IEC 60728-103

Edition 1.0 2026-11

INTERNATIONAL STANDARD

Cable networks for television signals, sound signals and interactive services - Part 103: Active wideband equipment for cable networks with digital signals only

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Cable networks for television signals, sound signals and interactive services - Part 103: Active wideband equipment for cable networks with digital signals only

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IEC 60728-103 has been prepared by IEC technical committee 100: Audio, video and multimedia systems and equipment. It is an International Standard.

IEC 60728-3:2017, fifth edition, has served as a basis for the development of this document.

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

Draft	Report on voting
100/4567/FDIS	100/4617/RVD

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

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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.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

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– withdrawn, or
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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 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 of the customer premises equipment.

The standardization work considers coexistence with users of the radio frequency (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.

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1 Scope

This part of IEC 60728 specifies the measuring methods, performance requirements and data publication requirements for active wideband equipment of cable networks for television signals, sound signals and interactive services with digital signals only.

This document:

– applies to all amplifiers used in cable networks;
– covers the frequency range 5 MHz to 3 000 MHz;

NOTE The upper limit of 3 000 MHz is an example, but not a strict value.

– applies to one-way and two-way equipment;
– specifies the basic methods of measurement of the operational characteristics of the active equipment in order to assess the performance of this equipment;
– identifies the performance specifications to be published by the manufacturers;
– states the minimum performance requirements of certain parameters.

While IEC 60728-3:2017 has served as a basis for its development, this document describes the methods of measurement for digital modulated signals only. It also covers the Data Over Cable Service Interface Specification (DOCSIS) 4.0 requirements with additional digital modulation schemes as well as for the extended frequency ranges:

– up to 1 794 MHz for the forward path;
– up to 684 MHz for the return path.

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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, *Environmental testing - Part 1: General and guidance*

IEC 60068-2-1, *Environmental testing - Part 2-1: Tests - Tests A: Cold*

IEC 60068-2-2, *Environmental testing - Part 2-2: Tests - Tests B: Dry heat*

IEC 60068-2-6, *Environmental testing - Part 2-6: Tests - Test Fc: Vibration (sinusoidal)*

IEC 60068-2-14, *Environmental testing - Part 2-14: Tests - Test N: Change of temperature*

IEC 60068-2-27, *Environmental testing - Part 2-27: Tests - Test Ea and guidance: Shock*

IEC 60068-2-30, *Environmental testing - Part 2-30: Tests - Test dB: Damp heat, cyclic (12 h + 12 h cycle)*

IEC 60068-2-31, *Environmental testing - Part 2-31: Tests - Test Ec: Rough handling shocks, primarily for equipment-type specimens*

IEC 60529, *Degrees of protection provided by enclosures (IP Code)*

IEC 60728-2, *Cable networks for television signals, sound signals and interactive services - Part 2: Electromagnetic compatibility for equipment*

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IEC 60728-4, *Cable networks for television signals, sound signals and interactive services - Part 4: Passive wideband equipment for coaxial cable networks*

IEC 60728-11, *Cable networks for television signals, sound signals and interactive services - Part 11: Safety*

IEC 61000-4-5, *Electromagnetic compatibility (EMC) - Part 4-5: Testing and measurement techniques - Surge immunity test*

IEC 61319-1, *Interconnections of satellite receiving equipment - Part 1: Europe*

IEC 61319-2, *Interconnections of satellite receiving equipment - Part 2: Japan*

IEC 62368-1, *Audio/video, information and communication technology equipment - Part 1: Safety requirements*

3 Terms, definitions, symbols and abbreviated terms

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

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

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3.1 Terms and definitions

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3.1.1
amplitude frequency response
gain or loss of equipment or system plotted against frequency

3.1.2
attenuation
ratio of the input power to the output power of equipment or system, usually expressed in decibels

3.1.3
carrier-to-noise ratio
difference in decibels between the vision or sound carrier level at a given point in equipment or system and the noise level at that point (measured within a bandwidth appropriate to the television or radio system in use)

3.1.4
CIN
composite intermodulation noise
sum of noise and intermodulation products from digital modulated signals

3.1.5
CINR
composite intermodulation and noise ratio
ratio of the signal level and the CIN level

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3.1.6
CCN
carrier to composite noise
component which is the summation of thermal noise and intermodulation noise (i.e. noise-like intermodulation distortion products)

Note 1 to entry: The composite noise produced by the amplifier CCN in this document is CINR in accordance with ANSI-SCTE 279.

[SOURCE: ANSI/SCTE 279:2022, 7.2.8.1, modified – reference to amplifier omitted from definition. Reproduced with the permission of SCTE.]

3.1.7
crosstalk attenuation
ratio of the wanted signal power to the unwanted signal power, which is caused by electromagnetic coupling between two leads, while equal signal powers are applied to the leads

Note 1 to entry: Crosstalk attenuation is usually expressed in decibels.

3.1.8
equaliser
device designed to compensate over a certain frequency range for the amplitude/frequency distortion or phase/frequency distortion introduced by feeders or equipment

Note 1 to entry: This device is for the compensation of linear distortions only.

3.1.9
feeder
transmission path forming part of a cable network

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Note 1 to entry: Such a path may consist of a metallic cable, optical fibre, waveguide or any combination of them. By extension, the term is also applied to paths containing one or more radio links.

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3.1.10
gain
ratio of the output power to the input power, usually expressed in decibels

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3.1.11
thermal noise
noise generated in a resistive component due to the thermal agitation of electrons

Note 1 to entry: The thermal power generated is given by

$$P = 4 \cdot B \cdot k \cdot T$$

where

P is the noise power, in Watts;

B is the bandwidth, in Hertz;

k is the Boltzmann constant = 1,38 × 10^{-23} J/K;

T is the absolute temperature, in Kelvin.

It follows that

$$\frac{U^2}{R} = 4 \cdot B \cdot k \cdot T$$

and

$$U = \sqrt{4 \cdot R \cdot B \cdot k \cdot T}$$

where

U is the noise voltage, in Volts (e.m.f.);

R is the resistance, in Ω.

In practice, it is normal for the source to be terminated with a load equal to the internal resistance value, the noise voltage at the input is then $U/2$.

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3.1.12
level
decibel ratio of any power P_1 to the standard reference power P_0, i.e.

$$10\lg\frac{P_1}{P_0}$$

decibel ratio of any voltage U_1 to the standard reference voltage U_0, i.e.

$$20\lg\frac{U_1}{U_0}$$

Note 1 to entry: The power level may be expressed in decibels relative to $P_0 = (U_0^2/R) = (1/75)$ pW, i.e. in dB(P_0), taking into account that the level of P_0 corresponds to 0 dB(P_0) or, as more usually, in dB(pW), taking into account that the level of P_0 corresponds to -18,75 dB(pW). The voltage level is expressed in decibels relative to 1 μV (across 75 Ω), i.e. in dB(μV).

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3.1.13
MER
modulation error ratio
sum of the squares of the magnitudes of the ideal symbol vectors is divided by the sum of the squares of the magnitudes of the symbol error vectors of a sequence of symbols, the result being expressed as a power ratio in dB

$$R_{\mathrm{ME}} = 10 \lg \left\{ \frac{\sum_{j=1}^{N} \left(I_j^2 + Q_j^2 \right)}{\sum_{j=1}^{N} \left(\delta I_j^2 + \delta Q_j^2 \right)} \right\} \text{ in dB}$$

3.1.14
multi-switch
equipment used in distribution systems for signals that are received from satellites and converted to a suitable IF

Note 1 to entry: The IF signals that are received from different polarisations, frequency bands and orbital positions are input signals to the multi-switch. Subscriber feeders are connected to the multi-switch output ports. Each output port is switched to one of the input ports, depending on control signals that are transmitted from the subscriber equipment to the multi-switch. Besides a splitter for each input port and a switch for each output port, a multi-switch can contain amplifiers to compensate for distribution or cable losses.

3.1.15
multi-switch loop-through port
one or more ports to loop through the input signals through a multi-switch

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Note 1 to entry: This enables larger networks with multiple multi-switches, each one installed close to a group of subscribers. The multi-switches are connected in a loop-through manner. The IF signals that are received by an outdoor unit from different polarisations, frequency bands and orbital positions are input signals to a first multi-switch. Cables connect the loop-through ports of this multi-switch to the input ports of a second multi-switch and so on.

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3.1.16
slope
difference in gain or attenuation at two specified frequencies between any two points in an equipment or system

Note 1 to entry: The slope sign is considered

a) negative when the attenuation increases with frequency (cables) or the gain (amplifiers) decreases with frequency,

b) positive when the gain (amplifiers) increases with frequency (compensating slope).

3.1.17
surge voltage
surge which is produced by a direct or indirect lightning stroke

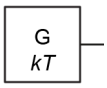
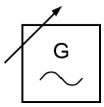
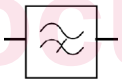
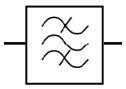
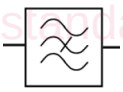
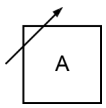
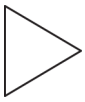
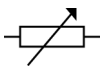
3.1.18
symbol rate
mega symbols per second, expressed as Msymb/s

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3.2 Symbols

The following graphical symbols in Table 1 are used in the figures of this document. These symbols are either listed in IEC 60617, are modifications of symbols defined in IEC 60617 or are composite symbols made up of more than one symbol defined in IEC 60617.

Table 1 – Graphical symbols used in figures

Symbols	Terms	Symbols	Terms
	Ampere meter [IEC 60617-S00910 (1996-05), modified – letter "A" added]		Voltmeter [IEC 60617-S00913 (1996-05), modified – grey background added.]
	Equipment under test [IEC 60617-S00059 (1996-05), modified – "EUT" text added, and thick black line and grey border added to box.]		Power meter [IEC 60617-S00910 (1996-05), modified – letter "W" added.]
	Noise generator [IEC 60617-S01230 (2002-07)]		Signal generator [IEC 60617-S00899 (1996-05), IEC 60617-S01403 (2001-09)]
	Surge generator [IEC 60617-S01228 (1996-05), modified – thick black line and grey border added to box.]		Variable signal generator [IEC 60617-S01229 (1996-05, modified – letter "f" and connection line omitted.]
	Low-pass filter [IEC 60617-S01248 (1996-05)]		High-pass filter [IEC 60617-S01247 (1996-05)]
	Band-pass filter [IEC 60617-S01249 (1996-05)]		Band-stop filter [IEC 60617-S01250 (1996-05)]
	Spectrum analyser (electrical) [IEC 60617-S00910 (1996-05), modified]		Attenuator [IEC 60617-S01244 (1996-05), modified]
	Variable attenuator [IEC 60617-S01245 (1996-05)]		Amplifier [IEC 60617-S01239 (1996-05)]
	Combiner [IEC 60617-S00059 (1996-05), modified]		Variable resistor [IEC 60617-S00557 (1996-06)]
	Functional equipotential bonding [IEC 60617-S01410 (2001-11), modified]		RF choke [IEC 60617-S00583 (1996-06), modified]
	Resistor [IEC 60617-S00555 (1996-06)]		Capacitor [IEC 60617-S00567 (1996-06), modified]

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3.3 Abbreviated terms

AC	alternating current
AM	amplitude modulation
ANSI	American National Standards Institute
BER	bit error ratio
CATV	community antenna television (system)
CCN	carrier to composite noise
CIN	composite intermodulation noise
CINR	composite intermodulation and noise ratio
CW	continuous wave
DC	direct current
DVB-C	digital video broadcasting baseline system for digital cable television (ETSI EN 300 429)
EMC	electromagnetic compatibility
EUT	equipment under test
HP	high pass
IF	intermediate frequency
LF	low frequency
LP	low pass
MER	modulation error ratio
OFDM	orthogonal frequency-division multiplexing
QAM	quadrature amplitude modulation
RF	radio frequency
RMS	root mean square
TCP	total composite power
SCTE	Society of Cable Telecommunications Engineers
TV	television

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4 Methods of measurement

4.1 General

This Clause 4 defines basic methods of measurement. Ensure that all test equipment is calibrated and all connectors, leads, and terminations have an adequate quality in order to not affect the test results.

Unless otherwise specified by the manufacturer, all measurements shall be carried out with 0 dB plug-in attenuators and equalisers. The position of variable controls used during the measurements shall be published.

A network can be used to distribute terrestrial signals in addition to the signals received from satellites. The terrestrial antennas are connected to an optional terrestrial input port of a multi-switch. On each output port, the terrestrial signals are available in addition to the satellite IF signals. Since the normal frequency ranges for terrestrial signals and satellite IF signals do not overlap, both can be carried on the same cable.

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