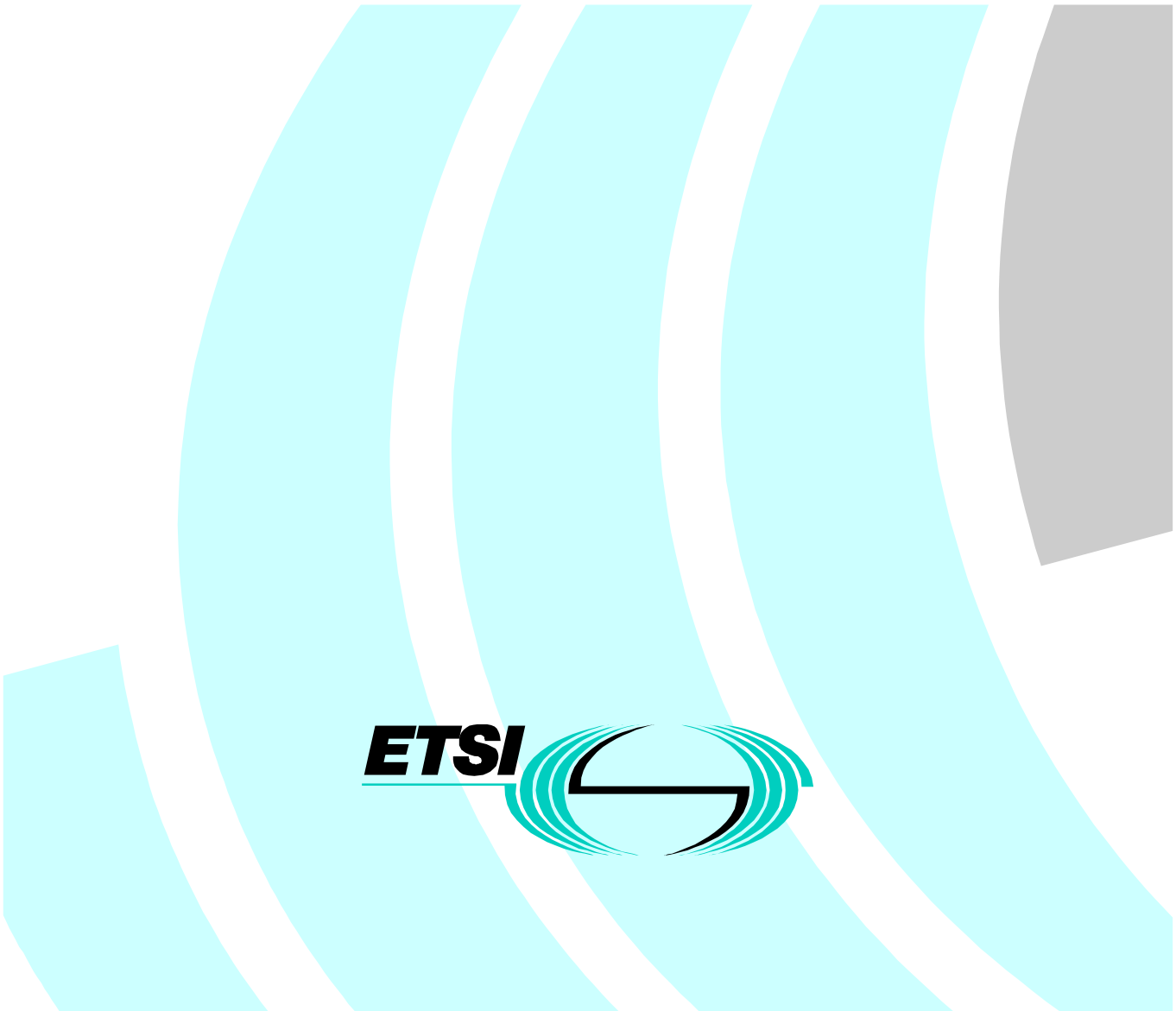
ETSI TS 101 136 V1.3.1 (2001-06)

Technical Specification

**Satellite Earth Stations and Systems (SES);
Guidance for general purpose earth stations transmitting in the 5,7 GHz to 30,0 GHz frequency bands towards geostationary satellites and not covered by other ETSI specifications or standards**



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Foreword

This Technical Specification (TS) has been produced by ETSI Technical Committee Satellite Earth Stations and Systems (SES).

Introduction

The present document applies to General Purpose Earth Stations (GPES) which could be capable of:

- providing the exchange and/or distribution of telephony-, television-, audio-signals and/or data between users; and/or
- performing the execution of Telemetry, Tracking, Command and Monitoring (TTC&M) functions; and/or
- interfacing to public networks (e.g. PSTN, PSPDN, ISDN).

The present document is intended to give guidance in order to protect other users of the frequency spectrum, both satellite and terrestrial, from unacceptable interference. The specifications in the present document have been determined in order to effectively use the spectrum allocated to terrestrial/space radio communications and orbital resources so as to avoid harmful interference.

However, for some GPES, it is recognized that relaxations of the specified limits may be necessary and may be accepted, taking into account the particular environment of the GPES installation on a case-by-case basis.

The determination of the parameters of the GPESs using a given geo-stationary satellite, for the protection of the spectrum allocated to that satellite, is considered to be under the responsibility of the satellite operator or the satellite network operators.

The present document is limited to radio frequency (RF) parameters and does not contain specifications for any control and monitoring functions (CMF) that may be required to protect other users of the spectrum.

The present document does not contain any recommendation or information about the installation or operation of the GPES.

1 Scope

The present document is applicable to General Purpose Earth Stations (GPESs) not covered by other ETSI specifications or standards.

The present document is intended to provide guidance for compliance of GPESs with the Radio and Telecommunications Terminal Equipment directive [1] requirements for the protection of other services from harmful interference. However, for some GPES, it is recognized that relaxation of the specified limits may be necessary and may be accepted, taking into account the particular environment of the GPES installation on a case-by-case basis.

NOTE 1: More stringent specifications may be needed and required by satellite operators.

NOTE 2: A GPES will be subject to a site clearance and a standard frequency co-ordination process.

The present document is applicable to GPESs which have the following characteristics:

- GPESs designed to transmit in all or part of any of the applicable frequency bands allocated to the Fixed Satellite Service (FSS),including feeder links for the Broadcast Satellite Service (BSS), as defined in table 1; and
- GPESs designed to operate through geostationary satellites with a typical orbital separation as defined in table 1 away from any other geostationary satellite operating in the same frequency band and covering common areas; and
- GPESs designed for operation at a fixed location; and
- GPESs designed for attended operation.

Table 1: Transmit frequency bands

Transmit frequency bands	Typical orbital separation
5,725 GHz - 7,075 GHz	3°
10,7 GHz - 11,7 GHz	3°
12,75 GHz - 14,50 GHz	3°
17,30 GHz - 18,40 GHz	3°
27,50 GHz - 30,00 GHz	2°

A GPES typically comprises six main parts as defined in clause 3.1.

The present document does not contain any recommendation or information about the method of modulation.

The present document applies to the GPES with its various equipment, its ancillary equipment and its various terrestrial ports when operated within the boundary limits of the operational environmental profile (including the ranges of humidity, temperature and supply voltage) declared by the applicant.

NOTE 3: Limits for spurious radiation from a GPES when transmitting multiple carriers simultaneously (multicarrier operation) have not been taken into consideration in the present document.

2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication and/or edition number or version number) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies.

[1] Directive 1999/5/EC of the European Parliament and of the Council of 9 March 1999 on radio equipment and telecommunications terminal equipment and the mutual recognition of their conformity.

[2] IEC 60510-1-2: "Methods of measurement for radio equipment used in satellite earth stations. Part 1: Measurements common to sub-systems and combinations of sub-systems. Section Two: Measurements in the r.f. range".

[3] IEC 60510-2-1: "Methods of measurement for radio equipment used in satellite earth stations. Part 2: Measurements of sub-systems. Section One: General - Section Two: Antenna (including feed network)".

[4] ITU-R Recommendation S.524-6: "Maximum permissible levels of off-axis e.i.r.p. density from earth stations in GSO networks operating in the fixed-satellite service transmitting in the 6 GHz, 14 GHz and 30 GHz frequency bands".

[5] ITU-R Recommendation S.732: "Method for statistical processing of earth-station antenna side-lobe peaks".

3 Definitions and abbreviations

3.1 Definitions

For the purposes of the present document, the following terms and definitions apply:

ancillary equipment: Equipment used in connection with a GPES is considered as ancillary if the three following conditions are met:

- the equipment is intended to be used in conjunction with a GPES to provide additional operational and/or control features (e.g. to extend control to another position or location);
- the equipment cannot be used on a stand alone basis, to provide user functions independently of a GPES; and
- the absence of the equipment does not inhibit the operation of the GPES.

applicant: manufacturer or his authorized representative within the European Community or the person responsible for placing the apparatus on the market

cross polarization discrimination: Cross polarization discrimination of an antenna, in a given direction, at a transmit or receive frequency, is defined in the present document as the ratio of the on-axis co-polar gain to the cross-polar gain in that direction. It is expressed in dB.

General Purpose Earth Station (GPES): It typically comprises six main parts:

1) the antenna sub-system which converts the incident radiation field into a guided wave and vice versa; in addition the antenna sub-system contains the support structure, the de-icing and the tracking equipment;

2) the transmit sub-system, which is composed of the IF equipment, the frequency translation equipment, the high power amplifier(s), the combining equipment and the redundancy switching equipment;

3) the receive sub-system, which consists of the low noise amplifier(s), the frequency translation equipment, the IF- and IF-distribution equipment and/any redundancy switching equipment;

4) the ground communication sub-system, which consists of the modulation and demodulation equipment, either analogue or digital, and the associated baseband equipment;

5) the monitoring and control sub-system;

6) the power sub-system, which consists of any power generation equipment that may be required.

nominated bandwidth: bandwidth of the GPES radio frequency transmission is nominated by the applicant
The nominated bandwidth does not exceed five times the occupied bandwidth.

NOTE: The nominated bandwidth is wide enough to encompass all spectral elements of the transmission which have a level greater than the specified spurious radiation limits. The nominated bandwidth is wide enough to take account of the transmit carrier frequency stability. This definition is chosen to allow flexibility regarding adjacent channel interference levels which will be taken into account by operational procedures depending on the exact transponder carrier assignment situation.

occupied bandwidth (digital modulation): For a digital modulation scheme the frequency width of the signal spectrum is that which is within the limits defined by power density level 10 dB below the maximum inband density.

occupied bandwidth (analogue modulation): For a analogue modulation scheme the width of a frequency band is such that, below the lower and above the upper frequency limits, the mean power emitted is equal to 0,5 % of the total mean power of the emission.

spurious radiation: any radiation outside the nominated bandwidth

3.2 Abbreviations

For the purposes of the present document, the following abbreviations apply:

BSS	Broadcast Satellite Service
CMF	Control and Monitoring Functions
EIRP	Equivalent Isotropically Radiated Power
ES	Earth Station
FSS	Fixed Satellite Service
GPES	General Purpose Earth Station
GSO	Geostationary Satellite Orbit
IF	Intermediate Frequency
ISDN	Integrated Service Digital Network
ITU	International Telecommunication Union
PSK	Phase Shift Keying
PSPDN	Public Switched Packet Data Network
PSTN	Public Switched Telephone Network
RF	Radio Frequency
SCPC	Single Channel Per Carrier
TTC&M	Telemetry, Tracking, Command and Monitoring

4 Radio Frequency (RF)

4.1 Off-axis EIRP emission density

4.1.1 Purpose

For the protection of other satellite (uplink) systems.

4.1.2 Specification 1: Emission limits for analogue transmissions of GPES

The following limits are applicable to analogue transmissions of GPES.

For the GPES emissions, the maximum EIRP emission density in any direction should not exceed the limits recommended in ITU-R Recommendation S.524-6 [4].

4.1.3 Specification 2: Emission limits for digital transmissions of GPES

4.1.3.1 General

The following limits are applicable to digital transmissions of GPES.

4.1.3.2 Transmit frequency bands below 18,4 GHz

For any GPES designed to transmit in a frequency band below 18,4 GHz, for any angle Φ which is 2,5° or more off the main lobe axis of the GPES, the maximum EIRP emission density in any direction within 3° of the GSO arc should not exceed the limits in table 2.

Additionally, for any GPES designed to transmit within the frequency band from 12,75 GHz to 14,50 GHz, the maximum EIRP density in any direction 3° or more away from the GSO arc should not exceed the limits in table 2 by more than 3 dB.

Table 2: Maximum EIRP emission density for GPES designed to transmit in bands below 18,4 GHz

Frequency range	**5,725 GHz to 7,075 GHz**	**5,725 GHz to 7,075 GHz**	**10,7 GHz to 11,7 GHz and 12,75 GHz to 14,50 GHz**	**17,30 GHz to 18,40 GHz**
Type of transmission	**Any**	**Voice-activated telephony SCPC/PSK systems**	**Any**	**Any**
Measurement bandwidth	**4 kHz**	**40 kHz**	**40 kHz**	**40 kHz**
Co-polar component:				
$2,5° \leq \Phi \leq 7°$	$32 – 25 \log \Phi$ dBW	$45 – 25 \log \Phi$ dBW	$39 – 25 \log \Phi$ dBW	$39 – 25 \log \Phi$ dBW
$7° \leq \Phi \leq 9,2°$	11 dBW	$45 – 25 \log \Phi$ dBW	18 dBW	18 dBW
$9,2° \leq \Phi \leq 48°$	$35 – 25 \log \Phi$ dBW	$45 – 25 \log \Phi$ dBW	$42 – 25 \log \Phi$ dBW	$42 – 25 \log \Phi$ dBW
$> 48°$	–7 dBW	3 dBW	0 dBW	0 dBW

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

For non-continuous transmission, the above limits may not apply for a specific portion of each burst as declared by the applicant. This excluded portion shall not exceed 50 µs or 10 % of the burst, whichever is the smaller.

The excluded portion shall have characteristics similar to the remaining part of the burst:

- same symbol rate and modulation; and
- same or lower maximum amplitude.

For systems in which more than one Earth Station (ES) is expected to transmit simultaneously in the same frequency band, e.g. for systems employing CDMA, the maximum EIRP values above should be decreased by 10 log (N) dB, where N is the number of ESs in the receive beam of the satellite to which these ESs are communicating and which are expected to transmit simultaneously in the same frequency band within that beam. This number should be declared by the applicant.

NOTE 1: N = 1 in a FDMA or TDMA system.

NOTE 2: The declared value of N should take account of all ES that can contribute, both GPES and other (non-GPES) ESs.

In the case of GPESs employing uplink power control, the above limits shall apply under clear-sky conditions and these limits include all additional margins above the minimum clear-sky level necessary for the implementation of uplink power control. For GPESs implementing uplink power control, the above limits may be exceeded by up to A dB during fade conditions, where A is the attenuation of the transmit signal relative to clear sky conditions.

The uplink power control shall be subject to the following additional requirement:

- The value of A shall not exceed 10 dB.

For GPESs operating in GSO networks in the FSS operating in the 12,75 to 13,25 GHz and 13,75 to 14,5 GHz frequency bands, the above limits may be exceeded by telecommand and ranging carriers transmitted to GSO-FSS satellites in both normal and emergency modes of telecommand operation. The amount by which these levels may be exceeded when operating in normal mode is 16 dB.

4.1.3.3 Transmit frequency bands above 27,5 GHz

For the protection of other satellite (uplink) systems for any GPES designed to transmit in a band above 27,5 GHz, for any angle Φ which is 1,8° or more off the GPES antenna main lobe axis, the maximum EIRP emission density in any direction within 3° of the GSO should not exceed the limits in table 3.

Additionally, for any GPES designed to transmit within the frequency band from 29,5 GHz to 30 GHz the maximum EIRP emission density in any direction 3° or more away from the GSO arc should not exceed the limits in table 3 by more than 3 dB.

Table 3: Maximum EIRP emission density for GPES designed to transmit in bands above 27,5 GHz

Frequency range	**27,5 GHz to 30,0 GHz (note 1)**
Measurement bandwidth	**40 kHz**
Co-polar component:	
$1,8° \le \Phi \le 7°$	$19 - 25 \log \Phi$ dBW
$7° \le \Phi \le 9,2°$	–2 dBW
$9,2° \le \Phi \le 48°$	$22 - 25 \log \Phi$ dBW
$> 48°$	–10 dBW

Where Φ is the angle, in degrees, between the main beam axis and the direction considered, and N is as defined below.

For systems in which more than one Earth Station (ES) is expected to transmit simultaneously in the same frequency band, e.g. for systems employing CDMA, the maximum EIRP values above should be decreased by 10 log (N) dB, where N is the number of ESs in the receive beam of the satellite to which these ESs are communicating and which are expected to transmit simultaneously in the same frequency band within that beam. This number should be declared by the applicant.

NOTE 1: N = 1 in a FDMA or TDMA system.

NOTE 2: The declared value of N should take account of all ESs that can contribute, both GPES and other (non-GPES) ESs.

For non-continuous transmission, the above limits may not apply for a specific portion of each burst as declared by the applicant. This excluded portion shall not exceed 50 µs or 10 % of the burst, whichever is the smaller.

The excluded portion shall have characteristics similar to the remaining part of the burst:

- same symbol rate and modulation; and
- same or lower maximum amplitude.

In the case of GPESs employing uplink power control, the above limits, for co-polar and cross-polar components, shall apply under clear-sky conditions and these limits include all additional margins above the minimum clear-sky level necessary for the implementation of uplink power control. For GPESs implementing uplink power control, the above limits may be exceeded by up to A dB during fade conditions, where A is the attenuation of the transmit signal relative to clear sky conditions.

The uplink power control shall be subject to the following additional requirement:

- The value of A shall not exceed 20 dB.

GPESs operating in the 27,5 to 30,0 GHz frequency band should be designed in such a manner that 90 % of their peak off-axis EIRP density levels do not exceed the above limits. The statistical processing of the off-axis EIRP density peaks should be dealt with using the method given in ITU-R Recommendation S.732 [5].

NOTE 3: Further study is needed to determine the off-axis angular range over which the peak off-axis EIRP density levels may be permitted to exceed the above limits, taking into account the interference level into adjacent satellites, in accordance with note 15 of ITU Recommendation S.524-6 [4].

For GPESs with low elevation angles, the above limits may be exceeded by the following amount:

Elevation angle to GSO (∅)	Increase in EIRP density (dB)
∅ ≤ 5°	2,5 dB
5° < ∅ ≤ 30°	0,1(25 - ∅) + 0,5 dB

NOTE 4: Further study is needed to determine the amount by which these limits may be exceeded for GPESs operating and ranging carriers in the 27,5 to 30,0 GHz frequency band in accordance with note 19 of ITU-R Recommendation S.524-6 [4].

4.1.4 Measurement guidelines

Conformance should be determined from:

- measurement of maximum RF power density entering the antenna feed;
- measurement and/or provision of antenna co-polar transmit gain pattern; to be provided by the applicant.

The applicant may select the appropriate test procedure.

The measurement of the RF power density should be made in accordance with IEC 60510-1-2 [2], clause 5.2.2.2. The measuring instrument should be a spectrum analyser. The measurements should be performed at three frequencies (low, middle, high) within the transmit frequency band. The measurement of the transmit gain patterns should be made in accordance to IEC 60510-2-1 [3] clause 8, or any other recognized method that can be shown to give similar results.

For antennas with adjustment ranges of less than ±15° conformance testing may be limited to the range of off-axis angles up to ±10°.

If satellites for verification measurement are used then the angular ranges may be limited to ±15° in azimuth and ±10° in elevation. Care shall be taken to ensure that the on-axis EIRP density of the radiated test signal never exceeds the EIRP density limits of interference towards adjacent satellites.

4.2 Off-axis spurious radiation

4.2.1 Purpose

To limit the level of interference to terrestrial and satellite radio services in the frequency bands outside the nominated bandwidth.

NOTE 1: Additional guidelines on the derivation of these limits is given in annex B.

4.2.2 Transmit frequency band 5,725 GHz to 7,075 GHz

With the carrier on, the off-axis spurious EIRP for any GPES designed to transmit in the band 5,725 GHz to 7,075 GHz should not exceed the limits in table 4 for all off-axis angles greater than 11°.

Table 4: Limits of spurious radiation for GPES designed to transmit in the frequency band 5,725 GHz to 7,075 GHz

49 dBpW	in any 100 kHz band	In the range 1,0 GHz to 3,4 GHz
55 dBpW	in any 100 kHz band	In the range 3,4 GHz to 5,475 GHz
98 dBpW (note 1)	in any 10 MHz band	In the range 5,475 GHz to 5,725 GHz
98 dBpW (note 1)	in any 10 MHz band	In the range 7,075 GHz to 7,325 GHz
55 dBpW	in any 100 kHz band	In the range 7,325 GHz to 10,70 GHz
61 dBpW (note 2)	in any 100 kHz band	In the range 10,70 GHz to 21,2 GHz
67 dBpW	in any 100 kHz band	In the range 21,2 GHz to 40 GHz

NOTE 1: This limit may be exceeded in a frequency band which shall not exceed 50 MHz centred on the carrier frequency, provided that the on-axis EIRP density at the considered frequency is 50 dB below the maximum on-axis EIRP density of the signal (within the nominated bandwidth) expressed in dBW/100 kHz.

NOTE 2: In the frequency band 10,95 GHz to 14,650 GHz, for any 20 MHz band within which one or more spurious signals exceeding the above limit of 61 dBpW/100 kHz are present, then the power of each of those spurious signals exceeding the limit should be added in watts, and the sum should not exceed 78 dBpW.

For GPESs designed to transmit simultaneously several different carriers (multicarrier operation), the above limits should apply to each individual carrier when transmitted alone.

4.2.3 Transmit frequency band 10,7 GHz to 11,7 GHz

With the carrier on, the off-axis spurious EIRP from a GPES transmitting in the frequency band from 10,7 GHz to 11,7 GHz should not exceed the limits in table 5 for all off-axis angles greater than 7°.

Table 5: Limits of spurious radiation for GPES designed to transmit in the frequency band 10,7 GHz to 11,7 GHz

49 dBpW	in any 100 kHz band	in the range 1,0 GHz to 3,4 GHz
55 dBpW	in any 100 kHz band	in the range 3,4 GHz to 10,45 GHz
78 dBpW (note 1)	in any 100 kHz band	in the range 10,45 GHz to 11,95 GHz
61 dBpW (note 2)	in any 100 kHz band	in the range 11,95 GHz to 21,2 GHz
67 dBpW (note 2)	in any 100 kHz band	in the range 21,2 GHz to 40 GHz
NOTE 1: This limit may be exceeded in a frequency band which shall not exceed 50 MHz, centred on the carrier frequency, provided that the on-axis EIRP density at the considered frequency is 50 dB below the maximum on-axis EIRP density of the signal (within the nominated bandwidth) expressed in dBW/100 kHz. NOTE 2: In the frequency band 20,9 GHz to 23,9 GHz, for any 20 MHz band within which one or more spurious signals exceeding the above limits of 61 dBpW/100 kHz or 67 dBpW/100 kHz are present, then the power of each of those spurii exceeding the limit should be added in watts, and the sum should not exceed 78 dBpW.		

For GPESs designed to transmit simultaneously several different carriers (multicarrier operation), the above limits should apply to each individual carrier when transmitted alone.

4.2.4 Transmit frequency band 12,75 GHz to 14,5 GHz

With the carrier on, the off-axis spurious EIRP from a GPES transmitting in the frequency band from 12,75 GHz to 14,5 GHz should not exceed the limits in table 6 for all off-axis angles greater than 7°.

Table 6: Limits of spurious radiation for GPES designed to transmit in the frequency band 12,75 GHz to 14,5 GHz

49 dBpW	in any 100 kHz band	in the range 1,0 GHz to 3,4 GHz
55 dBpW	in any 100 kHz band	in the range 3,4 GHz to 10,7 GHz
61 dBpW	in any 100 kHz band	in the range 10,7 GHz to 12,75 GHz
95 dBpW (note 1, 2)	in any 10 MHz band	in the range 14,25 GHz to 14,5 GHz
95 dBpW (note 1)	in any 10 MHz band	in the range 14,5 GHz to 14,75 GHz
61 dBpW	in any 100 kHz band	in the range 14,75 GHz to 21,2 GHz
67 dBpW (note 3)	in any 100 kHz band	in the range 21,2 GHz to 40 GHz
NOTE 1: This limit may be exceeded in a frequency band which shall not exceed 50 MHz, centred on the carrier frequency, provided that the on-axis EIRP density at the considered frequency is 50 dB below the maximum on-axis EIRP density of the signal (within the nominated bandwidth) expressed in dBW/100 kHz. NOTE 2: In countries where sharing with the Fixed Service does not apply this limit does not apply. NOTE 3: In the frequency band 25,0 GHz to 29,50 GHz, for any 20 MHz band within which one or more spurious signals exceeding the above limit of 67 dBpW/100 kHz are present, then the power of each of those spurii exceeding the limit should be added in watts, and the sum should not exceed 78 dBpW.		

For GPESs designed to transmit simultaneously several different carriers (multicarrier operation), the above limits should apply to each individual carrier when transmitted alone.

4.2.5 Transmit frequency band 17,3 GHz to 18,4 GHz

With the carrier on, the off-axis spurious EIRP from a GPES transmitting in the frequency band from 17,3 GHz to 18,4 GHz should not exceed the limits in table 7 for all off-axis angles greater than 7°.

Table 7: Limits of spurious radiation for GPES designed to transmit in the frequency band 17,3 GHz to 18,4 GHz

49 dBpW	in any 100 kHz band	in the range 1,0 GHz to 3,4 GHz
55 dBpW	in any 100 kHz band	in the range 3,4 GHz to 10,7 GHz
61 dBpW	in any 100 kHz band	in the range 10,7 GHz to 17,05 GHz
88 dBpW	in any 1 MHz band	in the range 17,05 GHz to 17,3 GHz
88 dBpW	in any 1 MHz band	in the range 18,4 GHz to 18,65 GHz
61 dBpW	in any 100 kHz band	in the range 18,65 GHz to 21,2 GHz
67 dBpW (note 1)	in any 100 kHz band	in the range 21,2 GHz to 40 GHz
NOTE 1: In the frequency band 34,1 GHz to 37,3 GHz, for any 20 MHz band within which one or more spurious signals exceeding the above limit of 67 dBpW/100 kHz are present, then the power of each of those spurii exceeding the limit should be added in watts, and the sum should not exceed 78 dBpW.		

NOTE: The lower limit should apply at the transition frequency.

For GPESs designed to transmit simultaneously several different carriers (multicarrier operation), the above limits should apply to each individual carrier when transmitted alone.

4.2.6 Transmit frequency band 27,5 GHz to 30,0 GHz

With the carrier on, the off-axis spurious EIRP from a GPES transmitting in the frequency band from 27,5 GHz to 30,0 GHz should not exceed the limits in table 8 for all off-axis angles greater than 7°.

Table 8: Limits of spurious radiation for GPES designed to transmit in the band 27,5 GHz to 30,0 GHz

49 dBpW	in any 100 kHz band	in the range 1,0 GHz to 3,4 GHz
55 dBpW	in any 100 kHz band	in the range 3,4 GHz to 10,7 GHz
61 dBpW	in any 100 kHz band	in the range 10,7 GHz to 21,2 GHz
67 dBpW	in any 100 kHz band	in the range 21,2 GHz to 27,35 GHz
85 dBpW (note 1)	in any 1 MHz band	in the range 27,35 GHz to 27,5 GHz
85 dBpW (note 1, 2)	in any 1 MHz band	in the range 27,5 GHz to 29,5 GHz
85 dBpW (note 1)	in any 1 MHz band	in the range 30 GHz to 30,15 GHz
67 dBpW	in any 100 kHz band	in the range 30,15 GHz to 40 GHz
NOTE 1: This limit may be exceeded in a frequency band which shall not exceed 50 MHz, centred on the carrier frequency, provided that the on-axis EIRP density measured in 100 kHz at the frequency of the considered spurious is 50 dB below the maximum on-axis EIRP density of the signal measured in 100 kHz. NOTE 2: This limit may not apply in frequency bands exclusively designated to FSS in regions where those bands have been adopted.		

NOTE: The lower limit should apply at the transition frequency.

For GPESs designed to transmit simultaneously several different carriers (multicarrier operation), the above limits should apply to each individual carrier when transmitted alone.

4.2.7 Measurement guidelines

Spurious radiation generated by a GPES under operation are measured above the cut-off frequency. The EIRP should be adjusted according to the maximum expected operational figure.

The power of the spurious radiation at the antenna port should be measured according to the measurement method in IEC 60510-1-2 [2], clause 5.2.2.2. The measuring instrument should be a spectrum analyser which should be protected against the main transmission by appropriate means.

The spectrum analyser resolution bandwidth should be set to the specified measuring bandwidth or as close as possible. If the resolution bandwidth is different from the specified measuring bandwidth then bandwidth correction should be performed for the noise-like wide-band spurious emissions.

To obtain the off-axis spurious EIRP the maximum measured antenna transmit gain for off-axis angles greater 11° (for transmit frequencies below 10 GHz) respectively for off-axis angles greater 7° (for transmit frequencies above 10 GHz) shall be added to any figure obtained in the above measurement and any correction or calibration factors summated with the results.

The antenna transmit gain patterns should be measured according to IEC 60510-2-1 [3], clause 8, or any other method, that can be proved to give the same results.

In case there are no measured antenna gain figures available, then the following highest figures should be used:

transmit frequency bands < 10 GHz	3 dBi for $\Phi > 11°$
transmit frequency bands > 10 GHz	8 dBi for $\Phi > 7°$

Annex A (informative): Antenna guidelines

A.1 General

The guidelines specified in this annex are intended to characterize antennas which are supplied as separate components.

A.2 Co-polar pattern of a Class Sxx antenna

The gain G (Φ) in dB relative to an isotropic antenna of the main lobe of a Class Sxx antenna should not exceed the limits given in table A.2 except as noted in this clause.

Table A.2: Co-polar pattern limits

S – 25log(Φ) dBi	$\Phi_{min}° \leq \Phi < \Phi_s°$
–3,5 dBi	$\Phi_s° \leq \Phi < 26,3°$
32 – 25log(Φ) dBi	$26,3° \leq \Phi < 48°$
–10 dBi	$48° \leq \Phi \leq 180°$

where:

Φ The angle, in degrees, between the antenna main beam axis and the direction considered.

$\Phi_{min} = 1,5°$

$\Phi_s = 10 \text{ ^ } ((S+3,5)/25)$ degrees

S = xx for a class Sxx antenna, as declared by the manufacturer (e.g. S = 29 for Class S29 antenna).

The declared value of S should not be greater than 29.

From $\Phi_{min} \leq \Phi \leq 180°$, no side-lobe may exceed the table A.2 limits by more than 3 dB.

From $\Phi_{min} \leq \Phi \leq 7°$ (Region 1), no more than 10 % of the side-lobes may exceed the table A.2 limits. The method of calculation shall be according to ITU-R Recommendation S.732 [5], except that a single angular region as defined above shall be used.

From $7° < \Phi \leq 180°$ (Region 2), no more than 10 % of the side-lobes may exceed the table A.2 limits. The method of calculation shall be according to ITU-R Recommendation S.732 [5], except that a single angular region as defined above shall be used.

Refer to figure A.2 for an illustration of Region 1 and Region 2.

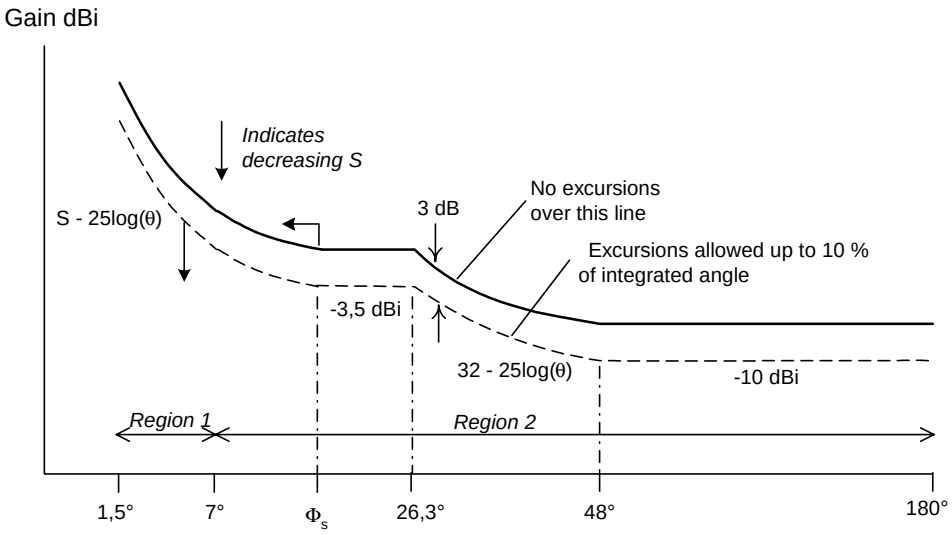

Figure A.2: Region 1 and Region 2

A.3 Cross-polar pattern of a Class Sxx antenna

The cross-polar gain G (Φ) in dB relative to an isotropic antenna of at least 90 % of the peaks should not exceed the limits defined in table A.3.

Table A.3: Cross-polar pattern limits

S – 6 – 25log(Φ) dBi	1,5° ≤ Φ < 7°
S – 8,8 – 16,7log(Φ) dBi	7° ≤ Φ ≤ 9,2°

Where:

Φ and S are as defined in clause A.2.

A.4 Cross-polar discrimination of a Class Cyy antenna

The polarization discrimination of a "Class Cyy" antenna at any transmit frequency shall be at least yy dB everywhere within a cone centred on the main beam axis, with the cone half-angle defined by the Beam Pointing Error (BPE).

EXAMPLE: A Class C35 antenna maintains 35 dB polarization discrimination within the BPE.

The manufacturer shall declare the value of C.

For linear polarization, the declared value of C should not be less than 30 (i.e. Class C30).

For circular polarization, the declared value of C should not be less than 20 (i.e. Class C20).

The Beam Pointing Error (BPE) is defined as the angle corresponding to the 1 dB contour of the pattern of the transmit beam at the operating frequency.

Annex B (informative): Off-axis spurious radiation limits

B.1 General

The limits specified in clause 4.2 may be adapted on a case-by-case basis to the local environment of each GPES. In isolated locations, more relaxed limits should be possible, but more stringent limits may be required in locations in the vicinity of other radio equipment.

The limits specified in clause 4.2 may be exceeded or may have to be lowered for the protection of the terrestrial equipment in the vicinity of the earth station. In any case the applicable limits shall be determined taking into consideration the equipment to consider with their distance, their locations and their antenna gain characteristics.

B.2 Requirements for the protection of terrestrial equipment

The following requirements for the protection of any terrestrial equipment in the vicinity of the transmitting earth station from harmful interference have been determined:

The EIRP density of the spurious radiated by the earth station in any direction at more than 7° from the transmitting earth station antenna main beam axis shall not exceed the following limits:

- 49 dBpW in any 100 kHz bandwidth from 1 GHz to 3,4 GHz
- 55 dBpW in any 100 kHz bandwidth from 3,4 GHz to 10,7 GHz
- 61 dBpW in any 100 kHz bandwidth from 10,7 GHz to 21,2 GHz
- 67 dBpW in any 100 kHz bandwidth from 21,2 GHz to 40 GHz

These limits have been determined such that the interfered equipment receiver noise temperature is increased by no more than 0,1 dB at the frequency f of the spurious, when the interferer is at a specific distance d from the interfered system and when it is located in a direction where the antenna gain of the interfered system has a specific value Gr.

These limits have been determined for the typical configurations given in table B.2.

Table B.2: Typical configurations

EIRP density	f	Gr	d
49 dBpW in any 100 kHz	3,4 GHz	-10 dBi	95 m
49 dBpW in any 100 kHz	3,4 GHz	0 dBi	300 m
55 dBpW in any 100 kHz	3,4 GHz	-10 dBi	190 m
55 dBpW in any 100 kHz	3,4 GHz	0 dBi	600 m
55 dBpW in any 100 kHz	10,7 GHz	-10 dBi	95 m
55 dBpW in any 100 kHz	10,7 GHz	0 dBi	300 m
61 dBpW in any 100 kHz	10,7 GHz	-10 dBi	190 m
61 dBpW in any 100 kHz	10,7 GHz	0 dBi	600 m
61 dBpW in any 100 kHz	21,2 GHz	-10 dBi	95 m
61 dBpW in any 100 kHz	21,2 GHz	0 dBi	300 m
67 dBpW in any 100 kHz	21,2 GHz	-10 dBi	190 m
67 dBpW in any 100 kHz	21,2 GHz	0 dBi	600 m
67 dBpW in any 100 kHz	40,0 GHz	-10 dBi	95 m
67 dBpW in any 100 kHz	40,0 GHz	0 dBi	300 m

Annex C (informative): Bibliography

- ITU-R: "Radio Regulations".
- ITU-R Recommendation S.731: "Reference earth-station cross-polarized radiation pattern for use in frequency coordination and interference assessment in the frequency range from 2 to about 30 GHz".
- ITU-R Recommendation S.580-5: "Radiation diagrams for use as design objectives for antennas of earth stations operating with geostationary satellites".

History

Document history		
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