

Es-Hail-2 Oscar-100

Es'hail-2 (QO-100) is a geostationary satellite in orbit at 25.9° East carrying amateur radio transponders.

It's reception footprint covers Africa, Europe, the Middle East, India, eastern Brazil and the west half of Russia/Asia.

A joint project by the Qatar Satellite Company (Es'hailSat), the Qatar Amateur Radio Society (QARS) and AMSAT Deutschland (AMSAT-DL).



Es'hail-2 (QO-100) carries two amateur radio transponders, a vertical polarized narrow band linear transponder (downlink 10489.550 - 10489.800 MHz). And a horizontally polarized wide band digital transponder for amateur digital TV DATV (downlink 10491.000 - 10499.000 MHz.).

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Satellite Dish

For reception of Es'hail-2 (QO-100) you need a dish in size >40 - 80 cm for the Narrow Band.

A size between 80 - 1.20 cm or more for the Wide band transponder is needed.



Im using my old 1.50 Mtr Primefocus pointed to Astra 23 East for TV Reception.

But offset dishes work off course fine to.



Bullseye BE01 LNB on the left/bottom so it points to 25,9 East Es'hail-2.

LNB

The Othernet Bullseye BE01 (<https://www.rtl-sdr.com/buy-rtl-sdr-dvb-t-dongles/>) is stable and precise LNB with a tunable TCXO instead of plain crystal oscillator.

It does not need a internal modification to receive the narrow or wide QO-100 transponder.



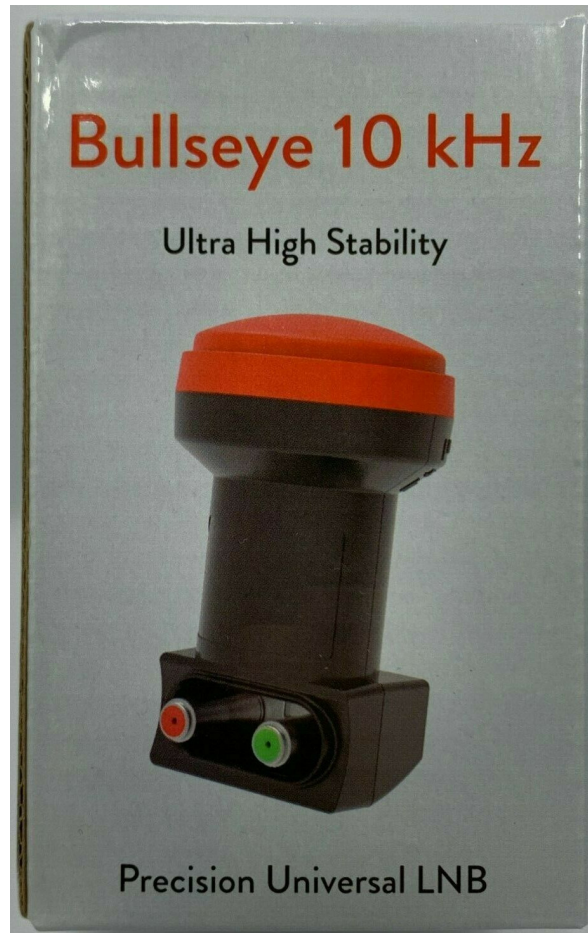
A second output F (red) is available to benefit from the 25 Mhz reference signal output in order to control another device or to check the stability.

Normal outdoor use (25°C), the frequency offset is well within 10 kHz of offset thanks to its integrated 2ppm TCXO and a 25 Mhz reference.

Satellite TV (DRO/PLL-based) LNBS can be used for Es'hail-2, but it is not recommend.

Regular Ku-band Satellite TV LNBS suffer from drift in frequency making it more difficult to keep a stable reception for the narrow band signals.

Because of outside conditions (temperature changes, sun, clouds, wind ect).



Specifications:

Input frequency: 10489 - 12750 MHz

LO frequency 9750/10600 MHz

LO frequency stability at 23C: +/- 10 kHz

LO frequency stability -20 - 60C: +/- 30 kHz

Gain: 50 - 66 dB

Output frequency: 739 - 1950 MHz (low band) and 1100 - 2150 (high band)

Return loss of 8 dB (739 - 1950 MHz) and 10 dB (1100 - 2150 MHz)

Noise figure: 0.5 dB

Features:

Bullseye 10 kHz BE01

Universal single output LNB

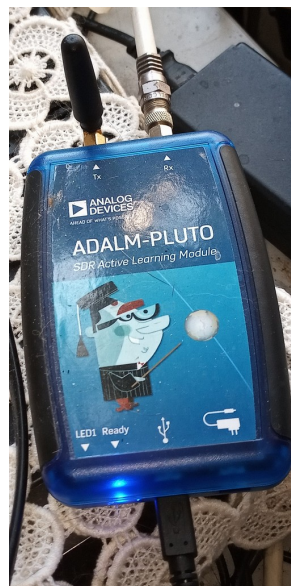
Frequency stability within 10 kHz in normal outdoor environment

Phase locked loop with 2 PPM TCXO

Factory calibration within 1 kHz utilizing GPS-locked spectrum analyzers
Ultra high precision PLL employing proprietary frequency control system (patent pending)
Digitally controlled carrier offset with optional programmer
25 MHz output reference available on secondary F-connector (red)

Testing results over here on my station with regular Goobay PLL LNB compared to the Othernet Bullseye LNB shows clearly a huge increase of frequency stability.
A must have LNB :)

SDR Radio



Any SDR radio should work fine on Es'hail-2 for reception.
E4000 Terratec and Adalm-Pluto are in use overhere.



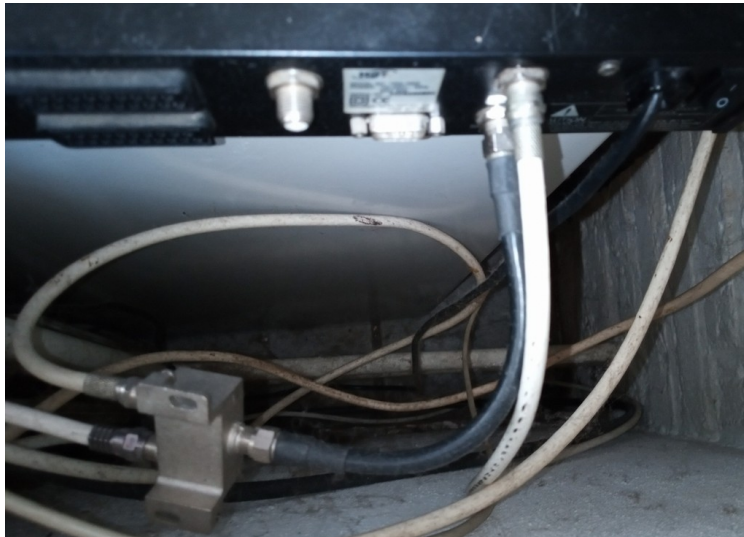
Coax sat splitter to feed both SDR Radio's.

Bias-Tee

Because a LNB uses 13/18 Volt to make H/V polarized switching possible, powered from the satellite receiver normally.

A Bias-Tee is needed, there are a few ways to achieve this from DIY (<http://www.oe8hsr.at/blog/?p=476>) or Internet buying.

It is also possible to use a (old) Satellite receiver to act as a Bias-Tee.



Any (FTA) DVB-S Digital sat-receiver will work as long it has a separate LNB-Output.

Which can be connected to the SDR-Radio or Split-ted to feed 2 SDR radio's.

The Narrow Band of Es'hail-2 Transponder is vertical, so to get signal on this part of the band a channel with vertical polarization is needed.

It does not matter if there is any actual signal on the pre programmed channel frequency only the switch of polarization matters.

Same for the Wide Band as it is Horizontal Polarized.

Point Dish to Es'hail-2

There are several ways to find Es'hail-2 in the sky,
dishpointer has a good website and app.

(<https://www.dishpointer.com>)

Es'hail-2 is positioned at 25,9 Degrees East.

Together with Badr 4 - 7 and Es'hail-1, roughly between
two Digital TV Satellites Astra 3B and Astra 2E/F and G at
28,2 Degrees East.

Which make it a lot easier to find with a satellite receiver
or just only the SDR looking for the satellite beacon
frequency

(http://frequencyplansatellites.altervista.org/Beacon-Telemetry_Europe-Africa-MiddleEast.html) looking like
this (http://frequencyplansatellites.altervista.org/Beacon-Telemetry_Europe-Africa-MiddleEast/Eutelsat_25B.html).

Using any (FTA) DVB-S Digital sat-receiver will work.

25,9 East position carries also DVB TV Channels but they
are broadcasted at a different beam with a smaller
footprint, only very big dishes can receive outside the
footprint.

However both beacon frequencies from Es'hail-1 and 2
are quite strong at 10706 V and 11205 V.

Let the satellite receiver scan Astra 28.2 East

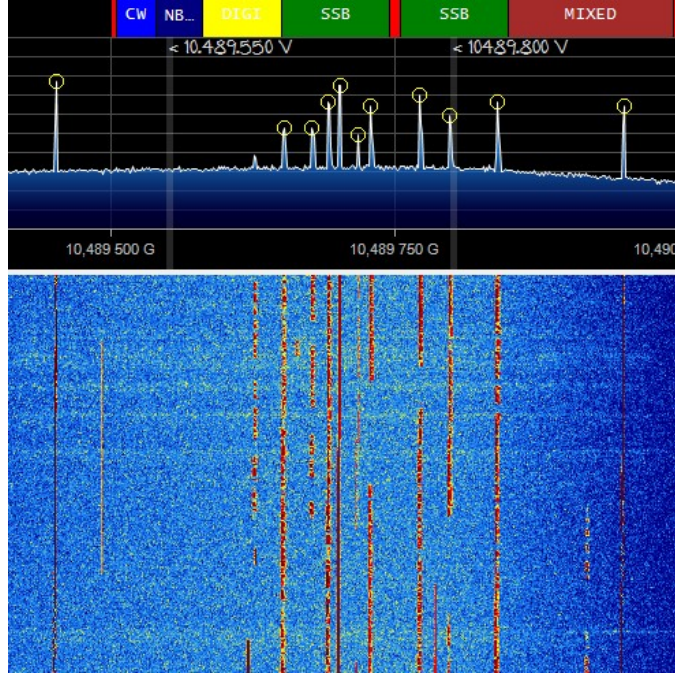
Transponder 44 ITV1 London 10.758 V DVB-S QPSK
Sr:22000 Fec 5/6. ([https://nl.kingofsat.net/tp.php?
tp=502](https://nl.kingofsat.net/tp.php?tp=502))

And Astra 28.2 East Transponder 41 Channel 4 107.14 H
DVB-s QPSK Sr:22000 Fec 5/6
(<https://nl.kingofsat.net/tp.php?tp=499>)

Use the details from Dishpointer to align the dish and
swing around until you got picture on ITV1 it should be
FTA.

Connect LNB-out from the satellite receiver into the SDR.
Tune in to 740MHz in SDR#

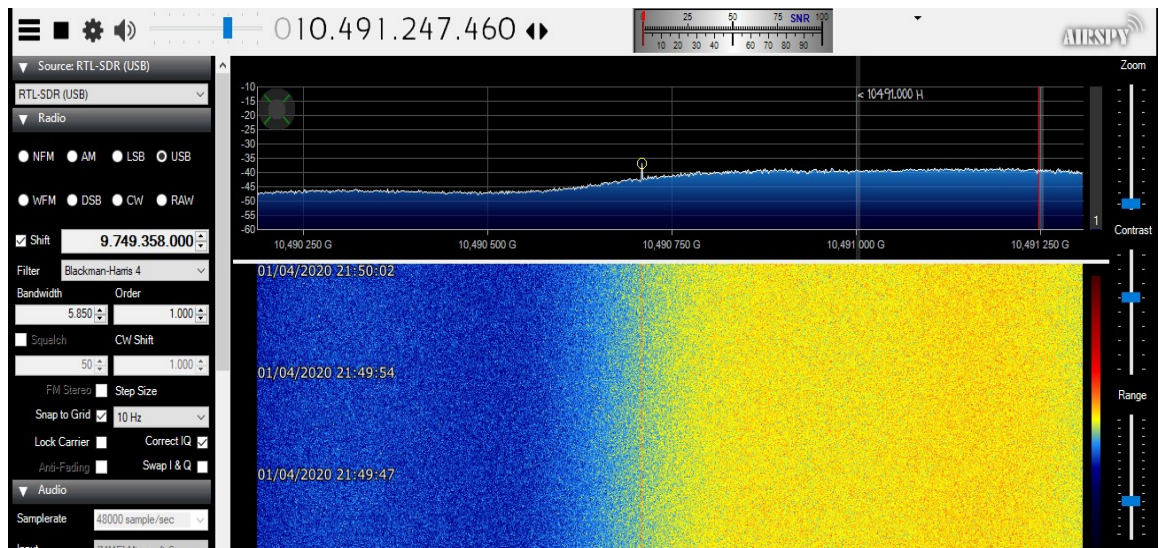
Just turn the dish a little to the right (when standing
behind the dish).



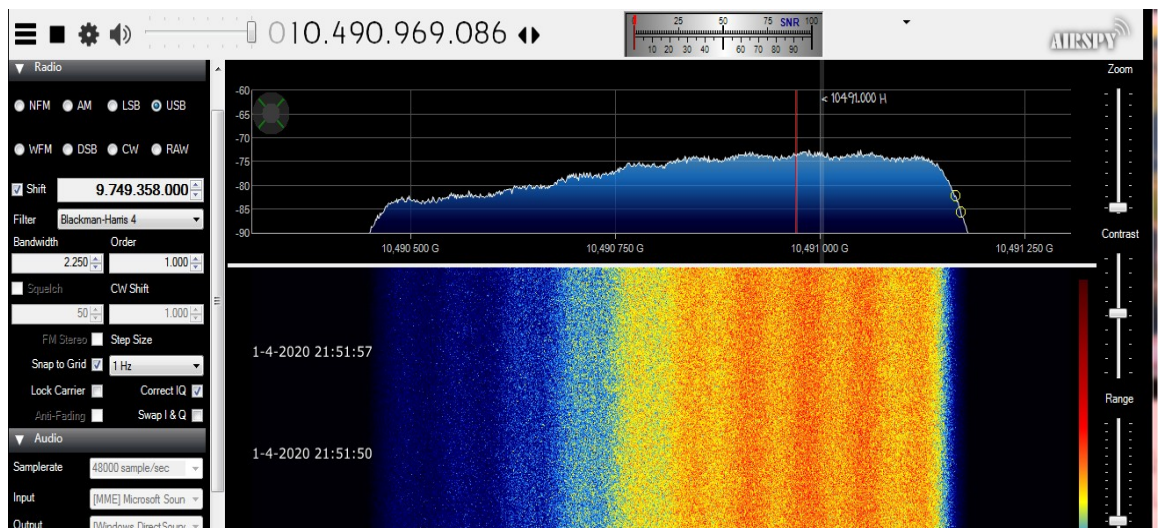
And the Narrow Band SSB signals and beacons should be visible in SDR#.

For wide band tune the satellite receiver in to Channel 4 Transponder 41.

Now try to find the DATV Beacon on 10.4915.



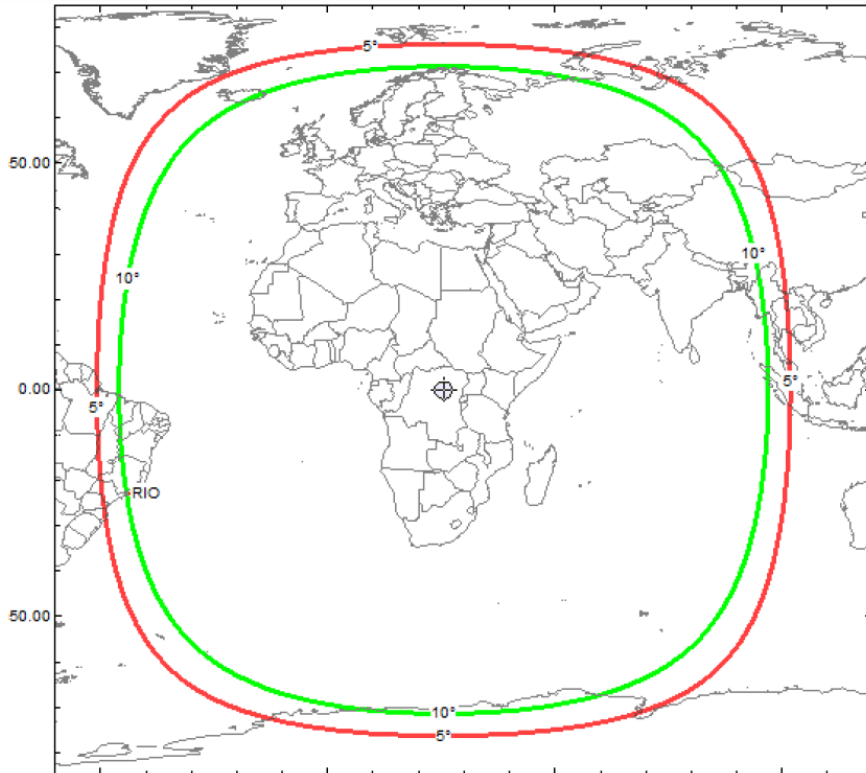
DATV Beacon on RTL-SDR E4000



DATV Beacon on Pluto-SDR

It look like a sort of hump of signal, should be visible around 741MHz in SDR#.

Align until the max signal is received.



Es'hail-2 Footprint

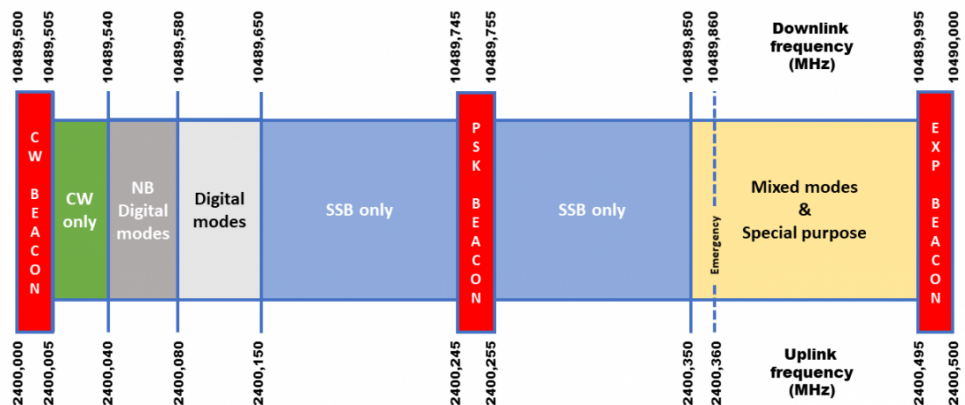
Narrow Band Transponder

The Narrow Band on Es'hail-2 (QO-100) is a vertical polarized linear transponder.

With Downlink on 10489.550 - 10489.800 MHz.

Modulation is USB and image below shows what modes are allowed and how they are specified:

AMSAT QO-100 / P4A NB Transponder Bandplan



Mar 18th 2020

(img/AMSAT-QO-100-NB-Transponder-Bandplan-Graph-1140x641.png)

AMSAT QO-100 / P4A NB Transponder Bandplan

Uplink		Downlink		Available [MHz]	Comment
Start [MHz]	End [MHz]	Start [MHz]	End [MHz]		
		10489,500	10489,505	0,005	Lower Beacon 10489,500 MHz, CW F1A, + guard band
2400,005	2400,040	10489,505	10489,540	0,035	CW only
2400,040	2400,080	10489,540	10489,580	0,040	digimodes (500 Hz max. BW)
2400,080	2400,150	10489,580	10489,650	0,070	digimodes (2700 Hz max. BW)
2400,150	2400,245	10489,650	10489,745	0,095	SSB only (2700 Hz max. BW)
		10489,745	10489,755	0,010	Middle Beacon 10489,750 MHz, 400 Bit/s BPSK + guard band
2400,255	2400,350	10489,755	10489,850	0,095	SSB only (2700 Hz max. BW)
2400,350	2400,495	10489,850	10489,995	0,145	mixed modes (2700 Hz max. BW) & special purpose
		10489,995	10490,000	0,005	Experimental Beacon 10490,000 MHz, CW and other modulations + guard Band

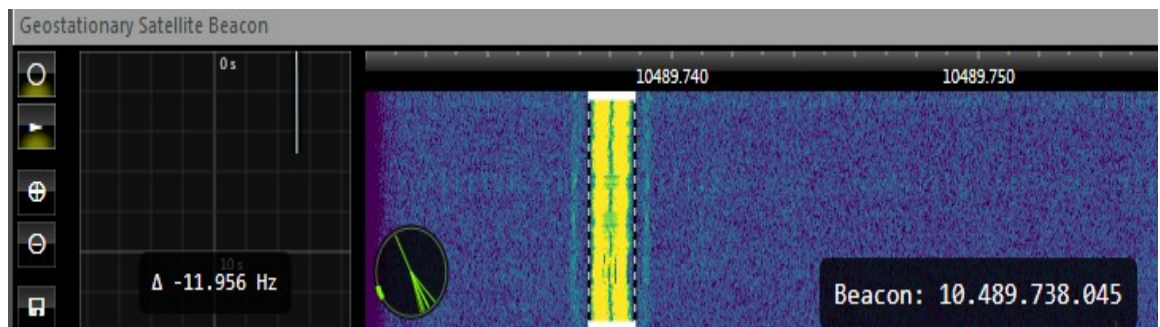
(img/AMSAT-QO-100-NB-Transponder-Bandplan-Listing.png)

Some of the very popular programs/modes used on Narrow Band SSB are:

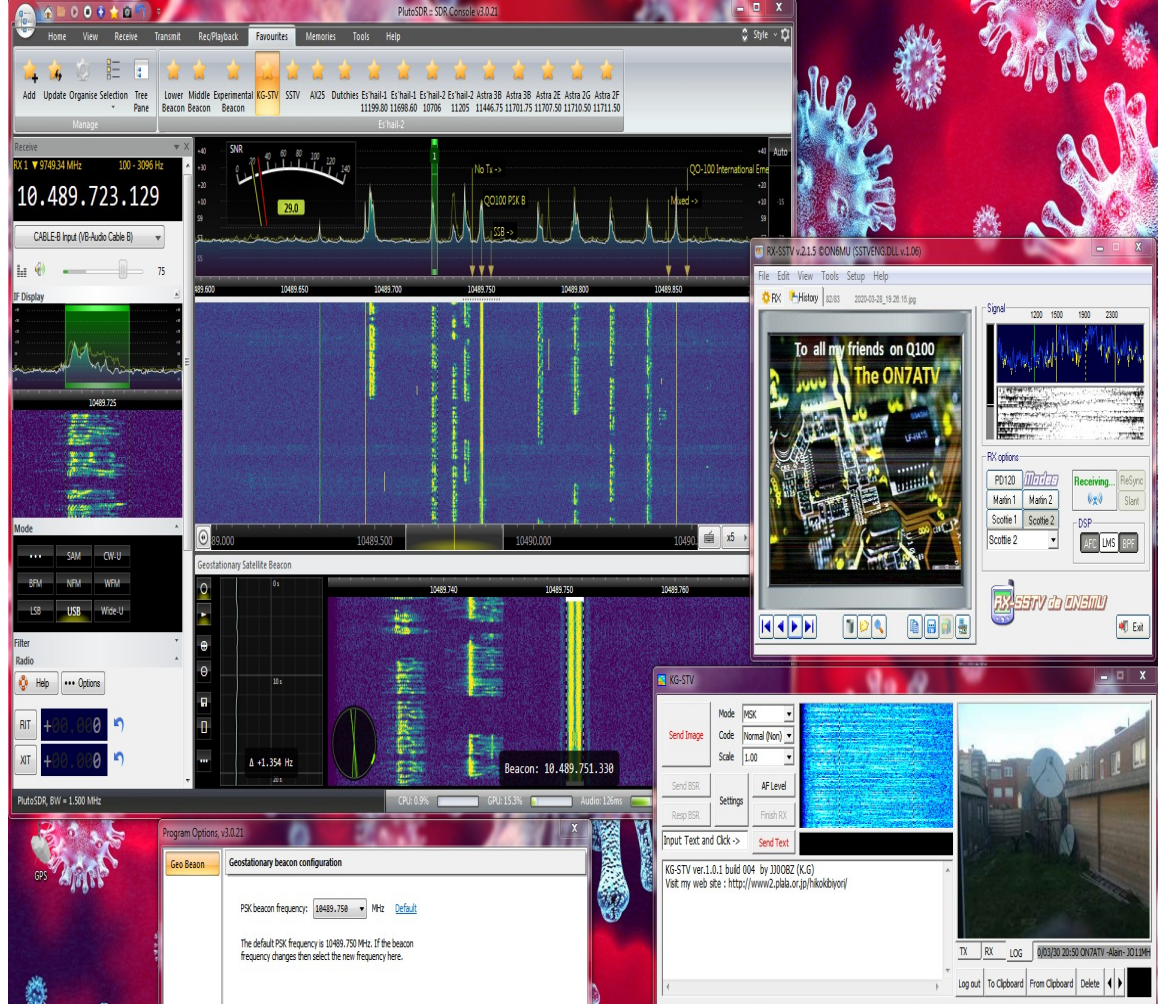
KG-STV (<http://www2.plala.or.jp/hikokibiyori/soft/kgstv/>),
SSTV (<http://users.belgacom.net/hamradio/rxsstv.htm>),
EasyPal (http://g0hwc.com/sstv_drm_news.html), AX-25
Packet Radio (<http://uz7.ho.ua/packetradio.htm>), FreeDV
(<https://freedv.org/>) and many more.

Software

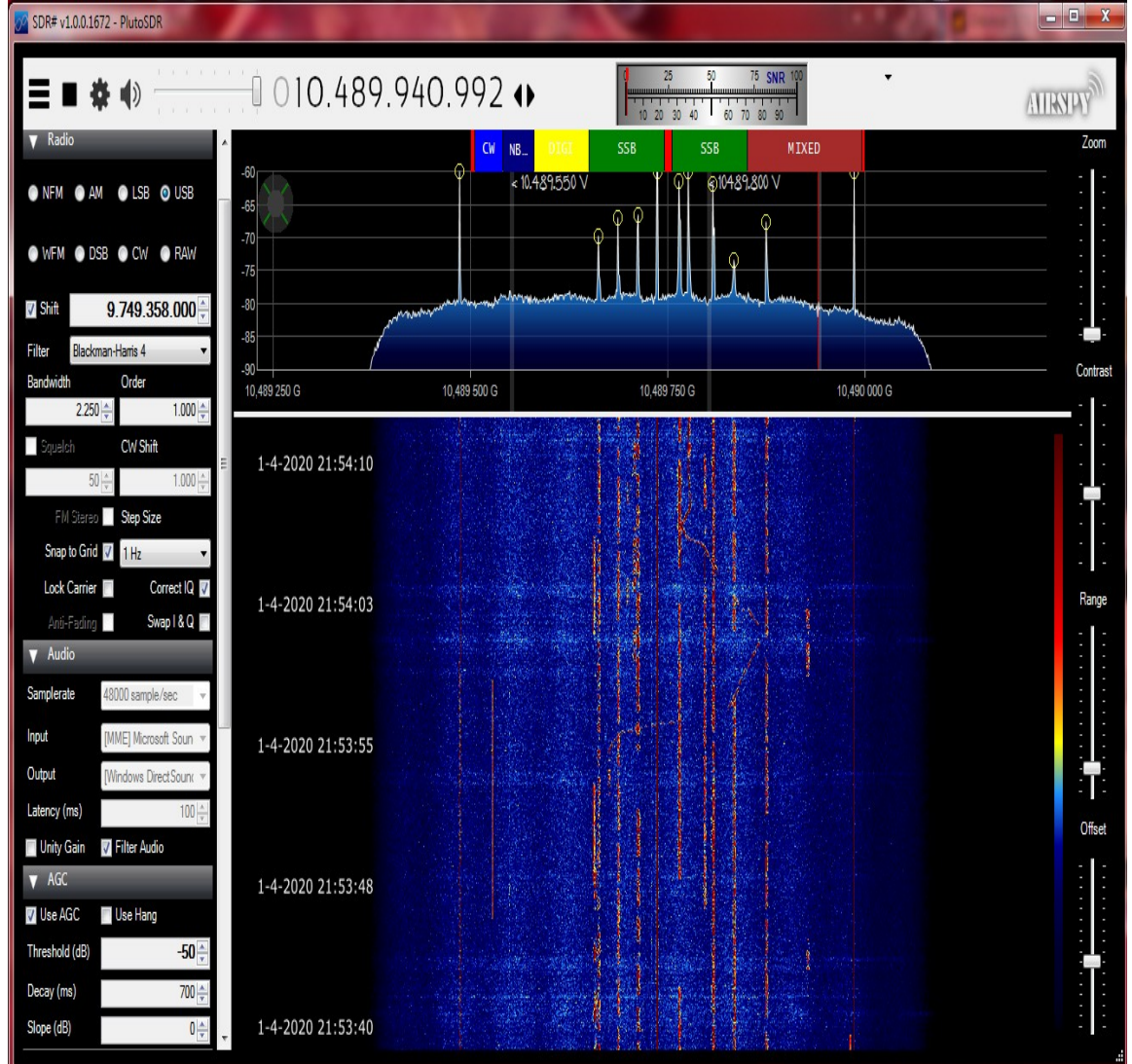
SDR Console is by far the best operating SDR software for Narrow Band mode.



With an option to synchronising the Telemetry beacon for better frequency stability. (<https://www.sdr-radio.com/EsHail-2#TelemetryBeacon>)



SDR Console receiving KG-STV and SSTV on Es'hail-2 (QO-100) Narrow Band Transponder.



With a simple modification SDR#
 (<https://airspy.com/download/>) can be used for the
 Pluto-SDR:
 Analog Devices ADALM-PlutoSDR driver for SDR#
 (<https://github.com/Manawyrn/sdrsharp-plutosdr>)

However there is no drift correction (plugin) available!

WebSDR

There are a few WebSDR available to see the Narrow
 band Live in action:

Official Qatar-OSCAR 100 Narrowband WebSDR
 (<https://eshail.batc.org.uk/nb/>)

Official Qatar-OSCAR 100 Wideband Spectrum Monitor
 (<https://eshail.batc.org.uk/wb/>)

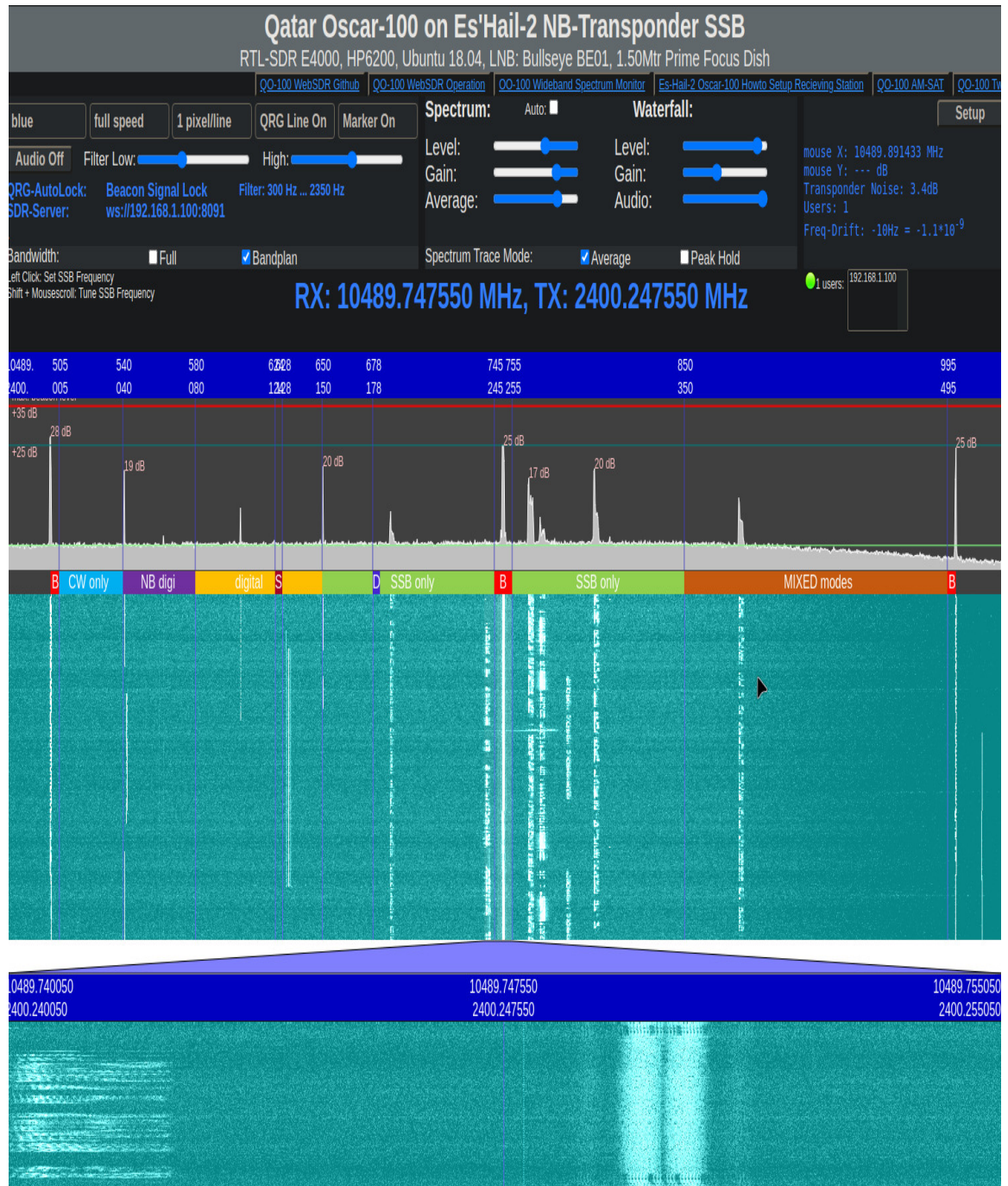
ISOGRB QO-100 (Es'Hail-2) WebSDR receiver
 (<http://217.133.56.150:8901/>)

Es'HailSat-2 (QO-100) WEBSDR - Brazil
 (<http://appr.org.br:8902/noid.html>)

It is also possible to make a Narrow-Band or Wide-Band WebSDR of your QO-100 receiving Station.

With options like Auto Locking the Telemetry Beacon for better Frequency stability.

Works in any webbrowser local network or internet with support USB-Audio, SSTV ect.



https://github.com/dj0abr/QO-100_SSB-WebSDR_DATV-WebSpectrum (https://github.com/dj0abr/QO-100_SSB-WebSDR_DATV-WebSpectrum)

Supported are Raspberry-Pi, Adalm-Pluto, SDRPlay and the rtl-sdr usb sdr.

Es-Hail Beacon Tracker Linux

GNU Radio flowgraph for receiving the Geostationary QO-100 / Es'hailsat-2 narrowband amateur transponder. Performing phaselocking to the PSK400 beacon for

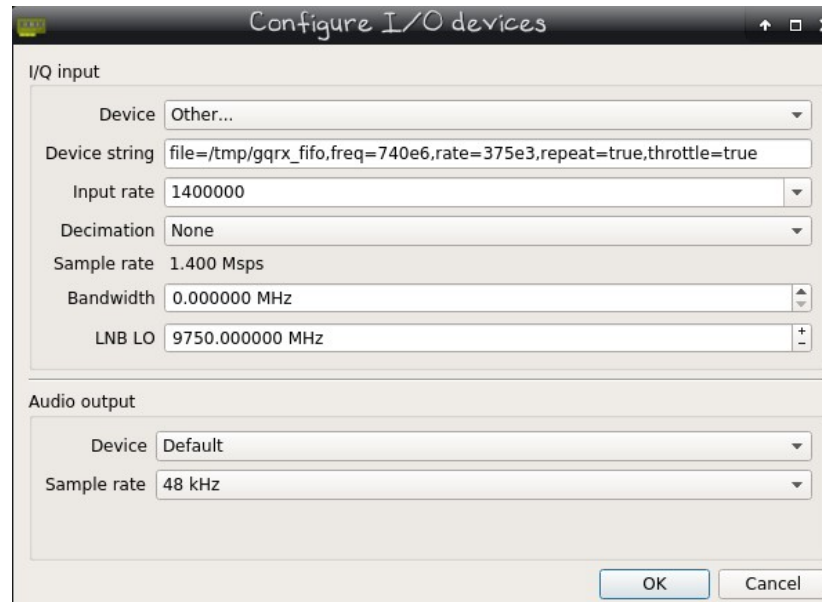
automatic LNB drift correction.

Usage:

Create new fifo object - execute `mkfifo /tmp/gqrx_fifo` command in linux terminal.

Start gnuradio-companion, open `beacontrack_gqrx.grc` flow and run it using "Play" button or F6 key.

Start GQRX and select Complex Sampled (IQ) File as input device.



Provide the following settings: GQRX configuration
Start reception in GQRX using "Play" button or ctrl-D.

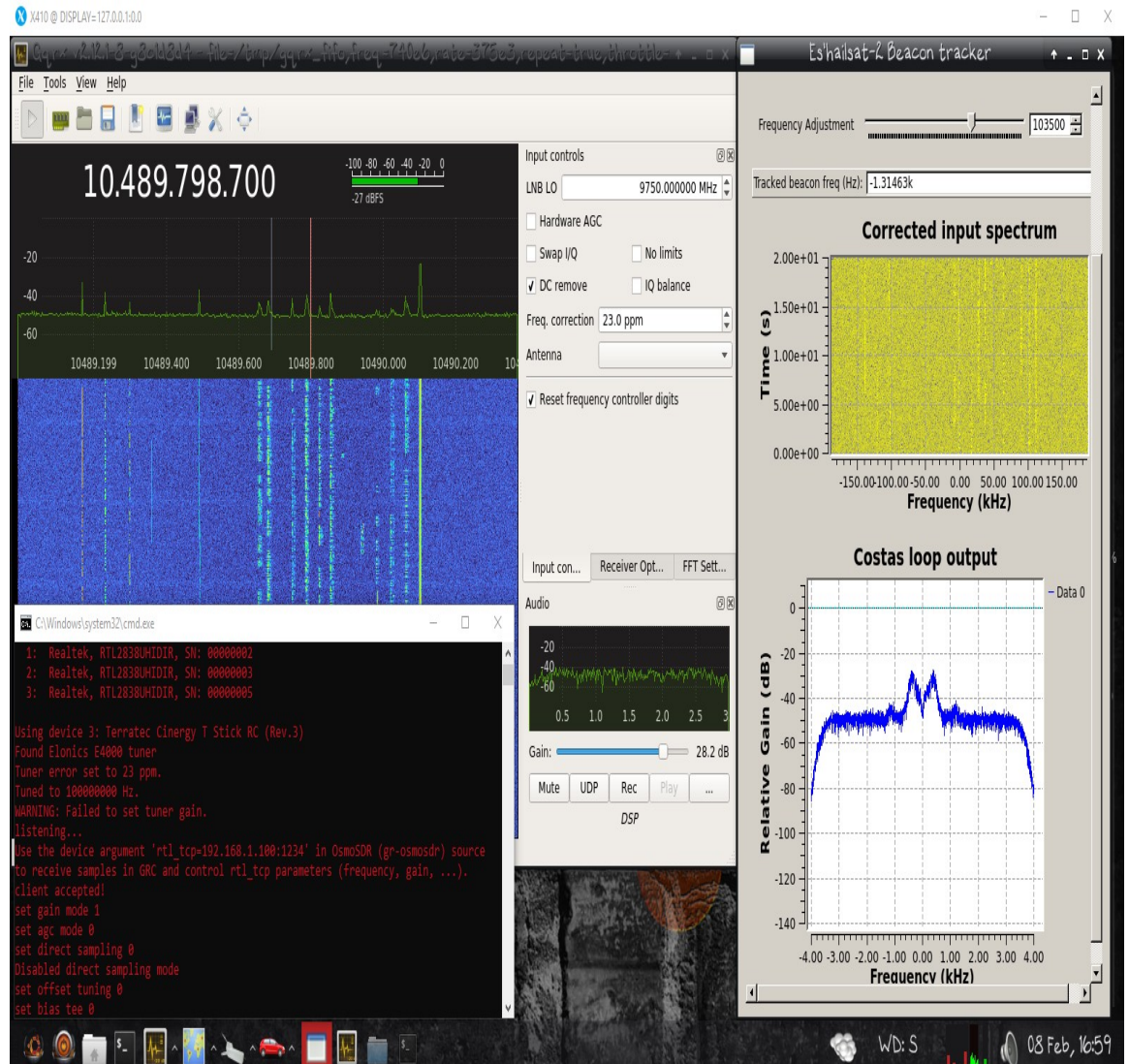
You should see both gqrx and grc workflow running.

`beacontrack_gqrx_rtlsdr.grc`

Input osmocomblock is using `rtl_tcp=0` as input string.

Sample rate is 1.5M with 4x decimation.

Use Frequency adjustment slider to move upper beacon about 110 kHz above center frequency.



Download Scripts and flowgraphs for the Es'hailsat-2 amateur transponder.
<https://github.com/pe4wj/eshailsat2>

Telemetry beacon

There are 3 decode-able beacons CW Lower, PSK Middle and CW Higher Beacon.

The image shows a screenshot of the RTL Ddongle software interface. The top window displays a spectrum analyzer with a frequency range from 10489.550 to 10490.000 MHz. A prominent peak is visible at 10489.750 MHz, labeled as 'QO100 PSK B'. Other labels include 'Narrow Digi -> Digi ->', 'SSB ->', 'Mixed ->', and 'QO-100 International Emergency Frequency'. A signal-to-noise ratio (SNR) meter shows a reading of 32.2 dB. Below the spectrum analyzer is a waterfall plot showing the signal's frequency over time.

The bottom window is titled 'AO40Rcv - Ver. 2.04 - CallNotSet' and displays various receiver parameters and status information. The 'RECEIVERS' section shows:

- 11MHz: ON, 24MHz: ON, V: Off, U: On HiGain
- L1: Omni, L2: ON, S1: ON
- S2: OFF, C: OFF, Le1a: #6120

 The 'TRANSMITTERS' section shows:

- U: Off, V: -, S1: OFF, S2: ON
- X: TWTA On, K: -

 The 'AGC / ALC' section shows:

- V-Rx: -4.39dB, U-Rx: -17.28dB, L1-Rx: -3.77dB
- L2-Rx: -3.21dB, S1-Rx: 24.63dB, S2/C-Rx: -81.06dB
- HF-Rx: 083, V-Tr: 032, U-Tr: 032, S2-Tr: 032

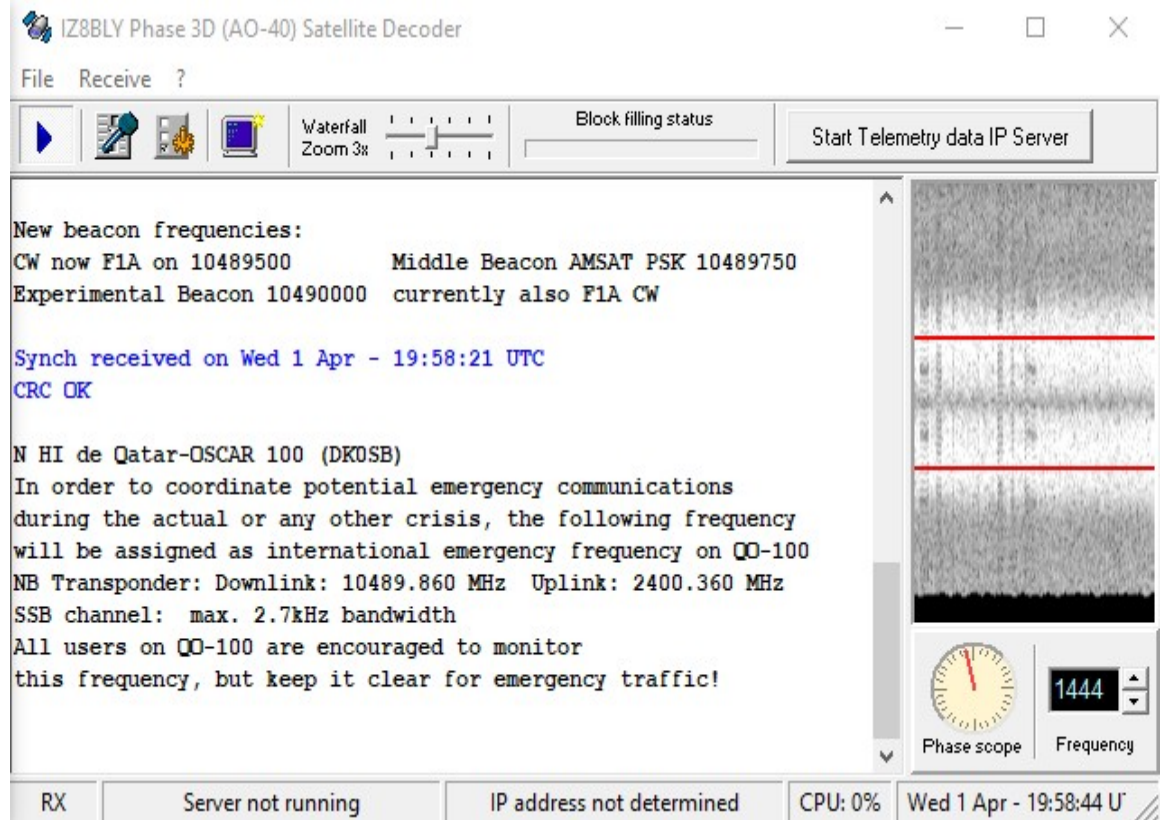
 The 'BEACONS' section shows:

- SignalF1: StatusF2: IF MatrixF3: NavigationF4: PowerF5: TemperatureF6: MailboxF7: Raw DataF8
- Reading CRC Block: 4/4, 1437 Hz
- Searching for FEC Block: 5/5, +18 Hz/Sec
- Corrected symbols / bytes = 0 / 0, 9/9
- STDP: F12
- Auto Freq: 0, Bit Clock Adj: 17.4 dB SNR

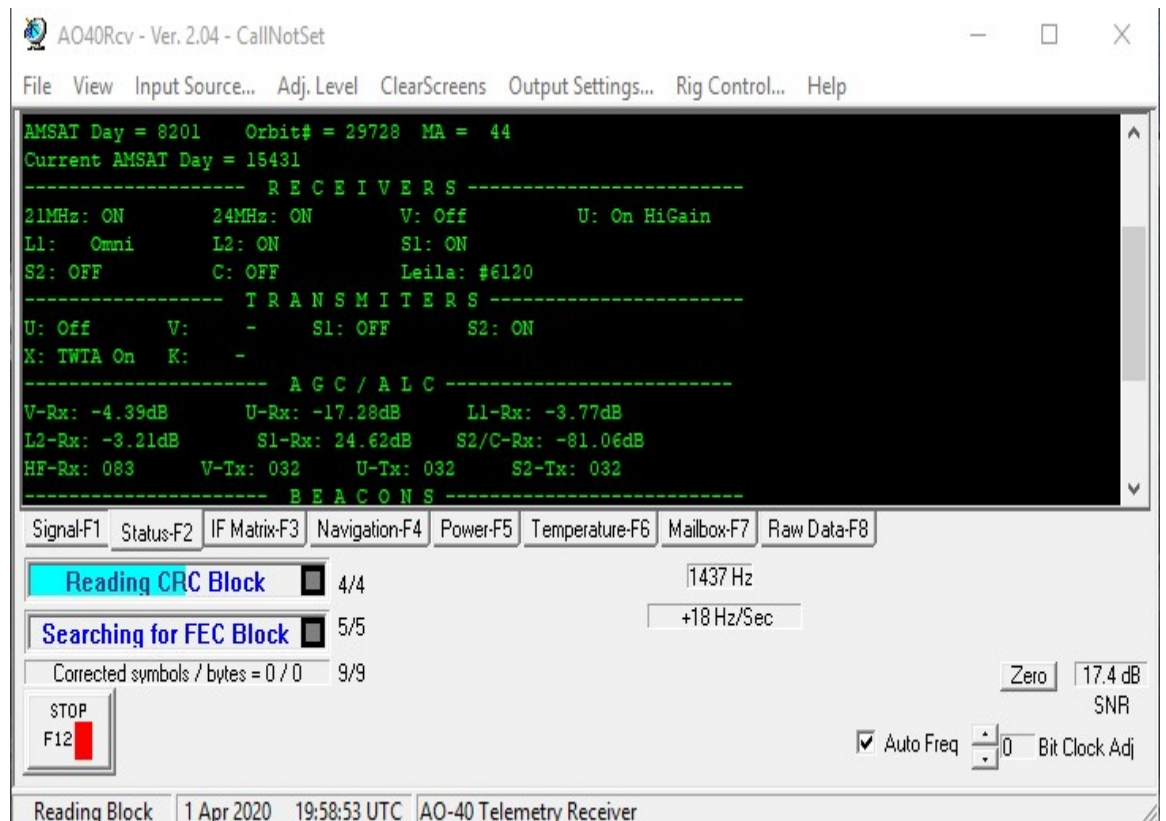
 The bottom right window is titled 'IZBBLly Phase 3D (AO-40) Satellite Decoder' and displays:

- New beacon frequencies: CW now FIA on 10489500, Middle Beacon AMSAT PSK 10489750, Experimental Beacon 10490000, currently also FIA CW
- Sync received on Wed 1 Apr - 19:58:21 UTC, CRC OK
- N HI de Qatar-OSCAR 100 (DK0SB)
- In order to coordinate potential emergency communications during the actual or any other crisis, the following frequency will be assigned as international emergency frequency on QO-100
- NB Transponder: Downlink: 10489.860 MHz, Uplink: 2400.360 MHz
- SSB channel: max. 2.7kHz bandwidth
- All users on QO-100 are encouraged to monitor this frequency, but keep it clear for emergency traffic!
- Sync received on Wed 1 Apr - 19:58:46 UTC

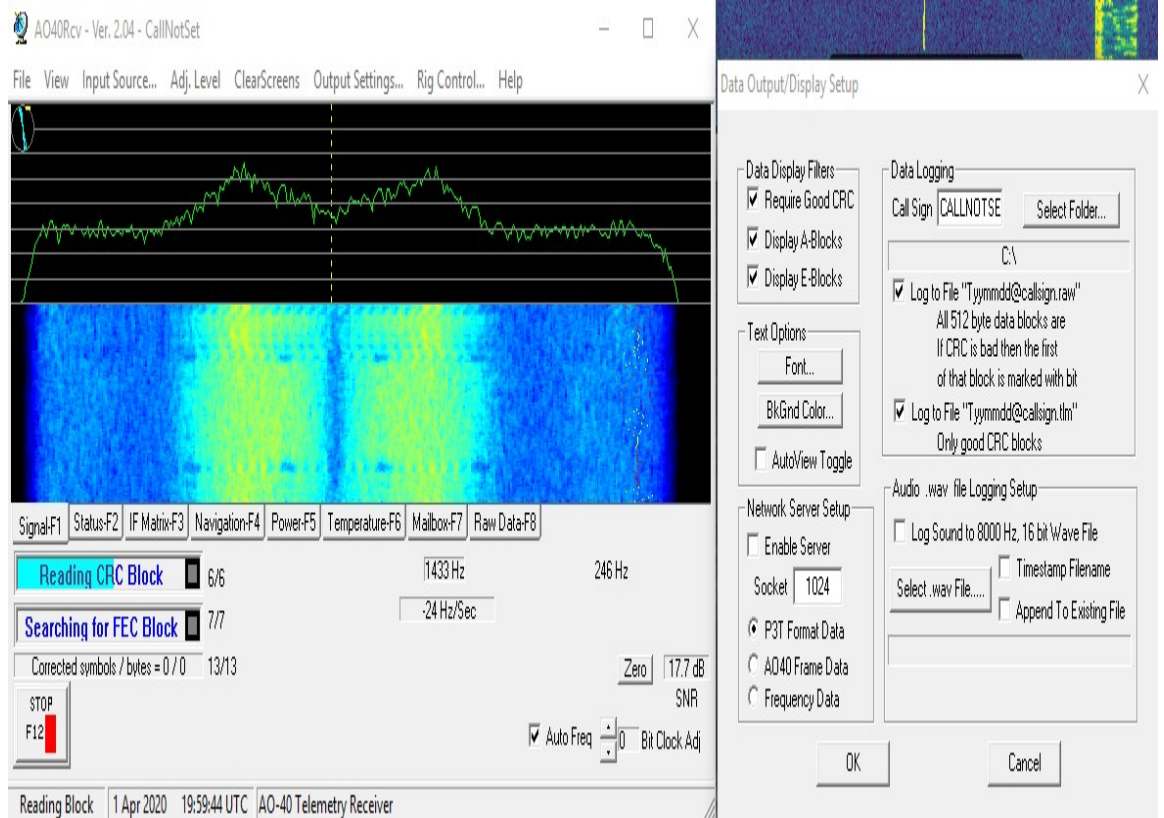
The middle PSK beacon displays telemetry and other info, which is not directly broadcasted from the satellite but from the AMSAT Groundstation (https://wiki.batc.org.uk/Es%27hail-2_Ground_Station) instead.



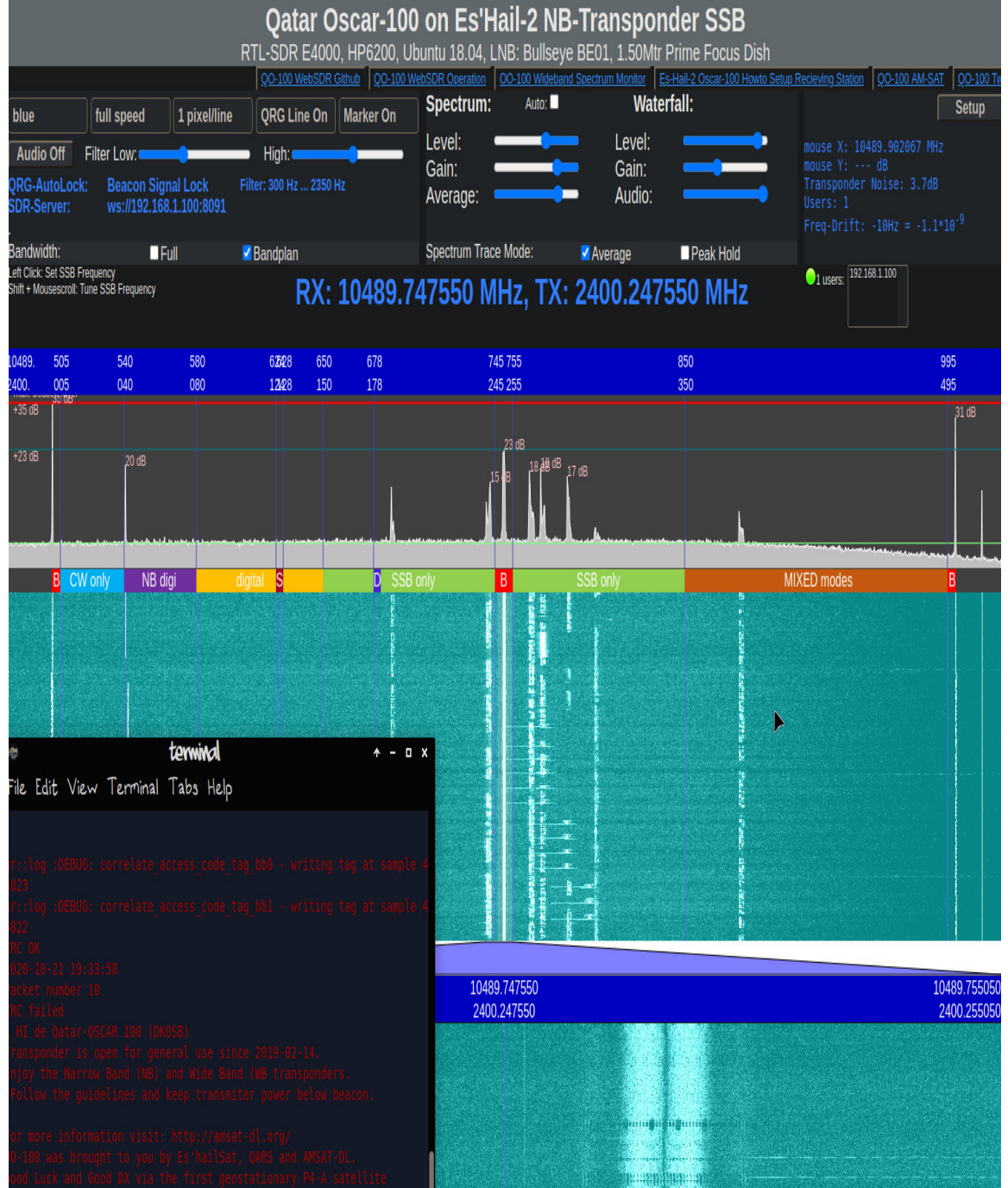
Phase 3D (AO-40) Decoder from IZ8BLY (<http://antoninoporcino.xoom.it/P3D/index.htm>) works great on the QO-100 beacon also in Linux Wine.



Another Decoder AO40Rcv (<http://www.moetronix.com/ae4jy/ao40rcv.htm>) displaying more info.



Works in Linux Wine but does not display any text (as a workaround check Log to File in Options for a saved text file with beacon details).

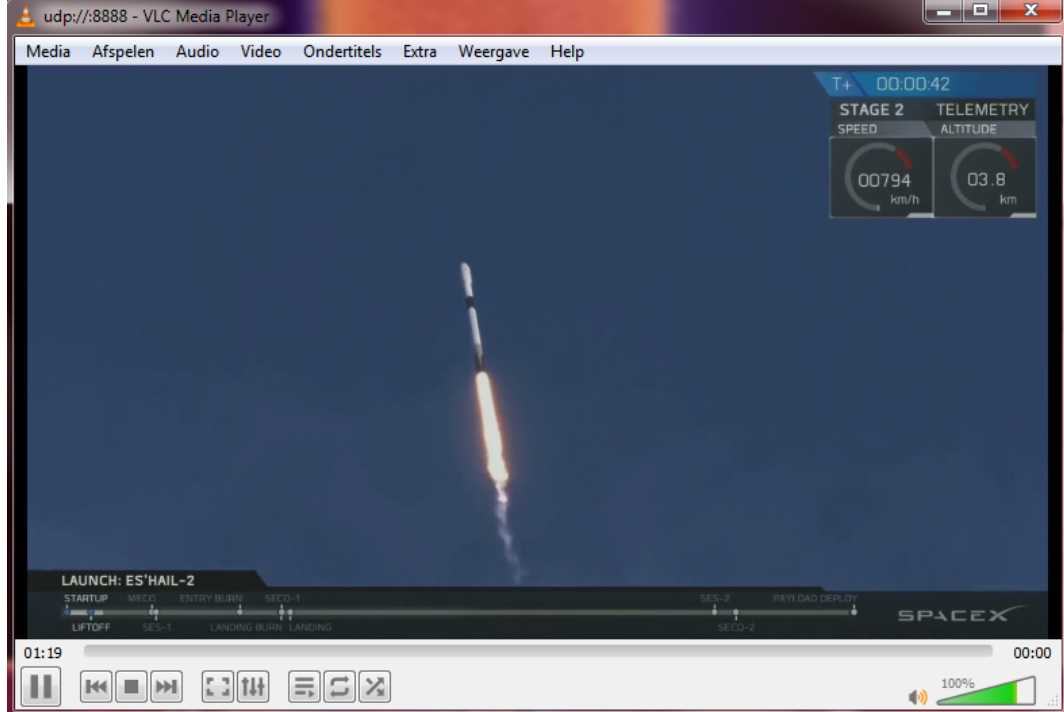


Decoding the QO-100 beacon with GNU-Radio gr-satellites (<https://destvez.net/2019/02/decoding-the-qo-100-beacon-with-gr-satellites/>)

Both CW Beacons can be used with FIDigi (<https://sourceforge.net/projects/fldigi/files/fldigi/>), or any other morse decoding program.

Wide Band Transponder

The Wide Band on Es'hail-2 (QO-100) is a horizontal polarized linear transponder. With Downlink on 10491.000 - 10499.000 MHz.



DATV beacon parameters are center 10.4915, DVB-S2, QPSK 4/5 FEC, 0.25 RollOff, C/N=4,6dB, 2,383 MBit
 This requires a C/N of 4.6 dB for decoding, but the beacon power density has been increased so that reception should still be possible on dishes of 80 cm and larger.

Bandplan below shows what modes are allowed and how they are specified:

	Beacon			Wide and Narrow DATV						Narrow DATV					
	Beacon			1MS		1MS		1MS							
				333	333	333	333	333	333	333	333	333	333	333	
	2401.5	2402.5		2403.5	2404.5	2405.5	2406.5	2407.5	2408.5	2409.5					
	Uplink (MHz)														
	10491.0	10492.0	10493.0	10494.0	10495.0	10496.0	10497.0	10498.0	10499.0						
	Downlink (MHz)														

Mode	Symbol Rate	Uplink Freq MHz	Downlink Freq MHz	Notes
Beacon	1500 kS	2402.0	10491.5	Beacon DVB-S2 FEC 4/5
Wide	1 MS	2403.75	10493.25	1.5 MS and 2 MS transmission should use this part of the band
Wide	1 MS	2405.25	10494.75	
Wide	1 MS	2406.75	10496.25	
Narrow	333 kS	2403.25	10492.75	Use these 14 frequencies for 500 kS, 333 kS and 250 kS Then every 500 kHz until
Narrow	333 kS	2409.75	10499.25	
Very Narrow	125 kS	2403.25	10492.75	Use these 27 frequencies for 125 kS, 66 kS and 33 kS Then every 250 kHz until
Very Narrow	125 kS	2409.75	10499.25	

More about receiving Oscar 100 DATV signals.

(https://wiki.batc.org.uk/Receiving_Oscar_100_DATV_signals)

Software DVB-S Demodulator

Over on the Amsat-DL forums (<https://forum.amsat-dl.org/index.php?thread/101-software-dvb-s-demodulator/&pageNo=1>) user Markro92 is developing a realtime Windows DVB-S demodulator with GUI.

The demodulator works with the RTL-SDR, Airspy, HackRF, SDRplay and PlutoSDR.

It can demodulate DVB-S and S2 signals with very low symbolrate on the Wideband Transponder.

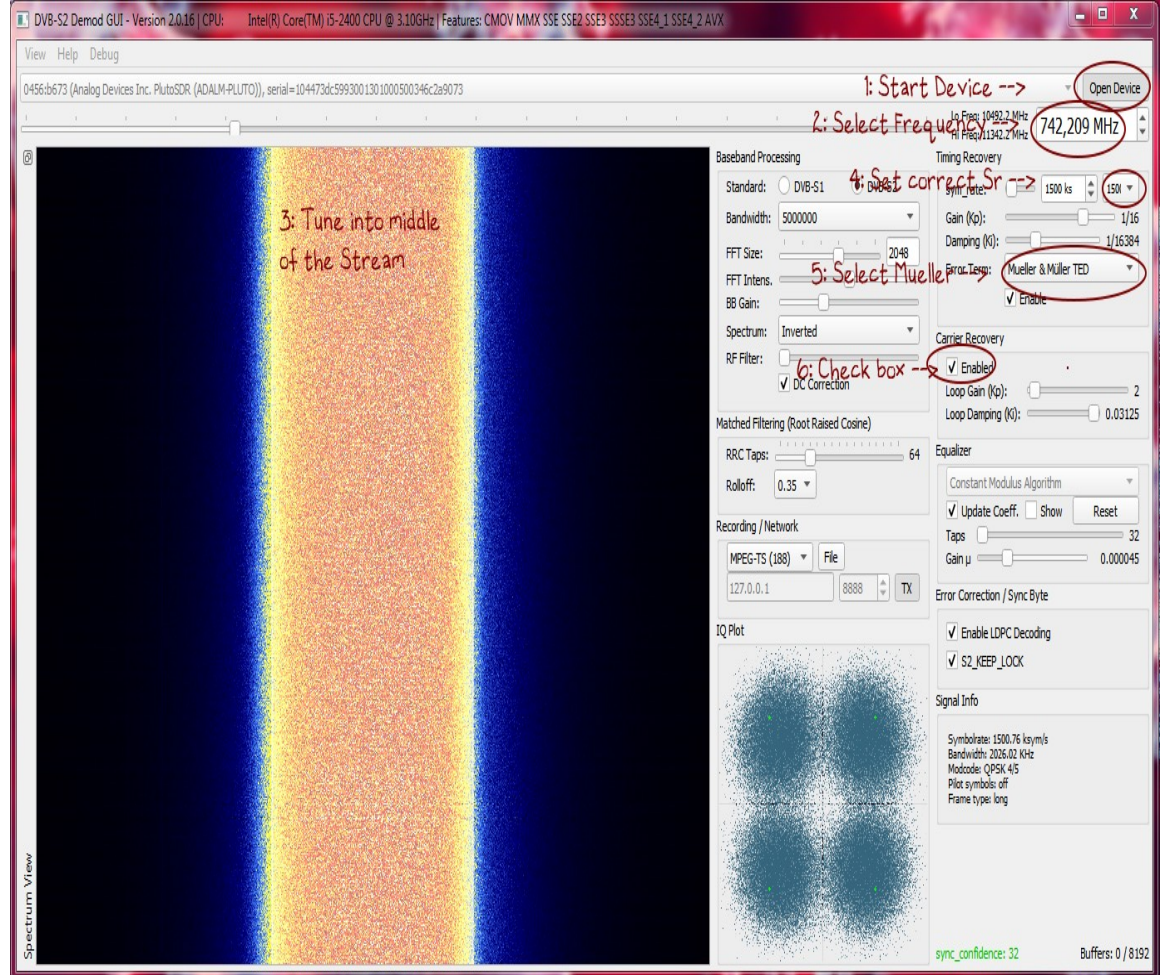
So you do not need a modified Inb or modified satellite receiver.

Of course you can also see the amateur tv streams which people uplink their self.

To see if there is any stream active one can visit the Official Qatar-OSCAR 100 Wideband Spectrum Monitor (<https://eshail.batc.org.uk/wb/>)

And the stream the info is displayed which parameters in use symbol rate and mode dvbs(2) so you can adjust these settings in the Demodulator program.

Example DATV Promo beacon video on 10.4915, DVB-S2, QPSK, Sr:1500, 4/5 FEC.



- 1: Select SDR and start Device.
- 2: Select correct Frequency.
- 3: Tune into the middle of the stream, every little bit counts with the bandwidth from the SDR.
- 4: Select correct Symbolrate.
- 5: Select mueller and muller filter (for all lower symbolrates use the gardner filter).
- 6: Check box Carrier recovery Enabled, if you do this right, you should see more symbols inside the IQ plot.

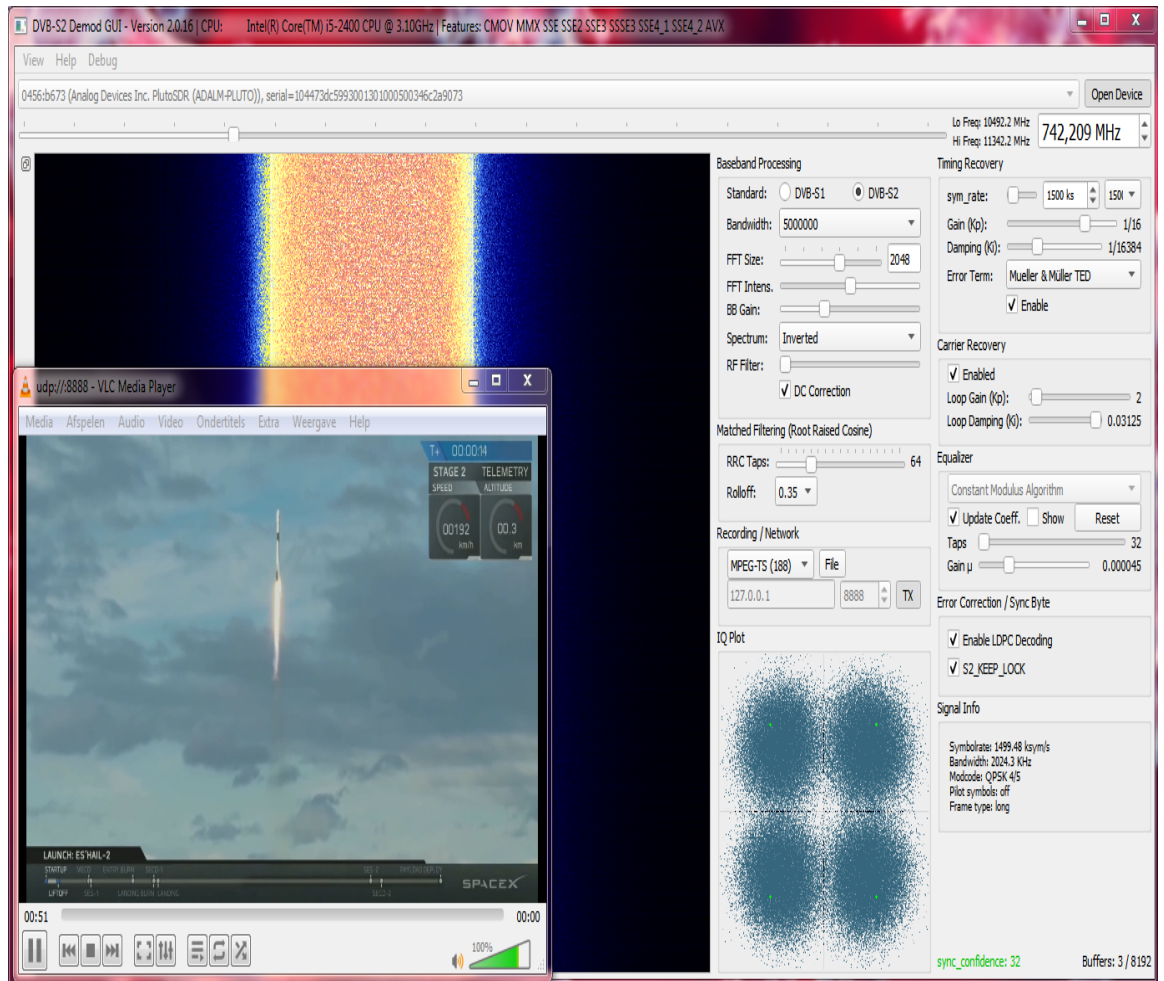
Play with the Carrier Recovery Loop Gain and Damping Sliders until you can see a circle inside the IQ plot and set appropriate Baseband-Gain Settings without overdriving. A valid QPSK constellation should also appear. For weak signals, increasing gain and damping can be necessary.

If you see the QPSK constellation (4 dots), you can decrease the gain again.

Keep also your eyes on actual symbolrate (right under).

When symbolrate is going higher, slightly go 1 symbolrate up and down, the symbolrate must stay around 1500 or the chosen value.

MPEG-TS output is localhost, UDP at port 8888.
 Open VLC (<https://www.videolan.org/>) and insert
 Network Stream: `udp://@:8888`



Or make Batch file with content:

```
"C:\Program Files\VideoLAN\VLC\vlc.exe"
"udp://@:8888"
```

The latest version of the software will always be always available at http://v.1337team.tk/dvb-s_gui_amsat.zip (http://v.1337team.tk/dvb-s_gui_amsat.zip)

Custom DATV Firmware for the Pluto

The guys from batc.org.uk came up with a excellent Wiki (https://wiki.batc.org.uk/Custom_DATV_Firmware_for_the_Pluto) about Flashing Custom Firmware for the Pluto SDR developed by F5OEO.

Offering a simple way to generate DATV DVB-S(2).

There is a video stream analyzer included with which you can easy adjust your video bitrate from OBS-Project (<https://obsproject.com/>) for the corresponding SR.

The following parameters can be used for streaming:

URL :

```
rtmp://192.168.2.1:7272/,437,DVBS2,QPSK,2000,23,Pass
: ,Happysat,
```

Default URL from Pluto

Frequency in MHz: 437

Mode (DVBS/DVBS2): DVBS2

Constellation (QPSK,8PSK,16APSK): QPSK (only QPSK is valid in DVBS)

SymbolRate in KS (33-2000): 2000

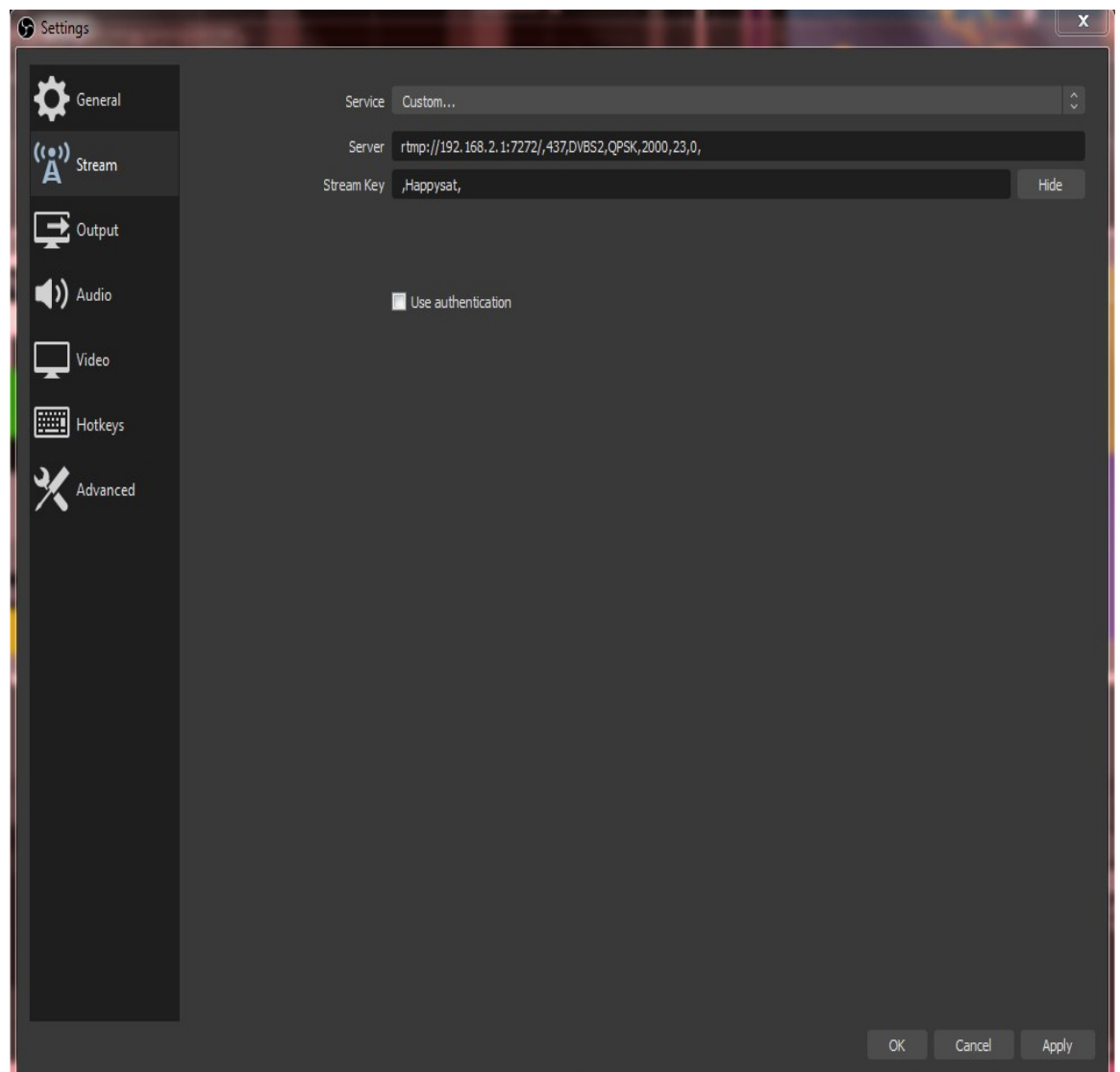
FEC (12,23,34,67,78...): 23

CALLSIGN: Happysat

Change to your needs.

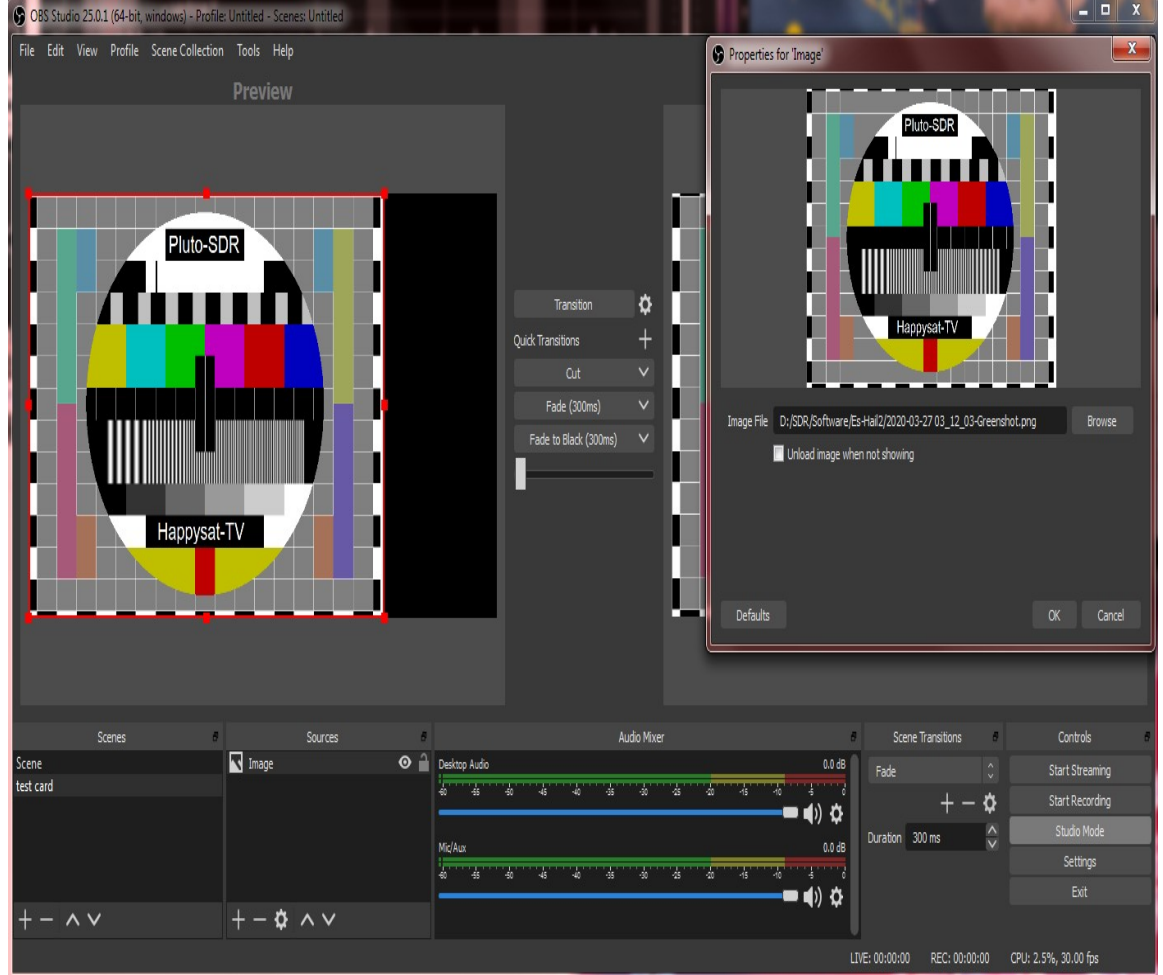
It is done in OBS by setting a RTMP Stream pointing to the Pluto-SDR.

In OBS Settings/Stream:



Every SR needs a different video bitrate for best results, rule of thumb is to set the video bitrate at about 75% of the SR.

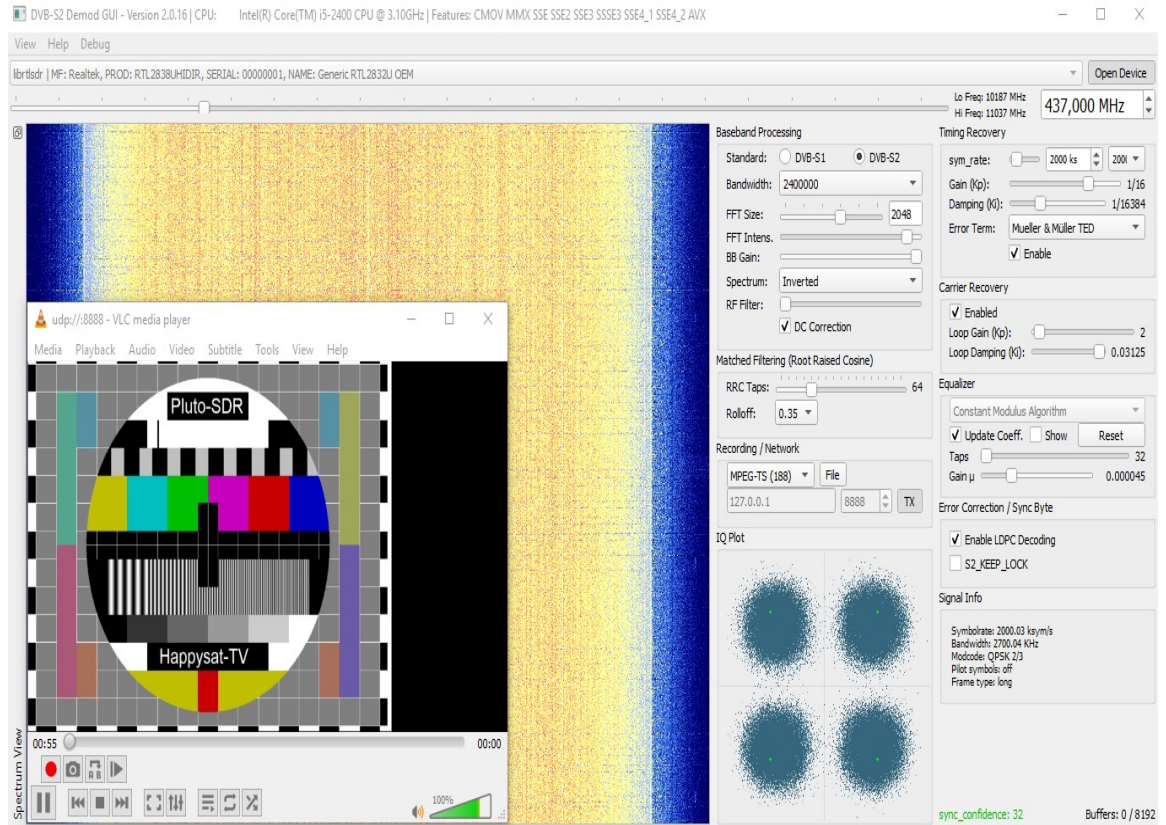
And reduce the audio bitrate to the minimum, 32kbps with OBS, framerate 25, this can be done in output.



The sources box bottom left, you can add a input source this can be anything a image or live video streams ect. In the control box select Studio Mode, and press streaming.

A QPSK carrier will be generated at 437MHz in about 5 seconds.

Which is perfectly receivable in the DVB-S Demodulator Program.



Usefull Links

SSTV RX Gallery (<http://live.cqsstv.com/max/#10GHz>)

QO-100 Realtime Live Decoding with LeanDVB
(<https://www.rtl-sdr.com/decoding-eshail-2-dvb-s2-realtime-in-linux-with-leandvb/>)

Setting up your DBV-S2 Decoder for QO-100 (Eshail-2) on Linux (<http://zr6aic.blogspot.com/2019/06/setting-up-your-dbv-s2-decoder-for-qo.html>)

rtl-sdr.com Bullseye LNB (<https://www.rtl-sdr.com/buy-rtl-sdr-dvb-t-dongles/>)

rtl-sdr.com Bullseye-tcxo LNB for QO-100 Reception Review (<https://www.rtl-sdr.com/the-othernet-bullseye-tcxo-lnb-for-qo-100-reception/>)

Othernet Bullseye 10 kHz Ultra High Stability Universal Single LNB (<https://othernet.is/products/bullseye-10-khz-ultra-high-stability-universal-lnb>)

Testing the Othernet "Bullseye BE01" LNB
(<http://www.pabr.org/radio/otherlnb/otherlnb.en.htm>)

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Happysat