P4-A / Es'hail-2
QO-100
Qatar-OSCAR 100
AMSAT Phase 4 = GEO

OSCAR-10 (P3-B)
OSCAR-13 (P3-C)
OSCAR-40 (P3-D)

AMSAT-OL
Satellites for Communication and Science
Satelliten für Kommunikation und Wissenschaft
The meaning of Es’hail

“The story behind the name Es’hail (Canopus) is the name of a star which becomes visible in the night sky of the Middle East as summer turns to autumn. Traditionally, the sighting of Es’hail brings happiness as it means that winter is coming and that good weather will soon be with us. We hope that the arrival of Es’hailSat will equally be beneficial for the satellite community.”

(from Es’hailSat: Follow the star)

Canopus /kəˈnoʊpəs/ is the brightest star in the southern constellation of Carina, and is located near the western edge of the constellation around 310 light-years from the Sun. Its proper name is generally considered to originate from the mythological Canopus, who was a navigator for Menelaus, king of Sparta.
H E Abdullah bin Hamad Al Attiyah, A71AU, 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.

**Time line**

1001+ arabian nights…

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, finalisation of requirements)

2016 **Kick-Off at MELCO Japan**

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

2018 **November 15th launch with SpaceX Falcon 9**
Qatar to create platform for regional HAM broadcasters

Qatar will push for creating a common platform for amateur radio broadcasters from all over the Arab world to "institutionalise" what currently is a hobby for individuals, H E the Prime Minister and Foreign Minister Sheikh Hamad bin Khalifa al-Thani said yesterday.

"We are looking into it and hope will be able to do that sometime next year," said Al-Atiyah, at a news conference in Doha.

Al-Atiyah, who is also the chairman of Qatar Amateur Radio Society (QARS), hoped that the country would be hosting early next year such broadcasts at least from the Gulf Co-operation Council (GCC) member states.

"We are going to have a very strong Arab union and this initiative can help us achieve that goal," Al-Atiyah added. He was talking to media after delivering a keynote speech at an international festival organised by the QARS.

Al-Atiyah said at least five mobile amateur radio stations would be set up on

Global amateur radio fest begins

By Raynald C Rivera

Doha: H E Abdullah bin Hamad Al Atiyah, Chairman of the Administrative Control and Transparency Authority, stressed the significant role amateur radio plays in the society during the opening of the Qatar international amateur radio festival yesterday at the Al Rayyan Theatre in Souq Waqif.

Al-Atiyah, who is also the chairman of the Qatar Amateur Radio Society (QARS), who are hosting the event for the first time in the Middle East addressed hundreds in the audience comprising officials of various amateur radio societies around the world and secondary schools and

H E Abdullah bin Hamad Al Atiyah receiving a sword from Dr Ahmed Al Moheiri, Vice-President of Qatar Amateur Radio Society (QARS).
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.
Melco DS-2000 Platform

- **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.
- **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.
Launch on November 15th 2018

the launch took place at 20:46 UTC from the legendary launch pad 39A, from which Apollo 11 to the moon and the maiden flights of the first Space Shuttle Columbia and the SpaceX Falcon Heavy were launched. About half an hour after the launch, the satellite was placed by the launch vehicle into a geostationary transfer orbit. Only a few days later the Es'hail-2 was injected into a circular semi-geostationary orbit with its own propulsion system. Later parked at temporarily at 24°E for the In-Orbit-Testing (IOT) phase before it was shifted to its final position of 26 degrees East over Central Africa.
Launch on November 15th 2018

QARS Vice President: Dr Ahmed Hamad Al-Muhannadi, AMSAT-DL President & P4-A Project Leader: Peter Gülzow DB2OS, QARS General Secretary: Sabaan Musmar Al-Jassim A71BP, AMSAT-DL P4-A Project Manager: Dr. Achim Vollhardt DH2VA
The earth as seen by Es'hail-2
Earth Coverage Es'hail-2
QO-100 Satellite Distance Record

QO-100 (NB) on 08-Feb-2020 at 11:47 UTC
Distance: 16,809 km.
9V1HY in Singapore (OJ11vh) ↔ PR8ZX in Brazil (GI64gl)

If you wish to claim a new record, see: https://www.amsat.org/satellite-distance-records/
103 DXCC countries on QO-100

MONACO, MAURITIUS ISLAND, GEORGIA, MONTENEGRO, SRI LANKA, ITU HQ, ISRAEL, CYPRUS, MADAGASCAR, TOGO, ALGERIA, MALDIVES, CROATIA, GHANA, MALTA, ZAMBIA, KUWAIT, WEST MALAYSIA, NEPAL, SINGAPORE, RWANDA, BOTSWANA, OMAN, UNITED ARAB EMIRATES, QATAR, BAHRAIN, CHINA, ANDORRA, THE, GAMBIA, ANTARCTICA, MOROCCO, PORTUGAL, MADEIRA ISLANDS, AZORES, CAPE VERDE, FEDERAL REPUBLIC OF GERMANY, BOSNIA-HERZEGOVINA, SPAIN, BALEARIC ISLANDS, CANARY ISLANDS, IRELAND, LIBERIA, IRAN, ESTONIA, BELARUS, FRANCE, REUNION ISLAND, FRENCH GUIANA, ENGLAND, ISLE OF MAN, NORTHERN IRELAND, JERSEY, SCOTLAND, GUERNSEY, WALES, HUNGARY, SWITZERLAND, LIECHTENSTEIN, THAILAND, SAUDI ARABIA, ITALY, SARDINIA, DJIBOUTI, NORWAY, LUXEMBOURG, LITHUANIA, BULGARIA, AUSTRIA, FINLAND, CZECH REPUBLIC, SLOVAK REPUBLIC, BELGIUM, DENMARK, NETHERLANDS, BRAZIL, WESTERN SAHARA, BANGLADESH, SLOVENIA, SWEDEN, POLAND, SUDAN, EGYPT, GREECE, CRETE, TURKEY, ICELAND, CORSICA, GABON, EUROPE, N RUSSIA, ASIATIC RUSSIA, KAZAKHSTAN, UKRAINE, NAMIBIA, INDIA, BURKINA FASO, IRAQ, LATVIA, ROMANIA, SERBIA, ALBANIA, UK BASES ON CYPRUS, REPUBLIC OF SOUTH AFRICA
380 unique locations by PA3FYM

on 22 Feb 2020
QO-100 Downlink Wide Beam

-3dB Beamwidth = 17.4° → ~20dB Antenna Gain !!
Es’hail-2 Ku-Band Downlink Coverage Over MENA

commercial SAT-TV Spot Beam!
QO-100 Wide Beam
Is your dish big enough?

QO-100 received SNR vs. RX antenna gain

DH2VA, 09/2019
As good as necessary?

noise penalty and TP excess noise vs. dish size (Tsys=150K)

75cm dish is ideal
Can you see the transponder noise?
**Bochum**

**Your location:**
- **Latitude:** 51.48° N (51° 28' 47'')
- **Longitude:** 7.22° E (7° 13' 11'')
- **City:** Bochum
- **Country:** Germany

**Azimuth angle:** 157°
**Elevation angle:** 29°

**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)

---

**Doha**

**Your location:**
- **Latitude:** 25.25° N (25° 15' 0'')
- **Longitude:** 51.60° E (51° 36' 0'')
- **City:** Doha
- **Country:** Qatar

**Azimuth angle:** 228°
**Elevation angle:** 49°

**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)
Custom design for AMSAT
“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
  → everything with less than 2.7 kHz Bandwidth!
  → no FM (DSTAR, etc.)

- 250 kHz allocated bandwidth + a “little” reserve
- 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)
  2-5W
Easy Sat! Ultra Cheap

There are two different kinds of LNB's:
- with DRO → bad
- with PLL → good

Bias-T (DC Power combiner)
NB → (V)ertical: 11…14 V
WB → (H)orizontal: 16…20 V

Dongles for NB Downlink:
- RTL-SDR or Funcube dongle
- free SDR software available

Display Spectrum and listen with SDR# or similar…

LNB with PLL

20€

12€

20€

35€
SDR Console with Beacon stabilisation
Going to the “Edge

Old bandplan: 250 KHz

New bandplan: 500 kHz!

NB-Transponder frequency response
AMSAT QO-100 / P4A
NB Transponder Bandplan

Downlink frequency (MHz)

Mixed modes & Special purpose

Uplink frequency (MHz)
## AMSAT QO-100 / P4A
### NB Transponder Bandplan

<table>
<thead>
<tr>
<th>Uplink</th>
<th>Downlink</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>2400,005</td>
<td>2400,040</td>
<td>10489,500</td>
</tr>
<tr>
<td>2400,040</td>
<td>2400,080</td>
<td>10489,505</td>
</tr>
<tr>
<td>2400,080</td>
<td>2400,150</td>
<td>10489,540</td>
</tr>
<tr>
<td>2400,150</td>
<td>2400,245</td>
<td>10489,580</td>
</tr>
<tr>
<td>2400,255</td>
<td>2400,350</td>
<td>10489,650</td>
</tr>
<tr>
<td>2400,350</td>
<td>2400,495</td>
<td>10489,745</td>
</tr>
<tr>
<td>2400,505</td>
<td>2400,715</td>
<td>10489,755</td>
</tr>
<tr>
<td>2400,715</td>
<td>2400,995</td>
<td>10489,850</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10489,995</td>
</tr>
</tbody>
</table>
Es gibt im drei unvermeidliche Verlustquellen:

1.) Da die PEP-Leistung des Transponders fest gegeben ist, ist damit auch der höchstmögliche Pegel im Empfang gegeben. Die verfügbare Dynamik ergibt sich daraus, wie hoch der Rauschpegel ist. Wenn nur Bodenrauschen vorhanden ist, ist sie am höchsten; durch das Uplink-Rauschen wird der Rauschpegel im Rx am Boden erhöht und damit die Dynamik reduziert. Das ist die Kurve $V_{dr}$.

2.) Bei genügend großer Verstärkung im Transponder wird immer mehr Leistung als Rauschen abgestrahlt. Diese Leistung steht den Benutzern nicht mehr zur Verfügung. Dieser Verlust ist mit $V_{rp}$ bezeichnet.

Die Downlinkverluste 1.) und 2.) zusammen ergeben die rote Kurve $V_{dr+rp}$.


Im Prinzip sind Fehler in der Verstärkung des Transponders zu kleineren Verstärkungen hin weniger schädlich, weil sie durch etwas mehr Uplink-Leistung ausgeglichen werden können. Für die Downlink-Verluste ist das nicht oder nur teilweise möglich (wenn man außerhalb des offiziellen Passbands arbeitet).

Wie man der Abbildung entnehmen kann, dürften wir sehr nahe am Optimum sein. Wenn man davon ausgeht, dass QRP-Stationen gleichzeitig eine kleinere Sende- und Empfangsantenne haben, verschieben sich die rote und die grüne Linie entgegengesetzt auf der Abszisse. D.h. die Lage des Optimums für die Verstärkung des Transponders ändert sich dadurch nicht.

73s Karl, DJ4ZC
Rolf, DK2ZF: First QSO with A71A via QO-100 (OP: Sabaan A71BP and Peter DB2OS)

„Nachdem wir gleich zu Beginn feststellen mussten: 5W HF am Spiegel sind schon zu viel. So wurde in den ersten Tagen viel darüber gesprochen wie man die überschüssige HF wegbekommt...“

„Meine Erfahrung 2W HF an einem 60er Spiegel für SSB voll ausreichend. Für CW reichen 1W HF für ein 579 Signal.“
“NB” Operating Guidelines

- **No FM mode** or any other modulation exceeding 2700 Hz bandwidth.
- **No transmission below the lower CW beacon**:  
  - the Amateur Satellites Service operate exclusively on a secondary basis in the band 2400-2450 MHz. **You are responsibly for you own transmissions!**
- **Respect the Guard-band around the CW/PSK beacons**

- Uplink polarisation is RHCP (right-hand circular polarization, the Feed must be LHCP!)
- Downlink polarisation for the **NB transponder is V** (vertical linear polarisation).
- You loose 3dB (half of your uplink power) with cheap WiFi-Antennas.

- AMSAT recommends to keep your own signal **in the same range as the CW beacon**
- Excessive signals might trigger LEILA warnings to remind you to reduce uplink power.

- **Full-Duplex operation is mandatory** (you must be able to monitor your own downlink while transmitting!)

- If you hear the transponder noise more than ~5dB above the LNB noise, everything is fine and a larger antenna will not subjectively increase the S/N.. Theoretical 3dB (S/N+N) improvement possible, but you need an EME style antenna to notice the difference..
How to get “wet” in the waterfall display!
Huge signal ≠ good signal!

- MANY station overdriving their cheap Chinese WLAN Power Amplifier.
- Intermodulation widening SSB signal, but also distorting modulation leading to bad readability
- Sometimes less is more!
“WB” Transponder (wide band)

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

First DATV transponder in space!!

- 8 MHz total 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 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 with promotional video.
- RF Bandwidth = 1.33 x Symbol-Rate = 1.33 x 2.5 MSymbols/sec = 3.33 MHz signal

✓ MiniTiouner or SW DVB-S2 decoder
✓ 30W into 1.2m dish with RB-TV DVB-S2 modulator
# WB Bandplan (DATV)

<table>
<thead>
<tr>
<th>Mode</th>
<th>Symbol Rate</th>
<th>Uplink Freq MHz</th>
<th>Downlink Freq MHz</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beacon</td>
<td>1500 kS</td>
<td>2402.0</td>
<td>10491.5</td>
<td>Beacon DVB-S2 FEC 4/5</td>
</tr>
<tr>
<td>Wide</td>
<td>1 MS</td>
<td>2403.75</td>
<td>10493.25</td>
<td>1.5 MS and 2 MS transmission should use this part of the band</td>
</tr>
<tr>
<td>Wide</td>
<td>1 MS</td>
<td>2405.25</td>
<td>10494.75</td>
<td></td>
</tr>
<tr>
<td>Wide</td>
<td>1 MS</td>
<td>2406.75</td>
<td>10496.25</td>
<td></td>
</tr>
<tr>
<td>Narrow</td>
<td>333 kS</td>
<td>2403.25</td>
<td>10492.75</td>
<td>Use these 14 frequencies for 500 kS, 333 kS and 250 kS</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>Then every 500 kHz until</strong></td>
</tr>
<tr>
<td>Narrow</td>
<td>333 kS</td>
<td>2409.75</td>
<td>10499.25</td>
<td>Use frequencies above 10497.0 first</td>
</tr>
<tr>
<td>Very Narrow</td>
<td>125 kS</td>
<td>2403.25</td>
<td>10492.75</td>
<td>Use these 27 frequencies for 125 kS, 66 kS and 33 kS</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>Then every 250 kHz until</strong></td>
</tr>
<tr>
<td>Very Narrow</td>
<td>125 kS</td>
<td>2409.75</td>
<td>10499.25</td>
<td>Use frequencies above 10497.0 first</td>
</tr>
</tbody>
</table>
## WB Bandplan (DATV)

<table>
<thead>
<tr>
<th>Beacon</th>
<th>Wide and Narrow DATV</th>
<th>Narrow DATV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beacon</td>
<td>1MS</td>
<td>1MS</td>
</tr>
<tr>
<td></td>
<td>333</td>
<td>333</td>
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</table>

<table>
<thead>
<tr>
<th>Uplink (MHz)</th>
<th>Downlink (MHz)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2401.5</td>
<td>10491.0</td>
</tr>
<tr>
<td>2402.5</td>
<td>10492.0</td>
</tr>
<tr>
<td>2403.5</td>
<td>10493.0</td>
</tr>
<tr>
<td>2404.5</td>
<td>10494.0</td>
</tr>
<tr>
<td>2405.5</td>
<td>10495.0</td>
</tr>
<tr>
<td>2406.5</td>
<td>10496.0</td>
</tr>
<tr>
<td>2407.5</td>
<td>10497.0</td>
</tr>
<tr>
<td>2408.5</td>
<td>10498.0</td>
</tr>
<tr>
<td>2409.5</td>
<td>10499.0</td>
</tr>
</tbody>
</table>
Qatar OSCAR-100 Wideband Spectrum Monitor

This spectrum monitor, hosted at Goonhilly Earth Station in Cornwall, shows the Qatar OSCAR-100 wideband transponder onboard the Es'hail-2 satellite.

You can read more about the WebSDR & Spectrum Viewer station at wiki.batc.org.uk/Eshail-2 Ground Station

- For more details on Qatar OSCAR-100 see amsat-dl.org/eshail-2-amsat-phase-4-a
- The Q0-100 narrowband websdr can be found here eshail.batc.org.uk/nb/
What is DVB-S2?

- **New DVB standard for digital 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!
Uplink Power Budget

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

<table>
<thead>
<tr>
<th>Power Budget (Watts)</th>
<th>8 MHz</th>
<th>4 MHz</th>
<th>2 MHz</th>
<th>1 MHz</th>
<th>0.5 MHz</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.4m</td>
<td>100</td>
<td>50</td>
<td>25</td>
<td>12.5</td>
<td>6.25</td>
</tr>
<tr>
<td>1.7m</td>
<td>200</td>
<td>100</td>
<td>50</td>
<td>25</td>
<td>12.5</td>
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<tr>
<td>1.2m</td>
<td>400</td>
<td>200</td>
<td>100</td>
<td>50</td>
<td>25</td>
</tr>
<tr>
<td>0.85m</td>
<td>800</td>
<td>400</td>
<td>200</td>
<td>100</td>
<td>50</td>
</tr>
</tbody>
</table>

Credit M0DTS
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
Es'hailSat Satellite Control Center
Es'hailSat Satellite Control Center
Es’hailSat Groundstation in the Shelter
(developed and constructed by AMSAT-DL team)
QARS HQ, Doha
- 3m antenna for 2.4 GHz Uplink with VE4MA septum feed
- 2.5m antenna for 10 GHz Downlink
- 20m dish available for emergency operations 😊
Inauguration Day, 2019-02-14

PM inaugurates Es’hailSat teleport

HE the Prime Minister and Interior Minister Sheikh Abdullah bin Nasser bin Khalifa al-Thani yesterday inaugurated the Teleport Control Station of Qatar Satellite Company (Es’hailSat) in Al Ghuwairiya area, north of Doha.

The ceremony attended by HE the Minister of Transport and Communications Jassem Selif Ahmed al-Sulaiti, Es’hailSat chairman Dr. Hassa Sultan al-Jabri and a number of other dignitaries began with the screening of a documentary film about the company.

PM inaugurates Es’hailSat teleport

HE the Prime Minister and Interior Minister Sheikh Abdullah bin Nasser bin Khalifa al-Thani yesterday inaugurated the Teleport Control Station of Es’hailSat as HE the Minister of Transport and Communications Jassem Selif Ahmed al-Sulaiti Es’hailSat chairman Dr Hassa Sultan al-Jabri and CCO Ali bin Marzouk looked on.

Teleport promotes Qatar’s economic position

Qatar Satellite Company was established in 2010 with the aim of creating satellites and operating rights, providing various services to the public and private sectors in the Middle East and enhancing satellite services through the development and acquisition of technology related to satellite development, all while providing new, material and infrastructure to achieve these objectives.

The Communications Regulatory Authority (CRA) president Mohamed Al A'Ali announced that the satellite control station is a major step forward after the launch of the Qatari satellites Es’hail-1 and Es’hail-2, which will be controlled by the station. In addition, he said the station will work on securing terrestrial communications, the internet and other tasks.

In a statement to the press, he said Qatar currently has a large capacity of communication satellites through various countries, which is sufficient to meet the current and future demands as well.
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.

- 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) analyses passband of NB transponder and send Marker tones on all stations which use too much uplink power.

- LEILA-2 generates pseudobeacon(s) and add them to the uplink signal (400 Bit/s PSK Telemetry with FEC).

- Hamradio shack equipped with SSB equipment for Voice and with DVB-S2 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 → SDR Console

* 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)
LEILAI

LEILAI is an german acronym for "LElstungs Limit Anzeige", which means: Power Limit Indicator.

The original concept of an hybrid analog/digital LEILAI 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.

LEILAI-2 on P4-A is ground-based !!

- Siren marker (sufficient if operators work full duplex)
- Notch filter not possible because of delay
LEILA-2

- 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).
- LEILA software by Mario DL5MLO
- installed at Es‘hailSat SCC, QARS backup and in Bochum at AMSAT-DL (currently active).
DATV - Groundstation
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.
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](http://www.dg0opk.darc.de/Octagon_LNB_mod_March2017.html)
- Suggested for SSB and other narrow band modes
- works with 27 MHz Quartz/TCXO
AMSAT QO-100 Down-Converter

- Published in AMSAT-DL Journal No. 3, September 2017 and on our Webpage.
- Kit is available at http://shop.amsat-dl.org

Note: Kit comes without tin box (111x74mm), photo only for illustration
Easy Sat!

Analog version without computer...

- 12€ Universal Down-Converter for P4-A
- 145 MHz
- 1339 MHz

- 20€

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

Existing 2m/VHF Transceiver: 0€

Universal Down-Converter for P4-A: 175€

Remote: 40€
New AMSAT QO-100 Down-Converter

- two versions: OCXO (20ppb) or TCXO with GPSDO !!
- IF frequency for RX: 28 MHz, 50 MHz, 70 MHz, 144 MHz or 145 MHz
- 10 MHz and 40 MHz Reference Output for Up-Converter or Adalm Pluto
- Ultrastable LNB with programable external Ref clock: 24/25/26/27 MHz
New AMSAT QO-100 Up-Converter

- 10 MHz Reference Input from Down-Converter
- OCXO (20ppb) or TCXO (500ppb)
- Programable Uplink IF for TX: 433 MHz / 435 MHz / 833 MHz / 1293 MHz
- Build-in PA with **8 Watt RF Output!!** (all you need!)
**Frequency Stability and Accuracy**

- **Long term Stability** (drift, measured over periods of a day or more)
- **Short term Stability** (kind of random noise, „wobbling“)
- **Phase Noise** (affects digital modulation)
- **Frequency stability: \( \Delta f/f (T) \)**
  - TCXO
    - Standard: 1-2 ppm
    - Precision: 0.1-0.3 ppm
  - OCXO: 2-100 ppb
  - GPSDO
    - Long term up to \(1 \times 10^{-12}\)
    - Short term depending on TCXO clock source.
Antennas for QO-100

- WIFI Grid linear
- Helix RHCP
- Patch Array
- Separate Dish Antennas for Up- and Downlink
Antennas for QO-100

60cm G3RUH dish & patch feed from OSCAR-40
Dualband Feeds for QO-100

G0MJW
PA3FYM
M0EYT
POTY Feed

LZ1JH
4 Yagis & LNB

DF2GB
Helix Feed with LNB

DJ7GP
Dual-band Feed

HB9PZK
Dipole Array & Waveguide
WiFi Booster for 2.4 GHz

2.4 GHz 20W Wifi Booster from AliExpress (190€)
- Good for SSB
- 33dB gain, up to 15W
- 12V input, 5A max.
- see article from Achim DH2VA in AMSAT-DL Journal
SG Laboratory 2.4 GHz Amplifier

- Output Power: 20W
- Gain: 16 dB
- 24..28V, 1.5A
- Price: ~126€
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

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency range (IF)</td>
<td>144 ... 146 MHz</td>
</tr>
<tr>
<td>Input power (IF)</td>
<td>0.5 ... 5 W (adjustable)</td>
</tr>
<tr>
<td>Frequency range (RF)</td>
<td>2400 ... 2402 MHz</td>
</tr>
<tr>
<td>LO accuracy @ 18 °C</td>
<td>typ. +/-2 ppm, max. +/-3 ppm</td>
</tr>
<tr>
<td>LO frequency stability</td>
<td>typ. +/-2 ppm, max. +/-3 ppm</td>
</tr>
<tr>
<td>Output power (Psat)</td>
<td>min. 20 W</td>
</tr>
</tbody>
</table>
ADALM-PLUTO

Software-Defined Radio Active Learning Module

- RF coverage from 325 MHz to 3.8 GHz
- (extended range: 70 MHz to 6 GHz)
- Up to 20 MHz of instantaneous bandwidth
- Supports SSB (SDR-Radio)... DVB-S (TX)
- Price: ~120 € (Digi-Key, Mouser)
Sie sehen den Wald vor lauter Bäumen nicht mehr?

besuchen Sie: forum.amsat-dl.org
THANK YOU!

The first AMSAT P4-A transponder in geostationary orbit on Es’hail-2 was brought to you by Es’hailSat, QARS and AMSAT-DL.

P4-A / Es’hail-2 is now called Qatar-OSCAR 100 (QO-100)

Please support AMSAT-DL

Visit our Website at: http://amsat-dl.org
Visit the QO-100 (Es’hail-2) Forum at: http://forum.amsat-dl.org
Partners