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INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

Methods of measurement for radio transmitters – Part 1: Performance characteristics of terrestrial digital television transmitters

Méthodes de mesure applicables aux émetteurs radioélectriques – Partie 1: Caractéristique de performance des émetteurs de télévision numérique terrestre

IEC 62273-1:2007

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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METHODS OF MEASUREMENT FOR RADIO TRANSMITTERS –

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International Standard IEC 62273-1 has been prepared by IEC technical committee 103: Transmitting equipment for radio communication.

This bilingual version (2012-04) corresponds to the monolingual English version, published in 2007-02.

The text of this standard is based on the following documents:

FDIS	Report on voting
103/63/FDIS	103/65/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

The French version of this standard has not been voted upon.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

The list of all the publications of the IEC 62273 series, under the general title *Methods of measurement for radio transmitters*, can be found on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the maintenance result date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

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METHODS OF MEASUREMENT FOR RADIO TRANSMITTERS –

Part 1: Performance characteristics of terrestrial digital television transmitters

1 Scope

This part of IEC 62273 gives the conditions for measuring the performance parameters of terrestrial digital transmitters and for facilitating the comparison of measurements which are carried out by different personnel. It contains details of specially selected methods for determining the most important performance parameters of digital transmitters. The measurement methods described apply to a limited number of performance parameters, i.e. those which can give rise to ambiguous interpretation due to the use of different methods and conditions. They are neither restrictive nor mandatory: measurements can be chosen for each particular case. If necessary, additional tests can be carried out but they shall comply with those standards which have been established by other study groups, subcommittees of the IEC or other international or suitably accredited organizations.

No limits have been assigned to quantify acceptable ranges of performance parameters. These are judged to be properly included in the technical specifications for individual transmitters; however, the terms and the manner used to quantify them should ideally be those described in a future IEC publication.

The measurement methods described in this standard are intended for type approval tests. However they can equally well apply to acceptance tests measurements and quality control tests either in factories or on site.

Test signals are used to measure performance parameters for both digital and analogue terrestrial transmitters. Their electronic characteristics and their associated performance parameters are widely understood. The test signals are measured after they have gone through the transmitter equipment to determine if their degradation is within the required quality criteria.

This standard does not go into any detail regarding MPEG 2 signals or DVB processes nor does it deal with digital signal processing.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60215, *Safety requirements for radio transmitting equipment*

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

ITU-R Recommendation BT.1306-3, *Error correction, data framing, modulation and emission methods for digital terrestrial television broadcasting*

ITU-R:2004, *Radio Regulations*

ETS 30 0744, *Digital video broadcasting – Framing structure, channel coding and modulation for digital terrestrial television*

ETSI 101 290, *Digital video broadcasting (DVB) – Measurement guidelines for DVB system*

3 Terms, definitions and abbreviations

For the purposes of this document, the following terms, definitions and abbreviations apply.

3.1
ASI
Asynchronous Serial Interface

3.2
ATSC
Advanced Television Systems Committee

3.3
BER
Bit Error Ratio

3.4
BW
Bandwidth

3.5
C/N
Ratio of the r.f. or i.f. carrier power to noise power

3.6
COFDM
Coded Orthogonal Frequency Division Multiplex

3.7
CPE
Common Phase Error

3.8
DVB
Digital Video Broadcasting

3.9
DVB-T
Digital Video Broadcasting baseline system for digital terrestrial television

3.10
END
Equivalent Noise Degradation

3.11
ETS
European Telecommunication Standard

3.12
ICI
Inter Carrier Interference

3.13
IEC
International Electrotechnical Commission

3.14
ISDB-T
Integrated Services Digital Broadcasting for Terrestrial broadcasting system

3.15
ISO
International Organization for Standardization

3.16
ITU
International Telecommunication Union

3.17
JEITA
Japan Electronics & Information Technology Industries Association

3.18
LO
Local Oscillator

3.19
MER
Modulation Error Ratio

3.20
MPEG
Moving Picture Expert Group

3.21
OFDM
Orthogonal Frequency Division Multiplex

3.22
PRBS
Pseudo Random Binary Sequence

3.23
QAM
Quadrature Amplitude Modulation

3.24
RF
Radiofrequency

3.25
RS
Reed-Solomon

3.26
SFN
Single Frequency Network

4 General conditions of measurement

4.1 Temperature and humidity

Equipment to be measured shall be operated in an environment which meets the temperature and humidity requirements as defined in their technical specifications. Temperature and humidity must never be such as to cause condensation on the equipment during measurements. In the absence of temperature and humidity requirements in the technical specifications, the provisions of IEC 60244-1 shall apply.

4.2 Conditions for primary power supply

The measurement is carried out at the nominal voltage and the nominal frequency of the power supply given in the relevant equipment specification.

During a series of measurements carried out as part of one test on one equipment, the voltage and frequency of the power supply shall not deviate from the nominal values more than indicated in the relevant equipment specification.

When the nominal voltage and frequency cannot be obtained during the measurement, the following shall apply.

a) If the quantities to be measured depend on voltage and/or frequency and the law dependence is known, the values are measured at a voltage and frequency which shall be within the limits laid down in the relevant equipment specification. If necessary, the measured quantities shall be corrected to the nominal voltage and/or frequency by calculation.

b) If the quantities to be measured depend on voltage and/or frequency and the law of dependence is unknown, the values are measured at a voltage and frequency which shall be within 2 % of nominal voltage and 1 % of the nominal frequency, unless closer tolerances are specified in the equipment specification.

   The conditions for primary power voltage and frequency shall be specified in the equipment specification. If the conditions for primary power are not specified, the provisions of IEC 60244-1, Clause 5, shall apply.

   Measurements shall be carried out at the nominal voltage and the nominal frequency of the power supply given in the relevant equipment specification.

4.3 Output power

The tests shall be carried out with the transmitter set to its nominal power output after the time for stabilization, as defined in the transmitter technical specification, has elapsed. Nominal output power is taken to mean the average output power as defined by the manufacturer.

4.4 Test load

The impedance of the test load to which the transmitter is connected shall satisfy the following requirements.

The nominal value of the test load shall be the same as the line characteristic impedance for which the transmitter has been designed. The tolerances for this equality shall be the same as the load tolerances as defined in the transmitter technical specification. The test load impedance shall remain adequately constant throughout the required frequency band for test

4.5 Auxiliary equipment

If the transmitter technical specification makes reference to related auxiliary units such as pass-band filters to limit the transmitted signal frequencies or multiplexing units for multiplex transmissions, these units shall be used during the test.

4.6 Test equipment and test signals

These test procedures for digital television transmitters require that the test signals used shall conform to the digital standard implemented in the transmitter (ATSC, DVB-T, ISDB-T) and that the measuring equipment is sufficiently accurate and stable and has the necessary dynamic range to provide error-free measurements of transmitter performance parameters. However, in order to validate the physical layer of the vector r.f. signal that carrying modulating the input signal. In the case of an ASI type signal, an eye-height measurement should be taken at the signal input to the transmitter being tested. The eye-height diagram shows the I and Q time-domain base band modulating signals. Interference caused by distortions which reduce the eye height can be observed. Limits for the eye-height diagram are given in Annex A.

5 General characteristics

5.1 Frequency

5.1.1 General

In order to achieve effective use of the radiofrequency spectrum and limit mutual interference caused by radio services occupying adjacent channels, any departure from the frequency assignees to a transmitter shall be kept within strictly observed limits. These are defined by the International Telecommunication Union and are laid down in the Radio Regulations. The frequency tolerance of frequency bands are given in IEC 60244-1, Annex C. In addition to the above, for the SFN mode, each transmitter frequency shall be kept within reasonable limits to avoid the degradation caused by the frequency deviation of plural transmitters. The acceptable limits for SFN operation depends on the network configuration and transmission parameters; therefore, the acceptable limits for SFN may be specified for each system.

5.1.2 Characteristic frequency

A frequency which can easily be identified and measured in the occupied band of an emission.

The term “characteristic frequency” is used in this standard to denote the actual frequency of that component of the emission, the nominal value of which is the assigned frequency.

Complementary information is given in Annex B.

5.1.3 Frequency tolerance

The frequency tolerance is the permissible departure of the characteristic frequency of an emission from the assigned frequency. The frequency tolerance is expressed in parts per 10^6 or in hertz.

5.1.4 Frequency stability

The frequency stability is the extent to which an emission maintains its assigned frequency within frequency tolerance.

A random departure from the assigned frequency is expressed as frequency error.

5.1.5 Frequency error

The frequency error is the difference between the assigned frequency and the characteristic frequency, and shall not exceed the specified frequency tolerance.

The maximum frequency error is expressed in hertz and shall be compared with the frequency tolerance in the ITU Radio Regulations or with the relevant statement in the equipment specification.

5.1.6 Frequency drift

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

The latter shall be chosen to identify short-term and/or long-term frequency variations, expressed in hertz against a defined timescale defined in the technical specification for the equipment.

Complementary information is given in Annex C.

5.1.7 Frequency-setting error

When a transmitter is set to a particular frequency, the characteristics frequency obtained will generally differ from the assigned frequency. This is the frequency-setting error.

5.1.8 Condition of operation

The transmitter shall be operated under the conditions given in Clause 4. These conditions shall be clearly stated together with the condition of modulation.

5.1.9 Methods of measurement of the characteristic frequency of an emission

The characteristic frequency may be measured with any suitable measuring device, provided that the accuracy attained during the measurement is better than approximately 10 % of the frequency tolerance of the frequency stability given in the relevant equipment specification of the transmitter.

NOTE To achieve the required accuracy, the spectrum analyser and, if necessary, the frequency counter used should be synchronized with a frequency reference independent of the transmitter being tested (GPS 10 MHz or rubidium standard).

Other methods of great precision use a standard reference frequency, the frequency of which is known with high accuracy. With such a method, the reception of a standard frequency transmission may be used to advantage.

When the frequency is to be measured as a function of time, measurements shall be made at intervals that are short enough to reveal the presence of superimposed periodic variations and long enough to reveal frequency drift. It is recommended that the measurements are made with a recording instrument.

The accuracy of the measuring method, if known, shall be stated with the results of the measurements. If not known, an estimate should be given, based on measuring data.

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

5.2 Output power

5.2.1 General note on output power

For a digital signal with the COFDM modulation process the power is distributed evenly throughout the transmission channel. Hence, when taking power measurements on such a signal, the total bandwidth occupied by the modulated signal shall be taken into account. The product of the mean power of the aerial voltage and current signals is defined as the power output for a particular channel.

The output power is the first parameter to be measured when checking performance parameters or carrying out conformity checks. In the case of a digital signal, the mean power value is the most appropriate for the modulation type being used.

5.2.2 Measuring arrangement

Figure 1 shows the measuring set-up to be used.

5.2.3 Test signal

The transmission parameters of the test signal shall be specified for each system. If no such specification is given, a signal comprising PRBS 2^23-1-8K 64-QAM 7/8 ¼ from the COFDM encoder and modulator shall be used.

5.2.4 Method of measurement

5.2.4.1 Calorimetric method

The value for the output power is derived either by measuring the heat dissipated in the test load or from a bolometer reading of the r.f. signal derived from a calibrated directive coupler on the transmitter output line. The output power is expressed in watts.

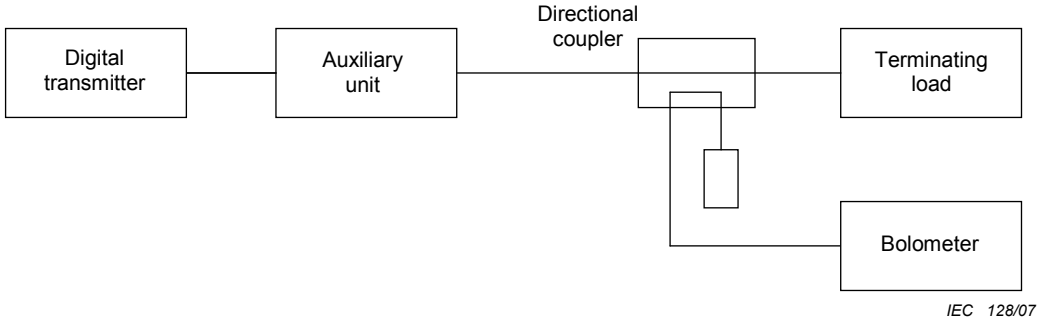

Figure 1 – Measuring set-up for output power

When the temperature rise of the water in the test load is used to derive the output power value, the following two sets of readings are taken so as to minimize the thermometer errors:

a) Thermometer A: water temperature at load inlet; Thermometer B: water temperature at load outlet;

b) Thermometer B: water temperature at load inlet; Thermometer A: water temperature at load outlet.

Inlet and outlet temperatures are taken as the averages of the two readings in each case.

The output power value is derived from the following formula:

$$P(W) = 0{,}069D.\Delta\theta$$

where

$P(W)$ is the measured power;

D is the water flow rate in litres per minute;

$\Delta\theta$ is the difference between the load inlet and the outlet water temperatures in °C.

This formula only applies in the absence of additives to the water.

When a bolometer reading of the r.f. signal from a calibrated directional coupler is used to derive the output power value, the following formula is used:

$$P(W) = (10^{ATT/10}) \times (Pm) \times (\text{cal factor})$$

where

$P(W)$ is the measured power;

ATT(dB) is the attenuation of the directional coupler;

cal factor(%) is the calibration factor for the bolometer probe at the operating frequency.

The method of calibration of the directional coupler is given in Annex D.

Since the output power value is a fundamental reference point when quantifying non-linear distortion parameters, it is recommended that a permanent output power reading is displayed by a measuring instrument capable of measuring the r.f. signal from the directional coupler which is bridged across the output r.f. line. This reading shall be available throughout the validation of the transmitter performance parameters.

5.2.4.2 Spectrum analyser method

a) Set the modulator output to reference signal

b) Connect a spectrum analyser to the measurement point, using a cable the loss of which has been calibrated. If the power level at the measurement point is too high, adjust it in such a way that it falls within the measurement range of the spectrum analyser, using a calibrated directional coupler and attenuator.

c) Setting of the spectrum analyser

Centre frequency	Span	RBW	VBW	Detect mode	Channel BW
Centre frequency of the modulated wave	10 MHz	30 kHz	300 kHz	Sample detection	See note
NOTE The channel bandwidth is defined for each system. Use the channel power measurement to measure the power.					

d) Determine the power from the reading of the spectrum analyser and the calibration value.

Power (dBm) = spectrum analyser reading (dBm) + cable loss (dB) + calibration value (dB) + directional coupler coupling factor (dB) + attenuator value

$P(W) = 10^{p(dBm)/10}/1000$