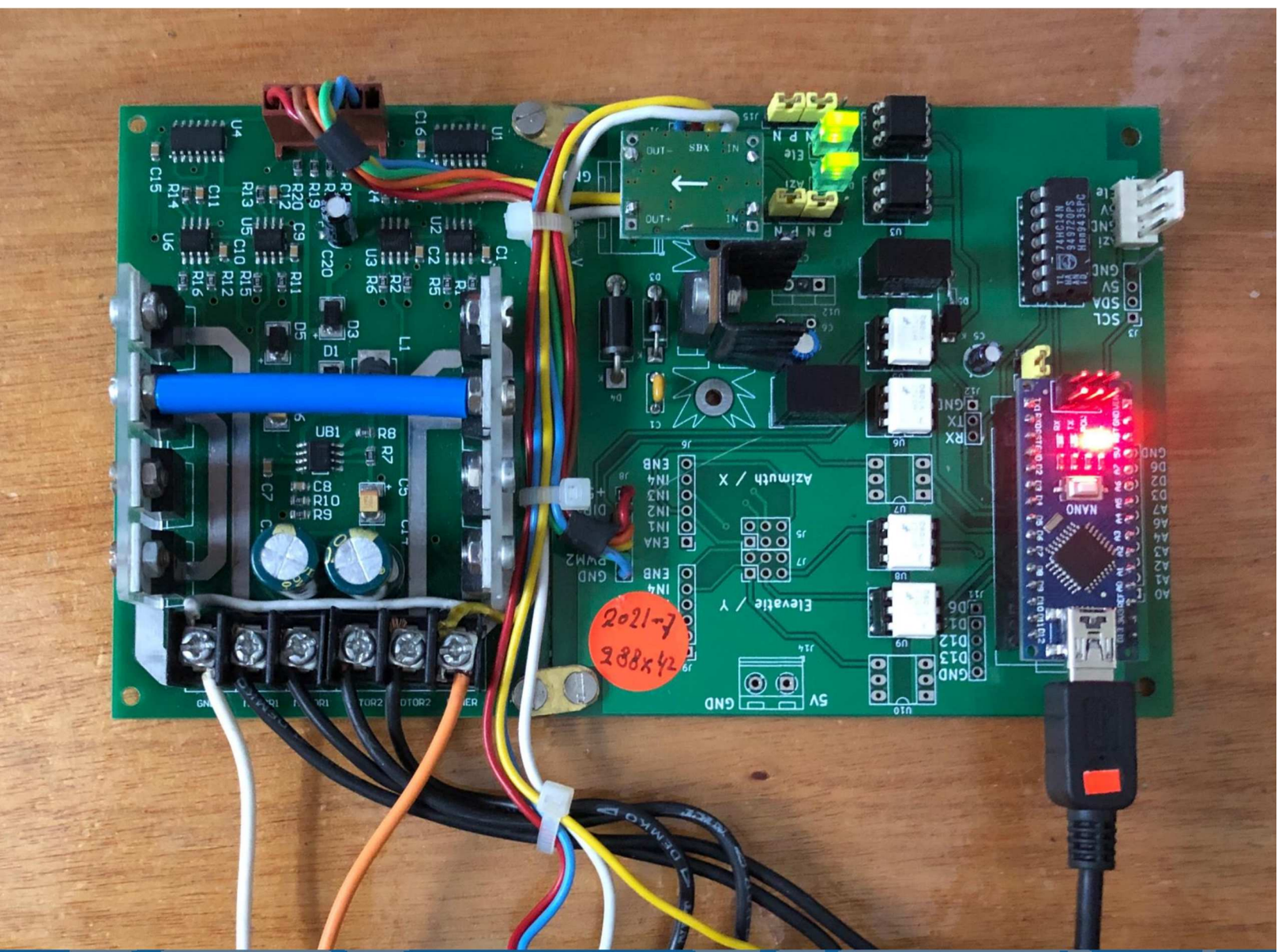
DE KUNSTMAAN

September 2021 – 48e jaargang nr. 3

Uitgave van de Werkgroep Kunstmanen



In dit nummer o.a.

- Rotorsturingsprint 2021
- Een aluminium behuizing maken
- GHz activiteiten van PE1FOT
- 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.

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werkgroep Kunstmanen
kunstmanen@alblas.demon.nl

Content

Photo front page:
Prototype rotorcontrol PCB built by Peter Smits.

Preface

Physical meeting

After a year and a half we reunited in the Nimeto. It was not a regular meeting but a General Members Meeting, the report can be found later in this Kunstmaan. A total of 13 members were present and three members via Zoom. It was nice to see everyone again and catch up. This is much better than via Zoom.

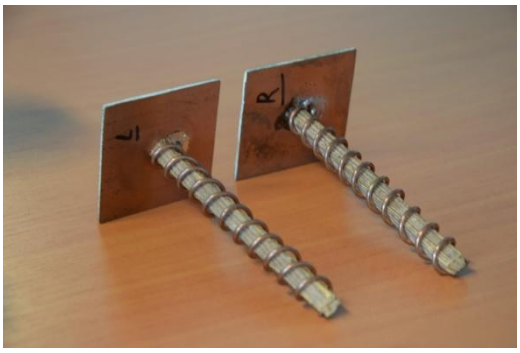
Because the canteen of the Nimeto is being renovated, the board had offered a snack and a drink which was gratefully used. We have a large room at our disposal. The big advantage compared to the canteen is that we are not disturbed by other groups during the presentations. The November meeting will also take place in this room.

What we still need to look at is how we can better let our members participate in the meeting remotely. Walking around with a laptop is not ideal. Especially because the laptop has a directional microphone and the sound does not always come across well or not at all. An extra loudspeaker is also useful if the members speak from a distance.

Despite the library being stored in moving boxes, Paul has many publications displayed on his table.

The library is open again!

Harm brought a lot of tinkering, such as filters, LNA, patch antenna and helicals for the 8 GHz. Hendrik showed self-turned worm wheels and a rotor control system similar to the antenna in Effelsberg.



Helical antennas for the 8 GHz

On the left Hendrik's rotor, after the idea of the radio telescope in Effelsberg. Look for the differences!

De Kunstmaan

Rob has developed the lecture that Frans gave at the May meeting into an article worth reading. We have put the presentation on our website.

Harm comes with his sequel to his article "A special artificial satellite". Herein a description of an "artificial satellite" for the 8 GHz. The starting point is an ADF4351 with a three-stage multiplier, both on the transmitting and receiving side. Harm demonstrated the set-up at the last meeting with 28mm copper tube as waveguide in the function of coupling between measuring transmitter and receiver.

Paul has researched the UKW-Message and has also written a contribution from the library.

Rob has written the report of the General Members' Meeting.

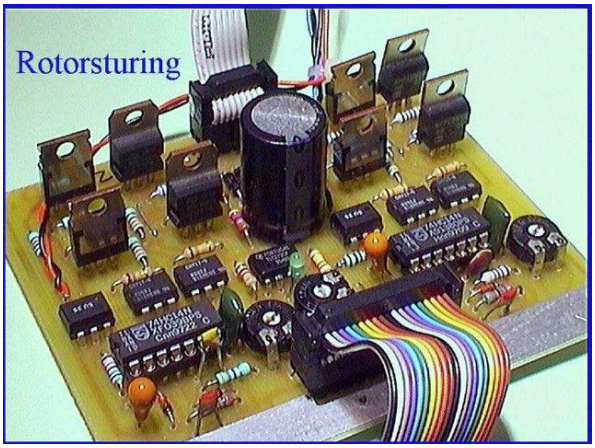
I wrote an article about the new rotor control PCB, suitable for DC motors with pulse counters. I've also been busy with metalworking lately, especially making housings. I have put my findings in an article.

Have fun reading this Kunstmaan and hopefully we'll see each other again at the meeting on November 13.

Rotor control PCB 2021

Introduction

Several members have recreated Harrie van Deursen's rotor control system. This rotor control consists of a small PCB with two H-bridges and opto-couplers. A 20-pin ribbon cable is used to connect to an Elektor 8052 processor board from 1991! The azimuth elevation or XY data is sent to the processor board via the serial port. Harrie's design has stood the test of time and has worked flawlessly for me for a decade.



Rotor control board from 2000 designed by Harrie

Rotors and rotor control are now a tricky subject. It involves mechanics and sometimes you have to work metal. It must be suitable to function in wind and weather. In any case, for me it was the "closing post" in the construction of a receiving station.

Rotor Discussion

In order to make the threshold of the rotor / antenna control as low as possible, we held a discussion at the March 2020 meeting about what an ideal rotor control would be. No clear “winner” has emerged from this discussion. But the DC motor with pulse generators has certainly not yet been written off.

It emerged from the discussion that the design had to be reliable, and that has become a problem with Harrie's design:

- You have to etch the prints yourself. For the enthusiasts: we still have the films with which you can expose the printed circuit board.

- If you use the Elektor processor board, you have to program EPROMs. The parts are still for sale after 30 years

- Harrie's rotor control is designed for 36V motors. I myself use 24V motors and this works just fine. 12V motors cannot be used because voltage dividers are used to drive the MOSFETs. There is then too little voltage to open the MOSFETs properly.

Starting points for a new rotor control

- As a microprocessor we have chosen the Arduino Nano. It is small and can be easily mounted on the PCB.

- Use opto-couplers to keep out interference. For example, there is a full galvanic isolation between the Arduino / PC side and the rotor control with the motors.

- We have not included the H-bridges on the PCB. It really doesn't pay to build it yourself. Apart from that, should a MOSFET fail, you will have to replace it. It is very difficult to desolder from a through-metallised PCB without damage.

Any one that is suitable for digital (5V) control can be used for the H-bridges. In the design we have taken into account L298N modules and a heavier IRF3205 driver board.

What must be known prior to construction

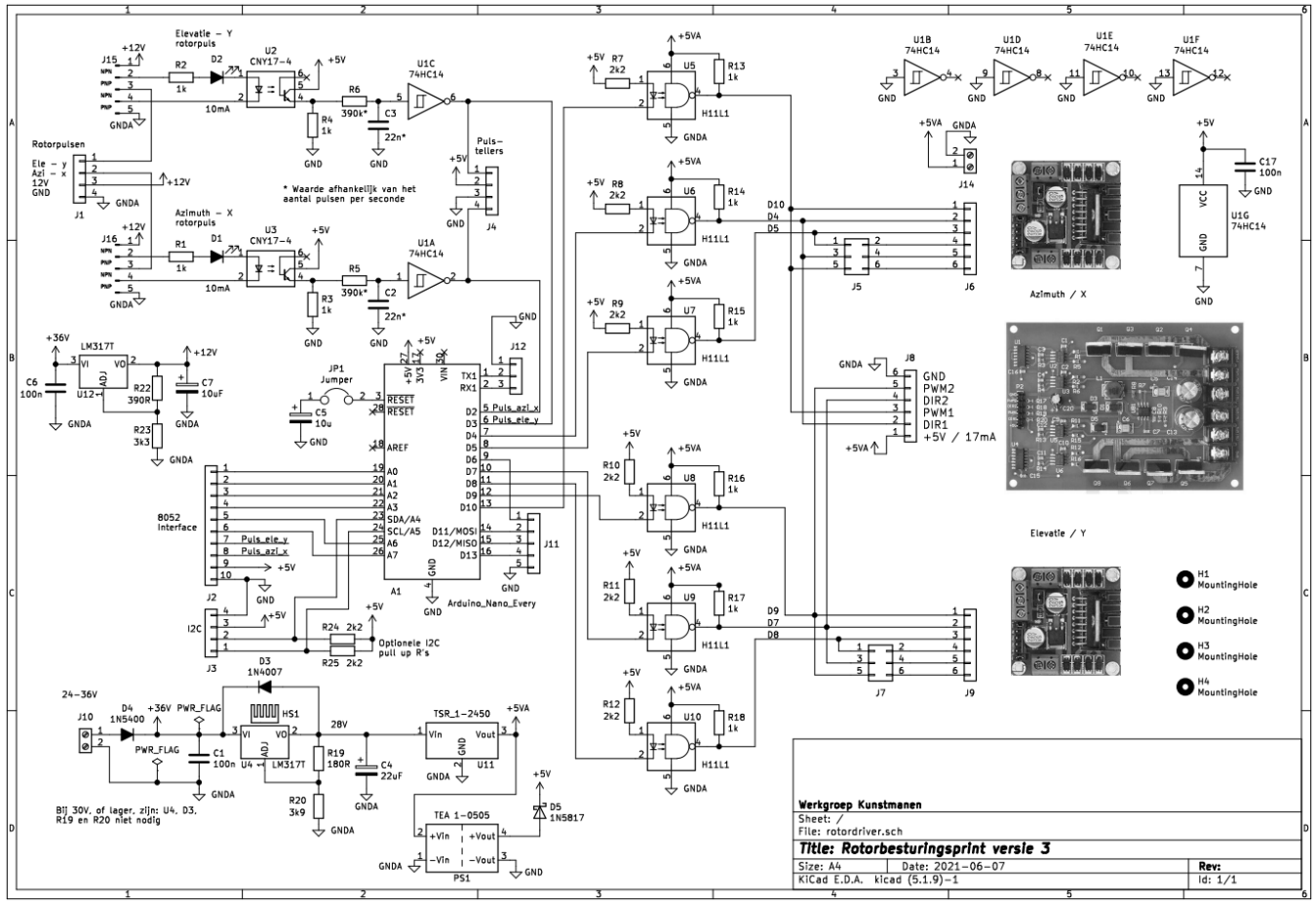
A number of things must be known before the construction of this rotor control can be started:

- How much voltage do the DC motors require and how much current do they draw.

- What is the number of pulses per second that the pulse generators deliver and what is the duty cycle? Because there are low-pass filters on the PCB, they may need to be adjusted.

- Switch the pulse generators as NPN or as PNP transistors. How much current do the pulse generators draw?

I will come back to this in detail when discussing the scheme.


Elevatie – Y rotorpuls
Azimuth – X rotorpuls
Rotorpulsen
Ele – y
Azi – x
12V
GND
* Waarde afhankelijk van het aantal pulsen per seconde
Puls-tellers
8052 Interface
Puls_ele_y
Puls_azi_x
Arduino_Nano_Every
Optionele I2C pull up R's
24–36V
Bij 30V, of lager, zijn: U4, D3, R19 en R20 niet nodig
TSR_1-2450
TEA 1-0505
PS1
Azimuth / X
Elevatie / Y
GND
PWM2
DIR2
PWM1
DIR1
+5V / 17mA
H1 MountingHole
H2 MountingHole
H3 MountingHole
H4 MountingHole
Werkgroep Kunstmanen
Sheet: /
File: rotordriver.sch
Title: Rotorbesturingsprint versie 3
Size: A4
Date: 2021-06-07
KiCad E.D.A. kicad (5.1.9)-1
Rev:
Id: 1/1

Description of the schematic

Power supply

The rotor control PCB can be supplied with a voltage of up to 36V. Incidentally, the current for the motors does not run through this PCB, but goes directly to the PCBs with the H-bridges.

Depending on the chosen motors, you will have to choose a suitable power supply. You can also connect this rotor control to this power supply.

If you use 36V motors, U4, an LM317, is often needed because it lowers the voltage to 28V. Some switching regulators may not have more at the input.

At the input of the power supply is U12, also an LM317. This has the sole purpose of feeding a possible pulse generator in the rotor. Here it is sized as a 12V power supply. Because U12 is not equipped with a heat sink, it must not be heavily loaded.

If you have 24V motors, U4 (and D3, R19 and R20) can be omitted and D4 can be connected directly to the TSR-1-2450.

If you have 12V motors, U12 (and R22 and R23) may also be omitted. This depends on the voltage for the pulse generators.

The TEA1-0505 is a galvanic isolation for the 5V, which the Arduino needs. This TEA1-0505 is optional, as the Arduino can also be powered via the USB port. If you don't use the TEA1-0505, U2, U3 and the 74HC14 will also be powered from the USB of the Arduino.

Resetting the Arduino

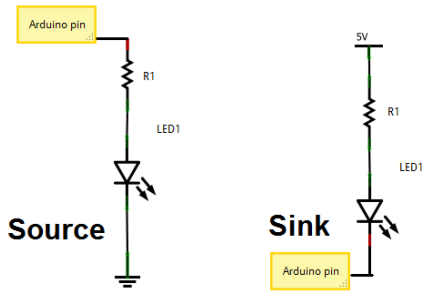
If you choose to power the Arduino via the USB port, the Arduino will always be on when the computer is on, even if you are not receiving satellites. The only way to reset the Arduino is to press the reset button on the Arduino nano. When the print is built-in, this is difficult to reach. You should put a reset switch in parallel with "JP1+C5", the Arduino will also reset.

If you want to prevent the Arduino from resetting when the serial port is opened (this is the standard behavior of the Arduino), you have to put jumper JP1. When the Arduino needs to be programmed, JP1 needs to be removed.

Optocouplers

In the schematic we see six optocouplers at the outputs of the Arduino. These are of the H11L1 type and are suitable for directly driving digital circuits up to a data rate of 1 MHz and have a built-in Schmitt trigger.

If you would connect the H11L1 standard (as current source, LED to the Arduino and GND), then it is inverting. This is especially not useful for the PWM (speed control of the motors). But you can also sink the Arduino. If you then put a logic one on the output, no current flows through the LED. Because the optocoupler is inverting, there is a logic one on the output.



Arduino pin as current source and sink.

Then we have the optocouplers where the rotor pulses come in. The CNY17-4 optocouplers were chosen here because a low-pass filter (R6/C3 and R5/C2) is present to suppress any interference pulses (which come from PWM control of the motors).

Low pass filter

The dimensioning of the low-pass filter depends on the encoder. If you have a spinning disc with a single hole, the duty cycle is very low. When you make a pennant, you can go to a duty cycle of 50 percent.

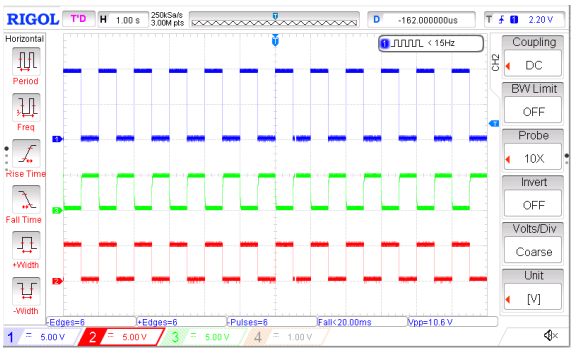
The low-pass filter must allow the pulses of the rotor to pass undisturbed but suppress any interference pulses.

I did some measurements with my signal generator:

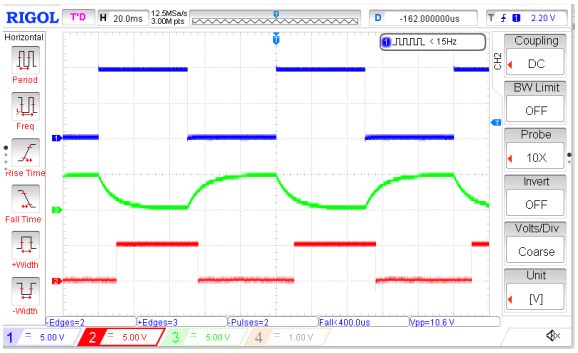
Measurement channel 1, blue: on pin 1 of J1, where the rotor pulses come in, but now from the signal generator.

Measurement channel 2, red: on pin 1 of J4. This is the output for an optional pulse counter. This signal goes to the Arduino.

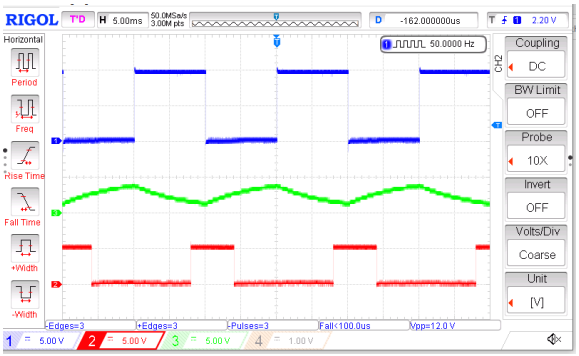
Measurement channel 3: green: after the low pass filter, on the input of the 74HC14.



Frequency: 1 Hz, duty cycle 50%, time base 1s



Frequency: 10 Hz, duty cycle 50%, time base 20 mS



Frequency: 50 Hz, duty cycle 50%, time base 5 mS

The higher the frequency, the shorter the pulse from the 74HC14 and you'll get a shift (which isn't a big deal). Above 65 Hz nothing gets through.

For the duty cycle below, the maximum frequency is as follows:

20% - 19 Hz

30% - 29 Hz

40% - 44 Hz

50% - 65 Hz

You can of course always resize the filter if the pulse frequency is too high.

Ideally you should have a duty cycle of 50 percent because this allows you to make the pass curve of the low pass filter as low as possible.

Description of the connectors

Below I want to continue with a description of the connectors. This will further clarify the operation of the rotor control PCB.

The connections on the rotor side

J10 - The power supply to the rotor control board. This can come from the same power supply as the motors.

J1 - This is the connection for the rotor pulses. The 12V and GND is for powering a pulse generator. This depends on the type of rotor / encoder that is used!

J15 - Encoder type for the elevation or y-axis: With two jumpers you indicate whether the encoder switches to GND (NPN) or to the plus (PNP).

J16 - As J15 but for azimuth or the y-axis.

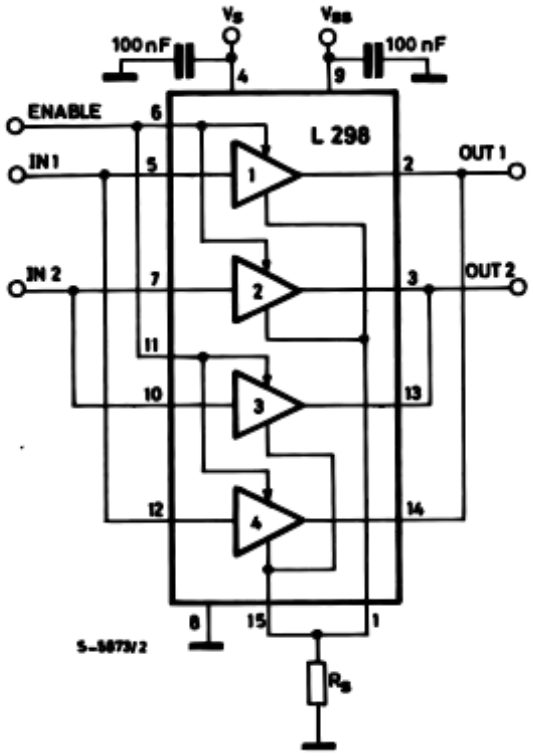
J14 - This is a 5V output when using the L298N modules.

J8 - This connector is for connecting the IRF3205 driver board.

J9 - For connecting the L298N.

J6 - For connecting second, optional, L298N. This if more power is needed for the motors.

J5 - If you place three jumpers here, the double H-bridge in the L298 will be connected in parallel and you can control one motor with a higher current. The two outputs of the L298 must therefore be connected in parallel. See also the datasheet of the L298, figure 7. We have not tested this?



Parallel connection of the inputs and outputs of the L298. From the datasheet, figure 7, more info there.

J7 - Like J5 but for the elevation / y-axis.

J5/J7 - If you place three jumpers between J5 and J7, you can connect an L298N module to J9 that can control two motors.

If you don't put jumpers on J5 and J7, you need two L298N modules that are half used.

The connections on the PC side

J2 - Is an optional connector that brings out all other Arduino pins. You could use these to connect the old 8052 board. The Arduino must then have a separate program. This has not been tested.

J3 - An optional I2C connection.

J12 - The serial port of the Arduino is connected to this. You will not use this because communication will go through the USB port of the Arduino.

J11 - Optional port.

J4 - For connecting optional pulse counters, so you can quickly see what is happening.

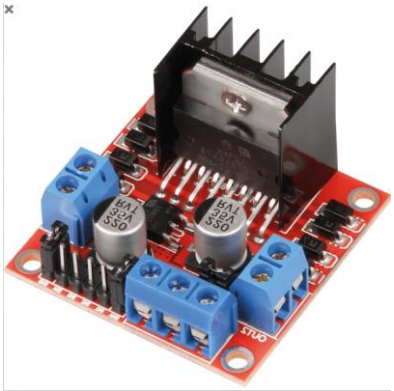
LEDs must be connected to D1 and D2. These also indicate that the rotor is spinning. Depending on the pulse duration, this is more or less visible.

Arduino

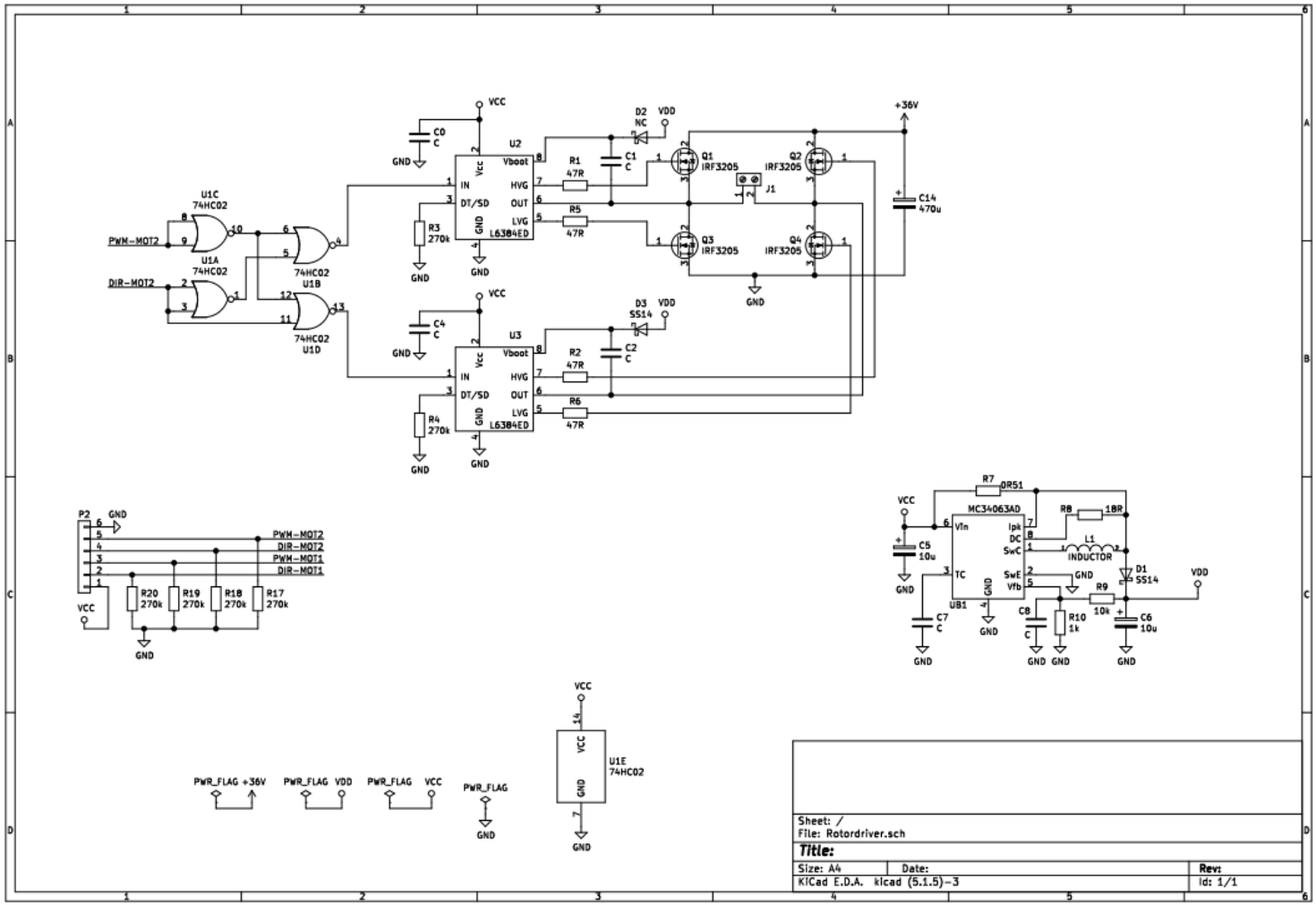
The software for the Arduino is already on github and can be downloaded there [1].

L298N driver board

For four to five Euros you can buy an L298N driver board. This module with the L298 is suitable for controlling two motors up to 35V and 2A. In addition to the L298, there are protection diodes on it and a 78M05 for powering the L298. The 78M05 may only be used up to 12V, otherwise it will get too hot.



L298 driver board


VCC
C0
C
GND
U2
Vboot
HVG
OUT
LVG
L6384ED
IN
DT/SD
GND
Vcc
R1
47R
C1
C
D2
NC
VDD
Q1
IRF3205
Q2
IRF3205
Q3
IRF3205
Q4
IRF3205
J1
+36V
C14
470u
R3
270k
R5
47R
U1C
74HC02
U1A
74HC02
U1B
74HC02
U1D
74HC02
PWM-MOT2
DIR-MOT2
C4
C
U3
R2
47R
C2
C
D3
SS14
R4
270k
R6
47R
P2
PWM-MOT2
DIR-MOT2
PWM-MOT1
DIR-MOT1
R20
270k
R19
270k
R18
270k
R17
270k
R7
0R51
MC34063AD
Vin
Ipk
DC
SwC
SwE
Vfb
TC
UB1
R8
18R
L1
INDUCTOR
D1
SS14
R9
10k
R10
1k
C5
10u
C6
10u
C7
C
C8
C
PWR_FLAG +36V
PWR_FLAG VDD
PWR_FLAG VCC
PWR_FLAG
U1E
74HC02
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Title:
Size: A4
Date:
Rev:
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The IRF3205 driver board

For about 15 Euro you can buy a motor driver on eBay, AliExpress or Amazon (search for “IRF3205 driver”) that can deliver up to 10A.

It might be interesting to take a look at the IRF3205 driver board. The diagram on the previous page is based on the print layout and is therefore not the official diagram. A section for one engine has been drawn.

The circuit around the MC34063 supplies around 14V, which goes to the L6384ED. The N-channel MOSFETs on the low end (Q3 and Q4) of the circuit require 7V or higher to conduct. To make Q1 and Q2 conductive on the high side, much more voltage will be needed, because the source is on the motor and not on GND. The L6384 takes care of this high voltage. So with this design you can make an H-bridge using only N-channel MOSFETs that are up to 600V! can switch.

This board needs edges on the input, so a PWM of 100% will not work. And at a high PWM frequency the duty cycle should not be too close to 100% either, because then the pulses become too narrow. This is arranged in the Arduino software.

Build

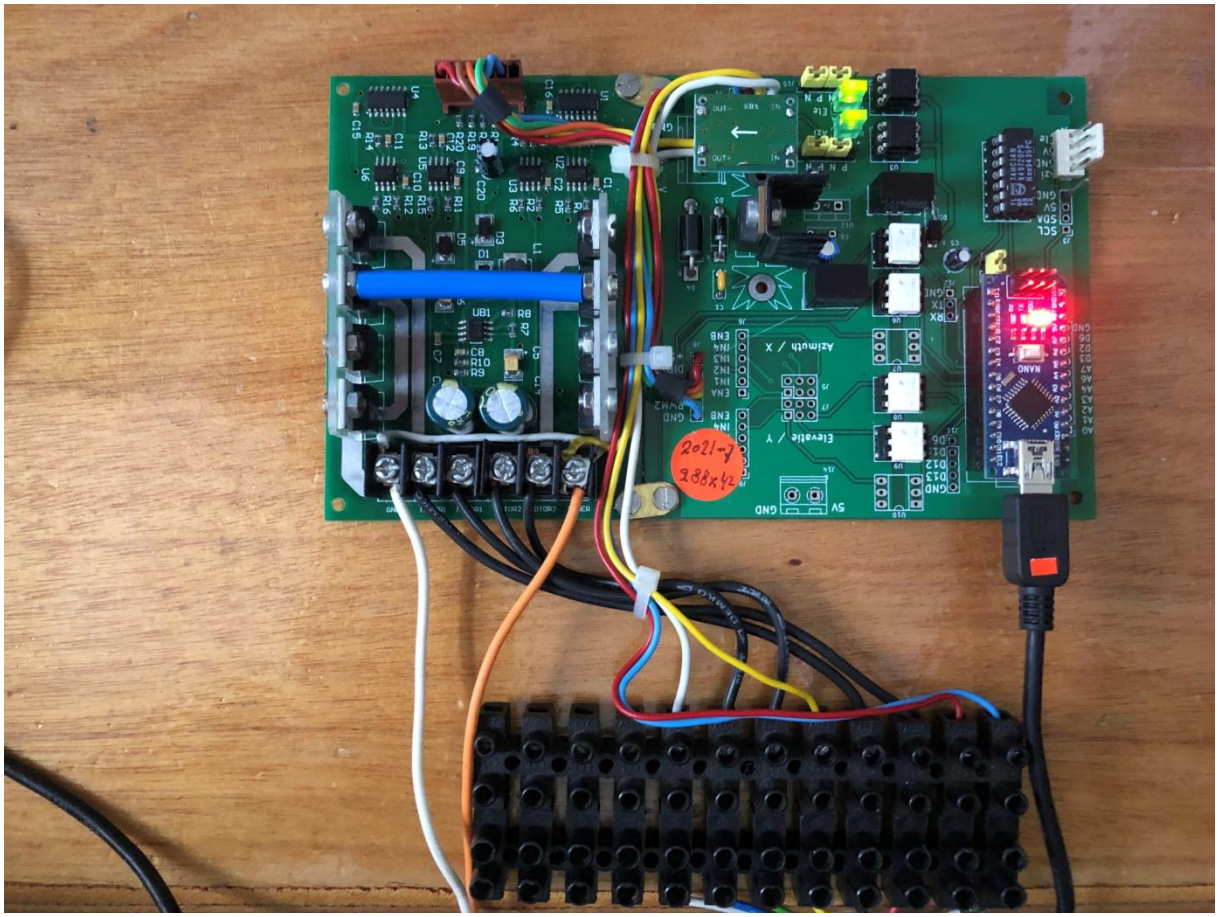
The build of the PCB will not cause many problems. At the bottom of the PCB are 0805 SMD parts, don't forget to install them. I always mount ICs in sockets. It is useful for experiments and fault finding and desoldering from a metallized PCB often does not work without damage. Note that the orientation of U2 and U3 is the other way around compared to U5 - U10.

A heat sink is provided for U4/LM317. Depending on the supply voltage, this may or may not be necessary.

You can mount the PCB in a housing consisting of aluminum profiles. The sides of the PCB have no ground plane so that the galvanic isolation remains intact.

Depending on your I2C bus you will have to mount the pull-up resistors R24 / R25.

To avoid crosstalk of the 10 kHz PWM control of the motors on the encoders, the wiring of the encoders must be well shielded, as well as the wiring to the motors separately.



Built prototype by Peter Smits

Closing remarks

What's not in it

This rotor control PCB has no short-circuit protection for the motors. Neither the L298 nor the IRF3205 motor driver have this. Now the IRF3205 motor driver will be a bit more insensitive as it can handle up to 30A peak load. But in the event of a short circuit (this happens when the motor seizes), something else will break. Keep this in mind! This is a topic for a future article.

There is a check in the software that if a motor is switched on and no pulses are returned, this is an error condition.

You will also want to do something about suppression from the motor driver, because the motors are controlled with PWM.

What connectors and cable are you going to use to get to the rotors?

Calibration is something that is arranged in the software of the Arduino. With this design of the rotor control system with DC motors, you use a limit switch. It is better to have a light barrier well before the limit switch so that you can slow down and there is no abrupt stop.

My thanks go to Rob Alblas and Peter Smits for building and testing the various prototypes.

I still have a few prints. Interested parties can contact me. You will lose about thirty euros on parts.

links

[1] Rotor control Arduino on github

A special ‘satellite’, continued

Harm de Wit

The previous contribution was about a “satellite” in the L-band, what now follows is a “satellite” for the X-band. On closer inspection it is very simple: transform the generated signal on the L-band to the X-band.

In order not to be too stubborn, I contacted Frans van Elk (PE1FOT). We have known each other for several years. Frans is a real "maker" in the field of microwaves and ATV; he has made everything that is needed for that. He is also one of the organizers of the Heelweg Microwave meeting.

The starting point is an RF generator realized with a synthesizer board on which an ADF4351 is located. To make an X-band beacon, this is followed by a tripler to 8 - 9 GHz (design Frans van Elk). The synthesizer boards come from China and with the prints from Frans and the necessary equipment I was able to generate the above frequencies after a few weeks.
The starting point for the IQ modulation is the circuit described in part 1 at 1.7 GHz.
Then I searched for a mixer to convert the 1.7 GHz signal with I/Q info to 8 GHz. I found this at Linear Technology, the LTC5576 , this is an active up-mixer (upper limit 8 GHz). In order not to get into trouble with the tripler, I lowered the L-band signal to 800 MHz (lower limit AD8346).

For the reception side, the same synthesizer board + tripler is used to make a LO with a frequency of around 6 GHz. I also looked for a suitable mixer. It has become an active mixer from a dated LNB , with type number AND5118T4C. Unfortunately there is nothing to be found of datasheets anywhere, but at least it needs a positive and negative voltage.

In summary, we have a beacon ("satellite") and a downconverter so conversion from X- to L-band. In the generator, the tripler outputs 7200 MHz (3 x 2400 MHz); together with the 800 MHz signal, modulated with I/Q info, this results in an output of 8000 MHz from the mixer. So this is the "satellite” signal.

On the receive side, the tripler outputs 6296.4 MHz (= 3 x 2098.8 MHz) to make a mixer output of 1703.6 MHz modulated with I/Q. We are almost there, the last signal is now connected to the meteosat downconverter, goes further into the famous / infamous qpsk receiver and with correct tuning all the bells and whistles will ring: there is a constellation diagram, the Godil locks and via Wsat and the pc this results in a test image.

Here too the following applies: long live the satellite.

PS The experiments to transport the signal via the ether requires further investigation.

Editor's note: The I/Q generator/decoder used here has been discussed in “de Kunstmaan”, March 2011 and beyond. This is realized with a programmable FPGA, on a so-called GODIL board. It is suitable for both HRPT and QPSK. The generator makes several test images on various channels of a particular satellite; an I and Q signal is created that can be used directly to drive a QPSK modulator. With the decoder, the I and Q signals obtained from the receiver are converted back into bits for further processing.

The “special satellite” described in part 1 is intended to generate signals such as METOP and Fengyun-3A...C; for the X-band this is for the newer satellites such as NOAA20 and Fengyun-3D.
In this setup, the modulation on X-band is done with data intended for the L-band (approx. 4 Mb/s); the bandwidth is therefore lower than in reality. The newer programs for the GODIL can also generate and decode signals up to 15 Mb/s, as broadcast by NOAA20. This has yet to be tested.

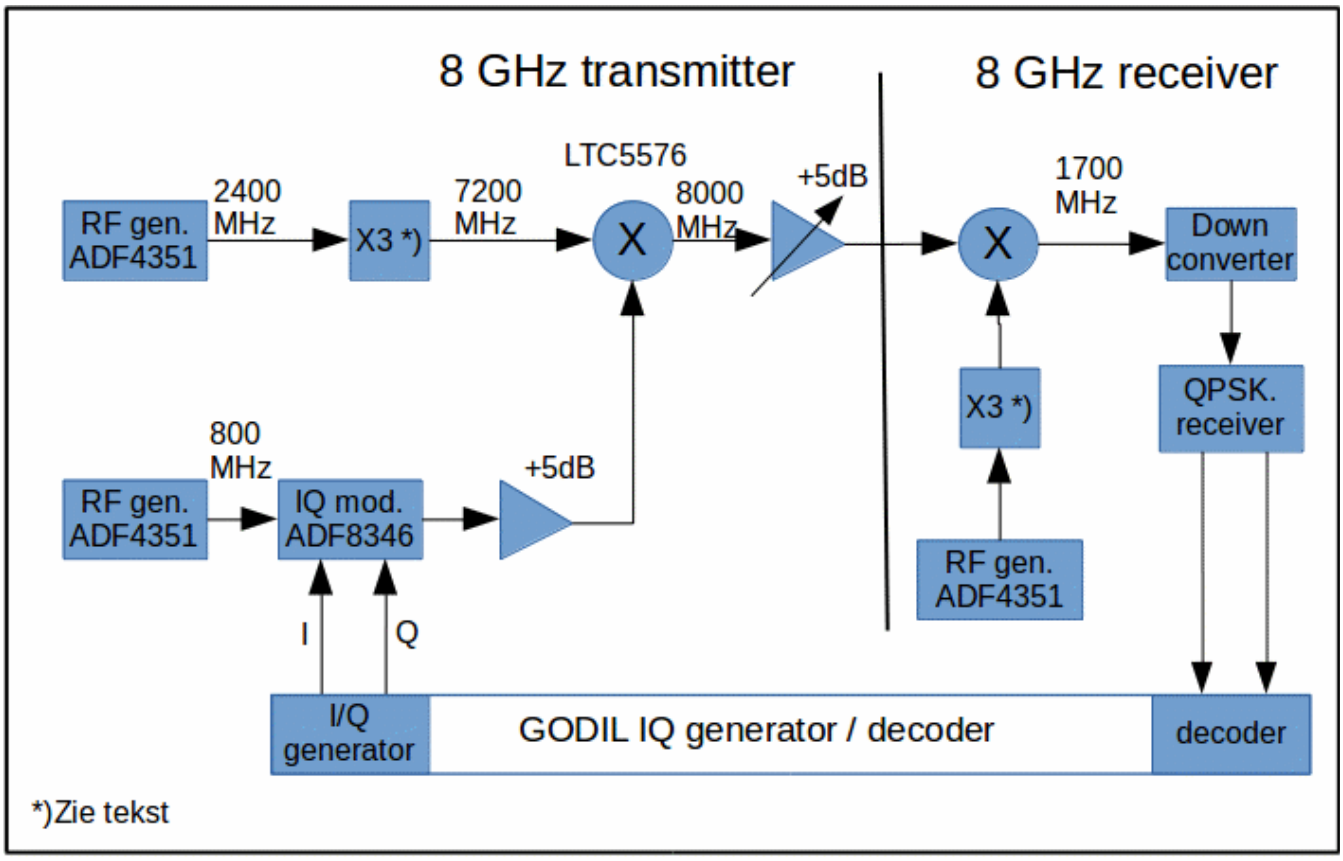


Fig. 1. Block diagram.

Fig. 2. Transmitter part; above 800 MHz generator and modulator, below the 8 GHz generator and mixer.

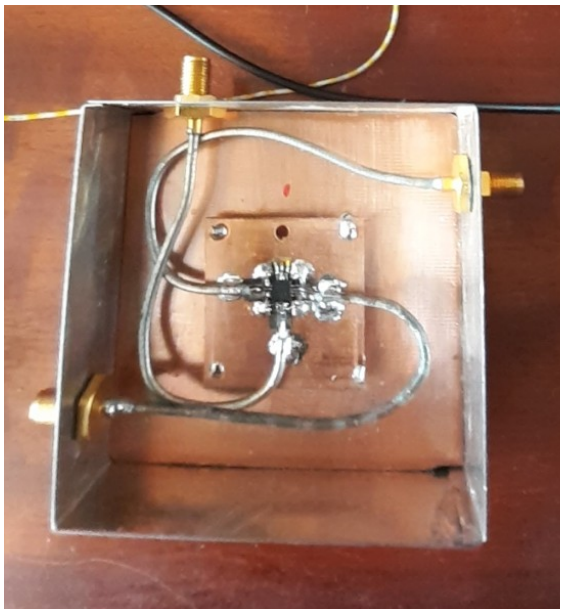


Fig. 3. The up mixer to 8 GHz.

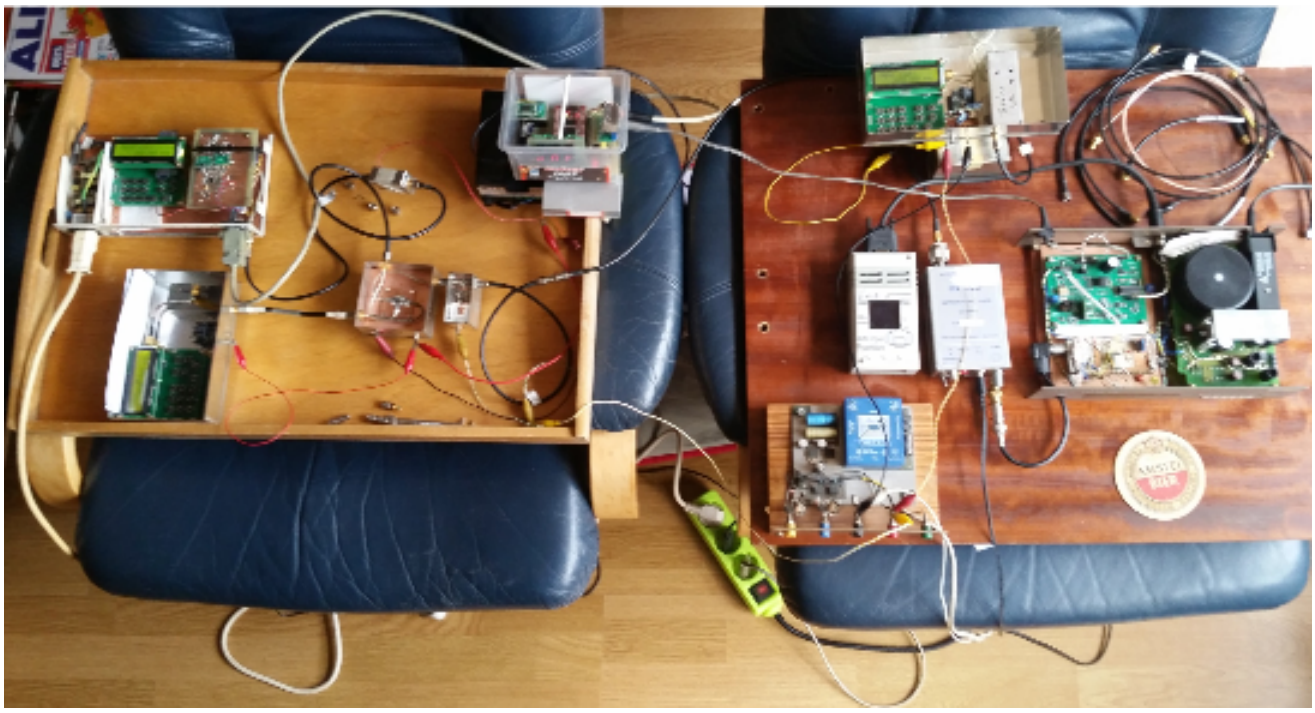


Fig. 4. The whole setup. Left: the L-band modulator and 7.2GHz synthesizer with tripler. On the right the downconverters 8 GHz→1.7 GHz→137 MHz and the QPSK receiver. In the middle the GODIL who serves here for both generator and decoder of the I/Q signals.

Presentation: GHz activities PE1FOT (Frans van Elk)

Nb In this section, reference is made to the presentation sheets as they can be found in [1].

Frans van Elk, introducing himself:

- 60 years, living in Spijk near Gorinchem, radio amateur since 1976.
- Occupation: Supply Chain-Purchase Manager in Automotive & Chemicals.
- Hobbies : electronics & mechanics. Self-taught, Out of the box thinker. Can not does not exist!
- Focus building equipment and antennas >1 GHz => 47 GHz (SSB and ATV)
- Building in modules after many "print" projects that didn't work
- Co-founder of the Heelweg Microwave meetings.
- www.pamicrowaves.nl

What this presentation is about:

- Possibilities use 5.7 and 10 GHz designs on 7-8 GHz, based on Harm de Wit's project on 8 GHz.
- MMIC Multipliers
- LNA
- There is a lot of information about 8 GHz on the internet.

Multipliers

A frequently used module is a MMIC multiplier. MMIC stands for Monolithic Microwave Integrated Circuit. Why MMIC?

- Inputs/outputs are 50 ohms
- they are stable, simple print design, cheap, give a lot of power

For frequencies < 3 GHz FR4 epoxy 0.8 mm is used, for > 3 GHz: ROGERS RT 4003 or Teflon 5870 0.5/0.8 MM

Overdriving the MMIC produces harmonics. Based on the setting specified by the manufacturer, the desired harmonic can be maximized by adjusting the current. Example: see fig. 1.

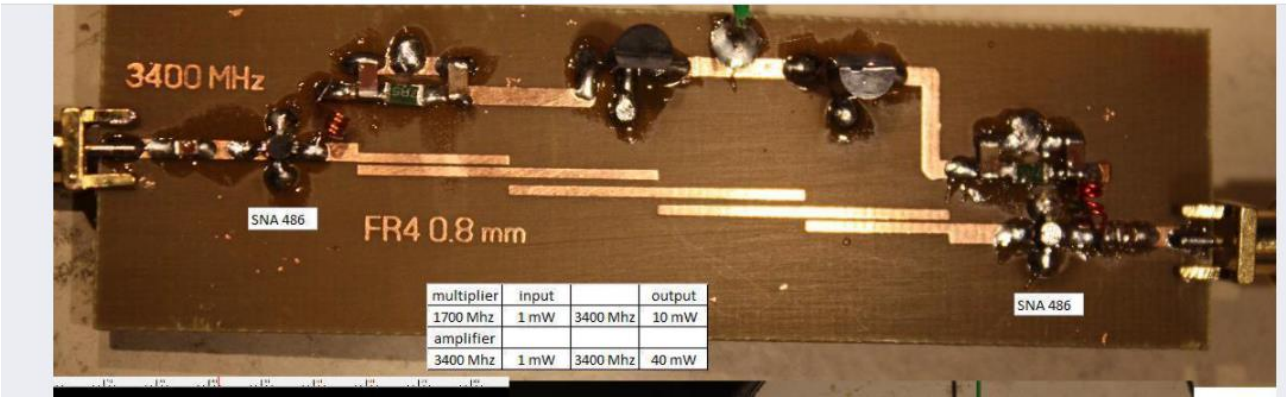


Fig. 1. Amplifier 3400 MHz, by overloading with 1700 MHz you get a doubler. On the left the FET that generates the harmonics, on the right an amplifier; the filter is in between.

What is typical for MMIC stripline multipliers:

- MESH SFET designs DB6NT, F6BVA, F1OPA etc. as base.
- Filters are coupled quarter and half wave circuits imp. 50 & 70 ohms.
- Connect input and output as strongly as possible, eg 0.1 mm. If you use an inkjet printer to make a transparency, there are restrictions on layout / exposure / etching for the hobbyist. Viewed under a microscope you see that lines are not neatly straight; you see the droplets.
- Forward and loss is determined by the number of circuits and coupling between the circuits.
- Attenuation is 6-10 dB; that's no problem; an amplifier behind it solves that problem.
- Measuring equipment e.g. sweeper is necessary

The table on sheets 9 and 10 of the presentation gives the necessary track width to make different impedances, on different materials. It can be seen that eg 70 ohms should have a track width of only 1.1 mm on ceramics; Teflon is then more favorable (1.5 mm track width).

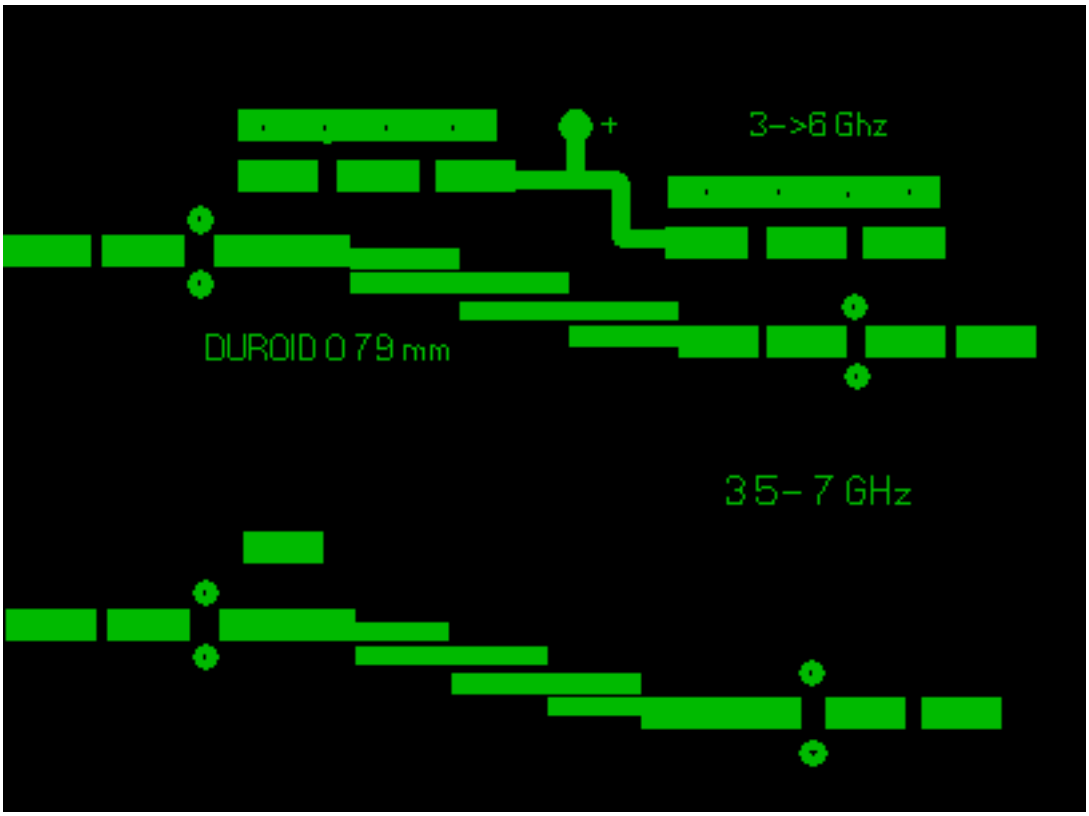


Fig. 2. Two doublers, for 3 to 6 GHz and 3.5 to 7 GHz

The drawing of the print is done with program Sprint-Layout (demonstrated by Frans). After this the result is printed on an overhead sheet. The print is provided with photo lacquer; if the print has been cleaned with acetone, the lacquer will flow out nicely. Vibrating the print also helps. If the layer at the edges gets too thick too much lacquer has been used.
(The shelf life of the paint is more than 6 years, just at room temperature.)
Then let it dry at 20 to at most 30 degrees; not in the microwave!

Fig. 3 shows a setup in which a multiplier is tested.
At the top a signal generator with ADF4351, at the bottom a frequency counter with the multiplier in between with which the setting current can be adjusted. Make sure that the input power is constant, then you can stably remove one of the harmonics with a certain bias current.

(By the way, a frequency set in the ADF does not always give the expected frequency at the output of the ADF!)

Fig. 3. Measurement setup multiplier.

With different input frequencies and with optimal setting you can get different multiplication factors, e.g.:

Input Freq.	**factor**	**output freq.**
1800	x5	9000
1900	x5	9500
2100	x4	8400
2200	x4	8800
2300	x4	9200
2400	x4	9600
2800	x3	8400
2900	x3	8700
3000	x3	9000
3100	x3	9300

The filter can be adjusted if necessary by, for example, sticking a piece of Kapton tape over the filter. See Fig. 4; in this case it yields a 500 MHz lower frequency.

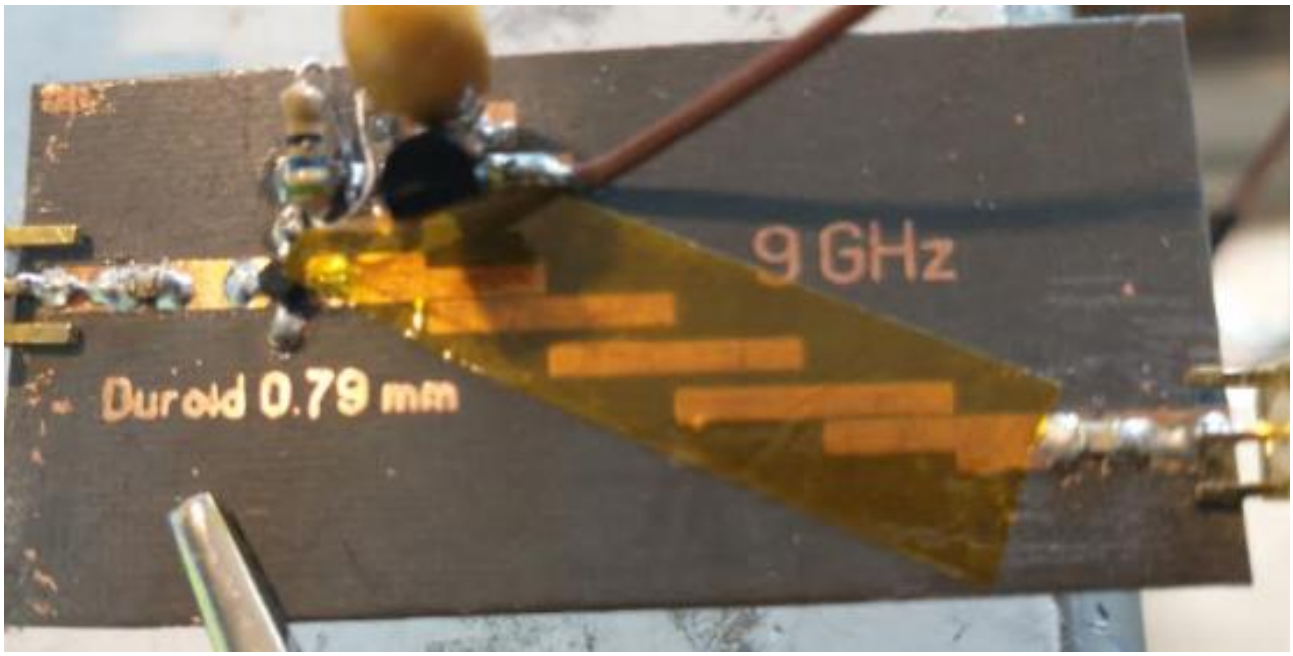


Fig. 4. Adjust frequency using kapton tape.

You can also extend the stripline a bit or take it off a bit. Again, you must be able to measure it!

As mentioned, an ADF4351 is used as generator; good and cheaper than if you have to work with crystals + surrounding electronics. The power supply for this generator is very important; noise on the power supply is reflected in the output signal and therefore also in the output signal of the connected mixer.

LNAs

Fig. 5 shows an LNA, with an NE325 GaAs-Fet. Frequency 5.7 GHz, noise figure 1.35 dB, gain 11 dB. The problem is that these amplifiers can oscillate at 3-10 GHz. To prevent this, a 0.1 ohm resistor has been added in the drain. Actually bad for noise figure and gain, but it prevents oscillation.
Fets are, for example, available from a LNA head, which you can buy for a few dollars from AliExpress. It contains 4 FETs NE321. If you can't use the head as such, you can solder the FETs out.

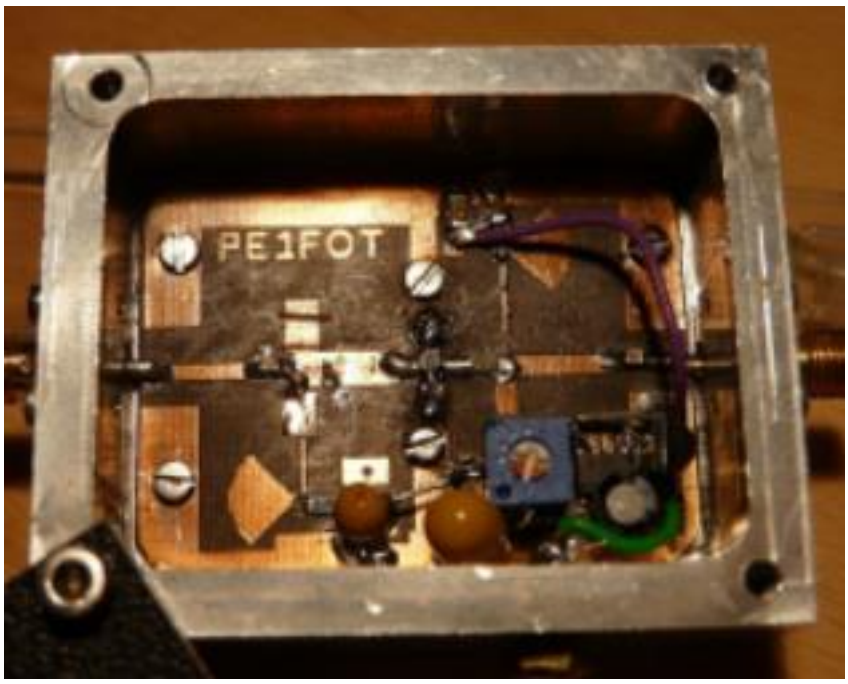


Fig. 5.

Another example, from the internet: see also presentation, sheet 30.

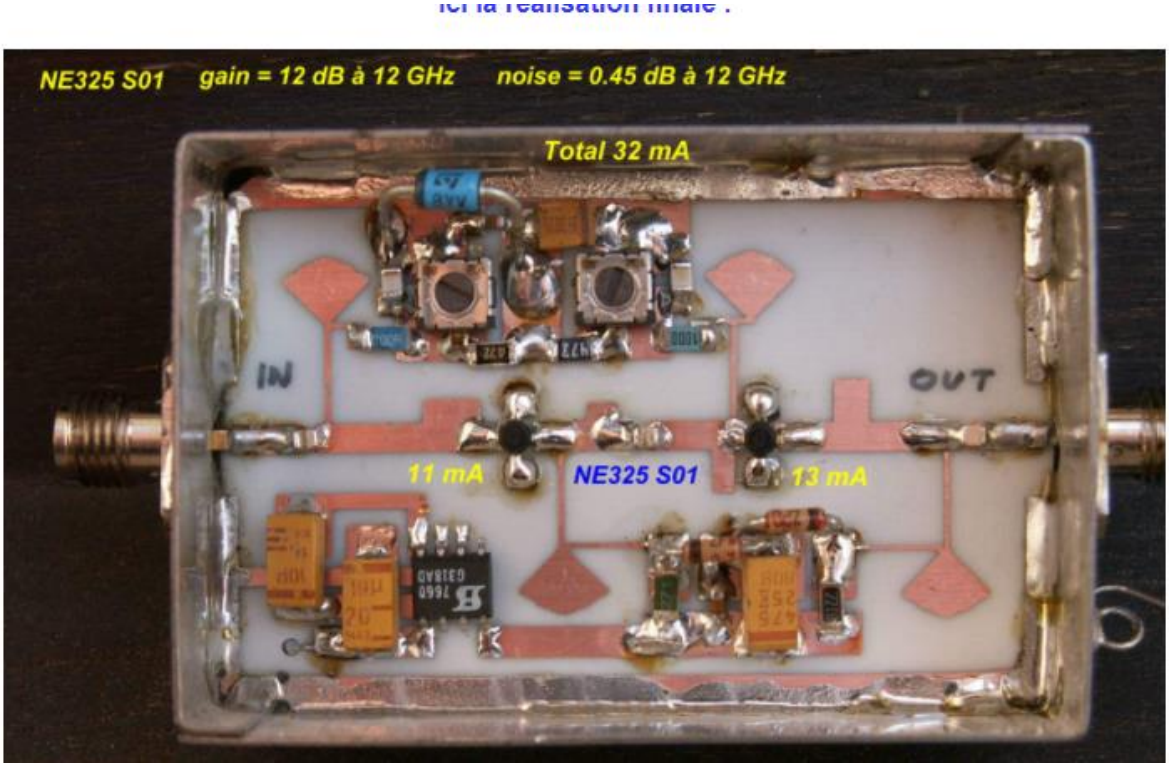


Fig. 6

This is from Albert, a French radio amateur:
http://f4fdw.free.fr/f6bon.albert/lna.html
A 12 GHz LA with 12 dB gain; the noise figure of 0.45dB may be a bit too optimistic. The table (sheet 30) shows that this is a broadband amplifier; It still works fine around 8 GHz.

So very useful for the X-band. You can see that there is way too much solder on the connections at the input and output.

Signals from the Mars Surveyor are also around 8 GHz, so suitable 8 GHz LNAs can be found in that corner. See sheet 31

Polarizers

You can also find everything about this on the internet.

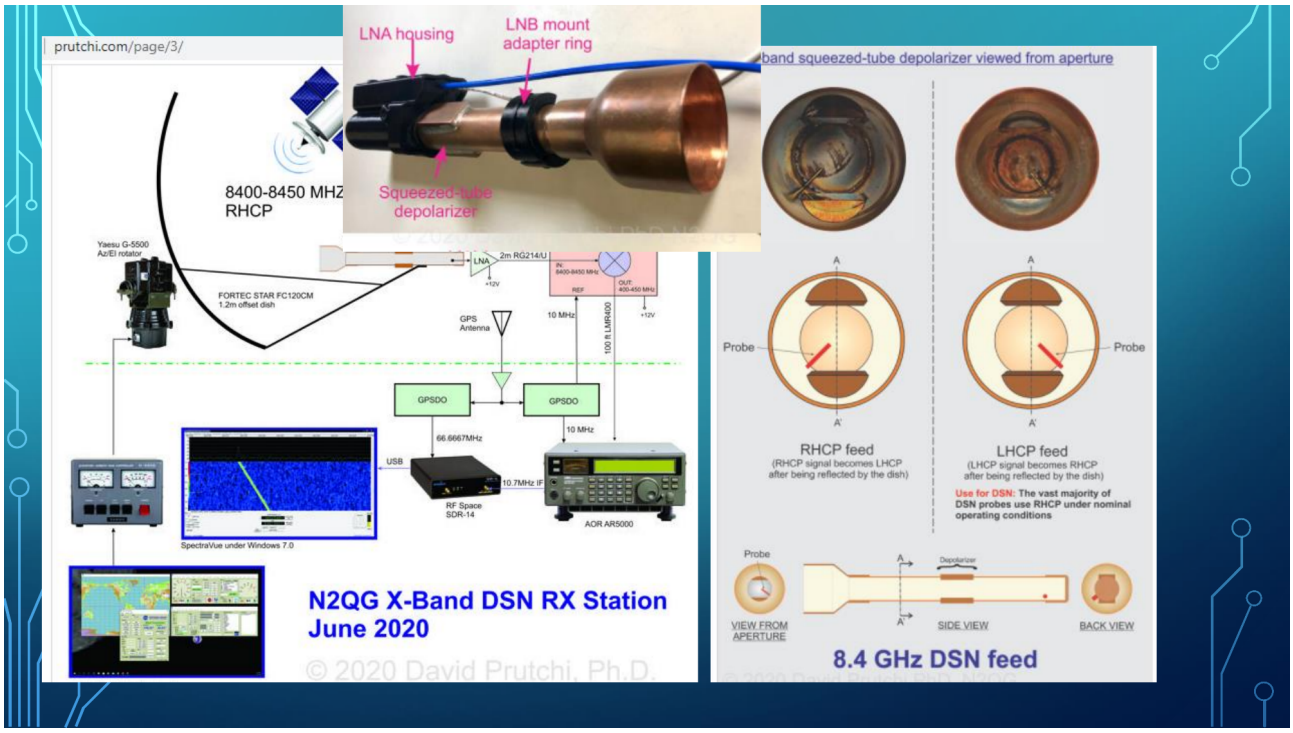


Fig. 7

Fig. 7 shows some polarizers, for both RHCP and LHCP. Please note: you should not solder with tin in waveguides! Preferably pinch, or work with silver solder.

For more info: search in particular for topics such as Deep Space reception and moon bouncers

References:

See website kunstmanen.net, menu ‘Weblinks’, 2021

[1] presentation sheets
Polarizers 1
Polarizers 2
Deep Space Network
8.4GHz-DSN
Low noise uwb amplifier + 10 GHz préamplifier
G3WDG004 HEMT Low noise Amplifier
3CM LOW NOISE AMPLIFIER
8.4 GHz bandpassfilter
prutchi.com

Make your own aluminium housing

Introduction

It is not my intention to give a metalworking course. Others are much more knowledgeable about that, but I still want to share some things that were very practical for me. Maybe someone thinks "I can't do that" and it's not that bad.

My experiments with the 8GHz amplifiers showed that the housing plays a major role for a successful end result. I have made many searches on the internet to see if standard housings are for sale. I couldn't find this one, so I made my own.

They don't have to be large enclosures. My prints are no larger than the 35mm format 24x36mm. Franco Rota's LNA isn't much bigger either.

My first thoughts went out to aluminium tubular profile on which I then mount two lids. You cannot mount the PCB on the cover because it is then much too low for mounting the connectors. You will have to place an extra aluminium plate under the PCB. To mount the lids you have to drill holes and tap threads. The aluminium tube must be 4mm thick, otherwise there is no room for the bolts. All in all, this is quite a lot of work.

During his lecture, Frans explained that he mills his housings from aluminium himself. The advantage is that you don't have to mount a lid and filler plate at the bottom. You are also much more flexible in the dimensions of the housing. The downside is that you must have a milling machine.

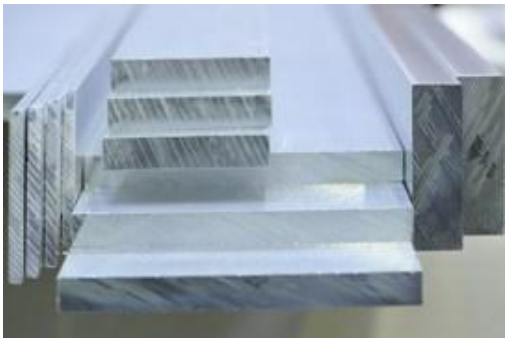
Now some time ago I bought a drill-milling machine. So far I have only used it for drilling holes. Making a housing was a good reason to start milling.

My milling machine. This is no longer available, but comparable models, now in blue [1].

Because I had never done anything with metal before, I started looking for courses on the internet. But there aren't many. You will find many full-fledged school courses, but I couldn't find anything in the evenings so quickly. In the end I found the Metaallokaal in Delft where they give courses in turning, milling and welding.

The housing

I want to make the housing from aluminium bar material of 15mm high and 50mm wide. You need the 15mm height to mount the 12.7mm high SMA connector. The interior space is 25x35mm. With an edge thickness of 4mm (due to the length of the dielectric of the connector) you arrive at 33x43mm. You can easily get this from 50mm rods. At the Metaalwinkel in Rotterdam I found a piece of 50 cm.



Aluminium bar stock

So first try to saw off a piece of 35mm. But that was very disappointing. You can cut the rod with a metal hacksaw. In any case, use a Bahco bi-metal saw blade. It is difficult to saw straight. The result was that at the bottom the aluminium was narrower than the 33mm required.

I tried to saw through the aluminium with a table saw. This is possible with a special saw blade, but you will not be happy if a saw goes through metal at 3000 rpm. Make sure your workpiece is very well secured. If this comes loose, it will go through space like a bullet. So I bought another tool. At HBM they have very affordable metal band saws that work well. It takes about a minute to saw through the staff.

A metal band saw. The saw can also be detached so that you can saw by hand.

Milling machine

A milling machine revolves around the milling cutter that can be moved along the workpiece in three directions: length, width and height. The workpiece, in our case a piece of aluminium, is clamped on the table or bed in a machine clamp.

Moving the table or the milling head is done with a hand wheel and this is where the problem lies. A scale of 0.02 mm is applied to the hand wheel. But the hand wheel has play. You can turn it and sometimes nothing happens for half a turn. You have to wait until you feel the handwheel engage and only then can you read the scale. This is very error prone. So you take your caliper to see if your workpiece is to size and this takes a lot of time. The problem may be with my cheap milling machine, but it's no different.

For me, this was something that made me hesitant to start milling. I solved this problem with the clearance with a digital ruler. Everyone knows the digital caliper, you also have it with a sliding box and a separate readout. Available from 30 Euro. You do need three because you have three axes. It took me two days to mount them to my milling machine but it is well worth it.

Digital ruler that you can mount on your milling machine.

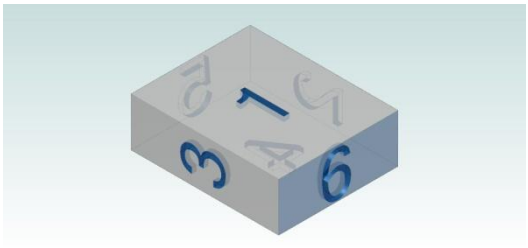
What are alternatives? Purchasing a milling machine with digital readout costs thousands of euros. You also have CNC machines, they are also expensive. And you also have to be able to make 3D drawings.

Another thing is that the axes of the milling machine must be square. Search the internet for "tramming a milling machine".

Make square angles

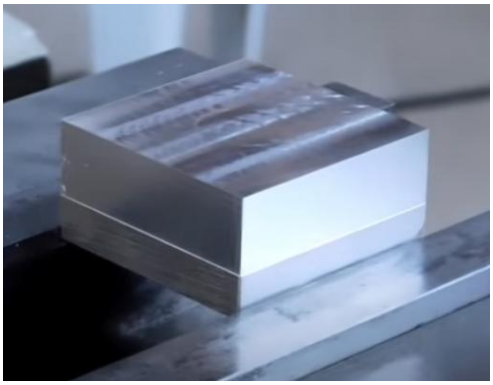
Then you have a piece of rough-formed aluminium that has to be milled to size and at right angles.

This seems to be a standard assignment in vocational training to be able to mill a perfect cube, at right angles and all sides equal. The order is often followed as shown in the picture below, which indicates the order in which the surfaces must be milled.



Order of the surfaces that you have to mill to achieve a perfectly square block of aluminium. More information on the themakersguide.com site [2].

This is quite a laborious method. On the internet I found a method that is faster, because you mill the housing to the right size [3].



First, mill the top and sides in one go without removing your workpiece. If you have a digital readout, you can immediately customize it.

You will first mill the tray at the top and around. Use an 8mm cutter for this. After you have milled the top flat, set the ruler of the z-axis to zero and you can then mill away the middle part. Go 2mm deeper each round until you have reached the correct depth. Make the container 0.2mm smaller than necessary so that you can do an extra circle around the edge to get it tight.

To make the radius of the corners smaller, replace the cutter with a 4mm cutter, set the ruler of the z-axis to zero. To zero you can bring the cutter down very slowly and see when it grabs, this is the zero. Now start milling along, this will make the milling surface the smoothest. Plunge milling is when the direction of rotation of the cutter and the direction in which the workpiece moves are the same. In the last round, bring the edge to exactly 4mm.

Determining the zero point

Once you have loosened and reattached your workpiece you will have to set the digital readout to zero in some way. This is necessary if you want to drill the holes for the SMA connector.

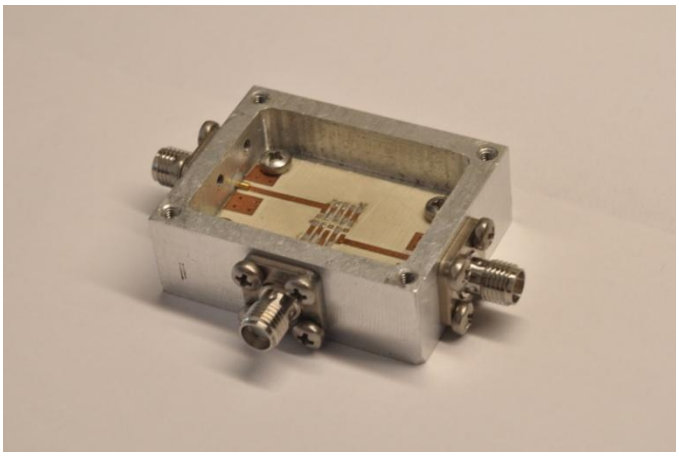
With an edge finder you can very well determine the edge of the workpiece

One way to do this is with an edge finder. You can buy these for a few Euros and you can perfectly look up the edge of your workpiece. The idea is that you move the workpiece very slowly towards the bottom of the edge finder. When the edge finder is detached from the workpiece, it will swing (it has a spring in it). When the edge finder touches the workpiece, it stops. If you then move very, very slowly, the edge finder will move a few millimeters to the side. At this point you can then set the zero point (take into account the thickness of the edge finder). This point appears to be accurate to the nearest hundredth of a millimeter. Don't ask me why this is so.

SMA flange connector

Check the connector sizes in the datasheet. Very often the mounting holes are at 0.340 inch = 8.7mm. The center pin is surrounded by a 4.12mm PTFE dielectric. I drill this hole with a 4.2mm drill. Drilling for the mounting bolts of an SMA flange connector has become something trivial with a digital readout: insert center drill, drill and then 8.4mm to the right, down, left and up. Place the drill and make the same circle. You can do this in a few minutes.

The mounting bolts are unfortunately 2.5mm and you will have to tap thread for this. You have to drill the holes with a 2.05mm drill. I bought special machine taps for blind holes (as opposed to through holes where the chips can get out on the other side of the drill hole). You can tap the screw thread with a hand drill on the lowest setting. Do this very carefully, you don't want to break the 20 Euro tap.



The result of a morning behind the milling machine. It is the housing for the MCA1-12G+ mixer from Mini-Circuits.

Closing remarks

Making a housing out of aluminium flat bar is fairly easy to do if you have acquired some skill. You don't need a big heavy milling machine. A digital readout is a must. The metal band saw is also welcome. So you see: good (and a lot of) tools is half the battle!

links

[1] Simple milling machine without digital readout

https://www.hbm-machines.com/products/metalworking/metal milling machines/metal milling machinesssub/hbm-x-2-milling machine

[2] Maker's guide

http://www.themakersguide.com/square-stock-cnc-milling-machine-2-2

[3] The best mill tip

https://www.youtube.com/watch?v=ZghLslZZ6sg

A nice milling instruction

https://d1rkab7tlqy5f1.cloudfront.net/IO/Over_de_faculteit/Faciliteiten/PMB/Manuals/Frees instruction expanded.pdf

FROM THE LIBRARY

Paul Baak

Some thoughts from our librarian

A nice long summer, as I managed to read my eyes almost into a eye cataract. All done for you, of course. An overloaded list of topics is the result, so I'll start right off and without my usual half-intellectual crap. I don't think you are waiting for that any more than I am.

In the fall edition of “Ruimtevaart” an article on the Russian space program from the beginning, with the first Salyut and Soyuz to about 2000. In the Space Chronicle the launches and related events from January 1 through May 15 this year. Mentioning the deaths of the famous Dutch astronomer Kees de Jager and also Michael Collins, known as "the forgotten astronaut" at the first moon landing. He himself had no problem with it, he said he was just sitting there quietly. I understand him completely. Michel van Pelt reviews the non-fiction book (also as an e-book and audiobook) the Cosmic Comedy[1], by Frank Westerman, about how the development of astronomy and space travel undermined the traditional image of heaven, hell, damnation and other social understandings. An A3-sized overview on the center section with all the Space Shuttle Missions and movements around them makes it clear how intense that program was. Also of interest is an article on the amazing ease with which GPS and Galileo signals can be disrupted, with, of course, potentially major consequences. A godsend for the criminals among us! However, work is now being done on jamming them. It's not a great sight: a plot of a group of ocean-going vessels circling in an industrial district.

GEO 70 has been released. You can get it and its predecessors up yourself [2]. No technical articles; but many nice or spectacular pictures from above. Like the traffic jam of Chinese gadgets at the Suez Canal and the (non) navigating cause of it. Or the iceberg (A-74) which is drifting near the South Pole and is touching the vulnerable Brunt ice shelf. I am not very familiar in the area, but I understood that it is serious. An eye opener is the print of the North Sea: an electromagnetic bustle there. A novelty for me is that there are fires that can hibernate under the snow, in Alaska and North-West Canada. A list of currently active satellites concludes the GEO.

September's Electron has nice topics, such as this post. The maker of antenna simulation software EZNEC[3] will make its product available for free (currently $500) as of January 1, 2022, albeit without support. Do you put it in the agenda already? Perhaps worthwhile for our area as well.

Some words start with a C: corruption, constipation, crisis, corona (hi, there it is again!), corrosion and so on. That's why the designers of the C programming language called it just C: then you have everything handy at once. If only it had been C, but no, there are still (too) many derivative languages. For an unreasonable reason, Python is now popular. I've wanted to wait for the storm to blow over, but it won't. Sooner or later you have to know about it, even in our field of interest. For example, for the Raspberry, the language Python seems to have been thought of as the preferred language. Therefore, I read for you: Python for Dummies. This reads like we are used to. If you want to grow very relaxed in knowledge and skills I see no objection here. If you feel more like a heavyweight, then I would look at something

else.

Harry Arends alerted us to a NAS problem. His NAS appeared to have received an unsolicited factory reset, presumably the result of a break-in attempt. Long story short: manufacturer Western Digital offers no support in his case. Now I have my reservations about those NASs; I have never seen the promise of worry-free use come true and there are also awkward security issues attached to them. Partly for that reason, I use a stack of USB disks. Since you are undoubtedly also a user of (a lot of) data storage, I am passing it on.

Earlier in this column I suggested the use of a Raspberry instead of an Arduino for controls. Above all, they are different systems, each with strengths and weaknesses. I will not argue that everyone should swap equipment at random if there is no reason to do so; the question is whether a Raspberry offers more or better capabilities in our field. This quickly generated an animated discussion within your board and is also a great topic for discussion at a meeting. Meanwhile, the two worlds are growing together: there is a new processor on the market, the RP2040 and both Arduino and Raspberry are coming out with a board based on it. For Arduino it is a break in the trend: to my knowledge, all previous boards were controllers. Raspberry, for its part, is coming out with a controller board and is entering the territory of Arduino and Espressif Systems (ESP32/ESP8266). My thought is that with all this stuff you can make nice advanced applications in our field. In the distance, I am already dreaming of a control system with voice recognition and a smart phone: "Hey crooked dish! Go chase that NOAA-19! And afterwards, a printout in four-color! Pronto!"

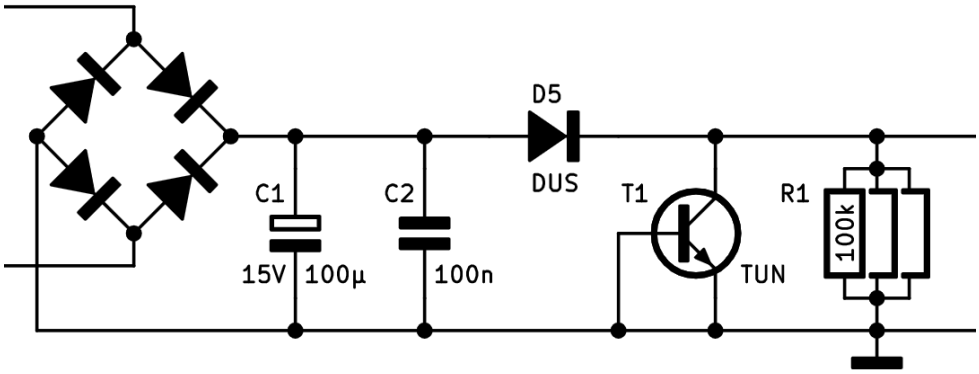
Meanwhile, the airwaves are quite polluted with interfering signals. Besides switching power supplies, solar panels are notorious. Now a group that is suspicious to me has joined them: smart energy meters. In [4] a treatise on smart meters that get confused by interference pulses and then give strange measurement results, namely energy return that is not there at all. Sounds nice, but if such a device is already so lousy at its essential function, even to the detriment of the energy company, then you can fear the worst for the interference output. For our area, not only interference through the air but also interference through the power line is relevant. Anyone who can say something about it, please do. I rejected a smart meter for me at home by the way. I saw no advantages or guarantees, including on this topic.

The Deutscher Wetterdienst broadcasts weather information on low frequencies. Elektuur has a simulator [5] for these signals. I was immediately reminded of Harm de Wit's contraption (see elsewhere in this magazine). The DWD simulator consists of no more than an Arduino and an AD9850 DDS board. Harm's setup is of a higher complexity, but so is the operating frequency.

In Elektormagazine we find an introduction to the use of LTspice [6]. Free and good program, but with a difficult learning curve and therefore I never picked it up. I've been using MultiSim for years, actually a front-end for Spice, gotten free at a seminar a long time ago. Much more intuitive than LTspice. That MultiSim is the reason I also have an old XP for that, so obviously I don't use it for vulnerable work. Apart from the pitying looks from the environment, that doesn't cause any problems. For a consultation I sometimes go to Youtube and then it strikes me that it is very slow because of javascripts. Now you will say: then you should get a faster machine, but

that can only partly explain the slower operation, according to a test. The question is: what happens behind the scenes? Is my entire private life plus the color of my socks being passed on to our big-tech friends? Is there anyone with scripting knowledge who can catch me up?

I have never been a supporter of the Kicad schematics with their thin and poorly visible lines. I always had the uncanny feeling that even on paper, a wire gets a lot of copper resistance from it. Poorly readable too, those schematics. I had and have appreciation for the schematics in Elektuur. Via Elektormagazine I found the existence of a Kicad library[7] of parts in Elektuur style. The schematic itself I really have my doubts about, but you get an idea of the looks.



Here is the soldering tip of the month: Ben talks in his article elsewhere about unsoldering a defective MOSFET on a metalized PCB. A tricky task. In the few times that I had to deal with this, I cut off the legs of the IC or the FET and the remaining pin was always fairly easy to remove.

And so we come to the end of yet another issue of From the Library. It is also my last one, as I am leaving the club. A receiving station is out of reach for me. The job of librarian is also outdated; anyone can get the information they need much more quickly and easily elsewhere these days. The times when we had to lug around hundreds of kilos of pressed wood pulp are gone, and with squeaking vertebrae I say: that's fine by all means. I have been a pleasure to serve you for many years, but now I am going to take up other activities and that leads today to the very last greeting from

Your Librarian

links

[1] Cosmic comedy
[2] GEO
[3] Eznec
[4] Smart energy meter
[5] DWD simulator

[6] Getting started with LTspice
[7] Elektor symbol library

UKW-BERICHTE

Paul Baak

Summary
In this article a concise review of articles published in the 2nd edition of 2021 of the German magazine UKW-Berichte. We have a subscription to this magazine.

Starting with an error correction on my part: in a few places in my previous summary (UKW berichte 2021 Heft 1) it was mentioned: PGA202+, this should however be: PHA-202+. With apologies.

I continue with a summary of UKW-Berichte 2021 Heft 2. There we find 5 main articles and also small sections with errata, useful links and messages. Our club has a subscription to this magazine. Please indicate if you appreciate this subscription. The latest issues are available for viewing at meetings on the library table; if this is not accessible to you due to current circumstances, please contact the librarian.

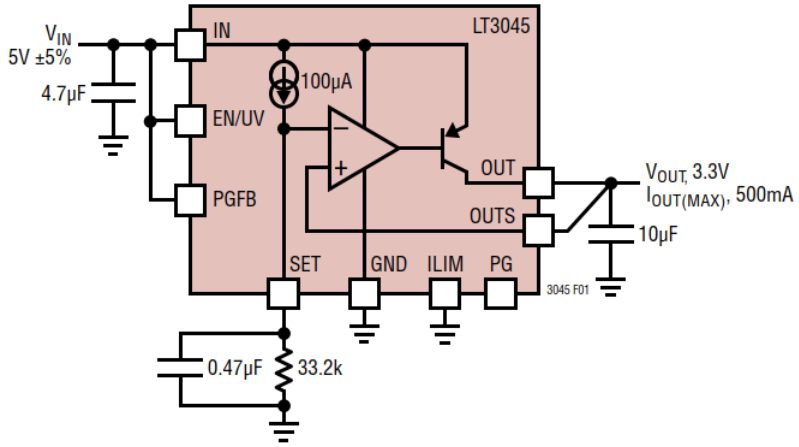
Gunthard Kraus describes an MMIC amplifier using an SBB5089Z with 20dB gain for a range of 5 MHz to 6 GHz. This is an off-the-shelf module from what is called the Chinese internet platforms. A small circuit board, including two SMA sockets. It is not mentioned what clone exactly is involved, and that can make a difference. The author points out a flaw in the circuit: parallel switching of several capacitors of different values in the feed line has an unintended effect: due to self-inductancies, the decoupling actually gets worse. The better method is to connect equal capacitors in parallel. The results are somewhat moderate, depending on the individual application. For example, the gain at 1.7 GHz is still 18 dB and at 8GHz (although a dip) almost 0dB. With a noise figure of 4 dB it is also not really a low-noise preamplifier.

Bernd Kaa describes a low-noise MMIC amplifier for 2 to 28 Ghz with a power of 0.1 Watt (and not 1 Watt

as stated in the table of contents). The ADL9006 from Analog Devices is used for this, with a gain of 15.5 dB between 6 and 28 GHz and a noise figure of 2.5 dB. See also the picture of the front cover. Coupling capacitors and termination resistors are integrated, as well as a gain control. Two versions were built, one with FR408 and one with FR4. The experiences about this MMIC are positive.

Konrad Hupfer describes a single-phase linear power amplifier for the 2 meter band with a power double transistor, the BLF978P. It is normally operated in counterphase, but it is here in a parallel circuit. The setup is intended for transmitter operation and so, in addition to pure power, things like linearity and intermodulation products get attention.

Wolfgang Schneider describes a voltage regulator using an LT3045 with very low noise and adjustable from 1.8 to 15 volts. It is intended for PLL and DDS applications. According to the manufacturer, the noise level is 0.8 microvolts RMS between 10Hz and 100Khz; the author did not measure this by himself but experience elsewhere confirms the specifications. See the picture of the coilless application and for more creative examples see the Application Note [1].



Heiko Leutbecher describes a number of configurations of an MMIC wideband amplifier with specific HF properties. Parallel connection of counterphase amplifiers, cascading of MMICs, measures against instability, adjustable and low-noise wideband amplifier and parallel connection of MMICs with directional couplers.

In Hinweise und Verbesserungen, among other things, a correction of erroneous characteristic curves in the previous UKW berichte. In that UKW-berichte there was an article about a receiver for weather satellites with some errors. Ben Schellekens approached UKW about this, but did not receive an answer and this Hinweise und Verbesserungen does not mention it either.

Then in Fundstelle Internet a list of useful and instructive links on the Internet. I mention: an integrated antenna with receiver for the mm range, Marchand balun (mistakenly called Marchant here), lightning detection, Cassegrain antenna, radar tutorial, PCB layout for HF signals, design of low-noise amplifier, idem for radar at 5 GHZ, a tutorial for mixers, a 26 GHz mixer, principles of surge protection [2].

In the Ultrakurz section a mention of a new book (German only; also available as e-book) by Hans Kummer: "Drahtlose Kommunikation" with much attention to coding and (de)modulation techniques. Here the table of contents [3].

UKW-Berichte [4] is a German language publication, now without an English version that used to exist under the name VHF communications. The magazine will cost 34 Euro per year from 2021, including shipping from Germany to the Netherlands. Single copies and volumes (DVD) are also available.

links:

[1] Application Note LT3045
[2] principles of surge protection
[3] content of "Drahtlose Kommunikation"
[4] UKW-Berichte

Report members meeting September 11, 2021

1 Opening.

This is the first real meeting in over a year. There are 13 attendees; Fred Jansen and Fred vd Bosch are participating via zoom. This is also the GMM, which was originally to be held in May as usual, but which has been postponed to this first 'real' meeting due to corona.

2 Explanation of 2020 figures + statement of the Cash Control Committee

The treasurer gives an explanation. A lot has happened in the last year that affects the finances: because of corona, a large number of meetings have been canceled so that we did not owe Nimeto rent. Furthermore, the PDF subscription has been introduced; on the one hand this results in a cost reduction in terms of printing and shipping costs; on the other hand, the contribution for PDF members is a lot lower. For “paper” subscriptions, the contribution has been slightly increased.
There is still a small loss; approx. 20 euros; in previous years it was many hundreds of euros. The costs will undoubtedly increase again, but we can bear a small loss for the time being; there are still plenty of reserves.

3 Discharge board regarding the policy pursued in 2020

There was a moment of confusion about who is on the cash control committee. So that is Rob Hollander and Wim Bravenboer. Rob Hollander is not present. Wim gives a short explanation; after a few corrections, the financial part has been approved. Wim gives discharge, also on behalf of Rob Hollander.
Rob Hollander will step down for the 2021 period; Harm de Wit takes his place.

4 Budget and contribution 2021

The contribution for "paper" members has been increased from 25 to 28 euros from 2021 on. This has of course been communicated in advance, but it must be officially approved by those present at the GMM. That has now been done.

5 Administrative matters

There are no developments.

6 Satellite status

Arne gives a small explanation; see satellite status later in this sheet. It's worth noting that Eumetcast is going to switch satellites, but that won't be until 2022. Furthermore, many fluctuations are reported in reception quality, but that can often be traced to local interferences and the like.
Fred Jansen mentions a number of things concerning satellites in the X-band. Aqua is “released” (no fuel available for orbit corrections) and thus is no longer in a controlled orbit. It will continue to work for the time being. The Terra satellite is under orbit control.
He also reports that China's Fengyun-3E has started transmitting high-resolution channels this week; these are all IR channels. Fred Jansen can receive this; the sample rate is 38 Ms/s, the bandwidth is 55 MHz. He uses a Lime SDR for this. He also receives the DPT from FY-3B: Delayed Picture Transmission. This is a dump of recorded data during one complete orbit of the satellite, which occurs over Svalbard. Some of that dump, if the satellite is still above the horizon, can be received. The sampling rate is 66 Ms/s, the bandwidth is no less than 70 MHz. With this kind of speed, the SDR has to be connected

to the PC via a special USB cable; 180 Mb/s must be written to SSD. It's just managable. Decoding the data, which has to be done afterwards, takes about an hour.
Furthermore, Fred also received the polar Oceansat-2 and the geostationary Elektro-L2 at 14 W.

There are currently a lot of satellites operating on the X-band. If you “accidentally” receive such a satellite, you can enter the time and direction in a program 'Stellarium' which will then find out which satellite it is. You can then look up the corresponding TLEs so that you can also track the relevant satellite.

Fred mentions concerns about large constellations of Internet satellites that could disrupt reception of X-band satellites.

7 Any other business

Hendrik Jalving has made a 20 cm worm wheel by tapping wire into an aluminum wheel. He demonstrates a model of a rotor that can run very slowly and at the same time is very strong. You need rotors like this to accurately track satellites with heavy dishes.

Peter Smits has built the new control board for rotor control and checked it for proper functioning.

Harm de Wit
Shows an arrangement of an 8 GHz transmitter, which is connected to a receiver via a waveguide. A down converter converts the signal to 1200 MHz, from there it goes via an SDR to a laptop that shows a spectrum.

Arne and Job have adapted an 8 GHz LNB that is suitable for both under and over mixing. In other words, there is no filter in it that filters out any of these products. This LNB could be suitable as a starting point for X-band reception.

Ben: Constructed an alternative slotted line. With a stepper motor, a signal pick-up can be moved along a transmission line, so that you can read the position of knots and bellies of a standing wave.

Rob: Show a test construction with a miniature stepper motor. Functionally it does the same as a single rotor with stepper motor. It is intended for software testing, and as a simple demo model.

Arne van Belle asks how do you know you're receiving Syracuse, if you can't decode the data. Fred Jansen says that the spectrum shows a number of large peaks that are stable; this is typical for Syracuse.

8 Closure

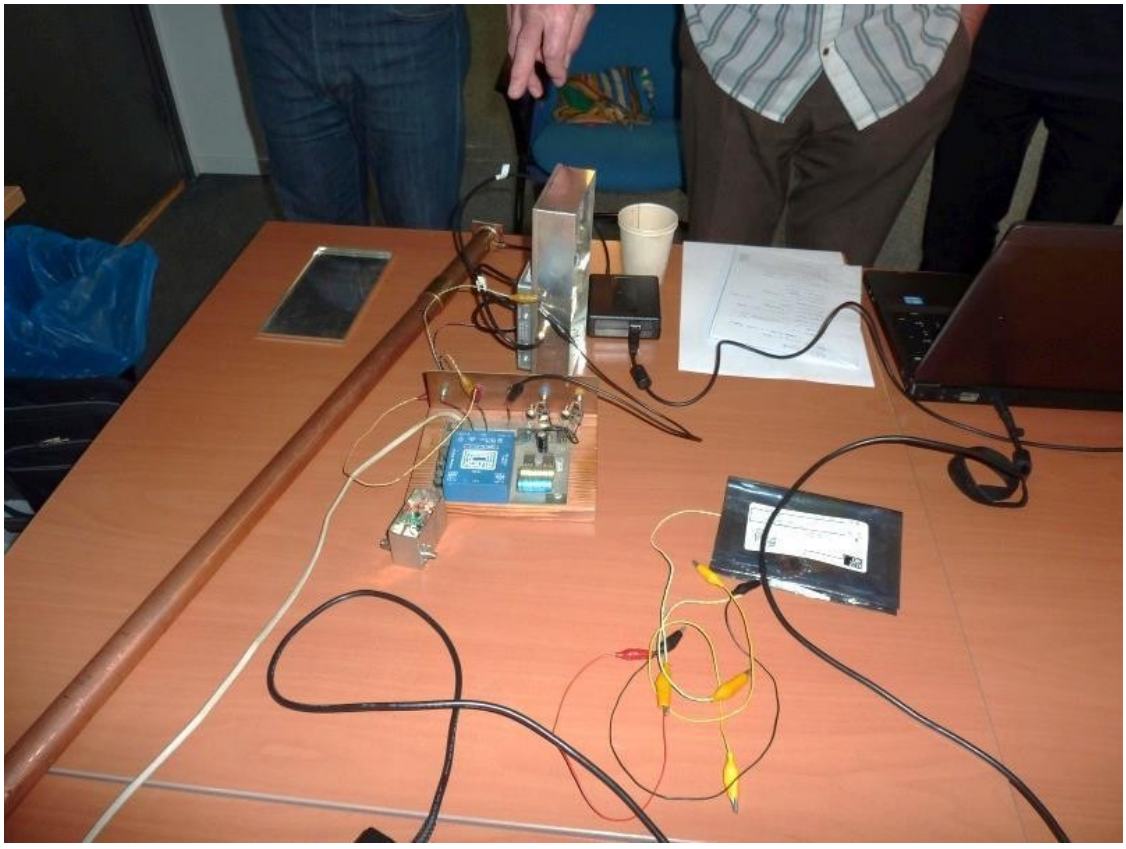
Afterwards, there is still some time to talk as you can only do with a 'real' meeting. While enjoying drinks and snacks: the postponed New Year's drink.

Rob Alblas
secretary AI

Azimut-elevation rotor using two worm transfers, made by Hendrik Jalving.

Gear-with-chain transmission of Hendrik

Slotted line of Ben



Up- and down-converter with waveguide of Harm

Satetllite status

Arne van Belle, September 29, 2021

POLAR	APT	HRPT	X-BAND	Remark
	(MHz)	(MHz)	(MHz)	
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-A	off(137.100 LRPT)	1701.3	7800	LRPT/AHRPT 2.33 Msym/s
Metop-B	no	1701.3	7800	Only AHRPT 2.33 Msym/s
Metop-C	no	1701.3	7800	Only AHRPT 2.33 Msym/s
METEOR M N2	137.100 LRPT	1700.0		LRPT/MHRPT
METEOR M N2-2	off(137.900 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	HRIT/GVAR	Orbital position/status
	(MHz)	(MHz)	
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.

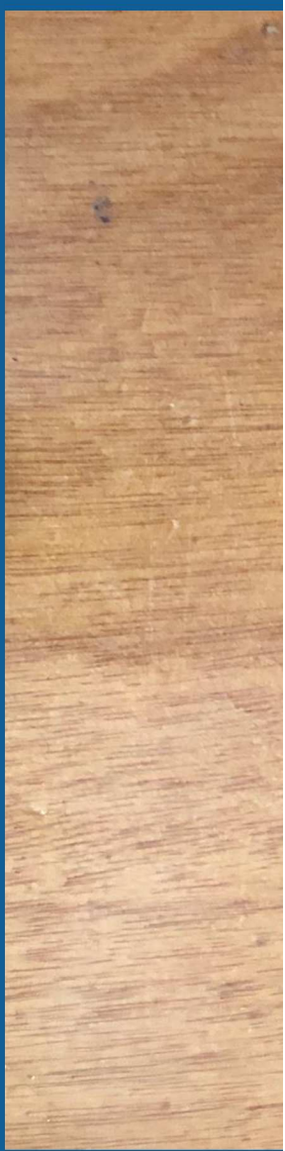
Since 23 September Meteor M-N2 is transmitting LRPT images on 137.100 MHz again !

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 !

Be warned for Solar outages on Eumetcast (Eutelsat 10E) from 9 to 15 October around 12:59 to 13:09 (Dutch location and time).

EUMETSAT is planning to terminate the life of Metop-A starting in November 2021, in compliance with space debris mitigation guidelines.

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