EMBRATEL STARONE
ENGINEERING DIRECTORATE
COMMUNICATIONS SYSTEMS MANAGEMENT

SYSTEM TECHNICAL CHARACTERISTICS

CHARACTERISTICS OF THE STAR ONE C3
FOR C BAND
COMMUNICATIONS NETWORK TECHNICAL PROJECT

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INTRODUCTION

The objective of this document is to set out the necessary technical characteristics for the design and sizing of satellite communications networks via Star One C3 satellite in C band.

1. Basic Characteristics of the Space Segment

The Star One C3 satellite is located at the orbital position 75.0°W.

1.1. Frequency Plan

1.1.1. Transponders

The Star One C3 satellite operates in the C-band in the frequency bands 5,850.0 MHz to 6,425.0 MHz in the uplink and 3,625.0 MHz to 4,200.0 MHz in the downlink, using 33/36 MHz bandwidth transponders in both Horizontal (H) and Vertical (V) polarizations.

1.1.2. Beacons

The Star One C3 satellite C Band beacons are located at 4,199.0 MHz and 4,199.5 MHz center frequencies, both in Horizontal polarization, with a bandwidth of 500.0 kHz and a minimum EIRP of 13.0 dBW.

1.1.3. Frequency Conversion

The Star One C3 satellite C Band transponders frequency conversion between uplink and downlink frequencies is 2,225.0 MHz..

1.2. Polarization

The Star One C3 satellite operates with linear polarization. Due to the fact that the Star One C3 satellite reuses frequencies through the use of dual polarization, the isolation of the satellite antennas between the two orthogonal polarizations is 30.0 dB within the coverage area, for both uplink and downlink.

1.3. Coverage Characteristics

The Star One C3 satellite operates in C Band using Brazil-South America (BSAC beam) coverage.

The typical Star One C3 satellite C band coverage maps (footprints) are presented in Figure 1 (BSAC Uplink) and Figure 2 (BSAC Downlink).

Notes:

1. Actual coverage may present certain differences in light of a specific transponder.
2. The reference contours for Saturation Flux Density, satellite G/T and satellite EIRP mentioned in this document correspond to the 0.0 dB advantage coverage contour.

1.3.1. BSAC Uplink

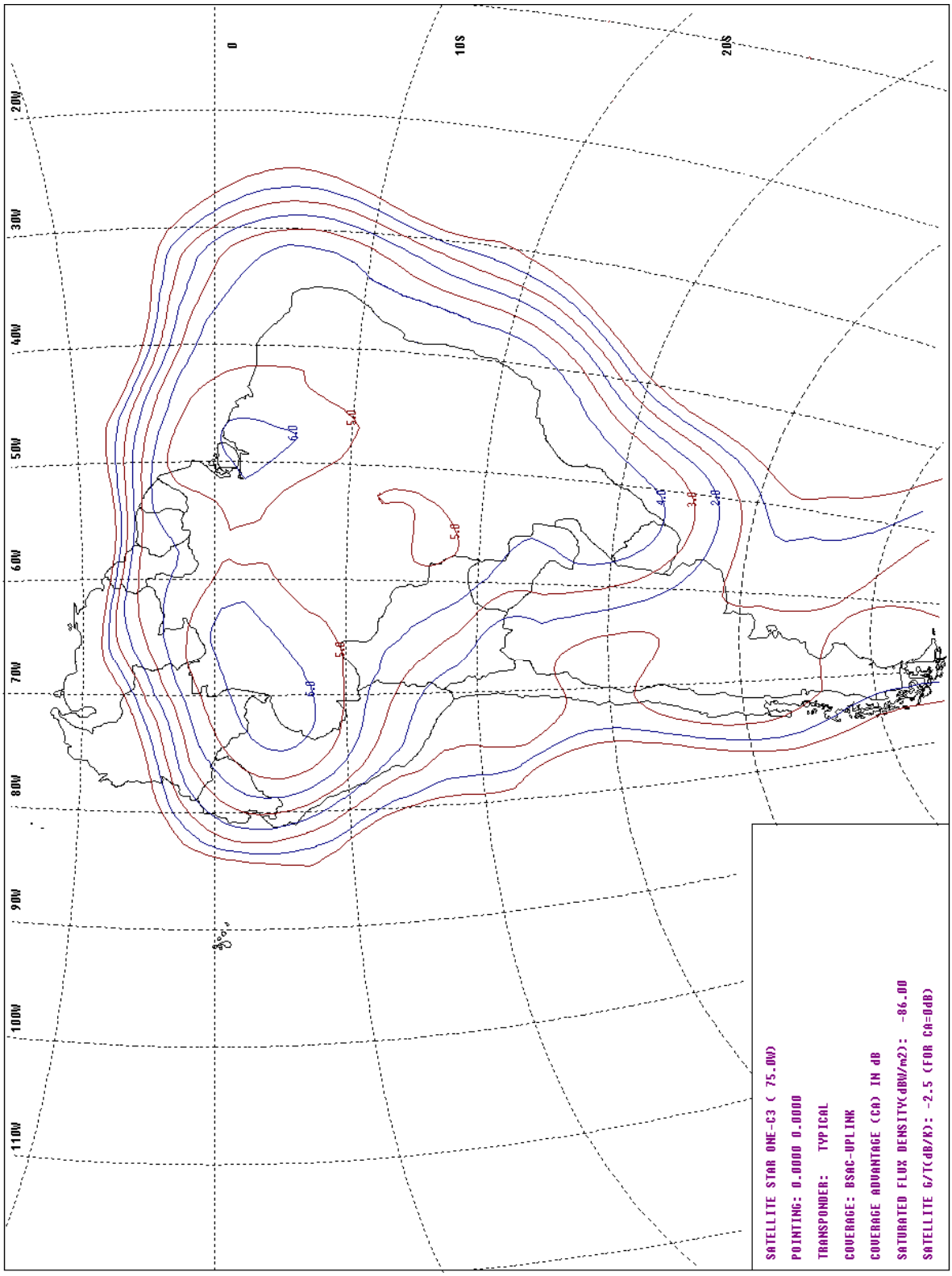


Figure 1 – Star One C3 (G/T) BSAC Typical Uplink Coverage

1.3.2. BSAC Downlink

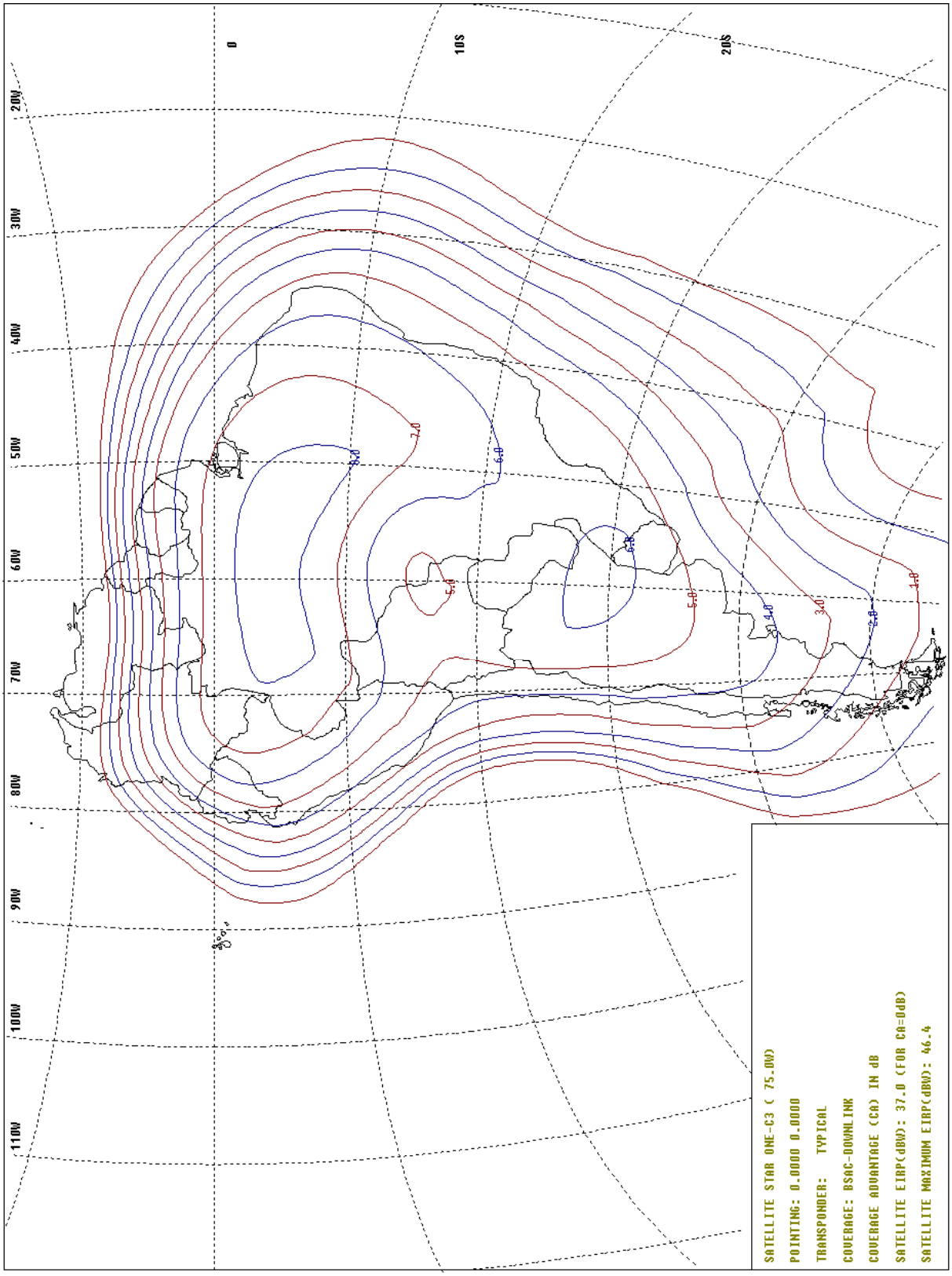


Figure 2 – Star One C3 (EIRP) BSAC Typical Downlink Coverage

1.4. EIRP

The Star One C3 satellite typical EIRP at the reference contour is 37.0 dBW in C Band.

1.5. G/T

The Star One C3 satellite typical G/T at the reference contour is -2.5 dB/K in C Band.

1.6. Saturation Flux Density

For Star One C3 satellite, in C Banda, it should be considered a typical Saturation Flux Density of -86.0 dBW/m^2 at the reference contour.

The Saturation Flux Density may be adjusted in a range of -4.0 dB to + 4.0 dB in steps of 1.0 dB to be assigned by Embratel Star One in light of service characteristics and selected transponder.

1.7. Typical Input and Output Back-off and Intermodulation Noise Density

The typical Star One C3 satellite input and output back-off for transponders allocated to multi-carrier (multi-carrier mode) are 5.5 dB and 4.0 dB, respectively. The intermodulation noise density in this case is -97.0 dB/Hz (33/36 MHz transponders), related to the saturation power output, corresponding to -24.0 dBW/4kHz, at the reference contour.

The typical Star One C3 satellite input and output back-off for transponders allocated to 2 (two) carriers (dual-carrier mode) are 3.0 dB and 2.0 dB, respectively. The intermodulation noise density in this case can be disregarded because its major part will occur outside the frequency limits of the transponder.

The typical Star One C3 satellite input and output back-off for transponders allocated to1 (one) carrier (single-carrier mode) are 1.0 dB and 0.5 dB, respectively. In the case of 16APSK carriers, the input and output back-off of -3.0 dB and -1.5 dB respectively must be used.

1.8. Operational Conditions

Carriers allocated in Star One C3 satellite transponders are subject to the following operational conditions:

1.8.1. Adjacent Satellites

Due to coordination agreements with operators of adjacent satellites sharing the same frequency band at the geostationary orbital arc, the minimum transmit antenna diameter of the earth stations operating in Star One C3 satellite is 1.8 m, and the carriers shall comply with the maximum densities levels listed below.

Note: the densities shall be calculated in a 1.0 Hz reference bandwidth, with the digital carrier bandwidth expressed in terms of its symbol rate.

1.8.1.1. Maximum Uplink Density

The maximum allowable uplink power density for carriers operating in Star One C3 satellite BSAC coverage is -45.0 dBW/Hz, referred to the earth station antenna input. Density values greater than -45.0 dBW/Hz requires **Embratel Star One prior written authorization**.

1.8.1.2. Maximum Downlink Density

The maximum allowable downlink EIRP density for carriers operating in the Star One C3 satellite BSAC coverage is -32.0 dBW/Hz, referred to the beam center. Density values greater than -32.0 dBW/Hz requires **Embratel Star One prior written authorization**.

Note: Star One C3 satellite BSAC coverage maximum saturated EIRP is about 46.4 dBW.

1.8.2. System/ Link Margins

- An overall margin of **3.6** dB to cover adjacent satellites interference, terrestrial interference, co-transponder cross-polarization interference and earth station spurs shall be assumed;
- An additional margin of 0.5 dB in TX and 0.5 dB in RX shall be assumed to cover mis-pointing of earth station antennas with diameter larger than 10.0 m, equipped with tracking system. For antennas without tracking system, it is recommended to use the following margins to cover mis-pointing due to movement of the satellite in its orbital control box (+/- 0.05 °):

Diameter (m)	TX Margin (dB)	RX Margin (dB)
D ≤ 4.5	0.3	0.2
D > 4.5	1.0	0.5

Table 1 – Typical Mis-pointing Margin for Antennas without Tracking System

- An additional earth station HPA margin of 2.0 dB shall be assumed to cover: differences between the real coverages, switching from primary to redundant satellite units in case of failures and possible degradations during satellite lifetime.

2. Mandatory Characteristics for Transmit Earth Stations

2.1 Emissions Characteristics

2.1.1. Frequency Stability

The tolerance in RF frequency accuracy (maximum frequency uncertainty of initial adjustment plus change over time) shall not exceed +/-800.0 Hz in one day and +/-3500.0 Hz in one month, for earth stations with equipment installed indoor, with temperature control as well as those installed outdoor.

2.1.2. Off-Axis EIRP Density Limits

The maximum off-axis EIRP density emission for any angle ϕ greater than ϕ_{min} (where ϕ_{min} is the greatest of 1.0° or 100°λ/D) outside the earth station antenna main lobe, within the geostationary satellite orbital arc, must not exceed the values presented on Table 2.

Off-Axis EIRP Density Limit (dBW/Hz)	Angle
-45 + 29 - 25 log ϕ	$\phi_{min} \leq \phi < 20°$
-45 - 3.5	$20° \leq \phi < 26.3°$
-45 + 32 - 25 log ϕ	$26.3° \leq \phi < 48°$
-45 - 10	$48° \leq \phi \leq 180°$

Table 2 – Off-Axis EIRP Density Limit

Notes:

1. Densities shall be calculated in 1.0 Hz reference bandwidth, with the digital carrier bandwidth expressed in terms of its symbol rate;
2. Use of an antenna/ transmission configuration exceeding Table 2 values requires **Embratel Star One prior written authorization**.

2.1.3. Out of Band Emission

The EIRP density transmitted outside the allocated band of the carrier shall not exceed the value of 10.0 dBW/4 kHz for intermodulation and 0.0 dBW/4 kHz for spurious, resulting in an aggregate of 10.4 dBW/4 kHz.

The limits presented above must be lowered from the value corresponding to the receive gain increase of the satellite antenna relative to the reference contour.

In any case, when an emission outside the authorized band causes prejudicial interference an additional decrease may be requested from those limits established above.

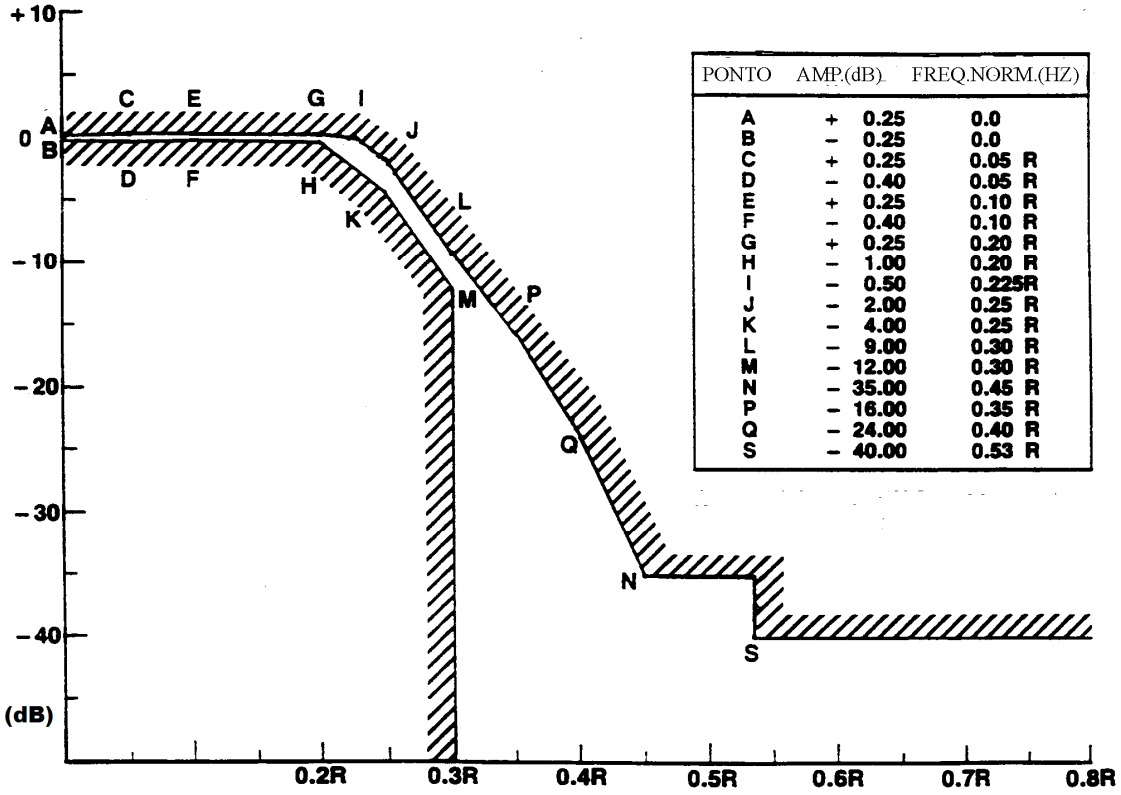
2.1.4. EIRP Stability

The daily earth station EIRP variation shall be below to 2.0 dB peak-to-peak, excluding the contribution of the satellite excursion through the control box and those of adverse weather condition. This performance shall apply for earth stations with equipment installed indoor, with temperature control, as well as those installed outdoor.

2.1.5. Spectral Power Density

The spectral power density of the modulated carrier at the modulator output and at the output of the earth station transmitter shall be in conformity with the masks presented in figures below. (Figures 3 and 4)

2.1.5.1. Spectral Power Density Mask at Modulator Output



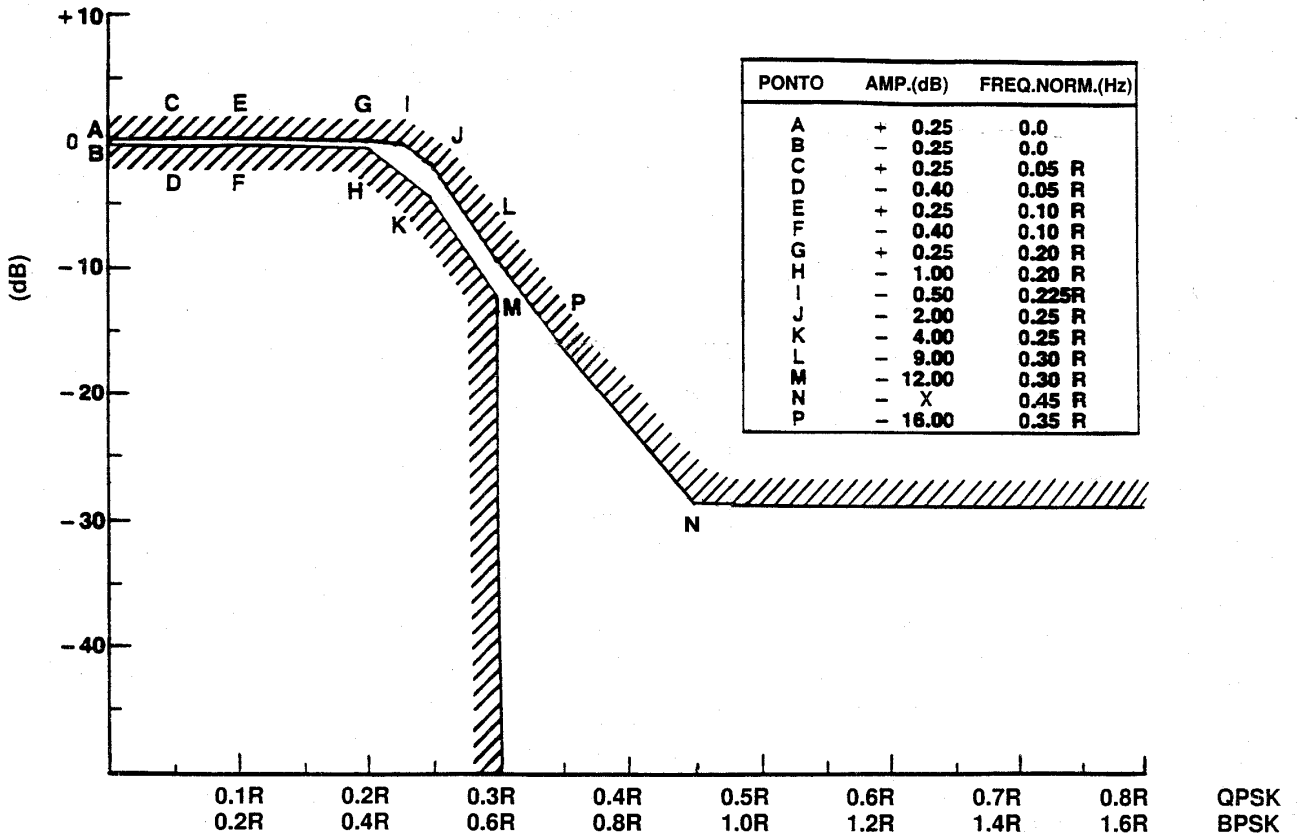
PONTO	AMP.(dB)	FREQ.NORM.(HZ)
A	+ 0.25	0.0
B	– 0.25	0.0
C	+ 0.25	0.05 R
D	– 0.40	0.05 R
E	+ 0.25	0.10 R
F	– 0.40	0.10 R
G	+ 0.25	0.20 R
H	– 1.00	0.20 R
I	– 0.50	0.225R
J	– 2.00	0.25 R
K	– 4.00	0.25 R
L	– 9.00	0.30 R
M	– 12.00	0.30 R
N	– 35.00	0.45 R
P	– 16.00	0.35 R
Q	– 24.00	0.40 R
S	– 40.00	0.53 R

Figure 3 - Spectral Power Density Mask at Modulator Output

Notes:

1. R = Transmission rate in bits per second;
2. The normalized frequency of the abscissa axis corresponds to the QPSK modulation; in order to obtain the frequency for BPSK modulation the values contained in the abscissa should be multiplied by 2 (two); in order to obtain the frequency for 8PSK modulation, divide the values contained in the abscissa by 1.5;
3. The relative power of 0.0 dB, for QPSK modulation corresponds to -10 log (R/2) dB/Hz in relation to the power of the carrier without modulation; in order to obtain the relative power for BPSK modulation, use R instead of R/2; in order to obtain the relative power for 8PSK modulation, use 3R/2 instead of R/2.

2.1.5.2. Spectral Power Density Mask at Transmitter Output



PONTO	AMP.(dB)	FREQ.NORM.(Hz)
A	+ 0.25	0.0
B	– 0.25	0.0
C	+ 0.25	0.05 R
D	– 0.40	0.05 R
E	+ 0.25	0.10 R
F	– 0.40	0.10 R
G	+ 0.25	0.20 R
H	– 1.00	0.20 R
I	– 0.50	0.225R
J	– 2.00	0.25 R
K	– 4.00	0.25 R
L	– 9.00	0.30 R
M	– 12.00	0.30 R
N	– X	0.45 R
P	– 16.00	0.35 R

Figure 4 - Spectral Power Density Mask at Transmitter Output

Notes:

1. R = Transmission rate in BITS per second;
2. NBPS = Number of BITS per symbol (1 for BPSK, 2 for QPSK);
3. The relative power of 0.0 dB corresponds to -10 log (R / NBPS) dB/Hz related to the power of the carrier without modulation;
4. X (dB) = $EIRP_{TX}$ (dBW) + VG_{UP} (dB) + 25.6 dB - 10 log (R / NBPS);
5. The value of X plotted refers to a BPSK carrier of 512KBPS+FEC1/2 with a typical $EIRP_{TX}$ = 56.0 dBW in an uplink contour of 7.0 dB;
6. The secondary lobe may not have relative amplitude (x) above -26.0 dB at the normalized frequency in relation to the center of 0.75R for QPSK and 1.5R for BPSK;
7. Note 6. may supersede note 5.;
8. Independent spurious should meet the criteria of 0.0 dBW/4kHz.

2.2. Antenna Characteristics

The minimum technical characteristics of antenna radiation at earth station used in communications links via geo-stationary satellites in Brazilian territory are indicated below:

- G = 29 - 25 log φ dBi for φ between 1 ° or 100 λ / D (whichever is greater) and 20 °
- G = - 3.5 dBi for 20 ° <φ ≤ 26.3 °
- G = 32 - 25 log φ dBi for 26.3 ° <φ <48 °
- G = –10 dBi for 48 ° ≤ φ ≤ 180 °

Where G is the gain of the antenna, φ the angle between the direction considered and the antenna axis, D the largest diameter of the antenna aperture area and λ the wavelength.

- Cross polarization isolation on the shaft
  - 27 dB for D ≤ 2.4 m
  - 30 dB for 2.4 m <D ≤ 7m
  - 35 dB for 7 m <D

Note: As the *"**Norma para Certificação e Homologação de Antenas de Estações Terrenas Operando com Satélites Geoestacionários**".*" (Annex to Resolution No. 572 issued by Anatel at 28/09/2011) was revoked, Embratel Star One started to adopt as reference the Recommendation **ITU-R S.580-6 Radiation diagrams For Use as Design Objectives for Antennas of Earth Stations Operating with Geostationary Satellites,** in particular the items 1 and 2.

3. Information

In case of doubts, suggestions or clarifications, please contact us or send mail to:

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