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Second edition
2003-07

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

Part 6:
Optical equipment

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

CABLE NETWORKS FOR TELEVISION SIGNALS, SOUND SIGNALS AND INTERACTIVE SERVICES –

Part 6: Optical equipment

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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International Standard IEC 60728-6 has been prepared by technical area 5: Cable networks for television signals, sound signals and interactive services, of IEC technical committee 100: Audio, video and multimedia systems and equipment.

This second edition cancels and replaces the first edition published in 2001 of which it constitutes a technical revision.

The text of this standard is based on

FDIS	Report on voting
100/680/FDIS	100/697/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.

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

The committee has decided that this publication remains valid until 2006. At this date, in accordance with the committee's decision, the publication will be:

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- withdrawn;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

INTRODUCTION

Standards of the IEC 60728 series deal with cable networks for television signals, sound signals and interactive services including equipment, systems and installations:

- for headend-reception, processing and distribution of sound and television signals and their associated data signals, and
- for processing, interfacing and transmitting all kinds of interactive multimedia signals using all applicable transmission media.

They cover all kinds of networks that convey modulated RF carriers such as

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

and all kinds of equipment, systems and installations installed in such networks.

The scope of these standards extends from antennas and special signal source inputs to headend or other interface points, to networks as a whole up through system outlets, or terminal inputs where no system outlet exists.

The standardization of any user terminals (i.e. tuners, receivers, decoders, multimedia terminals, etc.) is excluded.

CABLE NETWORKS FOR TELEVISION SIGNALS, SOUND SIGNALS AND INTERACTIVE SERVICES –

Part 6: Optical equipment

1 Scope

This part of IEC 60728 lays down the measuring methods, performance requirements and data publication requirements of optical equipment of cable networks for television signals, sound signals and interactive services.

This standard

- applies to all optical transmitters, receivers, amplifiers, directional couplers, isolators, multiplexing devices, connectors and splices used in cable networks;
- covers the frequency range 5 MHz to 3 000 MHz;

  NOTE The upper limit of 3 000 MHz 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

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 60068-1, *Environmental testing. Part 1: General and guidance*

IEC 60068-2, (all parts), *Environmental testing – Part 2: Tests*

IEC 60169-2, *Radio-frequency connectors – Part 2: Coaxial unmatched connector*

IEC 60169-24, *Radio-frequency connectors – Part 24: Radio-frequency coaxial connectors with screw coupling, typically for use in 75 ohm cable distribution systems (Type F)*

IEC 60417-DB:2002*, *Graphical symbols for use on equipment*

IEC 60529, *Degrees of protection provided by enclosures (IP Code)*

IEC 60617 (all parts) [DB]*, *Graphical symbols for diagrams*

* "DB" refers to the IEC on-line database.

IEC 60728-1, *Cabled distribution systems for television and sound signals – Part 1: Methods of measurement and system performance*

IEC 60728-2, *Cabled distribution systems for television and sound signals – Part 2: Electromagnetic compatibility of equipment*

IEC 60728-3, *Cabled distribution systems for television and sound signals – Part 3: Active coaxial wideband distribution equipment*

IEC 61280-2-2, *Fibre optic communication subsystem basic test procedures – Part 2-2: Test procedures for digital systems – Optical eye pattern, waveform, and extinction ratio*

IEC 61280-4-2, *Fibre optic communication subsystem basic test procedures – Part 4-2: Fibre optic cable plant – Single-mode fibre optic cable plant attenuation*

IEC 61282-4, *Fibre optic communication system design guides – Part 4: Guideline to accommodate and utilize nonlinear effects in single-mode fibre optic systems*

IEC 61290-1-3, *Optical fibre amplifiers – Basic specification – Part 1-3: Test methods for gain parameters – Optical power meter*

IEC 61290-3, *Optical fibre amplifiers – Basic specification – Part 3-1: Test methods for noise figure parameters*

IEC 61290-3-2, *Optical fibre amplifiers – Part 3-2: Test methods for noise figure parameters – Electrical spectrum analyzer*

IEC 61290-5, *Optical fibre amplifiers – Basic specification – Part 5: Test methods for reflectance parameters*

IEC 61291-1, *Optical fibre amplifiers – Part 1: Generic specification*

IEC 61931, *Fibre optics – Terminology*

IEC 80416, *Basic principles for graphical symbols for use on equipment*

ITU G.692, *Optical interfaces for multichannel systems with optical amplifiers*

EN 300019-1-3, *Environmental Engineering (EE); Environmental conditions and environmental tests for telecommunications equipment; Part 1-3: Classification of environmental conditions; Stationary use at weatherprotected locations*

3 Terms, definitions, symbols and abbreviations

3.1 Terms and definitions

For the purposes of this document, the definitions given in IEC 60728-1, IEC 61931 and the following terms and definitions apply.

3.1.1
optical transmitting unit; optical transmitter; Tx (abbreviation)
transmit fibre optic terminal device accepting at its input port an electrical signal and providing at its output port an optical carrier modulated by that input signal

NOTE For the purposes of this standard, optical transmitters may have more than one input port accepting electrical RF signals.

[IEC 61931, definition 2.9.6]

3.1.2
optical receiving unit; optical receiver; Rx (abbreviation)
receive fibre optic terminal device accepting at its input port a modulated optical carrier, and providing at its output port the corresponding demodulated electrical signal (with the associated clock, if digital)

NOTE For the purposes of this standard, optical receivers may have more than one output port providing electrical RF signals.

[IEC 61931, definition 2.9.7]

3.1.3
optical amplifier
optical waveguide device containing a suitably pumped, active medium which is able to amplify an optical signal

[IEC 61931, definition 2.7.75]

3.1.4
(optical) isolator
two port non-reciprocal optical device intended to suppress backward reflection, while having minimum insertion loss in the forward direction, based on Faraday effect

NOTE 1 An isolator is commonly used to prevent return reflections along a transmission path.

NOTE 2 An isolator is generally polarization dependent; however fibre optic polarization independent isolators exist.

[IEC 61931, definition 2.6.30]

3.1.5
(optical (fibre)) splice
permanent, or semi permanent, joint whose purpose is to couple optical power between two optical fibres

[IEV 731-05-05 modified]
[IEC 61931, definition 2.6.8]

3.1.6
fibre optic branching device; (optical) (fibre) branching device; (optical) (fibre) coupler (deprecated)]

optical fibre device, possessing three or more optical ports, which shares optical power among its ports in a predetermined fashion, at the same wavelength or wavelengths, without wavelength conversion

NOTE The ports may be connected to fibres, sources, detectors, etc.

[IEC 61931, definition 2.6.21]

3.1.7
directional branching device; directional coupler (deprecated)
device which distributes an optical signal among the output ports in a predetermined fashion only when light is launched into one preselected input port

[IEC 61931, definition 2.6.22]

NOTE For the purposes of this standard, directional coupler is the preferred term because this is also the term for its electrical equivalent.

3.1.8
multiplexing device; WDM device
wavelength selective branching device (used in WDM transmission systems) in which optical signals can be transferred between two predetermined ports, depending on the wavelength of the signal

[IEC 61931, definition 2.6.51]

3.1.9
reference output level of an optical receiver
offset x by which the electrical output level of an optical receiver can be calculated from the optical input level at a modulation index of m = 0,05 using following equation:

$$U = 2\ P_{opt,RX} + x\ \text{dB}(\mu\text{V}) \quad (1)$$

where

U is the electrical output level in dB(μV)

$P_{opt,RX}$ is the optical input level in dB(mW)

x is the reference output level in dB(μV)

3.1.10
optical modulation index
optical modulation index is defined as

$$m = \frac{\phi_h - \phi_l}{\phi_h + \phi_l} \quad (2)$$

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.

NOTE This definition does not apply to systems where the input signals are converted and transported as digital baseband signals. In this case, the terms modulation depth or extinction ratio defined in 2.6.79 and 2.7.46 of IEC 61931 must be used. A test procedure for extinction ratio is described in IEC 61280-2-2.

3.1.11
noise figure
decrease of the signal-to-noise ratio (SNR), at the output of an optical detector with unitary quantum efficiency, due to the propagation of a shot noise-limited signal through the optical amplifier (OFA), expressed in dB

[IEC 61291-1]

NOTE The noise figure of optical amplifiers depends on the optical input power and on the wavelength used.

3.1.12
relative intensity noise
RIN
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. The RIN is usually expressed in dB(Hz^{-1}) resulting in negative values then

NOTE The value for the RIN can be calculated from the results of a carrier-to-noise measurement for the system (see 4.18).

3.1.13
noise equivalent power
NEP
value of the radiant power at the input of an optical detector which produces at the output a signal-to-noise ratio equal to one, for a given wavelength, modulation frequency and equivalent noise bandwidth

[IEV 731-06-40]

[IEC 61931, definition 2.7.61]

NOTE The NEP can be calculated from the carrier-to-noise ratio C/N (see 4.18) of a receiver using:

$$NEP = \frac{mP}{\sqrt{2B}} 10^{-\frac{1}{20}C/N} \quad (3)$$

where

m is the optical modulation index;

P is the received optical power;

B is the bandwidth.

The NEP shall be expressed in units of W/√Hz.

3.1.14
equivalent input noise current density
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 4.18) of a device or system using:

$$I_r = \sqrt{\frac{C}{Z\,10^{\frac{1}{10}C/N}}} \quad (4)$$

where

C is the power of the carrier at the input of the device or system;

Z is its input impedance.

The equivalent input noise current density shall be expressed in units of A/√Hz.

3.1.15
responsivity
ratio of an optical detector's electrical output to its optical input at a given wavelength

[IEV 731-06-36 modified]

NOTE 1 The responsivity is generally expressed in amperes per watt or volts per watt of incident radiant power.

NOTE 2 Sensitivity is sometimes used as an imprecise synonym for responsivity.

NOTE 3 The wavelength interval around the given wavelength may be specified.

[IEC 61931, definition 2.7.56]

3.1.16
chromatic dispersion; total dispersion (deprecated)
spreading of a light pulse per unit source spectrum width in an optical fibre caused by different group velocities of the different wavelengths composing the source spectrum.

NOTE The chromatic dispersion may be due to the following contributions: material dispersion, waveguide dispersion, profile dispersion.

[IEC 61931, definition 2.4.54]

3.1.17
wavelength
distance covered in a period by the wavefront of a harmonic plane wave.

[IEC 61931, definition 2.2.9]

NOTE The wavelength λ of light in vacuum is given by

$$\lambda = \frac{c}{f} \qquad (5)$$

where

c is the speed of light in vacuum ($c \approx 2{,}99792 \times 10^8$ m/s);

f is the optical frequency.

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

3.1.18
chirping
rapid change of the emission wavelengths of a directly intensity-modulated optical source as a function of the intensity of the modulating signal

NOTE 1 Chirping should not be confused with long-term wavelength drift.

NOTE 2 Due to the fibre chromatic dispersion, using a single-mode laser, chirping can cause either degradation or improvement of the total bandwidth.

[IEC 61931, definition 2.7.44]

3.1.19
polarization
orientation of the electric field vector of the electromagnetic radiation

[IEC 61931, definition 2.1.44]

3.1.20
linewidth
spectral bandwidth of an individual mode of a laser, defined as the difference between those optical frequencies at which the amplitude reaches or first falls to half of the maximum amplitude

3.1.21
coherence length
propagation distance over which propagating light may be considered to be coherent radiation

[IEV 731-01-17 modified]

NOTE The coherence length in a medium of refractive index n is approximately

$$\lambda_0^{\,2}/(n \cdot \Delta\lambda)$$