EUROPEAN TELECOMMUNICATION STANDARD

ETS 300 332

December 1994

Source: ETSI TC-SES

Reference: DE/SES-02004

ICS: 33.060.30

Key words: VSAT, FSS

Satellite Earth Stations and Systems (SES); Transmit/receive Very Small Aperture Terminals (VSATs) used for data communications operating in the Fixed Satellite Service (FSS) 6 GHz and 4 GHz frequency bands

ETSI

European Telecommunications Standards Institute

ETSI Secretariat

Postal address: F-06921 Sophia Antipolis CEDEX - FRANCE
Office address: 650 Route des Lucioles - Sophia Antipolis - Valbonne - FRANCE
X.400: c=fr, a=atlas, p=etsi, s=secretariat - **Internet:** secretariat@etsi.fr

Tel.: +33 92 94 42 00 - Fax: +33 93 65 47 16

New presentation - see History box

Contents

Foreword

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

Transposition dates	
Date of latest announcement of this ETS (doa):	31st March 1995
Date of latest publication of new National Standard or endorsement of this ETS (dop/e):	30th September 1995
Date of withdrawal of any conflicting National Standard (dow):	30th September 1995

Blank page

1 Scope

This European Telecommunication Standard (ETS) provides specifications for the standardisation of the characteristics of transmit/receive Very Small Aperture Terminals (VSATs) operating as part of a satellite network used for the distribution and/or exchange of data between users.

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

These VSATs have the following characteristics:

- operating in the shared part of the C band allocated to the Fixed Services (FS) and to the Fixed Satellite Services (FSS), 5,850 to 6,425 GHz (Earth-Space), 3,625 to 4,200 GHz (Space-Earth);

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

- designed for unattended operation;

- limited to the reception and transmission of baseband digital signals;

- equipped with one, or several terrestrial ports but the total aggregate information bit rate transmitted towards the satellite through these ports shall be limited to 2 048 Mbit/s;

- antenna diameter not exceeding normally 7,3 m, or equivalent corresponding aperture.

The equipment considered in this ETS comprises both the "outdoor unit", usually composed of the antenna subsystem with the 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 does not contain any requirement, recommendation or information about the installation of the VSATs, nor is this ETS intended to apply to VSAT network hub stations.

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 electrical safety, structural safety and solar radiation 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.

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] IEC 950 (1991): "Safety of information technology equipment including electrical business equipment".

[2] IEC 81 (Co) 6 (1981): "Standards for Lightning Protection of Structures".

[3] CISPR Publication No. 22 (1992): "Limits and methods of measurement of radio interference characteristics of information technology equipment".

[4] CISPR Publication No. 16 (1987): "Specifications for radio interference measuring apparatus and measurement methods".

[5] EN 55011 (1986): "Limits and methods of measurements of radio interference characteristics of industrial, scientific and medical (ISM) radio-frequency equipment".

[6] IEC 510-2-1 (1978): "Methods of measurement for radio equipment used in satellite earth stations Part 2".

[7] IEC 510-1-2 (1984): "Methods of measurement for radio equipment used in satellite earth station Part 1".

[8] IEC 801-3 (1984): "Electromagnetic compatibility for industrial process measurement and control equipment Part 3".

[9] ETS 300 160: "Satellite Earth Stations (SES) - Control and monitoring functions at a VSAT".

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

[11] 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: Is the part of the terminal installed in a position within line of sight to the satellite and it is intended to be operated in outdoor environmental conditions.

It usually comprises three main parts:

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

2) 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;

3) 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 not included in 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 equipment. 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.

nominated bandwidth: The bandwidth of the VSAT radio frequency transmission is 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 parameter is 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: Is any radiation outside the nominated bandwidth.

3.2 Abbreviations

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

CCMF	Centralised Control and Monitoring Functions
CISPR	Comité International Spécial des Perturbations Radioélectriques
CSPDN	Circuit Switched Public Data Network
EIRP	Equivalent Isotropically Radiated Power
EUT	Equipment Under Test
FS	Fixed Service
FSS	Fixed Satellite Service
IEC	International Electrotechnical Commission
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 contain:

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

- the results of the tests.

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:

Two alternative methods are given for verification.

a) Wind tunnel testing.

A wind tunnel shall be used for the purpose of conformance testing. The wind tunnel tests shall be performed on the outdoor unit, or alternatively on a scale-model of the outdoor unit. The data obtained for the scale-model shall be computed in order to obtain data for the true antenna size.

b) Numerical analysis and simplified tests.

This method shall provide an alternative to the wind tunnel test. The effects of maximum wind load shall be first computed on the overall outdoor unit using a numerical analysis method, e.g. finite elements method by computer taking into account the intrinsic properties of the materials. In a second step, the computed loads shall be applied to the structure.

The purpose of the numerical analysis is twofold:

1) to show compliance with the specification under nominated conditions;

2) to compute equivalent static loads (force and torque) applied to the critical attachment points of the structure, e.g.:

- reflector - mounting legs fixing point;
- reflector - struts;
- struts - LNB.

Test procedure:

a) Wind tunnel.

The test object shall be mounted in such a way, that wind load can be applied from all horizontal directions in steps of 45°. The tests shall be carried out with the elevation angle of the antenna at its minimum and at its maximum in turn. The wind load shall be increased gradually in steps up to 180 km/h, each step lasting approximately one minute.

The tests may be performed at any atmosphere temperature and air pressure. If the atmospheric conditions differ from standard conditions (temperature = 293°K, air pressure = 1,013 x 10^5 Pa), then the test velocity shall be determined according to the formula:

$$V_T = V_S \times \sqrt{[(1{,}013 \times 10^5) / P_T] \times [T_T / 293]}$$

where: V_T = wind velocity in test;
V_S = wind velocity in standard conditions;
P_T = air pressure in test, (Pa);
T_T = temperature in test, (K).

During the load conditions the test object shall be observed and the distortions recorded.

The test report shall contain:

- description of the test equipment;
- description of the tests performed;
- results of the measurements or calculations on the mechanical loads transmitted from the outdoor unit to the attachment devices.

For the pointing stability (see subclause 7.1):

- results of the measurements of the deviation of the antenna position, and components with respect to each other.

b) Numerical analysis and tests.

The computations needed to derive the field of forces and torque and the equivalent static stresses shall be carried out for the same wind directions and elevation as specified in the wind tunnel test procedure a) above. Only the maximum 180 km/h shall be considered. The air related parameters, namely the kinematic viscosity used to calculate drags at the rims of the structure shall be calculated with the standard atmospheric environmental conditions given in a) above. It shall be verified with the simulated results that break point limits are not exceeded for any self-contained element. During the practical test the calculated equivalent static loads shall be applied at any critical fixing point of the assembly.

During the load conditions, the outdoor unit shall be observed, and any distortion recorded.

The test report shall contain:

- the computation method used;
- description of the test equipment;
- description of the tests performed;
- results of the safety margin calculation;
- results of the measurements or calculations on the mechanical loads transmitted from the outdoor unit to the attachment devices.

For the pointing stability (see subclause 7.1):

- results of the measurements or mechanical distortions.

5.2 Electrical safety

5.2.1 Power voltages

Purpose:

Protection of operating personnel and the public from electric shock.

Specification:

The electrical safety of the equipment shall be in accordance with the introduction and clauses 1 to 3 of IEC 950 [1]. These clauses deal with fundamental design requirements, wiring, connections and supply.

Verification:

Conformance shall be determined according to IEC 950 [1] verification methods.

5.2.2 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 table 7 of IEC 81 (Co) 6 [2].

Verification:

Conformance shall be determined by inspection.

5.2.3 Radio frequency radiation protection

Purpose:

Protection of operating personnel and the public from radio frequency radiation hazards.

Specification:

The equipment shall be fitted with a warning notice in a clearly visible position, indicating the region in which a radio frequency radiation level in excess of 10 W/m^2 may occur.

Verification:

By visual inspection.

5.2.4 Solar radiation protection

Purpose:

Protection of operating personnel and the public from solar radiation focusing effects.

Specification:

If, in conditions of sunshine, solar radiation is focused near the feed such that burning may occur, the equipment shall be fitted with a warning notice in a clearly visible position.

Verification:

A statement shall be provided to indicate that the surface of the antenna has been treated to avoid the situation, or otherwise by visual inspection to confirm the presence of warning notice.

6 Radio Frequency (RF)

6.1 Spurious radiation

Purpose:

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

Specification:

1) The VSAT shall satisfy the limits for radiated interference field strength specified in CISPR Publication No. 22 [3] over the frequency range from 30 MHz to 960 MHz, at a test distance of 10 m.

Table 1

Frequency range (MHz)	Quasi-peak at 10 m (dB μV/m)	
	Class B	Class A
30 to 230	30	40
230 to 960	37	47

The lower limits shall apply at the transition frequency.

The applicable class A or B shall be designated by the manufacturer and indicated in the data sheet of the test report.

2) For the carrier-off case, the off-axis spurious Equivalent Isotropically Radiated Power (EIRP) from the VSAT, in any 100 kHz band, shall be below the following limits, for all off-axis angles greater than 7°:

960,0 MHz to 10,7 GHz	48 dBpW;
10,7 GHz to 21,2 GHz	54 dBpW;
21,2 GHz to 40,0 GHz	60 dBpW.

The lower limits shall apply at the transition frequency.

3) For the carrier-on case, the off-axis spurious EIRP from the VSAT, shall be below the following limits, for all off-axis angles greater than 7°:

49 dBpW in any	100 kHz band in the range	960,0 MHz to 3,4 GHz;
55 dBpW in any	100 kHz band in the range	3,4 GHz to 5,450 GHz;
78 dBpW in any	20 MHz band in the range	5,450 GHz to 6,825 GHz;
55 dBpW in any	100 kHz band in the range	6,825 GHz to 10,7 GHz;
61 dBpW in any	100 kHz band in the range	10,7 GHz to 21,2 GHz;
78 dBpW in any	20 MHz band in the range	10,9 GHz to 13,650 GHz;
67 dBpW in any	100 kHz band in the range	21,2 GHz to 40 GHz.

The lower limits shall apply at the transition frequency.

4) These limits are applicable to the complete VSAT equipment, comprising the indoor and outdoor units and at least 10 m of connection cable between them.

Verification:

Measurement of spurious radiation generated by a VSAT terminal under operation.

Test procedure:

The full system shall be tested. The test procedure is given in annex A.

The environmental conditions of the test laboratory shall be within the range of those for which the indoor unit is designed to operate.

6.2 On axis spurious radiation (outside the nominated bandwidth)

Purpose:

To limit the level of interference to satellite radio services.

Specification:

In the 5,850 to 6,425 GHz band the EIRP spectral density of the spurious radiation excluding inter-modulation products and excluding the nominated bandwidth shall not exceed 4 - 10 log N dBW in any 100 kHz band with the carrier on.

The on axis spurious radiation, outside the 5,850 to 6,425 GHz band, are limited in subclause 6.1 by taking into account the on axis antenna gain, i.e. on axis limit is equal to limit in subclause 6.1 minus maximum off axis gain plus on axis gain.

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.

When the carrier is off, the EIRP spectral density of the spurious radiation in the 5,850 to 6,425 GHz band shall not exceed - 21 dBW in any 100 kHz band.

NOTE: Inter-modulation limits inside the band 5,850 to 6,425 GHz are to be determined by system design, subject to satellite operator specifications.

Verification:

Conformance shall be determined by direct measurement.

Test procedure:

The measurement shall be performed by the following method.

The power of the spurious radiation at the interface point between the antenna and the remaining outdoor unit shall be measured according to the measurement method in IEC 510-1-2 [7], section 2, subclause 5.2.2. The antenna on-axis gain shall be measured using one of the methods of IEC 510-2-1 [6], clause 8, or any other method, that can be proved to give the same results. The EIRP of the spurious radiation shall be calculated from the above two measurements. The environmental conditions of the test laboratory shall be those for which the indoor unit is designed to operate.

NOTE: Definitions and methods of measurement for integrated equipment are under study.

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 close-in 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:

Conformance shall be determined from documentary evidence.

6.4 Off-axis EIRP emission density (co-polar and cross-polar) within the band 5,850 to 6,425 GHz

Purpose:

Protection of other satellite (uplink) systems.

Specification:

The maximum EIRP in any 4 kHz band within the nominated bandwidth of the co-polarised component in any direction Ø degrees from the antenna main beam axis shall not exceed the following limits:

32 - 25 log Ø	- 10 log N	dBW for	2,5°	≤ Ø ≤	7°;
11	- 10 log N	dBW for	7°	< Ø ≤	9,2°;
35 - 25 log Ø	- 10 log N	dBW for	9,2°	< Ø ≤	48°;
-7	- 10 log N	dBW for		Ø >	48°.

In addition the cross-polarised component in any direction Ø degrees from the antenna main beam axis shall not exceed the following limits:

22 - 25 log Ø	- 10 log N	dBW for	2,5°	≤ Ø ≤	7°;
1	- 10 log N	dBW for	7°	< Ø ≤	9,2°.

Where Ø 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.

For Ø > 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 spillover.

For antennas designed for minimum off-axis gain in the direction of the geostationary orbit, the specification for Ø 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 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:

Conformance shall be determined from:

- measurement of maximum RF power density entering the antenna feed;

- measurement of the co-polar and cross-polar transmit gain patterns in four planes containing the main beam axis with an angular separation of 45°. When linear polarisation is used, one of these planes shall be the E-plane.

Test procedure:

The measurement of the RF power density shall be made in accordance with IEC 510-1-2 [7], subclause 5.2.2.2. The measurement of the transmit gain patterns shall be made in accordance to IEC 510-2-1 [6] clause 8, or any other recognised method that can be proved to give similar results, at 5,855 GHz, 6,140 GHz and 6,420 GHz.

6.5 Transmit polarisation discrimination (linear) or axial ratio (circular)

Purpose:

Protection of signals on the orthogonal polarisation.

Specification:

When linear polarisation is used, the ratio of the on-axis co-polar gain to the cross-polar gain in any direction in the transmit frequency band shall not be less than 25 dB, for all off-axis angles within the x° contour of the main beam, where x is declared by the manufacturer and x is greater than 0,150°.

When circular polarisation is used, the axial ratio shall be less than 1,3, for all off-axis angles within the x° contour of the main beam, where x is declared by the manufacturer and x is greater than 0,150°.

NOTE: Some satellite operators may require a better performance.

Verification:

Conformance shall be determined by measurement according to IEC 510-2-1 [6], clause 7, or any other recognised method that can be proved to give the same results.

When linear polarisation is used, the initial polarisation alignment shall be such that the cross-polarised component on the main axis is minimum. No other polarisation alignment shall be done during the measurement.

The test results shall consist of bi-dimensional plots of co-polar and cross-polar antenna gain versus angles from boresight to the specified contour of the main beam for the frequencies 5,855 GHz, 6,140 GHz and 6,420 GHz.

6.6 Carrier on-off (inside the nominated bandwidth)

Purpose:

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

Specification:

When the VSAT terminal is in suppressed transmission mode it shall transmit an EIRP density no more than 4 dBW in any 4 kHz band within the nominated bandwidth.

Verification:

Conformance shall be determined from practical tests as specified in subclause 6.2 of this ETS.

6.7 Electromagnetic immunity

Purpose:

Protection of the VSAT against interfering electromagnetic fields up to 2 GHz caused by other equipment. Beyond 2 GHz, a recommendation is given in clause 12 of this ETS.

Specification:

The VSAT shall have an adequate level of intrinsic immunity to enable it to operate as intended, when it is exposed to the following electrical field strengths:

1 V/m in the frequency range	150 kHz to 50 MHz;
3 V/m in the frequency range	50 MHz to 2 000 MHz.

Verification:

Conformance shall be determined by measurement according to IEC 801-3 [8], clauses 6 to 9. The Equipment Under Test (EUT) shall be as in annex A, clause A.3. For the test set-up see also annex A, clause A.5, second paragraph. For operating mode signal generation see annex A, clause A.4.

The VSAT shall be considered to satisfy the specification if the following conditions are met when the disturbing field is applied:

a) the quality of transmission observed is equal or better than the lowest acceptable quality of transmission declared by the manufacturer;

b) under these conditions the VSAT transmission shall be able to be suppressed by the CCMF or any CCMF simulator and it shall not restart without being enabled from the CCMF;

c) when the VSAT is in the carrier-off state, there shall be no change in the signal level;

d) when the VSAT is in the carrier-on, state there shall be no change in the signal level and frequency.

7 Mechanical

7.1 Pointing stability

Purpose:

To prevent interference to 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 repointing after the application of the wind load.

Verification and test procedure:

The verification tests shall be carried out at the same time as those for mechanical construction requirements. The methodology and procedures shall be those specified in subclause 5.1 of this ETS.

7.2 Antenna pointing accuracy capability

Purpose:

To make possible 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:

By documentary evidence provided by the manufacturer.

7.3 Linear polarisation angle alignment capability

Purpose:

To make possible precise antenna linear polarisation alignment in order to avoid interference to adjacent satellites.

Specification 1:

When linear polarisation is used, the polarisation angle shall be continuously adjustable in a range of at least 180°.

Specification 2:

When linear polarisation is used, it shall be possible to fix the transmit antenna polarisation angle with an accuracy of at least 1°.

Verification:

By documentary evidence provided by the manufacturer.

8 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.

This specification applies if required by the manufacturer.

The gain G (Ø) 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 following limits:

29 - 25 log Ø	for	2,5°	≤ Ø ≤ 7°;
8	for	7°	< Ø ≤ 9,2°;
32 - 25 log Ø	for	9,2°	< Ø ≤ 48°;
- 10	for		Ø > 48°.

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

19 - 25 log Ø	for	2,5°	≤ Ø ≤ 7°;
- 2	for	7°	< Ø≤ 9,2°.

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

For Ø > 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 spillover.

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 [11].

Specification 2: Protection of adjacent satellites.

This specification applies if required by the manufacturer.

Specification 1 shall be met for Ø between 2,5° and 20°.

For antennas designed for minimum off-axis gain in the direction of the geostationary orbit, the specification for Ø 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 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:

Conformance shall be determined by measurement of the co-polar and cross-polar transmit gain patterns in four planes containing the main beam axis with an angular separation of 45°. When linear polarisation is used, one of these planes shall be the E-plane.

The measurement shall be made in accordance to IEC 510-2-1 [6], clause 8, or any other recognised method that can be proved to give the same results for the frequencies 5,855 GHz, 6,140 GHz and 6,420 GHz.

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

Purpose:

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

Specification 1: Protection from terrestrial services:

This specification applies if required by the manufacturer.

The gain G (Ø) 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 following limits:

29 - 25 log Ø	for	2,8°	≤ Ø ≤ 7°;
8	for	7°	< Ø ≤ 9,2°;
32 - 25 log Ø	for	9,2°	< Ø ≤ 48°;
- 10	for		Ø > 48°.

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

19 - 25 log Ø	for	2,8°	≤ Ø ≤ 7°;
- 2	for	7°	< Ø ≤ 9,2°.

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

For Ø > 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 spillover.

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 [11].

Specification 2: Protection from adjacent satellites.

This specification applies if required by the manufacturer.

Specification 1 shall be met for Ø between 2,8° and 20°.

For antennas designed for minimum off-axis gain in the direction of the geostationary orbit, the specification for Ø 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 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:

Conformance shall be determined by measurement of the co-polar and cross-polar transmit gain patterns in four planes containing the main beam axis with an angular separation of 45°. When linear polarisation is used, one of these planes shall be the E-plane.

The measurement shall be made in accordance to IEC 510-2-1 [6], clause 8, or any other recognised method that can be proved to give the same results. The measurements shall be made for the frequencies 3,630 GHz, 3,910 GHz and 4,195 GHz.

10 Transmit polarisation discrimination

Purpose:

Protection of signals on the orthogonal polarisation.

Specification:

This specification applies if required by the manufacturer.

When linear polarisation is used, the polarisation discrimination of the antenna system in the transmit frequency band shall exceed 30 dB within the 1 dB contour of the main beam.

When circular polarisation is used, for antenna diameter larger than 2,5 meter, the axial ratio shall not exceed 1,06.

Verification:

Conformance shall be determined by measurement according to IEC 510-2-1 [6], clause 7, or any other recognised method that can be proved to give the same results.

When linear polarisation is used, the initial polarisation alignment shall be such that the cross-polarised component on the main axis is minimum. No other polarisation alignment shall be done during the measurement.

The test results shall consist of bi-dimensional plots of co-polar and cross-polar antenna gain versus angles from boresight to the 1 dB contour of the main beam for the frequencies 5,855 GHz, 6,140 GHz and 6,420 GHz.

11 Receive polarisation discrimination

Purpose:

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

Specification:

This specification applies if required by the manufacturer.

When linear polarisation is used, the polarisation discrimination of the antenna system in the receive frequency band shall exceed 27 dB within the 1 dB contour of the main beam.

When circular polarisation is used, for antenna diameter larger than 2,5 meter, the axial ratio shall not exceed 1,09.

Verification:

Conformance shall be determined by measurement according to IEC 510-2-1 [6], clause 7, or any other recognised method that can be proved to give the same results.

When linear polarisation is used, the initial polarisation alignment shall be such that the cross-polarised component on the main axis is minimum. No other polarisation alignment shall be done during the measurement.

The test results shall consist of bi-dimensional plots of co-polar and cross-polar antenna gain versus angles from boresight to the 1 dB contour of the main beam. The measurements shall be made for the frequencies 3,630 GHz, 3,910 GHz and 4,195 GHz.

12 Electromagnetic immunity

Purpose:

Protection of the VSAT against interfering electromagnetic fields between 2 GHz and 3 GHz caused by other equipment.

Specification:

This specification applies if required by the manufacturer.

The VSAT shall have an adequate level of intrinsic immunity to enable it to operate as intended, when it is exposed to the following electrical field strengths:

3 V/m in the frequency range 2 GHz to 3 GHz.

Verification:

As specified in subclause 6.7.

13 Terrestrial interfaces

Information is contained in relevant ETSs.

14 Control and monitoring

Relevant information is contained in ETS 300 160 [9] and ETS 300 161 [10].

Annex A (normative): Spurious radiation outside main-beam - test procedure

A.1 Introduction

This annex addresses the measurement procedure of spurious radiation from 30 MHz to 40 GHz generated by a VSAT terminal under operation. The radiation considered are those which are not only generated at the focal point of the antenna subsystem and are thus radiated in random directions around the terminal. Since these emissions are most likely to interfere with any type of equipment, the measurement shall be done at ground level and at several locations surrounding the Equipment Under Test (EUT).

For purpose of the test, the VSAT terminal includes:

- the outdoor unit;
- the indoor unit;
- a connection cable between indoor and outdoor unit;
- the necessary power supply cables and any other cable ensuring a proper functioning of the terminal.

The test procedure is based on already existing international standards and more specifically CISPR Publication No. 22 [3] and EN 55011 [5].

A.2 Measuring method

a) Below 960 MHz, the measurement method of CISPR Publication No. 22 [3] shall apply.

b) For frequencies above 960 MHz, EN 55011 [5] shall apply.

The amplitude-frequency response of any antenna and associated amplification system used for the measurement shall remain within ± 1 dB of its calibration curve across the measurement frequency range considered for this antenna.

The use of a spectrum analyser with sweep time variation capability is recommended. The analyser response to a constant amplitude sine wave signal shall remain within ± 1 dB across the frequency range of interest.

The screening performance of the spectrum analyser shall be in conformity with clause 6 of CISPR Publication No. 16 [4].

The measurement shall be executed in two stages.

The first stage is just to identify frequencies of spurious radiation. This stage should be carried out in an anechoic chamber with the measuring antenna close to the EUT.

The second stage could be carried out on an open air test site for each frequency identified in the first stage. The test set-up shall be as in clause A.5. The measuring procedure given in clause A.6 shall be applied.

Above the cut-off frequency of the waveguide connected to the VSAT antenna the off-axis spurious EIRP shall be estimated by measuring the input power at the antenna flange and using the maximum antenna gain for off-axis angles greater than 7 °. The maximum antenna gain shall be determined from the antenna gain patterns measured under the provisions of subclause 6.4.

NOTE: Definitions and methods of measurement for integrated equipment are under study.

A.3 Equipment Under Test (EUT)

The EUT is the VSAT terminal which consists of:

- the outdoor unit;
- the indoor unit terminated with a matched impedance at the terrestrial ports;
- at least 10 m of cable to connect the indoor and outdoor units. This cable shall be the same as one of those recommended by the manufacturer in his installation manual. The type of cable used shall be noted in the test report;
- the necessary power supply cables and any other cable ensuring a proper functioning of the system.

A.4 Operating mode signal generation

In order to measure the system radiation and electromagnetic immunity under operational conditions, proper arrangement has to be provided (by the manufacturer) to put the VSAT terminal in its normal operating mode. A receive signal shall be provided to emulate the operational conditions of reception.

For radiation measurement in carrier-on mode, the VSAT shall be put in a continuous transmit mode. The VSAT shall be operated at the maximum operational EIRP.

A.5 Test site and test set-up

The test site shall be on a reasonable level surface or ground and it shall be free from reflecting objects so that the measurement results are not unduly affected.

The indoor and outdoor units shall be installed with a separation of about 2 m. Between the two, at least 10 m of the connection cable shall be installed. The height of the cable shall be between 0,5 m and 1 m. The cable shall be maintained in that position by non-metallic means. The outdoor unit shall be normally set on the ground with its mounting structure. The indoor unit shall be set on a non-metallic table at a height between 0,5 m and 1 m.

For frequencies below 960 MHz, the measuring antenna shall be installed at a distance of 10 meters from the boundary of the EUT. The boundary is defined in CISPR Publication N° 22 [3], clause 10.

For frequencies above 960 MHz, the measuring antenna shall be installed at a distance greater than 10 meters from the boundary of the EUT and outside the near field energy flow of the VSAT antenna as well as outside the 7° off-axis cone around the main beam direction.

The main beam of the VSAT antenna shall have an elevation of at least 7°.

For measurement below the cut-off frequency of the waveguide connected to the antenna, the antenna feed horn may be replaced by a dummy load.

A.6 Measuring procedure below cut-off frequency

The following procedures shall be put in operation:

- measuring bandwidth: 100 kHz;
- measuring angular step: in the horizontal plane around the EUT in steps of 10°;
- main beam elevation angle: 7°;
- measuring aerial polarisation and azimuth shall be varied during the measurements to find the maximum field strength.

History

Document history	
December 1994	First Edition
January 1996	Converted into Adobe Acrobat Portable Document Format (PDF)