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INTERNATIONAL STANDARD

colour inside

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

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

Part 13-1: Bandwidth expansion for broadcast signal over FTTH system

FOREWORD

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International Standard IEC 60728-13-1 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 second edition cancels and replaces the first edition published in 2012. This edition constitutes a technical revision.

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

- Transmission frequency was expanded in order to achieve satellite signal for 4 K video service. The transmission frequency over FTTH would be 3 300 MHz.
- High signal modulation case like 16 APSK and 32 APSK was added in order to correspond to transmission for 4 K video service.

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

FDIS	Report on voting
100/2927/FDIS	100/2959/RVD

Full information on the voting for the approval of this International Standard can be found in the report on voting indicated in the above table.

This document has been drafted in accordance with the ISO/IEC Directives, Part 2.

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 "http://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- withdrawn,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.

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

The contents of the corrigendum of September 2017 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 and 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 is from the antennas and/or special interfaces to the headend or other interface points to the network up to any terminal interface of the customer premises equipment.

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, etc.) 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 13-1: Bandwidth expansion for broadcast signal over FTTH system

1 Scope

The purpose of this part of IEC 60728 is the precise description of an FTTH (fibre to the home) system for expanding broadband broadcast signal transmission from CATV services only, towards CATV plus broadcast satellite (BS) plus communication satellite (CS) services, additionally to other various signals such as data services.

The scope is limited to the RF signal transmission over FTTH systems.

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

IEC 60728-113:—, *Cable networks for television signals, sound signals and interactive services – Part 113: Optical systems for broadcast signal transmissions loaded with digital channels only*[1]

IEC 61280-1-3:2010, *Fibre optic communication subsystem test procedures – Part 1-3: General communication subsystems – Central wavelength and spectral width measurement*

ITU-T Recommendation G.694.1, *Spectral grids for WDM applications: DWDM frequency grid*

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

3 Terms, definitions, symbols and abbreviated terms

3.1 Terms and definitions

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

[1] Under preparation. Stage at the time of publication: IEC ACDV 60728-113: 2017.

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

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

3.1.1
regional broadband cable network
network designed to provide sound and television signals as well as signals for interactive services to a regional area covering several towns and/or villages

3.1.2
local broadband cable network
network designed to provide sound and television signals as well as signals for interactive services to a local area (e.g. one town or one village)

3.1.3
extended satellite television distribution network or system
distribution network or system designed to provide sound and television signals received by satellite receiving antenna to households in one or more buildings

Note 1 to entry: This kind of network or system can be combined with terrestrial antennas for the additional reception of TV and/or radio signals via terrestrial networks.

Note 2 to entry: This kind of network or system can also carry control signals for satellite switched systems or other signals for special transmission systems (e.g. MoCA or WiFi) in the return path direction.

3.1.4
extended terrestrial television distribution network or system
distribution network or system designed to provide sound and television signals received by terrestrial receiving antennas to households in one or more buildings

Note 1 to entry: This kind of network or system can be combined with a satellite antenna for the additional reception of TV and/or radio signals via satellite networks.

Note 2 to entry: This kind of network or system can also carry other signals for special transmission systems (e.g. MoCA or WiFi) in the return path direction.

3.1.5
individual satellite television receiving system
system designed to provide sound and television signals received from satellite(s) to an individual household

Note 1 to entry: This kind of system can also carry control signals for satellite switched systems or other signals for special transmission systems (e.g. MoCA or WiFi) in the return path direction.

3.1.6
individual terrestrial television receiving system
system designed to provide sound and television signals received via terrestrial broadcast networks to an individual household

Note 1 to entry: This kind of system can also carry other signals for special transmission systems (e.g. MoCA or WiFi) in the return path direction.

3.1.7
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

Note 1 to entry: For the purposes of this document, optical transmitters may 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 nm ± 10 nm in 1 530 nm to 1 625 nm region).

Note 3 to entry: The wavelength and necessary wavelength separation are described in Annexes B and C, respectively.

[SOURCE: IEC 60728-13:2010, 3.1.1, modified — Note 3 has been added.]

3.1.8
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)

Note 1 to entry: For the purposes of this document, optical receivers may have more than one output port providing electrical RF signals.

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

3.1.9
optical amplifier
optical waveguide device containing a suitably pumped, active medium which is able to amplify an optical signal

Note 1 to entry: In this document, erbium doped fibre amplifier (EDFA) is used for amplification in the 1 550 nm band.

Note 2 to entry: There are several methods based on the 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, 2.7.75, modified — Notes 1 and 2 have been added.]

3.1.10
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 1 to entry: The ports may be connected to fibres, detectors, etc.

[SOURCE: IEC TR 61931:1998, 2.6.21, modified — The term "splitter" has been added, "optical fibre branching" device has been deleted and "optical fibre coupler" is a preferred rather than a deprecated term.]

3.1.11
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]

3.1.12
optical modulation index
optical modulation index of k^{th} RF signal, OMI_k, which is defined as

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

where

ϕ_h is the highest, and

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

k is the considered RF 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 have been replaced by a new Note 1.]

3.1.13
total optical modulation index
resulting optical modulation index when more than one RF signal is transmitted, OMI_{tot}, which is defined as

$$OMI_{tot} = \sqrt{\sum_{k=1}^{K} OMI_k{}^2}$$

where

OMI_k is the optical modulation index of the k-th RF signal;

K is the total number of RF signals.

3.1.14
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 to entry: *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-noise measurement for the system.

[SOURCE: IEC 60728-13:2010, definition 3.1.8]

3.1.15
responsivity
ratio of an optical detector's electrical output to its optical input at a given wavelength

Note 1 to entry: The responsivity is generally expressed in ampere per watt or volt per watt of incident radiant power.

Note 2 to entry: Sensitivity is sometimes used as an imprecise synonym for responsivity.

Note 3 to entry: The wavelength interval around the given wavelength may be specified.

[SOURCE: IEC 60728-6, 3.1.14]

3.1.16
wavelength
distance covered in a period by the wavefront of a harmonic plane wave

Note 1 to entry: 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.

[SOURCE: IEC 60728-13:2010, 3.1.10]

3.1.17
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, 3.1.26, modified — The term "centre wavelength" has been replaced by "central wavelength".]

3.1.18
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

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

3.1.19
QAM signal
signal utilizing quadrature amplitude modulation as its modulation method

3.1.20
orthogonal frequency division multiplexing
OFDM
orthogonal frequency division multiplexing is one of the multiplexing schemes used for the transportation of terrestrial digital broadcasting SDTV and HDTV signals

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.

[SOURCE: IEC 60728-13:2010, 3.1.14, modified — OFDM has been specified and "OFDM signal" has been deleted and given as a new entry.]

3.1.21
OFDM signal
signal utilizing orthogonal frequency division multiplexing as the multiplexing scheme

3.1.22
phase shift keying
PSK
angle modulation in which each significant condition in a modulating discretely-timed signal is represented by a specified phase of a periodic sinusoidal oscillation.

[SOURCE: IEC 60050-721:1991, 721-06-07, modified — The preferred terms "phase shift modulation" and "phase shift signalling" have been deleted.]

3.1.23
PSK signal
signal utilizing phase shift keying as its modulation method

3.1.24
amplitude phase shift keying
APSK
digital modulation scheme that conveys data by changing, or modulating, both the amplitude and the phase of a reference signal

Note 1 to entry: APSK combines both amplitude-shift keying (ASK) and phase-shift keying (PSK) to increase the symbol-set.

3.1.25
APSK signal
signal utilizing amplitude phase shift keying as its modulation scheme

3.1.26
level of digitally modulated signal
RMS power of the signal within the channel bandwidth (S)

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

Table 1 – Level of RF signals

Signal		Level detection	Symbol	Remarks
Digitally modulated signals	QAM signal	RMS value	S	The value is averaged over a sufficiently long period of time compared to the period of the lowest frequency used for the modulation.
	OFDM signal			
	xPSK signal [a]			
	16 APSK signal			
	32 APSK signal			
FM audio carrier [b]		RMS value	C_{rms}	The carrier level is a constant value.

[a] xPSK means QPSK,8PSK,TC8PSK, etc.

[b] FM radio is not a kind of digitally modulated signals. However, it may exist in some digitally modulated optical broadcast system.

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

3.1.27
***S/N* ratio**
signal to noise ratio for a digitally modulated signal in the RF band

Note 1 to entry: In this document only digitally modulated carriers are considered. S/N is used only for a digitally modulated signal which expresses the same as $S_{D,RF}/N$ used in IEC 60728-1:2014, 3.1.80.

3.1.28
***D/U* ratio**
ratio of desired signal level, D, to undesired signal level, U

Note 1 to entry: The D/U ratio is generally used for multiple frequency interference as CSO and CTB, for single frequency interference as SCR.

Note 2 to entry: D/U ratio is expressed in dB.

[SOURCE: IEC 60728-13:2010, definition 3.1.20, modified — CCR in note 1 has been changed to SCR.]