Matthias Bopp DD1US

Gajow, June 7th 2019

AMSAT

Agenda

- QO-100 our first Phase-4 geostationary satellite (P4-A)
- QO-100 transponders
- Antenna
- RX for the narrowband transponder
- RX for the wideband transponder
- TX and amplifiers
- SDRs for RX and TX

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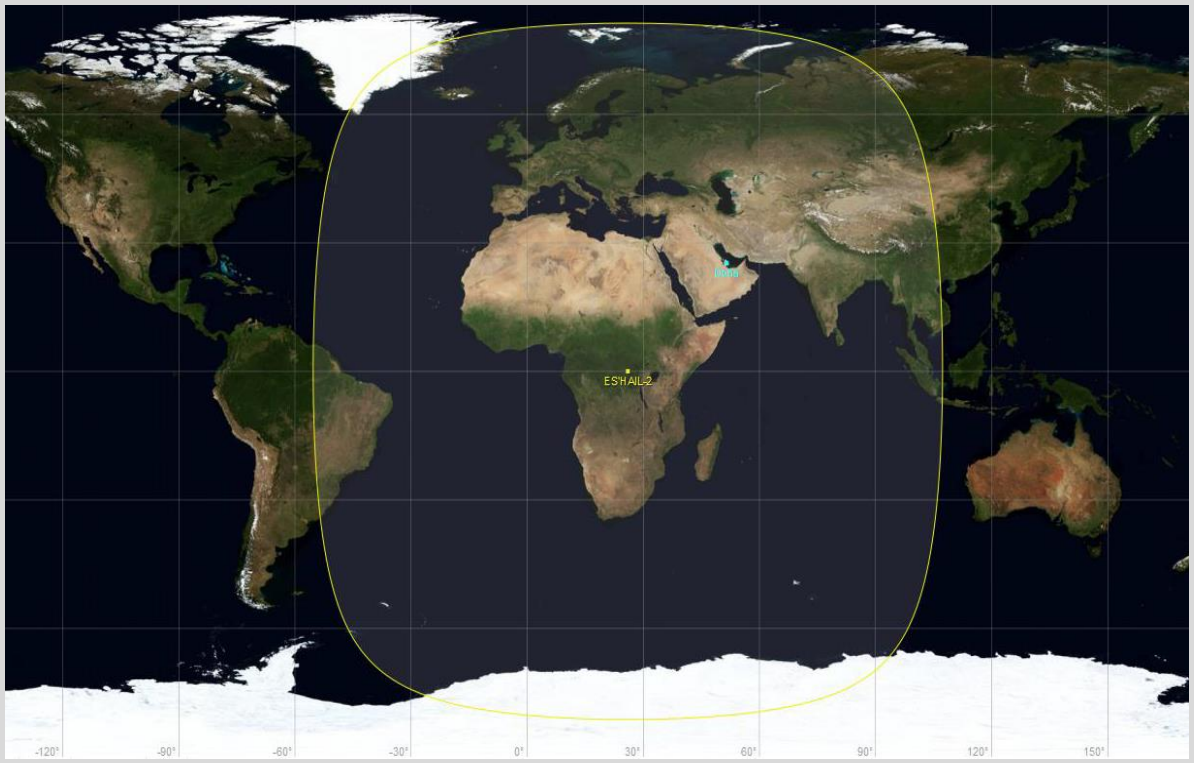
Qatar-OSCAR 100 (Es‘hail-2)

Es‘hail-2 was launched on November 15th 2018 on a Falcon 9 from SpaceX.



It is primarily a communication and TV-Broadcast satellite for the middle east.

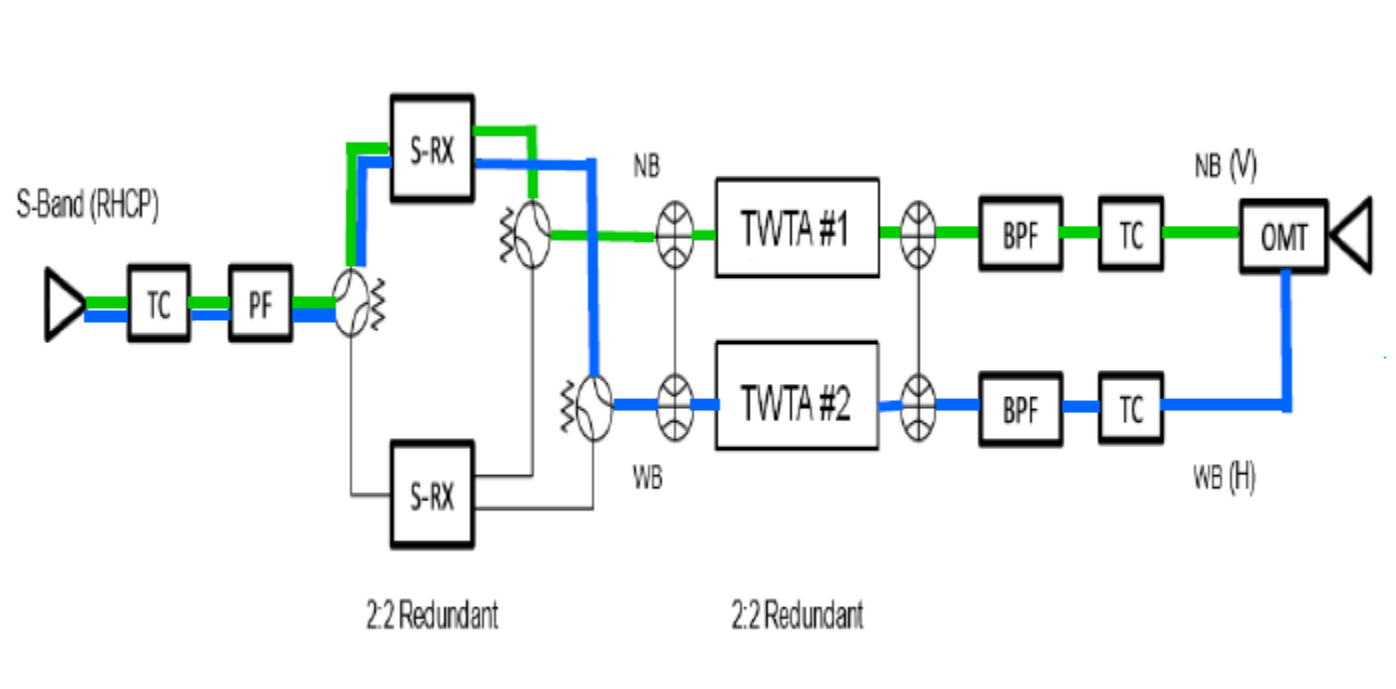
Es‘Hail-2 is positioned on 26° East and covers Europe, Africa and most of Asia.

Peter DB2OS (chairman of AMSAT-DL) convinced the owners in Qatar to add 2 transponders for Ham Radio (↑13cm Uplink / ↓3cm Downlink).

http://www.amsat-dl.de

Qatar-OSCAR 100 (Es‘hail-2)

QO-100 features a 250 kHz wide linear-transponder for narrowband modes as well as a 8 MHz wide transponder for digital wideband modulation (mostly DATV in DVB-S2).



Specifications were developed by AMSAT-DL, the payload was built my MELCO in Japan and kindly paid by Qatar.

http://www.amsat-dl.de

Qatar-OSCAR 100 (Es‘hail-2)

After extensive testing the Ham Radio transponders were released for general use on February 14th 2019.

http://www.qars.org.qa

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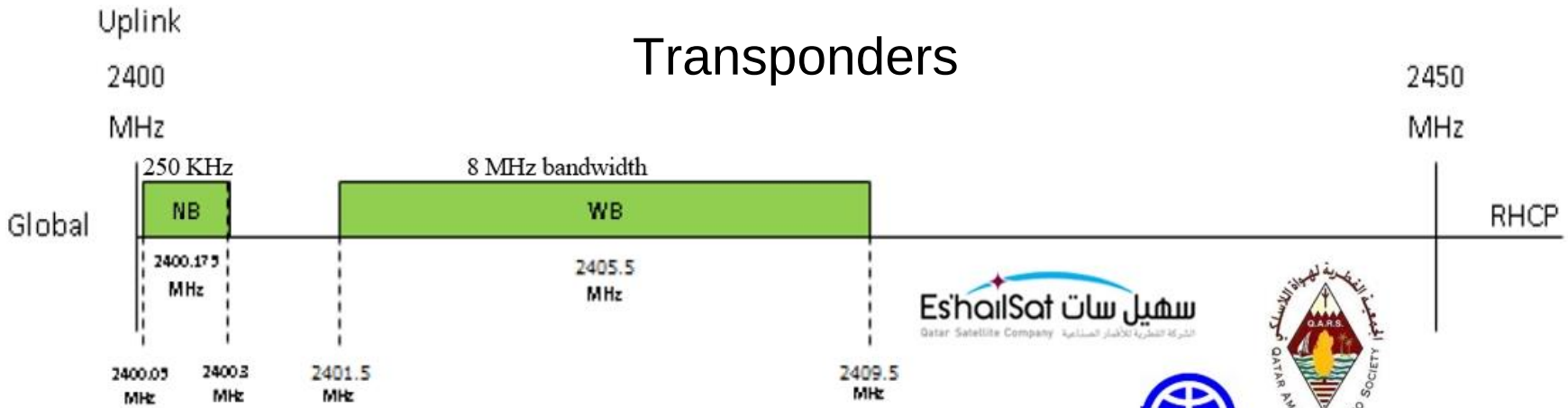
Qatar-OSCAR 100 (Es‘hail-2)

Transponders

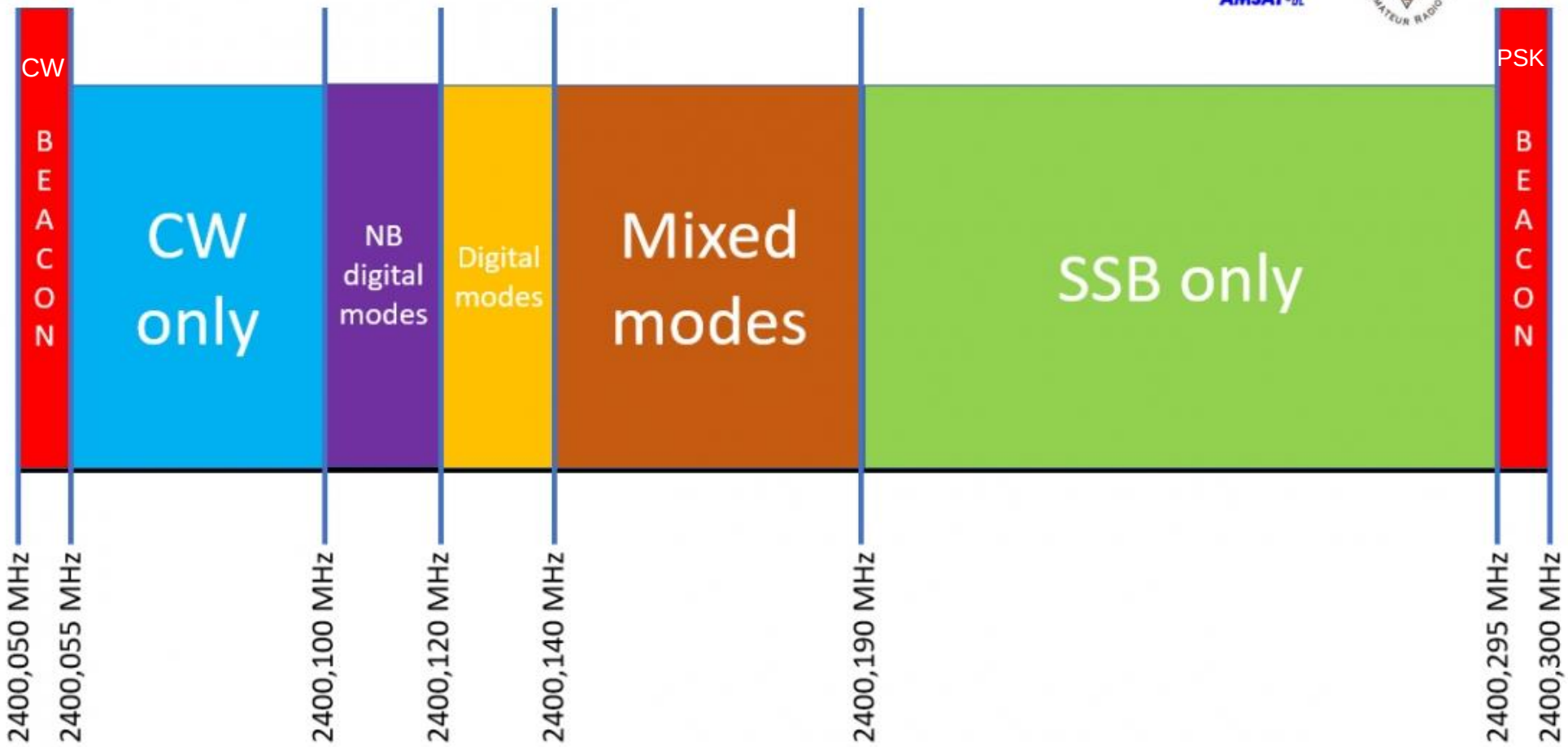


Xpdr	U/L FREQUENCY (MHz)				D/L FREQUENCY (MHz)				LO	BW
No	Pol	Begin	Center	End	Pol	Begin	Center	End	(MHz)	(MHz)
NB	RHCP	2400.05	2400.175	2400.3	V	10489.55	10489.675	10489.8	8089.5	0.25
WB	RHCP	2401.5	2405.5	2409.5	H	10491	10495	10499	8089.5	8

http://www.amsat-dl.de

Qatar-OSCAR 100 (Es‘hail-2)

Bandplan of the narrowband transponder:



http://www.amsat-dl.de

Qatar-OSCAR 100 (Es‘hail-2)

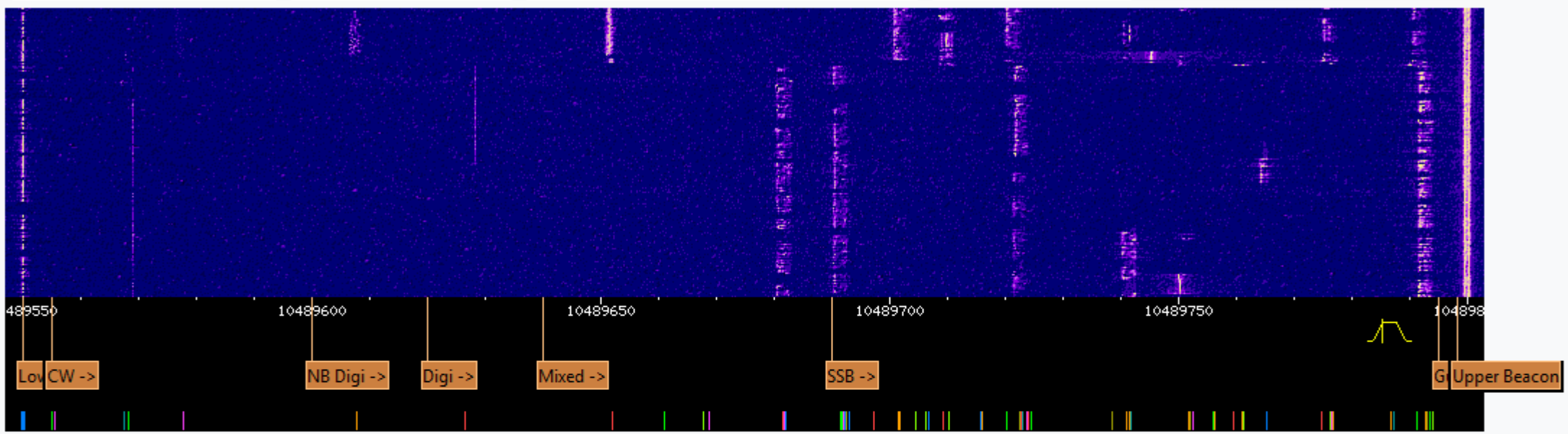
Operating modes on the narrowband transponder of QO-100:

- SSB
- FreeDV
- CW
- RTTY
- SSTV
- FAX
- Feldhell
- Digimodes such as PSK31 etc.

Maximum bandwidth is 2.7 kHz, no analog FM and no digital FM modes to be used !

Qatar-OSCAR 100 (Es‘hail-2)

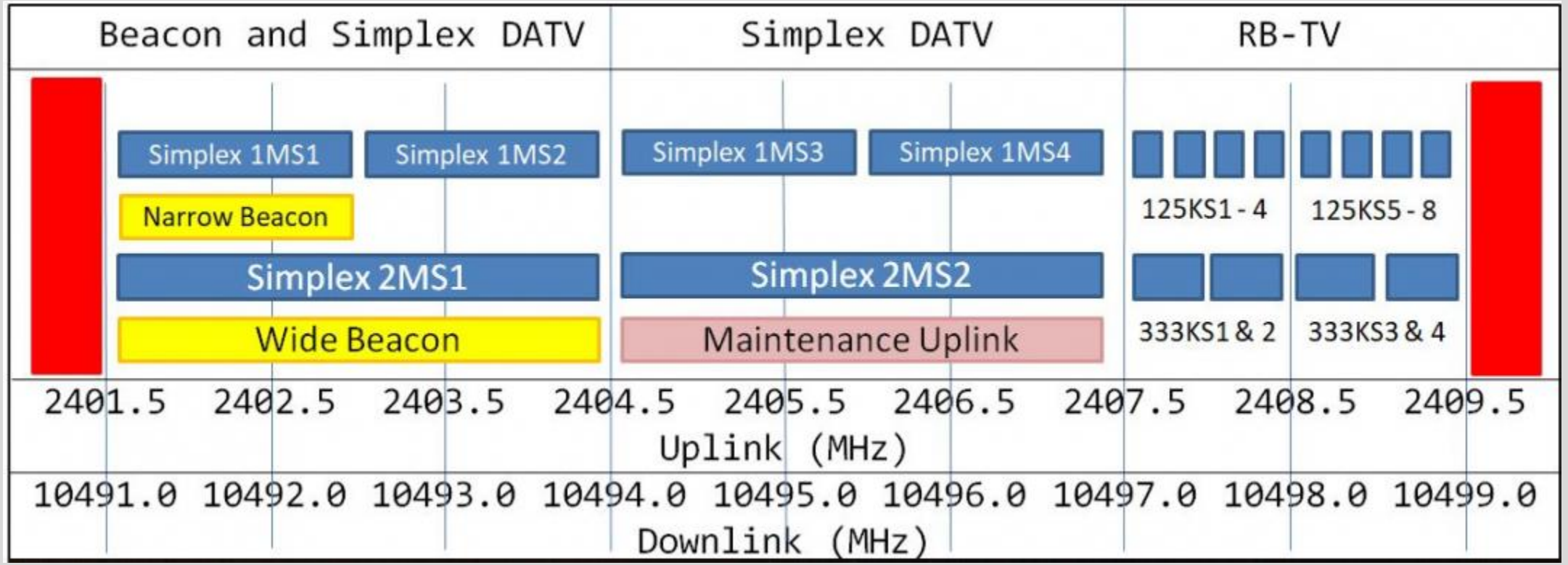
Narrowband transponder spectrum (BATC Web SDR)



http://eshail.batc.org.uk/nb/

Qatar-OSCAR 100 (Es‘hail-2)

Bandplan of the wideband transponder

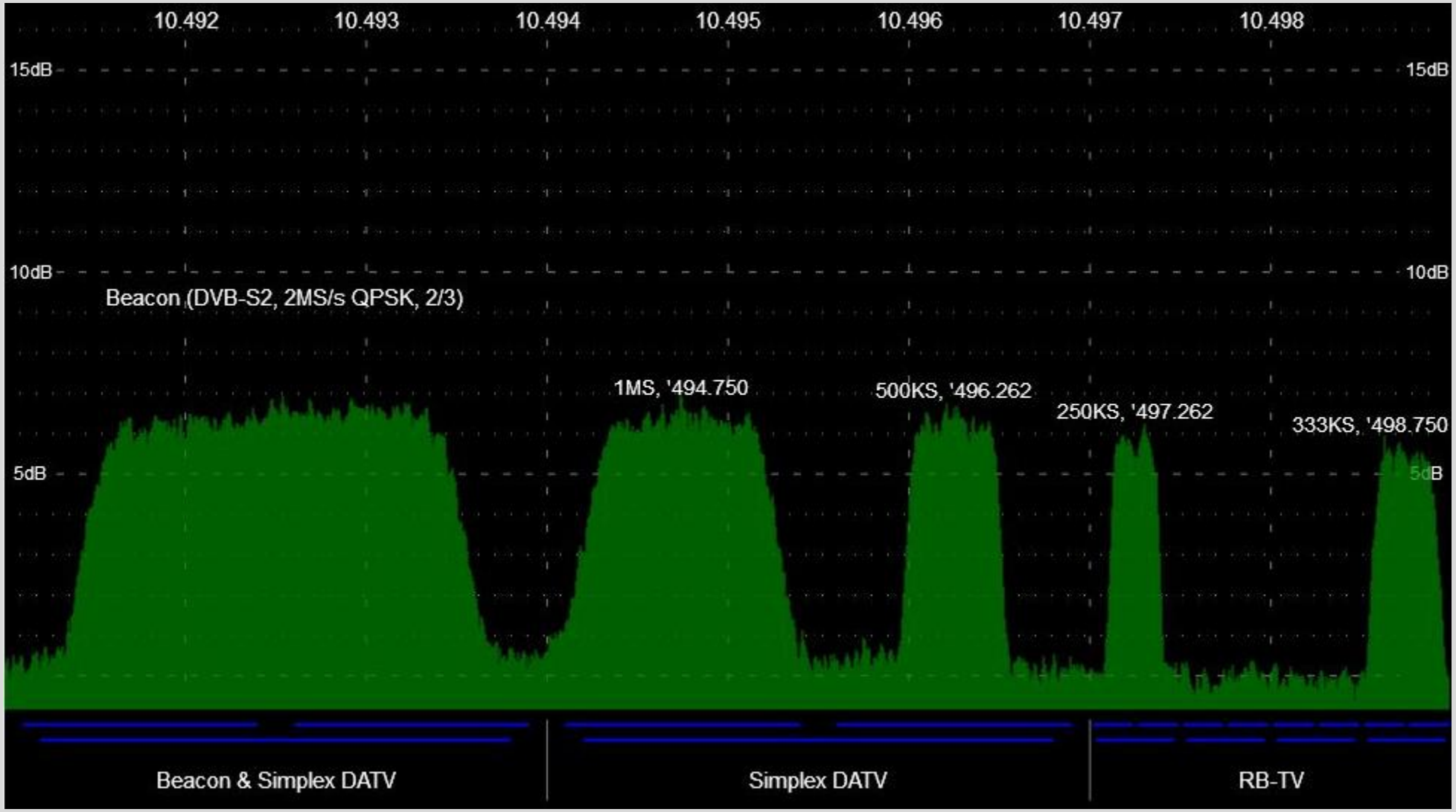


Most transmissions are in DVB-S2 (QPSK, 8PSK, 16APSK, 32APSK), only few transmissions in DVB-S (QPSK)

Used symbolrates are 66, 125, 250, 333, 500, 1000, 2000 ksps

http://eshail.batc.org.uk/wb/

Qatar-OSCAR 100 (Es‘hail-2)



Wideband transponder spectrum

http://eshail.batc.org.uk/wb/

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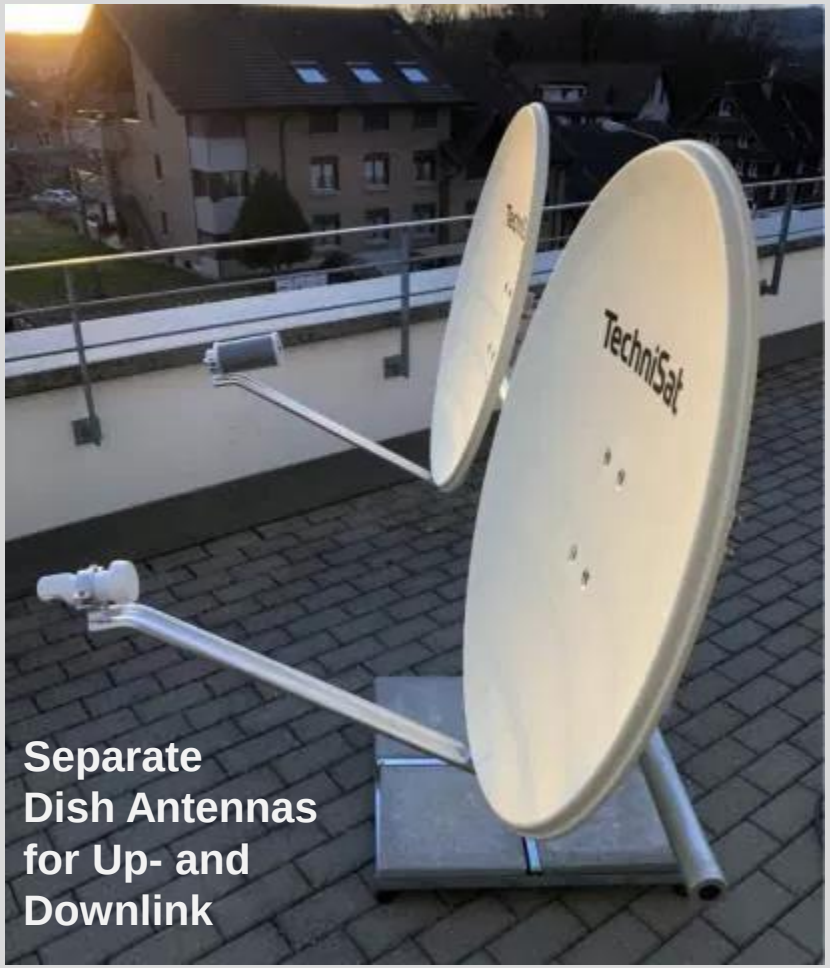
Antennas for QO-100

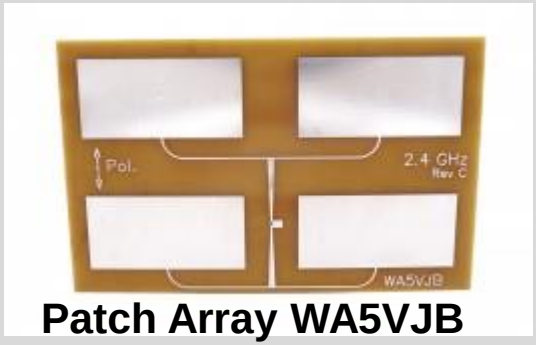

WIFI Grid linear


Helix RHCP



Separate Dish Antennas for Up- and Downlink

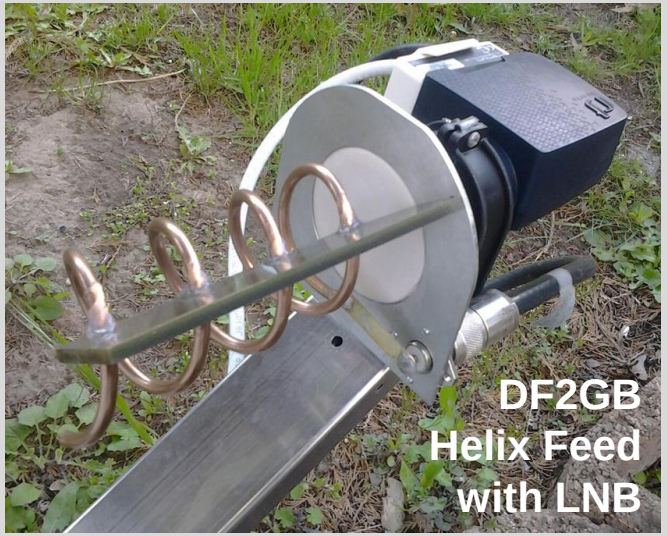

Patch Array

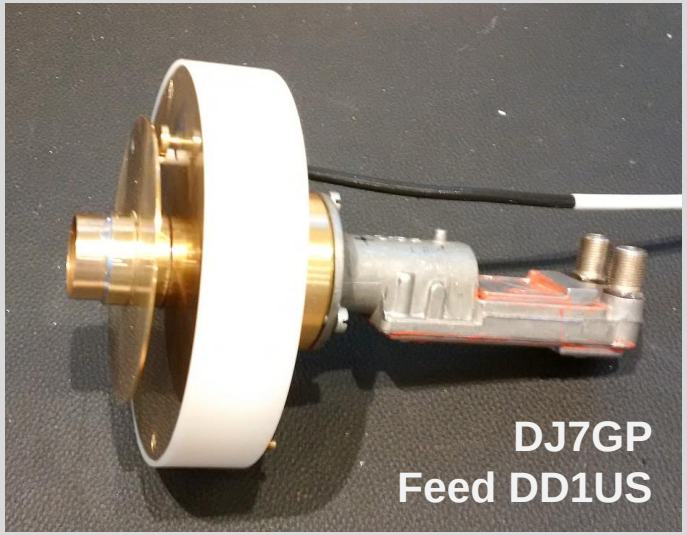


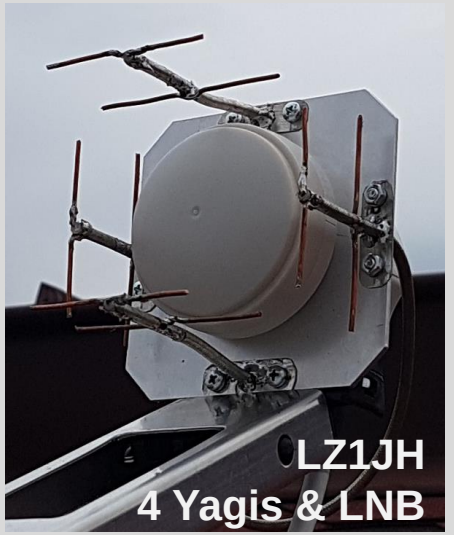
Patch Array WA5VJB

2.4 GHz uplink of NB and WB TPX is RHCP, 10 GHz downlink of NB TPX is vertical, WB TPX is horizontal.

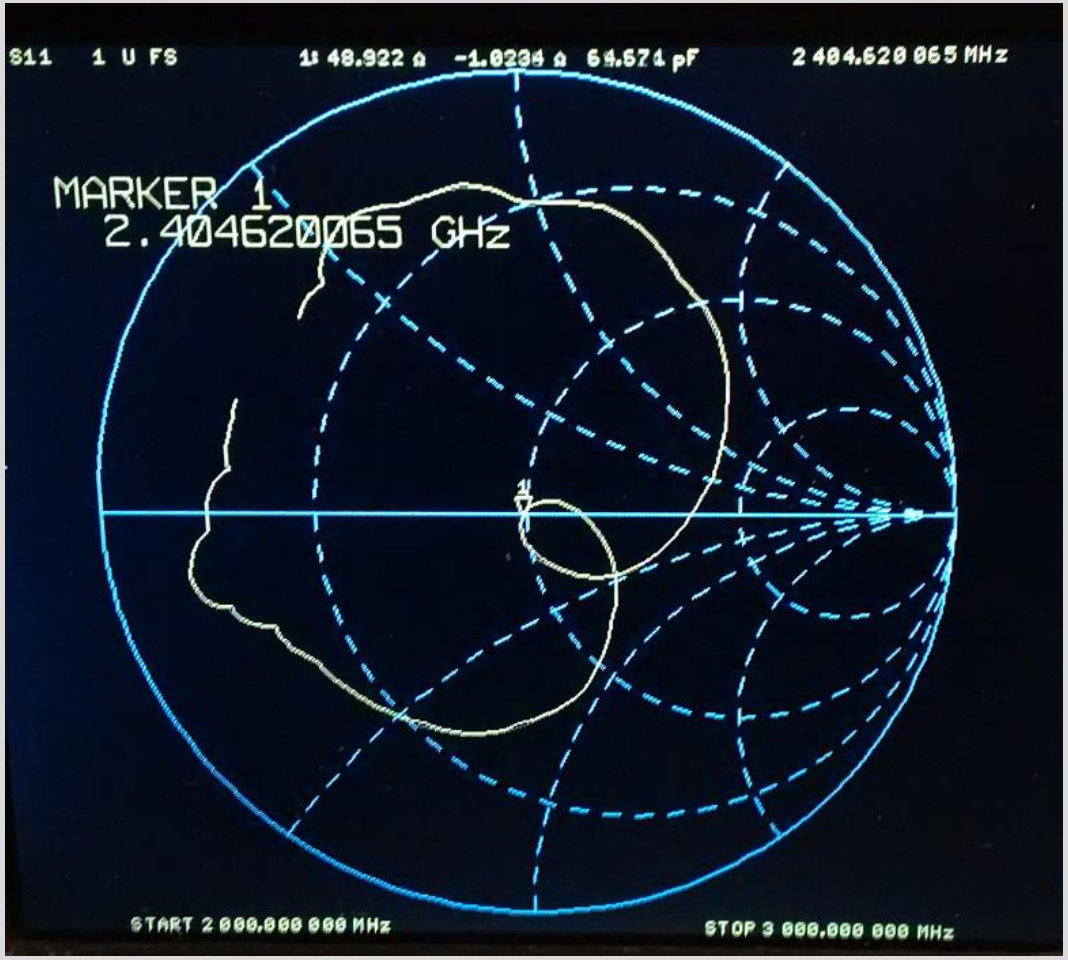
Feeds for QO-100

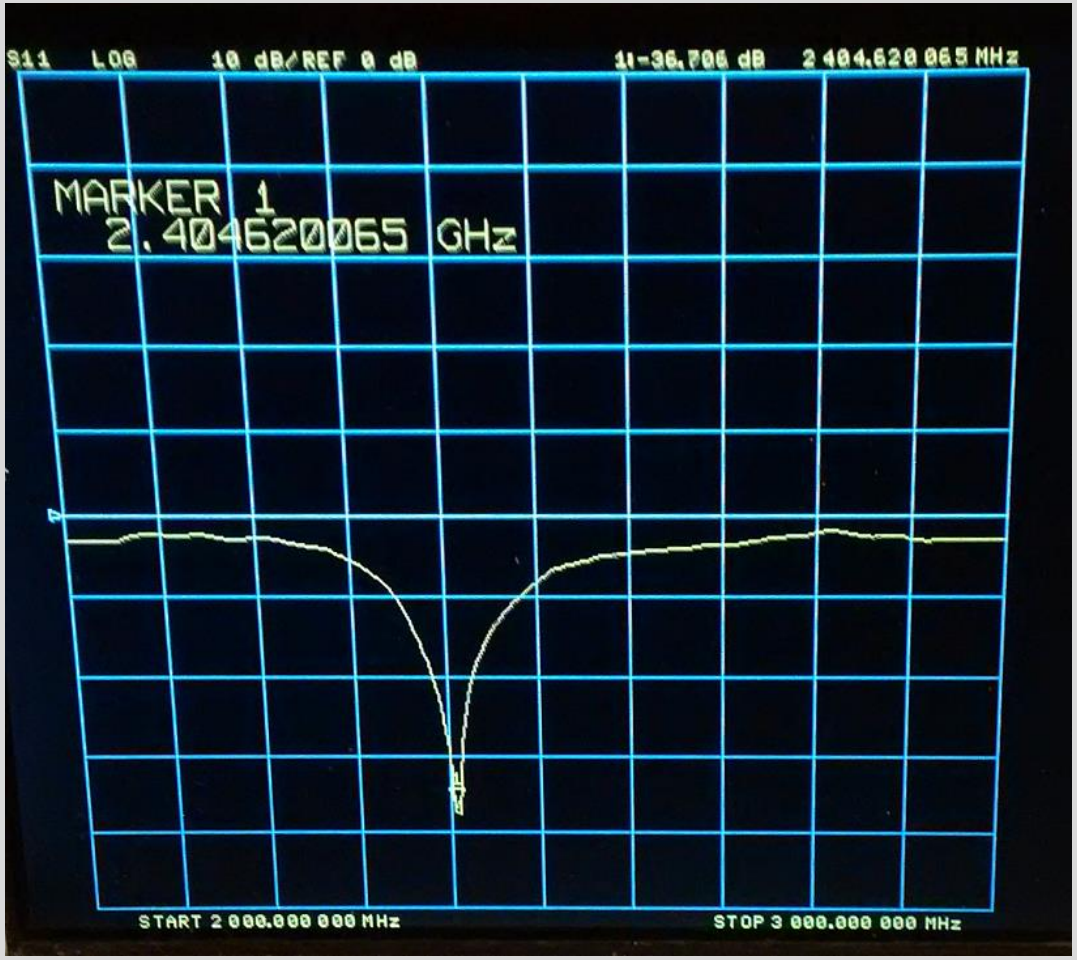






POTY Feed for QO-100





Antennas for QO-100

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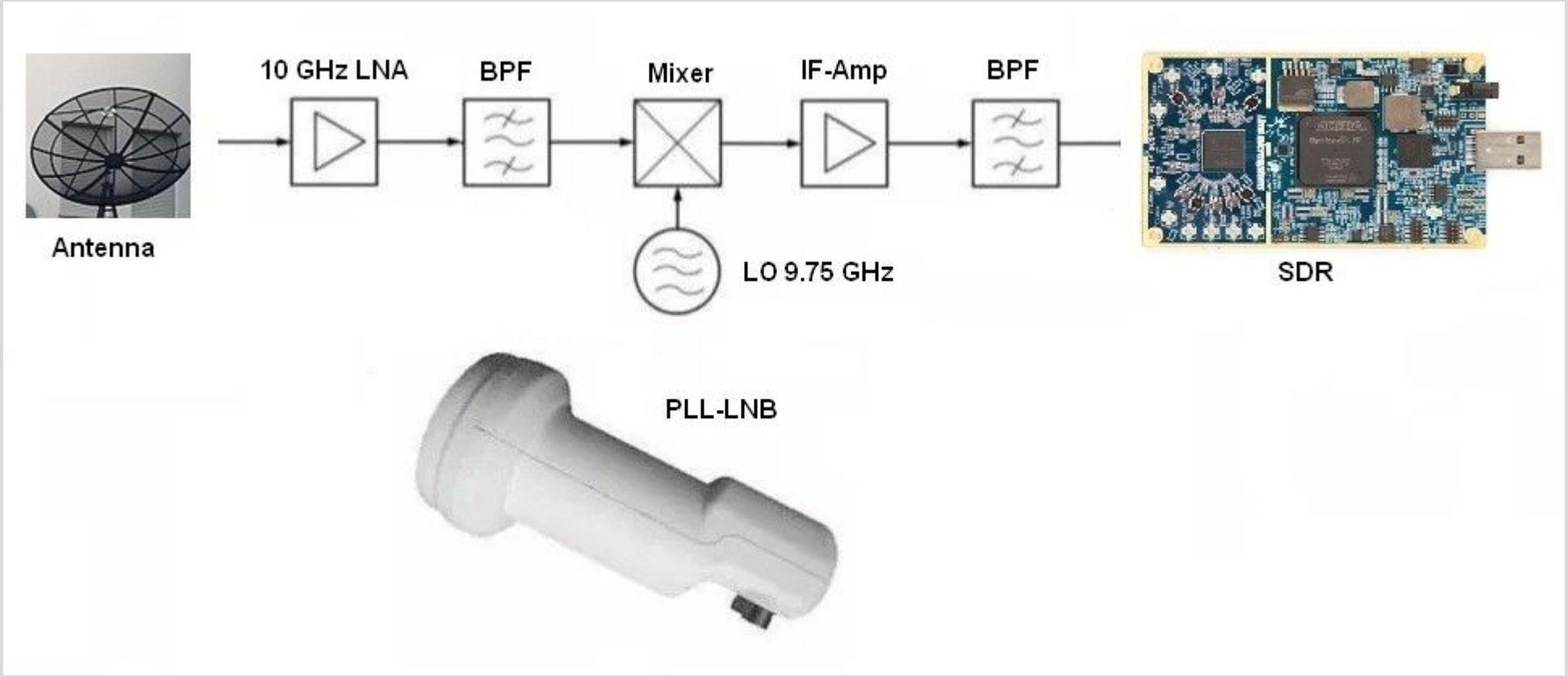
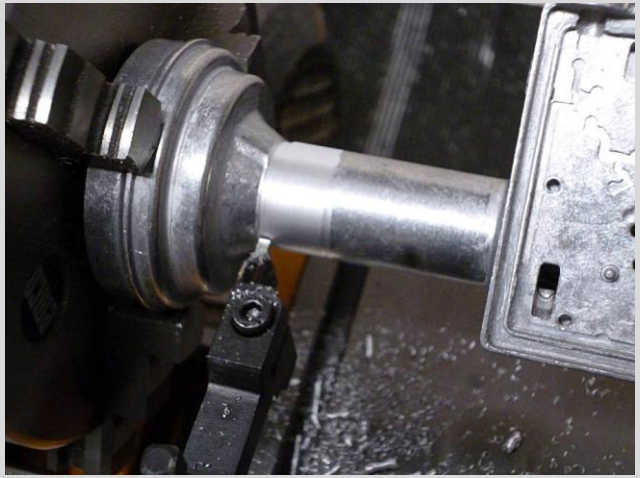
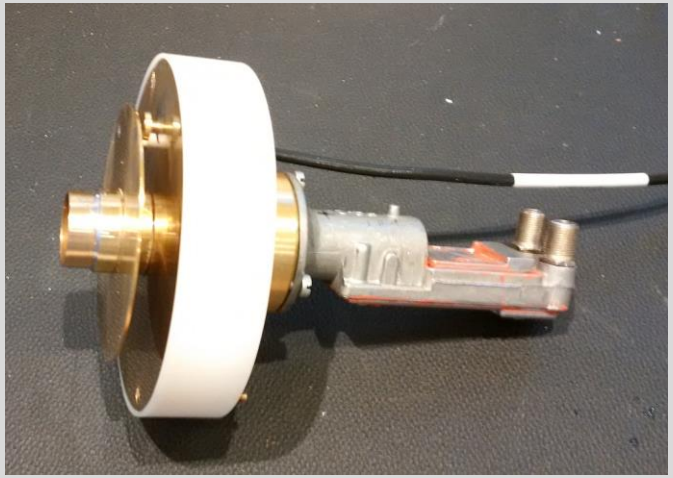
PLL-LNBs for QO-100



PLL-LNBs for QO-100





Megasat Diavolo

Octagon Dual OTSLO

SDRs for RX of NB TPX

RTL-SDR

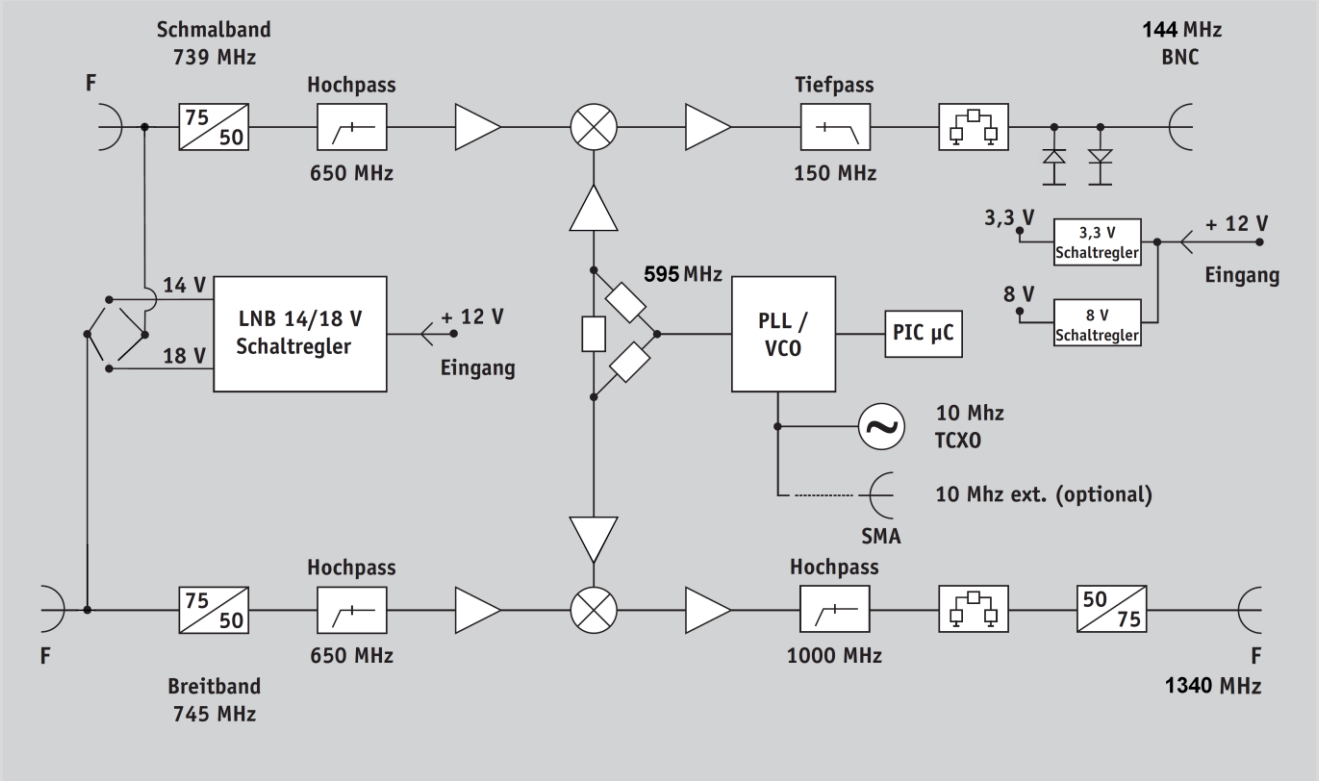
Funcube Pro

Airspy mini

SDRplay

Airspy 2

RX for QO-100



Downconverter AMSAT-DL
Price: 178,50€

Converts the IF of both polarizations
to conveniant bands:
- 1340 MHz for WB TPX to use Sat-TX
- 144 MHz for NB TPX to use 2m (T)RX

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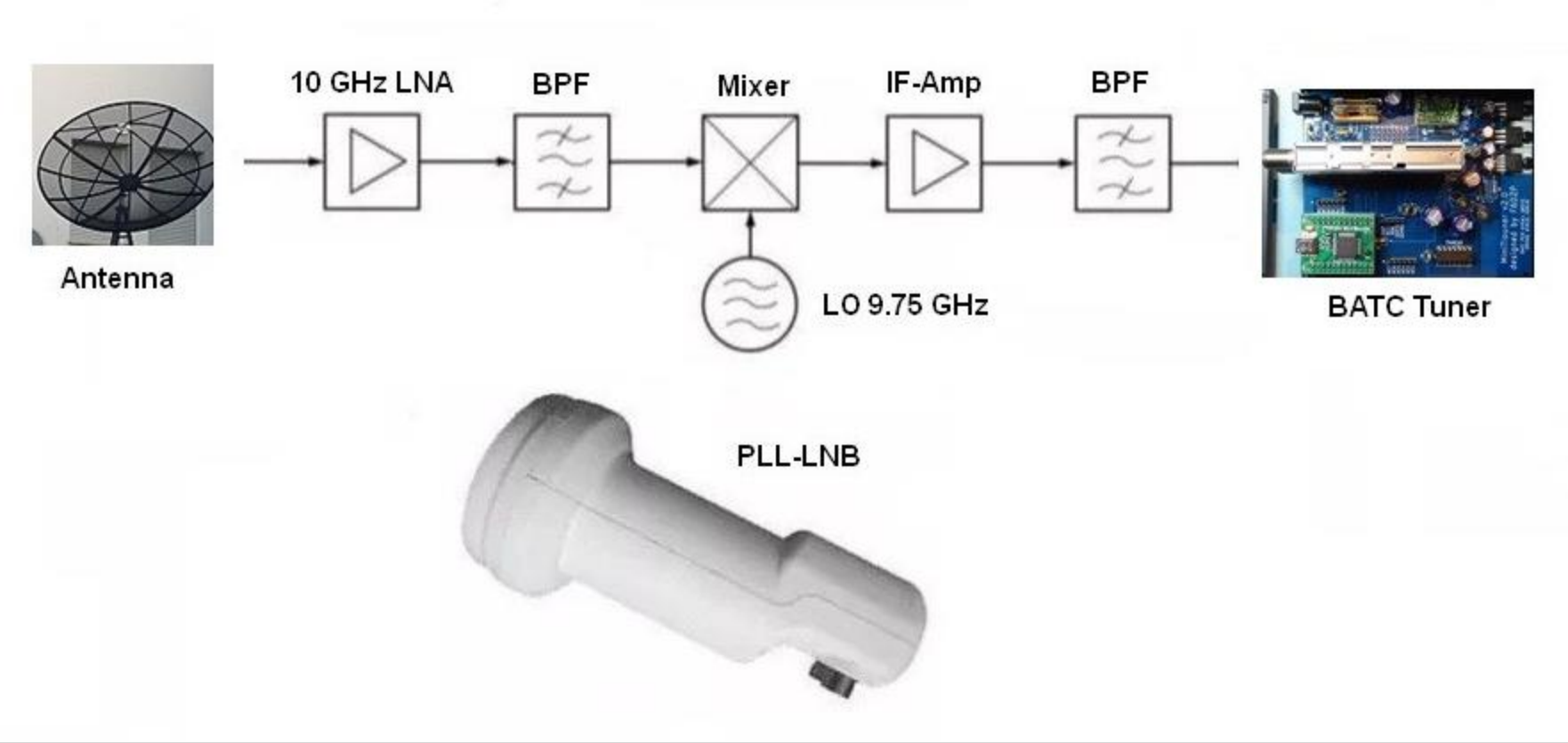
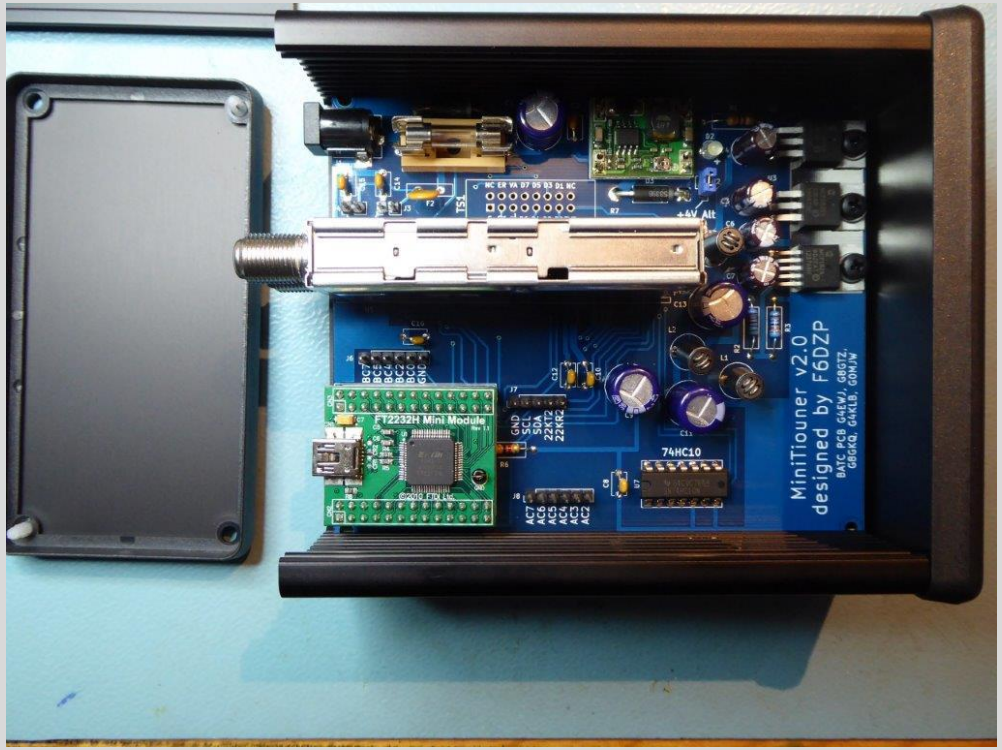
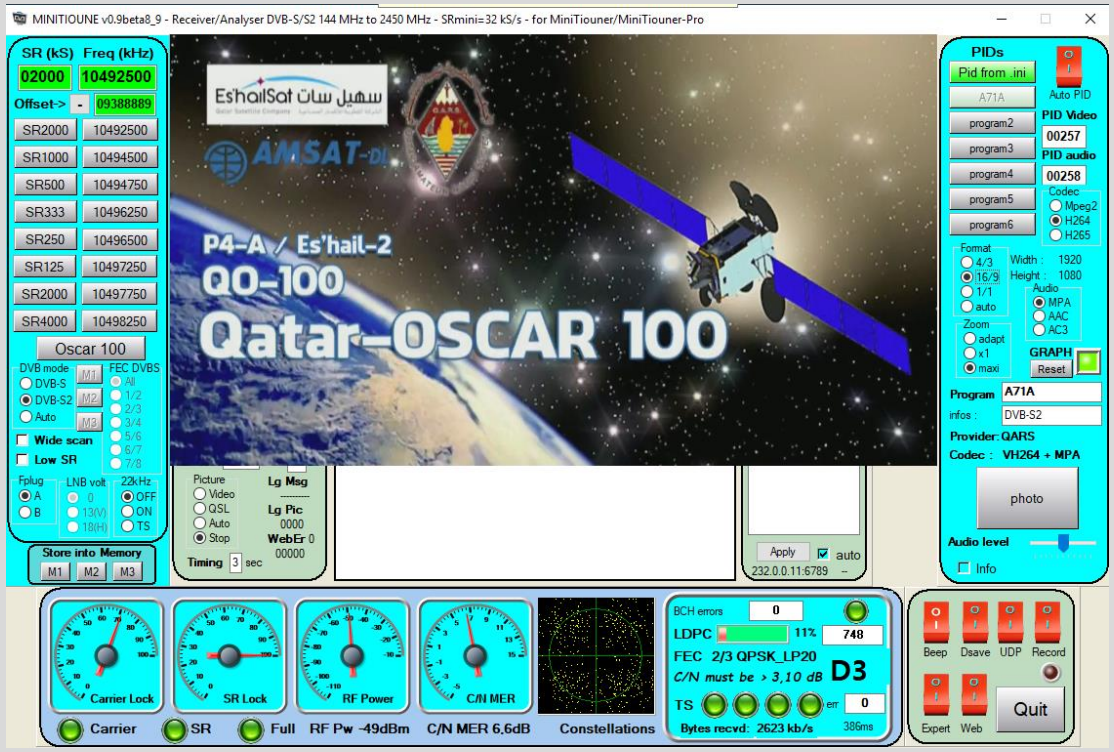
PLL-LNBs for QO-100



DATV-RX for QO-100

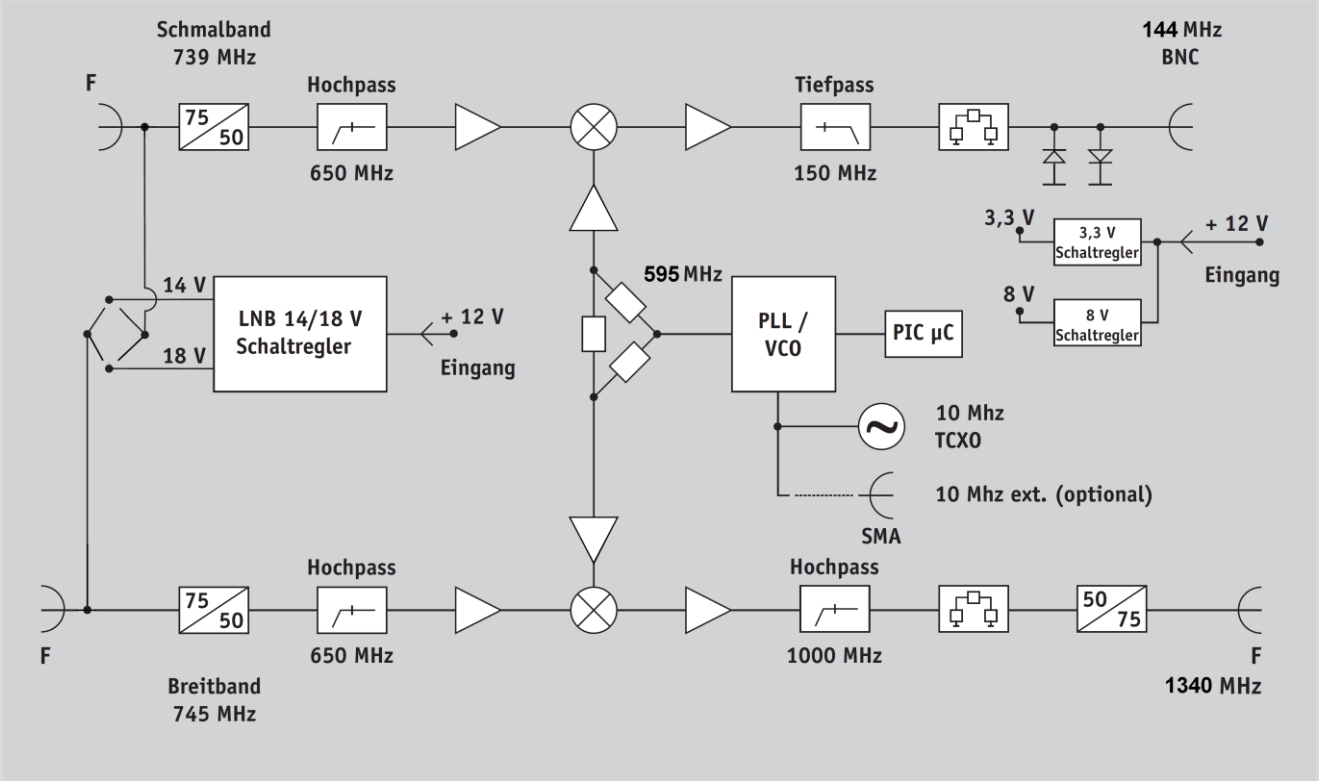




Minitiouner (Kit from BATC or REF)
Frequency range 143-2450 MHz

Software Minitioune from F6DZP
Supports all symbolrates and modes

DATV-RX for QO-100



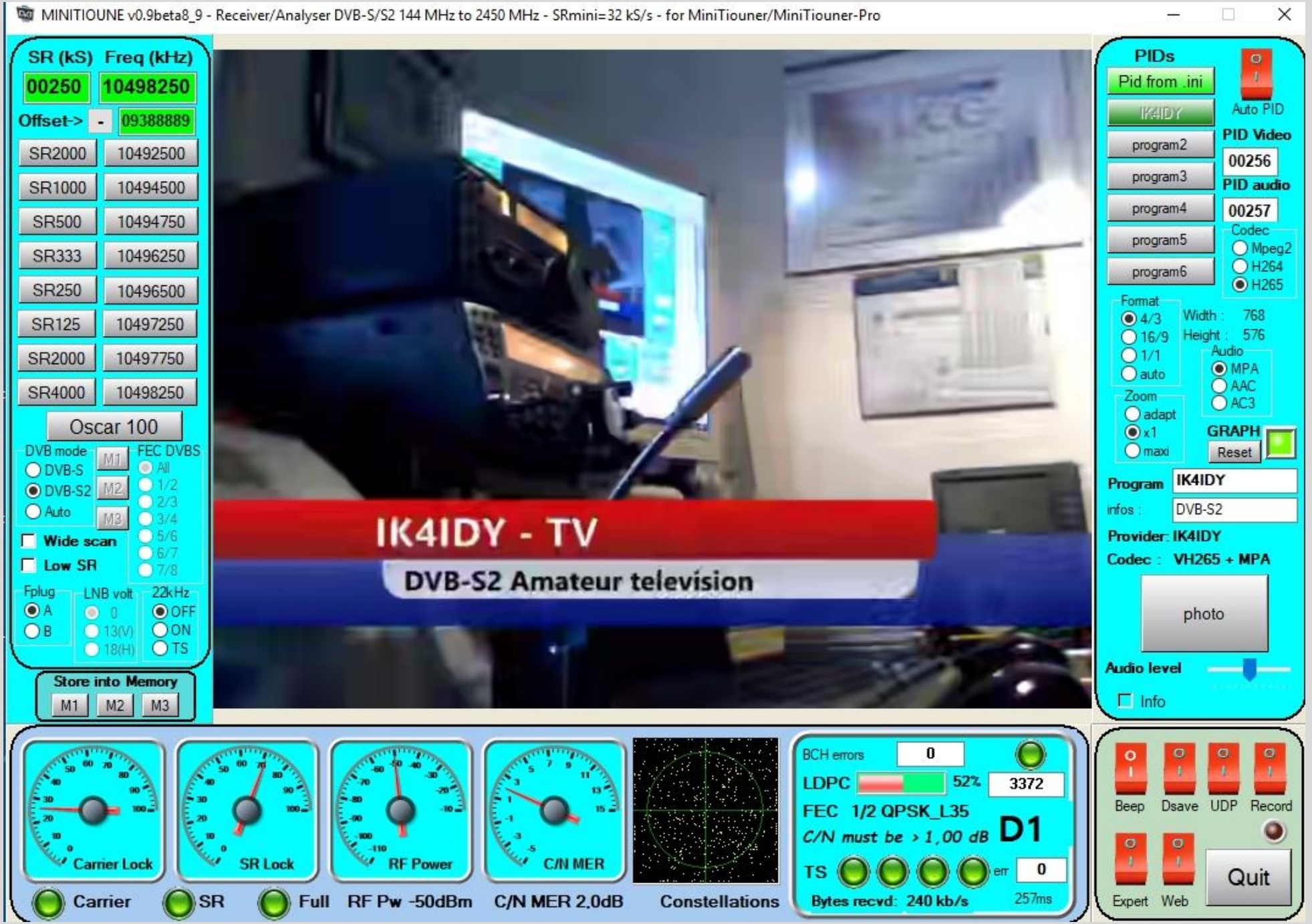
Downconverter AMSAT-DL

Converts the IF of both polarizations
to conveniant bands:
- 1340 MHz for WB TPX to use Sat-TX SF8008
- 144 MHz for NB TPX to use any 2m (T)RX

OCTAGON SF8008 4K UHD 2160p H.265 HEVC E2
Linux DVB-S2X Single Sat Receiver

Sat-TX SF8008 supports symbol rates 250kS and higher

DATV


MINITIOUNE v0.9beta8_9 - Receiver/Analyser DVB-S/S2 144 MHz to 2450 MHz - SRmini=32 kS/s - for MiniTiouner/MiniTiouner-Pro
SR (kS) Freq (kHz)
00250
10498250
Offset->
-
09388889
SR2000 10492500
SR1000 10494500
SR500 10494750
SR333 10496250
SR250 10496500
SR125 10497250
SR2000 10497750
SR4000 10498250
Oscar 100
DVB mode
DVB-S
DVB-S2
Auto
M1
M2
M3
FEC DVBS
All
1/2
2/3
3/4
5/6
6/7
7/8
Wide scan
Low SR
Fplug
A
B
LNB volt
0
13(V)
18(H)
22kHz
OFF
ON
TS
Store into Memory
M1
M2
M3
IK4IDY - TV
DVB-S2 Amateur television
PIDs
Pid from .ini
IK4IDY
program2
program3
program4
program5
program6
Auto PID
PID Video
00256
PID audio
00257
Codec
Mpeg2
H264
H265
Format
4/3
16/9
1/1
auto
Width : 768
Height : 576
Audio
MPA
AAC
AC3
Zoom
adapt
x1
maxi
GRAPH
Reset
Program IK4IDY
infos : DVB-S2
Provider: IK4IDY
Codec : VH265 + MPA
photo
Audio level
Info
Carrier Lock
SR Lock
RF Power
C/N MER
Carrier
SR
Full
RF Pw -50dBm
C/N MER 2,0dB
Constellations
BCH errors 0
LDPC 52% 3372
FEC 1/2 QPSK_L35
C/N must be > 1,00 dB
D1
TS
err 0
Bytes recvd: 240 kb/s
257ms
Beep
Dsave
UDP
Record
Expert
Web
Quit

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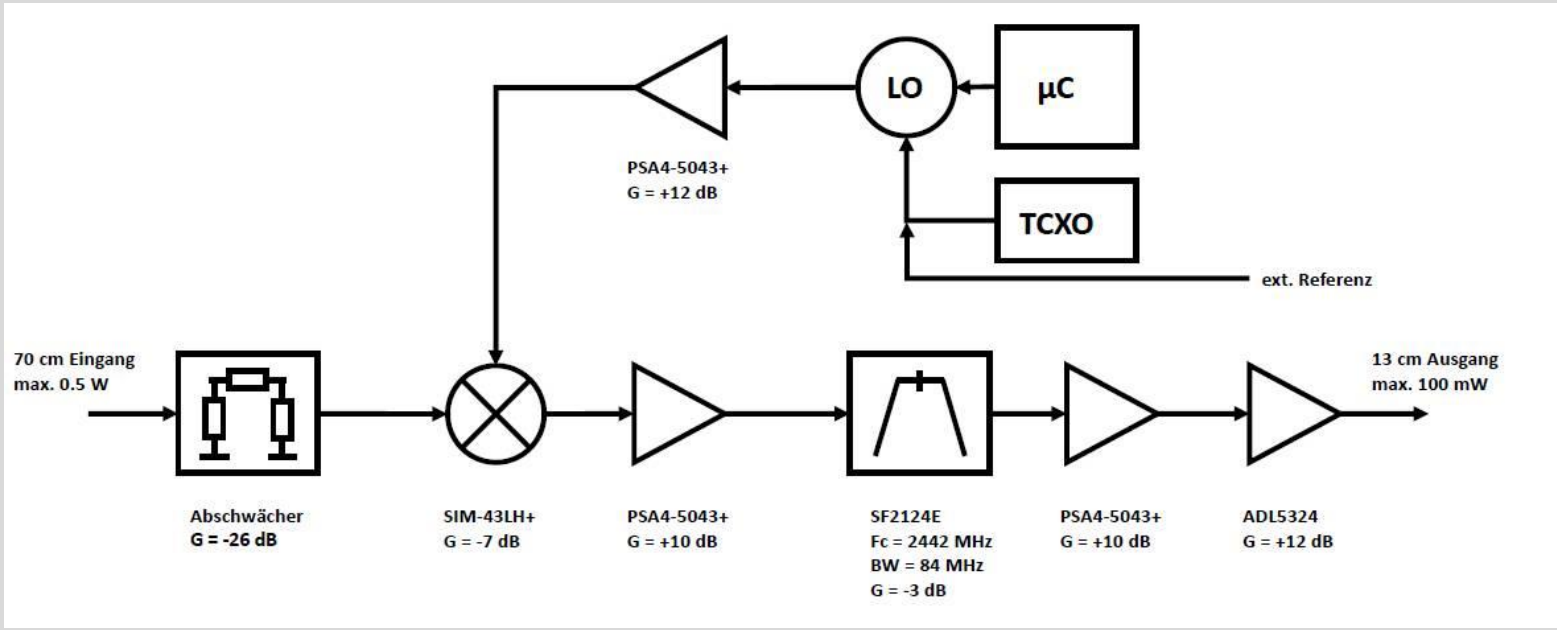
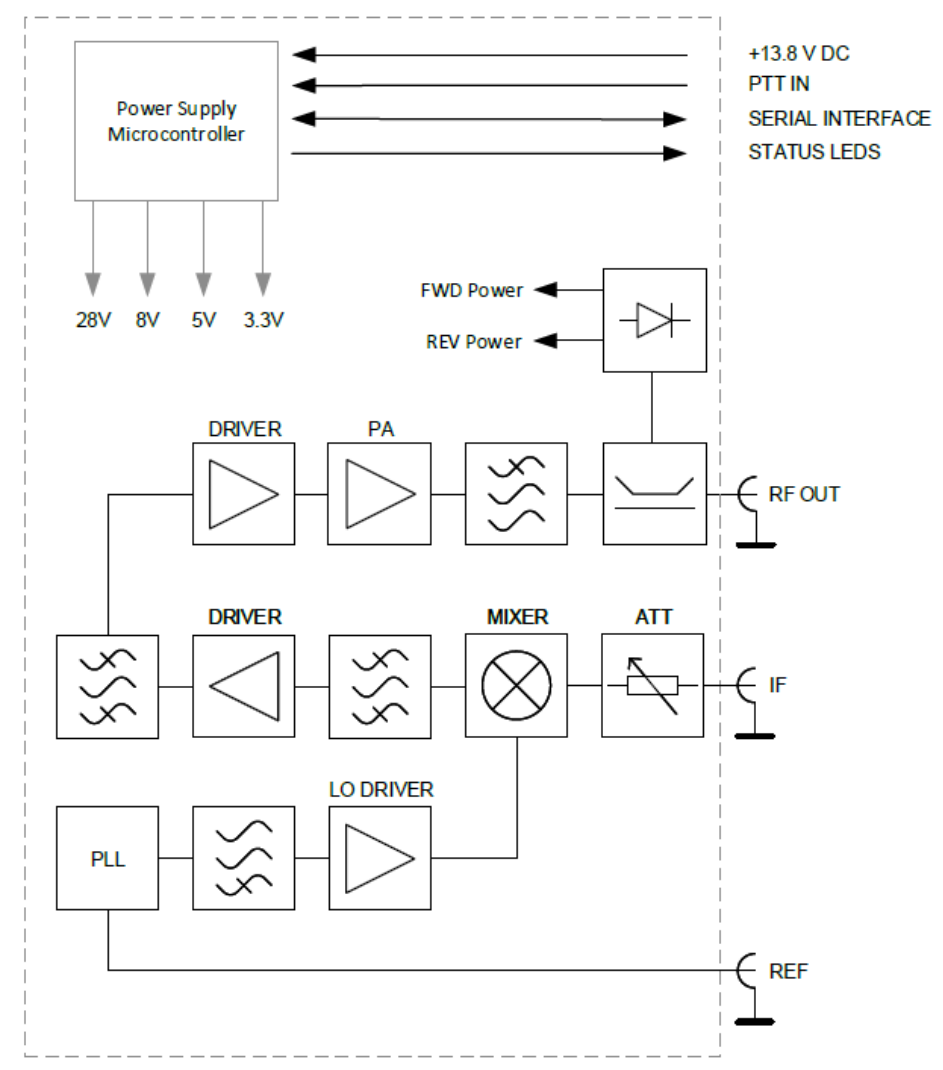
NB TX for QO-100



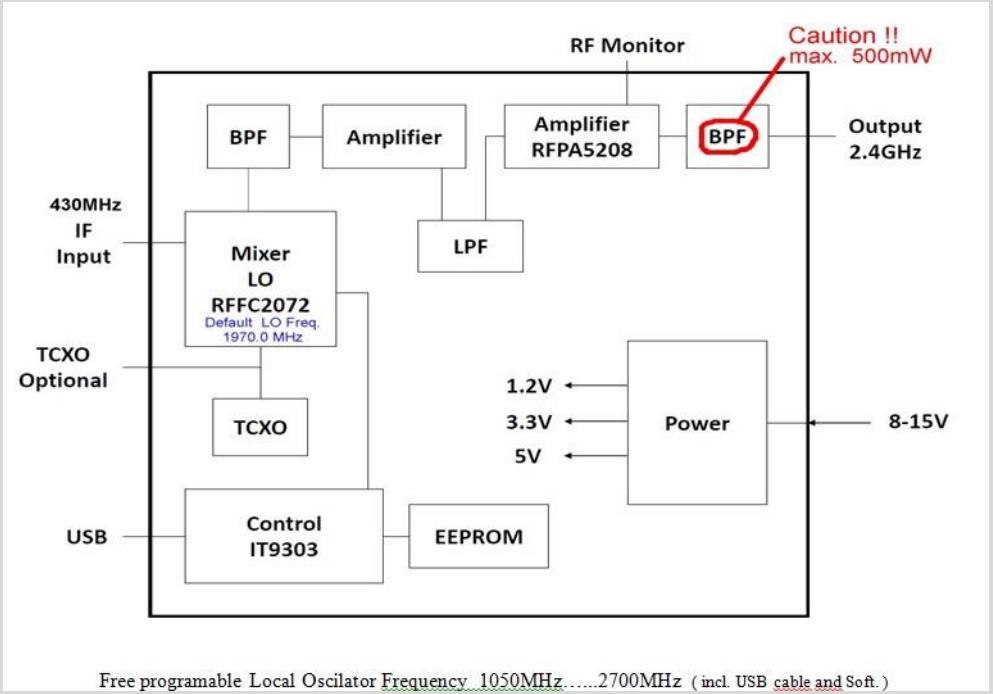
Upconverter AMSAT-DL
70cm input (max 500mW)
13cm output (max. 100mW)
99€

NB TX for QO-100

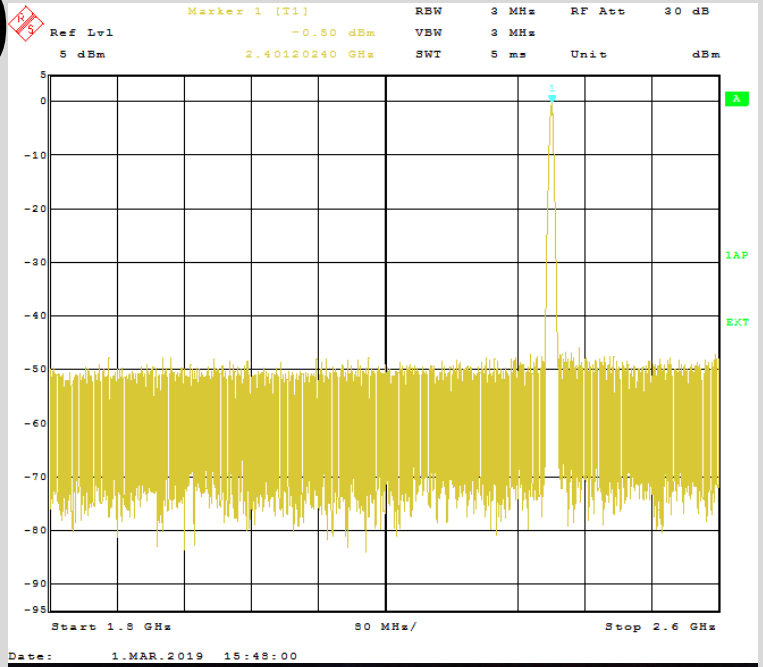
Upconverter Kuhne MKU UP 2424 B
2m or 70cm input (max 5W)
13cm output (20W)
10 MHz ref. freq. input
949 €

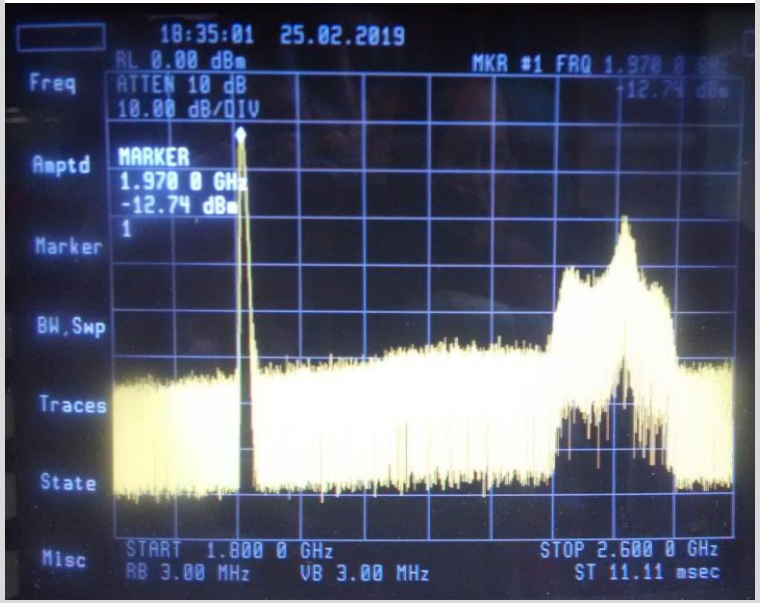


NB TX for QO-100



Free programable Local Oscilator Frequency 1050MHz.....2700MHz (incl. USB cable and Soft.)





HIDES BU-500 upconverter
2m or 70cm input (max. 10mW)
13cm output (max. 500mW)
169 US$ / 135€

NB TX for QO-100

SG-Labs Transverter TR2300 from LZ5HP

IF=70cm input (max. 5W)
RF=13cm(NF=1.5dB typ., Pout=2W typ.)
Switchable LO including split mode

200€

How much power for SSB via QO-100

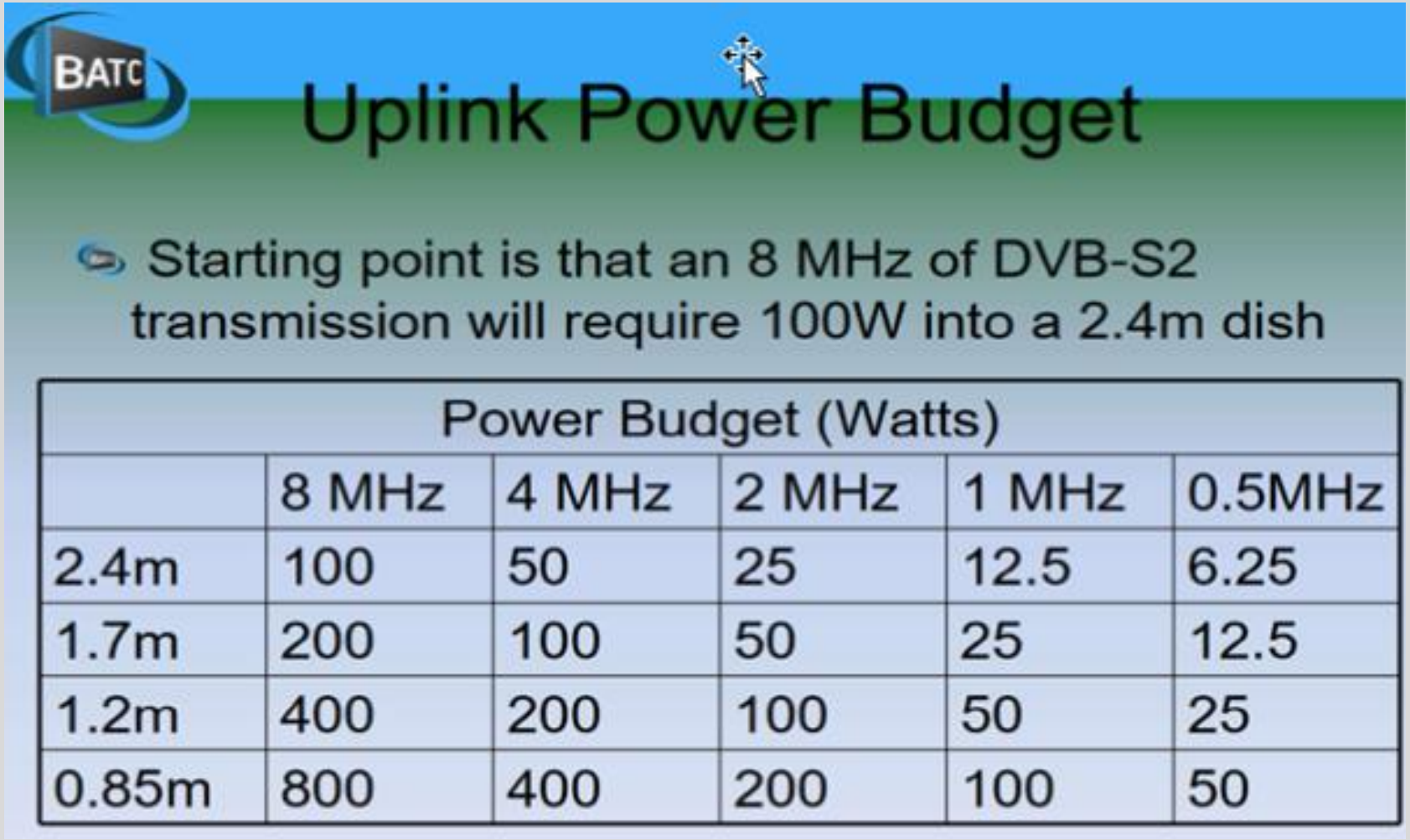
Many users use a 80cm dish and approximately 2-4 Watt

DD1US using 300mW with a linear patchfeed in a 1.8m dish

Some are using a long helix-antenna (20-40 turns) and use approximately 10-20 W

No uplink signal should result in a downlink signal stronger than the beacons

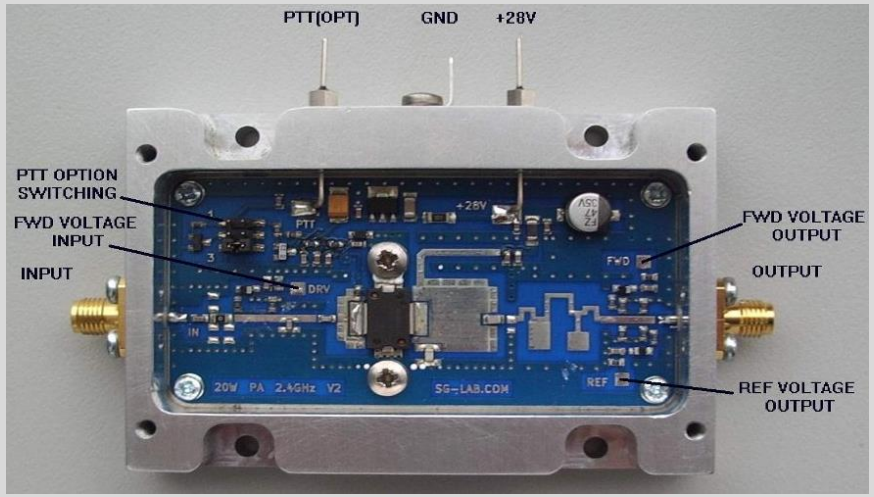
How much power for DATV via QO-100



Power Budget (Watts)					
	8 MHz	4 MHz	2 MHz	1 MHz	0.5MHz
2.4m	100	50	25	12.5	6.25
1.7m	200	100	50	25	12.5
1.2m	400	200	100	50	25
0.85m	800	400	200	100	50

Source: BATC

PAs for QO-100



SG-Labs 13cm PA LZ5HP
Pout=20W @28V, Gp=16dB
126 €

- http://www.ebay.com/bhp/spectrian
- 75W Spectrian Linear RF Amplifier Board
- 2.3-2.35 GHz, gain 18dB 24/26V
- 1.25 Watt Input Power

- Price: 99 $US on eBay

Surplus amplifiers (e.g. Ebay), mostly ex UMTS with lower gain & power @2.4 GHz but still useable with low efficiency

WIFI amplifiers for 2.4 GHz
typ. 3dB under spec but
useable (4W ca. 50€)

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SDRs for QO-100

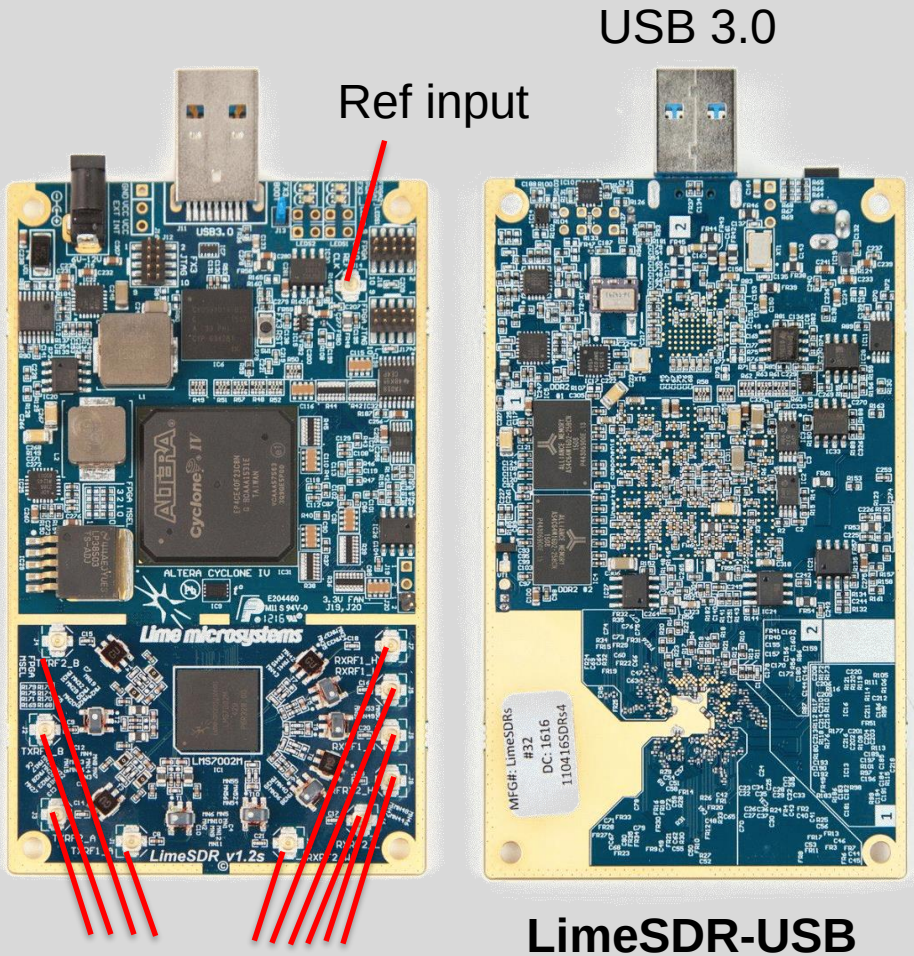
Besides traditional upconverter schemes as described before, modern SDR TRX provide a cost efficient solution for RX and TX of both, NB and WB TPX

Only drawback is that always a PC is needed

Especially the Lime-SDRs and ADALM Pluto can be used to transmit NB and DATV signals directly at 2.4 GHz

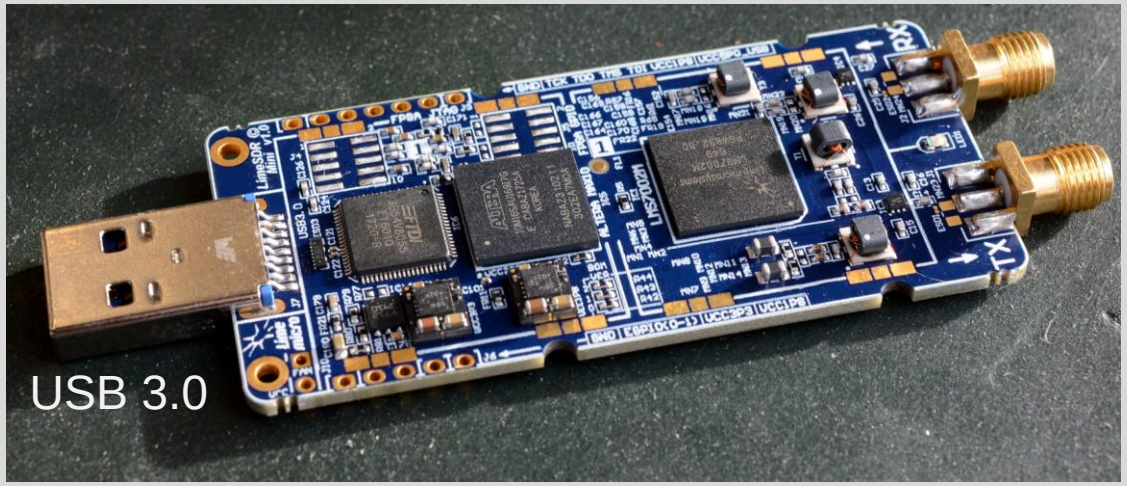
They support full duplex operation as needed to satellite communications

LimeSDR



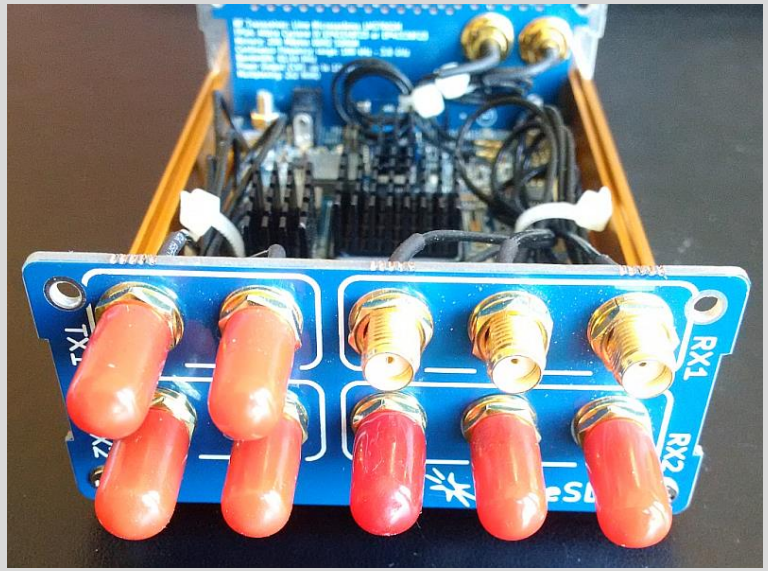
LimeSDR-USB

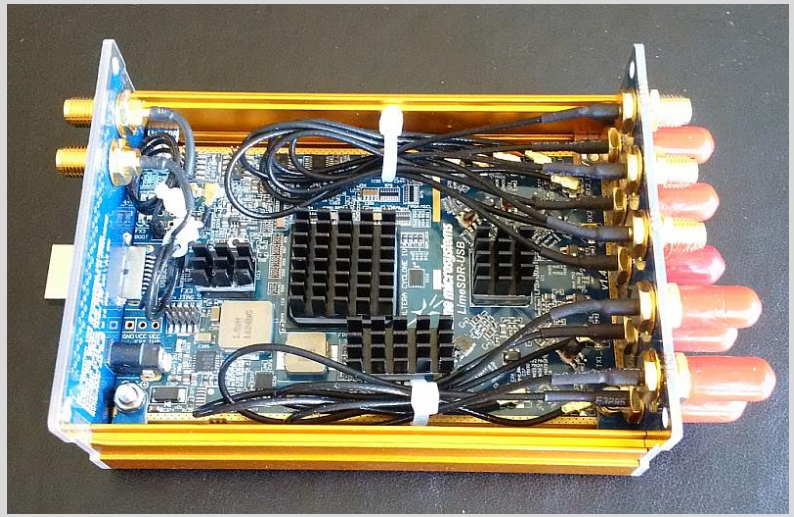
The LimeSDR USB and mini can be used up to 3.6 GHz for RX and TX



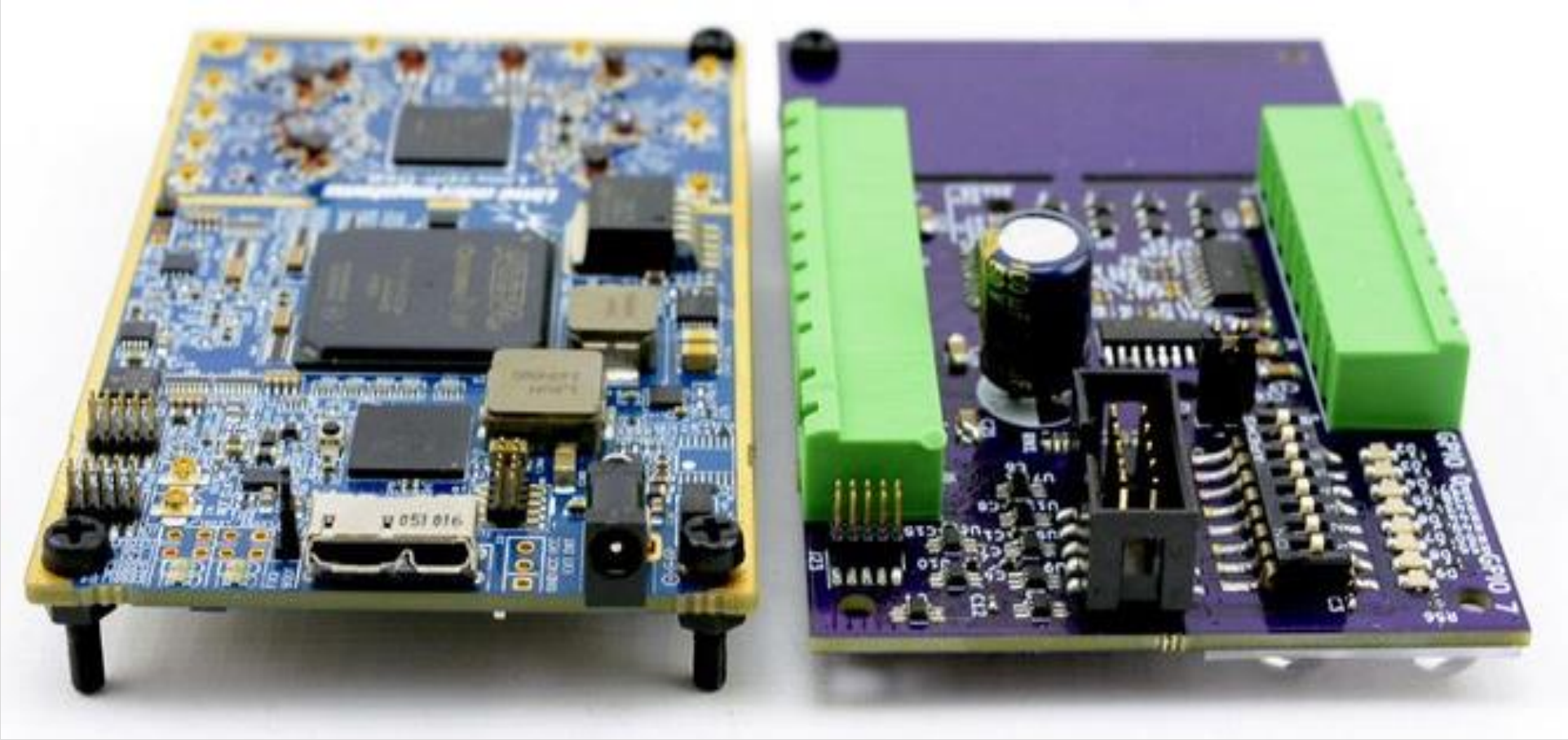
LimeSDR-mini

LimeSDR in metal case





LimeSDR with GPIO-board

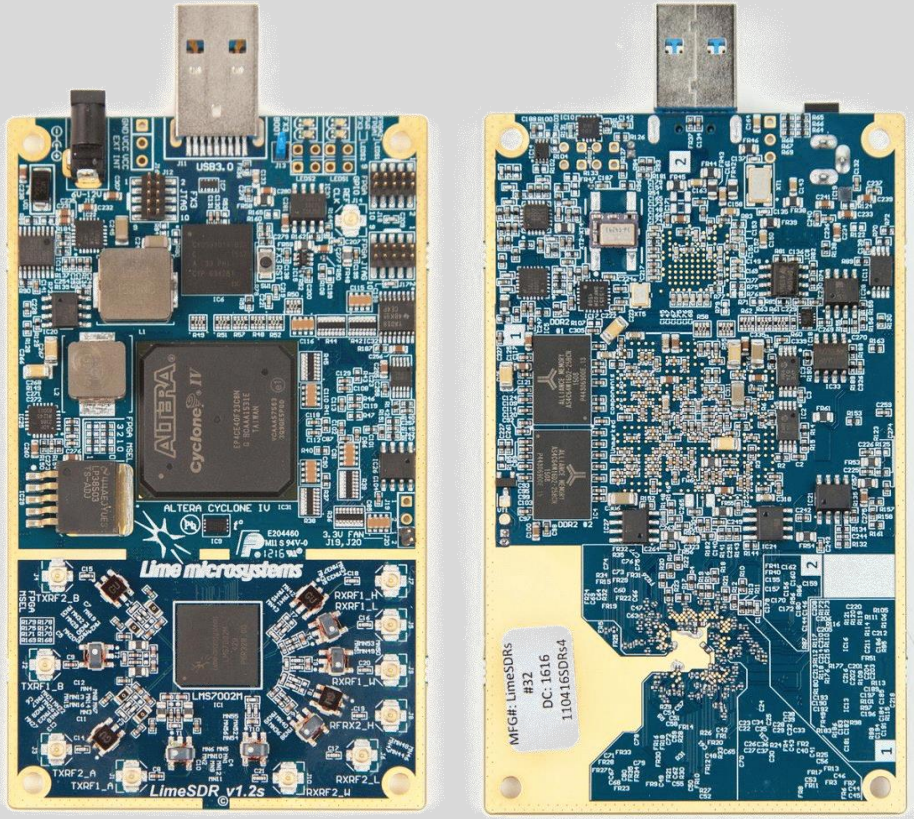


LimeSDR-USB

LimeSDR-GPIO board
supported by SDR-Radio software

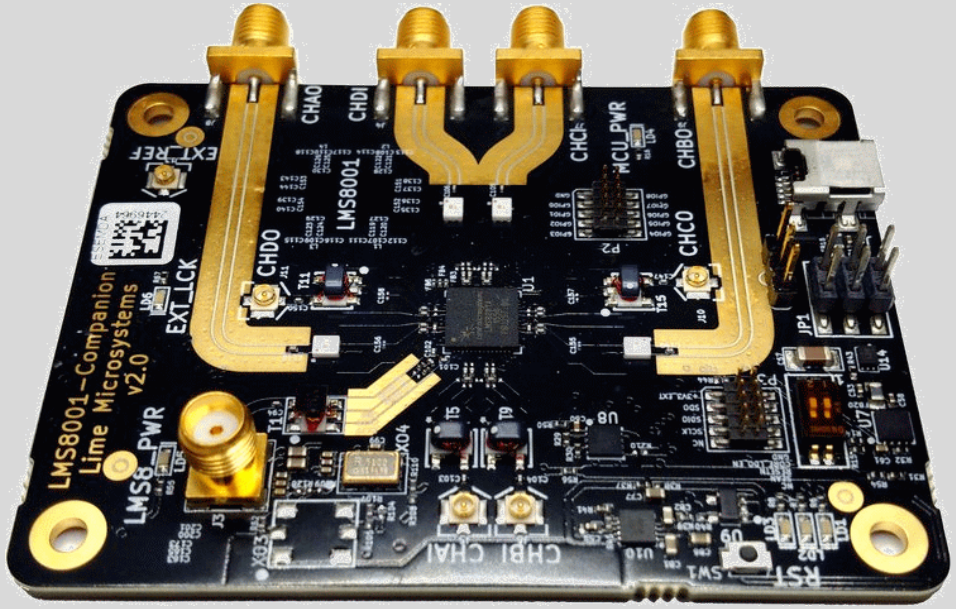
LimeSDR with LMS8001 companion board

USB 3.0



LimeSDR-USB
HF – 3.6 GHz

The LimeSDR companion board supports frequencies from 5-10 GHz

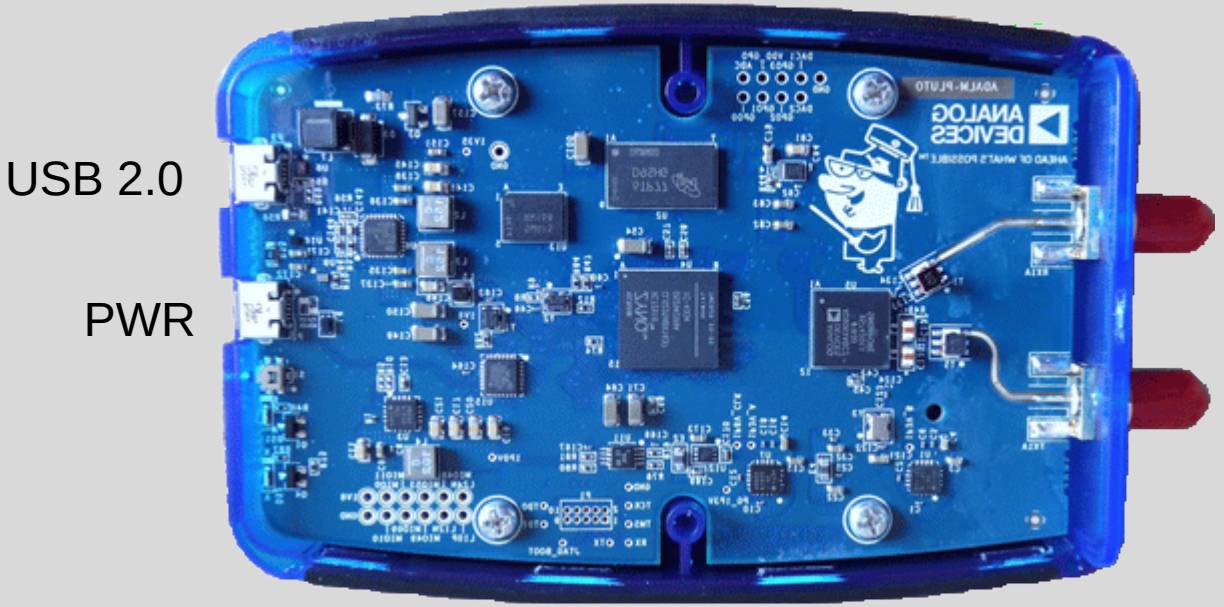


LMS8001 Companion board
5-10 GHz

Adalm Pluto

ADALM Pluto

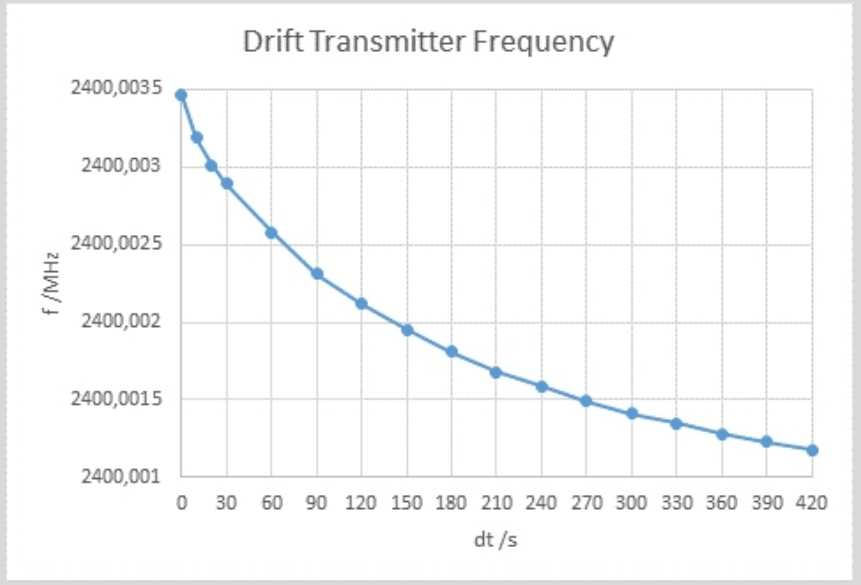
The Pluto SDR can be used up to 6 GHz for RX and TX



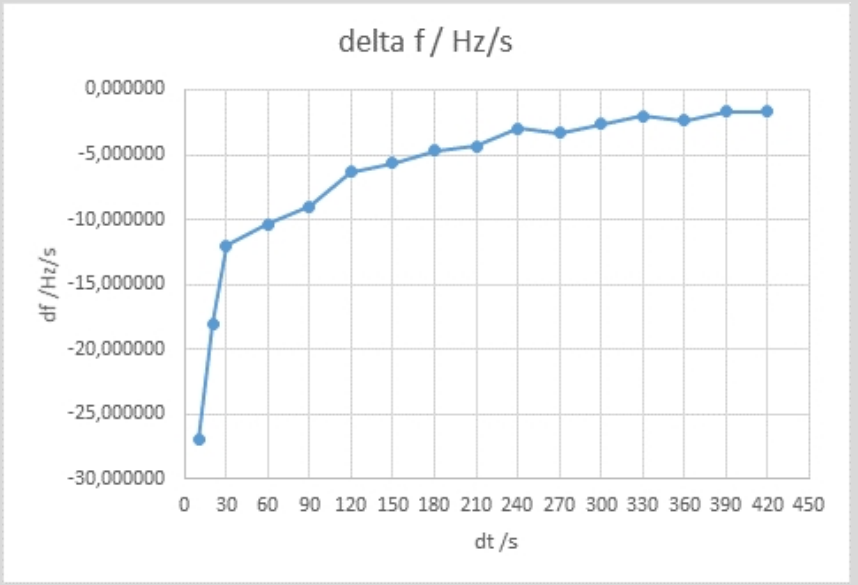
ADALM Pluto open

Adalm Pluto

ADALM Pluto as a network SDR TRX



Nice, but:

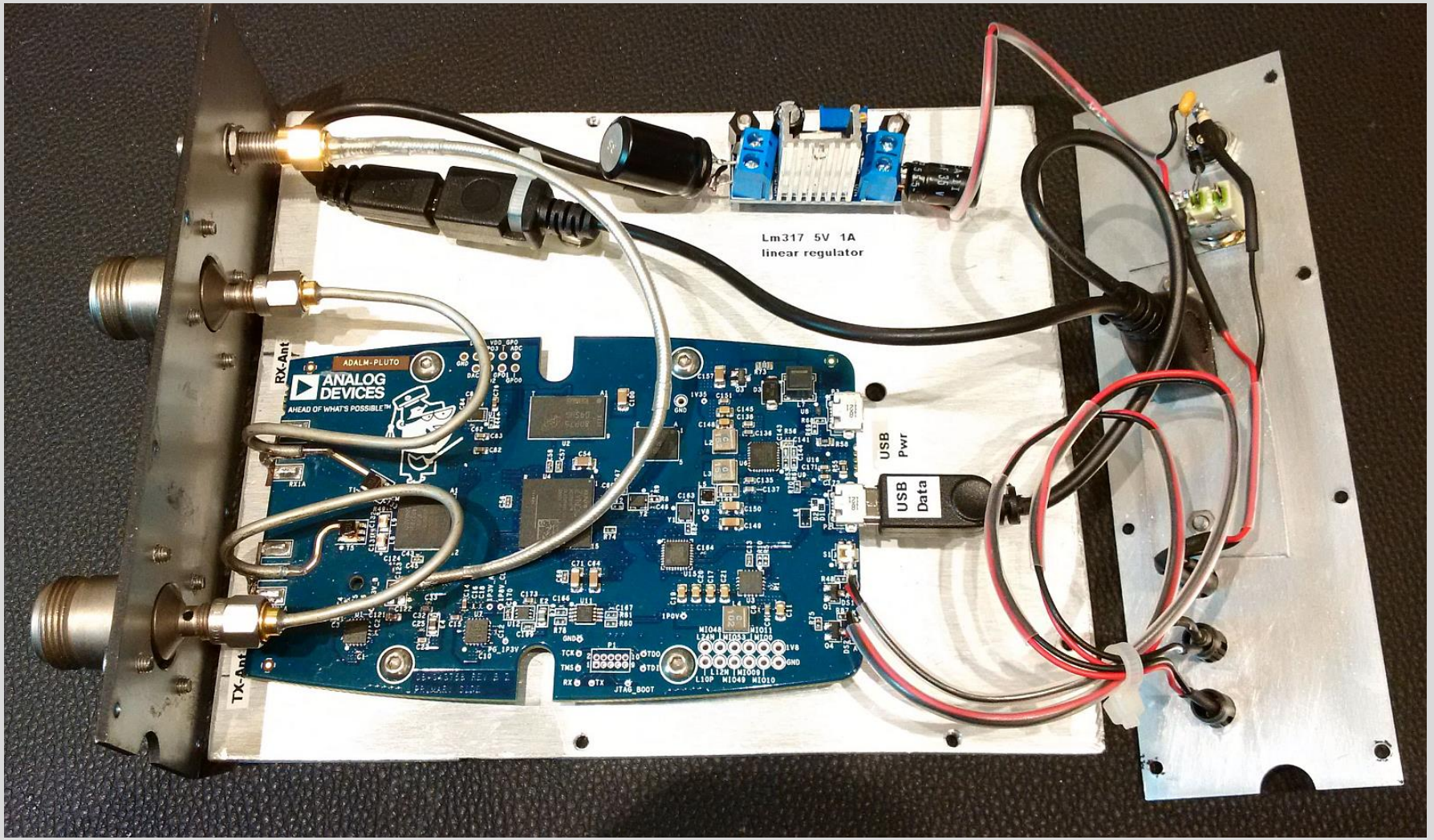


Internal 40 MHz TCXO needs to be replaced by a better TCXO or by an external reference

Adalm Pluto

ADALM Pluto in shielded encasing with external 40 MHz reference input

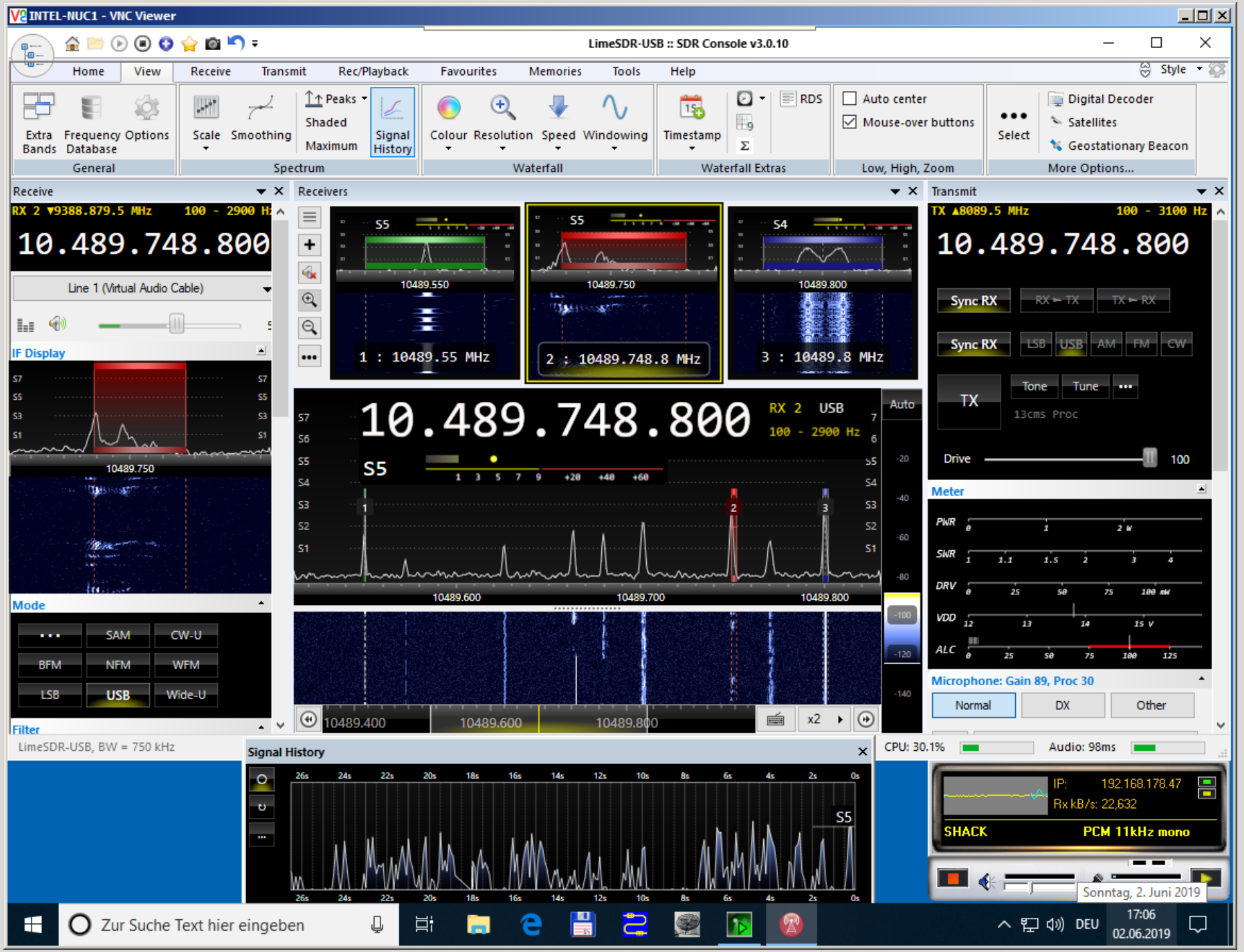
Adalm Pluto



ADALM Pluto in shielded encasing with external 40 MHz reference input

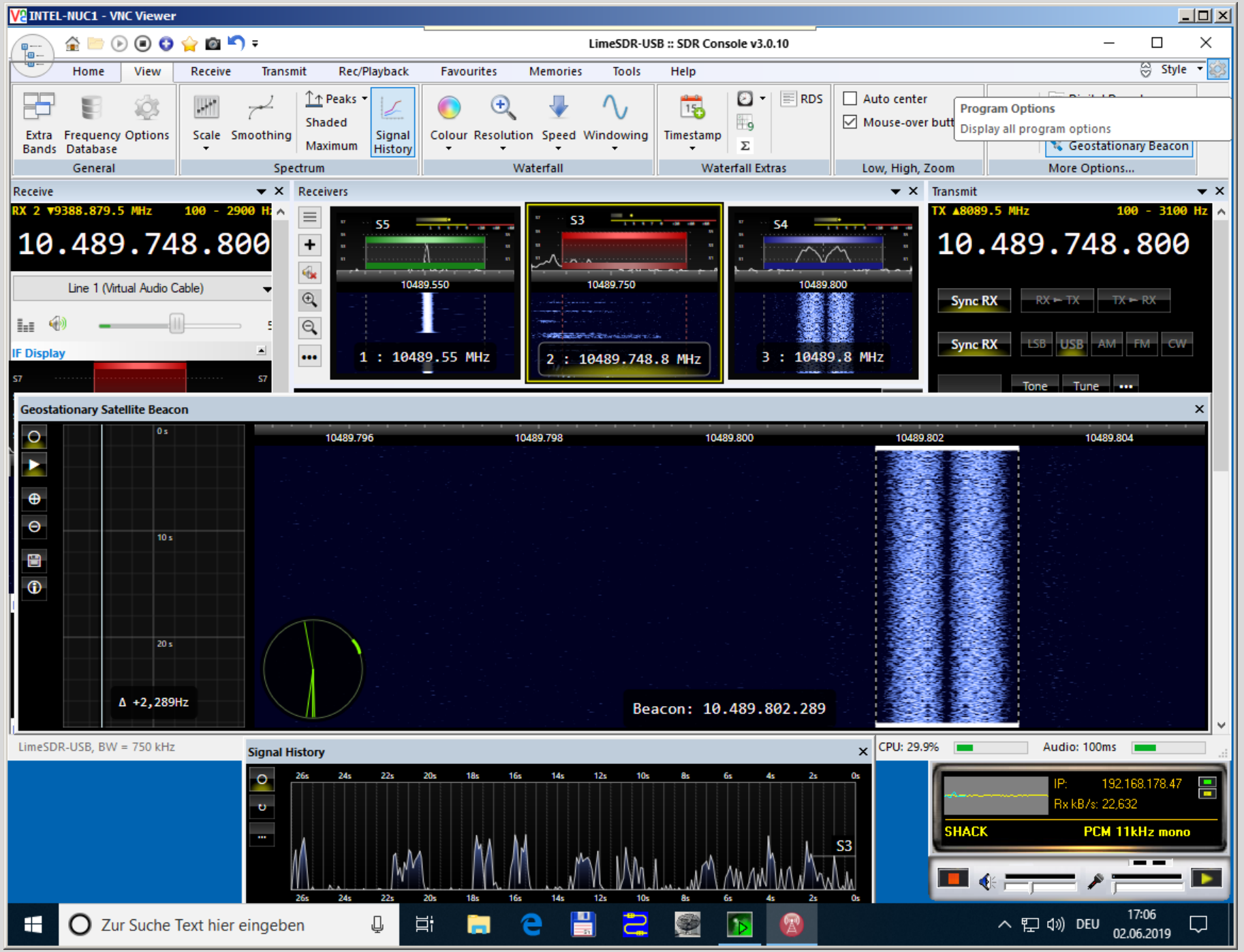
SDR-Radio

Fullduplex with automatic tracking of RX and TX frequency and mode



SDR-Radio

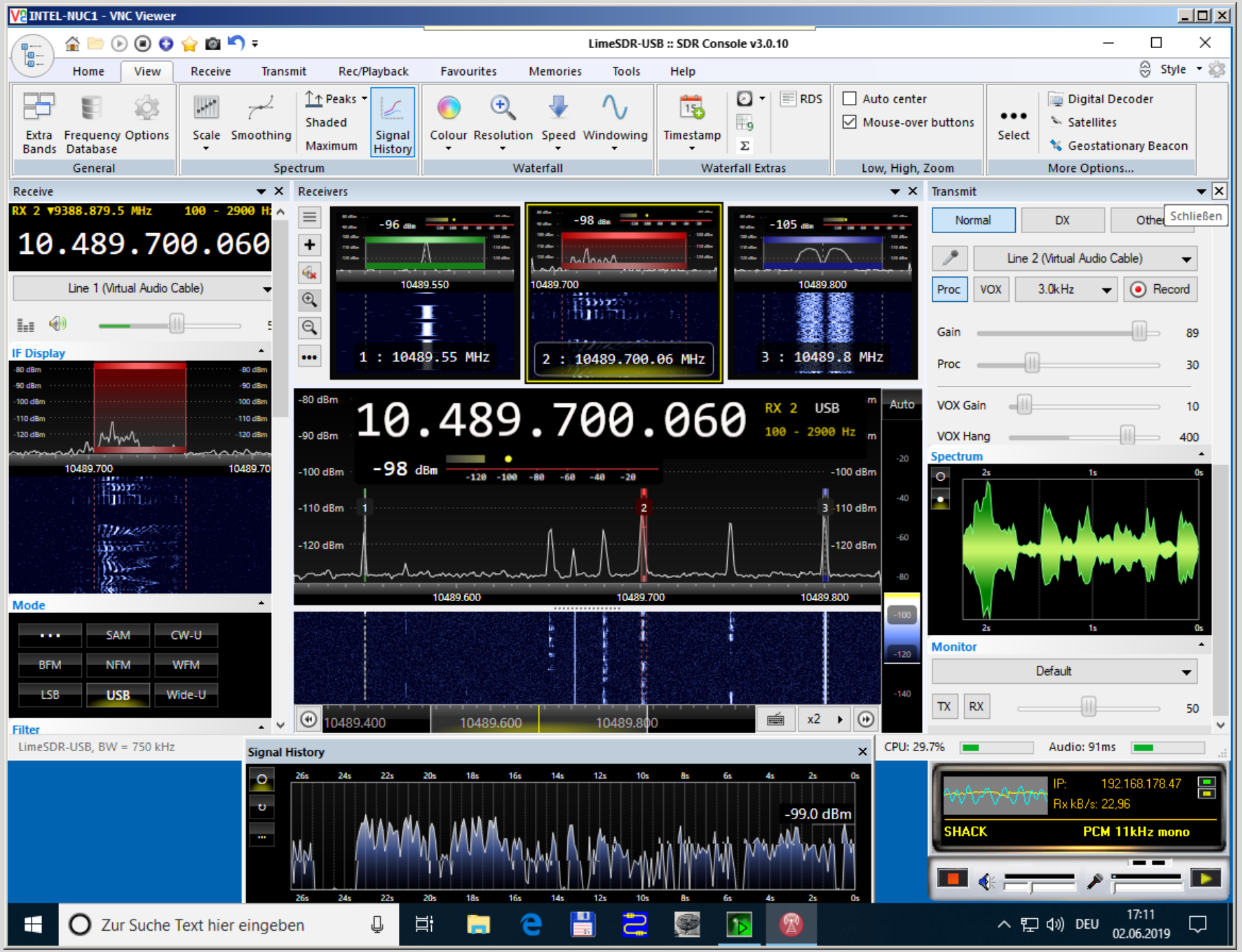
Locking the receiver to the PSK beacon elimininates the drift of the LNB



SDR-Radio

Multiple receiver windows conveniant to check beacon levels and own signal

Transmit Audio Scope and spectrum available

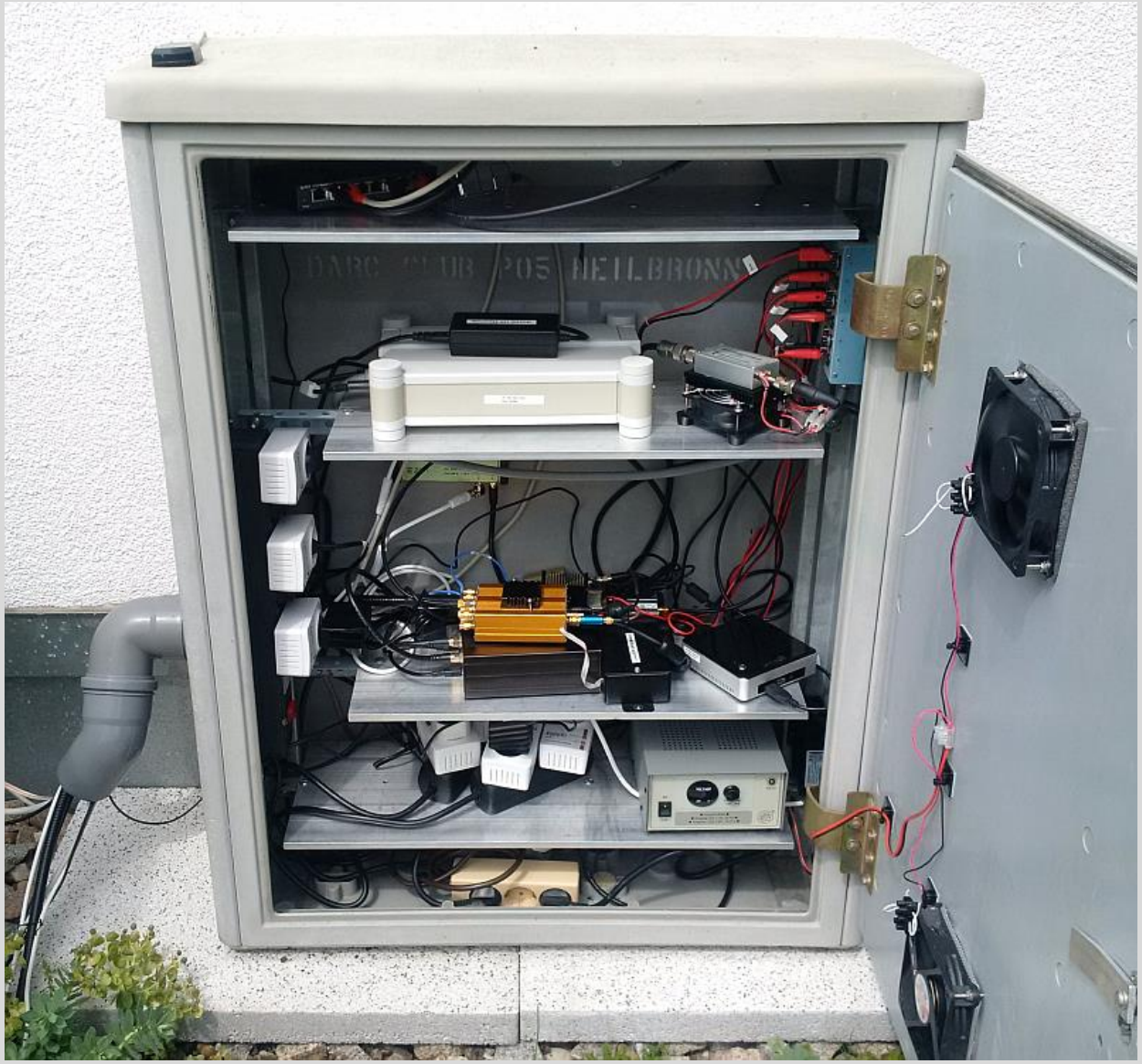


Out-Door-Unit DD1US

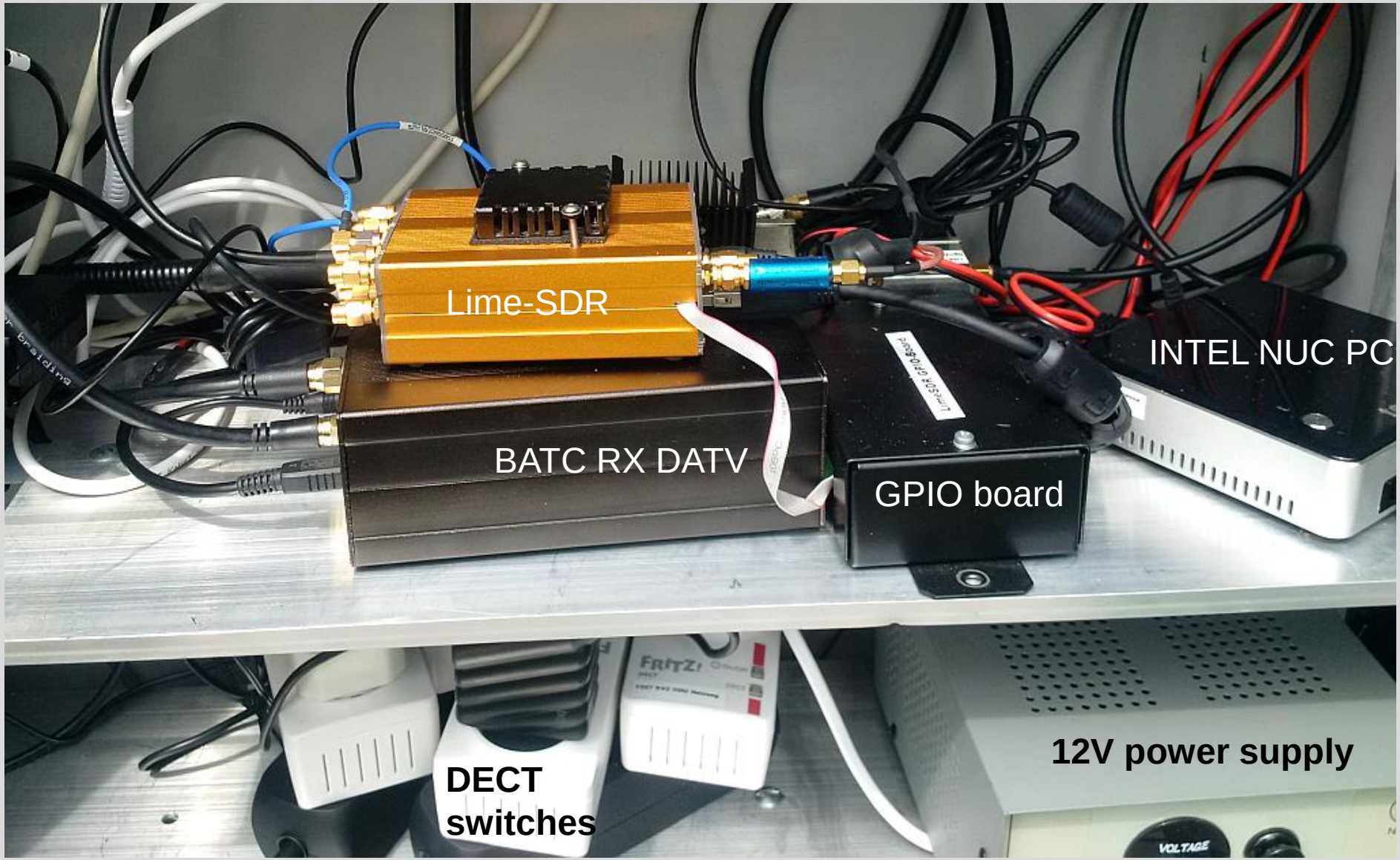
1.8m dish with dualband feed, 300mW enough for a good SSB signal

Out-Door-Unit DD1US

Out-Door-Unit DD1US

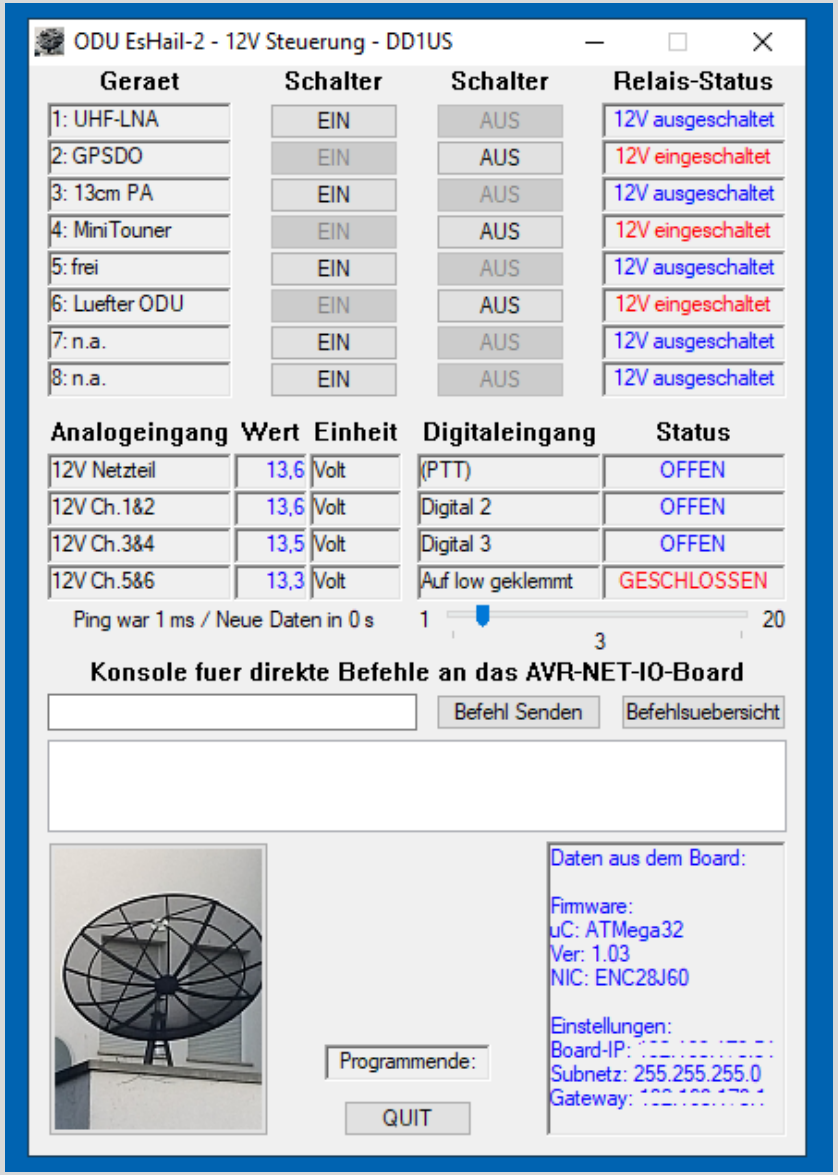


Out-Door-Unit DD1US



Out-Door-Unit DD1US

AVR Net-IO Unit (Pollin)



Control Software (DD1US)

QO-100 Logbook DD1US

DXCC	Country	Pfx
302	Western Sahara	S0
299	West Malaysia	9M2
294	Wales	GW
422	The Gambia	C5
387	Thailand	HS
287	Switzerland	HB9
281	Spain	EA
499	Slovenia	S5
504	Slovak Republic	OM
279	Scotland	GM
225	Sardinia	IS
275	Romania	YO
462	Republic of South Africa	ZS
376	Qatar	A7
272	Portugal	CT
269	Poland	SP
266	Norway	LA

DXCC	Country	Pfx
265	Northern Ireland	GI
263	Netherlands	PA
165	Mauritius	3B8
254	Luxembourg	LX
146	Lithuania	LY
248	Italy	I
336	Israel	4Z
114	Isle of Man	GD
324	India	VU
242	Iceland	TF
239	Hungary	HA
236	Greece	SV
227	France	F
224	Finland	OH
230	Fed. Republic of Germany	DL
054	European Russia	UA3
052	Estonia	ES

DXCC	Country	Pfx
223	England	G
221	Denmark	OZ
503	Czech Republic	OK
215	Cyprus	5B
497	Croatia	9A
214	Corsica	TK
029	Canary Is.	EA8
212	Bulgaria	LZ
108	Brazil	PY
501	Bosnia-Herzegovina	T9
209	Belgium	ON
027	Belarus	EU
021	Balearic Is.	EA6
149	Azores	CU
206	Austria	OE
015	Asiatic Russia	UA9

344 QSOs, 51 countries (all in SSB)

Homepage
DD1US

You will find this presentation and more information about my setup on my website www.dd1us.de

You can find there also a section called „Sounds from Space“ with more than 1500 recordings of various satellites and other space objects.

	Apollo 12 (crew: Charles "Pete" Conrad, Richard "Dick" F. Gordon, Alan L. "Al" Bean) CSM-108 #04225 1969-099A	This was the 2nd mission of Apollo with a landing on the moon. The rocket was struck twice (36 seconds and 52 seconds after launch) by a lightning. You can hear the launch campaign including the conversation about the lightning strikes in the first audio recording. The second audio files documents communication between LM (the lunar module with the nickname "Intrepid") and Houston ground control during the final descent phase (last 3 minutes) and the touch down on the moon (110 h, 32 min and 36 sec mission elapsed time). The crew returned safely on November 24th 1969. I extracted the recordings from the NASA audio collection. Alan L. Bean was the 4th man on the moon. After he left NASA he became an artist and started painting beautiful scenes of the moon. Enclosed a picture of himself which he named "A New Frontier".	Nov 14th 1969
	Apollo 13 aborted third manned mission to the moon (crew: James A. Lovell, Jr., John L. Swigert, Jr., Fred W. Haise, Jr.) CSM-109 #04371 1970-029A	This aborted 3rd manned mission to moon ended almost fatal. Due to an explosion of the oxygen tank in the service module the mission had to be aborted and luckily the crew returned safely on April 17th 1970. See here a short movie of the damaged service module when clicking on the picture to the right. Listen to the famous words of J. Swigert after the explosion of the tank: "Houston, we've had a problem here."	Apr 11th 1970

Thank you very much for your attention !