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Satellite Earth Stations and Systems (SES); Very Small Aperture Terminal (VSAT); Transmit-only, transmit/receive or receive-only satellite earth stations operating in the 11/12/14 GHz frequency bands

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Foreword

This draft 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), and is now submitted for Public Enquiry.

Introduction

The Council Directive in respect of satellite earth station equipment 93/97/EEC [1] which supplements the Council Directive on the approximation of the laws of the Member States concerning telecommunications terminal equipment, including the mutual recognition of their conformity 91/263/EEC [2] concerns the harmonisation of conditions for the placing on the market of such equipment.

Two classes of standards are applicable to satellite earth station equipment. European Telecommunication Standards (ETSs) give the full technical specifications for this equipment, whereas Technical Bases for Regulation (TBRs) give the essential requirements under the Satellite Earth Station Directive 93/97/EEC [1] and the Telecommunications Terminal Equipment Directive 91/263/EEC [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 300 157, ETS 300 159, ETS 300 160 and ETS 300 456 (see annex B, Bibliography).

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1 Scope

This TBR specifies those technical requirements under articles 4.1 to 4.5 of Council Directive 93/97/EEC [1] that apply to satellite earth station equipment that is capable of operation in one or more of the following frequency ranges of the Fixed Satellite Service (FSS):

- 10,70 to 11,70 GHz (Space - to - Earth, shared);
- 12,50 to 12,75 GHz (Space - to - Earth, exclusive);
- 14,00 to 14,25 GHz (Earth - to - Space, exclusive);
- 14,25 to 14,50 GHz (Earth - to - Space, shared).

These requirements are taken from:

- ETS 300 157 (see annex B, Bibliography);
- ETS 300 159 (see annex B, Bibliography);
- ETS 300 160 (see annex B, Bibliography).

This TBR does not contain the essential requirements under article 4.6 for interworking via the public telecommunications network in justified cases, and does not provide any guarantee of correct interworking between satellite earth station equipment.

This TBR specifies the requirements for satellite earth station equipment that:

- is capable of being used either for transmission only, or for transmission and reception (transmit-receive), or for reception only (receive-only), of radio-communications signals in any of the bands specified above;

- is not within the scope of other Ku-band TBRs (TVRO, SNG, LMES);

- has a diameter of 3,8 m or less;

- is not purpose built satellite earth station equipment intended for use as part of the public telecommunications network.

This TBR applies to all satellite equipment as described above, irrespective of whether the satellite earth station equipment provides additional interfaces, telecommunications services or functions. However additional TBRs may also apply.

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] Council Directive 93/97/EEC (1993) supplementing Directive 91/263/EEC in respect of satellite earth station equipment.

[2] 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] prETS 300 673 (1996): "Radio Equipment and Systems (RES); Electromagnetic Compatibility 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 Stations (TES) equipment".

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 B, 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 a VSAT is considered as ancillary if the three following conditions are met:

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

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

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

carrier-off state: A VSAT is in this state when it is authorised by the Centralised 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 VSATs designed for continuous transmission mode there may be no carrier-off state.

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

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

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

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

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.

integral antenna: An antenna which may not be removed during the tests according to the manufacturer’s statement.

nominated bandwidth: The bandwidth of the VSAT radio frequency transmission is nominated by the manufacturer. The nominated bandwidth is wide enough to encompass all spectral elements of the transmission which have a level greater than the specified spurious radiation limits. The nominated bandwidth is wide enough to take account of the transmit carrier frequency stability. The nominated bandwidth is within the transmit frequency band within which the VSAT operates.

NOTE 2: This definition is chosen to allow flexibility regarding adjacent channel interference levels which will be taken into account by operational procedures depending on the exact transponder carrier assignment situation.

occupied bandwidth: As defined in RR 147 of the ITU Radio Regulations.

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 upconverter 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.

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.

removable antenna: An antenna which may be removed during the tests according to the manufacturer's statement.

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

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	Centralised Control and Monitoring Functions
CV	Control Variable
EIRP	Equivalent Isotropically Radiated Power
EMC	ElectroMagnetic Compatibility
ETS	European Telecommunication Standard
EUT	Equipment Under Test
FSS	Fixed Satellite Service
ITU	International Telecommunications Union
LMES	Land Mobile Earth Station
LNB	Low Noise Block
RE	Reset Event
RF	Radio Frequency
RR	ITU Radio Regulations
SMF	Status Monitoring Fail
SMP	Status Monitoring Pass
SMV	Self Monitoring Variable
SNG	Satellite News Gathering
TBR	Technical Basis for Regulation
TES	Transportable Earth Station
TVRO	TeleVision Receive Only
VSAT	Very Small Aperture Terminal

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

This specification applies outside the nominated bandwidth.

1) The VSAT shall not exceed the limits for radiated interference field strength over the frequency range from 30 MHz to 960 MHz specified in table 1.

Table 1: Spurious radiation limits below 960 MHz

Frequency range MHz	Quasi-peak limits dBµV/m
30 to 230	30
230 to 960	37

The lower limits shall apply at the transition frequency.

2) When the VSAT is in the transmissions disabled state, the off-axis spurious Equivalent Isotropically Radiated Power (EIRP) from the VSAT, in any 100 kHz band, shall not exceed the limits in table 2, for all off-axis angles greater than 7°:

Table 2: Limits of spurious EIRP - transmission disable state

Frequency band	EIRP limit (dBpW)
960,0 MHz to 10,7 GHz	48
10,7 GHz to 21,2 GHz	54
21,2 GHz to 40,0 GHz	60

The lower limits shall apply at the transition frequency.

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

Table 3: Limits of spurious EIRP - other states

Frequency band	EIRP limit (dBpW)
960,0 MHz to 3,4 GHz	49
3,4 GHz to 10,7 GHz	55
10,7 GHz to 14,0 GHz	61
14,25 GHz to 21,2 GHz	61
21,2 GHz to 40,0 GHz	67

The lower limits shall apply at the transition frequency.

In the frequency bands 13,6 to 14,00 GHz and 14,25 to 14,9 GHz, for any 20 MHz band within which one or more spurious signals exceed the above limit of 61 dBpW are present, then the power of each of those spurious signals exceeding the limit shall be added in watts, and the sum shall not exceed 78 dBpW.

In the frequency band 28,0 to 29,0 GHz, for any 20 MHz band within which one or more spurious signals exceeding the above limit of 67 dBpW are present, then the power of each of those spurious signals exceeding the limit shall be added in watts, and the sum shall not exceed 78 dBpW.

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 satisfy the limits for radiated interference field strength specified in table 4 over the frequency range from 30 MHz to 960 MHz.

Table 4: Spurious radiation limits below 960 MHz

Frequency range MHz	Quasi-peak limits dBµV/m
30 to 230	30
230 to 960	37

The lower limits shall apply at the transition frequency.

2) The off-axis spurious Equivalent Isotropically Radiated Power (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	EIRP limit (dBpW)
960,0 MHz to 10,7 GHz	48
10,7 GHz to 21,2 GHz	54
21,2 GHz to 40,0 GHz	60

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 tests

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

4.2 On-axis spurious radiation for transmit VSATs

4.2.1 Justification

To limit the level of interference to satellite radio services.

4.2.2 Specification

4.2.2.1 Carrier-on state

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

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

NOTE 1: The on-axis spurious radiations, outside the 14,0 GHz to 14,5 GHz band, are indirectly limited by subclause 4.1.2.1. Consequently no specification is needed.

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

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

4.2.2.2 Carrier-off state and transmission disabled state

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

4.2.3 Conformance tests

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

4.3 Off-axis EIRP emission density within the band

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

4.3.1 Justification

Protection of other satellite (uplink) systems.

4.3.2 Specification

The maximum EIRP in any 40 kHz band within the nominated bandwidth of the co-polarised component in any direction ϕ degrees from the antenna main beam axis shall not exceed the following limits:

$33 - 25 \log \phi - 10 \log N$	dBW	for	2,5°	≤	ϕ	≤ 7,0°;
$+12 - 10 \log N$	dBW	for	7,0°	<	ϕ	≤ 9,2°;
$36 - 25 \log \phi - 10 \log N$	dBW	for	9,2°	<	ϕ	≤ 48°;
$-6 - 10 \log N$	dBW	for	ϕ	>	48°.	

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

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

For antennas designed for minimum off-axis gain in the direction of the geostationary orbit, the specification for ϕ between 2,5° and 20° need only be met within ± 3° of a plane bisected by the main beam axis. This plane shall be marked and identified on the antenna 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°. The antenna shall be capable of having the above plane aligned with the geostationary orbit plane.

In addition the maximum EIRP in any 40 kHz band within the nominated bandwidth of the cross-polarised component in any direction ϕ degrees from the antenna main beam axis shall not exceed the following limits:

$23 - 25 \log \phi - 10 \log N$	dBW	for	2,5°	≤	ϕ	≤ 7,0°;
$+2 - 10 \log N$	dBW	for	7,0°	<	ϕ	≤ 9,2°.

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

4.3.3 Conformance tests

Conformance tests 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 Transmitter polarisation discrimination

4.4.1 Justification

Protection of signals on the orthogonal polarisation.

4.4.2 Specification

4.4.2.1 -1 dB contour

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

NOTE: Some satellite operators may require a higher ratio.

4.4.2.2 -10 dB contour

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

NOTE: Some satellite operators may require a higher ratio.

4.4.3 Conformance tests

Conformance tests 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 CCMF.

4.5.2 Specification

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

4.5.3 Conformance tests

Conformance tests 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 VSATs.

4.7 Mechanical (antenna pointing) for transmit VSATs

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 s, the installation shall not show any sign of permanent distortion and shall not need repointing after the application of the wind load.

b) Pointing accuracy capability:
the antenna mount shall allow the position of the antenna transmit main beam axis to be maintained with an accuracy better 0,3° along the geostationary orbit.

c) Polarisation angle alignment capability:
the polarisation angle shall be continuously adjustable in a range of at least 180°;
it shall be possible to fix the transmit antenna polarisation angle with an accuracy of at least 1°.

4.7.3 Conformance tests

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

4.8 Control and monitoring for transmit VSATs

4.8.1 General

The following minimum set of control and monitoring functions shall be implemented in VSATs 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 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 control and monitoring functions:

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 which shall be called 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 VSATs shall achieve a controlled non-transmitting state following the activation of the terminal (power-on).

VSATs 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 REs.

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:

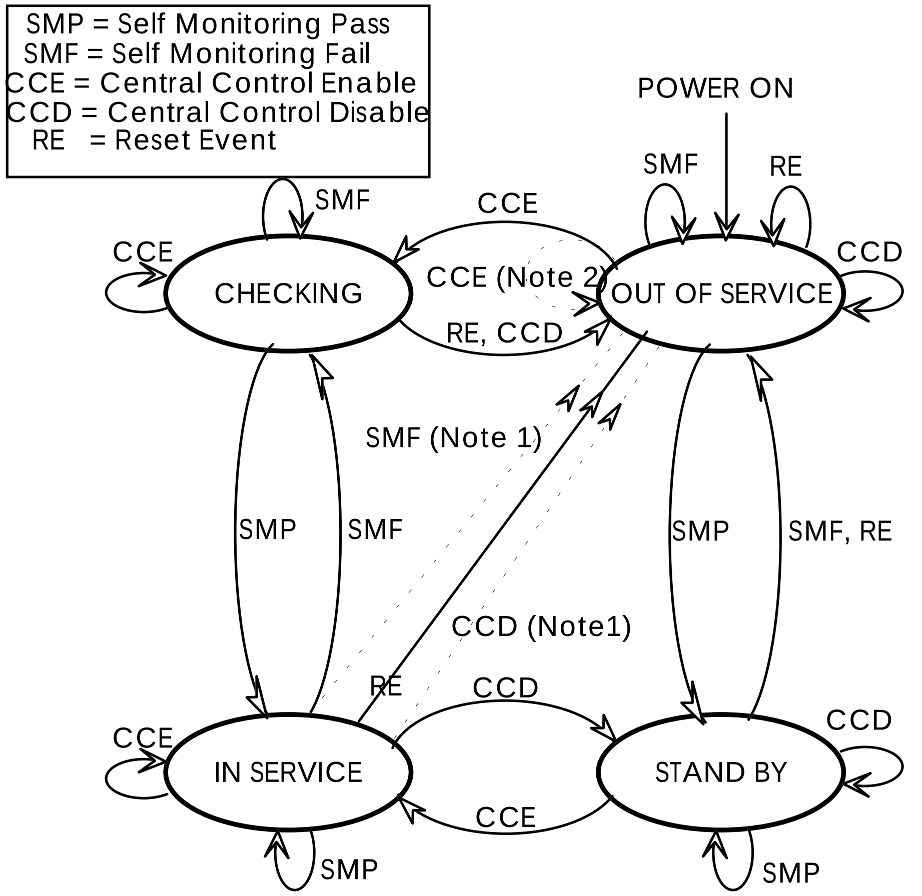
- out-of-service;
- checking;
- stand-by;
- in-service.

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 the 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. The events then apply to the subsystem associated with the specific carrier, 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 CCE event may be ignored.

NOTE 3: To get out of 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.

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

This subclause specifies the functions that the VSAT shall monitor in order to verify that all its subsystems are operating correctly.

These are:

- 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.

4.8.1.2 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.

When the VSAT is not allowed to transmit, it is in a transmission disabled state and the levels of the inband and spurious radiation shall be as specified in subclauses 4.1, 4.2 and 4.5 for transmission disable state.

4.8.2 Control channels

4.8.2.1 Justification

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

4.8.2.2 Specification

a) Specification 1:

The VSAT shall have CC(s) with the CCMF. The CC(s) shall be either internal to the VSAT network (via the same satellite and within the internal protocol structure of the system), or external to it (e.g. via the same or another satellite system, via the PSTN, etc.).

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 shall result in a SMF event, and the corresponding change of state shall occur within 33 seconds from 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 authorised 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 authorised control identification code shall result in a SMF event, and the corresponding change of state shall occur within 63 seconds of the failure.

The VSAT shall be capable of receiving, via any authorised 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 tests

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

4.8.3 Self monitoring functions

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 shall result in an SMF event, and the corresponding change of state shall occur within 33 seconds after the fault occurrence.

4.8.3.1.3 Conformance tests

Conformance tests shall be carried out in accordance with subclause 5.7.

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.

The failure of the transmit frequency generation subsystem for a period longer than 5 seconds shall result in a SMF event, and the corresponding change of state shall occur within 3 seconds after that event.

4.8.3.2.3 Conformance tests

Conformance tests shall be carried out in accordance with subclause 5.7.

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 VSATs 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 verify the ability of the CCMF to validate the correct operation of a transmitting VSAT by requesting it 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 thereafter without further stimuli from the CCMF.

4.8.3.3.1.3 Conformance tests

Conformance tests shall be carried out in accordance with subclause 5.7.

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 1 "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 within 11 minutes from receipt of the last "transmission validation message".

4.8.3.3.2.3 Conformance tests

Conformance tests shall be carried out in accordance with subclause 5.7.

4.8.3.3.3 Transmission validation for VSATs 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 messages" via the CC(s) the VSAT shall respond with a "status message".

4.8.3.3.3.3 Conformance tests

Conformance tests shall be carried out in accordance with subclause 5.7.

4.8.4 Reception of commands from the CCMF

This subclause specifies the conditions the VSAT shall satisfy to consider that it is authorised 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 tests

Conformance tests shall be carried out in accordance with subclause 5.7.

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 tests

Conformance tests shall be carried out in accordance with subclause 5.7.

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.

4.8.5.3 Conformance tests

Conformance tests shall be carried out in accordance with subclause 5.7.

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 table 6.

Table 6: Measurement uncertainty

Measurement parameter	Uncertainty
RF frequency	± 10 kHz
RF power	± 0,75 dB
Conducted spurious	± 4 dB
Radiated spurious	± 4 dB
Antenna gain	± 2 dB
Polarisation discrimination	± 2 dB

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.

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

5.1 Off-axis spurious radiation

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

5.1.1 Test method

A EUT with antenna is a VSAT with its antenna. It comprises both the indoor and outdoor units interconnected by 10 m of cable. A 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.

For frequencies between 80 MHz and 960 MHz the measuring antenna shall be a balanced dipole which shall be resonant in length. For frequencies below 80 MHz it shall have a length equal to the 80 MHz resonant length and shall be tuned and matched to the feeder by a suitable transforming device. For frequencies above 960 MHz 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 polarisation and at the specified height.

5.1.1.1 Below 960 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 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.

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.

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 EUT without antenna and the antenna flange shall be terminated by a dummy load.

b) The EUT shall be in the carrier-on state.

c) The EUT shall be rotated through 360° and the measuring antenna height simultaneously varied from 1 m to 4 m above the ground plane.

d) All spurious radiations shall be measured and noted in frequency and level.

5.1.1.2 Above 960 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:

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 though 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 opposite polarisation.

f) The test shall be repeated, for transmit capable equipment, in the carrier-on state whilst transmitting a modulated carrier at maximum power.

5.1.1.3 Measurement of radiated power levels of identified spurious radiation

5.1.1.3.1 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.

5.1.1.3.2 Procedure

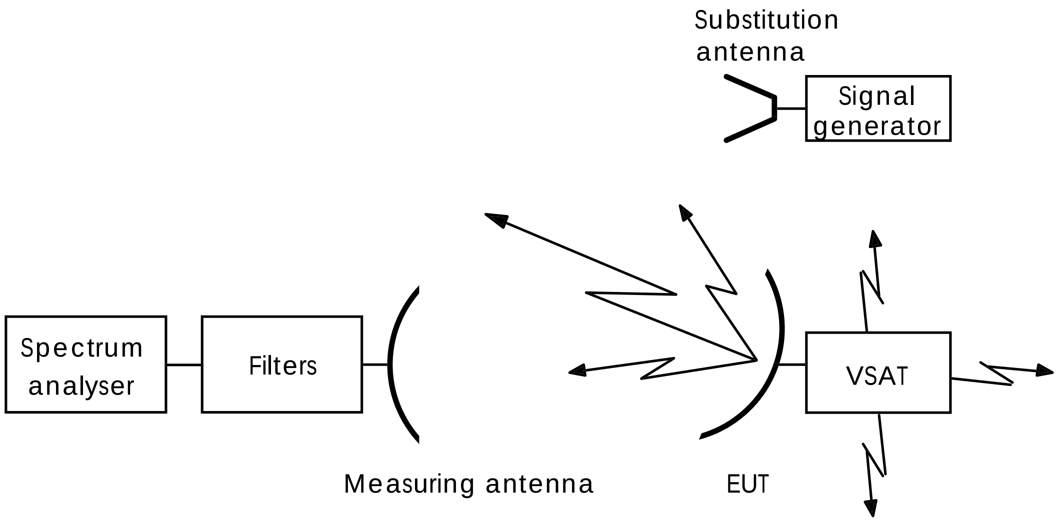


Figure 2: Test arrangement - Spurious radiation measurement above the cut-off frequency, for an EUT with antenna

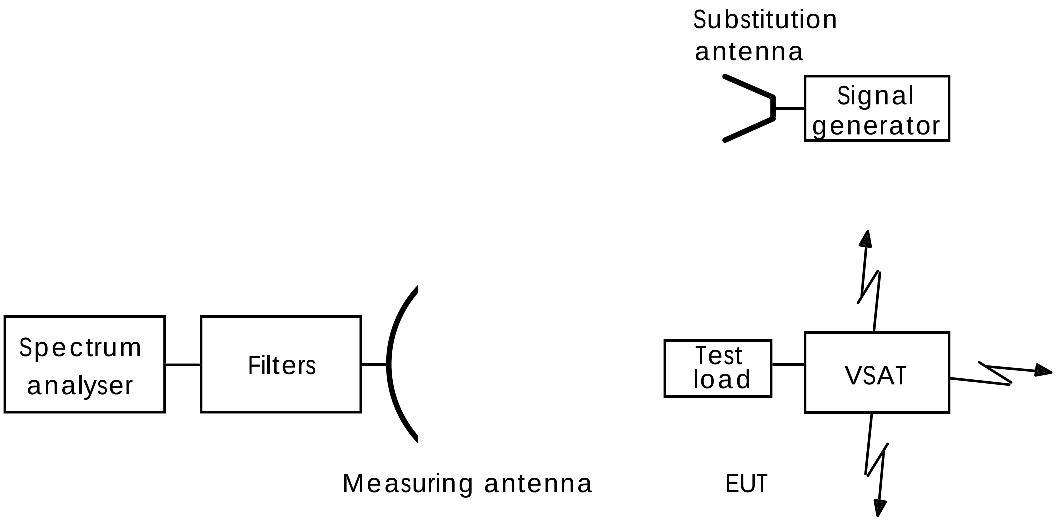


Figure 3: Test arrangement - spurious radiation measurements above the cut-off frequency, for an EUT without antenna

a) The test arrangement shall be as shown in figure 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 maintained 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 of 10 m from the EUT. 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 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 opposite polarisation 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 and the distance between them shall be 10 m.

f) The substitution and measuring antennas shall be aligned in the polarisation which produced the larger response between the EUT and the test antenna.

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.

5.1.1.4 Measurement of conducted spurious radiation at the antenna flange

5.1.1.4.1 Test site

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

5.1.1.4.2 Procedure

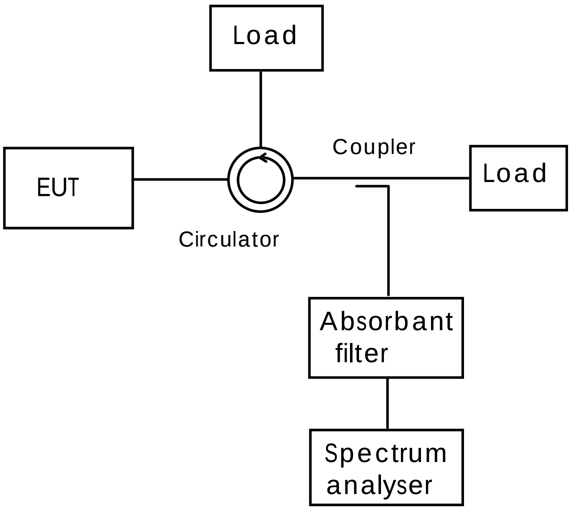


Figure 4: Test arrangement - conducted spurious radiation

a) The test arrangement shall be as shown in figure 4 with the absorbent filter tuned to 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, excluding intermodulation products 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 for off-axis angles greater than 7°, or its worst case assumed (i.e. 8 dBi for off-axis angles greater than 7°), shall be added to any figure obtained in the above measurement and any correction or calibration factors summated with the result.

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

5.2 On-axis spurious radiation

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

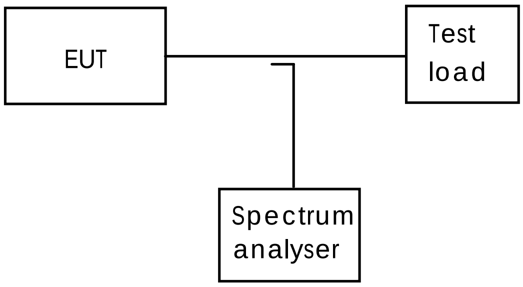


Figure 5: Test arrangement - on-axis spurious radiation measurements at the antenna flange

a) The EUT shall be connected to a test load as shown in figure 5.

b) The EUT shall transmit 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 14,00 GHz to 14,50 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 performed for noise-like wideband spurious radiation.

d) To obtain the on-axis spurious power level that would be transmitted, the antenna isotropic transmit gain shall be added to any figure obtained in the above measurement and any correction or calibration factor summated with the result.

e) The antenna gain shall be as measured in subclause 5.3.1.2.

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 condition but additionally noting any signals within the nominated bandwidth for use in the test described in subclause 5.5.

5.2.1.2.3 Method of measurement with a test antenna

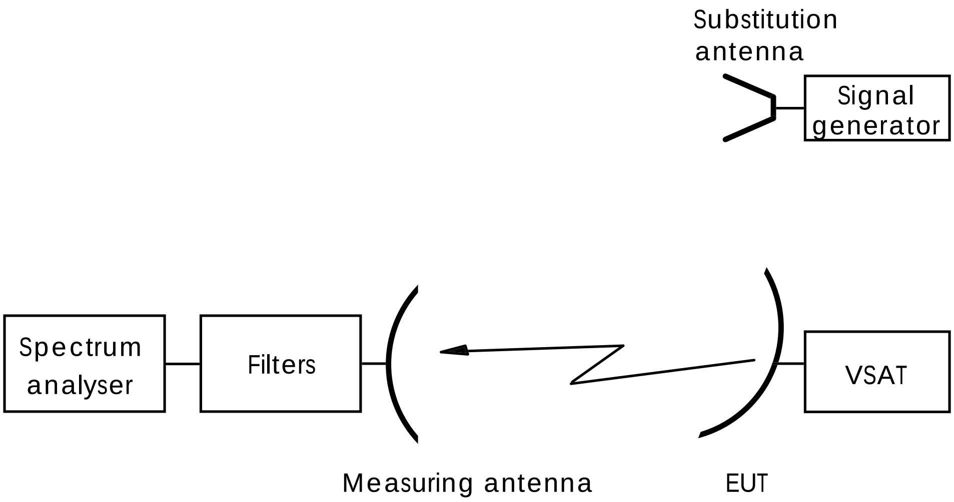


Figure 6: Test arrangement - on-axis spurious radiation measurements with a measuring antenna

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 maintained by non-metallic means at a height between 0,5 m and 1,0 m. The elevation angle shall be 7°.

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 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 14,00 GHz to 14,50 GHz shall be investigated.

e) The measuring antenna shall be positioned at a distance of 10 m from the EUT. The measuring antenna shall be adjusted in height and polarisation and the EUT rotated for a maximum response on the associated spectrum analyser at each spurious frequency previously identified. This response level shall be noted. The measuring antenna shall never enter the 7° off-axis cone around the main beam direction.

f) 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 and the distance between the antennas shall be 10 m.

g) The substitution and measuring antennas shall be aligned in the polarisation which produced the larger response between the EUT and the test antenna.

h) The output of the generator shall be adjusted so that the received level is identical to that of the previously noted largest spurious radiation.

j) 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.

k) The tests in d) to j) shall be repeated with a transmit frequency as close to the upper limit of the operating frequency band of the EUT as possible.

l) The test shall be repeated in the carrier-off condition but additionally noting any signals within the nominated bandwidth for use in the test described in subclause 5.6.

5.3 Off-axis EIRP emission density within the band

Off-axis EIRP emission density (co-polar and cross-polar) within the band 14,0 GHz to 14,5 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/40 kHz);
b) antenna transmit gain (dBi);
c) antenna transmit radiation patterns (dBi).

5.3.1.1 Transmitter output power density

For the purposes of this ETS, transmitter 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

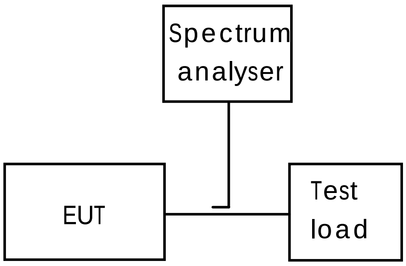


Figure 7: Test arrangement - transmit output power density measurement

a) The EUT shall be connected to a test load 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/40 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 ETS, the antenna transmit gain is defined as the ratio, expressed in decibels (dB), 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 parabolic reflector, 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.

5.3.1.2.3 Method of measurement

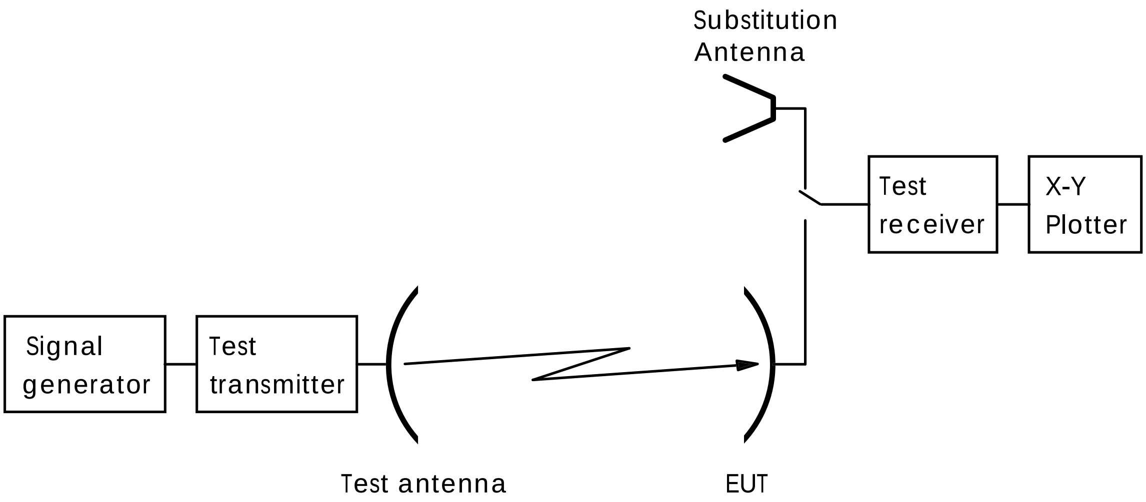


Figure 8: Test arrangement - antenna transmit gain measurement

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 14,005 GHz shall be transmitted in the E-plane by the test transmitter through the test antenna. The E-plane shall be vertical.

c) The EUT shall be aligned to maximise 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 maximised.

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 b) to j) shall be repeated with the frequency changed to 14,250 GHz.

l) The tests in b) to j) shall be repeated with the frequency changed to 14,495 GHz.

m) The tests in b) to l) may be performed simultaneously.

n) The tests in b) to m) shall be repeated with the test signal being transmitted in the H-plane instead of the E-plane.

p) The tests in b) to m) shall be repeated with the test signal being transmitted in a plane at +45° to the H-plane.

q) The tests in b) to m) shall be repeated with the test signal being transmitted in a plane at -45° to the H-plane.

5.3.1.3 Antenna transmit radiation patterns

5.3.1.3.1 General

For the purposes of this ETS, 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 parabolic reflector, 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.

5.3.1.3.3 Method of measurement

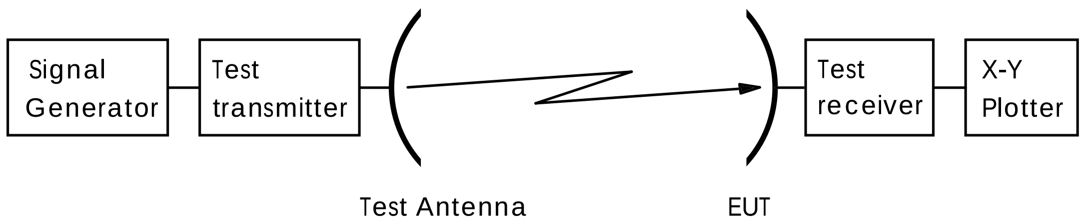


Figure 9: Test arrangement - antenna transmit radiation pattern measurement

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) A test signal at 14,005 GHz shall be transmitted in the E-plane by the test transmitter through the test antenna. The E-plane shall be vertical.

c) The EUT shall be aligned to maximise 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 through 180°.

e) The transmit pattern measurement is then obtained by driving the EUT in azimuth through 360° with the plotter recording the results.

f) The tests in b) to e) shall be repeated with the frequency changed to 14,250 GHz.

g) The tests in b) to e) shall be repeated with the frequency changed to 14,495 GHz.

h) The tests in b) to g) may be performed simultaneously.

j) The tests in b) to h) shall be repeated with the test signal being transmitted in the H-plane instead of the E-plane.

k) The tests in b) to h) shall be repeated with the test signal being transmitted in a plane at +45° to the H-plane.

l) The tests in b) to h) shall be repeated with the test signal being transmitted in a plane at -45° to the H-plane.

m) The tests in b) to l) shall be repeated between the angles of 2,5° and 9,2° either with the EUT rotated through 90°, or the test antenna or the polarisation subsystem of the EUT rotated by 90° to give the cross-polar measurement.

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 plot 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 Transmitter polarisation discrimination

5.4.1 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.

5.4.1.1 Method of measurement

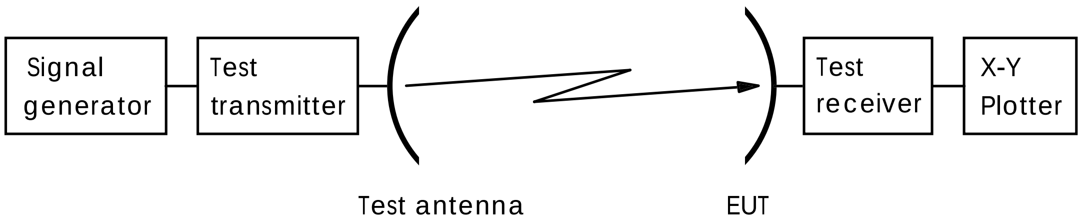


Figure 10: Test arrangement - transmit polarisation discrimination

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) A test signal at 14,005 GHz shall be transmitted in the E-plane by the test transmitter through the test antenna in the E-plane. The E-plane shall be vertical.

c) The EUT shall be aligned so that maximum deflection is obtained on the X-Y plotter.

d) This deflection shall be adjusted to the maximum reading on the chart.

e) The EUT shall be driven in azimuth until the level has dropped by 10 dB.

f) The EUT shall then be driven in azimuth through boresight to a corresponding offset on the other side with the X-Y plotter recording the level.

g) The EUT shall be returned to boresight.

h) The test antenna shall be aligned with the on-axis cross-polar component of the EUT.

j) The test shall be repeated between the same two angles used for the co-polar trace.

k) The plot obtained should show both co-polar and cross-polar traces.

l) The minimum transmit polarisation discrimination is the difference between the peak co-polar gain and the peak cross-polar gain between the points on the co-polar plot as stated in subclause 4.3.

m) The tests in b) and d) to l) shall be repeated with the frequency changed to 14,250 GHz.

n) The tests in b) and d) to l) shall be repeated with the frequency changed to 14,495 GHz.

p) The tests in b) to n) shall be repeated with the test signal being transmitted in the H-plane instead of the E-plane.

q) The tests in b) to n) shall be repeated with the test signal being transmitted in a plane at + 45° to the H-plane.

r) The tests in b) to n) shall be repeated with the test signal being transmitted in a plane at - 45° to the H-plane.

5.5 Carrier suppression

5.5.1 Test method

This test shall be carried out in conjunction with that for on-axis spurious radiation described in subclause 5.2.

The carrier-off state, referred to in subclauses 5.2.1.2.2 f) and 5.2.1.2.3 j), shall be obtained by use of CCMF and, if necessary, the manufacturer shall supply specialised test equipment to enable the VSAT transmission to be suppressed by the CCMF.

5.6 Mechanical (antenna pointing)

5.6.1 Test method

a) Pointing stability:

This test shall be performed by numerical analysis which 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 fields of force and torque 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 kinematic 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 x 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.

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) Polarisation 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

If the EUT is a VSAT that has been modified by the manufacturer for these tests then full wiring diagrams showing documentation of such modification(s) shall be provided to prove that the modification(s) will simulate the required test condition.

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

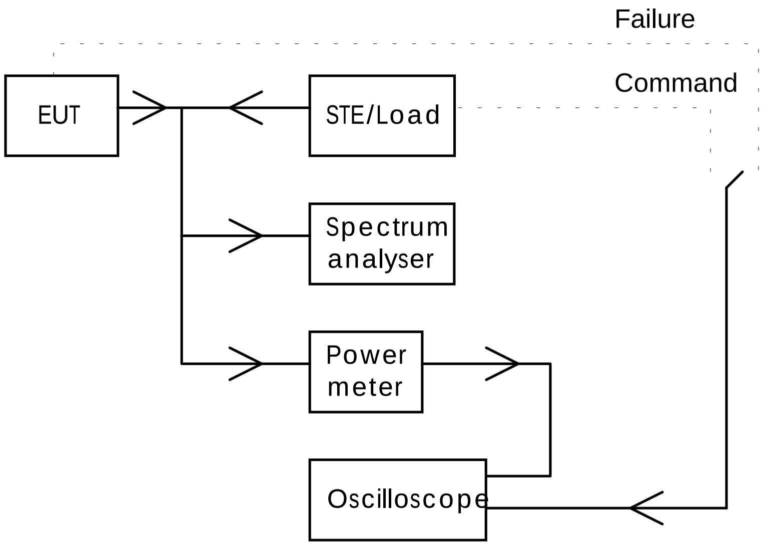


Figure 11: General test arrangement for control and monitoring tests for conducted measurements

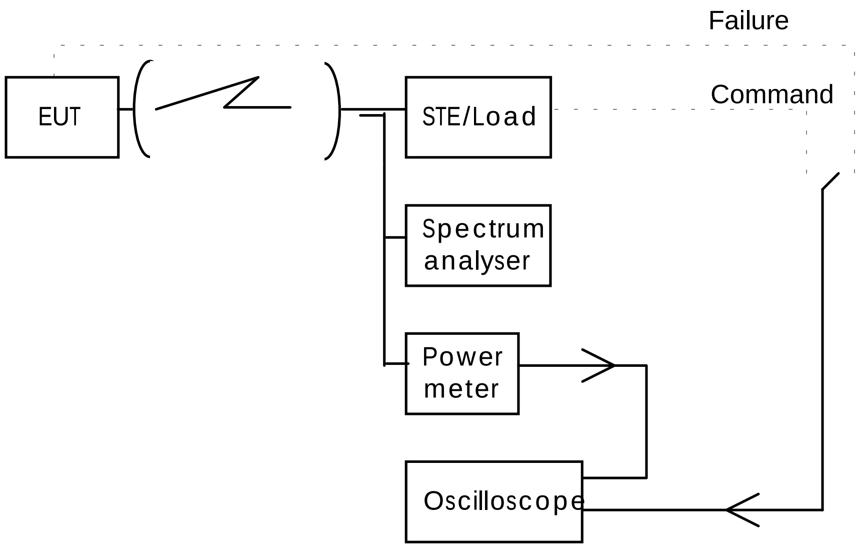


Figure 12: General test arrangement for control and monitoring tests for radiated measurements

The test arrangement shall be as shown in figure 11 or 12. The EUT shall be authorised 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 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.

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 64 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.

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.

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.

r) The type of CC (internal or external) shall be entered in the test report.

s) The characteristics of any external CC interface of the VSAT, including protocols, shall be recorded in the test report.

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.

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 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.

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

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

b) The EUT shall immediately transmit a status message to the CCMF.

c) The EUT shall transmit a message. The transmission validation message from the receiving station shall be suppressed.

d) The EUT shall recognise a SMF event.

e) Within 11 minutes of suppression of the validation message the EUT shall cease to transmit as seen on the spectrum analyser.

f) The power meter and spectrum analyser shall be observed to ascertain that the transmissions have been suppressed.

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 recognise 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.

e) A CCE message shall be received from the CCMF by the EUT.

f) The EUT shall recognise 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.

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 recognise this as an 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.

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

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

TBR Reference			TBR 028			
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 14,0 to 14,5 GHz band	Tx	M	
4	4.3	4.4	Transmit polarisation discrimination	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 Satellite Equipment 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): Bibliography

- prETS 300 157 Edition 2 (1996): "Satellite Earth Stations and Systems (SES); Receive-only Very Small Aperture Terminals (VSATs) used for data distribution operating in the 11/12 GHz frequency bands".

- prETS 300 159 Edition 2 (1996): "Satellite Earth Stations and Systems (SES); Transmit/receive Very Small Aperture Terminals (VSATs) used for data communications operating in the Fixed Satellite Service (FSS) 11/12/14 GHz frequency bands".

- prETS 300 160 Edition 2 (1996): "Satellite Earth Stations (SES); Control and monitoring functions at a Very Small Aperture Terminal (VSAT)".

- prETS 300 161 Edition 2 (1996): "Satellite Earth Stations (SES); Centralised control and monitoring functions for VSAT networks".

- ETS 300 456 (1995): "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".

- Council Directive 89/336/EEC (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			
August 1996	Public Enquiry	PE 111:	1996-08-05 to 1996-11-29