

Specification for

Compact disc digital audio system

The European Standard EN 60908:1992 has the status of a
British Standard

UDC 681.846.5:621.396

Cooperating organizations

The European Committee for Electrotechnical Standardization (CENELEC), under whose supervision this European Standard was prepared, comprises the national committees of the following countries:

Austria	Italy
Belgium	Luxembourg
Denmark	Netherlands
Finland	Norway
France	Portugal
Germany	Spain
Greece	Sweden
Iceland	Switzerland
Ireland	United Kingdom

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National foreword

This British Standard has been prepared under the direction of the Electronic Equipment Standards Policy Committee and is the English language version of EN 60908:1992, *Compact disc digital audio system* and its Amendment A1:1993, published by the European Committee for Electrotechnical Standardization (CENELEC). It is identical with IEC 908:1987, including its Amendment 1: September 1992 and the Corrigendum: March 1993, published by the International Electrotechnical Commission (IEC). This British Standard supersedes BS 7064:1989 which is withdrawn.

NOTE *Typographical error.* In the note to Figure 6 “et” should be read as “and”.

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.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, the EN title page, pages 2 to 42, 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

Compact disc digital audio system (includes amendment A1:1993)

(IEC 908:1987/A1:1992)

Système audionumérique à disque compact
(inclut l'amendement A1:1993)
(CEI 908:1987/A1:1992)

Digital-Audio-System, Compact-Disc
(enthält Änderung A1:1993)
(IEC 908:1987/A1:1992)

This European Standard was approved by CENELEC on 1992-06-01. 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.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.

CENELEC

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 CENELEC questionnaire procedure, performed for finding out whether or not the International Standard IEC 908:1987 could be accepted without textual changes, has shown that no common modifications were necessary for the acceptance as European Standard.

The reference document was submitted to the CENELEC members for formal vote and was approved by CENELEC as EN 60908 on 16 June 1992.

This European Standard supersedes HD 529 S1:1989.

The following dates were fixed:

- latest date of publication of an identical national standard (dop) 1993-06-01
- latest date of withdrawal of conflicting national standards (dow) 1993-06-01

For products which have complied with HD 529 S1:1989 before 1993-06-01, as shown by the manufacturer or by a certification body, this previous standard may continue to apply for production until 1998-06-01.

The following publication is quoted in this standard:

ISO 3901:1986, Documentation — International Standard Recording Code (ISRC).

Foreword of EN 60908:1992/A1:1993

The text of document 60A(CO)143, as prepared by Sub-Committee 60A: Sound recording, of IEC Technical Committee No 60: Recording, was submitted to the IEC-CENELEC parallel vote in August 1991 but failed.

Following a decision by the 73rd Technical Board, the print proof of IEC amendment 1 to IEC 908:1987 based on IEC 60A(CO)143 and IEC 60A(CO)140 was submitted to a second vote and was approved by CENELEC as amendment A1 to EN 60908 on 9 March 1993.

The following dates were fixed:

- latest date of publication of an identical national standard (dop) 1994-06-01
- latest date of withdrawal of conflicting national standards (dow) 1994-06-01

For products which have complied with EN 60908:1992 before 1994-06-01, as shown by the manufacturer or by a certification body, this previous standard may continue to apply for production until 1999-06-01.

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1 Scope

This standard is applicable to a prerecorded optical reflective digital audio disc system.

It is proposed to standardize a compact disc with a diameter of 80 mm, in addition to the compact disc with a diameter of 120 mm. The following additions to this standard are proposed. The small compact disc will be referred to as 8 cm — CD.

2 Object

This standard defines those parameters of compact discs that affect interchangeability between discs and players. It is also intended as a reference for manufacturers wishing to produce discs and/or players that conform to the system described in this standard.

Section 1. General

3 Description of system

The information carrier is a transparent disc, the substrate, one side of which carries the information. This side, the encoded side, is covered, in turn, by a reflective and a protective layer.

The information on the disc is stored in a spiral-shaped track consisting of successive shallow depressions (pits). When the disc is playing and viewed from the read-out side, the spiral starts near the centre of the disc and finishes near its edge.

The lengths of the pits and the spaces between them can take discrete values only, and represent the encoded two-channel audio information.

The information is read out by means of a beam of light which passes through the plain, i.e. the non-encoded side of the transparent disc to the encoded side, where it is reflected and modulated by the recorded information (see Figure 2b, detail B, page 21).

The information is followed by means of a servo-system for tracking and focusing.

4 Requirements for measurements

4.1 Conditions of measurement

Measurements and mechanical checks shall be carried out within the following limits unless otherwise specified:

- ambient temperature: 15 °C to 35 °C;
- relative humidity: 45 % to 75 %;
- air pressure: 86 kPa to 106 kPa.

4.2 Requirements for the measuring pick-up

The optical pick-up to be used for disc measurement shall comply with the following requirements:

- wavelength: 780 ± 10 nm;
- polarization: circular;
- numerical aperture (NA): 0.45 ± 0.01 ;
- intensity at the rim of the pupil of the objective lens: > 50 % of the maximum intensity value;
- diffraction limited performance of the optical system: within the Maréchal criterion, preferably equally divided between disc and player.

4.3 Requirements for the clamping of the disc

The disc shall be fixed between two equally sized concentric rings, having inner diameters of 29 mm and outer diameters of 31 mm, the clamping force being between 1 N and 2 N (see Figure 2b).

Section 2. Disc parameters

Parameters to be specified	Requirements	Methods and/or conditions of measurement
5 Mechanical parameters	Figure 2a, Figure 2b and Figure 2c, pages 20 to 22, specify the dimensions of the disc, including reflective layer, protective layer and label	
5.1 Outer dimensions of disc		
5.1.1 Outer diameter	120 ± 0,3 mm 80 ± 0,2 mm	To be measured at 23 ± 2 °C and (50 ± 5) % relative humidity
5.1.2 Radial run-out of outer edge	0.4 mm max.	Relative to the inscribed circle of centre hole
5.1.3 Edge shape	Edges shall be free from burrs; chamfer or radius is permitted on both sides For 8 cm – CD, see Figure 2c and Figure 2d	
5.2 Centre hole dimensions		
5.2.1 Diameter	15 ^{+0.1} ₀ mm	To be measured at 23 ± 2 °C and (50 ± 5) % relative humidity
5.2.2 Shape	Cylindrical	
5.2.3 Edge shape	Burrs are permitted on the label side, but not on the read-out side. Chamfer or radius is permitted (see Figure 2b, detail C)	
5.3 Thickness of disc	1.2 ^{+0.3} _{-0.1} mm	Including protective layer and labelling
5.4 Labelling		
5.4.1 Label dimensions	Shall not project over edge of centre hole or outer edge of disc	May be applied by printing or by means of a label
5.4.2 Label information	At least the following information shall be given: a) Title of program b) Catalogue number of disc c) Sequence number of and total number of discs if complete program occupies more than one disc (e.g.: disc 2 of 4)	
5.5 Reference plane	Ring between diameters of 26 mm and 33 mm (see Figure 2a and Figure 2b)	On the read-out side
5.6 Clamping area		
5.6.1 Inner diameter of clamping area	26 mm max. ^a	
5.6.2 Outer diameter of clamping area	33 mm min. ^a	
5.6.3 Thickness of disc in clamping area	Within the requirements given in Subclause 5.3 and Figure 2b, page 21	
5.6.4 Adaptor clamping area for 8 cm – CD	An outer ring with 1,5 mm in width	

^a These dimensions ensure that the ring between 26 mm and 33 mm is available for clamping.

Parameters to be specified	Requirements	Methods and/or conditions of measurement
5.6.5 Thickness in clamping area for 8 cm – CD adaptor	$1,2 \pm 0,1$ mm	
5.7 Mass of disc	14 g to 33 g 6 g to 16 g for 8 cm – CD	Within the information area (45 mm to 118 mm maximum diameter) (see Figure 2c, page 22)
5.8 Limits for the deflections of the read-out side of the disc		
5.8.1 Peak deflection	$\pm 0,4$ mm $\pm 0,3$ mm for 8 cm – CD	
5.8.2 Deflection averaged over one revolution	$\pm 0,3$ mm $\pm 0,2$ mm for 8 cm – CD	
5.8.3 Angular deviation (β)	$\pm 0,6^\circ$	See Figure 16, page 36
6 Optical parameters		
6.1 Thickness of transparent substrate	$1,2 \pm 0,1$ mm	Within the information area (see Figure 2a, Figure 2b, Figure 2c, pages 20 to 22). Excluding reflective layer, protective layer, and labelling
6.2 Refractive index	$1,55 \pm 0,1$	Referred to reference plane E (see Figure 2a and Figure 16) including disc deflection and substrate unparallelism
6.3 Limits for the angular deviation of the reflected beam (α)	$\pm 1,6^\circ$	
6.4 Birefringence of transparent substrate	100 nm max.	} Double pass through transparent substrate
6.5 Reflectivity	70 % min.	
6.6 Limits for reflectivity variation in program area	3 % for $f < 100$ Hz	The reflectivity variation is measured by observing the variation of A_{top} , during one revolution of the disc at scanning velocity (see subclause 7.1.2)
7 Recording parameters		
7.1 Rotation during playback		
7.1.1 Sense of rotation of disc as seen from read-out side	Counterclockwise	
7.1.2 Scanning velocity	1.2 m/s min. 1.4 m/s max.	
7.1.3 Limits for the velocity variation on any one disc	$\pm 0,01$ m/s	
7.2 Track		
7.2.1 Track path	Continuous spiral from inside (start of the lead-in) to outside (end of the lead-out) of disc	
7.2.2 Starting diameter of lead-in area	46 mm max.	See Figure 2c, page 22

Parameters to be specified	Requirements	Methods and/or conditions of measurement
7.2.3 <i>Starting diameter of program area</i>	$50_{-0.4}^0$ mm	} See Figure 2c To be measured at 23 ± 2 °C and (50 ± 5) % relative humidity
7.2.4 <i>Maximum diameter of program area</i>	116 mm 75 mm for 8 cm – CD	
7.2.5 <i>Minimum outer diameter of lead-out area</i>	Outer diameter of program area plus 1 mm	See Figure 2c As observed by the measuring pick-up, the disc rotating at scanning velocity (see Sub-clause 7.1.2) The nominal position is defined by an ideal disc of substrate thickness 1.2 mm and refractive index of 1.55 Disc rotating at scanning velocity (see Sub-clause 7.1.2) Relative to the inscribed inner circle of centre hole
7.2.6 <i>Pitch of track: distance between any two adjacent turns</i>	1.6 ± 0.1 µm	
7.3 <i>Limits for deviations of information layer perpendicular to reference plane</i>		
7.3.1 <i>For frequencies below 500 Hz</i>		
7.3.1.1 <i>Deviation from nominal value</i>	$\pm 0,5$ mm $\pm 0,35$ mm for 8 cm – CD	
7.3.1.2 <i>R.M.S. value</i>	$\pm 0,4$ mm max. $\pm 0,8$ mm max. for 8 cm – CD	
7.3.1.3 <i>Acceleration</i>	10 m/s^2 max.	
7.3.2 <i>For frequencies above 500 Hz</i>	2 µm peak-to-peak max.	
7.4 <i>Limits for radial deviations of the track</i>		
7.4.1 <i>For frequencies below 500 Hz</i>		
7.4.1.1 <i>Radial run-out of tracks</i>	140 µm peak-to-peak max.	Relative to the inscribed inner circle of centre hole
7.4.1.2 <i>Radial acceleration (eccentricity and unroundness)</i>	0.4 m/s^2 max.	
7.4.2 <i>For frequencies above 500 Hz</i>	See Sub-clause 10.4	
8 <i>Environmental conditions for playing the compact disc</i>		Sudden changes in temperature and humidity within these ranges may temporarily cause too large a deflection. Recovery time up to several hours has to be taken into account (see also IEC 721-3-5, class 5K2)
8.1 <i>Playing the compact disc</i>	The disc shall be played under the following conditions Temperature: -25 °C to $+70$ °C Relative humidity: 10 % to 95 % Absolute humidity: $0,5 \text{ g/m}^3$ to 60 g/m^3	

Parameters to be specified	Requirements	Methods and/or conditions of measurement
8.2 Temperature and humidity requirements 8.2.1 Dry heat test in accordance with IEC 68-2-2 Ba 8.2.2 Cyclic damp heat test in accordance with IEC 68-2-30 Db	Max. temperature change: 50 °C Max. humidity change: 30 % RH (see also climatogram, Figure 17 below) After these tests, some time should be left for recovery before measuring (24 h or 48 h) Temperature: 55 °C Relative humidity: 50 % max. at 35 °C Storage time: 96 h Severity: a; number of cycles: 6 Temperature: max. 40 °C ± 2 °C Relative humidity: 95 % Temperature: min. 25 °C ± 3 °C Cycle time: 12 h + 12 h	Parameters to be measured in accordance with clause 4.

Section 3. Operational signals

9 High-frequency signal

The scanning light spot is diffracted by the information pits in the reflective layer. The high frequency (h.f.) signal is defined as the modulation of the optical power that is diffracted back into the objective lens.

9.1 Measurement conditions

9.1.1 Time constant: $t = 100 \mu s$

9.1.2 Filtering: high-pass

9.1.3 Scanning velocity between 1.2 m/s and 1.4 m/s

9.2 Modulation amplitude

The lowest fundamental frequency of the modulation code is 196 kHz which corresponds to $T_{\max}$. (See Clause 13.) The peak-to-peak value of this component is A_{11} (see Figure 3, page 23)

and the peak value of the corresponding high frequency signal before high-pass filtering is A_{top} .

The highest fundamental frequency of the modulation code is 720 kHz which corresponds to $T_{\min}$. (See Clause 13.) Its peak-to-peak amplitude is A_3 (see Figure 3, page 23).

These parameters shall fulfill the following specifications:

$$\frac{A_3}{A_{\text{top}}} = 0.3 \text{ to } 0.7; \frac{A_{11}}{A_{\text{top}}} \geq 0.6$$

9.3 Signal asymmetry

9.3.1 Definitions

The asymmetry is defined by:

$$\left(\frac{A_D}{A_{11}} - \frac{1}{2} \right) \cdot 100 \%$$

where:

A_D is the decision level (see Figure 3).

The absolute value of the asymmetry shall be lower than or equal to 20 %.

9.4 Cross-talk

The ratio of the amplitude of the h.f. signal when the spot focuses between two adjacent turns of the track to the amplitude of the h.f. signal when the spot focuses on the track shall be less than 0.5 (50 %).

9.5 Frequency modulation of the channel bit frequency (see clause 13)

Unintentional frequency modulation of the channel bit frequency during mastering may cause clock regeneration problems in CD players. The maximum time error of the channel bit frequency as a function of the modulation frequency has to be below the values given in Figure 18. This time error is measured with a constant linear velocity.

10 Radial differential (RD) signal

A slightly off-track position of the scanning light spot results in a diffraction pattern that is asymmetrical in the radial direction of the disc. The radial differential signal is defined as the difference of the optical powers diffracted into the two halves (positioned on opposite sides of the track) of the aperture of the objective lens.

10.1 Measurement conditions

Time constant: $t = 15 \mu\text{s}$

Filtering: low-pass

10.2 Shape of the radial differential signal

See Figure 4, page 24. The zero-crossing with a positive slope corresponds to the correct radial position of the scanning spot. Detail B of Figure 2b, page 21, prescribes shallow pits, and defines the sign of the signal.

10.3 Sensitivity to radial offset

The sensitivity is equal to $\frac{|P_1 - P_2|}{A_{\text{top}}}$ at radial offset of $0.1 \mu\text{m}$,

where:

$P_1 - P_2$ is the optical power difference in the two halves of the reflected beam measured at far field and where A_{top} is the peak optical power (see Sub-clause 9.2).

The sensitivity shall be within 0.04 and 0.07.

The variation on any one disc shall be within $\pm 15 \%$.

10.4 Noise

When the RD signal is used for tracking, with a servo-bandwidth of 200 Hz (see Figure 5, page 24), the noise in the RD signal is measured in the frequency band of 500 Hz to 10 000 Hz.

The r.m.s. value measured with an integration time of 20 ms shall correspond to a tracking error of less than $0.03 \mu\text{m}$.

Optional measurement

Single frequency noise contributions should be avoided in the RD signal. It is recommended to measure the r.m.s value of the noise in the residual error signal with a real-time frequency analyzer (bandwidth of 100 Hz) over the frequency range from 500 Hz to 10 000 Hz.

The tracking error corresponding to the measured r.m.s. value should be less than $0.01 \mu\text{m}$.

11 Defects

11.1 Block error rate (BLER)

11.1.1 Definitions

The block error rate is measured at the input of the C_1 -decoder (see Figure 13, page 33).

A block (see Figure 9, page 29) is called erroneous if one or more symbols of that block are erroneous.

A symbol (see Sub-clause 16.2) is called erroneous if one or more bits of that symbol are erroneous.

11.1.2 Specification of random errors

BLER averaged over any 10 s shall be less than $3 \cdot 10^{-2}$.

11.1.3 Specification of burst errors

Burst errors in the HF signal due to local defects shall not induce audible effects for any error-correcting decoding strategy.

The most simple error-correcting decoder consists of a C_1 and C_2 single error corrector. No more than one symbol error shall occur in a data block measured at the input of the C_2 decoder.

In any case, the number of successive C1-uncorrectable blocks shall be less than 7.

11.2 Local defects

Maximum dimensions of local defects that are allowed are:

— air bubbles, diameter	100 μm
— black spots, diameter	200 μm
— black spots without birefringent area, diameter	300 μm

The minimum distance, measured between adjacent defects (of maximum diameter) along the track, is at least 20 mm.

Black spots may be dirt enclosures in the substrate, or “pin-holes” in the reflective layer.

Section 4. Recorded parameters

12 General

The recorded area on the disc shall be divided into three parts, viz:

- the lead-in area;
- the program area;
- the lead-out area.

The data to be recorded shall consist of 16-bit wide words encoded as 2's-complement numbers.

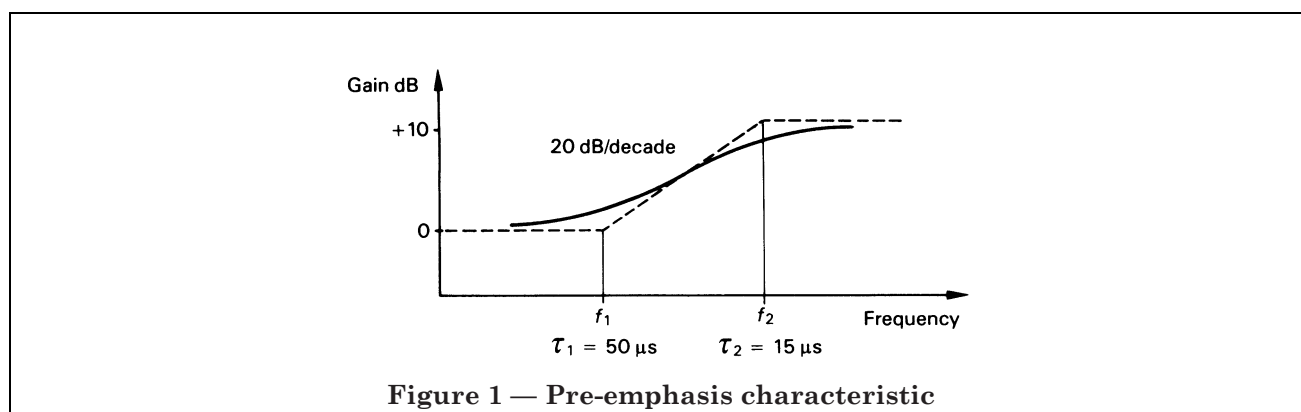
In the lead-in and the lead-out areas these encoded words are 2's-complement zero ± 15 LSB.

In the program area the data words contain audio information only, encoded in a two-channel format.

The sampling frequency (f_s) of the information in the program area shall be 44.1 kHz, both channels being simultaneously sampled.

The audio samples are linear encoded in a 16-bit, 2's-complement format.

The encoding is carried out either without pre-emphasis or with the first order pre-emphasis shown in Figure 1, page 11.



The recording and error protection process basically consists of:

- a) splitting each 16-bit audio sample word into two 8-bit symbols;
- b) introducing extra 8-bit parity symbols for error detection and correction (in accordance with CIRC encoding);
- c) building up a frame consisting of the previously defined 8-bit symbols, with one 8-bit symbol for control and display;
- d) representing these 8-bit symbols by particular channel bit sequences which are appropriate for recording on the disc (in accordance with the EFM encoding);
- e) adding specific synchronization patterns different from EFM-codes.