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Methods of measurement for radio equipment used in the mobile services - Part 5: Receivers employing single-sideband techniques (R3E, H3E or J3E)

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Meßverfahren für Funkgerät im beweglichen Funkdienst -- Teil 5: Empfänger für Einseitenband-Aussendungen (R3E, H3E oder J3E)

Méthodes de mesure applicables au matériel de radiocommunication utilisé dans les services mobiles -- Partie 5: Récepteurs con\us pour les émissions à bande latérale unique (R3E, H3E ou J3E)

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METHODS OF MEASUREMENT FOR RADIO EQUIPMENT USED IN THE MOBILE SERVICES PART 5: RECEIVERS EMPLOYING SINGLE-SIDEBAND TECHNIQUES (R3E, H3E OR J3E)

Méthodes de mesure applicables au matériel de radiocommunication utilisé dans les services mobiles Cinquième partie: Récepteurs conçus pour les émissions à bande latérale unique (R3E, H3E ou J3E)

Meßverfahren für Funkgerät im beweglichen Funkdienst Teil 5: Empfänger für Einseitenband-Aussendungen (R3E, H3E oder J3E)

BODY OF THE HD

The Harmonization Document consists of:

- IEC 489-5 (1987) ed 2; IEC/SC 12F, not appended

This Harmonization Document was approved by CENELEC on 12 June 1989.

The English and French versions of this Harmonization Document are provided by the text of the IEC publication and the German version is the official translation of the IEC text.

According to the CENELEC Internal Regulations the CENELEC member National Committees are bound:

to announce the existence of this Harmonization Document at national level by or before 1989-12-01

to publish their new harmonized national standard by or before 1990-06-01

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Harmonized national standards are listed on the HD information sheet, which is available from the CENELEC National Committees or from the CENELEC Central Secretariat.

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Récepteurs conçus pour les émissions à bande latérale unique (R3E, H3E ou J3E)

Methods of measurement for radio equipment used in the mobile services

Part 5:
Receivers employing single-sideband techniques (R3E, H3E or J3E)

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

METHODS OF MEASUREMENT FOR RADIO EQUIPMENT USED IN THE MOBILE SERVICES

Part 5: Receivers employing single-sideband techniques (R3E, H3E or J3E)

FOREWORD

1) The formal decisions or agreements of the IEC on technical matters, prepared by the Technical Committees on which all the National Committees having a special interest therein are represented, express, as nearly as possible, an international consensus of opinion on the subjects dealt with.
2) They have the form of recommendations for international use and they are accepted by the National Committees in that sense.
3) In order to promote international unification, the IEC expresses the wish that all National Committees should adopt the text of the IEC recommendation for their national rules in so far as national conditions will permit. Any divergence between the IEC recommendation and the corresponding national rules should, as far as possible, be clearly indicated in the latter.

PREFACE

This standard has been prepared by Sub-Committee 12F: Equipment Used in the Mobile Services, of IEC Technical Committee No. 12: Radiocommunications.

This second edition replaces the first edition of IEC Publication 489-5, IEC Publication 489-5A, and IEC Publication 489-5, Amendment No. 1.

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

Six Months' Rule	Reports on Voting
12F(CO)73	12F(CO)89
12F(CO)80	12F(CO)99
12F(CO)81	12F(CO)100
12F(CO)82	12F(CO)102
12F(CO)83, 83A	12F(CO)103
12F(CO)85	12F(CO)105
12F(CO)86	12F(CO)119
12F(CO)95	12F(CO)110
12F(CO)96	12F(CO)111
12F(CO)112	12F(CO)124
12F(CO)113	12F(CO)125
12F(CO)114	12F(CO)127
12F(CO)121	12F(CO)130

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

Other IEC publications quoted in this standard:

Publications Nos. 489-1 (1983): Methods of measurement for radio equipment used in the mobile services, Part 1: General definitions and standard conditions of measurement.

315-1 (1970): Methods of measurement on radio receivers for various classes of emission, Part 1: General conditions for measurements and measuring methods applying to several types of receivers.

315-2 (1971): Part 2: Measurements particularly related to the audio-frequency part of a receiver.

METHODS OF MEASUREMENT FOR RADIO EQUIPMENT USED IN THE MOBILE SERVICES

Part 5: Receivers employing single-sideband techniques (R3E, H3E or J3E)

SECTION ONE – GENERAL

1. Scope

This standard refers specifically to mobile radio receivers having audio-frequency bandwidths generally not exceeding 10 kHz for the reception of voice and other types of signals, using single-sideband amplitude modulation.

This standard is intended to be used in conjunction with IEC Publication 489-1. The supplementary terms and definitions and the conditions of measurement set forth in this standard are intended for type tests and may be used also for acceptance tests.

2. Object

The object of this standard is to standardize the definitions, the conditions and the methods of measurement used to ascertain the performance of receivers within the scope of this standard and to make possible a meaningful comparison of the results of measurements made by different observers and on different equipment.

SECTION TWO – SUPPLEMENTARY DEFINITIONS AND CONDITIONS OF MEASUREMENT

3. Supplementary terms and definitions

For the purpose of this standard, the following supplementary definitions apply.

3.1 *Output level*

3.1.1 *Rated output level*

The level, as defined in the equipment specifications, corresponding to:

– the power at the audio output terminals when these are connected to a specified load

or

– the voltage appearing across the output transducer

or

– the sound pressure.

In the absence of a value specified by the manufacturer, the rated output level is 3 dB below the maximum output level.

3.1.2 *Reference output level*

a) Where there is a continuously variable gain control, the reference output level is that which is 6 dB below the rated output level.

b) Where there is step-by-step output control, the reference output level is that closest to the level defined in Step *a)* above.

c) Where there is no gain control, the reference output level is the level obtained when a standard input signal is applied to the receiver.

3.2 *Audio-frequency load*

For equipment with an integral audio-frequency output transducer, the load is the output transducer.

Note. – The manufacturer should specify the method of connection and state the impedance (and tolerance) of the output transducer at 1000 Hz. It is desirable also to state the impedance at specified upper and lower audio-frequency band limits.

3.2.1 *Audio-frequency test load*

An impedance network which replaces the load to which the receiver is connected under normal operating conditions. It simulates the impedance of the normal load and any cables with which it is normally used.

Note. – The network shall be specified by the manufacturer. It usually consists of a single pure resistance.

3.3 *Standard signal-to-noise ratio*

Ratio of:
the power of the signal-plus-noise-plus-distortion
to
the power of the noise-plus-distortion
at the test load.

This ratio is abbreviated as: $\frac{S+N+D}{N+D}$

where:
S is the wanted audio-frequency signal due to standard test modulation
N is the noise with standard test modulation
D is the distortion with standard test modulation

It is expressed in decibels and is often referred to as SINAD.

The value of the standard signal-to-noise ratio is 12 dB.

The standard signal-to-noise ratio allows comparison between different equipment when the standard test modulation is used.

Note. – Other types and values of signal-to-noise ratio may be used by agreement between the purchaser and the manufacturer.

3.4 *Radiation sensitivity of a receiver with an integral antenna, in a given direction (field strength)*

The field strength required to produce the standard signal-to-noise ratio under specified conditions of operation.

Notes 1. – An integral antenna is an antenna which is considered to be an integral part of the equipment. In some cases, the receiver operates with the antenna inside the housing and in others with the antenna mounted on the exterior of the housing.

2. – For certain applications, another characteristic, for example, the squelch opening level, may be specified.

3. – In this publication, the term "antenna" is synonymous with "aerial".

3.5 *De-emphasis*

The process intended to restore the original form of a signal which has been transmitted with pre-emphasis.

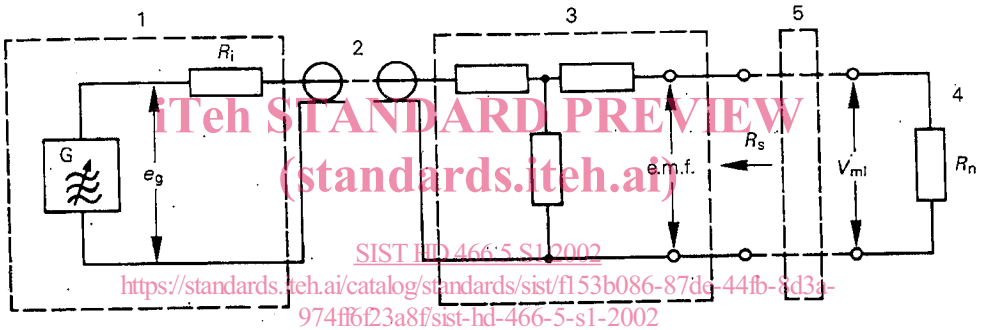
Note. – Pre-emphasis may be applied before modulation.

4. Standard test conditions

Unless otherwise stated, measurements shall be performed under the general test conditions as stated in IEC Publication 489-1 and the supplementary test conditions given below.

5. Supplementary test conditions

5.1 *Input-signal arrangements for testing receivers equipped with suitable antenna terminals*



1 = radio-frequency signal generator with source impedance R_i
2 = transmission line
3 = impedance matching network (pad)
4 = nominal input impedance of receiver: R_n
5 = artificial antenna (where required)
R_s = impedance of the input-signal source

FIG. 1. – Input-signal source arrangement.

The nominal radio-frequency input impedance (R_n) is that value stated by the manufacturer for which the equipment performance will be optimum when connected to an antenna of the same impedance.

The input-signal level should preferably be expressed as: the electromotive force (e.m.f.) present at the output of the unterminated input-signal source (e.m.f. of Figure 1) when the input-signal source impedance (R_s) is equal to the nominal radio-frequency input impedance (R_n) of the receiver.

Alternatively, the input-signal may be expressed as the matched-load (V_{ml}) voltage measured across an impedance having a value equal to R_n, when the source impedance (R_s) is equal to the nominal radio-frequency input impedance (R_n).

The matched-load voltage (V_{ml}) is one-half the value of the e.m.f.

When the meter that indicates the value of e_g is not in close proximity to the receiver input terminals, the transmission line loss shall be taken into account in addition to the loss of the impedance matching network.

5.1.1 *Input-signal source for receivers requiring a specified source resistance*

This sub-clause applies to receivers which are connected to the antenna by means of a transmission line (which is synonymous with "feeder line").

The input-signal source shall consist of a radio-frequency signal generator, a transmission line, and an impedance-matching network (pad) placed as close as possible to the receiver under test (see Figure 1, page 13).

5.1.2 *Input-signal source receivers tested with the aid of an artificial antenna*

This sub-clause is applicable to receivers intended to operate with an antenna having a complex impedance.

The input-signal source shall consist of a radio-frequency signal generator, a transmission line, an impedance matching network and an artificial antenna. The characteristics of the artificial antenna shall be specified by the manufacturer of the receiver.

5.2 *Input-signal level*

The input-signal level of the wanted signal shall be expressed as the r.m.s. value of a sinusoidal voltage, the peak value of which is equal to the amplitude of one radio-frequency cycle at the crest of the envelope of the modulation wave.

Note. – The input signal consisting of a carrier and a sideband component as specified in Sub-clause 5.3 should be expressed in terms of the sum of the r.m.s. voltages.

The input-signal level of any unmodulated unwanted signal shall be expressed in terms of its r.m.s. voltage.

The input levels of the wanted and unwanted signals shall be recorded in μV or dB (μV).

5.2.1 *Receivers requiring a specific source resistance*

The presentation of results should state whether the electromotive force of the source of the matched-load (V_{ml}) voltage has been recorded, for example 2 μV (e.m.f.) or 1 μV (V_{ml}). The source resistance (R_s) should also be stated. (See Figure 1.)

5.2.2 *Receivers tested with the aid of an artificial antenna*

The input-signal level is the e.m.f. of the source connected to the input terminals of an artificial antenna.

5.3 *Standard input signal*

A radio-frequency signal or a linear combination of two radio-frequency signals from a signal source that simulates the single-sideband emission from a transmitter when it is modulated with an audio-frequency signal of 1000 Hz.

The frequencies and the levels of the input signal are dependent upon the class of emission they represent. Two frequencies, one of which represents the carrier and the other which represents the sideband, are chosen such that when demodulated they will produce an audio output at a frequency of 1000 Hz.

The standard input-signal levels are:

Class of emission	Signal representing the	
	Carrier	Sideband
R3E H3E J3E	+42 dB (μV) +54 dB (μV) Omit or +20 dB (μV), as specified	+60 dB (μV) +54 dB (μV) +60 dB (μV)

5.4 *Networks for combining several signal sources*

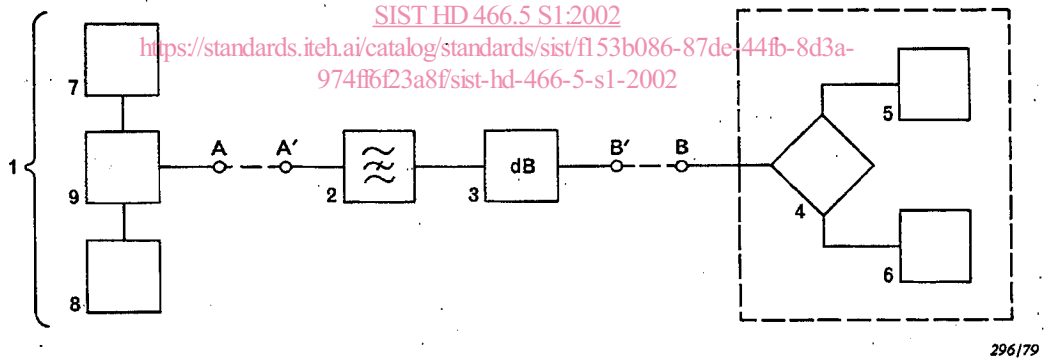
Examples of combining networks may be found in Appendix A.

5.5 *Input-signal arrangements for testing the receiving part of equipment for duplex operation*

When the performance of the receiver section of equipment for duplex operation is to be evaluated while the associated transmitter section is operating, precautions should be taken in order to ensure that the operation of the signal generator or generators used for testing the receiver section is not affected by the radio-frequency signal of the transmitter section and that the latter is terminated by its proper load impedance.

5.5.1 *Input-signal source*

An example of a suitable arrangement for making measurements on receivers of equipment for duplex operation is shown in Figure 2.



1 = input-signal source
2 = band-stop filter
3 = attenuator
4 = combining unit belonging to the equipment under test
5 = transmitting part of the equipment
6 = receiving part of the equipment
7 = radio-frequency signal generator
8 = radio-frequency signal generator
9 = radio-frequency combining network

FIG. 2. – Example of an arrangement for testing receivers for duplex operation.

Connect the input-signal source (1) (levels adjusted according to Sub-clause 5.3) to point A′. The centre frequency of the band-stop filter (2) is adjusted to the operating frequency of the transmitter under test.

The impedance at point B′ shall be such that the transmitter section is operating under the specified matched conditions. To ensure that the V.S.W.R. will be less than 1.25, irrespective of any mismatch caused by the band-stop filter (2) and the combining unit (4), the attenuation of the attenuator (3) should be at least 30 dB. It should be noted that the attenuator will dissipate nearly all of the power from the transmitter section and therefore must have suitable power-handling capacity.

5.5.2 *Input-signal level*

The level of the r.f. input signal shall be determined at point B′ of Figure 2, page 17.

5.6 *Input-signal arrangements for testing receivers having an integral antenna*

For receivers provided with an integral antenna and for equipment which has no facilities suitable for connecting the measuring equipment, the input-signal source will include the antenna specified by the manufacturer. For absolute measurements, a radiation test site where the field strength of the test signals is known should be used. For relative measurements, a radio-frequency coupling device (RFCD) may be used.

5.7 *Connection of the measuring equipment*

Care must be taken that the input impedance of the measuring equipment does not affect the loading conditions specified for the receiver.

5.7.1 *Limitation of the audio-frequency band*

Because some properties, for example, noise and audio-frequency harmonic distortion, depend upon the audio-frequency bandwidth, reproducible results can be obtained only when the band of audio frequencies occupied by the demodulated signal is restricted to specified limits.

This restriction may be accomplished by means of a band-limiting filter preceding any audio-frequency measuring device. The filter may be incorporated within the measuring equipment. When measuring residual hum and noise, only the low-pass portion of the filter need be specified.

5.8 *Squelch condition*

The circuit should be adjusted for the unsquelched condition unless otherwise specified.

Note. – The term "squelch" is synonymous with "mute".

5.9 *De-emphasis condition*

De-emphasis, if used, should be operative for all tests.

5.10 *Instrument input impedance*

Depending upon requirement, the measuring instrument (13) or (14), in Figure 7, page 84, 85, may be either a distortion factor/audio level meter (13) or a selective measuring device (14). The input impedance Z_2 of the band-limiting filter (12), in Figure 7, should be much greater than Z_1. If the band-limiting filter (12) is not used, the input impedance of the measuring device (13) or (14) should be much greater than Z_1.

6. Characteristics of the measuring equipment

Note. – For supplementary methods for testing measuring arrangements, refer to Appendix B.

6.1 *True r.m.s. voltage meter*

For the measurement of the signal-to-noise ratio, the characteristics of the indicating meter are important. In addition, for certain characteristics, measurement of the true r.m.s. voltage is required.

6.2 *Distortion-factor meter or SINAD meter*

The distortion-factor meter or SINAD meter shall have the following characteristics:

- The wide-band response shall not vary more than 0.1 dB over the frequency range 50 Hz to 20000 Hz.
- The band elimination filter attenuation shall be at least 40 dB at 1000 Hz, but not more than 0.5 dB between 50 Hz and 500 Hz and between 2000 Hz and 20000 Hz.

Note. – If the SINAD meter has a fixed filter, it should have 40 dB attenuation over a frequency band of 980 Hz to 1020 Hz.

- The noise signal level from a constant amplitude noise source between 300 Hz and 3000 Hz shall not be attenuated by more than 1 dB by the filter.
- The indicator shall be a true r.m.s. type for a crest factor of 3 or less.

Note. – As a result of the different characteristics of the band elimination filters, the measurement result obtained with the SINAD meter or distortion-factor meter specified above may differ from those obtained with the measuring equipment specified in earlier editions of this standard.

6.3 *Selective measuring device*

The selective measuring device may be either a frequency selective voltmeter, a spectrum analyzer, or a calibrated field-strength meter. The bandwidth of the measuring device shall be appropriate for the measurement being made or shall be adjusted to the value stated in the method of measurement.

6.4 *Radio-frequency coupling device (RFCD)*

The measurements in this standard are applicable to receivers having either antenna terminals or an integral antenna.

Measurements of the radio-frequency parameters of receivers having an integral antenna are performed in an RFCD. When making these measurements, precautions shall be taken to ensure that:

- the receiver is adequately shielded from electromagnetic disturbance;
- the attenuation of the coupling between the radiation source and the receiver being measured is sufficiently low, stable, and constant throughout the measuring frequency range.

Note. – The coupling loss depends on the particular measuring arrangement, the frequency being used, and the receiver being measured. Normally, it is not precisely measured, as it will only be useful for a particular measuring arrangement and frequency.

The coupling loss shall be sufficiently low so that the output power requirements of the signal generators used in this standard will not exceed the power output capability of commercially available signal generators.

To ensure measurement repeatability, an RFCD which includes the following should be used in the measurement arrangement:

- a radiating element;
- a radio-frequency input terminal connected to the radiating element through a transmission line;
- a means to ensure that the input impedance of the RFCD be the same as the impedance of the transmission line from the radio-frequency signal generator;