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HARMONISED EUROPEAN STANDARD

Satellite Earth Stations and Systems (SES);
Harmonised Standard for Satellite Interactive Terminals (SIT) and Satellite User Terminals (SUT) transmitting towards satellites in geostationary orbit, operating in the 29,5 GHz to 30,0 GHz frequency bands covering the essential requirements of article 3.2 of the Directive 2014/53/EU

Reference

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Foreword

This Harmonised European Standard (EN) has been produced by ETSI Technical Committee Satellite Earth Stations and Systems (SES).

The present document has been prepared under the Commission's standardisation request C(2015) 5376 final [i.4] to provide one voluntary means of conforming to the essential requirements of Directive 2014/53/EU on the harmonisation of the laws of the Member States relating to the making available on the market of radio equipment and repealing Directive 1999/5/EC [4].

Once the present document is cited in the Official Journal of the European Union under that Directive, compliance with the normative clauses of the present document given in table A.1 confers, within the limits of the scope of the present document, a presumption of conformity with the corresponding essential requirements of that Directive, and associated EFTA regulations.

National transposition dates	
Date of adoption of this EN:	16 May 2016
Date of latest announcement of this EN (doa):	31 August 2016
Date of latest publication of new National Standard or endorsement of this EN (dop/e):	28 February 2017
Date of withdrawal of any conflicting National Standard (dow):	28 February 2018

Modal verbs terminology

In the present document "**shall**", "**shall not**", "**should**", "**should not**", "**may**", "**need not**", "**will**", "**will not**", "**can**" and "**cannot**" are to be interpreted as described in clause 3.2 of the ETSI Drafting Rules (Verbal forms for the expression of provisions).

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Introduction

The present document is part of a set of standards developed by ETSI and is designed to fit in a modular structure to cover all radio equipment within the scope of the Directive 2014/53/EU [4]. The modular structure is shown in ETSI EG 201 399 [i.1].

Remarks on the present document

The present document applies to Satellite Interactive Terminals (SITs) and Satellite User Terminals (SUTs) either for individual or collective use.

The present document deals with the specification defined to protect other users of the frequency spectrum, both satellite and terrestrial, from harmful interference.

The determination of the parameters of the user earth stations using a given geostationary satellite for the protection of the spectrum allocated to that satellite, is considered to be under the responsibility of the satellite operator or the satellite network operators.

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.

The present document 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 the source of interference, or the interfered part or both.

The present document does not contain any requirement, recommendation or information about the installation of SITs and SUTs.

1 Scope

The present document applies to Satellite Interactive Terminals (SIT) and Satellite User Terminals (SUT) operating as part of a bi-directional satellite network. Satellite Terminal (ST) is used in the present document as a generic name that refers equally to a SIT and/or a SUT.

In such a network a Network Control Facility (NCF) is responsible for the monitoring and control of the transmit functions of the STs. These STs have the following characteristics:

- in the case of SITs reception is in the Fixed Satellite Service (FSS) frequency ranges from 10,70 GHz to 11,70 GHz and from 12,50 GHz to 12,75 GHz, as well as the Broadcast Satellite Service (BSS) frequency range from 11,70 GHz to 12,50 GHz;

- in the case of SUTs reception is in the Fixed Satellite Service (FSS) frequency ranges from 19,70 GHz to 20,20 GHz and from 17,70 GHz to 19,70 GHz, as well as the Broadcast Satellite Service (BSS) frequency range from 21,40 GHz to 22,00 GHz;

- in all cases ST transmission is in the frequency band allocated to FSS on a primary basis from 29,5 GHz to 30,0 GHz;

- STs transmit towards geostationary satellites with spacing down to 2° away from any other geostationary satellite operating in the same frequency band and covering the same area;

- linear or circular polarization is used for transmission or reception;

- the received signals may be analogue and/or digital;

- the transmitted signals are always of digital nature;

- the ST antenna diameter does not exceed 1,8 m, or equivalent effective area;

- the ST is designed for unattended operations.

The equipment considered in the present document comprises both the outdoor unit, usually composed of the antenna subsystem and associated upconverter, power amplifier and Low Noise Block (LNB) downconverter, and the indoor unit, usually composed of receive and transmit logic as well as the modulator, including cables between these two units.

The present document applies to the ST with its ancillary equipment and its various ports and when operated within the boundary limits of all the operational environmental profile declared by the applicant and when installed as required by the applicant by declaration or in the user documentation.

All parts of the indoor unit related to reception, processing and presentation of the received information except the control channel are not within the scope of the present document. The syntax of the control channel messages is outside the scope of the present document.

The present document is intended to cover the provisions of Directive 2014/53/EU [4] (RE Directive) article 3.2, which states that "... *radio equipment shall be so constructed that it both effectively uses and supports the efficient use of radio spectrum in order to avoid harmful interference*".

In addition to the present document, other ENs that specify technical requirements in respect of essential requirements under other parts of article 3 of the RE Directive [4] may apply to equipment within the scope of the present document.

NOTE: A list of such ENs is included on the web site http://www.newapproach.org/.

2 References

2.1 Normative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

Referenced documents which are not found to be publicly available in the expected location might be found at http://docbox.etsi.org/Reference.

NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long term validity.

The following referenced documents are necessary for the application of the present document.

[1] Void.

[2] Void.

[3] CISPR 16-1-4:2010+AMD1:2012 CSV: "Specification for radio disturbance and immunity measuring apparatus and methods - Part 1-4: Radio disturbance and immunity measuring apparatus - Antennas and test sites for radiated disturbance measurements".

[4] Directive 2014/53/EU of the European Parliament and of the Council of 16 April 2014 on the harmonisation of the laws of the Member States relating to the making available on the market of radio equipment and repealing Directive 1999/5/EC (RE Directive).

2.2 Informative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long term validity.

The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

[i.1] ETSI EG 201 399 (V2.1.1): "Electromagnetic compatibility and Radio spectrum Matters (ERM); A guide to the production of Harmonized Standards for application under the Radio & Telecommunication Terminal Equipment Directive 1999/5/EC (R&TTE) and a first guide on the impact of the Radio Equipment Directive 2014/53/EU (RED) on Harmonized Standards".

[i.2] ETSI TR 102 215 (V1.3.1): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Recommended approach, and possible limits for measurement uncertainty for the measurement of radiated electromagnetic fields above 1 GHz".

[i.3] ETSI TR 102 375 (V1.1.1): "Satellite Earth Stations and Systems (SES); Guidelines for determining the parts of satellite earth station antenna radiation patterns concerned by the geostationary satellite orbit protection".

[i.4] Commission Implementing Decision C(2015) 5376 final of 4.8.2015 on a standardisation request to the European Committee for Electrotechnical Standardisation and to the European Telecommunications Standards Institute as regards radio equipment in support of Directive 2014/53/EU of the European Parliament and of the Council.

3 Definitions, symbols and abbreviations

3.1 Definitions

For the purposes of the present document, the terms and definitions given in the Directive 2014/53/EU [4] and the following apply:

ancillary equipment: equipment used in connection with an ST is considered as ancillary if the three following conditions are met:

a) the equipment is intended for use in conjunction with the ST to provide additional operational and/or control features; and

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

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

applicant: manufacturer or his authorized representative within the European Community or the person responsible for placing the apparatus on the market

"carrier-off" radio state: radio state in which the ST may transmit and does not transmit any carrier

NOTE 1:   The expression "the ST may transmit" means that all the conditions for transmission are satisfied (e.g. in a state where transmissions are permitted and no failure detected).

NOTE 2:   The existence of a "Carrier-off" radio state depends on the system of transmission used. For STs designed for continuous transmission mode there may be no "Carrier-off" radio state.

"carrier-on" radio state: radio state in which the ST may transmit and effectively transmits a carrier

Control Channel (CC): channel or channels by which STs receive control information from the NCF for their network

NOTE: Typically the CC(s) is/are carried via the same or collocated satellite as used for transmission of user data and within the internal protocol structure of the broadcast system.

$EIRP_{max}$: maximum e.i.r.p. capability of the ST as declared by the applicant

$EIRP_{nom}$: nominal e.i.r.p. which is either:

a)   when uplink power control is not implemented, equal to $EIRP_{max}$; or

b)   when uplink power control is implemented, equal to the maximum required e.i.r.p. of the ST under clear sky condition as declared by the applicant.

NOTE: The applicant may declare different values of $EIRP_{max}$ and $EIRP_{nom}$ for each combination of occupied bandwidth and transmission parameters (see clause 4.2.1).

emissions disabled radio state: radio state in which the ST is not transmitting a carrier

NOTE: This radio state only applies in certain CMF states as defined in clause 4.1.2 (e.g. before System Monitoring Pass (SMP), before the control channel is received, when a failure is detected, when the ST is commanded to disable). The "Emissions disabled" radio state requires lower unwanted emissions than the "Carrier-off" radio state.

environmental profile: range of environmental conditions under which equipment within the scope of the present document is required to comply with the provisions of the present document

indoor unit: it is composed of that part of the ST which is not part of the outdoor unit

NOTE: It is generally installed inside a building and is connected to the outdoor unit.

integral antenna: antenna which may not be removed during the tests according to the applicant's statement

nominal antenna diameter: antenna diameter declared by the manufacturer that is a parameter in performance characteristics and that allows reference to a certain performance

NOTE: An antenna with circular aperture of diameter equal to the nominal diameter does typically have the performance specified.

Network operators might request antennas of a certain diameter. Then an antenna that is compliant with the requirement for nominal antenna diameter equal to the requested antenna diameter can be used. Manufacturers can mark their equipment with antenna diameters used in the requirements during compliance test.

nominated bandwidth: bandwidth of the ST radio frequency transmission nominated by the applicant

NOTE 1: The nominated bandwidth 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.

outdoor unit: parts of the ST intended to be installed outdoor, as declared by the applicant, or as indicated in the user documentation

NOTE 1: 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) downconverter, 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 (IF);

  c) the upconverter and the power amplifier which convert from the IF to RF and amplify the low level RF signals for transmission through the antenna subsystem.

NOTE 2: The installation equipment is outside the scope of the present document. 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 the present document.

port: particular interface of the specified apparatus with the external electromagnetic environment (figure 1)
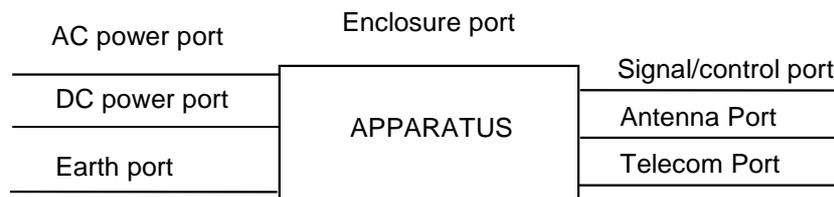
Figure 1: Examples of ports

removable antenna: antenna which may be removed during the tests according to the applicant's statement

Satellite Terminal (ST): throughout the present document either a SIT or a SUT

spurious radiation: any radiation outside the nominated bandwidth

transmission disabled state: ST is in this state when it is not authorized by the NCF to transmit

uplink power density control: control of the e.i.r.p. and/or occupied bandwidth and/or other transmission parameters (e.g. FEC, modulation, symbol rate) of the transmitted signal in order to adjust the e.i.r.p. in a given measurement bandwidth

NOTE: Uplink power density control may be used to respond to uplink fade conditions.

Wanted signal occupied bandwidth (BW): width of the signal spectrum 10 dB below the maximum inband power density

3.2   Symbols

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

dBsd   Ratio expressed in decibels relative to the spectral density

3.3   Abbreviations

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

BSS	Broadcast Satellite Service
BW	BandWidth
CC	Control Channel
CCF	Control Channel reception Failure
CCR	Control Channel correctly Received
CDMA	Code Division Multiple Access
CISPR	Comité International Spécial des Perturbations Radioélectriques (International Special Committee on Radio Interference)
CMF	Control and Monitoring Functions
EIRP, e.i.r.p.	Equivalent Isotropically Radiated Power
EUT	Equipment Under Test
FDMA	Frequency Division Multiple Access
FEC	Forward Error Correction
FSS	Fixed Satellite Service
GEUT	Gain of EUT
GSO	Geostationary Satellite Orbit
HPA	High Power Amplifier
IF	Intermediate Frequencies
LNB	Low Noise Block downconverter
LO	Local Oscillator
NCF	Network Control Facility
R&TTE	Radio and Telecommunications Terminal Equipment
RE	Radio Equipment
RED	Radio Equipment Directive
RF	Radio Frequency
SIT	Satellite Interactive Terminal
SMF	System Monitoring Fail
SMP	System Monitoring Pass
ST	Satellite Terminal
STE	Special Test Equipment
SUT	Satellite User Terminal
TDMA	Time Division Multiple Access
TxD	Transmission Disable command
TxE	Transmission Enable command

4   Technical requirements specifications

4.1   General

4.1.1   Environmental profile

The technical requirements of the present document apply under the environmental profile for operation of the equipment, which shall be declared by the applicant. The equipment shall comply with all the technical requirements of the present document at all times when operating within the boundary limits of the declared operational environmental profile.

The environmental profile for operation of the equipment shall include the ranges of humidity, temperature and supply voltage.

4.1.2   ST states and radio states

For the purpose of the present document the following four ST states are defined, without presuming the effective implementation of the ST state machine:

- "Non valid";

- "Initial phase";

- "Transmission disabled"; and

- "Transmission enabled".

The four ST states are represented in figure 2 and are used in clause 4.2.7 for the specification of the Control and Monitoring Functions (CMFs).

In the "Non-valid" state and in the "Transmission disabled" state the ST is not allowed to transmit. In the "Transmission-enabled" state the ST is allowed to transmit. In the "Initial phase" state the ST is only allowed to transmit initial bursts or is waiting for a transmit enable/disable command.

The ST "may transmit" when all the conditions for transmission are satisfied (e.g. in a state where transmissions are permitted, no failure detected).

The following radio states of the ST are defined:

- "Emissions disabled" when the ST does not transmit any carrier;

- "Carrier-off" when the ST may transmit and does not transmit any carrier;

- "Carrier-on" when the ST may transmit and transmits a carrier.

Table 1 gives the only possible combinations of the ST states and radio states which shall apply, with some examples of associated events.

When the ST transmits several carriers having different frequencies, an ST state machine as described above may be associated with each carrier or each set of carriers.

Table 1: ST states and Radio states

ST states	Radio states	Examples of events
"Non valid"	"Emissions disabled"	After-power on; or After any failure; or During the checking phase
"Initial phase"	"Emissions disabled"	When waiting for a transmission enable or disable command from the NCF Between initial bursts
	"Carrier-on"	During the transmission of each initial burst
"Transmission enabled"	"Carrier-on"	During transmission of carrier(s)
	"Carrier-off"	When no carrier is transmitted
"Transmission disabled"	"Emissions disabled"	When a disable command from the NCF has been received and waiting for a transmission enable command from the NCF

4.2   Conformance requirements

4.2.1   General

Under operational conditions an ST may dynamically change the occupied bandwidth and/or other transmission parameters (e.g. FEC, modulation, symbol rate) of the transmitted signal. For each combination of occupied bandwidth and other transmission parameters, an $EIRP_{max}$, an $EIRP_{nom}$ and a nominated bandwidth shall be declared by the applicant. The following specifications apply to the ST for each combination of occupied bandwidth and other transmission parameters.

The nominated bandwidth shall not exceed 5 times the occupied bandwidth.

4.2.2   Off-axis spurious radiation

4.2.2.1   Purpose

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

4.2.2.2 Specification

The following specifications apply to the ST transmitting at e.i.r.p. values up to and including $EIRP_{max}$.

1) The ST shall not exceed the limits for radiated interference field strength over the frequency range from 30 MHz to 1 000 MHz specified in table 2a.

Table 2a: Limits of radiated field strength at a test distance of 10 m in a 120 kHz bandwidth

Frequency range	Quasi-peak limits
30 MHz to 230 MHz	30 dBµV/m
230 MHz to 1 000 MHz	37 dBµV/m

The lower limit shall apply at the transition frequency.

2) When the ST is in the "Emissions disabled" radio state, the off-axis Equivalent Isotropically Radiated Power (e.i.r.p.) of spurious radiation from the ST, in any 100 kHz band, shall not exceed the limits in table 2b, for all off-axis angles greater than 7°.

Table 2b: Limits of spurious radiation - "Emissions disabled" radio state

Frequency band	e.i.r.p. limit
1,0 GHz to 2,0 GHz	42 dBpW
2,0 GHz to 10,7 GHz	48 dBpW
10,7 GHz to 21,2 GHz	54 dBpW
21,2 GHz to 40 GHz	60 dBpW

The lower limits shall apply at the transition frequencies.

3) The present document applies outside the nominated bandwidth. For both the "Carrier-on" and "Carrier-off" radio states, the off-axis e.i.r.p. of spurious radiation in the specified measurement bandwidth from the ST, shall not exceed the limits in table 3, for all off-axis angles greater than 7°.

Table 3: Limits of spurious radiation - "Carrier-on" and "Carrier-off" radio states

Frequency band	EIRP limit	Measurement bandwidth
1,0 GHz to 2,0 GHz	43 dBpW	100 kHz
2,0 GHz to 3,4 GHz	49 dBpW	100 kHz
3,4 GHz to 10,7 GHz	55 dBpW	100 kHz
10,7 GHz to 21,2 GHz	61 dBpW	100 kHz
21,2 GHz to 29,35 GHz	67 dBpW	100 kHz
29,35 GHz to 29,5 GHz	85 dBpW (see note)	1 MHz
30,00 GHz to 30,15 GHz	85 dBpW (see note)	1 MHz
30,15 GHz to 40 GHz	67 dBpW	100 kHz
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 e.i.r.p. density measured in 100 kHz at the frequency of the considered spurious is 50 dB below the maximum on-axis e.i.r.p. density of the signal measured in 100 kHz.		

The lower limits shall apply at the transition frequencies.

In the frequency band of 21,2 GHz to 29,35 GHz, for any 20 MHz band within which one or more spurious signals exceeding 67 dBpW/100 kHz are present, then the power of each of those signals exceeding the limit shall be added in Watts, and the sum shall not exceed 75 dBpW.

For STs designed to transmit simultaneously several carriers (multicarrier operation), the above limits apply to any combination of carriers declared by the applicant and outside the smallest continuous bandwidth encompassing the nominated bandwidths of the carriers.

Each combination of carriers shall be characterized by the carriers' centre frequencies and characteristics, the maximum value of the total on-axis e.i.r.p. of the carriers and the relative levels of the carriers (in dBs) at the input or output of the HPA or antenna.

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

4.2.2.3   Conformance tests

Conformance tests shall be carried out in accordance with clause 6.2.

4.2.3   On-axis spurious radiation

4.2.3.1   Purpose

To limit the level of interference to satellite radio services.

4.2.3.2   Specification

4.2.3.2.1   "Carrier-on" radio state

The following specification applies to the ST transmitting at e.i.r.p. values up to $EIRP_{nom}$. For e.i.r.p.(s) above $EIRP_{nom}$ (when uplink power control is implemented) the limits below may be exceeded by the difference in dB between the actual e.i.r.p. and $EIRP_{nom}$.

In the 29,5 GHz to 30,0 GHz band the e.i.r.p. spectral density of the spurious radiation outside the nominated bandwidth shall not exceed 4 - 10 log M dBW in any 100 kHz band. This limit may be exceeded provided that for any 20 MHz band within which one or more spurious signals exceeding 4 dBW/100 kHz are present, then the power of each of those signals exceeding the limit shall be added in Watts, and the sum shall not exceed 10 dBW.

NOTE 1: In order to avoid harmful interference to radio services using the same satellite or collocated satellites, the satellite operator or the satellite network operator may require more stringent limits, e.g. depending on the size of the network and the size of the satellite coverage.

The above limit may be exceeded in a bandwidth of 5 times the occupied bandwidth centred on the carrier centre frequency, in which case the e.i.r.p. spectral density of the spurious radiation outside the nominated bandwidth, shall not exceed 18 - 10 log M dBW in any 100 kHz band.

M is the maximum number of STs 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 M and the operational conditions of the system shall be declared by the applicant.

NOTE 2: The on-axis spurious radiation, outside the 29,5 GHz to 30,0 GHz band, is indirectly limited by clause 4.2.2.2. Consequently no specification is needed.

NOTE 3: Intermodulation limits inside the band 29,5 GHz to 30,0 GHz are to be determined by system design and are subject to satellite operator specifications.

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

4.2.3.2.2   "Carrier-off" and "Emissions disabled" radio states

The following specification applies for an ST in the "Carrier-off" and "Emissions disabled" radio states.

In the 29,5 GHz to 30,0 GHz band the e.i.r.p. spectral density of the spurious radiation outside the nominated bandwidth shall not exceed -21 dBW in any 100 kHz band.

NOTE: In order to avoid harmful interference to radio services using the same satellite or collocated satellites, the satellite operator or the satellite network operator may require more stringent limits, e.g. depending on the size of the network and the size of the satellite coverage.

4.2.3.3   Conformance tests

Conformance tests shall be carried out in accordance with clause 6.3.

4.2.4   Off-axis e.i.r.p. emission density within the band

4.2.4.1   Purpose

Protection of other satellite (uplink) systems.

4.2.4.2   Specification

The following specifications apply to the ST transmitting at e.i.r.p. values up to $EIRP_{max}$.

The maximum e.i.r.p. in any 40 kHz band within the nominated bandwidth for each of the co-polarized components in any direction ϕ degrees from the antenna main beam axis shall not exceed the following limits:

$$19 - 25 \log \phi - 10 \log N \qquad \text{dBW} \qquad \text{for} \qquad 1{,}8° \quad \leq \quad \phi \quad \leq 7{,}0°;$$

$$-2 - 10 \log N \qquad \text{dBW} \qquad \text{for} \qquad 7{,}0° \quad < \quad \phi \quad \leq 9{,}2°;$$

$$22 - 25 \log \phi - 10 \log N \qquad \text{dBW} \qquad \text{for} \qquad 9{,}2° \quad < \quad \phi \quad \leq 48°;$$

$$-10 - 10 \log N \qquad \text{dBW} \qquad \text{for} \qquad \phi \quad > 48°;$$

where ϕ is the angle, in degrees, between the main beam axis and the direction considered.

For systems in which more than one ST is expected to transmit simultaneously in the same 40 kHz band, e.g. for systems employing CDMA, the maximum e.i.r.p. values above are decreased by 10 log N dB, where N is the number of STs in the receive beam of the satellite to which these STs are communicating and which are expected to transmit simultaneously in the same 40 kHz band within that beam. The number N shall be declared by the applicant.

NOTE 1:   N = 1 for TDMA carriers with occupied bandwidth greater than 40 kHz. N > 1 may apply for FDMA or TDMA carriers with a lower occupied bandwidth.

In addition the maximum e.i.r.p. in any 40 kHz band within the nominated bandwidth of each of the cross-polarized components in any direction ϕ degrees from the antenna main beam axis shall not exceed the following limits:

$$9 - 25 \log \phi - 10 \log N \qquad \text{dBW} \quad \text{for} \qquad 1{,}8° \quad \leq \quad \phi \quad \leq 7{,}0°;$$

$$-12 - 10 \log N \qquad \text{dBW} \quad \text{for} \qquad 7{,}0° \quad < \quad \phi \quad \leq 9{,}2°;$$

where ϕ and N are as defined above.

For non-continuous transmission, the above limits may not apply for a specific portion of each burst as declared by the applicant. This excluded portion shall not exceed 50 μsec or 10 % of the burst, whichever is the smaller.

The excluded portion shall have characteristics similar to the remaining part of the burst:

- • same symbol rate and modulation; and

- • same or lower maximum amplitude.

In the case of STs employing uplink power density control, the above limits, for co-polar and cross-polar components, shall apply under clear-sky conditions and these limits include all additional margins above the minimum clear-sky level necessary for the implementations of uplink power density control. For STs implementing uplink power density control, the above limits may be exceeded by up to A dB during fade conditions, where A is the attenuation of the transmit signal relative to clear sky conditions. The above limits shall not be exceeded by more than 20 dB.

In the case of STs employing transmission parameter modification (e.g. FEC, modulation, symbol rate) of the transmitted signal as part of uplink power density control, the above limits shall apply to all combinations of occupied bandwidth and transmission parameters as declared by the applicant.

Any antenna off-axis direction may be defined by a pair of values (α, ϕ) where ϕ is the off-axis angle of that direction with the antenna main beam axis and α is the angle of the plane defined by that direction and the antenna main beam axis with an arbitrary reference plane containing the antenna main beam axis. The range of values of ϕ and α is from 0° to 180° for ϕ, and from -180° to +180° for α.

The above limits apply to any off-axis direction (α, ϕ) within $\pm 3°$ of the visible part of the GSO and may be exceeded up to 3 dB in any other direction. The above limits may also be exceeded by up to 3 dB for ϕ greater than 10° and within $\pm 3°$ of the visible part of the GSO provided that the total angular range over which this occurs does not exceed 20° when measured along both sides of the geostationary orbit. The concerned off-axis direction (α, ϕ) within $\pm 3°$ of the visible part of the GSO under all operational conditions declared by the applicant shall be any direction within the (α, ϕ) domain unless it can be demonstrated by documentary evidence that only a limited subset of the (α, ϕ) domain is concerned. Outside this subset the +3 dB relaxation applies.

When documentary evidence is provided to demonstrate that only a limited subset of the (α,ϕ) domain is concerned, the determination of the (α,ϕ) subset shall take into account the operational conditions for which the ST is designed, as declared by the applicant or indicated within the user documentation. These conditions shall include:

- the range of latitudes of the ST;

- the minimum elevation pointing angle;

- the type of antenna mount (e.g. with azimuth and elevation axes or equatorial);

- the range of adjustment for the major axis of the antenna for antennas with asymmetric main beam;

- the method of alignment of the antenna major axis with the GSO for antennas with asymmetric main beam;

- the maximum static and dynamic alignment errors of the antenna mount axes;

- the maximum static and dynamic alignment errors of the antenna major axis with respect to the GSO arc for antennas with asymmetric main beam;

- the range of directions of the electric field radiated by the satellite(s) with respect to the Earth's axis for which the equipment is designed, when the electric field is used for the antenna alignment.

The alignment errors shall not exceed the declared maximum values when applying the alignment method declared by the applicant or indicated within the user documentation.

NOTE 2: ETSI TR 102 375 [i.3] gives guidance for the determination of the concerned subset within the (α, ϕ) domain.

4.2.4.3   Conformance tests

Conformance tests shall be carried out in accordance with clause 6.4.

4.2.5   Carrier suppression

4.2.5.1   Purpose

To allow for the satisfactory suppression of transmissions of an ST in the "Emissions disabled" radio state (e.g. when requested by the NCF or a fault condition is detected).

4.2.5.2   Specification

When the ST is in the "Emissions disabled" radio state the on-axis e.i.r.p. shall not exceed 4 dBW in any 100 kHz band within the nominated bandwidth.

4.2.5.3   Conformance tests

Conformance tests shall be carried out in accordance with clause 6.5.

4.2.6   Antenna pointing accuracy

4.2.6.1   Purpose

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

4.2.6.2   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 applicant shall declare the usage area in terms of the range of latitude and longitude relative to the satellite orbital position where the alignments specified below are possible.

Specification 1: Main beam pointing accuracy

The antenna sub-system alignment facilities shall enable the main beam axis to be adjusted and fixed with a pointing accuracy ($\delta\phi$) of either:

1)   0,1°; or

2)   a greater value declared by the applicant, subject to the following restrictions:

-      the pointing accuracy ($\delta\phi$) shall not exceed 30 % of the antenna transmit main beam half power beamwidth;

-      the off-axis EIRP emission density pattern remains within the mask specified in clause 4.2.4.2 when shifted by an angle of $\pm(\delta\phi\text{-}0,1°)$.

Specification 2: Alignment with the geostationary satellite orbit

For antennas with asymmetric main beam, the antenna shall be capable of having the plane defined by the antenna main beam axis and its major axis aligned with the tangent to the geostationary orbit in accordance with the method declared by the applicant.

c)   Polarization angle alignment capability for linear polarization:

-      The polarization angle shall be continuously adjustable within the operational range as declared by the applicant.

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

-      When linear polarization is used for both transmission and reception, the angle between the receive and corresponding transmit polarization planes shall not deviate by more than 1° from the nominal value declared by the applicant.

4.2.6.3   Conformance tests

Conformance tests shall be carried out in accordance with clauses 6.4 and 6.6.

4.2.7   Control and Monitoring Functions (CMF)

4.2.7.1   General

The following minimum set of CMFs shall be implemented in STs in order to minimize the probability that they originate unwanted transmissions that may give rise to harmful interference to other systems.

In the "Non-valid" state and in the "Transmission disabled" state the ST shall not transmit and the "Emissions disabled" radio state shall apply as defined in table 1.

In the "Transmission-enabled" state the ST is allowed to transmit and the "Carrier-on" and "Carrier-off" radio states shall apply as defined in table 1.

In the "Initial phase" state the ST is only allowed to transmit initial bursts and the "Emissions disabled" and "Carrier-on" radio states shall apply as defined in table 1.
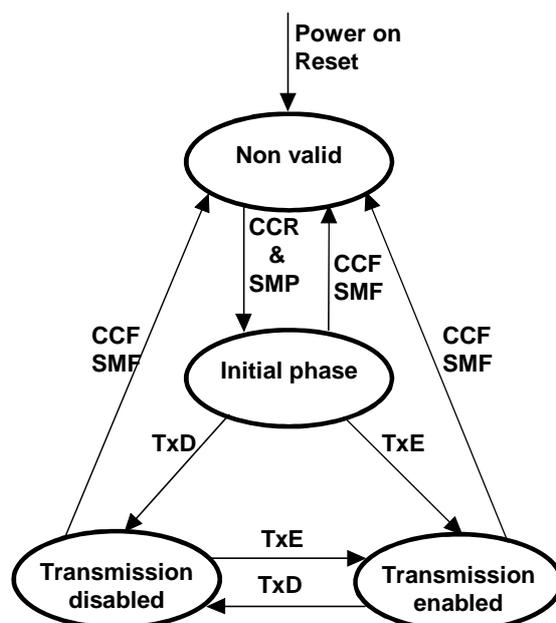
SMP: System Monitoring Pass;
SMF: System Monitoring Fail;
TxE: Transmission Enable command;
TxD: Transmission Disable command;
CCR: Control Channel correctly Received;
CCF: Control Channel reception Failure.

NOTE: From "Transmission disabled" state a TxE command may also result in a transition towards the "Initial phase" state.

Figure 2: State transition diagram of the control and monitoring function of an ST

When the ST transmits several carriers having different frequencies, an ST 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 ST.

4.2.7.2   Processor monitoring

4.2.7.2.1   Purpose

To ensure that the ST can suppress transmissions in the event of a processor sub-system failure.

4.2.7.2.2   Specification

The ST shall incorporate a processor monitoring function for each of its processors involved in the manipulation of traffic and in Control and Monitoring Functions (CMF).

The processor monitoring function shall detect failures of the processor hardware and software.

No later than 10 s after any fault condition occurs, the ST shall enter the "Non valid" state until the processor monitoring function has determined that all fault conditions have been cleared.

4.2.7.2.3   Conformance tests

Conformance tests shall be carried out in accordance with clause 6.7.2.

4.2.7.3   Transmit subsystem monitoring

4.2.7.3.1   Purpose

To ensure the inhibition of transmissions that are potentially harmful to other systems in the event of incorrect operation of the transmit frequency generation sub-system.

4.2.7.3.2 Specification

The ST shall monitor the operation of its transmit frequency generation sub-system and shall be able to detect:

1) Loss of frequency lock (if applicable).

2) Absence of Local Oscillator (LO) output signal.

No later than 1 s after any of these fault conditions of the transmit frequency generation sub-system occurs, the ST shall enter the "Non-valid" state until the transmit sub-system monitoring function has determined that all fault conditions have been cleared.

4.2.7.3.3 Conformance tests

Conformance tests shall be carried out in accordance with clause 6.7.3.

4.2.7.4 Power-on/Reset

4.2.7.4.1 Purpose

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

4.2.7.4.2 Specification

Following a manual reset, when this function is implemented, the ST shall enter the "Non-valid" state.

During and following "power-on" the ST shall remain in the "Non-valid" state.

4.2.7.4.3 Conformance tests

Conformance tests shall be carried out in accordance with clause 6.7.4.

4.2.7.5 Control Channel (CC) reception

4.2.7.5.1 Purpose

To ensure that the ST cannot transmit unless it correctly receives the CC messages from the NCF.

4.2.7.5.2 Specification

The ST shall enter the "Non-valid" state immediately after a period not exceeding 10 s without correct reception of the CC from the NCF.

The ST shall remain in the "Non-valid" state as long as the CC messages from the NCF are not received.

From the "Non-valid" state the ST may enter the "Initial phase" state if the following conditions are met:

- the CC messages from the NCF are correctly received; and

- no fault conditions are present.

4.2.7.5.3 Conformance tests

Conformance tests shall be carried out in accordance with clause 6.7.5.

4.2.7.6 Network control commands

4.2.7.6.1 Purpose

These requirements ensure that the ST is capable of:

a) retaining a unique identification in the network;

b) receiving commands from the NCF through its CC(s) and executing those commands.

4.2.7.6.2   Specification

The ST shall hold, in non-volatile memory, its unique identification code in the network.

The ST shall be capable of receiving through its CCs dedicated messages (addressed to the ST) from the NCF, and which contain:

- transmission enable commands;

- transmission disable commands.

From "Initial phase" or "Transmission enabled" states once a transmission disable command is received, within 10 s the ST shall enter into, and shall remain in, the "Transmission disabled" state until the transmission disable command is superseded by a subsequent transmission enable command.

4.2.7.6.3   Conformance test

Conformance tests shall be carried out in accordance with clause 6.7.6.

4.2.7.7   Initial burst transmission

4.2.7.7.1   Purpose

Restriction on the initial burst transmission is necessary to limit harmful interference to other services.

4.2.7.7.2   Specification

For systems where no transmission enable command is foreseen without request from the ST, in the "Initial phase" state the ST may transmit initial bursts.

    a)   The duty cycle of the burst retransmission shall not exceed 0,3 %.

    b)   Each burst shall not carry more than 256 data bytes excluding the burst preamble and the FEC coding bits.

    c)   The e.i.r.p. of the first initial burst shall not exceed $EIRP_{nom}$.

4.2.7.7.3   Conformance tests

Conformance tests shall be carried out in accordance with clause 6.7.7.

4.2.8   Receive antenna off-axis gain pattern

4.2.8.1   Justification

To protect the wanted signals from interference from terrestrial services and from other satellite services.

4.2.8.2   Specification

The maximum antenna gain of each of the co-polarized components in any direction φ degrees from the antenna main beam axis shall not exceed the following limits:

$$G \ = \ 32 \ - \ 25 \log \varphi \qquad \text{dBi} \qquad \text{for } \varphi_{min} \leq \ \varphi \ < 48°$$

$$G \ = \ -10 \qquad\qquad\qquad \text{dBi} \qquad \text{for } \ 48° \ \leq \ \varphi \ \leq 85°$$

$$G \ = \ 0 \qquad\qquad\qquad\quad \text{dBi} \qquad \text{for } \ 85° \ \leq \ \varphi \ \leq 180°$$

where:

$\varphi_{min} \ = \ 1°$ or $100 \ \lambda/D$ degrees, whichever is the greater, for $D/\lambda \geq 50$.

$\varphi_{min} = \ 2°$ or $114 \ (D/\lambda)^{-1.09}$ degrees, whichever is the greater, for $D/\lambda < 50$.

D is the nominal diameter of the antenna.

In addition the maximum antenna gain of each of the cross-polarized components in any direction φ degrees from the antenna main beam axis shall not exceed the following limits:

$$G_x(\varphi) = 23 - 20 \log \varphi \quad \text{dBi} \qquad \text{for } \varphi_r \leq \varphi \leq 7°$$

where φ$_r$ is equal to 1° or 100 λ/D, whichever is greater.

4.2.8.3   Conformance tests

Conformance tests shall be carried out in accordance with clause 6.8.

4.2.9   Blocking performance

4.2.9.1   Justification

To prevent high power signals outside the receive frequency band from blocking the reception of signals inside the receive frequency band.

4.2.9.2   Specification

Receiver blocking is characterized here through gain compression for a signal inside the receive frequency band that is caused by another signal outside the receive frequency band at high power. The level of the other signal is compared to the level of a signal inside the receive frequency band that would cause the same gain compression.

Receiver blocking rejection at a particular frequency is defined as the level of a second signal at this frequency that causes a certain gain compression to a first signal inside the receive frequency band, minus the level of a second signal at a frequency inside the receive frequency band that causes the same gain compression.

The first signal shall be at the centre frequency of the receive frequency band and have a level in the operational range. The second signal shall cause a gain compression for the first signal of 1 dB.

The rejection shall comply with table 4.

Table 4: Receiver blocking rejection

Frequency	Minimum rejection
below 14 GHz	20 dB
14 to 16 GHz	10 dB
24 to 27,5 GHz	10 dB
Above 27,5 GHz	20 dB
NOTE: In the frequency ranges 16 to 17,5 GHz and 21,2 to 24 GHz, the rejection needs further studies.	

4.2.9.3   Conformance tests

Conformance tests shall be carried out in accordance with clause 6.9.

4.2.10   Adjacent Signal Selectivity

4.2.10.1   Justification

To enable reception of a wanted signal in presence of other signals on adjacent frequencies which are transmitted with high EIRP density from target satellite orbital position.

   NOTE: The power level of signals transmitted from the same orbital position are under control of the satellite operator. Signals transmitted adjacent orbital position that is not near-by are suppressed by the antenna gain pattern.

4.2.10.2   Specification

Adjacent Signal Selectivity is a measure of a receiver's ability to receive a signal at its assigned channel frequency in the presence of an adjacent signal at a given frequency offset from the centre frequency of the assigned channel.

The adjacent signal shall occupy the same bandwidth as the wanted signal. Frequency offset and relative power level of the adjacent signal compared to the wanted signal shall take the value given in table 5. BW is the wanted signal occupied bandwidth.

Table 5: Adjacent signal frequency and Power level

Signal	Centre frequency offset from wanted signal	Power level relative to wanted signal
Adjacent Carrier	BW	7 dBsd

The decrease in the required signal to noise ratio in the presence of an adjacent signal shall be no more than 0,5 dB.

4.2.10.3   Conformance tests

Conformance tests shall be carried out in accordance with clause 6.10.

5   Testing for compliance with technical requirements

5.1   Environmental conditions for testing

Tests defined in the present document shall be carried out at representative points within the boundary limits of the declared operational environmental profile.

5.2   Radio test suites

The essential radio test suites for an ST are given in clause 6.

6   Test method

6.1   General

The values of measurement uncertainty associated with each measurement parameter apply to all of the test cases described in the present document. The measurement uncertainties shall not exceed the values shown in tables 6 and 7.

Table 6: Measurement uncertainty

Measurement parameter	Uncertainty
Radio frequency	±10 kHz
RF power	±0,75 dB
Conducted spurious	±4 dB
Radiated spurious	±6 dB
Antenna on-axis gain	±0,5 dB
Polarization discrimination	±2 dB

Table 7: Measurement uncertainties for antenna gain pattern

Gain relative to the antenna on-axis gain	Uncertainty
> -3 dB	±0,3 dB
-3 dB to -20 dB	±1,0 dB
-20 dB to -30 dB	±2,0 dB
-30 dB to -40 dB	±3,0 dB

NOTE: ETSI TR 102 215 [i.2] gives guidance on interpretation of measurement uncertainty and interpretation of results.

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

- since the ST requires to receive a data signal from the satellite in order to transmit, special test arrangements are required to simulate the satellite signal, thus enabling the ST 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 applicant.

The test procedures specified in clause 6 may be replaced by other equivalent procedures provided that the results are proven to be as accurate as these obtained according to the specified method.

All tests with carrier-on shall be undertaken with the transmitter operating at the maximum transmit burst rate for each combination of occupied bandwidth and transmission parameters, as declared by the applicant.

If the EUT is an ST that has had hardware and/or software modification(s) performed by the applicant 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 proved to allow the ST to operate without its main characteristics being changed.

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

All technical characteristics and operational conditions declared by the applicant shall be entered in the test report. The measurement configurations and test results shall be recorded in the test report.

6.2   Off-axis spurious radiation

6.2.1   Test method

6.2.1.1   General

The tests for the specification in clause 4.2.2 shall be limited to the "Carrier-on" radio state. The tests shall be undertaken with the transmitter operating at $EIRP_{max}$.

An EUT with antenna is an ST with its antenna comprising both the indoor and outdoor units interconnected by 10 m of cable. An EUT without antenna is an ST with the removable antenna removed. It comprises both the indoor and outdoor units, up to the antenna flange, interconnected by 10 m of cable. The connecting cable between the indoor and the outdoor units shall be of the same type as specified by the applicant in the installation manual. The type of cable used shall be entered in the test report.

The EUT shall be terminated with matched impedance at the terrestrial ports if recommended by the applicant in the user documentation and if there is no associated equipment connected to each port.

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 balanced transforming device. Measurements with broad band antennas are also possible provided that the test site has been validated according to CISPR No 16-1-4 [3].

For frequencies between 80 MHz and 1 000 MHz the measuring antenna shall be a balanced dipole which shall be resonant in length. Measurements with broad band antennas are also possible provided that the test site has been validated according to CISPR No 16-1-4 [3].

For frequencies above 1 000 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 polarization and at the specified height.

6.2.1.2   Multi-carrier operation

For STs designed to transmit simultaneously several carriers the verification up to 1 000 MHz shall be performed with one or more carriers and the verification above 1 000 MHz shall be repeated for each combination of carriers declared by the applicant.

For each combination of carriers the applicant shall declare the carriers' centre frequencies and characteristics, the maximum value of the total on-axis e.i.r.p. of the carriers and the relative levels of the carriers (in dBs) at the input or output of the HPA or antenna.

In the case of combinations of carriers with identical characteristics and when the power at the input of the HPA does not exceed the maximum input power with two carriers (i.e. when the Global Input Back-Off of the HPA is greater than the minimum Global Input Back-Off with two carriers), the verification may be limited to the case with two carriers and with the maximum frequency separation between them.

In any other case, the number of configurations to be verified above may be limited to the cases which can be proven by the applicant, by documentary evidence or demonstration, to generate the maximum e.i.r.p. density level of the out-of-band emissions due to inter-modulation products.

6.2.2 Measurements up to 1 000 MHz

6.2.2.1 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 CISPR No 16-1-4 [3].

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 the measuring antenna should be 10 m. For measurements at a different distance 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.

6.2.2.2 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 below the 1 dB compression point.

6.2.2.3 Procedure

a) The EUT shall be an EUT with antenna or, preferably, without antenna but with the antenna flange terminated by a dummy load.

b) The EUT shall be in the "Carrier-on" radio state.

c) The EUT shall be rotated through 360° and, except in an anechoic chamber, the measuring antenna shall be rotated and height varied from 1 m to 4 m above the ground plane to determine the maximum emission.

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

6.2.3 Measurements above 1 000 MHz

6.2.3.0 General

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" radio 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" radio 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.

6.2.3.1 Identification of the significant frequencies of spurious radiation

6.2.3.1.1 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.

6.2.3.1.2 Procedure

a) The EUT shall be in the "Carrier-off" radio state.

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 while 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 polarization.

f) The test shall be repeated in the "Carrier-on" radio state while transmitting one modulated carrier at maximum power.

6.2.3.2 Measurement of radiated power levels of identified spurious radiation

6.2.3.2.1 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.

6.2.3.2.2   Procedure
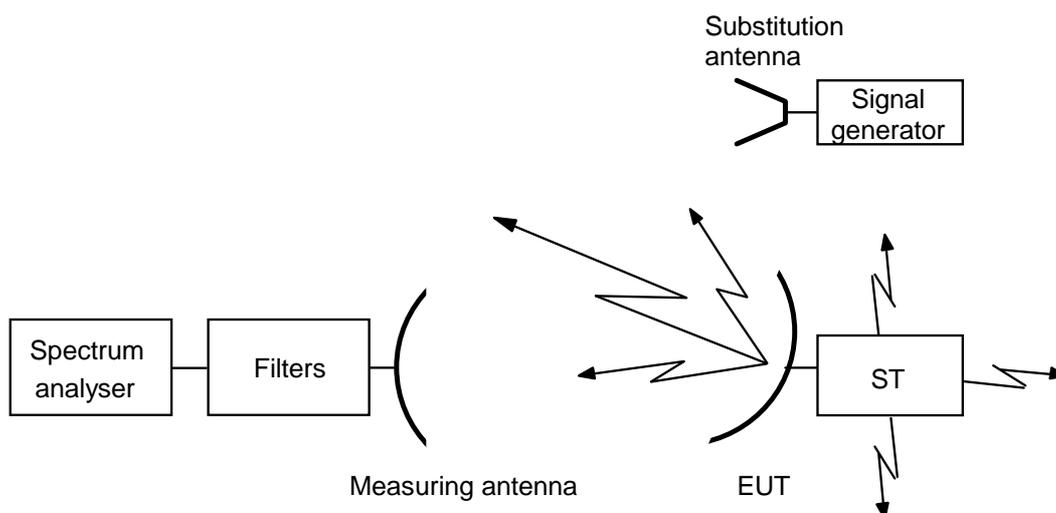
**Figure 3: Test arrangement - Spurious radiation measurement
above 1 000 MHz for an EUT with antenna**
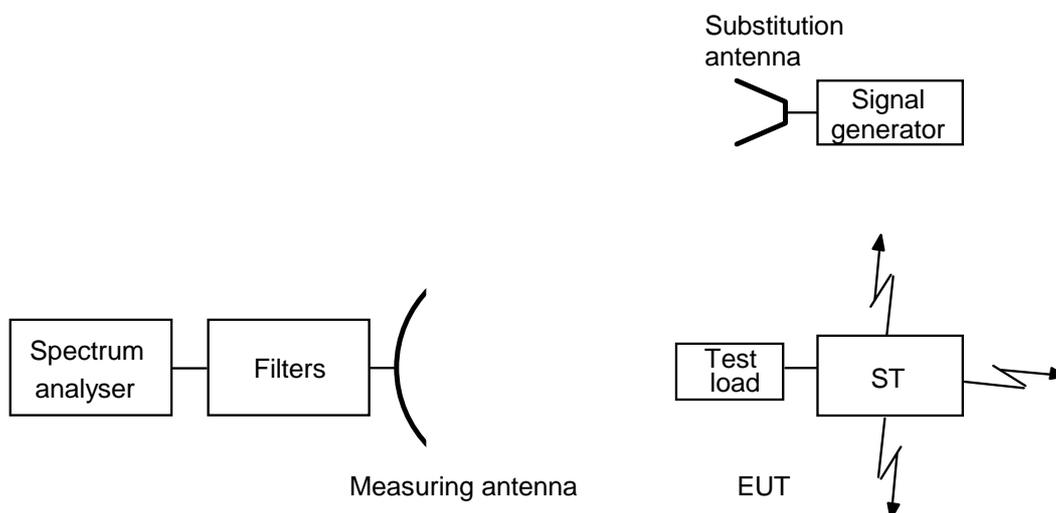
**Figure 4: Test arrangement - spurious radiation measurements
above 1 000 MHz for an EUT without antenna**

a)   The test arrangement shall be as shown in figures 3 or 4.

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 3 the main beam of the
       antenna shall have an angle of elevation of 7° and be oriented away from the Geostationary Satellite Orbit
       (GSO), or be inhibited by placing RF absorbing panels in that direction.

c)   The measuring antenna shall be positioned at a distance from the EUT (e.g. 3 m, 5 m, 10 m) relevant to the
       applied test site. The measuring antenna shall be adjusted in height and the EUT rotated, while 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 opposite 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 e.i.r.p. 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.

6.2.3.3   Measurement of conducted spurious radiation at the antenna flange

6.2.3.3.1   Test site

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

6.2.3.3.2   Procedure
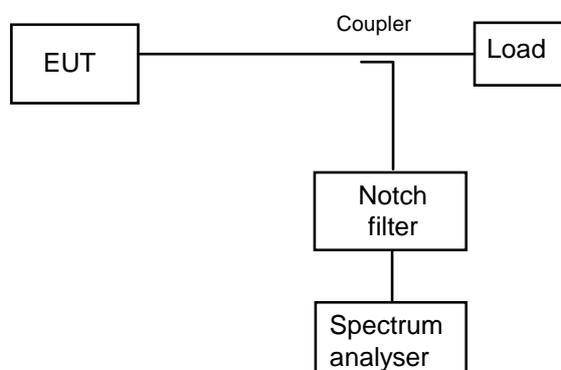
**Figure 5: Test arrangement - conducted spurious radiation
above the cut-off frequency**

a)   The test arrangement shall be as shown in figure 5 with the notch filter being optional. In order to protect the spectrum analyser while ensuring the necessary measurement accuracy, particularly close to the carrier, if a notch filter is used it shall be 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 while in the "Carrier-on" radio state with the carrier being at maximum power and normally modulated.

c)   To obtain the off-axis spurious e.i.r.p. 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 factors summated with the result. If agreed by the applicant, 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 off-axis antenna gain at the frequency of the identified unwanted emission.

d)   The test shall be repeated in the "Carrier-off" radio state.

6.3   On-axis spurious radiation

6.3.1   Test method

6.3.1.0   General

The tests shall be undertaken with the transmitter operating at $EIRP_{max}$.

6.3.1.1   Test site

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

6.3.1.2   Method of measurement

6.3.1.2.1   General

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

For ST equipment for which measurements at the antenna flange are not possible or not agreed by the applicant, the measurements shall be performed with a test antenna. The EUT is the ST with its antenna comprising both the indoor and outdoor units interconnected by 10 m of cable.

6.3.1.2.2   Method of measurement at the antenna flange

a)   The test arrangement shall be as shown in figure 5 with the notch filter being optional. In order to protect the spectrum analyser while ensuring the necessary measurement accuracy, particularly close to the carrier, if a notch filter is used it shall be tuned to 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 $EIRP_{max}$. The frequency range 29,50 GHz to 30,00 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 e.i.r.p., 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 clause 6.4.1.2 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 tests in b) to f) shall be repeated in the "Carrier-off" radio state.

### 6.3.1.2.3 Method of measurement for an EUT with antenna
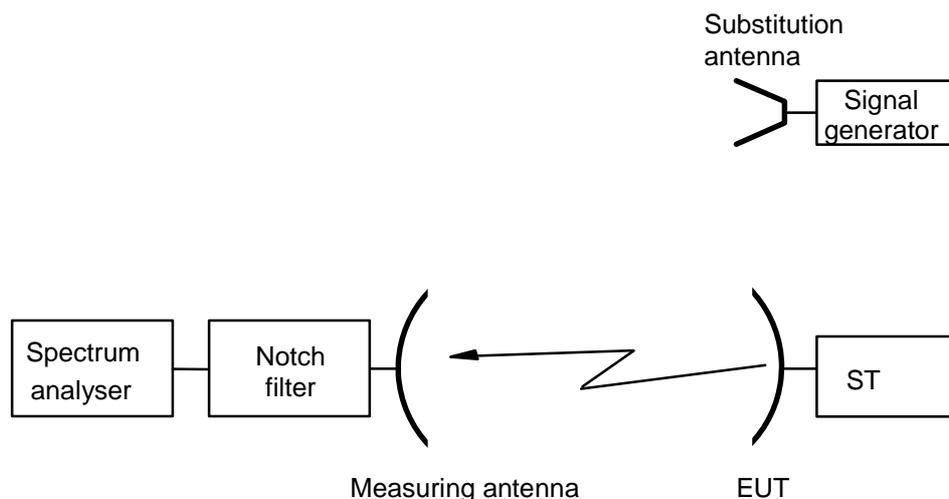
**Figure 6: Test arrangement - on-axis spurious radiation measurements
for an EUT with antenna**

a)   The test arrangement shall be as shown in figure 6 with the notch filter being optional.

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 $EIRP_{max}$. The frequency range 29,50 GHz to 30,00 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 lower. 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 m, 5 m, 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, while 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 a representative substitution antenna to which a signal generator is connected. 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 to that polarization which produced the largest response between the EUT and the test antenna.

i)   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 in the centre of the operating frequency band.

l)   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.

m)   The tests in b) to l) shall be repeated in the "Carrier-off" radio state.

6.4   Off-axis e.i.r.p. emission density within the band

6.4.1   Test method

6.4.1.0   General

The measurement shall be made in the operational configuration(s) (occupied bandwidth, $EIRP_{nom}$) producing the highest emission density in the frequency band. The selected configuration(s) shall be recorded in the test report. All of the e.i.r.p. emission density measurement shall be performed at $EIRP_{nom}$.

If the test is to be carried out with an STE, then the STE shall provide all the signals needed by the STs under normal operation (e.g. a radio beacon if it is expected to be received by the satellite).

For STs with uplink power density control capability the compliance of the ST with the specification of clause 4.2.4.2 during fading conditions shall be demonstrated by documentary evidence from the applicant.

The e.i.r.p. density is determined from the measurements of the antenna copolar and crosspolar gain patterns, and of the power density at the antenna flange. The e.i.r.p. density shall be compared to the specified mask, taking into account the applicant declared pointing accuracy $\delta\phi$ as defined in clause 4.2.6.2, if applicable.

To ascertain the off-axis e.i.r.p. 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 be performed:

a)   transmit output power density (dBW/40 kHz);

b)   antenna transmit gain (dBi);

c)   antenna transmit radiation patterns (dBi).

6.4.1.1   Transmit output power density

6.4.1.1.1   General

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

The EUT output power shall be set to the power corresponding to $EIRP_{nom}$.

6.4.1.1.2   Test site

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

6.4.1.1.3   Method of measurement
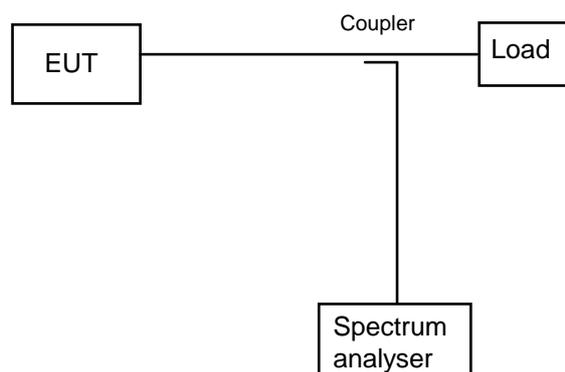
Figure 7: Test arrangement - transmit output power density measurement

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

b)   The EUT shall transmit one carrier modulated with data. For burst mode transmission the EUT shall transmit at its maximum burstrate. The power density 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 spectrum analyser shall be operated under the following conditions:

frequency span:	as required for the complete nominated bandwidth;
resolution bandwidth:	the resolution bandwidth of the spectrum analyser shall be set as close as possible to the specified measuring bandwidth of 40 kHz. If the resolution bandwidth is different from the specified bandwidth then bandwidth correction shall be performed;
display/video bandwidth:	equal to the resolution bandwidth;
averaging:	yes;
max hold:	no.

If required by the applicant, the test may be performed in max hold mode.

For an ST operating in a continuous carrier mode, the measurement time shall be sufficient to ensure that at any frequency the difference between any two measurement results is less than 1 dB.

For an ST operating in a non-continuous carrier mode, the average measurement shall be performed over the transmitted burst and the measurements from a series of bursts shall be combined as follows:

-      each measurement may exclude a specific portion of each burst. The excluded portion shall not exceed 50 μsec or 10 % of the burst, whichever is the smaller. The excluded portion shall be declared by the applicant;

-      the measurements from several bursts shall be averaged to give a final measurement result. The number of bursts that are averaged shall be sufficient to ensure that the difference between any two final measurement results is less than 1 dB.

c)   The measurement shall be made in the operational configuration(s) (occupied bandwidth, EIRP$_{nom}$) producing the highest emission density in the frequency band. The selected configuration(s) shall be recorded in the test report.

6.4.1.2   Antenna transmit gain

6.4.1.2.1   General

For the purpose of the present document, 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 purpose of this test the EUT is defined as that part of the outdoor unit which comprises the antenna and its flange. The antenna may include 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.

6.4.1.2.2   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.

#### 6.4.1.2.3   Method of measurement
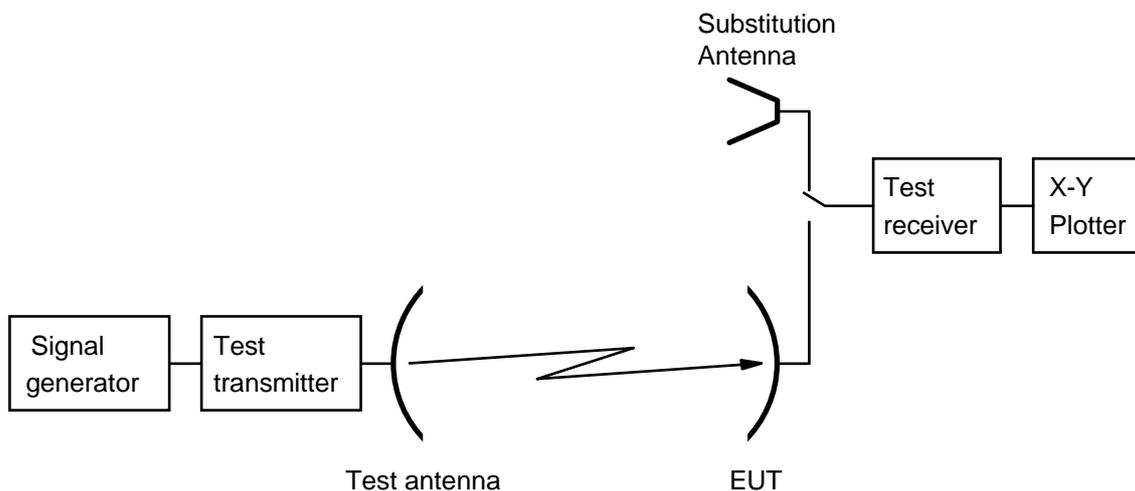
Figure 8: Test arrangement - antenna transmit gain measurement

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 29,750 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. 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.

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).

i)   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).

j)   The tests in c) to i) shall be repeated with the frequency changed to 29,505 GHz.

k)   The tests in c) to i) shall be repeated with the frequency changed to 29,995 GHz.

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

6.4.1.3   Antenna transmit radiation patterns

6.4.1.3.1   General

For the purposes of the present document, 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 purpose 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.

6.4.1.3.2   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.

6.4.1.3.3   Test arrangement
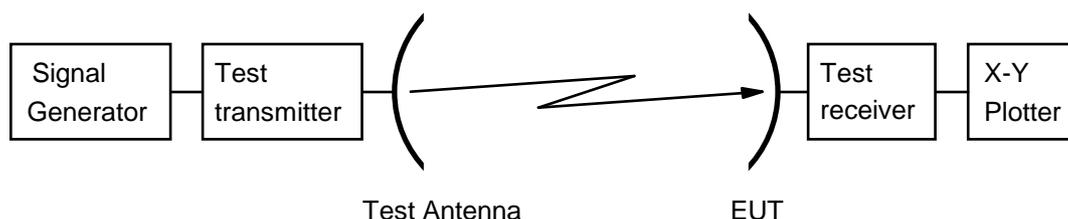
Figure 9: Test arrangement - antenna transmit radiation pattern measurement

6.4.1.3.4   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 29,750 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° with the plotter recording the results.

g)   The tests in d) to f) shall be repeated with the frequency changed to 29,505 GHz.

h)   The tests in d) to f) shall be repeated with the frequency changed to 29,995 GHz.

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

j)   The tests in d) to i) 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 29,750 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 (giving the minimum cross-polar receive signal). Precise co-polar peaking of the polarization shall be done by observing the cross-polar minimum.

6.4.1.3.5   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 29,750 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 29,505 GHz.

h)   The tests in d) to f) shall be repeated with the frequency changed to 29,995 GHz.

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

j)   The tests in d) to i) shall be repeated with the E-plane of the test signal being horizontal. The frequency of the test signal shall be set to 29,750 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).

6.4.1.3.6   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 29,750 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° with the plotter recording the results.

g) The tests in d) to f) shall be repeated with the frequency changed to 29,505 GHz.

h) The tests in d) to f) shall be repeated with the frequency changed to 29,995 GHz.

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

j) The tests in d) to i) 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 29,750 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.

6.4.1.3.7   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 29,750 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° with the plotter recording the results.

g) The tests in d) to f) shall be repeated with the frequency changed to 29,505 GHz.

h) The tests in d) to f) shall be repeated with the frequency changed to 29,995 GHz.

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

j) The tests in d) to i) 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 29,750 GHz. 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 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.

6.4.2   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 measurements, so as to ascertain that the off-axis EIRP density is within the mask, and thus conforming to the specification.

6.5   Carrier suppression

a)   The test arrangement for conducted measurements shall be as shown in figure 7. 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 29,750 GHz.

c)   The resolution bandwidth of the spectrum analyser shall be set to 100 kHz.

d)   The "Carrier-off" radio state shall be obtained by use of the STE.

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 e.i.r.p. density within the nominated bandwidth shall be measured and recorded.

6.6   Antenna pointing for STs

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 may be used to show compliance with the specification for pointing stability.

b)   Pointing accuracy capability:

Specification 1: Main beam pointing accuracy

   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 securing that movement.

   3)   The securing facility shall be examined to determine its permanency.

   4)   The test shall be repeated for the elevation axis.

Specification 2: Alignment with the Geostationary Satellite Orbit

   1)   The EUT shall be inspected to ascertain whether adjustment facilities are available to align the plane or range of planes defined in clause 4.2.4.2 with the geostationary arc with the specified accuracy.

   2)   The adjustment facilities shall be examined to determine both the angular movement possible and the means of securing that movement.

   3)   The securing facility shall be examined to determine its permanency.

c)   Polarization angle alignment capability (linear polarization only):

   1)   The adjustment facilities shall be examined to determine both the angular movement possible and the means of securing that movement.

   2)   The securing facility shall be examined to determine its permanency.

6.7   ST Control and Monitoring Functions (CMF)

6.7.1   Test arrangement

The applicant may modify an ST for the purpose of these tests provided that full documentation is given to prove that the modifications accurately simulate the required test conditions.

The EUT shall transmit at $EIRP_{nom}$.

For the purpose of these tests the EUT is the ST either with, or without its antenna connected.

The measurement of the e.i.r.p. spectral density shall be limited within either the nominated bandwidth or to a 40 MHz bandwidth centred on the carrier frequency, whichever is the greater.
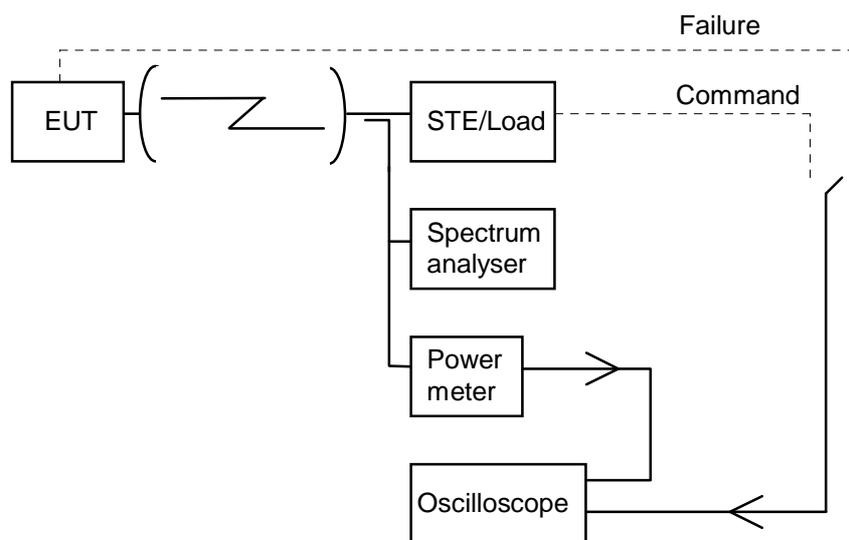
**Figure 10: General test arrangement for control and monitoring tests
for radiated measurements**
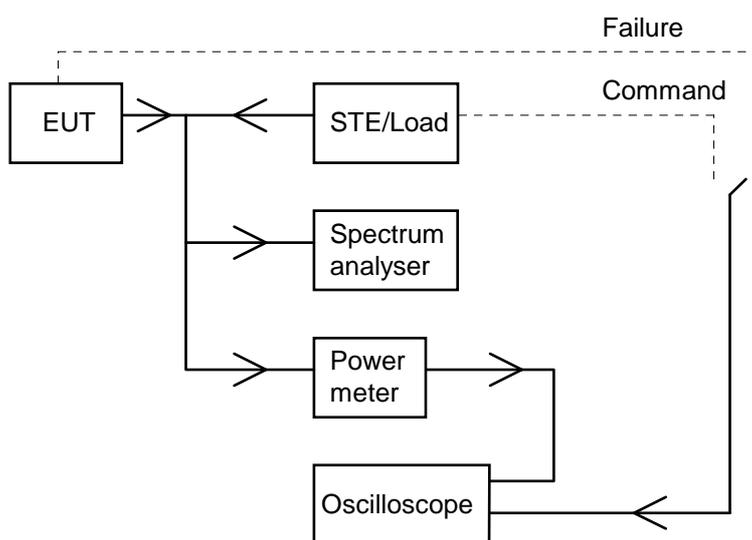
**Figure 11: General test arrangement for control and monitoring tests
for conducted measurements**

The test arrangement shall be as shown in figures 10 and 11. The EUT shall be authorized to transmit and shall be in the "Transmission enabled" state at the commencement of each test, unless otherwise stated. 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 spectrum analyser and the power meter shall monitor the EUT output level.

6.7.2 Processor monitoring - Test method

a) Each of the processors within the EUT shall, in turn, be caused to fail.

b) Within 10 s of such failure the EUT shall cease to transmit as measured by the oscilloscope.

c) The power meter and spectrum analyser shall be observed to ascertain that the transmissions have been suppressed ("Emissions disabled" radio state).

d) The failed processor shall be restored to normal working condition and the EUT shall restore automatically to normal working before the next processor shall be induced to fail.

Where it is considered impracticable to artificially induce processor faults in an EUT, compliance shall be demonstrated by documentary evidence.

6.7.3 Transmit subsystem monitoring - Test method

a) The frequency generation subsystem within the EUT shall be caused to fail in respect of:

1) loss of frequency lock (if applicable);

2) absence of Local Oscillator (LO) output signal.

b) Recognition of each failure in turn by the subsystem monitor shall constitute a SMF event.

c) Within 1 s of such failure the EUT shall cease to transmit as measured by the oscilloscope.

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

e) The failed elements shall be restored to normal working state and the EUT shall be restored to normal working condition before the next induced failure.

Where it is considered impracticable to artificially induce frequency generation subsystem faults in an EUT, compliance shall be demonstrated by documentary evidence.

6.7.4 Power-on/Reset - Test method

a) The EUT shall be switched off and the STE shall not transmit the CC.

b) The EUT shall be switched on.

c) The EUT shall not transmit during and after switching-on, and shall enter the "Non valid" state.

The events from a) to c) shall be displayed and verified with the oscilloscope and by measurement of the transmitted signal. If a manual reset function is implemented the following test shall be performed:

d) The EUT shall be restored to the "Initial phase" state and the STE shall transmit the CC.

e) The EUT shall remain in the "Initial phase" state.

f) The reset function shall be initiated.

g) Within 1 s the EUT shall enter the "Non valid" state.

h) The EUT shall be restored to the "Initial phase" state and the STE shall transmit the CC as well as a TxE.

i) The EUT shall enter the "Transmission enabled" state.

j) The reset function shall be initiated.

k)   Within 1 s the EUT shall enter the "Non valid" state.

The event from e) to k) shall be displayed and verified with the oscilloscope and by measurement of the transmitted signal.

6.7.5   Control Channel (CC) reception - Test method

Tests shall simulate the following events:

- the CC has never been received by the EUT after power-on;

- the CC is lost by the EUT after reception of a Transmission Enable command;

- the CC is lost by the EUT without reception of a Transmission Enable command;

- the CC is being lost by the EUT and a call is initiated within the Time-Out period T1.

The Time-Out period T1 used in the tests shall be 10 s.

a)   Case where the CC has never been received by the EUT after power-on:

a1)   The EUT shall be switched off and the STE shall not transmit the CC.

a2)   The EUT shall be switched on.

a3)   The EUT shall remain in the "Non valid" state.

The events from a2) to a3) shall be displayed and verified with the oscilloscope and by measurement of the transmit signal.

b)   Case where the CC is lost by the EUT after reception of a Transmission Enable command:

b1)   The EUT shall be switched-on and the STE shall transmit the CC and a TxE.

b2)   The EUT shall enter the "Initial phase" state and go, if applicable, to the "Transmission enabled" state.

b3)   A transmission request shall be initiated from the EUT.

b4)   The STE shall stop transmitting the CC.

b5)   Within the period T1 from event b4), the EUT shall enter the "Non valid" state.

The events from b1) to b5) shall be displayed and verified with the oscilloscope and by measurement of the transmitted signal.

c)   Case where the CC is lost by the EUT without reception of a "Transmission enabled" state:

c1)   The EUT shall be switched on and the STE shall transmit the CC.

c2)   The EUT shall enter the "Initial phase" state.

c3)   The STE shall stop transmitting the CC.

c4)   The EUT shall enter in the "Non valid" state not later than T1.

c5)   A transmission request shall be initiated and the EUT shall remain in the "Non valid" state.

The events from c2) to c5) shall be displayed and verified with the oscilloscope and by measurement of the transmitted signal.

d)   Case where the CC is being lost by the EUT and a call is initiated within the T1 period:

d1)   The EUT shall be switched on and the STE shall transmit the CC.

d2)   The STE shall stop transmitting the CC.

d3)   Within the period T1 from d2), a transmission request shall be initiated from the EUT.

d4) The EUT may transmit but within the T1 period the EUT shall enter the "Non valid" state.

The events from d2) to d4) shall be displayed and verified with the oscilloscope and by measurement of the transmitted signal.

6.7.6 Network Control commands - Test method

The following tests shall be performed in sequence:

- Transmission enable command.

- Transmission disable command received in the "Transmission enabled" state.

- Transmission disable command received in the "Initial phase" state.

a) Transmission enable command:

a1) The EUT shall be switched-on and the STE shall transmit the CC.

a2) The EUT shall enter the "Initial phase" state.

a3) A transmission request shall be initiated from the EUT, the EUT shall remain in the "Initial phase" state.

a4) The STE shall transmit an enable command to the EUT.

a5) A transmission request shall be initiated from the EUT.

a6) The EUT shall enter the "Transmission enabled" state and shall transmit.

The events from a2) to a6) shall be displayed and verified with the oscilloscope and by measurement of the transmitted signal.

b) Transmission disable command received in the "Transmission enabled" state:

b1) Continue from a6).

b2) The STE shall transmit a disable command to the EUT.

b3) The EUT shall enter the "Transmission disabled" state within 10 s.

b4) A transmission request shall be initiated from the EUT.

b5) The EUT shall remain in the "Transmission disabled" state.

b6) The STE shall transmit an enable command.

b7) The EUT shall enter either the "Transmission enabled" state or the "Initial phase" state.

b8) If the EUT is in the "Transmission enable" state then the test continues with b11).

b9) The STE shall transmit a TxE command.

b10) The EUT shall enter the "Transmission enable" state.

b11) If a transmission request is not active any more than a new transmission request shall be initiated.

b12) The EUT shall transmit.

b13) The EUT transmission shall be terminated.

The events from b2) to b13) shall be displayed and verified with the oscilloscope and by measurement of the transmitted signal.

c) Transmission disable command received in the "Initial phase" state:

c1) The EUT shall be switched-on and the STE shall transmit the CC.

c2) The EUT shall enter the "Initial phase" state.

c3) The STE shall transmit a disable command to the EUT.

c4) The EUT shall enter the "Transmission disabled" state within 1 s.

c5) A transmission request shall be initiated from the EUT.

c6) The EUT shall remain in the "Transmission disabled" state.

c7) The STE shall transmit an enable command.

c8) The EUT shall enter either the "Transmission enabled" state or the "Initial phase" state.

c9) If the EUT is in the "Transmission enable" state then the test continues with c12).

c10) The STE shall transmit a TxE command.

c11) The EUT shall enter the "Transmission enable" state.

c12) If a transmission request is not active any more than a new transmission request shall be initiated.

c13) The EUT shall transmit.

c14) The EUT transmission shall be terminated.

The events from c2) to c14) shall be displayed and verified with the oscilloscope and by measurement of the transmitted signal.

6.7.7 Initial burst transmission - Test method

Tests shall be performed to simulate the following events:

- The CC is being received by the EUT.

- The CC has not been received by the EUT since power-on.

a) Case where the CC is being received:

a1) The EUT shall be switched-off and the STE shall transmit the CC.

a2) The EUT shall be switched-on.

a3) The EUT shall not transmit, except the initial bursts.

a4) It shall be verified that the specifications given in clause 4.2.7.7 are fulfilled.

The events from a2) to a4) shall be displayed and verified with the oscilloscope and by measurement of the transmitted signal.

b) Case where the CC has not been received by the EUT since power-on:

b1) The EUT shall be switched-off and the STE shall not transmit the CC.

b2) The EUT shall be switched-on.

b3) The EUT shall not transmit.

The events from b2) to b3) shall be displayed and verified with the oscilloscope and by measurement of the transmitted signal.

6.8 Receive antenna off-axis gain pattern

6.8.1 Test method

6.8.1.1 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.

### 6.8.1.2 Method of measurement
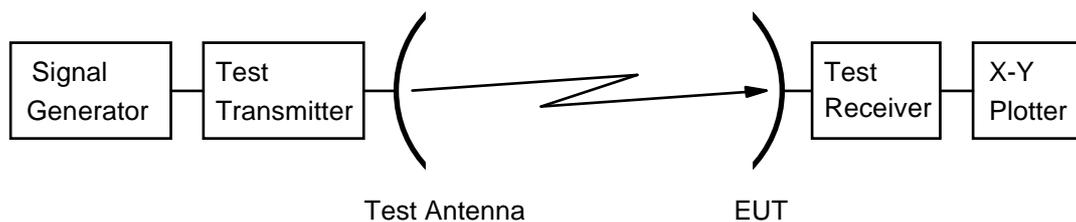
Figure 12: Test arrangement - antenna receive pattern measurement

a) The test arrangement shall be as shown in figure 12 with the EUT connected to the test receiver.

b) 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.

c) The test frequencies shall be the centre frequency of each applicable frequency range. The E-plane shall be vertical.

d) The EUT shall be aligned to maximize the received signal level and the X-Y plotter shall be adjusted to give the maximum reading on the chart.

e) The EUT shall be driven in azimuth through 180°.

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

g) The tests in b) to e) shall be repeated with the frequency changed to the lower limit of the applicable band as declared by the manufacturer.

h) The tests in b) to e) shall be repeated with the frequency changed to the upper limit of the applicable band as declared by the manufacturer.

i) The tests in b) to h) shall be repeated with the frequencies changed to the others specified if the design of the equipment is such that operation is possible, but not necessarily simultaneously, in all bands.

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 90° to that in k).

m) The tests in b) to l) shall be repeated between the angles of φ_r and 7° with the EUT rotated through 90°, or the test antenna or the polarization subsystem of the EUT rotated by 90°, to give the cross-polar measurement.

6.8.1.3   Computation

The computation of results shall be carried out by producing a "mask" to the specified limits with the reference level being equal to the gain of the antenna. This reference shall then be placed on the maximum point of the plot obtained from the pattern measurements.

6.9   Blocking performance

6.9.1   Test method

a)   The output signals of two signal generators shall be combined with equal weight. The combined signal shall be coupled to the LNB input in a reasonable and appropriate way.

b)   A spectrum analyser shall be connected to the LNB output in a way that allows to supply the LNB with power.

c) f_c is the center frequency of the receive frequency band.

d)   The first signal generator frequency shall be set to f_c.

e)   The first signal generator level shall be set to a level in the LNB operational input level range.

f)   The spectrum analyser shall be set for measuring the level of the converted first signal at the LNB output.

g)   The second signal generator frequency shall be set to $f_c - 20$ MHz.

h)   The second signal generator level shall be adjusted so that the measured level is 1 dB less than in absence of the second signal.

i)   The second signal generator level shall be noted down as reference level.

j)   The second signal generator frequency shall be set to the frequency of interest.

k)   The second signal generator level shall be adjusted so that the measured level is 1 dB less than in absence of the second signal.

l)   The rejection at the frequency of interest is equal to the second signal generator level minus the reference level determined in step i).

m)   Steps j) to l) shall be repeated for frequencies in the ranges of table 4.

NOTE: The worst case rejection in a particular frequency range can be determined after step i) by sweeping the second signal generator frequency over the frequency range and observe the gain compression, then perform steps j) to l) with the frequency where gain compression is highest.

6.10   Adjacent Signal Selectivity

6.10.1   Test method

a)   Two test signal generators shall be used. Each signal generator shall generate a modulated signal in the IDUinput frequency range and thermal noise.

b)   The signal generators shall be connected to the IDUinput through a splitter (combiner).

c)   The test signal generators shall be set to the frequencies and levels according to table 5.

d)   The IDUshall be set to receive the signal of the first test signal generator.

e)   The second test signal generator shall be set to signal off.

f)   The noise level (or signal to noise ratio) of the first test signal generator shall be varied in order to determine the threshold reference sensitivity level.

g)   The second signal generator shall be set to signal on.

h)   The noise level (or signal to noise ratio) of the first test signal generator shall be varied in order to determine the threshold reference sensitivity level.

i)   The degradation is equal to the noise level (or signal to noise ratio) determined in step d) minus that determined in step b).

j)   The result of the highest degradation found.

Annex A (normative):
Relationship between the present document and the essential requirements of Directive 2014/53/EU

The present document has been prepared under the Commission's standardisation request C(2015) 5376 final [i.4] to provide one voluntary means of conforming to the essential requirements of Directive 2014/53/EU on the harmonisation of the laws of the Member States relating to the making available on the market of radio equipment and repealing Directive 1999/5/EC [4].

Once the present document is cited in the Official Journal of the European Union under that Directive, compliance with the normative clauses of the present document given in table A.1 confers, within the limits of the scope of the present document, a presumption of conformity with the corresponding essential requirements of that Directive, and associated EFTA regulations.

The present document is therefore intended to cover the provisions of Directive 2014/53/EU [4] (RE Directive) article 3.2 which states that "....*radio equipment shall be so constructed that it both effectively uses and supports the efficient use of radio spectrum in order to avoid harmful interference*".

Recital 10 of Directive 2014/53/EU [4] states that "*in order to ensure that radio equipment uses the radio spectrum effectively and supports the efficient use of radio spectrum, radio equipment should be constructed so that: in the case of a transmitter, when the transmitter is properly installed, maintained and used for its intended purpose it generates radio waves emissions that do not create harmful interference, while unwanted radio waves emissions generated by the transmitter (e.g. in adjacent channels) with a potential negative impact on the goals of radio spectrum policy should be limited to such a level that, according to the state of the art, harmful interference is avoided; and, in the case of a receiver, it has a level of performance that allows it to operate as intended and protects it against the risk of harmful interference, in particular from shared or adjacent channels, and, in so doing, supports improvements in the efficient use of shared or adjacent channels.*"

Recital 11 of Directive 2014/53/EU [4] states that "*although receivers do not themselves cause harmful interference, reception capabilities are an increasingly important factor in ensuring the efficient use of radio spectrum by way of an increased resilience of receivers against harmful interference and unwanted signals on the basis of the relevant essential requirements of Union harmonisation legislation.*"

As a consequence, the present document includes both transmitting and receiving parameters to maximize the efficient use of radio spectrum.

Table A.1: Relationship between the present document and
the essential requirements of Directive 2014/53/EU

Harmonised Standard ETSI EN 301 459 The following requirements are relevant to the presumption of conformity under the article 3.2 of Directive 2014/53/EU [4]				
Requirement			**Requirement Conditionality**	
No	**Description**	**Reference: Clause No**	**U/C**	**Condition**
1	Off-axis spurious radiation	4.2.2	U	
2	On-axis spurious radiation	4.2.3	U	
3	Off-axis e.i.r.p. emission density within the band	4.2.4	U	
4	Carrier suppression	4.2.5	U	
5	Antenna pointing accuracy	4.2.6	U	
6	Processor monitoring	4.2.7.2	U	
7	Transmit subsystem monitoring	4.2.7.3	U	
8	Power-on/Reset	4.2.7.4	U	
9	Control Channel (CC) reception	4.2.7.5	U	
10	Network control commands	4.2.7.6	U	
11	Initial burst transmission	4.2.7.7	U	

Harmonised Standard ETSI EN 301 459				
The following requirements are relevant to the presumption of conformity under the article 3.2 of Directive 2014/53/EU [4]				
Requirement			Requirement Conditionality	
No	Description	Reference: Clause No	U/C	Condition
12	Receive Antenna off-axis gain pattern	4.2.8	C	Satellite communications networks may contain a central control unit that keeps received interference low by taking into account the actual antenna gain pattern of earth stations. The requirement is not relevant for earth stations that are always operated as part of such a network. The requirement is relevant in all other cases. If the receive antenna performance does not meet the requirement in clause 4.2.8, then the terminal shall accept an additional co-frequency interference caused by its off-axis gain which is not compliant to the mask.
13	Blocking performance	4.2.9	U	
14	Adjacent Signal Selectivity	4.2.10	U	

Key to columns:

Requirement:

No   A unique identifier for one row of the table which may be used to identify a requirement.

Description   A textual reference to the requirement.

Clause Number Identification of clause(s) defining the requirement in the present document unless another document is referenced explicitly.

Requirement Conditionality:

U/C   Indicates whether the requirement shall be unconditionally applicable (U) or is conditional upon the manufacturers claimed functionality of the equipment (C).

Condition   Explains the conditions when the requirement shall or shall not be applicable for a requirement which is classified "conditional".

Presumption of conformity stays valid only as long as a reference to the present document is maintained in the list published in the Official Journal of the European Union. Users of the present document should consult frequently the latest list published in the Official Journal of the European Union.

Other Union legislation may be applicable to the product(s) falling within the scope of the present document.

Annex B (informative):
Pointing stability methodology

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

In the first stage the effects of maximum wind speed should 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 should 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, for example:

    -   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 should 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 should 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: 160 km/h.

3) It should be verified with the simulated results that break point limits are not exceeded for any self-contained element.

4) The calculated equivalent static loads should be applied at any identified critical fixing point of the assembly.

5) While the loads are applied the outdoor unit should be observed and any distortion noted.

6) The test report should 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

- ETSI EN 301 358 (V1.1.1): "Satellite Earth Stations and Systems (SES); Satellite User Terminals (SUT) using satellites in geostationary orbit operating in the 19,7 GHz to 20,2 GHz (space-to-earth) and 29,5 GHz to 30 GHz (earth-to-space) frequency bands".

- ETSI EN 301 359 (V1.1.1): "Satellite Earth Stations and Systems (SES); Satellite Interactive Terminals (SIT) using satellites in geostationary orbit operating in the 11 GHz to 12 GHz (space-to-earth) and 29,5 GHz to 30,0 GHz (earth-to-space) frequency bands".

- ETSI EN 301 489-12 (V1.2.1): "Electromagnetic compatibility and Radio spectrum Matters (ERM); ElectroMagnetic Compatibility (EMC) standard for radio equipment and services; Part 12: Specific conditions for Very Small Aperture Terminal, Satellite Interactive Earth Stations operated in the frequency ranges between 4 GHz and 30 GHz in the Fixed Satellite Service (FSS)".

- Directive 98/34/EC of the European Parliament and of the Council of 22 June 1998 laying down a procedure for the provision of information in the field of technical standards and regulations.

- Directive 1999/5/EC of the European Parliament and of the Council of 9 March 1999 on radio equipment and telecommunications terminal equipment and the mutual recognition of their conformity (R&TTE Directive).

History

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