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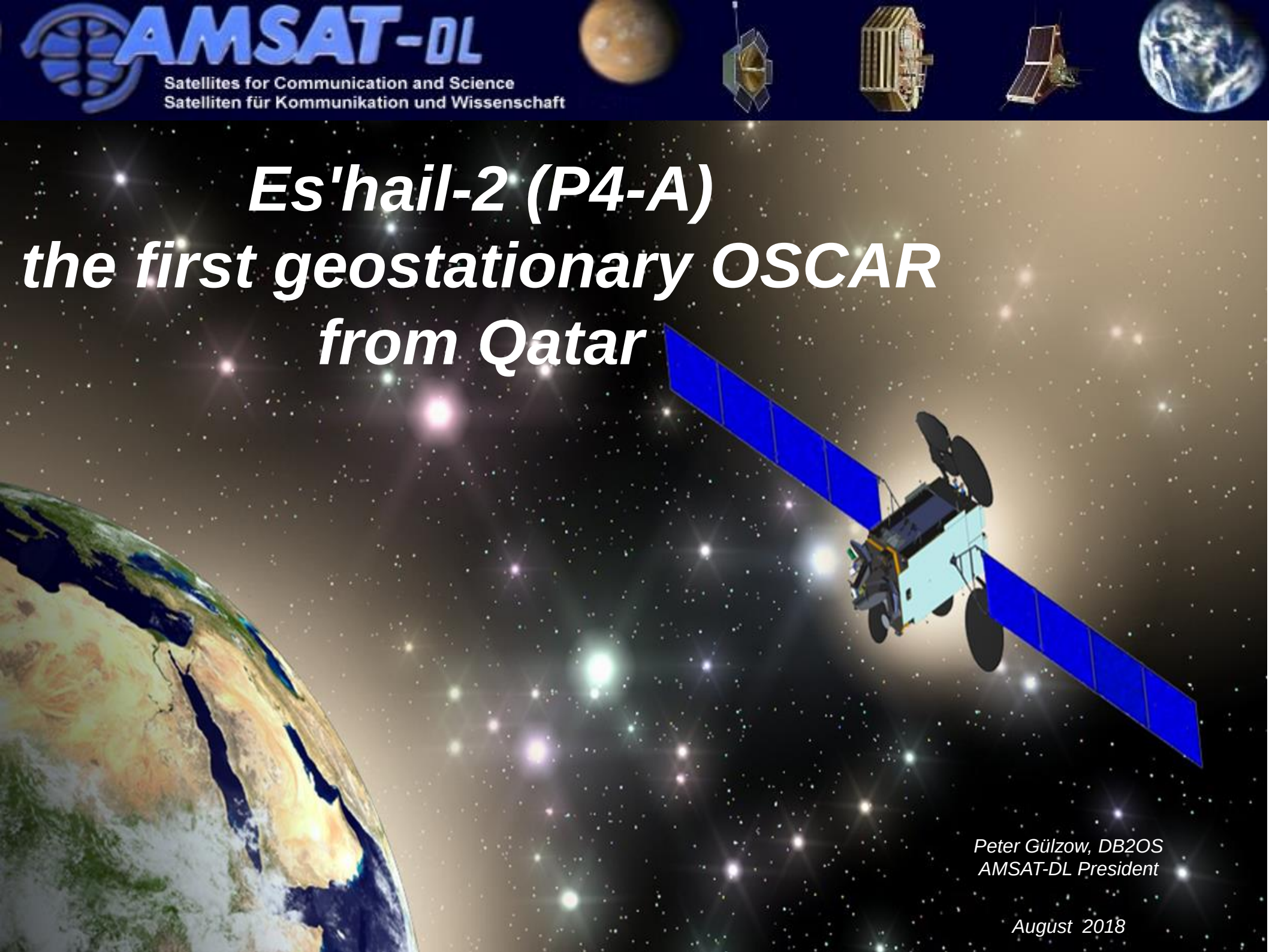
Satellites for Communication and Science
Satelliten für Kommunikation und Wissenschaft

# Es'hail-2 (P4-A) the first geostationary OSCAR from Qatar



*Peter Gülzow, DB2OS*
*AMSAT-DL President*

*August 2018*

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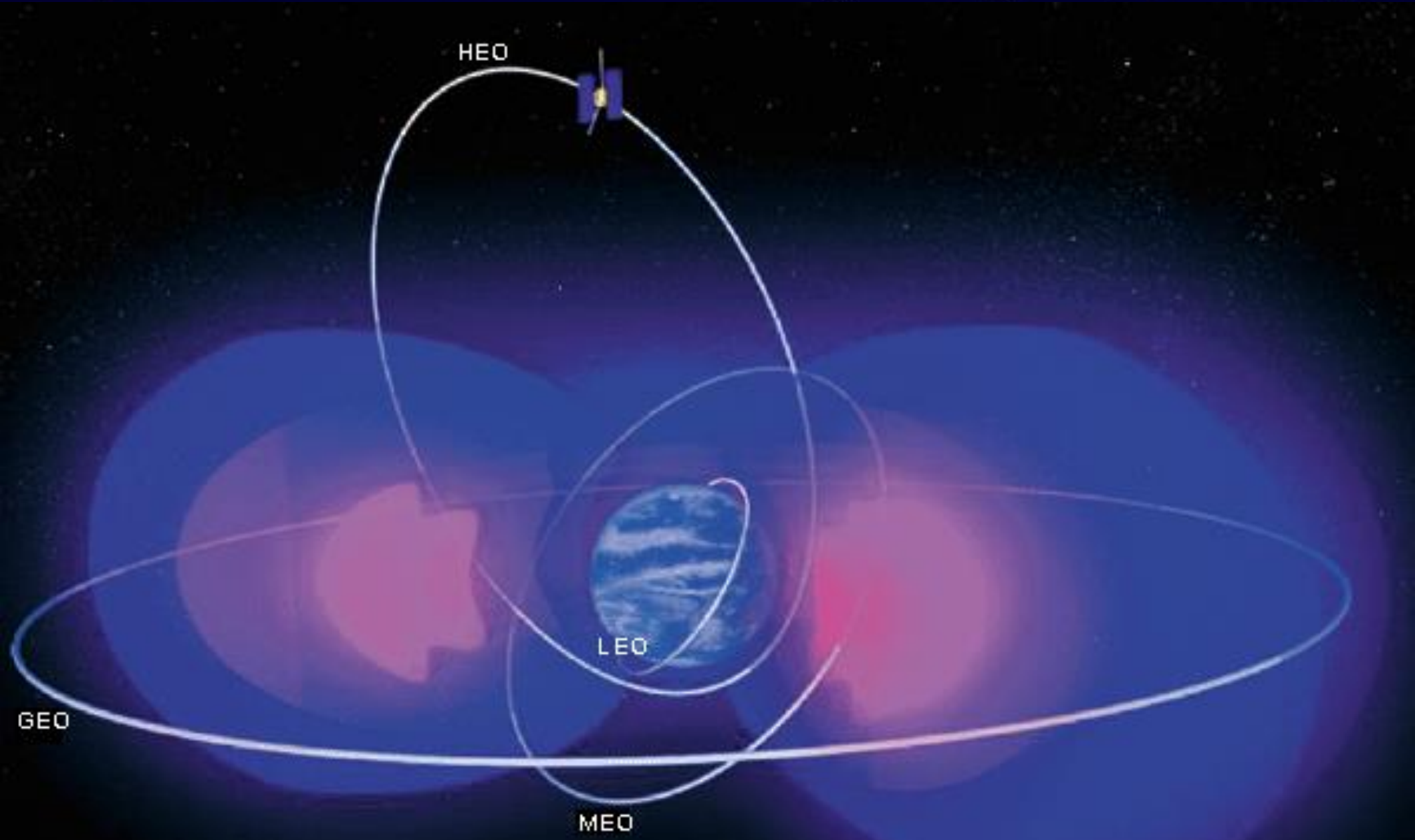


# *AMSAT Phase 4*

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**Hosted Amateur Radio Payload (AMSAT P4-A):**

- * S-Band uplink / X-Band downlink
- * Linear transponder (all modes)
- * 15 years lifetime

AMSAT-DL

Q.A.R.S.
QATAR AMATEUR RADIO SOCIETY

# Time line

*H E Abdullah bin Hamad Al Attiyah, Chairman of the Administrative Control and Transparency Authority, who is also the Chairman of the Qatar Amateur Radio Society (QARS) during the Qatar international amateur radio festival in December 2012.*

**2012 AMSAT-DL meets QARS**

(DB2OS @ International Amateur Radio Festival in Qatar)

**2013 Es'hailSat - Qatar Satellite Company**

(idea, concept, design requirements, RFI, meetings with potential suppliers, RFP, finalisiation of requirements)

**2016 Kick-Off at MELCO Japan**

(Technical presentations, Requirements review, Critical Design Review, Design Validation)

**2018 Launch with SpaceX Falcon 9**

# Satellites using DS2000 platform

MITSUBISHI ELECTRIC
Changes for the Better


| Satellite | Order | Launch | Launch Result | Launch Vehicle | Launch Mass |
|---|---|---|---|---|---|
| DRTS (Kodama) | N/A | 2002-09-10 | Success | H-2A-2024 | 2,800 kg (6,200 lb) |
| ETS-VIII (Kiku 8) | N/A | 2006-12-18 | Success | H-2A-204 | 5,800 kg (12,800 lb) |
| MTSAT-2 (Himawari 7) | 2000 | 2006-02-18 | Success | H-2A-2024 | 4,650 kg (10,250 lb) |
| Superbird-7 (Superbird-C2) | 2005 | 2008-08-14 | Success | Ariane 5 ECA | 4,820 kg (10,630 lb) |
| QZS-1 (Michibiki 1) | N/A | 2010-09-11 | Success | H-2A-202 | 4,100 kg (9,000 lb) |
| ST-2 | 2008 | 2011-05-20 | Success | Ariane 5 ECA | 5,090 kg (11,220 lb) |
| Himawari 8 | 2009 | 2014-10-07 | Success | H-2A-202 | 3,500 kg (7,700 lb) |
| Türksat 4A | 2011 | 2014-02-14 | Success | Proton-M/Briz-M | 4,850 kg (10,690 lb) |
| Türksat 4B | 2011 | 2015-10-16 | Success | Proton-M/Briz-M | 4,924 kg (10,856 lb) |
| Himawari 9 | 2009 | 2016-11-02 | Success | H-2A-202 | 3,500 kg (7,700 lb) |
| DSN-2 (Kirameki 2) | | 2017-01-24 | Success | H-2A-204 | |
| QZS-2 (Michibiki 2) | 2013 | 2017-06-01 | Success | H-2A-202 | 4,100 kg (9,000 lb) |
| QZS-3 (Michibiki 3) | 2013 | 2017-08-19 | Success | H-2A-204 | 4,100 kg (9,000 lb) |
| QZS-4 (Michibiki 4) | 2013 | 2017-10-09 | Success | H-2A-202 | 4,100 kg (9,000 lb) |
| Superbird-8 / DSN-1 | 2014 | 2018 | Planned 2018 | Ariane 5 ECA | N/A |
| Es'hail 2 | 2014 | 2018 | Planned 2018 | Falcon 9 Full Thrust | 3,000 kg (6,600 lb) |

# DS-2000 Platform Overview

- **Life:** 15+ yrs
- **Maximum Launch mass:** ~3,000 kg (3 – 5 tons class)
- **Launch Vehicle Compatibility:** Ariane-5, Proton Breeze M, Atlas, Falcon 9, H-IIA
- **Payload Heritage:** L, S, C, X, Ku and Ka frequency bands, 72 transponders (nominal)
- **EPS:** Electric Power Subsystem
  100v regulated bus, 12kW in sunlit and eclipse in maximum, automatic battery operation, 100-175Ah Li-Ion battery
- **SCS:** Satellite Control Subsystem
  Data handling of command/telemetry, satellite House-Keeping (battery, heater). MIL-STD-1553B processor and 64bit MPU (or HR5000) applied.
- **SPS:** Solar Power Subsystem
  12-13 kW total power generation (GaAs cells).
- **TC&R**: Telemetry Command and Ranging
  Maximum 4 command telemetry units. Standard bit rate 7.68 kbps for TLM, 500 bps for CMD. TLM, CMD and RNG operated simultaneously. Auto/variable heater control.
- **BPS:** Bi-Propellant Subsystem
  Fuel (MMH) and Oxygen (MON-3) Bipropellant, 1 Apogee Kick Motor + 12 Thrusters, Ion engine available on request.
- **AOCS:** Attitude and Orbit Control Subsystem
  Uses 4-skewed reaction wheel; standard highly accurate attitude control by with 0.03deg for three axis.

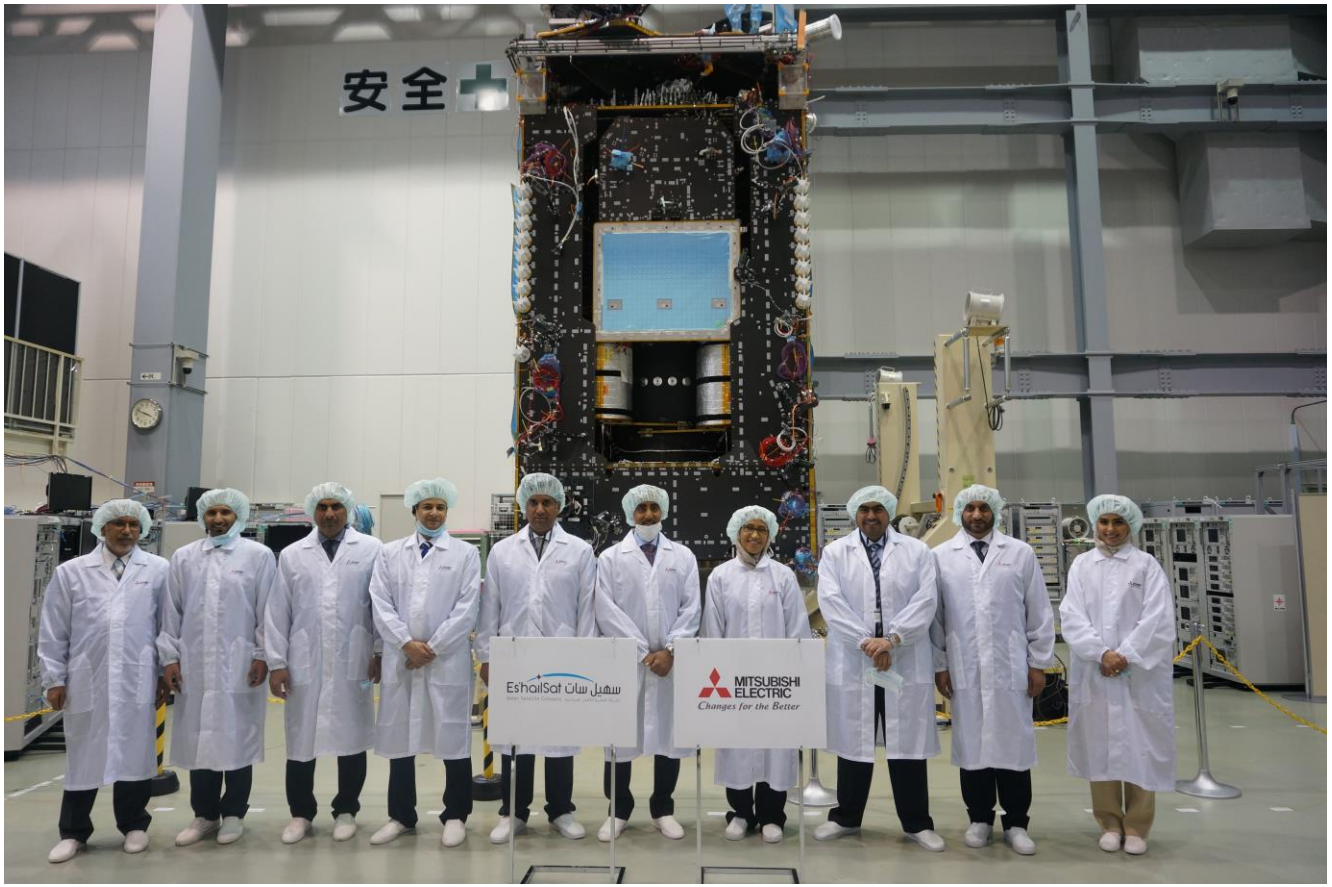
# Es'hail-2 status

Es'hail-2 successfully passed critical design review (CDR)

Environmental testing includes:

- Thermal vacuum
- Vibration
- …

Launch is planned for 2018 with SpaceX (Falcon 9) from Cape Canaveral.




*Executives from Qatar's Es'hailSat and Japan's Mitsubishi Electric Space Systems (MELCO) in Kamakura, outside of Tokyo, Japan, to observe the vacuum chamber test of Es'hail-2. Photograph courtesy of Es'hailSat, June 2016.*

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# The earth as seen by Es'hail-2


Es'hailSat سهيل سات
Qatar Satellite Company الشركة القطرية للأقمار الصناعية

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QATAR AMATEUR RADIO SOCIETY
الجمعية القطرية لهواة الراديو

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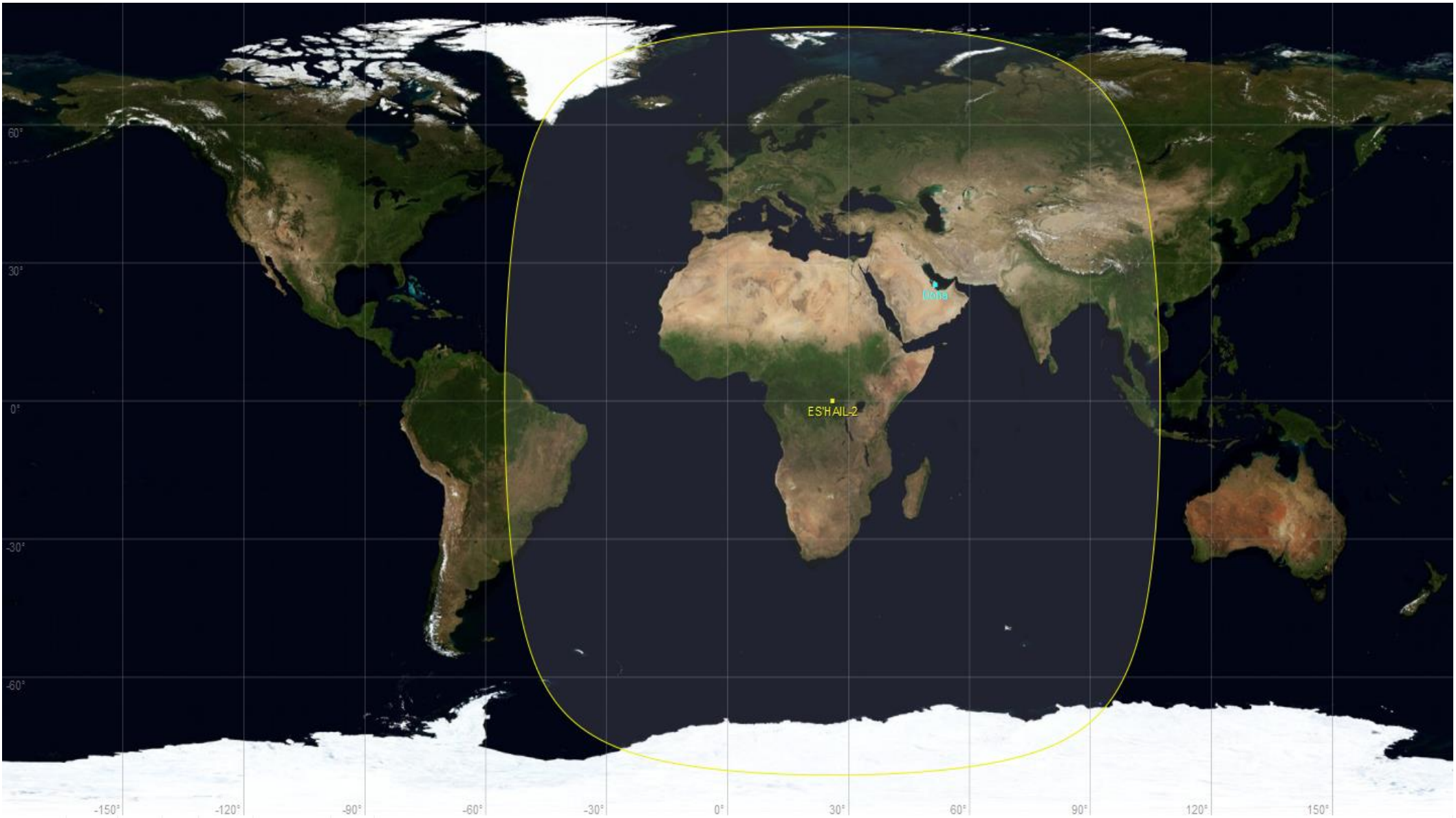
Satelliten für Kommunikation und Wissenschaft

# Earth Coverage Es'hail-2



# Bochum

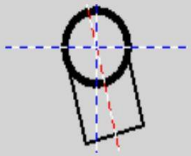
**Your location:**

Latitude:
**51.48° N (51° 28' 47")**

Longitude:
**7.22° E (7° 13' 11")**

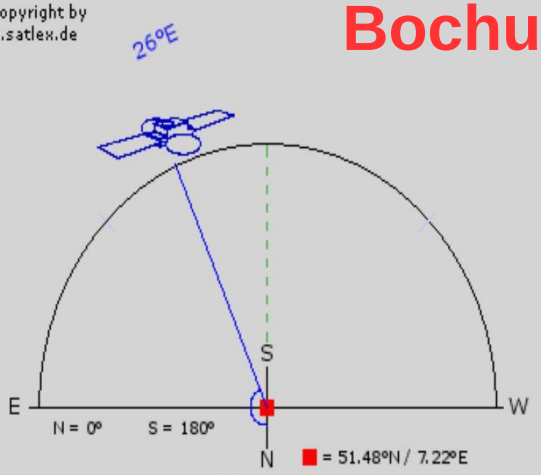
City:
**Bochum**

Country:
**Germany**



LNB tilt (Skew)






Azimuth angle

**Following values have been calculated for your location:**

Azimuth angle:
**156.51°** *(True North)*

Elevation angle:
**28.55°**

LNB tilt (Skew):
**-14.37°**

Offset angle:
**20.36°**

Distance to satellite:
**38747.37 Km**

Signal delay:
**258.32 ms** *(Uplink + Downlink)*

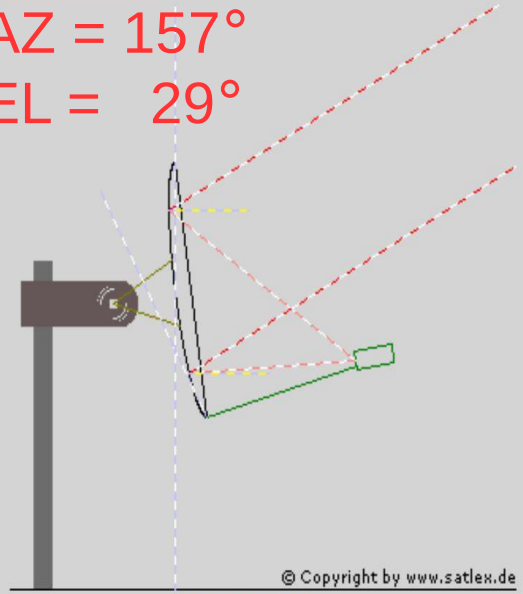
Declination angle:
**-7.34°**

Polarmount hour angle:
**159.33°**

Angle setting on motor:
**20.67° East**

Satellite:
**Badr 4/5/6 (26° E = 334° W)**

AZ = 157°
EL = 29°





Elevation angle

# Doha

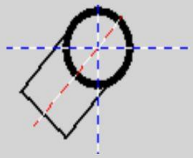
**Your location:**

Latitude:
**25.25° N (25° 15' 0")**

Longitude:
**51.60° E (51° 36' 0")**

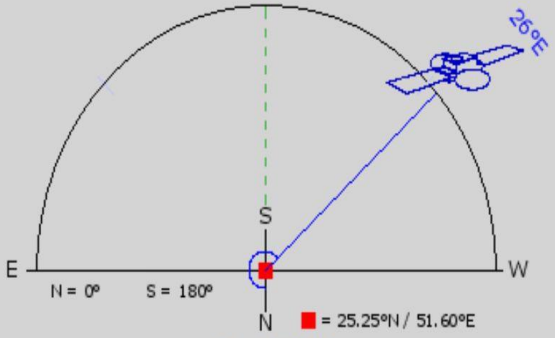
City:
**Doha**

Country:
**Qatar**



LNB tilt (Skew)






Azimuth angle

**Following values have been calculated for your location:**

Azimuth angle:
**228.32°** *(True North)*

Elevation angle:
**48.98°**

LNB tilt (Skew):
**42.49°**

Offset angle:
**20.36°**

Distance to satellite:
**37145.43 Km**

Signal delay:
**247.64 ms** *(Uplink + Downlink)*

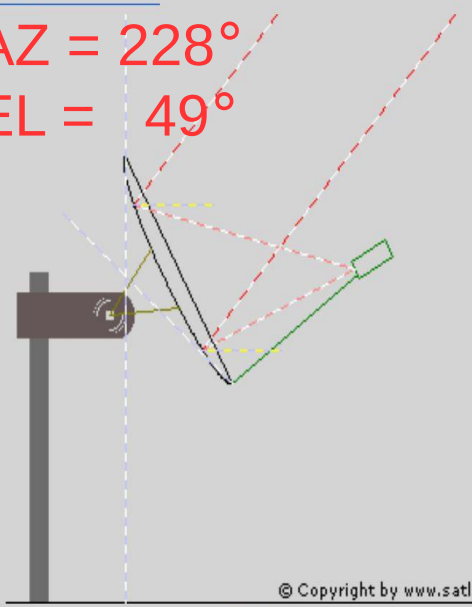
Declination angle:
**-4.18°**

Polarmount hour angle:
**209.44°**

Angle setting on motor:
**29.44° West**

Satellite:
**Badr 4/5/6 (26° E = 334° W)**

AZ = 228°
EL = 49°





Elevation angle

# Rio de Janeiro

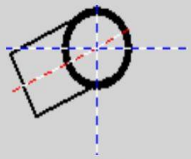
**Your location:**

Latitude:
**-22.90° N (22° 53' 59")**

Longitude:
**-43.23° E (43° 13' 47")**

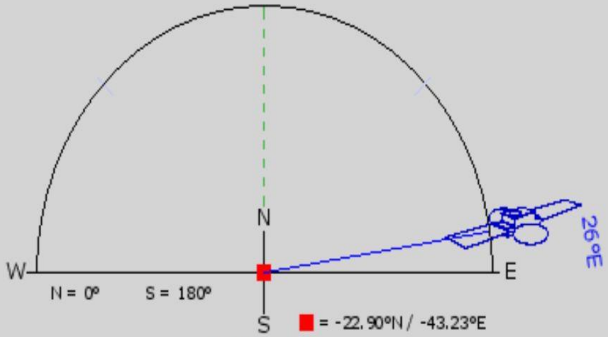
City:
**Rio De Janeiro**

Country:
**Brazil**



LNB tilt (Skew)






Azimuth angle

**Following values have been calculated for your location:**

Azimuth angle:
**81.60°** *(True North)*

Elevation angle:
**10.61°**

LNB tilt (Skew):
**65.69°**

Offset angle:
**20.36°**

Distance to satellite:
**40531.41 Km**

Signal delay:
**270.21 ms** *(Uplink + Downlink)*

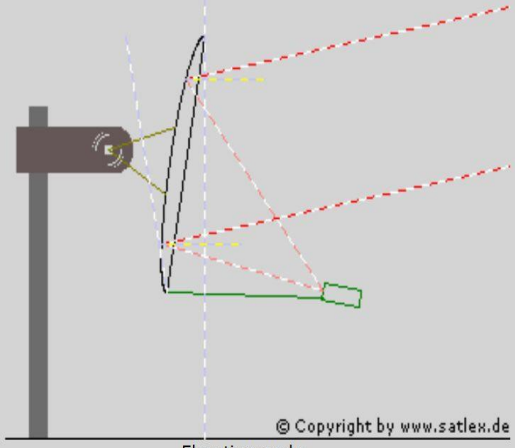
Declination angle:
**3.48°**

Polarmount hour angle:
**76.94°**

Angle setting on motor:
**103.06° East**

Satellite:
**Badr 4/5/6 (26° E = 334° W)**

AZ = 82°
EL = 11°




Elevation angle

# Penang

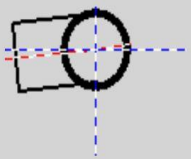
**Your location:**

Latitude:
**5.50° N (5° 30' 0")**

Longitude:
**100.46° E (100° 27' 35")**

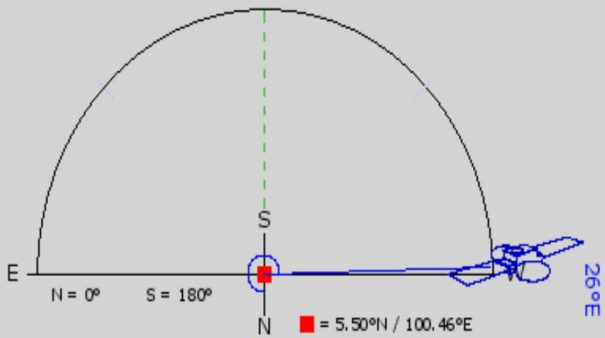
City:
**Pinang**

Country:
**Malaysia**



LNB tilt (Skew)






Azimuth angle

**Following values have been calculated for your location:**

Azimuth angle:
**268.47°** *(True North)*

Elevation angle:
**6.95°**

LNB tilt (Skew):
**84.29°**

Offset angle:
**20.36°**

Distance to satellite:
**40927.52 Km**

Signal delay:
**272.85 ms** *(Uplink + Downlink)*

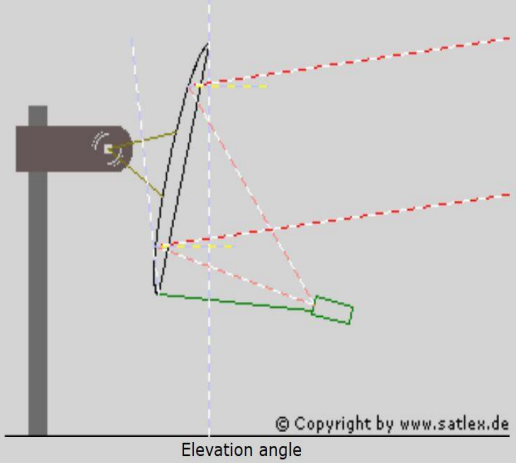
Declination angle:
**-0.85°**

Polarmount hour angle:
**262.93°**

Angle setting on motor:
**82.93° West**

Satellite:
**Badr 4/5/6 (26° E = 334° W)**

AZ = 268°
EL = 7°




Elevation angle

# The International Amateur Radio Union

**Since 1925, the Federation of National Amateur Radio Societies**
**Representing the Interests of Two-Way Amateur Radio Communication**

IARU Amateur Satellite Frequency Coordination

Back to List of Sats whose Frequencies have been coordinated

| | | | | |
|---|---|---|---|---|
| **Es'hail-2** | **Updated: 30 Jul 2018** | | **Responsible Operator** | **Majid AlNaimi A71A** |
| Supporting Organisation | Es'hailSat | | | |
| Contact Person | malnaimi@eshailsat.qa.nospam | | | |

**Headline Details:** Es hail-2 is a commercial geostationary broadcasting satellite which will also provide the first amateur radio Phase 4 transponders. The satellite will be positioned at 26 degrees east. Es hail-2 will carry two transponders operating in the 2400 MHz and 10450 MHz bands. A 250kHz bandwidth linear transponder intended for conventional analogue operations and an 8 MHz bandwidth transponder for experimental digital modulation schemes and DVB amateur television. ** The following frequencies have been coordinated: for narrowband linear transponder • downlink 10489.550 - 10489.800 MHz with 100 Watts output power • uplink 2400.050 - 2400.300 MHz for wideband digital transponder • downlink 10491.000 - 10499.000 MHz with 100 Watts output power • uplink 2401.500 - 2409.500 MHz **

| | | | |
|---|---|---|---|
| Application Date: | 28 May 2018 | Freq coordination completed on | 30 Jul 2018 |

The IARU Amateur Satellite Frequency Coordination Status pages are hosted by AMSAT-UK as a service to the world wide Amateur Satellite Community

# “NB” Transponder (narrow band)

*Linear Transponder for low power narrow bandwidth voice, morse and digital communication*

- preferred modes: narrow band modes like SSB and CW, PSK

- 250 kHz allocated bandwidth

- non-inverting bent-pipe transponder

- Assumes 50 simultaneous 2-way carriers to serve 100 Users

- X-Band Downlink (SAT-TV dish):
  - 90 cm dishes in rainy areas at EOC like Brazil or Thailand
  - 60 cm around around coverage peak
  - 75 cm dishes at peak -2dB

- Downlink Polarisation on X-Band is Vertical !

- Uplink Polarisation on S-Band is RHCP
- Uplink transmitter 5-10W PEP (22.5 dBi antenna gain, 75cm dish)

# “WB” Transponder (wide band)

*Linear Transponder for Digital Amateur Television (DATV) and other highspeed data transmissions.*

**First DATV transponder in space!!**

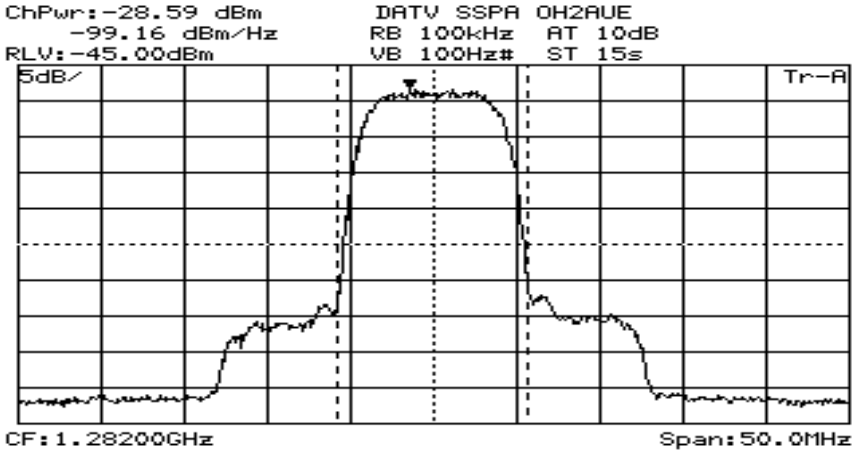
- 8 MHz bandwidth
- one or two DVB-S2 carrier in HD quality or more channels with SD or lower quality

- assumes S-Band Uplink peak EIRP of 53 dBW (100W PEP into 2.4m dish)

- X-Band Downlink (SAT-TV dish):
  - 90 cm dishes in rainy areas at EOC like Brazil or Thailand
  - 60 cm around around coverage peak
  - 75 cm dishes at peak -2dB

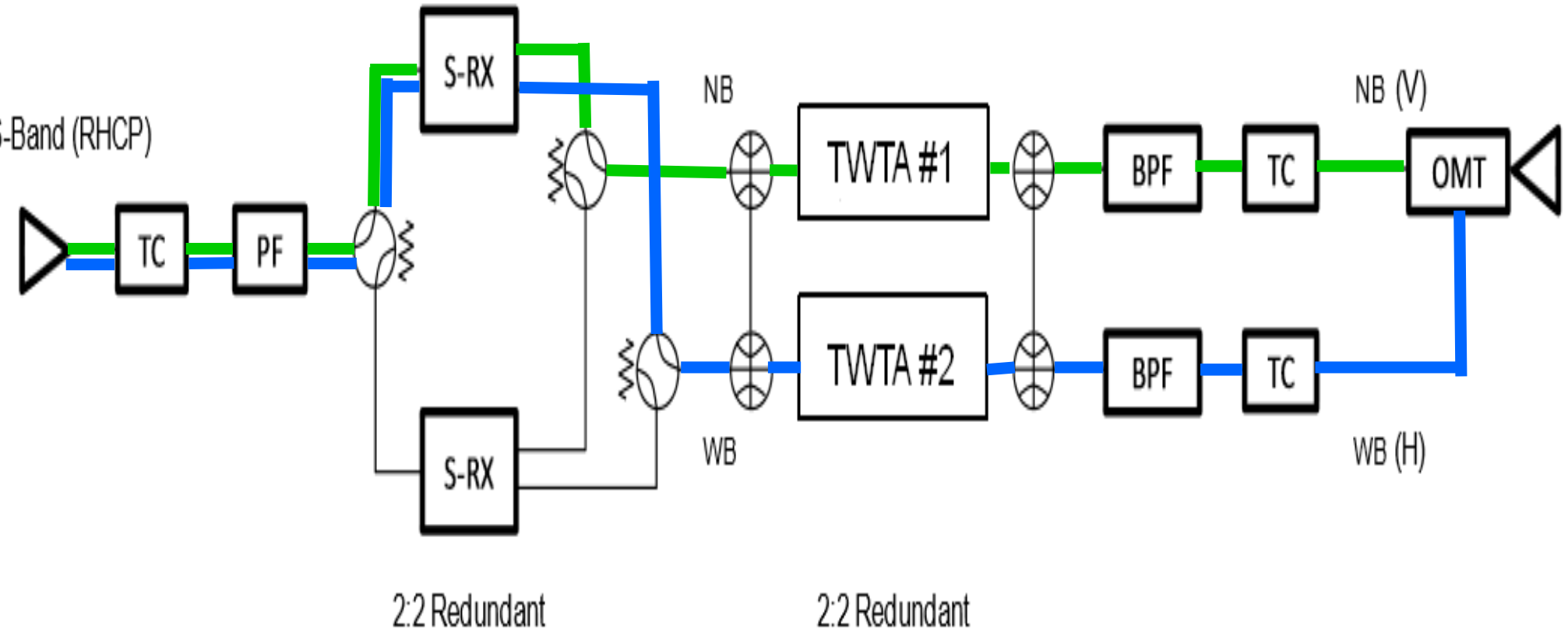
- Uplink Polarisation on S-Band is RHCP
- Downlink Polarisation on X-Band is Horizontal !

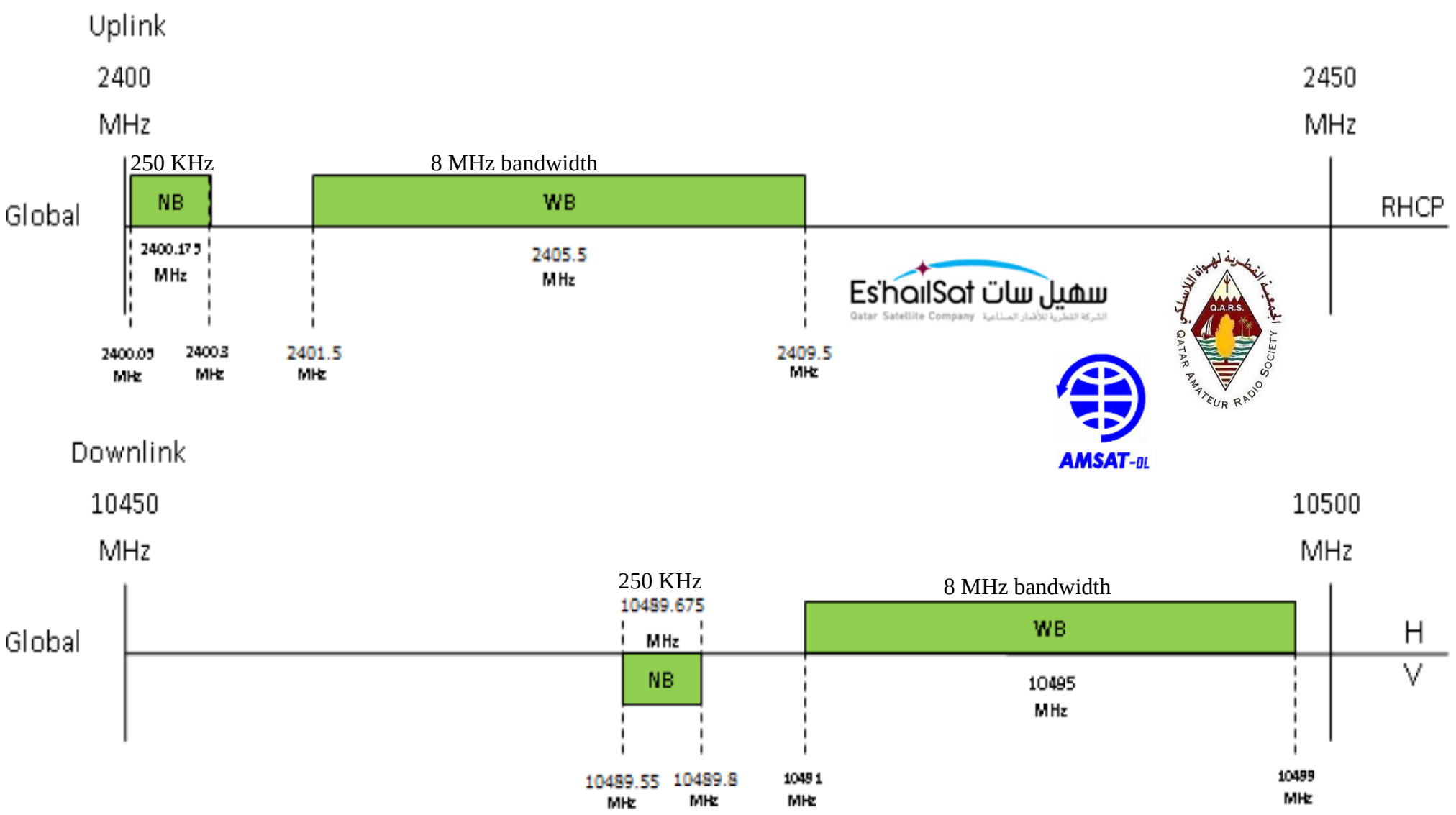
- DVB-S2 “beacon” from Qatar is planned with
  Live WebCam and promotional videos for
  Ham radio activities, visualisation, etc.




- RF Bandwidth = 1.33 x Symbol-Rate = 1.33 x 2.5 MSymbols/sec = 3.33 MHz signal

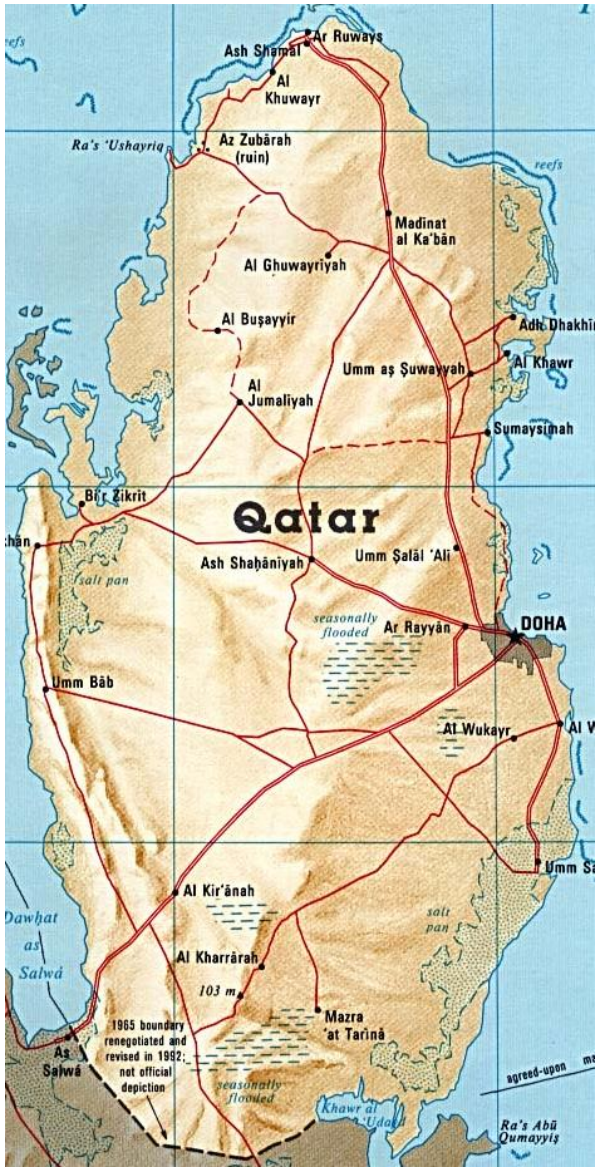
# AMSAT Payload Block Diagram






| 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 |

# Es'hailSat Satellite Control Center





# AMSAT-DL HQ Bochum

- 3m antenna for 2.4 GHz Uplink with VE4MA septum feed
- 2.5m antenna for 10 GHz Downlink
- 20m dish available for emergency operations

# AMSAT Ground Segment

Located at the Es'hailSat Satellite Control Center (SCC) near Doha in 'shelter' close to main Es'Hail 2 SCC uplink/downlink antennas

- unattended operations, but remote access to tweak LEILA-2 parameters shall be possible.

- 2.4 Meter dedicated Uplink antenna for AMSAT on S-Band

- In-Orbit-Verification and Monitoring of the AMSAT transponder with FFT passband (NB+WB) displays for quick assessment of situation.

- LEILA-2 (LEIstungs Limit Anzeige) will analyse passband of NB transponder and send Marker tones on all stations which use too much uplink power.

- LEILA-2 will generate pseudobeacon(s) and add them to the uplink signal (400 Bit/s PSK Telemetry with FEC). Telemetry will be derived from Es'hail-2 telementry.

- Hamradio shack equipped with SSB equipment for Voice and with DVB-S equipment for DATV transmissions directly from Doha.

- Backup station for LEILA will be located at QARS HQ and in Bochum at AMSAT-DL HQ

# Pseudobeacon

* A beacon signal to enable users a signal reference (frequency and level) to orient themself

* A beacon generated on ground, not inside spacecraft

* Same flight-proven Phase 3 format, 400 bit/s BPSK telemetry with FEC

* Pseudobeacons at both ends of the Passband (transmissions outside are not permitted)

# LEILA

**LEILA** is an german acronym for *"**LEIstungs Limit Anzeige**"*, which means: Power Limit Indicator.

The original concept of an hybrid analog/digital LEILA on AO-40 was developed by Dr. Karl Meinzer DJ4ZC and Dr. Matjaz Vidmar S53MV. It was the first time that such a system was used as part of an transponder with ***uncoordinated multiple access***.

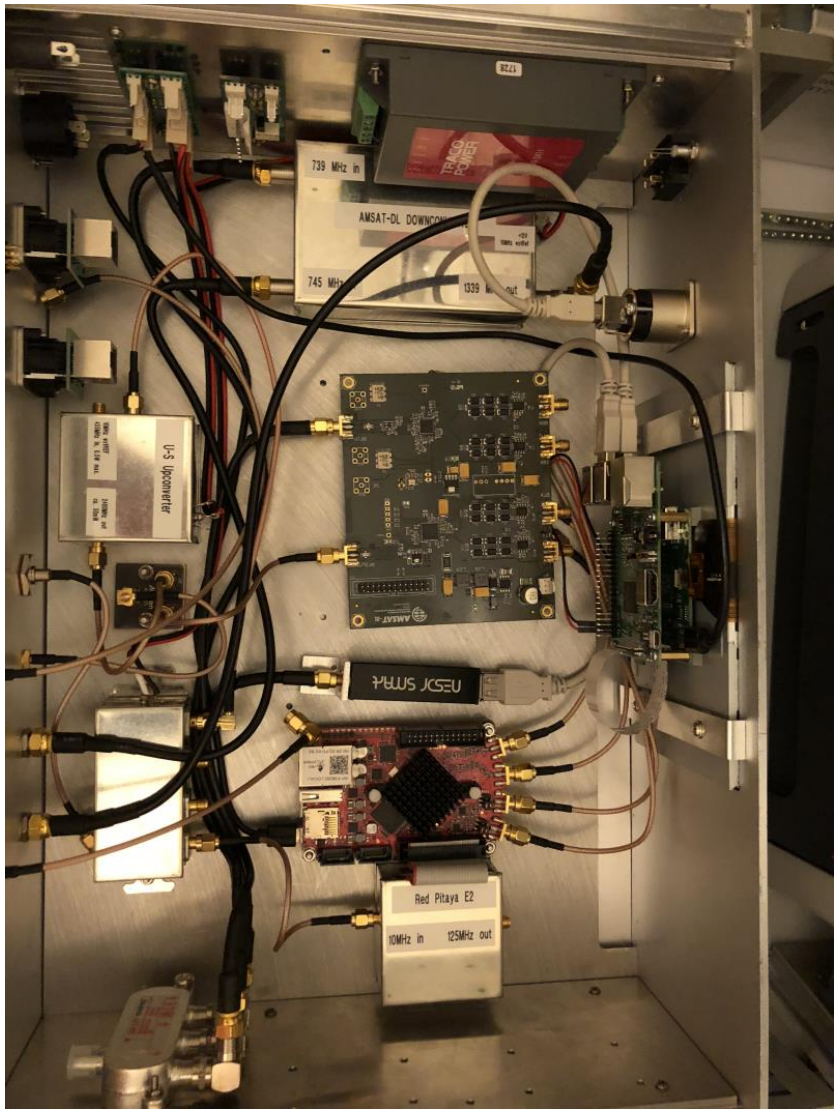
LEILA on P4-A is ***ground-based !!***

- Siren marker (sufficient if operators work full duplex)
- Notch filter not possible

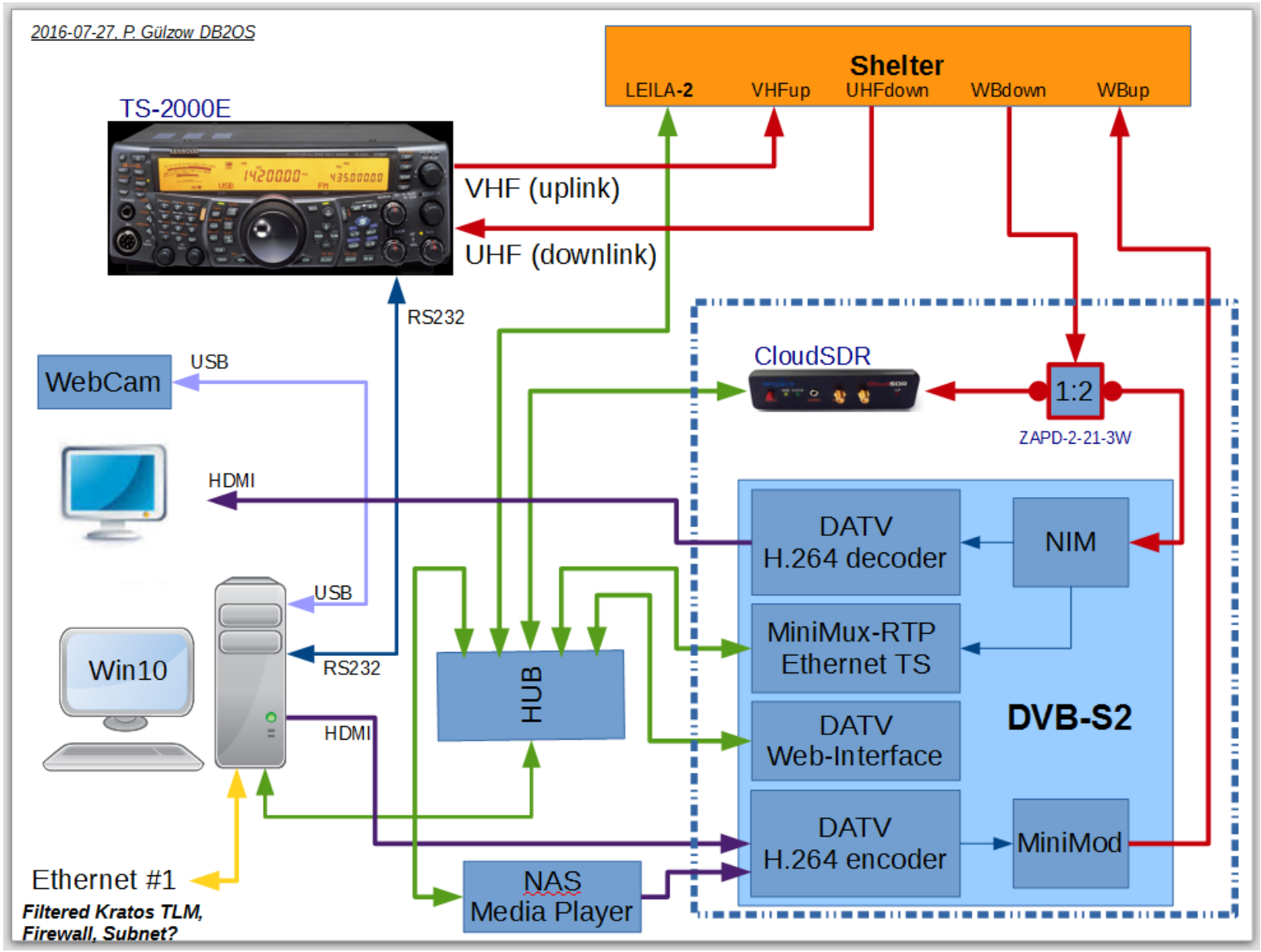
# LEILA-2

redpitaya

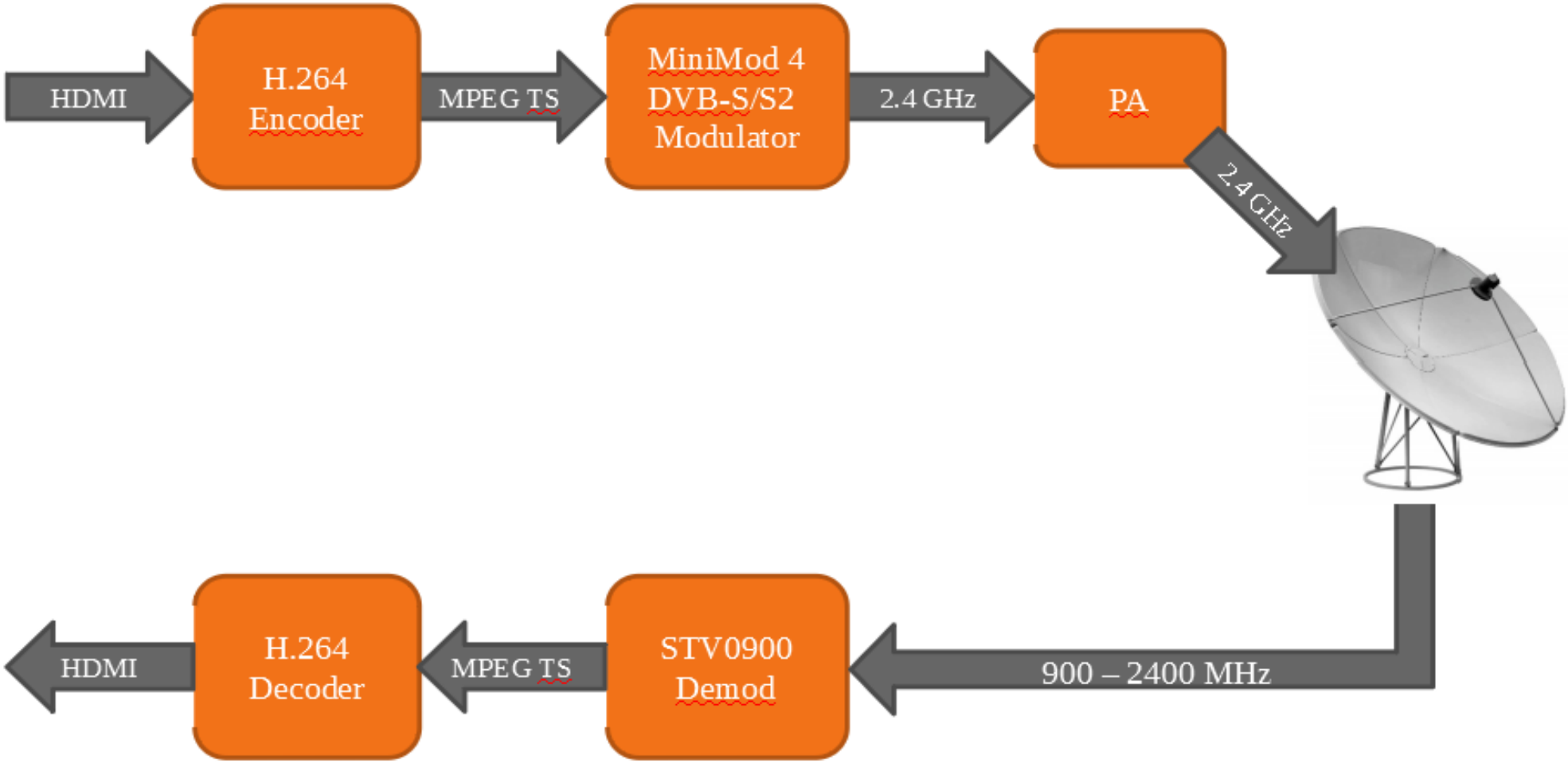
- Analyzing the NB transponder passband (FFT) and generating individual siren markers.
- Encoding (FEC) and generation of pseudobeacons at upper and lower passband limit,
- Up-/downconversion boards developed by AMSAT-DL/UK (G6LVB, DH2VA).
- will be installed at Es‘hailSat SCC, QARS backup and in Bochum at AMSAT-DL.



# SCC Radio Shack



# DATV - Video


HDMI
H.264 Encoder
MPEG TS
MiniMod 4 DVB-S/S2 Modulator
2.4 GHz
PA
2.4 GHz
900 – 2400 MHz
STV0900 Demod
MPEG TS
H.264 Decoder
HDMI

Advantech Wireless

# What is DVB-S2 ?

- **New DVB standard for digitial satellite communications**
- **Meant to replace DVB-S & DVB-DSNG**
- **Much better spectral efficiency**
  - –Up to 30% bandwidth saving
  - –Up to 2.5 dB margin gain
- New features such as
  - –Variable and Adaptive Coding and Modulation
  - –Generic Mode (no transport stream overhead)
  - –Support of multiple streams on a single carrier
- So close to the Shannon limit that it could be the last DVB-S standard!

# DATV transponder (WB)

DVB-S2

DVB-S2

HD Video + Audio QSO
(maybe even Full Duplex)

Data Broadcast

DATV Beacon
„Promo Video“

HW: DG8FAC (SR-Systems), DG0VE
SW: DG5NGI, DG2NDK, Matthias Kleffel,
Bastian Euler and more (maintech)

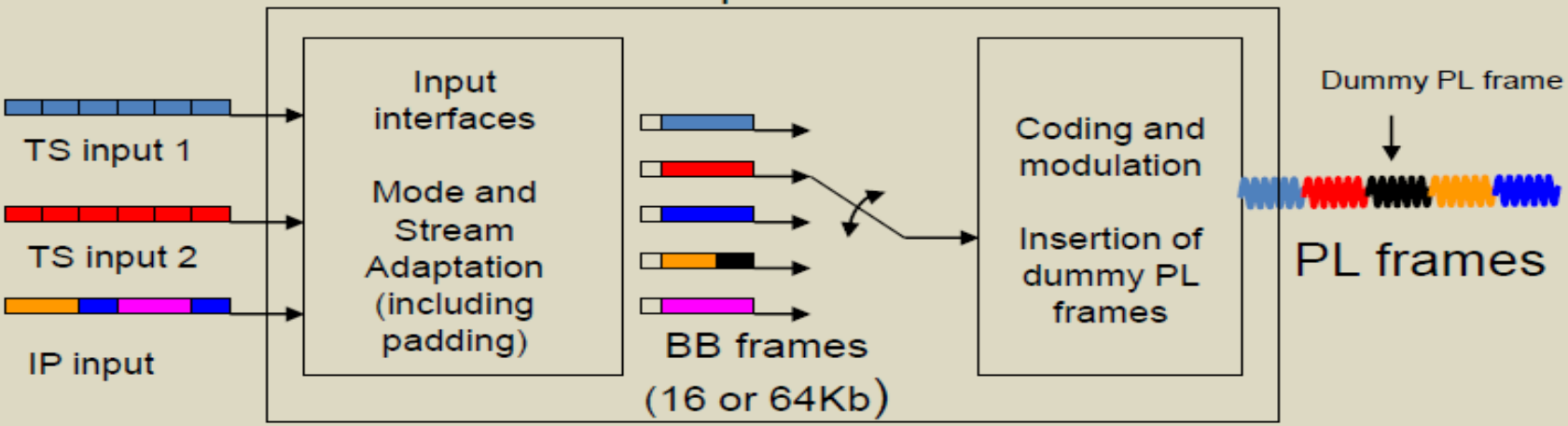
Bochum

Doha

Advantech Wireless

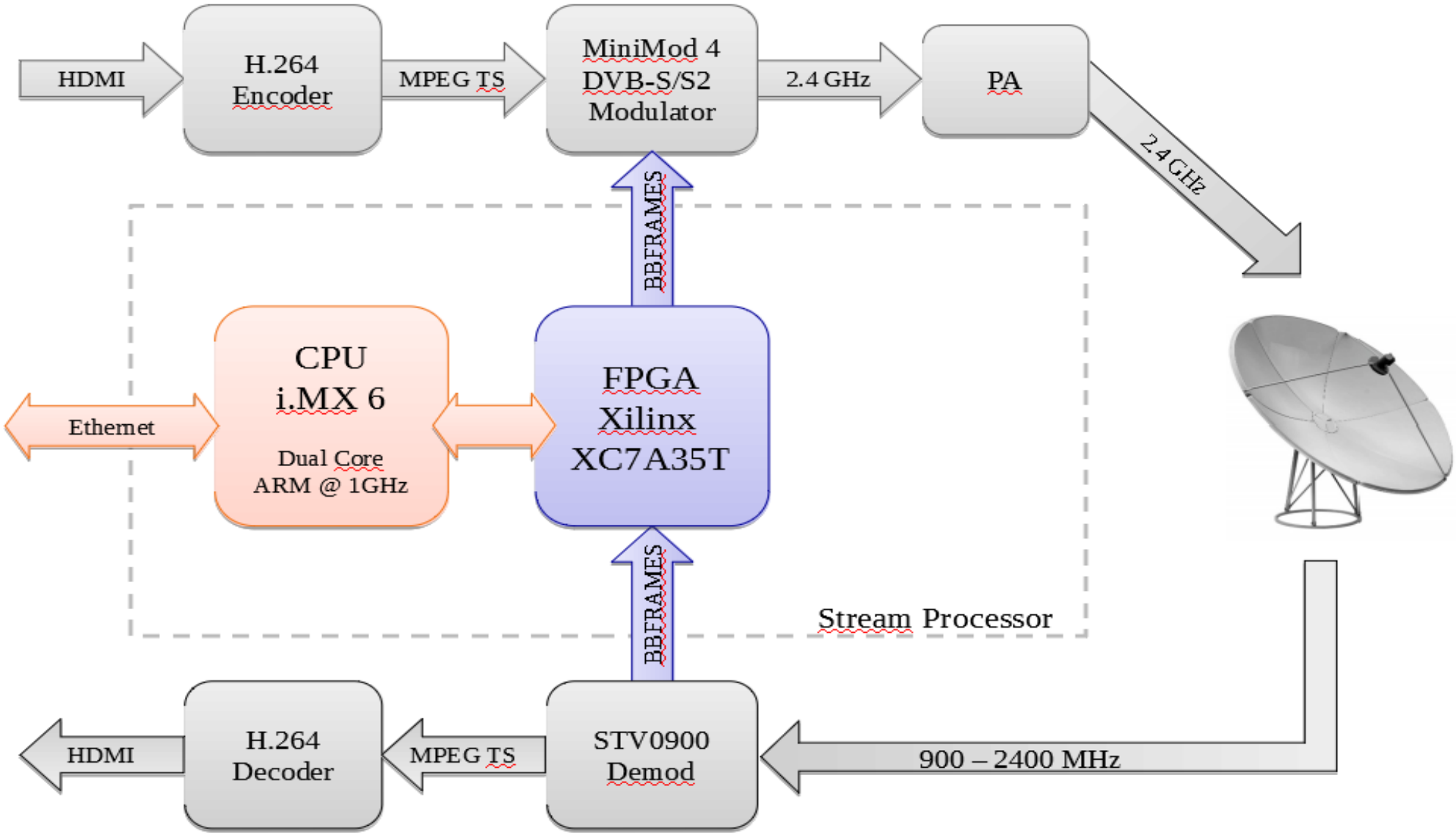
# Multiple streams on single carrier (CCM-VCM-ACM)

- A DVB-S2 modulator can have several physical or logical inputs:




- The data of each each input is processed in separated Base Band frames.
- The BB frames are time-multiplexed at the Physical Layer on the same carrier (no TS multiplexing)
- When no data is present the modulator can pad incomplete BB frames or insert dummy PL frames
- Demodulators can receive and decode individual streams independently from the other streams

# DATV - Data


HDMI
H.264 Encoder
MPEG TS
MiniMod 4 DVB-S/S2 Modulator
2.4 GHz
PA
2.4 GHz
BBFRAMES
CPU i.MX 6
Dual Core ARM @ 1GHz
Ethernet
FPGA Xilinx XC7A35T
BBFRAMES
Stream Processor
HDMI
H.264 Decoder
MPEG TS
STV0900 Demod
900 – 2400 MHz

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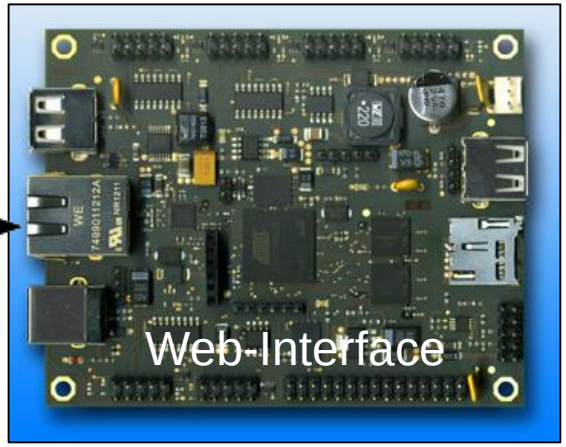
# DATV - Groundstation

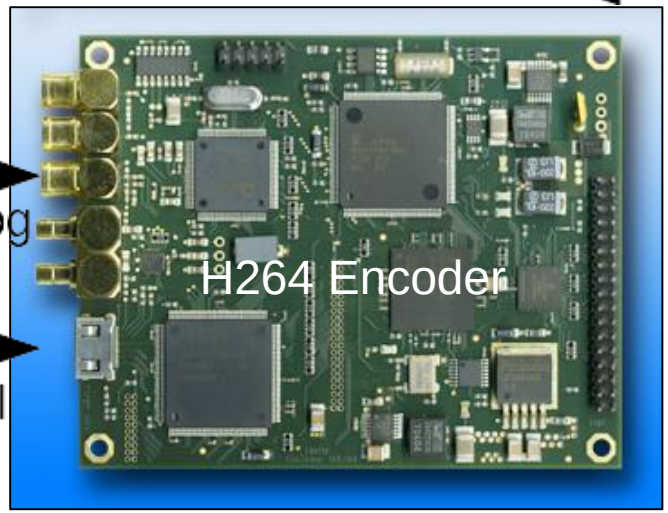

Analog

HDMI


RF-out: -35 … 0 dBm




Ethernet


Analog

HDMI

RF-in: 950…2150 MHz


RF OUT
ETH BRIDGE
SERVICE BRIDGE
SERVICE WEB
ETH WEB
RF IN
POWER

Rear Panel

N-Buchse
NE8FDP
LEMO
LEMO
NE8FDP
N-Buchse
NL2MP

Power Amplifier

DVB MiniMod 4
DVB-S/S2 Modulator

WEB-IF
User Interface Controller

POWER SPLITTER

DVB-S/S2 DUAL NIM

PWR DIST

i.MX6 Stream Processor
Linux based Ethernet Bridge

H.264 Encoder
HDMI HD video encoder

H.264 MPEG2 Decoder
HDMI HD video decoder

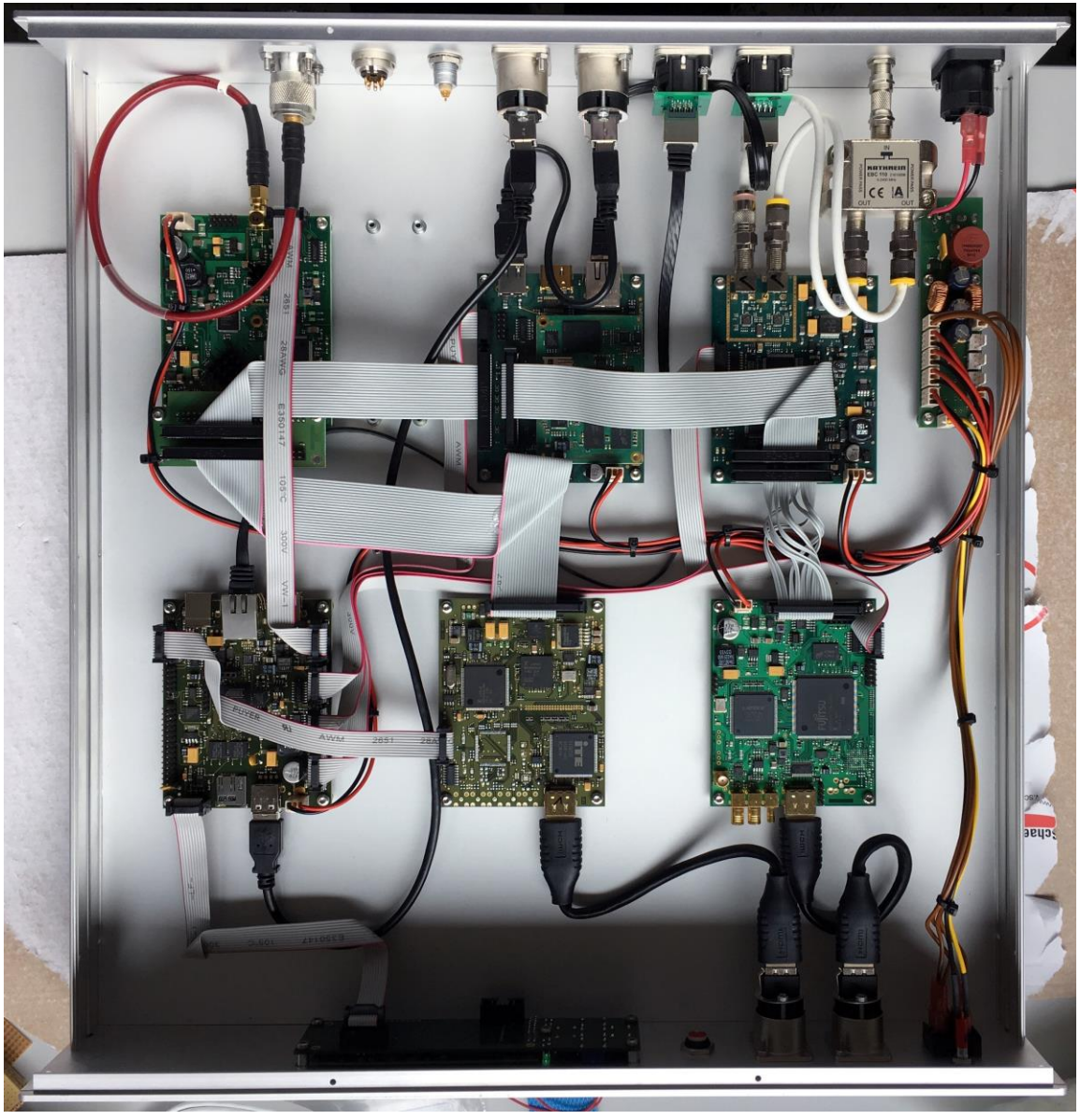
Front Panel

DISPLAY / KEYPAD

NAHDMI-W
HDMI IN

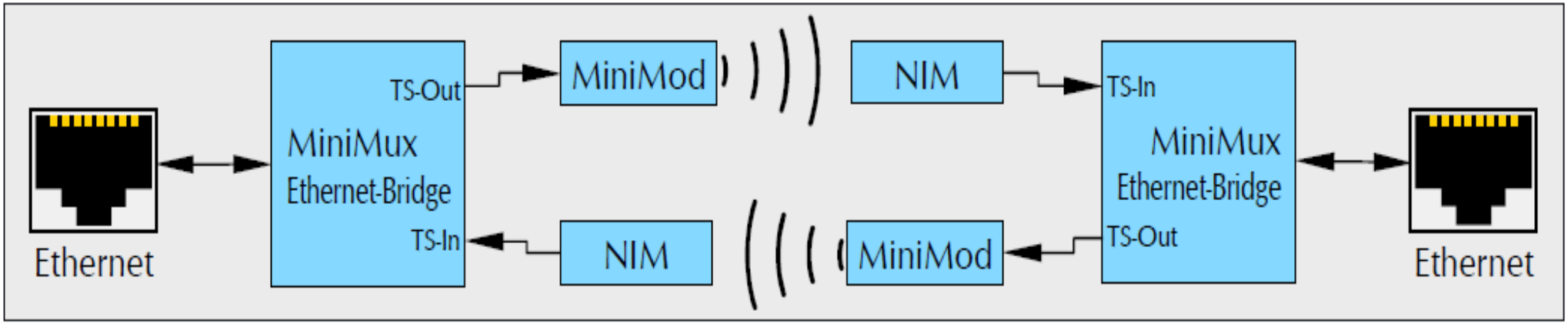
NAHDMI-W
HDMI OUT

# DATV - Groundstation



# DATV - Groundstation


# Ethernet-Bridge (Ethernet over DVB)

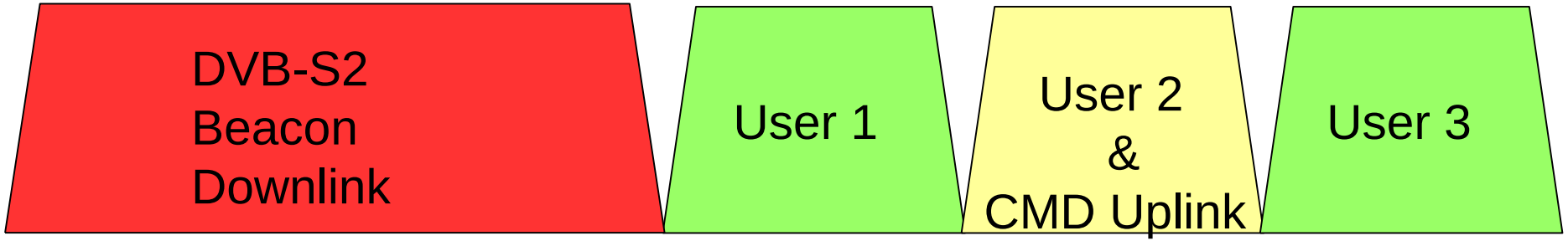



Unless only broadcast packets are sent, Ethernet bridging requires a full bidirectional link.

* Ethernet-Link
* Multiplexing with Video/Audio is possible
* Broadcast UDP
* full bidirectional link possible
* up to 30 Mbit/s

* 4 Uplinks possible when using Mux4 ??

# DATV Bandplan (draft)




**8 MHz**

Beacon: 2403,000 MHz, 2.4 Msym (BW=3 MHz, DVB-S2)
User 1: 2405,350 MHz, 1.2 Msym (DVB-S2 or DVB-S)
User 2: 2407,000 MHz (see User 1 and Command Uplink)
User 3: 2408,700 MHz (see User 1)

User DVB-S2: 8PSK with 2/3 FEC, BW = 1.5 MHz
User DVB-S: QPSK with 7/8 FEC, BW = 1.62 MHz

Cmd Uplink: 1.2 Msym / 3.6 Msym, ~ 9,3 Mbit Data

# BATC Involvement

- AMSAT-DL requested BATC help to manage and develop WB transponder use
- Hub of experimental DATV experience seems to centre on UK

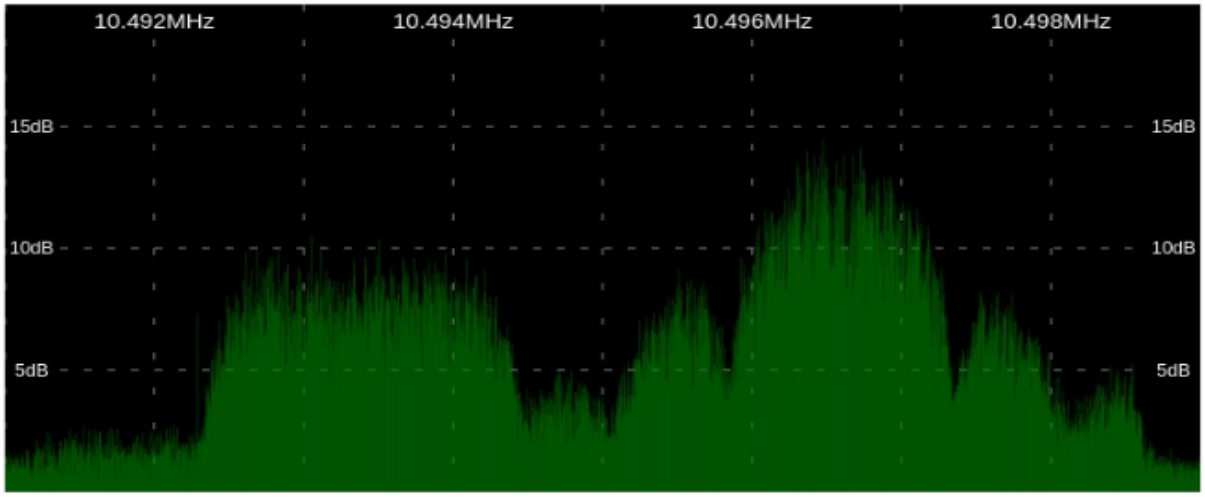
# Choice and Co-ordination

- Easiest mode to start with is “standard” DVB-S QPSK DATV at 2 or 4 Msymbols/Sec 1/2 FEC
- But we should encourage and allow experimentation as well as the standard QSO operation
- DATV receivers need to know basic info about the signal they are receiving
  - Modulation, symbol rate and possibly FEC
- With so many modes and bandwidth combinations possible simultaneously we need co-ordination
- BATC is working with AMSAT-DL to produce a web-based monitor and analysis tool
  - Without it, it just won’t work!
  - Will include a chat window for questions


# Proposed Web-based Spectrum Monitor

file:///home/phil/Projects/websocket-fft/index.html

## Es'hailSat Spectrum Monitor




**Users currently monitoring the spectrum: 1**

23/07/2016

19:05 **Phil_M0DNY**
Hello!

19:05 **Phil_M0DNY**
*World!

Type '/nick your_name' and press enter to join.

# Possible Frequency Plan

- A basic frequency / usage plan will help co-ordination - for example:
- 10,491 – 10,493 MHz = Reduced bandwidth TV
  - Up to 4 channels
- 10,493 – 10,495 MHz = IP based & experimental
  - Multiple channels depending on config
- 10,495 – 10,499 MHz = DVB channel
  - 2 * 2 MHz SD or 1 * 4 MHz HD
  - 1 * 8 MHz for super HD
- Usage can be varied on day to day basis

# Uplink Power Budget

- Starting point is that an 8 MHz of DVB-S2 transmission will require 100W into a 2.4m dish

| 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 |

Credit M0DTS

# Cheap Equipment

DATV DVB-S2 Equipment for Downlink:

- Most consumer DVB-S2 set top boxes shall “work out of the box”

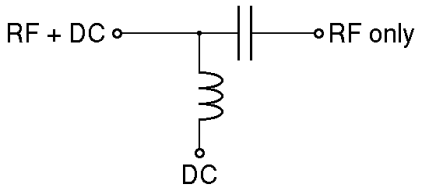
Dongles for NB Downlink:

- RTLSDR or Funcube dongle
- free SDR software available

# Easy Sat !
# Ultra Cheap

20€

12€




35€


Display Spectrum and listen with SDR# or similiar…

NB → (V)ertical: 11…14 V
WB → (H)orizontal: 16…20 V

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# Easy Sat !

20€

12€

H V

NB → (V)ertical: 11…14 V
WB → (H)orizontal: 16…20 V

150€

145 MHz

0€

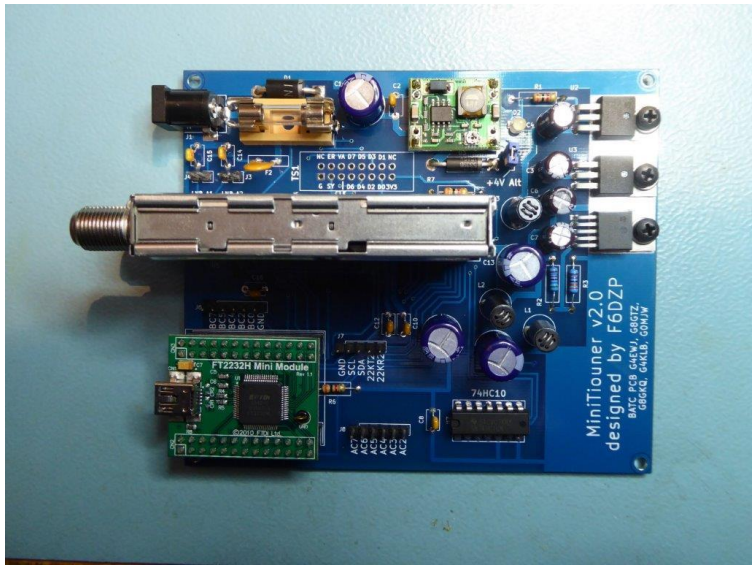
Existing 2m/VHF Transceiver

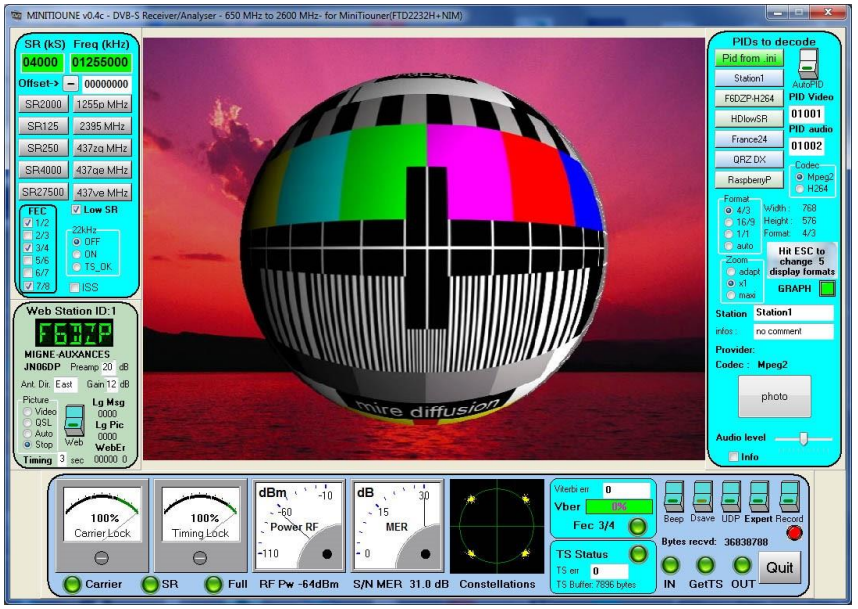
1339 MHz

40€

Universal Down-Converter for P4-A
Achim Vollhardt, DH2VA

# MiniTioune



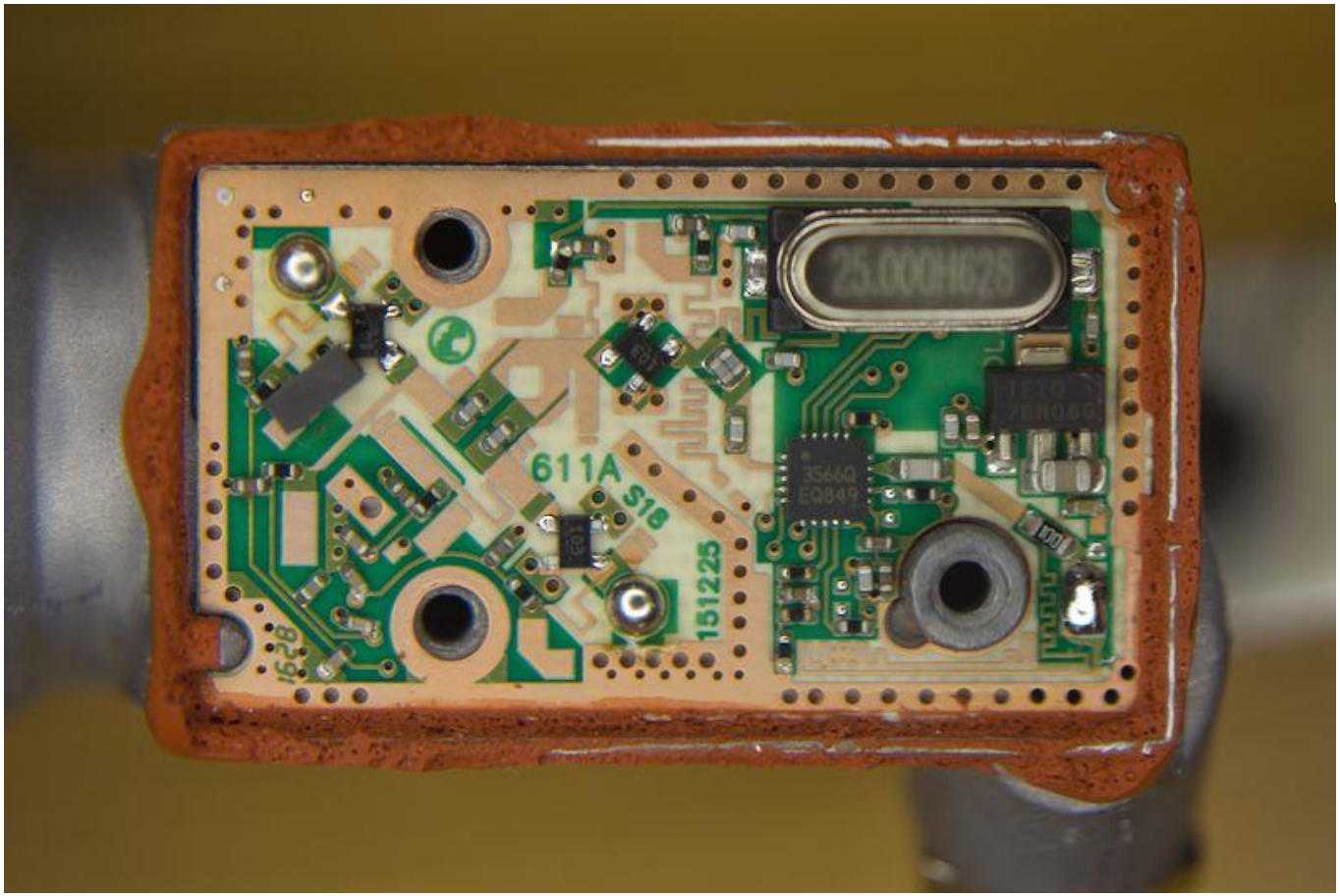

The MiniTioune receiver project, developed by Jean-Pierre F6DZP, interfaces via a standard USB 2.0 to a Windows PC running the MiniTioune software.

It will receive DVB-S QPSK and DVB-S2 QPSK, 8PSK, 16APSK, 32 APSK from broadcast and amateur TV transmissions with symbol rates (SR) from 30 Msymbols down to 120 Ksymbols per second. It is also capable of receiving Reduced Bandwidth (RB-TV) transmissions.

For more details: https://wiki.batc.org.uk/MiniTioune

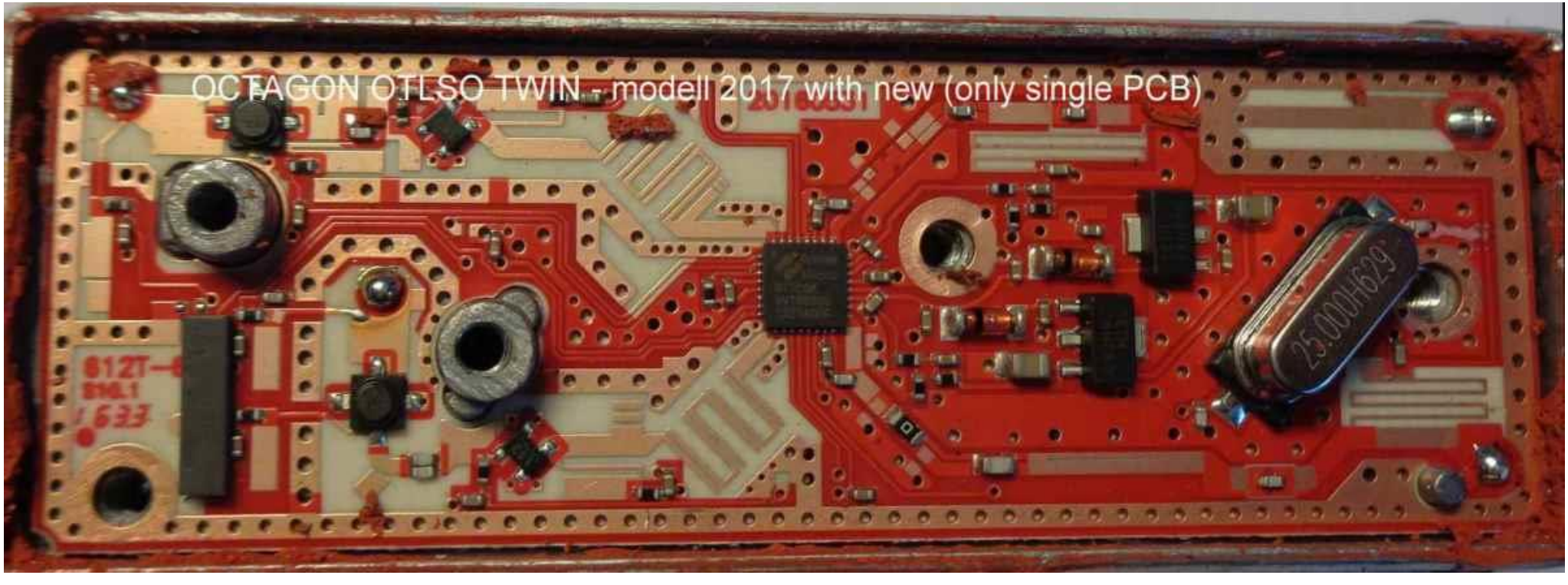
# Octagon Optima Single LNB (OSLO) with PLL

- new (!) RDA3566 with 25 MHz Quarz
- PLL does not work with 24 MHz Quarz



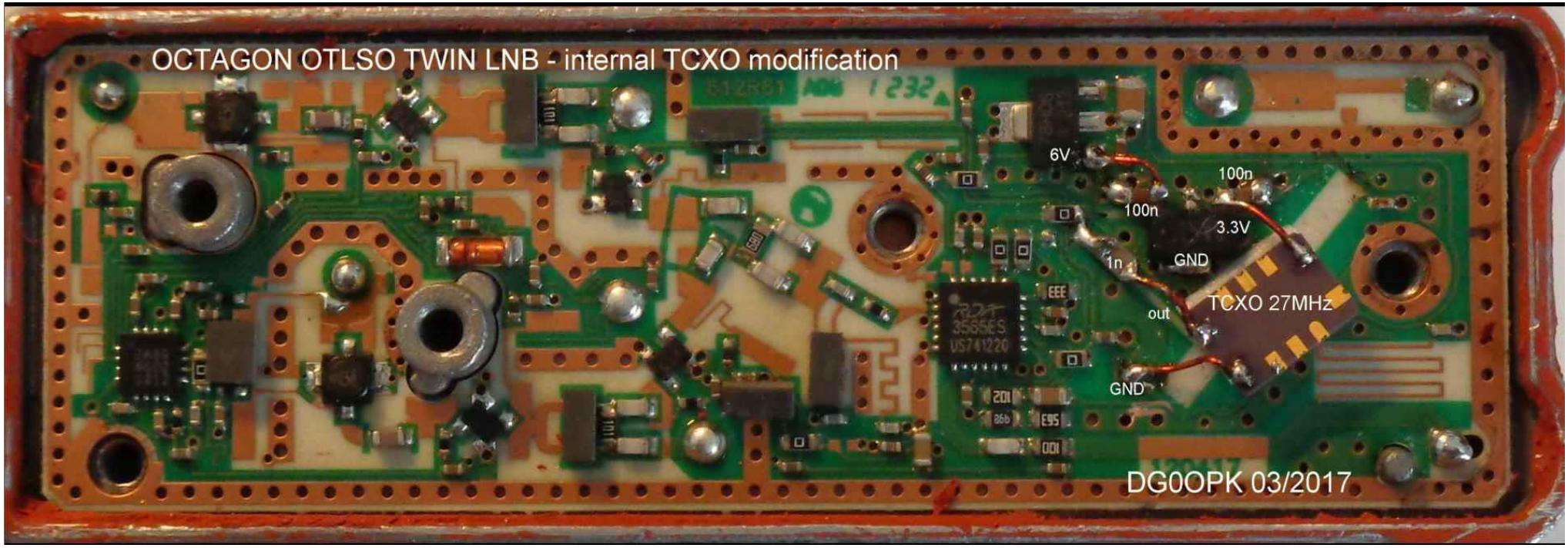
# Octagon Optima LNB Twin Slim OTLSO with PLL

- Price: 9€ – 15€ (eBay, Amazon)
- new RT320M from Rafael Micro
- 25 MHz Quartz instead of 27 MHz.
- 10 GHz selection filter behind preamps



# Modified LNB with TCXO

- D75F analog controlled TCXO from Conner Winfield
- with RDA356SES PLL chip
- 1 ppm stability over temperature range 0-70 degrees
- http://www.dg0opk.darc.de/Octagon_LNB_mod_March2017.html
- Suggested for SSB and other narrow band modes
- works with 27 MHz Quartz/TCXO



# *unmodified LNB*

## Frequency stability

Test Results from ZS6BTE
http://www.qsl.net/zs6bte/LNB%20Test%20Results.htm

- Standard 27 MHz LO crystal is cheaply and drifts heavily during warm-up.
- For the first 20 minutes the LNB is quite useless for narrow band working.
- After 40-45 minutes (tested indoors), the LO frequency stabilizes to 1 Hz at 27 MHz per 5 minutes or 360 Hz per 5 minutes at RF (9750 MHz).
- The LO at 9750 MHz ended up 36 kHz low, and reset to this same value subsequently (again indoors) when restarted.
- Once warmed up after 45 minutes it is thus very suitable for narrow-band working, provided time periods are not more than a minute or two.

# unmodified LNB

## Noise performance (Sensitivity) measurement (ZS6BTE)

| IF freq | Y-factor$_{dB}$ | $T_{sys}$ k | $NF_{sys}$ dB | Gain$_{dB}$ relative to IF 1200 MHz | Remarks |
|---|---|---|---|---|---|
| 600 | nearly dead | | | -30 | 10350 MHz |
| 618 | 1.5 | 480 | 4.2 | -24 | 10368 MHz |
| 700 | 2.6 | 206 | 2.3 | -10.3 | 10450 MHz |
| 740 | 2.8 | 180 | 2.1 | -9 P4-A Transponder | 10490 MHz |
| 800 | 3 | 158 | 1.9 | 0 | 10550 MHz |
| 900 | 4.5 | 55 | 0.7 | 0 | 10650 MHz |
| 1200 | 4.8 | 42 | 0.6 | 0 | 10950 MHz |

$T_{sys} = [(T_0 - Y.T_{cold})/(Y-1)]$

$NF_{sys}\ dB = (T_{sys}/297 + 1)\ {}_{10}\log^{10}$

RF = IF freq + 9750 MHz

Conditions:
Ground/cold sky method used to obtain Y-factor
Ambient temp 297k (24°C)
Sky background - clear in target area
Antenna temp - taken as 70k, also best fit to expected result at 1200 MHz IF
Attenuator - Weinschel 9621 precision 1 dB steps monitored on Rx d.c. AGC output
Supply voltage - 12V from Thomson FTA sat receiver, LNB loop through used as IF, LO freq ~9.750 GHz
Rx - ICOM IC-R8500 in wide band 12 kHz AM mode
This LNB has a PLL 27 MHz crystal controlled LO

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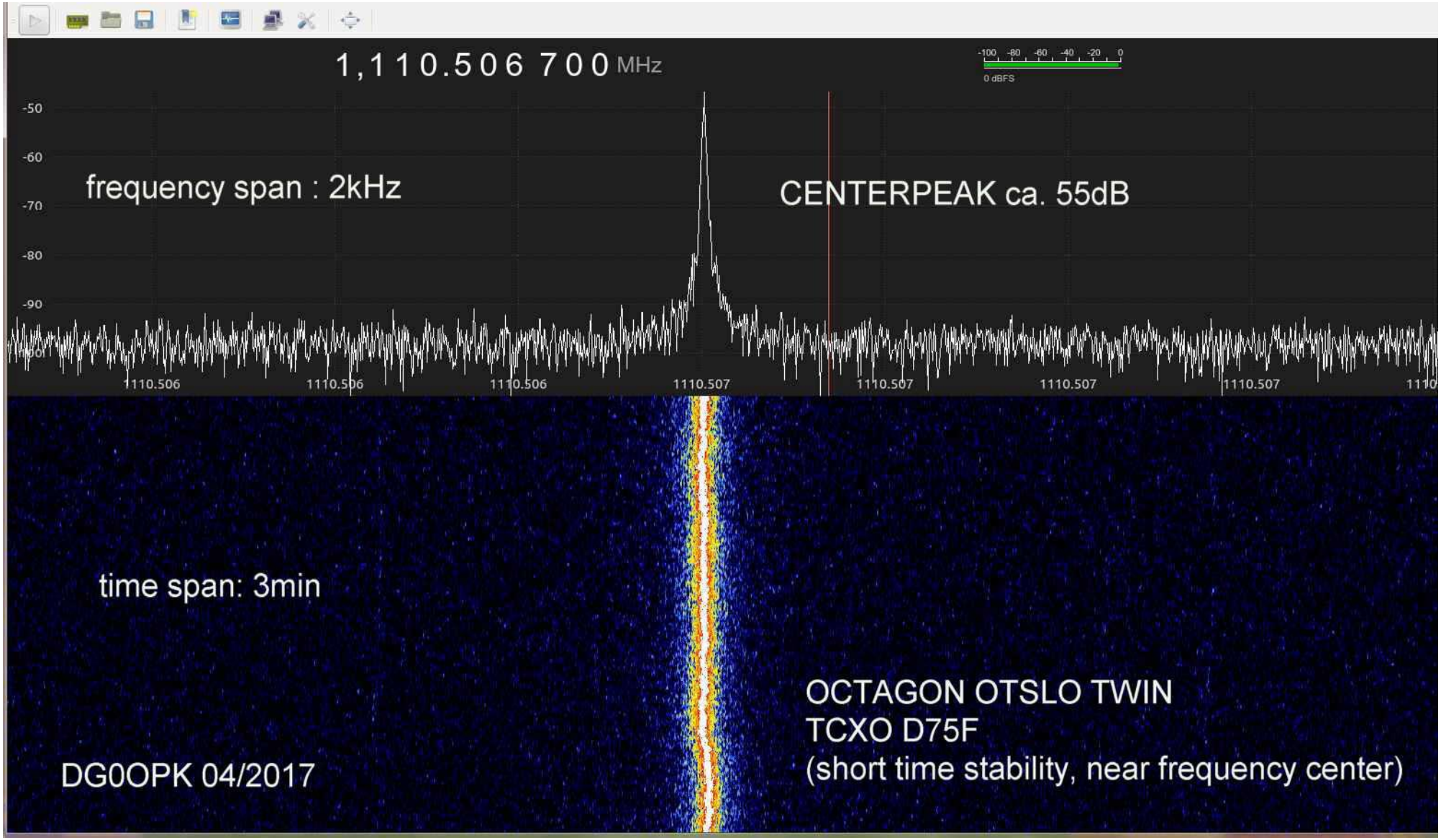
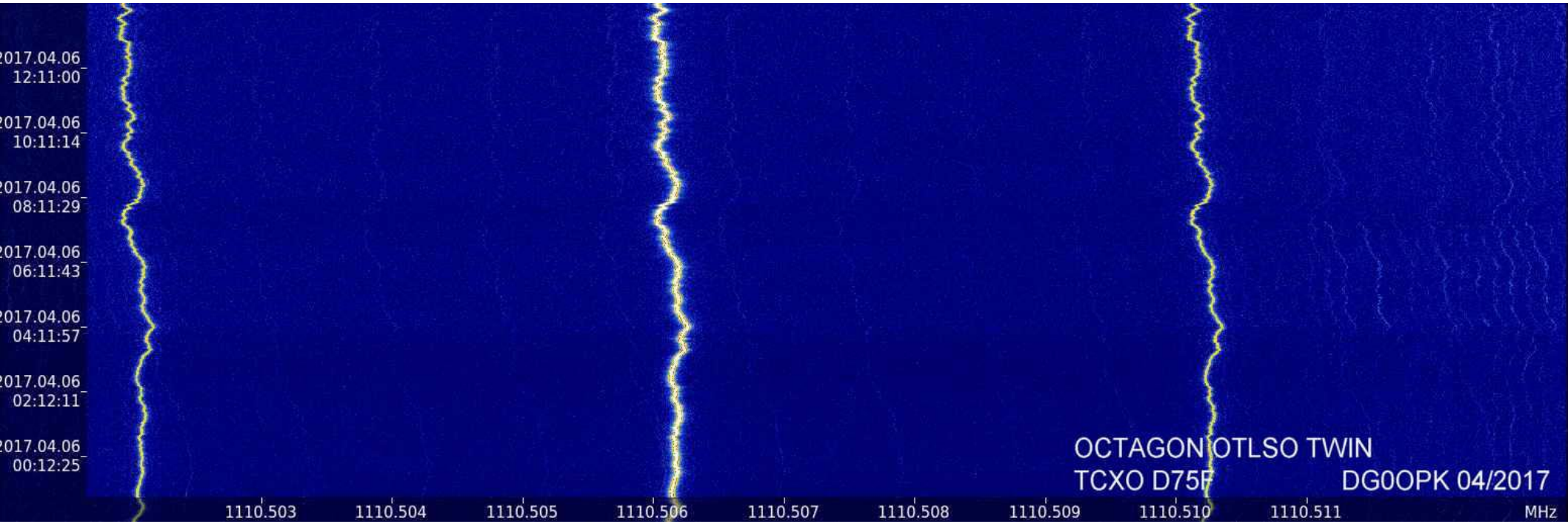
# Modified LNB with TCXO



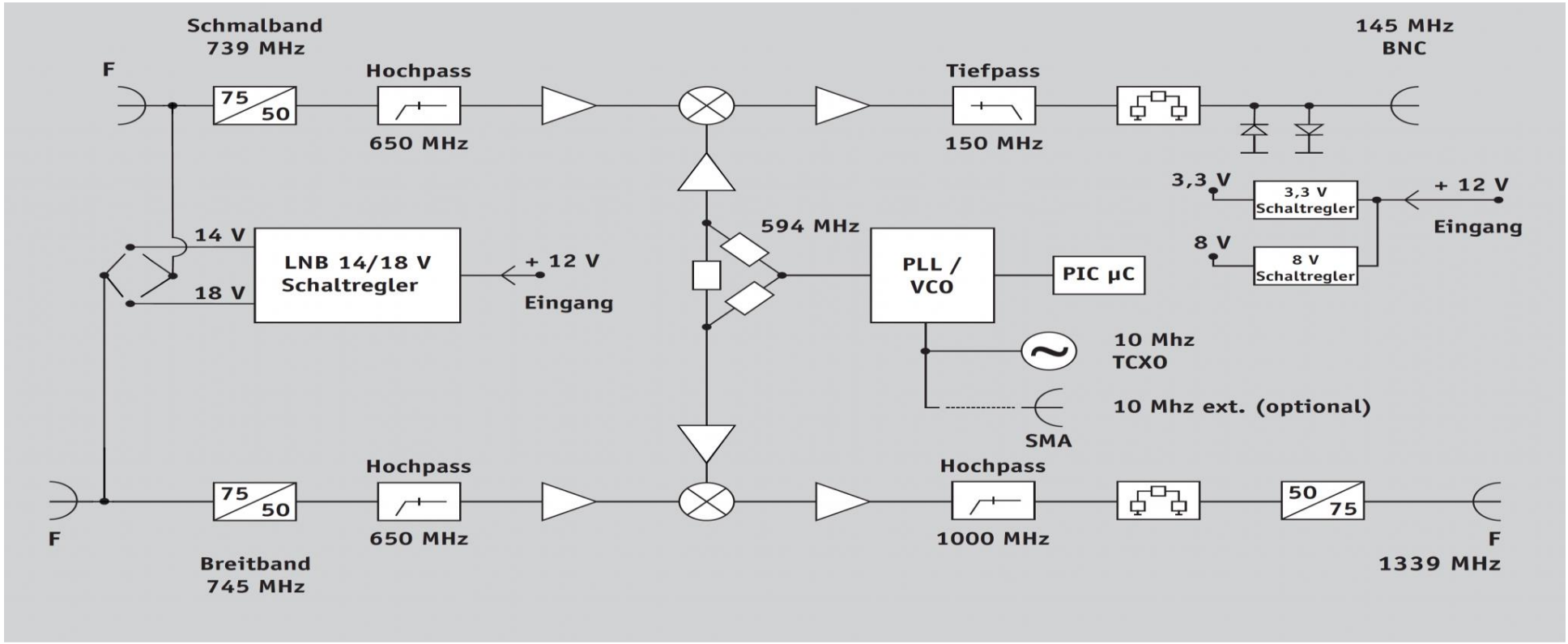
# Modified LNB with TCXO

- 14 hours long term stability
- Octagon LNB with Conner Winfield D75F-TCXO



# AMSAT P4-A Downconverter for SSB and DATV

- **LO** at 594/595 MHz to shift **NB Downlink to 144/145 MHz**
- **Same LO** signal to **shift WB Downlink to ~1340 MHz** (inside Sat-Receiver IF band)
- Optional: external 10 MHz reference clock
- Includes amplifier for following Receivers
- F connector for LNB (with 14/18V supply) and Sat-Receiver
- BNC for VHF Receiver

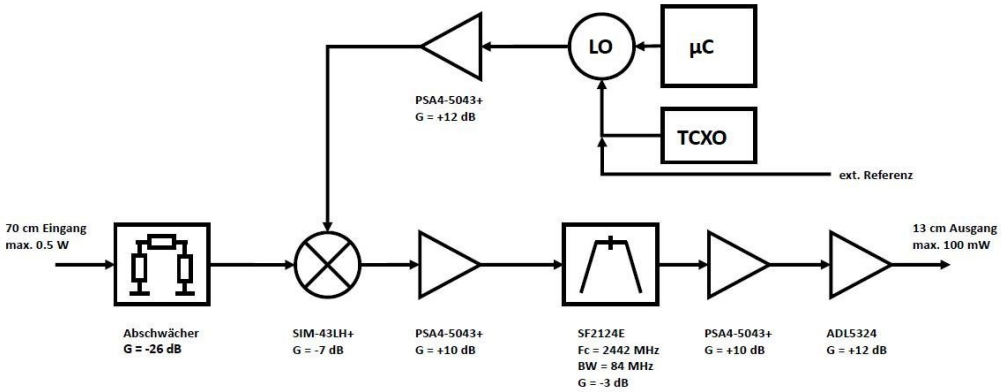


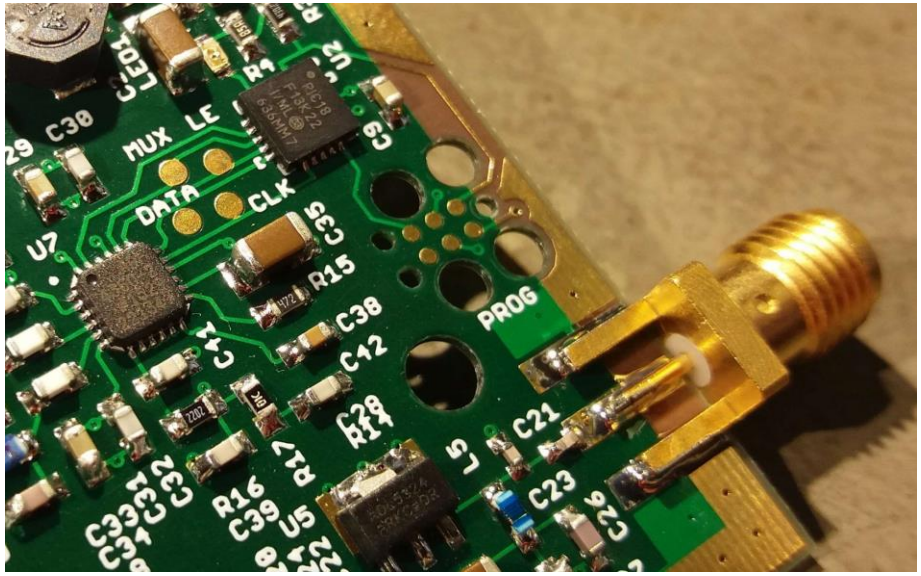
# AMSAT P4-A Downconverter for SSB and DATV



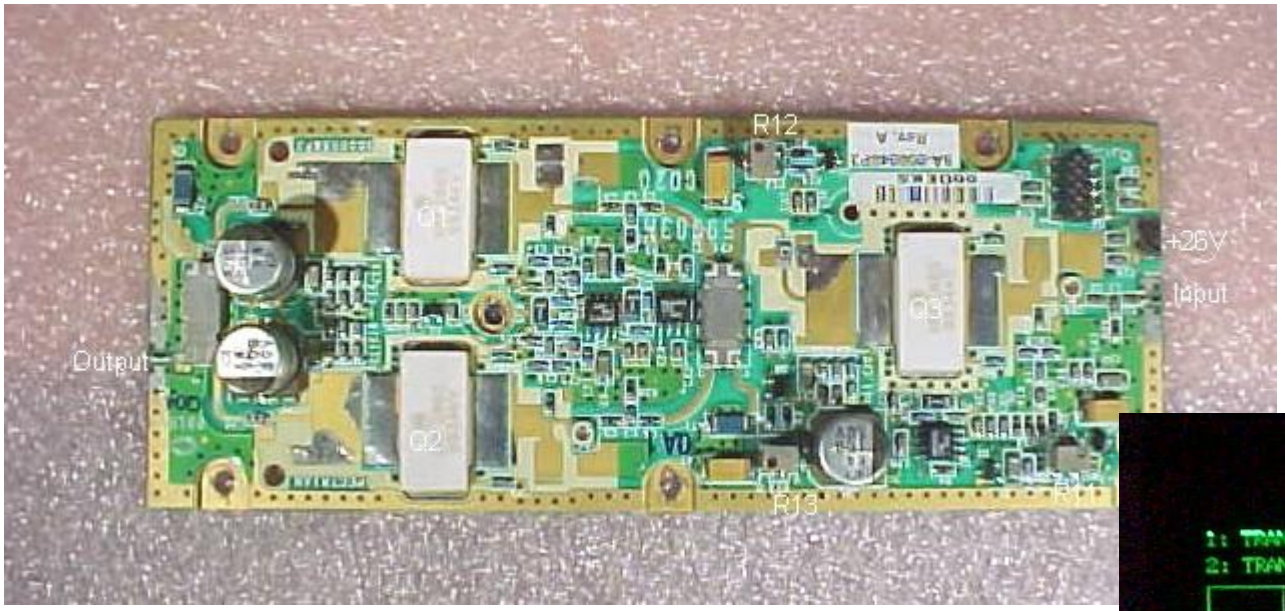
- Published in AMSAT-DL Journal No. 3, September 2017
- Kit will be available after launch of Es'hail-2 / AMSAT P4-A
- Please wait for further announcements from AMSAT-DL

# AMSAT P4-A U/S-Upconterer




# Surplus Power Amplifier 2.4 GHz

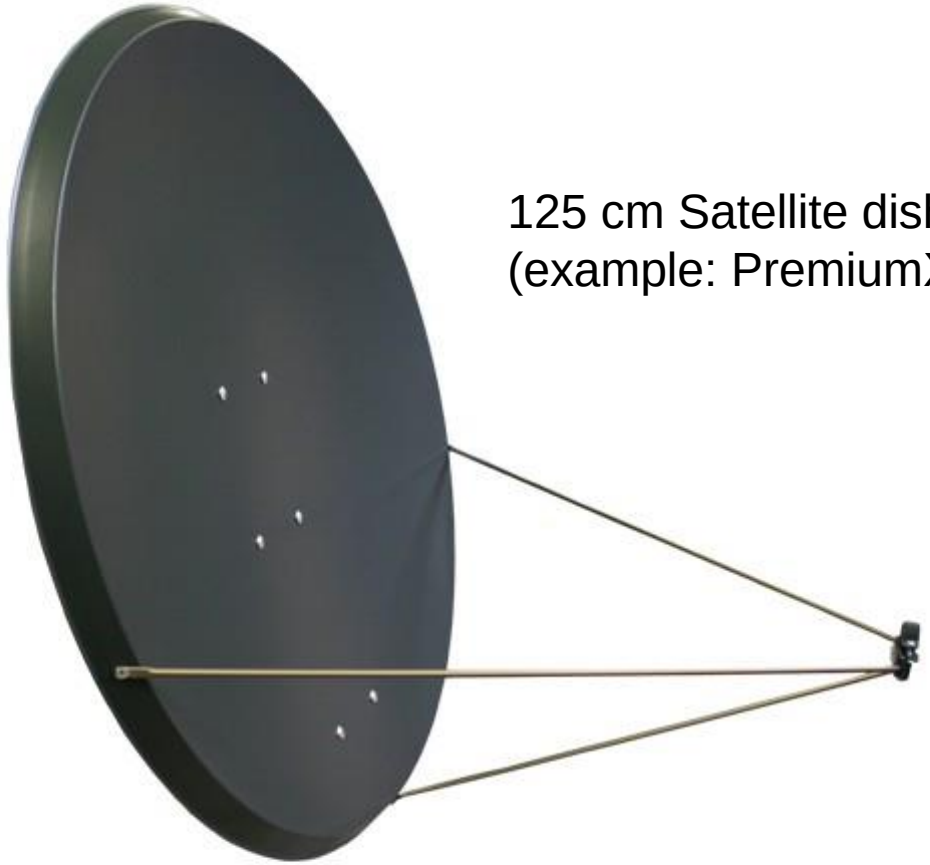




- http://www.ebay.com/bhp/spectrian
- 75W Spectrian Linear RF Amplifier Board
- 2.3-2.35 GHz, gain 18dB 24/26V
- 1.25 Watt Input Power

- Price:  99 $US on eBay

# S-Band Uplink Antenna

125 cm Satellite dish
(example: PremiumX)

5 turn HELIX for S-Band Uplink

- 40mm LNB mount
- 10 dBd Gain
- 170 x 80 mm
- LHCP for RHCP uplink
- Price: 38,70€
- http://www.winklerantennenbau.de/

# All-in-one solution (DB6NT)


## MKU LNC 10 OSCAR P4-A

**10489 ... 10500 MHz**

Low noise down converter with feed horn
1129 MHz ... 1140 MHz
Low frequency drift due to TCXO
Mountable with standard LNB peg

| | |
|---|---|
| Frequency range (RF) | 10489.. 10500 MHz |
| Frequency range (IF) | **1129..1140 MHz** |
| LO frequency | 9360 MHz |
| LO accuracy @ 18 °C | +/- 2.5 ppm |
| LO frequency stability (-20 ... +55 °C) | +/- 2 ppm |
| Supply voltage | +12/+18 V DC (vertical/horizontal polarization) |
| Current consumption | typ. 80 mA |
| Output connector / impedance | F-female, 75 ohms |

# All-in-one solution (DB6NT)


## MKU UP 2424 A, Oscar Phase 4 Up-Converter

**2400 ... 2402 MHz**

Stand-alone up converter for the OSCAR PHASE 4 geostationary satellite
144 MHz IF
Fully remote controllable

| | |
|---|---|
| Frequency range (IF) | 144 ... 146 MHz |
| Input power (IF) | 0.5 ... 5 W (adjustable) |
| Frequency range (RF) | 2400 ... 2402 MHz |
| LO accuracy @ 18 °C | typ. +/-2 ppm, max. +/-3 ppm |
| LO frequency stability | typ. +/-2 ppm, max. +/-3 ppm |
| Output power (Psat) | min. 20 W |

# Partners

Es'hailSat سهيل سات
Qatar Satellite Company الشركة القطرية للأقمار الصناعية

AMSAT-DL

الجمعية القطرية للهواة اللاسلكي
Q.A.R.S.
QATAR AMATEUR RADIO SOCIETY

KENWOOD

JAMSAT

AMSAT-UK

BATC

AMSAT-OH

maintech GmbH

SR-Systems

# Conclusion

Es'hailSat, QARS and AMSAT-DL are working towards the first AMSAT transponder in **geostationary orbit (P4-A)**

**Launch is planned for the year 2018**

Two transponders: 250 kHz narrowband, 8 MHz wideband

Target RX station size: 60-90cm

Target TX station size: 60-90cm, 10 W (narrowband)
240cm, 100W (wideband)

**Leaftlet with key information is available:**

AMSAT-DL Website: http://www.amsat-dl.org
https://www.facebook.com/amsat.deutschland/

Find us on Facebook