Interactive Satellite Terminal (IST)

Minimum Technical and Operational Requirements

Standard I

February 2019

EESS 503

Issue 1 / Rev. 1

eutelsat

eutelsat

communications via satellite

INTERACTIVE SATELLITE TERMINAL (IST) STANDARD

EESS 503

ISSUE 1 - REV. 1

February 2019

EESS 503 REVISION HISTORY

Issue/Revision	Date	Pages revised since the last version
1/0	9 April 2018	Original Issue
1/1	1 February 2019	8, 11, 13, 15, 22

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1. INTRODUCTION

Under EUTELSAT procedures, access to the Eutelsat space segment requires the prior approval of terminals (See ESOG Module 120).

The purpose of this document is to define the technical and operational conditions under which approval for access to the Eutelsat space segment may be granted to an Interactive Satellite Terminal (IST) for transmission and reception of carriers, in association with the related modulation and channel coding.

1.1. IST/SMARTLNB

IST, commercially also denoted as SmartLNB, represents a satellite terminal technology tailored to applications requiring low to modest throughput on the return link.

IST mainly targets:

1. Mass-market applications : connected TV and home automation
2. Professional applications: M2M (Machine-to-Machine) and IoT (Internet of Things) backhauling, Low Cost Internet Access.

IST is composed of:

a) A Satellite Dish (consumer grade or professional grade).

- Consumer grade is mainly used for mass-market applications. It shall be capable of receiving Ku-band DTH satellite signals and transmitting information through different frequency bands (see Tables 2.1 and 2.2). A fine-pointing mechanism is strongly recommended.

- Professional grade is required in professional applications. It shall be capable of receiving Ku-band and Ka-band satellite signals and transmitting information through different frequency bands (see Tables 2.3). The antenna shall be solid, qualified for the target application, compatible with mechanical and environmental requirements and it shall be practical in terms of mounting and installation A fine-pointing mechanism is required.

b) An Outdoor Unit (ODU), acting as an electronic interactive feed integrating a satellite modem and an IP router that shall be mountable onto a consumer grade and/or a professional grade satellite dish. The ODU translates the transmissions with the satellite system (air interface) to transmissions with the IDU.

c) An Indoor unit (IDU), providing electrical power to the ODU. It translates transmissions from/to the ODU onto standard interfaces for existing IP and/or multimedia devices or home appliances. Two types of IDU can be introduced in the IST setup:

- Ethernet over Coax mainly used for mass-market applications. This IDU uses coax cable as a physical means to interact with the ODU. The IDU shall separate Ethernet from L-Band signals coming from ODU.

- Power over Ethernet mainly used for professional applications that do not require TV channel reception on legacy STB (Set-Top-Box). This IDU is a PSE (Power Supplier Equipment) capable of powering the ODU and making available Ethernet traffic indoor through a RJ45 output connector.

1.2. SYSTEM OVERVIEW

As part of the “Eutelsat Broadcast Interactive System” ("EBIS"), Eutelsat has developed and deployed a series of platforms ("EBIS Platform") providing satellite services through the use of low-cost IST named “SmartLNB terminals”, hereafter referred to as “IST”, and Eutelsat satellites for different coverage areas.

The EBIS system – as depicted in Figure 1.2. – is composed of an IST communicating through a Eutelsat satellite with the EBIS headend. Each IST belonging to this network is equipped with an Ethernet port and acts as a modem/router capable of connecting any Customer IP device directly or through a LAN to the public internet or to the Customer PoP (Point of Presence) according to the service specifications detailed hereafter.

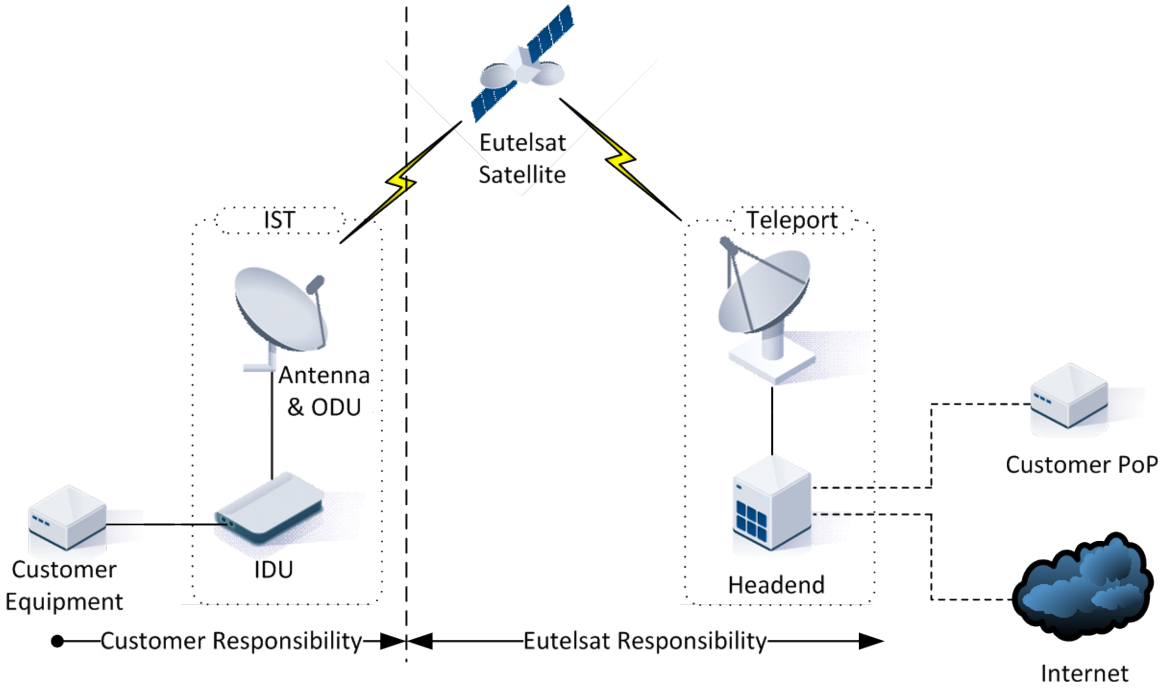

Figure 1.2.: System Architecture Overview (only one terminal is shown)

The EBIS headend is composed of a transmit and receive infrastructure at the teleport including its associated subsystems and provides an interface to the public internet. Each EBIS headend communicates with the IST through the satellite.

IST can be either fixed or mobile. For mobile applications satellite tracking is a mandatory requirement.

2. IST CONFIGURATIONS

This section presents the possible configurations applicable to each IST, for the transmitting (see Section 2.1) and receiving (see section 2.2) frequency bands. Depending on the selected frequency bands, several IST models (see Section 2.3) can be defined. Lastly, a list of antenna types (see Section 2.4) of various dimensions is provided as a reference.

2.1. IST Transmit Frequency Bands

The following table lists all possible transmit frequency bands applicable to an IST. Each set of frequency range(s) is uniquely identifiable (see 1st column of the table below).

Table 2.1: IST Transmit Frequency Bands

TX Band_Id	Reference	Transmit Frequency Band (GHz)
C_TX	C	5.850 - 6.725 6.725 - 7.025
Ku_ TX 1	Ku - AP30B	12.75 - 13.25
Ku_ TX 2	Ku	13.75 - 14.00
Ku_ TX 3	Ku	14.00 - 14.50
Ku_ Tx 4	Ku	14.50 - 14.75
K_ TX	K (DBS uplink)	17.30 - 18.10 18.10 - 18.40
Ka_ TX 1	Ka	27.50 - 30.00
Ka_ TX 2	Ka	30.00 - 31.00

2.2. IST RECEIVE FREQUENCY BANDS

The following table lists all possible receive frequency bands applicable to an IST. Each set of frequency range(s) is uniquely identifiable (see 1st column of the table below).

Table 2.2: IST Receive Frequency Bands

RX Band_Id	Reference	Receive Frequency Band (GHz)
C_RX	C	3.400 - 4.200 4.500 - 4.800
Ku_ RX	Ku	10.70 -12.75
K_ RX	K (DBS uplink)	10.70 -12.75
Ka_ RX 1	Ka	17.70 - 20.20
Ka_ RX 2	Ka	20.20 - 21.20

2.3. IST MODELS

The below table defines the possible IST models taking into account the transmit and receive frequency range as well as the selected polarization (either circular or linear).

Table 2.3. - IST Models

Model_ID	**Rx frequency bands**	**Rx pol.**	**Tx frequency band**	**Tx pol.**
1	Ku_RX	Linear, Horizontal/Vertical Switchable	Ka_TX1	Circular, RHCP/LHCP Switchable
1_CP	Ku_RX	Circular, RHCP/LHCP Switchable	Ka_TX1	Circular, RHCP/LHCP Switchable
2	Ku_RX	Linear, Horizontal/Vertical Switchable	C_TX	Circular, RHCP/LHCP Switchable
3	Ku_RX	Linear, Horizontal/Vertical Switchable	Ku_TX1/2/3	Linear, Horizontal/Vertical Switchable
3_DBS	K_ RX	Linear, Horizontal/Vertical Switchable	K_ TX	Linear, Horizontal/Vertical Switchable
4	Ka_RX1/2	Circular, RHCP/LHCP Switchable	Ka_TX1/2	Circular, RHCP/LHCP Switchable

2.4. IST ANTENNA TYPES

A list of reference antenna types is provided below in order to easily refer to each of them in the rest of this document. The first column contains the unique identifier used to define the type and the dimension of the antenna concerned.

Table 2.4. - IST Antenna Types

Antenna_ID	**Type**	**Dimensions**
D_120	Reflector	120cm Ø
D_75	Reflector	75cm Ø
D_60	Reflector	60cm Ø
D_45	Reflector	45cm Ø
D_30	Reflector	30cm Ø

2.5. IST CHANNEL BANDWIDTH

The possible channel bandwidths supported by an IST are listed hereafter.

Table 2.5. - IST Channel Bandwidth

Channel_ID	Bandwidth	Supported by IST Model
2.5 MHz	2.5 MHz	1,1_circ, 2, 3, 3_dbs, 4
5 MHz	5 MHz	1,1_circ, 2, 3, 3_dbs, 4
10 MHz	10 MHz	1,1_circ, 2, 3, 3_dbs, 4
40 MHz	40 MHz	4

3. GENERAL RADIO FREQUENCY REQUIREMENTS

3.1. General

The IST design shall be such that changes in transmit and receive carrier frequencies and power levels are possible so as to meet system planning requirements and ensure flexibility in intersystem coordination.

For the definition of the maximum permitted EIRP spectral density, refer to Chapter 6 (EMISSION CONSTRAINTS) of the standard EESS 502.

3.2. IST Bandwidth

The transmit and receive system shall be designed in such a way as to operate at any frequency within the specified frequency band as defined in Table 2.1. and 2.2

3.3. Receive Characteristics

Receive characteristics of the IST which are independent from environmental conditions, i.e. the receive antenna gain and the noise figure, are defined within this section.

3.3.1. IST Receive Antenna Gain

The Receive Antenna Gain of the IST antenna sub-system (consumer grade and professional grade), as defined below, shall not underperform the criteria provided within this subsection.

For IST antenna sub-systems constructed as parabolic dish antennas the ratio of the effective area (A_{eff}) to the physical area (A) denoted as antenna efficiency, recommended to be no less than 0.65. Indicative values for the C, Ku, K and Ka frequency bands are provided in Table 3.3.1 below. The antenna gain (in dBi) of the parabolic dish antenna can be derived as:

$$G = 10 \cdot \log_{10}\left(A_{eff} \cdot \frac{4\pi}{\lambda^2} \right)$$

where A_{eff} is provided in square meters (m^2) and the wavelength λ are provided in meters (m).

The values given in Table 3.3.1 represent typical values for the considered frequency bands providing a guideline for manufacturers.

The Rx antenna gain is measured at the feed RF output port (i.e. in Ku band).

Table 3.3.1 - IST Minimum Receive Antenna Gain

Antenna_ID	Rx Band_ID	IST Minimum Antenna RX Gain
D_120	C_RX @4.1GHz Ku_RX@11.725GHz K_RX@11.725GHz Ka_RX1@18.95GHz Ka_RX2@20.7GHz	32.4 dBi 41.5 dBi 41.5 dBi 45.7 dBi 46.4 dBi
D_75	C_RX @4.1GHz Ku_RX@11.725GHz K_RX@11.725GHz Ka_RX1@18.95GHz Ka_RX2@20.7GHz	28.3 dBi 37.4 dBi N/A 41.6 dBi 42.4 dBi
D_60	C_RX @4.1GHz Ku_RX@11.725GHz K_RX@11.725GHz Ka_RX1@18.95GHz Ka_RX2@20.7GHz	N/A 35.5 dBi N/A 39.6 dBi 40.4 dBi
D_45	C_RX @4.1GHz Ku_RX@11.725GHz K_RX@11.725GHz Ka_RX1@18.95GHz Ka_RX2@20.7GHz	N/A 33 dBi N/A 37.1 dBi 37.9 dBi
D_30	C_RX @4.1GHz Ku_RX@11.725GHz K_RX@11.725GHz Ka_RX1@18.95GHz Ka_RX2@20.7GHz	N/A 29.5 dBi N/A 33.6 dBi 34.4 dBi

3.3.2. IST Noise Figure

The IST Noise Figure F_{ODU} encompasses noise contributions from the receiver structure in the IST ODU including feed losses as sketched in Figure 3.3.2. The relationship between equivalent ODU noise temperature T_{ODU} in Kelvin (K) and the logarithmic representation of the noise figure $F_{ODU_{[dB]}}$ is determined by

$$T_{ODU} = \left(10^{F_{ODU_{[dB]}}/10} - 1\right) \cdot 290\ K$$

The F_{ODU} $[dB]$ is given in Table 3.3.2 for specific IST models.

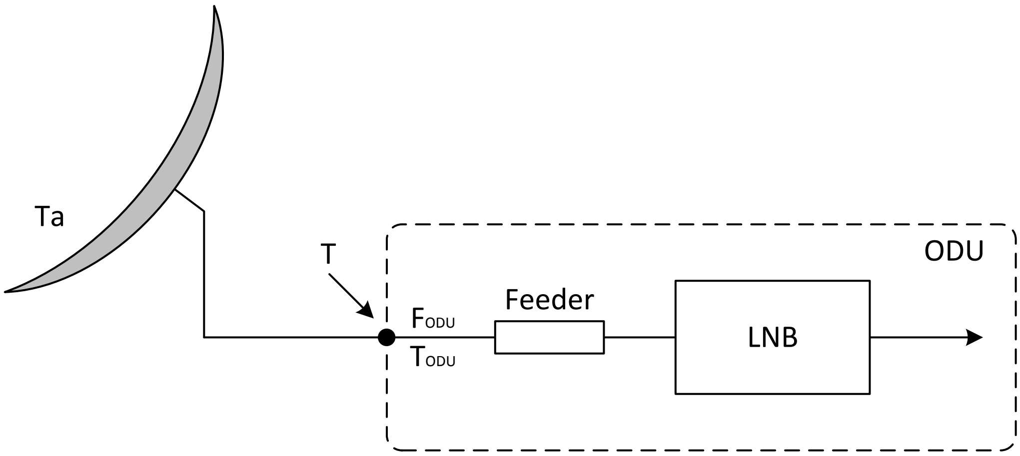

Figure 3.3.2.: IST noise model

The noise figure in decibels shall not exceed the values provided in Table 3.3.2 for specific IST models defined in Section 2.3.

The noise figure and antenna gain shall refer to the same interface.

Table 3.3.2 - IST Noise Figure

Model	**Noise figure** F_{ODU} $[dB]$
1	0.6
1_CP	0.8
2	0.8
3	0.8
3_DBS	0.8
4	1.8

The system noise temperature in Kelvin (K) can be calculated as follows:

$$T = T_a(\delta) + T_{ODU}$$

where $T_a(\delta)$ represents the antenna noise temperature in Kelvin at an elevation angle δ under clear sky conditions and T_{ODU} is the equivalent noise temperature of the ODU as described above. The proponent shall indicate down to which elevation angle the terminal figure of merit expressed by the G/T is reduced by 1 dB with respect to the G/T at zenith (i.e. 90° of elevation).

3.4. Common Wideband Receiving Amplifier Linearity Requirements

When two equal signals at any frequency within the IST receive band(s), each having a level of -88 dBW, are applied at the input of the wideband receiving amplifier subsystem, the level of any third order intermodulation product shall be at least 50 dB below the level of each signal, measured at the output of the subsystem.

3.5. Transmit and Receive Chain Amplitude and Group Delay Response

The transmit chain gain response, measured from the modulator output to the antenna transmit feed port, shall be flat to within ±0.25 dB in any 10 MHz bandwidth within the operating frequency band.

The receive chain gain response, measured from the antenna feed port output to the demodulator input, shall be flat to within ±0.5 dB in any 72 MHz bandwidth within the operating frequency band, and ±5 dB within the full receive frequency band.

The transmit chain group delay frequency response, measured from the modulator output to the antenna transmit feed port, shall be flat to within ±5 ns in any 10 MHz bandwidth within the operating frequency band.

The receive chain group delay frequency response, measured from the antenna feed port output to the demodulator input, shall be flat to within ±1 ns in any 72 MHz bandwidth within the operating frequency band. This applies when no group delay equalization is used in the demodulator. If group delay equalization is applied, the group delay variation shall be flat to ±5 ns in any 72 MHz bandwidth.

4. ANTENNA PERFORMANCE CHARACTERISTICS

4.1. ANTENNA SIDELOBE PATTERN / OFF-AXIS GAIN

4.1.1. Specified Envelope Transmit and Receive

Over the full extent of the antenna transmit frequency bands, the gain of the antenna sidelobe peaks shall not exceed:

$29 - 25 \log_{10}\theta$	dBi	for	α*	$< \theta \leq$	7°
+8	dBi	for	7°	$< \theta \leq$	9.2°
$32 - 25 \log_{10}\theta$	dBi	for	9.2°	$< \theta \leq$	48°
-10	dBi	for	48°	$< \theta$	

In addition, in the case of linear polarization in the cross-polarization plane, the gain of the antenna sidelobe peaks should not exceed:

$19 - 25 \log_{10} \theta$	dBi	for	1.8°	$< \theta \leq$	7°
-2	dBi	for	7°	$< \theta \leq$	9.2°

Where θ is the angle (in degrees) between the main beam axis and any direction towards the geostationary satellite orbit (within the bounds between 5° North and 5° South of this orbit, as seen from the center of the earth).

For antennas with a D/λ** ratio less than or equal to 30, over the full extent of the antenna transmit frequency bands, the gain of the antenna sidelobe peaks should not exceed:

$32 + (0.3 \times \alpha^* - 1) - 25 \log_{10}\theta$	dBi	for	α*	$< \theta \leq$	48°
$-10 + (0.3 \times \alpha^* - 1)$	dBi	for	48°	$< \theta$	

* α=1° or (100λ/D) whichever is the greater, where D is the antenna diameter and λ is the carrier wavelength.

** In case of non-circular apertures, D is the dimension of the antenna aperture in the plane of the geostationary orbit, as seen from the IST location.

4.1.2. Transmit and Receive Requirement

Over the full extent of the antennas transmit frequency bands, the antenna sidelobe peaks shall not exceed 10% of the envelopes specified in Chapter 4. Any individual peak shall not exceed those envelopes by more than 6 dB when θ is greater than 9.2° and by more than 3 dB when θ is equal to or smaller than 9.2°.

4.2. POLARIZATION

4.2.1. Polarization Capability

The terminal shall be capable of receiving simultaneously on both polarizations (linear or circular, see Table 2.3 for reference):

- Linear for Ku-Band;
- Circular for C-Band and Ka-Band

The terminal shall be capable of transmitting on one selectable polarization (linear or circular, see Table 2.3 for reference).

All antennas shall be provided with the possibility to change the polarization in which they operate (as seen from the IST location).

4.2.2. Polarization Alignment Capability

For linear polarization, the transmit and receive polarization alignment shall be adjusted, and if in move, the IST shall be continuously maintained, within 1° of the nominal satellite receive antenna polarization plane as seen from the IST location.

4.2.3. Polarization Discrimination

The corresponding values of the reference cross-polarization discrimination (transmit and receive) are the following:

- $\geq$ 25 dB for professional grade antenna,
- $\geq$ 20 dB for consumer grade antenna.

It is strongly recommended that the manufacturer provides a suitable smart-phone application which allows the precise setting of the polarization angle. The application shall include a look-up table providing the appropriate polarization offset angles.

Over the full extent of the antenna transmit frequency bands, the antenna polarization discrimination in the direction of the satellite shall correspond to the applicable reference value everywhere within a cone centred on the main beam axis, with the cone angle defined by the pointing error or the -1 dB contour of the main beam axis, whichever is greater.

4.3. ANTENNA STEERING

4.3.1. Antenna Steerability

All transmit IST shall be equipped with precise fine adjustment capabilities in both azimuth and elevation.

For operational reasons, it should be possible to point the antenna in the direction of any geostationary satellite visible from the IST location.

Transmissions with low elevation angles (below 10°) can be affected by tropospheric scintillations, under both adverse weather and clear weather conditions. Scintillation can impair the quality of the transmitted services and be a source of interference to other services.

Operation at such low elevation angles is considered to be critical and is therefore not recommended for permanent services.

In cases where such transmissions take place, either occasional, or permanent, additional restrictions may need to be applied on a case by case basis. In particular, in case of proven interference related to tropospheric scintillation, the IST generating the interference must immediately reduce the transmit EIRP or immediately stop transmissions as directed by the EBIS headend operator.

4.3.2. Antenna Beam Pointing Accuracy

In order to protect transmissions on other satellites and to ensure a suitable reception quality, the antenna main beam axis shall not deviate by more than ±ε [°] from the nominal direction of the satellite along the geostationary orbit, under the operating conditions and taking into account all relevant contributions including wind speeds of 72 km/h (45mph) and at higher speeds at which the IST may have to operate. In degrees ε is derived as

$$\varepsilon = 14 \cdot \frac{\lambda}{D} ,$$

where λ denotes the shortest wavelength of the TX/RX frequency bands in [m] and D is the antenna diameter in [m] in the direction of the Geostationary Orbit Arc.

Table 4.3.2 – Examples for pointing accuracy

Model	Rx frequency bands	Tx frequency band	Antenna ID	ε [°]
1	Ku_RX (12.750 GHz)	Ka_TX1 (30.000 GHz)	D_75 (0.75 m)	0.19
2	Ku_RX (12.750 GHz)	C_TX (7.025 GHz)	D_120 (1.20 m)	0.27
3	Ku_RX (12.750 GHz)	Ku_TX3 (14.50 GHz)	D_60 (0.60 m)	0.48

The above requirements apply to fixed and mobile IST.
For mobile IST, the above beam pointing accuracy requirement shall include the satellite tracking error.

4.3.3. Receive Capability

To ensure compliance of beam pointing accuracy with the Standard as specified in Paragraph 4.3.2., the transmit IST must be equipped with a receive chain which allows initial pointing optimization and tracking during transmission

4.3.4. Transmit and Receive Port Isolation and Filtering

The transmit/receive port isolation and transmit/receive filtering shall be such as to ensure that the receive E_b/N_o remains unchanged independently from transmission status (on or off). This applies even if reception is in the same polarization as transmission.

5. CARRIER CHARACTERISTICS

5.1. General

Eutelsat will assign the transmission and reception frequencies to be used for each of the carriers. Whichever frequencies may be initially assigned to the carriers, operational constraints may require that the frequency of a carrier(s) be changed at short notice, within the IST transmit and receive bands (see Section 2.1 and 2.2).

5.2. Carrier Frequency Tolerance

5.2.1. Transmit Frequency

The frequency tolerance (intended as initial frequency adjustment plus long-term drift, assumed being at least one month) of each carrier transmitted by the IST shall be in the range of ±1.5 kHz. The short term frequency stability shall be less than 20 Hz in 250 ms.

5.2.2. Receive Frequency

The frequency tolerance (maximum uncertainty of initial frequency adjustment plus long-term drift assumed as being at least one month) of each carrier transmitted by the IST shall be in the following range:

±1 MHz, in the full temperature range from -40°C to 70°C

±0.25 MHz at 25°C

5.3. Phase Noise

5.3.1. Transmit Phase Noise

The phase noise induced on any transmitted carrier consists of continuous and periodic components and shall satisfy both of the following limits:

a) **Periodic component**: The largest single periodic component shall not exceed -30 dB relative to the level of the transmitted carrier. The single sideband sum, in 40 MHz bandwidth (added on a power basis) of all other individual periodic components, shall not exceed -36 dB relative to the level of the transmitted carrier (the total phase noise including both sidebands can be up to 3 dB higher).

b) **Continuous component**: The single sideband power spectral density of the continuous component shall not exceed the envelope shown below.

Frequency offset	SSB Phase Noise
10 Hz	≤-16 dBc/Hz
100 Hz	≤-52 dBc/Hz
1 kHz	≤-64 dBc/Hz
10 kHz	≤-74 dBc/Hz
100 kHz	≤-85 dBc/Hz
>1 MHz	≤-106 dBc/Hz

5.3.2. Receive Phase Noise

The phase noise requirement for the receive side of the continuous component shall not exceed the envelope shown below:

Frequency offset	SSB Phase Noise
1 KHz	≤-50 dBc/Hz
10 KHz	≤-75 dBc/Hz
100 KHz	≤-95 dBc/Hz
1 MHz	≤-100 dBc/Hz

5.4. Frequency Spectrum

The spectrum at the input of the IST transmit antenna shall not be inverted with respect to the modulator output.

5.5. Transmission Characteristics

This section provide details of the main transmission characteristics related to an IST.

5.5.1. IST Transmit RF Output Power

The following table provides the Minimum RF Output Power expected for each IST Model defined in Section 2.3.

Table 5.5.1 – IST Transmit Minimum RF Output Power

Model	**Transmitted Output Power (with linear behaviour – see note below*)**	
1	0.1 W	20 dBm
1_CP	0.1 W	20 dBm
2	1 W	30 dBm
3	0.5 W	27 dBm
3_DBS	0.5 W	27 dBm
4	0.25 W	24 dBm

*Note: Linear behaviour means on operating output back-off with respect to saturation power of 3 dB.

5.5.2. IST Transmit Antenna Gain

The transmit antenna gain values for the reference antenna types defined in Section 2.4, are computed hereafter using efficiency at 65% and in proportion of the mid value of each frequency range defined in Section 2.1.

Table 5.5.2 – IST Minimum Transmit Antenna Gain

Antenna_ID	Tx Band_ID	IST Minimum Antenna TX Gain
D_120	C_TX@6.4GHz Ku_TX1@13GHz Ku_TX2/3/4@14.25 GHz K_TX1@17.85GHz Ka_TX1@28.75GHz Ka_TX2@30.5GHz	36.2 dBi 42.4 dBi 43.2 dBi 45.1 dBi 49.3 dBi 49.8 dBi
D_75	C_TX@6.4GHz Ku_TX1@13GHz Ku_TX2/3/4@14.25GHz K_TX1@17.85GHz Ka_TX1@28.75GHz Ka_TX2@30.5GHz	32.2 dBi 38.3 dBi 39.1 dBi N/A 45.2 dBi 45.7 dBi
D_60	C_TX@6.4GHz Ku_TX1@13GHz Ku_TX2/3/4@14.25GHz K_TX1@17.85GHz Ka_TX1@28.75GHz Ka_TX2@30.5GHz	N/A 36.4 dBi 37.2 dBi N/A 43.3 dBi 43.8 dBi
D_45	C_TX@6.4GHz Ku_TX1@13GHz Ku_TX2/3/4@14.25GHz K_TX1@17.85GHz Ka_TX1@28.75GHz Ka_TX2@30.5GHz	N/A 33.9 dBi 34.7 dBi N/A 40.8 dBi 41.3 dBi
D_30	C_TX@6.4GHz Ku_TX1@13GHz Ku_TX2/3/4@14.25GHz K_TX1@17.85GHz Ka_TX1@28.75GHz Ka_TX2@30.5GHz	N/A 30.4 dBi 31.2 dBi N/A 37.2 dBi 37.8 dBi

5.5.3. SSPA Power Stability

The SSPA power stability of any carrier in the direction of the satellite shall be maintained within ± 0.5 dB of the assigned operating value as defined in the relevant transmission plan.

5.5.4. Power Adjustment Capability

The output power of the SSPA shall be adjustable within ±0.5 dB from the assigned nominal value with a delay not exceeding 5 µs.

5.5.5. Cessation of Transmission (Mute)

Means shall be provided to cease the transmission within 1 sec. in case of forward link outage.

6. TERMINAL SPECTRAL EMISSION MASK

This document specifies the in-band and out-of-band spectral emission bounds for a single IST at both Ka and Ku bands.

Out-of-band spurious emissions have a maximum decay of 3 dB per each 1dB of transmission power back-off, when main contributions of the out-of-band spurious emissions are third-order intermodulation products. In this respect, two masks are provided: one with the terminal transmitting at Pmax and another applying a 5dB back-off to the terminal maximum output power.

Masks at IST Full Transmission Power shall not be exceeded. Masks at 5dB back-off are provided as expected pattern behavior, given that other spurious contributions have not been taken into account.

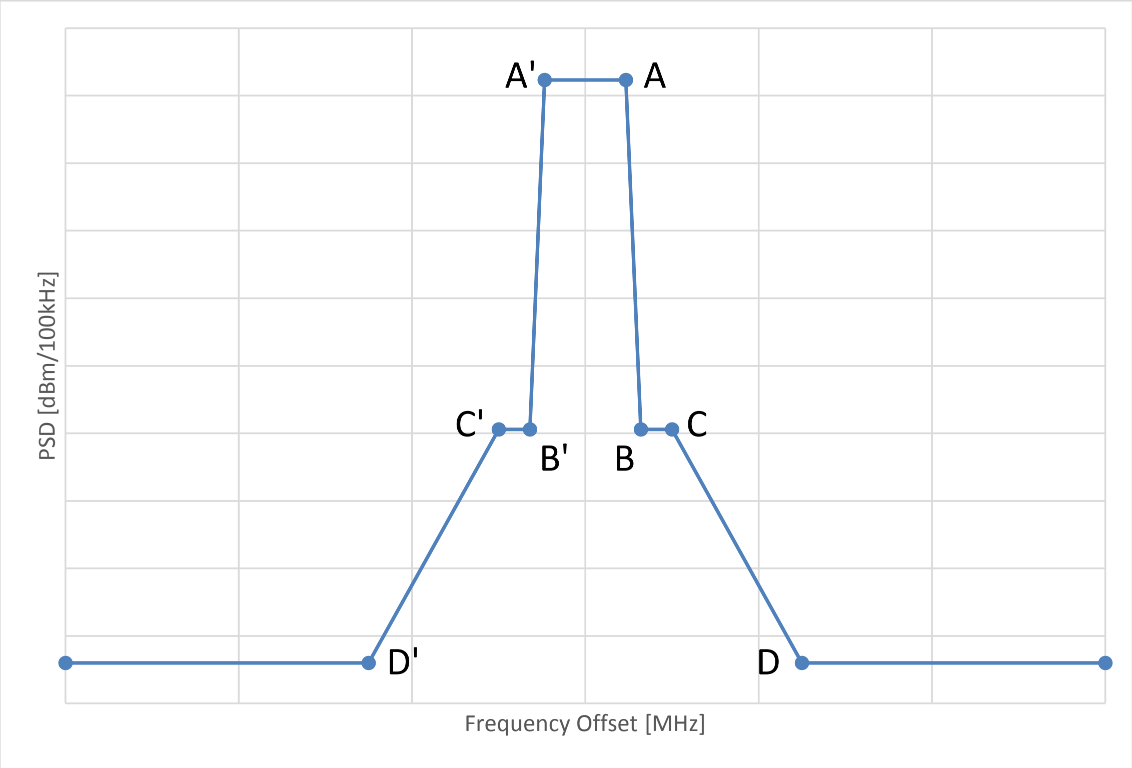

Figure 6.1: Spurious Emission Mask

The coordinates of points $A, A', B, B', C, C', D, D'$ are defined in Table 6 below.

- The Offset Frequency values are expressed in MHz
- The Power Spectral Density (PSD) values are expressed in dBm/100kHz

The mask is symmetrical with respect to the centre frequency vertical axis. Linear interpolation shall be applied between any two adjacent points.

The Power Spectral Density value in dBm/100kHz of the in-band component is computed as:

$$p = P - 10 - 10 \cdot \log(MCh)$$

where P denotes the IST Full Transmission Power at the antenna port input in dBm (as defined in Table 5.5.1) and MCh represents the transmission chip rate or symbol rate expressed in Mchips/s or MBaud.

The 10 dB factor results from the ratio between 1MHz and 100kHz.

Table 6.1 IST Spectral Emission Mask

Frequency Mask Points Coordinates		A, A'	B, B'	C, C'	D, D'
Offset Frequency (MHz)		$\pm 0.6094 \cdot MCh$	$\pm 0.6510 \cdot MCh$	$\pm 1.0417 \cdot MCh$	$\pm 3.552 \cdot MCh$
C-Band	IST Full Transmission Power, P	*p*	-10.7	-10.7	-27
C-Band	Backoff 5dB	*p*-5	-25.7	-25.7	-27
Ku-Band	IST Full Transmission Power, P	*p*	-14.7	-14.7	-32
Ku-Band	Backoff 5dB	*p*-5	-29.7	-29.7	-32
Ka-Band	IST Full Transmission Power, P	*p*	-17.7	-17.7	-39
Ka-Band	Backoff 5dB	*p*-5	-32.7	-32.7	-39
		PSD [dBm/100kHz]			

Figure 6.2 shows an example of spectral emission mask for an IST in Ku-band where $\mathrm{P} = 27\ \mathrm{dBm}$ and $\mathrm{MCh} = 3.84\ \mathrm{Mchips/s}$. Plotted values in Figure 6.2 are listed in Table 6.2 hereafter:

Table 6.2 IST Spectral Emission Mask Values @ P=27 dBm and MCh=3.84 Mchips/s

	Frequency	IST Full Transmission Power P	Backoff 5dB
	MHz	PSD [dBm/100kHz]	
3.84Mchips/s	-30	-32.0	-32.0
	-12.5	-32.0	-32.0
	-4	-14.7	-29.7
	-2.5	-14.7	-29.7
	-2.34	11.16	6.16
	2.34	11.16	6.16
	2.5	-14.7	-29.7
	4	-14.7	-29.7
	12.5	-32.0	-32.0
	-30	-32.0	-32.0

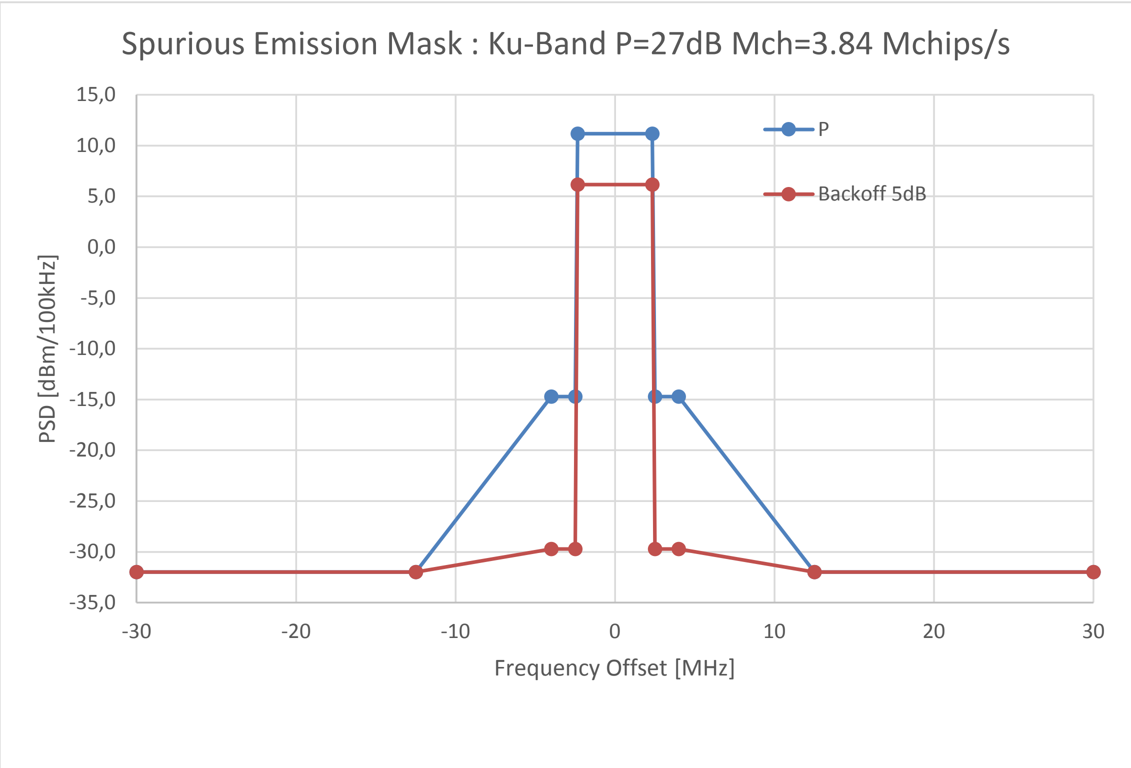

Figure 6.2: Example of Spurious Emission Mask in Ku-Band

7. OPERATING RANGE/CONDITIONS

The main operating range and related conditions are listed in this section. For each condition a specific requirement is provided. The IST shall comply with each requirement listed in Table 6.

Table 7. IST Operating range/conditions

Condition	**Requirement**
Weather protection	Industrial and coastal
Wind load	72 km/h (operational) 160 km/h (survival)
Solar radiation	1120W/m2
Humidity	0-100%
Lightning protection	According to IEC 60728-11 Grounding connection is recommended.
Rain	<100 mm/hr (survival)
Ambient temperature	-33° to +55° C (operational) -50° to +65° C (survival)

8. OPERATIONAL REQUIREMENTS

The operational requirements to be met by IST accessing space segment capacity are detailed in the previous chapters of this document. Only the systems which comply with these requirements and which have received an agreement named "Interactive Satellite Terminal Type Approval/Characterization" from Eutelsat are authorized to access the Eutelsat fleet. The list and details of the IST which are Eutelsat-agreed are available via the following link:
http://www.eutelsat.com/files/contributed/support/pdf/Eutelsat_IST_Services.pdf

The procedure to obtain an "Interactive Satellite Terminal Type Approval/Characterization" from Eutelsat is described in the ESOG 120, available on Eutelsat's website (http://www.eutelsat.com/files/contributed/satellites/pdf/esog120.pdf).

8.1. IST SYSTEM INTEGRITY

All elements of an IST Type Approved Terminal will be outlined in the associated approval certificate. Any alteration which may be relevant to the RF-performance leads to the immediate cessation of the approval. Should the applicant perform modifications to the approved equipment configuration, it will be necessary to apply for a revision of the existing approval, submitting for endorsement the related details to Eutelsat. This concerns in particular:

- Modification of the transmitter or RF power rating.
- Changes in the production of the antenna or feed components.
- Replacement / upgrade of components.
- Modification of the antenna support structure.

9. GLOSSARY – ABBREVIATIONS

DTH	Direct to Home
EBIS	Eutelsat Broadcast Interactive System
IDU	Indoor Unit
IoT	Internet of Things
IP	Internet Protocol
IST	Interactive Satellite Terminal
LAN	Local Area Network
LHCP	Left Hand Circular Polarised
M2M	Machine-to-Machine
ODU	Outdoor Unit
PoP	Point of Presence
RF	Radio Frequency
PSD	Power Spectral Density
PSE	Power Supplier Equipment
RHCP	Right Hand Circular Polarised
STB	Set-Top-Box