

INTERNATIONAL STANDARD

NORME INTERNATIONALE

**Cable networks for television signals, sound signals and interactive services –
Part 3: Active wideband equipment for cable networks**

**Réseaux de distribution par câbles pour signaux de télévision, signaux de
radiodiffusion sonore et services interactifs –
Partie 3: Matériel actif à large bande pour réseaux de distribution par câbles**





THIS PUBLICATION IS COPYRIGHT PROTECTED

Copyright © 2017 IEC, Geneva, Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either IEC or IEC's member National Committee in the country of the requester. If you have any questions about IEC copyright or have an enquiry about obtaining additional rights to this publication, please contact the address below or your local IEC member National Committee for further information.

Droits de reproduction réservés. Sauf indication contraire, aucune partie de cette publication ne peut être reproduite ni utilisée sous quelque forme que ce soit et par aucun procédé, électronique ou mécanique, y compris la photocopie et les microfilms, sans l'accord écrit de l'IEC ou du Comité national de l'IEC du pays du demandeur. Si vous avez des questions sur le copyright de l'IEC ou si vous désirez obtenir des droits supplémentaires sur cette publication, utilisez les coordonnées ci-après ou contactez le Comité national de l'IEC de votre pays de résidence.

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

Tel.: +41 22 919 02 11
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 corrigendum or an amendment might have been published.

IEC publications search - webstore.iec.ch/advsearchform

The advanced search enables 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 It also gives information on projects, replaced and withdrawn publications.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 online and once a month by email.

IEC 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: sales@iec.ch.

IEC online collection - oc.iec.ch

Discover our powerful search engine and read freely all the publications previews. With a subscription you will always have access to up to date content tailored to your needs.

Electropedia - www.electropedia.org

The world's leading online dictionary on electrotechnology, containing more than 22 000 terminological entries in English and French, with equivalent terms in 18 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

A propos de l'IEC

La Commission Electrotechnique Internationale (IEC) est la première organisation mondiale qui élabore et publie des Normes internationales pour tout ce qui a trait à l'électricité, à l'électronique et aux technologies apparentées.

A propos des publications IEC

Le contenu technique des publications IEC est constamment revu. Veuillez vous assurer que vous possédez l'édition la plus récente, un corrigendum ou amendement peut avoir été publié.

Recherche de publications IEC -

webstore.iec.ch/advsearchform

La recherche avancée permet de trouver des publications IEC en utilisant différents critères (numéro de référence, texte, comité d'études, ...). Elle donne aussi des informations sur les projets et les publications remplacées ou retirées.

IEC Just Published - webstore.iec.ch/justpublished

Restez informé sur les nouvelles publications IEC. Just Published détaille les nouvelles publications parues. Disponible en ligne et une fois par mois par email.

Service Clients - webstore.iec.ch/csc

Si vous désirez nous donner des commentaires sur cette publication ou si vous avez des questions contactez-nous: sales@iec.ch.

IEC online collection - oc.iec.ch

Découvrez notre puissant moteur de recherche et consultez gratuitement tous les aperçus des publications. Avec un abonnement, vous aurez toujours accès à un contenu à jour adapté à vos besoins.

Electropedia - www.electropedia.org

Le premier dictionnaire d'électrotechnologie en ligne au monde, avec plus de 22 000 articles terminologiques en anglais et en français, ainsi que les termes équivalents dans 16 langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International (IEV) en ligne.

INTERNATIONAL STANDARD

NORME INTERNATIONALE

**Cable networks for television signals, sound signals and interactive services –
Part 3: Active wideband equipment for cable networks**

**Réseaux de distribution par câbles pour signaux de télévision, signaux de
radiodiffusion sonore et services interactifs –
Partie 3: Matériel actif à large bande pour réseaux de distribution par câbles**

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

ICS 33.060.40; 33.170

ISBN 978-2-8322-9260-0

**Warning! Make sure that you obtained this publication from an authorized distributor.
Attention! Veuillez vous assurer que vous avez obtenu cette publication via un distributeur agréé.**

CONTENTS

FOREWORD	5
INTRODUCTION	7
1 Scope	8
2 Normative references	8
3 Terms, definitions, symbols and abbreviated terms	9
3.1 Terms and definitions	9
3.2 Symbols	12
3.3 Abbreviated terms	14
4 Methods of measurement	14
4.1 General	14
4.2 Linear distortion	15
4.2.1 Return loss	15
4.2.2 Group delay variation	15
4.3 Non-linear distortion	16
4.3.1 General	16
4.3.2 Types of measurements	16
4.3.3 Intermodulation	17
4.3.4 Composite triple beat	19
4.3.5 Composite second order beat	22
4.3.6 Method of measurement of non-linearity for pure digital channel load	22
4.3.7 Hum modulation of carrier	30
4.4 Noise figure	33
4.4.1 General	33
4.4.2 Equipment required	33
4.4.3 Connection of equipment	33
4.4.4 Measurement procedure	34
4.5 Crosstalk attenuation	34
4.5.1 Crosstalk attenuation for loop-through ports	34
4.5.2 Crosstalk attenuation for output ports	34
4.6 Measurement of noise power ratio (NPR)	36
4.6.1 General	36
4.6.2 Equipment required	37
4.6.3 Connection of equipment	37
4.6.4 Measurement procedure	38
4.6.5 Presentation of the results	38
4.7 Immunity to surge voltages	39
4.7.1 General	39
4.7.2 Equipment required	39
4.7.3 Connection of equipment	39
4.7.4 Measurement procedure	40
5 Equipment requirements	40
5.1 General requirements	40
5.2 Safety	40
5.3 Electromagnetic compatibility (EMC)	40
5.4 Frequency range	40
5.5 Impedance and return loss	40

5.6	Gain.....	41
5.6.1	Minimum and maximum gain.....	41
5.6.2	Gain control.....	41
5.6.3	Slope and slope control	41
5.7	Flatness.....	41
5.8	Test points.....	41
5.9	Noise figure	41
5.10	Non-linear distortion.....	42
5.10.1	General	42
5.10.2	Second-order distortion	42
5.10.3	Third order distortion	42
5.10.4	Composite triple beat.....	42
5.10.5	Composite second order.....	42
5.10.6	Maximum operating level for pure digital channel load	42
5.11	Hum modulation.....	43
5.12	Power supply	43
5.13	Environmental.....	43
5.13.1	General	43
5.13.2	Transportation	43
5.13.3	Installation or maintenance.....	43
5.13.4	Operation	43
5.13.5	Energy efficiency of equipment.....	44
5.14	Marking.....	44
5.14.1	Marking of equipment	44
5.14.2	Marking of ports.....	44
5.15	Requirements for multi-switches	44
5.15.1	Control signals for multi-switches	44
5.15.2	Amplitude frequency response flatness.....	44
5.15.3	Return loss	44
5.15.4	Through loss.....	44
5.15.5	Isolation.....	44
5.15.6	Crosstalk attenuation	44
5.15.7	Satellite IF to terrestrial signal isolation	45
5.16	Immunity to surge voltages	45
5.16.1	Degrees of testing levels	45
5.16.2	Recommendation of testing level degree	45
Annex A (normative)	Test carriers, levels and intermodulation products.....	46
A.1	Two signal tests for second- and third-order products	46
A.1.1	Intermodulation products with test signals at frequencies f_a and f_b , see Table A.1	46
A.1.2	Signal levels	46
A.2	Three signal tests for third order products – Intermodulation products with test signals at frequencies f_a , f_b and f_c , see Table A.2 and Figure A.3	47
Annex B (informative)	Test frequency plan for composite triple beat (CTB), composite second order (CSO).....	48
Annex C (informative)	Measurement errors that occur due to mismatched equipment	50
Annex D (informative)	Examples of measurement channels	51
D.1	Operating frequency range 110 MHz to 1 006 MHz	51
D.2	Operating frequency range 110 MHz to 862 MHz	51

D.3	Operating frequency range 258 MHz to 1 218 MHz	51
	Bibliography.....	52
Figure 1	– Basic arrangement of test equipment for evaluation of the ratio of signal to intermodulation product	18
Figure 2	– Connection of test equipment for the measurement of non-linear distortion by composite beat.....	21
Figure 3	– BER measurement test configuration	24
Figure 4	– CINR measurement test setup.....	28
Figure 5	– Plot of CINR in dB curve (forward path) versus EUT channel output signal level in dB μ V	29
Figure 6	– Carrier/hum ratio	30
Figure 7	– Test set-up for local-powered objects	31
Figure 8	– Test set-up for remote-powered objects	31
Figure 9	– Oscilloscope display	32
Figure 10	– Measurement of noise figure	33
Figure 11	– Measurement of crosstalk attenuation for loop through ports of multi-switches.....	36
Figure 12	– Characteristic of the noise filter.....	37
Figure 13	– Test setup for the non-linearity measurement.....	37
Figure 14	– Presentation of the result of <i>NPR</i>	39
Figure 15	– Measurement set-up for surge immunity test	40
Figure A.1	– An example showing products formed when $2f_a > f_b$	46
Figure A.2	– An example showing products formed when $2f_a < f_b$	47
Figure A.3	– Products of the form $f_a \pm f_b \pm f_c$	47
Figure C.1	– Error concerning return loss measurement	50
Figure C.2	– Maximum ripple	50
Table 1	– Measurement parameters for full channel load	26
Table 2	– Notch filter frequencies	37
Table 3	– Example of return loss requirements	41
Table 4	– Parameters of surge voltages for different degrees of testing levels	45
Table 5	– Recommendations for degree of testing levels	45
Table A.1	– Intermodulation products with two signals	46
Table A.2	– Intermodulation products with three signals.....	47
Table B.1	– Frequency allocation plan	48

INTERNATIONAL ELECTROTECHNICAL COMMISSION

**CABLE NETWORKS FOR TELEVISION SIGNALS,
SOUND SIGNALS AND INTERACTIVE SERVICES –****Part 3: Active wideband equipment for 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.
- 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 60728-3 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 fifth edition cancels and replaces the fourth edition published in 2010. This edition constitutes a technical revision.

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

- a) extension of upper frequency range limit for cable network equipment in the forward path from 1 000 MHz to 1 218 MHz (optional up to 1 794 MHz);
- b) extension of upper frequency range limit for cable network equipment in the return path from 85 MHz to 204 MHz;
- c) integration and update of IEC 60728-3-1 content;
- d) integration and update of the Technical Specification CLC/TS 50083-3-3 content;
- e) deletion of specifications and test methods for obsolete analogue parameters;

- f) additional normative references;
- g) additional terms and definitions and abbreviations.

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

FDIS	Report on voting
100/2975/FDIS	100/2990/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.

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 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.

INTRODUCTION

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 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 3: Active wideband equipment for cable networks

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.

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.

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 60068-2-40, *Basic environmental testing procedures – Part 2-40: Tests – Test Z/AM: Combined cold/low air pressure tests*