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Cable networks for television signals, sound signals and interactive services –

Part 3: Active wideband equipment for coaxial cable networks

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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

Part 3: Active wideband equipment for coaxial cable networks

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.
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International Standard IEC 60728-3 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 third edition cancels and replaces the second edition published in 2000 of which it constitutes a technical revision.

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

– New methods of measurement:
  - crosstalk attenuation, 4.5,
  - signal level for digitally modulated signals, 4.6,

- method of measurement for non-linearity of return path equipment carrying only digital modulated signals [Measurement of composite intermodulation noise ratio (CINR)], 4.7;

– New requirements for multi-switches, 5.18;

– New informative Annex E: Examples of signals, methods of measurement and network design for return paths

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

FDIS	Report on voting
100/946/FDIS	100/976/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.

IEC 60728 consists of the following parts, under the general title *Cable networks for television signals, sound signals and interactive services:*

Part 1: Methods of measurement and system performance Part 2: Electromagnetic compatibility for equipment

Part 3: Active wideband equipment for coaxial cable networks

Part 4: Passive coaxial wideband distribution equipment (under consideration)

Part 5: Headend equipment

Part 6: Optical equipment

Part 7-1: Hybrid fibre coax outside plant status monitoring – Physical (PHY) layer specification

Part 7-2: Hybrid fibre coax outside plant status monitoring – Media access control (MAC) layer specification

Part 7-3: Hybrid fibre coax outside plant status monitoring – Power supply to transponder interface bus (PSTIB) specification

Part 9: Interfaces for CATV/SMATV headends and similar professional equipment for DVB/MPEG-2 transport streams

Part 10: System performance of return path

Part 11: Safety

Part 12: Electromagnetic compatibility of systems

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.

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, interactive multimedia signals, interfaces and their associated data signals, 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.

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.

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.

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

Part 3: Active wideband equipment for coaxial cable networks

1 Scope

This part of IEC 60728 lays down the measuring methods, performance requirements and data publication requirements for active coaxial wideband distribution equipment of cable networks for television and sound signals.

This standard applies to all broadband amplifiers used in cable networks and covers the frequency range 5 MHz to 3 000 MHz. It also applies to one-way and two-way equipment.

NOTE The upper limit of 3 000 MHz is an example, but not a strict value. The frequency range, or ranges, over which the equipment is specified, should be published.

All requirements and published data are understood as guaranteed values within the specified frequency range and in well-matched conditions.

This standard

- applies to all broadband amplifiers used in cable networks;
- covers the frequency range 5 MHz to 3 000 MHz;
- applies to one-way and two-way equipment;
- lays down 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 that shall be published by the manufacturers;
- states the minimum performance requirements of certain parameters.

Amplifiers are divided into the following two quality levels:

Grade 1: amplifiers typically intended to be cascaded.

Grade 2: amplifiers for use typically within an apartment block, or within a single residence, to feed a few outlets.

Practical experience has shown these types meet most of the technical requirements necessary for supplying a minimum signal quality to the subscribers. This classification shall not be considered as a requirement but as the information for users and manufacturers on the minimum quality criteria of the material required to install networks of different sizes. The system operator has to select appropriate material to meet the minimum signal quality at the subscriber's outlet, and to optimise cost/performance, taking into account the size of the network and local circumstances.

All requirements and published data are understood as guaranteed values within the specified frequency range and in well-matched conditions.

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*
Amendment 1 (1992)

IEC 60068-2-1:1990), *Environmental testing – Part 2: Tests. Tests A: Cold*
Amendment 1 (1993)
Amendment 2 (1994)

IEC 60068-2-2:1974, *Environmental testing – Part 2: Tests. Tests B: Dry heat*
Amendment 1 (1993)
Amendment 2 (1994)

IEC 60068-2-6:1995, *Environmental testing – Part 2: Tests – Test Fc: Vibration (sinusoidal)*

IEC 60068-2-14:1984, *Environmental testing – Part 2: Tests. Test N: Change of temperature*
Amendment 1 (1986)

IEC 60068-2-27:1987, *Environmental testing – Part 2: Tests. Test Ea and guidance: Shock*

IEC 60068-2-29:1987, *Environmental testing – Part 2: Tests. Test Eb and guidance: Bump*

IEC 60068-2-30:1980, *Environmental testing – Part 2: Tests. Test Db and guidance: Damp heat, cyclic (12 + 12-hour cycle)*
Amendment 1 (1985)

IEC 60068-2-31:1969, *Environmental testing –. Part 2: Tests. Test Ec: Drop and topple, primarily for equipment-type specimens*
Amendment 1 (1982)

IEC 60068-2-32:1975, *Environmental testing – Part 2: Tests. Test Ed: Free fall (Procedure 1)*
Amendment 2 (1990)

IEC 60068-2-40:1976, *Environmental testing – Part 2: Tests. Test Z/AM: Combined cold/low air pressure tests*
Amendment 1 (1983)

IEC 60068-2-48:1982, *Environmental testing – Part 2: Tests. Guidance on the application of the tests of IEC 68 to simulate the effects of storage*

IEC 60169-2:1965, *Radio-frequency connectors. Part 2: Coaxial unmatched connector*
Amendment 1 (1982)

IEC 60169-24:1991, *Radio frequency connectors – Part 24: Radio frequency coaxial connectors with screw coupling, typically for use in 75 ohm cable distribution systems (Type F)*

IEC 60417-DB:2002[1] *Graphical symbols for use on equipment*

IEC 60529:1989, *Degrees of protection provided by enclosures (IP Code)*
Amendment 1 (1999)

[1] "DB" refers to the IEC on-line database.

IEC 60617-DB, 2001[2] *Graphical symbols for diagrams – database comprising parts 2 to 13 of IEC 60617*

IEC 60728-1:2001, *Cable networks for television signals, sound signals and interactive services – Part 1: Methods of measurement and system performance*

IEC 60728-2:2002, *Cable networks for television signals, sound signals and interactive services – Part 2: Electromagnetic compatibility for equipment*

IEC 60728-4:2000, *Cable networks for television signals, sound signals and interactive services – Part 4: Passive coaxial wideband distribution equipment*

IEC 60728-5:2001, *Cable networks for television signals, sound signals and interactive services – Part 5: Headend equipment*

IEC 60728-6:2003, *Cable networks for television signals, sound signals and interactive services – Part 6: Optical equipment*

IEC 60728-10:2001, *Cable networks for television signals, sound signals and interactive services – Part 10: System performance of return path*

IEC 60728-11:2005, *Cable networks for television signals, sound signals and interactive services – Part 11: Safety*

IEC 61319-1:1995, *Interconnections of satellite receiving equipment – Part 1: Europe*

IEC 61319-2:1997 *Interconnections of satellite receiving equipment – Part 2: Japan*

IEC 80416 (series), *Basic principles for graphical symbols for use on equipment*

ES 200 800 V1.3.12001, *Digital Video Broadcasting (DVB); DVB interaction channel for Cable TV distribution systems (CATV)*

3 Terms, definitions, symbols and abbreviations

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

3.1 Terms and definitions

3.1.1
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 This device is for the compensation of linear distortions only.

3.1.2
feeder
transmission path forming part of a cable network. 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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[2] "DB" refers to the IEC on-line database.

3.1.3
decibel ratio
ten times the logarithm of the ratio of two quantities of power P_1 and P_2, i.e.

$$10\lg\frac{P_1}{P_2} \qquad \text{(dB)}$$

3.1.4
standard reference power and voltage
in cable networks, the standard reference power, P_0, is (1/75) pW

NOTE This is the power dissipated in a 75 Ω resistor with an r.m.s. voltage drop of 1 μV across it.

the standard reference voltage, U_0, is 1 μV

3.1.5
level
of any power P_1 it is the decibel ratio of that power to the standard reference power P_0, i.e.

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

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

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

The power level may be expressed in decibels relative to $P_0 = (U_0^2/R) = (1/75)$ pW, i.d. 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.d. in dB(μV).

3.1.6
attenuation
ratio of the input power to the output power of an equipment or system, usually expressed in decibels

3.1.7
gain
ratio of the output power to the input power, usually expressed in decibels

3.1.8
amplitude frequency response
gain or loss of an equipment or system plotted against frequency

3.1.9
slope
difference in gain or attenuation at two specified frequencies between any two points in an equipment or system

3.1.10
crossmodulation
undesired modulation of the carrier of a desired signal by the modulation of another signal as a result of equipment or system non-linearities

3.1.11
carrier-to-noise ratio
difference in decibels between the vision or sound carrier level at a given point in an equipment or system and the noise level at that point (measured within a bandwidth appropriate to the television or radio system in use)

3.1.12
noise factor/noise figure
used as figures of merit describing the internally generated noise of an active device

The noise factor, F, is the ratio of the carrier-to-noise ratio at the input, to the carrier-to-noise ratio at the output of an active device.

$$F = \frac{C_1/N_1}{C_2/N_2}$$

where

C_1 is the signal power at the input;

C_2 is the signal power at the output;

N_1 is the noise power at the input (ideal thermal noise);

N_2 is the noise power at the output.

In other words, the noise factor is the ratio of noise power at the output of an active device to the noise power at the same point if the device had been ideal and added no noise.

$$F = \frac{N_{2\text{actual}}}{N_{2\text{ideal}}}$$

The noise factor is dimensionless and is often expressed as noise figure, NF, in dB

$$NF = 10 \lg F \quad \text{(dB)}$$

3.1.13
ideal thermal noise
noise generated in a resistive component due to the thermal agitation of electrons

The thermal power generated is given by

$$P = 4 \cdot B \cdot \mathrm{k} \cdot T$$

where

P is the noise power in watts;

B is the bandwidth in hertz;

k is the Boltzmann's constant = $1{,}38 \cdot 10^{-23}$ J/K;

T is the absolute temperature in kelvins.

It follows that

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

and

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

where

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

R is the resistance in ohms.

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 $U/2$.

3.1.14
chrominance-luminance delay inequality
difference in transmission delay of chrominance and luminance signals, which results in the spilling of colour to left or right of the area of corresponding luminance

[IEV 723-06-61]

3.1.15
well-matched
matching condition when the return loss of the equipment complies with the requirements of Table 3

NOTE Through mismatching of measurement instruments and the measurement object, measurement errors are possible. Comments to the estimation of such errors are given in Annex D.

3.1.16
multi-switch
equipment used in distribution systems for signals that are received from satellites and converted to a suitable IF

NOTE 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.

3.1.17
multi-switch loop through port
one or more ports to loop through the input signals through a multi-switch.

NOTE 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.

3.1.18
multi-switch port for terrestrial signals
port in a multi-switch used to distribute terrestrial signals in addition to the signals received from satellites

3.1.19
crosstalk attenuation
unwanted signals beside the wanted signal on a lead caused by electromagnetic coupling between leads. It is the ratio of the wanted signal power to the unwanted signal power, while equal signal powers are applied to the leads and is usually expressed in decibels

3.1.20
composite intermodulation noise (CIN)
sum of noise and intermodulation products from digital modulated signals

3.1.21
composite intermodulation noise ratio (CINR)
ratio of the signal level and the CIN level