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colour inside

Cable networks for television signals, sound signals and interactive services – Part 13: Optical systems for broadcast signal transmissions

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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

Part 13: Optical systems for broadcast signal transmissions

FOREWORD

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International Standard IEC 60728-13 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.

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

FDIS	Report on voting
100/1623/FDIS	100/1646/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 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 maintenance result 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- withdrawn,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.

The contents of the corrigendum of August 2010 have been included in this copy.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

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 includes

- CATV[1]-networks;
- MATV-networks and SMATV-networks;
- individual receiving networks;

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

The extent of this standardization 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 standardization 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.

[1] This word encompasses the HFC (Hybrid Fibre Cable) networks used nowadays to provide telecommunications services, voice, data, audio and video both broadcast and narrowcast.

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

Part 13: Optical systems for broadcast signal transmissions

1 Scope

This part of IEC 60728 is applicable to optical transmission system for broadcast signal transmission that consists of a head-end equipment, optical transmission lines, in-house wirings and a system outlet. The system is primarily intended for television and sound signals using analogue and/or digital transmission technology. This standard specifies the basic system parameters and methods of measurement for optical distribution system having a system outlet in order to assess the system performance and its performance limits.

The purpose of this part of IEC 60728 is to describe the system specification of FTTH (fibre to the home) network for broadcast signal transmission. This standard is also applicable to the broadcast signal transmission using telecommunication network if it satisfies the optical portion of this standard. This standard describes RF transmission for broadcast and narrowcast (limited area distribution of broadcast) signals over FTTH, and introduces xPON system as a physical layer media. The detailed description of physical layer is out of the scope of this standard. The scope is limited to RF signal transmission over FTTH, thus, it does not include IP transport technologies, such as IP Multicast and associate protocols. Some interference descriptions between telecommunication system and broadcast system addressed in Clause 7 and Annex D should be referred to for detailed explanations. Annex A describes actual service systems with design consideration based on this standard. Annex B gives an overview of the optical transmission systems applicable for broadcast signal transmission.

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 60728-1:2007, *Cable networks for television signals, sound signals and interactive services – Part 1: System performance of forward paths*

IEC 60728-6:2003, *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 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 (OFCS)*

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

IEC 61291-1:2006, *Optical amplifiers – Part 1: Generic specification*

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

IEC 61930:1998, *Fibre optic graphical symbology*

IEC 61931:1998, *Fibre optic – Terminology*

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*

3 Terms, definitions, symbols and abbreviations

3.1 Terms and definitions

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

3.1.1
optical transmitting unit
optical transmitter
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 61931, definition 2.9.6]

NOTE 1 For the purposes of this document, optical transmitters may have more than one input port accepting electrical RF signals.

NOTE 2 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 1 530 nm to 1 625 nm region).

3.1.2
optical receiving unit
optical receiver
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 61931, definition 2.9.7]

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

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]

NOTE 1 In this document, Erbium Doped Fibre Amplifier (EDFA) is used for amplification in the 1 550 nm band.

NOTE 2 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.

3.1.4
fibre optic branching device
optical fibre coupler
splitter
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, detectors, etc.

[IEC 61931, definition 2.6.21, modified]

3.1.5
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]

3.1.6
optical modulation index
optical modulation index of k^{th} RF carrier, m_k is defined as

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

total optical modulation index, M is defined as

$$M = \sqrt{\sum_{k=1}^{K} m_k^2}$$

where

ϕ_h is the highest and

ϕ_l is the lowest instantaneous optical power of the intensity modulated optical signal,

K is the total number of RF carriers and

M is the total optical modulation index.

NOTE This term is mainly used for analogue systems.

[IEC 60728-6, definition 3.1.10, modified]

3.1.7
noise figure
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 fibre amplifier, expressed in dB

[IEC 61291-1, definition 3.2.38]

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

3.1.8
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.

[IEC 60728-6, definition 3.1.12, modified]

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

3.1.9
responsivity
ratio of an optical detector's electrical output to its optical input at a given wavelength

NOTE 1 The responsivity is generally expressed in Ampere per Watt or Volt 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 60728-6, definition 3.1.15]

3.1.10
wavelength

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

NOTE The wavelength λ of light in vacuum is given by

$$\lambda = \frac{c}{f}$$

where

c is the speed of light in vacuum c = 2,997 92 × 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.

[IEC 60728-6, definition 3.1.17, modified]

3.1.11
central wavelength
the average of those wavelengths at which the amplitude of a light source reaches or last falls to half of the maximum amplitude

[IEC 60728-6, definition 3.1.26]

3.1.12
AM-VSB signal
sideband in which only the spectral components corresponding to the lower frequencies of the modulating signals are preserved, the other components being strongly attenuated

[IEV 702-06-28, modified]

NOTE This is the abbreviation for the vestigial sideband amplitude modulated signal used in the terrestrial broadcasting and CATV transmission system.

3.1.13
QAM signal
quadrature amplitude modulation
QAM
amplitude modulation by two separate signals of two sinusoidal carriers having the same amplitude and frequency but being in phase quadrature, the modulated signals being added for transmission in a single channel

[IEV 702-06-63, modified]

3.1.14
OFDM signal
orthogonal frequency division multiplexing is one of the multiplexing schemes used for the transportation of terrestrial digital broadcasting SDTV and HDTV signals

NOTE 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.

3.1.15
RF signal level definition
level of an RF signal is defined in Table 1; it is expressed in microvolt or in dB(μV) or in dB(mW)

3.1.16
AM-VSB analogue signals

vision carrier signal level is the RMS value of the vision carrier at the peak of the modulation envelope (C_{rms}), expressed in dB(μV) and measured across a 75 Ω termination or referred to 75 Ω

NOTE This will correspond, in negative modulation systems, to the carrier amplitude during synchronizing pulses and, in positive modulation systems, to that at peak white level without a chrominance signal, as shown in ITU-R Recommendation BT.470, Figure 1.

3.1.17
FM radio or FM audio carrier of a TV signals
level of an FM radio or of an FM audio carrier of a TV signal is the RMS value of the carrier expressed in dB(μV) and measured across a 75 Ω termination or referred to 75 Ω

3.1.18
digitally modulated signals
level of a digitally modulated signal is given by the RMS power of the signal within the channel bandwidth ($S_{D,RF}$) and can be expressed in dB(mW) or in dB(μV) referred to 75 Ω

NOTE 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 – Level of RF signals

Signal		Level detection	Symbol	Remarks
Analogue TV signal	**AM-VSB video carrier**	peak value	C_{rms}	RMS value of the carrier at the peak of the modulation envelope.
	FM audio carrier	RMS value	C_{rms}	The carrier level is a constant value.
QAM signal		RMS value	$S_{D,RF}$	The value is averaged over a sufficiently long period of time compared to period of the lowest frequency used for the modulation.
OFDM signal		RMS value		

3.1.19
carrier-to-noise ratio
C/N
signal-to-noise ratio
$S_{D,RF}/N$
ratios are given by

$$C/N \text{ (dB)} = C_{rms} - N_{rms} \quad \text{(for analogue signals)}$$
$$S_{D,RF}/N \text{ (dB)} = S_{D,RF} - N_{rms} \quad \text{(for digital signals)}$$

where N_{rms} is the RMS level of the noise in the equivalent noise bandwidth of the RF channel, expressed in dB(mW) or in dB(μV) referred to 75 Ω

NOTE The level of the analogue modulated carrier or of the RF digitally modulated signal and the level of the noise shall be expressed in the same units, in dB(mW) or in dB(μV) measured across a 75 Ω termination or referred to 75 Ω.

3.1.20
***D/U* ratio**
ratio of desired signal level, *D*[dB(μV)], to undesired signal level, *U*[dB(μV)]

NOTE The *D*/*U* ratio is generally used for multiple frequency interference as CSO and CTB, for single frequency interference as CCR.

3.1.21
single or multiple frequency interference
besides the *C*/*N* and $S_{D.RF}/N$ ratios, single or multiple frequency interference to video signal is defined as the ratio of desired signal level and undesired signal level

NOTE 1 The ratio of desired signal level, *D*(dB(μV)), to undesired signal level, *U*(dB(μV)) is given by

D/*U* (dB) = *D* − *U*

NOTE 2 The desired and the undesired signals can also be expressed both in dB(mW).

3.1.22
optical line terminal
OLT
central office-terminal equipment that is linked with the Optical Network Unit (ONU) in customer premises

NOTE OLT usually connects with headend equipment.

3.1.23
optical network unit
ONU
terminal equipment linked with OLT

3.1.24
video-optical network unit
V-ONU
terminal unit that changes the optical signal of a broadcast system into an electric signal

NOTE The term V-ONU is used as the synonym of optical receiver (O/E) in this standard.