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Satellite Earth Stations and Systems (SES); Land Mobile Earth Stations (LMESs) operating in the 11/12/14 GHz bands providing Low Bit Rate Data Communications (LBRDCs)

ETSI

European Telecommunications Standards Institute

ETSI Secretariat

Postal address: F-06921 Sophia Antipolis CEDEX - FRANCE
Office address: 650 Route des Lucioles - Sophia Antipolis - Valbonne - FRANCE
X.400: c=fr, a=atlas, p=etsi, s=secretariat - **Internet:** secretariat@etsi.fr

Tel.: +33 92 94 42 00 - Fax: +33 93 65 47 16

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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).

Every ETS prepared by ETSI is a voluntary standard. This ETS contains text concerning type approval of the equipment to which it relates. This text does not make this ETS mandatory in its status as a standard. However, this ETS can be referenced, wholly or in part, for mandatory application by decisions of regulatory bodies.

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1 Scope

This European Telecommunication Standard (ETS) provides specifications for the standardisation of the characteristics of Land Mobile Earth Stations (LMESs) with both transmit and receive capabilities in order to ensure general safety and to limit interference to radio communications services.

The LMESs operate as a part of a geostationary satellite network providing Low Bit Rate Data Communications (LBRDC) for land mobile applications.

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

LMESs transmit	14,00 - 14,25 GHz
LMESs receive	10,70 - 11,70 GHz 12,50 - 12,75 GHz

These LMESs generally have the following characteristics:

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

- the LMESs could consist of a number of modules including a keyboard interface to the user;

- the LMESs operate in a 3° satellite spacing environment with linear polarisation;

- the antenna of the LMES may be omnidirectional or directional with a means of tracking the satellite.

Because the transmissions from the LMES to the satellite in the 14,00 - 14,25 GHz band fall under a secondary allocation, the transmissions should not cause harmful interference to primary services (e.g. Fixed Satellite Service (FSS)) and at the same time cannot claim protection from harmful interferences from those services.

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;

- LMES control and monitoring: to specify a minimum set of Control and Monitoring Functions (CMF) that shall be implemented on each LMES 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:

a) Essential normative requirements (indicated in Clause 4)

Requirements are specified in order to protect other users of the frequency spectrum from unacceptable interference. In addition, requirements are specified for the purposes of general safety.

b) Recommendations (indicated in Clause 5)

Recommendations are specified relating to matters of general safety, minimisation of interference to other users of the radio spectrum and for the provision of protection of the LMES against electromagnetic interference from other systems.

All tests related to the requirements shall be performed and the results entered in the data sheets of the test report. The ability to comply with the recommendations shall also be noted in the data sheets of the test report. All parameters and operational conditions declared by the manufacturer shall be entered in the test report.

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 Publication No. 22 (1985): "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 300 282: "Satellite Earth Stations and Systems (SES); Network Control Facilities (NCFs) for Land Mobile Earth Stations (LMESs) operating in the 1,5/1,6 GHz and 11/12/14 GHz bands providing Low Bit Rate Data Communications (LBRDCs)".

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

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

3 Definitions and abbreviations

3.1 Definitions

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

Installable Equipment (IE), Internally Mounted Equipment (IME) and Externally Mounted Equipment (EME): an Installable Equipment (IE) is an equipment which is intended to be installed in a vehicle. An IE may consist of one or several interconnected modules. The manufacturer should indicate which modules are intended to be Externally Mounted Equipment (EME); the remaining module(s) will then be defined as Internally Mounted Equipment (IME). Where different specifications apply to IME and EME, this is noted in the text of this ETS.

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

Nominated bandwidth: the bandwidth of the LMES radio frequency transmission is nominated by the manufacturer. The nominated bandwidth should encompass all close-in spectral elements of the transmission which have a level greater than the specified spurious levels. The nominated bandwidth should be wide enough to take account of the transmit carrier frequency stability. The nominated bandwidth should be within the Ka transmit frequency band within which the LMES operates. The value of the nominated bandwidth should be entered on the data sheet of the test report.

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

Directional antenna: a directional antenna is defined as one with a transmit gain of 10 dBi or greater.

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
LBRDC	Low Bit Rate Data Communication
LMSS	Land Mobile Satellite Service
LMES	Land Mobile Earth Station
NCF	Network Control Facility
PE	Portable Equipment
RF	Radio Frequency
rms	root mean square
STE	Special Test Equipment

4 Requirements

4.1 Safety

4.1.1 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.

4.1.2 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 determined by documentary evidence and visual inspection.

4.1.3 Radio frequency radiation protection

Purpose:

To indicate the distance from the LMES below which RF power densities in excess of 10 W/m^2, when averaged over a 6 minute period, may be experienced.

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 10 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 LMES equipment shall be switched off or otherwise disabled so that it shall not transmit.

Where the equipment is vehicle mounted, a warning notice giving 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 Internally Mounted Equipment (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 notices 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 when no RF power density greater than 10 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 LMES 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 10 W/m^2, when under worst case conditions (e.g. maximum power, maximum on/off ratio) averaged over a 6 minute period, shall be 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 for affixing to vehicles, and the instructions provided relating to the affixing of these notices.

4.2 Radio Frequency (RF)

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

4.2.1 Unwanted emissions outside the band 14,00 - 14,25 GHz

Purpose:

Protection of terrestrial and satellite services from emissions caused by LMESs outside the band 14,00 - 14,25 GHz.

Specification:

The unwanted emissions from the LMES outside the band 14,00 GHz to 14,25 GHz, within which the LMES is designed to operate, shall be below the following limits:

- for unwanted emissions below 960 MHz, the LMES shall meet the requirements of CISPR Publication No. 22 [2] for class B equipment, with carrier on as given in table 1.

Table 1

Limits of radiated emission at a test distance of 10 m in a 120 kHz bandwidth	
Frequency (MHz)	**Quasi-peak Limits (dBµV/m)**
30 to 230	30
230 to 960	37

- the unwanted emissions EIRP above 960 MHz, in the measurement bandwidth and in all directions shall not exceed the limits given 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 - 1 525	49	100	48	100
1 525 - 1 559	49	100	17	3
1 559 - 3 400	49	100	48	100
3 400 - 10 700	55	100	48	100
10 700 - 21 200	61	100	54	100
21 200 - 40 000	67	100	50	100

Verification:

By measurement of unwanted emissions generated by an operating LMES.

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), made available 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 LMES 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 LMES to transmit allowing measurement of transmission parameters;

- any characteristic of these special test arrangements which may have direct or indirect effects on the parameters to be measured shall be clearly stated by the manufacturer.

Test procedure:

Below 960 MHz, the test procedures set out in CISPR Publication No. 22 [2], paragraphs 5, 6, 7, 8 and 10 shall be used.

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

Where it is possible, two LMES transmit frequencies shall be used for this test; these shall be selected to be as close as possible to the upper and lower limits of the transmit frequency band of the LMES, declared by the manufacturer to be intended for operational use of the LMES. The upper and lower extremes of the tuning range stated by the manufacturer shall be entered in the test report.

4.2.2 Maximum unwanted emission within the 14,00 GHz to 14,25 GHz band

Purpose:

Protection of the primary services operating in the above frequency band.

Specification:

When the carrier is on, in the 14,00 - 14,25 GHz band and outside the nominated bandwidth**,** the EIRP spectral density of the unwanted emissions shall not exceed 4 - 10 log N dBW/100 kHz.

N is the maximum number of LMESs which are expected to transmit simultaneously on the same frequency. This number shall not be exceeded for more than 0,01 % of the time. The value of N and the operational conditions of the system shall be declared by the manufacturer.

When the carrier is off, the EIRP spectral density of the unwanted emissions in the 14,00 GHz to 14,25 GHz band shall not exceed - 21 dBW/100 kHz.

Verification:

Conformance shall be determined by direct measurement.

The conditions (environment, power, STE etc.) set out in the verification section of subclause 4.2.1 shall apply.

Test procedure:

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 C;

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 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.

4.2.3 Off-axis EIRP emissions density in the nominated bandwidth

Purpose:

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

Specification:

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

33 - 25 log (ϕ + $\delta\phi$) - 10	log (K) dBW/ 40kHz	for	2,5°	$\leq \phi + \delta\phi \leq$	7,0°;
12 - 10	log (K) dBW/ 40kHz	for	7,0°	$< \phi + \delta\phi \leq$	9,2°;
36 - 25 log (ϕ + $\delta\phi$) - 10	log (K) dBW/ 40kHz	for	9,2°	$< \phi + \delta\phi \leq$	48,0°;
- 6 - 10	log (K) dBW/ 40kHz	for		$\phi + \delta\phi >$	48,0°;

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.

K is the power density ratio between the fully loaded system and a single LMES measured in a 40 kHz bandwidth.

The value of K and the operational conditions of the system shall be declared by the manufacturer.

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

For non-directional antennas, the maximum EIRP per 40 kHz in any direction shall not exceed:

$$-6 - 10 \log (K) \text{ dBW/40 kHz};$$

where K is as defined above.

Verification:

Conformance shall be calculated from:

- measurement of maximum RF power entering the antenna feed;
- measurement of transmit antenna gain pattern;
- measurement of the static RMS antenna pointing accuracy and a consideration of the RMS antenna tracking accuracy provided by the manufacturer.

The conditions (environment, power, STE etc.) set out in the verification section of subclause 4.2.1 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 plane 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 manufacturer shall demonstrate by documentary evidence 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 gain pattern shall be measured in accordance with IEC 510-2-1 [3], section 8.2.2 for three frequencies; one frequency close to each end of the transmit frequency band which could be used by the LMES, 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.

The static rms antenna pointing accuracy shall be determined according to the test procedure set out in Annex E.

For an IE, the manufacturer shall provide documentary evidence of the RMS antenna tracking accuracy within which at least 99 % of LMESs maintain their pointing during normal vehicle manoeuvres corresponding to the constraints described in Annex A, items a), b) and e).

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 LMES shall be in conformance with this subclause.

4.2.4 Electromagnetic immunity

Purpose:

To limit interference to radio communications services and to protect the LMES when the LMES is subjected to interfering electromagnetic fields up to 2 GHz caused by other equipment. Beyond 2 GHz, a recommendation is given in subclause 5.2 of this ETS.

Specification:

The LMES shall have an adequate level of intrinsic immunity to enable it to operate with the control and monitoring functions specified in subclause 4.3 of this ETS when it is exposed to the following electrical field strengths:

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

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

NOTE: It is not expected that the LMES continues successfully to receive the control messages addressed to it when in the presence of blocking Electro-Magnetic (EM) fields.

Verification:

Conformance shall be determined by a measurement method based on IEC 801-3 [5], Clauses 6 to 9, but taking into account the EMC frequency ranges defined above. The Equipment Under Test (EUT) shall be as in Annex B, Clause B.3. For the test set-up see also Annex B, Clause B.5, paragraphs 1, 2 and 3.

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

a) the control and monitoring functions continue to function normally;

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

c) when the LMES is in the carrier-on state there shall be no change in the signal level and 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 control and monitoring functions.

4.3 LMES Control and Monitoring Functions (CMF)

This subclause defines a minimum set of Control and Monitoring Functions (CMF) which shall be implemented on LMESs 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 LMES and separate Network Control Facilities (NCF) details of which may be found in ETS 300 282 [4].

4.3.1 Monitoring functions

4.3.1.1 Processor monitoring

Purpose:

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

Specification:

An LMES shall incorporate a processor monitoring function for each of its processors involved in the manipulation of traffic and in 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 transmission 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.

4.3.1.2 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:

An LMES 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.

4.3.2 Power on/reset

Purpose:

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

Specification:

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

Verification:

Compliance shall be verified by documentary evidence and demonstration.

4.3.3 Network control reception and authorisation

4.3.3.1 Network control authorisation

Purpose:

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

Specification:

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

b) transmission shall not continue for longer than 30 seconds unless further enables are received.

Verification:

By documentary evidence and demonstration.

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

It shall be demonstrated that after power on/reset of the LMES, it is not possible to initiate message transmission until an appropriate enable signal is received by the LMES.

4.3.3.2 Network control reception

Purpose:

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

The LMES shall be enabled or disabled through control channels.

Failure to receive an authorised control channel (either a command or a signal) for a period longer than 30 seconds shall inhibit message transmission.

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

Verification:

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

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

4.4 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 LMES after reset or power on:

- the transmission of the initial burst shall not exceed 1% of the time;
- each burst shall not last more than one second.

Verification:

By documentary evidence and demonstration.

5 Recommendations

5.1 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:

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

In the situation where such a component is part of the LMES, a clear reference should be noted in the users' 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 users' 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.

5.2 Electromagnetic immunity - General immunity between 2 GHz and 3 GHz

Purpose:

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

Specification:

The LMES shall have an adequate level of intrinsic immunity to enable it to operate with the CMF specified in subclause 4.3 of this ETS when it is exposed to the following electrical field strengths:

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

NOTE: It is not expected that the LMES continues successfully to receive the control messages addressed to it when in the presence of blocking EM fields.

Verification:

Compliance shall be demonstrated as specified in subclause 4.2.3.

5.3 Compliance with RF specifications under conditions of shock and vibration

Purpose:

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

Specification:

The manufacturer should design the LMES so that the in-band unwanted emission specifications set out in subclause 4.2.2 are met after the LMES has been subjected to the mechanical shocks and vibrations set out in Annex A, subclause A.1, items b), c) and d).

Verification:

After the LMES has been subjected to the specified mechanical shocks and vibrations, the verification procedure given in subclause 4.2.2 shall be applied. The tests in subclause 4.2.2 may be performed after mechanical shocks and vibrations, if the manufacturer requests. The test conditions given in Annex A, Clause A.2 paragraphs b), c) and d) shall apply.

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

Purpose:

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

Specification:

The method of attaching the EME to the vehicle, recommended by the manufacturer in the LMES documentation, shall be sufficiently strong such that the EME will not break away or be torn from the vehicle when subject to the wind loading, mechanical shock and vibration conditions specified in Annex A, Clause A.1.

Verification:

The test conditions given in Annex A, Clause A.2 shall apply.

6 Network Control Facilities (NCFs) for LMES networks

Relevant information is contained in ETS 300 282 [4].

Annex A (normative): Environmental and test conditions

A.1 Environmental conditions

The following requirements specify various environmental conditions to which certain of the requirements and recommendations of this ETS refer:

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

b) vibration: random vibration: 5 to 20 Hz at 0,005 g^2/Hz;
20 to 150 Hz at - 3 dB/oct (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 or 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 certain of the requirements and recommendations of this ETS refer:

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

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

vibration shall be performed for a period of 2 hours in each of 3mutually 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 or 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 from 960 MHz to 40 GHz generated by an LMES terminal under operating conditions (as specified in subclause 4.2.1).

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 (960 MHz to 40 GHz);

- the necessary post reference antenna pre-amplification and amplification devices;

- spectrum analyser(s) with sweep/store capability covering the frequency range of interest (960 MHz to 40 GHz).

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 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 [6], section 6.2);

B.3 Equipment Under Test (EUT)

For purpose of the test, the LMES 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 LMES 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 operational (transmitting) conditions, proper arrangement shall be made available (by the manufacturer) to put the LMES 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 subclause 4.2).

B.5 Test set-up

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

For IE, 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 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 LMES, 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 LMES. 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.

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 a spurious emission is detected that is near to the specification limits a measuring bandwidth not exceeding (e.g. twice) the nominated bandwidth shall be used.

The measuring antenna shall be placed at a fixed height and 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 1m and 4m. 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 entire frequency range from 960 MHz to 40 GHz 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 measuring procedure

For the case in which it is desired to measure the power of the emissions from the LMES by direct coupling at the interface point between the antenna and the rest of the LMES, 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 LMES 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 LMES in order to put the LMES into its normal transmit mode, as described in Clause C.4.

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

C.1 Introduction

The test procedure consists of the measurement of in-band unwanted emissions (as specified in subclause 4.2.2) 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 the apparatus utilised, it shall be verified that the specifications set out in Annex B, Clause B.2 of this ETS 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 of this ETS.

C.4 Special Test Equipment (STE)

In order to measure the system radiation under operational (transmitting) conditions, proper arrangement shall be made available (by the manufacturer) to put the LMES 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 subclause 4.2).

C.5 Test set-up

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

For IE, EME and IME shall be installed with a separation of about 0,5 m. Between the two equipment, 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.

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.

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 emission 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 1m and 4m and the EUT shall be rotated through 360° to maximise the emissions. Measurements shall be carried out with the measuring antenna in both planes of polarisation (vertical and horizontal) to ensure that the values obtained are maximised. The precise knowledge of distance between the two antennas, 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.

C.7 Alternative measuring procedure

For the case in which it is desired to measure the power of the emissions from the LMES by direct coupling at the interface point between the antenna and the rest of the LMES, 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 LMES 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 LMES in order to put the LMES into its normal transmit mode, as described in Clause C.4.

Annex D (normative): Off-axis EIRP density, test procedure

D.1 Introduction

This Annex describes a test procedure for determining the off-axis EIRP density (specified in subclause 4.2.3) radiated by LMES terminals. The EIRP density considered is the component of the main radiated carrier which is emitted via the sidelobes of the antenna.

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 of this ETS 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, Clause B.3 to this ETS, 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 LMES.

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 made available (by the manufacturer) to put the LMES 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 4.2).

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 4.2.3 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 LMES into a transmitting state. The transmitted spectrum shall be displayed on the spectrum analyser and the power spectral density in the worst 40 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 4.2.3 of this ETS to determine compliance.

Annex E (normative): Static rms antenna pointing accuracy

E.1 Introduction

This Annex describes a test procedure for determining the static rms antenna pointing accuracy of an LMES terminal (required as part of the test procedure for off-axis EIRP emission density, in subclause 4.2.3).

E.2 Measuring apparatus

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

- STE providing the means of simulating the satellite illumination of the LMES for tracking purposes;

- an adjustable noise source compatible with the Intermediate Frequency (IF);

- a calibrated RF attenuator.

For the apparatus utilised, it shall be verified that the specifications set out in Annex B, Clause B.2 of this ETS are met.

E.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 of this ETS.

E.4 Special Test Equipment (STE)

In order to measure the system pointing accuracy under realistic operational conditions, proper arrangements shall be provided, by the manufacturers, to put the LMES terminal in its normal tracking mode by simulating the satellite illumination. This shall require the use of STE provided by the manufacturer (see subclause 4.2).

E.5 Test set-up

The EUT will be installed such that the radiating part of the STE providing the simulated satellite illumination is in the far field of the LMES antenna. It shall be verified that both the absolute power density received by the EUT and the signal to noise ratio are representative of those expected for 95 % of the LMES within the network (typically 2 dB above the Edge of Coverage figure); if necessary, the noise and/or the RF carrier levels shall be adjusted to ensure that this condition is met. The manufacturer shall provide the test house with the power density and signal to noise ratios to be used in setting up the test equipment and shall also provide documentary evidence of the agreement of the satellite system provider to these figures.

E.6 Measuring procedures

Because the exact details of the measurement of rms tracking accuracy is specific to the particular LMES equipment being used, it is not possible to propose a detailed test procedure. Instead, the manufacturer shall provide the test house with an agreed test procedure written to measure the static rms antenna pointing accuracy with the test set-up specified.

As a minimum, the test proposed by the manufacturer shall contain the following elements:

- the test shall start with the LMES equipment switched off and the STE switched on; the LMES antenna shall at this stage be rotated from the nominal pointing direction by at least 90°;

- the LMES equipment shall be switched on and then left to acquire the nominal static pointing direction from cold start. The manufacturer shall state how it shall be determined that the LMES has achieved nominal static pointing alignment. The static pointing accuracy shall now be measured according to an agreed method to be proposed by the manufacturer. In the event that the LMES

pointing continues to vary to some degree once nominal static pointing has been achieved, the rms value of this pointing angle shall be taken;

- this test shall be repeated until 5 measurements of rms static pointing accuracy have been made;

- the STE shall then be switched off for a period of 1 second and at the same time the LMES antenna shall be rotated by at least 90°;

- the STE shall be switched back on and the LMES left to acquire the nominal static pointing alignment. The static pointing accuracy shall again be measured by the agreed method proposed by the manufacturer. Again, in the event that the LMES pointing continues to vary to some degree once nominal static pointing has been achieved, the rms value of this pointing angle shall be taken;

- this test shall be repeated until 5 further measurements of rms static pointing accuracy have been made;

- the value of rms static pointing accuracy to be used in subclause 4.2.3 shall be taken to be the largest value of the 10 measurements made.

History

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