IEC 60728-106

Edition 1.0 2023-05

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Cable networks for television signals, sound signals and interactive services – Part 106: Optical equipment for systems loaded with digital channels only

Réseaux de distribution par câbles pour signaux de télévision, signaux de radiodiffusion sonore et services interactifs – Partie 106: Matériel optique pour systèmes soumis à une charge de porteuses exclusivement numériques

IEC 60728-106:2023-05(en-fr)

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

COMMISSION ELECTROTECHNIQUE INTERNATIONALE

ICS 33.060.40

ISBN 978-2-8322-7053-0

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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

Part 106: Optical equipment for systems loaded with digital channels only

FOREWORD

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The text of this International Standard is based on the following documents:

Draft	Report on voting
100/3899/FDIS	100/3923/RVD

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

A list of all parts in the IEC 60728 series, published under the general title *Cable networks for television signals, sound signals and interactive services*, can be found on the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

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- withdrawn,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

INTRODUCTION

International Standards and other deliverables of the IEC 60728 series deal with cable networks, including equipment and associated methods of measurement for headend reception, processing and distribution of television and sound signals and for processing, interfacing and transmitting all kinds of data signals for interactive services using all applicable transmission media. These signals are typically transmitted in networks by frequency-multiplexing techniques.

This includes, for instance:

- regional and local broadband cable networks,
- extended satellite and terrestrial television distribution systems,
- individual satellite and terrestrial television receiving systems,

and all kinds of equipment, systems and installations used in such cable networks, distribution and receiving systems.

The extent of this standardization work ranges from antennas and/or special interfaces to headends, or other interface points on the network up to any terminal interface of the equipment on the customer's premises.

The standardization work will consider coexistence with users of the RF spectrum in wired and wireless transmission systems.

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

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

Part 106: Optical equipment for systems loaded with digital channels only

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 loaded with digital channels only.

This document

- 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 3 300 MHz;

NOTE The upper limit of 3 300 MHz is an example, but not a strict value.

- 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 documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 60068-2 (all parts), *Environmental testing*

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

IEC 60728-101, *Cable networks for television signals, sound signals and interactive services – Part 101: System performance of forward paths loaded with digital channels only*

IEC 60728-3:2017, *Cable networks for television signals, sound signals and interactive services – Part 3: Active wideband equipment for cable networks*

IEC 60728-11, *Cable networks for television signals, sound signals and interactive services – Part 11: Safety*

IEC 60793-2-50, *Optical fibres – Part 2-50: Product specifications – Sectional specification for class B single-mode fibres*

IEC 60825-1, *Safety of laser products – Part 1: Equipment classification and requirements*

IEC 61280-1-1, *Fibre optic communication subsystem basic test procedures – Part 1-1: Test procedures for general communication subsystems – Transmitter output optical power measurement for single-mode optical fibre cable*

IEC 61280-1-3, *Fibre optic communication subsystem test procedures – Part 1-3: General communication subsystems – Measurement of central wavelength, spectral width and additional spectral characteristics*

IEC 61290-1 (all parts), *Optical amplifiers – Test methods – Part 1: Power and gain parameters*

IEC 61290-3-2:2008, *Optical amplifiers – Test methods – Part 3-2: Noise figure parameters – Electrical spectrum analyser method*

IEC 61290-5 (all parts), *Optical amplifiers – Test methods – Part 5: Reflectance parameters*

IEC 61290-6-1, *Optical fibre amplifiers – Basic specification – Part 6-1: Test methods for pump leakage parameters – Optical demultiplexer*

IEC 61290-11 (all parts), *Optical amplifiers – Test methods – Part 11: Polarization mode dispersion parameter*

IEC 61300-3-6, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 3-6: Examinations and measurements – Return loss*

3 Terms, definitions, graphical symbols and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- IEC Electropedia: available at https://www.electropedia.org/
- ISO Online browsing platform: available at https://www.iso.org/obp

3.1.1
amplified spontaneous emission
ASE
optical power associated to spontaneously emitted photons amplified by an active medium in an optical amplifier

[SOURCE: IEC TR 61931:1998, 2.7.87]

3.1.2
stimulated Brillouin scattering
SBS
non-linear scattering of optical radiation characterized by a frequency shift as for the Raman scattering, but accompanied by a lower frequency (acoustical) vibration of the medium lattice

Note 1 to entry: The light is scattered backward with respect to the incident radiation.

Note 2 to entry: In silica fibres, the frequency shift is typically around 10 GHz.

[SOURCE: IEC TR 61931:1998, 2.1.88, modified – The term and definition have been altered to comply with the latest version of the ISO/IEC Directives, Part 2.]

3.1.3
centroidal wavelength
mean or average wavelength of an optical spectrum

Note 1 to entry: Other spectral wavelengths are central wavelengths, half-power wavelengths, and peak wavelengths

3.1.4
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 to entry: Chirping should not be confused with long-term wavelength drift.

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

[SOURCE: IEC TR 61931:1998, 2.7.44]

3.1.5
chromatic dispersion
DEPRECATED: total dispersion
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 1 to entry: The chromatic dispersion may be due to the following contributions: material dispersion, waveguide dispersion, profile dispersion.

[SOURCE: IEC TR 61931:1998, 2.4.54]

3.1.6
cladding mode

mode in which the electromagnetic field is confined in the cladding and the core by virtue of there being a lower refractive index medium surrounding the outermost cladding

[SOURCE: IEC 60050-731:1991, 731-03-60]

3.1.7
coherence time
time over which a propagating light can be considered to be coherent radiation

Note 1 to entry: The coherence time is equal to coherence length divided by the phase velocity of light in a medium.

Note 2 to entry: The coherence time is given approximately $\lambda_0^2/(c \cdot \Delta\lambda)$ where λ_0 is the central wavelength, $\Delta\lambda$ is the spectral linewidth and c is the velocity of light in vacuum.

3.1.8
directional coupler
directional branching device
device which distributes an optical signal among the output ports in a predetermined fashion only when light is launched into one preselected input port

Note 1 to entry: For the purposes of this document, directional coupler is the preferred term because this is also the term for its electrical equivalent.

[SOURCE: IEC TR 61931:1998, 2.6.22, modified – "directional coupler" given preferred term status instead of deprecated status, and Note 1 to entry has been added.]

3.1.9
directivity
the ratio, usually expressed in decibels, of the power output measured at the appropriate port of one of the transmission lines of a directional coupler, when power is fed into the other transmission line in the preferred direction, to the power output measured at the same place when the same power is fed into the same line in the opposite direction, matched terminations being connected to all ports

[SOURCE: IEC 60050-726:1982, 726-14-03]

3.1.10
equivalent input noise current density
notional input noise current density which, when applied to the input of an ideal noiseless device, produces an output noise current density equal in value to that observed at the output of the actual device under consideration

Note 1 to entry: It can be calculated from the RF signal-to-noise ratio (see 4.14).

3.1.11
fibre optic branching device
optical fibre branching device
DEPRECATED: optical fibre coupler
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 1 to entry: The ports may be connected to fibres, sources, detectors, etc.

[SOURCE: IEC TR 61931:1998, 2.6.21]

3.1.12
flatness
difference between the maximum and the minimum gain or attenuation reduced by the slope within the specified modulation frequency range of a device or system

3.1.13
optical isolator
isolator
two port non-reciprocal optical device intended to suppress backward reflection, while having minimum insertion loss in the forward direction, based on the Faraday effect

Note 1 to entry: An isolator is commonly used to prevent return reflections along a transmission path.

Note 2 to entry: An isolator is generally polarization dependent; however, fibre optic polarization-independent isolators exist.

[SOURCE: IEC TR 61931:1998, 2.6.30]

3.1.14
microscopic gain tilt
slope due to ripples in sub-nanometre intervals in the gain-versus-wavelength characteristic in the specified wavelength range of optical amplifiers (see Figure 1)

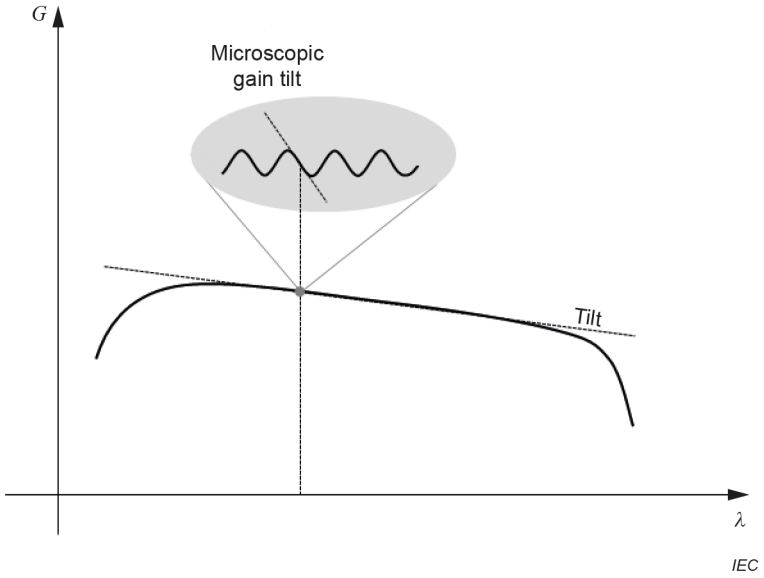

Figure 1 – Tilt and microscopic gain tilt of optical amplifiers

3.1.15
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

[SOURCE: IEC TR 61931:1998, 2.6.51]

3.1.16
noise figure
NF
decrease of the signal-to-noise ratio (SNR), at the output of an optical detector with unitary quantum efficiency and zero excess noise, due to the propagation of a shot noise-limited signal through the optical amplifier (OA)

Note 1 to entry: The operating conditions at which the noise figure is specified should be stated, especially since it depends on the optical input power and on the wavelength used.

Note 2 to entry: This property can be described as a discrete wavelength or as a function of wavelength.

Note 3 to entry: The noise degradation due to the OA, is attributable to different factors, for example signal-spontaneous beat noise, spontaneous-spontaneous beat noise, internal reflections noise, signal shot noise, spontaneous shot noise. Each of these factors depends on various conditions which should be specified for a correct evaluation of the noise figure.

Note 4 to entry: By convention, this noise figure is a positive number.

Note 5 to entry: In the case of OAs for analogue applications, the noise figure also represents the ratio between input and the output RF signal-to-noise ratios.

Note 6 to entry: Noise figure is expressed in dB.

3.1.17
optical amplifier
OA
optical waveguide device containing a suitably pumped, active medium which is able to amplify an optical signal

[SOURCE: IEC TR 61931:1998, 2.7.75]

3.1.18
optical receiving unit
optical receiver
RX
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 1 to entry: For the purposes of this document, optical receivers can have more than one output port providing electrical RF signals.

[SOURCE: IEC TR 61931:1998, 2.9.7, modified – Note 1 to entry has been added.]

3.1.19
optical return loss
return loss
ORL
ratio, expressed in dB, of the total reflected power to the incident power from an optical fibre, optical device, or optical system, and defined as Equation (1):

$$-10\lg\frac{P_r}{P_i} \tag{1}$$

where

P_r is the reflected power;

P_i is the incident power.

Note 1 to entry: When referring to a reflected power from an individual component, "reflectance" is the preferred term.

Note 2 to entry: For the purposes of this document, the term "reflectance" is used for optical amplifiers only. The term “optical return loss” is used for ports of all other types of equipment.

Note 3 to entry: The term "return loss" is also used for electrical ports. The definition relates to electrical powers in this case.

[SOURCE: IEC TR 61931:1998, 2.6.49, modified – Notes 2 and 3 to entry have been added.]

3.1.20
optical transmitting unit
optical transmitter
TX
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 1 to entry: For the purposes of this document, optical transmitters can have more than one input port accepting electrical RF signals.

[SOURCE: IEC TR 61931:1998, 2.9.6, modified – Note 1 to entry has been added.]

3.1.21
polarization
orientation of the electric field vector of the electromagnetic radiation

[SOURCE: IEC TR 61931:1998, 2.1.44]