

Methods of

Measurement on radio receivers for various classes of emission —

Part 7: Methods of measurement on digital satellite radio (DSR) receivers

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- British Broadcasting Corporation
- British Educational Suppliers' Association
- British Radio and Electronic Equipment Manufacturers' Association
- British Telecommunications plc
- Institution of Electrical Engineers
- International Consumer Electronics Association
- Radio, Electrical and Television Retailers' Association
- Radiocommunications Agency

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National foreword

This British Standard has been prepared by Subcommittee EPL/100/1 and is the English language version of EN 60315-7:1995 *Methods of measurement on radio receivers for various classes of emission. Part 7: Methods of measurement on digital satellite radio (DSR) receivers*, published by the European Committee for Electrotechnical Standardization (CENELEC). It is identical with IEC 315-7:1995, including corrigendum: 1995, published by the International Electrotechnical Commission (IEC), and forms Part 7 of a multi-Part standard on measurement methods on radio receivers.

This Part defines conditions and methods for determining the characteristics of a DSR tuner/receiver unit to facilitate comparison of measurements made using various methods. Performance requirements are not specified.

Cross-references

Publication referred to	Corresponding British Standard
HD 483.3 S2:1992 (IEC 268-3:1988)	BS 6840 <i>Sound system equipment</i> Part 3:1992 <i>Methods for specifying and measuring the characteristics of sound system amplifiers</i>
HD 483.15 S4:1992 (IEC 268-15:1987)	Part 15:1992 <i>Specification for matching values for the interconnection of sound system components</i>
HD 560.1 S1:1990 (IEC 315-1:1988)	BS 4054 <i>Methods of measuring and expressing the performance of radio receivers for sound broadcasting</i> Part 1:1995 <i>General considerations and methods of measurement, including audio-frequency measurements</i>
EN 60651:1994 (IEC 651:1979)	BS EN 60651:1994 <i>Specification for sound level meters</i>
EN 60958:1990 (IEC 958:1989)	BS EN 60958:1995 <i>Specification for digital audio interface</i>

Additional information. The following CENELEC editorial change has been incorporated: in Figure 11, “See Figure 7b” has been replaced by “See Figure 12”. A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

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Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, the EN title page, pages 2 to 32, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

English version

Methods of measurement on radio receivers for various
classes of emission
Part 7: Methods of measurement on digital satellite
radio (DSR) receivers

(IEC 315-7:1995)

Méthodes de mesure applicables aux récepteurs
radioélectriques pour diverses classes
d'émission Partie 7: Méthodes de mesure pour
les récepteurs de radiodiffusion sonore
numérique par satellite (DSR)
(CEI 315-7:1995)

Meßverfahren für Funkempfänger für
verschiedene Sendearten
Teil 7: Meßverfahren für Empfänger für
digitale Satelliten-Tonrundfunksendungen
(DSR)
(IEC 315-7:1995)

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European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

Central Secretariat: rue de Stassart 35, B-1050 Brussels

Foreword

The text of document 12A/378/DIS, future edition 1 of IEC 315-7, prepared by SC 12A, Receiving equipment, of IEC TC 12, Radiocommunications, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as EN 60315-7 on 1995-07-04.

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) 1996-04-01
- latest date by which the national standards conflicting with the EN have to be withdrawn (dow) 1996-04-01

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 Annex A is informative.

Annex ZA has been added by CENELEC.

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Section 1. General

1.1 Scope and object

This part of IEC 315 applies to the DSR tuner/receiver unit of a receiving installation for the direct reception of digital satellite sound broadcast transmissions in the 12 GHz band. The channels are identical to those defined by WARC BS-77 and RARC SAT-83 for television broadcasting. The DSR system is recommended in CCIR¹⁾ Recommendation 712 for the transmission of very high-quality sound programmes to fixed receivers within a wide coverage area in Region 1.

The object of this standard is to define the conditions and methods of measurement to be used to determine the characteristics of a DSR tuner unit, so as to make possible the comparison of results of measurements achieved by different observers. Performance requirements (limiting values for the characteristics, required for acceptable performance) are not specified.

NOTE 1 The tuner unit comprises a channel selector and a demodulator/decoder for the reception of digitally coded and phase-modulated satellite sound broadcast transmissions. The unit may additionally comprise a fixed frequency input.

NOTE 2 For more information about the system, see Annex A.

1.2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions in this part of IEC 315. At the time of publication, the editions indicated were valid. All normative documents are subject to revision, and parties to agreements based on this part of IEC 315 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

IEC 268-3:1988, *Sound system equipment — Part 3: Amplifiers*.

IEC 268-15:1987, *Sound system equipment — Part 15: Preferred matching values for the interconnection of sound system components*.

IEC 315-1:1988, *Methods of measurement on radio receivers for various classes of emission — Part 1: General considerations and methods of measurement, including audio-frequency measurements*.

IEC 651:1979, *Sound level meters*.

IEC 958:1989, *Digital audio interface*.

ITU-R Recommendation BS 468-4:1990, *Measurement of audio-frequency noise voltage level in sound broadcasting (Vol. X-1)*.

Section 2. General explanation of terms

For the purpose of this part of IEC 315 the following definitions apply.

2.1 DSR tuner/receiver unit

The function of this unit is to select a desired channel from a group of signals received and converted to a first intermediate frequency by the outdoor unit and possibly to a second intermediate frequency, for example in cable distribution systems, and to provide analogue and/or digital audio outputs. This unit is able to select a specific sound channel from a group of time multiplexed sound channels transmitted with 4-PSK (QPSK) modulation according to the DSR standard. For this purpose the unit includes an RF filter module followed by a demodulator, decoder and digital-analogue converter.

The exact configuration of the unit depends on overall product design and the transmission standards that the equipment is designed to receive (see Annex A).

2.2 Radio frequencies for measurements

DSR receivers may provide inputs for the first and/or second intermediate frequency, or they may have a switchable input. Receivers designed for several frequency ranges shall be measured in each of these frequency ranges.

¹⁾ CCIR is replaced by ITU-R.

2.3 Carrier frequency

The carrier frequency is the centre frequency of the spectrum of the modulated radio-frequency input signal, which is equal to the frequency of the unmodulated signal.

2.4 4-PSK (QPSK) modulation

For this system the phase steps of the 4-PSK modulation are defined as $n \times 90^\circ$ (for $n = 0$ to 3) i.e. the modulation is a QPSK modulation.

NOTE 4-PSK means four-phase phase-shift keying.
QPSK means quadrature phase-shift keying.

2.5 Rated values

In this standard, the term rated value is used as specified in IEC 315-1.

Section 3. General notes on measurements

3.1 Preliminary measurements

As the results of various measurements described in this standard may be influenced by other properties of the receiver, the related measurements given in IEC 315-1 should usually be carried out first.

3.2 General conditions

With respect to accuracy of measurement equipment, environment conditions, presentation of results and deviation from the recommended methods of measurements, reference is made to IEC 315-1.

Accuracy of measurements may be influenced by radio interference. In this case, measurements shall be carried out in a screened room.

3.3 Test signals

3.3.1 Standard radio-frequency input signal for measurements

The standard radio-frequency input signal is a signal with the appropriate standard carrier frequency using the audio signal according to 3.3.2 for modulation of programme channel 1 (if not stated otherwise) with a utilization factor corresponding to the standard utilization factor (see 3.3.3 and 3.3.4).

The available power of the signal generator at the antenna input of the receiver shall be as stated below:

- 50 dB (mW) = 70 dB (fW) for measurements at the first intermediate frequency, and/or
- 40 dB (mW) = 80 dB (fW) for measurements at the second intermediate frequency.

3.3.2 Standard audio signal for measurements

The audio-signal frequency or the standard audio-signal frequency shall be the standard reference frequency (1 000 Hz). Preferably these signals should be generated synthetically (see 3.4.2). In this case slightly different frequencies may be used.

If required, other audio frequencies may be chosen, preferably from the third-octave frequencies of Table 1 of IEC 315-1.

NOTE The DSR system does not make use of a pre-emphasis.

3.3.3 Utilization factor

For QPSK broadcasting the signal coding within the transmitter is used as a reference for the utilization factor in analogy to the definitions for AM and FM. A signal value corresponding to the maximum code value is defined as 100 % utilization. Severe distortion occurs above this signal level.

$$\text{Utilization factor} = \frac{\text{Peak value of coded signal}}{\text{Maximum permitted value of coded signal}} \times 100 \%$$

The clipping level may be found, for example by variation of the audio-frequency input signal level for the test generator up to increase of distortion, and any utilization factor can be set by defined reduction of input voltage. This measurement requires a good receiver, for which the increase of distortion below clipping value is not significant.

3.3.4 Standard utilization factor

The standard utilization factor shall be 90 %. Measurements with a utilization factor of 100 % are also important; in this case, the utilization factor shall be clearly stated with the measurement results.

NOTE A standard utilization factor of 90 % was chosen since that value should be as high as possible for a digital transmission system. However, in order to prevent severe distortion in case of small setting errors, the standard utilization factor of 100 % can not be chosen.

3.4 Measuring instruments

3.4.1 Test signal generator

A special test generator which provides an RF/IF signal according to the system description given in Annex A shall be used for the measurements. QPSK modulation by an external baseband signal should be possible (see also 3.4.6). To avoid influence on the measurement results the accuracy of the phase angles of the QPSK modulator should be better than $\pm 1^\circ$. It is assumed that the modulation of the test generator can be switched off (carrier only).

3.4.2 Generator for synthesized audio signals

In order to avoid detrimental influence from analogue-digital converters, it is recommended to use a synthetically generated modulation signal which is generated either directly within the test signal generator or by an external data generator connected via an appropriate interface. Synthetically generated means that audio-signal values (e.g. of a sinusoidal tone), corresponding with the sampling frequency (32 kHz), are calculated theoretically and stored in a memory. These values are fed directly to the encoding network. With the exception of some small system-related errors, the modulation of the transmitting signal in this case is a theoretically exact signal. Care shall be taken that the relationship between the sampling frequency and the synthesized audio frequency should not become a simple integer.

3.4.3 Noise source

For measurements with different signal-to-noise ratios, a radio-frequency noise source is needed. In order to obtain a noise power in the range of the input power level of the receiver, the noise signal generated by a noise source has generally to be amplified. Care shall be taken that the amplified noise signal represents white noise, at least in the frequency range of the transmitting channel (carrier frequency ± 7 MHz), i.e. the noise power density shall be constant and noise peaks shall not overload the amplifier.

3.4.4 Input coupling network

The DSR receiver may provide the d.c. power supply voltage for the outdoor unit, especially at the input for the first IF. Therefore, the test signal generator or the RF attenuator shall be equipped with a d.c. decoupling network. If necessary, an appropriate decoupling network has to be inserted.

3.4.5 RF/IF noise-measuring filter

The noise-measuring filter is a band-pass filter with a noise-power bandwidth (corresponds to the -3 dB bandwidth of a single tuned circuit) of 10 MHz.

NOTE A small variation (± 10 %) of this bandwidth may be permitted. However, this should be taken into account in the evaluation of measurement results.

3.4.6 Data generator/bit error measuring instrument (error detector)

Several performance characteristics of a DSR receiver are determined by using a data/bit error measuring device. Generally this device consists of a data generator and an error detector.

The data generator is connected, if necessary via an appropriate interface, to the QPSK modulation input of the test signal generator (see Figure 8 and Figure 9). The error detector is connected, if necessary via an interface, to the DSR receiver (see Figure 8 and Figure 10) at a test output suitable for bit error measurements (before error correction).

NOTE The interface at the transmitter side inserts synchronization words according to the DSR specification, whereas the interface at the receiver side stops bit error measuring (stops error detection) during these synchronization words. This is the minimum requirement for the receiver to make synchronization possible. Depending on the decoder strategy of the receiver other measures may be necessary.

The data generator provides, corresponding with the QPSK modulator input of the test signal generator, either two 10,24 Mbit/s bitstreams, or one common 20,48 Mbit/s bitstream, controlled by a clock signal of the test signal generator. A sequence length of $\geq 2^{15} - 1$ bits shall be used. If the same sequence is used to feed both modulation channels (A and B), there shall be a time delay of at least 64 bits between the supplied sequences.

Corresponding to the signal arrangement at the transmitter side, the error detector measures either separately two bitstreams or one common bitstream. This has to be taken into account in order to get comparable results.

3.4.7 Audio filters and level meters

a) *Audio band-pass filter*

For audio-frequency measurements at the audio outputs a band-pass filter for the audio-frequency band shall be used, if not specified otherwise. The pass-band shall cover the frequency range from 22,4 Hz to 15 kHz. The frequency/amplitude response curve is given in Figure 2.

The band-pass filter shall be designed in such a way that its inherent noise and/or distortion have no influence on the measurement results.

b) *Weighting filter level meters*

For certain measurements audio-frequency weighting filters may be used additionally, either

- a psophometric filter and a quasi-peak meter having a characteristic according to IEC 315-1, Appendix A, which are identical to those specified in ITU-R Recommendation BS 468, or
- a filter having the so-called A-weighting characteristic with tolerances type I as specified for sound level measurements in IEC 651 and a true r.m.s. meter.

If one of these filters is used this shall be clearly stated with the measurement results.

3.5 Measuring conditions

3.5.1 Standard measuring conditions

A receiver is operating under standard measuring conditions when:

- a) the power supply voltage and frequency are equal to the rate values;
- b) the standard radio-frequency input signal is applied to the antenna terminals of the receiver (see Figure 1);
- c) the audio-frequency output terminals for connection to loudspeakers (if any) are connected to audio-frequency substitute loads (see Figure 1);
- d) the receiver is tuned to the applied signal as specified by the manufacturer;
- e) the volume control (if any), is adjusted so that the output voltage at the main audio-frequency output terminals is 10 dB below the rated distortion limited output voltage; measurements may also be made at other stated values of output voltage or power, the power or equivalent voltage shall then be clearly stated with the results;
- f) the loudness control (physiologically compensated volume control) (if any) is inoperative; if the compensation cannot be switched off, measurements shall be carried out with the loudness control set at minimum attenuation, and the utilization factor reduced to avoid overload of the audio-frequency part of the receiver; this shall clearly be stated with the results;
- g) the environment conditions are within rated ranges;
- h) for the reception of stereophonic signals, the balance control or its equivalent (if any) is adjusted so that the output voltages of the two channels are equal;
- i) the tone controls (if any) are adjusted for the flattest possible audio-frequency response (for example, equal response at 100 Hz, 1 kHz and 10 kHz).

3.5.2 Setting of RF/IF carrier-to-noise ratio

For satellite sound broadcasting receivers the radio-frequency input stages and mixers are part of the antenna; therefore there is no need to design the receiver for very low input signal levels.

Thus a radio-frequency signal with a stated level (see 3.3.1) is used for measurements and the RF/IF carrier-to-noise ratio (C/N) is changed by addition of a noise signal.

The wanted signal and the noise signal are added in a power combiner, and their signal levels are adjusted by means of variable radio-frequency attenuators. The circuit arrangement is given in Figure 8. Using this arrangement, the wanted signal level and the noise signal level shall be measured separately with a radio-frequency power meter at the output of the band-pass filter according to 3.4.5.