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Candidate Harmonized European Standard (Telecommunications series)

Satellite Earth Stations and Systems (SES); Harmonized EN for satellite mobile Aircraft Earth Stations (AESs) operating in the 11/12/14 GHz frequency bands covering essential requirements under article 3.2 of the R&TTE directive

Reference

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Contents

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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 Council Directive 98/34/EC (as amended) laying down a procedure for the provision of information in the field of technical standards and regulations.

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

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

NOTE: Presently the frequency band from 14,0 GHz to 14,5 GHz is not allocated to the Aeronautical Mobile Satellite Service (AMSS). Nevertheless, the present document has been drafted with the assumption that the frequency band is allocated to the AMSS on a secondary basis during the 2003 World Radio Conference (WRC-03; Agenda Item 1.11). In this respect the end date of the Public Enquiry phase is such that it allows comments until 15 August 2003, so that WRC-03 decisions be taken into account.
This note will be deleted from the present document after Public Enquiry.

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

The present document is part of a set of standards designed to fit in a modular structure to cover all radio and telecommunications terminal equipment under the R&TTE Directive [1]. Each standard is a module in the structure. The modular structure is shown in figure 1.

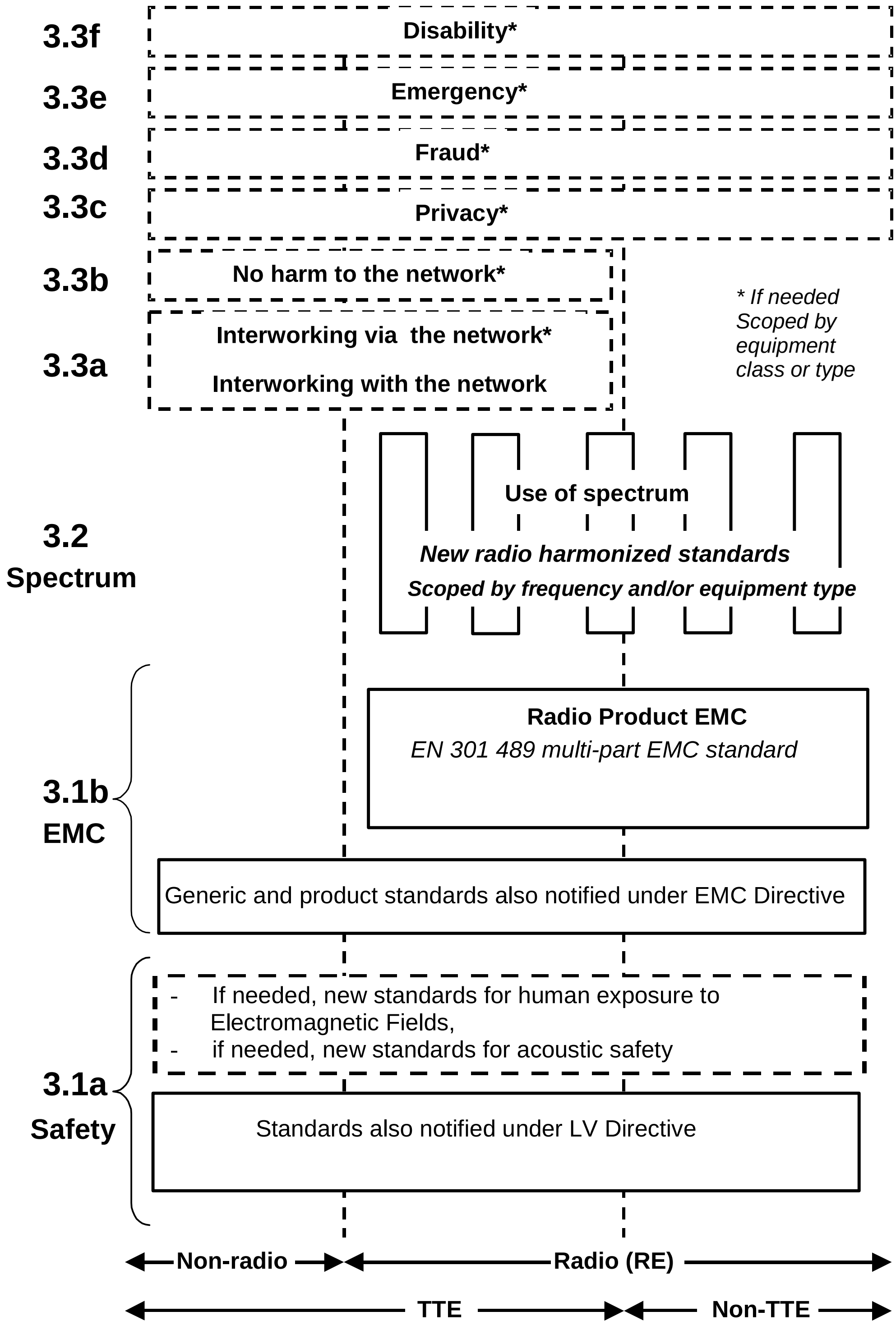

Figure 1: Modular structure for the various standards used under the R&TTE Directive

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

For article 3.3 various horizontal boxes are shown. Dotted lines indicate that at the time of publication of the present document essential requirements in these areas have to be adopted by the Commission. If such essential requirements are adopted, and as far and as long as they are applicable, they will justify 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 by radio equipment. 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 301 489, the multi-part product EMC standard for radio used under the EMC Directive [2].

For article 3.1a the diagram shows the existing safety standards currently used under the LV Directive [3] and new standards covering human exposure to electromagnetic fields. New standards covering acoustic safety may also be required.

The bottom of the figure shows the relationship of the standards to radio equipment and telecommunications terminal equipment. A particular equipment may be radio equipment, telecommunications terminal equipment or both. A radio spectrum standard will apply if it is radio equipment. An article 3.3 standard will apply as well only if the relevant essential requirement under the R&TTE Directive is adopted by the Commission and if the equipment in question is covered by the scope of the corresponding standard. Thus, depending on the nature of the equipment, the essential requirements under the R&TTE Directive may be covered in a set of standards.

The modularity principle has been taken because:

- it minimizes the number of standards needed. Because equipment may, in fact, 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.

The requirements have been selected to ensure an adequate level of compatibility with other radio services.

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 AES on aircraft.

The determination of the parameters of the AES using a given GeoStationary Orbiting (GSO) 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.

1 Scope

The present document specifies certain minimum technical performance requirements of Aircraft Earth Station (AES) equipment with both transmit and receive capabilities for provision of aeronautical mobile satellite service, in the frequency bands given in table 1.

Table 1: Frequency bands for the AES equipment specified in the present document.

Mode of Operation	Frequency Band
AES transmit	14,00 GHz to 14,50 GHz
AES receive	10,70 GHz to 11,70 GHz
AES receive	12,50 GHz to 12,75 GHz
	NOTE: The AESs are operating in one or more frequency ranges of the Fixed and Mobile-Satellite Services.

The AES has the following characteristics:

- These AESs are equipment for installation on aircraft.
- The AES could consist of a number of modules from the antenna subsystem to the user interfaces.
- The AES uses linear polarization.
- The AES system uses digital modulation.
- The AES operates through a GSO satellite at least 3° away from any other geostationary satellite operating in the same frequency band and covering the same area.
- The antenna of the AES is directional, with means of tracking the satellites, which can be achieved by using either an active phase array or reflective type configuration.
- These AESs are operating as part of a satellite network used for the distribution and/or exchange of information between users.
- These AESs are controlled and monitored by a Network Control Facility (NCF). The NCF is outside the scope of the present document.

The technical requirements in the present document are in two major categories:

- **emission limits:** to protect other radio services and systems from harmful interference generated by the AES in normal use;
- **AES Control and Monitoring Functions (CMF):** to protect other radio services and systems from unwanted transmissions from the AES. The CMF in each AES is capable of answering to commands from the Network Control Facility (NCF) for its supporting satellite network.

The present document applies to the AESs with their ancillary equipment and its various ports, and when operated within the boundary limits of the operational environmental profile declared by the manufacturer.

The present document is intended to cover the provisions of Directive 1999/5/EC (R&TTE Directive) [1] 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".

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 R&TTE Directive [1] may apply to equipment within the scope of the present document.

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

The present document does not cover equipment compliance with relevant civil aviation regulations. Furthermore, an AES and its installation on board aircraft are subject to additional national or international civil aviation airworthiness certification requirements.

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 (2002-10): "Specification for radio disturbance and immunity measuring apparatus and methods; Part 1: Radio disturbance and immunity measuring apparatus".

[3] ETSI EN 301 427 (V1.2.1): "Satellite Earth Stations and Systems (SES); Harmonized EN for Low data rate Mobile satellite Earth Stations (MESs) except aeronautical mobile satellite earth stations, operating in the 11/12/14 GHz frequency bands covering essential requirements under article 3.2 of the R&TTE directive".

[4] ETSI EN 301 428 (V1.2.1): "Satellite Earth Stations and Systems (SES); Harmonized EN for Very Small Aperture Terminal (VSAT); Transmit-only, transmit/receive or receive-only satellite earth stations operating in the 11/12/14 GHz frequency bands covering essential requirements under article 3.2 of the R&TTE directive".

[5] IEEE STD 149 (1979): "IEEE Standard Test Procedures for Antennas".

[6] EUROCAE ED14D (equivalently RTCA D0-160): "Environmental Conditions and Test Procedures for Airborne Equipment", Issued 7-29-97, Superseded DO-160C, Changes 1, 2 & 3, Prepared by SC-135. Coordinated with EUROCAE, RTCA/DO-160D and EUROCAE ED-14D are identically worded. DO-160D is recognized by the International Organization for Standardization (ISO) as de facto international standard ISO/IEC 7137.

3 Definitions, symbols and abbreviations

3.1 Definitions

For the purposes of the present document, the terms and definitions given in the R&TTE Directive [1] and the following apply:

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

a) the equipment is intended for use in conjunction with the AES 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 AES; and

c) the absence of the equipment does not inhibit the operation of the AES

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

carrier-off state: state in which AES is when either it is authorized by the Network Control Facility (NCF) to transmit but when it does not transmit any signal, or when it is not authorized by the NCF to transmit

carrier-on state: state in which AES is when it is authorized by the NCF to transmit and when it transmits a signal

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

NOTE: The CCs are not necessarily on separate RF channels from the RF channels carrying the user data streams.

$EIRP_{max}$: maximum EIRP capability of the AES as declared by the applicant

$EIRP_{nom}$: either:

i) $EIRP_{max}$;

ii) or, when uplink power control is implemented, the maximum required EIRP of the AES under clear sky condition as declared by the applicant

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

Externally Mounted Equipment (EME): those of the modules of the Installable Equipment (IE) which are intended to be mounted externally to the aircraft as stated by the manufacturer

Installable Equipment (IE): equipment which is intended to be fitted to an aircraft

NOTE: An IE may consist of one or several interconnected modules.

Internally Mounted Equipment (IME): those of the modules of the IE which are not declared by the manufacturer as EME are defined as IME

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

longitudinal angle: angle from the AES zenith direction to any other direction

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

Nominated bandwidth (Bn): bandwidth of the AES radio frequency transmission is nominated by the applicant. The nominated bandwidth is centred on the transmit frequency and does not exceed 5 times the occupied bandwidth.

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

Occupied Bandwidth (Bo): for a digital modulation scheme-the width of the signal spectrum 10 dB below the maximum in-band density.

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

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

spurious radiation: any radiation outside the nominated bandwidth

transmission disabled state: state in which AES is when it is not authorized to transmit by the NCF through a CC

3.2 Symbols

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

dBc	Decibel ratio relative to the absolute carrier EIRP level
dBi	Decibel ratio relative to isotropic gain
dBW	Decibel ratio relative to 1 watt
dBpW	Decibel ratio relative to 1 pico watt
dBµV/m	Decibel ratio relative to 1 (µV/m)

3.3 Abbreviations

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

AES	Aircraft Earth Station
AMSS	Aeronautical Mobile Satellite Service
B_o	Occupied Bandwidth
Bn	nominated Bandwidth
CC	Control Channel
CISPR	International Special Committee on Radio Interference
CMF	Control and Monitoring Function
EC	European Community
EIRP	Equivalent Isotropically Radiated Power
EME	Externally Mounted Equipment
EN	European Norm
EN-RT	EN Requirements Table
EUROCAE	EURopean Organisation for Civil Aeronautical Electronics
EUT	Equipment Under Test
FS	Fixed Service
FSS	Fixed-Satellite Service
GSO	GeoStationary Orbiting
HPA	High Power Amplifier
IE	Installable Equipment
IEEE	Institute of Electrical and Electronic Engineers
IME	Internally Mounted Equipment
IPR	Intellectual Property Rights
ISO	International Organization for Standardization
LNA	Low Noise Amplifier
LNA/D	Low Noise Amplifier/Diplexer
LRU	Line Replaceable Unit
MES	Mobile Earth Station
MSS	Mobile Satellite Service
NCF	Network Control Facility
PFD	Power Flux Density
R&TTE	Radio and Telecommunications Terminal Equipment
RAS	Radio Astronomy Service
RC	Response Channel
RF	Radio Frequency
rms	root mean square
RTCA	Radon Testing Corporation of America
SES	Satellite Earth Stations and System
STE	Special Test Equipment
STU	Satellite Terminal Unit
VSAT	Very Small Aperture Terminal

4 Technical requirement specifications

4.1 General

NOTE: The transmissions from the AES to the Satellite in the 14,00 GHz to 14,50 GHz band fall under a secondary allocation to the Mobile-Satellite Service (MSS), the transmissions should not cause harmful interference to primary services (e.g. the Fixed-Satellite Service (FSS)) and at the same time cannot claim protection from harmful interference from those services. In relation to Radio Astronomy (RA) service in the band 14,47 GHz to 14,5 GHz (whose allocation is on a secondary basis) the transmissions from AES equipment shall not cause unacceptable interference to RA sites operating in this band.

4.1a Environmental profile

The technical requirements of the present document apply under the environmental profiles for operation of the equipment (EME and IME), which shall be declared by the manufacturer. The equipment (EME and IME) shall comply with all the technical requirements of the present document at all times when operating within the boundary limits of the declared operational environmental profiles and for the environmental conditions (as specified in clause B.3) corresponding to the type of equipment as specified in clause B.2.

4.2 Conformance requirements

4.2.1 General

The applicant shall declare the aircraft model for which the AES is designed.

4.2.2 Spurious radiation

4.2.2.1 Justification

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

4.2.2.2 Specification

The following specifications apply to the AES transmitting at EIRP values up to and including $EIRP_{max}$.

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

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

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

The lower limits shall apply at the transition frequency.

2) When the AES is in the "Transmission disabled" state, the off-axis spurious Equivalent Isotropically Radiated Power (EIRP) from the AES, in the measurement bandwidth, shall not exceed the limits in table 3, for all off-axis angles greater than 7°:

Table 3: Limits of off-axis spurious EIRP - "Transmission disabled" state

Frequency band	EIRP limit (dBpW)	measurement bandwidth
1,0 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) When the AES is in the "Transmission enabled" state, the present document applies outside the nominated bandwidth. For both the carrier-on and carrier-off states, the off-axis spurious EIRP density from the AES, shall not exceed the limits in table 4, for all off-axis angles greater than 7°:

Table 4: Limits of off-axis spurious EIRP "Transmission Enabled" state

Frequency band	EIRP limit (dBpW)	Measurement bandwidth
1,0 GHz to 3,4 GHz	49	100 kHz
3,4 GHz to 10,7 GHz	55	100 kHz
10,7 GHz to 13,75 GHz	61	100 kHz
13,75 GHz to 14,0 GHz	95 (see note)	10 MHz
14,5 GHz to 14,75 GHz	95 (see note)	10 MHz
14,75 GHz to 21,2 GHz	61	100 kHz
21,2 GHz to 40,0 GHz	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 EIRP density at the considered frequency is 50 dB below the maximum on-axis EIRP density of the signal (within the nominated bandwidth) expressed in dBW/100 kHz.		

The lower limits shall apply at the transition frequency.

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

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

4.2.2.3 Conformance tests

Conformance tests shall be carried out in accordance with clause 6.1.

4.2.3 On-axis spurious radiation

4.2.3.1 Justification

To limit the level of interference to satellite radio services.

4.2.3.2 Specification

4.2.3.2.1 "Carrier-on" state

The following specification applies to the AES transmitting at EIRP values up to $EIRP_{nom}$. For EIRPs above $EIRP_{nom}$ (when uplink power control is implemented) the limits below may be exceeded by the difference in dB between the current EIRP and $EIRP_{nom}$).

1) In the 14,0 GHz to 14,5 GHz band the EIRP spectral density of the spurious radiation shall not exceed:

   4 - K, dBW in any 100 kHz bandwidth.

2) In a bandwidth of 5 times the occupied bandwidth centred on the carrier centre frequency, the EIRP spectral density of the spurious radiation, shall not exceed:

   18 - K, dBW in any 100 kHz bandwidth.

K may be different if co-frequency AESs operate with different EIRP levels. In this case, K = -10 log ($EIRP/EIRP_{Aggregate}$), where EIRP is the EIRP spectral density of the AES and $EIRP_{Aggregate}$ is the maximum aggregate EIRP spectral density of the network. $EIRP_{Aggregate}$ shall not be exceeded for more than 0,01 % of the time. The value of $EIRP_{Aggregate}$ and the operational conditions of the systems shall be declared by the applicant.

NOTE 1: The on-axis spurious radiations, outside the 14,0 GHz to 14,5 GHz band, are indirectly limited by clauses 4.2.2.2. Consequently no specification is needed.

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

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

4.2.3.2.2 "Carrier-off" state and "transmission disabled" state

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

4.2.3.3 Conformance tests

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

4.2.4 Off-axis EIRP emissions density in the nominated bandwidth

4.2.4.1 Justification

Protection of other satellite systems which use the same frequency band.

4.2.4.2 Specification

The maximum EIRP in any 40 kHz band in any direction ϕ degrees from the AES antenna main beam axis shall not exceed the following limits within 3° of the geostationary orbit:

$33 - 25 \log (\phi+\delta\phi)$	dB(W),	where	2,5°	$\leq \phi+\delta\phi$	$\leq$ 7,0°
+12	dB(W),	where	7,0°	$< \phi+\delta\phi$	$\leq$ 9,2°
$36 - 25 \log (\phi+\delta\phi)$	dB(W),	where	9,2°	$< \phi+\delta\phi$	$\leq$ 48°
-6	dB(W),	where	48°	$< \phi+\delta\phi$	$\leq$ 180°

- where ϕ is the angle, in degrees, between the main beam axis and the direction considered;
- The value of $\delta\phi$ is equal to either:
  a) the rms antenna tracking accuracy; or
  b) twice the static rms antenna pointing accuracy; whichever is the larger.

For any direction in the region outside 3° of the GSO, the above limits may be exceeded by no more than 3 dB.

These limits apply over the range of geometries relative to the geostationary orbit arc declared by the manufacturer.

The applicant shall declare the maximum on-axis EIRP corresponding to each range of main beam directions and the corresponding envelope of the EIRP density as a function of the off-axis angle. This envelope could also be the EIRP density mask given above. For each range of the main beam directions the above mask in clause 4.2.4.2 must not be exceeded. The AES shall be able to reduce its on-axis EIRP as required by the NCF in a CC when several AESs are transmitting simultaneously at the same carrier frequency.

4.2.4.3 Conformance tests

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

4.2.5 Control and Monitoring Functions (CMF)

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

Under any fault condition when the AES transmissions are being suppressed the limits for carrier-off state shall apply.

4.2.5.1 Processor monitoring

4.2.5.1.1 Justification

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

4.2.5.1.2 Specification

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

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

No later than one second after any fault condition occurs, the AES shall enter the carrier-off state until the processor monitoring function has determined that all fault conditions have been cleared.

4.2.5.1.3 Conformance tests

Conformance tests shall be carried out in accordance with clause 6.5.2.

4.2.5.2 Transmit subsystem monitoring

4.2.5.2.1 Justification

To ensure the correct operation of the transmit frequency generation subsystem, and to inhibit transmissions should the subsystem fail.

4.2.5.2.2 Specification

The AES shall monitor the operation of its transmit frequency generation subsystem.

No later than 5 seconds after any fault condition of the transmit frequency generation subsystem occurs, the AES shall enter the carrier-off state until the transmit subsystem monitoring function has determined that all fault conditions have been cleared.

4.2.5.2.3 Conformance tests

Conformance tests shall be carried out in accordance with clause 6.5.3.

4.2.5.3 Power-on/Reset

4.2.5.3.1 Justification

To demonstrate that the AES 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.

4.2.5.3.2 Specification

During and following "power on" or a manual reset when this function is implemented, the AES shall remain in the carrier-off state.

4.2.5.3.3 Conformance tests

Conformance tests shall be carried out in accordance with clause 6.5.4.

4.2.5.4 Control Channel (CC) reception

4.2.5.4.1 Justification

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

4.2.5.4.2 Specification

a) Without correct reception of the CC messages from the NCF, the AES shall remain in the carrier-off state.

b) The AES shall enter the carrier-off state immediately after a period not exceeding 30 seconds without correct reception of the CC messages from the NCF.

4.2.5.4.3 Conformance tests

Conformance tests shall be carried out in accordance with clause 6.5.5.

4.2.5.5 Network control commands

4.2.5.5.1 Justification

These requirements ensure that the AES is capable of:

a) retaining a unique identification in the network and transmitting it upon reception of an appropriate request;

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

4.2.5.5.2 Specification

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

The AES shall be capable of receiving through its CC dedicated commands (addressed to the AES) from the NCF, and which contain:

- transmission enable commands;
- transmission disable commands;
- identification request.

Once a transmission enable command is received the AES is authorized to transmit.

After power-on or reset the AES shall remain in the carrier-off state until it receives a transmission enable command. For systems where no transmission enable command is expected after power-on or reset the AES may only transmit initial bursts (see clause 4.2.5.6).

Once a transmission disable command is received, within 1 second the AES shall enter and shall remain in the carrier-off state until the transmission disable command is superseded by a subsequent transmission enable command.

The AES shall be capable of transmitting its identification code upon reception of an identification request.

4.2.5.5.3 Conformance tests

Conformance tests shall be carried out in accordance with clause 6.5.6.

4.2.5.6 Initial burst transmission

4.2.5.6.1 General

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

4.2.5.6.2 Specification

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

a) The duty cycle of the burst retransmission shall not exceed 0,2 %.

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

c) The initial burst shall be transmitted at $EIRP_{nom}$.

4.2.5.6.3 Conformance tests

Conformance tests shall be carried out in accordance with clause 6.5.7.

4.2.6 Power Flux Density at the Surface of the Earth

4.2.6.1 General

The limitation of the Power Flux Density (PFD) at the surface of the Earth may be controlled either by the AES itself, or by the NCF.

4.2.6.2 Power flux density limit in the 14,25 GHz to 14,50 GHz frequency band to protect FS receivers

4.2.6.2.1 Justification

In Europe, some countries operate Fixed Service (FS) links in the band 14,25 GHz to 14,50 GHz (shared band with FSS) on a primary basis. Since AES operation in the band 14,00 GHz to 14,50 GHz are on a secondary basis, there is a requirement for protection of Fixed Service (FS) systems in the band 14,25 to 14,50 GHz from in-band and out-band emissions from AES operating in the band 14,0 GHz to 14,5 GHz. The specification of protection of FS systems in the band 14,25 GHz to 14,50 GHz is based on the Power Flux Density (PFD) limits per AES. These limits are of a regulatory nature and only a small number of countries in Europe are employing FS systems in the band 14,25 GHz to 14,50 GHz. This requirement is applicable when the AES is in line of sight with a country employing FS systems and could be relaxed if the operator of the AES network has an agreement with the Administration of that country.

4.2.6.2.2 Specification 1

FS systems operating in the band 14,25 GHz to 14,5 GHz have to be protected from the in-band and out-of-band signals from the AES operating in the 14,0 GHz to 14,5 GHz band.

The AES shall, based on its location, either:

a) be informed by the NCF, by a PFD limitation command, that the PFD must be limited for the protection of FS systems; or

b) determine itself that its PFD must be limited for the protection of the FS systems.

The determination of the locations, where a PFD limitation is necessary, shall take into account the inaccuracy of the AES location and of the country borders in the data base of the system.

4.2.6.2.3 Specification 2

When the AES must limit its PFD at the surface of the Earth, then in any 1 MHz bandwidth in the band 14,25 GHz to 14,5 GHz the PFD at the surface of the Earth shall not exceed the following limits:

$$-132 + 0{,}5 \times \theta \text{ dB(W/m2), where } 0° \leq \theta \leq 40°$$

$$-112 \text{ dB(W/m2), where } 40° < \theta \leq 90°$$

where θ (in degrees) is the angle of arrival at the Earth surface of the radio-frequency wave from the AES.

The above PFD limits relate to the PFD and angles of arrival that would be obtained under free space propagation conditions.

The above specification applies for any AES altitude relative to sea level within the operational altitude range of the AES as declared by the manufacturer. Outside this range of altitude the AES shall not transmit.

The relationship between the PFD, the EIRP and the altitude (H) of the AES is given in annex C.

4.2.6.2.4 Specification 3

In the AES there may be implemented means for relaxation of the above PFD mask over the countries where an agreement has been obtained with the Administration. The possible PFD masks or relaxation mechanism shall be declared by the applicant and shall be in accordance with the user documentation. The relaxation mechanism shall operate as declared by the applicant.

4.2.6.2.5 Conformance tests

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

4.2.6.3 Power flux density limit in the 14,47 GHz to 14,50 GHz frequency band to protect Radio Astronomy Service

4.2.6.3.1 Justification

In Europe certain countries may be operating radio astronomy receivers in the band 14,47 GHz to 14,50 GHz on a secondary basis. Existing radio astronomy sites which use the 14,47 GHz to 14,50 GHz frequency band require protection from AES operations in the band 14,00 GHz to 14,50 GHz. The specification of protection of RAS receivers in the band 14,47 GHz to 14,50 GHz is based on the Power Flux Density (PFD) limits per AES. These limits are of a regulatory nature and only a small number RAS sites in Europe may be employing such systems in this band. This requirement is applicable when the AES is in line of sight with the RAS receiver and could be relaxed if the operator of the AES network has an agreement with the Administration of that country.

4.2.6.3.2 Specification 1

RAS systems operating in the band 14,47 GHz to 14,5 GHz have to be protected from the in-band and out-of-band signals from the AES operating in the 14,0 GHz to 14,5 GHz band.

The AES shall, based on its location, either:

a) be informed by the NCF, by a PFD limitation command, that the PFD must be limited for the protection of RAS receiver; or

b) determine itself that its PFD must be limited for the protection of the RAS receivers.

The determination of the locations where a PFD limitation is necessary shall take into account the inaccuracy of the AES location and of the country borders in the data base of the system.

4.2.6.3.3 Specification 2

When the AES must limit its PFD at the surface of the Earth, then in any 150 kHz bandwidth in the band 14,47 GHz to 14,5 GHz the PFD at the surface of the Earth shall not exceed the following limits:

$$-190 + 0,5 \times \theta \text{ dB(W/m2), where } 0° \leq \theta \leq 10°$$

$$-185 \text{ dB(W/m2), where } 10° \leq \theta \leq 90°$$

where θ (in degrees) is the angle of arrival at the Earth surface of the radio-frequency wave from the AES.

The above PFD limits relate to the PFD and angles of arrival that would be obtained under free space propagation conditions.

The above specification applies for any AES altitude relative to sea level within the operational altitude range of the AES as declared by the manufacturer. Outside this range of altitude the AES shall not transmit.

The relationship between the PFD, the EIRP and the altitude (H) of the AES is given in annex C.

4.2.6.3.4 Conformance tests

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

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 (see annex B).

5.2 Essential radio test suites

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

6 Test methods

6.0 General

The AES will consist of equipment located within the interior of an aircraft fuselage (Internally Mounted Equipment or IME) and mounted on the exterior of the aircraft (Externally Mounted Equipment or EME). In addition, the externally mounted equipment will be designed and tested to meet the requirements given in clause 4, as tested per the procedures in this clause.

Formal testing will be accomplished under the direction of a test procedure. This test procedure will have been created specifically for testing the exact equipment intended for qualification or certification. The test procedure will describe or provide reference to all expected test conditions and parameters, including cable harness construction details, all equipment set-up, interconnect, placement and configuration details, instructions for operating the device and for determining its proper operation, and any necessary instructions for performing the test measurements.

Clause 6 defines testing for the purpose of determining if the Equipment Under Test (EUT) will produce radio frequency (RF) emissions that could interfere with other off-board radio receiver systems. In particular, this includes other ground based systems such as may be located in or near to an airport environment.

Measurement Accuracy: 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	±2 dB

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

Monitoring Function: To enable the performance tests to be carried out, the use of a NCF Control Channel 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 AES must 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 system to transmit, thereby 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 given in 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. Because each applicant's equipment may be different, then different test methods can be suggested and proposed by the applicant to account for the different equipment characteristics. Specific test procedures must be fully documented in the test procedure and test report.

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

If the EUT 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 AES 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.

6.1 Spurious radiation

6.1.1 Test method

An EUT comprises all of the exterior mounted Line Replaceable Units (LRUs), including the antenna and radome (if any). These LRUs shall be interconnected by the longest cable expected to be seen in service as recommended by the applicant, or, if that is unknown, by a 10 m cable. The connecting cable between the internal and the external units shall be the same type as recommended by the applicant in the installation manual. The type of cable used shall be entered in the test procedure and the test report.

Because an AES antenna is typically attached directly to the skin of the airplane fuselage, and is usually the primary aperture for externally generated emissions, testing without an antenna will not be an option, herein.

The internal unit(s) shall be terminated with matched impedances at the interface ports if there is no associated equipment connected to such ports and if recommended by the applicant in the user documentation.

Antennas

For frequencies up to 80 MHz the measuring antenna shall be calibrated according to the requirements of CISPR 16-1 [2].

For frequencies between 80 MHz and 1 000 MHz the measuring antenna shall be calibrated according to the requirements of CISPR 16-1 [2].

For frequencies above 1 000 MHz the antenna shall be a horn radiator of known gain/frequency characteristics. When used for reception, the antenna and any associated amplification system shall have an amplitude/frequency response within ±2 dB of the combined calibration curves across the antenna's measurement frequency range. The antenna is mounted on a support capable of allowing the antenna to be used in either horizontal or vertical polarization and at the specified height.

6.1.1.1 Up to 1 000 MHz (see clause 4.2.2.2, table 2)

6.1.1.1.1 Test site

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

The open area test site shall be flat, free of overhead wires and nearby reflecting structures, sufficiently large to permit aerial placement at the specified measuring distance and provide adequate separation between aerial, test unit and reflecting structures, according to the specification of CISPR 16-1 [2].

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

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

6.1.1.1.2 Measuring receivers

The measuring receiver will either be located outside the test area such that no radiations from the measuring receiver in the band of interest are detectable at the measuring antenna, or the test area will be calibrated without the EUT to determine the contribution of the receiving equipment active elements.

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.

6.1.1.1.3 Procedure

a) The EUT shall be all exterior mounted LRUs.

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

c) The EUT shall be rotated in azimuth through 360° in minimum steps of 45° and, except in an anechoic chamber, the measuring antenna height simultaneously varied from 1 m to 4 m above the ground plane. Alternatively, the measuring antenna may be moved around the EUT at a fixed distance from the EUT.

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

e) The boresight of the antenna shall be pointing at zenith, i.e. upwards.

6.1.1.2 Above 1 000 MHz (see clause 4.2.2.2, tables 3 and 4)

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, a bandwidth correction shall be performed for the noise-like wideband spurious emissions.

Tests shall be performed in two stages for both the carrier-on and carrier-off states:

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

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

6.1.1.2.1 Identification of the significant frequencies of spurious radiation

6.1.1.2.1.1 Test site

The identification of frequencies emitting from the EUT shall be performed either in an anechoic chamber, an open area test site or a semi-anechoic chamber with the test antenna close to the EUT and at the same height as the volume centre of the EUT. See also figure 2 for the AES positioning.

6.1.1.2.1.2 Procedure

a) The EUT shall be in the carrier-off state.

b) The main beam of the antenna shall have an angle of elevation of 7°.

c) The measuring receivers shall scan the frequency band while the EUT revolves or the test antenna is moved around the EUT.

d) The EUT shall be rotated in azimuth though 360° in minimum steps of 45° and the frequency of any spurious signals noted for further investigation. Alternatively, the measuring antenna may be moved around the EUT at a fixed distance from the EUT.

e) The test shall be repeated with the test antenna being in the opposite polarization.

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

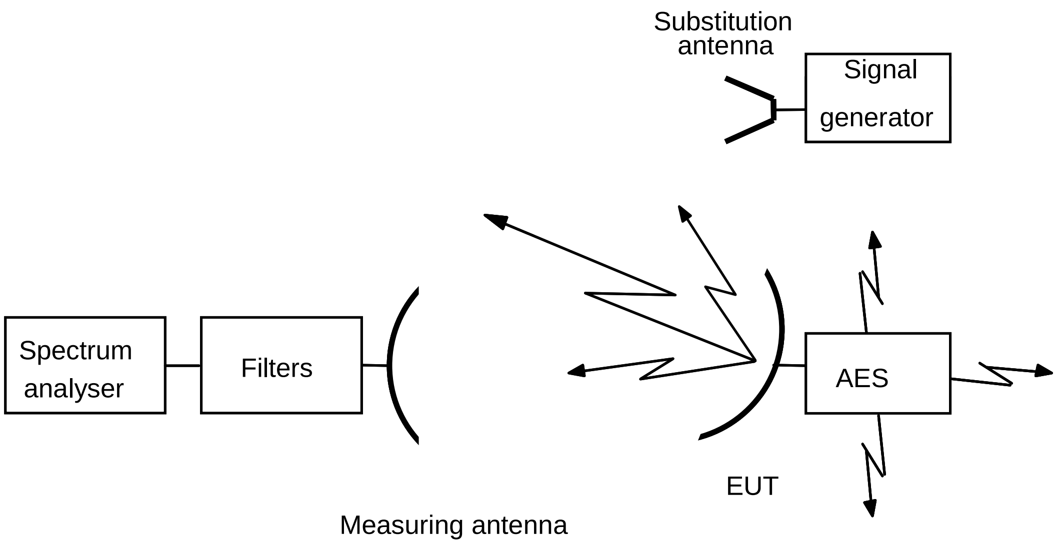

Figure 2: Test arrangement-spurious radiation measurement above 1 000 MHz for an EUT with antenna

6.1.1.2.2 Measurement of radiated power levels of identified spurious radiation

6.1.1.2.2.1 Test site

The measurement of each spurious radiation noted during procedure a) of the test shall be performed on a test site that is free from reflecting objects, i.e. either an open-area test site, a semi-anechoic chamber or an anechoic chamber. See also figure 2 for the AES positioning.

6.1.1.2.2.2 Procedure

a) The test arrangement shall be as shown in figure 2.

b) The EUT shall be installed such that if there are more than one LRU under simultaneous test, they are separated by about 1 m to 2 m. The height at which the EUT is tested will be determined by the manufacturer. The interconnection cable shall be maintained by non-conductive means at a height from the ground plane simulating the worst-case expected airplane installation for wiring relative to the fuselage. For the test arrangement shown in figure 2 the main beam of the antenna shall have an angle of elevation of 7° (or the minimum elevation angle as specified by the manufacturer) and be oriented away from the geostationary orbit, or be inhibited by placing RF absorbing panels in that direction (this is to minimize interference towards the GSO satellites while the test is performed). 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 or the measuring antenna move around the EUT, while the EUT is in the appropriate carrier condition. For the maximum response on the associated spectrum analyser at each spurious frequency previously identified, the 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° (or the minimum elevation angle as specified by the manufacturer) 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, for each frequency identified as a spurious signal.

h) The output level of the signal generator shall be noted. The EIRP of the spurious radiation is the sum, in dB, of the signal generator output plus the substitution antenna isotropic gain minus the interconnection cable loss.

6.2 On-axis spurious radiation

6.2.1 Test method

6.2.1.1 Test site

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

6.2.1.2 Method of measurement

6.2.1.2.1 General

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

For AES 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 AES 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 AES with its antenna comprising both the internal and external units.

6.2.1.2.2 Method of measurement at the antenna flange

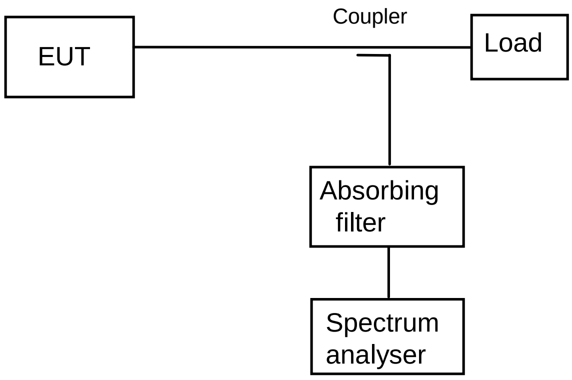

Figure 3: Test arrangement - on-axis spurious radiation measurements at the antenna flange

a) The test arrangement shall be as shown in figure 3. 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 EUT shall transmit one modulated carrier continuously, or at its maximum burst rate where applicable, centred on a frequency as close to the lower limit of the operating frequency band of the EUT as possible. The EUT shall be operated at the highest normal operating EIRP. The frequency range 14,00 GHz to 14,50 GHz shall be investigated.

c) Due to the proximity of the carrier the spectrum analyser resolution bandwidth shall be set to a measurement bandwidth of 3 kHz, or as close as possible. If the measurement bandwidth is different from the specified measurement bandwidth, a bandwidth correction factor shall be performed for noise-like wideband spurious radiation.

d) To obtain the on-axis spurious EIRP, the antenna transmit gain shall be added to any figure obtained in the above measurement and any correction or calibration factor summated with the result. The antenna gain shall be as measured in clause 6.3.3.2 at the closest frequency to the spurious frequency.

e) The tests in b) to d) shall be repeated with a transmit frequency in the centre of the operating frequency band.

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

g) The test shall be repeated in the carrier-off state.

h) The test shall be repeated in the "transmission disabled state".

6.2.1.2.3 Method of measurement with a test antenna

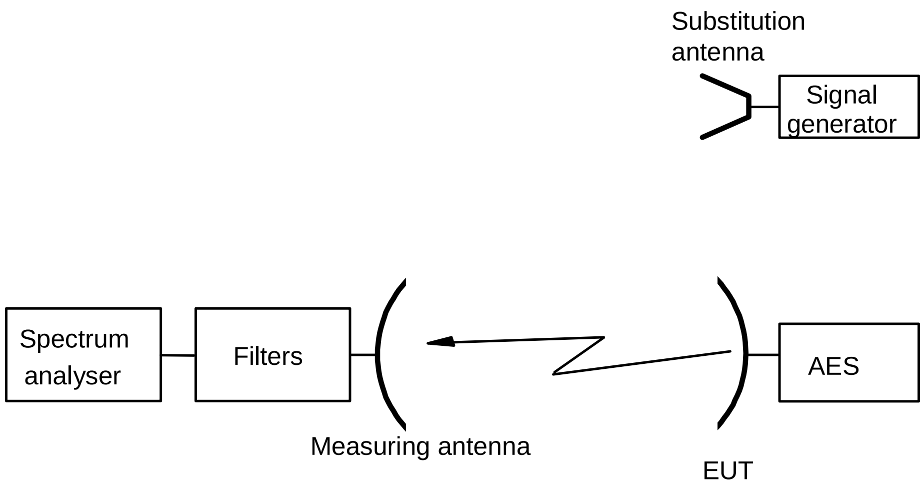

Figure 4: Test arrangement-on-axis spurious radiation measurements for an EUT with antenna

a) The test arrangement shall be as shown in figure 4.

b) The EUT shall be installed such that the LRUs are at a height between 0,5 m and 1,0 m on a turntable. If there are more than one LRU in the EUT, they shall be separated by 1 m to 2 m. The interconnection cable shall be maintained by non-conductive 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, a bandwidth correction factor shall be performed for noise-like wideband spurious radiation.

d) The EUT shall transmit one modulated carrier continuously, or at its maximum burst rate where applicable, centred on a frequency as close to the lower limit of the operating frequency band of the EUT as possible. The EUT shall be operated at $EIRP_{max}$. The frequency range 14,00 GHz to 14,50 GHz shall be investigated and each spurious frequency shall be noted.

e) Due to the proximity of the carrier the spectrum analyser resolution bandwidth shall be set to a measurement bandwidth of 3 kHz, or as close as possible. If the measurement bandwidth is different from the specified measurement bandwidth, a bandwidth correction factor shall be performed for noise-like wideband spurious radiation.

f) The measuring antenna shall be positioned at a distance from the EUT (e.g. 3 m, 5 m, 10 m) relevant to the applied test site and shall be aligned with the EUT antenna for the transmit frequency. The measuring antenna shall be adjusted in height, while the EUT is in the appropriate carrier condition, for a maximum response on the associated spectrum analyser at each spurious frequency previously identified, this response level shall be noted. The adjustment in height of the measuring antenna does not apply when an anechoic chamber is being used.

g) The EUT shall be replaced by a representative substitution antenna to which 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 that produced the largest response between the EUT and the test antenna.

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

j) The output level of the signal generator shall be noted. The EIRP of the on-axis spurious radiation is the sum, in dB, of the signal generator output plus the substitution antenna isotropic gain minus the interconnection cable loss.

k) The tests in d) to j) shall be repeated with a transmit frequency in the centre of the operating frequency band.

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

m) The test shall be repeated in the carrier-off state.

n) The test shall be repeated in the "transmission disabled state" state.

6.3 Off-axis EIRP emissions density in the nominated bandwidth

6.3.1 General

Conformance shall be determined from:

a) the measurement of the static rms pointing accuracy;

b) the measurement of the off-axis EIRP.

For the measurement of the off-axis EIRP, the EUT shall be either with or without its antenna:

- For AES equipment for which measurements at the antenna flange are possible and agreed by the manufacturer, the EUT shall be without the antenna. The test shall be performed in three stages:

  a) the measurement of the transmitter output power density (dBW/40 kHz);

  b) the measurement of the antenna transmit gain (dBi);

  c) the measurement of the antenna transmit radiation patterns (dBi).

- For AES equipment for which measurements at the antenna flange are not possible or not agreed by the manufacturer, the EUT shall be fitted with the antenna. The test shall be performed in three stages:

  a) the measurement of the maximum EIRP density per 40 kHz ratio relative to the EIRP (dBc/40 kHz);

  b) the measurement of the maximum on-axis EIRP (dBW);

  c) the measurement of the antenna transmit radiation patterns (dBi).

6.3.2 Static rms antenna pointing accuracy

6.3.2.1 Method of measurement

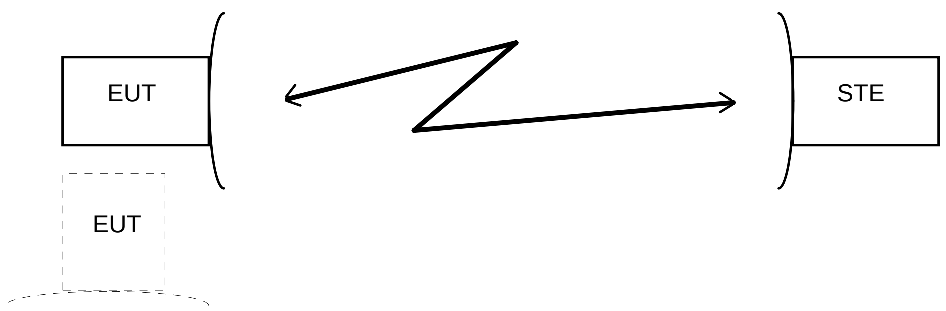

Figure 5: Test arrangement - static rms pointing accuracy

a) The equipment shall be arranged as shown in figure 5 such that the two antennas are in the far field of each other with the EUT rotated away from the STE. The STE shall be switched-on and the EUT shall be switched-off.

b) The level of the signal radiated by the STE shall be adjusted so that the EUT receives a power density corresponding to the signal to noise ratio declared by the manufacturer. This power density shall be representative of those expected for 95 % of the AES within the network and typically will be 2 dB above the edge of coverage figures for which the AES is designed to operate.

c) The EUT shall be switched-on and allowed to acquire the static pointing position.

d) The static pointing accuracy shall be measured and recorded. The method of measurement to be used shall be agreed between the manufacturer and the test house.

e) The static pointing accuracy shall be monitored to ascertain if the pointing varies, if so the rms value of this pointing angle shall be taken.

f) The static pointing accuracy shall be measured five times.

g) The EUT shall be switched-off whilst the EUT is rotated through at least 90° and for a minimum period of 1 s.

h) The tests in c) to f) shall be repeated.

i) The value of rms static pointing accuracy shall be taken to be the largest value of the ten measurement results recorded.

6.3.3 Measurement of the off-axis EIRP without the antenna

6.3.3.1 Transmitter output power density

For purpose of the test, the EUT comprises all of the equipment (Installable Equipment; IE) noted up to the antenna flange:

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

Where the EUT is so designed that it is not normally possible to make a direct connection to the feed at the antenna flange, or connecting point, the manufacturer shall provide a means of so doing specifically for the test AES.

6.3.3.1.1 Method of measurement

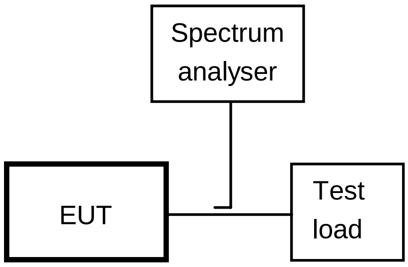

Figure 6: Test arrangement - transmit output power density measurement

a) The EUT shall be connected to a test load as shown in figure 6.

b) The test be carried out with the transmit signal of the operational waveform which carries a pseudorandom data stream, the maximum power density supplied to the antenna flange shall be measured in dBW/40 kHz. The coupling factor of the test coupler at the test frequency and the attenuation of any necessary waveguide adapter shall be taken into account. The resolution bandwidth of the spectrum analyser shall be set as close as possible to the specified measuring bandwidth. If the resolution bandwidth is different from the specified bandwidth then a bandwidth correction factor shall be performed.

6.3.3.2 Antenna transmit gain

6.3.3.2.1 General

For the purpose of the present document, the antenna transmit gain is defined as the ratio, expressed in decibels, 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 AES that comprises the antenna and its flange. The EUT includes an enclosure of equal weight/distribution to any electrical equipment normally housed within the antenna (see clause 6.3.3.1 regarding this requirement).

6.3.3.2.2 Test site

This test shall be performed on either an outdoor far-field test site or compact test range. However, if the near-field scanner technology to convert near-field measurements to far-field results is proven and sufficiently accurate by reference to tests taken in both regions then antenna measurements may be taken in the near field.

6.3.3.2.3 Method of measurement

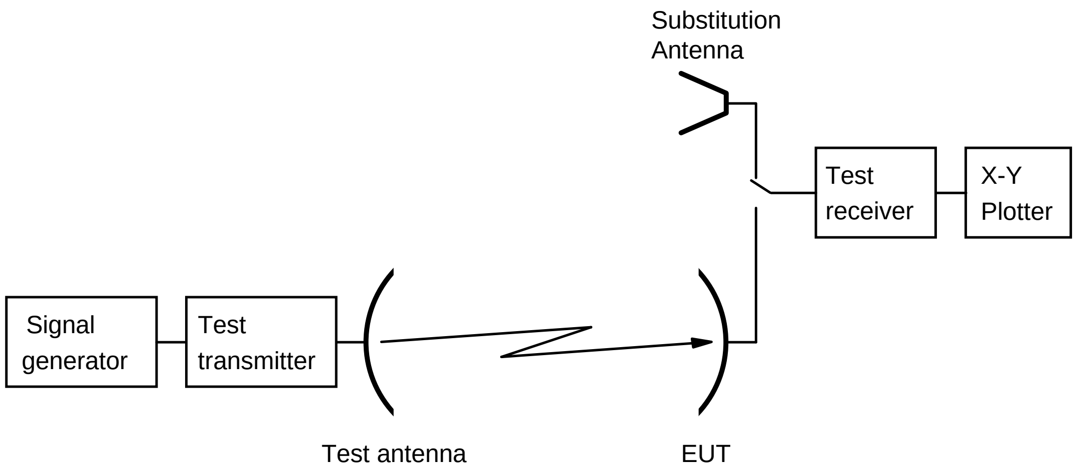

Figure 7: Test arrangement - antenna transmit gain measurement

a) The test arrangement shall be as shown in figure 7 with the EUT connected to the test receiver. A signal proportional to the angular position from the servomechanism shall be applied to the X-axis and the signal level from the test receiver shall be applied to the Y-axis of the plotter.

b) The antenna shall be pointed at zenith relative to the antenna ground plane (0° longitudinal angle) and zero azimuth.

c) The initial E-plane of the test signal radiated by the test transmitter through its antenna shall be horizontal. The EUT antenna main beam axis shall be aligned with the main beam axis of the test transmitter. The EUT antenna or its polarizer shall be rotated around its main beam axis such that its E-plane coincides with the E-plane of the test transmitter.

d) After any change of the E-plane of the test signal, the EUT antenna shall be rotated around its main beam axis such that its E-plane coincides with the E-plane of the test transmitter.

e) The frequency of the test signal shall be set 5 MHz above the bottom of the lowest frequency band declared by the manufacturer.

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

g) The EUT shall be driven in azimuth in one direction through 10°.

h) The pattern measurement is then obtained by driving the EUT in azimuth back through boresight to 10° the other side with the plotter recording the results.

i) The EUT shall be replaced by the substitution antenna and the received signal level maximized.

j) This level shall be recorded on the X-Y plotter.

k) The substitution antenna shall be driven in azimuth as in f) and g).

l) The gain of the EUT shall be calculated from:

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

where:

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

m) The tests in e) to l) shall be repeated with the frequency changed to the middle of the lowest frequency band declared by the manufacturer.

n) The tests in e) to l) shall be repeated with the frequency changed to 5 MHz below the top of the lowest frequency band declared by the manufacturer.

o) The tests in d) to n) may be performed simultaneously.

p) The tests in c) to p) shall be repeated with the E-plane vertical.

q) The tests in c) to p) shall be repeated with the E-plane +45° to the horizontal plane.

r) The tests in c) to p) shall be repeated with the E-plane -45° to the horizontal plane.

s) The tests in c) to s) shall be repeated with the longitudinal angle increased in 15° increments up to the maximum longitudinal angle declared by the manufacturer when gain variation is expected with longitudinal angle.

t) The tests in c) to s) shall be repeated with the azimuth angle increased in 15° increments when gain variation is expected with azimuth angle.

u) The tests in b) to s) shall be repeated for all frequency bands declared by the manufacturer.

6.3.3.3 Antenna transmit radiation patterns

6.3.3.3.1 General

For the purpose of the present document, the antenna transmit radiation patterns are diagrams relating field strength to direction relative to the pointing angle of 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 AES which comprises the antenna and its flange. The antenna includes the parabolic reflector, feed, support struts and an enclosure of equal weight/distribution to any electrical equipment normally housed with the feed at the antenna focal point (see clause 6.3.3.1 regarding this requirement).

6.3.3.3.2 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.

6.3.3.3.3 Method of measurement

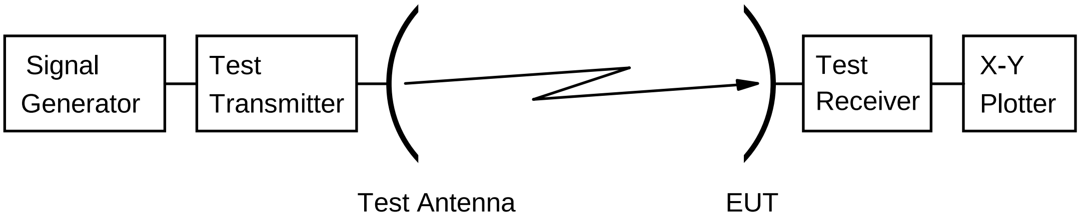

Figure 8: Test arrangement - antenna transmit radiation pattern measurement

a) The test arrangement shall be as shown in figure 8 with the EUT connected to the test receiver. A signal proportional to the angular position from the servomechanism shall be applied to the X-axis and the signal level from the test receiver shall be applied to the Y-axis of the plotter.

b) The antenna shall be pointed at zenith relative to the antenna ground plane (0° longitudinal angle) and zero azimuth.

c) The initial E-plane of the test signal radiated by the test transmitter through its antenna shall be horizontal. The EUT antenna main beam axis shall be aligned with the main beam axis of the test transmitter. The EUT antenna or its polarizer shall be rotated around its main beam axis such that its E-plane coincides with the E-plane of the test transmitter.

d) After any change of the E-plane of the test signal, the EUT antenna shall be rotated around its main beam axis such that its E-plane coincides with the E-plane of the test transmitter.

e) The frequency of the test signal shall be set 5 MHz above the bottom of the lowest frequency band declared by the manufacturer.

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

g) The EUT shall be driven in azimuth to -180°.

h) The transmit pattern measurement is then obtained by driving the EUT in azimuth through from -180° to +180° with the plotter recording the results. Measurements may be excluded where the radiation pattern from the antenna is fully blocked by the aircraft fuselage for the models declared by the manufacturer. Exclusions shall be noted in the test report.

i) The tests in d) to h) shall be repeated with the frequency changed to the middle of the lowest frequency band declared by the manufacturer.

j) The tests in d) to h) shall be repeated with the frequency changed to 5 MHz below the top of the lowest frequency band declared by the manufacturer.

k) The tests in d) to j) may be performed simultaneously.

l) The tests in d) to k) shall be repeated with the E-plane being vertical.

m) The tests in d) to k) shall be repeated with the E-plane at $+\alpha$ to the vertical plane. α is defined as the worst-case angle (°) between the horizontal plane and the geostationary orbital arc, as seen from the range of latitudes as declared by the manufacturer.

n) The tests in d) to k) shall be repeated with the E-plane at $-\alpha$ to the horizontal. α is as defined in m).

o) The tests in d) to s) shall be repeated with the longitudinal angle increased in 15° increments up to the maximum longitudinal angle declared by the manufacturer when transmit radiation pattern variation is expected with longitudinal angle.

p) The tests in d) to s) shall be repeated with the azimuth angle increased in 15° increments when transmit radiation pattern variation is expected with azimuth angle.

q) The tests in c) to n) shall be repeated for all frequency bands declared by the manufacturer.

6.3.3.4 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, the gain of the antenna and twice the static rms pointing accuracy. This reference shall then be placed on the maximum point of the plot obtained from the transmit radiation pattern measurement, so as to ascertain that the off-axis EIRP density is within the mask, and thus conforming to the specification.

6.3.4 Measurement of the off-axis EIRP with the antenna

6.3.4.1 General

The requirements set out in clauses 6.1.1 to 6.1.3.1.2 for the measurements above 1 000 MHz shall apply.

6.3.4.2 Maximum EIRP density per 40 kHz ratio relative to the EIRP

For purpose of the test, the EUT shall be the AES fitted with its antenna.

6.3.4.2.1 Method of measurement

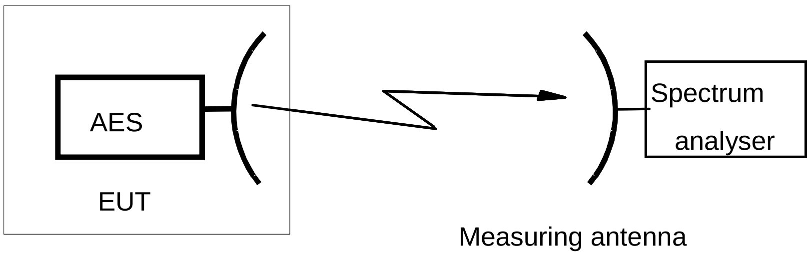

Figure 9: Test arrangement - radiated power density measurement

a) The test arrangement shall be as shown in figure 9, both antennas being in line of sight of each other.

b) The test be carried out with the transmit signal of the operational waveform which carries a pseudorandom data stream. The transmission shall be continuous where possible.

c) The resolution bandwidth of the spectrum analyser shall be set larger but as close as possible to the B_o of the transmitted signal. The total power P1 received shall be measured in dBW.

d) The resolution bandwidth of the spectrum analyser shall be set as close as possible to the specified measuring bandwidth: 40 kHz. If the resolution bandwidth is different from the specified bandwidth then a bandwidth correction factor shall be performed. The maximum value P2 of the power received in any 40 kHz bandwidth over the B_o shall be measured in dBW.

e) The maximum EIRP density per 40 kHz ratio relative to the EIRP, in dBc/40 kHz, is the difference (P1 - P2).

6.3.4.3 Maximum on-axis EIRP

6.3.4.3.1 General

For purpose of the test, the EUT is the AES fitted with its antenna.

The distance between the EUT or the substitution antenna and the measuring antenna shall be such that the radiating near-field of each antenna shall not overlap with that of the other. The larger radiating near-field of the EUT and substitution antenna shall be used to determine the minimum distance between the EUT and measuring antenna in the first instance.

6.3.4.3.2 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.

6.3.4.3.3 Method of measurement

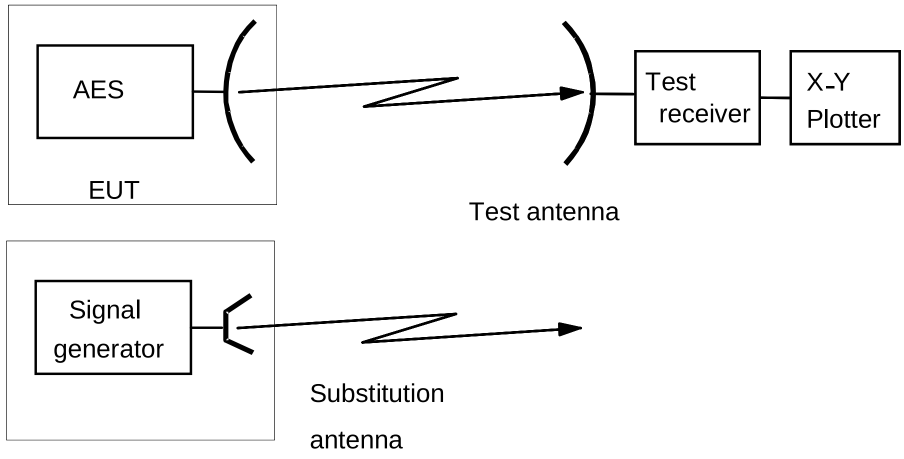

Figure 10: Test arrangement - maximum on-axis EIRP received measurement

a) The test arrangement shall be as shown in figure 10, both antennas being in line of sight of each other. A signal proportional to the angular position from the servomechanism shall be applied to the X-axis and the signal level from the test receiver proportional to the power received in dBW shall be applied to the Y-axis of the plotter.

b) The test be carried out with the EUT transmitting the operational waveform signal, at maximum power, which carries a pseudorandom data stream. The transmission shall be continuous where possible.

c) The resolution bandwidth of the spectrum analyser shall be set larger but as close as possible to the B_o of the transmitted signal.

d) The antenna shall be pointed at zenith relative to the antenna ground plane (0° longitudinal angle) and zero azimuth.

e) The initial E-plane of the test signal radiated by the EUT through its antenna shall be horizontal. The test receiver antenna main beam axis shall be aligned with the main beam axis of the EUT antenna. The test receiver antenna or its polarizer shall be rotated around its main beam axis such that its E-plane coincides with the E-plane of the EUT.

f) After any change of the E-plane of the test signal, the test receiver antenna shall be rotated around its main beam axis such that its E-plane coincides with the E-plane of the EUT.

g) The frequency of the test signal shall be set 0,5 x B_o above the bottom of the lowest frequency band declared by the manufacturer.

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

i) The EUT shall be driven in azimuth in one direction through 10°.

j) The pattern measurement is then obtained by driving the EUT in azimuth back through boresight to 10° the other side with the plotter recording the results.

k) The EUT shall be replaced by the signal generator connected to a calibrated antenna (a substitution antenna), transmitting a carrier at a frequency equal to the EUT carrier frequency. The received signal level shall be maximized.

l) This level shall be recorded on the X-Y plotter.

m) The signal generator with the substitution antenna shall be driven in azimuth as in h) and j).

n) The EIRP of the signal radiated by the EUT shall be calculated from:

$$EIRP_{EUT} = L_1 - L_2 + G + P$$

where:

- $EIRP_{EUT}$ is the EIRP of the signal radiated by the EUT (dBW), in the considered direction;
- L_1 is the level obtained with the EUT (dBW), in the considered same direction;
- L_2 is the level obtained with the signal generator with the substitution antenna (dBW);
- G is the calibrated gain of the substitution antenna at the test frequency (dBi);
- P is the power produced by the signal generator at the flange of the substitution antenna (dBW).

o) The tests in h) to n) shall be repeated with the frequency changed to the middle of the lowest frequency band declared by the manufacturer.

p) The tests in h) to n) shall be repeated with the frequency changed to 0,5 x B_o below the top of the lowest frequency band declared by the manufacturer.

q) The tests in h) to p) may be performed simultaneously.

r) The tests in h) to q) shall be repeated with the E-plane vertical.

s) The tests in h) to q) shall be repeated with the E-plane at +45° to the horizontal plane.

t) The tests in h) to q) shall be repeated with the E-plane at -45° to the horizontal plane.

u) The tests in h) to t) shall be repeated with the longitudinal angle increased in 15° increments up to the maximum longitudinal angle declared by the manufacturer when maximum EIRP variation is expected with longitudinal angle.

v) The tests in h) to t) shall be repeated with the azimuth angle increased in 15° increments when maximum EIRP variation is expected with azimuth angle.

w) The tests in g) to v) shall be repeated for all frequency bands declared by the manufacturer.

z) The maximum on-axis EIRP of the signal radiated by the EUT is the maximum value of the values calculated in step n).

6.3.4.4 Antenna transmit radiation patterns

6.3.4.4.1 General

For the purpose of the present document, the antenna transmit radiation patterns are diagrams relating field strength to direction relative to the pointing angle of the antenna at a constant large distance from the antenna.

For purpose of the test, the EUT shall be the AES fitted with its antenna.

The distance between the EUT or the substitution antenna and the measuring antenna shall be such that the radiating near-field of each antenna shall not overlap with that of the other. The larger radiating near-field of the EUT and substitution antenna shall be used to determine the minimum distance between the EUT and measuring antenna in the first instance.

6.3.4.4.2 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.

6.3.4.4.3 Method of measurement

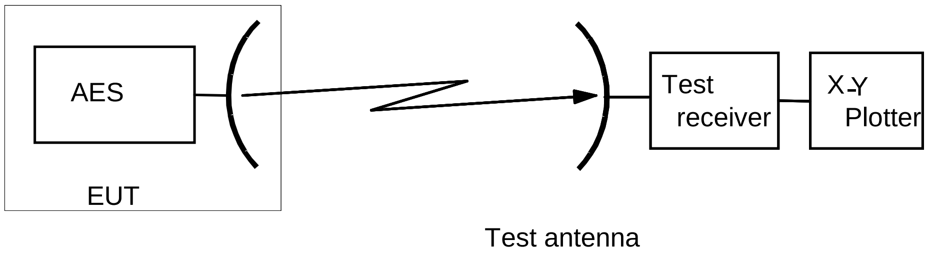

Figure 11: Test arrangement - antenna transmit radiation pattern measurement

a) The test arrangement shall be as shown in figure 11, both antennas being in line of sight of each other. A signal proportional to the angular position from the servomechanism shall be applied to the X-axis and the signal level from the test receiver proportional to the power received in dBW shall be applied to the Y-axis of the plotter.

b) The test be carried out with the EUT transmitting the operational waveform signal, which carries a pseudorandom data stream. The transmission shall be continuous where possible.

c) The resolution bandwidth of the spectrum analyser shall be set larger but as close as possible to the B_o of the transmitted signal.

d) The antenna shall be pointed at zenith relative to the antenna ground plane (0° longitudinal angle) and zero azimuth.

e) The initial E-plane of the test signal radiated by the EUT through its antenna shall be horizontal. The test receiver antenna main beam axis shall be aligned with the main beam axis of the EUT. The test receiver antenna or its polarizer shall be rotated around its main beam axis such that its E-plane is coincides with the E-plane of the EUT.

f) After any change of the E-plane of the EUT test signal, the test receiver antenna shall be rotated around its main beam axis such that its E-plane is coincides with the E-plane of the EUT.

g) The frequency of the EUT test signal shall be set 0,5 x B_o above the bottom of the lowest frequency band declared by the manufacturer.

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

i) The EUT shall be driven in azimuth to -180°.

j) The transmit pattern measurement is then obtained by driving the EUT in azimuth through from -180° to +180° with the plotter recording the results. Measurements may be excluded where the radiation pattern from the antenna is fully blocked by the aircraft fuselage for the models declared by the manufacturer. Exclusions shall be noted in the test report.

k) The tests in h) to j) shall be repeated with the frequency changed to the middle of the lowest frequency band declared by the manufacturer.

l) The tests in h) to j) shall be repeated with the frequency changed to 0,5 x B_o below the top of the lowest frequency band declared by the manufacturer.

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

n) The tests in f) to m) shall be repeated with the E-plane vertical.

o) The tests in f) to m) shall be repeated with the E-plane at +α to the horizontal plane. α is defined as the worst-case angle (°) between the horizontal plane and the geostationary orbital arc, as seen from the range of latitudes as declared by the manufacturer.

p) The tests in f) to m) shall be repeated with the E-plane at -α to the horizontal plane. α is as defined in k).

q) The tests in f) to p) shall be repeated with the longitudinal angle increased in 15° increments up to the maximum longitudinal angle declared by the manufacturer when maximum EIRP variation is expected with longitudinal angle.

r) The tests in f) to p) shall be repeated with the azimuth angle increased in 15° increments when maximum EIRP variation is expected with azimuth angle.

s) The tests in f) to r) shall be repeated for all frequency bands declared by the manufacturer.

6.3.4.5 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 maximum on-axis EIRP, the maximum EIRP density per 40 kHz ratio to the EIRP, the rms antenna tracking accuracy or twice the static rms pointing accuracy. This reference shall then be placed on the maximum point of the plot obtained from the transmit radiation pattern measurement, so as to ascertain that the off-axis EIRP density is within the mask, and thus conforming to the specification.

6.4 Power Flux Density Test

Tests shall be performed in three stages:

Procedure a) Measurement of the radiation pattern below the aircraft fuselage (see clause 6.4.1).

Procedure b) Measurement of on-axis EIRP as a function of altitude (see clause 6.4.2).

Procedure c) Computation of the power flux density at the surface of the Earth (see clause 6.4.3).

6.4.1 Measurement of the antenna radiation pattern below the aircraft fuselage

6.4.1.1 General

In this test the EUT is mounted on a ground plane that is representative of an aircraft fuselage section. The ground plane shall have a diameter equal to the smallest fuselage diameter of the range of aircraft models declared by the manufacturer with which the EUT will operate. If required this test can be repeated with ground planes representative of each aircraft model declared by the manufacturer.

One method for a test of the EUT is given below in clause 6.4.1.3. It is the responsibility of the equipment manufacturer to define a detailed test methodology for his AES system.

6.4.1.2 Test Site

Test sites, far-field or compact range, shall be limited to those that adhere to the standards and definitions provided in IEEE STD 149-1979 [5]. The test site shall be capable of substitution method gain measurements as defined by the above IEEE standard.

6.4.1.3 Test Method Procedure

This test measures the antenna radiation pattern on a cross section perpendicular to the aircraft longitudinal axis, with the AES mounted on the aircraft fuselage.

All range setup and tests shall be undertaken with the EUT drive amplifier operating at a level consistent with producing EIRPmax.

The following setup and test pertains to each frequency and polarization to be measured. All EUT measurements are to have the radome in place.

a) A typical fuselage roll plane test arrangement shall be as shown in figure 12. This figure shows an AES antenna mounted on a metallic fuselage section of an aircraft. The fuselage section is mounted in the compact range such that it can be rotated through 360° to allow the measurement of the radiation pattern below the fuselage section;

b) Range receiver linearity and peak level shall be set using an appropriate certified gain standard;

c) Range receiver dynamic range shall be greater than 120 dB with linearity demonstrated 30 dB above the peak standard level;

d) A reference level gain pattern shall be recorded through the beam peak;

e) The reference standard shall be removed from the test set-up and replaced with the fuselage section, EUT, and radome. No change to the range configuration other than the replacement of the range standard with the fuselage section, EUT, and radome is permitted;

f) Set the longitudinal angle of the EUT to the maximum specified angle;

g) Record the complete 360° EUT roll plane radiation pattern;

h) Adjust/normalize the received EUT radiation pattern level based on the difference between the measured reference gain standard level and the certified reference gain level.

Repeat a) through h) at each desired frequency and emitted polarization.

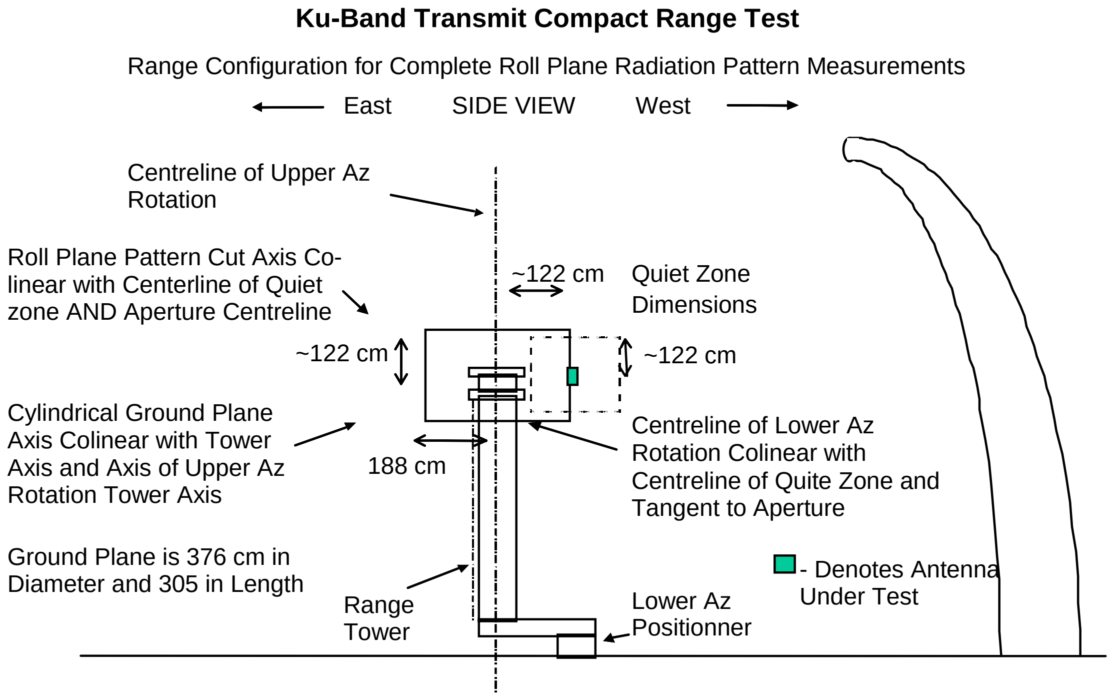

Figure 12: An example of a test set-up for measuring the roll plane radiation pattern beneath the fuselage of an aircraft

6.4.2 Measurement of on-axis EIRP as a function of altitude

6.4.2.1 General

In this test the STE is used to simulate the operation of the AES within line-of-sight of an operating FS (within the 14,25 GHz to 14,5 GHz) and/or a radio astronomy site (14,47 GHz to 14,5 GHz). The test will measure EIRP as a function of altitude. In cases where the NCF issues PFD limitation commands, STE will also be used to simulate the NCF.

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

6.4.2.2 Test site

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

6.4.2.3 Method of measurement with a test antenna

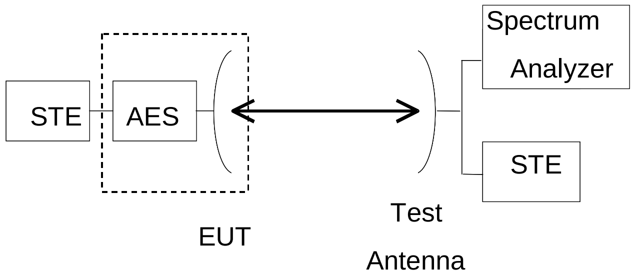

Figure 13: Test arrangement for measurement of on-axis EIRP as a function of altitude

a) The test arrangement shall be as shown in figure 13.

b) The resolution bandwidth of the spectrum analyser shall be set larger but as close as possible to the B_o of the transmitted signal.

c) The STE shall be set to simulate AES operation at 3 km in altitude within line-of-sight of an operating FS, or a radio astronomy site.

d) The EUT shall transmit one modulated carrier continuously, or at its maximum burst rate where applicable, centred on a frequency as close to the lower limit of the operating frequency band of the EUT as possible. The EUT shall be operated at the maximum EIRP permitted by the AES, or NCF PFD management algorithm, consistent with the altitude under consideration. The maximum EIRP spectral density level in the 14,25 GHz to 14,5 GHz band shall be noted for testing with respect to the FS limits in clause 4.2.6.2. The maximum ERIP spectral density level in the 14,47 GHz to 14,50 GHz band shall be noted for testing with respect to the clause 4.2.6.3.

e) 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.

f) The tests in d) to e) shall be repeated with a transmit frequency in the centre of the operating frequency band.

g) The tests in d) 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.

h) The tests in d) to g) shall be repeated with the simulated altitude increased in at most 3 km increments up to 12 km.

6.4.3 Computation of the power flux density at the surface of the Earth

The PFD at the surface of the Earth shall be calculated as follows:

1) The EIRP pattern below the aircraft shall be computed for each transmit frequency and altitude tested in clause 6.4.2. This is done using the maximum on-axis EIRP spectral density measured in:

   a) the 14,25 GHz to 14,50 GHz band with respect to FS requirements and;

   b) the 14,47 GHz to 14,50 GHz band with respect to Radio Astronomy requirements;

   using the gain pattern below the aircraft measured in clause 6.4.1.

2) Then for each transmit frequency and altitude tested in clause 6.4.2, the PFD at the surface of the earth as a function of arrival angle shall be computed using the EIRP pattern below the aircraft (calculated above) for that test condition and the method of computing the PFD at the surface of the Earth described in annex C.

3) Finally, for each frequency and altitude tested, the resulting PFD at the surface of the earth as a function of arrival angle can be compared to the limits in clauses 4.2.6.2 and 4.2.6.3 to verify compliance.

6.5 Control and monitoring

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

For the purpose of this test the EUT is defined as the AES either with or without its antenna connected.

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

6.5.1 Test arrangement

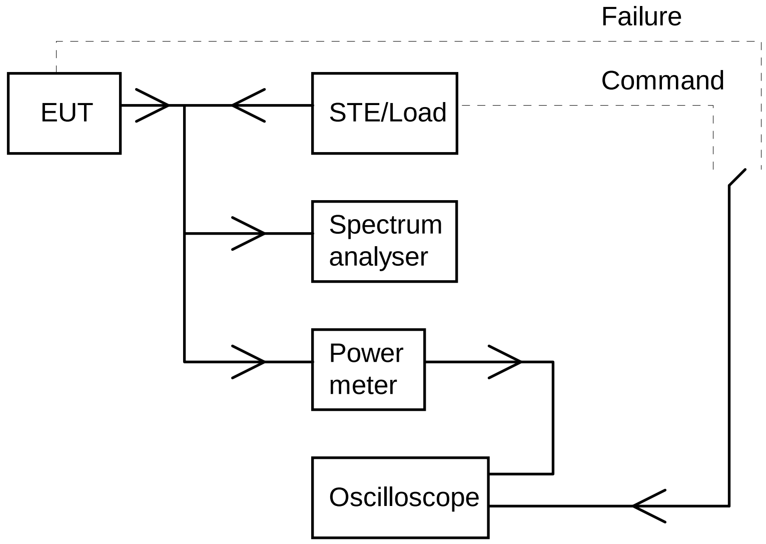

Figure 14: General test arrangement for control and monitoring tests for conducted measurements

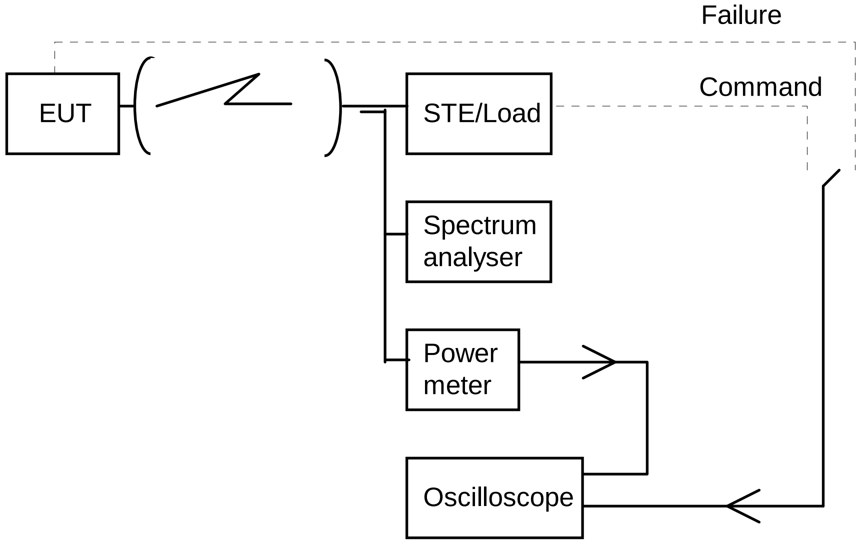

Figure 15: General test arrangement for control and monitoring tests for radiated measurements

The test arrangement shall be as shown in figures 14 or 15. The EUT shall be authorized to transmit and shall be in the carrier-on state at the commencement of each test. The dual trace storage oscilloscope shall monitor by measuring the time difference between the command, or failure, and the occurrence of the expected event (e.g. the transmission suppression). Alternatively, command messages may be automatically recoded and time stamped for comparison to the occurrance of the expected event. The power meter and spectrum analyser shall monitor the EUT output level.

6.5.2 Processor monitoring

6.5.2.1 Test method

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

b) Within 1 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.

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

6.5.3 Transmit subsystem monitoring

6.5.3.1 Test method

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

   1) frequency stability;

   2) output.

b) Within 6 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.

d) The frequency generation subsystem shall be restored to normal working condition and the EUT shall be restored to normal working before the next induced failure.

6.5.4 Power-on/Reset

6.5.4.1 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 carrier-off 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 switched on and the STE shall transmit the CC.

e) A call shall be initiated from the EUT and the EUT shall enter the carrier-on state.

f) The reset function shall be initiated.

g) The EUT shall enter the carrier-off state.

The event from e) to g) shall be displayed and verified with the oscilloscope or recorded command time and by measurement of the transmitted signal.

6.5.5 Control Channel (CC) reception

6.5.5.1 Test method

The following tests shall be performed:

- case where the CC has never been received by the EUT;
- case where the CC is lost by the EUT during a transmission period of a call;
- case where the CC is lost by the EUT during a period without transmission;
- case where 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 seconds.

a) Case where the CC has never been received by the EUT:

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

  a2) The EUT shall be switched on.

  a3) A call shall be initiated from the EUT.

  a4) The EUT shall remain in the carrier-off state.

The events from a2) to a4) shall be displayed and verified with the oscilloscope or recorded command time and by measurement of the transmit signal.

b) Case where the CC is lost by the EUT during a transmission period of a call:

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

  b2) A call shall be initiated from the EUT.

  b3) The STE shall stop transmitting the CC.

  b4) Within T1 from b3), the EUT shall enter the carrier-off state.

The events from b2) to b4) shall be displayed and verified with the oscilloscope or recorded command time and by measurement of the transmitted signal.

c) Case where the CC is lost by the EUT during a period without transmission:

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

  c2) The STE shall stop transmitting the CC.

  c3) More than T1 later, a call shall be initiated from the EUT.

  c4) The EUT shall remain in the carrier-off state.

The events from c2) to c4) shall be displayed and verified with the oscilloscope or recorded command time 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 call shall be initiated from the EUT.

  d4) The EUT may transmit but within the T1 period the EUT shall enter the carrier-off state.

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

6.5.6 Network control commands

6.5.6.1 Test method

The following tests shall be performed in sequence:

- Transmission enable command.
- Transmission disable command.
- Identification request.

a) Transmission enable command:

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

  a2) The EUT shall enter the carrier-off state.

  a3) A call shall be initiated from the EUT, the EUT shall remain in the carrier-off state.

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

  a5) A call shall be initiated from the EUT.

  a6) The EUT shall enter the carrier-on state and shall transmit.

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

b) Transmission disable command:

  b1) Continue from a6).

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

  b3) The EUT shall enter the carrier-off state within 1 s.

  b4) A call shall be initiated from the EUT.

  b5) The EUT shall remain in the carrier-off state.

  b6) The STE shall transmit an enable command.

  b7) A call shall be initiated from the EUT.

  b8) The EUT shall enter the carrier-on state and shall transmit.

  b9) The call shall be terminated at the EUT.

The events from b2) to b9) shall be displayed and verified with the oscilloscope or recorded command time and by measurement of the transmitted signal.

c) Identification request:

  c1) Continue from b9).

  c2) The STE shall transmit an identification request.

  c3) The EUT shall enter the carrier-on state and shall transmit its identification code.

The STE shall display the identification code sent by the EUT.

6.5.7 Initial burst transmission

6.5.7.1 Test method

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, if any.

d) Each initial burst shall not last more than 1 second, and the transmission of the initial bursts shall not exceed 1 % of the time.

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

Annex A (normative): The EN Requirements Table (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 manufacturer 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**				**Comment**
No.	**Reference**	**EN-Requirements** (see note)	**Status**			
1	4.2.2	Spurious radiation	M			
2	4.2.3	On-axis spurious radiation	M			
3	4.2.4	Off-axis EIRP density in the Nominated bandwidth	M			
4	4.2.5.1.1	Processor monitoring	M			
5	4.2.5.2	Transmit subsystem monitoring	M			
6	4.2.5.3	Power-on/Reset	M			
7	4.2.5.4	Control Channel (CC) reception	M			
8	4.2.5.5	Network control commands	M			
9	4.2.5.6	Initial burst transmission	M			
10	4.2.6.2	PFD limit in the 14,25 GHz to 14,5 GHz frequency band to protect Fixed Service receivers	M			
11	4.2.6.3	PFD limit in the 14,47 GHz to 14,5 GHz frequency band to protect Radio Astronomy Service	M			
NOTE: These EN-Requirements are justified under article 3.2 of the R&TTE Directive.						

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;
- O Optional, may be provided, but if provided shall be implemented in accordance with the requirements;
- O.n This status is used for mutually exclusive or selectable options among a set. The integer "n" shall refer to a unique group of options within the EN-RT. A footnote to the EN-RT shall explicitly state what the requirement is for each numbered group. For example, "It is mandatory to support at least one of these options", or, "It is mandatory to support exactly one of these options".

Comments To be completed as required.

Annex B (normative): Environmental conditions

B.1 General

This annex specifies the environmental conditions under which the relevant requirements of the present document shall be fulfilled.

Testing under other environmental conditions will be undertaken by manufacturers according to the requirements of EUROCAE ED-14D/RTCA DO-160D, and need not be repeated here to demonstrate compliance with the present document.

NOTE: DO-160D "Environmental Conditions and Test Procedures for Airborne Equipment", Issued 7-29-97, Superseded DO-160C, Changes 1, 2 & 3, Prepared by SC-135. Standard procedures and environmental test criteria for testing airborne equipment for the entire spectrum of aircraft from light general aviation aircraft and helicopters through the "Jumbo Jets" and SST categories of aircraft. The document includes 25 clauses and three annexes. Examples of tests covered include vibration, power input, radio frequency susceptibility, lightning, and electrostatic discharge. Coordinated with EUROCAE, RTCA/DO-160D and EUROCAE/ED-14D [6] are identically worded. DO-160D is recognized by the International Organization for Standardization (ISO) as de facto international standard ISO/IEC 7137.

B.2 Environmental conformance requirements

Aircraft Earth Stations are installable equipments (IE) typically consisting of:

a) an Internally Mounted Equipment (IME) may consisting of the following three units:

   i) a Satellite Terminal Unit (STU);

   ii) a High Power Amplifier (HPA);

   iii) a Low Noise Amplifier/Diplexer (LNA/D);

b) an Externally Mounted Equipment (EME), consisting of an antenna assembly which can be either:

   i) a single reflector antenna; or

   ii) two active phased array antennas (one receive and one transmit).

B.3 Environmental test conditions

The equipments comprising the AES may be subject to different environmental hazards and are required to maintain their performance in accordance with the present document under all environmental circumstances for the Equipment Categories applicable to them as defined in EUROCAE ED-14D. Whilst the AES being subjected to the EUROCAE ED-14D environmental conditions and specifications, tests specified in the present document shall be maintained within the following envelope of environmental conditions (or otherwise as specified by the manufacturer):

A) for the IME (ambient conditions):

   - temperature: +15°C to +35°C;

   - relative humidity: ≤ 85 %;

   - pressure: 840 hPa to 1 070 hPa (equivalent to +1 525m to –460m altitude).

Tests made at environmental conditions other than ambient as specified above shall be conducted subject to the following tolerances:

- Temperature: ± 3°C;
- Pressure: ± 5 %.

B) for the EME:

- temperature: -55°C to +35°C;
- relative humidity: ≤ 85 %;
- pressure: 91 hPa to 1 070 hPa (equivalent to +16 800 m to -460 m altitude).

The power supply shall be in accordance with EUROCAE ED-14D/RTCA DO-160D [6] Normal Operating Conditions (nominal), for the Equipment Category applicable to the AES.

Annex C (informative): Equations to convert PFD to EIRP and vice-versa

The PFD limits in clause 4.2.6 relate to the power flux density and angles of arrival that would be obtained under free space propagation conditions.

These PFD limits apply over the range of operating frequencies, aircraft models, height above sea level, latitudes, and for any geostationary orbital arc.

These PFD limits will translate in the NCF real-time commanding of the AES to reduce or enhance its EIRP emissions based on its altitude (height above sea level).

The conversion between the PFD to EIRP and vice versa, is a function of the aircraft height above sea level (H) and the angle γ which is the angle below the local horizontal of the aircraft (see figure C.1). Thus:

- given the EIRP, H and γ (see note below), the PFD(θ) is calculated as follows:

$$PFD(\theta) = EIRP(\gamma) - 10 \text{ Log } (4 \pi d^2) - 60, \text{ in dB(W/m2) in any 1 MHz}$$

where:

$$\theta = \arccos((R_e+H) \cos(\gamma/R_{e)}$$

$$d = \text{sqrt}(R_e{}^2 + (R_e+H)^2 - 2 R_e (R_e+H) \cos(\gamma - \arccos((R_e+H) \cos(\gamma/R_{ee})), \text{ in km}$$

The note below gives the conditions of validity of γ. Vice versa;

- given the PFD, θ and the altitude H at which the AES is located, the EIRP(γ, H) is given by:

$$EIRP(\gamma, H) = PFD(\theta) + 10\log_{10}(4 \pi d^2) + 60, \text{ in dB(W) in 1 MHz}$$

where:

$$\gamma = \arccos(R_e/(R_e+H) \cos \theta)$$

$$d = \text{sqrt}(R_e{}^2 + (R_e+H)^2 - 2 R_e(R_e+H) \cos(\arccos(R_e/(R_e+H) \cos \theta) - \theta)), \text{ in km}$$

Here

EIRP	= Effective Isotropically Radiated Power in dB(W) per 1 MHz;
PFD(θ)	= is the PFD as a function of the arrival angle θ;
θ	= angle of arrival in degrees with respect to the local ground plane at the FS station;
d	= is the distance between the AES and the point on the Earth surface which the vector in the direction θ from the AES intersect the Earth surface;
R_e	= Average Earth radius (6 378 km);
H	= Altitude of the aircraft in km;
γ	= Angle below horizontal in degrees, with γ ≥ arcos (Re / (Re + H)).

NOTE: γ ≥ arcos (Re / (Re + H)), otherwise the argument is greater than 1, which means that the propagation path in the direction of the angle γ does not intersect the Earth. In this case, which occurs for values of γ of about 3,5° or less, a value for θ does not exist and so there is no given value for the PFD mask. In such case any EIRP value is allowed.

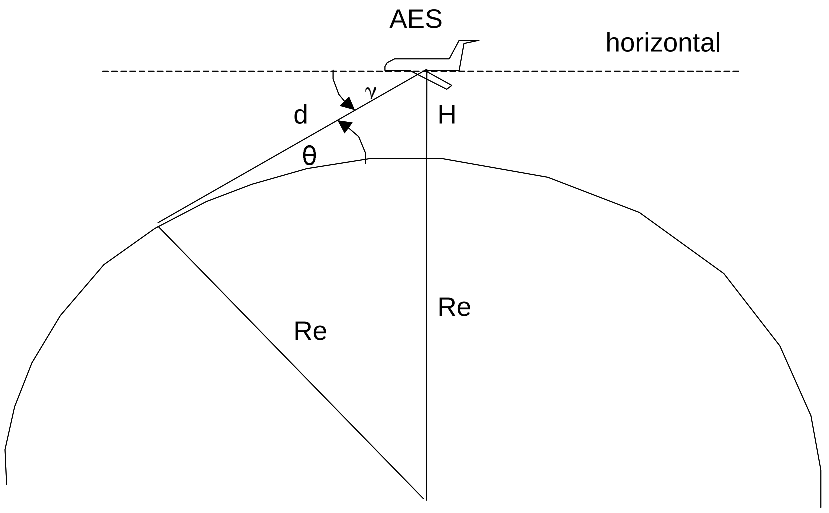

Figure C.1: Geometry of the AES with respect to the ground where the PFD is applicable

Annex D (informative): Bibliography

ISO/IEC 7137: "Aircraft; Environmental conditions and test procedures for airborne equipment".

History

Document history		
V1.1.1	April 2003	Public Enquiry PE 20030815: 2003-04-16 to 2003-08-15