Amos Satellite System

Earth-Station

Performance Requirements

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1. General

This document describes the basic performance requirements & characteristics of earth stations, approved to access the AMOS-system space segment. All specified parameters must be fully guaranteed by stations accessing the AMOS network, with primary emphasis on the antenna performance and the radio frequency (RF) subsystems.

Requirements are classified into:

- Mandatory requirements – Affecting the AMOS network users as well as users of other satellites, related to possible interference, transmission and reception quality. (Mandatory requirements are indicated by the dotted vertical line on the left side of the text).

- Recommended requirements - Affecting the quality of the received and transmitted signals by the AMOS users.

Mandatory requirements should be met at all times, with no exceptions.

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2. ***Antenna***

2.1. Transmit Side-lobes requirements (Mandatory):

90% of the co-polarized and cross-polarized side-lobe peaks gain shall not exceed an envelope described by the following:

For antennas of diameter D<50λ (D<1m @ 14GHz , D<1.2m @ 13GHz)

G=32-25 log θ [dBi]	100 λ /D ° ≤ θ ≤ 48°
G= -10 [dBi]	48°≤θ

For antennas of diameter D>50λ (D>1m @ 14GHz , D>1.2m @ 13GHz)

G=29-25 log θ [dBi]	1 ° ≤ θ ≤ 20°
-10 [dBi]	20° < θ ≤ 26.3°
G=32-25 log θ [dBi]	26.3° < θ ≤ 48°
G= -10 [dBi]	48°≤θ

Where:

G is the gain of the side-lobe envelope relative to isotropic antenna in the direction of GEO in dBi.

θ is the angle in degrees between the main beam axis to the direction considered.

- The above requirements are based on Rec. ITU-R S.580-5 and Rec. ITU-R S.465-5.
- The above requirements should be met within the following frequency bands: 12.75-13.25GHz and 13.75-14.5GHz
- The requirements should be met in any direction within 3º of the geo-stationary arc.

2.2. Receive Side-lobes Recommendation:

It is recommended that the transmit side-lobe characteristics apply to the receive band as well (10.7-11.7GHz), in order to protect receive signals from interference arising elsewhere.

2.3. Polarization (Mandatory):

a) The earth stations shall transmit with linear polarization (Rx / Tx Orthogonal in most cases).
b) Polarization error (Transmit) shall be less than 0.5º.
c) The Polarization Isolation of the transmit antenna in the direction of the satellite shall not exceed 27dB everywhere within a cone centered on the main beam axis and whose angle is defined by the antenna tracking and/or pointing error.
d) The off transmit cross-polarized gain of the earth-station shall lie bellow the following envelope:

G=19-25 log θ [dBi]	1.8 ° ≤ θ ≤ 7.0°
G= -2 [dBi]	7.0° ≤ θ ≤ 9.2°

Where:

G is the cross-polarization gain of the antenna relative to isotropic radiator in dBi.

θ is the angle in degrees between the main beam axis to the direction considered in the plane of GEO.

e) It is highly recommended that this polarization isolation not be exceeded for reception.

2.4. Tracking (Mandatory):

The Amos satellites are maintained for station keeping from their nominal position within ± 0.1°(N-S) , ±0.08°(E-W) at worst case . Based on these limits and earth station antenna beam-width, auto-track is required for transmit antennas with diameter larger than 4m.

The Beacon carriers transmitted from the satellites (circularly polarized) can be used for antenna tracking. The frequencies of the beacon carriers are detailed in Table 1.

3. General RF Requirements

3.1. Ability to control EIRP (Mandatory):

The station shall be capable of controlling the transmitted power within a range of at least 15dB. The resolution shall be better than 0.5dB.

3.2. EIRP Stability (Mandatory):

The EIRP in the direction of the satellite shall, except under adverse weather conditions, be maintained within +1/-1.5 dB from the level assigned by Spacecom (the –1.5dB requirement may be modified to a larger value for links having sufficient margin). These tolerances include all earth stations factors contributing to EIRP variations, antenna beam pointing and/or tracking error and fluctuations in the RF power output developed by the earth-station transmit equipment, all added on a root-sum-square basis.

It is highly recommended to use an Automatic Uplink Power Control (AUPC) system based on a beacon receiver. AUPC allows continuity of service during periods of heavy rainfall, and must be carefully maintained to guarantee proper operation. It is mandatory that the AUPC be performed in an automated fashion, to guarantee that the power flux density at the input to the satellite never exceeds the nominal level by more than 1dB.

3.3. Frequency Agility and Stability (Mandatory):

a) The capability to vary the frequency of each transmitted carrier shall be provided, in order to enable carriers to be radiated anywhere within the earth station operating RF band.
b) It is highly recommended that the station U/L frequency band cover the full U/L band available in the Amos satellites network. The U/L and D/L frequency bands are listed in table 2.
c) It is recommended that earth stations should incorporate transmit and receive equipment that allows the carrier frequency to be set with a precision of at least 2.5KHz.
d) The frequency stability (for digital carriers) should be better than ±0.015**R** (**R**= Transmission Rate in Bits per Second), but in no case to exceed ±10KHz.

4. ***Emission Constraints***

4.1. Off –Beam Emission EIRP Density (Mandatory):

At any angle θ which is 2.5º or more off the main lobe axis of the earth station antenna, the EIRP density in any direction within 3º of the GSO should not exceed the following values:

Angle off-axis	Maximum EIRP per 40KHz
2.5 ° ≤ θ ≤ 7°	39-25 log θ [dB (W/40KHz)]
7° < θ ≤ 9.2°	18 [dB (W/40KHz)]
9.2° < θ ≤ 48°	42-25 log θ [dB (W/40KHz)]
48° > θ ≤ 180 °	0 [dB (W/40KHz)]

The off-beam emission limits are based on Rec. ITU-R S.524-8.

4.2. Spurious Emission (Mandatory):

The spurious emission, within the U/L frequency band (12.75-13.25GHz [1] & 13.75-14.5GHz), transmitted from the U/L station shall not exceed 2 dBW/40KHz [2].

The spurious EIRP results from spurious tones, bands of noise (i.e HPA's N.F), or other undesirable products, including multi-carrier inter-modulation products and spectral spreading.

The above limit applies to U/L stations located within the satellite's beam center. For any other U/L station, located off beam center the following constraint shall apply:

Max Spurious Emission < 2 + OBL [dBW/40KHz]

OBL = Off Beam Loss (absolute level in [dB] relative to beam center).

[1] See detailed U/L frequency bands in table 2.

[2] 9dBW/40KHz for U/L stations within the NA beam.

4.3. Carrier Spectral Side-lobes

Outside the channel bandwidth, the spectral side-lobe density shall be less than 26dBc related to the main lobe peak. The acceptable level of spectral side-lobes falling within the allocated bandwidth is determined by the user.

Table 1 List of Telemetry Beacons

	TM1	TM2
AMOS 1	10,951.000 [MHz]	11,451.000 [MHz]
AMOS 2	10,949.000 [MHz]	11,200.000 [MHz]

(*) TM carriers are circularly polarized .

Table 2 Amos Satellites U/L Frequency Bands

	12.75-13.00GHz	**13.00-13.25GHz**	**13.75-14.00GHz**	**14.00-14.50GHz**
AMOS 1	-	-	-	√
AMOS 2	-	√	√	√
AMOS 3	√	√	√	√