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Earth Station Minimum Technical and Operational Requirements

eutelsat
communications via satellite

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REQUIREMENTS

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1. INTRODUCTION

1.1. GENERAL

Under Eutelsat procedures, approval of earth stations for access to the Eutelsat space segment is required (See ESOG Module 110).

Eutelsat recognises that it is the Allottee's responsibility to establish compatibility between all earth stations within their network and to comply with Eutelsat criteria for minimising interference between earth stations and Eutelsat satellites on which space segment capacity is provided.

The scope of this document is to define the minimum conditions under which approval may be given for an earth station to access the capacity in the Eutelsat Space Segment.

Earth station approval procedures are defined in the Eutelsat Systems Operations Guide (ESOG).

Mandatory requirements, i.e. requirements that have to be met by an earth station before approval can be given for it to access a Eutelsat satellite, are given in those parts which are marked by a line in the left-hand margin, as shown for this paragraph.

In addition, an earth station shall meet the conditions given in the Technical Annex to the relevant contract for the capacity allotment.

1.2. THE EUTELSAT SATELLITES

All Eutelsat satellites have a three axis stabilized configuration with deployable solar arrays and batteries to power the satellite in sunlight and eclipse.

Eutelsat satellites are normally maintained within ± 0.1°, both in longitude and in latitude, of their respective nominal positions in geosynchronous orbit. However, at the end of their nominal station-keeping lifetime, they may be operated in inclined orbit whilst still being maintained within ± 0.1° in longitude.

2. GENERAL CONSIDERATIONS

The technical and operating characteristics described in the following sections are mainly those which are necessary to ensure an adequate level of protection to the other services carried via the Eutelsat Space Segment, as well as to services carried by adjacent satellite systems.

For this reason no mention is made of characteristics such as modulation methods, G/T, quality objectives, etc., that are left to the Allottee to define as part of the design of the transmission system that meets his particular requirements. However, Eutelsat may require to review and agree on these parameters.

Transmissions in the 13.75 GHz to 14.00 GHz frequency band are subject to additional constraints imposed by the Radio Regulations. Earth stations operating in the band 13.75 - 14.00 GHz shall have minimum antenna diameter of 1.2 m.

For earth stations within the fixed-satellite service having an antenna diameter greater than or equal to 4.5 m, the e.i.r.p. of any emission should be at least 68 dBW and should not exceed 85 dBW.

Earth station owners should be aware of the need for flexibility in the design and operation of the earth station to accommodate any changes in the overall configuration of the Eutelsat Space Segment.

In addition to fulfilling the requirements outlined below, the earth station owner shall provide Eutelsat with information on the shape of the transmit signal spectrum so that the necessary frequency separation of adjacent carriers can be assessed.

3. GENERAL RADIO FREQUENCY REQUIREMENTS

3.1. GENERAL

The earth station design shall be such that changes of transmitted and received carrier frequencies and levels are possible so as to conform to overall system planning needs and ensure flexibility in intersystem coordination.

3.2. SYSTEM BANDWIDTH

Whichever satellite transponder is to be accessed by the earth station, it may be necessary to reallocate the corresponding satellite capacity from one frequency to another. For this reason the earth station should be capable of transmitting carriers at any frequency over the full extent of at least one of the frequency bands of the Eutelsat satellites.

3.3. AMPLITUDE AND GROUP DELAY RESPONSE

Each FM television carrier shall be filtered on the transmit chain, according to its bandwidth requirement.

For FM TV carriers the out-of-band amplitude response of the transmit station path, measured from the modulator output to the transmit antenna feed port, shall be maintained within the out-of-band limits given in Figure 1 and Table 1a.

It is recommended that the in–band amplitude and group delay response of the transmit station path be maintained within the limits given in Figure 1, Table 1a and Table 1b.

In case of digital carriers, the recommended amplitude and group delay response is given in Figure 2

In the case of fractional transponder lease, the in-band amplitude and group delay response of the transmit station path are mandatory requirements, for both FM TV and digital carriers.

3.4. GAIN-TO-NOISE TEMPERATURE RATIO

The earth station gain-to-noise temperature ratio (G/T) is not specified and it is left to the Allottee to define the earth station G/T that meets his particular requirements.

The Allottee should be aware that the lower the earth station G/T, the higher the power required from the satellite for a given transmission.

The Allottee shall also provide Eutelsat with information on the minimum G/T under clear sky conditions for each of the earth station receive bands and for any elevation angle of the antenna greater than or equal to 10°.

3.5. COMMON WIDEBAND RECEIVING AMPLIFIER LINEARITY REQUIREMENTS

The linearity requirements will be determined by the earth station owner for his specific applications, taking into consideration that the maximum total power flux density at the surface of the earth could be -101 dBW/m². This figure refers to the aggregate power flux density from all the transponders on one plane of polarization.

3.6. SUPERIMPOSED CARRIERS

If in one network more than one carrier can fall simultaneously in the same frequency band, the sum of the e.i.r.p. spectral densities shall be employed when determining compatibility with the requirements of Section 4.2.1.2. on polarisation discrimination, Section 5.4. on e.i.r.p. and Section 6., on emission constraints.

4. ANTENNA PERFORMANCE CHARACTERISTICS

4.1. ANTENNA SIDELOBE PATTERN

4.1.1. Transmit

4.1.1.1. Recommendation

Over the full extent of the antenna transmit frequency bands, it is recommended that the gain of the antenna sidelobe peaks should 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 it is recommended that 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 and within the bounds between 3° North and 3° South of the geostationary satellite orbit (as seen from the centre 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, it is recommended that the gain of the antenna sidelobe peaks should not exceed:

$32 - 25 \log_{10}\theta$	dBi	for	α*	$< \theta \leq$	48°
-10	dBi	for	48°	$< \theta$	

* For the antennas procured after 01/03/2005: α=1° or (100λ/D) whichever is the greater, where D is the antenna diameter and λ is the carrier wavelength. For antennas procured before 01/03/2005 α=2.5°.

** In case of non circular apertures, D is the dimension of the antenna aperture in the plane of the geostationary orbit.

4.1.1.2. Requirement

Over the full extent of the antennas transmit frequency bands, no more than 10% of the antenna sidelobe peaks shall exceed the envelopes specified in Paragraph 4.1.1.1. 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°.

In addition, the transmit sidelobe pattern of the antenna shall be such that the off-axis e.i.r.p. density limits specified in Paragraph 6.2 can be met for any given operating conditions as may be required in practical situations.

4.1.2. Receive

In order to protect receive signals from interference from other networks, for any frequency within the antenna receive band(s), the gain of the antenna sidelobe peaks should 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 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 and within the bounds between 3° North and 3° South of the geostationary satellite orbit (as seen from the centre of the earth).

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

$32 - 25 \log_{10}\theta$	dBi	for	α*	$< \theta \leq$	48°
-10	dBi	for	48°	$< \theta$	

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* For the antennas procured after 01/03/2005: α=1° or (100λ/D) whichever is the greater, where D is the antenna diameter and λ is the carrier wavelength. For antennas procured before 01/03/2005 α=2.5°.

** In case of non circular apertures, D is the dimension of the antenna aperture in the plane of the geostationary orbit.

4.2. POLARIZATION

All the EUTELSAT satellites use linear dual polarization with the exception of those transponders transmitting to the Russian coverage in the frequency band 17.3 – 18.1 GHz on W4, the C-Band transponders on ATLANTIC BIRD™3 and W2A and the Ka-sat transponders, which use dual circular polarization.

4.2.1. LINEAR POLARIZATION

4.2.1.1. Polarization Capability

For transmit/receive stations it is recommended that the antenna feed be equipped for dual polarization operation on both transmission and reception.

Transmit/receive stations having antennas equipped only with single polarization capability shall be able to transmit and receive orthogonal polarizations (e.g. transmit on X and receive on Y).

All antennas shall be provided with the means to change the polarization planes in which they operate.

It should be noted that the beacons of Eutelsat satellites are transmitted on polarization X. The beacon of EXPRESS-A3 satellite and one of the beacons of TELECOM 2D and ATLANTIC BIRD^{TM} 3 satellites are transmitted on polarization Y.

4.2.1.2. Polarization Discrimination

4.2.1.2.1. Ku-Band and W3A Ka-Band

4.2.1.2.1.1 Transmit

Over the full extent of the antenna transmit frequency bands, the antenna polarization discrimination in the direction of the satellite shall be at least 35 dB 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.

Earth stations may operate with a polarization discrimination down to 25 dB, provided that the power density of the transmitted carrier does not exceed the following:

Polarization discrimination in dB	35	30	25
Maximum allowed e.i.r.p. density in dBW/4 kHz	39	37	34

Linear interpolation shall be applied between the above values*

The maximum allowed e.i.r.p. densities given above are given for a G/T equal to 0 dB/K (for a specific location, the satellite G/T given for this location needs to be subtracted from the value above).

If the e.i.r.p. spectral density of more than one carrier can fall simultaneously in the same 4 kHz band, the sum of such e.i.r.p. spectral densities shall not exceed the values given in the above table.

4.2.1.2.1.2. Receive

The earth station polarization discrimination in the receive frequency band(s) should be at least 35 dB 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.

4.2.1.2.2. Ka-band (HB6™)

4.2.1.2.2.1 Transmit

Over the full extent of the antenna transmit frequency bands, the antenna polarization discrimination in the direction of the satellite shall be at least 35 dB 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.

Earth stations may operate with a polarization discrimination down to 25 dB, provided that the power density of the transmitted carrier does not exceed the following:

Polarization discrimination in dB	35	30	25
Maximum allowed e.i.r.p. density in dBW/4 kHz	29	27	24

Linear interpolation shall be applied between the above values*

The maximum allowed e.i.r.p. densities given above are given for a G/T (for a specific location, the satellite G/T given for this location needs to be subtracted from the value above).

* Stations, which meet the polarization discrimination requirement of 35 dB, will not be subject to a restriction on the maximum allowed e.i.r.p. density, apart from that which is necessary to meet the off-axis e.i.r.p. limit of Section 6.2.

If the e.i.r.p. spectral density of more than one carrier can fall simultaneously in the same 4 kHz band, the sum of such e.i.r.p. spectral densities shall not exceed the values given in the above table.

4.2.1.2.2.2. Receive

The earth station polarization discrimination in the receive frequency band(s) should be at least 35 dB 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.

4.2.1.3. Polarization Alignment Capability

It shall be possible to adjust the earth station transmit polarization plane to within 1° of the nominal satellite receive antenna polarization plane.

4.2.2. CIRCULAR POLARIZATION

4.2.2.1. Polarization Capability

It is recommended that the antenna feed be equipped for dual polarization operation on both transmission and reception.

4.2.2.2. Polarization Discrimination

4.2.2.2.1. Ku-Band (W4)

4.2.2.2.1.1. Transmit

Over the frequency band of W4, the antenna polarization discrimination in the direction of the satellite shall be at least 30 dB* everywhere within a cone 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.

Earth stations may operate with a polarization discrimination down to 25 dB, provided that the power density of the transmitted carrier does not exceed the following:

* This requirement corresponds to a voltage axial ratio in the direction of the satellite of 1.06.

Polarization discrimination in dB	30	25
Maximum allowed e.i.r.p. density in dBW/4 kHz	37	34

Linear interpolation shall be applied between the above values*

The maximum allowed e.i.r.p. densities given above are given for a G/T equal to 0 dB/K (for a specific location, the satellite G/T given for this location needs to be subtracted from the value above).

If the e.i.r.p. spectral density of more than one carrier can fall simultaneously in the same 4 kHz band, the sum of such e.i.r.p. spectral densities shall not exceed the values given in the above table.

4.2.2.2.1.2. Receive

The earth station polarization discrimination in the W4 receive frequency band should be at least 30 dB 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.

4.2.2.2.2. C-Band

4.2.2.2.2.1. Transmit

Over the frequency band of ATLANTIC BIRD™ 3 and W2A, the antenna polarization discrimination in the direction of the satellite shall be at least 27dB everywhere within a cone 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.

Earth stations may operate with a polarization discrimination down to 18 dB, provided that the e.i.r.p. spectral density of the transmitted carrier does not exceed the following:

Polarization discrimination in dB	27	24	22	18
Maximum allowed e.i.r.p. density in dBW/4 kHz	33	31.5	30	26

Linear interpolation shall be applied between the above values**

* Stations, which meet the polarization discrimination requirement of 30 dB, will not be subject to a restriction on the maximum allowed e.i.r.p. density, apart from that which is necessary to meet the off-axis e.i.r.p. limit of Section 6.2.

** Stations, which meet the polarization discrimination requirement of 27 dB, will not be subject to a restriction on the maximum allowed e.i.r.p. density, apart from that which is necessary to meet the off-axis e.i.r.p. limit of Section 6.2.

The maximum allowed e.i.r.p. densities given above are given for a G/T equal to 0 dB/K (for a specific location, the satellite G/T given for this location needs to be subtracted from the value above).

If the e.i.r.p. spectral density of more than one carrier can fall simultaneously in the same 4 kHz band, the sum of such e.i.r.p. spectral densities shall not exceed the values given in the above table. For future satellites using the C-band, it is envisaged to reduce the e.i.r.p. densities of the table above by 3 dB.

4.2.2.2.2.2. Receive

The earth station polarization discrimination in the ATLANTIC BIRD™ 3 and W2A receive frequency band should be at least 27 dB 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.

4.2.2.2.3. Ka-Band (Ka-sat)

4.2.2.2.3.1. Transmit

Over the full extent of the antenna transmit frequency bands, the antenna polarization discrimination in the direction of the satellite shall be at least 30 dB 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.

Earth stations may operate with a polarization discrimination down to 20 dB, provided that the power density of the transmitted carrier does not exceed the following:

Polarization discrimination in dB	30	25	20
Maximum allowed e.i.r.p. density in dBW/4 kHz	22	19	16

Linear interpolation shall be applied between the above values*

The maximum allowed e.i.r.p. densities given above are given for a G/T for a specific location, the satellite G/T given for this location needs to be subtracted from the value above).

If the e.i.r.p. spectral density of more than one carrier can fall simultaneously in the same 4 kHz band, the sum of such e.i.r.p. spectral densities shall not exceed the values given in the above table.

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* Stations, which meet the polarization discrimination requirement of 30 dB, will not be subject to a restriction on the maximum allowed e.i.r.p. density, apart from that which is necessary to meet the off-axis e.i.r.p. limit of Section 6.2.

4.2.2.2.3.2. Receive

The earth station polarization discrimination in the Ka-Sat receive frequency band should be at least 25 dB 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

For operational reasons it should be possible to point the antenna in the direction of any geostationary satellite located in the orbit arc from 15°W to 90°E and visible from the earth station location with an elevation angle greater than 5°.

Sufficient steering capability is also desirable to permit demonstration of compliance with the mandatory transmit sidelobe envelope specification.

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 earth station generating the interference must immediately reduce the transmit EIRP or immediately stop transmissions as directed by the Eutelsat Communication Systems Control Centre (CSC).

4.3.2. Beam Pointing

In order to protect transmissions on other satellites, the antenna main beam axis shall not deviate by more than ±0.4° from the nominal direction of the satellite along the geostationary orbit, at all wind speeds at which the earth station may have to operate.

The maximum pointing error of the antenna main beam axis from the actual position of the satellite shall be such that the polarization discrimination requirements of Paragraphs 4.2.1. and 4.2.2. are met, as well as any other requirements which may apply.

4.3.3. Tracking

The need for tracking will be determined by the earth station owner. In the receive side, the depointing losses will need to be compensated for by increasing the e.i.r.p. of the transmitted carrier and the allotted resources. For transmit antennas the need for tracking is determined by taking into consideration the requirement of the e.i.r.p. stability, Section 5.4.2., the necessary increase in the on-axis e.i.r.p. to compensate for antenna depointing losses, as well as the polarization discrimination requirement of Section 4.2.1. and 4.2.2.

For tracking purposes the satellite beacon may be used.

The frequencies and the characteristics of the satellite beacons are available on request.

5. CARRIER CHARACTERISTICS

5.1. GENERAL

Due to the fact that large networks exist for certain applications, Eutelsat makes its best efforts to avoid changes of frequency of transmitted and received carriers of an approved transmission plan. However, Eutelsat, in full consultation with the allottee, may have to change power level and frequency of the carriers of an approved transmission plan whenever overall system planning so requires.

5.2. CARRIER FREQUENCY TOLERANCE

5.2.1. Transmit Frequency

The frequency tolerance (maximum uncertainty of initial frequency adjustment plus long-term drift) of each carrier transmitted by the earth station shall be at least as shown below:

a) Digital Carriers:

±1.5 kHz for TSR < 30 kSymbols/s

±0.05 x TSR (kHz) for 30 kSymbols/s ≤ TSR ≤ 200 kSymbols/s

±10 kHz for 200 kSymbols/s < TSR

where TSR is the transmission symbol rate in kSymbols/s

b) FM/TV: ±250 kHz

The above frequency tolerance shall include the maximum uncertainty of initial frequency adjustment plus long-term drift, long-term being assumed to be at least one month.

5.2.2. Receive Frequency

The earth station receive chain frequency stability will be determined by the earth station owner, taking into account the frequency acquisition and tracking capabilities of the demodulator and the frequency drift of the earth station transmit chain and the satellite transponder translation tolerance.

However it is recommended that the frequency inaccuracy due to earth station down conversion should not be greater than ±1.5 kHz over any 6 month period.

5.3. PHASE NOISE

The level of the phase noise induced on any carrier by the transmit and receive earth stations is the responsibility of the earth station owner, since this affects only the quality of the transmitted carrier.

The phase noise contributed by the satellite frequency translation is as shown in Figure 3.

5.4. EQUIVALENT ISOTROPICALLY RADIATED POWER (E.I.R.P.)

5.4.1. Level

The maximum permissible operating e.i.r.p. levels for transmitting to a Eutelsat satellite will be constrained by the requirement imposed on the off-axis e.i.r.p. density in Paragraph 6.2.

For earth stations which do not comply with the transmit polarization discrimination of 35 dB the operating e.i.r.p. levels are also constrained by the maximum allowed e.i.r.p. density given in Section 4.2.1. and 4.2.2.

The operating e.i.r.p. for transmission from any given location shall be agreed with EUTELSAT prior to the starting of operation from the location.

5.4.2. Stability

The e.i.r.p. of any carrier, in the direction of the satellite shall be maintained to within ± 1.5 dB of the assigned operating value.

In certain operational modes of the transmission, where the Output Back-Off of carriers is such that:
Transponder Carrier Output Back-Off < 3.5 + 10*log (Nominal Bandwidth of the Transponder in use / Transmit Symbol rate of the Carrier) [expressed in positive values, dB],
the e.i.r.p. in the direction of the satellite shall be maintained to within ± 0.5 dB.

5.4.3. Adjustment Capability

Adequate means shall be provided to allow adjustment of the carrier level.

The level of each carrier should be adjustable over a range of 20 dB below the assigned operating value.

6. EMISSION CONSTRAINTS

6.1. GENERAL

The levels indicated in Paragraphs 6.2 and 6.3 as well as the levels associated with the polarization discrimination of section 4.2.1.2 for Ku-band transmissions and Ka-Band transmissions on W3A satellite are applicable only to earth stations at the satellite receive beam edge. For other earth station locations within the satellite receive beam those levels shall be decreased by the difference in dB between the satellite receive antenna gain towards the earth station and the satellite receive antenna gain beam edge.

For the purpose of this specification the beam edge is defined as the satellite receive G/T contour of 0 dB/K.

For the Ka-Band transmissions on HB6^{TM} , levels indicated in 6.2, 6.3 and 4.2.1.2 are applicable to earth stations located anywhere at the satellite receive G/T contours $\geq$10 dB/K.

For the Ka-Band transmissions on Ka-sat, levels indicated in 6.2, 6.3 and 4.2.2.2 are applicable to earth stations located anywhere at the satellite receive G/T contours $\geq$18 dB/K.

For C-Band transmissions the levels indicated in Paragraphs 6.2 and 6.3 are applicable to earth stations located anywhere in the coverage area and the levels indicated in Paragraphs 4.2.2.2 are given for a G/T equal to 0 dB/K (for a specific location, the satellite G/T given for this location needs to be subtracted from the given values).

6.2. OFF-AXIS E.I.R.P. DENSITY

6.2.1. Ku-Band Transmission

The off-axis e.i.r.p. in any 40 kHz band in the direction of an adjacent satellite shall not exceed the following values* :

* These values apply to earth stations approved after the 01/10/2007. In certain operational modes and depending on the space capacity used, more restrictive off-axis e.i.r.p. densities and/or values of α may apply.

$31 - 25 \log_{10} \theta$	dBW	for	α**	$< \theta \leq$	7°
+10	dBW	for	7°	$< \theta \leq$	9.2°
$34 - 25 \log_{10} \theta$	dBW	for	9.2°	$< \theta \leq$	48°
-8	dBW	for	48°	$< \theta$	

Where θ is the angle, in degrees, between the main beam axis and the direction considered.

If the off-axis e.i.r.p. spectral density of more than one carrier can fall simultaneously in the same 40 kHz band, the sum of such off-axis e.i.r.p. spectral densities should not exceed the values given above.

In the case of linear polarized transmissions the orthogonally polarized component of the off-axis e.i.r.p. in any 40 kHz band in the direction of an adjacent satellite shall not exceed the following values:

$21-25 \log_{10} \theta$	dBW	for	α**	$< \theta \leq$	7°
+0	dBW	for	7°	$< \theta \leq$	9.2°

Where θ is the angle, in degrees, between the main beam axis and the direction considered.

If the off-axis e.i.r.p. spectral density of more than one carrier falls simultaneously in the same 40 kHz band, the sum of such off-axis e.i.r.p. spectral densities shall not exceed the values given above.

In the band 13.75-14 GHz, the level of off-axis e.i.r.p. emitted in any 1MHz band by an earth station with an antenna diameter smaller than 4.5m shall not exceed the following values in any 1MHz band

$43 - 25 \log_{10}\theta$	dBW	for	α**	$< \theta \leq$	7°
22	dBW	for	7°	$< \theta \leq$	9.2°
$46 - 25 \log_{10}\theta$	dBW	for	9.2°	$< \theta \leq$	48°
4	dBW	for	48°	$< \theta$	

** α= 100λ/D, where D is the antenna diameter and λ is the carrier wavelength. This formula is valid as long as $1 \leq \alpha \leq 2$. If the formula yields values outside this range of validity, α is set to either 1 or 2, depending on which is the nearest. For antennas procured before 01/03/2005 α=2.5°.

6.2.2. C-Band Transmission

For the transmission in C-Band it is strongly recommended that the off-axis e.i.r.p. in any 4 kHz band in the direction of an adjacent satellite should not exceed the following values:

$32-25 \log_{10} \theta$	dBW	for	α*	$< \theta \leq$	7°
+11	dBW	for	7°	$< \theta \leq$	9.2°
$35-25 \log_{10} \theta$	dBW	for	9.2°	$< \theta \leq$	48°
-7	dBW	for	48°	$< \theta$	

If the off-axis e.i.r.p. spectral density of more than one carrier falls simultaneously in the same 4 kHz band, the sum of such off-axis e.i.r.p. spectral densities should not exceed the values given above.

6.2.3. Ka-Band Transmission

6.2.3.1 HB6™

For the transmission in HB6™ Ka-Band it is strongly recommended that the off-axis e.i.r.p. in any 40 kHz band in the direction of an adjacent satellite should not exceed the following values:

$19-25 \log_{10} \theta$	dBW	for	α *	$\leq \theta \leq$	7°
-2	dBW	for	7°	$< \theta \leq$	9.2°
$22-25 \log_{10} \theta$	dBW	for	9.2°	$< \theta \leq$	48°
-20	dBW	for	48°	$< \theta$	

If the off-axis e.i.r.p. spectral density of more than one carrier falls simultaneously in the same 40 kHz band, the sum of such off-axis e.i.r.p. spectral densities should not exceed the values given above.

6.2.3.2 Ka-sat

For the transmission in Ka-sat it is strongly recommended that the off-axis e.i.r.p. in any 40 kHz band in the direction of an adjacent satellite should not exceed the following values:

* α= 100λ/D, where D is the antenna diameter and λ is the carrier wavelength. This formula is valid as long as $1 \leq \alpha \leq 2$. If the formula yields values outside this range of validity, α is set to either 1 or 2, depending on which is the nearest.

11-25 $\log_{10}\theta$	dBW	for	α *	$\leq \theta \leq$	7°
-10	dBW	for	7°	$< \theta \leq$	9.2°
14-25 $\log_{10}\theta$	dBW	for	9.2°	$< \theta \leq$	48°
-28	dBW	for	48°	$< \theta$	

If the off-axis e.i.r.p. spectral density of more than one carrier falls simultaneously in the same 40 kHz band, the sum of such off-axis e.i.r.p. spectral densities should not exceed the values given above.

6.3. OUT-OF-BAND RADIATION

The maximum peak e.i.r.p. spectral density outside the allocated bandwidth but within any of the frequency band segments of the Eutelsat satellites shall not exceed the following values:

- 12 dBW per 4 kHz nor 42 dBW per 12.5 MHz for a transmission in Ku-Band
- 15 dBW per 4 kHz nor 45 dBW per 12.5 MHz for a transmission in K-Band (17.3 – 18.4 GHz)
- 4 dBW per 4 kHz nor 34 dBW per 12.5 MHz for a transmission in C-Band (ATLANTIC BIRD™ 3)
- 1 dBW per 4 kHz nor 31 dBW per 12.5 MHz for a transmission in C-Band (W2A and future satellites)
- 19 dBW per 4 kHz nor 49 dBW per 12.5 MHz for a transmission in Ka-Band on the W3A satellite
- 9 dBW per 4 kHz nor 39 dBW per 12.5 MHz for Ka-Band on the HB6™ satellite
- 1 dBW per 4 kHz nor 31 dBW per 12.5 MHz for Ka-Band on the Ka-sat satellite

The values above refer to the cumulative effect of all out-of-band emissions including in particular intermodulation products, carrier spectral sidelobes and spurious radiation.

It may be permissible in some cases for this limit to be exceeded if it can be shown that, for the particular frequency plan, this will not cause the overall noise performance objectives of the interfered–with carriers to be exceeded.

6.4 SPECTRAL SPREADING OF THE CARRIER ENERGY

6.4.1. Energy Dispersal (FM/TV Carriers)

For FM/TV carriers, energy dispersal shall be provided by a symmetrical field rate triangular waveform.

* $\alpha = 100\lambda/D$, where D is the antenna diameter and λ is the carrier wavelength. This formula is valid as long as $1 \leq \alpha \leq 2$. If the formula yields values outside this range of validity, α is set to either 1 or 2, depending on which is the nearest.

The peak-to-peak frequency deviation due to energy dispersal shall be 4 MHz when the video signal is not present and, when the video is present, as follows*:

For transmissions in the FSS frequency bands 2 MHz p-p for PAL, SECAM and NTSC and for MAC systems either 1.2 MHz p-p or 2 MHz p-p.

For transmissions in the BSS frequency bands from 11.7 to 12.5 GHz, at least 600 kHz p-p.

6.4.2. Scrambling (Digital Carriers)

Scrambling shall be provided to ensure that uniform spectral spreading is applied to the transmitted carrier at all times.

A synchronous data scrambler with the characteristics specified in EESS 501, or a self-synchronizing scrambler as specified in EESS 501 or a functional equivalent with similar spectrum spreading characteristics shall be used.

* The video signal is present when the synchronization pulses can be detected.

7. OPERATIONAL REQUIREMENTS

The operational requirements to be met by earth stations accessing allotted capacity are documented in the Eutelsat Systems Operation Guide (ESOG).

The ESOG is available on the Eutelsat WEB www.eutelsat.com.

Television Carrier Bandwidth MHz	A (MHz)	B (MHz)	C (MHz)	D (MHz)	a (dB)	b * (dB)	c * (dB)	d * (dB)	e (dB)
17.5	12.6	15.75	18.0	26.5	0.3	2.5	6.5	25.0	0.1
20.0	14.4	18.0	20.5	28.0	0.3	2.5	7.5	25.0	0.1
25.0	18.0	22.5	25.75	34.0	0.3	2.5	8.0	25.0	0.2
27.0	19.4	24.3	27.8	36.0	0.3	2.5	8.0	25.0	0.2
30.0	24.0	30.0	35.0	50.0	0.5	2.5	7.0	25.0	0.3
36.0	28.8	36.0	45.25	60.0	0.6	2.5	10.0	25.0	0.3

TABLE 1a: **FM TV CARRIER TRANSMIT CHAIN AMPLITUDE CHARACTERISTICS**

(See Figure 1)

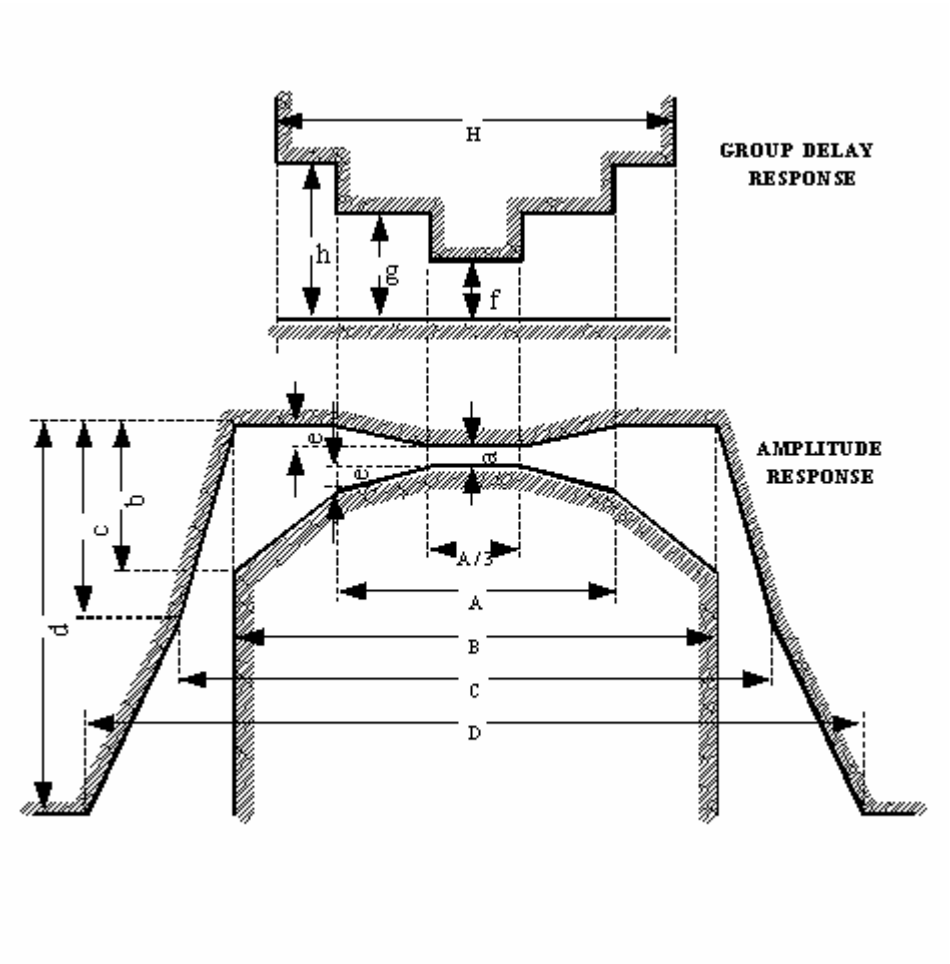
Television Carrier Bandwidth MHz	A (MHz)	H (MHz)	f (ns)	g (ns)	h (ns)
17.5	12.6	14.2	6.0	6.0	15.0
20.0	14.4	16.6	4.0	5.0	15.0
25.0	18.0	20.7	3.0	5.0	15.0
27.0	19.4	22.4	3.0	5.0	15.0
30.0	24.0	30.0	5.0	5.0	15.0
36.0	28.8	33.1	3.0	5.0	15.0

TABLE 1b: FM TV CARRIER TRANSMIT CHAIN GROUP DELAY CHARACTERISTICS

(See Figure 1)

Note:

* Out-of-band amplitude response



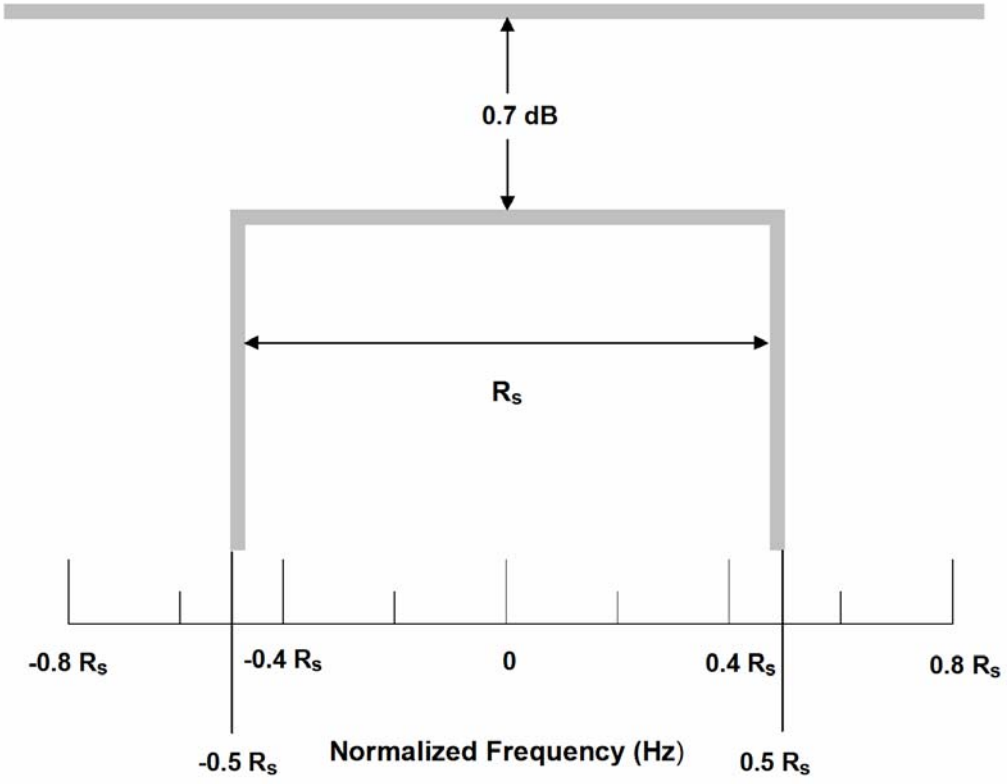
NOTES: (1) Figures are symmetrical relative to centre frequency

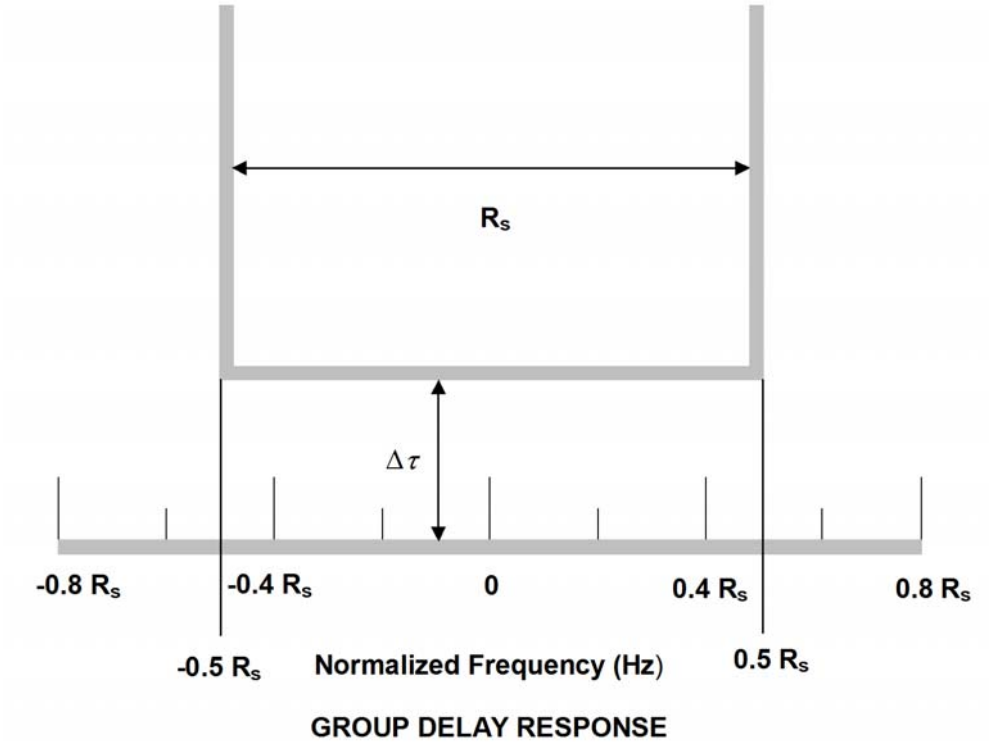
(2) Figures are not drawn to scale

(3) Amplitude scale is linear in dB

(4) Frequency scale is linear in MHz

Figure 1. FM TV TRANSMIT CHAIN AMPLITUDE AND GROUP DELAY CHARACTERISTICS

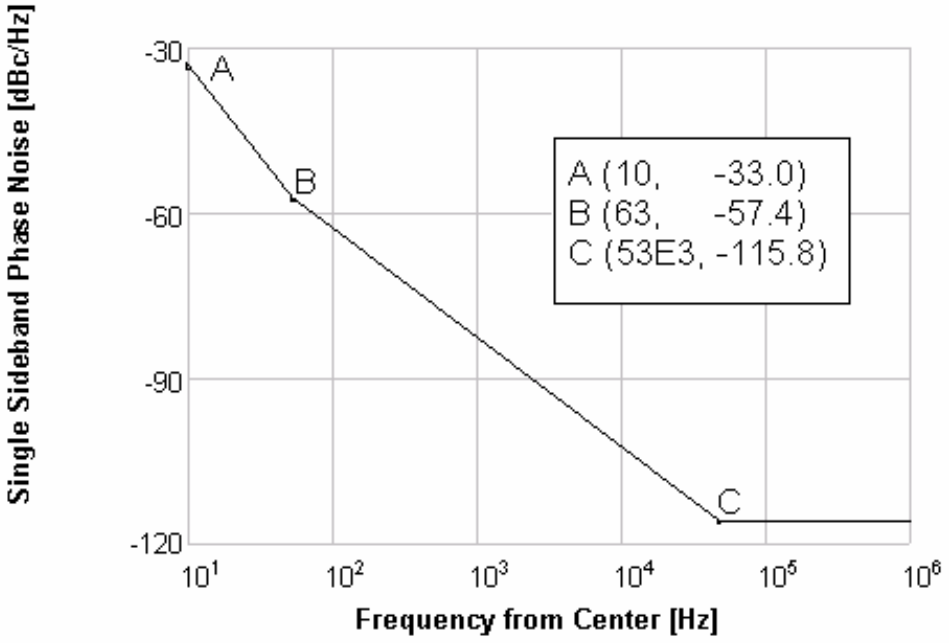




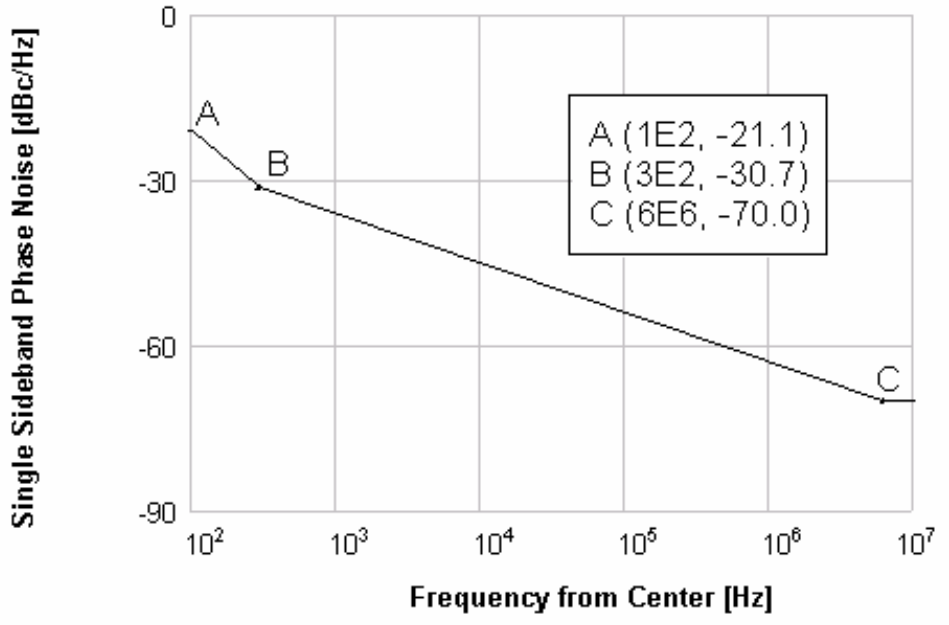
NOTES: R is the transmission symbol Rate in Baud

$$\Delta\tau \text{ [nsec]} = \frac{0.15 \times 10^9}{R_s[\text{Baud}]}$$

Figure 2. DIGITAL CARRIERS AMPLITUDE AND GROUP DELAY CHARACTERISTICS



(a) Limits for random phase noise



(b) Limits for any single component of phase noise

Figure 3. SATELLITE SPURIOUS MODULATION