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Satellite Earth Stations and Systems (SES); Transmit-only or transmit-and-receive Very Small Aperture Terminals (VSATs) used for communications operating in the Fixed Satellite Service (FSS) 11/12/14 GHz frequency bands

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Foreword

This second edition European Telecommunication Standard (ETS) has been produced by the Satellite Earth Stations and Systems (SES) Technical Committee of the European Telecommunications Standards Institute (ETSI).

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1 Scope

This European Telecommunication Standard (ETS) provides specifications for the standardisation of the characteristics of transmit-only or transmit-and-receive Very Small Aperture Terminals (VSATs) operating as part of a satellite network (e.g. star, mesh or point-to-point) used for the distribution and/or exchange of information between users.

In such a network a Centralised Control and Monitoring Function (CCMF) is responsible for the monitoring and control of VSATs.

These VSATs have the following characteristics:

- operating in the exclusive part of the Ku-band allocated to the Fixed Satellite Services (FSS), 14,00 to 14,25 GHz (Earth-Space), 12,50 to 12,75 GHz (Space-Earth), and/or in the shared parts of the Ku-band, allocated to the FSS and Fixed Services (FS), 14,25 to 14,50 GHz (Earth-Space) and/or 10,70 to 11,70 GHz (Space-Earth);

- in these frequency bands linear polarization is normally used and the system operates through satellites at 3° spacing;

- designed usually for unattended operation;

- antenna diameter not exceeding 3,8 m, or equivalent corresponding aperture.

The equipment considered in this ETS comprises both the "outdoor unit", usually composed of the antenna sub-system and associated power amplifier and Low Noise Block (LNB), and the "indoor unit" composed of the remaining part of the communication chain, including the cable between these two units.

This ETS applies to the VSAT with its ancillary equipment and its various terrestrial ports, and operated under the conditions which are within the ranges of humidity, temperature and supply voltage declared by the manufacturer.

EMC specifications are contained in ETS 300 673 [3].

This ETS does not contain any specification or information on the installation of the VSATs.

The specifications have been selected to ensure an adequate level of compatibility for VSATs. The levels, however, do not cover extreme cases which may occur in any location but with a low probability of occurrence. In such a case it may be necessary to use special protection supplied to either the source of interference, or the interfered part or both.

This ETS deals with two types of specification:

- specifications defined in order to protect other users of the frequency spectrum, both satellite and terrestrial, from unacceptable interference. In addition, these specifications are specified for the purposes of structural safety and lightning protection as well as protection from harmful interference;

- specifications related to characteristics which contribute to the quality of reception by providing the VSAT with minimum interference protection from other radio systems. These specifications apply if required by the manufacturer.

2 Normative references

This ETS incorporates, by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to, or revisions of, any of these publications apply to this ETS only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

[1] ITU Radio Regulations, Article 1.

[2] EN 50083-1 (1993): "Cabled distribution systems for television and sound signals - Part 1: Safety requirements".

[3] prETS 300 673: "Radio Equipment and Systems (RES); ElectroMagnetic Compatibility (EMC) standard for 4/6 GHz and 11/12/14 GHz Very Small Aperture Terminal (VSAT) equipment and 11/12/13/14 GHz Satellite News Gathering (SNG) Transportable Earth Station (TES) equipment".

[4] ETS 300 456: "Satellite Earth Stations and Systems (SES); Test Methods for Very Small Aperture Terminals (VSATs) operating in the 11/12/14 GHz frequency bands".

[5] ETS 300 160: "Satellite Earth Stations and Systems (SES); Control and monitoring functions at a Very Small Aperture Terminal (VSAT)".

[6] ETS 300 161: "Satellite Earth Stations and Systems (SES); Centralised control and monitoring functions for VSAT networks".

[7] ITU-R Recommendation 732 (1992): "Method for statistical processing of earth-station antenna side-lobe peaks".

3 Definitions and abbreviations

3.1 Definitions

For the purposes of this ETS, the following definitions apply:

outdoor unit: The part of the VSAT intended to be installed outdoor, as declared by the manufacturer, or as indicated in the user documentation.

The outdoor unit usually comprises three main parts:

a) the antenna sub-system which converts the incident radiation field into a guided wave and vice versa;

b) the LNB, which is a device that amplifies, with very low internal noise, the received signals in the Radio Frequency (RF) band and converts them to intermediate frequencies;

c) the power amplifier which amplifies the low level RF signals for transmission through the antenna subsystem.

NOTE 1: The installation equipment (means of attachment) is outside the scope of this ETS. However, the antenna structures and other components directly mounted on the antenna and forming an integral part of it, are subject to the specifications of this ETS.

indoor unit: Is composed of the remaining part of the VSAT. It is generally installed inside the buildings and is connected to the outdoor unit. The connection cable between the outdoor and indoor unit belongs to the indoor unit.

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

a) the equipment is intended for use in conjunction with a VSAT to provide additional operational and/or control features (e.g. to extend control to another position or location); and

b) the equipment cannot be used on a stand alone basis, to provide user functions independently of a VSAT; and

c) the absence of the equipment does not inhibit the operation of the VSAT.

nominated bandwidth: The bandwidth of the VSAT radio frequency transmission nominated by the manufacturer. The nominated bandwidth is wide enough to encompass all spectral elements of the transmission which have a density greater than the specified spurious levels and to take account of the transmit carrier frequency stability.

NOTE 2: 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.

spurious radiation: Any radiation outside the nominated bandwidth.

cross-polarization discrimination: The ratio of the on-axis co-polar gain to the cross-polar gain in a given direction, at a transmit or receive frequency. It is usually expressed in dB.

transmissions disabled state: A VSAT is in this state when it is not authorised by the CCMF to transmit.

carrier-on state: A VSAT is in this state when it is authorised by the CCMF to transmit and when it transmits a signal.

carrier-off state: A VSAT is in this state when it is authorised by the CCMF to transmit, but when it does not transmit any signal.

NOTE 3: The existence of a carrier-off state depends on the system of transmission used. For VSATs designed for continuous transmission mode there may be no carrier-off state.

3.2 Abbreviations

For the purposes of this ETS, the following abbreviations apply:

CCMF	Centralised Control and Monitoring Functions
EIRP	Equivalent Isotropically Radiated Power
FS	Fixed Service
FSS	Fixed Satellite Service
ITU	International Telecommunication Union
ITU-R	ITU Radiocommunication Sector
LNB	Low Noise Block (low noise amplifier and down converter)
RF	Radio Frequency
VSAT	Very Small Aperture Terminal

4 Test report

The test report shall be as specified in ETS 300 456 [4] and shall contain:

- the value of the nominated bandwidth declared by the manufacturer;

  the value of the nominated bandwidth shall not exceed 5 times the "Occupied Bandwidth" [1];

- the results of the tests;

- all operational conditions and parameters.

5 Safety

5.1 Mechanical construction

Purpose:

Protection of operating personnel, the public and goods from insecure structures.

Specification:

This specification applies to the outdoor unit only.

The outdoor unit, including mounted and structural components, (but excluding the means of attachment) shall be designed to support the following main loads due to:

- the weight of the antenna and structural components;

- the wind speed.

Loading due to snow and ice is not considered.

At wind speeds up to 180 km/h, referred to standard atmosphere temperature and pressure (293 K and $1{,}013 \times 10^5$ Pa (1 013 mbar)) none of the components shall be torn away.

Verification:

The test method specified in subclause 5.1 of ETS 300 456 [4] shall apply.

5.2 Lightning

Purpose:

To avoid dangerous potential differences between the outdoor unit and any other conductive structure.

Specification:

Means shall be provided to permit the attachment of bonding conductors of dimension indicated in EN 50083-1 [2], subclause 10.2.3.

Verification:

The test method specified in subclause 5.2 of ETS 300 456 [4] shall apply.

6 Radio Frequency (RF)

6.1 Spurious radiation

Purpose:

To limit the level of interference to terrestrial and satellite radio services.

Specification:

This specification applies outside the nominated bandwidth.

a) when the VSAT is in the transmissions disabled state, the off-axis spurious Equivalent Isotropically Radiated Power (EIRP) from the VSAT, in any 100 kHz band, shall not exceed the limits in table 1, for all off-axis angles greater than 7°;

Table 1

Frequency band	EIRP limit (dBpW)
960,0 MHz to 10,7 GHz	48
10,7 GHz to 21,2 GHz	54
21,2 GHz to 40,0 GHz	60
NOTE: The lower limits shall apply at the transition frequency.	

b) for both the carrier-on and carrier-off states, the off-axis spurious EIRP in any 100 kHz band from the VSAT, shall not exceed the limits in table 2, for all off-axis angles greater than 7°;

Table 2

Frequency band	EIRP limit (dBpW)
960,0 MHz to 3,4 GHz	49
3,4 GHz to 10,7 GHz	55
10,7 GHz to 21,2 GHz	61
21,2 GHz to 40,0 GHz	67
NOTE: The lower limits shall apply at the transition frequency.	

In the frequency band 13,6 to 14,9 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 spurious signals exceeding the limit shall be added in watts, and the sum shall not exceed 78 dBpW.

In the frequency band 28,0 to 29,0 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 spurious signals exceeding the limit shall be added in watts, and the sum shall not exceed 78 dBpW.

c) these limits are applicable to the complete VSAT equipment, comprising of the indoor and outdoor units with at least 10 m of cable connecting them.

Verification:

The test method specified in subclause 6.6 of ETS 300 456 [4] shall apply.

The tests for specification b) shall be limited to the carrier on-state.

6.2 On-axis spurious radiation

Purpose:

To limit the level of interference to satellite radio services.

Specification 1: Carrier-on state

In the 14,0 GHz to 14,5 GHz band the EIRP spectral density of the spurious radiation excluding intermodulation products and outside the nominated bandwidth shall not exceed 4 - 10 log N dBW in any 100 kHz band.

Exceptionally, in a bandwidth of 5 times the "Occupied Bandwidth" [1] (RR 146) centred on the carrier centre frequency, the EIRP spectral density of the spurious radiation excluding intermodulation products and outside the nominated bandwidth, shall not exceed 18 - 10 log N dBW in any 100 kHz band.

NOTE 1: The on-axis spurious radiation, outside the 14,0 GHz to 14,5 GHz band, are indirectly limited by the off-axis limits given in subclause 6.1. Consequently no specification is needed.

NOTE 2: Intermodulation limits inside the band 14,0 GHz to 14,5 GHz are to be determined by system design, subject to satellite operator specifications.

N is the maximum number of VSATs which are expected to transmit simultaneously in the same carrier frequency band. This number shall be indicated by the manufacturer.

Specification 2: Carrier-off state and transmission disabled state:

In the 14,0 GHz to 14,5 GHz band the EIRP spectral density of the spurious radiation outside the nominated bandwidth shall not exceed -21 dBW in any 100 kHz band.

Verification:

The test method specified in subclause 6.7 of ETS 300 456 [4] shall apply.

Due to the vicinity of the carrier the measurements shall be performed with a measurement bandwidth of 3 kHz.

6.3 Transmit carrier centre frequency stability

Purpose:

Protection of transmissions on the same satellite.

Specification:

The transmitted carrier centre frequency shall not deviate from its nominal value by more than an amount which allows the carrier (and its spectral components which have a spectral power density greater than the specified spurious levels) to remain within its nominated bandwidth. This frequency tolerance refers to the initial frequency adjustment plus long-term drift. Long-term drift shall be assumed to be at least one month.

Verification:

The test method specified in subclause 6.5 of ETS 300 456 [4] shall apply.

6.4 Off-axis EIRP emission density within the band 14,0 GHz to 14,5 GHz

Off-axis EIRP emission density (co-polar and cross-polar) within the band 14,0 GHz to 14,5 GHz.

Purpose:

Protection of other satellite (uplink) systems.

Specification:

The maximum EIRP in any 40 kHz band within the nominated bandwidth of the co-polarized component in any direction (Φ) degrees from the antenna main beam axis shall not exceed the limits in table 3.

Table 3

Direction (Φ)	EIRP limit (dBW)
$2,5° \leq (\Phi) \leq 7°$	33 - 25 log (Φ) - 10 log N
$7° < (\Phi) \leq 9,2°$	12 - 10 log N
$9,2° < (\Phi) \leq 48°$	36 - 25 log (Φ) - 10 log N
$\Phi > 48°$	- 6 - 10 log N

For $\Phi > 70°$ the values given above may be increased to 4 - 10 log N dBW over the range of angles for which the particular feed system may give rise to relatively high levels of spill-over.

For antennas designed for minimum off-axis gain in the direction of the geostationary orbit, the specification for Φ between 2,5° and 20° need only be met within ± 3° of a plane bisected by the main beam axis. This plane shall be marked and identified on the antenna. There shall be an axis of rotation along or parallel to the main beam axis, with adjustment capability to an accuracy of 0,5°. The antenna shall be capable of having the above plane aligned with the geostationary orbit plane.

In addition the maximum EIRP in any 40 kHz band within the nominated bandwidth of the cross-polarized component in any direction Φ degrees from the antenna main beam axis shall not exceed the limits in table 4.

Table 4

Direction (Φ)	EIRP limit (dBW)
$2,5° \leq \Phi \leq 7°$	$23 - 25 \log \Phi - 10 \log N$
$7° < \Phi \leq 9,2°$	$2 - 10 \log N$

Where Φ is the angle, in degrees, between the main beam axis and the direction considered, and N is the maximum number of VSATs which may transmit simultaneously in the same carrier frequency band. This number shall be indicated by the manufacturer.

Verification:

The test method specified in subclause 6.1 of ETS 300 456 [4] shall apply.

6.5 Carrier suppression

Purpose:

To allow for the satisfactory suppression of transmissions of a VSAT by the CCMF.

Specification:

When the VSAT is in the transmission disabled state, the EIRP density shall not exceed 4 dBW in any 4 kHz band within the nominated bandwidth.

Verification:

The test method specified in subclause 6.7 of ETS 300 456 [4] shall apply.

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

Purpose:

Protection of other satellite (uplink) systems and terrestrial services.

Specification 1: Protection of terrestrial services, mean values

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 shall not exceed the limits in table 5.

Table 5

Direction (Φ)	Gain limit (dBi)
$2,5° \leq \Phi \leq 7°$	$29 - 25 \log \Phi$
$7° < \Phi \leq 9,2°$	8
$9,2° < \Phi \leq 48°$	$32 - 25 \log \Phi$
$\Phi > 48°$	- 10

For $\Phi > 70°$ the values given above may be increased to 0 dBi over the range of angles for which the particular feed system may give rise to relatively high levels of spill-over.

Additionally, the cross-polar gain G (Φ) in dB relative to an isotropic antenna of at least 90 % of the peaks shall not exceed the limits in table 6.

Table 6

Direction (Φ)	Cross-polar gain limit (dBi)
$2,5° < \Phi \leq 7°$	$19 - 25 \log \Phi$
$7° < \Phi \leq 9,2°$	- 2

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

The method of statistical processing of side-lobe peaks and the definition of a peak is dealt with in Annex II of ITU-R Recommendation 732 [7].

Specification 2: Protection of terrestrial services, peak values

The gain G (Φ) in dB relative to an isotropic antenna of the main lobe and of the side-lobe peaks shall not exceed the limits in table 7.

Table 7

Direction (Φ)	Gain limit (dBi)
$2,5° \Phi \leq 7°$	$32 - 25 \log \Phi$
$7° < \Phi \leq 12°$	11
$12° < \Phi \leq 33°$	$38 - 25 \log \Phi$
$\Phi > 33°$	0

Additionally, the cross-polar gain G (Φ) in dB relative to an isotropic antenna of the side-lobe peaks shall not exceed the limits in table 8.

Table 8

Direction (Φ)	Cross-polar gain limit (dBi)
$2,5° \leq (\Phi) \leq 7°$	$22 - 25 \log \Phi$
$7° \leq \Phi \leq 9,2°$	1

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

Specification 3: Protection of adjacent satellites between 2,5° and 20°.

Specification 1 and 2 shall be met.

For antennas designed for minimum off-axis gain in the direction of the geostationary orbit, the specification for Φ between 2,5° and 20° need only be met within ± 3° of a plane bisected by the main beam axis. This plane shall be marked and identified on the antenna. There shall be an axis of rotation along or parallel to the main beam axis, with adjustment capability to an accuracy of 0,5°. The antenna shall be capable of having the above plane aligned with the geostationary orbit plane.

Verification:

The test method specified in subclause 6.1.3.3 of ETS 300 456 [4] shall apply.

6.7 Transmit polarization discrimination

Purpose:

Protection of signals on the orthogonal polarization.

Specification 1:

The polarization discrimination of the antenna in the transmit frequency band shall exceed 28 dB within the -1 dB contour of the main beam.

NOTE 1: Some satellite operators may require a higher ratio.

Specification 2:

The polarization discrimination of the antenna system in the transmit frequency band shall exceed 25 dB within the -10 dB contour of the main beam.

NOTE 2: Some satellite operators may require a higher ratio.

Specification 3:

This specification applies if required by the manufacturer.

The polarization discrimination of the antenna system in the transmit frequency band shall exceed 30 dB within the -1 dB contour of the main beam.

NOTE 3: Some satellite operators may require a higher ratio.

Verification:

The test method specified in subclause 6.3 of ETS 300 456 [4] shall apply.

6.8 Antenna receive gain pattern (co-polar and cross-polar)

Purpose:

Protection of the wanted signals from interference from terrestrial services and from the same satellite or adjacent satellites.

Specification 1: Protection from terrestrial services, mean values

This specification applies if required by the manufacturer.

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 shall not exceed the limits in table 9.

Table 9

Direction (Φ)	Gain limit (dBi)
$2{,}8° \leq \Phi \leq 7°$	$29 - 25 \log \Phi$
$7° < \Phi \leq 9{,}2°$	8
$9{,}2° < \Phi \leq 48°$	$32 - 25 \log \Phi$
$\Phi > 48°$	- 10

For $\Phi > 70°$ the values given above may be increased to 0 dBi over the range of angles for which the particular feed system may give rise to relatively high levels of spill-over.

Additionally, the cross-polar gain G(Φ) in dB relative to an isotropic antenna of at least 90 % of the peaks shall not exceed the limits in table 10.

Table 10

Direction (Φ)	Cross-polar gain limit (dBi)
2,8° < Φ ≤ 7°	19 - 25 log Φ
7° < Φ ≤ 9,2°	- 2

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

The method of statistical processing of side-lobe peaks and the definition of a peak is dealt with in annex II of ITU-R Recommendation 732 [7].

Specification 2: Protection from adjacent satellites between 2,8° and 20°:

This specification applies if required by the manufacturer.

Specification 1 shall be met.

For antennas designed for minimum off-axis gain in the direction of the geostationary orbit, the specification for Φ between 2,8° and 20° need only be met within ± 3° of a plane bisected by the main beam axis. This plane shall be marked and identified on the antenna. There shall be an axis of rotation along or parallel to the main beam axis, with adjustment capability to an accuracy of 0,5°. The antenna shall be capable of having the above plane aligned with the geostationary orbit plane.

Verification:

The test method specified in subclause 6.2.3 of ETS 300 456 [4] shall apply.

6.9 Receive polarization discrimination

Purpose:

To provide protection of the wanted signals from signals on the orthogonal polarization.

Specification:

This specification applies if required by the manufacturer.

The polarization discrimination of the antenna system in the receive frequency bands shall exceed 27 dB, within the -1 dB contour of the main beam.

NOTE: Some satellite operators may require a higher ratio.

Verification:

The test method specified in subclause 6.4 of ETS 300 456 [4] shall apply.

7 Mechanical

7.1 Pointing stability

Purpose:

To prevent interference to and from adjacent satellites during severe wind conditions.

Specification:

Under the condition of 100 km/h maximum wind speed, with gusts of 130 km/h lasting 3 seconds, the installation shall not show any sign of permanent distortion and shall not need re-pointing after the application of the wind load.

Verification:

The test method specified in subclause 7.4 of ETS 300 456 [4] shall apply.

7.2 Antenna pointing accuracy capability

Purpose:

To make precise antenna pointing in order to avoid interference to adjacent satellites.

Specification:

The antenna mount shall allow the position of the antenna transmit main beam axis to be fixed with an accuracy of better than 0,3° along the geostationary orbit.

Verification:

The test method specified in subclause 7.3 of ETS 300 456 [4] shall apply.

7.3 Polarization angle alignment capability

Purpose:

To make precise antenna linear polarization alignment in order to avoid interference to and from the same satellite and also adjacent satellites.

Specification 1:

The polarization angle shall be continuously adjustable in a range of at least 180°.

Specification 2:

It shall be possible to fix the transmit antenna polarization angle with an accuracy of at least 1°.

Verification:

The test method specified in subclause 7.5 of ETS 300 456 [4] shall apply.

8 Control and monitoring

Relevant information is contained in ETS 300 160 [5] and ETS 300 161 [6].

History

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