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INTERNATIONAL STANDARD

NORME INTERNATIONALE

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Cable networks for television signals, sound signals and interactive services – Part 115: In-building optical systems for broadcast signal transmissions

Réseaux de distribution par câbles pour signaux de télévision, signaux de radiodiffusion sonore et services interactifs – Partie 115: Systèmes optiques internes aux immeubles pour la transmission de signaux de diffusion

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Part 115: In-building optical systems for broadcast signal transmissions

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

Draft	Report on voting
100/3705/FDIS	100/3721/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.

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.

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/standardsdev/publications.

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

Part 115: In-building optical systems for broadcast signal transmissions

1 Scope

This part of IEC 60728 is applicable to in-building optical transmission systems for broadcast signal transmission that consist of optical transmitters, optical amplifiers, splitters, V-ONUs, etc. 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 in-building optical distribution systems between building network interfaces (BNI) and home network interfaces (HNI) in order to assess the system's performance and its performance limits.

This document is also applicable to broadcast signal transmission using a telecommunication network if it satisfies the requirements of the optical portion of this document. This document describes RF transmission for fully digitalized broadcast and narrowcast (limited area distribution of broadcast) signals over an FTTH network and introduces the X-PON system as a physical layer media. The detailed description of the physical layer is out of the scope of this document. The scope is limited to RF signal transmission over optical networks; thus, it does not include IP transport technologies, such as IP multicast and associated protocols.

This document specifies the required system performance of all-optical building networks in order to establish connections with FTTH networks, which are defined by IEC 60728-113 and IEC 60728-13-1. Use of in-building optical networks is very effective for saving costs (installation and maintenance) and enabling future network upgrades, especially in huge apartment buildings.

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

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 60728-113:2018, *Cable networks for television signals, sound signals and interactive services – Part 113: Optical systems for broadcast signal transmissions loaded with digital channels only*

IEC 60728-13-1:2017, *Cable networks for television signals, sound signals and interactive services – Part 13-1: Bandwidth expansion for broadcast signal over FTTH system*

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, *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*

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 terminological 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
MER
modulation error ratio
sum of the sequence of the squares of the magnitudes of the ideal symbol vector divided by the sum of the squares of magnitudes of the symbol error vectors of a sequence of symbols

[SOURCE: IEC 60728-1:2014, 3.1.61, modified – The note to entry has been omitted.]

3.1.4
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 can used for amplification. EDFA (erbium-doped fibre amplifier) is used for the optical amplifier of cable television FTTH network.

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

3.1.5
optical modulation index
optical modulation index of k-th RF signal, m_k is defined as

$$m_k = \frac{\phi_h - \phi_l}{\phi_h + \phi_l}$$

where

ϕ_h is the highest instantaneous optical power of the intensity modulated optical signal;

ϕ_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.]

3.1.6
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 to entry has been added, and the term "optical receiving unit" has been omitted.]

3.1.7
OFDM
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 channel 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 channels.

3.1.8
optical transmitter
transmitting fibre optic terminal device accepting at its input port an electrical signal and providing at its output port an optical signal 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 1 500 ± 10 nm in the C-band (1 530 nm to 1 625 nm).

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

3.1.9
QAM
quadrature amplitude modulation
quadrature amplitude modulation by two separate signals of two sinusoidal signals having the same amplitude and frequency but being in phase quadrature, the modulated signals being added for transmission in a single channel

[SOURCE: IEC 60050-702:1992, 702-06-63]

3.1.10
signal level
strength of a digitally modulated signal given by the RMS power of the signal within the channel bandwidth (S)

Note 1 to entry: The level of an OFDM signal is the average electrical power of the overall signal comprised of multi-carriers and is not the individual carrier level of the multi-carrier signal, as shown in Table 1.

Table 1 – Signal level

Signal	Level detection	Symbol	Remarks
QAM	RMS value	S	The value is averaged over a sufficiently long period of time compared to period of the lowest frequency used for the modulation.
OFDM	RMS value		

Note 2 to entry: The level of digitally modulated signal can be expressed in dB(mW) or in dB(µV) referred to 75 Ω.

3.1.11
RIN
relative intensity noise
ratio between the mean square of the intensity fluctuations in the optical power of a light source and the square of the mean optical output power

Note 1 to entry: The RIN is usually expressed in dB(Hz^{-1}), resulting in negative values.

Note 2 to entry: The value of RIN can also be calculated from the results of a signal-to-intermodulation and noise measurement for the system.

[SOURCE: IEC 60728-6:2011, 3.1.12, modified – In Note 2 to entry, "signal-to-intermodulation and noise measurement" replaces "carrier-to-noise measurement".]

3.1.12
SINR
signal-to-intermodulation and noise ratio for a digitally modulated signal in the RF band signal-to-intermodulation and noise ratio (R_{SIN}) is given by

$$R_{SIN}\ (\text{dB}) = S - N_{IN,\ rms} \qquad \text{(digital signals)}$$

where

S is the signal level;

$N_{IN,\ rms}$ is the RMS level of the intermodulation and noise in the equivalent noise bandwidth of the RF channel.

Note 1 to entry: The level of the RF digitally modulated signal and the level of the noise are expressed in the same units, in dB(mW) or in dB(µV) measured across a 75 Ω termination, or referred to 75 Ω.

Note 2 to entry: In this document, only digital modulated carriers are considered. The term SINR used in this document is the same as the term $S_{D,RF}/N$ defined in IEC 60728-1:2014, 3.1.72.