Es'hailSat سهيل سات

Qatar Satellite Company الشركة القطرية للأقمار الصناعية

Es’hail-2 Satellite
AMSAT Payload

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Table of Content

- Es'hail-2 Overview
- AMSAT High Level Requirements
- Frequency Band Selection
- AMSAT Technical Solution

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Es'hail-2 Payloads

- 2x AMSAT transponders covering the visible Earth

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AMSAT High Level Requirements

High Level Requirements

Req. 1	• The AMSAT payload shall provide communications from the GEO orbit to the visible Earth (10° elevation, optional 5 ° elevation).
Req. 2	• At least 100 users shall be able to communicate mono-directionally and simultaneously.
Req. 3	• The ground segment shall require antennas smaller than 1 m and HPA with a rated output power less than 10 W.
Req. 4	• the on-board receiver shall have a sensitivity of -117 dBm for C/N = 20 dB in 3 KHz bandwidth
Req. 5	• Wideband experimental transponder for video transmission (experimental)

- Guidelines
  - One-way communication channel requires 2.7 KHz (AM SSB Modulation)
  - 100 users = 50 communication channels. 250 KHz wide transponders can accommodate up to 100 communication channels.
  - The mission is more interesting if the Earth areas at the edge of the satellite visible Earth are covered to allow users from Brazil to communicate with the Far East. Therefore, restricted antenna coverage to increase the spacecraft gain is not recommended.

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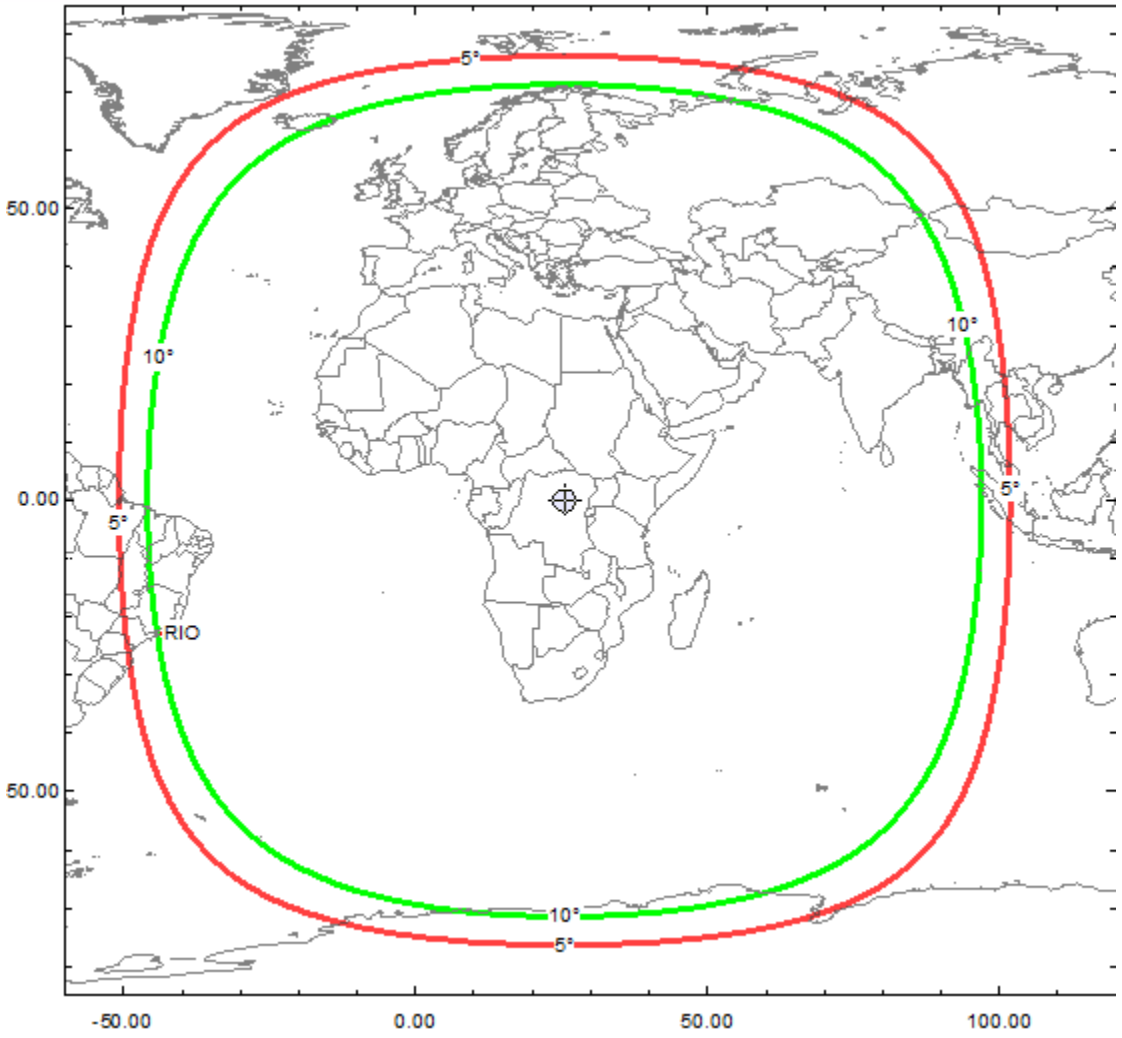
Coverage from 26°E



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Synergy with other Es'hail-2 payloads

- Compared to the previous AMSAT missions, Es'hail-2 AMSAT payload takes full advantage from the satellite power and HPA redundancy with Ku-band mission. The mission provides two transponders to cover the following services over the visible Earth:
  - HAM Radio voice communication through the Narrow Band (NB) transponder which will allow 90 simultaneous voice transmissions for 180 users.
  - Video transmission through the Wide Band (WB) transponder for 2 to three video channels.

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Frequency Band Selection

Frequency Range (1/2)

- Two frequency band combinations were possible:
  - Uplink in L-band and downlink in S-band, or
  - Uplink in S-Band and downlink in X-band

	Pros	Cons
L/S-band	• Equipment are widely available	• faces the interference risk from WIFI and ISM.
S/X-band	• easier to put on Es'hail-2 as it takes less space. • It will benefit from the downlink that can be shared with the Ku-band payload using COTS TWTAs.	• Equipment are less spread. However, they are available.

Frequency Range (2/2)

S-Band Uplink

2400-2403 MHZ

X-Band Downlink

10450-10500 MHz

- Frequency band selection
  - Es'hailSat takes S/X-band solution for the AMSAT payload
  - The AMSAT are using RHCP in S-band. Es'hail-2 shall keep this convention.
  - The S-band frequencies for the S/X payload will be at the lower spectrum edge and therefore far from the WIFI interference.

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Technical Solution

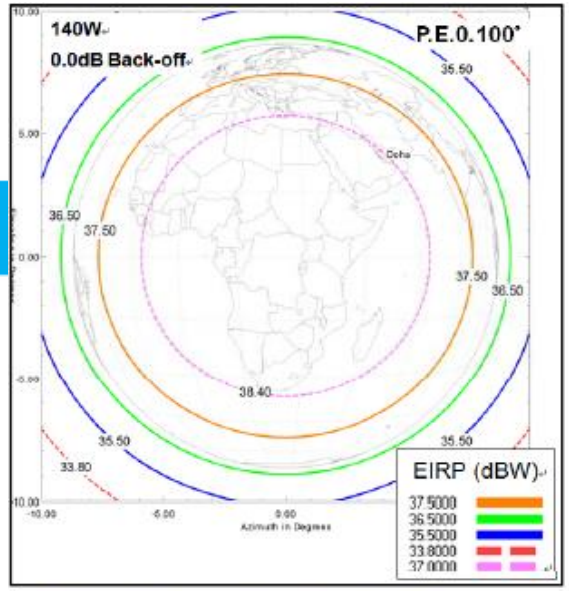
Transponders

- Narrow-band filtering was among the challenges for the SATCOM industry
- S-RX has double conversion inside the Receiver.
  - (1) S to IF down-conversion
  - (2) Filtering: 250 KHz for the NB
  - (3) AGC function (only for NB)
  - (4) IF to S to X up-conversion
  - (5) Combined power by OMT and One horn is applied

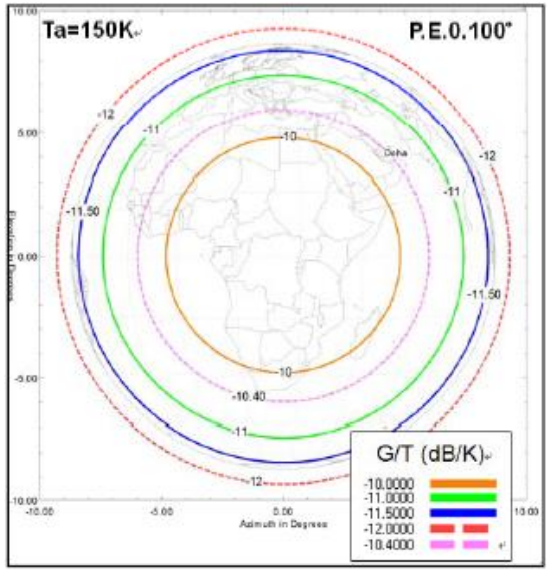
Transponder		Freq. Band	Polarization	Central Freq. (MHz)	Transponder Bandwidth
NB	Uplink	S-band	RHCP	2400.175	250 KHz
	Downlink	X-band	LVP	10489.675	
WB	Uplink	S-band	RHCP	2405.5	8 MHz
	Downlink	X-band	LHP	10495	

Space Segment: on-board design

- Using horn antennas for up- and dowlink
- G/T at the Edge of Coverage (EoC): -12 dB/°K
- EIRP at the Edge of Coverage (EoC): 31 dBW (at 6 dB OPBO)
  - NPR is about 26dB for 6 dB OBO using COTS Ku-band TWTA.
- NB Transponder has an AGC function with an AGC Attack Time of 50 msec and an AGC Decay Time of 2 seconds.

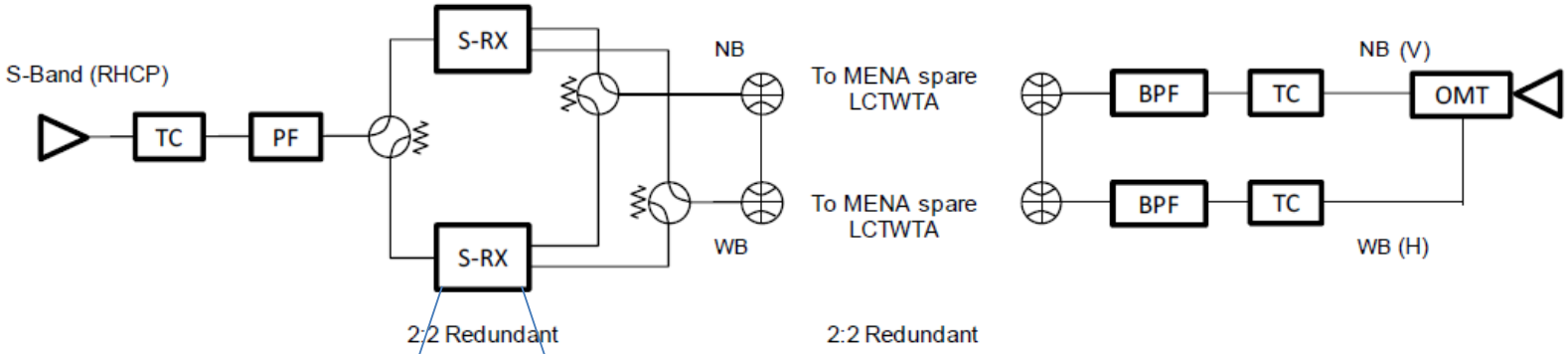


D/L (X-band) Global Beam

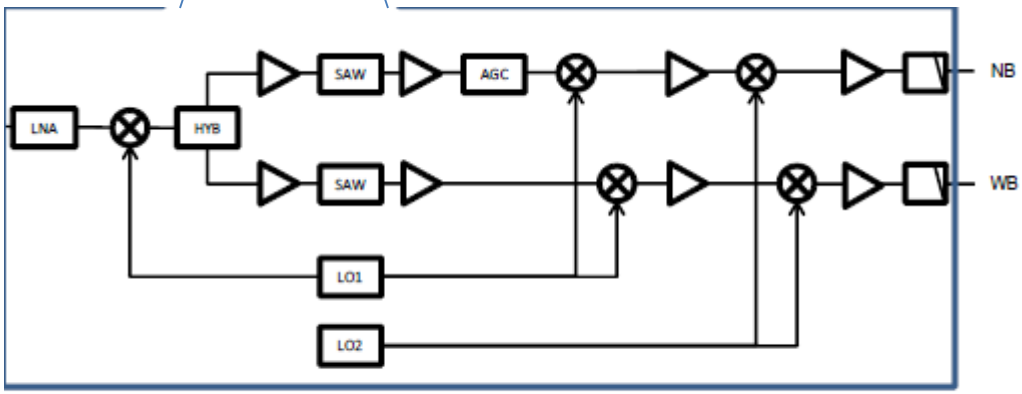


U/L (S-band) Global Beam

AMSAT Block Diagram



AMSAT Payload Block Diagram



S-band Receiver/X-band Upconverter Assembly

System Design: Ground Segment

- Target user segment:
  - 89 cm dishes in rainy areas at EOC, like Brazil
  - 60 cm around coverage peak.
  - 75 cm dishes elsewhere.
  - 10 W BUCs
- Initial link budgets with worst case satellite performance.

Uplink (EOC, SFD = -106 dBW/m2)			Downlink (EOC)		
Freq	2.4	GHz	Freq	10.5	GHz
Dish size	0.75	m	TWTA output power	100	W
Ant gain	23.64	dBi	OBO	6	dB
HPA Output Power	10	W	On-board losses	1.5	dB
Uplink path losses	1.5	dB	S/C Ant. Gain	17	dBi
Ground EIRP	32.14	dBW	S/C EIRP	29.5	dBW
			Power sharing	50	channels
			S/C EIRP per channel	12.5	dBW
Earth-S/C distance	41126	Km			
Free Space Loss	192.3	dB	Free Space Loss	205.1	dB
95% availability att	0.12	dB	95% availability att	0.55	dB
S/C G/T	-12	dB/K	Ground Sta. G/T	13.98	dB/K
C/N0	56.3	dBHz	C/N0	49.4	dBHz
Channel Bw	2.5	KHz	Channel Bw	2.5	KHz
C/N per user (PEP)	22.3	dB	C/N per user (Avg.)	15.4	dB

- AMSAT-DE/ At least 3 AMSAT spacecraft were in HEO. Thus, long distance communications were already tested for AMSAT systems. However, it was mainly for lower frequencies.

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THANK YOU