

Cable networks for television signals, sound signals and interactive services —

Part 6: Optical equipment

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National foreword

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Cable networks for television signals, sound signals and interactive services Part 6: Optical equipment

Réseaux de distribution par câbles pour signaux de
télévision, signaux de radiodiffusion sonore et
services interactifs
Partie 6: Matériels optiques

Kabelnetze für Fernsehsignale, Tonsignale und
interaktive Dienste
Teil 6: Optische Geräte

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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

This second edition of the European Standard was prepared by CENELEC Technical Committee CENELEC TC 209, Cable networks for television signals, sound signals and interactive services, on the basis of EN 50083-6:1994 and the first amendment to EN 50083-6.

The text of this first amendment was approved by CENELEC on 1997-03-11 with the request to prepare a second edition of EN 50083-6, by incorporating this amendment into the European Standard EN 50083-6:1994.

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) 1998-07-01
- latest date by which national standards conflicting with the EN have to be withdrawn (dow) 1998-07-01

For products which have complied with EN 50083-6:1994 before 1998-07-01, as shown by the manufacturer or by a certification body, this previous standard may continue to apply for production until 2003-07-01.

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1 Scope

1.1 General

Standards of the EN 50083 series deal with cable networks for television signals, sound signals and interactive services including equipment, systems and installation:

- for headend-reception, processing and distribution of television and sound signals and their associated data signals; and
- for processing, interfacing and transmitting all kinds of interactive services;

using all applicable transmission media.

All kinds of networks like:

- CATV-networks;
- MATV-networks and SMATV-networks;
- individual receiving networks;

and all kinds of equipment, systems and installations installed in such networks, are within this scope.

The extent of this standardization work is from the antennas, special signal source inputs to the headend or other interface points to the network up to the system outlet or the terminal input, where no system outlet exists.

The standardization of any user terminals (i.e. tuners, receivers, decoders, multimedia terminals, etc.) as well as of any coaxial and optical cables and accessories is therefore excluded.

1.2 Specific scope of this part 6

This standard:

- applies to all optical transmitters, receivers, amplifiers, splitters, directional couplers, isolators, multiplexers, connectors and splices used in cable networks;

- covers the frequency range 5 MHz to 3 000 MHz;

NOTE The upper limit is an example, but not a strict value. The frequency range or ranges, over which the equipment is specified, shall be published.

- identifies guaranteed performance requirements for certain parameters;
- lays down data publication requirements with guaranteed performance;
- describes methods of measurement for compliance testing.

All requirements and published data relate to minimum performance levels within the specified frequency range and in well matched conditions, as might be applicable to cable networks for television signals, sound signals and interactive services.

2 Normative references

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the places in the text and the publications are listed hereafter.

For dated references, subsequent amendments to or revisions of any of these publications apply to EN 50083-6 only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

EN 50083-1:1994 + A1:1997, *Cable networks for television signals, sound signals and interactive services — Part 1: Safety requirements.*

EN 50083-2:1995 + A1:1997, *Cable networks for television signals, sound signals and interactive services — Part 2: Electromagnetic compatibility for equipment and systems.*

EN 50083-3:1994, *Cable networks for television signals, sound signals and interactive services — Part 3: Active coaxial wideband distribution equipment.*

EN 50083-5:1994, *Cable networks for television signals, sound signals and interactive services — Part 5: Headend equipment.*

EN 50083-7:1996, *Cable networks for television signals, sound signals and interactive services — Part 7: System performance.*

EN 60068/HD 323 series, *Environmental testing — Basic environmental testing procedures* (IEC 68 series).

EN 60529:1991, *Degrees of protection provided by enclosures (IP Code)* (IEC 529:1989).

EN 60617-13:1993, *Graphical symbols for diagrams — Part 13: Analogue elements* (IEC 617-13:1993).

EN 60825-1:1994 + A11:1996, *Safety of laser products — Part 1: Equipment, classification, requirements and user's guide* (IEC 825-1: 1993).

EN 60825-2:1994, *Safety of laser products — Part 2: Safety of optical fibre communication systems* (IEC 825-2: 1993).

EN 181000:1994, *Fibre optic branching devices.*

HD 243 S12:1995, *Graphical symbols for use on equipment — Index, survey and compilation of the single sheets* (IEC 417:1973 + supplements A:1974 to M:1994).

HD 571 S1:1990, *General principles for the creation of graphical symbols for use on equipment* (IEC 416:1988).
IEC 617-1 to -12:1983, *Graphical symbols for diagrams.*

3 Terms, definitions, symbols and abbreviations

3.1 Terms and definitions

For the purposes of this part of EN 50083, the following terms and definitions apply.

3.1.1 Equipment

3.1.1.1

optical transmitter

a device for converting electrical signals into optical signals; it consists of a light source (e.g. laser) and its associated components as well as all components between the coaxial input and optical output connectors

3.1.1.2

optical receiver

a device for converting optical signals into electrical signals; it consists of a detector (e.g. PIN-diode) and its associated components as well as all the components between the optical input and coaxial output connectors

3.1.1.3

optical amplifier

a device for amplifying optical signals directly; it consists of an active medium, and its associated components, which amplifies the optical signal without demodulation or regeneration

3.1.1.4

optical isolator

a device which transports optical power in one direction only

3.1.1.5

optical fibre splice

a permanent joint of two fibre ends

3.1.1.6

splitters, directional couplers, and multiplexers

splitters, directional couplers and multiplexers are fibre optic branching devices as defined in EN 181000

3.1.2 Performance characteristics

3.1.2.1

extinction ratio

the ratio of the high-level φ_h optical power to the low-level φ_l optical power of a modulated optical transmitter:

$$e = \frac{\varphi_h}{\varphi_l} \quad (1)$$

This term is mainly used for digital systems.

3.1.2.2

optical modulation index

the optical modulation index is defined as:

$$m = \frac{\varphi_h - \varphi_l}{\varphi_h + \varphi_l} \quad (2)$$

where φ_h is the highest and φ_l is the lowest instantaneous optical power of the intensity modulated optical signal. This term is mainly used for analogue systems.

3.1.2.3

noise figure/factor

figures of merit describing the internally generated noise of an active device. The noise factor NF is the ratio of the carrier to noise ratio at the input, to the carrier to noise ratio at the output of an active device, assuming the incoming carrier is noise free

$$NF = \frac{C_1/N_1}{C_2/C_2} \quad (3)$$

where:

C_1 is the signal power at the input;

C_2 is the signal power at the output;

N_1 is the noise power at the input (ideal thermal noise for electrical devices; quantum noise for optical devices).

N_2 is the noise power at the output.

In other words, the noise factor is the ratio of noise power at the output of an active device to the noise power at the same point if the device had been ideal and added no noise:

$$NF = \frac{N_{2, \text{ actual}}}{N_{2, \text{ ideal}}} \quad (4)$$

The noise factor is dimensionless and is often expressed as noise figure F , in dB:

$$F = 10 \lg NF \quad (5)$$

3.1.2.4

relative intensity noise (RIN)

the ratio of the mean square of the intensity fluctuations in the optical power of a light source to the square of the mean of the optical output power

NOTE The value for the RIN can be calculated from the results of a carrier to noise measurement for the system (see 4.19).

3.1.2.5

noise equivalent power (NEP)

the notional optical power which, when applied to the input of a noiseless optical receiver, would give rise to an electrical output noise power density equal to that observed at the output of an actual receiver under consideration

NOTE The NEP can be calculated from the carrier to noise ratio C/N (see 4.19) of a receiver using:

$$NEP = \frac{mP}{\sqrt{2B}} 10^{-\frac{1}{20} C/N} \quad (6)$$

in this equation, m is the optical modulation index, P is the received optical power and B is the bandwidth; the NEP shall be expressed in units of W/Hz.

3.1.2.6

equivalent input noise current density

the notional input noise current density which, when applied to the input of an ideal noiseless device, would produce an output noise current density equal in value to that observed at the output of the actual device under consideration

NOTE It can be calculated from the carrier to noise ratio C/N (see 4.19) of a device or system using:

$$I_r = \sqrt{\frac{C}{Z 10^{\frac{1}{10} C/N}}} \quad (7)$$

In this equation, C is the amplitude of the carrier at the input of the device or system and Z is its input impedance. The equivalent input noise current density shall be expressed in units of A/Hz.

3.1.2.7

bit error rate (*BER*)

the number of erroneous bits at the output of a system divided by the total number of received bits; this term is used in digital transmission systems

3.1.2.8

responsivity

the ratio of the output current of a photodiode to the incident optical power:

$$r_s = \frac{I}{P} \quad (\text{static responsivity}) \quad (8)$$

$$r_d = \frac{dI}{dP} \quad (\text{dynamic responsivity}) \quad (9)$$

For practical purposes static and dynamic responsivities can be assumed to be equal.

3.1.2.9

voltage responsivity of an optical receiver

the ratio of the change of output voltage to the change of the incident optical power:

$$r_v = \frac{dU}{dP} \quad (10)$$

3.1.2.10

chromatic dispersion

the velocity at which an optical pulse travels on a fibre depends on its wavelength; chromatic dispersion is defined as “minus the change of group travel time per unit length of fibre per change of wavelength”

3.1.2.11

wavelength

the wavelength λ of light in a vacuum is given by:

$$\lambda = \frac{c}{f} \quad (11)$$

where:

$$\begin{aligned} c &= 2,997\,93 \times 10^8 \text{ m/s (speed of light in vacuum);} \\ f &= \text{optical frequency.} \end{aligned}$$

Although the wavelength in dielectric material such as fibres is shorter than in vacuum, only the wavelength of light in vacuum is used.

3.1.2.12

chirp

the incidental frequency modulation caused by intensity modulation of a laser diode

NOTE Chirping effectively broadens the laser spectral bandwidth. Due to the chromatic dispersion of the fibre, parts of the spectrum travel at different speeds, resulting in harmonic distortion of the transferred signal.

3.1.2.13

polarization

the projection of the electric vector on a plane perpendicular to the direction of transmission of the polarized light wave

3.1.2.14

linewidth

the spectral bandwidth of an individual mode of a laser; it is defined as the difference between those optical frequencies at which the amplitude reaches or first falls to half of the maximum amplitude

3.1.2.15

coherence time and coherence length

the coherence time is the time which light needs to travel the coherence length. The coherence time is the reciprocal of 2π times the linewidth. Both values are used to describe the phase stability of a light source.

3.1.2.16

well cleaved

a well cleaved end of fibre has a clean plane front perpendicular to the axis of the fibre

3.1.2.17

amplified spontaneous emission (*ASE*)

part of an optical amplifier's output power caused by photons emitted from excited ions whose lifetime was over before their energy was used for amplification

3.1.2.18

directivity

the attenuation between the output port and interface port minus the attenuation between input and interface port, of any equipment or system

3.1.2.19

central wavelength

the average of those wavelengths at which the amplitude of a light source reaches or last falls to half of the maximum amplitude

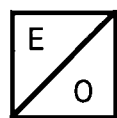
3.1.2.20

spectral width

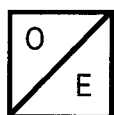
the difference of those wavelengths at which the amplitude of a light source reaches or last falls to half of the maximum amplitude

3.2 Symbols

According to EN 60617-13 and IEC 617, the following graphical symbols are used in the figures of this standard:



optical transmitter



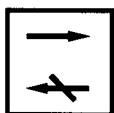
optical receiver



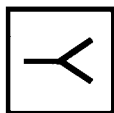
optical amplifier



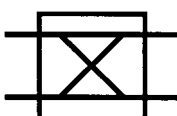
optical fibre



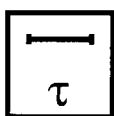
isolator



coupler



directional coupler



delay line



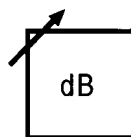
polarization control device



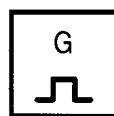
low-pass filter



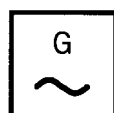
bandpass filter



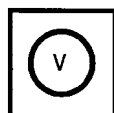
variable attenuator



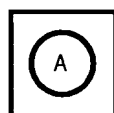
pulse generator



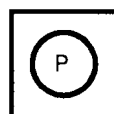
sine-wave generator



voltmeter



current meter



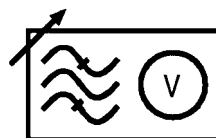
power meter



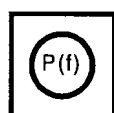
bit error detector



oscilloscope



selective voltmeter



spectrum analyser



RF choke



ground



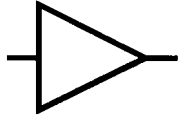
resistor



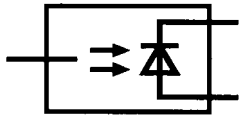
capacitor



DC power supply



amplifier



photodiode with fibre pigtail

3.3 Abbreviations

The following abbreviations are used in this standard:

AC	alternating current
AGC	automatic gain control
ALC	automatic level control
ASE	amplified spontaneous emission
BER	bit error rate
CATV	community antenna television (network)
C/N	carrier to noise ratio
CSO	composite second order
CTB	composite triple beat
CW	continuous wave
CXM	composite crossmodulation
dB	decibel
DC	direct current
EMC	electromagnetic compatibility
IF	intermediate frequency
MATV	master antenna television (network)
MTBF	mean time between failure
NEP	noise equivalent power
NF	noise figure
PS	polarization stability
PRBS	pseudo random bit sequence
RF	radio frequency
RIN	relative intensity noise
SMATV	satellite master antenna television (network)

NOTE Only the abbreviations used in the English version of this part of EN 50083 are mentioned in this subclause. The German and the French versions of this part may use other abbreviations. Refer to 3.3 of each language version for details.

4 Methods of measurement

4.1 General measurement requirements

For all methods of measurements described in this section the following requirements shall be considered.

4.1.1 Input specification

The following conditions shall be obtained from the device specification:

- supply voltage(s);
- control signal(s), if any, with correct impedance, level and frequency.

4.1.2 Measurement conditions

Unless otherwise specified, all measurements shall be carried out under the following conditions:

- the ambient or reference point temperature shall be 25 ± 5 °C;
- the ambient humidity shall be in the range 40 to 70 %;
- sufficient care shall be taken to ensure that optical reflection does not impair the accuracy of the measurement;
- during measurement any control input signal(s) shall be held constant.

4.2 Optical power

4.2.1 Purpose

The purpose of this test method is to measure the average optical power emanating from the end of a test fibre. The test fibre and the coupling means shall be as specified by the manufacturer. The optical power shall be expressed in dB-m.

4.2.2 Equipment required

4.2.2.1 An optical power meter with a range suitable for the expected power. The detector system of the power meter shall have a sufficiently large area to collect all the radiation from the test fibre and a spectral sensitivity compatible with the light source. A minimum accuracy of ± 10 % is recommended.

4.2.2.2 A length of fibre for connecting the light source to the power meter.

4.2.2.3 A cladding mode stripper if the fibre has no cladding mode stripping coating.

4.2.2.4 Test signal generator(s).

4.2.3 General measurement requirements

4.2.3.1 A digital transmitter shall be modulated with a Pseudo Random Bit Sequence (PRBS) with a sequence length of at least $2^{15} - 1$, with the specified pulse repetition frequency and pulse width at the specified extinction ratio. Analogue transmitters shall be modulated with at least one modulation carrier at the specified optical modulation index.

4.2.3.2 Cladding modes shall be stripped from the fibre by means of suitable cladding mode stripping techniques.

4.2.4 Procedure

4.2.4.1 Set the supply voltage(s) and any control input signal(s) to the specified value(s).

4.2.4.2 Connect the equipment as shown in Figure 1.

4.2.4.3 Connect the optical output of the device under test to the detector (a power meter) through the test fibre and the specified coupling means.

4.2.4.4 Measure and record the output power using the power meter.

4.2.5 Potential sources of error

4.2.5.1 The inaccuracy of the power meter, for example if its dark current is not sufficiently low.

4.2.5.2 The attenuation of the test fibre and the specified coupling means.

4.3 Loss, isolation, directivity and coupling ratio

The measurement of the following parameters is based on the measurement of optical power and therefore no special methods of measurement are given for these items:

- loss of fibres, connectors, multiplexers, and optical isolators;
- gain of optical amplifiers;
- directivity of optical couplers;
- isolation of optical isolators, multiplexers and optical couplers.

4.3.1 General measurement requirements

4.3.1.1 Optical couplers, multiplexers and isolators shall be tested with a light source suitable for the specified wavelength range.

4.3.1.2 All optical inputs or outputs not involved during the measurement shall be terminated to make sure that no reflected light can impair the accuracy of the measurement.

4.3.2 Principle of measurement

4.3.2.1 Connect the light source to the power meter and measure the optical output power P_1 of the light source (see 4.2).

4.3.2.2 Connect the device under test to the light source and the optical power meter as shown in Figure 2 and measure the power P_2 .

4.3.2.3 The loss, gain, directivity or isolation is calculated by:

$$a = 10 \lg \frac{P_1}{P_2} \quad (12)$$

4.4 Return loss

4.4.1 Purpose

Reflection of the transmitted light occurs at the boundary of two different dielectric media. The return loss is the reflectance which is the ratio of the incident optical power P_{in} to the reflected optical power P_{back} , expressed in dB. The purpose of this test is to measure the return loss of an optical equipment. A method for splitters, directional couplers and multiplexers can be found in EN 181000.

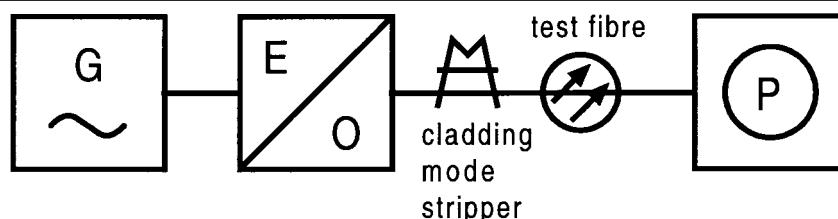


Figure 1 — Measurement of optical power

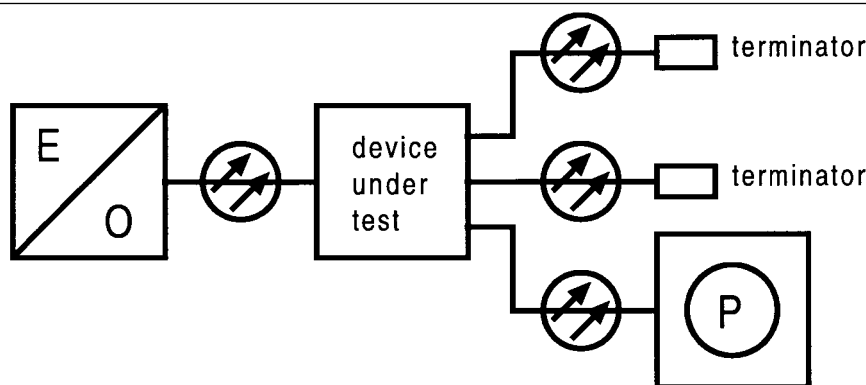


Figure 2 — Measurement of optical loss, directivity and isolation