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Satellite Earth Stations and Systems (SES); Land Mobile Earth Stations (LMESs) operating in the 1,5 / 1,6 GHz bands providing voice and/or data 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).

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1 Scope

This European Telecommunication Standard (ETS) provides specifications for the standardisation of the characteristics of Mobile Earth Stations (MESs) using geostationary satellites with both transmit and receive capabilities in order to ensure general safety and to limit interference to radiocommunication services.

The geostationary satellite networks referred to in this ETS operate under the Land Mobile Satellite Service (LMSS). The MESs operate as a part of a satellite network providing voice and/or data communications.

The frequency bands under which the MESs operate should be within the following bands:

	LMSS
MESs transmit	1 631,5 - 1 634,5 MHz 1 656,5 - 1 660,5 MHz
MESs receive	1 530 - 1 533 MHz 1 555 - 1 559 MHz

These MESs generally have the following characteristics:

- the MESs could be either vehicle mounted or portable equipment;

- the MES could consist of a number of modules including suitable interfaces to the user.

The main specifications are contained in three categories related to:

- **safety:** to protect personnel, public and goods from unsafe operating conditions or equipment;

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

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

This ETS deals with two types of specification:

- specifications defined in order to protect other users of the frequency spectrum from unacceptable interference. In addition, these specifications are specified for the purposes of general safety;

- specifications related to matters of general safety, minimisation of interference to other users of the radio spectrum and for the provision of protection of the MESs against electromagnetic interference from other systems. These specifications apply if required by the manufacturer.

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] IEC 215 (1987): "Safety requirements for radio transmitting equipment".

[2] CISPR 22 (1993): "Limits and methods of measurement of radio disturbance characteristics of information technology equipment".

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

[4] prETS 300 424 (1994): "Satellite Earth Stations and Systems (SES); Network Control Facilities (NCF) for Land Mobile Earth Stations (LMESs) operating in the 1,5/1,6 GHz bands providing voice and/or data communications".

[5] IEC 801-3 (1984): "Electromagnetic compatibility for industrial process measurement and control equipment; Part 3: Radiated electromagnetic field requirements".

[6] CISPR 16 (1987): "Specifications for radio interference measuring apparatus and measurements methods".

3 Definitions and abbreviations

3.1 Definitions

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

directional antenna: An antenna with a transmit gain equal to or greater than 10 dBi.

Installable Equipment (IE): An equipment which is intended to be installed in a vehicle. An IE may consist of one or several interconnected modules as follows:

Internally Mounted Equipment (IME) and Externally Mounted Equipment (EME): The manufacturer indicates which modules are intended to be Externally Mounted Equipment (EME); the remaining module(s) are then defined as Internally Mounted Equipment (IME). Where different specifications apply to IME and EME, this is noted in the relevant text.

nominated bandwidth: 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 LMSS transmit frequency band within which the MES operates. The bandwidth of the MES radio frequency transmission is nominated by the manufacturer and included in the data sheet of the test report.

Portable Equipment (PE): A portable equipment is generally intended to be self-contained, free standing and portable. A PE would normally consist of a single module, but may consist of several interconnected modules. In some cases different specifications apply to PE and this is noted in the relevant text.

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

3.2 Abbreviations

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

CMF	Control and Monitoring Function
EIRP	Equivalent Isotropically Radiated Power
EM	Electro-Magnetic
EME	Externally Mounted Equipment
EUT	Equipment Under Test
IE	Installable Equipment
IME	Internally Mounted Equipment
LMES	Land Mobile Earth Station
LMSS	Land Mobile Satellite Service
MES	Mobile Earth Station
NCF	Network Control Facilities
PE	Portable Equipment
RF	Radio Frequency
rms	root mean square
s	second
STE	Special Test Equipment

4 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 Safety

5.1 Mechanical construction

Purpose:

Protection of operating personnel, the public and goods from insecure or unsafe structures.

Specification:

For Installable Equipment (IE) and Portable Equipment (PE) the mechanical design, construction and finish of the equipment shall conform to IEC 215 [1], section 3, paragraph 9.1.

Verification:

Verification shall be demonstrated by documentary evidence and visual inspection.

5.2 Electrical safety, power voltages

Purpose:

Protection of operating personnel and the public from electric shock.

Specification:

The electrical safety of the equipment shall be in accordance with paragraphs 13, 14, 15 and 16 and Appendix B of IEC 215 [1].

Verification:

Conformance shall be demonstrated by documentary evidence and visual inspection.

5.3 Radio frequency radiation protection

Purpose:

To indicate the distance from the MES below which RF power densities in excess of 8 W/m^2 may be experienced, when averaged over a 6 minute period.

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 distance to the radiating part within which a person may approach the equipment without experiencing radio frequency power density levels in excess of 8 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 MES equipment shall be switched off or otherwise disabled so that it shall not transmit.

Where the equipment is vehicle mounted a warning notice providing the same information as that affixed to the radiating part shall be provided for fixing in the vehicle near to and clearly visible from the normal operating position of the IME. In addition, for vehicle mounted equipment where the radiating part is mounted in a position where it is not normally visible to a person standing on the ground next to the vehicle, further warning labels shall be provided with instructions that they be attached to the vehicle so as to be clearly visible to anyone attempting to climb on to the part of the vehicle where the radiating part of the equipment is mounted.

In the case where the antenna is enclosed in a radome or other antenna enclosure and 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 vehicle in the manner indicated above. Instead, the radiating part shall be clearly labelled with a warning that the MES 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. Where the equipment is vehicle mounted, a label containing the same warning shall be provided, to be mounted in the vehicle near to, and clearly visible from, the normal operating position of the IME.

Verification:

Verification of the distance below which exist RF power densities in excess of 8 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.

6 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.

6.1 Unwanted emission outside the bands 1 631,5 to 1 634,5 MHz and 1 656,5 to 1 660,5 MHz

Purpose:

Protection of other terrestrial and satellite services from emissions caused by MESs outside the bands 1 631,5 to 1 634,5 MHz and 1 656,5 to 1 660,5 MHz.

Specification:

The unwanted emissions from MESs outside the band 1 631,5 to 1 634,5 MHz and 1 656,5 to 1 660,5 MHz within which the MES is designed to operate shall be below the following limits.

For unwanted emissions below 960 MHz, the MESs shall meet the requirements of CISPR 22 [2] for class B equipment with carrier on given in table 1.

Table 1

Limits of unwanted emissions at a test distance of 10 m in any 120 kHz band	
Frequency	**Quasi-peak limits (dBµV/m)**
30 MHz to 230 MHz	30
230 MHz to 960 MHz	37

The unwanted emission EIRP above 960 MHz in the measurement bandwidth in all directions shall not exceed the limits in table 2.

Table 2

Frequency range	Carrier On		Carrier Off	
MHz	**EIRP limit (dBpW)**	**Measurement bandwidth (kHz)**	**EIRP limit (dBpW)**	**Measurement bandwidth (kHz)**
960,0 - 1 525,0	49	100	48	100
1 525,0 - 1 559,0	49	100	17	3
1 559,0 - 1 600,0	49	100	48	100
1 600,0 - 1 625,8	74	100	48 (note 5)	100
1 625,8 - 1 631,5	(note 1)	(note 1)	57	3
1 634,5 - 1 656,5	(note 1)	(note 1)	57	3
1 660,5 - 1 661,2	(note 1)	(note 1)	57	3
1 661,2 - 1 690,0	74	100	48 (note 5)	100
1 690,0 - 3 400,0	49 (note 2)	100	48	100
3 400 - 10 700	55 (notes 3 & 4)	100	48	100
10 700 - 21 200	61	100	54	100
21 200 - 40 000	67	100	60	100

NOTE 1: The limit of subclause 6.2 (in-band unwanted emission limit) shall apply and in any 3 kHz frequency band the EIRP including the spectrum lines shall not exceed 104 dBpW.

NOTE 2: In the band 3 263,0 to 3 321,0 MHz the maximum EIRP in one, and only one, 100 kHz measurement bandwidth shall not exceed 82 dBpW. Prior to 1 January 1998 this figure shall be 92 dBpW. Elsewhere in this band the power limit in table 2 shall be applied.

NOTE 3: In each of the bands 4 894,5 to 4 981,5 MHz, 6 526,0 to 6 642,0 MHz and 8 157,5 to 8 302,5 MHz the maximum EIRP in one, and only one, 100 kHz measurement bandwidth shall not exceed 72 dBpW. Prior to 1 January 1998 this figure shall be 82 dBpW. Elsewhere in this band the power limit in table 2 shall be applied.

NOTE 4: In the band 9 789,0 to 9 963,0 MHz the maximum power in one, and only one, 100 kHz measurement bandwidth shall not exceed 61 dBpW. Prior to 1 January 1998 this figure shall be 71 dBpW. Elsewhere in this band the power limit in table 2 shall be applied.

NOTE 5: Prior to 1 January 1998 this figure shall be 51 dBpW.

Verification:

By measurement of unwanted emissions generated by an operating MES.

All RF tests in this subclause shall be carried out at ambient environmental conditions and for a nominal power supply voltage.

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

To enable the performance tests to be carried out, the use of Special Test Equipment (STE), supplied by the manufacturer or system provider, may be necessary. Since this test equipment will be specific for the particular system, it is not possible to provide detailed specifications in this ETS.

However, the following baseline is provided:

- if the MES requires to receive a modulated carrier from the satellite in order to transmit, then special test arrangements are required to simulate the satellite signal, thus enabling the MES to transmit allowing measurement of transmission parameters;

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

Test procedure:

Below 960 MHz, the test procedures set out in CISPR 22 [2], paragraphs 6, 7, 8, 9 and 11 shall be used.

Above 960 MHz, the full system shall be tested according to the test procedure given 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.

Where possible, up to four MES 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 sub-band(s) used by the MES declared by the manufacturer, to be intended for operational use of the MES. The upper and lower extremes of the tuning range stated by the manufacturer shall be entered in the test report.

6.2 Maximum unwanted emission within the 1 631,5 to 1 634,5 MHz and 1 656,5 to 1 660,5 MHz bands

Purpose:

Protection of satellite and terrestrial services operating in the above frequency bands.

Specification:

The unwanted emission EIRP in any 3 kHz band within the 1 631,5 to 1 634,5 MHz and 1 656,5 to 1 660,5 MHz bands in which the MES is designed to transmit, but outside the nominated bandwidth, shall not exceed the following limits:

- when the carrier is off: 57 dBpW;

- when the carrier is on: the limits of table 3.

Table 3

Offset from the edge of the band of the nominated bandwidth (kHz)	Maximum EIRP (dBpW)
0 to 10	125
10 to 20	110
20 to 100	105
100 to 200	95
200 to 700	88 (note 1)
greater than 700	78 (note 1)
NOTE: Future considerations may be given to reducing this figure by up to 3 dB.	

The limits of table 3 do not apply to spectrum lines, but the total EIRP of the unwanted emissions, including spectrum lines, shall not exceed 128 dBpW.

Verification:

Conformance shall be determined by direct measurement.

The conditions (environment, power, special test equipment (STE) etc.) set out in the verification section of subclause 6.1 shall apply.

Test procedure:

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

a) the full system shall be tested according to the test procedure presented in annex C; or

b) 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 C. The

antenna on-axis 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.

6.3 Maximum EIRP emission density in the nominated bandwidth

Purpose:

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

Specification:

The EIRP density in any 3 kHz band radiated from the MES, in any direction ϕ degrees from the antenna main beam axis, shall not exceed the following limits within ± 5° of the geostationary orbit:

148 dBpW	for $\phi < 40°$;
177 - 25 log ϕ dBpW	for $40° < \phi < 75°$;
130 dBpW	for $\phi > 75°$;

where:

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

These limits apply over the European land mass, and for the geostationary orbital arc declared by the manufacturer.

Verification:

Conformance shall be calculated from:

- measurement of maximum RF power entering the antenna feed;
- measurement of transmit antenna gain pattern.

The conditions (environment, power, special test equipment (STE) etc.) set out in the verification section of subclause 6.1 shall apply.

Test procedure:

The test procedure for the measurement of the RF power shall be in accordance with that specified in annex D.

The antenna gain pattern in dB relative to an isotropic antenna shall be measured in a cut at an angle, relative to the horizontal, corresponding to the worst operational case (in terms of off-axis EIRP) with regard to the relative position between the geostationary arc and the antenna beam. The angle of this cut shall be indicated by the manufacturer.

The gain pattern shall be measured in accordance with IEC 510-2-1 [3], subclause 8.2.2 for three frequencies:

- one frequency close to each of the ends of the transmit frequency band which could be used by the MES; and
- one frequency in the centre of this band. The gain profile to be used in the test procedure shall be the maximum envelope of the three profiles measured.

A knowledge of the measured RF power entering the antenna feed and the measured antenna gain profile will allow the off-axis EIRP profile to be determined. This shall be compared to the limits set in the specification of this subclause and if equal to or lower than these limits for all off axis angles, the MES shall be in conformance with this subclause.

6.4 Electro-Magnetic (EM) immunity

Purpose:

To limit interference to other radiocommunications services and to protect the MES when the MES is subjected to interfering EM fields up to 2 GHz caused by other equipment. Beyond 2 GHz a recommendation is given in clause 10.

Specification:

The MES shall have an adequate level of intrinsic immunity to enable it to operate with the CMFs specified in clause 7 when it is exposed to the following electrical field strengths (except that it is not expected that the MES continues successfully to receive the control messages addressed to it when in the presence of blocking EM fields):

- 1 V/m in the frequency range 150 kHz to 50 MHz;

- 3 V/m in the frequency range 50 MHz to 2 GHz.

Verification:

Conformance shall be determined by a measurement method based on IEC 801-3 [5], clauses 6 to 9, but taking into account the frequency ranges defined above. The Equipment Under Test (EUT) shall be as in annex B, clause B.3. For the test set-up see annex B, clause B.5.

The MES shall be considered to satisfy this specification if the following conditions are met when the disturbing EM field is applied:

a) the CMFs shall continue to function normally;

b) when the MES is in the carrier-off state there shall be no change in the signal level;

c) when the MES is in the carrier-on state there shall be no change in the signal level or frequency.

Test procedure:

Conformance shall be determined according to the test procedure set out in IEC 801-3 [5]. The manufacturer shall provide the test house with a method for determining the correct functioning of the CMFs.

6.5 Protection of the radio astronomy service from emissions produced by the MES operating in the band 1 660,0 to 1 660,5 MHz

Purpose:

Protection of the radio astronomy observations taking place in the frequency band 1 660,0 to 1 660,5 MHz.

Specification:

The MES shall provide means of suppressing transmission in the frequency band 1 660,0 to 1 660,5 MHz when needed.

Verification:

By documentary evidence and demonstration.

It shall be demonstrated that the transmitting MES can suppress transmissions in the band 1 660,0 to 1 660,5 MHz, when it has received a disable command or other indication that the radio astronomy service is required to be protected, and transmissions remain suppressed until an appropriate enable command or indication has been received.

6.6 Protection of electronic equipment from excessive EM fields produced by the MES

Purpose:

To indicate the distance from the MES below which a certain electric field strength may be experienced.

Specification:

A warning notice as described in subclause 5.3 shall also indicate the closest distance to the radiating part, with which an electric field strength may be exceeded as follows:

- 1 V/m in the frequency range 150 kHz to 50 MHz;

- 3 V/m in the frequency range 50 MHz to 2 GHz.

Verification:

As described in subclause 5.3.

7 MES Control and Monitoring Functions (CMFs)

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

There shall be a CMF at each MES, associated to separate Network Control Facilities (NCFs) as described in ETS 300 424 [4].

7.1 Monitoring functions

7.1.1 Processor monitoring

Purpose:

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

Specification:

The MES 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 1 second (s) 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 s 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.

7.1.2 Transmit frequency generation 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 MES 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 s 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 s 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 written to demonstrate this transmission shutdown.

7.2 Power on/reset

Purpose:

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

Specification:

Following POWER ON/RESET the MES shall enter a controlled, non-transmitting state.

Verification:

Compliance shall be verified by documentary evidence and demonstration.

7.3 Network control reception and authorisation

7.3.1 Network control authorisation

Purpose:

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

Specification:

a) without reception of an appropriate enable to the MES via an authorised control channel, it shall not be possible to initiate message transmission;

b) transmissions shall not continue for longer than 30 s unless further enables are received.

Verification:

By documentary evidence and demonstration.

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

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

7.3.2 Network control reception

Purpose:

These requirements ensure that the MES 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 MES shall hold, in non-volatile memory, the unique identification codes of the terminal itself.

The MES shall be enabled or disabled through its control channels.

Message transmission shall be inhibited for any failure to receive an authorised control channel (either a command or a signal) lasting 30 s or more.

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

Verification:

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

The other requirements shall be verified by documentary evidence and demonstration showing that the MES 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.

8 Initial burst transmission

Purpose:

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

Specification:

For systems which do not inhibit initial burst transmission from the MES after reset or power-on:

- the duration of an initial burst shall not exceed 1 s;

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

Verification:

By documentary evidence and demonstration.

9 Electrical safety while loading and unloading hazardous fuels or gases

Purpose:

Protection of operating personnel and the public from danger of fire and explosion.

Specification:

This specification applies, if required by the manufacturer.

The use of components that may, under normal operating conditions, produce arcs or sparks or excessive heat shall be avoided.

In the situation where such a component is part of the MES, a clear reference shall be noted in the user's documentation by the manufacturer.

The manufacturer shall state whether the equipment meets any standard relevant to the protection of operating personnel and the public from danger of fire and explosion while loading and unloading hazardous fuels or gases.

Verification:

By visual inspection of the user's documentation for the equipment provided by the manufacturer.

The standards relevant to the protection of operating personnel and the public from danger of fire and explosion while loading and unloading hazardous fuels or gases, stated as met by the manufacturer shall be recorded in the test report.

10 EM immunity between 2 GHz and 3 GHz

Purpose:

To limit interference to other radio communications services and to protect the MES when the MES is subjected to interfering EM fields between 2 GHz and 3 GHz caused by other equipment.

Specification:

This specification applies, if required by the manufacturer.

The MES shall have an adequate level of intrinsic immunity to enable it to operate with the CMFs specified in clause 7 when it is exposed to the following electric field strength (except that it is not expected that the MES continues successfully to receive the control messages addressed to it when in the presence of blocking EM fields):

- 3 V/m in the frequency range 2 GHz to 3 GHz.

Verification:

Compliance shall be demonstrated as specified in subclause 6.4.

11 Compliance with RF specifications under conditions of shock and vibration

Purpose:

To ensure that in-band unwanted emission parameters of the MES remain within specification when the MES is subjected to mechanical shock or vibration.

Specification:

This specification applies, if required by the manufacturer.

The manufacturer shall design the MES so that the in-band unwanted emission specifications set out in subclause 6.2 are met after the MES has been subjected to the mechanical shocks and vibrations set out in annex A, clause A.1, items b), c) and d).

Verification:

After the MES has been subjected to the specified mechanical shocks and vibrations, the verification procedure given in subclause 6.2 shall be applied. The tests in subclause 6.2 may be performed after mechanical shocks and vibrations, if the manufacturer requests. The test configurations given in annex A, clause A.2 paragraphs b), c) and d) shall apply.

12 Method of attachment of the Externally Mounted Equipment (EME) to a vehicle

Purpose:

To ensure that the EME is capable of being adequately attached to a vehicle for reasons of general safety.

Specification:

This specification applies, if required by the manufacturer.

The means of attaching the EME to a vehicle, recommended by the manufacturer in the MES documentation, shall be sufficiently strong such that the EME will not break away or be torn from the vehicle when subjected to the wind loading, mechanical shock and vibration conditions specified in annex A, clause A.1.

Verification:

By documentary evidence. The test conditions given in annex A, clause A.2 shall apply.

13 Network Control Facilities (NCFs) for MES networks

Relevant information is contained in ETS 300 424 [4].

Annex A (normative): Environmental and test conditions

A.1 Environmental conditions

The following requirements specify various environmental conditions to which this ETS refers:

a) wind loading: relative wind speeds up to 200 km/h;

b) vibration: random vibration, 5 to 20 Hz at 0,005 g^2/Hz;
20 to 150 Hz at - 3 dB/octave (0,5 g rms);

c) mechanical shock: half sine wave shock with a peak of 20 g and a duration of 11 ms;

d) induced acceleration: maximum tangential of linear acceleration of up to 2 g;

e) rate of turn: 10 °/s.

All requirements are applicable to IE.

Requirements a), d) and e) do not apply to PE.

Requirement a) does not apply to the IME of IE.

A.2 Test conditions

The following requirements specify various test conditions to which this ETS refers:

a) wind loading: relative wind speeds up to 200 km/h;

b) vibration: random vibration; 5 to 20 Hz at 0,005 g^2/Hz;
20 to 150 Hz at - 3 dB/octave (0,5 g rms).

Vibration is to be performed for a period of 2 hours in each of 3 mutually perpendicular axes;

c) mechanical shock: half sine wave shock with a peak of 20 g and a duration of 11 ms.
A total of 18 shocks shall be performed (6 shocks in each of 3 mutually perpendicular axes);

d) induced acceleration: maximum tangential of linear acceleration of up to 2 g;

e) rate of turn: 10 °/s.

All requirements are applicable to IE.

Requirements a), d) and e) do not apply to PE.

Requirement a) does not apply to the IME of IE.

Annex B (normative): Out-of-band unwanted emissions above 960 MHz - test procedure

B.1 Introduction

This annex describes the measurement procedure of unwanted emissions above 960 MHz generated by an MES terminal under operating conditions (as specified in subclause 6.1).

B.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 (above 960 MHz);
- the necessary post reference antenna pre-amplification and amplification devices;
- spectrum analyser(s) with sweep/store capability covering the frequency range of interest (above 960 MHz).

For the apparatus utilised, it shall be verified that:

- the response of the apparatus, including any antenna and associated amplification system, to a constant amplitude sine wave signal remain 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 16 [6], section 6.2).

B.3 Equipment Under Test (EUT)

For the purpose of the test, the MES terminal comprises, for IE:

- 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.

For PE, the MES terminal comprises:

- for a single module PE, the module itself with any deployable parts in their normal operating configuration;
- for a multiple module PE, all such modules with all necessary interconnecting cables of lengths as normally supplied by the manufacturer; again any deployable parts should be in their normal operating configuration.

B.4 Special Test Equipment (STE)

In order to measure the system radiation under operation (transmitting) conditions, proper arrangements shall be made available (by the manufacturers) to put the MES terminal in its normal operating mode (in particular in the normal transmit mode with maximum transmit burst rate and with maximum transmitter power). This may require the use of STE provided by the manufacturer (see clause 6).

B.5 Test set-up

The tests shall be carried out at ambient environmental conditions and for a nominal power supply voltage.

For IE, the EME and the IME it 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 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 and 1 m. The IME shall be set on a non-metallic table at a height between 0,5 and 1 m. Any associated equipment, e.g. portable computer or data terminal if required for operation of the MES, shall be placed next to, and at the same height as the IME.

For PE, the equipment shall be arranged in its normal operating configuration as recommended by the manufacturer on a non-metallic table at a height between 0,5 and 1 m.

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

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

B.6 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 and the measured EIRP given in the specified bandwidth. Where an unwanted emission is detected that is near to the specification limits, a measuring bandwidth not exceeding twice the nominated bandwidth shall be used.

The measuring antenna shall be placed at an appropriate distance from the EUT. Measurements shall be made around the EUT to detect unwanted emissions. A suitable test procedure follows.

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 maximise the emission value.

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

The received power density shall be measured over the frequency range of interest above 960 MHz in 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.

B.7 Alternative measurement procedure

For the case in which it is desired to measure the power of the emissions from the MES by direct coupling at the interface point between the antenna and the rest of the MES, 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 MES maximum antenna gain at the measurement frequency shall be taken into account.

For this test set-up it may also be necessary to arrange for the coupling of signals from the STE to the MES in order to put the MES into its normal mode, as described in clause C.4.

Annex C (normative): In-band unwanted emissions - test procedure

C.1 Introduction

The test consists of the measurement of in-band unwanted emissions (as specified in subclause 6.2) radiated from the EUT by means of a reference antenna whose gain is accurately known across the frequency range of interest.

C.2 Measuring apparatus

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

- a reference antenna calibrated across the frequency range of interest;
- the necessary post reference antenna pre-amplification and amplification devices;
- a spectrum analyser with sweep/store capability.

For this apparatus utilised, it shall be verified that the specifications set out in annex B, clause B.2 are met.

C.3 Equipment Under Test (EUT)

The EUT comprises those units with all necessary cables ensuring a proper functioning of the equipment as specified in annex B, clause B.3.

C.4 Special Test Equipment (STE)

In order to measure the system radiation under operational (transmitting) conditions, proper arrangement shall be provided (by the manufacturers) to put the MES terminal in its normal operating mode (in particular in the normal transmit mode with maximum transmit burst rate). This may require the use of STE provided by the manufacturer (see clause 6).

C.5 Test set-up

The tests shall be carried out at ambient environmental conditions and for a nominal power supply voltage.

For IE, the EME and the 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 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 and 1 m. The IME shall be set on a non-metallic table at a height between 0,5 and 1 m.

For PE, the equipment shall be arranged in its normal operating configuration as recommended by the manufacturer on a non-metallic table at a height between 0,5 and 1 m.

The measuring antenna shall be installed in the horizontal plane of the radiating part of the MES. Each antenna shall be positioned to be outside the nearfield of the other antenna.

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

C.6 Measuring procedure

The EUT shall be switched on and the STE (if used) activated. The measuring antenna shall be placed at the specified distance from the EUT. Measurements shall be made in the horizontal plane around the EUT to detect unwanted emissions within the specified bands in order to obtain the position where the power spectral density is maximum. The height of the measuring antenna shall be varied between 1 m and 4 m and the EUT shall be rotated through 360° to maximise the emissions (vertical and horizontal) to ensure that the values obtained are maximised. The precise knowledge of the distance between the two antennas, the reference antenna gain and the determination of the amplification/attenuation characteristics of the post reference antenna network allow the determination of the unwanted EIRP density radiated by the EUT.

C.7 Alternative measuring procedure

For the case in which it is desired to measure the power of the emissions from the MES by direct coupling at the interface point between the antenna and the rest of the MES, 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 MES maximum antenna gain at the measurement frequency shall be taken into account.

For this test set-up it may also be necessary to arrange for the coupling of signals from the STE to the MES in order to put the MES into its normal transmit mode, as described in clause C.4.

Annex D (normative): EIRP density - test procedure

D.1 Introduction

This annex describes a test procedure for determining the EIRP density (specified in subclause 6.3) radiated by MES terminals. The EIRP density considered is the component of the main radiated carrier which is emitted in any direction.

D.2 Measuring apparatus

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

- spectrum analyser covering the necessary frequency range;

- means of connecting the test equipment directly to the antenna feed in order to measure the signals input to the antenna.

For the apparatus utilised, it shall be verified that the specifications set out in annex B, clause B.2 are met.

D.3 Equipment Under Test (EUT)

The EUT comprises those units with all necessary cables ensuring a proper functioning of the equipment as specified in annex B, subclause B.1.3, but without the antenna.

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

D.4 Special Test Equipment (STE)

In order to measure the system radiation under worst case transmitting conditions (in terms of unwanted emissions), proper arrangement shall be provided (by the manufacturers) to put the MES terminal in its transmit mode, in particular with maximum transmit duty cycle. This may require the use of STE provided by the manufacturer (see subclause 6.1).

D.5 Test set-up

The necessary connections shall be made with the STE, the power supply and the measuring apparatus.

D.6 Measuring procedure

First the antenna transmit gain pattern shall be determined according to subclause 6.3 of this ETS.

The measuring apparatus shall be connected to the EUT at the antenna connecting point. The STE (if used) shall be enabled in order to put the MES into a transmitting state. The transmitted spectrum shall be displayed on the spectrum analyser and the maximum power spectral density per 3 kHz shall be determined.

A combination of the known transmit antenna gain pattern and the measured power spectral density fed to the antenna will enable the EIRP to be determined for all off-axis angles. This EIRP should be compared with the specification of subclause 6.3 to determine compliance.

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