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**Satellite Earth Stations and Systems (SES);
Very Small Aperture Terminal (VSAT)
transmit-only, transmit-and-receive, receive-only
satellite earth stations operating in the
4 GHz and 6 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

Internet: secretariat@etsi.fr - <http://www.etsi.fr> - <http://www.etsi.org>

Tel.: +33 4 92 94 42 00 - Fax: +33 4 93 65 47 16

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Contents

| | |
|--|----|
| Foreword | 7 |
| Introduction | 7 |
| 1 Scope | 9 |
| 2 Normative references | 10 |
| 3 Definitions and abbreviations | 10 |
| 3.1 Definitions | 10 |
| 3.2 Abbreviations | 12 |
| 4 Requirements | 12 |
| 4.1 Off-axis spurious radiation | 12 |
| 4.1.1 Justification | 12 |
| 4.1.2 Specification | 13 |
| 4.1.2.1 Transmit VSAT | 13 |
| 4.1.2.2 Receive-only VSAT | 14 |
| 4.1.3 Conformance test | 14 |
| 4.2 On-axis spurious radiation for transmit VSAT | 14 |
| 4.2.1 Justification | 14 |
| 4.2.2 Specification | 14 |
| 4.2.2.1 Specification 1: Carrier-on state | 14 |
| 4.2.2.2 Specification 2: Carrier-off state and transmission disabled state | 15 |
| 4.2.3 Conformance test | 15 |
| 4.3 Off-axis EIRP emission density (co-polar and cross-polar) within the band 5,850 GHz to 6,650 GHz | 15 |
| 4.3.1 Justification | 15 |
| 4.3.2 Specification | 15 |
| 4.3.3 Conformance test | 16 |
| 4.4 Transmit polarization discrimination (linear) or voltage axial ratio (circular) | 16 |
| 4.4.1 Justification | 16 |
| 4.4.2 Specification | 16 |
| 4.4.2.1 Specification 1 | 16 |
| 4.4.2.2 Specification 2 | 16 |
| 4.4.3 Conformance test | 16 |
| 4.5 Carrier suppression | 16 |
| 4.5.1 Justification | 16 |
| 4.5.2 Specification | 16 |
| 4.5.3 Conformance test | 17 |
| 4.6 ElectroMagnetic Compatibility (EMC) | 17 |
| 4.7 Mechanical (antenna pointing) for transmit VSAT | 17 |
| 4.7.1 Justification | 17 |
| 4.7.2 Specification | 17 |
| 4.7.3 Conformance test | 17 |
| 4.8 Control and monitoring for transmit VSAT | 17 |
| 4.8.1 General | 17 |
| 4.8.1.1 Control and Monitoring Functions (CMF) | 18 |
| 4.8.1.2 Specification of states | 19 |
| 4.8.2 Control Channels (CC) | 19 |
| 4.8.2.1 Justification | 19 |
| 4.8.2.2 Specification | 20 |
| 4.8.2.3 Conformance test | 20 |
| 4.8.3 Self monitoring functions | 20 |
| 4.8.3.1 Processor monitoring | 21 |
| 4.8.3.1.1 Justification | 21 |

| | | | |
|---------|-------------|--|----|
| | 4.8.3.1.2 | Specification | 21 |
| | 4.8.3.1.3 | Conformance test..... | 21 |
| 4.8.3.2 | | Transmit subsystem monitoring..... | 21 |
| | 4.8.3.2.1 | Justification | 21 |
| | 4.8.3.2.2 | Specification | 21 |
| | 4.8.3.2.3 | Conformance test..... | 21 |
| 4.8.3.3 | | VSAT transmission validation | 21 |
| | 4.8.3.3.1 | VSAT transmission validation by the CCMF | 21 |
| | 4.8.3.3.1.1 | Justification | 21 |
| | 4.8.3.3.1.2 | Specification | 22 |
| | 4.8.3.3.1.3 | Conformance test..... | 22 |
| | 4.8.3.3.2 | VSAT transmission validation by receiving station(s) | 22 |
| | 4.8.3.3.2.1 | Justification | 22 |
| | 4.8.3.3.2.2 | Specification | 22 |
| | 4.8.3.3.2.3 | Conformance test..... | 22 |
| | 4.8.3.3.3 | Transmission validation for VSAT using external CC(s) | 22 |
| | 4.8.3.3.3.1 | Purpose | 22 |
| | 4.8.3.3.3.2 | Specification | 22 |
| | 4.8.3.3.3.3 | Conformance test..... | 22 |
| 4.8.4 | | Reception of commands from the CCMF | 22 |
| | 4.8.4.1 | Disable message | 23 |
| | 4.8.4.1.1 | Justification | 23 |
| | 4.8.4.1.2 | Specification | 23 |
| | 4.8.4.1.3 | Conformance test..... | 23 |
| | 4.8.4.2 | Enable message | 23 |
| | 4.8.4.2.1 | Justification | 23 |
| | 4.8.4.2.2 | Specification | 23 |
| | 4.8.4.2.3 | Conformance test..... | 23 |
| 4.8.5 | | Power-on/Reset | 23 |
| | 4.8.5.1 | Justification | 23 |
| | 4.8.5.2 | Specification..... | 23 |
| | 4.8.5.3 | Conformance test..... | 23 |
| 5 | | Test methods | 24 |
| | 5.1 | Off-axis spurious radiation | 24 |
| | 5.1.1 | Test method..... | 25 |
| | 5.1.1.1 | Up to 1 000 MHz | 25 |
| | 5.1.1.1.1 | Test site..... | 25 |
| | 5.1.1.1.2 | Measuring receivers..... | 25 |
| | 5.1.1.1.3 | Procedure..... | 26 |
| | 5.1.1.2 | Above 1 000 MHz..... | 26 |
| | 5.1.1.2.1 | Identification of the significant frequencies of spurious radiation | 26 |
| | 5.1.1.2.1.1 | Test site..... | 26 |
| | 5.1.1.2.1.2 | Procedure..... | 26 |
| | 5.1.1.2.2 | Measurement of radiated power levels of identified spurious radiation | 27 |
| | 5.1.1.2.2.1 | Test site..... | 27 |
| | 5.1.1.2.2.2 | Procedure..... | 27 |
| | 5.1.1.2.3 | Measurement of conducted spurious radiation at the antenna flange..... | 28 |
| | 5.1.1.2.3.1 | Test site..... | 28 |
| | 5.1.1.2.3.2 | Procedure..... | 28 |
| | 5.2 | On-axis spurious radiation for transmit VSAT | 29 |
| | 5.2.1 | Test method..... | 29 |
| | 5.2.1.1 | Test site | 29 |
| | 5.2.1.2 | Method of measurement..... | 29 |
| | 5.2.1.2.1 | General..... | 29 |
| | 5.2.1.2.2 | Method of measurement at the antenna flange..... | 29 |

| | | | |
|------------------------|---|---|----|
| | 5.2.1.2.3 | Method of measurement with a test antenna | 30 |
| 5.3 | Off-axis EIRP emission density within the band | | 31 |
| | 5.3.1 | Test method | 31 |
| | 5.3.1.1 | Transmit output power density..... | 31 |
| | | 5.3.1.1.1 Test site | 31 |
| | | 5.3.1.1.2 Method of measurement..... | 31 |
| | 5.3.1.2 | Antenna transmit gain..... | 32 |
| | | 5.3.1.2.1 General | 32 |
| | | 5.3.1.2.2 Test site | 32 |
| | | 5.3.1.2.3 Method of measurement..... | 32 |
| | 5.3.1.3 | Antenna transmit radiation patterns..... | 33 |
| | | 5.3.1.3.1 General | 33 |
| | | 5.3.1.3.2 Test site | 33 |
| | | 5.3.1.3.3 Method of measurement..... | 33 |
| | | 5.3.1.3.4 Co-polar radiation pattern - azimuth | 34 |
| | | 5.3.1.3.5 Co-polar radiation pattern - elevation.... | 34 |
| | | 5.3.1.3.6 Cross-polar radiation pattern - azimuth | 35 |
| | | 5.3.1.3.7 Cross-polar radiation pattern - elevation..... | 35 |
| | 5.3.2 | Computation of results | 36 |
| 5.4 | Transmit polarization discrimination (linear) or voltage axial ratio (circular) | | 36 |
| | 5.4.1 | General..... | 36 |
| | 5.4.2 | Test method | 36 |
| | | 5.4.2.1 Method of measurement..... | 36 |
| 5.5 | Carrier suppression | | 38 |
| | 5.5.1 | Test method | 38 |
| 5.6 | Antenna pointing for transmit VSAT | | 38 |
| | 5.6.1 | Test method | 38 |
| 5.7 | Control and monitoring for transmit VSAT | | 39 |
| | 5.7.1 | Test arrangement..... | 39 |
| | 5.7.2 | Control channels | 40 |
| | | 5.7.2.1 Test method..... | 40 |
| | | 5.7.2.1.1 Test method for internal CC(s) | 40 |
| | | 5.7.2.1.2 Test method for external CC(s) | 40 |
| | 5.7.3 | Processor monitoring | 41 |
| | | 5.7.3.1 Test method..... | 41 |
| | 5.7.4 | Transmit subsystem monitoring | 41 |
| | | 5.7.4.1 Test method..... | 41 |
| | 5.7.5 | VSAT transmission validation..... | 41 |
| | | 5.7.5.1 Test method for VSAT validation by the CCMF for VSAT using internal CC(s)..... | 41 |
| | | 5.7.5.2 Test method for VSAT validation by receiving station(s) for VSAT using internal CC(s) | 41 |
| | | 5.7.5.3 Test method for transmission validation for VSAT using external CC(s) | 41 |
| | 5.7.6 | Reception of commands from the CCMF..... | 42 |
| | | 5.7.6.1 Test method..... | 42 |
| | 5.7.7 | Power-on/Reset..... | 42 |
| | | 5.7.7.1 Test method..... | 42 |
| 6. | Test methods for modified VSAT | | 42 |
| | 6.1 | Antenna subsystem replacement | 43 |
| Annex A (normative): | The TBR Requirements Table (TBR-RT)..... | | 44 |
| Annex B (informative): | Pointing stability methodology | | 45 |
| Annex C (informative): | Bibliography | | 46 |
| History..... | | | 47 |

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Foreword

This Technical Basis for Regulation (TBR) has been produced by the Satellite Earth Stations and Systems (SES) Technical Committee of the European Telecommunications Standards Institute (ETSI).

The present document has been produced by ETSI in response to a mandate from the European Commission issued under Council Directive 83/189/EEC (as amended) laying down a procedure for the provision of information in the field of technical standards and regulations.

The present document is intended to become a Harmonized Standard, the reference of which will be published in the Official Journal of the European Communities referencing the Council Directive 93/97/EEC of 29 October 1993 supplementing Directive 91/263/EEC in respect of satellite earth station equipment (the "SES Directive").

A common technical regulation may be established by the European Commission in accordance with the Directive.

Introduction

The Satellite Earth Station (SES) Directive [1] which supplements the Telecommunications Terminal Equipment (TTE) Directive [2] concerns the harmonisation of conditions for the placing on the market of such equipment.

Two classes of standard are applicable to SES equipment. European Telecommunication Standards (ETS) give the full technical specifications for this equipment, whereas Technical Bases for Regulation (TBR) give the essential requirements under the SES Directive [1] and the TTE Directive [2] for placing such equipment on the market. Receive-only equipment, not intended for terrestrial connection to the public telecommunications network, may be put into use. Nothing in this TBR is construed to prevent the use of Community internal production control procedures as set out in the annexes to the two Directives for such receive-only equipment. This TBR is based on ETS 300 332, ETS 300 333, ETS 300 160 and ETS 300 456 (see annex C, Bibliography).

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1 Scope

This Technical Basis for Regulation (TBR) specifies the technical requirements that apply to Very Small Aperture Terminal (VSAT) for compliance with Articles 4.1 and 4.3 of the SES Directive [1].

The VSAT has the following characteristics:

- the VSAT is operating in the following bands allocated to the Fixed Satellite Service (FSS), shared with other services, e.g. the Fixed Service (FS) and the Mobile Service (MS):
 - 5,85 GHz to 6,65 GHz (earth-to-space);
 - 3,40 GHz to 4,20 GHz (space-to-earth);
- the VSAT uses linear or circular polarization;
- the VSAT operates through a geostationary satellite at least 3° away from any other geostationary satellite operating in the same frequency band and covering the same area;
- the VSAT antenna diameter does not exceed 7,3 m, or equivalent effective area;
- the VSAT is either:
 - transmit-only VSAT: designed for transmission-only of radio-communications signals in the frequency band specified above; or
 - transmit-and-receive VSAT: designed for transmission-and-reception of radio-communications signals in the frequency band specified above; or
 - receive-only VSAT: designed for reception-only of radio-communications signals in the frequency band specified above;
- the VSAT is designed usually for unattended operation;
- the VSAT is 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;
- the transmit-only and transmit-and-receive VSAT is controlled and monitored by a Centralized Control and Monitoring Function (CCMF). The CCMF is outside the scope of this TBR.

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

The requirements have been selected to ensure an adequate level of compatibility with other radio services. The levels, however, do not cover extreme cases which may occur in any location but with a low probability of occurrence.

This TBR may not cover those cases where a potential source of interference which is producing individually repeated transient phenomena or a continuous phenomenon is present, e.g. a radar or broadcast site in the near vicinity. In such a case it may be necessary to use special protection applied to either the source of interference, or the interfered part or both.

This TBR does not contain any requirement, recommendation or information about the installation of the VSAT.

Compliance of a VSAT to the requirements of this TBR does not imply compliance to any requirement related to the use of the VSAT (e.g. licensing requirements).

2 Normative references

This TBR incorporates by dated or undated reference, provisions from other publications. These 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 TBR only when incorporated into it by amendment or revision. For undated references the latest edition of the publication referred to applies.

- [1] SES Directive: "Council Directive 93/97/EEC (1993) supplementing Directive 91/263/EEC in respect of satellite earth station equipment".
- [2] TTE Directive: "Council Directive 91/263/EEC (1991) on the approximation of the laws of Member States concerning telecommunications terminal equipment, including the mutual recognition of their conformity".
- [3] ETS 300 673 (1996): "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] CISPR N 16-1 (1993): "Specification for radio interference measuring apparatus and measurements methods; Part 1: Radio disturbance and immunity measuring apparatus" (Annex G: Validation of the open area test site for the frequency range of 30 MHz to 1 000 MHz).

NOTE: This TBR also contains a number of informative references which have been included to indicate the sources from which various material has been derived, hence they do not have an associated normative reference number. Details of these publications are given in annex C (Bibliography).

3 Definitions and abbreviations

3.1 Definitions

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

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

- a) the equipment is intended for use in conjunction with the 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 the VSAT; and
- c) the absence of the equipment does not inhibit the operation of the VSAT.

carrier-off state: A VSAT is in this state when it is authorized by the Centralized Control and Monitoring Functions (CCMF) to transmit, but when it does not transmit any signal.

NOTE 1: The existence of a carrier-off state depends on the system of transmission used. For VSAT designed for continuous transmission mode there may be no carrier-off state.

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

Centralized Control and Monitoring Functions (CCMF): A set of functional entities that, at system level, monitor and control the correct operation of all transmit VSAT in a network.

Control Channel (CC): A channel or channels by which VSAT receive control information from the CCMF.

Cross-Polarization Discrimination (XPD): The ratio of the on-axis co-polar gain to the cross-polar gain in a given direction, at a transmit or receive frequency.

external Control Channel (CC): A control channel which is either (i) carried by the VSAT network via the same or another satellite, but not within the internal protocol of the VSAT system, or (ii) carried by the PSTN or some other means.

external Response Channel (RC): A response channel which is either (i) carried by the VSAT network via the same or another satellite, but not within the internal protocol of the VSAT system, or (ii) carried by the PSTN or some other means.

indoor unit: Is composed of that part of the VSAT which is not part of the outdoor unit. It is generally installed inside a building and is connected to the outdoor unit. The connection cable between the outdoor and indoor unit is considered part of the indoor unit.

internal Control Channel (CC): A control channel which is carried by the VSAT network via the same satellite as used for transmission of user data and within the internal protocol of the VSAT system.

internal Response Channel (RC): A response channel which is carried by the VSAT network via the same satellite as used for transmission of user data and within the internal protocol of the VSAT system.

manufacturer: The legal entity responsible under the terms of the Council Directive 93/97/EEC [1] for placing the product on the market in a member state.

network: In this TBR a network is any network configuration including star, mesh and point-to-point configurations.

nominated bandwidth: The bandwidth of the VSAT radio frequency transmission is nominated by the manufacturer. The nominated bandwidth is centred on the transmit frequency and does not exceed 5 times the occupied bandwidth.

NOTE 2: 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 (Bo): For a digital modulation scheme - the width of the signal spectrum 10 dB below the maximum in-band density. For an analogue modulation scheme - the width of a frequency band 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.

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 Low Noise Block (LNB) down-converter, 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 up-converter and the power amplifier which convert from the intermediate frequency to RF and amplify the low level RF signals for transmission through the antenna subsystem.

NOTE 3: The installation equipment (means of attachment) is outside the scope of this TBR. 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 TBR.

Response Channel (RC): A channel by which VSAT transmit monitoring information to the CCMF.

spurious radiation: Any radiation outside the nominated bandwidth.

NOTE 4: For a receive-only VSAT there is no nominated bandwidth therefore any radiation is a spurious radiation.

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

transmit VSAT: A VSAT capable of being used either for transmission-only, or for transmission-and-reception.

voltage axial ratio: The voltage axial ratio of an antenna at a transmit or a receive frequency is the ratio r equal to $(x + 1)/(x - 1)$ where x is the square root of the Cross-Polarization Discrimination (XPD) (not expressed in dB).

3.2 Abbreviations

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

| | |
|------|--|
| CC | Control Channel |
| CCD | Central Control Disable |
| CCE | Central Control Enable |
| CCMF | Centralized Control and Monitoring Functions |
| CMF | Control and Monitoring Functions |
| CV | Control Variable |
| EIRP | Equivalent Isotropically Radiated Power |
| EMC | ElectroMagnetic Compatibility |
| EUT | Equipment Under Test |
| FS | Fixed Service |
| FSS | Fixed Satellite Service |
| IF | Intermediate Frequency |
| LNB | Low Noise Block (low noise amplifier and down-converter) |
| MS | Mobile Service |
| PSTN | Public Switched Telephone Network |
| RC | Response Channel |
| RE | Reset Event |
| RF | Radio Frequency |
| SMF | Status Monitoring Fail |
| SMP | Status Monitoring Pass |
| SMV | Self Monitoring Variable |
| STE | Specialized Test Equipment |
| VSAT | Very Small Aperture Terminal |
| XPD | Cross-Polarization Discrimination |

4 Requirements

4.1 Off-axis spurious radiation

4.1.1 Justification

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

4.1.2 Specification

4.1.2.1 Transmit VSAT

- 1) The VSAT shall not exceed the limits for radiated interference field strength over the frequency range from 30 MHz to 1,0 GHz specified in table 1.

Table 1: Radiated field strength at a distance of 10 m

| Frequency range (MHz) | Quasi-peak limits dB (μ V/m) |
|-----------------------|-----------------------------------|
| 30 to 230 | 30 |
| 230 to 1 000 | 37 |

The lower limits shall apply at the transition frequency.

- 2) When the VSAT is in the transmission 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 2, for all off-axis angles greater than 7°.

Table 2: Limits of spurious EIRP - transmission disabled state

| Frequency band (GHz) | EIRP limit (dBpW) |
|----------------------|-------------------|
| 1,0 to 10,7 | 48 |
| 10,7 to 21,2 | 54 |
| 21,2 to 40,0 | 60 |

The lower limits shall apply at the transition frequency.

- 3) This specification applies outside the nominated bandwidth.

For both the carrier-on and carrier-off states, the off-axis spurious EIRP from the VSAT, in any 100 kHz band shall not exceed the limits in table 3, for all off-axis angles greater than 7°.

Table 3: Limits of spurious EIRP

| Frequency band (GHz) | EIRP limit (dBpW) |
|---|-------------------|
| 1,0 to 3,4 | 49 |
| 3,4 to 5,7 | 55 |
| 5,7 to 5,85 | 75 (note) |
| 6,65 to 6,8 | 75 (note) |
| 6,8 to 10,7 | 55 |
| 10,7 to 21,2 | 61 |
| 21,2 to 40,0 | 67 |
| NOTE: 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. | |

The lower limits shall apply at the transition frequency.

In the frequency bands 5,450 GHz to 5,700 GHz and 6,800 GHz to 7,050 GHz, for any 20 MHz band within which one or more spurious signals exceeding the above limit of 55 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 11,700 GHz to 13,300 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.

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

- 4) 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.

4.1.2.2 Receive-only VSAT

- 1) The VSAT shall not exceed the limits for radiated interference field strength over the frequency range from 30 MHz to 1 000 MHz specified in table 4.

Table 4: Limits of radiated field strength at a test distance of 10 m

| Frequency range (MHz) | Quasi-peak limits dB (µV/m) |
|-----------------------|-----------------------------|
| 30 to 230 | 30 |
| 230 to 1 000 | 37 |

The lower limits shall apply at the transition frequency.

- 2) The off-axis spurious EIRP from the VSAT, in any 100 kHz band, shall not exceed the limits in table 5, for all off-axis angles greater than 7°.

Table 5: Limits of spurious EIRP

| Frequency band (GHz) | EIRP limit (dBpW) |
|----------------------|-------------------|
| 1,0 to 10,7 | 48 |
| 10,7 to 21,2 | 54 |
| 21,2 to 40,0 | 60 |

The lower limits shall apply at the transition frequency.

- 3) 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.

4.1.3 Conformance test

Conformance test shall be carried out in accordance with subclause 5.1.

4.2 On-axis spurious radiation for transmit VSAT

4.2.1 Justification

To limit the level of interference to satellite radio services.

4.2.2 Specification

4.2.2.1 Specification 1: Carrier-on state

In the 5,850 GHz to 6,650 GHz band the EIRP spectral density of the spurious radiation and outside the nominated bandwidth shall not exceed $4 - 10 \log N$ dBW in any 100 kHz band.

In a bandwidth of 5 times the occupied bandwidth centred on the carrier centre frequency, the EIRP spectral density of the spurious radiation outside the nominated bandwidth, shall not exceed $18 - 10 \log N$ dBW in any 100 kHz band.

N is the maximum number of VSAT which are expected to transmit simultaneously in the same carrier frequency band. This number shall not be exceeded for more than 0,01% of the time. The value of N and the operational conditions of the system shall be declared by the manufacturer.

NOTE 1: The on-axis spurious radiation, outside the 5,850 GHz to 6,650 GHz band, are indirectly limited by the off-axis limits given in subclause 4.1.2.1. Consequently no specification is needed.

NOTE 2: Inter-modulation limits inside the band 5,850 GHz to 6,650 GHz are to be determined by system design, subject to satellite operator specifications.

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

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

In the 5,850 GHz to 6,650 GHz band the EIRP spectral density of the spurious radiation outside the nominated bandwidth shall not exceed -21 dBW in any 100 kHz band.

4.2.3 Conformance test

Conformance test shall be carried out in accordance with subclause 5.2.

4.3 Off-axis EIRP emission density (co-polar and cross-polar) within the band 5,850 GHz to 6,650 GHz

4.3.1 Justification

Protection of other satellite (uplink) systems.

4.3.2 Specification

The maximum EIRP in any 4 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 following limits:

$$\begin{array}{ll} 32 - 25 \log \Phi - 10 \log N \text{ dBW for} & 2,5^\circ \leq \Phi \leq 7^\circ \\ 11 - 10 \log N \text{ dBW for} & 7^\circ < \Phi \leq 9,2^\circ \\ 35 - 25 \log \Phi - 10 \log N \text{ dBW for} & 9,2^\circ < \Phi \leq 48^\circ \\ -7 - 10 \log N \text{ dBW for} & \Phi > 48^\circ \end{array}$$

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

For $\phi > 70^\circ$ 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 ϕ between $2,5^\circ$ and 20° need only be met within $\pm 3^\circ$ of a plane bisected by the main beam axis. This plane shall be marked and identified on the antenna in order to be able to align it tangentially to the geostationary orbit. There shall be an axis of rotation along or parallel to the main beam axis, with adjustment capability to an accuracy of $0,5^\circ$. The antenna shall be capable of having the above plane aligned with the geostationary orbit plane.

In addition the maximum EIRP in any 4 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 following limits:

$$\begin{array}{ll} 22 - 25 \log \Phi - 10 \log N \text{ dBW for} & 2,5^\circ \leq \Phi \leq 7^\circ \\ 1 - 10 \log N \text{ dBW for} & 7^\circ < \Phi \leq 9,2^\circ \end{array}$$

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

4.3.3 Conformance test

Conformance test shall be carried out in accordance with subclause 5.3.1 with the results being computed in accordance with subclause 5.3.2.

4.4 Transmit polarization discrimination (linear) or voltage axial ratio (circular)

4.4.1 Justification

Protection of signals on the orthogonal polarization.

4.4.2 Specification

4.4.2.1 Specification 1

When linear polarization is used, the polarization discrimination of the antenna in the transmit frequency band shall exceed the limits of table 6.

When circular polarization is used, the voltage axial ratio of the antenna in the transmit frequency band shall be less than the limits of table 6.

Table 6: Limits for Cross-Polarization Discrimination (XPD) and voltage axial ratio

| Antenna Diameter (D) | Linear polarization | Circular polarization |
|----------------------|---|-----------------------|
| | Cross-Polarization Discrimination (XPD) | voltage axial ratio |
| $D \leq 4,5$ m | 25 dB | 1,3 |
| $D > 4,5$ m | 27 dB | 1,09 |

The above specification applies to all off-axis angles of less than $0,1^\circ$ plus the pointing accuracy. See subclause 4.7.2, a), specification 1.

NOTE: Some satellite operators may require a better performance.

4.4.2.2 Specification 2

When linear polarization is used, the polarization discrimination of the antenna in the transmit frequency band shall exceed 20 dB within the -10 dB contour of the main beam.

NOTE: Some satellite operators may require a better performance.

4.4.3 Conformance test

Conformance test shall be carried out in accordance with subclause 5.4.

4.5 Carrier suppression

4.5.1 Justification

To allow for the satisfactory suppression of transmissions of a VSAT by the Centralized Control and Monitoring Function (CCMF).

4.5.2 Specification

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

4.5.3 Conformance test

Conformance test shall be carried out in accordance with subclause 5.5.

4.6 ElectroMagnetic Compatibility (EMC)

There are no specific EMC requirements under this TBR however ETS 300 673 [3] contains the EMC requirements for VSAT.

4.7 Mechanical (antenna pointing) for transmit VSAT

4.7.1 Justification

Protection of signals to and from both the same and adjacent satellites.

4.7.2 Specification

a) Pointing stability:

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.

b) Pointing accuracy capability:

Specification 1: Main beam pointing accuracy

The antenna mount shall allow the position of the antenna transmit main beam axis to be maintained with an accuracy better than the off-axis angle measured when the main beam gain has decreased by 1 dB at any frequency in the equipment operating band, over the full range of azimuth and elevation movement available to the antenna.

Specification 2: Non-symmetrical main beam orientation

This specification applies to antennas designed for minimum off-axis gain in the direction of the geostationary orbit (e.g. elliptical antennas). The plane bisected by the main beam axis and where the off-axis is minimum shall be marked 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.

c) Linear polarization angle alignment capability:

When linear polarization is used, the polarization angle shall be continuously adjustable in a range of at least 180°; it shall be possible to fix the transmit antenna polarization angle with an accuracy of at least 1°.

4.7.3 Conformance test

Conformance test shall be carried out in accordance with subclause 5.6.

4.8 Control and monitoring for transmit VSAT

4.8.1 General

The following minimum set of Control and Monitoring Functions (CMF) shall be implemented in VSAT in order to minimise the probability that they may originate transmissions that may interfere with other systems.

Under any fault condition when the VSAT transmissions are being suppressed the EIRP density shall not exceed the limits for the transmission disabled state specified in subclauses 4.1, 4.2 and 4.5.

4.8.1.1 Control and Monitoring Functions (CMF)

A VSAT shall implement two sets of CMF:

- a) Monitoring functions: these functions encompass all the checks and verifications that the VSAT shall perform in order to identify any anomalous situation which may cause impairments to other systems.

The overall result of these checks and verifications are contained in a functional variable named Self Monitoring Variable (SMV). The states of this variable are "pass" and "fail".

The state of the SMV may change as a result of events. These are:

- Status Monitoring Pass event (SMP);
- Status Monitoring Fail event (SMF).

The circumstances under which these events may take place are specified in subclause 4.8.3 of this TBR.

- b) Control functions: these functions are associated with the ability of the CCMF to inhibit and to permit transmissions from an individual VSAT.

These functions are reflected in the state of a functional variable, resident at each VSAT, named Control Variable (CV). The states of this variable are "enable" and "disable".

The CV may change as a result of events. These are:

- Central Control Disable (CCD);
- Central Control Enable (CCE).

The circumstances associated to the reception of the messages resulting in these events are specified in subclause 4.8.4 of this TBR.

Besides these two sets of control and monitoring functions, the VSAT shall achieve a controlled non-transmitting state following actuation of the terminal (power-on).

VSAT that allow local operator intervention may include a terminal reset function which when actuated results in a Reset Event (RE).

Subclause 4.8.5 specifies the functions associated with the occurrence of the "power-on" and Reset Event (RE).

The combination of the SMV and CV results in the definition of 4 possible states in which a VSAT may be from the control and monitoring point-of-view.

The states of the VSAT are:

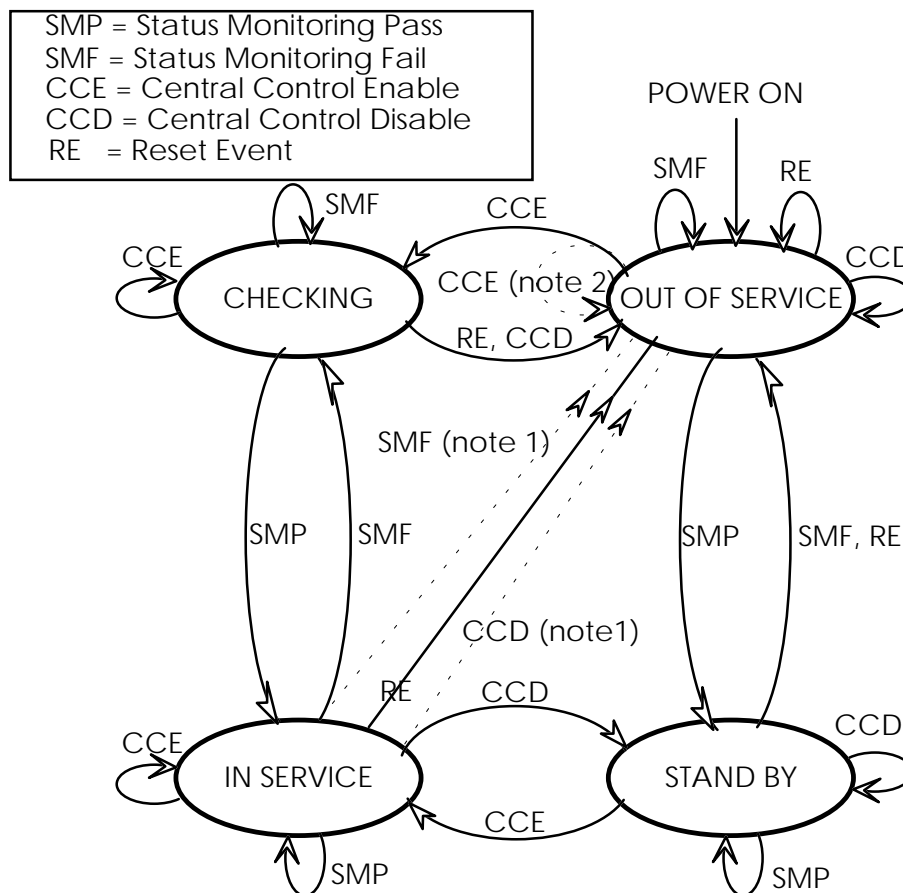
- out-of-service;
- checking;
- stand-by;
- in-service.

Figure 1 shows the state transition diagram associated with these 4 states. The operational behaviour of the VSAT (with respect to control and monitoring), in each of these states, is specified in subclause 4.8.1.2.

In the "in-service" state, the SMF and CCD events may be processed as the RE, in order to set the VSAT in the "out-of-service" state.

In the "out-of-service" state the first or all CCE events may be ignored.

When the VSAT transmits several carriers having different frequencies, a VSAT state machine as described above may be associated with each carrier or each set of carriers. The events then apply to the subsystem associated with the specific carrier or the specific set of carriers, rather than the whole VSAT.



NOTE 1: In the "in-service" state, the occurrence of a SMF and/or CCD may result in a transition to the "out-of-service" state.

NOTE 2: In the "out-of-service" state, the occurrence of the first or all CCE event may be ignored.

Figure 1: State transition diagram of the control and monitoring function of a VSAT

4.8.1.2 Specification of states

The "checking" state shall apply when the SMV is "fail" and when the CV is "enable". In the "checking" state, the VSAT shall not transmit.

The "out-of-service" state shall apply when the SMV is "fail" and when the CV is "disable". In the "out-of-service" state the VSAT shall not transmit. This state shall be entered following power-on or reset.

The "stand-by" state shall apply when the SMV is "pass" and when the CV is "disable". In the "stand-by" state, the VSAT shall not transmit.

The "in-service" state applies when the SMV is "pass" and when the CV is "enable". In the "in-service" state the VSAT is allowed to transmit.

In the "out-of-service", "checking" and "stand-by" states the requirements for the "transmission disabled state" as specified in subclauses 4.1, 4.2 and 4.5 shall apply.

4.8.2 Control Channels (CC)

4.8.2.1 Justification

Control Channel(s) (CC) are used to receive control information from the CCMF.

4.8.2.2 Specification

a) Specification 1:

The VSAT shall have at least one Control Channel (CC) with the CCMF. The CC(s) shall be either internal CC(s) or external CC(s).

The type of CC (internal or external) shall be declared by the manufacturer.

NOTE 1: The availability of the external CC(s) and the number of external CCs are not within the scope of this TBR.

NOTE 2: Some satellite operators may require that internal CC(s) are available.

b) Specification 2 for internal CC(s):

The VSAT shall monitor the operation of its CC receive subsystem, i.e. its ability to lock to the received carrier frequency, demodulate, decode and receive messages from the CCMF.

Failure of the CC receive subsystem for a period of time longer than 30 seconds shall result in a SMF event. The corresponding change of state shall occur not later than 33 seconds after the beginning of the failure.

c) Specification 3 for internal CC(s):

The VSAT shall hold, in non-volatile memory, two unique identification codes:

- the identification code of the control channel or channels which it is authorized to receive; and
- the identification code of the VSAT when the CC is received by more than one VSAT.

Failure to receive and validate an authorized control identification code for a period of time not exceeding 60 seconds shall result in a SMF event. The corresponding change of state shall occur not later than 63 seconds after the beginning of the failure.

The VSAT shall be capable of receiving, via any authorized control channel, messages addressed to the VSAT containing CCD and CCE.

d) Specification 4 for external CC(s):

The VSAT shall be able either to be permanently connected to the CCMF or to be connected to the CCMF on demand, in order to receive messages from the CCMF containing CCD and CCE.

4.8.2.3 Conformance test

Conformance test shall be carried out in accordance with subclause 5.7.2.

4.8.3 Self monitoring functions

In order to ensure that all the subsystems of the VSAT are operating correctly during transmission, the following self monitoring functions shall be implemented in the VSAT:

- processor monitoring;
- transmit subsystem monitoring;
- VSAT transmission validation.

The successful verification of all conditions shall result in a SMP event.

The failure of any of the conditions shall result in a SMF event.

The monitoring functions shall be performed in all states of the VSAT.

4.8.3.1 Processor monitoring

4.8.3.1.1 Justification

To ensure that the VSAT can suppress transmissions in the event of a processor failure.

4.8.3.1.2 Specification

A VSAT shall incorporate a processor monitoring function for each of its processors involved in the manipulation of traffic and in the control and monitoring functions.

The processor monitoring function shall verify the correct operation of the processor hardware and software.

The detection by the processor monitoring function of a processor fault for a period of time not exceeding 30 seconds shall result in an SMF event. The corresponding change of state shall occur not later than 33 seconds after fault occurrence.

4.8.3.1.3 Conformance test

Conformance test shall be carried out in accordance with subclause 5.7.3.

4.8.3.2 Transmit subsystem monitoring

4.8.3.2.1 Justification

To ensure that the VSAT can suppress the transmissions in the event of a transmit subsystem error.

4.8.3.2.2 Specification

A VSAT shall monitor the operation of its transmit frequency generation subsystem.

Failure of the transmit frequency generation subsystem for a period of time not exceeding 5 seconds shall result in a SMF event. The corresponding change of state shall occur no later than 8 seconds after the beginning of the failure.

4.8.3.2.3 Conformance test

Conformance test shall be carried out in accordance with subclause 5.7.4.

4.8.3.3 VSAT transmission validation

For a VSAT using internal CC(s) two alternative methods exist to confirm that the VSAT transmissions are being correctly received. These are:

- transmission validation by the CCMF in accordance with subclause 4.8.3.3.1;
- transmission validation by receiving station(s) in accordance with subclause 4.8.3.3.2.

For those VSAT using internal CC(s) at least one of these methods shall be implemented.

For a VSAT using external CC(s) the specification in subclause 4.8.3.3.3 applies.

4.8.3.3.1 VSAT transmission validation by the CCMF

4.8.3.3.1.1 Justification

To ensure that the transmitting VSAT remains controllable and transmits correctly, by requesting the VSAT to send to the CCMF one or multiple status messages.

4.8.3.3.1.2 Specification

When the VSAT is in the "in-service" state, and when it receives a "poll-for-status message" from the CCMF via a CC the VSAT shall transmit a "status message". The status message may be transmitted by the VSAT periodically there after without further stimuli from the CCMF.

The status message shall be transmitted via an internal Response Channel (RC).

NOTE: The status message is used by the CCMF to verify the correct operation of the VSAT.

4.8.3.3.1.3 Conformance test

Conformance test shall be carried out in accordance with subclause 5.7.5.1.

4.8.3.3.2 VSAT transmission validation by receiving station(s)

4.8.3.3.2.1 Justification

To ensure that the VSAT transmits correctly, by informing the VSAT that its transmissions are being correctly received at receiving station(s).

For every 10 minutes during which the VSAT transmits at least once, the VSAT should receive at least one "transmission validation message" indicating that its transmissions are being received at the receiving station(s).

4.8.3.3.2.2 Specification

If no "transmission validation message" has been received by the VSAT for more than 10 minutes after any transmission, it shall result in a SMF event and the corresponding change of state shall occur not later than 11 minutes from the last "transmission validation message".

4.8.3.3.2.3 Conformance test

Conformance test shall be carried out in accordance with subclause 5.7.5.2.

4.8.3.3.3 Transmission validation for VSAT using external CC(s)

4.8.3.3.3.1 Purpose

To ensure that the transmitting VSAT remains controllable and transmits correctly, by requesting the VSAT to send to the CCMF one or multiple status messages.

4.8.3.3.3.2 Specification

When the VSAT is in the "in-service" state, and when it receives a "poll-for-status message" via the CC(s) the VSAT shall respond with a "status message".

The "status message" shall be either:

- transmitted via an external Response Channel (RC) and shall contain the values of the assigned EIRP and carrier frequencies of the VSAT; or
- transmitted via an internal RC. In this case, the "status message" is used by the CCMF to verify the correct transmission of the VSAT.

4.8.3.3.3.3 Conformance test

Conformance test shall be carried out in accordance with subclause 5.7.5.3.

4.8.4 Reception of commands from the CCMF

This subclause specifies the conditions the VSAT shall satisfy to consider that it is authorized to transmit.

4.8.4.1 Disable message

4.8.4.1.1 Justification

To verify the ability of a transmitting VSAT to suppress all its transmissions when it receives a CCD message from the CCMF.

4.8.4.1.2 Specification

Reception of a CCD message from the CCMF shall result in a CCD event and the corresponding change of state shall occur within 3 seconds of that event.

4.8.4.1.3 Conformance test

Conformance test shall be carried out in accordance with subclause 5.7.6.

4.8.4.2 Enable message

4.8.4.2.1 Justification

To verify the ability of a VSAT to transmit when it has received a CCE message from the CCMF.

4.8.4.2.2 Specification

Reception of CCE message from the CCMF shall result in a CCE event.

4.8.4.2.3 Conformance test

Conformance test shall be carried out in accordance with subclause 5.7.7.

4.8.5 Power-on/Reset

4.8.5.1 Justification

To demonstrate that the VSAT achieves a controlled non-transmitting state following the powering-on of the unit, or the occurrence of a reset made by a local operator when this function is implemented.

4.8.5.2 Specification

Following "power-on" the VSAT shall enter the "out-of-service" state.

Following the application of a reset to the VSAT, a RE shall be considered to have taken place, causing the unit to enter the "out-of-service" state within 3 seconds.

NOTE: To leave the "out-of-service" state or the "stand by" state, the VSAT needs to receive a CCE message from the CCMF. This CCE message could be either:

- requested by the VSAT via an external CC not carried by the same VSAT network; or
- sent by the CCMF regularly via an internal CC; or
- via an external CC within the same VSAT network.

The manner of reception of this CCE remains a design matter.

4.8.5.3 Conformance test

Conformance test shall be carried out in accordance with subclause 5.7.7.

5 Test methods

The values of measurement uncertainty associated with each measurement parameter apply to all of the test cases described in this TBR. The measurement uncertainties shall not exceed the values shown in tables 7 and 8.

Table 7: Measurement uncertainty

| Measurement parameter | Uncertainty |
|-----------------------------|---------------|
| Radio Frequency (RF) | ± 10 kHz |
| RF power | $\pm 0,75$ dB |
| Conducted spurious | ± 4 dB |
| Radiated spurious | ± 6 dB |
| Antenna on-axis gain | $\pm 0,5$ dB |
| Polarization discrimination | ± 2 dB |

Table 8: Measurement uncertainties for antenna gain pattern

| Gain relative to the antenna on-axis gain (dB) | Uncertainty (dB) |
|--|------------------|
| < -3 | $\pm 0,3$ |
| -3 to -20 | $\pm 1,0$ |
| -20 to -30 | $\pm 2,0$ |
| -30 to -40 | $\pm 3,0$ |

To enable the performance tests to be carried out the use of Special Test Equipment (STE), made available by the manufacturer or system provider, may be necessary. Since this test equipment will be specific for the particular system, it is not possible to provide detailed specifications in this TBR. However, the following baseline is provided:

- if the VSAT requires to receive a modulated carrier from the satellite in order to transmit, then special test arrangements are required to simulate the satellite signal, thus enabling the VSAT to transmit allowing measurement of transmission parameters;
- any characteristic of these special test arrangements which may have direct or indirect effects on the parameters to be measured shall be clearly stated by the manufacturer.

All tests with carrier-on shall be undertaken with the transmitter operating at full power and with the maximum transmit burst rate, where applicable, which shall be declared by the manufacturer.

If the Equipment Under Test (EUT) is a VSAT that has had hardware and/or software modification(s) performed by the manufacturer for these tests then full documentation of such modification(s) shall be provided to prove that the modification(s) will simulate the required test condition. Such modification(s) shall be provided to allow the VSAT to operate without its main characteristics being changed.

The antenna shall not be rotated around its main beam axis.

All technical characteristics and operational conditions declared by the manufacturer shall be entered in the test report.

For VSAT already compliant with this TBR and which have been modified the procedure set out in clause 6 shall apply if applicable.

5.1 Off-axis spurious radiation

The tests for the transmit VSAT specification 3 (see subclause 4.8.2.2) shall be limited to the carrier-on state.

5.1.1 Test method

An EUT with antenna is a VSAT with its antenna. It comprises both the indoor and outdoor units interconnected by 10 m of cable. An EUT without antenna is a VSAT with the removable antenna removed. It comprises both the indoor and outdoor units, up to the antenna flange, interconnected by at least 10 m of cable. The connecting cable between the indoor and the outdoor units shall be the same types as recommended by the manufacturer in the installation manual. The type of cable used shall be entered in the test report.

The indoor unit shall be terminated with matched impedances at the terrestrial ports if there is no associated equipment connected to such ports if recommended by the manufacturer in the user documentation.

For frequencies up to 80 MHz the measuring antenna shall be a balanced dipole with a length equal to the 80 MHz resonant length and shall be matched to the feeder by a suitable transforming device. Measurements with broadband antennas are also possible provided that the test site has been calibrated according to the requirements of CISPR N 16-1 [4].

For frequencies between 80 MHz and 1 GHz the measuring antenna shall be a balanced dipole which shall be resonant in length. Measurements with broadband antennas are also possible provided that the test site has been calibrated according to the requirements of CISPR N°16-1 [4].

For frequencies above 1 GHz the antenna shall be a horn radiator of known gain/frequency characteristics. When used for reception the antenna and any associated amplification system shall have an amplitude/frequency response within ± 2 dB of the combined calibration curves across the measurement frequency range considered for the antenna. The antenna is mounted on a support capable of allowing the antenna to be used in either horizontal or vertical polarization and at the specified height.

5.1.1.1 Up to 1 000 MHz

5.1.1.1.1 Test site

The test shall be performed either in an open area test site, a semi-anechoic chamber or an anechoic chamber. Ambient noise levels shall be at least 6 dB below the applicable unwanted emissions limit.

The open area test site shall be flat, free of overhead wires and nearby reflecting structures, sufficiently large to permit aerial placement at the specified measuring distance and provide adequate separation between aerial, test unit and reflecting structures according to the specification of CISPR N 16-1 [4].

For both the open area test site and the semi-anechoic chamber a metal ground plane shall be inserted on the natural ground plane and it shall extend at least 1 m beyond the perimeter of the EUT at one end and at least 1 m beyond the measurement antenna at the other end.

The distance between the EUT and measuring antenna shall be 10 m. An inverse proportionality factor of 20 dB per decade shall be used to normalize the measured data to the specified distance for determining compliance. Care should be taken in measurement of large test units at 3 m at frequencies near 30 MHz due to near field effects.

5.1.1.1.2 Measuring receivers

Measuring receivers shall conform to the following characteristics:

- the response to a constant amplitude sine wave signal shall remain within ± 1 dB across the frequency range of interest;
- quasi-peak detection shall be used in a -6 dB bandwidth of 120 kHz;
- the receiver shall be operated at more than 1 dB below the compression point during tests/measurements.

5.1.1.1.3 Procedure

- a) The EUT shall be an VSAT with antenna or, preferably, a VSAT without antenna but with the antenna flange terminated by a dummy load.
- b) The EUT shall be in the carrier-on state.
- c) The EUT shall be rotated through 360° and, except in an anechoic chamber, the measuring antenna height simultaneously varied from 1 m to 4 m above the ground plane.
- d) All identified spurious radiations shall be measured and noted in frequency and level.

5.1.1.2 Above 1 000 MHz

The spectrum analyser resolution bandwidth shall be set to the specified measuring bandwidth or as close as possible. If the resolution bandwidth is different from the specified measuring bandwidth, bandwidth correction shall be performed for the noise-like wideband spurious.

For an EUT with antenna the tests shall be performed in two stages for both the carrier-on and carrier-off states. The appropriate polarization shall be utilized for both the measuring and substitution antennas:

Procedure a: Identification of the significant frequencies of spurious radiation;

Procedure b: Measurement of radiated power levels of identified spurious radiation.

For an EUT without antenna the tests shall be performed in three stages for both the carrier-on and carrier-off states:

Procedure a: Identification of the significant frequencies of spurious radiation;

Procedure b: Measurement of radiated power levels of identified spurious radiation;

Procedure c: Measurement of conducted spurious radiation radiated through the antenna flange.

5.1.1.2.1 Identification of the significant frequencies of spurious radiation

5.1.1.2.1.1 Test site

The identification of frequencies emitting from the EUT shall be performed either in an anechoic chamber, an open area test site or a semi-anechoic chamber with the test antenna close to the EUT and at the same height as the volume centre of the EUT.

5.1.1.2.1.2 Procedure

- a) The EUT shall be in the carrier-off state (receive-only terminals shall be in the normal operating condition).
- b) For an EUT with antenna the main beam of the antenna shall have an angle of elevation of 7°, and, for an EUT without antenna the antenna flange shall be terminated by a dummy load.
- c) The receivers shall scan the frequency band whilst the EUT revolves.
- d) The EUT shall be rotated through 360° and the frequency of any spurious signals noted for further investigation.
- e) For an EUT with antenna the test shall be repeated with the test antenna being in the orthogonal polarization.
- f) For transmit capable equipment the test shall be repeated in the carrier-on state whilst transmitting one modulated carrier at maximum power.

5.1.1.2.2 Measurement of radiated power levels of identified spurious radiation

5.1.1.2.2.1 Test site

The measurement of each spurious radiation noted during procedure a) of the test shall be performed on a test site that is free from reflecting objects, i.e. either an open-area test site, a semi-anechoic chamber or an anechoic chamber.

5.1.1.2.2.2 Procedure

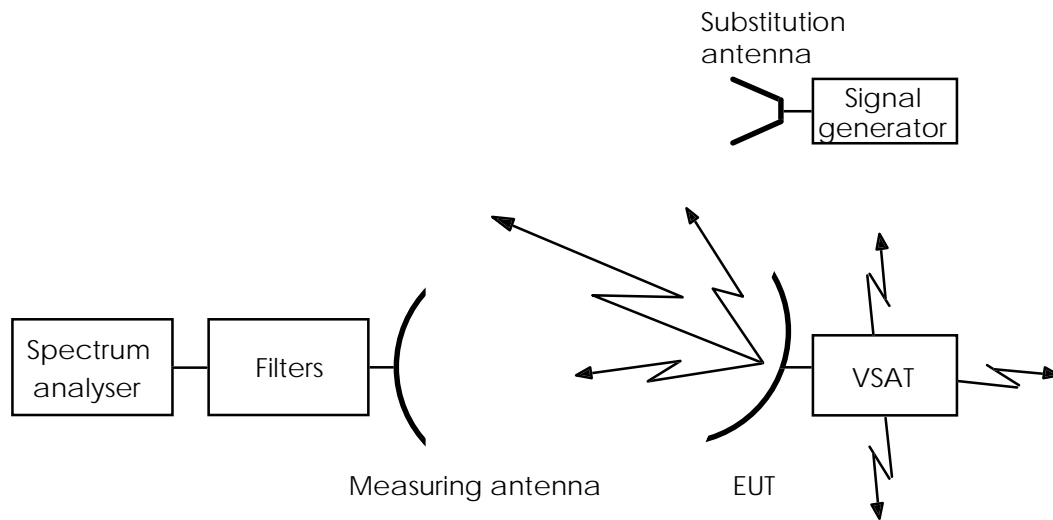


Figure 2: Test arrangement - Spurious radiation measurement above the cut-off frequency for an EUT with antenna

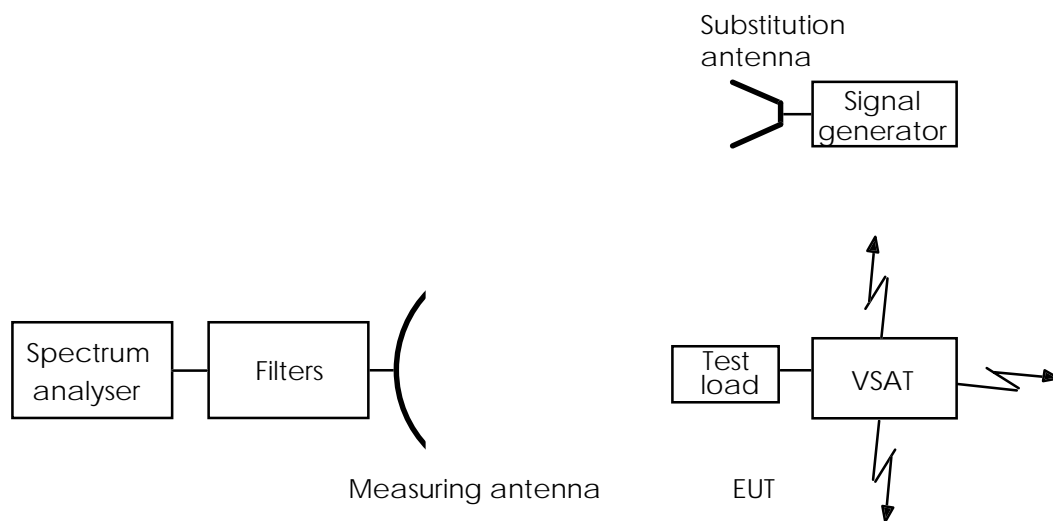


Figure 3: Test arrangement - spurious radiation measurements above the cut-off frequency, for an EUT without antenna

- a) The test arrangement shall be as shown in figures 2 or figure 3.
- b) The EUT shall be installed such that the units are separated by about 1 m to 2 m with the indoor unit at a height between 0,5 m and 1,0 m on a turntable. The interconnection cable shall be supported by non-metallic means at a height between 0,5 m and 1,0 m. For the test arrangement shown in figure 2 the main beam of the antenna shall have an angle of elevation of 7° and be oriented away from the geostationary orbit, or be inhibited by placing RF absorbing panels in that direction. For antennas designed for minimum off-axis gain in the direction of the geostationary orbit plane, the plane containing the larger cut of the main lobe shall be set vertical.

- c) The measuring antenna shall be positioned at a distance from the EUT (e.g. 3, 5, 10 m) relevant to the applied test site. The measuring antenna shall be adjusted in height and the EUT rotated, whilst the EUT is in the appropriate carrier condition, for a maximum response on the associated spectrum analyser at each spurious frequency previously identified, this response level shall be noted. The adjustment in height of the measuring antenna does not apply when an anechoic chamber is being used. The measuring antenna shall never enter the 7° off-axis cone around the main beam direction.
- d) The investigation shall be repeated with the measuring antenna in the orthogonal polarization and the response level similarly noted.
- e) The EUT shall be replaced by the substitution antenna to which is connected a signal generator. The main beam axes of the measuring and substitution antennas shall be aligned. The distance between these antennas shall be the distance determined under test c).
- f) The substitution and measuring antennas shall be aligned in the polarization which produced the larger response between the EUT and the test antenna in steps c) and d).
- g) The output of the generator shall be adjusted so that the received level is identical to that of the previously noted largest spurious radiation.
- h) The output level of the signal generator shall be noted. The EIRP of the spurious radiation is the sum, in dB, of the signal generator output plus the substitution antenna isotropic gain minus the interconnection cable loss.

5.1.1.2.3 Measurement of conducted spurious radiation at the antenna flange

5.1.1.2.3.1 Test site

There are no requirements for the test site to be used for this test.

5.1.1.2.3.2 Procedure

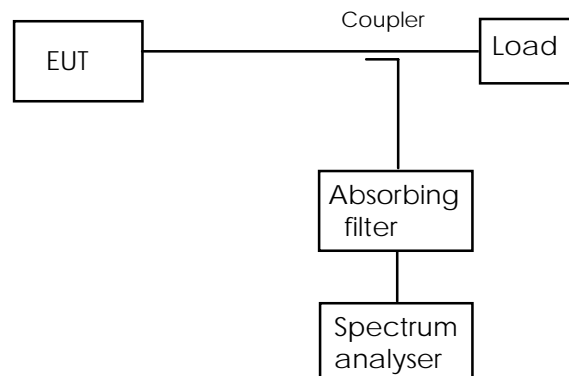


Figure 4: Test arrangement - conducted spurious radiation

- a) The test arrangement shall be as shown in figure 4. In order to protect the spectrum analyser while ensuring the necessary measurement accuracy, particularly close to the carrier, if an arrangement of coupler and absorbing filter is used it shall be tuned to and calibrated about the transmit carrier frequency.
- b) The frequency range from the cut-off frequency of the waveguide of the EUT to 40 GHz shall be investigated for spurious radiation whilst in the carrier-on state with the carrier being at maximum power and normally modulated.
- c) To obtain the off-axis spurious EIRP the maximum measured antenna transmit gain, measured at the frequency of the identified unwanted emission, for off-axis angles greater than 7° shall be added to the measured power density and any correction or calibration and coupling factors summated with the result. If agreed by the manufacturer, it shall be acceptable that the worst case value assumed (i.e. 8 dBi for off-axis angles greater than 7°) is used in place of the maximum antenna gain at the frequency of the identified unwanted emission.

- d) The test shall be repeated, for transmit capable equipment, in the carrier-off state.

5.2 On-axis spurious radiation for transmit VSAT

5.2.1 Test method

5.2.1.1 Test site

There are no requirements for the test site to be used for this test.

5.2.1.2 Method of measurement

5.2.1.2.1 General

For VSAT equipment for which measurements at the antenna flange are not possible or not agreed by the manufacturer, the measurements shall be performed with a test antenna.

For VSAT equipment for which measurements at the antenna flange are possible and agreed by the manufacturer, the measurements shall be performed at the antenna flange.

5.2.1.2.2 Method of measurement at the antenna flange

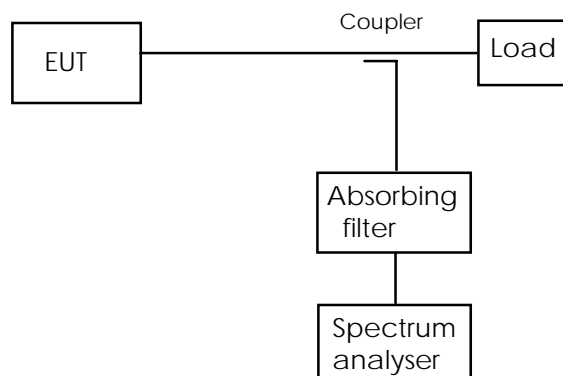


Figure 5: Test arrangement - on-axis spurious radiation measurements at the antenna flange

- a) The test arrangement shall be as shown in figure 5. In order to protect the spectrum analyser while ensuring the necessary measurement accuracy, particularly close to the carrier, if an arrangement of coupler and absorbing filter is used it shall be tuned to and calibrated about the transmit carrier frequency.
- b) The EUT shall transmit one modulated carrier continuously, or at its maximum burst rate where applicable, centred on a frequency as close to the lower limit of the operating frequency band of the EUT as possible. The EUT shall be operated at the highest normal operating EIRP. The frequency range 5,850 GHz to 6,650 GHz shall be investigated.
- c) Due to the proximity of the carrier the spectrum analyser resolution bandwidth shall be set to a measurement bandwidth of 3 kHz, or as close as possible. If the measurement bandwidth is different from the specified measurement bandwidth, bandwidth correction shall be applied as appropriate to noise-like wideband spurious radiation.
- d) To obtain the on-axis spurious EIRP, the antenna transmit gain shall be added to any figure obtained in the above measurement and any correction or calibration factor summated with the result. The antenna gain shall be as measured in subclause 5.3.1.2 at the closest frequency to the spurious frequency.
- e) The tests in b) to e) shall be repeated with a transmit frequency in the centre of the operating frequency band.

- f) The tests in b) to e) shall be repeated with a transmit frequency as close to the upper limit of the operating frequency band of the EUT as possible.
- g) The test shall be repeated in the carrier-off state.
- h) The test shall be repeated in the "transmission disabled state".

5.2.1.2.3 Method of measurement with a test antenna

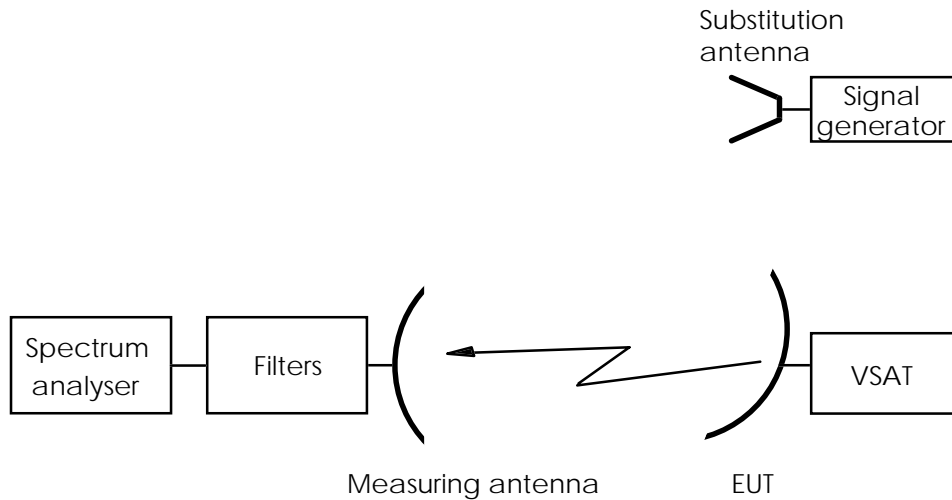


Figure 6: Test arrangement - on-axis spurious radiation measurements with a measuring antenna

- a) The test arrangement shall be as shown in figure 6.
- b) The EUT shall be installed such that the units are separated by about 1 m to 2 m with the indoor unit at a height between 0,5 m and 1,0 m on a turntable. The interconnection cable shall be supported by non-metallic means at a height between 0,5 m and 1,0 m.
- c) The spectrum analyser resolution bandwidth shall be set to the specified measuring bandwidth or as close as possible. If the resolution bandwidth is different from the specified measuring bandwidth, bandwidth correction shall be performed for noise-like wideband spurious radiation.
- d) The EUT shall transmit one modulated carrier continuously, or at its maximum burst rate where applicable, centred on a frequency as close to the lower limit of the operating frequency band of the EUT as possible. The EUT shall be operated at the highest normal operating EIRP. The frequency range 5,850 GHz to 6,425 GHz shall be investigated and each spurious frequency shall be noted.
- e) Due to the proximity of the carrier the spectrum analyser resolution bandwidth shall be set to a measurement bandwidth of 3 kHz, or as close as possible. If the measurement bandwidth is different from the specified measurement bandwidth, bandwidth correction shall be performed for noise-like wideband spurious radiation.
- f) The measuring antenna shall be positioned at a distance from the EUT (e.g. 3, 5, 10 m) relevant to the applied test site, and shall be aligned with the EUT antenna for the transmit frequency. The measuring antenna shall be adjusted in height, whilst the EUT is in the appropriate carrier condition, for a maximum response on the associated spectrum analyser at each spurious frequency previously identified, this response level shall be noted. The adjustment in height of the measuring antenna does not apply when an anechoic chamber is being used.
- g) The EUT shall be replaced by the substitution antenna to which is connected a signal generator. The main beam axes of the measuring and substitution antennas shall be aligned. The distance between these antennas shall be the distance determined under test f).
- h) The substitution and measuring antennas shall be aligned in the polarization which produced the larger response between the EUT and the test antenna.

- j) The output of the generator shall be adjusted so that the received level is identical to that of the previously noted largest spurious radiation.
- k) The output level of the signal generator shall be noted. The EIRP of the on-axis spurious radiation is the sum, in dB, of the signal generator output plus the substitution antenna isotropic gain minus the interconnection cable loss.
- l) The tests in d) to k) shall be repeated with a transmit frequency in the centre of the operating frequency band.
- m) The tests in d) to k) shall be repeated with a transmit frequency as close to the upper limit of the operating frequency band of the EUT as possible.
- n) The test shall be repeated in the carrier-off state.
- p) The test shall be repeated in the "transmission disabled state" state.

5.3 Off-axis EIRP emission density within the band

Off-axis EIRP emission density (co-polar and cross-polar) within the band 5,850 GHz to 6,650 GHz.

5.3.1 Test method

To ascertain the off-axis EIRP it is necessary to know the transmit power density and antenna transmit radiation pattern. To ascertain the radiation pattern it is necessary to know the antenna transmit gain.

The following three measurement procedures shall, therefore, be performed:

- a) transmitter output power density (dBW/4 kHz);
- b) antenna transmit gain (dBi);
- c) antenna transmit radiation patterns (dBi).

5.3.1.1 Transmit output power density

For the purposes of this TBR, transmit output power is defined as the maximum power delivered continuously by the transmitting equipment to the antenna flange.

For the purposes of this test, the EUT is defined as the indoor unit and that part of the outdoor unit up to the antenna flange.

5.3.1.1.1 Test site

There are no requirements for the test site to be used for this test.

5.3.1.1.2 Method of measurement

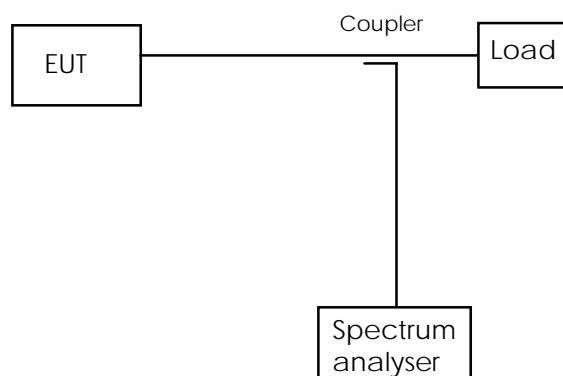


Figure 7: Test arrangement - transmit output power density measurement

- a) The test arrangement shall be as shown in figure 7.

- b) With the carrier being modulated by a pseudo random bit sequence, the maximum power supplied to the antenna flange shall be measured in dBW/4 kHz. The coupling factor of the test coupler at the test frequency and the attenuation of any necessary waveguide adapter shall be taken into account. The resolution bandwidth of the spectrum analyser shall be set as close as possible to the specified measuring bandwidth. If the resolution bandwidth is different from the specified bandwidth then bandwidth correction shall be performed.

5.3.1.2 Antenna transmit gain

5.3.1.2.1 General

For the purposes of this TBR, the antenna transmit gain is defined as the ratio, expressed in decibels (dBi), of the power that would have to be supplied to the reference antenna, i.e. an isotropic radiator isolated in space, to the power supplied to the antenna being considered, so that they produce the same field strength at the same distance in the same direction. Unless otherwise specified the gain is for the direction of maximum radiation.

For the purposes of this test the EUT is defined as that part of the outdoor unit which comprises the antenna and its flange. The antenna includes the reflector(s), feed, support struts and an enclosure of equal weight/distribution to any electrical equipment normally housed with the feed at the antenna focal point.

5.3.1.2.2 Test site

This test shall be performed on either an outdoor far-field test site or compact test range. However if the near-field scanner technology to convert near-field measurements to far-field results is proven and sufficiently accurate by reference to tests taken in both regions then antenna measurements may be taken in the near field. Fully automated systems can be used for these tests providing that the results can be proven to be as accurate as if they were done according to the specified method.

5.3.1.2.3 Method of measurement

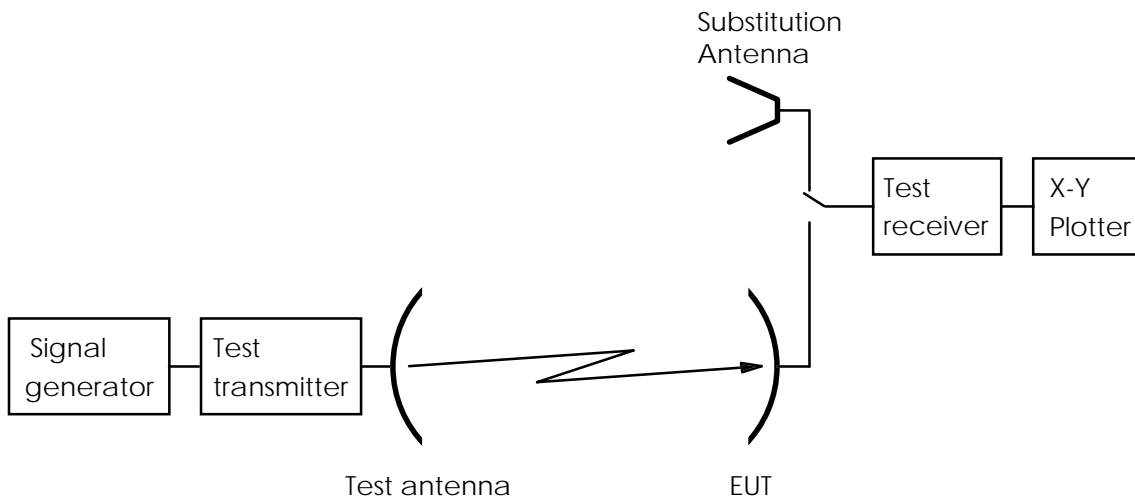


Figure 8: Test arrangement - antenna transmit gain measurement

- a) The test arrangement shall be as shown in figure 8 with the EUT connected to the test receiver. A signal proportional to the angular position from the servo mechanism shall be applied to the X-axis and the signal level from the test receiver shall be applied to the Y-axis of the plotter.
- b) A test signal at 5,855 GHz shall be transmitted by the test transmitter through the test antenna. The E-plane shall be vertical. The EUT antenna main beam axis shall be aligned with the main beam axis of the test transmitter. For linear polarization the polarizer of the EUT antenna shall be rotated and adjusted such that the E-plane coincides with the E-plane of the test transmitter for linear polarization.

- c) The EUT shall be aligned to maximize the received signal and the X-Y plotter adjusted to give the maximum reading on the chart.
- d) The EUT shall be driven in azimuth in one direction through 10°.
- e) The pattern measurement is then obtained by driving the EUT in azimuth back through boresight to 10° the other side with the plotter recording the results.
- f) The EUT shall be replaced by the substitution antenna and the received signal level maximized.
- g) This level shall be recorded on the X-Y plotter.
- h) The substitution antenna shall be driven in azimuth as in d) and e).
- j) The gain of the EUT shall be calculated from:

$$G_{EUT} = L_1 - L_2 + C$$

where:

- G_{EUT} is the gain of the EUT (dBi);
- L_1 is the level obtained with the EUT (dB);
- L_2 is the level obtained with the substitution antenna (dB);
- C is the calibrated gain of the substituted antenna at the test frequency (dBi).

- k) The tests in c) to j) shall be repeated with the frequency changed to 6,1375 GHz.
- l) The tests in c) to j) shall be repeated with the frequency changed to 6,420 GHz.
- m) The tests in b) to l) may be performed simultaneously.

5.3.1.3 Antenna transmit radiation patterns

5.3.1.3.1 General

For the purposes of this TBR, the antenna transmit radiation patterns are diagrams relating field strength to the angle of the direction pointed by the antenna at a constant large distance from the antenna.

For the purposes of this test, the EUT is defined as that part of the outdoor unit which comprises the antenna and its flange. The antenna includes the reflector(s), feed, support struts and an enclosure of equal weight/distribution to any electrical equipment normally housed with the feed at the antenna focal point.

5.3.1.3.2 Test site

This test shall be performed on either an outdoor far-field test site or compact test range. However, if the near-field scanner technology to convert near-field measurements to far-field results is proven and sufficiently accurate by reference to tests taken in both regions then antenna measurements may be taken in the near field. Fully automated systems can be used for these tests providing that the results can be proven to be as accurate as if they were done according to the specified method.

5.3.1.3.3 Method of measurement



Figure 9: Test arrangement - antenna transmit radiation pattern measurement

5.3.1.3.4 Co-polar radiation pattern - azimuth

- a) The test arrangement shall be as shown in figure 9 with the EUT connected to the test receiver. A signal proportional to the angular position from the servo mechanism shall be applied to the X-axis and the signal level from the test receiver shall be applied to the Y-axis of the plotter.
- b) The frequency of the test signal shall be set to 6,1375 GHz.
- c) The initial E-plane of the test signal radiated by the test transmitter through its antenna shall be vertical for linear polarization or left hand for circular polarization antennas. The EUT antenna main beam axis shall be aligned with the main beam axis of the test transmitter. For linear polarization the polarizer of the EUT antenna shall be rotated and adjusted such that its E-plane coincides with the E-plane of the test transmitter. Precise co-polar peaking of the polarization shall be done by observing the cross-polar minimum (fine adjustment).
- d) The EUT shall be aligned to maximize the received signal and the X-Y plotter adjusted to give the maximum reading on the chart.
- e) The EUT shall be driven in azimuth to -180° .
- f) The transmit pattern measurement is then obtained by driving the EUT in azimuth from -180° to $+180^\circ$ with the plotter recording the results.
- g) The tests in d) to f) shall be repeated with the frequency changed to 5,855 GHz.
- h) The tests in d) to f) shall be repeated with the frequency changed to 6,420 GHz.
- j) The tests in b) to h) may be performed simultaneously.
- k) The tests in d) to j) shall be repeated with the E-plane of the test signal being horizontal or right hand circular as appropriate. The frequency of the test signal shall be set to 6,1375 GHz. For linear polarization the polarizer of the EUT antenna shall be rotated and adjusted such that its E-plane coincides with the E-plane of the test transmitter. Precise co-polar peaking of the polarization shall be done by observing the cross-polar minimum (fine adjustment).

5.3.1.3.5 Co-polar radiation pattern - elevation

- a) The test arrangement shall be as shown in figure 9 with the EUT connected to the test receiver. A signal proportional to the angular position from the servo mechanism shall be applied to the X-axis and the signal level from the test receiver shall be applied to the Y-axis of the plotter.
- b) The frequency of the test signal shall be set to 6,1375 GHz.
- c) The initial E-plane of the test signal radiated by the test transmitter through its antenna shall be vertical for linear polarization or left hand for circular polarization antennas. The EUT antenna main beam axis shall be aligned with the main beam axis of the test transmitter. For linear polarization the polarizer of the EUT antenna shall be rotated and adjusted such that its E-plane coincides with the E-plane of the test transmitter. Precise co-polar peaking of the polarization shall be done by observing the cross-polar minimum (fine adjustment).
- d) The EUT shall be aligned to maximize the received signal and the X-Y plotter adjusted to give the maximum reading on the chart.
- e) The EUT shall be driven in elevation to -1° .
- f) The transmit pattern measurement is then obtained by driving the EUT in elevation from -1° to 70° with the plotter recording the results.
- g) The tests in d) to f) shall be repeated with the frequency changed to 5,855 GHz.
- h) The tests in d) to f) shall be repeated with the frequency changed to 6,420 GHz.
- j) The tests in b) to h) may be performed simultaneously.

- k) The tests in d) to j) shall be repeated with the E-plane of the test signal being horizontal or right hand circular as appropriate. The frequency of the test signal shall be set to 6,1375 GHz. For linear polarization the polarizer of the EUT antenna shall be rotated and adjusted such that its E-plane coincides with the E-plane of the test transmitter. The EUT antenna main beam axis shall be aligned with the main beam axis of the test transmitter. Precise co-polar peaking of the polarization plane shall be done by observing the cross-polar minimum (fine adjustment).

5.3.1.3.6 Cross-polar radiation pattern - azimuth

- a) The test arrangement shall be as shown in figure 9 with the EUT connected to the test receiver. A signal proportional to the angular position from the servo mechanism shall be applied to the X-axis and the signal level from the test receiver shall be applied to the Y-axis of the plotter.
- b) The frequency of the test signal shall be set to 6,1375 GHz.
- c) The initial E-plane of the test signal radiated by the test transmitter through its antenna shall be vertical for linear polarization or left hand for circular polarization antennas. The EUT antenna main beam axis shall be aligned with the main beam axis of the test transmitter. For linear polarization the polarizer of the EUT antenna shall be rotated and adjusted such that its E-plane is orthogonal to the E-plane of the test transmitter. Precise fine adjustment of the polarization plane shall be done by observing the cross-polar minimum.
- d) In order to adjust the X-Y plotter giving the maximum reading on the chart the boresight co-polar receive signal shall be used.
- e) The EUT shall be driven in azimuth to -10° .
- f) The transmit pattern measurement is then obtained by driving the EUT in azimuth from -10° to $+10^\circ$ with the plotter recording the results.
- g) The tests in d) to f) shall be repeated with the frequency changed to 5,855 GHz.
- h) The tests in d) to f) shall be repeated with the frequency changed to 6,420 GHz.
- j) The tests in b) to h) may be performed simultaneously.
- k) The tests in d) to j) shall be repeated with the E-plane of the test signal being horizontal or right hand circular as appropriate. The frequency of the test signal shall be set to 6,1375 GHz. The EUT antenna main beam axis shall be aligned with the main beam axis of the test transmitter. For linear polarization the polarizer of the EUT antenna shall be rotated and adjusted such that its E-plane is orthogonal with the E-plane of the test transmitter. Precise fine adjustment of the polarization plane shall be done by observing the cross-polar minimum.

5.3.1.3.7 Cross-polar radiation pattern - elevation

- a) The test arrangement shall be as shown in figure 9 with the EUT connected to the test receiver. A signal proportional to the angular position from the servo mechanism shall be applied to the X-axis and the signal level from the test receiver shall be applied to the Y-axis of the plotter.
- b) The frequency of the test signal shall be set to 6,1375 GHz.
- c) The initial E-plane of the test signal radiated by the test transmitter through its antenna shall be vertical for linear polarization or left hand for circular polarization antennas. The EUT antenna main beam axis shall be aligned with the main beam axis of the test transmitter. For linear polarization the polarizer of the EUT antenna shall be rotated and adjusted such that its E-plane is orthogonal to the E-plane of the test transmitter. Precise fine adjustment of the polarization plane shall be done by observing the cross-polar minimum.
- d) In order to adjust the X-Y plotter giving the maximum reading on the chart the boresight co-polar receive signal shall be used.
- e) The EUT shall be driven in elevation to -1° .

- f) The transmit pattern measurement is then obtained by driving the EUT in elevation from -1° to $+10^\circ$ with the plotter recording the results.
- g) The tests in d) to f) shall be repeated with the frequency changed to 5,855 GHz.
- h) The tests in d) to f) shall be repeated with the frequency changed to 6,420 GHz.
- j) The tests in b) to h) may be performed simultaneously.
- k) The tests in d) to j) shall be repeated with the E-plane of the test signal being horizontal or right hand circular as appropriate. The frequency of the test signal shall be set to 6,1375 GHz. The EUT antenna main beam axis shall be aligned with the main beam axis of the test transmitter. For linear polarization the polarizer of the EUT antenna shall be rotated and adjusted such that its E-plane is orthogonal with the E-plane of the test transmitter. Precise fine adjustment of the polarization plane shall be done by observing the cross-polar minimum.

5.3.2 Computation of results

The results shall be computed by producing a "mask" to the specified limits with the reference level being equal to the sum of the transmitter output power density and the gain of the antenna. This reference shall then be placed on the maximum point of the plots obtained from the transmit radiation pattern measurement, so as to ascertain that the off-axis EIRP density is within the mask, and thus conforming to the specification.

5.4 Transmit polarization discrimination (linear) or voltage axial ratio (circular)

5.4.1 General

For the purposes of this test, the EUT is defined as that part of the outdoor unit which comprises the antenna and its flange. The antenna includes the reflector(s), feed, support struts and an enclosure of equal weight/distribution to any electrical equipment normally housed with the feed at the antenna focal point.

The test method described is only valid for the measurement of the transmit polarization discrimination in the case of linear polarization. The measurement of the voltage axial ratio in the case of circular polarization shall be done according to a method agreed between the manufacturer and the test house.

5.4.2 Test method

This test shall be performed on either an outdoor far-field test site or compact test range. However if the near-field scanner technology to convert near-field measurements to far-field results is proven and sufficiently accurate by reference to tests taken in both regions then antenna measurements may be taken in the near field. Fully automated systems can be used for these tests providing that the results can be proven to be as accurate as if they were done according to the specified method.

5.4.2.1 Method of measurement



Figure 10: Test arrangement - transmit polarization discrimination

- a) The test arrangement shall be as shown in figure 10 with the EUT connected to the test receiver. A signal proportional to the angular position from the servo mechanism shall be applied to the X-axis and the signal level from the test receiver shall be applied to the Y-axis of the plotter.

- b) The frequency of the test signal shall be set to 6,1375 GHz.
- c) The initial E-plane of the test signal radiated by the test transmitter through its antenna shall be vertical. The EUT antenna main beam axis shall be aligned with the main beam axis of the test transmitter. For linear polarization the polarizer of the EUT antenna shall be rotated and adjusted such that its E-plane coincides with the E-plane of the test transmitter. Precise fine adjustment of the polarization plane shall be done by observing the cross-polar minimum.
- d) The co-polar level on the test receiver shall be noted.
- e) The EUT shall be driven in azimuth and in elevation in opposite direction until the received level in each case drops 1,0 dB. The lowest and highest angles in azimuth (Az1, Az2) and in elevation (EI1, EI2) corresponding to this 1 dB co-polar gain reduction shall be noted. The azimuth angle shall be set to 0° and the elevation angle shall be set to 50 % of EI1. The EUT shall be driven in azimuth in each direction until the received level is dropped to the level noted in d) minus 1,0 dB. The lowest and highest angle (Az3, Az4) corresponding to this -1 dB co-polar boresight gain reduction at an elevation angle of 50 % of EI1 shall be noted. The azimuth angle shall be set to 0° and the elevation angle shall be set to 50 % of EI2. The EUT shall be driven in azimuth in each direction until the received level is dropped to the level noted in d) minus 1,0 dB. The lowest and highest angle (Az5, Az6) corresponding to this -1 dB co-polar boresight gain reduction at an elevation angle of 50 % of EI2 shall be noted.
The elevation angle and the azimuth angle shall be set to 0°. For linear polarization the test antenna shall be rotated by 90° around its main beam axis for the reception of the cross-polar component.
- f) The EUT shall be driven for the cross-polar component in azimuth from Az1 to Az2 with the X-Y plotter recording the ratio of the level recorded in d) and the actual cross-polar signal level of the test receiver.
- g) The EUT shall be adjusted to an elevation angle of 50 % of EI1. The EUT shall be driven for the cross-polar component in azimuth from Az3 to Az4 with the X-Y plotter recording the ratio of the level noted in d) and the actual cross-polar level of the test receiver.
- h) The EUT shall be adjusted to an elevation angle of 50 % of EI2. The EUT shall be driven for the cross-polar component in azimuth from Az5 to Az6 with the X-Y plotter recording the ratio of the level noted in d) and the actual cross-polar level of the test receiver.
- j) The EUT shall be adjusted to an azimuth angle of 0°. The EUT shall be driven for the cross-polar component in elevation from EI1 to EI2 with the X-Y plotter recording the ratio of the level noted in d) and the actual cross-polar level of the test receiver.
- k) For linear polarization the test antenna shall be rotated by 90° around its main beam axis for reception of the co-polar component. The tests in d) to j) shall be repeated with the frequency changed to 5,855 GHz.
- l) For linear polarization the test antenna shall be rotated by 90° around its main beam axis for reception of the co-polar component. The tests in d) to j) shall be repeated with the frequency changed to 6,420 GHz.
- m) The tests in b) to l) may be performed simultaneously.
- n) The frequency of the test signal shall be set to 6,1375 GHz.
For linear polarization the initial E-plane of the test signal radiated by the test transmitter through its antenna shall be horizontal. The EUT antenna main beam axis shall be aligned with the main beam axis of the test transmitter. The polarizer of the EUT antenna shall be rotated and adjusted such that its E-plane coincides with the E-plane of the test transmitter. Precise fine adjustment of the polarization plane shall be done by observing the cross-polar minimum. The tests in d) to m) shall be repeated for this H-plane.

The given test procedure results in four plots for every frequency and every plane which show the transmit polarization discrimination in three azimuth cuts and one elevation cut each between the angles corresponding to the -1 dB co-polar contour. Contour plots resulting from fully automated systems are also possible.

The maximum EIRP density PD is averaged over the occupied bandwidth and is calculated from the formula:

$$PD = EIRP_{\max} - 10 \log \frac{B_o}{4\ 000} \text{ dBW} / 4 \text{ kHz}$$

Where: $EIRP_{\max}$ is the maximum operating EIRP, dBW
 B_o is the occupied bandwidth in Hz

5.5 Carrier suppression

5.5.1 Test method

- a) The test arrangement for conducted measurements shall be as shown in figure 5. The test arrangement for radiated measurements shall be as shown in figure 6.
- b) The EUT shall transmit one modulated carrier continuously, or at its maximum burst rate where applicable, centred on 6,1375 GHz.
- c) The resolution bandwidth of the spectrum analyser shall be set to 3 kHz.
- d) The "transmission disabled state" shall be obtained by use of the CCMF.
- e) For conducted measurements the maximum residual carrier power density within the nominated bandwidth shall be measured and added to the antenna on-axis gain.
- f) For radiated measurements the maximum residual EIRP density within the nominated bandwidth shall be measured and recorded.

Instead of the CCMF an STE provided by the manufacturer may be used to enable the VSAT transmission to be suppressed.

5.6 Antenna pointing for transmit VSAT

5.6.1 Test method

- a) Pointing stability

As it is considered impracticable to perform the test on pointing stability no test is given.

The test methodology described in annex B (informative) may be used to show compliance with the specification for pointing stability.

- b) Pointing accuracy capability
 - 1) The EUT shall be inspected to ascertain whether fine adjustment facilities are available for the azimuth axis (coarse adjustment is usually provided by the positioning of the means of attachment).
 - 2) The adjustment facilities shall be examined to determine both the angular movement possible and the means of arresting that movement.
 - 3) The arresting facility shall be examined to determine its permanency.
 - 4) The test shall be repeated for the elevation axis.
- c) Polarization angle alignment capability
 - 1) The adjustment facilities shall be examined to determine both the angular movement possible and the means of arresting that movement.
 - 2) The arresting facility shall be examined to determine its permanency.

5.7 Control and monitoring for transmit VSAT

For the purposes of this test the EUT is defined as the indoor unit and that part of the outdoor unit up to the antenna flange.

The measurement of the EIRP spectral density shall be limited to the on-axis EIRP spectral density within either the nominated bandwidth or to a 10 MHz bandwidth centred on the carrier frequency, whichever is the greater.

5.7.1 Test arrangement

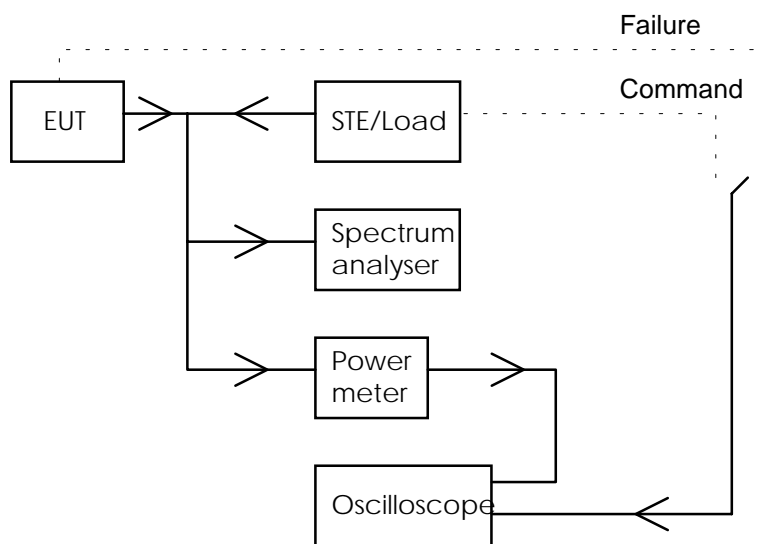


Figure 11: General test arrangement for control and monitoring tests for conducted measurements

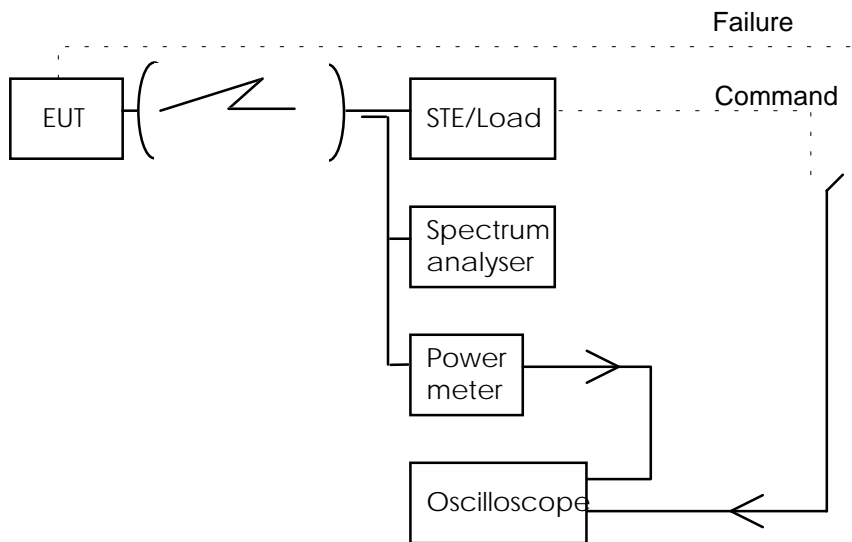


Figure 12: General test arrangement for control and monitoring tests for radiated measurements

The test arrangement shall be as shown in figures 11 or 12. The EUT shall be authorized to transmit and shall be in the carrier-on state at the commencement of each test. The dual trace storage oscilloscope shall monitor by measuring the time difference between the command, or failure, and the occurrence of the expected event (e.g. the transmission suppression). The power meter and spectrum analyser shall monitor the EUT output level.

5.7.2 Control channels

5.7.2.1 Test method

- a) The type of CC (internal or external) shall be entered in the test report.
- b) The characteristics of any external CC interface of the VSAT, including protocols, shall be recorded in the test report.
- c) Apply the test method described in subclause 5.7.2.1.1 to internal CC(s).
- d) Apply the test method described in subclause 5.7.2.1.2 to external CC(s).

5.7.2.1.1 Test method for internal CC(s)

- a) The CC receive subsystem shall be caused to fail.
- b) Recognition of this shall constitute a SMF event.
- c) Within 33 seconds of the failure the EUT shall cease to transmit as seen on the spectrum analyser.
- d) The power meter and spectrum analyser shall be observed to ascertain that the transmissions have been suppressed (transmission disabled state).
- e) The CC receive subsystem shall be restored and the EUT shall be able to transmit again after a CCE message is received from the CCMF.
- f) The unique identification code for the EUT shall be removed from the CC.
- g) Recognition of this shall constitute a SMF event.
- h) Within 63 seconds of the loss of identification code the EUT shall cease to transmit as seen on the spectrum analyser.
- j) The power meter and spectrum analyser shall be observed to ascertain that the transmissions have been suppressed (transmission disable state).
- k) The unique identification code for the EUT shall be restored and the EUT shall be able to transmit again after a CCE message is received from the CCMF.
- l) The unique identification code for the control channel(s) shall be removed from the CC.
- m) Recognition of this shall constitute a SMF event.
- n) Within 63 seconds of the loss of CC identification code the EUT shall cease to transmit as seen on the spectrum analyser.
- p) The power meter and spectrum analyser shall be observed to ascertain that the transmissions have been suppressed (transmission disabled state).
- q) The unique identification code for the CC shall be restored and the EUT shall be able to transmit again after a CCE message is received from the CCMF.

5.7.2.1.2 Test method for external CC(s)

- a) The CC shall be established.
- b) The test described in subclause 5.7.6 shall be conducted.

5.7.3 Processor monitoring

5.7.3.1 Test method

- a) Each of the processors within the EUT shall, in turn, be caused to fail.
- b) Recognition of each failure in turn by the processor monitor shall constitute a SMF event.
- c) Within 33 seconds of each failure the EUT shall cease to transmit as seen on the spectrum analyser.
- d) The power meter and spectrum analyser shall be observed to ascertain that the transmissions have been suppressed (transmission disabled state).
- e) The failed processor shall be restored to normal working condition and the EUT restored to normal working before the next processor shall be induced to fail.

5.7.4 Transmit subsystem monitoring

5.7.4.1 Test method

- a) The frequency generation shall be caused to fail in respect of:
 - 1) frequency stability;
 - 2) output.
- b) Recognition of each failure in turn by the subsystem monitor shall constitute a SMF event.
- c) Within 9 seconds of each failure the EUT shall cease to transmit as seen on the spectrum analyser.
- d) The power meter and spectrum analyser shall be observed to ascertain that the transmissions have been suppressed (transmission disabled state).
- e) The frequency generation shall be restored to normal working condition and the EUT restored to normal working before the next induced failure.

5.7.5 VSAT transmission validation

5.7.5.1 Test method for VSAT validation by the CCMF for VSAT using internal CC(s)

- a) The EUT shall be in the "in-service" state and a "poll-for-status" message shall be received from the CCMF a CC.
- b) The EUT shall immediately transmit a status message to the CCMF via an internal RC.

5.7.5.2 Test method for VSAT validation by receiving station(s) for VSAT using internal CC(s)

- a) The EUT shall be transmitting. The "transmission validation message" from the receiving station shall be suppressed.
- b) No later than 11 minutes after the suppression of the transmission validation message the EUT shall recognize a SMF event and cease to transmit as seen on the spectrum analyser.
- c) The power meter and spectrum analyser shall be observed to ascertain that the transmissions have been suppressed (transmission disabled state).

5.7.5.3 Test method for transmission validation for VSAT using external CC(s)

- a) The EUT shall be in the "in-service" state and a "poll for status" message shall be received from the CCMF via a CC.

- b) The EUT shall immediately transmit a status message to the CCMF via an internal RC, or an external RC.
- c) For external RC(s) the contents of the status message shall be verified.

5.7.6 Reception of commands from the CCMF

5.7.6.1 Test method

- a) A CCD message shall be received from the CCMF by the EUT.
- b) The EUT shall recognize this as a CCD event.
- c) Within 3 seconds of the receipt of the CCD message the EUT shall cease to transmit as seen on the spectrum analyser.
- d) The power meter and spectrum analyser shall be observed to ascertain that the transmissions have been suppressed (transmission disabled state).
- e) A CCE message shall be received from the CCMF by the EUT.
- f) The EUT shall recognize this as a CCE event.
- g) Within 3 seconds of the receipt of the CCE message the EUT shall be enabled to start transmission.

5.7.7 Power-on/Reset

5.7.7.1 Test method

- a) Remove the power supplying the EUT.
- b) Stop the CCMF from transmitting the CCE.
- c) Replace the power supplying the EUT.
- d) The EUT shall enter the out of service state, i.e. no transmission shall be observed on the spectrum analyser.
- e) The power meter and spectrum analyser shall be observed to ascertain that the transmissions have been suppressed (transmission disabled state).
- f) The system shall be restored and the EUT shall be able to transmit again after a CCE message is received from the CCMF.
- g) Reset the EUT.
- h) The EUT shall recognize this as a RE event.
- j) Within 3 seconds of the reset the EUT shall cease to transmit as seen on the spectrum analyser.
- k) The power meter and spectrum analyser shall be observed to ascertain that the transmissions have been suppressed.

6. Test methods for modified VSAT

The modifications of a VSAT may consist of the replacement of one or several of the following modules:

- 1) antenna subsystem;
- 2) High Power Amplifier (HPA);
- 3) up-converter;
- 4) Low Noise Amplifier (LNA);
- 5) down-converter;

6) Modulator/Demodulator (Modem).

The intermediate and final results of the VSAT tests before modification shall be made available by the manufacturer.

6.1 Antenna subsystem replacement

This subclause is only applicable to passive antennas.

The following measurements made on the VSAT before modification shall not be repeated.

- 5.1.1.1 Procedure for off-axis spurious radiation up to 1 000 MHz
- 5.1.1.2.1 Identification of the significant frequencies of spurious radiation
- 5.1.1.2.2 Measurement of radiated power levels of identified spurious radiation (EUT without antenna)
- 5.1.1.2.3 Measurement of conducted spurious radiation at the antenna flange
- 5.2.1.2.2 Method of measurement at the antenna flange of on-axis spurious radiation
- 5.3.1.1 Transmit output power density
- 5.5 Carrier suppression
- 5.7 Control and monitoring

The results of these measurements shall be used as those of the unmodified VSAT and entered in the computation of these subclauses.

Annex A (normative): The TBR Requirements Table (TBR-RT)

Notwithstanding the provisions of the copyright clause related to the text of this TBR, ETSI grants that users of this TBR may freely reproduce the TBR-RT proforma in this annex so that it can be used for its intended purposes and may further publish the completed TBR-RT.

Table A.1: TBR Requirements Table (TBR-RT)

| TBR Reference | | | TBR 043 | | | |
|---------------|----------|-----------|--|----------|--------|---------|
| No | Category | Reference | TBR-R | Tx or Rx | Status | Support |
| 1 | 4.3 | 4.1 | Off-axis spurious radiation | Tx Rx | M | |
| 2 | 4.3 | 4.2 | On-axis spurious radiation | Tx | M | |
| 3 | 4.3 | 4.3 | Off-axis EIRP emission density (co-polar and cross-polar) within the band 5,850 to 6,650 GHz | Tx | M | |
| 4 | 4.3 | 4.4 | Transmit polarization discrimination or axial ratio | Tx | M | |
| 5 | 4.3 | 4.5 | Carrier suppression | Tx | M | |
| 6 | 4.3 | 4.7 | Mechanical (antenna pointing) | Tx | M | |
| 7 | 4.3 | 4.8.2 | Control channels | Tx | M | |
| 8 | 4.3 | 4.8.3.1 | Processor monitoring | Tx | M | |
| 9 | 4.3 | 4.8.3.2 | Transmit subsystem monitoring | Tx | M | |
| 10 | 4.3 | 4.8.3.3 | VSAT transmission validation | Tx | M | |
| 11 | 4.3 | 4.8.4 | Reception of commands | Tx | M | |
| 12 | 4.3 | 4.8.5 | Power-on/Reset | Tx | M | |

Key to columns:

- No** TBR-RT entry number;
- Category** Category of essential requirement as per Article 4 of the SES Directive [1];
- Reference** Clause reference within this TBR of the supporting text for the entry;
- TBR-R** Title of entry within this TBR-RT;
- Tx or Rx** Transmit VSAT or receive-only VSAT;
- Status** Status of the entry (M = Mandatory, shall be implemented under all circumstances);
- Support** Does the equipment support the essential requirement of this entry; Y/N.

Annex B (informative): Pointing stability methodology

This test based on a numerical analysis shall be performed in two stages.

In the first stage the effects of maximum wind speed shall be computed on the outdoor unit using a numerical analysis method (finite elements method by computer) taking into account the intrinsic properties of the materials.

In the second stage the computed loads shall be applied to the structure.

The purpose of the numerical analysis is twofold:

- 1) to show that the torque and the fields of force applied to the outdoor unit structure under nominated conditions do not reach the breakpoint limit of any element of the structure;
- 2) to compute equivalent static loads (force and torque) applied to the critical attachment points of the structures, e.g.:
 - reflector - mounting legs fixing point;
 - reflector - struts;
 - LNB - struts.

Numerical analysis and load applications procedure:

- 1) The air related parameters, namely the kinetic viscosity used to calculate drags at the rims of the structure shall be calculated with the standard atmospheric environmental conditions (temperature = 293 K, air pressure = $1,013 \times 10^5$ Pascal).
- 2) The computations needed to derive the field of force and torque and the equivalent static stresses shall be carried out for each of the following variables:
 - elevation angle: maximum and minimum;
 - wind direction: in steps of 45° around the outdoor unit;
 - wind speed: 180 km/h.
- 3) It shall be verified with the simulated results that break point limits are not exceeded for any self-contained element.
- 4) The calculated equivalent static loads shall be applied at any identified critical fixing point of the assembly.
- 5) Whilst the loads are applied the outdoor unit shall be observed and any distortion noted.
- 6) The test report shall contain the following information:
 - the computation method used;
 - description of the test equipment;
 - description of the tests performed;
 - results of the safety margin test;
 - any signs of distortion observed;
 - results of the measurements of the deviation of the antenna position;
 - component deviation with respect to each other.

Annex C (informative): Bibliography

- ETS 300 332 (June 1996): "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) 6 GHz and 4 GHz frequency bands".
- ETS 300 333 (June 1996): "Satellite Earth Stations and Systems (SES); Receive-only Very Small Aperture Terminals (VSATs) operating in the 4 GHz frequency band".
- ETS 300 160 (1996): "Satellite Earth Stations and Systems (SES); Control and monitoring functions at a Very Small Aperture Terminal (VSAT)".
- ETS 300 161 (1996): "Satellite Earth Stations and Systems (SES); Centralized control and monitoring functions for Very Small Aperture Terminal (VSAT) networks".
- 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".
- ETR 169 (1995): "Satellite Earth Stations and Systems (SES); Common Technical Regulations (CTRs) in the satellite earth station equipment field".
- EMC Directive: "Council Directive 89/336/EEC of 3 May 1989 on the approximation of the laws of Member States relating to electromagnetic compatibility".
- EN 55022 (1994): "Limits and methods of measurement of radio disturbance characteristics of information technology equipment".

History

| Document history | |
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