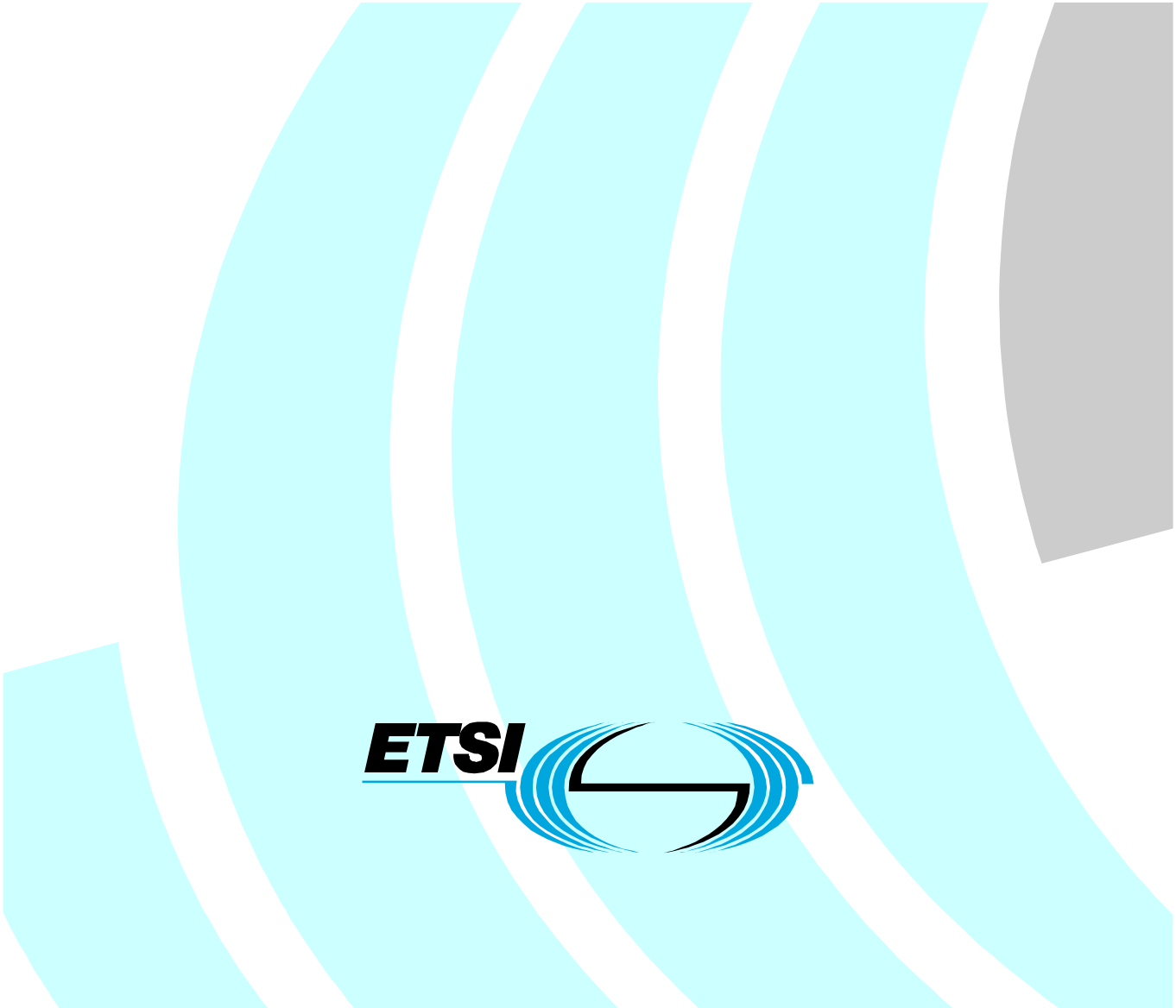
ETSI EN 302 018-1 V1.2.1 (2006-03)

European Standard (Telecommunications series)

Electromagnetic compatibility and Radio spectrum Matters (ERM); Transmitting equipment for the Frequency Modulated (FM) sound broadcasting service; Part 1: Technical characteristics and test methods



Reference
REN/ERM-TG17WG2-004-1

Keywords
audio, broadcasting, FM, radio, terrestrial, transmitter

ETSI

650 Route des Lucioles
F-06921 Sophia Antipolis Cedex - FRANCE

Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16

Siret N° 348 623 562 00017 - NAF 742 C
Association à but non lucratif enregistrée à la
Sous-Préfecture de Grasse (06) N° 7803/88

Important notice

Individual copies of the present document can be downloaded from:
http://www.etsi.org

The present document may be made available in more than one electronic version or in print. In any case of existing or perceived difference in contents between such versions, the reference version is the Portable Document Format (PDF). In case of dispute, the reference shall be the printing on ETSI printers of the PDF version kept on a specific network drive within ETSI Secretariat.

Users of the present document should be aware that the document may be subject to revision or change of status. Information on the current status of this and other ETSI documents is available at
http://portal.etsi.org/tb/status/status.asp

If you find errors in the present document, please send your comment to one of the following services:
http://portal.etsi.org/chaircor/ETSI_support.asp

Copyright Notification

No part may be reproduced except as authorized by written permission.
The copyright and the foregoing restriction extend to reproduction in all media.

© European Telecommunications Standards Institute 2006.
All rights reserved.

DECT™, **PLUGTESTS**™ and **UMTS**™ are Trade Marks of ETSI registered for the benefit of its Members.
TIPHON™ and the **TIPHON logo** are Trade Marks currently being registered by ETSI for the benefit of its Members.
3GPP™ is a Trade Mark of ETSI registered for the benefit of its Members and of the 3GPP Organizational Partners.

Contents

Intellectual Property Rights

IPRs essential or potentially essential to the present document may have been declared to ETSI. The information pertaining to these essential IPRs, if any, is publicly available for **ETSI members and non-members**, and can be found in ETSI SR 000 314: *"Intellectual Property Rights (IPRs); Essential, or potentially Essential, IPRs notified to ETSI in respect of ETSI standards"*, which is available from the ETSI Secretariat. Latest updates are available on the ETSI Web server (http://webapp.etsi.org/IPR/home.asp).

Pursuant to the ETSI IPR Policy, no investigation, including IPR searches, has been carried out by ETSI. No guarantee can be given as to the existence of other IPRs not referenced in ETSI SR 000 314 (or the updates on the ETSI Web server) which are, or may be, or may become, essential to the present document.

Foreword

This European Standard (Telecommunications series) has been produced by ETSI Technical Committee Electromagnetic compatibility and Radio spectrum Matters (ERM).

The present document is part 1 of a multi-part deliverable covering transmitting equipment for the Frequency Modulated (FM) sound 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".

National transposition dates	
Date of adoption of this EN:	24 February 2006
Date of latest announcement of this EN (doa):	31 May 2006
Date of latest publication of new National Standard or endorsement of this EN (dop/e):	30 November 2006
Date of withdrawal of any conflicting National Standard (dow):	30 November 2006

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 an FM sound broadcasting service.

Other documents directly associated with the present document:

- EN 302 018-2 [1];
- EN 301 489-11 [2].

1 Scope

The present document applies to transmitting equipment for the frequency-modulated sound broadcasting service.

The types of equipment covered by the present document are as follows:

- Transmitting equipment for frequency modulated sound broadcasting service operating in both Monophonic and Stereophonic operating in the frequency range 68 MHz to 108 MHz.

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 302 018-2: "Electromagnetic compatibility and Radio spectrum Matters (ERM); Transmitting equipment for the Frequency Modulated (FM) sound 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 55011: "Industrial, scientific and medical (ISM) radio-frequency equipment - Radio disturbance characteristics - Limits and methods of measurement".

[4] ITU-R Recommendation BS.468-4 (1986): "Measurement of audio-frequency noise voltage level in sound broadcasting".

[5] IEC 60489-1: "Methods of measurement for radio equipment used in the mobile services. Part 1: General definitions and standard conditions of measurement".

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

[7] ITU-R Recommendation SM.329: "Unwanted emissions in the spurious domain".

[8] ITU-R Recommendation BS.412: "Planning standards for terrestrial FM sound broadcasting at VHF".

[9] ITU-R Recommendation BS.641: "Determination of radio-frequency protection ratios for frequency-modulated sound broadcasting".

[10] ITU-R Recommendation BS.450-3 (2001): "Transmission standards for FM sound broadcasting at VHF".

3 Definitions, symbols and abbreviations

3.1 Definitions

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

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

broadcasting service: radio communication 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.

channel L: left hand channel of a stereophonic signal

channel R: right hand channel of a stereophonic signal

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

carrier power: average power supplied to the antenna port by a transmitter during one cycle taken under the condition of no modulation

class of emission: set of characteristics of an emission, designated by standard symbols, e.g. type of modulation of the main carrier, modulating signal, type of information to be transmitted, and also, if appropriate, any additional signal characteristics

composite: See "Multiplex (MPX) signal".

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.

difference signal : signal (S) theoretically equal to half the difference between the left (L) and right (R) stereophonic signals. $S = (L - R) / 2$

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 302 018-1 is required to comply with the provisions of EN 302 018-1

exclusion band: band of radio frequencies where no measurements are made

frequency tolerance: maximum permissible departure of the characteristic frequency of an emission from the assigned frequency

NOTE: The frequency tolerance is expressed in parts per 10^6 or in Hz.

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 (2^{nd} harmonic = 2 × fundamental frequency)

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 (MPX) signal: contains all information, including the pilot tone and any supplementary signal which is used to frequency modulate the VHF FM transmitter

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

pilot tone: 19 kHz tone used to recover the stereo subcarrier in the stereo-receiver

Radio Data System (RDS): signal containing information on programmes and broadcasting network as defined in EN 50067

NOTE: This signal is carried by a subcarrier at 57 kHz, amplitude modulated by the encoded data with suppressed carrier in a frequency band of ±2,4 kHz.

reference bandwidth: bandwidth in which the emission level is specified

signal L: corresponds to the information in the left channel of the stereophonic signal

signal R: corresponds to the information in the right channel of the stereophonic signal

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.

stereo subcarrier: 38 kHz subcarrier used to carry the difference signal

sum signal: signal (M) theoretically equal to half of the sum of the left (L) and right (R) stereophonic signals.
$M = (L + R) / 2$

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

3.2 Symbols

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

Ω	ohms (unit of resistance)
μ	micro, 10^{-6}

3.3 Abbreviations

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

a.c.	alternating current
AF	Audio Frequency
AM	Amplitude Modulation
dB	deciBel, logarithmic ratio (tenths of a "Bel")
dBm	dB relative to one milliwatt
d.c.	direct current
EMC	ElectroMagnetic Compatibility
EN	European Norm
ERM	Electromagnetic compatibility and Radio spectrum Matters
EUT	Equipment Under Test
FM	Frequency Modulation
Hz	Hertz (cycles per second)
LV	Low Voltage
MPX	MultiPleX
R&TTE	Radio equipment and Telecommunications Terminal Equipment
RDS	Radio Data System

RF	Radio Frequency
rms	root mean square
SNR	Signal to Noise Ratio
VHF	Very High Frequency
V	Volts
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 input configuration

If the transmitter does not incorporate a stereo encoder and is intended for stereo operation then a suitable test encoder shall be used.

4.3 Transmitter output characteristics

4.3.1 Rated output power

4.3.1.1 Definition

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

4.3.1.2 Method of measurement

4.3.1.2.1 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):

1) connect the EUT to the Test Load, via the Coupling Device;

2) connect the Spectrum Analyser or power meter to the Coupling Device.

NOTE: AF Signal Generator and Voltage measuring equipment are not required for this test.

4.3.1.2.2 Procedure

1) operate the EUT at each of the test frequencies as defined in clause 4.3.1.2.1;

2) measure the results on the Spectrum Analyser or power meter.

4.3.1.2.3 Test requirements

The results obtained shall be compared to the limits in clause 4.3.1.3 in order to demonstrate compliance.

4.3.1.3 Limit

The carrier output power shall be within ±0,5 dB of the rated output power under normal operating conditions as defined by the manufacturer.

4.3.2 Frequency drift

4.3.2.1 Definition

The frequency drift of an emission is the uncontrolled continuous and irreversible variation of frequency against a predetermined timescale.

4.3.2.2 Method of measurement

4.3.2.2.1 Initial conditions

Test environment:

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

Test frequency:

- any one frequency within the tuning range of the EUT.

Test arrangement (see figure A.1):

1) connect the EUT to the Test Load, via the Coupling Device;

2) connect a frequency recorder to the Coupling Device.

NOTE: AF Signal Generator and Voltage measuring equipment are not required for this test.

4.3.2.2.2 Procedure

1) operate the exciter of the EUT at the test frequency as defined in clause 4.2.2.2.1;

2) measure the results on the frequency recorder.

4.3.2.2.3 Test requirements

The results obtained shall be compared to the limits in clause 4.3.2.3 in order to demonstrate compliance.

4.3.2.3 Limit

For a period of not less than ninety days, the frequency tolerance of the transmitter shall stay within ±300 Hz.

4.3.3 Deviation sensitivity stability

4.3.3.1 Definition

Stability of the required audio or MPX input level to the transmitter to achieve desired deviation.

4.3.3.2 Method of measurement

4.3.3.2.1 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):

1) connect the AF Signal Generator to the EUT;

2) connect the EUT to the Test Load, via the Coupling Device;

3) connect deviation recording equipment to the Coupling Device.

4.3.3.2.2 Procedure

1) Switch the preemphasis off.

2) Using a single sinus AF the manufacturer has to define an AF input level that meets the rated deviation. Operate the EUT with this AF input level.

3) Set the RF operating frequency constant and change the AF frequency in the range declared by the manufacturer, but not outside the frequency range 40 Hz to 15 kHz.

4) Measure the deviation. This shall be compared to the limits in clause 4.3.3.3 a) in order to demonstrate compliance.

For frequency agile transmitters:

1) Repeat item 3) at other RF operating frequencies including the lowest and highest operating frequency as specified in clause 4.3.3.2.1.

2) Measure the deviation. This shall be compared to the limits in clause 4.3.3.3 b) in order to demonstrate compliance.

4.3.3.2.3 Test requirements

The results obtained shall be compared to the limits in clause 4.3.3.3 in order to demonstrate compliance.

4.3.3.3 Limit

a) The deviation sensitivity of the transmitters shall remain within ±3 % of the declared value under the manufacturers declared operating conditions.

b) For frequency-agile transmitters the deviation sensitivity shall remain within ±5 % of the declared value under the manufacturers declared operating conditions.

4.3.4 Residual AM (Hum and noise)

4.3.4.1 Definition

The amplitude modulated hum and noise level is the peak voltage of the a.c. component at the output of a linear envelope detector, in the absence of any modulation signal. The result is expressed as a percentage of the d.c. component of the envelope detector output.

4.3.4.2 Method of measurement

4.3.4.2.1 Initial conditions

Test environment:

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

Test arrangement:

- see figure A.1 in the case where no stereo coder is present and figure A.2 in the case where a Stereo Coder is present in the transmitter.

1) connect the EUT to the Test Load, via the Coupling Device;

2) connect a linear Envelope Detector to the Coupling Device;

3) connect a Peak Voltmeter and a d.c. Voltmeter to the output of the Envelope Detector. Alternatively, a Modulation Meter may be used.

4.3.4.2.2 Procedure

1) if applicable, switch the stereo coder in monophonic mode;

2) check that the appropriate de- and pre-emphasis filters are in circuit;

3) no input signal is applied to the transmitter or Stereo Coder;

4) connect the audio input terminal(s) of the transmitter or Stereo Coder to a load impedance corresponding to the nominal source impedance;

5) measure the d.c. component (U_0) at the detector output which corresponds to the carrier output;

6) measure the peak a.c. voltage (U_s) at the Envelope Detector output.

4.3.4.2.3 Test requirements

Calculate the noise and hum level by means of the following formula:

$$N = 100\frac{U_s}{U_0}(\%)$$

When a modulation meter is used the result is indicated directly.

The results obtained shall be compared to the limits in clause 4.3.4.3 in order to demonstrate compliance.

4.3.4.3 Limit

The permitted level of residual AM in the absence of modulation shall not exceed 1 % when measured in a bandwidth of 20 Hz to 20 kHz (unweighted).

4.3.5 Synchronous AM (AM due to FM)

4.3.5.1 Definition

Synchronous amplitude modulation is evaluated by measuring the peak voltage of the a.c. component at the output of a linear envelope detector due to presence of a specified modulating signal. The result is expressed as a percentage of the d.c. component corresponding to the unmodulated carrier.

4.3.5.2 Method of measurement

4.3.5.2.1 Initial conditions

Test environment:

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

Test arrangement:

- see figure A.1 in the case where no stereo coder is present and figure A.2 in the case where a stereo coder is present in the transmitter.

1) connect the EUT to the Test Load, via the Coupling Device;

2) connect a linear Envelope Detector to the Coupling Device;

3) connect a Peak Voltmeter and a d.c. Voltmeter to the output of the Envelope Detector. Alternatively, a Modulation Meter may be used.

4.3.5.2.2 Procedure

1) if applicable, switch the stereo coder to monophonic mode;

2) check that the appropriate de- and pre-emphasis filters are in circuit;

3) adjust input signal to a frequency within the audio-frequency band;

4) adjust input signal level for specified deviation (normally maximum deviation);

5) measure the d.c. component (U_0) at the Envelope Detector output;

6) measure the a.c. component (U_a) at the Envelope Detector output.

4.3.5.2.3 Test requirements

Calculate the amplitude modulation depth expressed as a percentage by means of the following formula:

$$m = 100\frac{U_a}{U_0}(\%)$$

for each audio-frequency.

Present the AM depth levels as a function of the audio-frequency and state the deviation with the results.

When a modulation meter is used for the measurements, the results can be influenced by noise and hum.

The results obtained shall be compared to the limits in clause 4.3.5.3 in order to demonstrate compliance.

4.3.5.3 Limit

The permitted level of AM due to FM shall not exceed 2 % for a peak deviation of ±40 kHz at a modulation frequency of 500 Hz.

4.3.6 Modulator performance (pulse response)

4.3.6.1 Definition

The amplitude and phase performance required for the transmitter to ensure compliance with the maximum frequency deviation.

NOTE: If the amplitude and phase performance of a modulator is out of tolerance the pulse response leads to the result of overdeviation respectively underdeviation. Overdeviation leads to a wider spectrum and in case of clipping etc. to intermodulation products.

4.3.6.2 Method of measurement

As a measure of the modulator performance the pulse response is taken without audio processing like stereo coder and preemphasis. Therefore the audio processing unit if existing is bridged and the MPX input of the transmitter is used.

For the measurement two test signals are taken with an amplitude that corresponds to a frequency deviation of 40 kHz. (40 kHz is chosen in order to avoid an unwanted clipping inside the modulator due to ringing or tilt of the test signals)

The two test tones are derived from sine wave signals (40 Hz and 10 kHz) by clipping at 25 % (-12 dB) of the crest of the sine wave. The amplitude of the clipped sine wave has to be adjusted to a level that is equal to the peak level of a sine wave that results in a 40 kHz frequency deviation.

Alternatively to the use of the clipped sine waves, trapezoidal pulse with a slew rate that is equal to the slew rate of the clipped sine wave, can be used.

4.3.6.2.1 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):

1) connect the AF Signal Generator to the EUT;

2) connect the EUT to the Test Load, via the Coupling Device;

3) connect deviation measure equipment to the Coupling Device.

4.3.6.2.2 Procedure

1) bridge the audioprocessor or use the MPX input;

2) set the AF Signal Generator to deliver a test signal sine wave signal of 1 kHz;

3) adjust the peak sine wave signal to level that results in a modulation with 40 kHz peak deviation and determine the peak voltage of the sine wave signal (Oscilloscope);

4) replace the sine wave signal by one of the two test tones and adjust the level of the test signal to the peak level determined in 3);

5) measure the peak frequency from the deviation measurement equipment.

4.3.6.2.3 Test requirements

The results obtained shall be compared to the limits in clause 4.3.6.3 in order to demonstrate compliance.

4.3.6.3 Limit

The frequency deviation limits in the following table shall apply.

Table 4.1: Frequency deviation limits

Audio frequency	Adjusted frequency deviation via sine-wave	Measured frequency deviation via clipped sine-wave/trapezoide
40 Hz	40 kHz ± 3 %	40 kHz ± 10 %
10 kHz	40 kHz ± 3 %	40 kHz ± 10 %
NOTE: In the case of monophonic transmitters, the "clipped sine wave" limits do not apply.		

4.3.7 MPX intermodulation

4.3.7.1 Definition

Distortion products of the MPX-signal caused by base-band intermodulation effects of the modulator.

4.3.7.2 Method of measurement

4.3.7.2.1 Initial conditions

Test environment:

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

Test frequencies:

- a frequency mid-way between the lowest and the highest operating frequency of the EUT.

Test arrangement (see figure A.1):

1) connect two AF Signal Generators to the EUT;

NOTE 1: If available use the multiplex signal input otherwise the supplementary signal input.

2) connect the EUT to the Test Load, via the Coupling Device;

3) connect deviation measurement equipment to the Coupling Device;

4) connect an AF Spectrum Analyser to the output of the deviation measurement equipment.

NOTE 2: The modulator should be able to generate FM signals in accordance with ITU-R Recommendation BS.450-3 [10]. The amplitude and phase performance of the modulator has to ensure compliance with the Out of Band emission mask and the maximum allowed frequency deviation.

4.3.7.2.2 Procedure

1) Modulate the transmitter with a signal, consisting of two single tone AF frequencies with the same amplitude and with a frequency difference of approximately 1 kHz.

2) Choose the test frequencies from the range of 15 kHz to the end of the supplementary information channel, for example 76 kHz.

3) Increase the combined output levels of both AF Generators to achieve the maximum frequency deviation of ±75 kHz.

4) Using the AF Spectrum Analyser; measure:

- the amplitude level of the test tones;
- the amplitude level of the second order intermodulation product which has the frequency of 1 kHz.

4.3.7.2.3 Test requirements

The results obtained shall be compared to the limits in clause 4.3.7.3 in order to demonstrate compliance.

4.3.7.3 Limit

The amplitude of the 1 kHz second order intermodulation product shall be less than -50 dB relative to the amplitude of the test tones.

4.3.8 Deviation limiting

4.3.8.1 Definition

The capability of the limiter function to keep the deviation inside specified limits.

4.3.8.2 Method of measurement

4.3.8.2.1 Initial conditions

Test environment:

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

Test frequencies:

- a frequency mid-way between the lowest and the highest operating frequency of the EUT.

Test arrangement (see figure A.1):

1) connect the AF Signal Generator to the EUT;

NOTE 1: If available use the multiplex signal input otherwise the supplementary signal input.

2) connect the EUT to the Test Load, via the Coupling Device;

3) connect deviation measurement equipment to the Coupling Device;

4) enable the deviation limiter.

NOTE 2: The modulator should be able to generate FM signals in accordance with ITU-R Recommendation BS.450-3 [10].
The amplitude and phase performance of the modulator has to ensure compliance with the Out of Band emission mask and the maximum allowed frequency deviation.
The deviation should not exceed the limits for European countries given in ITU-R Recommendation BS.450-3 [10], i.e. 75 kHz or 50 kHz, if the deviation limiter is enabled.

4.3.8.2.2 Procedure

For monophonic operation:

1) modulate the transmitter with a sinewave AF signal;

2) adjust the output of the AF Generator at 1 kHz to a level which corresponds to a frequency deviation of ±32 kHz i.e. 7,4 dB below maximum deviation of ± 75 kHz;

3) increase the output level of the AF Generator by 12 dB, resulting in a frequency deviation of approximately ±128 kHz with the deviation limiter disabled;

4) enable the deviation limiter and measure the results from the deviation measurement equipment.

For stereophonic operation:

1) both channels L and R shall be fed simultaneously with an AF signal in the ratio L = R - 6 dB (channel L with half the amplitude of channel R);

2) adjust the output of the AF Generator at 1 kHz to a level which corresponds to a frequency deviation of ±40 kHz including the pilot tone;

3) increase the output level of the AF Generator by 12 dB, resulting in a frequency deviation of approximately ±145 kHz with the deviation limiter disabled;

4) enable the deviation limiter and measure the results from the deviation measurement equipment.

4.3.8.2.3 Test requirements

The results obtained shall be compared to the limits in clause 4.3.8.3 in order to demonstrate compliance.

4.3.8.3 Limit

The deviation limits in table 4.2 shall apply.

Table 4.2: Deviation limits

Maximum operating frequency deviation	Peak deviation
50 kHz	±50 kHz ±3 %
75 kHz	±75 kHz ±3 %

4.3.9 FM Signal to Noise Ratio (SNR)

4.3.9.1 Definition

The FM noise level is the voltage (see note) of the a.c. components at the output of the demodulator in absence of a modulation signal expressed in dB relative to a reference level corresponding to maximum frequency deviation of ±75 kHz at a modulation frequency of 500 Hz.

NOTE: Unweighted noise ratio: Voltage unfiltered and measured as quasi peak according to ITU-R Recommendation BS.468-4 [4].

Weighted noise ratio: Voltage filtered and measured as quasi peak according to ITU-R Recommendation BS.468-4 [4].

4.3.9.2 Method of measurement

4.3.9.2.1 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.2 for stereophonic or A.1 for monophonic only transmitters):

1) connect the AF Signal Generator to the EUT;

2) connect the EUT to the Test Load, via the Coupling Device;

3) connect a suitable modulation test device to the output of the Coupling Device (with a quasi peak detector as in ITU-R Recommendation BS.468-4 [4] with pre-emphasis and de-emphasis in).

4.3.9.2.2 Procedure

1) set the AF Signal Generator to deliver a test signal of 500 Hz, sine wave, at a level to achieve 100 % modulation (75 kHz deviation);

2) measure the reference voltage;

3) disconnect the AF Signal Generator from the EUT and terminate the input according to the manufacturers recommendation;

4) measure the weighted and unweighted voltage and compare to the reference voltage;

5) repeat the above procedure at each of the test frequencies as defined in clause 4.3.9.2.1.

4.3.9.2.3 Test requirements

The results obtained shall be compared to the limits in clause 4.3.9.3 in order to demonstrate compliance.

4.3.9.3 Limit

The SNR, measured on both decoded outputs and related to full rated output power at 500 Hz and ±75 kHz deviation, shall be:

- unweighted SNR ≥ 72 dB;
- weighted SNR ≥ 72 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.

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:

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):

1) connect the AF Signal Generator to the EUT;

2) connect the EUT to the Test Load, via the Coupling Device;

3) connect the Spectrum Analyser to the Coupling Device.

4.4.1.2.2 Procedure

1) measure the peak power of the unmodulated carrier on the Spectrum Analyser and set its value as a reference;

2) operate the EUT at each of the test frequencies as defined in clause 4.4.1.2.1;

3) measure the peak power of harmonic emissions on the Spectrum Analyser;

4) set the AF Signal Generator to deliver a test signal as defined in clause A.1.4;

5) measure the peak power of the modulated carrier on the Spectrum Analyser and set its value as a reference;

6) operate the EUT at each of the test frequencies as defined in clause 4.4.1.2.1;

7) measure the results on the Spectrum Analyser.

NOTE: Measurements shall be made in the operational mode producing the largest emission in the frequency band.

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 4.3, shown additionally in figure 4.1 for the frequency range 9 kHz to 1 GHz.

Table 4.3: Spurious emission limits

Mean power of the transmitter	**Limits Mean power absolute levels (dBm) or relative levels (dBc) below the power supplied to the antenna port in the reference bandwidth (see annex A)**
P < 9 dBW	-36 dBm
9 dBW ≤ P < 29 dBW	75 dBc
29 dBW ≤ P < 39 dBW	-16 dBm
39 dBW ≤ P < 50 dBW	85 dBc
50 dBW ≤ P	-5 dBm
NOTE: Within the band 108 MHz to 137 MHz the limits above apply without exceeding the absolute limit of 25 µW (-16 dBm).	

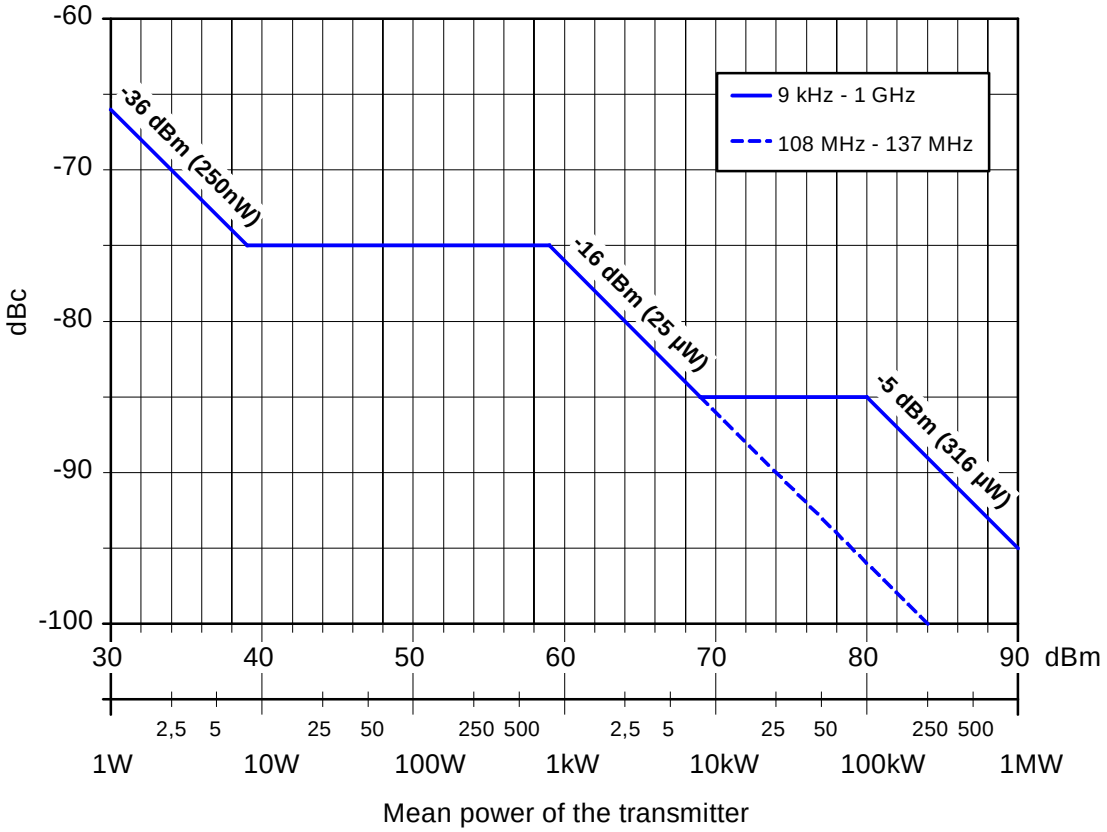


Figure 4.1: Spurious emission limits for FM sound broadcasting transmitters

4.4.2 Transmitter muting during frequency shift

4.4.2.1 Definition

The suppression of emissions during the retuning of transmitters or the loss of carrier frequency control. This is particularly relevant to frequency agile transmitters incorporating frequency control loops.

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:

a) the lowest operating frequency of the EUT;

b) the highest operating frequency of the EUT.

Test arrangement (see figure A.1):

1) connect the EUT to the Test Load, via the Coupling Device;

2) connect the Spectrum Analyser to the Coupling Device;

3) set reference bandwidth as per clause A.1.3;

4) set span to correspond to the tuneable frequency range shown at clause 4.4.2.2.1 points "a" and "b";

5) sweep time of the spectrum analyser should be not greater than 1/10 the frequency switching period of the EUT.

NOTE 1: AF Signal Generator and Voltage measuring equipment are not required for this test.

NOTE 2: If it is not possible to attain the necessary dynamic range in the Spectrum Analyser, the measuring range can be split into several parts.

4.4.2.2.2 Procedure

1) operate the EUT at the present frequency as defined in clause 4.4.2.2.1 point "a";

2) initiate frequency change to frequency defined in clause 4.4.2.2.1 point "b";

3) to measure the results set the spectrum analyser to "MAX HOLD" and retune the EUT at least 5 times between points "a" and "b".

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 table 4.3 and additionally shown in figure 4.1.

4.4.3 Out-of-band emissions

4.4.3.1 Definition

Emission on a frequency or frequencies immediately outside the necessary bandwidth, which results from the modulation process, but excludes spurious emissions.

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:

a) the lowest operating frequency of the EUT; the highest operating frequency of the EUT;

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

Test arrangement (see figure A.1):

1) connect the AF Signal Generator to the EUT;

2) connect the EUT to the Test Load, via the Coupling Device;

3) connect the Spectrum Analyser to the Coupling Device.

4.4.3.2.2 Procedure

For monophonic operation:

The test arrangement in clause A.1.1 shall be used.

One generator shall be a AF Signal Generator. The other generator shall deliver standardized coloured noise described in clause A.1.4. This can be obtained from a "white-noise" generator after a passive filter, as shown in figure A.4, and a low-pass filter of 15 kHz with a slope of 60 dB per octave.

A second output from a directional coupler is connected to a RF Spectrum Analyser.

1) check that the pre- and de-emphasis filters are in circuit;
2) adjust the output of the AF generator at 1 kHz to a level which corresponds to a frequency deviation of ±32 kHz i.e. 7,4 dB below maximum deviation of ± 75 kHz;
3) measure the effective value by means of the noise meter (see note) at the input of the EUT modulator;
4) switch the AF Generator out of circuit and the Noise Generator in circuit and adjust the output of the noise generator, so that the noise meter gives the same reading; (The peak-deviation is now correct.)
5) switch the Analyser to a bandwidth of 1 kHz;
6) adjust the Spectrum Analyser with the unmodulated FM carrier to 0 dB as reference level;
7) modulate the transmitter with the coloured noise;
8) tune the Analyser to frequencies between the carrier frequency and ±100 kHz to ±500 kHz i.e. to all frequencies required in the out of band emission(s) mask;
9) determine the r.m.s. value of the noise corresponding to power density, relative to the unmodulated carrier level;
10) operate the EUT at each of the test frequencies as defined in clause 4.4.3.2.1.

For stereophonic operation:

The test arrangement in clause A.1.2, shall be used.

The AF Signal Generator has to be replaced during the measurement by the standard Coloured Noise Generator. Both channels L and R shall be fed simultaneously with a AF signal or with white noise in the ratio L = R - 6 dB:

1) check that the appropriate pre- and de-emphasis filters are in circuit;
2) adjust the output of the AF Generator at ≤ 1 kHz to a level which corresponds to a frequency deviation 7,4 dB below maximum rated deviation and additional include pilot tone. That is = ±40 kHz for ±75 kHz rated deviation;
3) measure the effective power value by means of the Noise Meter (see note) at the input of the EUT Stereo Coder in channel R;
4) for the remaining procedure, see the method used for monophonic operation.

NOTE: The Noise Meter has to be applicable to determine a true effective value (rms) of power or voltage of a stochastic noise probe. Suitable instruments are bolometric power meters or psophometric voltage meters. All and any weighting networks have to be disconnected.

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 values set out in table 4.4 and additionally shown in figure 4.2.

Table 4.4: Break points of spectrum limit mask for VHF FM sound broadcasting

Frequency relative to the centre of the channel (kHz)	Relative level (dBc)
-500	-85
-300	-85
-200	-80
-100	0
100	0
200	-80
300	-85
500	-85

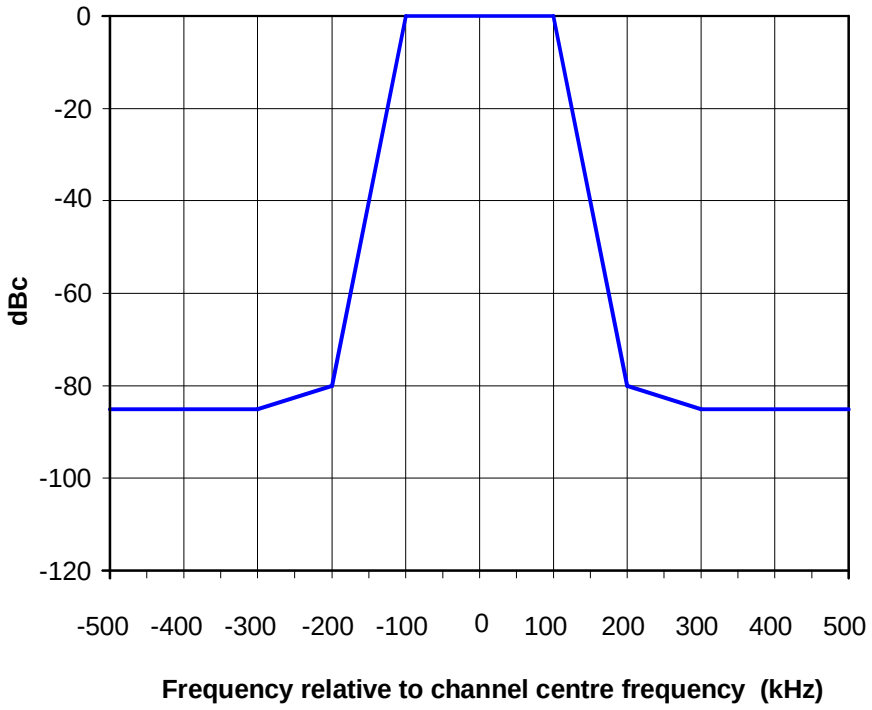


Figure 4.2: Out-of-band emission limits for FM sound broadcasting transmitters

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.5)

1) connect the AF Signal Generator to the EUT;

2) connect the EUT to the Test Load, via the Coupling Device;

3) connect the measuring device to the measuring antenna.

4.5.1.2.2 Procedure

1) operate the EUT without any modulation at each of the test frequencies as defined in clause 4.5.1.2.1;

2) measure the results on the measuring device (using a Quasi Peak Detector);

3) set the AF Signal Generator to deliver a test signal as defined in clause A.1.4;

4) operate the EUT at each of the test frequencies as defined in clause 4.5.1.2.1;

5) measure the results on the measuring device (using a Quasi Peak Detector).

NOTE: Testing shall be carried out at a suitably calibrated test site, unless physical size is a restriction, in which case the test method shall be in accordance with EN 55011 [3]:

- measurements shall be made outside the exclusion band (see table 4.5);
- 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;
- RF 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 Limit

Radiated emissions shall not exceed the values set out in table 4.5, shown additionally in figure 4.3, for the frequency range 30 MHz to 1 GHz.

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 to 3). Tests shall not be carried out in the exclusion band (see note 2 in table 4.5).

Table 4.5: Limits for radiated unwanted emissions

Quasi-peak limits (dBµV/m) at 10m (see notes 1 and 2)	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 1: P_0 = RF output power in W. NOTE 2: The exclusion band for the transmitter extends from Fc - 300 kHz to Fc + 300 kHz, where Fc is the operating frequency in MHz.	

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.

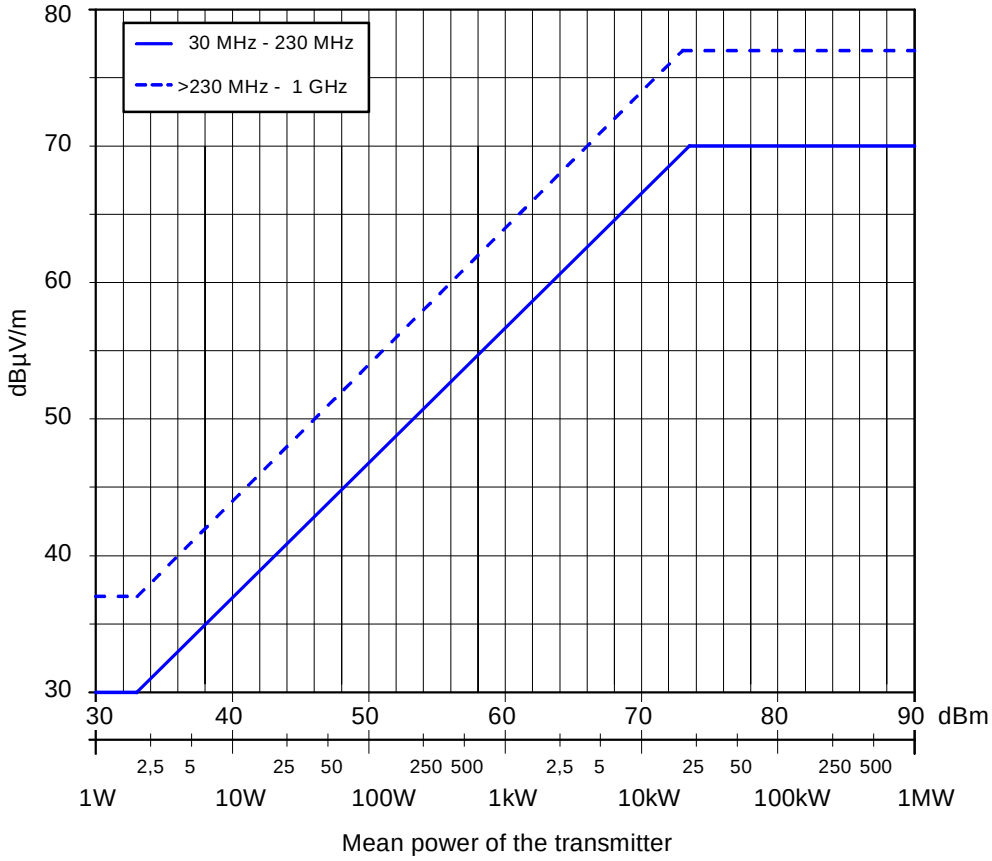


Figure 4.3: Cabinet radiation limits for FM transmitters

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 [6].

Annex A (normative): General measuring arrangements

A.1 Testing arrangements for antenna port measurements

A.1.1 Testing arrangement for monophonic transmitters

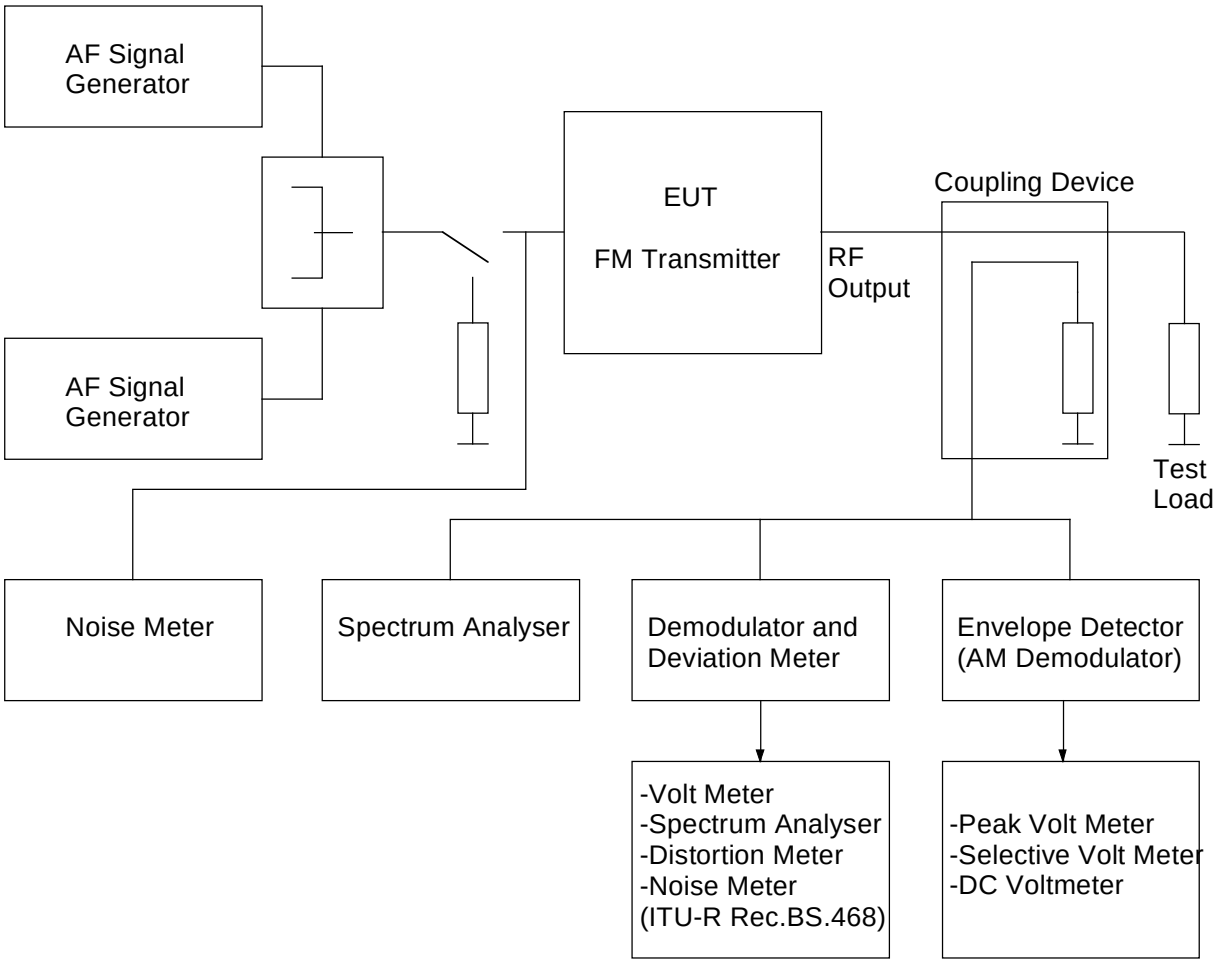
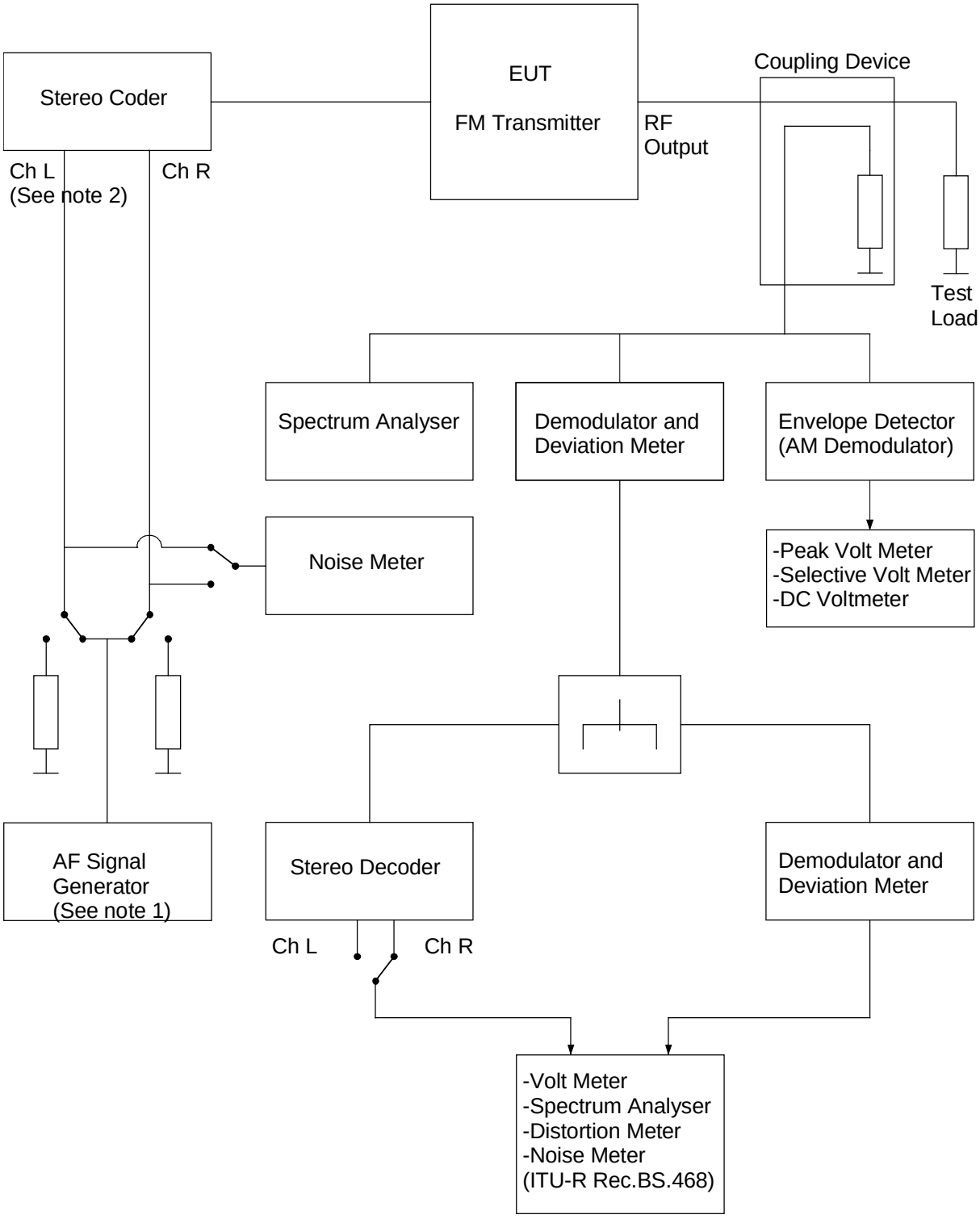


Figure A.1: Testing arrangement for monophonic transmitters

A.1.2 Testing arrangement stereophonic transmitters



NOTE 1: AF Signal Generator is replaced by coloured noise generator when is requested.
NOTE 2: Ch L = Ch R - 6dB.

Figure A.2: Testing arrangement for stereophonic transmitters

A.1.3 Test frequency range

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: Test frequency range

Transmitter fundamental frequency range	Unwanted emission frequency measurement range	
	lower frequency	upper frequency
68 MHz to 108 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:

- 1 kHz.

For definition of reference bandwidth, see ITU-R Recommendation SM.329 [7].

A.1.4 Test modulating signal

Introduction

The allocation of radio frequencies and the place of operation for broadcasting transmitters are planned such that mutual interferences as far as possible are avoided. Basis for frequency planning are the protection margin curves and the curves about propagation of RF signals in the relevant frequency range. The curves on protection margin were specified and internationally approved by ITU-R in its ITU-R Recommendation BS.412 [8].

For these radio-frequency protection ratios it is assumed that the maximum peak deviation of ±75 kHz is not exceeded. Moreover, it is assumed that the power of the complete multiplex signal (including tone and additional signals) integrated over any interval of 60 s is not higher than the power of a multiplex signal containing a single sinusoidal tone which causes a peak deviation of ±19 kHz.

The power of a sinusoidal tone causing a peak deviation of ±19 kHz is equal to the power of the coloured noise modulation signal according to ITU-R Recommendation BS.641 [9], i.e. a coloured noise signal causing a quasi peak deviation of ±32 kHz.

Noise signal for modulating the signal generator

The noise is weighted in accordance with the curves shown in figure A.3.

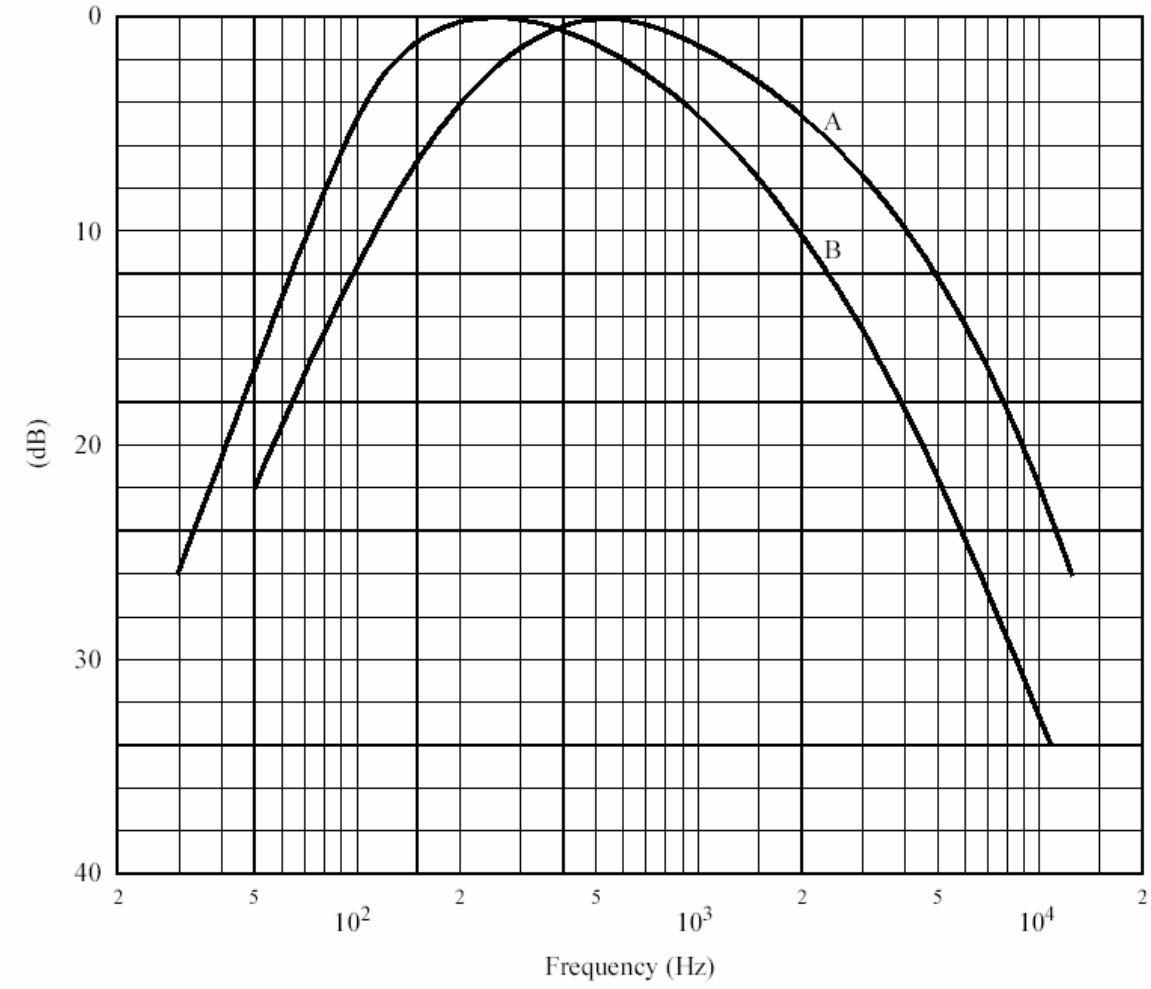
Two conditions should be fulfilled by the standardized signal to simulate programme modulation:

- its spectral constitution must correspond to that of a representative broadcast programme;
- its dynamic range must be small to result in a constant unequivocal reading on the instrument.

The amplitude distribution of modern dance music was taken as a basis, as it is a type of programme with a considerable proportion of high audio-frequencies, which occur most frequently. However, the dynamic range of this type of programme is too wide and does not fulfil, therefore, the second requirement mentioned above. A signal which is appropriate for this purpose is a standardized coloured noise signal, the spectral amplitude distribution of which is fairly close to that of modern dance music (see curve A of figure A.3, which is measured using one-third octave filters).

This standardized coloured noise signal may be obtained from a white-noise generator by means of a passive filter circuit as shown in figure A.4. The frequency-response characteristic of this filter is reproduced as curve B of figure A.3. (It should be noted that the difference between curves A and B of figure A.3 is due to the fact that curve A is based on measurements with one-third octave filters which pass greater amounts of energy as the bandwidth of the filter increases with frequency).

The spectrum beyond the required bandwidth of the standardized coloured noise should be restricted by a low-pass filter having a cut-off frequency and a slope such that the bandwidth of the modulating signal is approximately equal to half the standardized bandwidth of emission. The audio-frequency amplitude/frequency characteristic of the modulating stage of the signal generator shall not vary by more than 2 dB up to the cut-off frequency of the low-pass filter.



Curves A: frequency spectrum of standardized noise (measured with one-third octave filters)
B: frequency response characteristic of filter-circuit

Figure A.3: Coloured noise modulation

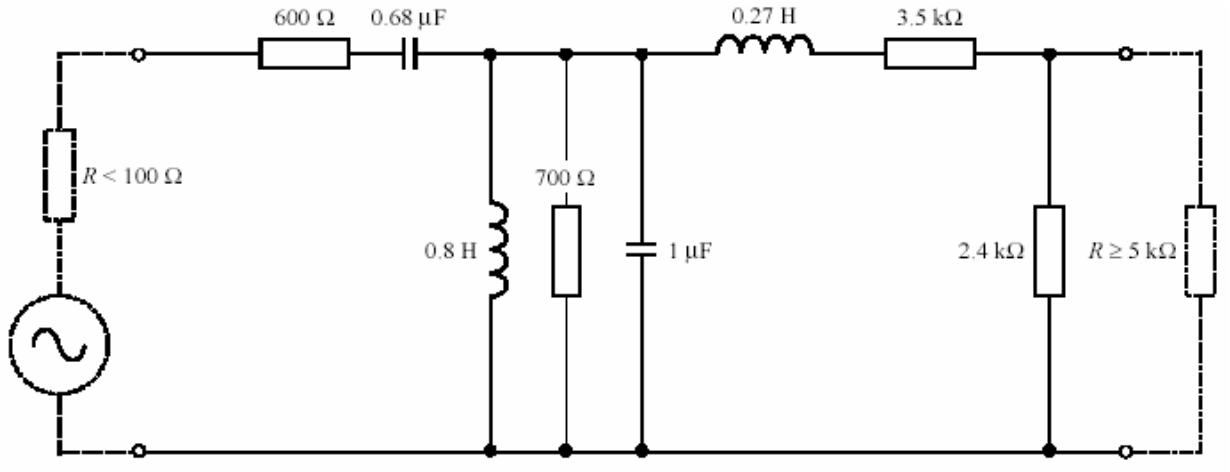


Figure A.4: Filter circuit

A.2 Testing arrangements for enclosure port (radiated emissions) measurements

Guidance on methods of measurement can be found in IEC 60489-1 [5].

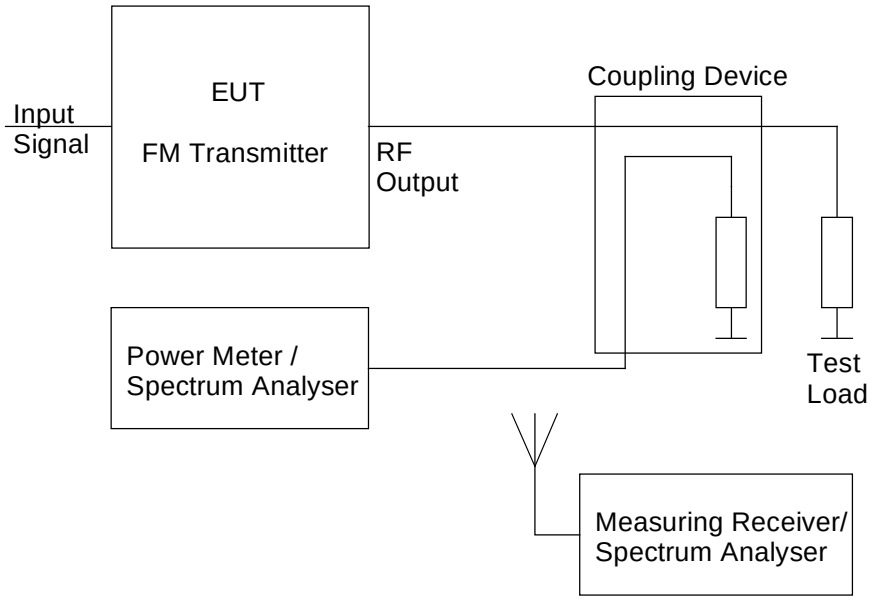


Figure A.5: Testing arrangement for cabinet radiation

A.3 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 B (informative): Bibliography

ITU-R Recommendation BS.559: "Objective measurement radio-frequency protection ratios in LF, MF and HF broadcasting".

ETSI ETR 132: "Radio broadcasting systems; Code of practice for site engineering Very High Frequency (VHF), frequency modulated, sound broadcasting transmitters".

CENELEC EN 50067: "Specification of the radio data system (RDS) for VHF/FM sound broadcasting in the frequency range from 87,5 to 108,0 MHz".

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

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

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

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 harmonization of the laws of Member States relating to electrical equipment designed for use within certain voltage limits (LV Directive).

CISPR 16-1: "Specification for radio disturbance and immunity measuring apparatus and methods - Part 1: Radio disturbance and immunity test".

CISPR 16-2: "Specification for radio disturbance and immunity measuring apparatus and methods - Part 2: "Methods of measurement of disturbances and immunity".

CENELEC EN 60244-1: "Methods of measurements for radio transmitters - Part 1: General characteristics for broadcast transmitters".

CENELEC EN 60244-12-1: "Methods of measurements for radio transmitters - Part 12-1: Guideline for drawing up descriptive leaflets for transmitters and transposers for sound and television broadcasting - Characteristics to be specified".

CENELEC EN 60244-12-2: "Methods of measurements for radio transmitters - Part 12-2: Guideline for drawing up descriptive leaflets for transmitters and transposers for sound and television broadcasting - Specification sheets".

CENELEC EN 60244-13: "Methods of measurement for radio transmitters - Part 13: Performance characteristics for FM sound broadcasting".

History

Document history				
V1.1.1	October 2002	Publication		
V1.2.1	June 2005	Public Enquiry	PE 20051007:	2005-06-08 to 2005-10-07
V1.2.1	December 2005	Vote	V 20060224:	2005-12-26 to 2006-02-24
V1.2.1	March 2006	Publication		