UAE Administration

REFERENCE ASSUMPTIONS FOR NSAT01.001 and NSAT01 IN THE 1164-1215 MHz BAND

INTERFACE CONTROL DOCUMENT

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Table of Contents

1 Scope 4

2 Reference Documents 5

3 Acronyms and definitions 6

3.1 Acronyms 6

3.2 Definitions 6

4 Reference System Assumptions 8

4.1 General Parameters 8

4.1.1 NSAT01.001 General Parameters 8

4.1.2 NSAT01 General Parameters 8

4.2 Orbit and Constellation Parameters 9

4.2.1 NSAT01.001 Orbit Parameters 9

4.2.2 NSAT01 Orbit and Constellation Parameters 9

4.3 Satellite and Payload Parameters 11

4.3.1 NSAT01.001 Transmitted Power 11

4.3.2 NSAT01 Transmitted Power 11

4.3.3 NSAT01.001 Satellite Antenna Gain Patterns 11

4.3.4 NSAT01 Satellite Antenna Gain Patterns 13

4.4 Signal description 14

4.4.1 NSAT01.001 L5T Signal Parameters 14

4.4.2 NSAT01.001 E5T Signal Parameters 15

4.4.3 NSAT01 L5T Signal Parameters 15

4.4.4 NSAT01 E5T Signal Parameters 16

1 Scope

This document compiles NSAT01.001 and NSAT01.001 system parameters assumptions, which has impact on the additional aggregated PFD of RNSS signals in the 1164-1215 MHz frequency band concerned by ITU Resolution 609 Consultation meeting.

It contains three main parts after the general assumptions:

1. NSAT01.001 and NSAT01 orbit parameters assumptions
2. NSAT01.001 and NSAT01 satellite RNSS payload assumptions
3. NSAT01.001 and NSAT01 RNSS signals assumptions

2 Reference Documents

	No reference document for this version

3 Acronyms and definitions

3.1 Acronyms

BOC	Binary Offset Carrier
LEO	Low Earth Orbit
GNSS	Global Navigation Satellite Service
NSSTC	National Space Science Technology Center
NSAT01.001	NSAT experimental satellite
NSAT01	NSAT satellite constellation network
PNT	Position Navigation Timing
PRN	Pseudo Random Code
RF	Radio Frequency
SIS	Signal-in-Space
TRA	Telecommunication Regulatory Authority
UAEU	United Arab Emirates University

3.2 Definitions

The NSSTC of UAEU provides here information about NSSTC two satellite networks which will transmit RNSS signals in the 1164-1215 MHz band concerned by ITU Resolution 609. These two satellite networks are called NSAT01.001 and NSAT01. This information should allow participants to the ITU Resolution 609 meeting to cross check the compatibility of the two satellite networks with Resolution 609, in term of additional aggregated PFD.

The complete ITU references of our two satellite networks are mentioned hereafter, in accordance with the ITU list of RNSS publication identified in the frequency band 1164-1215 MHz, as of 08 April 2021 (keeping the ITU accronyms describing the columns).

ntc_id	adm	org	sat_name	long_nom	ntf_rsn	d_rcv	pub_ref	pub_no	ific_no	d_ific	dBiU
119520187	UAE		NSAT01	N-GSO	C	07.08.2019	CR/C	5121	2914	18.02.2020	
119520188	UAE		NSAT01.001	N-GSO	C	07.08.2019	CR/C	5122	2914	18.02.2020	

The date of receipt by ITU of the NSAT01.001 and NSAT01 notices is the 7th of August 2019.

BOC - Binary Offset Carrier is a measure to form the spectral shape (power spectral density distribution over frequency) of a transmitted signal. BOC type signals are usually expressed in the form BOC(f_{shift},f_{chip}) where frequencies are indicated as multiples of the GNSS reference frequency of 1.023 MHz.

For example, a BOC(2,1) signal has actually a sub-carrier frequency of 2 x 1.023 MHz = 2.046 MHz and a code chip rate of 1 x 1.023MHz = 1.023 MHz.

The central frequencies of the NSAT01.001 and NSAT01 satellite networks are as follows:

NSAT01.001 GNSS central frequencies:

L5T	1176.450 MHz
E5T	1191.795 MHz
ST	2491.005 MHz

NSAT01 GNSS central frequencies:

L5T	1176.450 MHz
E5T	1191.795 MHz
ST	2491.005 MHz

4 Reference System Assumptions

4.1 General Parameters

The format of some parameters provided in this ICD is maybe not the one expected in certain cases, but we thank the Resolution 609 team in advance to consider the provided information to perform official technical examination allowing us spectrum granting, in particular for NSAT01.001 satellite, which will be launched in 2021:

4.1.1 NSAT01.001 General Parameters

NSAT01.001 is a single experimental LEO GNSS cubesat satellite which will transmit GNSS waveforms in L and S bands.

NSAT01.001 has operational restrictions as follows:

- L5T and E5T signals will be transmitted only when NSAT01.001 is above the ground station in the UAE.
- The mentioned signals will not be transmitted during every pass over the ground station.
- During RNSS transmission periods, the L5T and E5T beams will be pointed towards the ground station.
- The transmitted power for L5T and E5T mentioned in paragraph 4.3.1 is tunable on board the NSAT01.001 satellite and could be reduced of a few % if needed.
- NSAT01.001 is not intended to be operated more than 3 years after its launch, currently planned in Q3/Q4 2021.

4.1.2 NSAT01 General Parameters

NSAT01 will be a LEO PNT constellation of 96 cubesatellites overlaying other GNSS systems. The inclination of the related orbits is 40 degrees. NSAT01 will transmit GNSS waveforms in L and S bands.

The transmitted power for L5T and E5T mentioned in paragraph 4.3.2 will tunable on board the NSAT01 satellites and could be reduced if required.

4.2 Orbit and Constellation Parameters

4.2.1 NSAT01.001 Orbit Parameters

The orbital parameters of NSAT01.001 are presented in the following table:

Table 1: Orbital parameters of NSAT01.001

Orbital plane id. no.	*A4b4a Inclination angle*	*A4b4b No. of satellites in this plane*	*A4b4d Apogee*	*A4b4e Perigee*	*A4b4f Min. altitude*
1	**97 degrees**	**1**	**500 km**	**500 km**	**500 km**

4.2.2 NSAT01 Orbit and Constellation Parameters

The Orbit Parameters of NSAT01.001 are summarized herefter:

- No. of satellite per constellation : 96 satellites
- Orbit : Circular
- Altitude : 800 km
- Number of orbits : 8
- Number of satellites per orbit : 12, separated by 30 degrees
- Inclination of all the orbits : 40 degrees

The NSAT01 orbit and constellation parameters are in the following tables:

Table 2: Orbit and constellation parameters of NSAT01 (Part 1)

Orbital plane id. no.	Inclination angle	No. of satellites in this plane	Period (h)	Apogee (km)	Perigee (km)	Min. altitude (km)	Arg. of perigee
1	40	12	1H40	800	800	800	0
2	40	12	1H40	800	800	800	45
3	40	12	1H40	800	800	800	90
4	40	12	1H40	800	800	800	135
5	40	12	1H40	800	800	800	180
6	40	12	1H40	800	800	800	225
7	40	12	1H40	800	800	800	270
8	40	12	1H40	800	800	800	315

Table 3: Orbit and constellation parameters of NSAT01 (Part 2)

Orbital plane no.	Satellite no.	Initial phase angle
K	1	0
K	2	30
K	3	60
K	4	90
K	5	120
K	6	150
K	7	180
K	8	210
K	9	240
K	10	270
K	11	300
K	12	330

4.3 Satellite and Payload Parameters

The satellite and payload parameters mainly consist of transmitted power and satellite antenna gain patterns.

4.3.1 NSAT01.001 Transmitted Power

“L5T”-band Satellite transmited power at the antenna output is 0.35 Watt

“E5T”-band Satellite transmited power at the antenna output is 0.35 Watt

On board power control is implemented on board NSAT01.001

4.3.2 NSAT01 Transmitted Power

“L5”-band Satellite transmited power at the antenna output is 3 Watts

“E5”-band Satellite transmited power at the antenna output is 3 Watts

On board power control will be implemented on board NSAT01.001

4.3.3 NSAT01.001 Satellite Antenna Gain Patterns

The NSAT01.001 LE-E5 transmitting experimental antenna has been built in the UAE. The in-axis antenna gain is 10.6 dB, in the direction of 0 degree shown in the directivity patern (Figure 1). The directivity is 0 dB in that direction (Figure 1). The 3 dB antenna beam width is +/- 52.5 degrees.

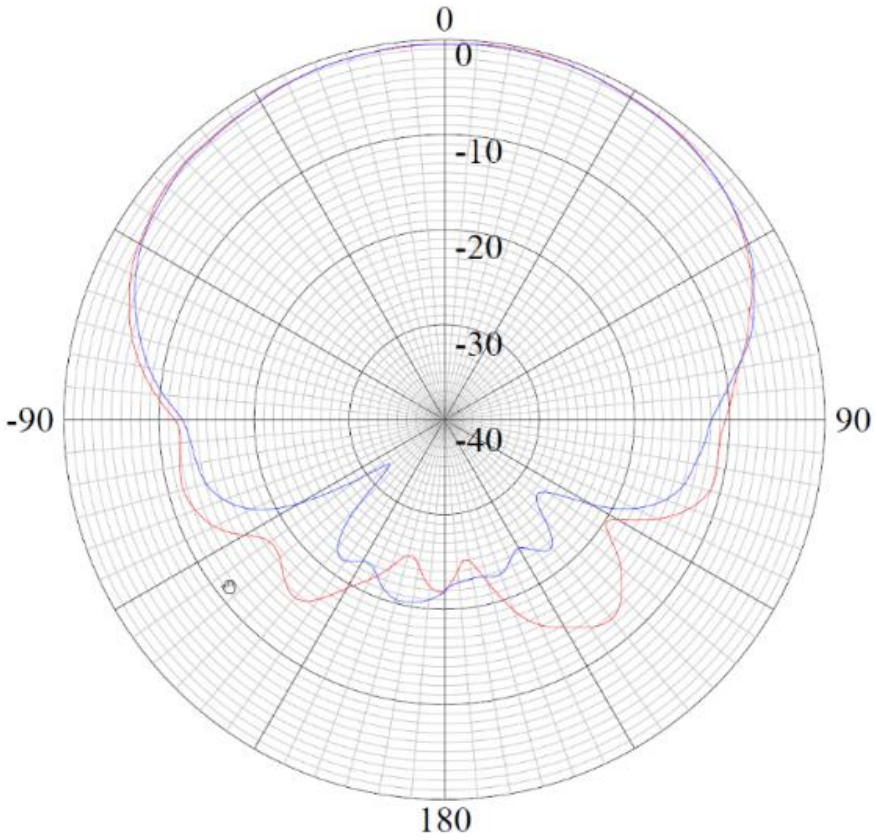


Figure 1 : NSAT01.001 transmitting directivity antenna patern in dBi,
in L5T and E5T bands

- The NSAT01.001 antenna pointing accuracy is 1 degree.
- NSAT01.001 polarization is RHCP.
- NSAT01.001 Antenna phase quality: The polarization losses between the NSAT01 transmitting antenna and a typical 0 dBic user antenna gain are estimated to be 1.5 dB.

4.3.4 NSAT01 Satellite Antenna Gain Patterns

The NSAT01 L5-E5 antenna will be nominally built in the UAE. The pattern has isoflux features to limit the transmitted power and related PFD. The absolute gain antenna pattern is provided in Figure 2.

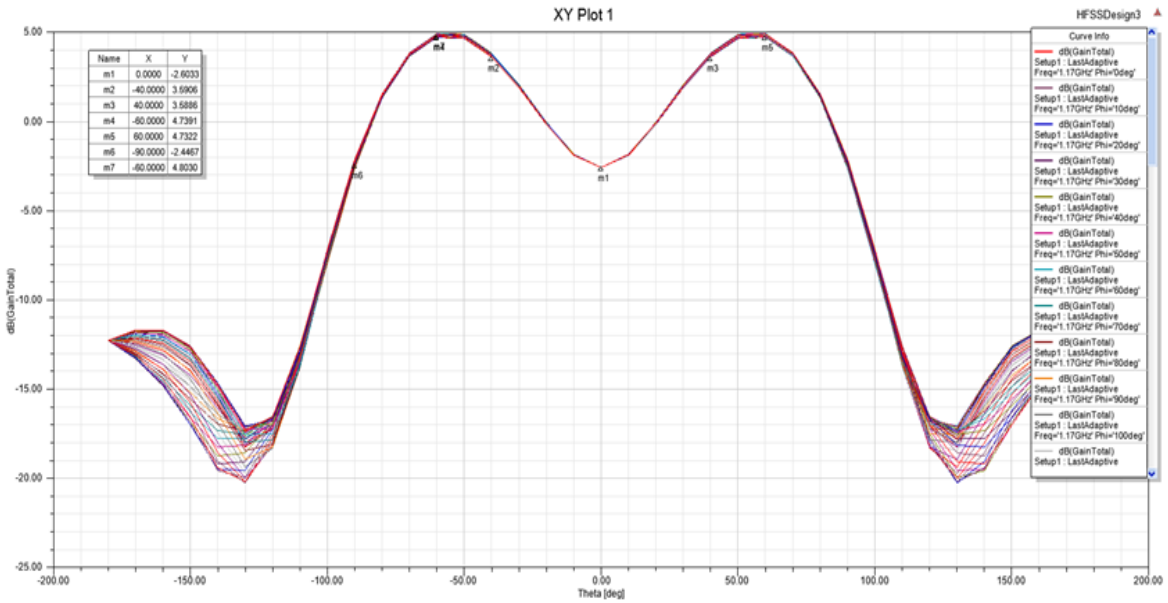


Figure 2 : NSAT01 absolute gain antenna pattern in dBi, in L5T and E5T bands

- The NSAT01 antenna pointing accuracy is 1 degree.
- NSAT01 antenna polarization is RHCP.
- NSAT01 antenna phase quality: The polarization losses between the NSAT01 transmitting antenna and a typical 0 dBic user antenna gain is estimated to be 1.5 dB.

4.4 Signal description

The NSAT01.001 experimental satellite will allow the testing of several waveforms, including the baseline signal and one optional signal.

The NSAT01 satellites will transmit in L-band waveforms which will be choosen among the different possibilities presented hereafter thanks to several selection criteria, among which the feedbacks of the Resolution 609 meeting in 2021, and the GNSS raw measurement performance results of NSAT01.001.

As a reminder, BOC(n,m) means a Binary Offset Carrier modulation having a subcarrier frequency of n times 1.023 MHz and a spread spectrum chip rate of m times 1.023 Mcps.

The NSAT01.001 and NSAT01 baseline signal waveforms are BOC(2,1) for each central frequency in L5T and E5T bands. This baseline waveform has been choosen in 2018, and succesfully checked versus Resolution 609 PFD margin available in 2018. The date of receipt by ITU of the NSAT01.001 and NSAT01 notices is before the Resolution 609 meeting of 2019. As backup, the optional signal waveform has been proposed also for cross-checkings of Resolution 609 meeting participants.

All the proposed signals in L5T are BOC signals to be within the PFD limit at 1176.45 MHz, where the RNSS aggregated PFD has a maximum in the 1164-1215 MHz frequency band.

4.4.1 NSAT01.001 L5T Signal Parameters

The NSAT01.001 baseline in L5T band is a BOC(2,1) waveform. The NSAT01.001 option in L5T band is a BOC(2,2) waveform.

The NSAT01.001 signal in L5T is a data channel signal, with a data rate of 25 bits/s and a data symbol rate of 50 symbol/s.

The NSAT01.001 PRN code length used for L5T signals are 1023 chips long. The used PRN codes are specific. As such, we would like to report than whatever the

NSAT01.001 signal PRN code structure, the interference on other GNSS signals in L5/E5a/B2a/… band will be nearly the same from a technical point of view, taking into account the specific spectral shape of the NSAT01.001 waveform, and the Doppler dynamic carried-out by a LEO satellite.

The declared unfiltered L5T band is 16*1.023 MHz

4.4.2 NSAT01.001 E5T Signal Parameters

The NSAT01.001 baseline waveform in E5T band is a BOC(2,1). The NSAT01.001 option in E5T band is a BOC(2,2) waveform.

The NSAT01.001 signal in E5T is a pilot channel signal.

The NSAT01.001 PRN code length used for E5T signals are 1023 chips long. The used PRN codes are specific.

The declared unfiltered E5T band is 16*1.023 MHz

4.4.3 NSAT01 L5T Signal Parameters

The NSAT01 baseline in L5T band is a BOC(2,1) waveform. The NSAT01 option in L5T band is a BOC(2,2) waveform.

In addition to these baseline and option, NSAT01 satellite network also has a BOC(4,2) option in L5T band that we kindly request to be also considered in Resolution 609 cross-checking analysis.

The NSAT01 signals in L5T band are transmitted in both a data and a pilot channel, each sharing 50% of the transmitted power. The data channel has a data rate of 25 bits/s and a data symbol rate of 50 symbol/s.

The NSAT01 PRN code length used for L5T signals are 1023 chips long. The used PRN codes are specific. As such, we would like to report than whatever the NSAT01.001 signal PRN code structure, the interference on other GNSS signals in L5/E5a/B2a/… band will be nearly the same from a technical point of view, taking into account the specific spectral shape of the NSAT01.001 waveform, and the Doppler dynamic carried-out by a LEO satellite.

The declared unfiltered L5T band is 16*1.023 MHz

4.4.4 NSAT01 E5T Signal Parameters

The NSAT01 baseline waveform in E5T band is a BOC(2,1). The NSAT01 option in E5T band is a BOC(2,2) waveform.

In addition to these baseline and option, NSAT01 satellite network also has a BOC(4,2) option in L5T band that we kindly request to be also considered in Resolution 609 cross-checking analysis.

The NSAT01 signal in E5T band is both a data and a pilot channel, each sharing 50% of the transmitted power. The data channel has a data rate of 25 bits/s and a data symbol rate of 50 symbol/s.

The NSAT01.001 PRN code length used for E5T signals are 1023 chips long. The used PRN codes are specific.

The declared unfiltered E5T band is 16*1.023 MHz

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