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European Standard (Telecommunications series)

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



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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 the transmitting equipment for the Amplitude Modulated (AM) 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:	26 August 2005
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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 AM sound broadcasting service.

Other documents directly associated with the present document:

- EN 302 017-2 [1];
- EN 301 489-11 [2].

1 Scope

The present document applies to Double Side Band Transmitting equipment for the Amplitude-modulated radio broadcast service.

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

- Transmitting equipment for Amplitude Modulated 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 302 017-2: "Electromagnetic compatibility and Radio spectrum Matters (ERM); Transmitting equipment for the Amplitude Modulated (AM) 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 - Electromagnetic disturbance characteristics - Limits and methods of measurement".
- [4] ETSI TR 100 028 (V1.4.1) (all parts): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Uncertainties in the measurement of mobile radio equipment characteristics".
- [5] ITU-R Recommendation SM.329-10 (2003): "Unwanted emissions in the spurious domain".
- [6] IEC 60489-1: "Methods of measurement for radio equipment used in the mobile services. Part 1: General definitions and standard conditions of measurement".

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: 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

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

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, 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

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 302 017-1 document is required to comply with the provisions of EN 302 017-1

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 (2nd 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 transmission line 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

necessary bandwidth: for a given class of emission, 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

reference bandwidth: bandwidth in which the spurious emission level is specified

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 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:

AF	Audio Frequency
AM	Amplitude Modulation
dB	deciBel, logarithmic ratio (tenths of a "Bel")
dBm	dB relative to one milliwatt
EMC	ElectroMagnetic Compatibility
EUT	Equipment Under Test
HF	High Frequency
LF	Low Frequency
LV	Low Voltage
MF	Medium Frequency
R&TTE	Radio equipment and Telecommunications Terminal Equipment
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 Antenna port measurements

4.2.1 Rated output power

4.2.1.1 Definition

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

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:

- 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.

4.2.1.2.2 Procedure

- 1) operate the EUT at each of the test frequencies as defined in clause 4.2.1.2.1;
- 2) measure the results on the Spectrum Analyser or power meter.

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 carrier output power shall be within $\pm 1,0$ dB of the rated output power under normal operating conditions as defined by the manufacturer.

4.2.2 Frequency drift

4.2.2.1 Definition

The uncontrolled continuous and irreversible 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 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.

4.2.2.2.2 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.

Measurements should be made at intervals, which are short enough to reveal the presence of superimposed periodical variations.

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.

4.2.3 Spurious emissions

4.2.3.1 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.

4.2.3.2 Method of measurement

4.2.3.2.1 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) the measurement shall be done without any modulation;
- 2) connect the EUT to the Test Load, via the Coupling Device;
- 3) connect the Spectrum Analyser to the Coupling Device.

4.2.3.2.2 Procedure

- 1) terminate the input of the transmitter as specified by the manufacturer;
- 2) operate the EUT at each of the test frequencies as defined in clause 4.2.3.2.1;
- 3) measure the results on the Spectrum Analyser.

4.2.3.2.3 Test requirements

The results obtained shall be compared to the limits in clause 4.2.3.3 in order to demonstrate compliance.

4.2.3.3 Limit

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

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)

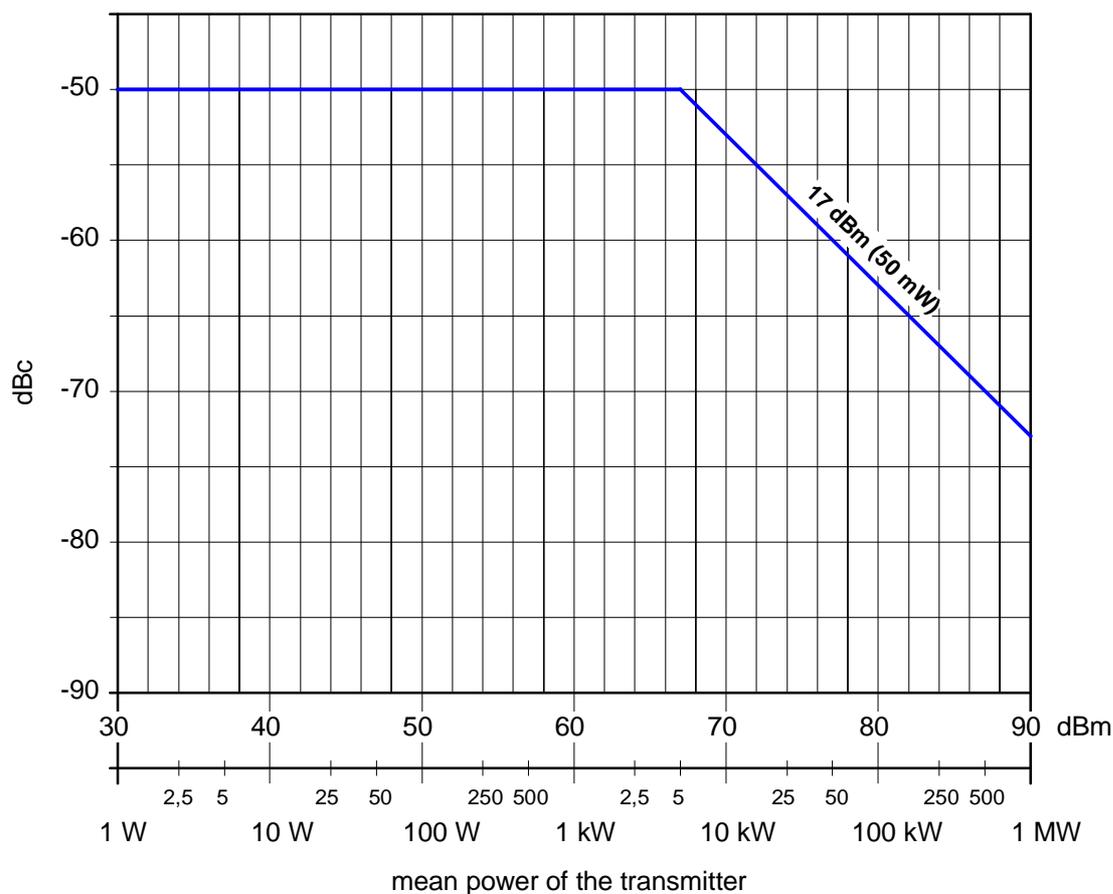


Figure 4.1: Spurious emission limits

4.2.4 Transmitter muting during frequency shift

4.2.4.1 Definition

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

4.2.4.2 Method of measurement

4.2.4.2.1 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.

4.2.4.2.2 Procedure

- 1) operate the EUT at the present frequency;
- 2) initiate frequency change;
- 3) observe the output signal on an oscilloscope.

4.2.4.2.3 Test requirements

The results obtained shall be compared to the limits in clause 4.2.4.3 in order to demonstrate compliance.

4.2.4.3 Limit

The muting shall be as defined in clause 4.2.3.3.

4.2.5 Out-of-band emissions

4.2.5.1 Definition

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

4.2.5.2 Method of measurement

4.2.5.2.1 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.

4.2.5.2.2 Procedure

- 1) set the AF Signal Generator to deliver a test signal as defined in clause A.3;
- 2) operate the EUT at each of the test frequencies as defined in clause 4.2.5.2.1;
- 3) measure the results on the Spectrum Analyser: the measurement shall be repeated for at least 5 times and the results shall be averaged.

The spectrum limits described in this clause for amplitude-modulated emissions for sound broadcasting have been deduced from measurements performed on transmitters which were modulated by weighted noise to an rms modulation factor of 35 % in the absence of any dynamic compression of the signal amplitudes (see clause A.3).

4.2.5.2.3 Test requirements

The results obtained shall be compared to the limits in clause 4.2.5.3 in order to demonstrate compliance.

4.2.5.3 Limit

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

Relationship between the 0 dB reference level and the carrier level:

- The reference level 0 dB corresponds to power density that would exist if the total RF power, excluding the power of the carrier, were distributed uniformly over the necessary bandwidth.

The ratio α_B (dB) of 0 dB reference level to the carrier is given by the equation:

$$\alpha_B = 10 \log \frac{m_{rms}^2 B_{eff}}{2 F} \quad \text{where: } m_{rms} = \text{r.m.s modulation factor of the transmitter}$$

$$B_{eff} = \text{effective noise bandwidth of the analyser}$$

$$F = \text{necessary bandwidth for the emission}$$

Hence the reference level depends on the power of the sideband P_s , given by the formula:

$$P_s = \frac{m_{rms}^2}{2} P_c \quad \text{where: } P_c = \text{carrier power}$$

If frequency is plotted as the abscissa in logarithmic units and if the power densities are plotted as ordinates (dB) the curve representing the out-of-band spectrum should lie below two straight lines starting at point $(0,5 F; 0 \text{ dB})$ or at point $(-0,5 F; 0 \text{ dB})$ and finishing at point $(0,7 F; -35 \text{ dB})$ or $(-0,7 F; -35 \text{ dB})$ respectively. Beyond these points and down to the level of -60 dB , this curve should lie below two straight lines starting from the latter points and having a slope of 12 dB/octave . Thereafter, the same curve should lie below the level -60 dB . The ordinate of the curve so defined represents the average power intercepted by an analyser with an rms noise bandwidth of 100 Hz , the frequency of which is tuned to the frequency plotted on the abscissa.

Table 4.2: Out-of-band emission limits

Relative Frequency (f/F)	Frequency difference (f) from the centre frequency at different channel bandwidths (F) (kHz)				Relative level (dB)
	F=4,5	F=5	F=9	F=10	
$\pm 0,1$	0,45	0,5	0,9	1	0
$\pm 0,5$	2,25	2,5	4,5	5	0
$\pm 0,7$	3,15	3,50	6,3	7	-35
$\pm 1,4$	6,3	7	12,6	14	-47
$\pm 2,8$	12,6	14	25,2	28	-59
$\geq \pm 2,952$	13,28	14,76	26,57	29,52	-60

NOTE: Figure 4.2 is only an additional representation of the limits given in table 4.2. It is not representative of the output of a spectrum analyser. The slope outside $\pm 0,7 F$ is 12 dB per octave until the value of -60 dB is reached.

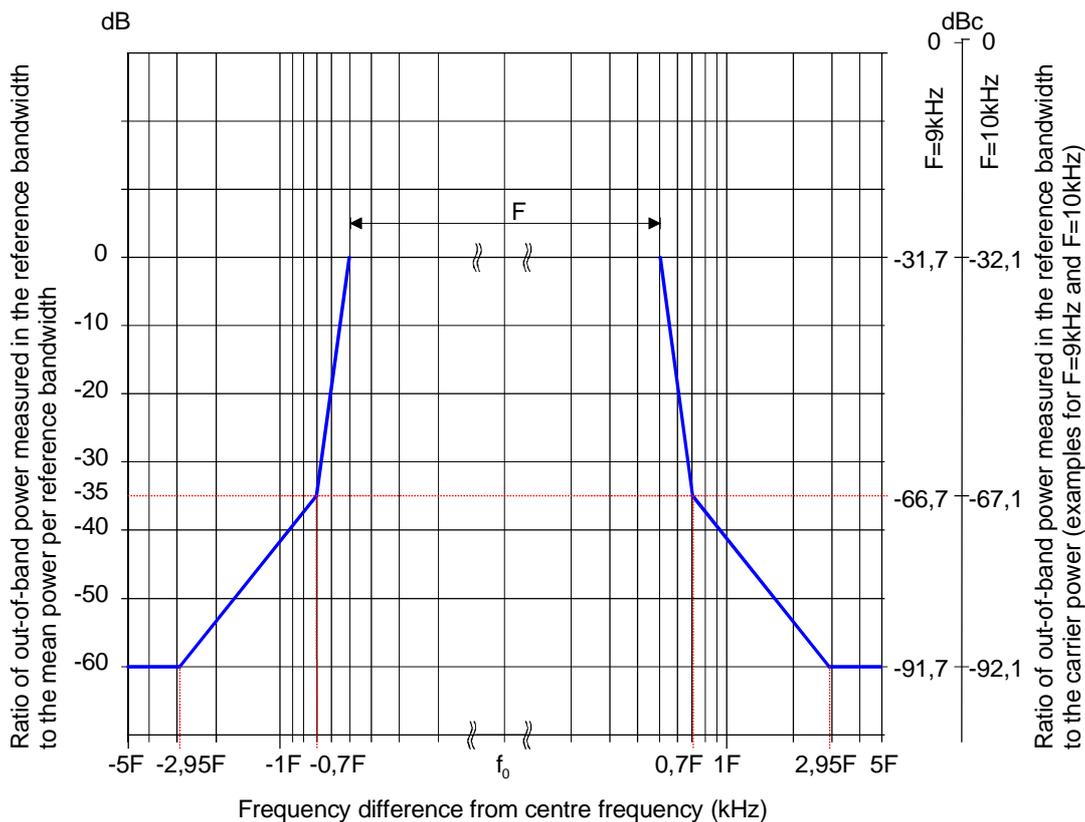


Figure 4.2: Out of band emission limits shown on a logarithmic axis

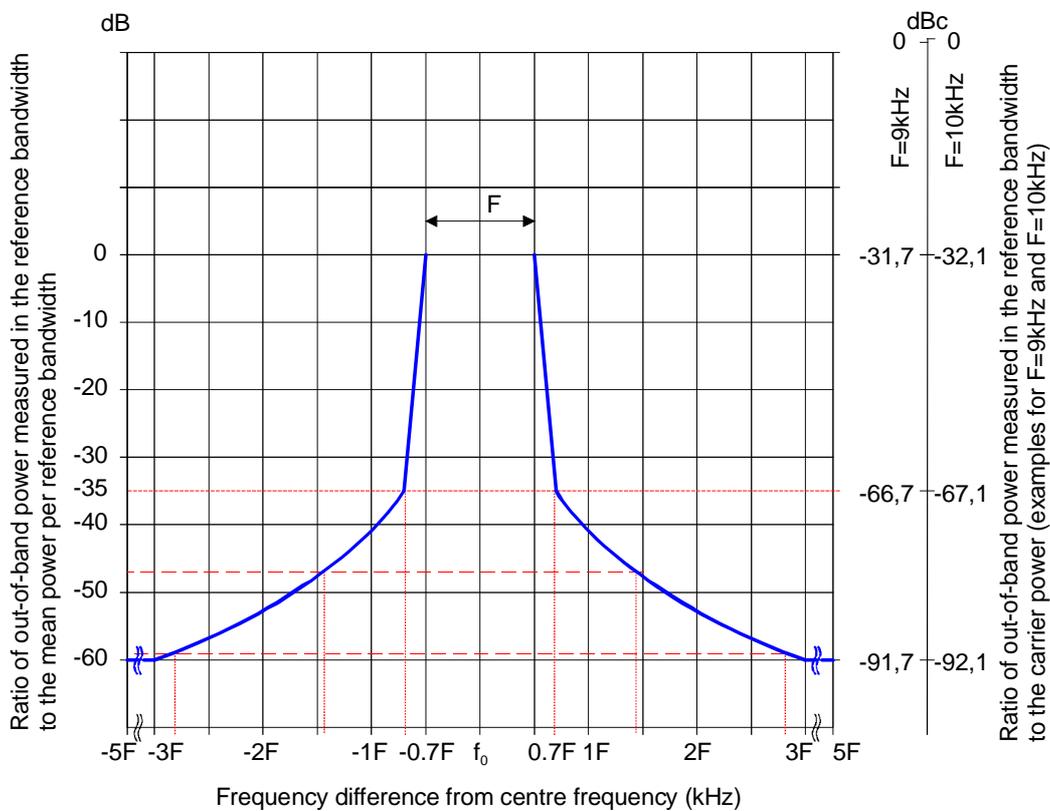


Figure 4.3: Out of band emission limits shown on a linear axis

4.3 Enclosure port measurements (radiated emissions)

4.3.1 Cabinet radiation

4.3.1.1 Definition

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

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 clause A.4):

- 1) connect the AF Signal Generator to the EUT;
- 2) connect the EUT to the Test Load;
- 3) connect the Spectrum Analyser to the measuring antenna.

4.3.1.2.2 Procedure

- 1) set the AF Signal Generator to deliver a test signal as defined in clause A.3;
- 2) operate the EUT at each of the test frequencies as defined in clause 4.3.1.2.1;
- 3) measure the results on the Spectrum Analyser.

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 ± 500 % of the necessary bandwidth of the transmission;
- 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.

4.3.1.3 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 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, 2 and 3 below).

Table 4.3: Cabinet radiation limits

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

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

$$L(x) = L(10\text{m}) + 20 \log (10/x) \quad \text{where } x = \text{distance in meter (m)}.$$

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.

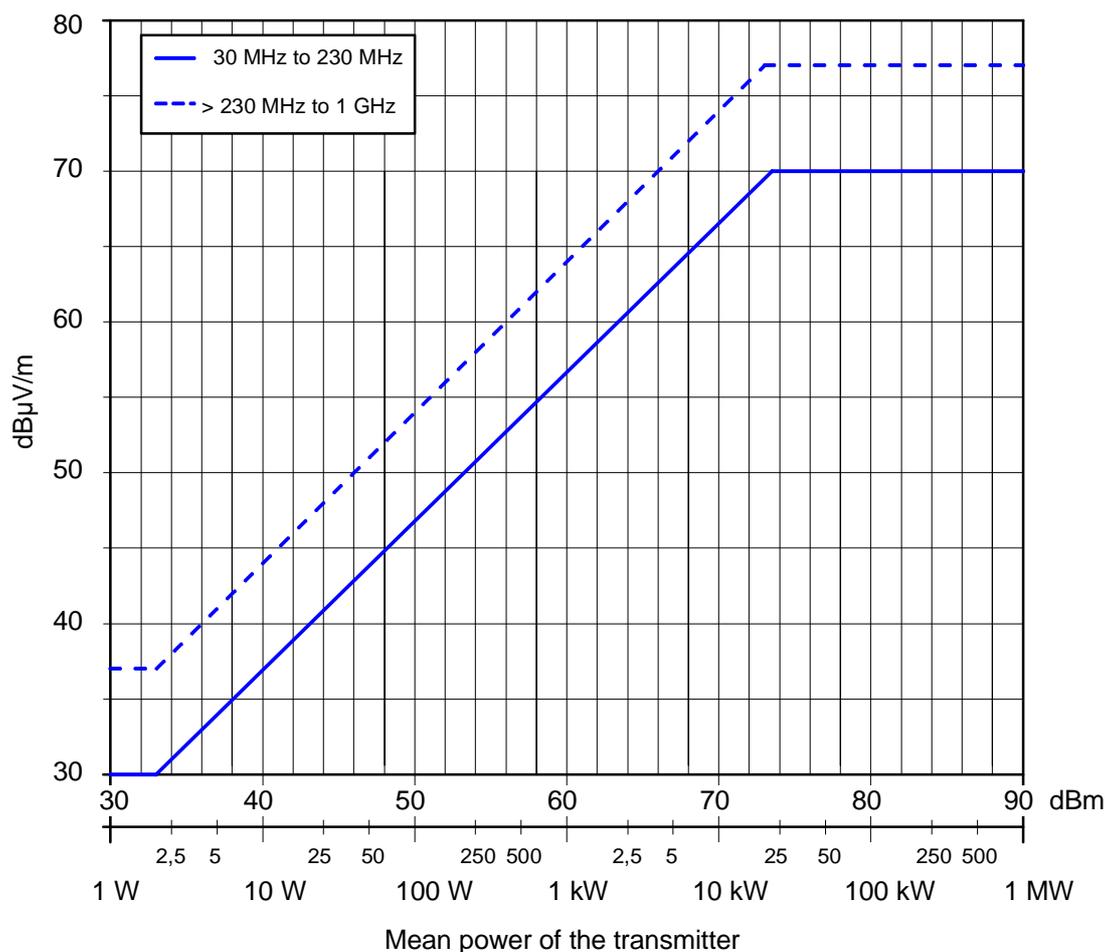


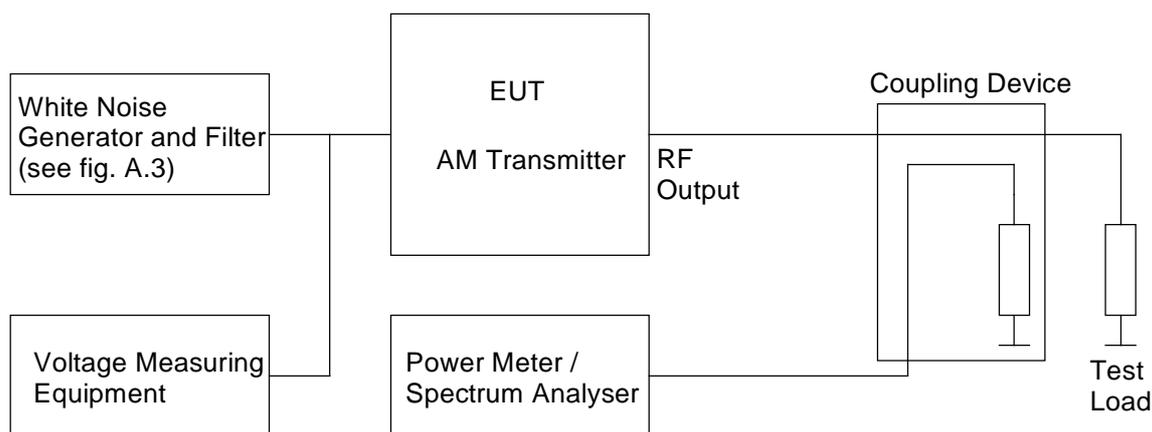
Figure 4.4: Cabinet radiation limits for sound broadcasting transmitters

4.4 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 (TR 100 028 [4]).

Annex A (informative): General measuring arrangements

A.1 Testing arrangements for antenna port measurements



NOTE: In the case of spurious emissions the White Noise Generator and Filter are not used.

Figure A.1: Testing arrangement

A.2 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
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.

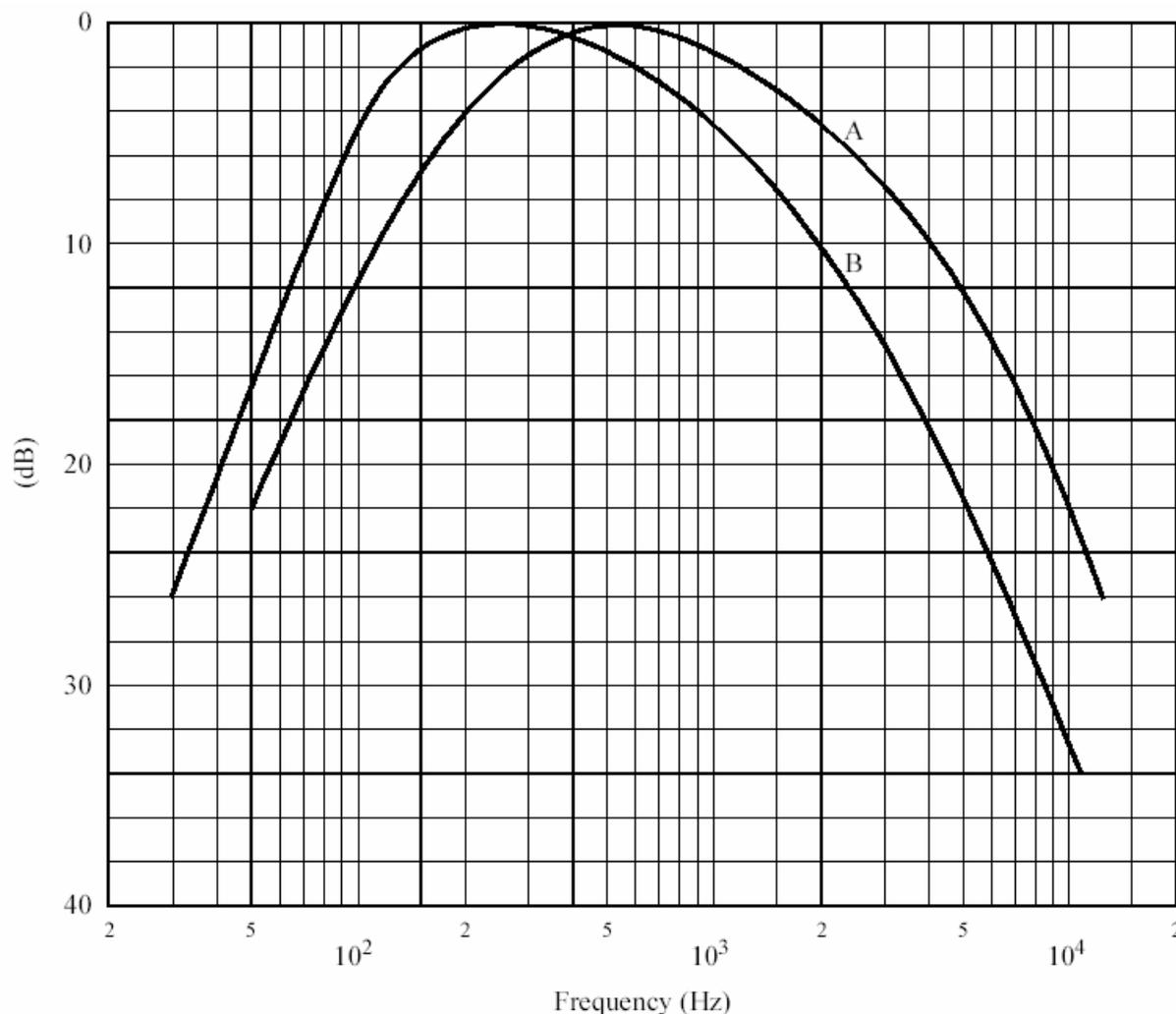
For definition of reference bandwidth, see ITU-R Recommendation SM.329-10 [5].

A.3 Test modulating signal

The noise is weighted in accordance with the curves shown in figure A.2.

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 small to result in a constant unequivocal reading on the instrument.



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

Figure A.2: Coloured noise modulation

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.2, 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.3. The frequency-response characteristic of this filter is reproduced as curve B of figure A.2. (It should be noted that the difference between curves A and B of figure A.2 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.

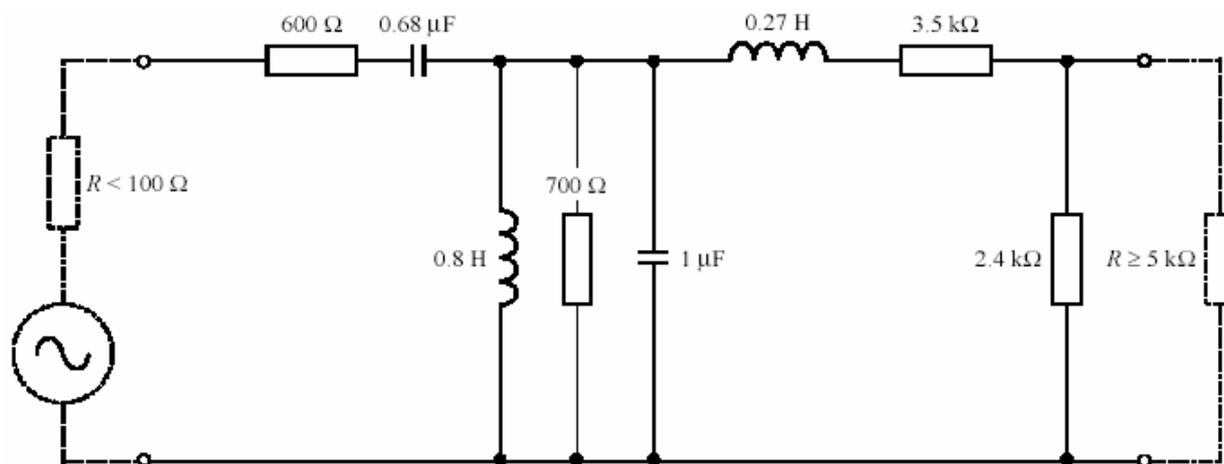


Figure A.3: White Filter circuit

A.4 Testing arrangements for radiated measurements

Examples of a typical test sites can be found in IEC 60489-1 [6].

A.5 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 Radio Regulations (1998).
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