# IEC 60728-113

Edition 2.0 2023-05

# INTERNATIONAL STANDARD

# NORME INTERNATIONALE

colour inside

## Cable networks for television signals, sound signals and interactive services – Part 113: Optical systems for broadcast signal transmissions loaded with digital channels only

## Réseaux de distribution par câbles pour signaux de télévision, signaux de radiodiffusion sonore et services interactifs – Partie 113: Systèmes optiques pour la transmission de signaux de radiodiffusion soumis à une charge de porteuses exclusivement numériques



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IEC Secretariat
3, rue de Varembé
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
info@iec.ch
www.iec.ch

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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

## Part 113: Optical systems for broadcast signal transmissions loaded with digital channels only

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This second edition cancels and replaces the first edition published in 2018 and IEC 60728-13-1:2017. This edition constitutes a technical revision.

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

a) IEC 60728-13-1, which deals with the bandwidth expansion for broadcast signal over FTTH systems, has been merged with this document;
b) a table containing the digital signal level at the system outlet (Table 8) has been added.

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

| Draft | Report on voting |
|---|---|
| 100/3900/FDIS | 100/3920/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.

The list of all the parts of 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.

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.

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# 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 113: Optical systems for broadcast signal transmissions loaded with digital channels only

## 1 Scope

This part of IEC 60728 is applicable to optical transmission systems for broadcast signal transmission that consist of headend equipment, optical transmission lines, in-house wirings and system outlets. These systems are primarily intended for television and sound signals using digital transmission technology. This document specifies the basic system parameters and methods of measurement for optical distribution systems between headend equipment and system outlets in order to assess the system performance and its performance limits.

In this document, the upper signal frequency is limited to about 3 300 MHz.

The purpose of this part of IEC 60728 is to describe the system specifications of FTTH (fibre to the home) networks for digitally modulated broadcast signal transmission. This document is also applicable to broadcast signal transmission using a telecommunication network if it satisfies the performance of the optical portion of the system defined in this document. This document describes RF transmission for fully digitalized broadcast and narrowcast (limited area distribution of broadcast) signals over FTTH, and introduces the xPON system as a physical layer media. The detailed description of the physical layer is out of scope of this document. The scope is limited to downstream RF video signal transmission over FTTH; IP transport technologies, such as IP Multicast and associate protocols, which require a two-way optical transmission system, are out of scope of this document.

Some interference effects occurring between the telecommunication system and the broadcast system are addressed in Clause 7.

## 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 60068-1:2013, *Environmental testing – Part 1: General and guidance*

IEC 60728-1:2014, *Cable networks for television signals, sound signals and interactive services – Part 1: System performance of forward paths*

IEC 60728-6:2011, *Cable networks for television signals, sound signals and interactive services – Part 6: Optical equipment*

IEC TR 60728-6-1:2006, *Cable networks for television signals, sound signals and interactive services – Part 6-1: System guidelines for analogue optical transmission systems*

IEC 60728-101:2016, *Cable networks for television signals, sound signals and interactive services – Part 101: System performance of forward paths loaded with digital channels only*

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

IEC 60825-2, *Safety of laser products – Part 2: Safety of optical fibre communication systems (OFCSs)*

IEC 60825-12, *Safety of laser products – Part 12: Safety of free space optical communication systems used for transmission of information*

IEC 61280-1-1:2013, *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 61755-1:2005, *Fibre optic connector optical interfaces – Part 1: Optical interfaces for single mode non-dispersion shifted fibres – General and guidance*

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

ITU-T Recommendation G.694.2, *Spectral grids for WDM applications: CWDM wavelength grid*

ITU-T Recommendation J.83, *Digital multi-programme systems for television, sound and data services for cable distribution*

ITU-T Recommendation J.183, *Time-division multiplexing of multiple MPEG-2 transport streams and generic formats of transport streams over cable television systems*

ITU-T Recommendation J.382, *Advanced digital downstream transmission systems for television, sound and data services for cable distribution*

## 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**
**BER**
**bit error ratio**
ratio between erroneous bits and the total number of transmitted bits

[SOURCE: IEC 60728-1:2014, 3.1.9]

**3.1.2**
**central wavelength**
average of those wavelengths at which the amplitude of a light source reaches or last falls to half of the maximum amplitude

[SOURCE: IEC 60728-6:2011, 3.1.23, modified – The term "centre wavelength" has been replaced by "central wavelength".]

**3.1.3**
**D/U ratio**
single or multiple frequency interference ratio of desired signal level to undesired signal level

Note 1 to entry: The ratio of desired signal level, $D$(dB(µV)), to undesired signal level, $U$(dB(µV)) is given by

$$D/U\ (\text{dB}) = D - U$$

Note 2 to entry: Both the desired and the undesired signals can also be expressed in dB(mW).

Note 3 to entry: The D/U ratio is generally used for multiple frequency interference as CSO and CTB, for single frequency interference as SCR.

Note 4 to entry: Note the similarity of the definition to the definition of SINR (3.1.20).

**3.1.4**
**MER**
**modulation error ratio**
sum of the sequence of the squares of the magnitudes of the ideal symbol vectors divided by the sum of the squares of magnitudes of the symbol error vectors of a sequence of symbols, the result being expressed as a power ratio in dB

[SOURCE: IEC 60728-1:2014, 3.1.61, modified – Note 1 to entry has been deleted, and "the result being expressed as a power ratio in dB" has been added to the end of the definition.]

**3.1.5**
**OFDM signal**
**orthogonal frequency division multiplexing**
multiplexing scheme used for the transportation of terrestrial digital broadcasting SDTV and HDTV signals based on the idea of frequency-division multiplexing

Note 1 to entry: OFDM is based on the idea of frequency-division multiplexing, where each frequency subcarrier is modulated with a simpler modulation, and the frequencies and modulation of FDM are arranged to be orthogonal with each other, which almost eliminates the interference between subcarriers.

**3.1.6**
**optical amplifier**
optical waveguide device containing a suitably pumped, active medium which is able to amplify an optical signal

Note 1 to entry: There are several methods based on wavelength to be used for amplification. The term "Erbium Doped Fibre Amplifier (EDFA)" is the synonym of optical amplifier in this document.

[SOURCE: IEC TR 61931:1998, 2.7.75, modified – Note 1 to entry has been added.]

**3.1.7**
**optical modulation index**
optical modulation index of $k$-th RF signal, $m_k$ is defined as

$$m_k = \frac{\phi_{\mathrm{h}} - \phi_{\mathrm{l}}}{\phi_{\mathrm{h}} + \phi_{\mathrm{l}}}$$

where

$\phi_h$ is the highest instantaneous optical power of the intensity modulated optical signal;

$\phi_l$ is the lowest instantaneous optical power of the intensity modulated optical signal

Note 1 to entry: 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 61931:1998 are used. A test procedure for extinction ratio is described in IEC 61280-2-2.

[SOURCE: IEC 60728-6:2011, 3.1.10, modified – The definition has been clarified and Notes 1 and 2 to entry have been replaced by a new Note 1 to entry.]

**3.1.8**
**optical receiver**
receiving fibre optic terminal device accepting at its input port a modulated optical signal, 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 has been added, and the terms "optical receiving unit" and "Rx" have been omitted.]

**3.1.9**
**optical transmitter**
transmitting 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.

Note 2 to entry: This piece of equipment amplifies frequency multiplexed electrical signals and converts these electrical signals into optical signals. The optical wavelength is a 1 500 nm band (1 550 ± 10 nm in the 1 530 nm to 1 625 nm range).

[SOURCE: IEC TR 61931:1998, 2.9.6, modified – Notes 1 and 2 to entry have been added, and the terms "optical transmitting unit" and "Tx" have been omitted.]

**3.1.10**
**OLT**
**optical line terminal**
central office terminal equipment that is linked with the optical network unit (ONU) in the customer premises

Note 1 to entry: The OLT usually connects with headend equipment.

**3.1.11**
**ONU**
**optical network unit**
device at the customer premises that is linked with the optical line terminal (OLT)

Note 1 to entry: The ONU usually connects with other customer premises equipment.