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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, Publicly Available Specifications (PAS) 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 third edition cancels and replaces the second edition published in 2003 of which it constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition.

- The normative references were updated.
- The methods of measurement for optical power and return loss were substituted by references to other standards.
- The method of measurement for polarization dependent loss was deleted.

- A method of measurement for carrier-to-crosstalk ratio (CCR) was added.
- The methods of measurement for CSO and CTB of optical amplifiers were substituted by a method of measurement for microscopic gain tilt of optical amplifiers. This parameter can be used for calculating the second order distortion of optical amplifiers according to the method described in the new Annex B.
- New classes for optical transmitters and receivers have been defined.

The text of this standard is based on the following documents:

CDV	Report on voting
100/1654/CDV	100/1789/RVC

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 list of all the parts of the IEC 60728 series, 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 publication will remain unchanged until the stability date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

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- withdrawn,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

A bilingual version of this publication may be issued at a later date.

INTRODUCTION

Standards of the IEC 60728 series deal with cable networks including equipment and associated methods of measurement for headend reception, processing and distribution of television signals, sound signals and their associated data signals and for processing, interfacing and transmitting all kinds of signals for interactive services using all applicable transmission media.

- This covers 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.

NOTE CATV encompasses the Hybrid Fibre Coaxial (HFC) networks used nowadays to provide telecommunications services, voice, data and audio and video both broadcast and narrowcast.

The extent of this standardisation work is from the antennas and/or special signal source inputs to the headend or other interface points to the network up to the terminal input.

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

The reception of television signals inside a building requires an outdoor antenna and a distribution network to convey the signal to the TV receivers.

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.
- 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 60068-1:1988, *Environmental testing – Part 1: General and guidance*

IEC 60068-2-1, *Environmental testing – Part 2-1: Tests – Test A: Cold*

IEC 60068-2-2, *Environmental testing – Part 2-2: Tests – Test B: Dry heat*

IEC 60068-2-6:2007, *Environmental testing – Part 2-6: Tests – Test Fc: Vibration (sinusoidal)*

IEC 60068-2-14, *Environmental testing – Part 2-14: Tests – Test N: Change of temperature*

IEC 60068-2-27, *Environmental testing – Part 2-27: Tests – Test Ea and guidance: Shock*

IEC 60068-2-30, *Environmental testing – Part 2-30: Tests – Test Db: Damp heat, cyclic (12+ 12 h cycle)*

IEC 60068-2-31, *Environmental testing – Part 2-31: Tests – Test Ec: Rough handling shocks, primarily for equipment-type specimens*

IEC 60068-2-40, *Environmental testing – Part 2-40: Tests – Test Z/AM: Combined cold/low air pressure tests*

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, *Graphical symbols for use on equipment*

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

IEC 60617, *Graphical symbols for diagrams*

IEC 60728-1, *Cable networks for television signals, sound signals and interactive services – Part 1: System performance of forward paths*

IEC 60728-2, *Cable networks for television signals, sound signals and interactive services – Part 2: Electromagnetic compatibility for equipment*

IEC 60728-3:2010, *Cable networks for television signals, sound signals and interactive services – Part 3: Active wideband equipment for coaxial cable networks*

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

IEC 60728-13:2010, *Cable networks for television signals, sound signals and interactive services – Part 13: Optical systems for broadcast signal transmissions*

IEC 60793-2-50:2008, *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 basic test procedures – Part 1-3: General communication subsystems – Central wavelength and spectral width measurement*

IEC 61282-4, *Fibre optic communication system design guides – Part 4: Accomodation and utilization of non-linear effects*

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

IEC 61290-1-3, *Optical amplifiers – Test methods – Part 1-3: Power and gain parameters – Optical power meter method*

IEC 61290-3-2:2003, *Optical amplifiers – Part 3-2: Test methods for noise figure parameters – Electrical spectrum analyzer method*

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

IEC 61290-6 (all parts), *Optical fibre amplifiers – Basic specification – Part 6: Test methods for pump leakage parameters*

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

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

IEC 61291-5-2, *Optical amplifiers – Part 5-2: Qualification specifications – Reliability qualification for optical fibre amplifiers*

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

IEC 61754-4, *Fibre optic connector interfaces – Part 4: Type SC connector family*

IEC/TR 61931:1998, *Fibre optic – Terminology*

IEC 80416 (all parts), *Basic principles for graphical symbols for use on equipment*

3 Terms, definitions, symbols and abbreviations

3.1 Terms and definitions

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

3.1.1
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

[IEC/TR 61931:1998, definition 2.9.6]

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

3.1.2
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)

[IEC/TR 61931:1998, definition 2.9.7]

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

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

[IEC/TR 61931:1998, 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/TR 61931:1998, 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

[IEC 60050-731:1991, 731-05-05, modified] and [IEC/TR 61931:1998, 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/TR 61931:1998, 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/TR 61931:1998, 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/TR 61931:1998, 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 the 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

NOTE 1 This term is mainly used for analogue systems.

NOTE 2 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/TR 61931 are 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 (OA), expressed in dB

[IEC 61291-1:2006, definition 3.2.38]

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

NOTE 1 The RIN is usually expressed in dB(Hz^{-1}) resulting in negative values.

NOTE 2 The value for the RIN can be calculated from the results of a carrier-to-noise measurement for the system (see 4.16).

3.1.13
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