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Technical Specification

Satellite Earth Stations and Systems (SES); Guidance for general purpose earth stations transmitting in the 5,7 GHz to 18,4 GHz frequency bands and not covered by other ETSI standards

European Telecommunications Standards Institute

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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 or the execution of Tracking Telemetry, Control and Monitoring (TTC&M) functions of satellites in the transfer and drift phase;

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

1 Scope

The present document is intended to provide guidance for compliance with national type approval of General Purpose Earth Stations (GPESs) not covered by other ETSI standards.

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

- transmitting in the frequency bands allocated to the Fixed Satellite Service (FSS) and the Broadcast Satellite Service (BSS);
- these GPESs operate through geostationary satellites typically at 3° away from any other geostationary satellite operating in the same frequency band and covering the same area;
- designed for operation at a fixed location;
- designed for attended operation;
- transmitting in all frequency bands or in parts of according to table 1.

Table 1: Transmit frequency bands

Transmit frequency bands
5,725 GHz - 6,425 GHz
12,75 GHz - 14,50 GHz
17,30 GHz - 18,40 GHz

The equipment considered in the present document comprises the antenna and the transmit and receive equipment.

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

The present document applies to the earth station with its various equipment, its ancillary equipment and its various terrestrial ports, being operated under the conditions which are within the ranges of humidity, temperature and supply voltage declared by the manufacturer.

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.

2 References

References may be made to:

a) specific versions of publications (identified by date of publication, edition number, version number, etc.), in which case, subsequent revisions to the referenced document do not apply; or

b) all versions up to and including the identified version (identified by "up to and including" before the version identity); or

c) all versions subsequent to and including the identified version (identified by "onwards" following the version identity); or

d) publications without mention of a specific version, in which case the latest version applies.

A non-specific reference to an ETS shall also be taken to refer to later versions published as an EN with the same number.

2.1 Normative references

[1] 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".

[2] IEC 510-2-1, Part 2: "Measurements of sub-systems. Section One: General. Section Two: Antenna (including feed network)".

2.2 Informative references

[3] ITU: "Radio Regulations".

[4] ITU-R Recommendation S.524-5: "Maximum permissible levels of off-axis e.i.r.p. density from earth stations in the fixed-satellite service transmitting in the 6 and 14 GHz frequency bands".

[5] ITU-R Recommendation S.580-5: "Radiation diagrams for use as design objectives for antennas of earth stations operating with geostationary satellites".

[6] 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".

[7] INTELSAT SSOG 210: "Earth Station Verification Tests: Section 8.2 Test Procedures using an INTELSAT satellite communications system monitor".

3 Definitions and abbreviations

3.1 Definitions

For the purposes of the present document, the following 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.

cross polarization discrimination: The 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.

exclusion band: The exclusion band is centred on the transmit frequency and is equal to 5 times of the occupied bandwidth.

General Purpose Earth Station (GPES): It usually 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.

occupied bandwidth: 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.

For an 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 exclusion band.

3.2 Abbreviations

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

BSS	Broadcast Satellite Service
EIRP	Equivalent Isotropically Radiated Power
FSS	Fixed Satellite Service
GPES	General Purpose Earth Station
IF	Intermediate Frequency
ISDN	Integrated System Digital Network
ppm	parts per million
PSPDN	Public Switched Packet Data Network
PSTN	Public Switched Telephony Network
RF	Radio Frequency
TTC&M	Tracking Telemetry, Control and Monitoring

4 Radio Frequency (RF)

4.1 Off-axis EIRP emission density (co-polar and cross-polar)

For the protection of other satellite (uplink) systems, for both co-polarized and cross-polarized components, for any angle Φ which is 2,5 degrees or more off the main lobe axis of the GPES, the maximum EIRP emission density in any direction within 3 degrees of the GSO should not exceed the limits in table 2.

Table 2: Maximum EIRP emission density for the co-polar and the cross-polar component

Frequency range	5,725 GHz to 6,425 GHz (note 1)	12,75 GHz to 14,50 GHz (note 2)	17,30 GHz to 18,40 GHz (note 2)
Co-polar component:			
$2,5° \leq \Phi \leq 7°$	32 – 25 log Φ dBW	39 – 25 log Φ dBW	39 – 25 log Φ dBW
$7° \leq \Phi \leq 9,2°$	11 dBW	18 dBW	18 dBW
$9,2° \leq \Phi \leq 48°$	35 – 25 log Φ dBW	42 – 25 log Φ dBW	42 – 25 log Φ dBW
$> 48°$	–7 dBW	0 dBW	0 dBW
Cross-polar component:			
$2,5° \leq \Phi \leq 3°$	22 – 25 log Φ dBW	29 – 25 log Φ dBW	29 – 25 log Φ dBW
NOTE 1: To be measured in 4 kHz. NOTE 2: To be measured in 40 kHz.			

Φ is the angle , in degrees, between the main beam axis and the direction considered. Antennas with coverage ranges of less than ±15° should at least demonstrate compliance within an elevation movement range of ±10°.

Conformance should be determined from:

- measurement of maximum RF power density entering the antenna feed; the maximum power density is determined by the modulation equipment and by the operational EIRP. These values have to be provided by the manufacturer;

- measurement and/or provision of typical antenna co-polar and cross-polar transmit gain patterns; to be provided by the manufacturer.

The manufacturer may select the appropriate test procedure.

The measurement of the RF power density should be made in accordance with IEC 510-1-2 [1], subclause 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 510-2-1 [2] clause 8, or any other recognised method that can be proved to give similar results.

An example of a measurement method using satellites is given in INTELSAT SSOG 210 [7]. If satellites for verification measurement are used then the angular ranges may be limited to ±15° in azimuth and ±10° in elevation. The antenna gain should be corrected by the attenuation between the antenna and the test point.

4.2 Off-axis spurious radiation

To limit the level of interference to terrestrial and satellite radio services. With the carrier on, the off-axis spurious EIRP should be below the following limits for all:

- off-axis angles greater than 11° for GPESs operating in transmit frequency bands < 10 GHz and off-axis angles greater than 7° for GPESs operating in transmit frequency bands > 10 GHz;

a) Transmit frequency band 5 725 MHz to 6 425 MHz:

55 dBpW	in any 100 kHz band	in the range 3,7 GHz to 5,35 GHz
78 dBpW	in any 100 kHz band	in the range 5,35 GHz to 5,725 GHz
78 dBpW	in any 100 kHz band	in the range 6,425 GHz to 10,70 GHz
61 dBpW	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

In the frequency band 10,7 GHz to 13,35 GHz, for any 20 MHz band within which one or more spurious signals exceeding the above limit of 61 dBpW 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.

b) Transmit frequency band 12,75 GHz to 14,50 GHz:

55 dBpW	in any 100 kHz band	in the range 7,8 GHz to 10,7 GHz
61 dBpW	in any 100 kHz band	in the range 10,7 GHz to 11,7 GHz
78 dBpW	in any 100 kHz band	in the range 11,7 GHz to 12,75 GHz
78 dBpW	in any 100 kHz band	in the range 14,50 GHz to 21,2 GHz
67 dBpW	in any 100 kHz band	in the range 21,2 GHz to 40 GHz

In the frequency band 24,7 GHz to 29,80 GHz, for any 20 MHz band within which one or more spurious signals exceeding the above limit of 67 dBpW 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.

c) Transmit frequency band 17,3 GHz to 18,4 GHz:

61 dBpW	in any 100 kHz band	in the range 11,6 GHz to 16,9 GHz
78 dBpW	in any 100 kHz band	in the range 16,9 GHz to 17,3 GHz
78 dBpW	in any 100 kHz band	in the range 18,4 GHz to 21,2 GHz
67 dBpW	in any 100 kHz band	in the range 21,2 GHz to 40 GHz

In the frequency band 33,8 GHz to 37,6 GHz, for any 20 MHz band within which one or more spurious signals exceeding the above limit of 67 dBpW 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.

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 510-1-2 [1], subclause 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 510-2-1 [2], clause 8, or any other method, that can be proved to give the same results.

An example of a measurement method using satellites is given in INTELSAT SSOG 210 [7].

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 Φ>11°
transmit frequency bands >10 GHz	8 dBi for Φ>7°

4.3 On-axis spurious radiation

To limit the level of interference to satellite radio services in the transmit frequency bands outside the exclusion band the EIRP spectral density of the spurious radiation shall not exceed 4 dBW in any 4 kHz band.

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

NOTE 1: The on-axis spurious radiation, outside the specified frequency bands is indirectly limited by subclause 4.2. Consequently no specification is needed.

NOTE 2: Intermodulation limits inside the specified transmit frequency band(s) are to be determined by system design and are subject to satellite operator specifications.

Spurious radiation should be measured by a GPES under operational conditions and the EIRP adjusted according to the maximum expected operational figure.

The EIRP spectral density of the spurious radiation at the antenna port should be measured according to the measurement method in IEC 510-1-2 [1], subclause 5.2.2.2. The measuring instrument should be a spectrum analyser which should be protected from 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 that specified than a bandwidth correction should be performed for the noise-like wide-band spurious emissions. To obtain the off-axis spurious EIRP the antenna transmit gain should be added and any correction or calibration factors summated.

The antenna transmit gain should be measured according to IEC 510-2-1 [2], clause 8, or by any other method that can be proved to give the same results.

An example of a measurement method using satellites is given in INTELSAT SSOG 210 [7].

4.4 Antenna transmit gain pattern (co-polar and cross-polar)

For the protection of other satellite (uplink) systems and terrestrial services the gain G (Φ) in dB relative to an isotropic antenna of the main lobe and of at least 90 % of the side-lobe peaks should not exceed the following limits ITU-R Recommendation S.580-5 [5]:

29 – 25 log Φ dBi	1°≤Φ≤20°
–3,5 dBi	20°≤Φ≤26,3°
32 – 25 log Φ dBi	26,3°≤Φ≤48°
–10 dBi	48°≤Φ≤180°

No side-lobe peak should exceed the following envelope:

32 – 25 log Φ dBi	1°≤Φ≤20°

Additionally, the cross-polar gain G (Φ) in dB relative to an isotropic antenna of at least 90 % of the peaks should not exceed the following limits:

23 – 25 log Φ dBi	1°≤Φ≤7°
20,2 – 16,7 log Φ dBi	7°≤Φ≤9,2°

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

Conformance should be determined from measurement and/or provision of typical antenna transmit gain patterns.

The manufacturer may select the appropriate test procedure. The antenna transmit gain patterns should be measured according to IEC 510-2-1 [2], clause 8, or by any other method, that can be proved to give the same results.
An example of a measurement method using satellites is given in INTELSAT SSOG 210 [7].

4.5 Transmit polarization discrimination

For the protection of signals on the orthogonal polarization the polarization discrimination of the antenna in the transmit frequency band within the −1 dB contour of the main beam should exceed 30 dB (equal to a voltage axial ratio of 1,07) for circular polarization and 35 dB for linear polarization.

NOTE: For temporary uplinks other values of the polarization discrimination could be allowed by a satellite operator.

Conformance should be determined from measurement and/or provision of typical antenna polarization discrimination values.

The manufacturer may select the appropriate test procedure, e.g. IEC 510-2-1 [2], clause 7, or any other method, that can be proved to give the same results.

4.6 Transmit carrier centre frequency stability

For the protection of transmissions on the same satellite the transmitted carrier centre frequency of the unmodulated carrier should not drift by more than ±1 ppm per day and deviate by not more than 10 ppm of absolute values.
Conformance should be determined by documentary evidence.

History

Document history		
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