IEC 60728-13-1

Edition 1.0 2012-05

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

IEC 60728-13-1:2012(E)

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

Tel.: +41 22 919 02 11
Fax: +41 22 919 03 00
info@iec.ch
www.iec.ch

About the IEC

The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications

The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigenda or an amendment might have been published.

Useful links:

IEC publications search - www.iec.ch/searchpub

The advanced search enables you to find IEC publications by a variety of criteria (reference number, text, technical committee,…).
It also gives information on projects, replaced and withdrawn publications.

IEC Just Published - webstore.iec.ch/justpublished

Stay up to date on all new IEC publications. Just Published details all new publications released. Available on-line and also once a month by email.

Electropedia - www.electropedia.org

The world's leading online dictionary of electronic and electrical terms containing more than 30 000 terms and definitions in English and French, with equivalent terms in additional languages. Also known as the International Electrotechnical Vocabulary (IEV) on-line.

Customer Service Centre - webstore.iec.ch/csc

If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: csc@iec.ch.

IEC 60728-13-1

Edition 1.0 2012-05

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

INTERNATIONAL ELECTROTECHNICAL COMMISSION

PRICE CODE XA

ICS 33.160.01; 33.180.01

ISBN 978-2-88912-044-4

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

_____

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

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

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.
2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
6) All users should ensure that they have the latest edition of this publication.
7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

International Standard IEC 60728-13-1 has been prepared by technical area 5: Cable networks for television signals, sound signal 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:

CDV	Report on voting
100/1801/CDV	100/1931/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 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.

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.

A bilingual version of this standard 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 includes

- 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, audio and video both broadcast and narrowcast.

The extent of this standardization work is from the antennas, 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, terminals, etc.) as well as of any coaxial and optical cables and accessories thereof is excluded.

In this standard, informative Annex A describes the system composition and model system based on this standard, and Annex B describes basic concepts for optical wavelength division multiplexing and adds notes for system configuration. Annex C gives the minimum wavelength separation, and Annex D explains the relationship between *C*/*N* degradation and rain attenuation.

This standard describes the pass-through method of satellite broadcast signals over the FTTH system which uses AM-FDM (SCM) transmission. For an FTTH system below 1 GHz refer to IEC 60728-13. This standard contains descriptions of the measurement methods and specifications for optical wavelength division multiplex and for PSK modulation systems. It specifies the downstream video signal transmission and thus the two-way optical transmission system is out of the scope of this standard.This standard applies to the FTTH system of broadband broadcast signal transmission which conveys satellite broadcast signals using one or multiple optical wavelengths. It is provided for cable/satellite operators to extend their broadband services in order to avoid interference between optical wavelengths based on the technologies described in IEC 60728-13.

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 the fibre to the home (FTTH) 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 the FTTH (fibre to the home) system. Thus, this part of IEC 60728 does not include IP transport technologies.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. 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 60728-6:2011, *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 61280-1-3, *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: CWDM wavelength grid*

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
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

[SOURCE: IEC 61931:1998, definition 2.9.6]

Note 1 to entry: For the purposes of this standard, 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 ± 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, definition 3.1.1, modified – Note 3 has been added]

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)

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

[SOURCE: IEC/TR 61931:1998, definition 2.9.7, modified – Note 1 has been added]

3.1.3
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 standard, 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 wavelength to be used for amplification. The term “Erbium Doped Fibre Amplifier (EDFA)” is the synonym of optical amplifier in this standard.

[SOURCE: IEC/TR 61931:1998, definition 2.7.75, modified – Notes 1 and 2 have been added]

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

[SOURCE: IEC/TR 61931:1998, definition 2.6.21, modified – The term has been clarified]

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

[SOURCE: IEC 61931:1998, definition 2.6.51]

3.1.6
optical modulation index
OMI
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 1 to entry: This term is mainly used for analogue systems.

[SOURCE: IEC 60728-13:2010, definition 3.1.6]

3.1.7
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: 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 carrier-to-noise measurement for the system.

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

[SOURCE: IEC 60728-6:2011, definition 3.1.12]

3.1.8
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 60728-6:2011, definition 3.1.14]

3.1.9
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 ($c \approx 2{,}997\ 92 \times 10^8$ m/s)

f is the optical frequency

Note 2 to entry: 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 60728-6:2011, definition 3.1.16]

3.1.10
centre 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, definition 3.1.23]

3.1.11
vestigial sideband
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

[SOURCE: IEC 60050-702:1992, definition 702-06-28, modified – The abbreviation has been completed]

Note 1 to entry: This is the abbreviation for the vestigial sideband amplitude modulated signal used in the terrestrial broadcasting and CATV transmission system.

[SOURCE: IEC 60728-13:2010, definition 3.1.12]

3.1.12
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

[SOURCE: IEC 60728-13:2010, definition 3.1.13]

3.1.13
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 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, definition 3.1.14]

3.1.14
phase shift keying
PSK signal
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, definition 721-06-07, modified – One term has been deleted and one term has been modified.]

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)

[SOURCE: IEC 60728-13:2010, definition 3.1.15]

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 1 to entry: 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.

[SOURCE: IEC 60728-13:2010, definition 3.1.16]

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

[SOURCE: IEC 60728-13:2010, definition 3.1.17]

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 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 – 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.
Digitally modulated signals	**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		
	PSK signal	RMS value		

[SOURCE: IEC 60728-13:2010, definition 3.1.18, modified – Table 1 has been improved.]

3.1.19
carrier-to-noise ratio
signal-to-noise ratio
if the noise level is expressed as

N_{rms} 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

the carrier-to-noise ratio (C/N) or the signal to noise ratio ($S_{D,RF}/N$) is given by

C/N (dB) = $C_{rms} - N_{rms}$ (analogue signals)

$S_{D,RF}/N$ (dB) = $S_{D,RF} - N_{rms}$ (digital signals)

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

[SOURCE: IEC 60728-13:2010, definition 3.1.19, modified – The definition has been revised.]

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

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

[SOURCE: IEC 60728-13:2010, definition 3.1.20, modified]