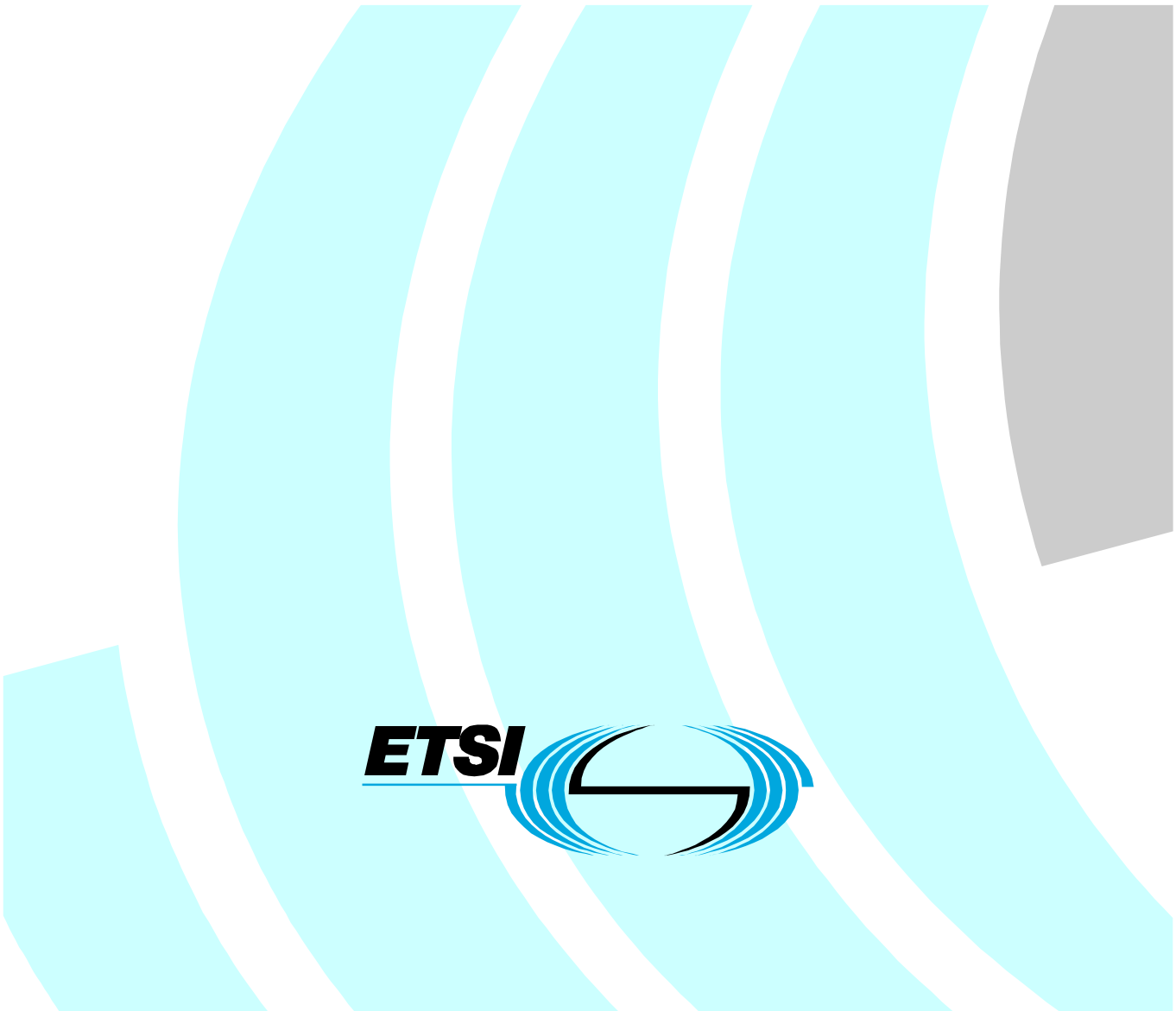
Final draft ETSI EN 302 245-1 V1.1.1 (2004-11)

European Standard (Telecommunications series)

Electromagnetic compatibility and Radio spectrum Matters (ERM); Transmitting equipment for the Digital Radio Mondiale (DRM) broadcasting service; Part 1: Technical characteristics and test methods



Reference
DEN/ERM-TG17WG2-001-1

Keywords
audio, broadcasting, digital, DRM, radio,
terrestrial, transmitter

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Contents

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Foreword

This European Standard (Telecommunications series) has been produced by ETSI Technical Committee Electromagnetic compatibility and Radio spectrum Matters (ERM), and is now submitted for the Vote phase of the ETSI standards Two-step Approval Procedure.

The present document is part 1 of a multi-part deliverable covering the Transmitting equipment for the Digital Radio Mondiale (DRM) broadcasting service, as identified below:

Part 1: "Technical characteristics and test methods";

Part 2: "Harmonized EN under article 3.2 of the R&TTE Directive".

Proposed national transposition dates	
Date of latest announcement of this EN (doa):	3 months after ETSI publication
Date of latest publication of new National Standard or endorsement of this EN (dop/e):	6 months after doa
Date of withdrawal of any conflicting National Standard (dow):	6 months after doa

Introduction

The present document covers a set of non mandatory technical parameters that are considered to be the minimum requirement for the design and operation of a DRM sound broadcasting service.

Other documents directly associated with the present document:

- EN 302 245-2 [1];
- EN 301 489-11 [2].

1 Scope

The present document covers the following types of equipment:

Transmitting equipment for the Digital Radio Mondiale (DRM) sound broadcasting service operating in the LF, MF and HF bands.

2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication and/or edition number or version number) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies.

Referenced documents which are not found to be publicly available in the expected location might be found at http://docbox.etsi.org/Reference.

[1] ETSI EN 302 245-2: "Electromagnetic compatibility and Radio spectrum Matters (ERM); Transmitting equipment for the Digital Radio Mondiale (DRM) broadcasting service; Part 2: Harmonized EN under article 3.2 of the R&TTE Directive".

[2] ETSI EN 301 489-11: "Electromagnetic compatibility and Radio spectrum Matters (ERM); ElectroMagnetic Compatibility (EMC) standard for radio equipment and services; Part 11: Specific conditions for terrestrial sound broadcasting service transmitters".

[3] CENELEC EN 55022: "Limits and methods of measurement of radio disturbance characteristics of information technology equipment".

[4] CENELEC EN 55011: "Industrial, scientific and medical (ISM) radio-frequency equipment - Radio disturbance characteristics - Limits and methods of measurement".

[5] ETSI TR 100 028 series: "Electromagnetic compatibility and Radio spectrum Matters (ERM); Uncertainties in the measurement of mobile radio equipment characteristics".

3 Definitions, symbols and abbreviations

3.1 Definitions

For the purposes of the present document, the following terms and definitions apply:

amplitude imbalance: error caused by different amplification of the I and Q signals

antenna port: port of an apparatus which is designed, in normal operation, to be connected to an antenna using coaxial cable

broadcasting service: radiocommunication service in which the transmissions are intended for direct reception by the general public

NOTE: This service may include sound transmissions, television transmissions or other types of transmission.

cabinet radiation: radiation from an enclosure containing, equipment, excluding radiation from connected antennas or cables

channel bandwidth: frequency band of defined width (as a multiple of the carrier grid) including safety margin for operation on adjacent channels, located symmetrically around a carrier frequency in the carrier grid

class of emission: set of characteristics of an emission, designated by standard symbols

NOTE: Type of modulation of the main carrier, modulating signal, type of information to be transmitted, and also, if appropriate, any additional signal characteristics.

dBc: decibels relative to the unmodulated carrier power of the emission

NOTE: In the cases which do not have a carrier, for example in some digital modulation schemes where the carrier is not accessible for measurement, the reference level equivalent to dBc is decibels relative to the mean power P.

enclosure port: physical boundary of the apparatus through which electromagnetic fields may radiate or impinge

NOTE: In the case of integral antenna equipment, this port is inseparable from the antenna port.

environmental profile: range of environmental conditions under which equipment within the scope of EN 302 245-1 is required to comply with the provisions of EN 302 245-1

harmonic: component of order greater than 1 of the Fourier series of a periodic quantity

harmonic number: integral number given by the ratio of the frequency of a harmonic to the fundamental frequency

NOTE: 2^{nd} harmonic = 2 × fundamental frequency.

intermodulation products: unwanted frequencies resulting from intermodulation between carriers or harmonics of emission, or between any oscillations generated to produce the carrier

mean power: average power supplied to the antenna port by a transmitter during an interval of time sufficiently long compared with the lowest frequency encountered in the modulation envelope taken under normal operating conditions

multiplex: stream of all the digital data carrying one or more services within a single physical channel

necessary bandwidth: for a given class of emission, the width of the frequency band which is sufficient to ensure the transmission of information at the rate and with the quality required under specified conditions

out-of-band emissions: emission on a frequency or frequencies immediately outside the necessary bandwidth which results from the modulation process, but excluding spurious emissions

quadrature error: error caused by phase shift between the I and Q signals

reference bandwidth: bandwidth in which the emission level is specified

RMS power: apparent power of an AC power that is calculated by multiplying root-mean-square (rms) current by the root mean square voltage

NOTE 1: In a purely resistive circuit this is held to be the equivalent heating effect of a DC power and can be deemed to be true power. In a circuit that consists of reactance as well as resistance the apparent power is greater than the true power (the vector difference between true power and apparent power is called reactive power).

True Power = Vrms × (Irms Δ cos Ø)

Where Δ cos Ø is the phase difference between voltage and current introduced by the reactance of the load.

NOTE 2: From the above definition it becomes clear that unless any measuring system can be completely devoid of reactance then the measured power cannot be considered to be RMS power. It therefore becomes apparent that this parameter would be difficult to measure with any degree of accuracy at RF frequencies.

spurious emissions: emission on a frequency or frequencies which are outside the necessary bandwidth and the level of which may be reduced without affecting the corresponding transmission of information

NOTE: Spurious emissions include harmonic emissions, parasitic emissions, intermodulation products and frequency conversion products but exclude out-of-band emissions.

unwanted emissions: spurious emissions and out-of-band emissions

3.2 Symbols

For the purposes of the present document, the following symbol applies:

µ	micro

3.3 Abbreviations

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

AI	Amplitude Imbalance
dB	Decibel, logarithmic ratio (tenths of a "Bel")
dBm	dB relative to one milliwatt
COFDM	Coded Orthogonal Frequency Division Multiplex
DRM	Digital Radio Mondiale
EMC	Electro-Magnetic Compatibility
EN	European Norm
EUT	Equipment Under Test
HF	High Frequency
I	In-phase component of a signal
ITU	International Telecommunications Union
LF	Low Frequency
LV	Low Voltage
MER	Modulation Error Ratio
MF	Medium Frequency
N	Noise power
OFDM	Orthogonal Frequency Division Multiplex
Q	Quadrature phase component of a signal
QE	Quadrature Error
R&TTE	Radio and Telecommunications Terminal Equipment
RF	Radio Frequency
RMS	Root Mean Square
s	second (unit of time)
V	Volt
W	Watt

4 Technical requirements specifications

4.1 Environmental profile

The environmental profile for operation of the equipment shall be declared by the supplier. The equipment shall comply with all the technical requirements of the present document at all times when operating within the boundary limits of the required operational environmental profile.

4.2 Transmitter output characteristics

4.2.1 Rated output power

4.2.1.1 Definition

The rated output power is the mean power that the transmitter shall deliver at its antenna port under the manufacturers specified conditions of operation.

NOTE: It is, however, recommended that this parameter is not quoted as RMS power.

4.2.1.2 Method of measurement

4.2.1.2.1 Initial conditions

Test environment:

- the normal operating environment, as declared by the equipment manufacturer.

Test frequencies:

1) the lowest operating frequency of the EUT;
2) the highest operating frequency of the EUT;
3) a frequency mid-way between 1) and 2) above.

Test arrangement (see figure A.1):

1) all ports unused at the time of testing shall be correctly terminated;
2) connect the EUT to the test load, via the coupling device or via the attenuator;
3) connect the measuring device to the coupling device or attenuator.

4.2.1.2.2 Procedure

The power of the signal of a DRM transmitter is defined as the long-term average of the time-varying short-term signal power. An appropriate instrument for low power DRM transmitters is a thermal power meter; for high power DRM transmitters a calorimetric method may be used.

4.2.1.2.3 Test requirements

The results obtained shall be compared to the limits in clause 4.2.1.3 in order to demonstrate compliance.

4.2.1.3 Limit

The mean output power shall be within ±10 % of the rated output power under normal operating conditions as defined by the manufacturer.

4.2.2 Frequency stability

4.2.2.1 Definition

The frequency stability of an emission is the variation of frequency against a predetermined time scale.

4.2.2.2 Method of measurement

4.2.2.2.1 Initial conditions

Test environment:

- the normal operating environment, as declared by the equipment manufacturer.

Test frequencies:

- one frequency within the tuning range of the EUT.

Test arrangement (see figure A.1):

1) all ports unused at the time of testing shall be correctly terminated;
2) connect the EUT to the test load, via the coupling device or via the attenuator;

3) connect the measuring device to the coupling device or attenuator.

NOTE: Alternatively the transmitter local oscillator may be measured in order to calculate the frequency stability of the EUT RF output signal.

4.2.2.2.2 Procedure

The characteristic frequency may be measured with any suitable measuring device, provided that the accuracy attained during the measurement is better than approximately 10 % of the frequency tolerance of the frequency stability specified in clause 4.3.2.3.

For a tight frequency tolerance or a high degree of frequency stability, the measuring accuracy stated above puts higher demands on the accuracy of the measuring equipment.

Other methods of great precision use a standard reference frequency, the frequency of which is known with high accuracy. With such methods, the reception of a standard frequency transmission may be used to advantage. When the frequency is to be measured as a function of time, measurements shall be made at intervals, which are short enough to reveal the presence of superimposed periodical variations.

In this case, the measurements shall preferably be made with a recording instrument.

The accuracy of the measuring method shall be stated with the results of the measurements.

The conditions of operation shall also be given together with the assigned frequency of the emission which has been used as the characteristic frequency.

4.2.2.2.3 Test requirements

The results obtained shall be compared to the limits in clause 4.2.2.3 in order to demonstrate compliance.

4.2.2.3 Limit

For a period of not less than ninety days, the frequency of the transmitter shall stay within the tolerance of ±10 Hz.

4.3 Digital signal processing

4.3.1 Modulation Error Ratio (MER)

4.3.1.1 Definition

MER is a single parameter to measure the quality of the transmitted signal. It is defined as the sum of the squares of the magnitudes of the ideal symbol vectors is divided by the sum of the squares of the magnitudes of the symbol error vectors. The result is expressed as a power ratio in dB.

4.3.1.2 Method of measurement

The carrier frequency of the OFDM signal and the symbol timing are recovered by the receiver. In the received signal Origin Offset (e.g. caused by residual carrier or DC offset in the mixers), Quadrature Error (e.g. caused by phase shift between the I and Q signal) and Amplitude Imbalance (e.g. caused by different amplification of I and Q) are not corrected in the receiver.

A time record of N received symbol co-ordinate pairs (Ij, Qj) is captured.

For each received symbol, a decision is made as to which symbol was transmitted. The error vector is defined as the distance from the ideal position of the chosen symbol (the centre of the decision box) to the actual position of the received symbol.

This distance can be expressed as a vector (δIj, δ Qj).

$$MER = 10 \times \log_{10} \left\{ \frac{\sum_{j=1}^{N} \left(I_j^2 + Q_j^2 \right)}{\sum_{j=1}^{N} \left(\delta I_j^2 + \delta Q_j^2 \right)} \right\} dB$$

Measurements are taken at the transmitter output using the set-up shown in figure A.1.

The measurement should be determined with the use of a receiver with the lowest possible noise factor in order to avoid causing measurement error. This receiver should be able to demodulate a clean DRM signal and should have a MER, that is at least 10 dB higher than the limit stated in clause 4.4.1.3.

Operate the transmitter at its nominal output power. Measure the MER at the different modulation modes (QAM64 as well as QAM16).

Measurements are taken on all the carriers with an integration period taking into account the average value over 100 OFDM symbols.

The result will be presented in a table or graphs for the different modulation modes.

4.3.1.3 Limit

The result shall be not less than 30 dB.

4.4 Antenna port measurements

4.4.1 Spurious emissions

4.4.1.1 Definition

Emission on a frequency or frequencies which are outside the necessary bandwidth and the level of which may be reduced without affecting the corresponding transmission of information. Spurious emissions include harmonic emissions, parasitic emissions, intermodulation products and frequency conversion products but exclude out-of-band emissions.

For the purposes of the present document spurious emissions are emissions at frequencies outside 500 % of the necessary bandwidth.

4.4.1.2 Method of measurement (essential test suite)

4.4.1.2.1 Initial conditions

Test environment:

- the normal operating environment, as declared by the equipment manufacturer.

Test frequencies:

1) the lowest operating frequency of the EUT;

2) the highest operating frequency of the EUT;

3) a frequency mid-way between 1) and 2) above.

Test arrangement (see figure A.1):

1) all ports unused at the time of testing shall be correctly terminated;

2) connect the EUT to the test load, via the coupling device;

3) connect the measuring device to the coupling device (a filter may be used to attenuate the wanted signal).

4.4.1.2.2 Procedure

1) Operate the EUT at each of the test frequencies as defined in clause 4.4.1.2.1.

2) Measure the results on the spectrum analyser.

4.4.1.2.3 Test requirements

The results obtained shall be compared to the limits in clause 4.4.1.3 in order to demonstrate compliance.

4.4.1.3 Limit

Spurious emissions shall not exceed the values set out in table 4.1 and additionally figure 4.1 for the frequency range 9kHz to 1 GHz.

NOTE: In the case of a DRM transmitter supplied without an internal band-pass output filter, the manufacturer shall specify the characteristics of the filter necessary to fulfil the spurious emission limits defined in table 4.1. The manufacturer shall include this information in their test report.

Table 4.1: Spurious emission limits

Mean power of the transmitter	**Limits Mean power absolute levels (dBm) or relative levels (dBc) below the mean power supplied to the antenna port in the reference bandwidth (see annex A)**
All power ranges	-50 dBc, without exceeding the absolute mean power of 50 mW (17 dBm)

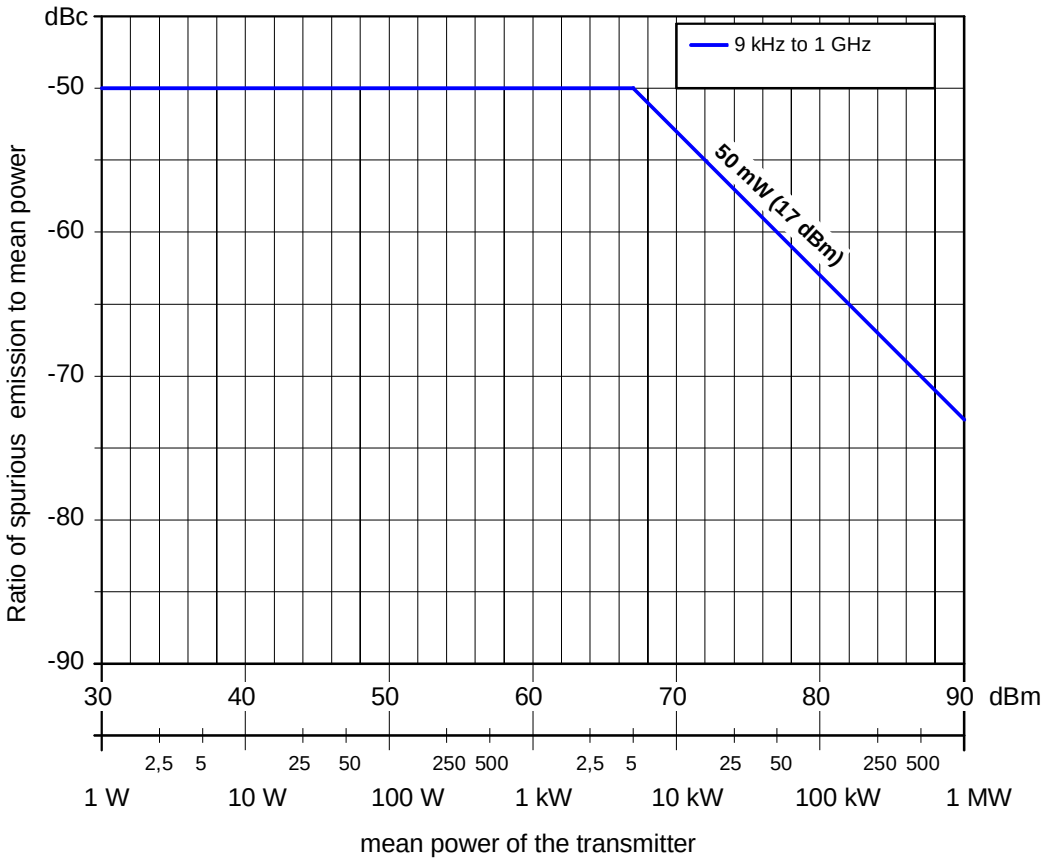


Figure 4.1: Spurious emission limits for DRM transmitters

4.4.2 Transmitter muting during frequency shift

4.4.2.1 Definition

The suppression of emissions during the re-tuning of transmitters.

4.4.2.2 Method of measurement (essential test suite)

4.4.2.2.1 Initial conditions

Test environment:

- the normal operating environment, as declared by the equipment manufacturer.

Test frequencies:

- present frequency to desired frequency.

Test arrangement (see figure A.1):

1) all ports unused at the time of testing shall be correctly terminated;
2) connect the EUT to the test load, via the coupling device;
3) connect the measuring device to the coupling device.

4.4.2.2.2 Procedure

1) Operate the EUT at the present frequency.
2) Initiate frequency change.
3) Observe the output signal on an oscilloscope.

4.4.2.2.3 Test requirements

The results obtained shall be compared to the limits in clause 4.4.2.3 in order to demonstrate compliance.

4.4.2.3 Limit

The muting shall be as defined in clause 4.4.1.3.

4.4.3 Out-of-band emissions

4.4.3.1 Definition

Out-of-band emissions are defined as any emission on a frequency or frequencies immediately outside the necessary bandwidth which results from the modulation process, but excluding spurious emissions.

For the purposes of the present document the out-of-band region shall extend to ±500 % of the necessary bandwidth.

4.4.3.2 Method of measurement (essential test suite)

4.4.3.2.1 Initial conditions

Test environment:

- the normal operating environment, as declared by the equipment manufacturer.

Test frequencies:

1) the lowest operating frequency of the EUT;

2) the highest operating frequency of the EUT;

3) a frequency mid-way between 1) and 2) above.

Test arrangement (see figure A.1).

4.4.3.2.2 Procedure

1) All ports unused at the time of testing shall be correctly terminated.

2) Operate the EUT at each of the test frequencies as defined in clause 4.4.3.2.1.

3) Measure the results on the spectrum analyser.

4.4.3.2.3 Test requirements

The results obtained shall be compared to the limits in clause 4.4.3.3 in order to demonstrate compliance.

4.4.3.3 Limit

Out-of-band emissions shall not exceed the limits specified in table 4.2. Additionally the limits shown in figure 4.2 on a linear frequency axis and in figure 4.3 on a logarithmic axis.

Out-of-band emissions limits in table 4.2 are given as relative levels measured in 100 Hz reference bandwidth, where the 0 dB reference level corresponds to the mean output power measured in the same bandwidth.

In figures 4.2 and 4.3 the additionally 0 dBc reference level corresponds to the mean output power measured in the channel bandwidth.

NOTE 1: The figure 4.3 is only an additional representation of the limits given in table 4.2. It is not a reflection provided by a spectrum analyser! The slope outside ±0,53 F is 12 dB per octave until the value of –60dB is reached.

NOTE 2: In the case of a DRM transmitter supplied without an internal band-pass output filter, the manufacturer shall specify the characteristics of the filter necessary to fulfil the spurious emission limits defined in table 4.1. The manufacturer shall include this information in their test report.

Table 4.2: Out-of-band emission limits

Relative frequency (f/F)	Effective frequency (f) at different nominal bandwidth or occupied channel bandwidth (F) (kHz)						Relative level [dB]
	F = 4,5	F = 5	F = 9	F = 10	F = 18	F = 20	
±0,10	0,45	0,50	0,90	1,00	1,80	2,00	0,00
±0,50	2,25	2,50	4,50	5,00	9,00	10,00	0,00
±0,53	2,39	2,65	4,77	5,30	9,54	10,60	-30,00
±1,06	4,77	5,30	9,54	10,60	19,08	21,20	-42,04
±2,12	9,54	10,60	19,08	21,20	38,16	42,40	-54,08
±2,98	13,41	14,90	26,82	29,80	53,64	59,60	-60,00
< ±5	22,5	25,00	45,00	50,00	90,00	100,00	-60,00
NOTE: The effective frequency (f) is the frequency difference from the centre frequency.							

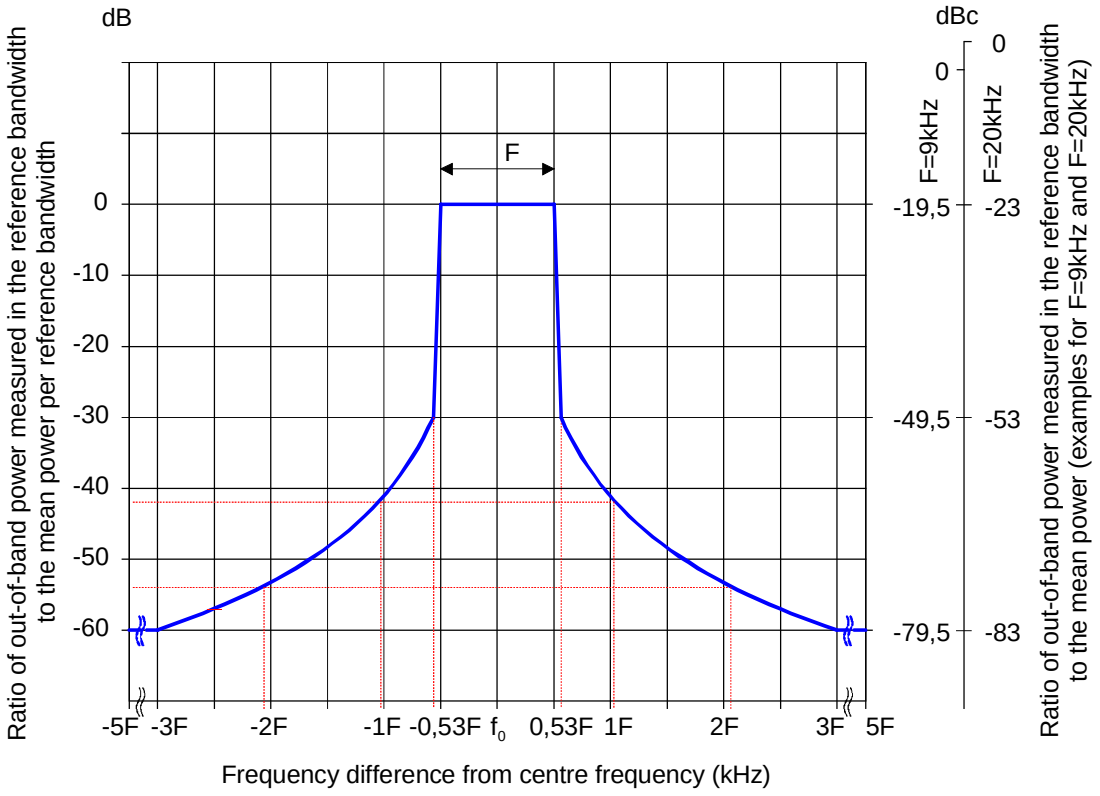


Figure 4.2: Out-of-band emission limits shown on a linear axis

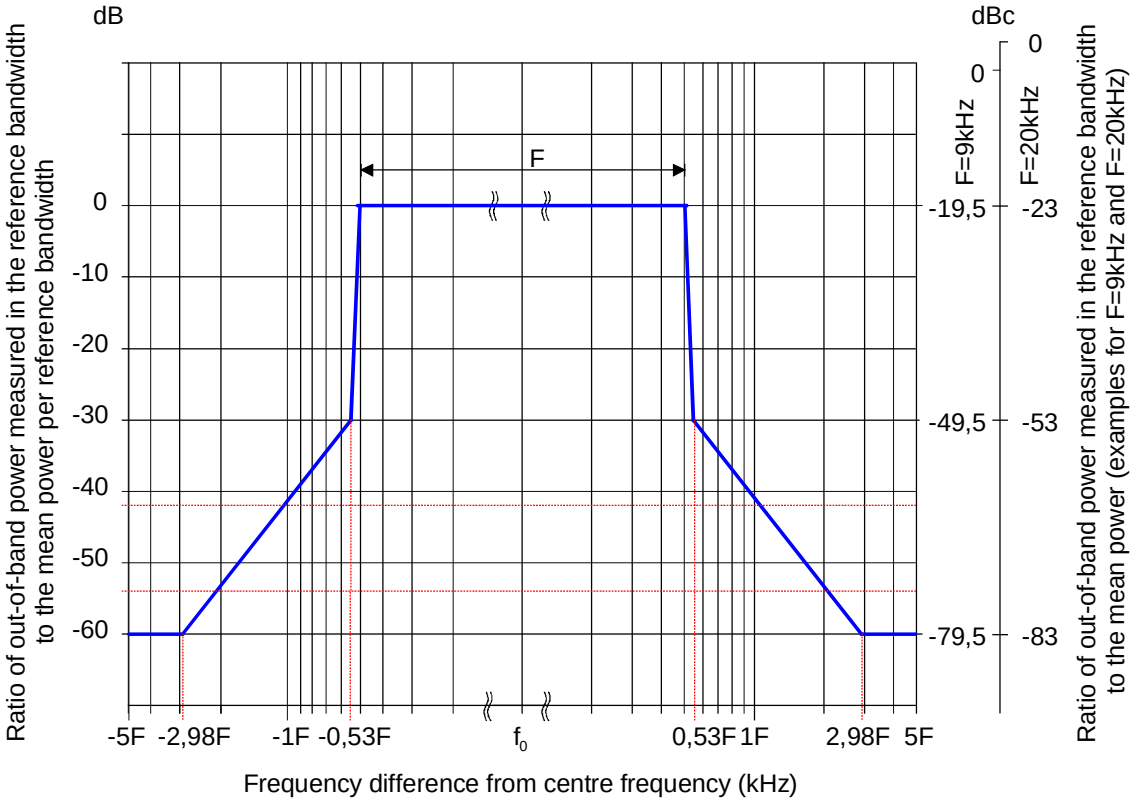


Figure 4.3: Out-of-band emission limits shown on a logarithmic axis

4.5 Enclosure port measurements (radiated emissions)

4.5.1 Cabinet radiation

4.5.1.1 Definition

Emissions from the equipment, radiated from the enclosure port, other than those present at the antenna port.

4.5.1.2 Method of measurement (essential test suite)

4.5.1.2.1 Initial conditions

Test environment:

- the normal operating environment, as declared by the equipment manufacturer.

Test frequencies:

a) the lowest operating frequency of the EUT;

b) the highest operating frequency of the EUT;

c) a frequency mid-way between a) and b) above.

Test arrangement (see figure A.1).

4.5.1.2.2 Procedure

The test method shall be in accordance with EN 55022 [3], unless physical size is a restriction, in which case the test method shall be in accordance with EN 55011 [4].

- Measurements shall be made in the operational mode producing the largest emission in the frequency band being investigated consistent with normal applications.
- The equipment shall be configured in a manner which is representative of a normal/typical operation, where practical.
- An attempt shall be made to maximize the detected radiated emission, e.g. by moving the cables of the equipment.
- The configuration and mode of operation during measurements shall be precisely noted in the test report.
- All input/output ports shall be correctly terminated.
- The tests shall be carried out at a point within the specified normal operating environmental range and at the rated supply voltage for the equipment.

4.5.1.2.3 Test requirements

The results obtained shall be compared to the limits in clause 4.5.1.3 in order to demonstrate compliance.

4.5.1.3 Limits

Radiated emissions shall not exceed the values set out in table 4.3, shown additionally in figure 4.4, for the frequency range 30 MHz to 1GHz.

This test shall be performed at a distance of 10 m, where feasible. When size and/or power requirements necessitate testing in a manufacturing facility, other distances may be used (see notes 1, 2 and 3).

Table 4.3: Cabinet radiation limits

Quasi-peak limits (dBµV/m) at 10 m (see note)	Frequency range
30 dBµV/m ≤ 60 + 10 $\log_{10}$ (P_0 / 2 000) ≤ 70 dBµV/m	30 MHz to 230 MHz
37 dBµV/m ≤ 67 + 10 $\log_{10}$ (P_0 / 2 000) ≤ 77 dBµV/m	> 230 MHz to 1 GHz
NOTE: P_0 = RF output power in W.	

NOTE 1: The measurements can be carried out at other distances. In that case limits are modified according to the relation:

L(x) = L(10m) + 20 log (10/x) where x = distance in meter (m).

NOTE 2: Care should be taken if measuring at test distances below 10 m as this may be in the near field.

NOTE 3: In cases of dispute the measurement distance of 10 m shall take precedence.

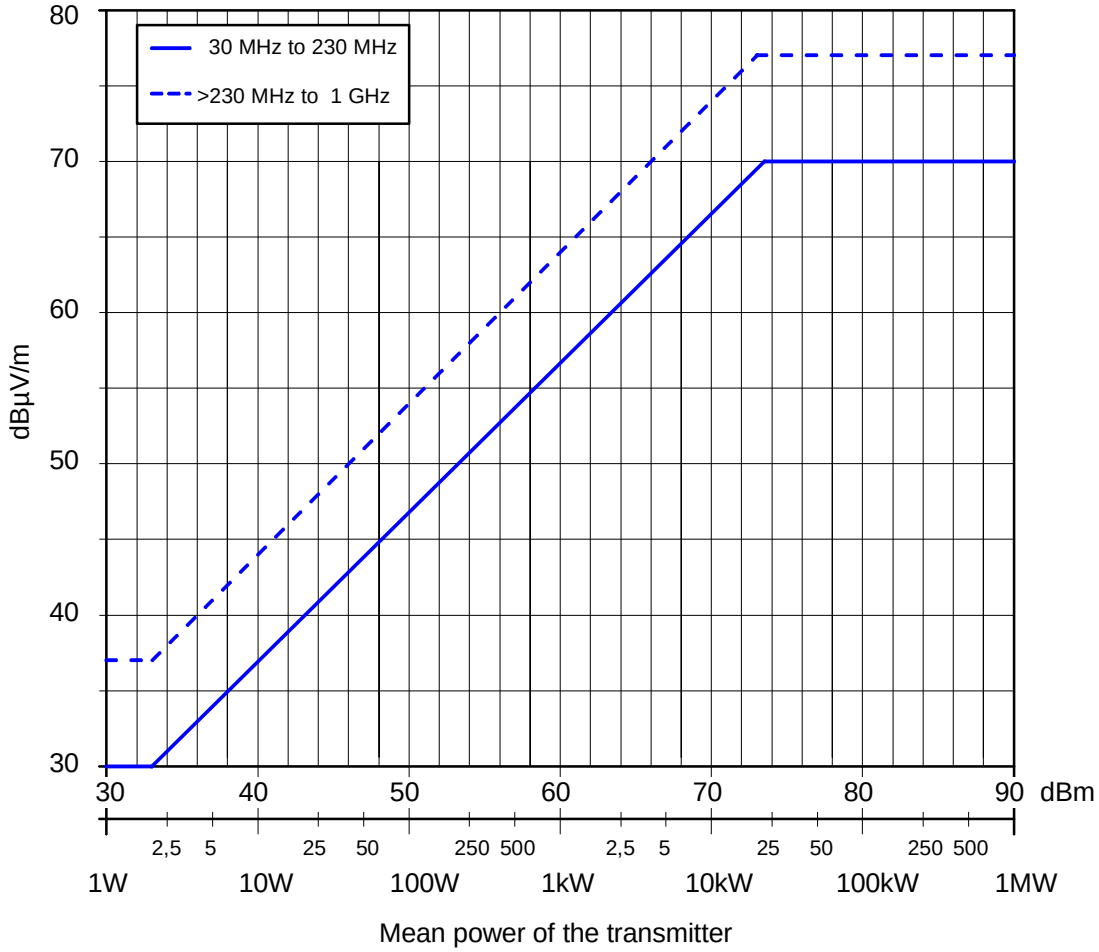


Figure 4.4: Cabinet radiation for DRM transmitters

4.6 Measurement uncertainties

Measurement uncertainty should be calculated and techniques employed to minimize its range. This uncertainty should be applied to the limit and any measurement falling below the range is deemed acceptable (see TR 100 028 series [5]).

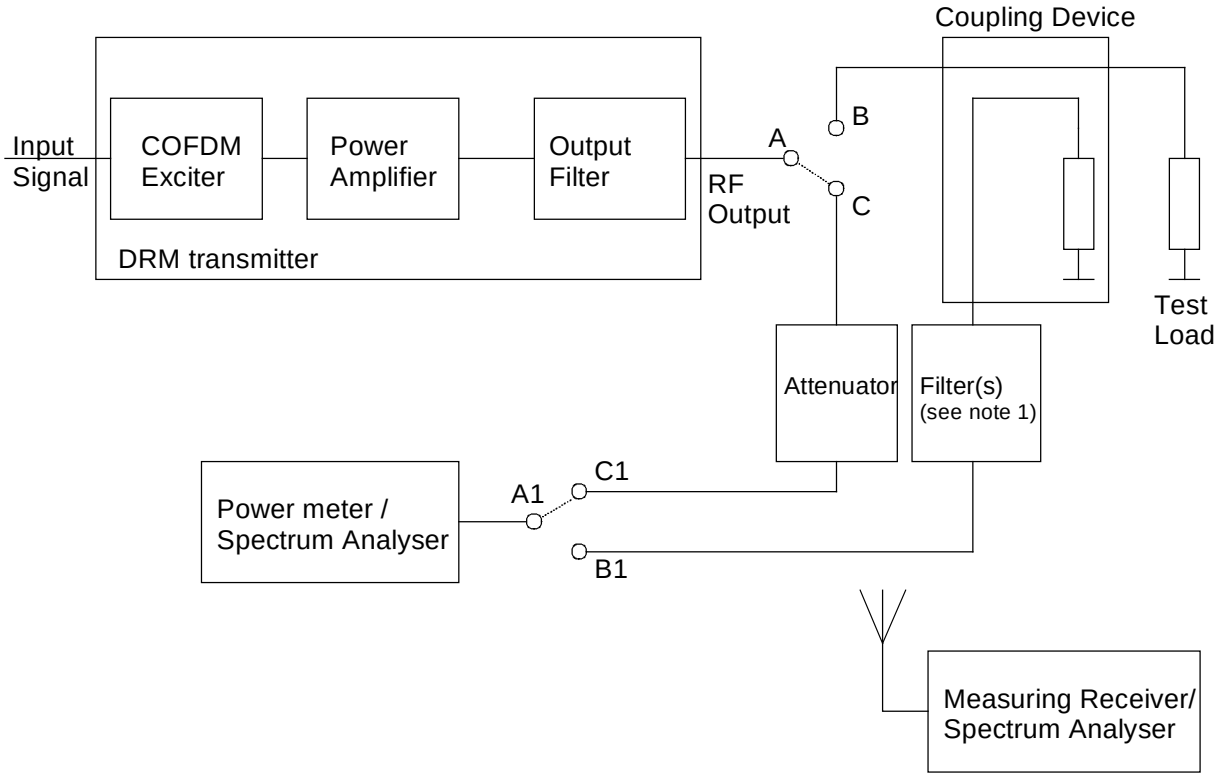
Annex A (normative): Typical measuring arrangements

A.1 Testing arrangements for antenna port (and MER) measurements

The optional filter should suppress the output signal so that no intermodulation products are generated by the spectrum analyser. The insertion loss throughout the measuring range should be known.

For MER measurements substitute DRM receiver and MER measuring device for "Power meter/Spectrum Analyser".

A.1.1 Testing arrangement



NOTE 1: Filter(s) not used in Rated output power measurements.
The optional filter should suppress the output signal so that no intermodulation products are generated by the spectrum analyser. The insertion loss throughout the measuring range should be known.
NOTE 2: For high power transmitters the preferred set up would require A to be connected to B and A1 to be connected to B1.
NOTE 3: For low power transmitters the preferred set up would require A to be connected to C and A1 to be connected to C1.
NOTE 4: For enclosure port measurements the "Measuring Receiver/Spectrum Analyser" is used to measure the results.
NOTE 5: In the case of a DRM transmitter supplied without an internal band-pass output filter, the manufacturer shall specify the characteristics of the filter necessary to fulfil the spurious emission limits defined in table 4.1and the out-of-band emission limit defined in table 4.2. In this case, the antenna port measurements shall be performed at the output of this extra filter.

Figure A.1: Testing arrangement for antenna port (and MER) measurements

A.1.2 Test frequency range (antenna port measurements)

Limits on unwanted emissions for radio equipments are considered to be applicable to the range 9 kHz to 300 GHz. However, for practical measurement purposes, the frequency range of spurious emissions may be restricted. As guidance for practical purposes, the following measurement parameters in table A.1 are recommended:

Table A.1: Antenna port measurements

Transmitter fundamental frequency range	Unwanted emission frequency measurement range	
	Lower frequency	Upper frequency
9 kHz to 30 MHz	9 kHz	1 GHz

The following reference bandwidths are to be used:

For spurious emissions:

- 1 kHz between 9 kHz and 150 kHz;
- 10 kHz between 150 kHz and 30 MHz;
- 100 kHz between 30 MHz and 1 GHz.

For out-of-band emissions:

- 100 Hz.

A.1.3 Test modulating signal

No special test signal is required, however an input signal should be provided, according to the specification of the transmitter, to obtain a valid DRM output signal.

Annex B (normative): Test load characteristics

The transmitter may be required to operate into a precision load with return loss of > 26 dB in the frequency band in which the transmitter is designed to operate.

Annex C (informative): Bibliography

ETSI ES 201 980: "Digital Radio Mondiale (DRM) System Specification".

Directive 1999/5/EC of the European Parliament and of the Council of 9 March 1999 on radio equipment and telecommunications terminal equipment and the mutual recognition of their conformity (R&TTE Directive).

Council Directive 89/336/EEC of 3 May 1989 on the approximation of the laws of the Member States relating to Electromagnetic Compatibility (EMC Directive).

Council Directive 73/23/EEC of 19 February 1973 on the harmonisation of the laws of the Member States relating to Electrical Equipment designed for use within certain voltage limits (LV Directive).

CEPT/ERC/REC 74-01: "Spurious emissions".

ITU-R Recommendation SM 329-10: "Spurious emissions".

ITU-R Recommendation SM 328-10: "Spectra and bandwidth of emissions".

ITU-R Recommendation SM 1541: "Unwanted emissions in the out-of-band domain".

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IEC 60244-1: "Methods of measurement for radio transmitters - Part 1: General characteristics for broadcast transmitters".

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ITU-R Recommendation V.662-3: "Terms and definitions".

History

Document history			
V1.1.1	May 2004	Public Enquiry	PE 20040910: 2004-05-12 to 2004-09-10
V1.1.1	November 2004	Vote	V 20050114: 2004-11-15 to 2005-01-14