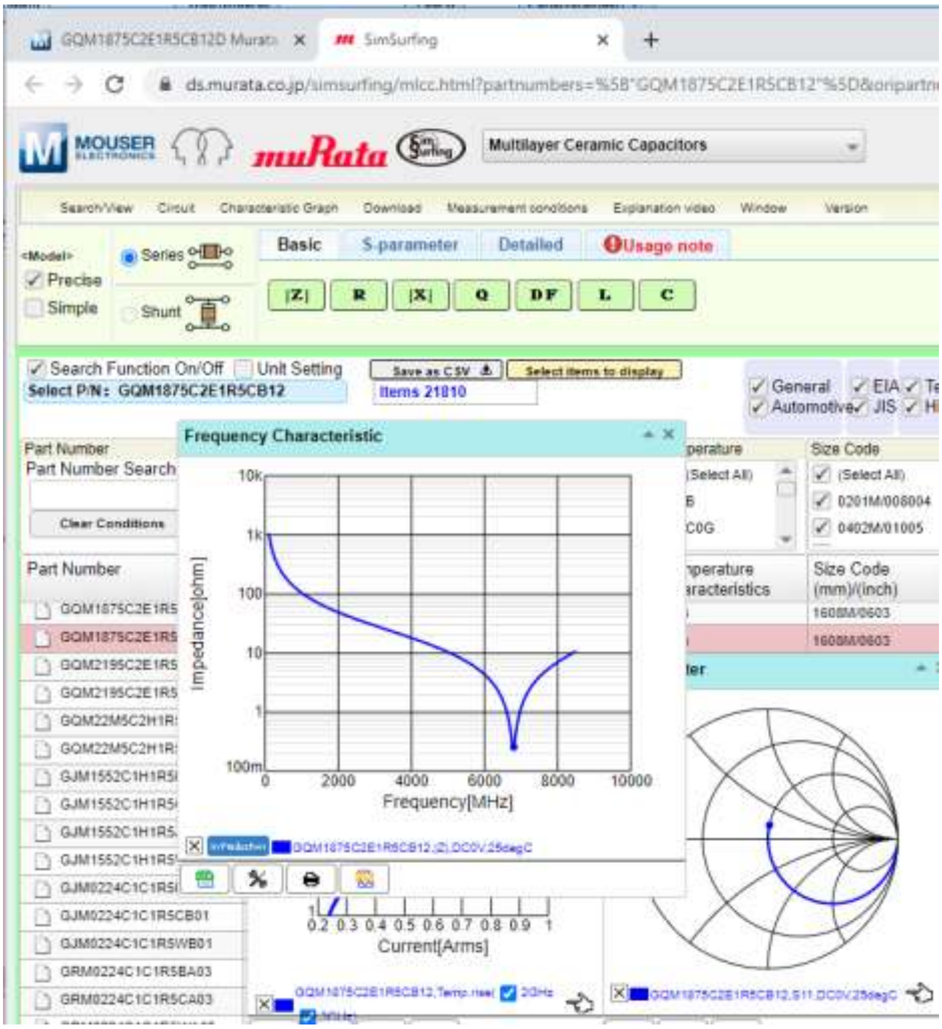
Scheme

The schedule is very simple. I took the datasheet and evaluation board of the Gali-2 as a starting point [6]. An LM317 is an adjustable voltage regulator that here produces an output voltage of 7.5V. With this I can use a series resistor of 100 Ohm. This is the 1206 format because there still some warmth comes in free .

The coil is the TCCH-80 + from Mini-Circuits, this is also used in the evaluation board.



The DC blocking capacitors are from Murata. On the Murata site (and also via the Mouser datasheets) you can view the self - resonant frequency of the capacitors [7] . With this type, the SRF is around 7 GHz, so the signal is not attenuated.

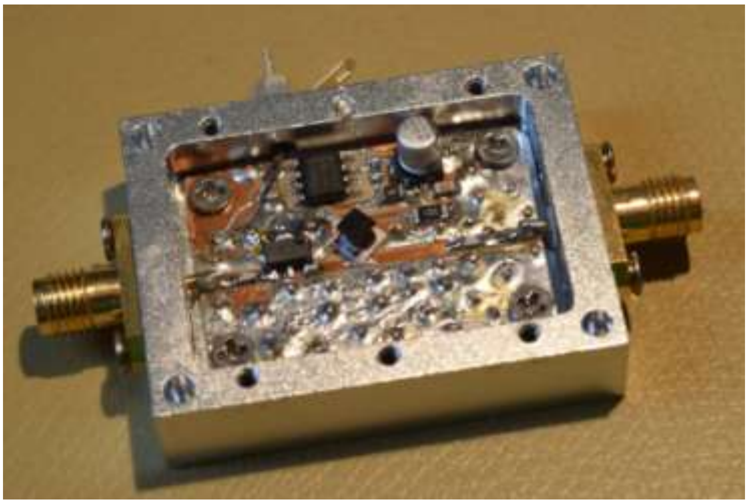


Self-resonant frequency of C2 and C4

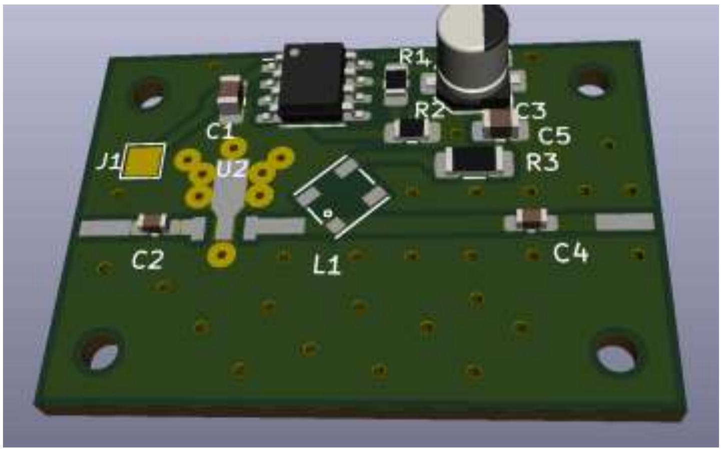
Construction

Construction is "reasonable" to do. The problem is the coil, which must be soldered at the bottom. With a hot air station I eventually got it soldered, but it didn't go well.

With the Gali-2 there were some threads of the through-metalization in the way. So the Gali-2 is not perfectly flat on the print.



The built-up print in the housing. The lid cannot be put on because the elco is too high.



3-D Animation from KiCAD

Measurement results

Frequency	Level from the ADF4351	3rd harmonic	Level after the filter	Level after the Gali-2	Level with lid
2604 MHz	1.8 dBm	7812 MHz	-28.8 dBm	-20.4 dBm	-20.6 dBm
2667 MHz	2.1 dBm	8000 MHz	-26.2 dBm	-17.9 dBm	-17.9 dBm
2737 MHz	2.3 dBm	8212 MHz	-22.5 dBm	-12.6 dBm	-13.2 dBm

The output level of the ground signal from the ADF4351, between 2604 and 2737 MHz, differs 0.5dB. This is quite a lot. Maybe the print of the ADF4351 is not perfect?

The level behind the 8 GHz band-pass filter has large differences. My suspicion is that the 7812 MHz is on the edge of the transmission curve. I do not (yet) have equipment to measure the filter.

The gain of the Gali-2 ranges from 8.4 to 10.1 dB. Is this good? I myself hoped for a higher gain, but it is many times better than the print from Minikits. Strange that the gain dropped as I put the cover over the input of the LNA (see last column).

A subsequent experiment

There are a few things that can result in an improvement . In random order:

- Placing the cover indicated that the track width for this housing is not optimal. I need to investigate this further. In a new design I will use a higher housing.

- The SMA connectors that were on the housing, are of very dubious quality and have a thick pin. It is better to use connectors with a very thin pin to minimize the transition on the track.

- By soldering by hand, many copper planes are covered with solder. Due to the "skin effect" the signal does not pass through copper, but through the solder, which is a much worse conductor. So work with little solder paste and heat the entire print.

- Find out how you can measure the 50 Ohm track width.

- Widen the 8 GHz-track so that there is no earth plane next to it. This connects better to the Gali-2 and it saves making many vias . Another advantage is, that the etching process is better to check the width. The capacitors need to be wider (and therefore much more expensive).

Closing

I want to thank Timo for helping me think through the whole story. It turns out that such a "simple" Gali-2 on 8 GHz becomes a much more difficult story and it has a bit of voodoo. It is not easy possible to design a down converter. Every part must be right.

Self-build is difficult at these frequencies because the parts can no longer be soldered normally. Another point is the measuring equipment you must have.

Links

[1] Mini kits. An experimental print for the SOT-89

https://www.minikits.com.au/components/hardware/Printed-Circuit-Boards/EME162-PCB

[2] Signal generator 8 GHz and power meter

Experiments on the 7.8 GHz, Kunstmaan June 2018, page 20

[3] Isola

https://www.isola-group.com/products/all-printed-circuit-materials/is680/

[4] AppCAD

http://www.hp.woodshot.com/

[5] KiCad

https://kicad-pcb.org/

[6] Gali-2 from Mini-Circuits

https://www.minicircuits.com/pdfs/GALI-2+.pdf

https://www.minicircuits.com/pcb/WTB-409-2+_P02.pdf

[7] Murata Capacitors

https://ds.murata.co.jp/simsurfing/mlcc.html?lcid=en-us#

Discussion about the rotor control March 14, 2020

At the meeting on March 14, we had a discussion about what requirements should be placed on a rotor system. The aim is to come up with a recommendation on how to build such a rotor system, with a high chance of success. The results of this discussion, with additional comments, are included here.

This story should be seen as a working document and will have to be adapted and, in particular, made more concrete.

General considerations

How often is the rotor system used?

- A rotor system that is actually always in a design phase. Very good for concepts and brainstorming. This observer has a challenge in building an electromechanical construction
- The weekend observer who goes out (in good weather), puts down the rotor system with dish and receives pictures. The requirements are less high because the installation is not permanently (in wind and weather) outside and the observer is there. With regard to "putting down", there are of course gradations in this: from lugging, to transport to a specific location on a trailer. If we need a larger dish diameter for the reception of 8 GHz, a permanent setup is not possible for some and the entire installation will have to be made removable / movable.
- Permanent installation in the outdoor area. This rotor must always work, in all weather conditions. It must be a proven solution that can last for years.

Construction:

- should be simple
- normally available parts

Accuracy and rigidity

This depends on the satellite to be received. To receive satellites on the 8 GHz with a 150 cm dish, a desired accuracy of 1 degree is required; for 1.7 GHz with a small dish, a smaller accuracy is sufficient. The larger the diameter of the dish and the higher the frequency to be received, the more precisely the dish must be aimed.

In addition to accuracy, the construction must also be rigid enough. So that the whole thing does not whip with a breath of wind, so that the desired accuracy is not achieved. The "structural rigidity" also includes the "dimensional stability" of the dish itself; this is a separate topic. Some possible measures:

- Tether at the top of the mast
- The rotors must do their work regularly, without jerks

Vertical mast alignment is crucial. In addition, the angle between the X / Y or azimuth / elevation rotors must be accurate enough 90 degrees.

The table below gives the (theoretical) opening angle in degrees as a function of frequency and dish diameter starting from -3 dB. From this an idea can be obtained for the required aiming accuracy.

f -> D	0.7 m	1.0 m	1.2 m	1.5 m	1.7 m	2.0 m
1.7 GHz	17	12	10	8.2	7.2	6.2
8.0 GHz	3.7	2.6	2.2	1.7	1.5	1.3

Used formula: 70 * 0.3 / D / f (d = diameter in meters, f = freq. In GHz)

Limit switches; calibration

The limit switches serve as protection so that the rotor cannot rotate too far. The limit switch can also be used as a calibration point. Higher accuracy can be achieved by doing this separately with a light barrier.

Calibration at a point around the end position can take a long time if this has to be done from the storm position (from storm position to end position and back to storm position). By taking the calibration point around the storm position, this can be accelerated considerably. It is a bit more complex, and the calibration position must always be approached from one side.

Rotors

A rotor consists of a motor and a reduction unit usually in the form of gears. The delay part may or may not be combined with the motor. Affordable individual gearboxes are hard to find.

DiSEqC rotors

These are rotors designed to target TV satellite dishes. They can rotate at (almost) 180 degrees and can therefore be used to track polar satellites. In terms of mechanics, these rotors can be bought completely, with built-in gear. They still have to be assembled into an X / Y or elevation / azimuth rotor system.

Benefits

- Virtually no difficult parts; turnkey design with built-in mid-turn calibration
- No feedback needed; works autonomously. It is sufficient to simply state the desired position.

Cons

- Not suitable for continuous use (some gears are plastic)
- Not suitable for a large dish

- No possibility of variable speed
- waterproofing can be tricky; these rotors are used in a different position than for which they are designed.
- The question is whether these rotors will remain available in the future because "targeting" is increasingly being done with the help of multi-head LNBs.

Rotor with stepper motor and gearbox

Stepper motors are less powerful. The gearbox can be a problem in particular; see section "Gearboxes". In principle, no feedback is required; each pulse gives a defined angular displacement.

Brushless DC motors with gearbox

The speed can be regulated using PWM. There are motors with built-in gearbox, eg BLDC3650 or BLDC4260. Delays from 100: 1 to 625: 1. Momentum output shaft: 50 kg / cm, that will soon be too little, especially for an X / Y rotor system. An extra gearbox must then be used; see section "Gearboxes".

These BLDC motors do not require any external control in the form of an H-bridge, other types may.

The advantage is that the motors themselves do not cause spark interference and that they are stronger than stepper motors.

These motors need feedback to determine the exact position. Some motors already have a pulse generator built in.

Jaeger rotor

This is a complete construction with delay and pulse counter. Sometimes they need to be modified a little bit for our purpose. The motors can also be controlled with PWM. An H bridge is required for control. There are good experiences with these rotors.

Yaesu rotors

Are expensive and are only made for 2 meters Yagis. They have a potentiometer for the feedback and are therefore too inaccurate

Gearboxes.

It is important that the entire rotor assembly is self-braking, ie the disc does not "drop" when the power is removed. A worm wheel is self-braking but has a low efficiency. And gives a lot of play unless a compression spring is used (not present in standard worm gearboxes). There is wear under high load because the wheel is often made of plastic or aluminum. A worm gear only goes up to approx. 70: 1 so a second gearbox is needed.

Planetary gear units have a high efficiency and a high gear ratio due to multiple stages. The engine must be able to be "somehow" braked. Mostly all-steel gears and ball bearings. The heavy planetary cabinets have little play (max 25 arcmin = less than ½ degree)

Harmonic gears are even better than planetary but too big in diameter and too expensive for us.

The problem with gearboxes is that they are difficult to get and / or expensive. Therefore, this way of making a rotor is only suitable for the amateur who does not shy away from a lot of DIY.

Position readout.

Potentiometers are too inaccurate for precision tracking (AD conversion and not linear). There is also a risk of moisture / oxidation.

Electronic protractors are very sensitive to shaking / vibrations and do not give reproducible results.

Pulse generators are robust and can provide high resolution. The disadvantage is that you have no reference when the system is out. Calibration, for example on a limit switch, is necessary. The pulse generator is built into Chinese planetary BLDC.

An absolute position reading is best but is expensive at high resolution and requires a separate interface if the position is to be available "far from the rotors".

2-axis rotor systems: X/Y versus azimuth/elevation

Advantages X / Y versus azimuth / elevation

- No high rotation speed needed at high passages; speed differences are small (approx. 4 degrees / sec). No problem with antennas <1 meter and 1.7 GHz.
- More suitable if high accuracy (8 GHz?) Is needed

Disadvantages X / Y:

- Construction is more difficult.
- Only the bottom axle can have a counterweight. Optionally, a tension spring can be used on the top shaft as an alternative to a counterweight. This also depends on the engine used, gear and construction (dish as close as possible to the pivot points). DiSEqC rotors are having a hard time in that regard.

The required rotational speed during tracking depends on the type and the passage. For a very high transfer, 87 degrees elevation, the following applies :

- azimuth / elevations:
    - elevation: max. 0.5 degree / sec (at elev = 79 degree)

◦azimuth: max. 11.1 degree / sec (at elev = 87 degree)

- X / Y system: (Y to dish)
  - X: max. 0.24 degree / sec (at elev = 4 degree)
  - Y: max. 0.47 degree / sec (at elev = 87 degree)
- X / Y system: (X to dish)
  - X: max. 0.15 degree / sec (at elev = 87 degree)
  - Y: max. 0.47 degree / sec (at elev = 87 degree)

In the case (theoretical at our location) that the crossing has an elevation of 90 degrees, the azimuth rotor should rotate 180 degrees infinitely fast.

In practice, the azimuth speed is no problem with 1.7GHz / 1 meter dish; this may cause problems with larger dishes and 8 GHz. The azimuth rotor may be left a bit behind, as long as the direction does not deviate too much. An X / Y system is an advantage in that respect.

Possible design of rotor control

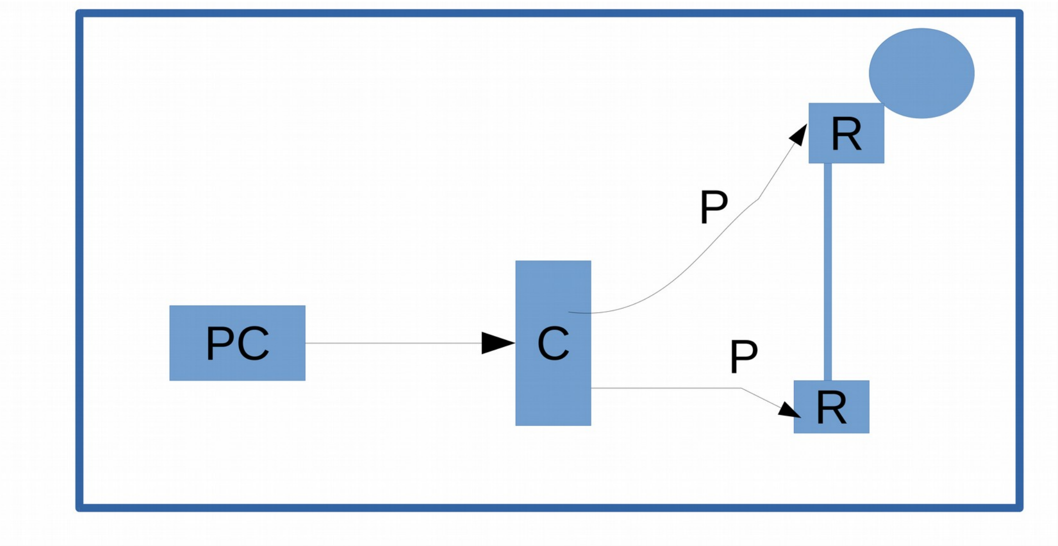


Fig. 1. Rotor system design with DiSEqC motors

- The PC calculates the position and sends it to the C(ontroller) (elevation / azimuth or X / Y)
- The Controller converts the desired position into a DiSEqC command. and sends it to the engines. The engines also operate completely autonomously.

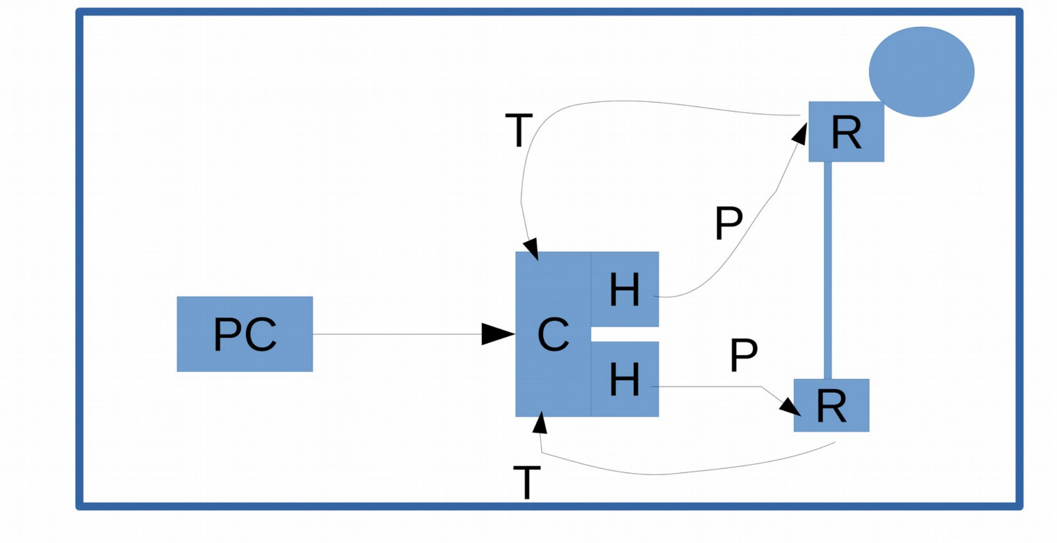


Fig. 2. Rotor system design with motors and separate control.

- The PC calculates the position that sends to the C(ontroller) (elevation / azimuth or X / Y)
- The Controller controls the H-bridge in such a way that the motors run at the desired speed (stepper motor: pulse speed, DC motor: PWM). The position is sent to the controller via T (feedback).

Electronics control motor (stepper motor, DC motor)

- With PWM control, the electronics should not be placed too close to the dish or LNA / LNB due to interferences. Filters may need to be added (folding core around the control wires to the motors?).
- The H-bridge (if necessary) can be purchased as a ready-made module. It is not profitable to design / build this yourself.
- The Controller controls the H-bridge (or motor module) in such a way that the motors run at the desired speed and direction
- Stepper motors need a different control.
- Communication from PC to controller at the mast: eg RS485 or Ethernet / Wifi. It is important here that a large distance may have to be bridged. (RS485 can bridge distances of 15 meters with 10 Mb / s, and 1200 meters with 100 kb / s. With RS232, 15 meters or more with 19.2 kb This also depends on the type of cable used.)

Controller

Some possible controllers:

- *Arduino:* Seems best suited for this task, powerful enough for now.
- *STM32 - Blue Pill:* Much more powerful than the Arduino. It takes a little more effort to set up a programming environment; by default there is no boot loader available.

- *Raspbery Pi:* This is more of a computer than a controller; contains an operating system and must therefore 'boot'. May be of interest if PC and controller are to be combined into a standalone rotor controller. This could run completely autonomously, including the regular retrieval of new Kepler data.

Software in the microcontroller (stepper motor, DC motor)

Driving motors in such a way that the dish movement is not too jerky:

- speed control via PWM or steps per second
- Possibly a PI controller to monitor continuously and completely shock-free, especially if high accuracy is required.

Manual control must also be possible, eg for aligning the construction. It can also be useful to be able to manually add an offset during tracking.

Software in the PC: track calculation

There are several software options, eg xtrack. The SGP4 algorithm is always used in combination with the Kepler data (TLE). For the satellites at 1.7 GHz, the accuracy is not so important (a few degrees); for 8 GHz (accurate to 1 degree) it may be important to include the flattening of the earth in the calculations.

For elevation / azimuth rotor systems, it must also be possible to determine an east / west passage to prevent the azimuth rotor from seizing against its limit switches during a passage.

Optimize accuracy

Only necessary for antennas with a small opening angle, ie, large antennas / high frequencies. For this it is necessary to control the motors in such a way that successive position calculations result in a smooth rotor movement, instead of moving quickly to the next position and then waiting for the next position.

With a stepper motor, the speed could be calculated in advance by the PC. On other motors, the speed of the rotor movement may depend on the position of the dish, ie whether the dish is moving up or down. The algorithm that ensures a smooth movement should therefore need the current position, derived from the encoder. This means that this information must be sent back to the PC by the controller, or the controller must determine the speed itself.

Perhaps a table can be drawn up for a specific rotor system in which the desired speed and thus PWM can be determined from the current position and the following position. In an X / Y system, that table for the bottom rotor would depend on the position of the top rotor, so that means a 3-dimensional table.

A PI (D) control in the controller may be the most elegant method.

Feedback

Possibilities:

- reed contact

- light barrier
- HAL sensor
- Feedback with absolute values. This does not require calibration.

The number of pulses per degree of feedback rotation must be high enough to achieve the required accuracy. Feedback with absolute values should be mounted behind the transmission; a light barrier or AL sensor can also be coupled to the motor shaft. In the latter case, the encoder needs to give fewer pulses per revolution for the same accuracy.

Security

High-gear BLDC motors give enormous torque, good limit switches are required to avoid damage. An emergency button near the rotor is also recommended if you get pinched.
The disadvantage of BLDC is that you can not include limit switches with diode in the motor wires (reversing direction is done with a separate control wire, not by reversing the polarity of the power supply). A robust method must therefore be devised to allow the rotor to rotate backwards, out of its end position. Overcurrent protection (at x seconds longer than the maximum expected current) is also recommended.

Calibration; rotor system positioning

If it is a normal dish, a rough check can be done by following the sun and checking that the shadow of the cup falls exactly in the middle of the dish. This is not possible with an offset dish.

For precise alignment, when tracking a satellite, an offset could be given to the rotors to see if it makes the signal stronger. This offset could then be realized "mechanically" later, or recorded in the tracker software.

General

Long cables may be required to power the motors. To prevent the spread of interference related to PWM, CAT-7 Ethernet cable can be considered. These have extra thick wires and are shielded in pairs.

Literature

- Book: "motor control", of Elektor

Comments to sort out

The following comments were made during the discussion, but their relevance / correctness remains to be verified.

- Lenze: suitable motors?
- Alignment using laser pointer
- *Failsafe feedback in case of cable defect etc.*
- Availability Jaeger motors

UKW-BERICHTE (v 0.03)

Paul Baak

Summary
In this article a concise review of articles published in the 1th edition of 2020 of the German magazine UKW-Berichte. We have a subscription to this magazine.

Here is an overview of UKW report 2020 Heft 1. This was published in May this year, so the backlog in publications has partly been made up. We find 5 articles, plus the regular overview with internet links. Our club has a subscription to this magazine. Please indicate whether you appreciate this subscription! Positive or negative, it doesn't matter, as long as your board hears something. The latest editions are available for reading at meetings on the library table.

Alexander Meijer describes dozens of coax cables with their properties. Material for the inner and outer conductor, inner conductor solid or stranded, outer conductor single or double, plastics for the dielectric and outer sheath, cut-off frequencies, damping and reflection; mechanical rigidity, all found in multiple tables. We also see a graph of a measurement of the insertion loss that is influenced by the quality of shrinkage. Like the tables, everything is taken from data sheets.

Gunthard Kraus describes a loop antenna for the 70 cm, with support from 4NEC2. This is versatile and free software for designing wire-based antennas (not dishes). I do not think the images of the radiation diagrams and the connection method very clear. Fortunately, a further explanation follows later in the article.

Guido Schönwälder describes a dummy load for the range from DC to 1700 MHz for DIY. The result is a large imposing metal block with a fan control. The actual resistance section consists of an Anaren G450N50W4 (HF resistor with cooling surface) that can dissipate up to 450 Watt.

An article Tips and Improvements, with a correction for an error block diagram of the article about the receiver for 5.8 GHz with output at 1.7 GHz in the previous UKW report.

In this edition we also find the annual table of contents of 2019.

In Fundstelle Internet we often find inspiring internet links. I just mention here: APT reception of orbital satellites in satellitenwelt.de, a radar tutorial at radartutorial.eu; antenna theory in antenna-theory.com and on eurovna.net: a European 2-port VNA, bidirectional, that lacks S11, S21, S22 and S12 but runs as a spectrum analyzer and SDR receiver up to 11 GHz. When it comes into production, be prepared for a few hundred euros.

Under the heading Ultrakurz a new dual polarized (with additional coupling device also circular) horn antenna from Telemeter Electronic. The range is from 6 to 76 GHz. I am thinking of our recent efforts towards 7.8 GHz.

UKW-Berichte is a German language edition, now without an English version that previously existed under the name VHF communications. Including shipping from Germany, the magazine costs 33.20 Euro per year as of the year 2020.

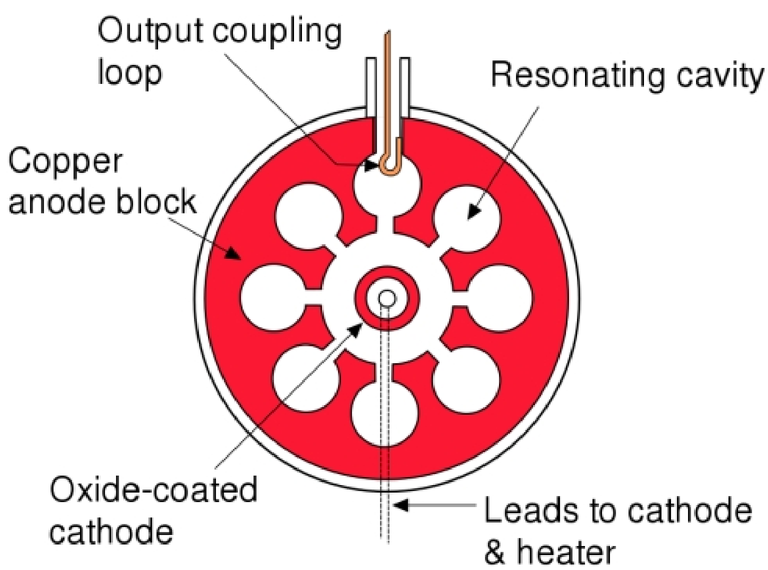
links:
[1] UKW-berichte
[2] euroVNA

From the Library 2020KM2

Dear people,

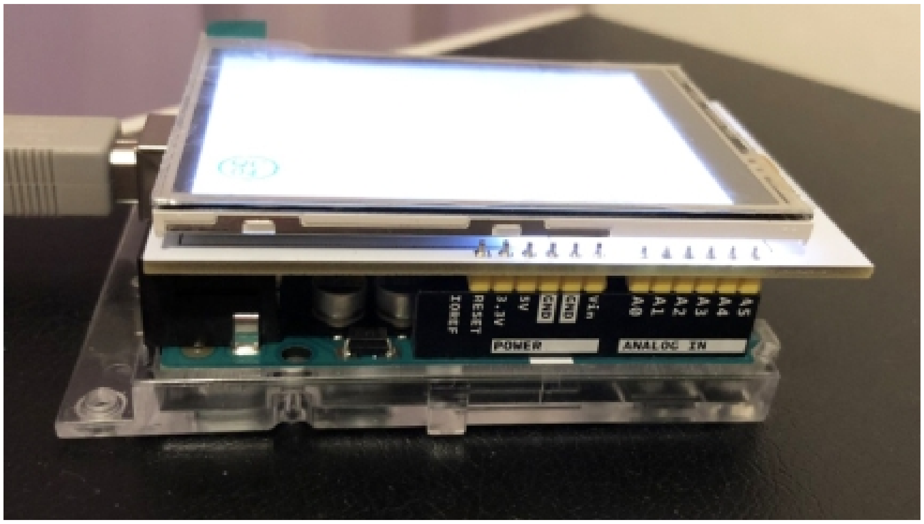
That corona-thing does have a great advantage for all those columnists, opinion-makers and librarians in our country: there is always a cheap subject to start with. It really spreads like a virus through all texts. Of course I don't do that; I don't even mention the word corona and go straight to high-quality topics without which you can't get through the summer.

On quiet evenings I sometimes browse the internet for scientific sites. No, not that kind of sites. I mean really scientific. I passed by a drawing of a microwave and immediately thought of the corona virus. Call it obsessive, but I can't help it. I am just caught in this era. And at home.



Resonant cavity magnetron high-power high-frequency oscillator

I've been looking for some bigger screen than the 0.95 inch OLED screens that show up everywhere. Ben Schellekens has previously described them and Rob Alblas has used them for an I-Q diagram. I like them, but think they are just a bit too small and found the VMA412 from Velleman, a 2.8 inch with even a touchscreen option. It is very affordable with 20 euros. The thing is in house, but not yet active. Maybe a report in the next Kunstmaan. I am thinking, for example, of an I-V curve tracer; the DAC / ADC work can easily be completed by an Arduino. Let us know if you see a nice application for our specific satellite work.



VMA412

Can we still meet as a working group? It was difficult for another group, a small computer and discussion group of mine. Due to several sad circumstances, there was the wish and necessity to meet. Keeping distance between people in the meeting room was no problem there. The question remained: is it allowed? Press conferences of those noble people above us suggest serious criminal offenses, but my investigations did not support this. The Constitution offers freedom of assembly and remains above emergency regulations, which, incidentally, differ within our country. Also because of the (then approaching) May meeting of our working group, I called the governmental corona information line, which I expected to answer, because the marketing of the corona virus is very chaotic. However, they had no answer to the specific question of whether a meeting is a the criminal offense in my case.

Over to our working group. It became easy in the end for our May meeting. Nimeto turned out to be closed because of the corona. So we could almost completely forget about the board meeting and the May meeting. Almost, because nowadays there is Zoom as a means of remote conference. I must say, it was not too bad given the situation is the way it is. Compared to the city council meetings I sometimes attend, it was sacred. Weak points are the poor sound (sometimes echoing, stuttering and distorted; the sound may be given more priority by Mister Zoom than the image) and the difficult changes of speaker. You miss eye contact anyway. A small topic of mine continued to simmer a bit and then you miss the opportunity to steer discussion with a hand gesture. Ben held the conversation smoothly on track. He is our chairman with a reason.

There are also advantages: you save travel time and travel and parking costs, members abroad could also participate, and a recording is simple. In the past I have sometimes suggested a sound recording; there was no need for that then. Now it is different. Maybe we will organize our communication differently in the future, who knows.

For years, our sister organization GEO published a magazine that now only appears as a PDF. Easier for me, because I don't have to lift and print paper back and forth. I would like to give you the link with which you can collect them yourself. Don't forget or I'll help you remember. Meanwhile, we arrived at GEO 66 in June 2020. I like the coloring page of our flower bulb fields in bloom. Something different than the prints in shades of gray. Attention is paid to the dramatic outbreak of St. Helens, now 40 years ago. Photos from above show how nature takes back the lost area. It is slow, but also thanks to the satellite photos insightful and unmistakable. In this GEO a description if you also want to start with 3-D playback. In the many years of satellite receiving, the display has improved a lot. 3-D has now been added to that.

The radio Society of Great Britain, the large amateur broadcasting association there, released their association magazine Radcom of May 2020 for free because of the difficult times (they mean corona, of course). Underlying it is of course a bit of public relations, but I will forgive them for that. There is a nice explanation of how to perform FM demodulation with an I-Q signal. Unfortunately, you have to browse it in the browser with difficulty (anti-copying measure) and it does not read smoothly, so I made the article readable to myself in a PDF with some cutting and pasting. I think it is solid material, but worth it. Demystifying SDR FM demodulation is in the links.

Due to the corona crisis, even the April jokes become flavorless. In the Electron a story that electromagnetic waves propagate much more easily when they are ironed flat. So now someone climbs onto a roof with ironing board and iron, with really encouraging measurement results: many dB's gain. Unfortunately, it is not even useful to us, because circularly polarized waves do not benefit. If you think a little beforehand, that's no surprise.

Seen on television on April 15 this year: documentary The Knowledge of Now about the Solar Orbiter that was sent to the sun to clarify the open riddles on the poles. What I miss anyway: nobody is talking about all that data having to go back to earth. However, not a word was devoted to this essential part of the mission, data communication. Also on the wikipedia (I learned that you have to be careful with that, but yes, for lack of better ..) I only read that there is a receiver dish in Argentina. I gues the connection is over the X band, but that's all I can fantasize about.

Due to the corona status, you can no longer go to a seminar or class day, all the more reason to look at what is available on the internet. Today I focus on Youtube. Those who want to get scientific information had to rely on a book for centuries. That did not work badly, but was nevertheless replaced by the internet with all the misery. More specifically at the moment: youtube. It now seems that anyone with a webcam with 10x10 pixels thinks they can make an instruction movie. I passed some videos about antennas, controllers and electronics and I was quite shocked. I thought the man who explained something in Tibetan was best: at least you know that you no longer have to spend time on it. Worse misconduct: a vibrant image when someone is typing and holding the camera at the same time, with the reflection of a room lamp. A 1200x1800 screen directly on the film, of which nothing remains in youtube screen definition. Dull sound and varying loudness. And perhaps worst of all: crippled language. Every half sentence I hear: "hey guys, what happens basically, you know," or "that's it, so to speak" or some other illogical (un) linguistic interjection. Is there, uh, well, no one can make a full sentence what you understand, you say?

Elektor publishing house has published a book about controlling motors with an Arduino and Raspberry. The book is already sold out again, but I was allowed to borrow a copy from Wim Bravenboer (thank). It describes the types of engines and the programming obstacles that seem simple from a distance, but require a lot of time when elaborated. Issues such as controlling via Bluetooth and the use of interrupts are also discussed. It is not a superficial book and is its value. (update: now available as a PDF. That offers opportunities, because a lot of retyping listings is not attractive)

Finally. You may have noticed that there is a corona virus going around. (mocking the dutch PM here:) Therefore the following instructions! Don't go on vacation and stay home this summer for our hobby as much as possible! Keep less than a meter and a half away from your satellite receiver! Only go into the garden to visit your reception dish! Hold on! That is what you are instructed by, and, I repeat again! by

your librarian

[1] Demystifying SDR
[2] Boek Motor control

Member meeting report 9 May 2020.

Opening by the chairman.
Due to the Corona crisis, this meeting is held "at a distance", via 'Zoom'. This also gives members who normally cannot be present the chance to "participate", such as Fred vd Bosch in Vietnam and Peter Kuiper who is now in Curaçao.

Unfortunately the visit to Eumetsat is cancelled. Hopefully we can still do this visit next year; it is still too uncertain to arrange something in the autumn, for example.

Furthermore, something seems to have gone wrong in sending the "Kunstmaan", one of the members may not have received anything . All now "present" members have received the magazine. Incidentally, on the website of the working group you can see if and when the magazine has been sent.

Setting the agenda
No changes.

Administrative affairs
Nothing unusual. The ALV is shifted to September, hopefully there will be a "real" meeting. The treasurer has been in contact with the Cash Control Committee and no errors or ambiguities have been identified. The treasurer's discharge is therefore only a formality.

About our magazine "de Kunstmaan":
The shipping costs are skyrocketing; we consider a pdf-only membership. This will be discussed at the September meeting. This type of membership, with a lower membership fee (already available to foreigners) would then start in 2021.

Satellite status
Arne reports that there are no changes; no new launches are expected in the short term . The Meteor-MN2-2 has been damaged, possibly by a meteorite, as a result of which the cooling of the instruments no longer works optimally. Therefore, LRPT is disabled; (A) HRPT can still be received. For an overview see further in this magazine.

Any other business

Herman ten Grotenhuis: mentions working in progress on an oscillator synchronized with GPS, for an 8 GHz system. This system will give more information than just "in-sync"; the accuracy will also be shown. A NEO-6 module is used; it is very accurate and costs only about 8 euros. A DCF77 system can also be considered. This project does involve narrow-band systems, in which the tuning of the local oscillator is very critical. The question is to what extent this accuracy is required for our relatively broadband weather satellites at 8 GHz.

Paul Baak : Is cleaning up the workgroup cabinets in Nimeto. There is a list of equipment etc. An obstacle (lots of space taken) is a Koden receiver. It may be collected by an interested party, otherwise it will be removed.

Arne van Belle: Is busy with trackingissues; he assumes an X / Y system. Question: The calibration is now done at 0 degrees; it is much more convenient to do that on the storm setting, so 90 degrees. Limit switches are still required, additionally a sensor (eg light barrier) should be constructed at 90 degrees. That calibration should then always be done from a certain side with respect to the 90 degrees, otherwise there will be differences between calibration taken from an angle smaller resp. greater than 90 degrees. Calibration is now performed at 0 degrees, which is the position at which the limit switch switches off the motor.

Arne is also working on a feedhorn for a dish; with a stepped divider it can be determined whether the horn is suitable for left or right polarization. It is based on data from OK1DFC; different sources give different sizes, so it's not always clear how the partitions should be made. These types of horns are quite compact, which is necessary if the dish is not very "deep". The question is how accurate the different dimensions must be . According to Job, accuracy is not so important at first; start making something what works, then go for optimization. Fred Jansen agrees with this. Mechanical strength is important. Fred has a dish of 1.5 meters, with which he gets a good signal. The satellite Aqua in particular gives a strong signal. The aiming of the dish must be very accurate, less than 1 degree accurate.

Another point is the LNB. Existing LNBs for 12 GHz can not work with "upper sideband mixing", and therefore are not really adaptable to 8 GHz. The result would not be optimal anyway. For now you have to purchase relatively expensive components (order size 70 euros) .

The question is whether Mini Circuits have anything in the 8 GHz area. Ben has bought a 12 GHz LNA for 200 euro, with a noise figure of 1.4, he wants to try bulding the LNA himself using a FET type BFP840FESD. For this he uses circuit board type Isola, which is suitable for 8 GHz. He wants to make the necessary femtofarad capacities with microstrip, but this also gives parasitar induction. For etching he wants to illuminate the print with a light box designed by Elmar.

Peter Smit asks whether an old Amsat LNB can be used. According to Arne, it is difficult to adjust, and the noise figure is not too good either (old stuff) .

Peter Smit asked how to far a local oscillator for LNB can be detuned. The LO is usually fixed; Fred Jansen uses 6.5 GHz. Ben uses an ADF4351 synthesizer. Job notes that if you want to tune in small steps you need fractional dividers, which by definition give a lot of spurious.
Correcting for Doppler shift is not necessary or can be done afterwards (so after receipt).

Wim Bravenboer: shows some (2nd hand) 8 GHz components that he has purchased.

Job: Is working with a Network analyzer suitable for frequencies above 10 GHz. He also tinkers with LNAs and rotors.

Elmar: About orders via web shops: the transport time is currently very long, up to 2 months. Shipping costs have also gone up considerably.

Closure .

This first "zoom session" can be considered successful; the number of participants (approx. 14) was greater than the last 'real' meeting in March. Hopefully we will see each other "really" again in September, in Utrecht, but also with a zoom session for those who cannot travel to Utrecht.

Rob Alblas
(secretary AI)

satellietstatus

Arne van Belle, June 20 2020

POLAIR	APT (MHz)	HRPT (MHz)	Overkomst
NOAA 15	137.620	1702.5	Morning/evening, HRPT weak + sync problems
NOAA 18	137.9125	1707.0	Early morning/afternoon
NOAA 19	137.100	1698.0	noon/night
FengYun 3A	-	1704.5	AHRPT 2.80 Msym/s
FengYun 3B	-	1704.5	AHRPT 2.80 Msym/s
FengYun 3C	-	1701.3	AHRPT 2.60 Msym/s, off at the moment
FengYun 3D	-	7820.0 X-band	noon MPT 30 Msym/s
Metop-A	off(137.100 LRPT)	1701.3	LRPT/AHRPT 2.33 Msym/s
Metop-B	-	1701.3	Alleen AHRPT 2.33 Msym/s
Metop-C	-	1701.3	Alleen AHRPT 2.33 Msym/s
METEOR M N2	137.100 LRPT	1700.0	LRPT QPSK 72k /MHRPT
METEOR M N2-2	off(137.900 LRPT)	1700.0	LRPT OQPSK 72k /MHRPT
NPP	geen	7812.0 X-band	HRD 15 Mbps
JPSS-1/NOAA 20	geen	7812.0 X-band	HRD 15 Msym/s

NOAA 15, 18 and 19 are the last satellites that still broadcast APT.

METEOR M N2-2 has been hit, most likely by a micro-meteorite. It changed orbit suddenly en is depressurized. They have control back but due to overheating of the batteries they had to switch off LRPT. MHRPT is only on when solar panels are lit

NPP (NPOESS Preparatory Project) and JPSS-1 (NOAA-20) only broadcast on the X-band at 15 Mbit/s. A tracking dish with a diameter of 2.4 meters is recommended! [2]

FengYun 3A, 3B and 3C broadcast AHRPT, this can only be received with the new QPSK receiver from Harrie and Ben. This AHRPT is not entirely according to the standard so that even a Metop AHRPT receiver is not suitable for the FY-3 series!

FengYun 3C also has a different data rate than 3A and 3B and broadcast on X-band with LHCP. Rob Alblas has expanded his GODIL decoder and can now demodulate HRPT, Meteor HRPT, METOP and FY3A / B and FY3C in the 1700 MHz band!

Recently FY-3C does not transmit on 1701.3 MHz.
Like NPP and JPSS-1, FY-3D only broadcasts on the X-band!

GEOSTATIONAIR	APT (MHz)	(SDUS)/PDUS (MHz)	Baanpositie
MET-11 (MSG-4)	no LRIT	1695.15 HRIT	0 degree, operational
MET-10	no LRIT	1695.15 HRIT	9.5 degree E, RSS
MET-9	no LRIT	1695.15 HRIT	3.5 degree E, RSS parallel operation
MET-8	no LRIT	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	1691 LRIT	1685,7 GVAR	60 degree W, Backup
GOES 15	1691 LRIT	1685,7 GVAR	128 degree W parallel with GOES 17
Elektro-L2	1691 LRIT	1693 HRIT	78 Degree E, via Eumetcast
Elektro-L3	LRIT	HRIT	165.8 degree E, in test phase
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	1681HRIT	99.5 degree E, Operational

Launches	
Meteor-M2-3	expected August 2021

Unfortunately, DVB-S and most “DVB-S2 without VCM” receivers are no longer usable for EUMETCast. With a special driver, some recent DVB-S2 receivers can still be made suitable for Basic Service Only. (only the TBS-5980 and Skystar 2 eXpress HD, unfortunately this does not apply to the Skystar HD USB box)
The signal at 10 degrees east has a larger bandwidth and is therefore weaker than before.
Recommended dish diameter is 80-90 cm for Basic Service and at least 120 cm for High Volume Service 1 and 2

The 2nd EUMETCast TP2 transponder is set to 11387.500 MHz Horizontal and broadcasts HVS-2. The Symbol Rate and mode is the same as HVS-1 (33000 kSym/s DVB-S2, CCM mode, MODCOD 16APSK2 / 3).
For good reception the same applies as for HVS-1, in good weather a 90 cm dish is sufficient, but a 120 cm is recommended.

After requesting, users can receive live GOES 16 and 17 data on TP1 / HVS-1. Unfortunately this is in NetCDF format. In addition to SNAP, EUMETCastView by Hugo van Ruys can also display this. [3]
David Taylor has written the excellent GOES ABI Manager for Goes 16 and 17 NetCDF data. [4]

Due to "congestion" in the TV satellite world, we see that more and more transponders are being used on Eutelsat 10A. For optimum signal quality (SNR) you must rotate (Skew) the LNB in such a way that vertical transmitters are weakened as much as possible. A moderate or poor quality LNB can suddenly cause problems if it has poor attenuation for the vertical signals. This is called Cross-polarization. This value should be better than 22 dB and indicates how much a vertical transmitter is weakened if the LNB receives horizontally.
Dishes smaller than 120 cm have a larger opening angle and may experience more interference from neighboring satellites.

Eumetsat recommends repeating the fine alignment of your dish every year and paying attention to the correct rotation (Skew) of the LNB. If possible, also check the focus (sliding in and out towards the dish).
If the old SNR values are no longer achievable, it may be necessary to replace the LNB with one with better "Cross-polarization Isolation". [5]

With a splitter you can connect a second receiver to the same dish / LNB and receive Transponder 2 at the same time. The same PC runs 3 instances of Tellicast, for BAS, for HVS-1 and for HVS-2. If you also want to save all data then you must use a ram disk and multiple hard disks or a fast SSD.

The TBS dual or quad tuner cards are able to receive both transponders at the same time and have a build-in splitter/switch. Unfortunately the Ayecka SR1 cannot decode both TP1 and TP2 although it has dual tuners.

Eumetsat has released an update for Tellicast, TC 2.14.5. In addition to improvements, the license can handle up to 500 Mbit/s instead of 200. The channel files are also completely revised. Make a backup of your old ini and channels file in advance! The software update arrives 2x every day on Eumetcast on “Info-Channel-1”
This update is only necessary if you have problems with the reception of HVS-1 or 2.
If you have problems with Tellicast, Eumetsat advises you to upgrade first.

Eumetsat is now testing with the addition of certain Metop-C and Meteor-M N2 data, which will soon also be available via EUMETCast.

Himawari-8 images are now broadcast every 10 minutes via EUMETCast. Because this concerns all 16 spectral channels with a resolution of 2 km, these are transmitted via HVS-1 under channel E1H-TPG-2. Unfortunately, this stopped the half-hourly Himawari-8 images on the Basic Service on 10 October.

GOES 16 channel B01 is now available so that you can make "real" RGB images.

With effect from 15 January 2019, a license is no longer required for the hourly Meteosat data.
For the more frequent data and that of many other satellites, however, a license (including 3 annual renewal) is required. You still need your EKU for this.

Now that we have had the spring “solar outage” for EUMETCast it is recommended to check your LNB for damage ! A burst cover can be repaired using plexiglas and transparent silicone.

[1] Meteorontvangst met RTL dongle
[2] Info van NOAA20
[3] EUMETCastView
[4] GOES ABI Manager
[5] EUMETCast Europe Link Margins Explained.

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