

**Satellite Earth Stations and Systems (SES);
Harmonized EN for satellite Earth Stations on board
Vessels (ESVs) operating in the 4/6 GHz frequency bands
allocated to the Fixed Satellite Service (FSS) covering
essential requirements under article 3.2 of the R&TTE directive**



Reference

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Foreword

This Candidate Harmonized European Standard (Telecommunications series) has been produced by ETSI Technical Committee Satellite Earth Stations and Systems (SES), and is now submitted for the Public Enquiry phase of the ETSI standards Two-step Approval Procedure.

The present document has been produced by ETSI in response to a mandate from the European Commission issued under Directive 98/34/EC [3] laying down a procedure for the provision of information in the field of technical standards and regulations.

The present document is intended to become a Harmonized Standard, the reference of which will be published in the Official Journal of the European Communities referencing the Directive 1999/5/EC [1] 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 ("the R&TTE Directive").

Technical specifications relevant to Directive 1999/5/EC [1] are given in annex A.

Proposed national transposition dates	
Date of latest announcement of this EN (doa):	3 months after ETSI publication
Date of latest publication of new National Standard or endorsement of this EN (dop/e):	6 months after doa
Date of withdrawal of any conflicting National Standard (dow):	6 months after doa

Introduction

ETSI has designed a modular structure for the standards. Each standard is a module in the structure. The modular structure is shown in figure 1.

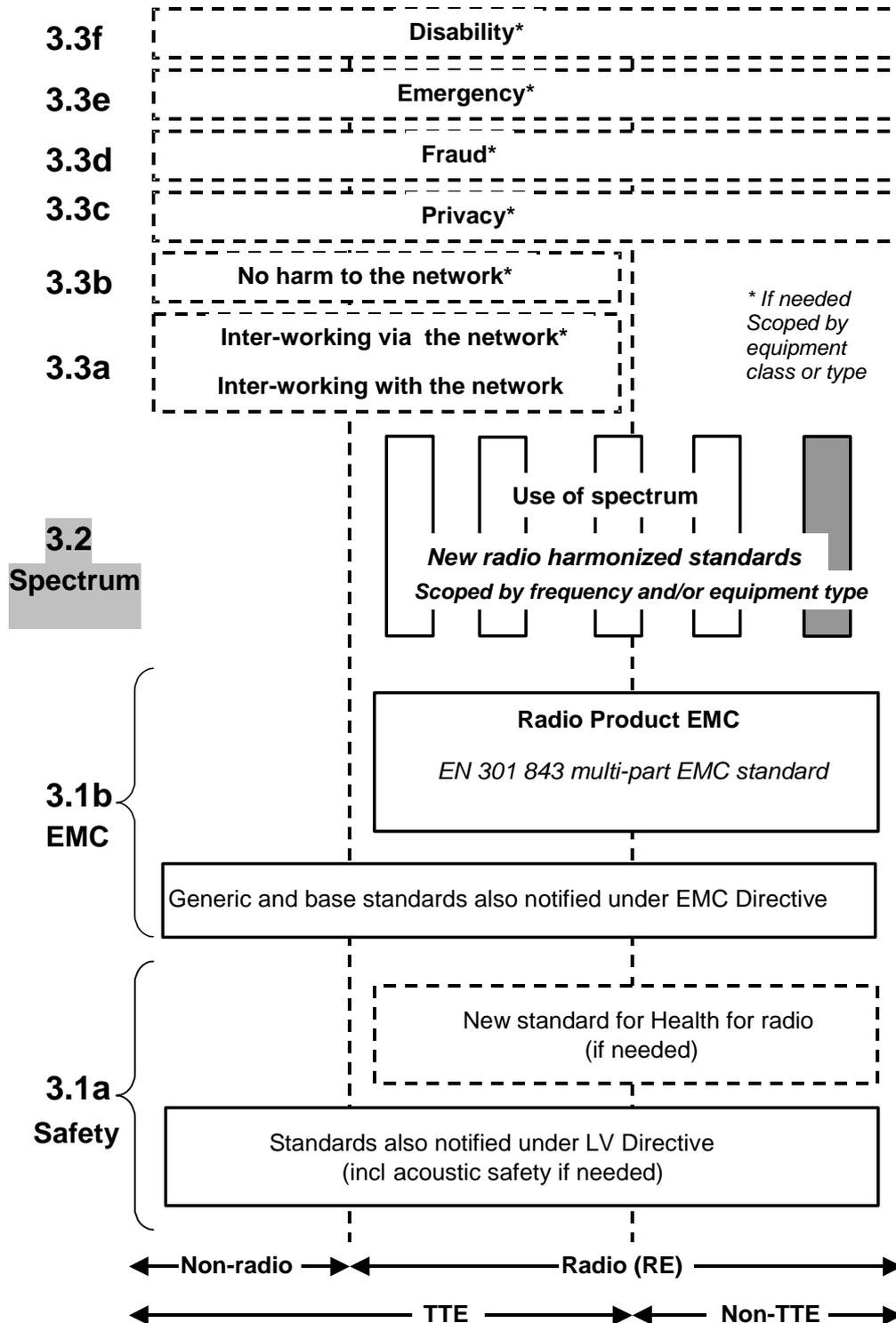


Figure 1: Modular structure for the various standards used under the R&TTE Directive [1]

The left hand edge of the figure shows the different clauses of Article 3 of the R&TTE Directive [1].

For article 3.3 various horizontal boxes are shown. Their dotted lines indicate that no essential requirements in these areas have yet been adopted by the Commission. If such essential requirements are adopted, they will be elaborated in individual standards whose scope is likely to be specified by function or interface type.

The vertical boxes show the standards under article 3.2 for the use of the radio spectrum. The scopes of these standards are specified either by frequency (normally in the case where frequency bands are harmonized) or by radio equipment type.

For article 3.1b, the diagram shows EN 301 843 (see bibliography), the multi-part product EMC standard for maritime radio used under the EMC Directive [7].

For article 3.1a the diagram shows the existing safety standards currently used under the LV Directive [6] and the possibility of a new standard on health relating to radio emissions.

The bottom of the figure shows the relationship of the standards to radio equipment and telecommunications terminal equipment. Particular equipment may be radio equipment, telecommunications terminal equipment or both.

The modular approach has been taken because:

- it minimizes the number of standards needed. Because equipment may have multiple interfaces and functions it is not practicable to produce a single standard for each possible combination of functions that may occur in an equipment;
- it provides scope for standards to be added:
 - under article 3.2 when new frequency bands are agreed; or
 - under article 3.3 should the Commission take the necessary decisions, without requiring alteration of standards that are already published.
- It clarifies, simplifies and promotes the usage of harmonized standards as the relevant means of conformity assessment.

Remarks on the present document

The determination of the parameters of the user earth stations using a given geo-stationary 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 is based on the application of ITU-R Res. 902 (WRC-03) (see Bibliography).

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 either 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 the ESV.

All parts of the below-deck 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 EN is based upon the standard for environmental conditions for marine navigational equipment, EN 60945 [4]. In addition, attention should be paid to clause 11.1 (Acoustic noise and signals), and clause 11.2 (Compass safe distance).

1 Scope

The present document applies to Earth Stations located on board Vessels (ESVs) which have the following characteristics:

- The ESV is comprised of all the equipment, electrical and mechanical, from the antenna itself to the interface with other communications equipment on board (usually referred to as the terrestrial interface).
- The ESV transmits in the frequency range from 5,925 GHz to 6,425 GHz allocated to the Fixed Satellite Services (FSS) (earth-to-space).
- The ESV receives in one or more frequencies within the range from 3,700 GHz to 4,200 GHz in the bands allocated to the Fixed Satellite Services (FSS) (space-to-earth), depending on the ITU Region where the ESV is located.
- The ESV uses linear or circular polarization.
- The ESV operates through a geostationary satellite at least 2° to 3° away from any other geostationary satellite operating in the same frequency band and covering the same area.

NOTE 1: The satellite spacing is mainly equal to 3° in ITU Regions 1 and 3 and 2° in ITU Region 2.

The ESV transmits at elevations greater or equal to the minimum elevation angle declared by the applicant.

- The ESV antenna diameter is not smaller than 1,2 m.
- The ESV is designed for transmission and reception of radio-communications signals in accordance with any of the frequency bands specified above.
- The ESV is usually designed for unattended operation.
- The ESV is operating as part of a satellite network (e.g. star, mesh or point-to-point) used for the distribution and/or exchange of information between users.
- The ESV is controlled and monitored by a Network Control Facility (NCF). The NCF is outside the scope of the present document.

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

The present document is intended to cover the provisions of Directive 1999/5/EC [1] (R&TTE Directive) Article 3.2, which states that "... radio equipment shall be so constructed that it effectively uses the spectrum allocated to terrestrial/space radio communications and orbital resources so as to avoid harmful interference".

The present EN incorporates the technical limitations listed in annex 2 of ITU-R Res. 902 (WRC-03) (see Bibliography).

NOTE 2: According to Res. 902, any transmission from ESVs within the 300 km minimum distance of each country where the ESV transmit frequency band is used by the Fixed Service will be subject to the prior agreement of the concerned administration(s) or to the relevant ECC Decision and may specify additional operational requirements.

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 Directive 1999/5/EC [1] (R&TTE Directive) may apply to equipment within the scope of the present document.

NOTE 3: A list of such ENs is included on the web site <http://www.newapproach.org/>.

2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication and/or edition number or version number) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies.

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

- [1] 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).
- [2] CISPR 16-1 (2003): "Specification for radio disturbance and immunity measuring apparatus and methods".
- [3] 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.
- [4] EN 60945 (2002): "Maritime navigation and radiocommunication equipment and systems - General requirements - Methods of testing and required test results".
- [5] ITU-R Radio Regulations (2004).
- [6] Council Directive 73/23/EEC of 19 February 1973 on the harmonization of the laws of Member States relating to electrical equipment designed for use within certain voltage limits (LV Directive) as amended 93/68/EEC.
- [7] Council Directive 89/336/EEC of 3 May 1989 on the approximation of the laws of the Member States relating to electromagnetic compatibility (EMC Directive).
- [8] CISPR 16-1-5 (2003): "Specification for radio disturbance and immunity measuring apparatus and methods - Part 1-5: Radio disturbance and immunity measuring apparatus - Antenna calibration test sites for 30 MHz to 1 000 MHz).

3 Definitions, symbols and abbreviations

3.1 Definitions

For the purposes of the present document, the terms and definitions in the Directive 1999/5/EC [1] and the following apply:

above-deck unit: part of the ESV intended to be installed above deck, as declared by the applicant, or as indicated in the user documentation

The above-deck unit usually comprises the following main parts:

- a) the antenna sub-system which converts the incident radiation field into a guided wave and vice versa;
- b) the Low Noise Block (LNB) down converter, which is a device that amplifies, with very low internal noise, the received signals in the Radio Frequency (RF) band and converts them to intermediate frequencies;
- c) the up-converter and the power amplifier which convert from the intermediate frequency to RF and amplify the low level RF signals for transmission through the antenna subsystem;

- d) the stabilization and tracking subsystems that ensure pointing of the antenna main beam towards the satellite within the required accuracy.

NOTE: The installation equipment (means of attachment) 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.

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

- a) the equipment is intended for use in conjunction with the ESV to provide additional operational and/or control features (e.g. to extend control to another position or location); and
- b) the equipment cannot be used on a stand alone basis, to provide user functions independently of the ESV; and
- c) the absence of the equipment does not inhibit the operation of the ESV.

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

below-deck unit: part of the ESV equipment which is installed inside the vessel (i.e. below deck) and its connection cables with the above deck units

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

NOTE 1: The phrase "the ESV may transmit" means that all the conditions for transmission are satisfied (e.g. in a state where transmissions are permitted, no failure detected, and the ESV is correctly pointed towards the satellite).

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

carrier-on radio state: radio state in which the ESV may transmit and transmits a carrier

Control Channel (CC): channel or channels by which ESVs receive control information from the NCF

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

emissions disabled radio state: radio state in which the ESV must not emit

NOTE: Examples of cases where the ESV in this radio state: before system monitoring pass, before the control channel is received, when a failure is detected, when the ESV is commanded to disable, and when the ESV in a location requiring cessation of emissions.

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

external control channel: control channel which is either (i) carried by the ESV network via the same or another satellite, but not within the internal protocol of the ESV system, or (ii) carried by any other radio communication system

external response channel: response channel which is either (i) carried by the ESV network via the same or another satellite, but not within the internal protocol of the ESV system, or (ii) carried by any other radio communication system

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

internal control channel: control channel which is carried by the ESV network via the same satellite as used for transmission of user data and within the internal protocol structure of the ESV system

internal response channel: response channel which is carried by the ESV network via the same satellite as used for transmission of user data and within the internal protocol structure of the ESV system

network: a network is any network configuration including star, mesh and point-to-point configurations

Network Control Facility (NCF): set of functional entities that, at system level, monitor and control the correct operation of all ESVs in a network

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

NOTE 1: The nominated bandwidth is centred on the transmit frequency and does not exceed 5 times the occupied bandwidth.

NOTE 2: The nominated bandwidth is wide enough to encompass all spectral elements of the transmission which have a level greater than the specified spurious radiation limits. The nominated bandwidth is wide enough to take account of the transmit carrier frequency stability. This definition is chosen to allow flexibility regarding adjacent channel interference levels which will be taken into account by operational procedures depending on the exact transponder carrier assignment situation.

occupied bandwidth:

- for a digital modulation scheme: the width of the signal spectrum between the points 10 dB below the maximum in-band density;
- for an analogue modulation scheme-the width of a frequency band such that, below the lower and above the upper frequency limits, the mean power emitted is equal to 0,5 % of the total mean power of the emission.

off-axis angle: angle between the direction of the axis of the antenna main beam and the considered direction

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

Response Channel (RC): channel by which ESV transmit monitoring information to the NCF

spurious radiation: any radiation outside the nominated bandwidth

Transmission disabled state: ESV is in this state when it is not authorized by the NCF to transmit

Transmission enabled state: ESV is in this state when it is authorized by the NCF to transmit

3.2 Symbols

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

dBc	Ratio expressed in decibels relative to the e.i.r.p. of the unmodulated carrier
dBi	Ratio of an antenna gain to the gain of an isotropic antenna, expressed in decibels
dBW	Ratio of a power to 1 watt, expressed in decibels
dBpW	Ratio of a power to 1 pico watt, expressed in decibels
dB μ V/m	Ratio of an electric field to 1 μ V/m, expressed in decibels ($20 \log(\text{electric field} / 1 \mu\text{V/m})$)

3.3 Abbreviations

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

CC	Control Channel
CCF	Control Channel reception Failure
CEPT	Conférence Européenne des Postes et Télécommunications (European Conference of Postal and Telecommunications Administrations)
CER	Cessation of Emissions Requested
CENR	Cessation of Emissions Not Requested
CISPR	Comité International Spécial des Perturbations Radioélectriques (International Special Committee on Radio Interference)
CMF	Control and Monitoring Functions
CCR	Control Channel correctly Received
ECC	Electronic Communications Committee (of CEPT)
e.i.r.p.	Equivalent Isotropically Radiated Power
EMC	Electro-Magnetic Compatibility
EN	European Standard
ESV	Earth Station on board a Vessel
EUT	Equipment Under Test
FEC	Forward Error Correction
FSS	Fixed Satellite Service
GSO	Geostationary Satellites Orbit

HPA	High Power Amplifier
IPR	Intellectual Property Rights
ITU	International Telecommunications Union
LHCP	Left Hand Circular Polarization
LNB	Low Noise Block
LO	Local Oscillator
LV	Low Voltage
NCF	Network Control Facility
R&TTE	Radio and Telecommunications Terminal Equipment
RC	Response Channel
RF	Radio Frequency
RHCP	Right Hand Circular Polarization
SMF	System Monitoring Fail
SMP	System Monitoring Pass
STE	Special Test Equipment
TxD	Transmission Disable command
TxE	Transmission Enable command
XPD	Cross Polar Discrimination
WRC	ITU World Radio Conference

4 Technical requirements specifications

4.1 General

4.1.1 Environmental profile

Before carrying out any other tests specified in the present document, survivability testing of the ESV shall be conducted under the following clauses of EN 60945 [4]:

- Clause 8.1: General.
- Clause 8.3: Damp heat.
- Clause 8.7: Vibration.

The components of the ESV may be subject to different operational environmental conditions and shall maintain their performance in accordance with the present document under all environmental circumstances for the environmental classes applicable to them as defined in EN 60945 [4]. Specifically, the operational environmental conditions for:

- "protected" class shall apply to the below deck equipment; and
- "exposed" class shall apply to the above deck equipment.

4.1.2 Operational configurations

Under operational conditions an ESV may dynamically change the occupied bandwidth and other transmission parameters (e.g. FEC, modulation, symbol rate) of the transmitted signal. For each occupied bandwidth an $EIRP_{max}$ and a nominated bandwidth shall be declared by the applicant. The nominated bandwidth shall be centred on the transmit frequency and does not exceed 5 times the occupied bandwidth.

The following specifications apply to the ESV for each occupied bandwidth and other transmission parameters.

4.1.3 ESV states and radio states

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

- "Non valid";
- "Initial phase";
- "Transmission disabled"; and
- "Transmission enabled".

The four ESV states are represented on figure 2 and are used in clause 4.2.9 for the specification of the Control and Monitoring Functions (CMFs).

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

The "Initial phase" is divided into three sub-states:

- "Initial phase-0" until the first initial burst is transmitted or when no initial bursts are transmitted;
- "Initial phase-1" during the transmission of the initial bursts;
- "Initial phase-2" between initial bursts.

NOTE: ESVs which do not transmit initial bursts have no "Initial phase-1" state and no "Initial phase-2" state.

The ESV "may transmit" when all the conditions for transmission are satisfied (e.g. in a state where transmissions are permitted, no failure detected, correctly pointed towards the satellite and there is no requirement for cessation of emissions).

The following radio states of the ESV are defined:

- "Emissions disabled" when the ESV must not transmit any carrier;
- "Carrier-off" when the ESV may transmit and does not transmit any carrier;
- "Carrier-on" when the ESV may transmit and transmits a carrier.

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

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

Table 1: ESV states and radio states of the ESV

ESV states	Radio states	Examples of events
"Non valid"	"Emissions disabled"	After-power on, or After any failure, or During the checking phase
"Initial phase"		When waiting for a transmission enable or disable command from the NCF
"Initial phase-0"	"Emissions disabled"	Before the first initial burst transmissions; or In locations where no transmission is allowed
"Initial phase-1"	"Carrier-on"	During the transmission of each initial burst, and the pointing is correct
"Initial phase-2"	"Carrier-off"	Between initial bursts, or When the pointing threshold is exceeded
"Transmission enabled"	"Carrier-off"	When no carrier is transmitted, or When the pointing threshold is exceeded
	"Carrier-on"	During transmission of carrier(s), and the pointing is correct
"Transmission disabled"	"Emissions disabled"	When a disable command from the NCF has been received and waiting for a transmission enable command from the NCF, or In locations where no transmission is allowed

4.2 Conformance requirements

4.2.1 Off-axis spurious radiation

4.2.1.1 Justification

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

The limits below 2 GHz are those specified in EN 60945 [4] for marine navigational equipment, i.e. for the maritime environment.

4.2.1.2 Specification

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

- 1) The electric field strength level of any radiation from the ESV in the frequency range from 30 MHz to 2 GHz shall not exceed the limits specified in table 2.

Table 2: Limits of radiated electric field strength at a measuring distance of 3 m

Frequency range	Limit (Quasi Peak)	Limit (Peak)	Measurement bandwidth
30 MHz to 1 GHz	54 dB μ V/m	No limit applies	100 kHz to 120 kHz
1 GHz to 2 GHz	No limit applies	54 dB μ V/m	100 kHz to 120 kHz
156 MHz to 165 MHz	24 dB μ V/m	30 dB μ V/m	9 kHz to 10 kHz

NOTE: The EN 60945 [4] limits below 30 MHz are not relevant for ESVs radiating in the 6 GHz frequency band.

The Peak and Quasi Peak detectors shall be in accordance with CISPR 16-1 [2].

- 2) When the ESV is in the "Emissions disabled" radio state, the off-axis spurious Equivalent Isotropically Radiated Power (e.i.r.p.) from the ESV, in any 100 kHz band, shall not exceed the limits in table 3, for all off-axis angles greater than 7° or greater than the minimum elevation angle declared by the applicant, whichever is lower.

Table 3: Limits of spurious e.i.r.p. - "Emissions disabled" radio state

Frequency band	e.i.r.p. limit (dBpW)	Measurement bandwidth
2,0 GHz to 10,7 GHz	48	100 kHz
10,7 GHz to 21,2 GHz	54	100 kHz
21,2 GHz to 40,0 GHz	60	100 kHz

The lower limits shall apply at the transition frequency.

- 3) This specification applies outside the nominated bandwidth. In the "Carrier-on" and "Carrier-off" radio states, the off-axis spurious e.i.r.p. density from the ESV, shall not exceed the limits in table 4, for all off-axis angles greater than 7° or greater than the minimum elevation angle declared by the applicant, whichever is lower.

Table 4: Limits of spurious e.i.r.p.- "Carrier-on" and "Carrier-off" radio states

Frequency band (GHz)	e.i.r.p. limit (dBpW)	Measurement bandwidth	Remarks
2,0 to 3,4	49	100 kHz	
3,40 to 5,47	55	100 kHz	
5,47 to 5,775	75	10 MHz	
5,775 to 5,925	95	10 MHz	See note
5,925 to 6,425	95	10 MHz	See note
6,425 to 6,575	95	10 MHz	See note
6,575 to 7,025	75	10 MHz	
7,025 to 10,7	55	100 kHz	
10,7 to 21,2	61	100 kHz	
21,2 to 40,0	67	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 at the considered frequency is 50 dB below the maximum on-axis e.i.r.p. density of the signal (within the nominated bandwidth) expressed in dBW/100 kHz.

The lower limits shall apply at the transition frequency.

In the frequency band 11,85 GHz to 12,85 GHz, for any 20 MHz band within which one or more spurious signals exceeding the above limit of 61 dBpW/100 kHz are present, then the power of each of those spurious signals exceeding the limit shall be added in watts, and the sum shall not exceed 78 dBpW.

For ESVs designed to transmit simultaneously several carriers (multicarrier operation), the above limits apply to any combination of carriers declared by the applicant and outside the shortest 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 ESV equipment, comprising the equipment units below and above deck including cabling between the units.

4.2.1.3 Conformance tests

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

4.2.2 On-axis spurious radiation for ESV

4.2.2.1 Justification

To limit the level of interference to satellite radio services.

4.2.2.2 Specification

4.2.2.2.1 "Carrier-on" radio state

The following specification applies to the ESV transmitting at e.i.r.p. values up to $EIRP_{max}$.

In the 5,925 MHz to 6,425 MHz band the e.i.r.p. spectral density of the spurious radiation and outside a bandwidth of 5 times the occupied bandwidth centred on the carrier centre frequency shall not exceed 4 - K dBW in any 100 kHz band.

The e.i.r.p. spectral density of the spurious radiation outside the nominated bandwidth and within a bandwidth of 5 times the occupied bandwidth centred on the carrier centre frequency, shall not exceed 18 - K dBW in any 100 kHz band.

Where K is the factor that accounts for a reduction on the on-axis spurious radiation level in case of multiple ESVs transmitting towards the same satellite on the same frequency and polarization; the value of K is given by one the following cases:

- 1) For the case where only one ESV transmits at any one time on a given carrier frequency, the value of K is 0.
- 2) For the case where several ESVs are expected to transmit simultaneously on a given carrier frequency at the same e.i.r.p. then $K = 10 \log(N)$ where N is the maximum number of these ESVs. The value of N shall not be exceeded for more than 0,01 % of the time. The value of N and the operational conditions of the system shall be declared by the applicant.
- 3) For the case where several ESVs are expected to transmit simultaneously on a given carrier frequency at different e.i.r.p. levels then $K = -10 \log(e.i.r.p./EIRP_{Aggregate})$, where:
 - e.i.r.p. is the on-axis e.i.r.p. (Watts) of the ESV within the nominated bandwidth; and
 - $EIRP_{Aggregate}$ is the maximum on-axis aggregate e.i.r.p. (Watts) within the nominated bandwidth of the ESV system towards the satellite;
 - $EIRP_{Aggregate}$ shall not be exceeded for more than 0,01 % of the time.

The value of $EIRP_{Aggregate}$ and the operational conditions of the ESV network shall be declared by the applicant.

NOTE 1: The on-axis spurious radiations, outside the 5 925 MHz to 6 425 MHz band, are indirectly limited by clause 4.2.1.2. Consequently no specification is needed.

NOTE 2: Intermodulation limits inside the band 5 925 MHz to 6 425 MHz are to be determined by system design and are subject to satellite operator specifications.

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

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

In the 5 925 MHz to 6 425 MHz 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.

4.2.2.3 Conformance tests

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

4.2.3 Maximum ESV emissions towards the horizon

4.2.3.1 Justification

Protection of terrestrial services.

4.2.3.2 Specification

4.2.3.2.1 Specification 1: Maximum e.i.r.p. spectral density towards the horizon

The ESV e.i.r.p. spectral density towards the horizon, within the frequency band 5 925 MHz to 6 425 MHz, shall not exceed 17 dBW in any 1 MHz frequency band as specified in ITU-R Resolution 902 (WRC-03) (see Bibliography), for all operational elevations angles of the antenna main beam axis.

The applicant shall declare the range of operational elevations angles of the antenna main beam axis of the ESV.

4.2.3.2.2 Specification 2: Maximum e.i.r.p. towards the horizon

The ESV e.i.r.p. towards any horizontal direction, within the frequency band 5 925 MHz to 6 425 MHz, shall not exceed 20,8 dBW as specified in ITU-R Resolution 902 (WRC-03) (see Bibliography), for all operational elevations angles of the antenna main beam axis.

The applicant shall declare the range of operational elevations angles of the antenna main beam axis of the ESV.

4.2.3.3 Conformance tests

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

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

This clause deals with the off-axis e.i.r.p. emission density (co-polar and cross-polar) within the band 5 925 MHz to 6 425 MHz.

4.2.4.1 Justification

Protection of other satellite (uplink) systems.

4.2.4.2 Specification

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

The maximum e.i.r.p. in any 4 kHz band within the nominated bandwidth of the co-polarized component in any direction ϕ degrees from the antenna main beam axis shall not exceed the following limits:

$$\begin{array}{llll}
 32 - 25 \log(\phi + \delta\phi) - H \text{ dBW} & \text{for} & \phi_{min} \leq \phi + \delta\phi \leq 7,0^\circ; & \\
 +11 - H \text{ dBW} & \text{for} & 7,0^\circ < \phi + \delta\phi \leq 9,2^\circ; & \\
 35 - 25 \log(\phi + \delta\phi) - H \text{ dBW} & \text{for} & 9,2^\circ < \phi + \delta\phi \leq 48^\circ; & \\
 - 7 - H \text{ dBW} & \text{for} & \phi + \delta\phi > 48^\circ. &
 \end{array}$$

where:

- ϕ is the angle, in degrees, between the main beam axis and the direction considered; and
- $\delta\phi$ is the pointing error threshold, in degrees, **relative to the line between the ESV and the satellite with which it is operating**, as declared by the applicant (see clause 4.2.6.2).

For ESVs designed to transmit always at $EIRP_{max}$, H (in dB) is the maximum number of ESVs transmitting towards the same satellite on the same frequency and polarization which may transmit at $EIRP_{max}$ in the same 4 kHz band as declared by the manufacturer.

For ESVs designed to operate in an FSS network where the e.i.r.p. of each ESV is determined by the NCF and where the NCF is in charge of the compliance of the aggregate e.i.r.p. density with the above mask, H is the margin as declared by the manufacturer for compliance with the mask, when the ESV is transmitting at $EIRP_{max}$. In the case where the NCF uses the antenna pattern or the off-axis $EIRP_{sd}$ the manufacturer shall declare the applicable pattern, the value of H shall be set to 0 dB and the ESV e.i.r.p. density shall not exceed the e.i.r.p. density corresponding to the declared pattern. This margin H or this pattern may be a function of the position of the ESV relative to the GSO arc (e.g. in the case of active antennas).

The applicant shall declare the minimum satellite separation, ΔL , for which the equipment is designed. Where ΔL shall be a value from $2,0^\circ$ to $3,0^\circ$. With this, ϕ_{min} as used in the above equation is equal to $\Delta L - 0,2^\circ$.

NOTE 1: The minimum satellite spacing, ΔL , is mainly equal to 3° in ITU Regions 1 and 3 and 2° in ITU Region 2.

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

In addition the maximum e.i.r.p. in any 4 kHz band within the nominated bandwidth of the cross-polarized component in any direction ϕ degrees from the antenna main beam axis shall not exceed the following limits:

$$\begin{aligned} 22 - 25 \log(\phi + \delta\phi) - H \text{ dBW} & \quad \text{for} \quad \phi_{min} \leq \phi + \delta\phi \leq 7,0^\circ; \\ +1 - H \text{ dBW} & \quad \text{for} \quad 7,0^\circ < \phi + \delta\phi \leq 9,2^\circ. \end{aligned}$$

where ϕ , ϕ_{min} and H 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 μ sec 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.

NOTE 2: The satellite operator may require lower off-axis e.i.r.p. limits in compliance with FSS Intersystem Coordination Agreements. In other cases, operation of the ESV within national waters, off-axis e.i.r.p. emissions are subject to compliance with national regulations and the relevant FSS intersystem coordination agreements.

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 any arbitrary plane containing the antenna main beam axis. The range of values of ϕ and α is from $\phi_{min} - \delta\phi$ to 180° for ϕ , and from -180° to $+180^\circ$ for α .

The above limits only apply to any off-axis direction (α , ϕ) within $\pm 3^\circ$ of the visible part of the GSO. The concerned directions 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.

The determination of the (α , ϕ) subset shall take into account the operational conditions for which the ESV is designed, as declared by the applicant or indicated within the user documentation. These conditions shall include:

- the range of latitudes of the ESV;
- the minimum elevation pointing angle;
- the type of antenna mount (e.g. with azimuth and elevation axes or equatorial);
- 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;
- the range of adjustment for the major axis of the antenna for antennas with asymmetric main beam;

- the direction of the electric field radiated by the satellite with respect to the Earth's axis, 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 3: TR 102 375 (see bibliography) 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 6.5.1 with the results being computed in accordance with clause 6.5.2.

4.2.5 Carrier suppression

4.2.5.1 Justification

To allow for the satisfactory suppression of transmissions of the ESV by the NCF, under any fault condition and under any cessation of emissions condition.

4.2.5.2 Specification

In the "Carrier-off" and in the "Emissions disabled" radio states the on-axis e.i.r.p. density 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 6.6.

4.2.6 Antenna Pointing and Polarization Alignment for ESVs

4.2.6.1 Justification

Protection of transmissions to adjacent satellites and cross-polarized transponders on the same satellite.

4.2.6.2 Specification

a) Mechanical 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 that could affect the radiation subsystem of the ESV after the application of the wind load.

b) Pointing error detection:

The ESV shall be able to detect the pointing error. The ESV, when in the "Carrier-on" radio state, shall enter the "Carrier-off" radio state when the instantaneous pointing error exceeds the pointing error threshold, $\delta\phi$, relative to the direction of the wanted satellite at its actual position, within T s. The values of $\delta\phi$ and T shall be declared by the applicant and the value of T shall not exceed 5 s. The ESV shall not re-enter the "Carrier-on" radio state until the instantaneous pointing error is within $\delta\phi$ for a period of $2 \times T$ s.

The applicant may declare ranges of values for $\delta\phi$ as functions of on-axis e.i.r.p. spectral density such that the e.i.r.p. density limits in 4.2.3.2 are not exceeded.

c) Polarization angle alignment capability for linear polarization:

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

The misalignment error, α , of the transmit antenna polarization is the sum of the misalignment errors due to the tracking process plus, for ESVs that set the transmit polarization by tracking the receive polarization, the misalignment error of the transmit polarization plane relative to the receive polarization plane. The misalignment error, α , shall not exceed the maximum polarization misalignment, α_{\max} , such that:

$$\alpha_{\max} = \text{ArcTan} \left(\sqrt{\frac{10^{\frac{XPD_{\text{antenna}}[\text{dB}]}{10}} - 10^{\frac{XPD_{\text{ESV}}[\text{dB}]}{10}}}{10^{\frac{XPD_{\text{ESV}}[\text{dB}] + XPD_{\text{antenna}}[\text{dB}]}{10}} - 1}} \right)$$

where:

XPD_{ESV} is the maximum equivalent cross polar discrimination (XPD) of the ESV as declared by the applicant;

XPD_{antenna} is the antenna XPD at the centre frequency of the transmit band as declared by the applicant.

NOTE 1: Satellite operators may require specific values for XPD_{ESV} and they may also require the ESV to stop its transmissions (e.g. to enter the "Carrier-off" radio state) if the value XPD_{ESV} is exceeded.

NOTE 2: The lower bound XPD_{er} of the global XPD of the ESV antenna with a receiving antenna is given by the following formula.

$$XPD_{\text{er}} \geq \left(\frac{1 + \sqrt{XPD_{\text{ESV}}} \cdot \sqrt{XPD_r}}{\sqrt{XPD_{\text{ESV}}} + \sqrt{XPD_r}} \right)^2$$

where:

XPD_r is the XPD of the receiving satellite antenna.

d) Polarizer static adjustment for circular polarization:

The applicant shall declare the maximum axial ratio of the antenna at the centre frequency of the transmit band. In the case of a reconfigurable polarizer, the declared value of the maximum axial ratio shall include re-positioning errors.

4.2.6.3 Conformance tests

Conformance tests shall be carried out in accordance with clauses 6.7, 6.8 and 6.9.

4.2.7 Cessation of emissions of the ESV

4.2.7.1 Justification

For cessation of emissions of the ESV to fulfil the requirements of Res. 902 (WRC-03) (see Bibliography), annex 1, Item 6 in locations where the ESV is not allowed to transmit.

4.2.7.2 Specification

4.2.7.2.1 Specification 1: Mode of cessation of emissions

At least one the following two modes of cessation of emissions shall be implemented:

- a) the NCF determines that the ESV must cease emissions; and/or
- b) the ESV autonomously determines that it must cease emissions.

In addition, there shall be a "single-action" means (e.g. operating a switch) on the front panel of the ESV below deck unit by which a local operator may cease emissions.

Cessation of emissions shall be implemented in such a way that the corresponding mechanisms cannot be bypassed on board the vessel, except under the provisions of **Article 4.9** of the Radio Regulations of the ITU-R [5].

NOTE: The capability to bypass these functions for emergency purposes is outside the scope of the present document.

The applicant shall declare the ESV interfaces involved in the cessation of emissions:

- the list of relevant parameters which are collected by the ESV or the NCF for determination as to whether the ESV should cease emissions;
- the list of these relevant parameters which are used by the ESV;
- the list of these relevant parameters which are transmitted by the ESV to the NCF;
- the list of the relevant parameters which are received by the ESV from the NCF;
- for the collected relevant parameters, the ESV interface (s), including the protocols, the timing, the ranges of the values, the speed of the variations and the required accuracies;
- for the relevant parameters transmitted to the NCF, the ESV interface with the NCF, including the protocols and the timing;
- for the transmission parameter received from the NCF, the ESV interface with the NCF, including the protocols and the timing;
- these declared ESV interfaces shall be in accordance with the user documentation.

4.2.7.2.2 Specification 2: Conditions under which the ESV must cease emissions

For ESV networks where the NCF determines completely or partially where and under which conditions the emissions of the ESV must be ceased, the collection of the relevant parameters by the ESV and the exchange of information between the ESV and the NCF shall be sufficient for the NCF to determine when to cease emissions with the accuracy declared by the applicant and to inform in time the ESV to cease emissions.

For ESVs which determine completely where and under which conditions the emissions must be ceased, the collection of the relevant parameters by the ESV shall be sufficient for the ESV to determine when to cease emissions with the accuracy declared by the applicant.

The determination of these conditions shall take into account the inaccuracy of the ESV location and of the boundaries of the authorized operating areas in the data base used either by the ESV or the NCF, as declared by applicant.

The conditions for cessation of emissions shall take into account at least the following parameters:

- the location of the ESV and the boundaries of the authorized operating area;
- the operating parameters specified in annex 2 of Res. 902 (WRC-03) (see Bibliography);
- the carrier frequency and the authorized frequency bands.

4.2.7.2.3 Specification 3: Cessation of emissions

When in the "Transmission enabled" state a condition requiring cessation of emissions occurs, the ESV shall cease transmissions and enter the "Transmission disabled" state.

When in the "Transmission disabled" state, the ESV shall not leave that state for the "Transmission enable" state as long as a condition requiring cessation of emissions exists or the last CC command received from the NCF is a transmission disable command.

When in the "Initial phase-1" and "Initial phase-2" sub-state a condition requiring cessation of emissions occurs, the ESV shall cease transmissions and enter the "Initial phase-0" radio state.

When in the "Initial phase-0" sub-state, the ESV shall not leave that state for the "Initial phase-1" or the "Transmission enabled" states as long as a condition requiring cessation of emissions exists.

The time for transition in any state from the occurrence of a condition requiring cessation of emissions to the "Emissions disabled" radio state shall not exceed 5 s.

4.2.7.2.4 Specification 4: Fault conditions

Any collection of the relevant parameters by the ESV or transmission of these parameters to the NCF, which have not been completed correctly within the required delay(s) as declared by the applicant, shall be considered as a fault condition.

Any transmission parameter not received or not correctly received from the NCF within the required delay declared by the applicant shall be considered as a fault condition.

These fault conditions shall be processed as conditions requiring cessation of emissions.

4.2.7.3 Conformance tests

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

4.2.8 Identification of ESV

4.2.8.1 Justification

To fulfil the requirements of Res. 902 (WRC-03) (see Bibliography), annex 1, Item 6 for use by duly authorized entities.

4.2.8.2 Specification

The ESV shall be designed such that it is possible for the network operator to identify which ESVs are transmitting with at least 1 km accuracy in a given geographic area. The applicant shall declare the means by which identification of ESVs is accomplished. In the case where an external system is required, the applicant must declare which additional means are necessary for identification of the ESV.

4.2.8.3 Conformance tests

Conformance tests shall be carried out in accordance with clause 6.11.

4.2.9 Control and Monitoring Functions (CMFs)

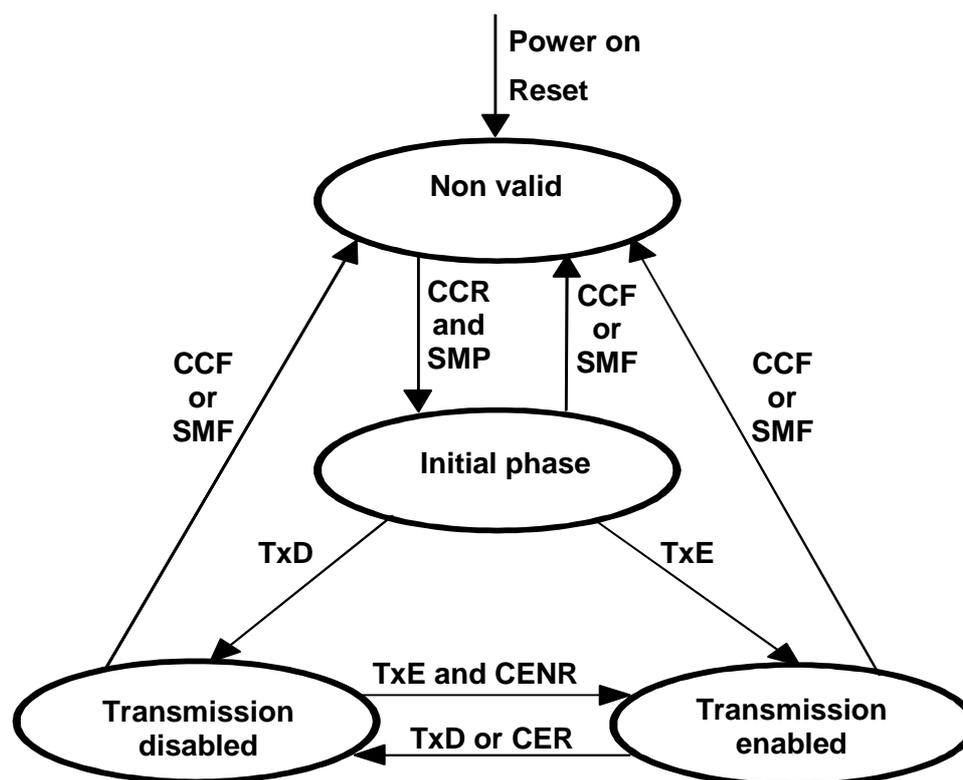
4.2.9.1 CMF State Diagram

The following minimum set of CMFs shall be implemented in ESVs 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 ESV shall not transmit. In the "Transmission-enabled" state the ESV is allowed to transmit. In the "Initial phase" state the ESV is only allowed to transmit initial bursts.

NOTE 1: The restrictions in the "Initial phase" state are for the protection of other systems when the ESV is entering the system after a power-on or a reset. These initial burst restrictions do not apply to the ESV transmissions in the "Transmission-enabled" state and once a transmission enable command has been received by the ESV the ESV may transmit or not transmit as required.

Under any fault condition the ESV shall enter the "Non-valid" state where the e.i.r.p. limits for the "Emissions disabled" radio state apply.



CER: Cessation of Emissions Required
 CENR: Cessation of Emissions Not Required
 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

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

NOTE 2: From "Transmission disabled" state a TxE command may also result in a transition towards the "Initial phase" state.

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

4.2.9.2 Processor monitoring

4.2.9.2.1 Justification

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

4.2.9.2.2 Specification

The ESV shall incorporate a processor monitoring function for each of its processors involved in maintaining the performance requirements of the present document and in Control and Monitoring Functions (CMF).

The processor monitoring function shall detect failures of these processors" hardware and software.

In the "Transmission enabled" state, the ESV shall enter the "Non valid" state or the "Carrier-off" radio state no later than 5 s after any fault condition occurs, and in any case enter the "Non valid" state within 30 s until the processor monitoring function has determined that all fault conditions have been cleared. In any other state after any fault condition occurs, the ESV shall enter the "Non valid" state within 30 s until the processor monitoring function has determined that all fault conditions have been cleared.

4.2.9.2.3 Conformance tests

Conformance tests shall be carried out in accordance with clause 6.12.2.

4.2.9.3 Transmit subsystem monitoring

4.2.9.3.1 Justification

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.

4.2.9.3.2 Specification

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

- a) loss of frequency lock (if applicable);
- b) failure of the Local Oscillator (LO).

No later than 5 s after any of these fault conditions of the transmit frequency generation sub-system occurs, the ESV shall enter the "Non-valid" state until the transmit sub-system monitoring function has determined that all fault conditions have been cleared.

4.2.9.3.3 Conformance tests

Conformance tests shall be carried out in accordance with clause 6.12.3.

4.2.9.4 Power-on/Reset

4.2.9.4.1 Justification

To demonstrate that the ESV 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.

4.2.9.4.2 Specification

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

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

4.2.9.4.3 Conformance tests

Conformance tests shall be carried out in accordance with clause 6.12.4.

4.2.9.5 Control Channel (CC) and Response Channel (RC)

4.2.9.5.1 Justification

Control Channels (CC) are used by ESVs to receive control information from the NCF and Response Channels (RCs) to respond to the NCF. For ESV designed to operate within networks where the NCF determines that the ESV must cease emissions, then the CCs and RCs are also used for the dialogue with the NCF.

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

4.2.9.5.2 Specification

4.2.9.5.2.1 Specification 1: types of CCs and RCs

- a) The ESV shall have at least one CC and one RC with the NCF. Each CC and each RC may be internal or external.

The types (internal or external) of each CC and each RC shall be declared by the applicant.

NOTE 1: The availability of the network carrying the external CC(s) and RC(s) and the numbers of external CC(s) and RC(s) are not within the scope of the present document.

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

- b) The connection between the NCF and the ESV via the CCs and RCs shall be either permanent or shall be set up on a call by call basis through a switched network. In case of connection through a switched network the ESV shall be able to receive calls from the NCF and to initiate calls towards the NCF in order to set up the CCs and RCs.
- c) The ESV with an external CC shall not transmit without receiving an appropriate signal from the NCF through the satellite to which the ESV transmits, indicating to the ESV that the NCF is alive and insuring that the ESV is pointing to the target satellite.

4.2.9.5.2.2 Specification 2: CC Reception

- a) The ESV shall immediately enter the "Non-valid" state when it is not able to correctly receive messages through the CC, from the NCF, for a period not exceeding 30 s. This event is called a "CC disruption".

In the case of external CCs and RCs without permanent connection of the NCF with the ESV, the ability to correctly receive CC messages from the NCF is the ability to receive calls and messages from the network through a permanent connection to the switched network to which is connected the NCF.

The inability to receive CC messages from the NCF may be due to the following various causes but not limited to them: no received signal from the NCF or from the network, a too low level received signal, no network accessible, the inability to lock onto the received carrier frequency, to demodulate, to decode, to receive calls and/or messages, a hardware failure or power off.

- b) The ESV shall remain in the "Non-valid" state as long as the ESV is unable to receive CC messages from the NCF.
- c) From the "Non-valid" state the ESV may enter the "Initial phase" state if the following conditions are met:
- the ESV is able to receive CC messages from the NCF; and
 - no fault conditions are present.

4.2.9.5.3 Conformance tests

Conformance tests shall be carried out in accordance with clause 6.12.5.

4.2.9.6 Network control commands

4.2.9.6.1 Justification

These requirements ensure that the ESV 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.

4.2.9.6.2 Specification

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

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

- transmission enable commands (TxE);
- transmission disable commands (TxD).

When in the "Initial phase" or "Transmission enabled" states, once a transmission disable command is received, within 1 s the ESV shall enter into, and shall remain in the "Transmission disabled" state until the transmission disable command is superseded by a subsequent transmission enable command.

When in the "Initial phase" or "Transmission disabled" states, once a transmission enable command is received, the ESV may enter into the "Transmission enabled" state.

When entering the "Initial phase" from the "Non-valid" state, the last TxE or TxD command received from the NCF may be used by the ESV to enter the "Transmission enabled" state or the "Transmission disabled" state, respectively, if since the time of reception of that command no "CC disruption" occurred.

NOTE: The physical unit in charge of the reception of the CCs, of the transmissions of the RCs and of the CC commands reception may be a separate and independent unit from the other units of the ESV and it may be common to several ESVs.

4.2.9.6.3 Conformance test

Conformance tests shall be carried out in accordance with clause 6.12.6.

4.2.9.7 Initial burst transmission

4.2.9.7.1 Justification

Restrictions on the initial burst transmissions are necessary to limit disturbance to other services.

4.2.9.7.2 Specification

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

- a) The ESV shall not start the transmission of initial bursts before having obtained a confirmation that no cessation of emission applies where the ESV is located. This confirmation shall be obtained either by local means of determination of the cessation of emissions (See clause 4.2.7) or from the NCF via an external control channel.
- b) The duty cycle of the burst retransmission shall not exceed 0,2 %, where the duty cycle is defined as the ratio of burst duration to the duration between two successive bursts.
- c) Each burst shall not carry more than 256 data bytes excluding the burst preambles and the FEC coding bits.
- d) The initial burst shall be transmitted at an e.i.r.p. no greater than $EIRP_{max}$.
- e) The duration between two successive bursts shall not be less than the required NCF response time as declared by the applicant. This response time is defined as the duration, measured at the ESV, between an initial burst transmission and the reception and processing of a transmission enable or disable command from the NCF which is never exceeded during 99 % of the cases under normal conditions in the system for which the ESV is designed, as declared by the applicant.

NOTE: The present document does not address the possibility for ESVs of transmitting initial bursts in locations where transmissions are not permitted. This possibility is under study within CEPT/ECC WGSE.

4.2.9.7.3 Conformance tests

Conformance tests shall be carried out in accordance with clause 6.12.7.

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 Essential radio test suites

The essential radio test suites for a complete ESV are given in clause 6.

6 Test methods for the complete ESV

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 5 and 6.

Table 5: 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	±1,0 dB
Polarization discrimination	±2 dB
Angles	0,1°

Table 6: 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: TR 102 215 (see bibliography) 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 for the particular system, it is not possible to provide detailed specifications in the present document. However, the following baseline is provided:

- if the ESV requires to receive a modulated carrier from the satellite in order to transmit, then special test arrangements are required to simulate the satellite signal, thus enabling the ESV 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 this clause 6 may be replaced by other equivalent procedures provided that the results are proven to be as accurate as those obtained according to the specified method.

All tests with carrier-on shall be undertaken with the transmitter operating at $EIRP_{max}$ and with the maximum transmit burst rate, where applicable, which shall be declared by the applicant.

If the Equipment Under Test (EUT) is an ESV 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 ESV to operate without its main characteristics being changed.

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

For testing under this clause 6 the cable lengths used should be the maximum lengths declared by the applicant. For maximum cable lengths longer than 10 m, the tests may be performed with cables no shorter than 10 m.

6.2 Off-axis spurious radiation

The tests for the ESV specification 3) shall be limited to the "Carrier-on" radio state. The tests shall be undertaken with the transmitter operating at $EIRP_{max}$.

6.2.1 Test method

An EUT with antenna is an ESV with its antenna. It comprises both the below-deck and above-deck units interconnected by the appropriate cable(s). An EUT without antenna is an ESV with the removable antenna removed. It comprises both the below-deck and above-deck units, up to the antenna flange, interconnected by the appropriate cable(s). The connecting cable(s) between the below-deck and the above-deck units shall be the same types as recommended by the applicant in the installation manual. The type of each cable used shall be entered in the test report.

The below-deck unit shall be terminated with matched impedances at the telecommunication ports if there is no associated equipment connected to such ports if recommended by the applicant in the user documentation.

For frequencies up to 80 MHz the measuring antenna shall be a balanced dipole with a length equal to the 80 MHz resonant length and shall be matched to the feeder by a suitable transforming device. Measurements with broad band antennas are also possible provided that the test site has been calibrated according to the requirements of CISPR 16-1-5 [8].

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 calibrated according to the requirements of CISPR 16-1-5 [8].

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, the combined amplitude/frequency response calibration curves shall be verified across the measurement frequency range considered for the antenna, to account for the interaction between the components. 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.

Unused input and output ports of the EUT shall be connected to cables of the appropriate length (see clause 6.1) and terminated to simulate the impedance of the relevant ports of the radio equipment. These cables shall be bundled at the approximate centre of the cable with the bundles of 30 cm to 40 cm in length running in the horizontal plane from the port to which it is connected. If it is impractical to do so because of cable bulk or stiffness, the disposition of the excess cable shall be precisely noted in the test report.

The radiations shall be measured in the frequency range of 30 MHz to 2 GHz in accordance with CISPR 16-1 [2] using the measuring receiver or a comparable spectrum analyser. During the measurements up to 1 GHz the quasi-peak detector shall be used, for measurements in the frequency range 1 GHz to 2 GHz a peak detector shall be used.

In addition, for the frequency band 156 MHz to 165 MHz, the measurement shall be repeated with a receiver bandwidth of 9 kHz to 10 kHz. The equipment shall meet both, the quasi peak and the peak emission limits set out in table 2.

6.2.1.0 Multi-carrier operation

For ESVs designed to transmit simultaneously several carriers the verification below 2 000 MHz shall be performed with the minimum number of carriers and the verification above 2 000 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 Global Input Back-Off at the input of the HPA does not exceed the maximum Global Input Back-Off at the input of the HPA of 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.

6.2.1.1 Up to 2 000 MHz

6.2.1.1.1 Test site

The test method shall be in accordance with EN 60945 [4] and the test site shall also be in accordance with EN 60945 [4] as well as CISPR 16-1-5 [8], with the following modifications.

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

The open area test site shall be flat, free of overhead wires and nearby reflecting structures, sufficiently large to permit aerial placement at the specified measuring distance and provide adequate separation between aerial, test unit and reflecting structures, according to the specification of CISPR 16-1-5 [8].

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 EUT shall be placed on a non-conductive support.

The distance between the EUT and measuring antenna should be 3 m for measurements below 2 000 GHz. 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.

The measuring bandwidth shall be in accordance with table 2.

The setting of controls which may affect the level of radiated interference shall be varied in order to ascertain the maximum emission level.

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.

6.2.1.1.2 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 height simultaneously varied from 1 m to 4 m above the ground plane.
- d) All identified spurious radiations shall be measured and noted in frequency and level.

6.2.1.2 Above 2 000 MHz

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

For an EUT with antenna the tests shall be performed in two stages for both the "Carrier-on" and "Carrier-off" radio states:

Procedure a) Identification of the significant frequencies of spurious radiation.

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

NOTE: Testing for an EUT with antenna attached is not recommended due to difficulties in achieving the required measurement accuracy.

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 at the antenna flange.

6.2.1.2.1 Identification of the significant frequencies of spurious radiation

6.2.1.2.1.1 Test site

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

6.2.1.2.1.2 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 equal to 7° or to the minimum angle of elevation declared by the applicant, whichever is greater, and, for an EUT without antenna the antenna flange shall be terminated by a dummy load.
- c) The receivers shall scan the frequency band whilst the EUT revolves.
- d) The EUT shall be rotated through 360° and the frequency of any spurious signals noted for further investigation.
- e) For an EUT with antenna the test shall be repeated with the test antenna being in the opposite polarization.
- f) The test shall be repeated in the "Carrier-on" radio state whilst transmitting one modulated carrier at maximum power.

6.2.1.2.2 Measurement of radiated power levels of identified spurious radiation

6.2.1.2.2.1 Test site

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

6.2.1.2.2.2

Procedure

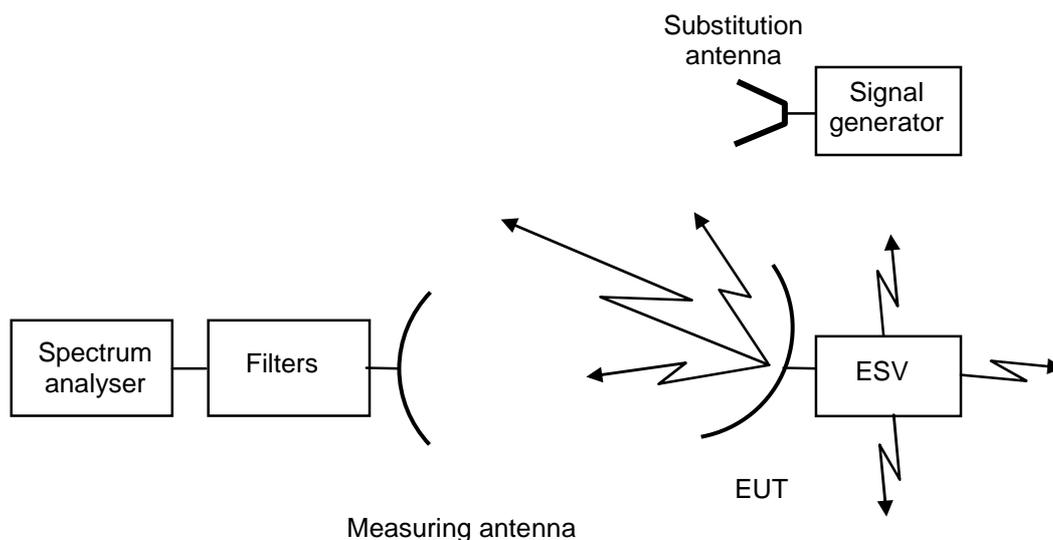


Figure 3: Test arrangement-Spurious radiation measurement above 2 000 MHz for an EUT with antenna

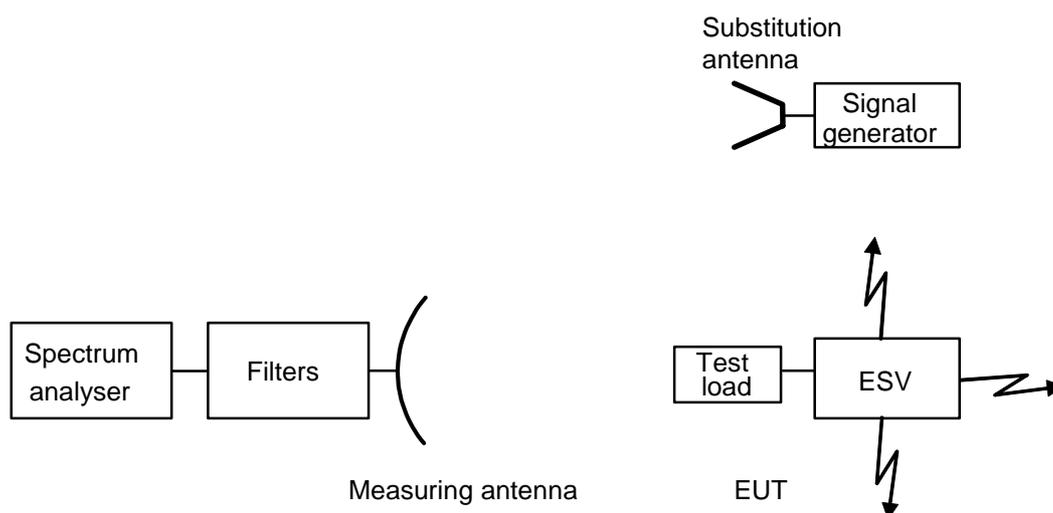


Figure 4: Recommended test arrangement-spurious radiation measurements above 2 000 MHz for an EUT without antenna

- a) The test arrangement shall be as shown in figure 3 or preferably figure 4. A tuneable notch filter should be used to remove the wanted (non-spurious) signal. However, precautions should be taken to prevent spectrum analyser damage due to accidental filter mistuning during test or other potentially harmful scenarios.
- b) The EUT shall be installed such that the units are separated by about 1 m to 2 m with the below-deck unit at a height between 0,5 m and 1,0 m on a turntable. The interconnection cable shall be maintained by non-metallic means at a height between 0,5 m and 1,0 m. For the test arrangement shown in figure 3 the main beam of the antenna shall have an angle of elevation equal to 7° or to the minimum angle of elevation declared by the applicant, whichever is greater, and be oriented away from the geostationary orbit, or be inhibited by placing RF absorbing panels in that direction. For antennas designed for minimum off-axis gain in the direction of the geostationary orbit plane, the plane containing the larger cut of the main lobe shall be set vertical.

- c) The measuring antenna shall be positioned at a distance from the EUT (e.g. 3 m, 5 m, 10 m) relevant to the applied test site. The measuring antenna shall be adjusted in height and the EUT rotated, whilst the EUT is in the appropriate carrier condition, for a maximum response on the associated spectrum analyser at each spurious frequency previously identified, this response level shall be noted. The adjustment in height of the measuring antenna does not apply when an anechoic chamber is being used. The measuring antenna shall never enter the 7° off-axis cone around the main beam direction.
- d) The investigation shall be repeated with the measuring antenna in the 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.

6.2.1.2.3 Measurement of conducted spurious radiation at the antenna flange

6.2.1.2.3.1 Test site

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

6.2.1.2.3.2 Procedure

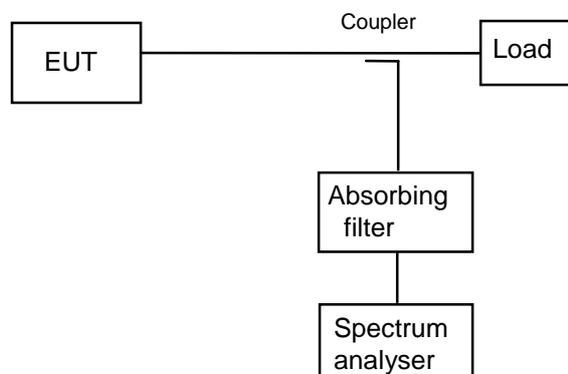


Figure 5: Test arrangement-conducted spurious radiation above the cut-off frequency

- a) The test arrangement shall be as shown in figure 5. In order to protect the spectrum analyser while ensuring the necessary measurement accuracy, particularly close to the carrier, if an absorbing 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 whilst 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, for transmit capable equipment, in the "Carrier-off" radio state.

6.3 On-axis spurious radiation

6.3.1 Test method

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

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

For ESV 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.

For ESV equipment for which measurements at the antenna flange are possible and agreed by the applicant, the measurements shall be performed at the antenna flange. The EUT is the ESV with its antenna comprising both the below- and above-deck units interconnected by appropriate cables.

6.3.1.2.2 Method of measurement at the antenna flange

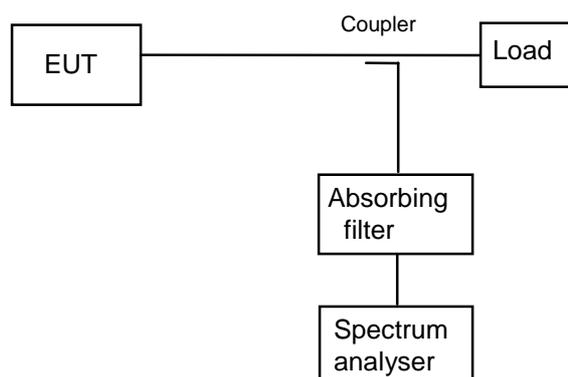


Figure 6: Test arrangement - on-axis spurious radiation measurements at the antenna flange

- The test arrangement shall be as shown in figure 6. In order to protect the spectrum analyser while ensuring the necessary measurement accuracy, particularly close to the carrier, if an absorbing filter is used it shall be tuned to the transmit carrier frequency.
- The EUT shall transmit one modulated carrier continuously, or at its maximum burst rate where applicable, centred on a frequency as close to the lower limit of the operating frequency band of the EUT as possible. The EUT shall be operated at the highest normal operating e.i.r.p. The frequency range 5 925 MHz to 6 425 MHz shall be investigated.
- 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.
- 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 6.5.1.3 at the closest frequency to the spurious frequency.
- The tests in b) to e) shall be repeated with a transmit frequency in the centre of the operating frequency band.
- The tests in b) to e) shall be repeated with a transmit frequency as close to the upper limit of the operating frequency band of the EUT as possible.

- g) The test shall be repeated in the "Carrier-off" radio state.
- h) The test shall be repeated in the "Emissions disabled" radio state.

6.3.1.2.3 Method of measurement with a test antenna

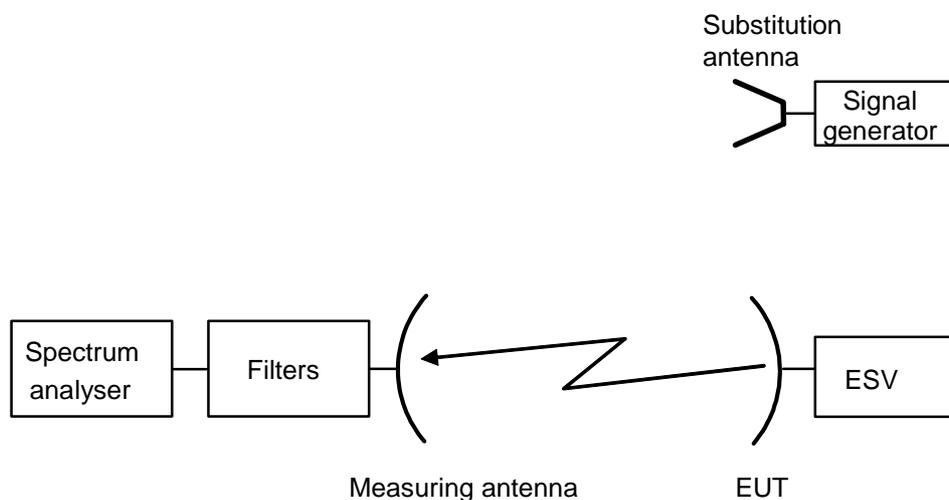


Figure 7: Test arrangement-on-axis spurious radiation measurements for an EUT with antenna

- a) The test arrangement shall be as shown in figure 7.
- b) The EUT shall be installed such that the units are separated by about 1 m to 2 m with the below-deck unit at a height between 0,5 m and 1,0 m on a turntable. The interconnection cable shall be maintained by non-metallic means at a height between 0,5 m and 1,0 m.
- 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 the modulated carrier(s) 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 5 925 MHz to 6 425 MHz shall be investigated and each spurious frequency shall be noted.
- e) Due to the proximity of the carrier the spectrum analyser resolution bandwidth shall be set to a measurement bandwidth of 3 kHz, or as close as possible. If the measurement bandwidth is different from the specified measurement bandwidth, bandwidth correction shall be performed for noise-like wideband spurious radiation.
- f) The measuring antenna shall be positioned at a distance from the EUT (e.g. 3 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, whilst the EUT is in the appropriate carrier condition, for a maximum response on the associated spectrum analyser at each spurious frequency previously identified, this response level shall be noted. The adjustment in height of the measuring antenna does not apply when an anechoic chamber is being used.
- g) The EUT shall be replaced by a representative substitution antenna to which is connected a signal generator. The main beam axes of the measuring and substitution antennas shall be aligned. The distance between these antennas shall be the distance determined under test f).
- h) The substitution and measuring antennas shall be aligned in the polarization which produced the 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 e.i.r.p. 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 test shall be repeated in the "Carrier-off" radio state.
- n) The test shall be repeated in the "Emissions disabled" radio state.

6.4 Maximum ESV emissions towards the horizon

6.4.1 Maximum e.i.r.p. towards the horizon

- a) The co-polarization radiation pattern in the elevation plane shall be taken from measurements made in clause 6.5.1.4.5.
- b) The maximum e.i.r.p. towards the horizon, $EIRP_{horizon}$ (dBW), shall be calculated from:

$$EIRP_{horizon} = EIRP_{max} - G_{max_on_axis} + G_{max_horizon}$$

where:

$EIRP_{max}$ is the maximum on-axis e.i.r.p. (dBW) as declared by the applicant;

$G_{max_on_axis}$ is the maximum on-axis antenna gain (dBi), as measured in clause 6.5.1.3;

$G_{max_horizon}$ is the maximum antenna gain (dBi) towards the horizon within the range of the declared operational elevation angles. The determination of $G_{max_horizon}$ shall take into account the maximum pointing threshold, $\delta\phi$ as declared by the applicant, for operating elevation angles on the main beam.

- c) It shall be verified that the $EIRP_{horizon}$ does not exceed 20,8 dBW (clause 4.2.3.2.2).

6.4.2 Maximum e.i.r.p. spectral density towards the horizon

- a) The co-polarization radiation pattern in the elevation plane shall be taken from measurements made in clause 6.5.1.4.5.
- b) The maximum e.i.r.p. spectral density towards the horizon, $EIRP_{sd_horizon}$ (dBW/1MHz), shall be calculated from:

$$EIRP_{sd_horizon} = PSD_{max} + G_{max_horizon}$$

where:

PSD_{max} is the maximum power spectral density (dBW/1MHz) at the antenna flange measured using the procedure in clause 6.5 using a resolution bandwidth of 1 MHz instead of 4 kHz and performed at $EIRP_{max}$;

$G_{max_horizon}$ is as defined above in clause 6.4.1.

- c) It shall be verified that the $EIRP_{sd_horizon}$ does not exceed 17 dBW/1MHz (clause 4.2.3.2.1).

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

Off-axis e.i.r.p. emission density (co-polar and cross-polar) within the band 5 925 MHz to 6 425 MHz.

6.5.1 Test method

6.5.1.1 General

The measurement shall be made in the operational configuration(s) (occupied bandwidth, $EIRP_{max}$) 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 measurements shall be performed at $EIRP_{max}$.

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

The test antenna and the substitution antenna shall use the same type of polarization as the EUT.

The e.i.r.p. densities are determined from the measurements of the antenna copolar and crosspolar gain patterns, and of the power density at the antenna flange. These e.i.r.p. densities shall be compared to the specified masks.

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, therefore, be performed:

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

6.5.1.2 Transmit output power density

6.5.1.2.1 General

For the purpose of this test the EUT is defined as the below deck unit and that part of the above deck unit up to the antenna flange.

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

6.5.1.2.2 Test site

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

6.5.1.2.3 Method of measurement

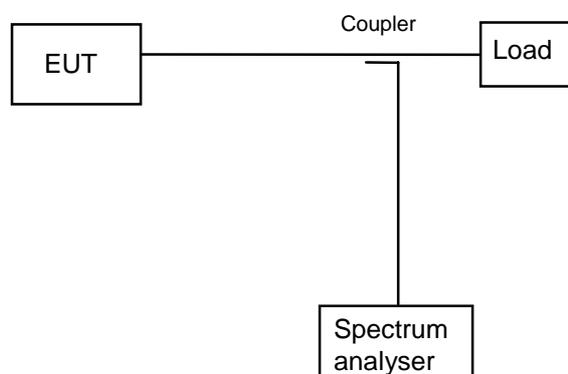


Figure 8: Test arrangement-transmit output power density measurement

- a) The test arrangement shall be as shown in figure 8.

- b) The EUT shall transmit the carrier(s) modulated with data or with a pseudo random signal. For burst mode transmission the EUT shall transmit at its maximum burst-rate. The power density supplied to the antenna flange shall be measured in dBW/4 kHz. The coupling factor of the test coupler at the test frequency and the attenuation of any necessary waveguide adapter shall be taken into account.

The 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 4 kHz. If the resolution bandwidth is different from the specified bandwidth then bandwidth correction shall be performed except for spectrum components the width of which are narrower than the measurement bandwidth;
- 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 ESV 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 ESV 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 μ s 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_{max}) producing the highest emission density in the frequency band. The selected configuration(s) shall be recorded in the test report.

6.5.1.3 Antenna transmit gain

6.5.1.3.1 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 above-deck 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.

For antennas designed to operate over a wider range of frequencies than the operating frequency band declared by the applicant for the EUT, the full operating range of the antenna, up to a maximum of 5 850 MHz to 7 075 MHz, may be used to perform the measurements in the following procedures.

6.5.1.3.2 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.

6.5.1.3.3 Method of measurement

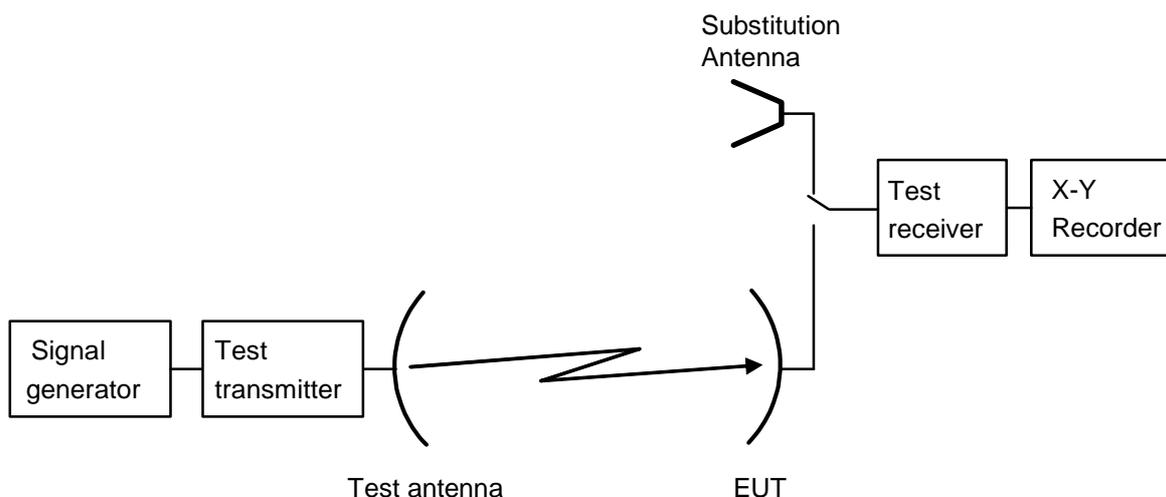


Figure 9: Test arrangement-antenna transmit gain measurement

- The test arrangement shall be as shown in figure 9 with the EUT connected to the test receiver. The test arrangement shall enable the test results to be displayed and recorded with the angular position along the X-axis and the signal level along the Y-axis.
- A test signal shall be transmitted by the test transmitter through the test antenna. The centre frequency of the test signal shall be set to the middle of the operating frequency band as declared by the applicant. The EUT antenna main beam axis shall be aligned with the main beam axis of the test antenna.

For linearly polarized antennas, the E-plane of the test antenna shall be vertical. The polarizer of the EUT antenna shall be rotated and adjusted such that the E-plane coincides with the E-plane of the test antenna.

For circular polarized antennas the EUT and the test antenna polarizers shall be set to RHCP.

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

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

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 substitution antenna at the test frequency (dBi).

- The tests in c) to i) shall be repeated with the frequency changed to lowest carrier centre frequency of the operating frequency band as declared by the applicant.

- k) The tests in c) to i) shall be repeated with the frequency changed to highest carrier centre frequency of the operating frequency band as declared by the applicant.
- l) The tests in b) to k) may be performed simultaneously.

6.5.1.4 Antenna transmit radiation patterns

6.5.1.4.1 General

For the purpose 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 above deck 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.

For antennas designed to operate over a wider range of frequencies than the operating frequency band declared by the applicant for the EUT, the full operating range of the antenna, up to a maximum of 5 850 MHz to 7 075 MHz, may be used to perform the measurements in the following procedures.

6.5.1.4.2 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.

6.5.1.4.3 Test arrangement

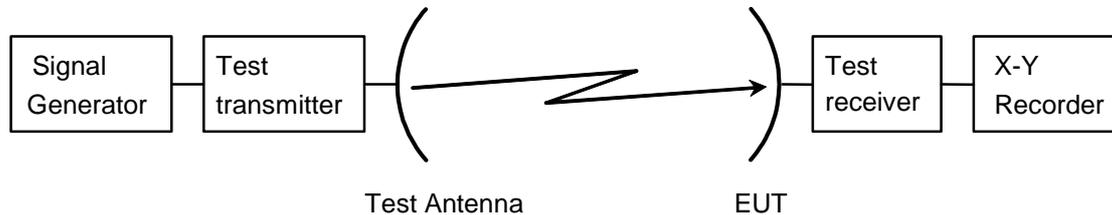


Figure 10: Test arrangement-antenna transmit radiation pattern measurement

6.5.1.4.4 Co-polar radiation pattern-azimuth

- a) The test arrangement shall be as shown in figure 10 with the EUT connected to the test receiver. The test arrangement shall enable the test results to be displayed and recorded with the angular position along the X-axis and the signal level along the Y-axis.
- b) The frequency of the test signal shall be set to the middle frequency of the operating frequency band as declared by the applicant.
- c) The EUT antenna main beam axis shall be aligned with the main beam axis of the test transmitter.

For linearly polarized antennas, the initial E-plane of the test signal radiated by the test transmitter through its antenna shall be vertical. 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).

For circular polarized antennas the EUT and test antenna polarizers shall be set to RHCP.

- d) The EUT shall be aligned to maximize the received signal and the X-Y display adjusted to give the maximum reading on the plot.
- e) The EUT shall be driven in azimuth to -180° .

- f) The transmit pattern measurement is then obtained by driving the EUT in azimuth from -180° to $+180^{\circ}$ with the results recorded.
- g) The tests in d) to f) shall be repeated with the frequency changed to the lowest carrier centre frequency of the operating frequency band as declared by the applicant.
- h) The tests in d) to f) shall be repeated with the frequency changed to the highest carrier centre frequency of the operating frequency band as declared by the applicant.
- i) The tests in b) to h) may be performed simultaneously.
- j) The frequency of the test signal shall be set to middle of the operating frequency band as declared by the applicant.

For linearly polarized antennas, the tests in d) to i) shall be repeated with the E-plane of the test signal being horizontal. 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.

For circular polarized antennas the tests in d) to i) shall be repeated with EUT and the test antenna polarizers set to LHCP.

6.5.1.4.5 Co-polar radiation pattern-elevation

- a) The test arrangement shall be as shown in figure 10 with the EUT connected to the test receiver. The test arrangement shall enable the test results to be displayed and recorded with the angular position along the X-axis and the signal level along the Y-axis.
- b) The frequency of the test signal shall be set to the middle frequency of the operating frequency band as declared by the applicant.
- c) The EUT antenna main beam axis shall be aligned with the main beam axis of the test transmitter.

For linearly polarized antennas, the initial E-plane of the test signal radiated by the test transmitter through its antenna shall be vertical. 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).

For circular polarized antennas the EUT and test antenna polarizers shall be set to RHCP.

- d) The EUT shall be aligned to maximize the received signal and the X-Y display adjusted to give the maximum reading on the plot.
- e) The EUT shall be driven in elevation to -1° .

NOTE: An equivalent measurement may be obtained by mechanical offsets or moving the test antenna.

- 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 the lowest carrier centre frequency of the operating frequency band as declared by the applicant.
- h) The tests in d) to f) shall be repeated with the frequency changed to the highest carrier centre frequency of the operating frequency band as declared by the applicant.
- i) The tests in b) to h) may be performed simultaneously.
- j) The frequency of the test signal shall be set to middle of the operating frequency band as declared by the applicant.

For linearly polarized antennas, the tests in d) to i) shall be repeated with the E-plane of the test signal being horizontal. 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.

For circular polarized antennas the tests in d) to i) shall be repeated with EUT and the test antenna polarizers set to LHCP.

6.5.1.4.6 Cross-polar radiation pattern-azimuth

- a) The test arrangement shall be as shown in figure 10 with the EUT connected to the test receiver. The test arrangement shall enable the test results to be displayed and recorded with the angular position along the X-axis and the signal level along the Y-axis.
- b) The frequency of the test signal shall be set to the middle frequency of the operating frequency band as declared by the applicant.
- c) The EUT antenna main beam axis shall be aligned with the main beam axis of the test antenna.

For linearly polarized EUT antennas, the initial E-plane of the test signal radiated by the test antenna shall be vertical. 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 antenna. Precise fine adjustment of the polarization plane shall be done by observing the cross-polar minimum.

For circularly polarized EUT antennas, the polarizer of the EUT shall be set for RHCP and the polarizer of the test antenna shall be set for LHCP.

- d) The boresight co-polar receive signal shall be used to adjust the X-Y display such that it gives the maximum reading on the plot.
- e) The EUT shall be driven in azimuth to -10° .
- f) The transmit pattern measurement is then obtained by driving the EUT in azimuth from -10° to $+10^\circ$ with the results recorded.
- g) The tests in d) to f) shall be repeated with the frequency changed to the lowest carrier centre frequency of the operating frequency band as declared by the applicant.
- h) The tests in d) to f) shall be repeated with the frequency changed to the highest carrier centre frequency of the operating frequency band as declared by the applicant.
- i) The tests in b) to h) may be performed simultaneously.
- j) The frequency of the test signal shall be set to the middle frequency of the operating frequency band as declared by the applicant. The EUT antenna main beam axis shall be aligned with the main beam axis of the test transmitter.

For linearly polarized EUT antennas, the tests in d) to i) shall be repeated with the E-plane of the test signal being horizontal. 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 antenna. Precise fine adjustment of the polarization plane shall be done by observing the cross-polar minimum.

For circularly polarized EUT antennas, the tests in d) to i) shall be repeated with the polarizer of the EUT set to LHCP and the polarizer of the test antenna set to RHCP.

6.5.1.4.7 Cross-polar radiation pattern-elevation

- a) The test arrangement shall be as shown in figure 10 with the EUT connected to the test receiver. The test arrangement shall enable the test results to be displayed and recorded with the angular position along the X-axis and the signal level along the Y-axis.
- b) The frequency of the test signal shall be set to the middle frequency of the operating frequency band as declared by the applicant.
- c) The EUT antenna main beam axis shall be aligned with the main beam axis of the test antenna.

For linearly polarized EUT antennas, the initial E-plane of the test signal radiated by the test antenna shall be vertical. 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 antenna. Precise fine adjustment of the polarization plane shall be done by observing the cross-polar minimum.

For circularly polarized EUT antennas, the polarizer of the EUT shall be set for RHCP and the polarizer of the test antenna shall be set for LHCP.

- d) The boresight co-polar receive signal shall be used to adjust the X-Y display such that it gives the maximum reading on the plot.
- e) The EUT shall be driven in elevation to -1° .

NOTE: An equivalent measurement may be obtained by mechanical offsets or moving the test antenna.

- f) The transmit pattern measurement is then obtained by driving the EUT in elevation from -1° to $+10^\circ$ with the results recorded.
- g) The tests in d) to f) shall be repeated with the frequency changed to the lowest carrier centre frequency of the operating frequency band as declared by the applicant.
- h) The tests in d) to f) shall be repeated with the frequency changed to the highest carrier centre frequency of the operating frequency band as declared by the applicant.
- i) The tests in b) to h) may be performed simultaneously.
- j) The frequency of the test signal shall be set to the middle frequency of the operating frequency band as declared by the applicant. The EUT antenna main beam axis shall be aligned with the main beam axis of the test transmitter.

For linearly polarized antennas, the tests in d) to i) shall be repeated with the E-plane of the test signal being horizontal. 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 antenna. Precise fine adjustment of the polarization plane shall be done by observing the cross-polar minimum.

For circularly polarized antennas, the tests in d) to i) shall be repeated with the polarizer of the EUT set to LHCP and the polarizer of the test antenna set to RHCP.

6.5.2 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 e.i.r.p. density is within the mask, and thus conforming to the specification in clause 4.2.4.

6.6 Carrier suppression

6.6.1 Test method

- a) For EUTs with antenna, the test arrangement for conducted measurements shall be as shown in figure 6. Otherwise, for EUTs without antenna, the test arrangement for radiated measurements shall be as shown in figure 7.
- b) The EUT shall transmit one modulated carrier continuously, or at its maximum burst rate where applicable, centred on the middle frequency of the operating frequency band as declared by the applicant.
- c) The resolution bandwidth of the spectrum analyser shall be set to 3 kHz.
- d) The "transmission disabled state" shall be obtained by use of the NCF.
- 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.

Instead of the NCF an STE provided by the applicant may be used to enable the ESV transmission to be suppressed.

6.7 Antenna pointing for ESV

6.7.1 General

The antenna pointing test method is designed to verify the ability of the EUT to detect and correctly respond to pointing errors that exceed the threshold, $\delta\phi$, declared by the applicant as required in clauses 4.2.4 and 4.2.6. For the purposes of testing antenna pointing, the applicant shall declare:

- the operational dynamic limits for ship motion under which the ESV is expected to maintain tracking within the declared $\delta\phi$;
- the survivability dynamic limits for operation without permanent damage; and
- the dynamic limits for testing of the EUT, which shall not be less than the operational dynamic limits and not greater than the survivability dynamic limits.

For the purpose of these tests the EUT is the ESV with its antenna connected.

6.7.2 Test method

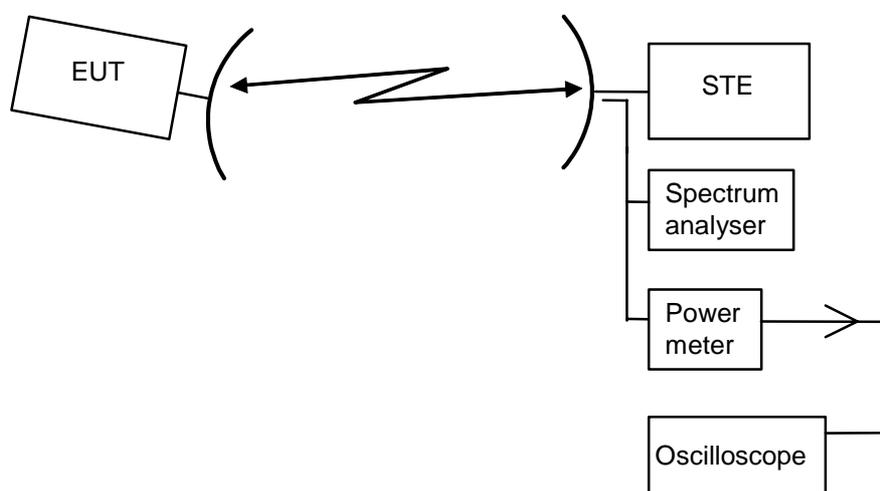


Figure 11: Test arrangement for pointing error detection

- The equipment shall be arranged as shown in figure 11. An actual satellite link may be used in place of the STE. In which case, care should be taken so that interference to adjacent satellites does not occur due to the pointing errors that will be induced in the test procedure (e.g. suppress the carrier or use a low e.i.r.p.).
- The signal received by the EUT shall be adjusted so that the signal to noise ratio corresponds to the minimum threshold signal to noise ratio declared by the applicant for reliable tracking.
- If the test is done with the carrier on then the spectrum analyzer or the power meter shall be used to verify that the EUT has suppressed the carrier. Otherwise, the applicant shall describe how the tests are performed and it is determined that the carrier is suppressed.
- There shall be a means for measuring and analyzing true pointing error values declared by the applicant. The means of measuring and analyzing pointing errors shall be included in the test report.
- There shall be a means of dynamically inducing pointing errors that exceed the threshold declared by the applicant. The means for inducing pointing errors shall be representative of operating vessel dynamics, within the dynamic limits for testing the EUT, as declared by the applicant in clause 6.7.1. If dynamic means alone are not sufficient to induce pointing errors that exceed the threshold for pointing errors, then an alternative means shall be used. Pointing errors shall be induced in at least two orthogonal directions; but not necessarily during the same test sequence. The means of inducing pointing errors shall be included in the test report.

- f) Conduct of test:
- 1) EUT shall be switched on and pointing towards the STE in a stable tracking state.
 - 2) Pointing errors of an increasing magnitude shall be induced in the EUT using the means given in e) above until the declared pointing error threshold is exceeded.
 - 3) It shall be verified that the EUT correctly detects that the induced pointing error has exceeded the pointing error threshold and enters the "Carrier-off" radio state no later than T s after the pointing error threshold is exceeded, where T is the response time declared by the applicant.
 - 4) Using the dynamic means given in e), the induced pointing error shall be decreased until it is less than the pointing error threshold.
 - 5) It shall be verified that the EUT does not re-enter the "Carrier-on" radio state for at least $2 \times T$ s.
- g) Step f) shall be repeated ten times.
- h) If the results in f) 3) are satisfied on all ten tests, then the EUT shall be declared compliant with the requirements.

6.8 Antenna mechanical stability

6.8.1 Test method

As it is considered impracticable to perform a test on mechanical stability no test is given.

The methodology described in annex B shall be used to show compliance with the specification for mechanical stability.

6.9 Polarization angle alignment capability:

6.9.1 Test method

The adjustment facilities shall be examined to determine both the angular movement possible and the means of establishing and fixing the alignment.

The applicant shall demonstrate by documentary evidence that the ESV complies with the specification c) in clause 4.2.6.2.

6.10 Cessation of emissions of the ESV

6.10.1 Test arrangement

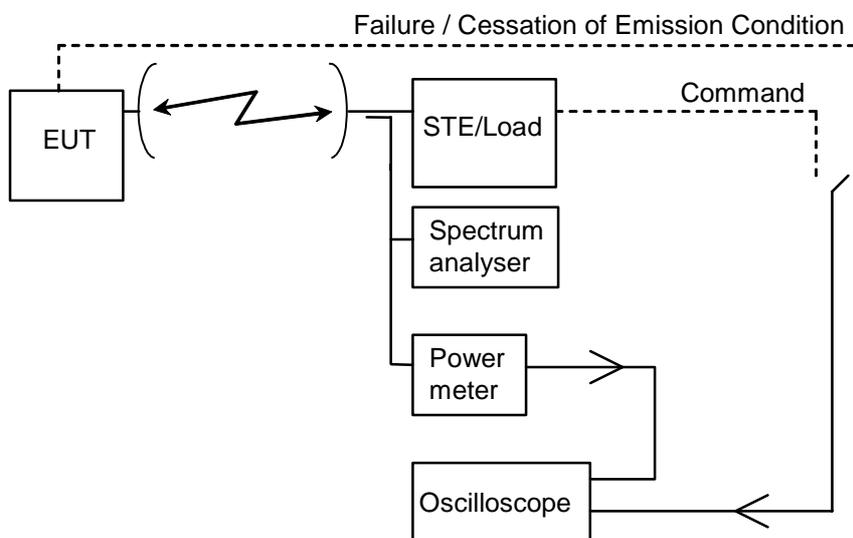


Figure 12: General test arrangement for control and monitoring tests for radiated measurements

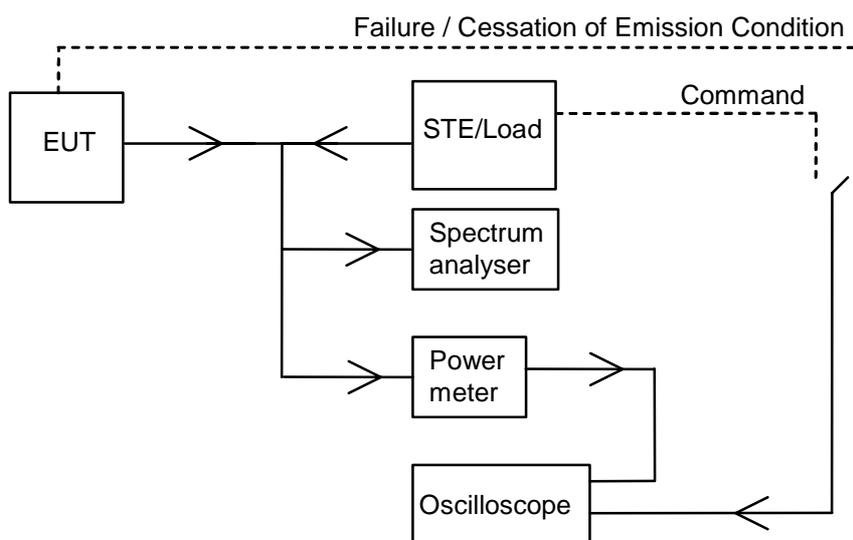


Figure 13: General test arrangement for control and monitoring tests for conducted measurements

The test arrangement shall be as shown in figure 12 or 13. There shall be a means of simulating a condition where cessation of emissions is required. The spectrum analyser or the oscilloscope shall be used to measure the time difference between the occurrence of the condition and the cessation of emissions. In all test methods, it shall be verified that the time difference does not exceed 5 s as specified in clause 4.2.7.2.3.

Where the EUT adds an operational margin around areas where cessation of emissions is required to account for the position determination accuracy and latency, the test procedure may simulate the actual behaviour of an EUT as it sails into an area where cessation of emissions is required. For example, if the EUT adds a margin of X meters around areas where cessation of emissions is required, then the test may begin with the EUT being simulated at a position more than X meters outside of an area where cessation of emissions is required. The test may then simulate the motion of the EUT towards the area where cessation of emissions is required. In any event, the EUT shall enter the "emission disabled" radio state within 5 s of entering the actual area where cessation of emissions is required.

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

6.10.2 Test method

6.10.2.1 Required documentation

The applicant shall declare the mode(s) of cessation of emissions implemented in the EUT and the ESV interfaces involved in the cessation of emissions as specified in clause 4.2.7.2.1.

The applicant shall demonstrate by documentary evidence compliance with Specification 2 in clause 4.2.7.2.2 for the determination of the conditions under which the ESV must cease emissions.

6.10.2.2 Cessation of emissions from the "Transmission enabled" state

- a) The EUT shall be set in the "Transmission enabled" ESV state.
- b) The EUT shall be set in the "Carrier on" radio state.
- c) A condition requiring the cessation of emission shall be initiated either by the STE or the EUT.
- d) It shall be verified that the EUT enters the "Emissions disabled" radio state.
- e) In order to verify that the EUT is in the "Transmission disabled" ESV state, it shall be verified that the EUT remains in the "Emissions disabled" radio state when the EUT is requested to transmit data.

6.10.2.3 Cessation of emission from the "Transmission disabled" state

- a) The EUT shall be set in the "Transmission disabled" state.
- b) A condition requiring the cessation of emission shall be initiated either by the STE or the EUT.
- c) In order to verify that the EUT remains in the "Transmission disabled" ESV state, it shall be verified that the EUT remains in the "Emissions disabled" radio state when the EUT is requested to transmit data.
- d) The STE shall send a TxE command to the EUT.
- e) In order to verify that the EUT remains in the "Transmission disabled" ESV state, it shall be verified that the EUT remains in the "Emissions disabled" radio state when the EUT is requested to transmit data.
- f) The STE shall send a TxD command to the EUT.
- g) The condition requiring the cessation of emissions shall be removed.
- h) In order to verify that the EUT remains in the "Transmission disabled" ESV state, it shall be verified that the EUT remains in the "Emissions disabled" radio state when the EUT is requested to transmit data.

6.10.2.4 Cessation of emission from the "Initial Phase" state

6.10.2.4.1 EUTs transmitting initial bursts

This applies only to EUTs transmitting initial bursts (i.e. where "Initial phase-1" and "Initial phase-2" are implemented).

- a) The EUT shall be set in "Initial phase-1" state.
- b) The STE shall not send the TxE command and the EUT shall be allowed to cycle between "Initial phase-1" and "Initial phase-2" as it would under normal operations.
- c) A condition requiring the cessation of emission shall be initiated either by the STE or the EUT.
- d) It shall be verified that the EUT enters the "Emissions disabled" radio state.
- e) In order to verify that the EUT is in the "Initial phase-0" ESV state, it shall be verified that the EUT remains in the "Emissions disabled" radio state when the EUT is requested to transmit data.
- f) The STE shall send a TxE command to the EUT.

- g) In order to verify that the EUT remains in the "Initial phase-0" ESV state or enters the "Transmission disabled" ESV state, it shall be verified that the EUT remains in the "Emissions disabled" radio state when the EUT is requested to transmit data.
- h) Repeat the test steps a) through g) using a TxD command in step f) instead of the TxE command.

6.10.2.4.2 EUTs not transmitting initial bursts

This applies only to EUTs that do not transmit initial bursts (i.e. where only "Initial phase-0" is implemented).

- a) The EUT shall be set in "Initial phase-0" ESV state.
- b) The STE shall not send the TxE command to maintain the EUT in "Initial phase-0" ESV state.
- c) A condition requiring the cessation of emission shall be initiated either by the STE or the EUT.
- d) In order to verify that the EUT remains in the "Initial phase-0" ESV state, it shall be verified that the EUT remains in the "Emissions disabled" radio state when the EUT is requested to transmit data.
- e) The STE shall send a TxE command to the EUT.
- f) In order to verify that the EUT remains in the "Initial phase-0" ESV state or enters the "Transmission disabled" ESV state, it shall be verified that the EUT remains in the "Emissions disabled" radio state when the EUT is requested to transmit data.
- g) Repeat the test steps a) through f) using a TxD command in step e) instead of the TxE command.

6.10.2.5 "Single action" means of cessation of emissions

- a) It shall be verified that there is a "single action" means of ceasing emissions on the below deck unit of the EUT.
- b) The EUT shall be set in the "Transmission enabled" ESV state.
- c) The EUT shall be set in the "Carrier on" radio state.
- d) The "single action" means of cessation of emissions shall be activated (e.g. the switch thrown).
- e) It shall be verified that the EUT enters the "Emissions disabled" radio state.
- f) In order to verify that the EUT is in the "Transmission disabled" ESV state, it shall be verified that the EUT remains in the "Emissions disabled" radio state when the EUT is requested to transmit data.
- g) The STE shall send a TxE command to the EUT.
- h) In order to verify that the EUT remains in the "Transmission disabled" ESV state, it shall be verified that the EUT remains in the "Emissions disabled" radio state when the EUT is requested to transmit data.
- i) The EUT shall be switched off and then switched on and the EUT shall enter the "Initial phase" ESV state without receiving a TxE from the STE.
- j) The "single action" means of cessation of emissions shall be activated.
- k) The STE shall send a TxE command to the EUT.
- l) In order to verify that the EUT remains in the "Initial phase" ESV state or enters the "Transmission disabled" ESV state, it shall be verified that the EUT remains in the "Emissions disabled" radio state when the EUT is requested to transmit data.
- m) The EUT shall be switched off and then switched on and the EUT shall enter the "Initial phase" ESV state without receiving a TxE from the STE.
- n) The STE shall send a TxD command to the EUT so that it enters the "Transmission disabled" ESV state.
- o) The "single action" means of cessation of emissions shall be activated.

- p) The STE shall send a TxE command to the EUT.
- q) In order to verify that the EUT remains in the "Transmission disabled" ESV state, it shall be verified that the EUT remains in the "Emissions disabled" radio state when the EUT is requested to transmit data.

6.10.2.6 Fault conditions

The applicant shall declare the means of generating fault conditions.

- a) The EUT shall be set in the "Transmission enabled" ESV state.
- b) The EUT shall be set in the "Carrier on" radio state.
- c) A fault condition requiring the cessation of emission shall be generated either by the STE or directly on the EUT.
- d) It shall be verified that the EUT enters the "Emissions disabled" radio state as long as the fault condition persists.
- e) Steps a) through d) shall be repeated for each fault condition declared by applicant.

6.11 Identification of ESV

6.11.1 Test arrangement

The test arrangement shall be as shown in figures 12 and 13. The test shall be arranged such that EUT can determine its own location, or if external means are employed, the test shall be arranged so that the EUT can be located by the means declared by the applicant. The STE shall be arranged to simulate the NCF. The actual location of the EUT shall be known within 100 m.

6.11.2 Test method

- a) The EUT shall be in the "Transmission enabled" state.
- b) The EUT shall report its location to the STE.
- c) The reported EUT location shall be within 1 km of the actual location of the EUT.

6.12 Control and Monitoring Functions

The applicant may modify an ESV 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 $EIRP_{max}$.

For the purpose of these tests the EUT is the ESV 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 10 MHz bandwidth centred on the carrier frequency, whichever is the greater.

6.12.1 Test arrangement

The test arrangement shall be as shown in figures 12 or 13. 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.

6.12.2 Processor monitoring - Test method

- a) Each of the processors within the EUT shall, in turn, be caused to fail.
- b) Within 5 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 within the limits of the "Carrier-off" radio state emission levels.
- d) Within 30 s of such failure the power meter and spectrum analyser shall be observed to ascertain that the transmissions have been suppressed within the limits of the "Emissions disabled" radio state emission levels.
- e) 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.

6.12.3 Transmit subsystem monitoring - Test method

To demonstrate compliance with clause 4.2.9.3.2, the following test procedure shall apply. However, for EUTs where it is not possible to directly induce failures in the components of the frequency generation subsystem, the applicant shall demonstrate compliance by documentary evidence.

- a) The frequency generation subsystem within the EUT shall be caused to fail in respect of:
 - 1) loss of frequency lock (if applicable);
 - 2) failure of the Local Oscillator (LO).
- b) Recognition of each failure in turn by the subsystem monitor shall constitute a SMF event.
- c) Within 5 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 within the limits of the "Emissions disabled" radio state emission levels.
- 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.

6.12.4 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) 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;
- h) the EUT shall enter the "Non valid" state.

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

6.12.5 Control Channel and Response Channel - 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 30 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.

6.12.6 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 a transmit 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 1 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 then 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 then 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.

6.12.7 Initial burst transmission-Test method

The applicant shall declare the initial burst duration.

The following test shall be performed in sequence:

- a) the EUT shall be switched-off and the STE shall transmit the CC;
- b) the EUT shall be switched-on;
- c) the EUT shall not transmit, except the initial bursts;
- d) it shall be verified that the specifications given in clause 4.2.9.7.2 are fulfilled.

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

Annex A (normative): The EN Requirements table (EN-RT)

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

The EN Requirements table (EN-RT) serves a number of purposes, as follows:

- it provides a tabular summary of all the requirements;
- it shows the status of each EN-Requirement, whether it is essential to implement in all circumstances (Mandatory), or whether the requirement is dependent on the applicant having chosen to support a particular optional service or functionality (Optional). In particular it enables the EN-Requirements associated with a particular optional service or functionality to be grouped and identified;
- when completed in respect of a particular equipment it provides a means to undertake the static assessment of conformity with the EN.

The EN-RT is placed in an annex of the EN in order that it may be photocopied and used as a proforma.

Table A.1: EN Requirements table (EN-RT)

EN Reference		EN 301 447 (the present document)		Comments
No.	Reference	EN-Requirements (see note)	Status for ESV	
1	4.2.1	Off-axis spurious radiation	M	
2	4.2.2	On-axis spurious radiation for ESV	M	
3	4.2.3	Maximum ESV emissions towards the horizon	M	
4	4.2.4	Off-axis e.i.r.p. emission density within the band	M	
5	4.2.5	Carrier suppression	M	
6	4.2.6	Antenna pointing and polarization alignment for ESVs	M	
7	4.2.7	Cessation of emissions of the ESV	M	
8	4.2.8	Identification of ESV	M	
9	4.2.9.1	CMF state diagram	M	
10	4.2.9.2	Processor monitoring	M	
11	4.2.9.3	Transmit subsystem monitoring	M	
12	4.2.9.4	Power on/Reset	M	
13	4.2.9.5	Control Channel (CC) and Response Channel (RC)	M	
14	4.2.9.6	Network control commands	M	
15	4.2.9.7	Initial burst transmissions	M	
NOTE: These EN-Requirements are justified under Article 3.2 of the R&TTE Directive [1].				

Key to columns:

No	Table entry number;
Reference	Clause reference number of conformance requirement within the present document;
Status	Status of the entry as follows:
M	Mandatory, shall be implemented under all circumstances;
Comments	To be completed as required.

Annex B (normative): Mechanical stability methodology

This test based on an analytical or numerical analysis shall be performed in two stages.

In the first stage the loads generated by the maximum wind speed shall be computed on the above deck unit, taking into account the intrinsic properties of the materials.

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

The purpose of the analysis is twofold:

- a) to show that the torque and the fields of force applied to the above deck unit structure under nominated conditions do not reach any of the following:
 - the point where deformation fouls the antenna pointing mechanism;
 - the yield point of any element of the structure;
 - the buckling point of any element of the structure.

NOTE: The yield point is elastic limit of the material and the buckling point is the failure point for the material.

- b) to compute equivalent static loads (force and torque) applied to the critical attachment points of the structures, e.g.:
 - for antennas without a radome:
 - reflector-mounting legs fixing point;
 - reflector-struts;
 - LNB- struts.
 - for antennas with a radome:
 - radome surface;
 - radome mounting points.

Analysis and load applications procedure:

- a) The air related parameters, namely the kinetic viscosity used to calculate drags at the rims of the structure shall be calculated with the standard atmospheric environmental conditions (temperature = 293 K, air pressure = $1,013 \times 10^5$ Pascal).
- b) The computations needed to derive the field of force and torque and the equivalent static stresses shall be carried out for each of the following variables:
 - elevation angle: maximum and minimum for antennas without a radome;
 - wind direction: in steps of 45° around the above-deck unit;
 - wind speed: 100 km/h;
 - gust speed: 130 km/h for 3 s.
- c) It shall be verified with the simulated results that yield point limits are not exceeded for any self-contained element.
- d) The calculated equivalent static loads shall be applied at any identified critical fixing point of the assembly.
- e) Whilst the loads are applied the above deck unit shall be observed and any distortion noted.

- f) The test report shall contain the following information:
- the computation method used;
 - the description of the test equipment;
 - the description of the tests performed;
 - the results of the safety margin test;
 - any signs of distortion observed;
 - the results of the measurements of the deviation of the antenna or radome position;
 - the component deviation with respect to each other.

Annex C (informative): Bibliography

ETSI ETR 169 (1995): "Satellite Earth Stations and Systems (SES); Common Technical Regulations (CTRs) in the satellite earth station equipment field".

ETSI EN 301 843-6 (2005): "Electromagnetic compatibility and Radio spectrum Matters (ERM); ElectroMagnetic Compatibility (EMC) standard for marine radio equipment and services; Part 6: Specific conditions for Earth Stations on board Vessels, transmitting above 3 GHz".

ETSI TR 102 215 (2004): "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".

ETSI TR 102 375 (2005): "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".

ITU-R RESOLUTION 902 (WRC-03): "Provisions relating to earth stations located on board vessels which operate in fixed-satellite service networks in the uplink bands 5 925-6 425 MHz and 14-14.5 GHz".

Annex D (informative): The EN title in the official languages

Language	EN Title
Czech	Družicové pozemské stanice a systémy (SES) - Harmonizovaná EN pro družicové pozemské stanice na palubách lodí (ESVs), pracující v kmitočtových pásmech 4/6 GHz přidělených pevné družicové službě (FSS), pokrývající základní požadavky podle článku 3.2 Směrnice R&TTE
Danish	Satellitjordstationer og systemer (SES); Harmoniseret EN for satellitjordstationer om bord på skibe (ESVs), som benytter 4/6 GHz frekvensbåndene, der er allokeret til den faste satellittjeneste (FSS), og som dækker de væsentlige krav i R&TTE direktivets artikel 3.2
Dutch	Satellietgrondstations en -systemen (SES); Geharmoniseerde EN voor satellietgrondstations aan boord van schepen (ESVs) in de 4/6 GHz frequentiebanden toegewezen aan de vaste satellietdienst (FSS) ter dekking van de essentiële eisen onder artikel 3.2 van de R&TTE Directive
English	Satellite Earth Stations and Systems (SES); Harmonized EN for satellite Earth Stations on board Vessels (ESVs) operating in the 4/6 GHz frequency bands allocated to the Fixed Satellite Service (FSS) covering essential requirements under article 3.2 of the R&TTE directive
Estonian	Kosmoseside maajaamad ja süsteemid (SES); Paiksele kosmosesidele (FSS) eraldatud raadiosagedusalades 4/6 GHz töötavate veesõidukitele paigaldatud kosmoseside maajaamade (ESV) põhinõuded, harmoneeritud EN R&TTE direktiivi artikli 3.2 alusel
Finnish	Satelliittimaa-asetat ja -järjestelmät (SES); Yhdenmukaistettu standardi (EN), joka kattaa R&TTE-direktiivin artiklan 3.2 mukaiset olennaiset vaatimukset laivoissa käytettäville satelliittimaa-asetille, jotka toimivat kiinteälle satelliittiliikenteelle osoitetuilla 4/6 GHz:n taajuualueilla
French	Stations terriennes et systèmes à satellites (SES) - Norme Européenne (EN) harmonisée pour les stations terriennes placées à bord de navires (ESV) fonctionnant dans les bandes de fréquences à 4 et 6 GHz allouées au Service Fixe par Satellite (SFS), couvrant l'exigence essentielle de l'article 3.2 de la Directive R&TTE
German	Satelliten-Erdfunkstellen und -systeme (SES); Harmonisierte EN für Erdfunkstellen an Bord von Schiffen (ESVs) zum Betrieb in den Frequenzbändern 4/6 GHz des Festen Funkdienstes über Satelliten (FSS), die wesentliche Anforderungen nach Artikel 3.2 der R&TTE-Richtlinie enthält
Greek	Δορυφορικοί Επίγειοι Σταθμοί και Συστήματα (SES) - Εναρμονισμένο EN για επινήσιους δορυφορικούς επίγειους σταθμούς (ESV) που λειτουργούν στις ζώνες συχνοτήτων 4/6 GHz, οι οποίες έχουν καταχωρισθεί στη Σταθερή Δορυφορική Υπηρεσία (FSS), για την κάλυψη των ουσιωδών απαιτήσεων του άρθρου 3.2 της Οδηγίας R&TTE
Hungarian	Műholdas földi állomások és rendszerek (SES). A 4/6 GHz-es frekvenciasávokban, a helyhez kötött műholdas szolgálat (FSS) keretében a hajók fedélzetén működő műholdas földi állomásokra (ESV-kre) vonatkozó, az R&TTE-irányelv 3.2. cikkelyének alapvető követelményeit tartalmazó, harmonizált európai szabvány
Icelandic	
Italian	Stazioni e sistemi satellitari di terra (SES); Norma europea armonizzata per stazioni satellitari di terra a bordo di navi (ESV) operanti nelle bande di frequenze a 4/6 GHz riservate ai servizi satellitari fissi (FSS), relativa ai requisiti essenziali dell'articolo 3.2 della direttiva R & TTE
Latvian	Satelītu Zemes stacijas un sistēmas (SES) - Harmonizēts Eiropas standarts (EN) uz kuģu mastiem nostiprinātām satelītu Zemes stacijām, kuras darbojas 4/6 GHz frekvenču joslās, kas ir iedalītas fiksētajām satelītu dienestam (FSS) un atbilst R&TTE direktīvas 3.2.punkta būtiskajām prasībām
Lithuanian	Laiivų borto palydovinių Žemės stotčių, veikiančių 4/6 GHz dažnių juostose, skirtose fiksuotajai palydovinei tarnybai, darnusis Europos standartas, apimantis esminius reikalavimus pagal 1999/5/EC direktyvos 3.2 straipsnį
Maltese	Stazzjonijiet Dinjin u Sistemi tas-Satelliti (SES); EN armonizzata għal Stazzjonijiet ta' l-Art għal satelliti abbord Bastimenti (ESVs) li joperaw fil-frekwenzi 4/6 GHz allokatati għas-Servizz ta' Satelliti Fissi (FSS) li jkopri rekwiżiti essenzjali taħt l-artiklu 3.2 tad-direttiva R&TTE
Norwegian	Satellitjordstasjoner og -systemer (SES); Harmonisert EN som dekker de grunnleggende krav i R&TTE-direktivets artikkel 3.2 for satellitjordstasjoner ombord på fartøyer (ESVs) som opererer i frekvensbåndene 4/6 GHz allokeret til den faste satellittjenesten (FSS)
Polish	Naziemne stacje i systemy satelitarne (SES) - Zharmonizowana EN dotycząca naziemnych stacji satelitarnych instalowanych na pokładach statków (ESVs), pracujących w zakresach częstotliwości 4/6 GHz przeznaczonych dla stałej służby satelitarnej (FSS), spełniających zasadnicze wymagania artykułu 3.2 dyrektywy R&TTE
Portuguese	
Slovak	Družicové zemské stanice a systémy (SES). Harmonizovaná EN na družicové zemské stanice na palubách lodí (ESV), pracujúce vo frekvenčných pásmach 4/6 GHz pridelených pevnej družicovej službe (FSS), vzťahujúca sa na základné požiadavky podľa článku 3.2 smernice R&TTE
Slovenian	Satelitske zemeljske postaje in sistemi (SES) - Harmonizirani EN za satelitske zemeljske postaje na ladjah, delujoče v frekvenčnih pasovih 4/6 GHz, razporejenih za fiksne satelitske storitve (FSS), ki zajema bistvene zahteve člana 3.2 direktive R&TTE

Language	EN Title
Spanish	
Swedish	

History

Document history			
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