DE KUNSTMAAN

In dit nummer o.a.
Ontvangst METOP
De nieuwe QPSK ontvanger

en nog veel meer

Dear member,

This pdf contains translated articles of our Dutch magazine "De Kunstmaan".
Google Translate is used; and mostly some corrections are done afterwards. Hoping that this will give a usable translation. Translation for each article is mostly done by the author; pictures from the original article are not always added. In that case please use the "paper" (Dutch) magazine together with these translations.
Internet links mentioned in the articles can also be found at our website; see menu 'Weblinks' at: www.kunstmanen.net

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

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Content

In front of you is the last Kunstmaan of this year. Not entirely unjustified with the emphasis on receiving the Metop.

With the realization of the reception of METOP satellites we have put a very big step in securing the direct reception of weather satellites.

At t the time of this writing, there are three prototypes that work well in combination with a 80cm dish. This is quite an achievement because other radio amateurs need larger dishes. On the last meeting Harrie, Rob and myself held a lecture about the receiver.

In this issue you will find this information of the new receiver. This consists of:

- A receiver board for UV916, this is also in the WRX1700

- The demodulator. Here, the intermediate frequency coming from the receiver print is converted to I- and Q-data streams

- To control the receiver a new display board designed based on the Arduino.

Disclaimer: the receiver as it is presented now iw working properly. But the story is not finished yet. So it is quite possible that there will be changes in the future. This is unavoidable and not something we should fear. Availability of components is also a constant concern.

Further in this Kunstmaan a story of Rob on the decoding of the Metop. Fred makes its contribution from Vietnam, thanks. The story of our librarian puts us in the right mood for the festival season.

Subscription list

During the January meeting, there is a sign-up list where interested parties can register for a parts package. If you have no antenna rotor this receiver is of no use. In addition, the HRPT decoder is discontinued in its present form, in particular: the USB interface Sparkfun is no longer available. On eBay is to find another module, but it does not fit on the PCB. So we stay busy ....

Are we done?

In addition to the new receiver, the following issues will still need to be addressed:

- Reception and decoding of Feng Yun. How the signal must be decoded and will fit the decoder GODIL, we do not know it (yet).

- The down converter. A familiar story: the LNC in 1700 is no longer available. Very difficult to reconstruct and to calibrate. Very good performance.

- We have to follow the satellites! Harry has already done much work with the Arduino, Rob's Xtrack is suitable for both azimuth - elevation and XY controllers. For people with a background in electronics often the mechanical aspect of the rotor is difficult. Therefore, an antenna - rotor controls must meet the following requirements:

- suitable weathertight.

- Easy to build. Parts must be obtained normally have and you do not need special tools.

Presentation on January 7

Filter and filter again. The rollout of new 4G networks give very high signal levels at 800-900 MHz. The helical and wideband LNA receive this unattenuated. There will have to be filtered. In the previous Kunstmaan was an article about the interdigital bandpass filter of Hendrik. At the meeting on January 7 Jos Disselhorst, PA3ACJ, known for the DIY exhibition of the Day for the Radio Amateur will give a presentation. As a homebuilder from interdigital bandpass filters he knows the intricacies of the design and construction of the filters.

Finally, I want everyone on behalf of the entire board, wish a mary Christmas. I hope all 7 January to meet you at our meeting followed with new years drinks.

Sincerely,

Ben Schellekens

PS: We remind you to pay your dues for 2017. We keep the fee of 25 euros per years for members in the Netherlands and 30 euros for members abroad. An important part of the contribution is paid to the dissemination of the Kunstmaan in the A4 format.

Summary
My experiences with weather satellites, etc. in Vietnam.

HRPT
Rotor
Fairly bad weather of the last time I'm only late October continued with the rotor. The current rain jacket complies well with a stationary rotor, but when moving it rains in. So the thing just stand still for a long time. But because I might have to buy units in the Netherlands, I still picked up the case. The problem is that the top rotor continues to hold a lot of difficulty moving the dish, especially if he must return at once from 0 gr. to 90 gr. Often the rotor hangs or is it "something more than warm." During an email exchange Ben came about with the following suggestion: "The lower motor you can fully balance. This engine has to move the dish from North to South, almost equal to the orbit of a satellite. "

That sounded very attractive, but I was there to do think about it, because it meant a lot: the rotor support 90 gr. turning, switching cables, adjusting settings and completely align again. Balancing the lower rotor lucky happened a long time ago.

Rob commented: "If you do X and Y interchanges then you should also Xtrack / WSAT set as such. Preferences, Tracker, rotor system, "Dish at ': must be X.

When choosing X or Y to dish I have previously only looked at the max. speed to turn the rotors. I had not yet looked at loads. Y to dish gives the most optimal config., If you want to follow polar satellites. Also in terms of load it is.

However, if you can balance the lower rotor and the upper (to the plate) not then it is a different matter. Then it becomes a balance between what the Y dish gets his choosing and any tracking problems (very) low on contracts. The calculations that I've done with the subsequent images in KM2, 2013, should actually be looked into in more detail. When you get really into tracking problems, and is coming over then so low that the event is not such an interesting coming over to take?

If so, then X to dish perhaps better, all things considered. At the end of the transit state X (= NZ) already at 0 or 180, and costs twisting Y little or no effort (dish remains about the same height and is already not too far from 90 degrees). Then in the storm position will drag all anyway go easier.

I'm still programming the MetOp decoding process, but then I'll see if there is something to calculate. "

Finally I decided and turned everything, changed and adapted. The "mess with the settings" I have done by the satellite selecting Met-7 Xtrack and then put the dish in the right direction through the flip function. Optical seemed following the track pretty nice. So it was time for a real satellite. The result? AWESOME !! The chosen track was -not entirely coincidentally- about right over, so at the end did the upper rotor but turn a little to the 90 gr. And if the dish is pointing to the horizon seems rotor load somewhat less.

Alignment on the terrace, I reflect Ben's article [1]. Except that I both N-Z and O-W have used the spirit level. I had some doubts beforehand because the dish edge is not quite right, but it works. Apparently, the opening angle of the antenna is big enough. After the final installation on the roof, I'm going to do this very carefully again.

To return to the storm position even easier WSAT edited by Rob. It now offers the possibility to first send the top rotor to the storm position (the bottom is still 0 or 180 gr.) And then the lower rotor. In this way, the load is the smallest for the X-rotor. This is partly because the top rotor is not really a counterweight be provided. A future enhancement will be WSAT, you can send for the interfering beams at the end of a recording path automatically.

For the moment the plans for a new rotor go into the refrigerator (translation from a Dutch proverb) and the rotor after painting on the roof. That will be after my Christmas holidays in the Netherlands: I cannot find here a good suitable paint. Well, a full and heavy suitcase again.

AutoHotKey
Meanwhile, after the AHK-WSAT-script [2] is also an AHK script to create an image with HRPTReader David Taylor. This script is via an option in WSAT <Edit | Preferences | Dir / Files> automatically launched at the end. The last received file is read and stored as corrected FalseColor.jpg. In the script are listed some other form as vegetation, RGB and SST. For those who do not want to see: they can be easily deactivated by entering / * before the block and * / after the block. At the same time the old script is a little extended and made more sense.

Who wants to have both scripts can send an email. Guarantee till the modem: It is written for an old and slow laptop. For a faster system, the script can be made faster I think. Personally, I will be there in no time stabbing: the photo will be saved 15 seconds earlier. So what.

Weather
In the previous Kunstmaan I mentioned that the storm detector upper block (0-5 km.) [3] never see light. It has become clear: the light works! And I almost not anymore: so loud was the bang! It must have been really close. But now I don't need to worry anymore.

Several things
3D positioning of stars
The ESA has put live a new website just now, which makes it possible to visualize the 3D positioning of some 60,000 stars. See [4]. This info comes from the Hipporcos satellite launched in 1989. may soon be going the dates of the Gaia satellite will be used. The accompanying (English) text speaks of a new revolutionary step forward when this happens. Source: [5]

webshop
"Mainly astro stuff, but also photomaterial. It seems that this is an astro-wholesale buyer that buys damage stuff. Therefore, they have also in this description the quality. Quite good, of course. Stuff can buy that are normally much more expensive, but so please note: I include an RDF seen who did it, but they suspect that it's just what soldering, 6 euros for such a thing of course is not expensive, but if actually broken, it is still a waste of money "Website:. [6]. Source and text: Astro Forum [7]

Live stream from the ISS
For 24/7 Live stream [8]
https://www.youtube.com/watch?v=UGPuEDyAsU8

Glue
After reading the good results of a glued column for a telescope [9] I was going to gluing and riveting the housing of the new rotor to each other. This idea is for the time being in the same refrigerator. But who wants to aluminum bonding definitely the forum post read once.

Milky Way
Fine images how the Milky Way radio waves looks at [10].

References
[1] The President, The Kunstmaan 2016-2, p. 4
[2] Weather Satellites in Vietnam (21) The Kunstmaan 2016-2, p. 6
[3] Weather Station, see website
[4] 3D positioning of stars, see website
[5] sources [4], see website
[6] Webshop for astro stuff, see website
[7] Source of [6], see website

[8] Liver stream from ISS, see website
[9] Adhesives, see website
[10] Galaxy in radio waves, see website

Direct reception of METOP

summary

This article Describes how to demodulate and decode directly received METOP-signals using hardware. The actual hardware description of the QPSK demodulator is described in another article.

Introduction.

Besides the American polar NOAA's there is also Europe's METOP. The METOP satellites have the same AVHRR instrument on board and therefore give similar pictures. The two types also complement each other in terms of passes.
Besides AVHRR the METOP's have some more instruments on board. A list:

type	function	Data speed
AVHRR	5 channels visual and IR	622.368 kb / s
IASI	CO2 detection by IR	1500 kb / s
Gome	Global Ozone Monitoring	400 kb / s
GRASS	Atmospheric temperature, humidity	60 kb / s
ASCAT	sea ice, permafrost, desertification	60 kb / s

Obviously NOAA also has multiple instruments on board but the data rate of these instruments pales into insignificance compared with the AVHRR data.

The data-rate of METOP is therefore much higher than that of NOAA:
- NOAA: 665.4 kb / s
- METOP: 4600 kb / s

The way of broadcasting by METOP differs significantly compared to NOAA, and therefore requires different receiving and decoding equipment:

	NOAA	METOP
frequency band	1700 MHz	1700 MHz
transmission speed	665.4 kb / s	4600 kb / s
Net data rate	665.4 kb / s	3500 kb / s
modulation	PSK: +/- 67,5°, split-phase	QPSK
Error detection / correction	not	Viterbi, Reed Solomon
frame length	110900 bits	8192 bits

For METOP, the difference between actually transmitted bits and the net (useful) bits is because extra bits are added in order to achieve error correction (so-called FEC: Forward Error Correction).

Receiving METOP can be done in several ways. One method is the use of Software Defined Radio (SDR). For METOP this requires quite a bit of reworking to eventually come to a picture; "Live" display of the incoming data is not (yet?) possible.
Another way is the "old fashioned" method: the use of hardware for demodulation and decoding. The great advantage is that there is no need for complex post-processing, and the picture can be displayed 'live'. A relatively "light" computer is sufficient. Actually, for the user reception is like NOAA HRPT.

In this article I will cover the various stages of decoding METOP. A number of issues have already been discussed in previous articles; the description will therefore here be somewhat less extensively.
In a next article I will discuss more on processing the received data to an image. Because all data is stored during reception, not only those of AVHRR, there may also what to do with the data of the above mentioned instruments, like IASI and GOME.

Block diagram.

Figure 1 shows a block diagram of the METOP-decoder. As you can see a big part is situated in the GODIL, the FPGA module also used for HRPT- and Meteor decoders. The blocks needed for METOP still fit in the same FPGA.

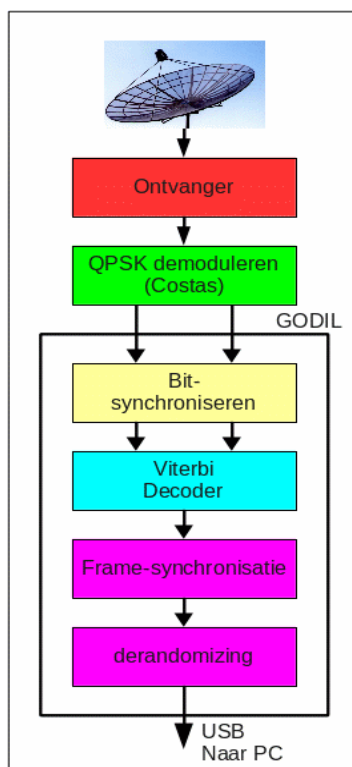The blocks will now be discussed one by one.

Fig. 1. Block diagram METOP receiver.

Demodulation.

In fig. 2, the modulations of NOAA and METOP are shown, that is to say, the phase of the transmitted signal relative to the carrier wave. The beads at the end visualize noise, both in the received phase and on the amplitude. With strong noise the beads become bigger and may overlap each other which means that error-free demodulation becomes difficult or
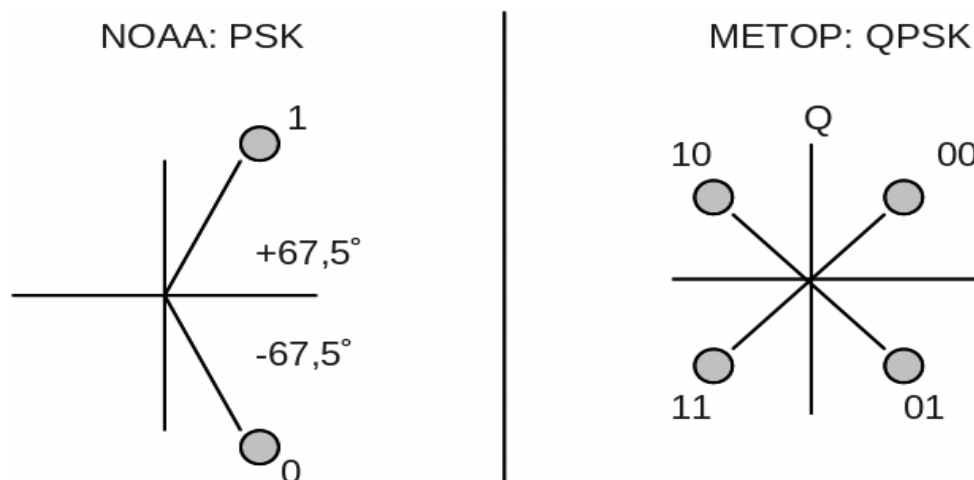
impossible.

Fig. 2. Modulation of NOAA and METOP.

With QPSK 2 bits are transmitted simultaneously. Compared to (B) PSK, this is a gain in bandwidth, but a loss in signal-to-noise ratio. QPSK corresponds to 2x BPSK, the transmit power must now be distributed over the two BPSK signals. The bit rate of METOP, 4.6 Mb/s, here it is in fact 2.3 Msymbol / sec, in which each symbol contains 2 bits. With the required receiver bandwidth, we have to do with the "2.3", so as if the bit-rate is 2.3 Mb/s.

As shown in Fig. 2 bitcodes are allocated to the 4 phases. Going around the encoding of the phases is like Gray coding, ie, with each step only one bit changes: 00, 01, 11, 10. However, In fact, there is certainly no question of Gray coding of the data: transitions from 00 to 11 and conversely come to broadcast equally well. There is another reason why the phases are encoded this way. At demodulation, it is not sure what is the absolute phase; the carrier is not present in the received signal. Suppose that the transmitter (in our case METOP) broadcasts "00", which is a phase of +45 degrees. At demodulation, it may be that all the phases are turned 90 degrees, as a result, +135 degrees is received which corresponds to '10'.

So "00" is received as "10", "10" becomes "11", "11" becomes "01" and "01" becomes "00".

Upon decoding, this results in very many errors, which is detected as such. By turning the phases back the data will again be properly decoded. Thist is done using the following schedule:

- reverse the two bits

- Invert the second bit

broadcast	receive	correct
00 = 45°	135° = 10	10-> 01-> 00
10 = 135°	180° = 11	11-> 11-> 10
11 = 225°	315° = 01	01 -> 10 -> 11
01 = 315°	45° = 00	00 -> 00 -> 01

Because of the way codes are assigned to phases this scheme is valid for each situation. This correction is done through 'trial and error': many errors -> do the correction -> no (few) errors.

The rotation can also happen in the other direction. Application of the scheme will then not give good results: if "00" is received as "01" then, after correction this will be "11". Actually, the "corrected" bits are inverted. As will be seen lateron this results not in errors in the first stage of decoding, but will end-up in all-inverted bits after decoding. This again is detectable, and then it is just a matter of 'inverting back' all bits to get the right bitstream.

Demodulating QPSK, which lacks a subcarrier, requires a much more complex circuit compared to BPSK: a Costas loop. For the operation of this demodulator: see [1]. Harrie van Deursen has now designed an efficient and relatively easy to reconstruct demodulator. The demodulator outputs two bits, labelled with I and Q. Such a couple is also called symbol; as said, the speed is 2.3 Ms/s (mega-symbols per second = 4.6Mb/s).

Bit synchronization, Bitintegration.

The symbol rate of 2.3 Ms/s means that each symbol has a period duration of 428 ns. Each period will be sampled; see Fig. 3. In order to do this in the right place a PLL is needed, which synchronizes on the bit stream. The PLL also outputs a clock signal; this signal is needed to run the rest of the logic "in sync" with the incoming bit stream.
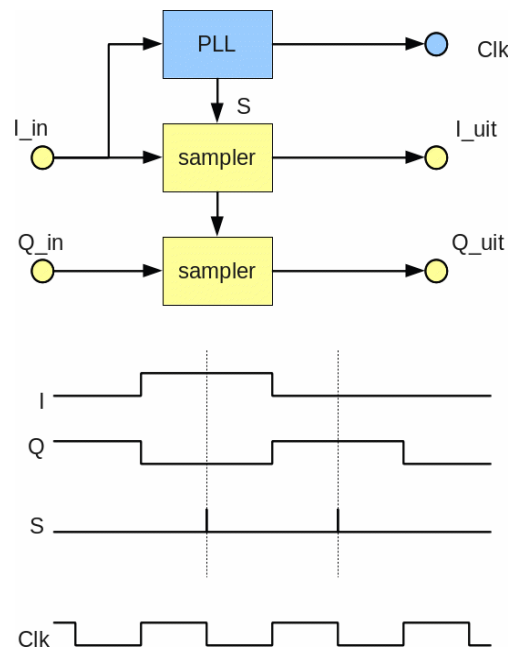

Fig. 3. Sampling input signal.

During a bit period, due to noise a bit may be inverted for a short time. If, at that time a sample is taken then this results in an error, while a sample taken slightly earlier or later would give a good result. See Fig. 4, S1.
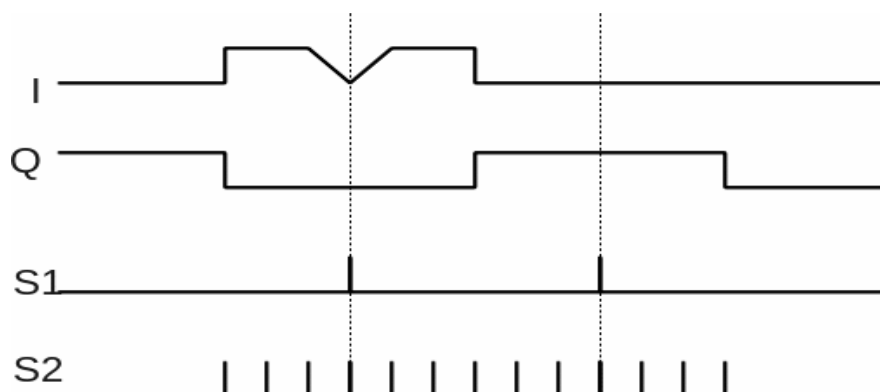
Fig. 4. Oversampling: bit-integration

By taking multiple samples per period (S2 instead of S1) and then take a majority decision some noise reduction is possible. This is done with a so-called. Bit-integrator. The result depends on the degree of oversampling; in practice it appears that a factor of 16 or more is needed.

Decoding.

This step is entirely absent in a NOAA HRPT decoder. If a bit error occurs upon reception of HRPT / NOAA (in spite of the above-mentioned bitintegrator), then this is not detectable, let alone correctable. In METOP a special way of coding is done so that error detection and even correction is possible to a certain extent. This for a price in the form of adding additional bits which increases the needed bandwidth. The coding used in METOP (and in many other satellites) is called Punctured Viterbi; for details, see [2] and [3]. In [3] the "Punctured" part has been discussed, but this was based on BPSK, instead of QPSK. With QPSK it looks a little different, so I'll dive a little further into this part.
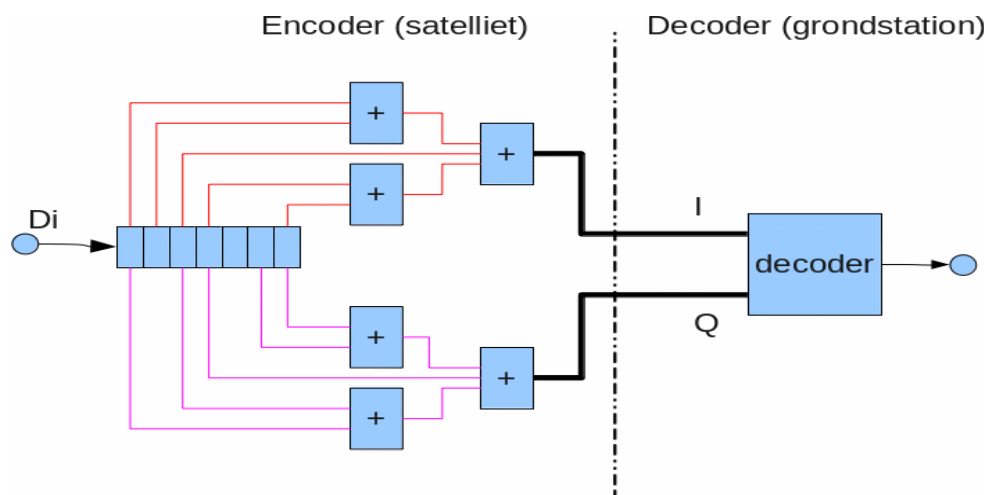

Fig. 5. Viterbi encoder and decoder.

In fig. 5, the left part shows the Viterbi encoder, as implemented in a satellite; on the right side the decoder in the ground station is shown. The bit stream to be transmitted is converted into two streams using a shift register and a plurality of EXOR's. The resulting I and Q signals go to the QPSK transmitter. I and Q are different because the EXOR circuits are different.

In the groundstation, these two streams enter the Viterbi decoder. The EXOR-trees in the encoder are designed in such a way that the decoder can reconstruct the original bitstream from the received IQ signal.

This way of broadcasting has the advantage that the decoder can correct errors in the received data stream. This is to make somewhat plausible by realizing that each original bit entering the encoder is spread out over time; each bit "stays" 7 bit periods in the 7-bit shift register, and will then make a contribution to I and / or Q via the two EXOR circuits. A disturbance by noise at a particular time then does not distort an original data bit as a whole, because there are also contributions in the IQ-stream at other times of the same bit.

The profit is no less than 5.2 dB. Unfortunately we lose 3dB because now 2x as many bits have to be transmitted, but ultimately the profit remains positive at 2.2 dB. That means for example that the receiving antenna may be 40% smaller to still get the same result.

The encoder is very simple; in fact, the complete diagram is already shown in Fig. 5. It could be made with just a few TTL-IC's.

The decoder is a different story. Here, a number of received IQ-pairs are stored (eg. 32 pairs), on which an analysis is performed in order to determine the most likely bitstream. In [2] I have tried to explain this, but it is not easy. The decoder scheme is therefore omitted here.

Viterbi encoding / decoding can be done in various ways; with shorter or longer shift registers, and with 2 or 3 sets of EXOR-trees. Happily METOP uses a relatively simple version, called Voyager variant. This circuit is also used in the two Voyagers launched in the 70s; the Viterbi encoding gives a contribution to the fact that signals are still received, although these spacecrafts have now left our solar system.

"Punctured" Viterbicoding.

In METOP a customized Viterbicoding is applied. The doubling of the number of transmit bits for the coding is still very coarse; it means a halving of net bitstream. The Viterbi encoder itself cannot be custimized, but the outgoing IQ bitstream can be adpated. This is done by simply remove one I and one Q for each 3 IQ-pairs; as a result, the increase of bits is 4/3 = 1.333 instead of a doubling the bit stream (6/3). This is done using a fixed schedule. Suppose the Viterbi-encoder outputs the following sequence:

	X1	X2	X3	Y1	Y2	Y3	......
I	Ia	Ib	Ic	Id	Ie	If	...
Q	Qa	Qb	Qc	Qd	Qe	Qf	...

From this, for each set of 3 pairs, the I in the second pair and the Q in the third pair is deleted. Then, pair 2 and 3 are pushed into each other so that the open spaces are being filled. Result:

	X1	X23	Y1	Y23	......
I	Ia	Ic	Id	If	...
Q	Qa	Qb	Qd	Qe	...

This reduces the number of bits to transmit by 1/3.

At the receiving side, the original open spaces are created again ("depunctured"):

	X1	X2	X3	Y1	Y2	Y3	......
I	Ia	I?	Ic	Id	I?	If	...
Q	Qa	Qb	Q?	Qd	Qe	Q?	...

The red marked bits are not sent so are on the receiving side unknown. Here a '0' (completely arbitrarily) is inserted. The remaining spots are filled by the received bits. These pairs are now supplied to the Viterbi decoder. The unknown bits (I? And Q?) are marked as such so that the decoder "knows" that no value should be attached to these bits while decoding. Due to the error-correcting nature, the decoder is able to reconstruct the original data bits, in spite of the fact that not all bits after the actual Viterbi encoder are

transmitted. The gain in S / N will be lower, but still positive. Note that there are still more I/Q bits broadcasted compared with the original data-bits.

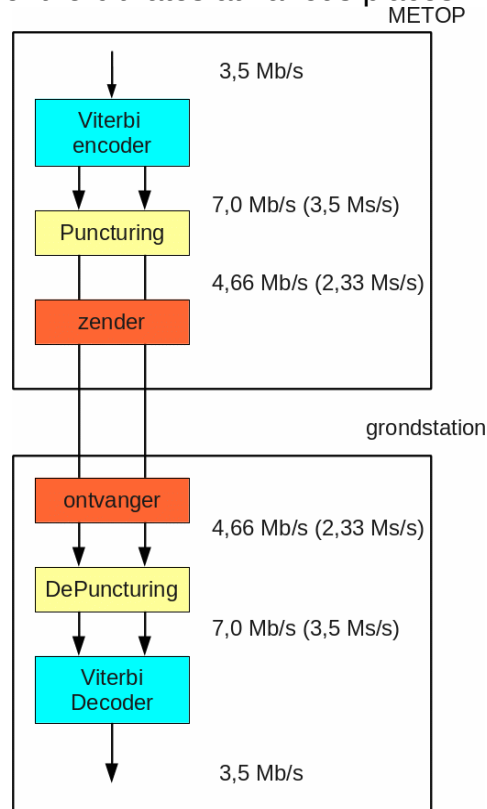Fig. 6 provides an overview of the bit rates at various places.

Fig. 6. Bit rates at various points in the transmit and receive path.

There is yet a problem to solve: At which places should the extra bits be added? This is not clear in advance, in a continuous stream of symbols (bit pairs).

There are basically two types of bit pairs received: a complete pair (in the second table Ia / Qa and Id / Qd) and a compound pair (Ic / Qb and If / Qe). The composite couple must be converted into two pairs: Ic / Qb ==> lb / Qb, Ic / Qc), the complete pair (Ia / Qa) is already good. So the question is: what is the composite pair? This is solved by "trial and error": choose a pair as a composite pair, split it into two pairs as described, let the Viterbi decoder do it's thing. If many errors occur: apparently the wrong pair was choosen; take the next pair as composite couple.

At the demodulator side we saw also a 'trial and error' for whether or not I / Q should be converted in -Q / I. In both cases, the error detection in the Viterbi decoder is used to determine what is the correct result. So all together four possibilities must be considered:
- I / Q, 2nd pair is composed
- Q / -I, 2nd pair is composed
- I / Q, 1st pair is composed
- Q / -I, 1st pair is composed

Only one of these possibilities will give the right, in the ideal case, error-free result.

Frame synchronization, derandomizer

The Viterbi decoder outputs a bit stream in which a few more operations must be performed. As is said before the bits are transmitted in frames of 8192 bits (1024 bytes). Each frame begins with a 32-bit synchronization word: 1A CF FC 1D (hex). This word is the reference point in the "endless"

bitstream, and must be detected. After this, the bits can be grouped in 1024-byte frames.

As indicated in the 'Demodulation' part it is possible that the entire bitstream is inverted is. This is easily recognizable because then the synchronization word is also inverted. By searching for two words (the sync word and it's inverse), it's easy to determine whether the data flow is inverted or not, and the remaining bits can be put right.

The remaining 1020 bytes must still undergo further processing; at the transmitting side, these bytes are "randomized". See Fig. 7. This circuit consists of a so-called. Pseudo-random generator. It consists of an 8-bit shift register from which a plurality of bits are fed back through an EXOR-tree. If properly configured this circuit generates a random bit sequence that repeats after 255 chimes, hence 'pseudo'. (8 bits give 256 states. One of these is a so-called forbidden state: if all bits are "0" then the generator sticks forever on this state.)
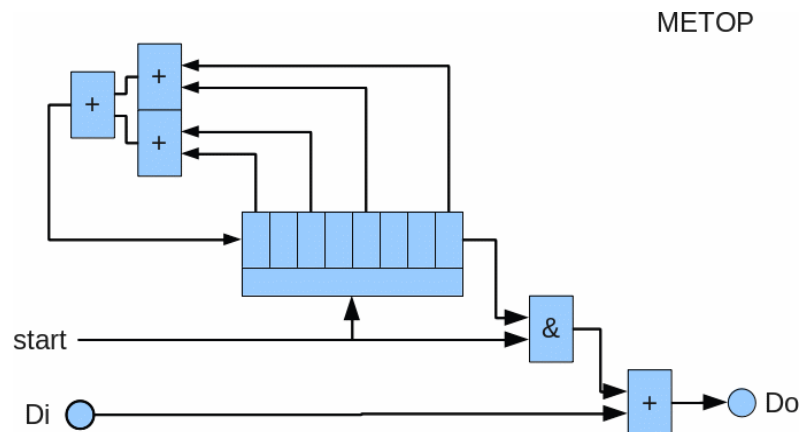

Fig. 7. (de)-randomizing the data string.

The shift register is put at the beginning of each frame to '11111111'. As soon as the first bit after the synchronization word enters input Di, the generator is started, and the input data will be either inverted or not, depending on the output of the generator (the synchronization word itself is thus not affected).

The reason that this is done is to prevent that there are too many consecutive zeros or ones to be transmitted; this would give synchronization problems at the receiver.

The original data is simple to recover by doing exactly the same operation on the receiver side.

Resume

Together there are three uncertainties in the data stream to solve in the decoder circuit:

- I / Q 90 degrees rotated, Viterbi decoder is used to detect this
- Position of the "punctured" bits, ie, which bits are removed, Viterbi decoder is used to detect
- inverted or non-inverted bit stream, the sync word is used to detect this

And then...

The bits coming from the derandomizer are sent to the PC via USB where further processing takes place, eventually giving the 'desired image' as the ultimate result. There are quite a few operations discussed. All these operations could be done in software, but that takes a lot of computing power and disk space. With the above blocks implemented in hardware, things become a lot easier. All the blocks after the demodulator fit into the GODIL module, including the old HRPT / METEOR decoder. It's a matter of choosing the appropriate decoder, and start recording...

In the next part I will try to explain how the data stream is put together and how we end up with a picture.

References

[1] Demodulating QPSK. . KM 2013 No. 1, p. 22; no. 2, p. 58

[2] Receive and dcoderen LRIT (2). KM 2012 no. 1, p. 18

[3] Punctured Viterbi. KM 2014, no. 1, p. 20.

From THE LIBRARY
Paul Baak

Dear people,

December! That great month with time for family and the hobby! With glowing wine (to warm your hands), hot chocolate milk (almost burnng your hands at) and the soldering iron (now you burn your fingers really great). Yet I have fine memories. Every winter I remember with gratitude that I once received from the hands of Mr. Pete Black an electronics kit, which made the foundations for a successful career and now the current hobby. Too bad that this man, generous and always in a good mood, just a jewel for our society (yes a pattern for all of us!) now is faced with contempt. Your librarian hopes for peace and calmth and to this end offers the following contribution.

In the December Electron an in-circuit defective fuse detector. Sometimes rather useful; I'm once was tricked by a fuse gleaming like silverware, but in the meantime completely defectivo. And I just kept replacing expensive MOSFETs. With some bjt's and resistors you prevent this.

An Australian guy has sent a balloon with a transmitter on 434 MHz @25 mW one and a half time round the globe. Beautiful pictures of the distance traveled in flat and spherical projection. I can not believe it is allowed (apart from registration, not even consent necessary). I do not like to be the airline pilot who gets the thing on his windshield, or between the teeth. The radar reflector must prevent all evil ?! As for us, maybe nice job to follow a thing like that. There are, of course, no keplerdata. What would be possible with just a UHF Yagi on one of our rotors?

The Veron (radio hams) soon organizes a discussion forum on their website. Anonymous responses will not be allowed for fear of abuses. This reveals how sublime our club is: we do not even know this problem. We speak to each other and work together at the meetings as it should be. If you know the club mainly from a distance: just come along. Great enthousiastic atmosphere always.

Perhaps receiving weather satellites will remain unattainable for me because of the flats surrounding my garden. Earth-moon-earth is a more viable challenge then. In Electron magazine a successful project in the UHF, but the power used is not mentioned, alas. You can expect that with a few watts is not enough, because on the whole track we have 230 dB attenuation. Moreover, I should first neatly arrange a broadcast license. Or would ISS listening on 437.55 also be nice? On

clear skies, alignment by hand might be feasibale. So there remains some dreams te be dreamt.

In august Funkamateur a series articles started on the DIY construction of a 13 cm helix antenna. Of course we are a little lower in frequency, but maybe it offers interesting ideas. Also a field strength meter with a MMIC. Let's see if I can lay hands on these recent Funk's.

In Elektormagazine that I get in the mail along with a bunch of advertisements, a sequel to the quarrels within Arduino's. That's a workhorse for our hobby and so your librarian annex trendwatcher can not avoid a consideration. A year or so back one Arduinofounder split off taking commercial rights with him. The further development went towards Intel on the one hand and to Atmel on the other hand. Now it comes together again in an Arduino Foundation, but I'm not confident as to the further development direction. Microchip (from the PIC's) also bought Atmel (the basis for the straight Arduino). Must I gamble that the PIC will survive? That hardware architecture makes me think of Pompeii and its assembly language reminds of the Latin signs on the walls there. I never found it easy and was already glad that I got half a led flashing.

Once more a look back at Philae. From the television news this time. Rosetta itself has also been dumped on the comet. Can someone on journey with that emigration mission to Mars and coming along that comet, please put these two devices upright and clean and wipe off the solar panels? Thats handy for us here. Thanks.

Enough words, it is time for the yummy snack. I think the chocolate Santa Claus on the chimney will vanish. Nothing human is unknown to

your librarian

Our new WRX-QPSK / HRPT Workgroup receiver 2017.

Everything is changing and we must change with it in order to be able to receive images.
APT becomes extinct, HRPT is there and QPSK signals at 1700 MHz are the future.
Currently broadcast Metop-A, Metop-B and 3-Feng Yun's with QPSK modulation.
On HRPT works well: NOAA 18 and 19 and Meteor M 2.
At 1700 Mhz you need a steerable dish to follow the Sats, my 90cm offset dish is just good enough when everything else is optimal, think of the optimal Helical described in the KM of December 2015.

What is so special about QPSK modulation that you need another receiver?
There is simply no more a central carrier to tune into and you have to do it with sidebands from to the modulation. To be able to tune in to the missing carrier, Mr. John P. Costas has a circuit invented called the Costas Loop.
In practical terms it means that signals from two down mixers with 90 degree phase difference, will be crosswise multiplicated with each other and the added together. You will receive a control voltage for the VCO to tune in phase and frequency to the virtual carrier. Well, almost everything has now become virtually ....

> The default Costas loop Fig1.

The Limiters are comparators and in fact they make sure that the analog signal from the other branch is multiplied by 1 or -1, thus reversing the phase.
To get rid of difficult analog multipliers, I got the idea to work with balanced signals and use Fet switches to reverse the phase.

> New Costas Loop Fig2.

Then go through data sheets in order to achieve an optimum choice of operating components together and also to clean up considerably.
As comfortable down mixers, I chose the LT5546, virtually the only device which is suitable for our purpose and also available. Very small with 16 terminals on 4x4 mm!

> Block Diagram LT5546 Fig3.

All inputs and outputs are balanced and that makes the circuit less susceptible to interference.
Also, there is a gain control input, and you need only a double frequency for the mixer (73 Mhz) instead of the usual four-fold. The IF output DET is independent of the gain setting and we can use it to control the gain of the tuner and avoid clipping the signals, because then the Costa loop will not work any more.

>The schematics

We use the same UV917 / IEC tuner as in the WRX-1700.

From the Tuner we come in at 36.5 Mhz to the SAW filter that attenuates about 15 dB.
The MAX2471 amplifies 16x and via transformer T4-1 to the LT5546 inputs.

As VCO at 73 MHz, the choice fell on the MAX2606. This is an oscillator with a built-Varicap and requires few external components, L1 is the tunable oscillator coil.

The I and Q outputs of the LT5546 are on a DC level of approximately 3.8 volts and then coupled via 100nF to the inputs of the active 2.3 MHz low pass filters LTC1566.

Because we work with a single +5 volt supply, we use a Vref of 2.5 volts to give the circuits a center reference voltage. Through buffers EL5170, we go at low impedance to comparators TLV3202 and the 74HC4053 Fet switches. Addition of signals with R7-R8 and via Loop-Filter-Amplifier TCL272 we will adjust the VCO that is all!

In order to allow for HRPT reception, a DC phase detector will be required.
Already avaliable into the LT5546 and comes out in the form of a small voltage difference between I + and I-.
With the other half of the TLC272 we amplify and filter to get a control signal for the VCO on a DC voltage around 3.8 volts.
Switching between the two TLC272 outputs we do with the third switch of the HC4053 and output TUNE

goes to the VCO. Sometimes, how beautiful can it be come out with a single component.

The choice QPSK / HRPT will be done by MODtype. GND for QPSK, open for HRPT or automatically via the Frequency choice if Jumper J2 is inserted.
Capturing by the Costas loop will be automactic most of the time, but it helps if you switch from mode or frequency giving a reset to the TLC272's to low level for the VCO.
Frequency switching will also give a reset pulse (QPSKpuls), Jumper J1 determines whether that is used.

In Lock on HRPT usually goes automatic, but you can if necessary, Fine-Tune via connection Tune HRPT with a 100k potentiometer between 3 and 5 volts. The need depends on frequency drift due to temperature differences in the Down Converter, Tuner, VCO and the Satellite.

The digital I and Q outputs for Rob's Decoder come from the TLV3202 comparators.
For HRPT decoding we only use the I output.

There are two analogue outputs, I and Q where we can look at an X-Y scoop to the Constellation Diagram.
In HRPT mode we see two clouds and with QPSK 4 clouds. Fig 4. and Fig 5.
On reception without noise there will be sharp dots, but that's impossible with my 90cm dish. A 110 cm dish makes everything less critical.

Connecting and Adjusting.

Obviously you will check the 5 volt power supply before connecting the ribbon cable to the other prints.
Also, you have made the modification to the flat cable on wires 13-14-15-16. See Fig 7.

Connect, Power on and see if it begins to smoke anywhere!
If all is well, in HRPT mode a VCO voltage of about 3.8 volts will be on the LCD display.
In QPSK mode, approximately 2.4 volts without signal.
The I and Q analog outputs should have a DC voltage of approximately 2.5 volts.

Connect the converter, select 1701.3 MHz and adjust RV1 on the tuner board until you see the RF level up to about 20, noise from the Universe and Everything behind the dish................

Receive a HRPT satellite and adjust RV1 on the demodulator board for 1 volt peak-peak on the analog I output.
Adjust L1 so that, on the scoop in X-Y mode, the two dots are horizontal equals minimum signal on the analog Q output.

With RV2 you can compensate for the offset voltage caused by the switching of the HC4053.
It allows you rotate the X-Y diagram to the right position.
Also, it has an effect on capture by the Costa Loop, on received noise at 1701.3 Mhz the VCO voltage must be set to approximately 4.15 volts.

QPSK Harrie

UV916 print

Summary

This article describes a PCB for the UV916 tuner. The IF is available on header pins and can be used for various receivers. Also included is the power supply for the UV916.

Introduction

In the WRX1700 we used the UV916. This tuner removes much of the complexity of the construction of a receiver. Therefore, for the new QPSK receiver we have also chosen this tuner. Unfortunately, they are no longer made, but the Working Group has copies and they are also available on eBay.

The intermediate frequency from the UV916 is available on the ribbon cable and goes to the demodulator pcb. Lovers of APT could connect an FM receiver.

Main functions

Power supply

The UV916 requires the following supply voltages:

- 12V. This is the input voltage. This should be a stabilized 12V power supply because it goes directly to the UV916. From this, the following voltages are generated:

- 32V. There is the MC34063 designed as a step-up converter. The circuit is the same as in the WRX1700. Note that diode D1 of the 1N5819 type is due to the high voltage that is generated. This is the tuning voltage for the UV916.

- 5V. This comes from a switching regulator. You can use the type that is in the HRPT decoder. I opted for the cheaper Recom. The first draft was an LM317, but it was much too hot as it was fed with 12V. The 5V is in addition to the UV916 also needed for the display board and the demodulator

AGC control

Of the demodulator pcb comes an AGC-signal which the gain of the UV916 is controlled. With an op-amp the derived signal "RFlevel" is made that goes to the display board.

Figure 1 shows a prototype constructed. Here, even with a LM317, this is replaced by a switched variant.

Construction

The construction will not pose a problem. Note that some SMD components are on the bottom.

Connector P5 and P6 need not be mounted. Connector P5 is useful when you want to watch what happens on the I2C bus. P6 connector can be used if you need other places in the receiver 5 or 12V.

Check the voltages before you install the UV916.

New display board for the QPSK receiver

Summary

The new QPSK receiver comes with a new display print. This printer uses I2C for communication with the LCD display. A ribbon cable connects the display board with the board tuner and the demodulator.

Introduction

With the new receiver it was also time to reflect on another display board. With the old display print was not much wrong, but there were a few things for improvement. For a description of the first version I refer to [1].

Disclaimer: This article is a snapshot. Do you build always ask the latest version of diagram and PCB lay - out. In the course of time, there may be slight improvements have been made.

Why a new display board

- The number of required connections is smaller, among other things because there is no audio squelch and more is needed.

- At the old display board was the LCD display mounted on the PCB. When you do this with plug connections you got quite a deep in that much valuable space in the case.

- Also connecting the old print on the LCD display was difficult. You could choose a ribbon cable, not really handy when 16 veins is wide.

Figure 3D animation of the new display board

Adjustments

There's not much has changed:

- The LCD display is controlled via I2C. These displays have become so cheap that the price is not an argument for not using them. The advantage is that you can easily change a display to test it for proper operation.

- All available I / O pins of the connector pins Arduino have gotten on the board.

- Separate 5V.

What has remained the same

- The ribbon cable. The old display PCB can also be used with the new QPSK receiver. You must then load the new sketch.

- Programming Interface. To program the Arduino you can collect it from the display board and prick in an Arduino board. Note: If you do this a few times, the chip is not getting better and you run the risk of breaking pins.

 - The Arduino. We still use the ATmega328. This is good and is not difficult to solder SMD chip, ideal for experimentation.

Figure 2 The programming interface, see [2]. More expensive than an Arduino board but quite comfortable

New sketch

See also the description of the sketch of the first display board [3]. Major changes include:

- Adjustable center frequency. In the old sketch the number of steps for the UV916 at different frequencies was fixed in the sketch. In this version, the number of steps is calculated. As we are when we would choose a different intermediate frequency a lot more flexible.

- Supporting an I2C display

The sketch

What I always find a fuss, is the use of libraries. If it is not necessary, I do not use too. In an I2C display have you ever need one. I used the library Francisco Malpartida [4]. Installing libraries is difficult and does not always give the desired result. Several times I completely removed the Arduino software from my system and reinstalled everything to ensure that there were no conflicts between libraries.

Below I will explain a few things from the sketch that might be interesting. I also refer to the article on the sketch for the first display board [3].

Down Converter

In the sketch is determined which down-converter is used by looking at the tuning frequency of the UV916. Is the frequency higher than 200 MHz, then a down-converter is used. There can be used two types of downconverters: the known LNC1700 or a downconverter where the intermediate frequency 1 GHz is lower. We are currently experimenting with a intermediate frequency of around 700 MHz.

With a jumper we indicate whether the LNC1700 or the other is used. The jumper is placed on D11 and D12, which are the two I / O pins of the Arduino.

With the commands:

```
#define TYPEDOWNC 11
pinMode (TYPEDOWNC, INPUT_PULLUP);
```

pin 11 is defined as input and using an internal (in the Arduino) pull-up resistor pulled high.

With the commands:

```
#define PIN12LOW 12
pinMode (PIN12LOW, OUTPUT);
Digital write (PIN12LOW, LOW);
```

pin 12 is defined as output and put low, this is made an "artificial" ground pin. This is not a problem because the internal pull-up resistor between the 20k and 50k, so there will no major currents flow.

By placing the jumper D11-D12, D11 is pulled to ground. In the sketch is then tested here. The variable is DownConvFreq is put on 10000 or 15570. This is the oscillator frequency of the down-converter multiplied by 10.

When writing a sketch you need to specify what type of variable you use. Often, an unsigned integer, integer with a maximum value of 65535. If you want to use "decimal" you use a double. The major drawback is that there remains little room for the Arduino sketch. By multiplying everything by 10, I can still make accurate calculations.

The code below:

```
if (TuneFreq> 2000) // Down Converter is used
          UV916Freq = TuneFreq - DownConvFreq;
else
          UV916Freq = TuneFreq;

nrSteps = (UV916Freq + 365) * 16;

nrSteps = nrSteps / 10; // Because all frequencies x 10

--nrSteps; // SAW filter center frequency is 36.45, not 36.5
MHz

msb = nrSteps / 256;
lsb = nrSteps 256%;
```

The variable UV916Freq is the frequency of the UV916. The intermediate frequency (36.5 MHz) must be added in order to arrive at the oscillator frequency. By multiplying with 16 we come to the number of steps.

The number of steps is divided by 10 and decremented by one because the medium frequency actually is 50 kHz lower. The last two lines to calculate the number of steps in bytes.

VCO-level and RF level

The display board also measures the VCO voltage. This is an indication of whether the QPSK demodulator is in-lock. The RF level indicates the signal strength. First, there are 10 samples are taken where the average is calculated. If this differs from the previous value, the display is updated. The latter I do to get a quiet reading.

It was really a hassle to the 4V and 4.00V, 4.1V display as 4.10V. This, too, for a quiet readout. Also here you have to deal with the problem of limited space in Arduino, where otherwise you can use a command like "sprintf". Below is a part of the code:

```
lung centivolts = ((VCOAvgNew * 500L) / 1023);
int dispvalue;
dispvalue = centivolts / 100;
StrVCO string = string (centivolts / 100);
strVCO.concat ( ".");

int = fraction centivolts 100%;

if (fraction == 0)
strVCO.concat ( "00");
else if (fraction <10)
  {
strVCO.concat ( "0");
strVCO.concat (fraction);
} else
strVCO.concat (fraction);
```

Here I did not escape the use of Long-variable (4 bytes). Depending on the rest, variable fraction, I stick one or two zeros after the decimal point. If anyone has suggestions how this can be better, I'd like to hear this.

Construction

See the chart on the next page.

The construction will not pose many problems. On the bottem side of the pcb are a few resistors and capacitors, do not forget to solder them. They have the format 0805, this will not pose too many problems.

Figure 4 The display board in action

Testing

Connect the I2C display to connector P8 or P5. Check the polarity.

Place the Arduino and check the polarity. We assume that you have a programmed Arduino.

If you use the LNC1700 there must be a jumper on pins D12 and D11.

Connect to 5V connector P2

If all goes well, the LCD display will light up. Turn the trimmer on the back of the LCD display so that the contrast is maximized.

Conclusion

It is not all that complex. The complete listing of the sketch is too long to publish in the Kunstmaan. Interested parties may request the sketch with me.

Links

[1] Print Display the WRX-1700

Artificial satellite in September 2012, page 108

[2] Programming Interface

http://www.ftdichip.com/Products/Cables/USBTTLSerial.htm

[3] Sketch for the WRX-1700 Display Print

Kunstmaan October 2014, page 120

[4] I2C LCD display library

https://bitbucket.org/fmalpartida/new-liquidcrystal/wiki/Home

Report meeting November 12, 2016.

Opening by the Chairman.

Ben asks if members have suggestions for fairs where we stand. Called an exhibition in Bad Bentheim.

Minutes from meeting September 24,
No comments

adoption agenda
No comments

administration
No changes.

Finance 2016: financial control committee
Wim Bravenboer continues, Herman Grotenhuis is relieved by
Peter Kuiper.

satellite Status
The Sentinel is now active; Data is distributed via EUMETCast. The resolution can go up to 300 m, a lot higher than we are accustomed to using NOAA and METOP. With good weather this HVS data stream can be received with a 80 cm dish. It does need a special receiver; DVB2 with VCM. With the inexpensive receiver (as described in the previous Kunstmaan), this data can not be received.

Any other business
Hendrik Jalving has made an interdigital filter with BNC connectors.

Wim Bravenboer: mentions receiving radio signals of stars and nebulae, with a 1.2 meter satellite dish. It's something different to receive than Satellite.

Ben Schellekens has made a print for the PGA amplifier, designed by Timo Lampe.

Peter & Peter: Their XY rotor system is now working well mechanically. There still needs to be made an adjustment in Xtrack because it sends this rotor exactly the wrong direction. Matter of definition: X = 0 degrees equals east or west? Let's leave it at 'east'. This is made adjustable in xtrack any case.

Elmar: again has some things in his "shop"; including a small cutting pliers for only 5 euros.

Job de Haas: Has recently joined. He has been involved for 20 years with include helping banks to improve their security.
He is now interested in radio reception, including SDR, tracking satellites etc.

Arne:
Reports that one of the type RG59 coaxial cable is perfect for EUMETCast reception. The advantage of this cable is that you can drive over it without damaging the cable, convenient to exhibitions where the cable must walk across a parking lot.

Rob: Reports that we now can receive 'live' METOP; the receiving and decoding parts operate well.

closure

Reading:
Ben Schellekens talks about the pcb's of the QPSK receiver, QPSK demodulator and display board, required for receiving METOP.
Parts are not all readily available; there will be a sign-up list.
The QPSK demodulator is in a very small SMD-IC, there is an adapter board made in order to make it somewhat to handle, so it can be mounted as a DIL IC.

Harrie van Deursen talks about the QPSK demodulator designed by him.

Rob Alblas tells something about how the data stream is constructed. The program WSAT can now translate the METOP data in an image, just like HRPT NOAA.

Rob Alblas
(Secretary AI)