TECHNICAL BASIS for REGULATION

DRAFT
pr **TBR 027**
August 1996

Source: ETSI TC-SES

Reference: DTBR/SES-00005

ICS: 33.060.50

Key words: earth station, LMES, MES, mobile, radio, satellite, type approval

Satellite Earth Stations and Systems (SES); Low data rate Land Mobile satellite Earth Stations (LMES) operating in the 11/12/14 GHz frequency bands

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Foreword

This draft Technical Basis for Regulation (TBR) has been produced by the Satellite Earth Stations and Systems (SES) Technical Committee of the European Telecommunications Standards Institute (ETSI), and is now submitted for Public Enquiry.

Introduction

The Council Directive in respect of satellite earth station equipment (93/97/EEC) [1] which supplements the Council Directive on the approximation of the laws of the Member States concerning telecommunications terminal equipment, including the mutual recognition of their conformity (91/263/EEC) [2] concerns the harmonisation of conditions for the placing on the market of such equipment.

Two classes of standards are applicable to satellite earth station equipment. European Telecommunication Standards (ETSs) give the full technical specifications for this equipment, whereas Technical Bases for Regulation (TBRs) give the essential requirements under the Satellite Earth Station Directive (93/97/EEC) [1] and the Telecommunications Terminal Equipment Directive (91/263/EEC) [2] for placing such equipment on the market. Receive-only equipment, not intended for terrestrial connection to the public telecommunications network, may be put into use. Nothing in this TBR is construed to prevent the use of Community internal production control procedures as set out in the Annexes to the two Directives for such receive-only equipment. This TBR is based on ETS 300 255 (see annex B, Bibliography).

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1 Scope

This TBR specifies those technical requirements under articles 4.1 to 4.5 of Council Directive 93/97/EEC [1] that apply to satellite earth station equipment that is capable of operation in one or more of the following frequency ranges:

- 10,70 to 11,70 GHz (Space - to - Earth, shared);
- 12,50 to 12,75 GHz (Space - to - Earth, exclusive);
- 14,00 to 14,25 GHz (Earth - to - Space exclusive);

of the Fixed Satellite Service (FSS).

These requirements are taken from: ETS 300 255 (see annex B, Bibliography).

This TBR does not contain the essential requirements under article 4.6 for interworking via the public telecommunications network in justified cases, and does not provide any guarantee of correct interworking between satellite earth station equipment.

This TBR specifies the requirements for satellite earth station equipment that:

- is capable of being used either for transmission only, or for transmission and reception (transmit-receive), or for reception only (receive-only), of radio-communications signals in any of the bands specified above;

- is not within the scope of other Ku-band TBRs [TVRO, VSAT, SNG];

- is not purpose built satellite earth station equipment intended for use as part of the public telecommunications network.

This TBR applies to all satellite equipment as described above, irrespective of whether the satellite earth station equipment provides additional interfaces, telecommunications services or functions. However additional TBRs may also apply.

2 Normative references

This TBR incorporates by dated or undated reference, provisions from other publications. These 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 TBR only when incorporated into it by amendment or revision. For undated references the latest edition of the publication referred to applies.

[1] Council Directive 93/97/EEC (1993) supplementing Directive 91/263/EEC in respect of satellite earth station equipment.

[2] Council Directive 91/263/EEC (1991) on the approximation of the laws of Member States concerning telecommunications terminal equipment, including the mutual recognition of their conformity.

[3] prETS 300 339 (1996): "Radio Equipment and Systems (RES); General Electro-Magnetic Compatibility (EMC) Standard for Radio-communications equipment".

[4] Council Directive 89/336/EEC of 3 May 1989 on the approximation of the laws of Member States relating to electromagnetic compatibility.

NOTE: This TBR also contains a number of informative references which have been included to indicate the sources from which various material has been derived, hence they do not have an associated normative reference number. Details of these publications are given in annex B.

3 Definitions and abbreviations

3.1 Definitions

For the purposes of this TBR the following definitions apply:

carrier-off state: A LMES is in this state when either it is authorised by the Network Control Facility (NCF) to transmit but when it does not transmit any signal, or when it is not authorised by the NCF to transmit.

carrier-on state: An LMES is in this state when it is authorised by the NCF to transmit and when it transmits a signal.

manufacturer: The legal entity responsible under the terms of the Council Directive 93/97/EEC [1], for placing the product on the market.

nominated bandwidth: The bandwidth of the LMES radio frequency transmission is nominated by the manufacturer. The nominated bandwidth is wide enough to encompass all spectral elements of the transmission which have a level greater than the specified unwanted emissions limits. The nominated bandwidth is wide enough to take account of the transmit carrier frequency stability. The nominated bandwidth is within the transmit frequency band within which the LMES operates.

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

3.2 Abbreviations

EIRP	Equivalent Isotropically Radiated Power
EMC	ElectroMagnetic Compatibility
EME	Externally Mounted Equipment
ETS	European Telecommunication Standard
EUT	Equipment Under Test
FSS	Fixed Satellite Service
IE	Installable Equipment
IME	Internally Mounted Equipment
LMES	Land Mobile Earth Station
NCF	Network Control Facility
PE	Portable Equipment
rms	root mean square
SNG	Satellite News Gathering
STE	Special Test Equipment
TBR	Technical Basis for Regulation
TVRO	TeleVision Receive Only
VSAT	Very Small Aperture Terminal

4 Requirements

4.1 Unwanted emissions outside the band

4.1.1 Justification

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

4.1.2 Specification

The unwanted emissions in the measurement bandwidth and in all directions 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:

1) The LMES shall not exceed the limits for radiated interference field strength over the frequency range from 30 MHz to 960 MHz specified in table 1.

Table 1: Limits of unwanted emissions below 960 MHz at a measuring distance of 10 m

Frequency (MHz)	Quasi-peak Limits (dBµV/m)
30 to 230	30
230 to 960	37

The lower limit shall apply at the transition frequency.

2) 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: Limits of unwanted emissions above 960 MHz and outside the band 14,00 to 14,25 GHz

Frequency range (MHz)	Carrier-on		Carrier-off	
	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	60	100

The lower limits shall apply at the transition frequencies.

4.1.3 Conformance tests

Conformance tests shall be carried out in accordance with subclause 5.1.

4.2 Unwanted emissions within the band

4.2.1 Justification

Protection of the primary services operating in the 14,00 to 14,25 GHz frequency band.

4.2.2 Specification

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

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 LMES is in the carrier-off state 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.

4.2.3 Conformance tests

Conformance tests shall be carried out in accordance with subclause 5.2.

4.3 Off-axis EIRP emissions density in the nominated bandwidth

4.3.1 Justification

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

4.3.2 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/40 kHz where	2,5°	$\leq \phi + \delta\phi \leq$ 7,0°;
+12 - 10 log (K)	dBW/40 kHz where	7,0°	$< \phi + \delta\phi \leq$ 9,2°;
36 - 25 log (ϕ + $\delta\phi$) - 10 log (K)	dBW/40 kHz where	9,2°	$< \phi + \delta\phi \leq$ 48°;
-6 - 10 log (K)	dBW/40 kHz where	48°	$< \phi + \delta\phi \leq$ 180°.

where ϕ is the angle, in degrees, between the main beam axis and the direction considered. The value of $\delta\phi$ is equal to either:

a) the rms antenna tracking accuracy; or
b) twice the static rms antenna pointing accuracy; whichever is the larger.

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, all technical characteristics and the operational conditions declared by the manufacturer shall be entered in the test report.

These limits apply over Europe, 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) dBW/40 kHz.

where K is as defined above.

4.3.3 Conformance tests

Conformance tests shall be carried out in accordance with subclause 5.3.

4.4 ElectroMagnetic Compatibility (EMC)

There are no specific EMC requirements under this TBR however ETS 300 339 [3] contains general EMC specifications. Once this ETS becomes a harmonised EMC standard, and until a product specific harmonised EMC standard is published, compliance to the general harmonised EMC standard will give presumption of compliance with the EMC Directive, Council Directive 83/336/EEC [4]. Upon publication of the product specific harmonised EMC standard compliance with that standard will give presumption of compliance with the EMC Directive, Council Directive 83/336/EEC [4].

4.5 Control and Monitoring Functions (CMF)

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

Under any fault condition when the LMES transmissions are being suppressed the EIRP density shall not exceed -21 dBW in any 100 kHz band.

4.5.1 Processor monitoring

4.5.1.1 Justification

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

4.5.1.2 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.

4.5.1.3 Conformance tests

Conformance tests shall be carried out in accordance with subclause 5.4.

4.5.2 Transmit subsystem monitoring

4.5.2.1 Justification

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

4.5.2.2 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.

4.5.2.3 Conformance tests

Conformance tests shall be carried out in accordance with subclause 5.4.

4.5.3 Power-on/Reset

4.5.3.1 Justification

To demonstrate that the LMES achieves a controlled non-transmitting state following the powering of the unit or the occurrence of a reset made by a local operator when this function is implemented.

4.5.3.2 Specification

Following "power-on" the LMES shall enter a controlled non-transmitting state.

4.5.3.3 Conformance tests

Conformance tests shall be carried out in accordance with subclause 5.4.

4.5.4 Network control authorisation

4.5.4.1 Justification

To ensure that the LMES cannot transmit unless it receives an appropriate enable signal from the NCF.

4.5.4.2 Specification

a) Without reception of an appropriate enable signal by 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 enable signals are received.

4.5.4.3 Conformance tests

Conformance tests shall be carried out in accordance with subclause 5.4.

4.5.5 Network control reception

4.5.5.1 Justification

These requirements ensure that the LMES is capable of:

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

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

4.5.5.2 Specification

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

The LMES shall be enabled or disabled through control channels.

A failure to receive an appropriate control channel (either a command or a signal) for a period longer than 30 seconds shall result in message transmissions being inhibited.

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.

4.5.5.3 Conformance tests

Conformance tests shall be carried out in accordance with subclause 5.4.

4.6 Initial burst rate transmission

4.6.1 Justification

To limit disturbance to other services.

4.6.2 Specification

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

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

4.6.3 Conformance tests

Conformance tests shall be carried out in accordance with subclause 5.4.

5 Test methods

The values of measurement uncertainty associated with each measurement parameter apply to all of the test cases described in this TBR. The measurement uncertainties shall not exceed the values shown in table 3.

Table 3: Measurement uncertainty

Measurement parameter	Uncertainty
RF frequency	± 10 kHz
RF power	± 0,75 dB
Conducted spurious	± 4 dB
Radiated spurious	± 4 dB
Antenna gain	± 2 dB

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

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

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

5.1 Unwanted emissions outside the band 14,00 to 14,25 GHz

5.1.1 General

For purpose of the test, the EUT comprises:

a) for IE:

- the EME;
- the IME;
- interconnecting cables between IME and EME units as supplied by the manufacturer;
- the necessary power supply cables and any other cable ensuring a proper functioning of the terminal.

b) for PE:

- 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.

For measurements below 960 MHz the distance between the EUT and the measuring antenna shall be 10 m. For measurements above 960 MHz the distance between the EUT or the substitution antenna and the measuring antenna shall be such that the radiating near-field of each antenna shall not overlap with that of the other. The larger radiating near-field of the EUT and substitution antenna shall be used to determine the minimum distance between the EUT and measuring antenna in the first instance.

The upper and lower extremes of the tuning range shall be stated by the manufacturer.

5.1.2 Test site

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

An open area test site shall be flat, free of overhead wires and nearby reflecting structures, sufficiently large to permit aerial placement at the specified measuring distance and provide adequate separation between aerial, test unit and reflecting structures.

A metal ground plane shall be inserted on the natural ground plane and it shall extend at least 1 m beyond the perimeter of the EUT at one end and at least 1 m beyond the measurement antenna at the other end.

5.1.3 Test method

For IE, the EUT shall be installed with a separation of about 0,5 m between the IME and the EME, 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 of 0,8 m for tests below 960 MHz and between 0,5 and 1 m for tests above 960 MHz. 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 EUT shall be terminated with matched impedances at the terrestrial ports if there is no associated equipment connected to such port.

For frequencies between 80 MHz and 960 MHz the measuring antenna shall be a balanced dipole which shall be resonant in length. For frequencies below 80 MHz it shall have a length equal to the 80 MHz resonant length and shall be tuned and matched to the feeder by a suitable transforming device. For frequencies above 960 MHz the antenna shall be a horn radiator of known gain/frequency characteristics. When used for reception the antenna and any associated amplification system shall have an amplitude/frequency response within ± 2 dB of the combined calibration curves across the measurement frequency range considered for the antenna. The antenna is mounted on a support capable of allowing the antenna to be used in either horizontal or vertical polarisation and at the specified height.

For tests below 960 MHz the receive test equipment shall be a measuring receiver. For tests above 960 MHz the receive test equipment shall be a spectrum analyser.

5.1.3.1 Receive test equipment

5.1.3.1.1 Measuring receiver

Measuring receivers shall conform to the following characteristics:

- the response to a constant amplitude sine wave signal shall remain within ± 1 dB across the frequency range of interest;

- quasi-peak detection shall be used in a - 6 dB bandwidth of 120 kHz;

- the receiver shall be operated at more than 1 dB below the compression point during tests/measurements.

5.1.3.1.2 Spectrum analyser

The spectrum analyser resolution bandwidth shall be set to the specified measuring bandwidth or as close as possible. If the resolution bandwidth is different from the specified measuring bandwidth, bandwidth correction shall be performed for noise-like wideband signals. The measuring system shall be capable of detecting signals at least 6 dB below the applicable unwanted emissions limit.

5.1.4 Procedure

5.1.4.1 Test arrangements

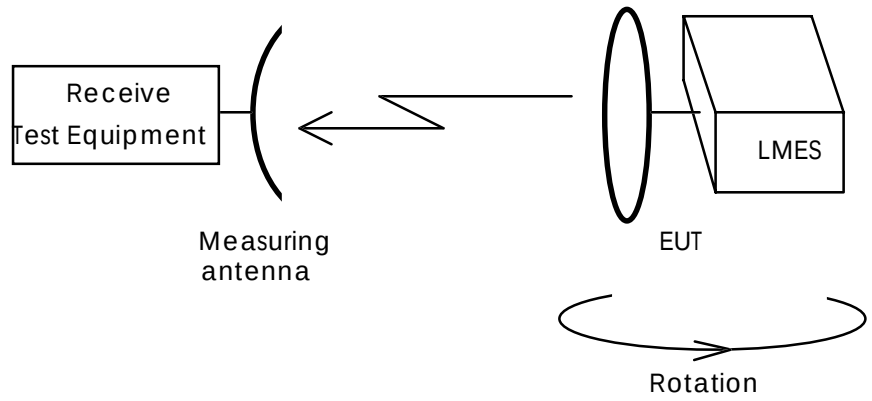

Figure 1: Test arrangement - Unwanted emissions measurement, first axis

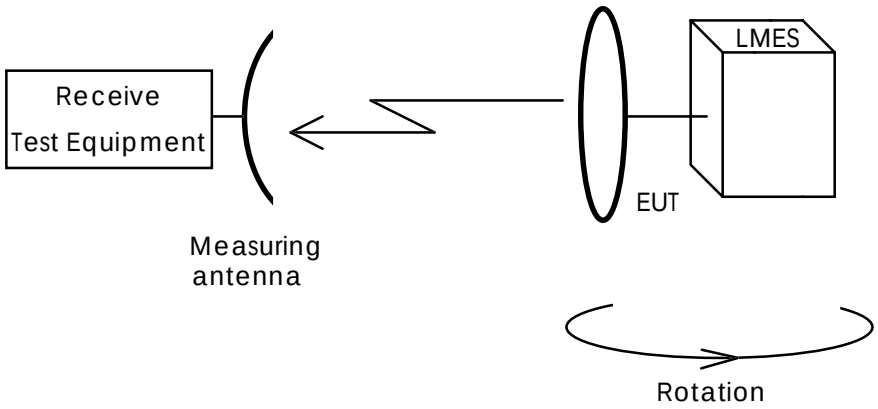

Figure 2: Test arrangement - Unwanted emissions measurement, second axis

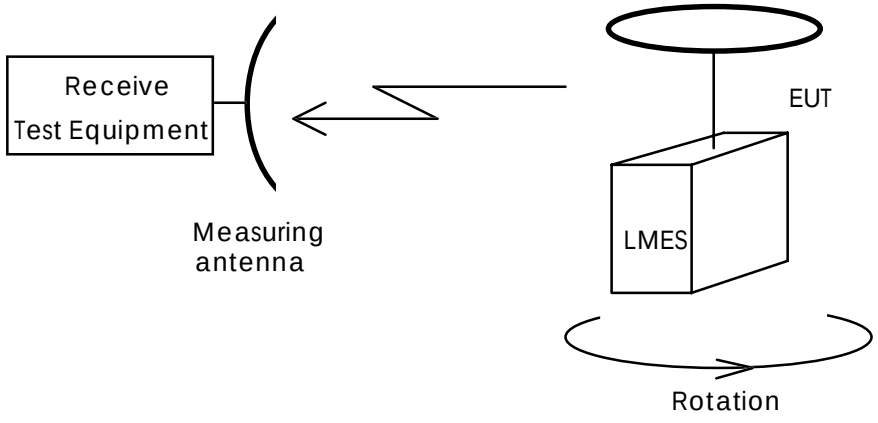

Figure 3: Test arrangement - Unwanted emissions measurement, third axis

5.1.4.2 Below 960 MHz

a) The test arrangement shall be as shown in figure 1 with the measuring receiver installed. EUTs with adjustable antennas shall have the antenna boresight axis in the plane of rotation. The measuring antenna boresight axis shall coincide with the plane of rotation of the boresite of the EUT.

b) The EUT shall be in the carrier-on state with the carrier at the lowest possible centre frequency.

c) The EUT shall be rotated through 360 degrees whilst unwanted emissions are measured in frequency and amplitude, over the frequency range 30 MHz to 960 MHz. The frequency and amplitude of each signal shall be noted.

d) The measurements shall be repeated with the measuring antenna in the opposite polarisation and the signal levels similarly noted.

e) The tests in c) and d) above shall be repeated with the EUT carrier at the highest possible centre frequency.

f) The tests in c) and d) above shall be repeated with the carrier-off.

g) The tests in b) to f) above shall be repeated with the EUT turned so that its axis of rotation is orthogonal to that of the first case, as shown in figure 2. The EUT antenna boresight axis shall remain in the plane of rotation.

h) The tests in b) to f) above shall be repeated with the EUT turned so that its axis of rotation is mutually orthogonal to those of the first two cases, as shown in figure 3. The EUT antenna boresight axis shall be perpendicular to the plane of rotation.

5.1.4.3 Above 960 MHz

Unless the manufacturer declares that the antenna is integral to the equipment and cannot be removed the tests shall be conducted without the antenna.

For an EUT complete with an antenna the test shall be performed in two stages:

procedure a): identification of the significant frequencies of the radiated unwanted emissions;
procedure b): measurement of radiated power levels of identified unwanted emissions.

For an EUT without an antenna the test shall be performed in three stages:

procedure a): identification of the significant frequencies of the radiated unwanted emissions;
procedure b): measurement of radiated power levels of identified unwanted emissions;
procedure c): measurement of conducted unwanted emissions.

5.1.4.3.1 Identification of the significant frequencies of the radiated unwanted emissions

a) The test arrangement shall be as shown in figure 1 with the spectrum analyser installed. EUTs with adjustable antennas shall have the antenna boresight axis in the plane of rotation. The measuring antenna boresight axis shall coincide with the plane of rotation of the boresite of the EUT.

b) The EUT shall be in the carrier-on state with the carrier at the lowest possible centre frequency.

c) The EUT shall be rotated through 360 degrees whilst unwanted emissions are measured in frequency and amplitude, over the frequency range 960 MHz to 40 GHz. The frequency and amplitude of each signal shall be noted.

d) The measurements shall be repeated with the measuring antenna in the opposite polarisation and the signal levels similarly noted.

e) The tests in c) and d) above shall be repeated with the EUT carrier at the highest possible centre frequency.

f) The tests in c) and d) above shall be repeated with the carrier-off.

g) The tests in b) to f) above shall be repeated with the EUT turned so that its axis of rotation is orthogonal to that of the first case, as shown in figure 2. The EUT antenna boresight axis shall remain in the plane of rotation.

h) The tests in b) to f) above shall be repeated with the EUT turned so that its axis of rotation is mutually orthogonal to those of the first two cases, as shown in figure 3. The EUT antenna boresight axis shall be perpendicular to the plane of rotation.

5.1.4.3.2 Measurement of radiated power levels of identified spurious radiation

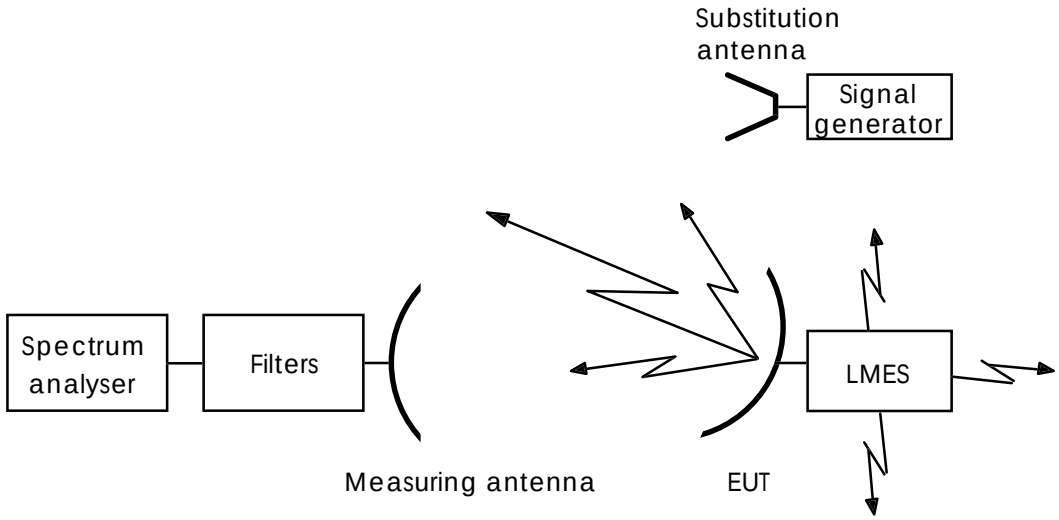

Figure 4: Test arrangement - Unwanted emissions measurement for an EUT with antenna

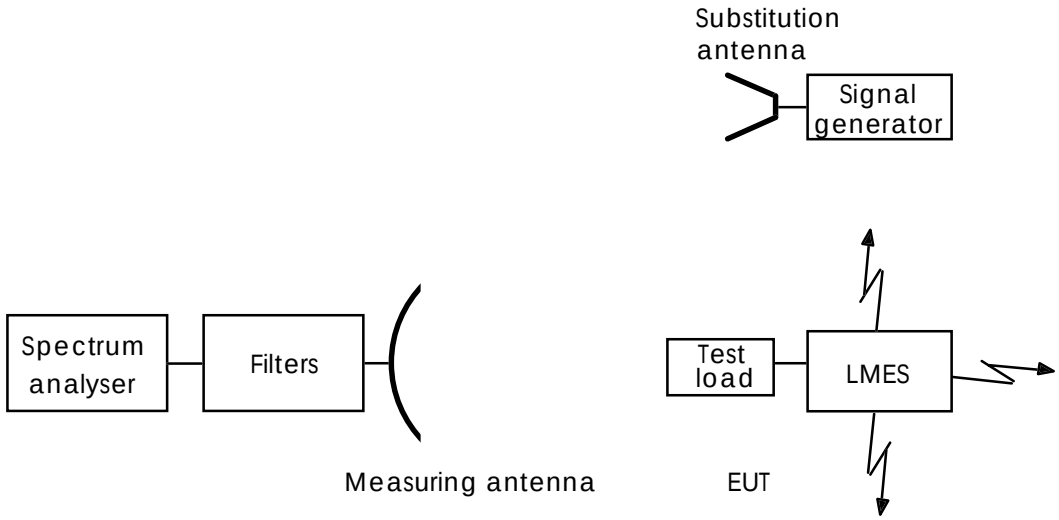

Figure 5: Test arrangement - Unwanted emissions measurement for an EUT without antenna

a) The test arrangement shall be as shown in figure 4 or figure 5.

b) The EUT shall be in the carrier-on state with the modulated carrier centre frequency as appropriate to the previously identified unwanted emission.

c) The measuring antenna shall be adjusted in height and the EUT rotated for a maximum response on the associated spectrum analyser at each unwanted emission previously identified, this response level shall be noted.

d) For the test arrangement in figure 1 the investigation shall be repeated with the measuring antenna in the opposite polarisation and the response level similarly noted.

e) The EUT shall be replaced by the substitution antenna to which is connected a signal generator. The main beam axes of the measuring and substitution antennas shall be aligned.

f) The substitution and measuring antennas shall be aligned in the polarisation which produced the larger response between the EUT and the test antenna.

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

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

5.1.4.3.3 Measurement of conducted unwanted emissions at the antenna flange

5.1.4.3.3.1 Test site

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

5.1.4.3.3.2 Procedure

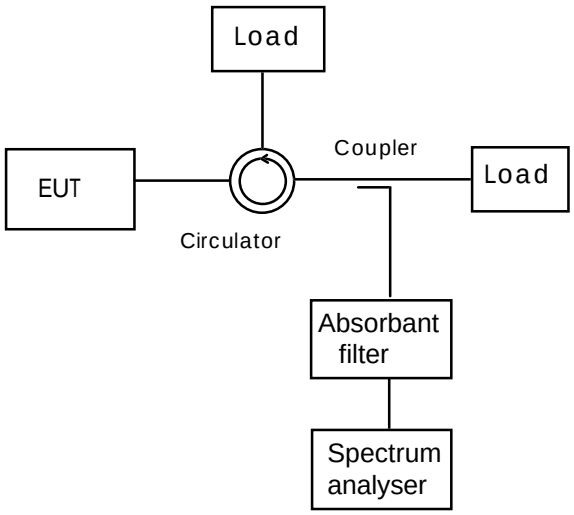

Figure 6: Test arrangement - conducted unwanted emissions

a) The test arrangement shall be as shown in figure 6 with the absorbent filter tuned to the transmit carrier frequency.

b) The frequency range 960 MHz to 40 GHz shall be investigated for unwanted emissions, excluding intermodulation products whilst in the carrier-on state with the carrier being at maximum power and normally modulated. The power density of the unwanted emissions identified shall be measured.

c) To obtain the maximum EIRP the maximum antenna gain measured at the frequency of the identified unwanted emission shall be added to the measured power density and any correction or calibration factors summated with the result. If agreed by the manufacturer, it shall be acceptable that the maximum antenna gain measured under subclause 5.3.1.2 is used in place of the maximum antenna gain at the frequency of the identified unwanted emission.

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

5.2 Unwanted emissions within the band 14,00 to 14,25 GHz

5.2.1 Test method

For purpose of the test, the EUT comprises:

a) 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.

b) for PE:

- 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.

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

5.2.1.1 General

For LMES equipment for which measurements at the antenna flange are possible and agreed by the manufacturer, the measurements shall be performed at the antenna flange.

For LMES equipment for which measurements at the antenna flange are not possible or not agreed by the manufacturer, the measurements shall be performed with a test antenna.

5.2.1.2 Method of measurement at the antenna flange

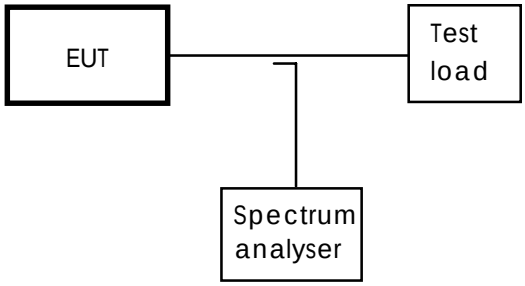

Figure 7: Test arrangement - on-axis unwanted emissions measurements at the antenna flange

a) The EUT shall be connected to a test load as shown in figure 7.

b) Whilst transmitting a modulated carrier, centred on a frequency as close to the lower limit of the operating frequency band of the EUT as possible, at maximum power the operating frequency ranges declared by the manufacturer shall be investigated.

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

d) To obtain the on-axis unwanted emission power level that would be transmitted, the antenna isotropic transmit gain shall be added to any figure obtained in the above measurement and any correction or calibration factor summated with the result.

e) The antenna gain shall be as measured in subclause 5.3.1.2.

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

g) The tests in b) to e) shall be repeated in the carrier-off state.

5.2.1.3 Method of measurement with a test antenna

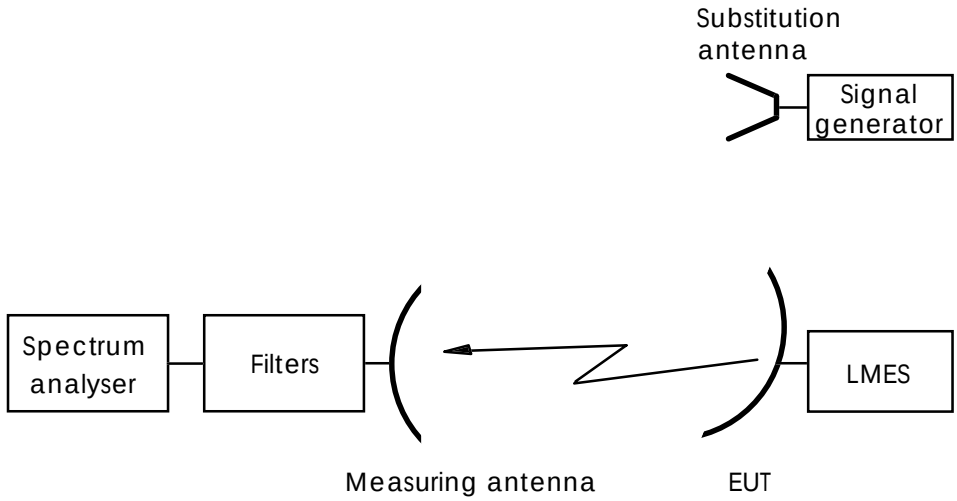

Figure 8: Test arrangement - on-axis unwanted emissions measurements with a measuring antenna

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

b) Whilst transmitting a modulated carrier at maximum power, centred on a frequency as close to the lower limit of the operating frequency band of the EUT as possible, the operating frequency ranges declared by the manufacturer shall be investigated.

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

d) The EUT shall be installed such that the various units are placed in their normal operating positions relative to each other. Any interconnection cables shall be maintained by non-metallic means at a height between 0,5 m and 1,0 m.

e) The measuring antenna shall be adjusted in height and the EUT rotated for a maximum response on the associated spectrum analyser at each unwanted emission identified, this response level shall be noted.

f) The measuring antenna shall be adjusted in height and polarisation and the EUT rotated for a maximum response on the associated spectrum analyser at each unwanted emission previously identified, this response level shall be noted.

g) The EUT shall be replaced by the substitution antenna to which is connected a signal generator. The main beam axes of the measuring and substitution antennas shall be aligned.

h) The substitution and measuring antennas shall be aligned in the polarisation which produced the larger response between the EUT and the test antenna.

j) The output of the generator shall be adjusted so that the received level is identical to that of the previously noted largest unwanted emission.

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

l) The tests in d) to k) shall be repeated in the carrier-off state.

5.3 Off-axis EIRP emissions density in the nominated bandwidth

5.3.1 Test method

Conformance shall be determined from:

a) measurement of the off-axis EIRP;
b) measurement of the static rms pointing accuracy.

To ascertain the off-axis EIRP it is necessary to know the transmit power density and antenna transmit radiation pattern. To ascertain the radiation pattern it is necessary to know the antenna transmit gain.

The following four measurement procedures shall, therefore, be performed:

a) transmitter output power density (dBW/40 kHz);
b) antenna transmit gain (dBi);
c) antenna transmit radiation patterns (dBi);
d) static rms antenna pointing accuracy (°).

5.3.1.1 Transmitter output power density

For purpose of the test, the EUT comprises all of the equipment noted up to the antenna flange:

a) 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.

b) for PE:

- 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.

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

5.3.1.1.1 Method of measurement

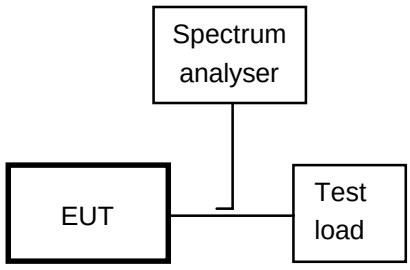

Figure 9: Test arrangement - transmit output power density measurement

a) The EUT shall be connected to a test load as shown in figure 9.

b) With the carrier being modulated by a pseudo random bit sequence, the maximum power density supplied to the antenna flange shall be measured in dBW/40 kHz. The coupling factor of the test coupler at the test frequency and the attenuation of any necessary waveguide adapter shall be

taken into account. The resolution bandwidth of the spectrum analyser shall be set as close as possible to the specified measuring bandwidth. If the resolution bandwidth is different from the specified bandwidth then bandwidth correction shall be performed.

5.3.1.2 Antenna transmit gain

5.3.1.2.1 General

For the purposes of this TBR, the antenna transmit gain is defined as the ratio, expressed in decibels, of the power that would have to be supplied to the reference antenna, i.e. an isotropic radiator isolated in space, to the power supplied to the antenna being considered, so that they produce the same field strength at the same distance in the same direction. Unless otherwise specified the gain is for the direction of maximum radiation.

For the purposes of this test the EUT is defined as that part of the LMES which comprises the antenna and its flange. The EUT includes an enclosure of equal weight/distribution to any electrical equipment normally housed within the antenna (see subclause 5.3.1.1 regarding this requirement).

5.3.1.2.2 Test site

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

5.3.1.2.3 Method of measurement

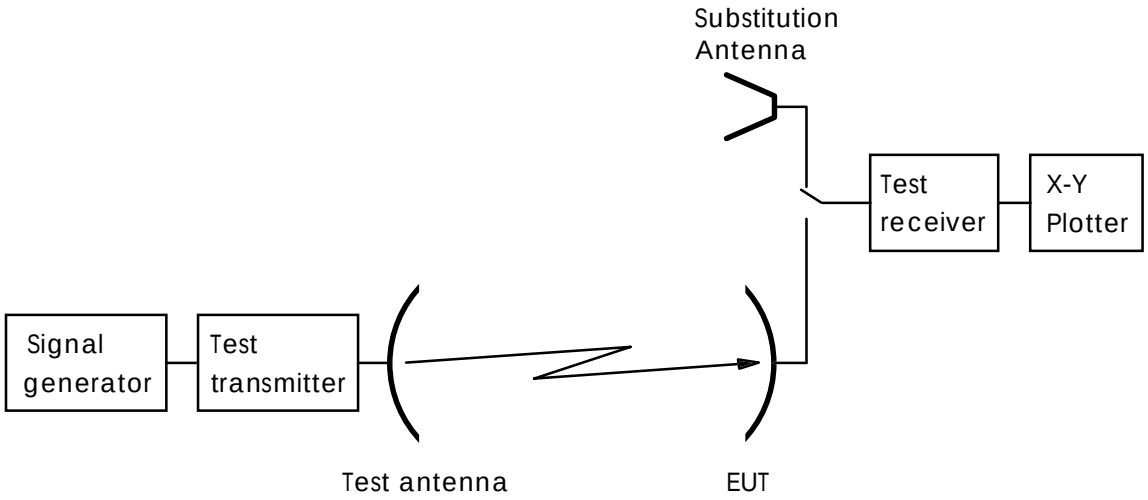

Figure 10: Test arrangement - antenna transmit gain measurement

a) The test arrangement shall be as shown in figure 10 with the EUT connected to the test receiver. A signal proportional to the angular position from the servo mechanism shall be applied to the X-axis and the signal level from the test receiver shall be applied to the Y-axis of the plotter.

b) A test signal at 5 MHz above the bottom of the lowest frequency band declared by the manufacturer shall be transmitted in the E-plane by the test transmitter through the test antenna. The E-plane shall be vertical.

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

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

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

f) The EUT shall be replaced by the substitution antenna and the received signal level maximised.

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

h) The substitution antenna shall be driven in azimuth as in d) and e).

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

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

where:

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

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

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

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

n) The tests in b) to m) shall be repeated with the test signal being transmitted in the H-plane instead of the E-plane.

p) The tests in b) to m) shall be repeated with the test signal being transmitted in a plane at + 45° to the H-plane.

q) The tests in b) to m) shall be repeated with the test signal being transmitted in a plane at - 45° to the H-plane.

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

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

5.3.1.3 Antenna transmit radiation patterns

5.3.1.3.1 General

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

For the purposes of this test the EUT is defined as that part of the LMES which comprises the antenna and its flange. The antenna includes the parabolic reflector, feed, support struts and an enclosure of equal weight/distribution to any electrical equipment normally housed with the feed at the antenna focal point (see subclause 5.3.1.1 regarding this requirement).

5.3.1.3.2 Test site

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

5.3.1.3.3 Method of measurement

Figure 11: Test arrangement - antenna transmit radiation pattern measurement

a) The test arrangement shall be as shown in figure 11 with the EUT connected to the test receiver. A signal proportional to the angular position from the servo mechanism shall be applied to the X-axis and the signal level from the test receiver shall be applied to the Y-axis of the plotter.

b) A test signal at 5 MHz above the bottom of the lowest frequency band declared by the manufacturer shall be transmitted in the E-plane by the test transmitter through the test antenna. The E-plane shall be vertical.

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

d) The EUT shall be driven in azimuth through 180°.

e) The transmit pattern measurement is then obtained by driving the EUT in azimuth through 360° with the plotter recording the results.

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

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

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

j) The tests in b) to h) shall be repeated with the test signal being transmitted in the H-plane instead of the E-plane.

k) The tests in b) to h) shall be repeated with the test signal being transmitted in a plane at + α° to the H-plane. α° is defined as the worst case angle between the horizontal plane and the geostationary orbital arc, as seen from Europe and agreed with the manufacturer.

l) The tests in b) to h) shall be repeated with the test signal being transmitted in a plane at - α° to the H-plane. α° is as defined in k).

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

5.3.1.4 Static rms antenna pointing accuracy

5.3.1.4.1 Method of measurement

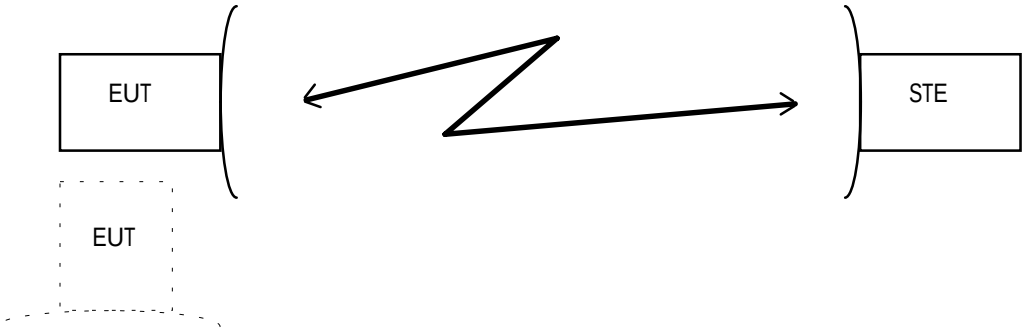

Figure 12: Test arrangement - static rms pointing accuracy

a) The equipment shall be arranged as shown in figure 12 such that the two antennas are in the far field of each other with the EUT rotated away from the STE. The STE shall be switched-on and the EUT shall be switched-off.

b) The STE shall be adjusted so that the EUT receives both power density and signal to noise ratio at a level declared by the manufacturer. These levels shall be representative of those expected for 95% of the LMES within the network and typically will be 2 dB above the Edge of Coverage figures for the network.

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

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

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

f) The static pointing accuracy shall be measured 5 times.

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

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

j) The value of rms static pointing accuracy shall be taken to be the largest value of the 10 measurement results recorded.

5.3.2 Computation of results

The results shall be computed by producing a "mask" to the specified limits with the reference level being equal to the sum of the transmitter output power density, the gain of the antenna and twice the static rms pointing accuracy. This reference shall then be placed on the maximum point of the plot obtained from the transmit radiation pattern measurement, so as to ascertain that the off-axis EIRP density is within the mask, and thus conforming to the specification.

5.4 Control and monitoring

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

For the purposes of this test the EUT is defined as the IME and that part of the EME up to the antenna flange or the PE up to the antenna flange.

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

5.4.1 Test arrangement

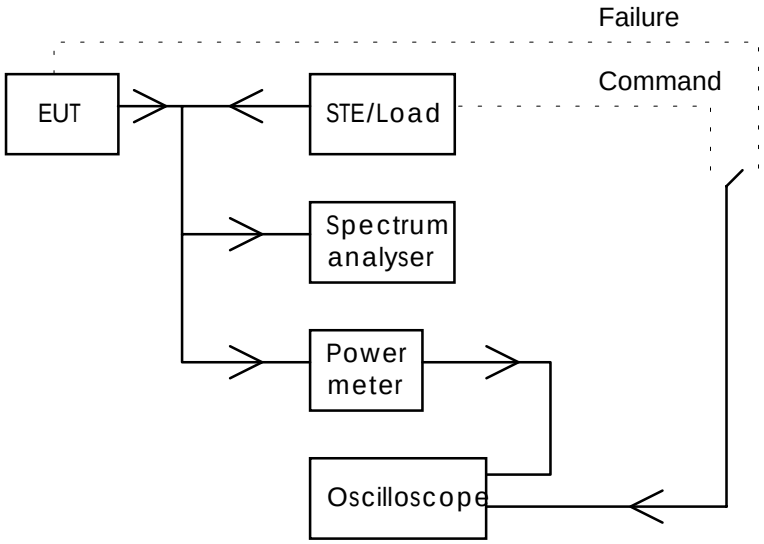

Figure 13: General test arrangement for control and monitoring tests for conducted measurements

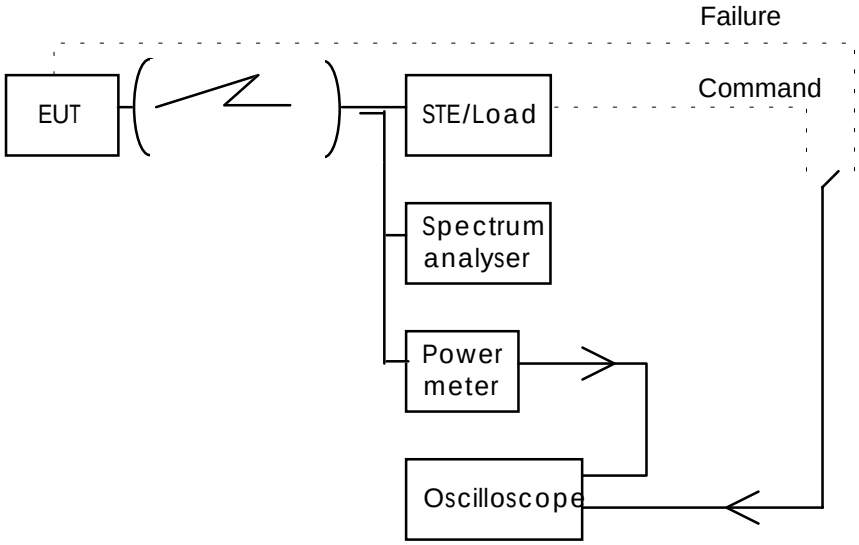

Figure 14: General test arrangement for control and monitoring tests for radiated measurements

The test arrangement shall be as shown in figure 13 or 14. The EUT shall be authorised to transmit and shall be in the carrier-on state at the commencement of each test. The dual trace storage oscilloscope shall monitor by measuring the time difference between the command, or failure, and the occurrence of the expected event (e.g. the transmission suppression). The power meter and spectrum analyser shall monitor the EUT output level.

5.4.2 Processor monitoring

5.4.2.1 Test method

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

b) Within 1 second of such failure the EUT shall cease to transmit as measured by the oscilloscope.

c) The power meter and spectrum analyser shall be observed to ascertain that the transmissions have been suppressed.

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

5.4.3 Transmit subsystem monitoring

5.4.3.1 Test method

a) The frequency generation sub-system shall be caused to fail in respect of:

1) Frequency stability;
2) Output.

b) Within 6 seconds of such failure the EUT shall cease to transmit as measured by the oscilloscope.

c) The power meter and spectrum analyser shall be observed to ascertain that the transmissions have been suppressed.

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

5.4.4 Power-on/Reset

5.4.4.1 Test method

a) Remove the power supply from the EUT.

b) Restore the power supply to the EUT.

c) The EUT shall not transmit during or after power-on.

d) The power meter and spectrum analyser shall be observed to ascertain that the transmissions are suppressed.

e) The EUT shall be restored to the carrier-on state.

f) Operate the reset control of the EUT.

g) The EUT shall cease to transmit.

h) The power meter and spectrum analyser shall be observed to ascertain that the transmissions have been suppressed.

5.4.5 Network control authorisation

5.4.5.1 Test method

a) The EUT shall be switched-off and the NCF enable signal shall be disabled.

b) The EUT shall be switched-on.

c) The EUT shall not transmit more than the permitted initial burst rate transmission as monitored by the oscilloscope (see also subclause 5.5.)

d) The NCF enable signal shall be transmitted.

e) The EUT shall be put into the carrier-on state.

f) The NCF enable message shall be stopped.

g) The EUT shall transmit for a maximum period of 30 seconds from this event.

h) The power meter and spectrum analyser shall be observed to ascertain that the transmissions have been suppressed.

5.4.6 Network control reception

5.4.6.1 Test method

a) The system used to enable the EUT to transmit shall be removed.

b) Within 31 seconds of this event the EUT shall cease to transmit as measured by the oscilloscope.

c) The power meter and spectrum analyser shall be observed to ascertain that the transmissions have been suppressed.

d) The system shall be restored and the EUT shall be authorised to transmit.

e) The STE shall cease to transmit the unique identification code for the EUT.

f) Within 31 seconds of this event the EUT shall cease to transmit as measured by the oscilloscope.

g) The power meter and spectrum analyser shall be observed to ascertain that the transmissions have been suppressed.

h) The system shall be restored and the EUT shall be authorised to transmit.

j) The EUT shall be in receipt of an enable command and a control message from the NCF requesting the EUT's identification code.

k) The EUT shall transmit an identification message to the NCF.

l) A transmitter disable message shall be received from the NCF by the EUT.

m) Within 30 seconds of receipt of this message the EUT shall cease to transmit as measured by the oscilloscope.

n) The power meter and spectrum analyser shall be observed to ascertain that the transmissions have been suppressed.

p) A transmitter enable message shall be received from the NCF by the EUT.

q) Reception of this message shall authorise the EUT to start transmission.

5.5 Initial burst rate transmission

5.5.1 Test method

a) The test arrangement shall be as shown in figure 10 or 11. The EUT shall be switched-off.

b) The EUT shall be switched-on and the transmitted power monitored. The monitoring shall be performed over a period of one minute.

c) The oscilloscope shall be observed to ensure that the permitted initial burst rate transmission is not exceeded.

Annex A (normative): The TBR Requirements Table (TBR-RT)

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

Table A.1: TBR Requirements Table (TBR-RT)

TBR Reference			TBR 027		
No	**Category**	**Reference**	**TBR-R**	**Status**	**Support**
1	4.3	4.1	Unwanted emissions outside the 14,00 to 14,25 GHz band	M	
2	4.3	4.2	Unwanted emissions within the 14,00 to 14,25 GHz band	M	
3	4.3	4.3	Off-axis EIRP density in the nominated bandwidth	M	
4	4.3	4.5.1	Processor monitoring	M	
5	4.3	4.5.2	Transmit subsystem monitoring	M	
6	4.3	4.5.3	Power-on/Reset	M	
7	4.3	4.5.4	Network control authorisation	M	
8	4.3	4.5.5	Network control reception	M	
9	4.3	4.6	Initial burst rate transmission	M	

Key to columns:

No TBR-RT entry number;

Category Category of essential requirement as per Article 4 of the Satellite Equipment Directive [1];

Reference Clause reference within this TBR of the supporting text for the entry;

TBR-R Title of entry within this TBR-RT;

Status Status of the entry (M = Mandatory, shall be implemented under all circumstances);

Support Does the equipment support the essential requirement of this entry; Y/N.

Annex B (informative): Bibliography

- ETS 300 255 (1994): "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)".

- ETS 300 456 (1995): "Satellite Earth Stations and Systems (SES); Test methods for Very Small Aperture Terminals (VSATs) operating in the 11/12/14 GHz frequency bands".

- Council Directive 89/336/EEC (1989) on the approximation of the laws of Member States relating to electromagnetic compatibility.

- EN 55022 (1994): "Limits and methods of measurement of radio disturbance characteristics of information technology equipment".

History

Document history			
August 1996	Public Enquiry	PE 111:	1996-08-05 to 1996-11-29