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Methods of mesurement for radio transmitters - Part 15: Amplitude-modulated transmitters for sound broadcasting (IEC 60244-15:1999)

Methods of measurement for radio transmitters -- Part 15: Amplitude-modulated transmitters for sound broadcasting

Meßverfahren für Funksender -- Teil 15: Amplitudenmodulierte Sender für Tonrundfunk

Méthodes de mesure applicables aux émetteurs radioélectriques -- Partie 15: Emetteurs de radiodiffusion sonore à modulation d'amplitude

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Methods of measurement for radio transmitters
Part 15: Amplitude-modulated transmitters for sound broadcasting
(IEC 60244-15:1999)

Méthodes de mesure applicables aux émetteurs radioélectriques
Partie 15: Emetteurs de radiodiffusion sonore à modulation d'amplitude
(CEI 60244-15:1999)

Meßverfahren für Funksender
Teil 15: Amplitudenmodulierte Sender für Tonrundfunk
(IEC 60244-15:1999)

This European Standard was approved by CENELEC on 2000-01-01. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CENELEC member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the Central Secretariat has the same status as the official versions.

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CENELEC

European Committee for Electrotechnical Standardization
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Foreword

The text of document 103/15/FDIS, future edition 1 of IEC 60244-15, prepared by IEC TC 103, Transmitting equipment for radiocommunication, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as EN 60244-15 on 2000-01-01.

This European Standard partly supersedes HD 236.2 S1:1977, HD 236.3 S1:1977 and HD 236.4 S2:1978.

The following dates were fixed:

- latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2000-10-01
- latest date by which the national standards conflicting with the EN have to be withdrawn (dow) 2003-01-01

This standard is intended to be used in conjunction with EN 60244-1:2000.

Annexes designated "normative" are part of the body of the standard.
Annexes designated "informative" are given for information only.
In this standard, annex ZA is normative and annexes A, B and C are informative.
Annex ZA has been added by CENELEC.

Endorsement notice

The text of the International Standard IEC 60244-15:1999 was approved by CENELEC as a European Standard without any modification.

In the official version, for annex C, Bibliography, the following notes have to be added for the standards indicated:

IEC 60244-12-1	NOTE: Harmonized as EN 60244-12-1:1993 (not modified).
IEC 60244-12-2	NOTE: Harmonized as EN 60244-12-2:1993 (not modified).
IEC 60215	NOTE: Harmonized as EN 60215:1989 (not modified).
IEC 60864-1	NOTE: Harmonized, together with its amendment 1:1987, as HD 577 S1:1990 (not modified).
IEC 60864-2	NOTE: Harmonized as EN 60864-2:1997 (not modified).

CONTENTS

Page

Page

1 Scope ... 4
2 Normative references ... 4
3 Definitions ... 5
4 General conditions of operation ... 5
5 General conditions of measurement ... 6
5.1 Input and output measurement arrangements ... 6
5.2 Measuring equipment ... 6
5.3 Modulation and output power conditions ... 6
6 General characteristics ... 7
6.1 Rated output power ... 7
6.2 DSB output power ... 7
6.3 SSB output power ... 8
7 Transmission performance characteristics ... 9
7.1 Modulation ... 9
7.2 DSB modulation ... 9
7.3 DCC modulation ... 10
7.4 SSB modulation ... 11
7.5 Amplitude/radiofrequency characteristic ... 12
7.6 Amplitude/audiofrequency characteristic ... 12
7.7 Modulation capability ... 13
7.8 Long-term stability ... 13
7.9 RF intermodulation ... 14
7.10 Audiofrequency harmonic distortion ... 14
7.11 Audiofrequency intermodulation ... 15
7.12 AM noise level ... 16
7.13 Unwanted synchronous phase-modulation ... 16
7.14 Carrier amplitude variation (carrier shift) ... 17
7.15 Out-of-band emission ... 17
7.16 Suppression of the unwanted sideband ... 18
7.17 Measurement of supplementary signals ... 18

Figure 1 Configuration of measuring arrangements ... 20
Figure 2 RF envelopes of double-sideband (DSB) emissions with full carrier ... 21
Figure 3 RF envelopes of single-sideband (SSB) emissions with 6 dB carrier reduction ... 21
Figure 4 RF envelopes of single-sideband (SSB) emissions with 12 dB carrier reduction ... 21
Figure 5 Signal spectra for DSB transmission ... 22
Figure 6 Signal spectra for SSB transmission ... 22

Annex A (informative) Noise-weighting filters ... 23
Annex B (informative) Out-of-band spectrum ... 24
Annex C (informative) Bibliography ... 26
Annex ZA (normative) Normative references to international publications with their corresponding European publication ... 27

METHODS OF MEASUREMENT FOR RADIO TRANSMITTERS –

Part 15: Amplitude-modulated transmitters for sound broadcasting

1 Scope

This part of IEC 60244 contains the methods of measurement to assess the performance characteristics of amplitude-modulated transmitters for sound broadcasting in the LF, MF and HF bands.

This standard is intended to be used for type tests and acceptance or factory tests.

Fewer or additional measurements may be carried out by agreement between customer and manufacturer. Any additional measurements should preferably be in accordance with relevant standards published by the IEC or by other international bodies.

This part of IEC 60244 does not specify limiting values for acceptable performance as these are usually given in the equipment specification or in requirements laid down by the responsible regulating bodies. However, some values are quoted, where appropriate, for guidance in the presentation of the results.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of IEC 60244. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of IEC 60244 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of IEC and ISO maintain registers of currently valid International Standards.

IEC 60244-1,— *Methods of measurement for radio transmitters – Part 1: General characteristics for broadcast transmitters* [1)]

ITU-R Recommendation 326, *Determination and measurement of the power of radio transmitters*

ITU-R Recommendation 559-1, *Interference protection evaluation model for the radionavigation-satellite service in the 1 559-1 610 MHz band*

ITU-R Recommendation 640, *Single sideband (SSB) system for HF broadcasting*

ITU-R Report 458, *Characteristics of system in LF, MF and HF broadcasting*

ITU-R Report 1059, *Characteristics of single-sideband system in HF broadcasting*

1) To be published.

3 Definitions

For the purposes of this part of IEC 60244, the following definitions apply.

3.1
amplitude-modulated sound transmitter
radio transmitting equipment whose primary purpose is to convert audiofrequency signals into amplitude-modulated radiofrequency transmission

This definition covers double-sideband (DSB) transmitters with full carrier, including dynamic carrier-controlled systems (DCC), and single-sideband (SSB) transmitters with or without carrier reduction.

NOTE Particular examples of dynamic carrier-controlled systems include dynamic amplitude modulation (DAM) and AM companding (AMC). See figures 5 and 6 for ideal spectra for DSB, DCC and SSB transmissions.

3.2
description of the transmission system for AM sound broadcasting
Relevant information concerning transmission systems for AM sound broadcasting is given in ITU-R Recommendations 326 and 640, and in ITU-R Reports 458 and 1059.

3.3
definitions of performance characteristics
For convenience, the definitions of particular performance characteristics are included in clause 6 describing the method of measurement.

4 General conditions of operation

Any device for the suppression of unwanted signals, irrespective of whether or not the device is located inside the transmitter, shall be considered as a part of the transmitter for the purpose of this standard.

Unless otherwise specified, the measurements shall be made under normal operating conditions and at rated output power. If required, they shall be repeated under extreme environmental conditions, in accordance with the equipment specification.

The transmitting mode and the measured output power of the transmitter under test shall be stated.

The mains supply and the environmental conditions shall be stated with the measurement results.

The transmitter shall be connected to a test load having a VSWR, relative to the nominal load impedance of the transmitter, not greater than

- 1,2:1 at frequencies within the designated broadcasting band;
- 1,5:1 at frequencies of any measured unwanted frequency up to ten times the highest frequency of the designated broadcasting band.

If the transmitter includes filters at the audiofrequency input to control the audiofrequency band transmitted, all characteristics shall be measured with the filters in circuit.

5 General conditions of measurement

5.1 Input and output measurement arrangements

For the purposes of measurement, the input and output signal arrangements are given in the form of diagrams.

Where required, the impedance of the test equipment, of the transmitter under test and of all the connections between them shall be appropriately matched.

5.2 Measuring equipment

At the input:

– the modulating signals for the transmitter under test shall be provided by one or two low-distortion low-frequency test signal generators covering frequencies up to 10 kHz, or an ITU-R coloured noise generator;
– if required, auxiliary equipment for supplementary signals shall be used.

At the output:

the following measuring instruments may be used.

a) For measurements within the radiofrequency domain:
   – RF oscilloscope;
   – RF spectrum analyser;
   – RF phase meter.

b) For measurements within the audiofrequency domain using:
   – test demodulator;

     For SSB transmitters, synchronous detection shall be used. For DSB transmitters synchronous or envelope detection can be used.
   – AF spectrum analyser;
   – AF distortion meter.

NOTE 1 Because the results of the measurements are critically dependent on the performance of the test equipment, it is desirable to check the test arrangement first by making measurements without the transmitter in circuit.

NOTE 2 RF measurements carried out by an RF analyser may differ from those obtained by measuring at the output of an envelope detector, as the influence of the carrier phase variation due to the modulation signal is not compensated for. The analyser cannot discriminate between amplitude and phase modulation sideband components located on the same sideband frequencies.

5.3 Modulation and output power conditions

The modulation signal or signals for each measurement are stated in the clauses describing the method of measurement.

The output power of the transmitter is dependent on the modulating signal(s) and on the transmission mode. The appropriate reference power level shall be used in accordance with ITU-R Recommendation 326.

6 General characteristics

The methods of measurement for the general characteristics of transmitters such as input impedance, output power and frequency stability are described in IEC 60244-1.

Specific aspects related to the output power of AM sound broadcasting transmitters are described in 6.1 to 6.3.

6.1 Rated output power

6.1.1 Introduction

The output power capability of a transmitter is given by its rated output power.

6.2 DSB output power

6.2.1 Definition

The rated output power of an amplitude-modulated DSB transmitter is defined by the level of its carrier power, when unmodulated (see figure 5).

The rated power of a DCC transmitter is defined by its maximum carrier power level.

The power levels at the RF output of a DSB transmitter are as follows.

a) Without modulation:
carrier power P_c (rated power).

b) With full modulation:
Mean power $P_m = 1{,}5\ P_c$;
Peak envelope power PEP = $4\ P_c$.

6.2.2 Measuring arrangement

Measuring arrangement A (see figure 1) shall be used with one test signal generator at the input. The test load measures the mean RF power.

6.2.3 Measuring procedure

- Adjust the output of the unmodulated transmitter to its rated power.
- Establish a reference line on the oscilloscope.
- Modulate the transmitter with an 800 Hz or 1 000 Hz audio signal to full modulation so that the peak envelope amplitude on the RF oscilloscope is twice the carrier reference amplitude.
- Note the voltage of the audio signal for the transmitter under test as the reference value for full modulation.

6.2.4 Calculation and presentation of results

The results may be presented as a table stating the rated output power of the transmitter and detailing the power levels measured, together with the modulating frequency used.

State the measured reference level of the modulating signal for full modulation.

6.3 SSB output power

6.3.1 Definition

The rated output power of an SSB transmitter with reduced carrier is defined by the level of its peak envelope power when fully modulated.

SSB transmitters for HF broadcasting are operated with reduced carrier. The peak envelope power level of a fully modulated SSB transmitter depends on the degree of carrier reduction. In accordance with the decisions taken at WARC-79 and WARC-92, the degree of carrier reduction is 6 dB during a transition period of 20 years from 1987, and 12 dB after that period (see figure 6).

The power levels at the RF output of an SSB transmitter working with full modulation are as follows.

a) With carrier reduction of 6 dB:

peak envelope power PEP (rated power)

carrier power P_c = 0,25 PEP

mean power P_m = 0,5 PEP

b) With carrier reduction of 12 dB:

peak envelope power PEP (rated power)

carrier power P_c = 0,063 PEP

mean power P_m = 0,625 PEP

NOTE In accordance with ITU-R Recommendation 640 concerning SSB transmission for broadcasting, the unwanted (lower) sideband and the intermodulation products in that part of the transmitter spectrum have to be suppressed. The current level of suppression recommended by ITU-R is at least 35 dB and, wherever possible, greater than 40 dB, relative to the wanted sideband level.

6.3.2 Measuring arrangement

Measuring arrangement A (see figure 1) shall be used with one test signal generator at the input. The test load measures the mean RF power.

6.3.3 Measuring procedure

- Adjust the output power of the unmodulated transmitter as follows.
  - a) for an SSB transmitter with 6 dB carrier reduction: 0,25 times its rated power (peak envelope power for full modulation).
  - b) for an SSB transmitter with 12 dB carrier reduction: 0,063 times its rated power (peak envelope power for full modulation).
- Establish a reference line on the oscilloscope.
- Modulate the transmitter with a 800 Hz or 1 000 Hz audio signal to full modulation so that:
  - a) for an SSB transmitter with 6 dB carrier reduction, the peak envelope amplitude on the RF oscilloscope is twice the carrier reference amplitude;
  - b) for an SSB transmitter with 12 dB carrier reduction, the peak envelope amplitude on the RF oscilloscope is four times the carrier reference amplitude.
- In the case of an SSB transmitter with 12 dB carrier reduction, check that the mean power of the transmitter modulated as above is 0,625 times its rated power (peak envelope power for fully modulated transmitter).

– Note the voltage of the audio signal for the transmitter under test as the reference value for full modulation.

6.3.4 Calculation and presentation of results

The results may be presented as a table stating the rated output power of the transmitter and detailing the power levels measured, together with the modulating frequency used.

State the measured reference levels of the modulating signal for full modulation.

7 Transmission performance characteristics

The performance characteristics of the transmitter are determined by RF measurements, or by audio measurement after detection.

For DSB transmitters, envelope detection is generally used.

For SSB transmitters, synchronous detection is necessary.

Where necessary, the special detection mode is given with the measurements.

7.1 Modulation

7.1.1 Introduction

In amplitude-modulated transmission, the output signal has an amplitude determined by the instantaneous amplitude of the modulating signal. The deviation of the envelope amplitude from the unmodulated carrier amplitude is a function of the depth of the modulation.

In the case of double side-band transmission with full carrier, the depth of modulation is expressed as "modulation factor". The modulation factor is the ratio of (1) the deviation from the average of the envelope to (2) the average of the envelope.

However, the concept of modulation factor is not appropriate for dynamic controlled or reduced carrier DSB systems, nor is it appropriate for SSB systems with or without carrier reduction. For these systems, the depth of modulation is expressed as "utilization factor".

The appropriate definitions of depth of modulation for the various systems of AM transmission used in broadcasting are given in 7.2 to 7.4.

7.2 DSB modulation

7.2.1 Definition

For DSB modulation the term "modulation factor" is used. Modulation factor is defined as the ratio of (1) the deviation from the average of the envelope to (2) the average of the envelope.

The positive (negative) modulation factor may be distinguished by measuring the positive (negative) peak of the envelope referred to the carrier (see figure 1).

NOTE The r.m.s. value of the modulation factor is defined as the ratio of (1) the r.m.s. value of the a.c. component of the envelope amplitude multiplied by 1,41, to (2) the d.c. amplitude of the modulated signal.