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Satellite Earth Stations and Systems (SES); Maritime Mobile Earth Stations (MMES) operating in the 1,5/1,6 GHz bands providing Low Bit Rate Data Communications (LBRDC) in the Maritime Mobile Satellite Service (MMSS), not intended for distress and safety communications

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Foreword

This European Telecommunication Standard (ETS) has been produced by the Satellite Earth Stations and Systems (SES) Technical Committee of the European Telecommunications Standards Institute (ETSI).

Transposition dates	
Date of adoption:	7 March 1997
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1 Scope

This European Telecommunication Standard (ETS) provides specifications for the standardization of the characteristics of Maritime Mobile Earth Stations (MMESs) not providing those distress and safety functions required by the International Maritime Organization (IMO) with both transmit and receive capabilities in order to limit interference to radio communications services.

The geostationary satellite networks referred to in this ETS operate under the Maritime Mobile Satellite Service (MMSS). The MMESs operate as part of a geostationary satellite network providing Low Bit-Rate Data Communications (LBRDC). The frequency bands allocated by the Radio Regulations [5] to the MMSS are as follows:

	MMSS
Transmit frequencies	1 626,5 to 1 645,5 MHz
Receive frequencies	1 525,0 to 1 545,0 MHz

The MMESs could consist of a number of modules including a keyboard interface to the user.

The main specifications are contained in three categories related to:

- **safety:** to protect persons from potentially dangerous RF power densities;

- **unwanted emissions:** to protect terrestrial and satellite radio services from harmful interference;

- **MMES control and monitoring:** to specify a minimum set of Control and Monitoring Functions (CMF) to be implemented on each MMES in order to minimize the probability that they originate unwanted transmissions that may give rise to harmful interference to other systems.

Additionally to these specifications the satellite operator may require other specifications or different limits.

2 Normative references

This ETS incorporates, by dated or undated references, provisions from other publications. These normative references are cited at the appropriate places in the text, and the publications are listed hereafter. For dated references subsequent amendments to, or revisions of, any of these publications apply to this ETS only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

[1] CISPR Publication No. 16 (1987): "CISPR specification for radio interference measuring apparatus and measurement methods".

[2] EN 55022: "Limits and methods of measurement of radio interference characteristics of information technology equipment".

[3] IEC 510-2-1 (1978): "Methods of measurement for radio equipment used in satellite earth stations, Part 2: Measurement for sub systems".

[4] ETS 300 459: "Satellite Earth Stations and Systems (SES); Network Control Facilities (NCF) for Maritime Mobile Earth Stations (MMES) operating in the 1,5/1,6 GHz and 11/12/14 GHz bands providing Low Bit Rate Data Communications (LBRDC)".

[5] ITU Radio Regulations (1994).

3 Definitions and abbreviations

3.1 Definitions

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

Internally Mounted Equipment (IME): Equipment or units designed to be protected from the weather.

Externally Mounted Equipment (EME): Equipment or units designed to be exposed to the weather.

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

unwanted emissions: Unwanted emissions are emissions falling outside the nominated bandwidth.

Special Test Equipment (STE): Specific equipment which enables the tests specified in this ETS to be carried out.

Equipment Under Test (EUT): For the purpose of this ETS the EUT includes all units necessary for intended operation.

This includes:

- the Externally Mounted Equipment (EME);
- the Internally Mounted Equipment (IME) including the data terminal equipment such as keyboard, Video Display Units (VDU), printer, etc.;
- all interconnecting cables and power supply leads.

3.2 Abbreviations

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

ac	alternating current
CMF	Control and Monitoring Function
EIRP	Equivalent Isotropically Radiated Power
EME	Externally Mounted Equipment
EUT	Equipment Under Test
IME	Internally Mounted Equipment
IMO	International Maritime Organization
LBRDC	Low Bit Rate Data Communication
MES	Mobile Earth Station
MMES	Maritime Mobile Earth Station
MMSS	Maritime Mobile Satellite Service
NCF	Network Control Facilities
RF	Radio Frequency
STE	Special Test Equipment

4 Tests

4.1 Special Test Equipment (STE)

The STE shall be supplied by the manufacturer or system provider. Since the STE will be specific for the particular system, it is not possible to provide detailed specifications in this ETS. However, the following baseline is provided:

- special test arrangements are required to simulate the satellite signal, thus enabling the MMES to transmit, to allow measurement of transmission parameters;

- any specification of these special test arrangements which may have direct or indirect effects on any specification of this ETS shall be clearly stated by the manufacturer;

- when using the STE it shall be ensured that no transmission to the satellite occurs.

4.2 Test report

The test report shall contain:

- the value of the nominated bandwidth declared by the manufacturer;

- the results of the tests;

- all parameters and operational conditions.

5 Radio Frequency (RF)

In this clause, whenever a change of limit between adjacent frequency bands occurs, the lower of the two limits shall apply at the transition frequency.

5.1 Radio frequency radiation protection

Purpose:

To ensure the protection of persons from potentially dangerous RF power densities.

Specification:

The radiating part of the equipment (which includes the exterior of any radome or other antenna enclosure where fitted) shall be labelled with a warning notice which shall be clearly visible when the equipment is in its normal operating configuration. This notice shall indicate the closest distances to the radiating part within which a person may approach the equipment without experiencing radio frequency power density levels in excess of 8, 10, 25 and 100 W/m^2, when under worst case conditions (e.g. maximum power, maximum on/off ratio), averaged over a 6 minute period. This notice shall also state that before approaching the radiating part within any distance closer than that indicated, the MMES equipment shall be switched-off or otherwise disabled so that it shall not transmit.

Where the radiating part is mounted in a position where it is not normally visible, further warning notices shall be provided to be attached to the ship so as to be clearly visible to anyone attempting to reach the radiating part of the equipment.

In the case where the antenna is enclosed in a radome, or other antenna enclosure, and when no RF power density greater than 8 W/m^2, when under worst case conditions (e.g. maximum power, maximum on/off ratio), averaged over a 6 minute period, is produced outside of this radome, or antenna enclosure, then it is not necessary to label the radiating part or provide labels for the ship in the manner indicated above. Instead, the external surface of the radome or the antenna enclosure shall be clearly labelled with a warning that the MMES equipment shall be switched-off, or otherwise disabled, so that it shall not transmit before any work requiring the removal of the radome or antenna enclosure takes place.

Verification:

Verification of the distances below which exist RF power densities in excess of 8, 10, 25 and 100 W/m^2, when under worst case conditions (e.g. maximum power, maximum on/off ratio) averaged over a 6 minute period, shall be demonstrated by documentary evidence. The manufacturer shall quantify the worst case conditions.

Conformance with the labelling requirements of this subclause shall be demonstrated by visual inspection of the radiating part and, if relevant, an examination of the notices provided by the manufacturer.

5.2 Unwanted emissions outside the band 1 626,5 - 1 645,5 MHz

Purpose:

Protection of terrestrial and satellite services from emissions caused by MMESs outside the band 1 626,5 to 1 645,5 MHz.

Specification:

The unwanted emissions from the MMES outside the band 1 626,5 to 1 645,5 MHz within which the MMES is designed to operate shall be below the following limits.

For unwanted emissions below 1 GHz, the levels of field strength shall not exceed the values given in figure 1.

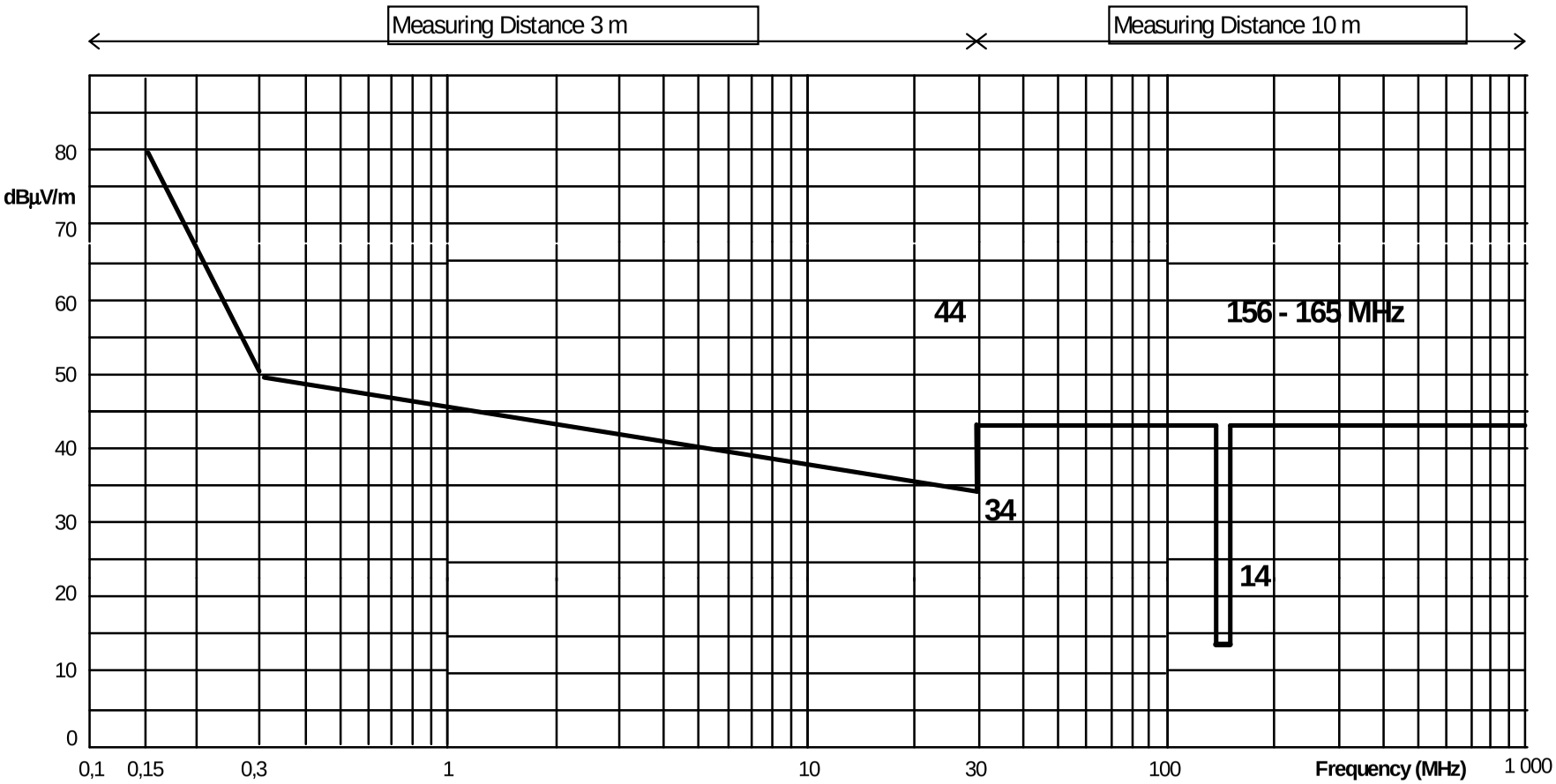

Figure 1: Maximum level of field strength of unwanted emissions at the distances specified above

The unwanted emissions EIRP above 1 GHz in the measurement bandwidth and in all directions shall not exceed the following limits:

Table 1: Unwanted emissions EIRP above 1 GHz

Frequency range (MHz)	Carrier-on		Carrier-off	
	EIRP limit (dBpW)	Measurement bandwidth (kHz)	EIRP limit (dBpW)	Measurement bandwidth (kHz)
1 000 - 1 525	49	100	48	100
1 525 - 1 559	49	100	17	3
1 559 - 1 600	49	100	48	100
1 600 - 1 623,5	74	100	48	100
1 623,5 - 1 626	74 (note 1)	100 (note 1)	48	100
1 626 - 1 626,5	84	3	48	100
1 645,5 - 1 645,6	104	3	57	3
1 645,6 - 1 646,1	84	3	57	3
1 646,1 - 1 661	74	3	57	3
1 661 - 1 663,5	74 (note 1)	100 (note 1)	48	100
1 663,5 - 1 690	74	100	48	100
1 690 - 3 400	49 (note 2)	100	48	100
3 400 - 10 700	55 (note 3)	100	48	100
10 700 - 21 200	61	100	54	100
21 200 - 40 000	67	100	60	100

NOTE 1: These figures shall be 74 dBpW/3 kHz prior to 1st January 1998.

NOTE 2: In the band 3 253 - 3 291 MHz the maximum EIRP in one, and only one, 100 kHz measurement bandwidth shall not exceed 82 dBpW. Prior to 1st January 1998 this figure shall be 92 dBpW. Elsewhere in this band the power limit in table 1 shall be applied.

NOTE 3: In each of the bands 4 879,5 - 4 936,5 MHz, 6 506,0 - 6 582,0 MHz and 8 132,5 - 8 227,5 MHz the maximum EIRP in one, and only one, 100 kHz measurement bandwidth shall not exceed 72 dBpW. Prior to 1st January 1998 this figure shall be 82 dBpW. Elsewhere in these bands the power limit in table 1 shall be applied.
In the band 9 759,0 - 9 873,0 MHz the maximum power in one, and only one, 100 kHz measurement bandwidth shall not exceed 61 dBpW. Prior to 1st January 1998, this figure shall be 71 dBpW. Elsewhere in this band the power limit in table 1 shall be applied.

Verification:

By measurement of unwanted emissions generated by an operating MMES.

The tests with carrier on shall be undertaken with the transmitter operating at full power and with the maximum transmit burst rate where applicable.

For measurement of unwanted emissions below 1 GHz the full system shall be tested according to the method described below. The tests shall be carried out at ambient environmental conditions.

The EUT shall be placed on a non-conductive support with a height of 0,8 m. In the frequency range 150 kHz - 30 MHz the measuring distance between the centre of the test antenna and the EUT shall be 3 m. In the frequency range 30 MHz - 1 GHz the measuring distance between the centre of the test antenna and the EUT shall be 10 m. The test site as indicated in EN 55022 [2] shall be used.

The quasi-peak measuring receivers specified in CISPR 16 [1] shall be used. The receiver bandwidth in the frequency ranges 150 kHz to 30 MHz and 156 MHz to 165 MHz shall be 9 kHz and in the frequency ranges 30 MHz to 156 MHz and 165 MHz to 1 GHz shall be 120 kHz.

For frequencies from 150 kHz to 30 MHz, measurements shall be made of the magnetic H field. The measuring antenna shall be an electrically screened loop antenna of dimension such that the antenna can be completely enclosed by a square having sides of 60 cm in length, or an appropriate ferrite-rod antenna as described in CISPR 16 [1].

The correction factor for the antenna shall include the factor +51,5 dB to convert the magnetic field strength to equivalent electric field strength.

For frequencies above 30 MHz measurements shall be made of the electric E field.

For measurement of unwanted emissions above 1 GHz the full system shall be tested according to the test procedure given in annex A. The tests shall be carried out at the environmental conditions specified in annex B.

The upper frequency to which tests shall be performed shall be at least the 10th harmonic of the highest frequency conversion oscillator or ten times the highest operational frequency, whichever is greater.

Two MMES transmit frequencies shall be used for this test. The frequencies shall be selected to be as close as possible to the upper and lower limits of the transmit frequency band intended for operational use by the MMES. These frequency limits shall be declared by the manufacturer and entered in the test report. The upper and lower extremes of the tuning range shall be declared by the manufacturer and entered in the test report.

5.3 Maximum unwanted emission within the band 1 626,5 - 1 645,5 MHz

Purpose:

Protection of satellite and terrestrial services operating in the band 1 626,5 to 1 645,5 MHz.

Specification:

The unwanted emissions EIRP in any 3 kHz band within the 1 626,5 to 1 645,5 MHz band in which the MMES is designed to transmit, but outside the nominated bandwidth, shall not exceed the following limits:

- when carrier-off: 57 dBpW;

- when carrier-on; as follows in table 2:

Table 2: Unwanted emission within the band 1 626,5 - 1 645,5 MHz when carrier-on

Offset from the edge of the band of the nominated bandwidth (kHz)	Maximum EIRP (dBpW)
0 - 100	117
100 - 200	104
200 - 700	84
greater than 700	74

Verification:

Conformance shall be determined by direct measurement.

The tests shall be carried out at the environmental conditions specified in annex B.

The tests with carrier on shall be undertaken with the transmitter operating at full power and with the maximum transmit burst rate where applicable.

The measurement shall be performed by either of the two following methods:

a) in the first method, the full system shall be tested according to the test procedure presented in annex A;

b) in the second method, the power of the unwanted emissions at the interface point between the antenna and the remaining EME shall be measured according to the alternative measurement method in annex A. The antenna gain shall be measured according to the measurement methods in IEC 510-2-1 [3]. The EIRP of the unwanted radiation shall be calculated from the above two measurements.

6 MMES Control and Monitoring Functions (CMF)

6.1 General

This clause defines a minimum set of CMF which shall be implemented on MMESs in order to minimize the probability that they originate unwanted transmissions that may give rise to harmful interference to other systems.

There shall be a CMF at each MMES, associated to separate Network Control Facilities (NCF) as specified in ETS 300 459 [4].

6.1.1 Monitoring functions

6.1.1.1 Processor monitoring

Purpose:

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

Specification:

The MMES shall incorporate a processor monitoring function for each of its processors involved in the manipulation of traffic and in CMFs.

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 transmissions shall be suppressed until the processor monitoring function has determined that the fault condition has been cleared.

Verification:

Compliance shall be verified by documentary evidence and demonstration.

The demonstration shall show that all transmissions are suppressed within 1 second following a controllable processor induced fault (e.g. processor board disconnected).

The manufacturer shall provide the test house with a test procedure to demonstrate this transmission shutdown.

6.1.1.2 Transmit frequency sub-system

Purpose:

To verify the correct operation of the transmit frequency generation sub-system and to inhibit transmissions should the sub-system fail.

Specification:

The MMES shall monitor the operation of its transmit frequency generation sub-system.

The failure of the transmit frequency generation sub-system for a period longer than 5 seconds shall result in transmissions being suppressed until the fault condition has been cleared.

Verification:

Compliance shall be verified by documentary evidence and demonstration.

The demonstration shall show that all transmissions are suppressed within 6 seconds following a controllable transmit frequency generation sub-system fault (e.g. replacement of frequency reference).

The manufacturer shall provide the test house with a test procedure to demonstrate this transmission shutdown.

6.1.2 POWER ON/RESET

Purpose:

To demonstrate that the MMES achieves a controlled non-transmitting state following the POWER ON/RESET or restart of the unit.

Specification:

Following POWER ON/RESET the MMES shall enter a controlled and non-transmitting state.

Verification:

Compliance shall be verified by documentary evidence and demonstration.

6.1.3 Network control reception and authorization

6.1.3.1 Network control authorization

Purpose:

To ensure that the MMES cannot transmit unless it receives an appropriate enable indication.

Specification:

a) Without reception of an appropriate enable signal to the MMES via an authoriser control channel it shall not be possible to initiate message transmission.

b) Transmissions shall not continue for longer than 30 seconds unless further enables are received. For half-duplex transmission systems in operation before 1st January 1994 this period of time shall be 15 minutes.

Verification:

By documentary evidence and demonstration.

It shall be demonstrated that a transmitting MMES suppresses transmissions when it has not received a suitable enable for a period of time longer than 30 seconds and the MMES transmissions shall remain suppressed until a further enable is received.

For half-duplex systems in operation before 1st January 1994 this period of time shall be 15 minutes.

It shall be demonstrated that after POWER ON/RESET of the MMES, it is not possible to initiate message transmission until an appropriate enable signal is received by the MMES.

6.1.3.2 Network control reception

Purpose:

These requirements ensure that the MMES shall be capable of:

- receiving and implementing commands from the NCF through its correct reception of the appropriate control channel(s);

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

Specification:

The MMES shall hold, in non-volatile memory, the unique identification codes of the terminal itself.

The MMES shall be enabled or disabled through control channels.

Message transmission shall be inhibited for any failure to receive an authoriser control channel (either a command or a signal) lasting more than 30 seconds or more. For half-duplex systems in operation before 1st January 1994, this period of time shall be 15 minutes.

The MMES shall be capable of receiving and acting upon the control messages that are addressed to it which contain transmitter enabling and disabling information. The MMES shall be capable of transmitting its identification code upon reception of an appropriate control message addressed to the MMES.

Verification:

The method of setting and storing the MMES identification codes shall be verified by documentary evidence.

The other requirements shall be verified by documentary evidence and demonstration showing that the MMES is capable of receiving appropriate signals from the NCF to implement enables, disables and identification functions.

The manufacturer shall provide the test house with a test procedure to demonstrate the implementation of enables, disables and identification functions.

6.2 Initial burst rate transmission

Purpose:

To limit disturbance duration and period to other services when interference occurs.

Specification:

For systems which do not inhibit initial burst transmission from the MMES after RESET or POWER ON:

- the transmission of the initial burst shall not exceed 1 second;

- over any 60 seconds period, the total duration of initial bursts shall not exceed 1 % of that period (0,6 seconds).

Verification:

By documentary evidence and demonstration.

7 Network Control Facilities (NCF) for MMES networks

Relevant information is contained in ETS 300 459 [4].

Annex A (normative): Unwanted emissions above 1 GHz - test procedure

A.1 Introduction

This annex describes the measurement procedure of unwanted emissions from 1 GHz to 40 GHz generated by an MMES terminal under operating conditions (as specified in subclauses 5.2 and 5.3).

A.2 Measuring apparatus

In order to carry out the test, the following elements are required, as a minimum:

- a set of calibrated reference antennas covering the frequency range of interest;
- the necessary post reference antenna pre-amplification and amplification devices;
- spectrum analyser(s) with sweep/store capability covering the frequency range of interest.

For the apparatus utilized, it shall be verified that:

- the response of the apparatus, including any antenna and associated amplification system, to a constant amplitude sine wave signal remains within ± 1 dB of calibration across the frequency range of interest;

- the screening performance of the measuring apparatus shall be such that when the measuring antenna/post-antenna equipment is removed, and the input to the measuring apparatus is screened, the measured power density shall fall to a value at least 60 dB below the measured value (see CISPR Publication No. 16 [1], section 2.8).

A.3 Test set-up

The EME and IME shall be installed with a separation of about 0,5 m. Between the two equipments, the maximum length connection cable specified by the manufacturer shall be installed. The height of the cable shall be between 0,5 m and 1 m. The cable shall be maintained in that position by non-metallic means. The EME shall be set, in its normal operating configuration on a non-metallic table at a height between 0,5 m and 1 m. The IME shall be set on a non-metallic table at a height between 0,5 m and 1 m. Any associated equipment (e.g. portable computer or data terminal if required for operation of the MMES) shall be placed next to and at the same height as the IME.

The measuring antenna shall be installed in the horizontal plane of the radiating part of the MMES. Each antenna shall be positioned to be outside the near field of the other antenna.

In addition, it shall be verified that the test site shall be suitable with respect to ambient noise which shall be at least 6 dB lower than the lowest specification value being measured.

A.4 Measuring procedure

The EUT shall be switched-on and the STE (if used) activated. The measuring equipment shall be set to an appropriate measuring bandwidth.

The measuring antenna shall be placed at a fixed height and an appropriate distance from the EUT. Measurements shall be carried out with the measuring antenna and the EUT antenna so oriented that the values of unwanted emissions are maximized.

Testing should first be performed in angular steps of 90° while varying the height of the measuring antenna between 1 m and 4 m. For those directions and frequencies, or frequency bands, where unwanted emissions are detected that are near to the specified limits, additional tests shall be performed for each detected emission by varying the height of the measuring antenna between 1 m and 4 m and rotating the EUT through 360° to maximize the emission value.

These measurements shall be carried out with the measuring antenna in both planes (vertical and horizontal) of polarization to ensure that the values of measured EIRP obtained are maximized.

The received power density shall be measured over the entire frequency range of interesting measurement ranges appropriate to the test equipment being used. The precise knowledge of distance between the EUT and the reference antenna, the reference antenna gain and the amplification/attenuation characteristics of the post reference antenna network allow the determination of the unwanted EIRP density radiated by the EUT.

A.5 Alternative measuring procedure

For the case in which it is desired to measure the power of the emissions from the MMES by direct coupling at the interface point between the antenna and the rest of the MMES, the method set out in this annex shall apply except that the test set-up will need to be modified to allow direct coupling of the measuring equipment to the antenna feed and references to the positioning of the measuring antenna shall be ignored. The MMES maximum antenna gain at the measurement frequency shall be taken into account.

For this test set-up up it may also be necessary to arrange for the coupling of signals from the STE to the MMES in order to put the MMES into its normal transmit mode.

Annex B (normative): Environmental conditions

B.1 General

This normative annex specifies the environmental conditions under which the relevant requirements of this ETS shall be fulfilled.

B.2 Environmental requirements

B.2.1 Temperature

The MMES shall fulfil all the requirements in the full temperature range of:

a) +15 °C to +35 °C; for normal conditions (with relative humidity of 25 % to 75 %);

b1) -15 °C to +55 °C; for extreme conditions for IME;

b2) -30 °C to +55 °C; for extreme conditions for EME.

B.2.2 Voltage

The MMES shall fulfil the requirements in the full voltage range, i.e. the voltage range between the extreme voltages.

a) ± 10 % of nominal mains voltage; for ac mains supply;

b) +30 % / -10 % of nominal battery voltage; for secondary battery power supply.

For EUT using other power sources, the extreme test voltages shall be stated by the manufacturer.

B.2.3 Vibration

The MMES shall fulfil all the requirements when vibrated at the frequencies given below.

a) 2 Hz (-0 / + 3 Hz) to 13,2 Hz with an excursion of ± 1 mm ± 10 %;

(7 m/s^2 maximum acceleration at 13,2 Hz);

b) 13,2 Hz to 100 Hz with a constant maximum acceleration of 7 m/s^2.

B.3 Environmental test conditions

The tests in subclauses 5.2 and 5.3 shall be performed under the conditions given in table B.1.

Table B.1: Environmental test conditions

Temperature	Relative Humidity	Voltage	Vibration
Normal	25 % - 75 %	Nominal	No
+ 55 °C ± 3 °C	25 % - 75 %	High extreme	No
+ 55 °C ± 3 °C	25 % - 75 %	Low extreme	No
+ 40 °C ± 3 °C	91 % - 95 %	High extreme	No
+ 40 °C ± 3 °C	91 % - 95 %	Low extreme	No
- 15 °C ± 3 °C for IME - 30 °C ± 3 °C for EME	25 % - 75 %	High extreme	No
- 15 °C ± 3 °C for IME - 30 °C ± 3 °C for EME	25 % - 75 %	Low extreme	No
Normal	25 % - 75 %	Nominal	Yes

Normal test conditions shall be as specified in clause B.2.

All other tests shall be performed under normal conditions for temperature and voltage, and without vibration.

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