

INTERNATIONAL STANDARD

NORME INTERNATIONALE



Scales and sizes for plotting frequency characteristics and polar diagrams

Échelles et dimensions des graphiques pour le tracé des courbes de réponse en fréquence et des diagrammes polaires



THIS PUBLICATION IS COPYRIGHT PROTECTED

Copyright © 2020 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 It also gives information on projects, replaced and withdrawn publications.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.

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 16 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

IEC Glossary - std.iec.ch/glossary

67 000 electrotechnical terminology entries in English and French extracted from the Terms and Definitions clause of IEC publications issued since 2002. Some entries have been collected from earlier publications of IEC TC 37, 77, 86 and CISPR.

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.

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.

Glossaire IEC - std.iec.ch/glossary

67 000 entrées terminologiques électrotechniques, en anglais et en français, extraites des articles Termes et Définitions des publications IEC parues depuis 2002. Plus certaines entrées antérieures extraites des publications des CE 37, 77, 86 et CISPR de l'IEC.

INTERNATIONAL STANDARD

NORME INTERNATIONALE



Scales and sizes for plotting frequency characteristics and polar diagrams

Échelles et dimensions des graphiques pour le tracé des courbes de réponse en fréquence et des diagrammes polaires

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

ICS 17.140.50

ISBN 978-2-8322-8497-1

**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.....	3
INTRODUCTION.....	5
1 Scope.....	6
2 Normative references	6
3 Terms and definitions	6
4 Characteristics plotted versus a logarithmic frequency scale	6
4.1 Decibel vs. log frequency plots	6
4.2 Log quantities vs. log frequency plots	7
5 Polar level diagrams.....	7
5.1 General.....	7
5.2 Polar plots of absolute level.....	7
5.3 Polar plots of relative level.....	7
Annex A (informative) Examples of the requirements specified in this document.....	8
Annex B (informative) Information regarding linear y-axis vs. logarithmic frequency plots	14
B.1 General.....	14
B.2 Phase	14
B.3 Group delay	14
Figure A.1 – Example of a microphone calibration curve showing the relative response in dB as a function of frequency with an aspect ratio of 10 dB/decade	8
Figure A.2 – Example of the response of a loudspeaker crossover filter network with an aspect ratio of 20 dB/decade.....	9
Figure A.3 – Example of the response of a loudspeaker with an aspect ratio of 25 dB/decade (dB re. 20 µPa).....	9
Figure A.4 – Example of the response of a hearing aid with an aspect ratio of 50 dB/decade.....	10
Figure A.5 – Example of the noise from a mobile communications device with an aspect ratio of 0,5 decades/decade (10 dB/decade).....	10
Figure A.6 – Example of amplifier noise with an aspect ratio of 1 decade/decade (20 dB/decade)	11
Figure A.7 – Example of total harmonic distortion of an earphone with an aspect ratio of 1,25 decades/decade (25 dB/decade)	11
Figure A.8 – Example of total harmonic distortion of a loudspeaker with an aspect ratio of 2,5 decades/decade (50 dB/decade)	12
Figure A.9 – Example of a polar diagram of absolute level with a range of 60 dB, showing the sound pressure level from a siren at a distance of 3 m	12
Figure A.10 – Example of a polar diagram of relative level with a range of 30 dB and a reference circle radius of 25 dB, showing the directional response of a highly directional shotgun microphone at 2,5 kHz.....	13

INTERNATIONAL ELECTROTECHNICAL COMMISSION

**SCALES AND SIZES FOR PLOTTING FREQUENCY
CHARACTERISTICS AND POLAR DIAGRAMS**

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 60263 has been prepared by IEC technical committee TC 29: Electroacoustics.

This fourth edition cancels and replaces the third edition published in 1982. This edition constitutes a technical revision.

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

- a) the scope is expanded to include electronic files (e.g., PDF), scientific publications, graphs in other standards, and screen displays in programs and apps;
- b) a Terms and Definitions clause has been added;
- c) aspect ratios of 20 dB/decade, and 0,5, 1, 1,25, and 2,5 decades/decade have been added;
- d) ranges of 60 dB or 30 dB are specified for polar plots of absolute level; a 30 dB range is specified for polar plots of relative level;
- e) as most graphs are now computer generated, tolerances and sizes have been removed;
- f) all informative figures have been updated with contemporary examples;

- g) an informative annex with information about linear y-axis vs. logarithmic frequency has been added.

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

CDV	Report on voting
29/1038/CDV	29/1060/RVC

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 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.

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

Historically, on analogue level recorders, 1 dB was represented by 1 mm, 2 mm or 5 mm, corresponding to level ranges of 50 dB, 25 dB and 10 dB, respectively. One of these three level ranges was equal in length to 1 decade on the logarithmic frequency scale of the paper used for the plot, limiting the available aspect ratios. With the advent of computer-generated graphics, plots can now be of any size that is legible or enlarged on a display as necessary.

A plot of the data may only represent a graphical summary that is convenient for communicating via a report or other publication where one does not wish to list out the entire data set. This further emphasizes the importance of the visual representation.

Therefore, in order to gain an accurate impression from a graph in which a response is plotted as level (in decibels) or as an amplitude or percentage on a logarithmic y-axis versus frequency on a logarithmic scale, it remains important that the aspect ratio be standardized. Otherwise, a spectrum or response curve can be made to appear unduly flat or unduly steep by compression or expansion of one of the axes.

The subject of interest is usually a frequency response or output spectrum that results from the application of an input spectrum to a device such as a microphone, amplifier, hearing aid, headphone, or loudspeaker, or alternatively, level differences for the response of these devices compared to a reference response. Analogous characteristics may be measured and plotted for the mechanical vibration of structures. Similarly, an insertion gain or transmission loss may be plotted. For cascaded systems, the contribution of each sub-system to the overall result is more readily understood if each characteristic is plotted to a standard aspect ratio.

For displaying frequency spectra and response characteristics, different ranges are often needed. A range of 10 dB may suffice for the response of a standard measurement microphone, but a range of more than 60 dB may be required for a filter or loudspeaker. Although these requirements illustrate the need for different aspect ratios, the number of standard aspect ratios should be kept to a minimum to facilitate comparisons.

Graphs for publication may be reduced or enlarged to fit the printed page. Likewise, graphs may appear on the display of a computer screen or mobile app. Therefore, the use of a standard aspect ratio makes it feasible to compare graphs from different sources or to view the same data displayed on different sized displays.

SCALES AND SIZES FOR PLOTTING FREQUENCY CHARACTERISTICS AND POLAR DIAGRAMS

1 Scope

This document specifies standard aspect ratios for logarithmic or level characteristics expressed in decibels versus a logarithmic frequency axis and ranges for the radius of polar diagrams of level. Applications include hard copy printouts, electronic files (e.g., PDF files), scientific publications, screen displays in computer programs and apps, as well as graphs in standards.

Informative examples of graphs that conform to the requirements in this document are found in Annex A.

Although outside the scope of this document, graphs with a linear y-axis versus logarithmic frequency (e.g., phase, group delay, etc.) often accompany the standard aspect ratio graphs of level described in the normative part of this document. These are described in informative Annex B.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

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

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

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

3.1

aspect ratio

scale proportion between the y-axis and x-axis of a graph

Note 1 to entry: For graphs with a logarithmic frequency x-axis, the aspect ratio is expressed as the y-axis factor per decade (in frequency), for example 25 dB/decade, or 1,25 decades/decade.

3.2

decade

factor of 10 on a logarithmic scale

Note 1 to entry: For example, 500 Hz is 1 decade above 50 Hz; 0,01 % is 3 decades below 10 %.

4 Characteristics plotted versus a logarithmic frequency scale

4.1 Decibel vs. log frequency plots

For graphs in which the y-axis depicts a level (in decibels) plotted versus logarithmic frequency on the x-axis, the aspect ratio shall be 10 dB/decade, 20 dB/decade, 25 dB/decade or 50 dB/decade.