IEC 60263

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INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

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

IEC 60263:2020-06(en-fr)

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

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

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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SCALES AND SIZES FOR PLOTTING FREQUENCY CHARACTERISTICS AND POLAR DIAGRAMS

FOREWORD

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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- withdrawn,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.

NOTE Direct comparison of hardcopy printouts to older analogue plots is facilitated by ensuring that 1 dB is equal to 1 mm, 2 mm, or 5 mm, as required.

4.2 Log quantities vs. log frequency plots

For graphs in which the y-axis depicts an absolute quantity or a percentage on a logarithmic amplitude scale plotted versus logarithmic frequency on the x-axis, the aspect ratio shall be 0,5 decades/decade, 1 decade/decade, 1,25 decades/decade or 2,5 decades/decade.

NOTE These aspect ratios correspond exactly to the level equivalents of 10 dB/decade, 20 dB/decade, 25 dB/decade and 50 dB/decade in 4.1, respectively.

5 Polar level diagrams

5.1 General

Polar level diagrams shall depict level as increasing outward versus radius. The angle of incidence shall be depicted as increasing moving counterclockwise relative to the reference direction. The angle assigned to the reference direction shall be 0°. Major angular divisions shall be plotted as radii at a minimum of 30° intervals and shall be labelled.

5.2 Polar plots of absolute level

For a polar plot of absolute level referred to a reference quantity (e.g. dB re. 20µPa), the level range of the graph shall be 60 dB or 30 dB to the origin.

For polar plots of absolute level with a range of 60 dB to the origin, the maximum level shall be plotted less than 10 dB below the circle of maximum radius. Major level divisions shall be plotted as concentric circles with radii in multiples of 10 dB. Major divisions shall be labelled. Optional minor divisions are plotted as circles in 2 dB intervals without labels.

For polar plots of absolute level with a range of 30 dB to the origin, the maximum level shall be plotted less than 5 dB below the circle of maximum radius. Major level divisions shall be plotted as circles with radii in multiples of 5 dB. Major divisions shall be labelled. Optional minor divisions are plotted as circles in 1 dB intervals without labels.

5.3 Polar plots of relative level

For a polar plot of relative level, such as the difference between the absolute level from a transducer and the absolute level in a reference direction, the level range of the graph shall be 30 dB to the origin. The reference circle shall represent a relative level of 0 dB. The reference circle radius shall be 10 dB, 15 dB, or 20 dB or 25 dB. The maximum level shall be plotted less than or equal to 5 dB below the circle of maximum radius. Major level divisions shall be plotted as circles with radii in multiples of 5 dB. Major divisions shall be labelled. Optional minor divisions are plotted as circles in 1 dB intervals without labels.

NOTE The level in the reference direction is 0 dB.

Annex A
(informative)

Examples of the requirements specified in this document

Examples of plots with the eight aspect ratios specified in this document are shown in Figure A.1 through Figure A.8, respectively. The examples are plotted with typical data but are not intended to restrict the plotting of data to any one of the aspect ratios or ranges illustrated. Figure A.8 also shows the equivalence of level difference in decibels and percentage on a logarithmic amplitude scale with a secondary y-axis scale in decibels on the right-hand side.

NOTE Minor gridlines following a base-10 pattern are preferred.

Figure A.9 is an example of a polar diagram according to this document with a 60 dB range, showing the sound pressure level emitted by a siren at a distance of 3 m.

Figure A.10 is an example of a polar diagram showing the directional response of a shotgun highly directional microphone at 2,5 kHz, relative to its on-axis response. The range of the plot is 30 dB and the reference circle radius is a level difference of 25 dB.

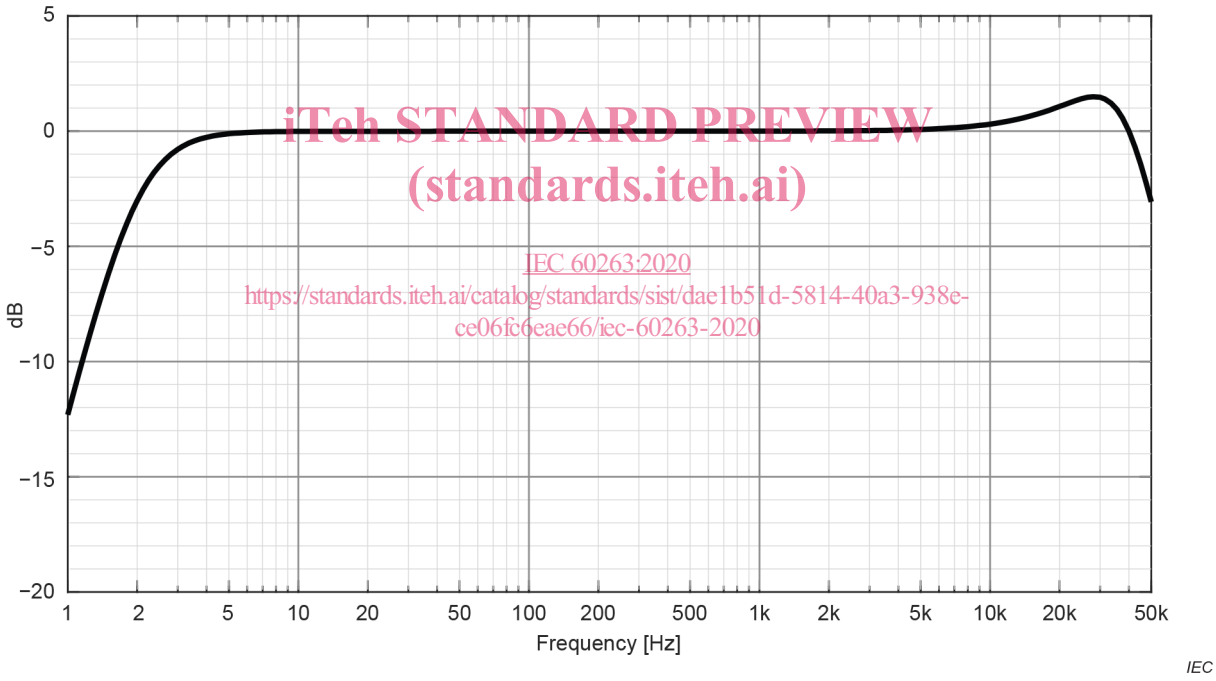

Figure A.1 – Example of a microphone calibration curve showing the relative response in dB as a function of frequency with an aspect ratio of 10 dB/decade

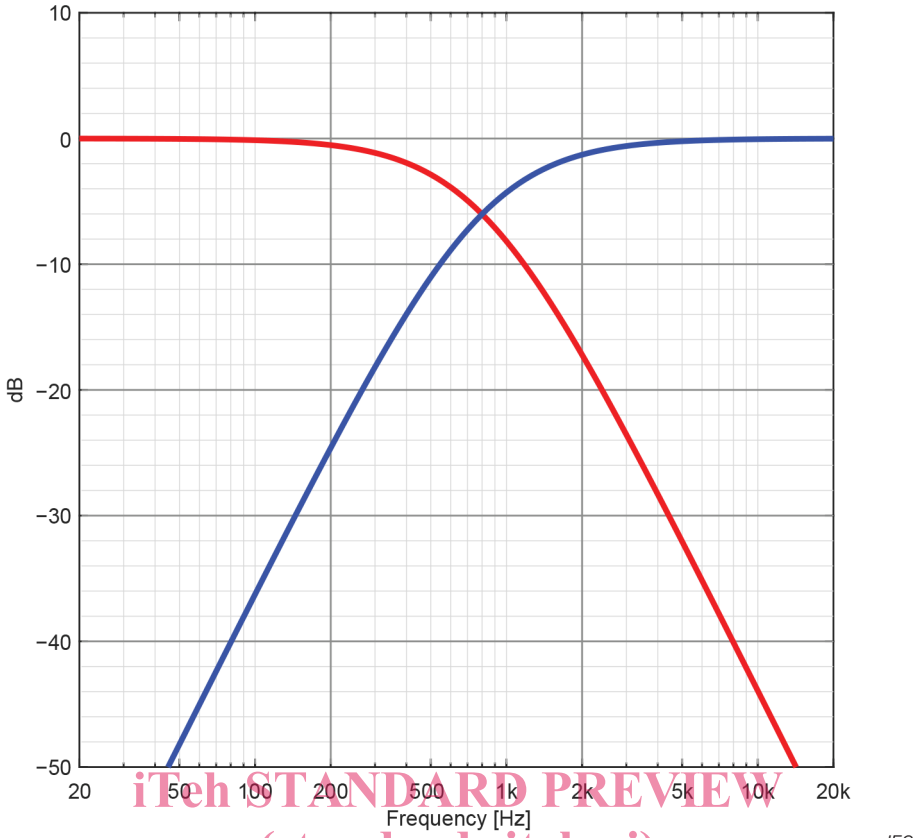

Figure A.2 – Example of the response of a loudspeaker crossover filter network with an aspect ratio of 20 dB/decade

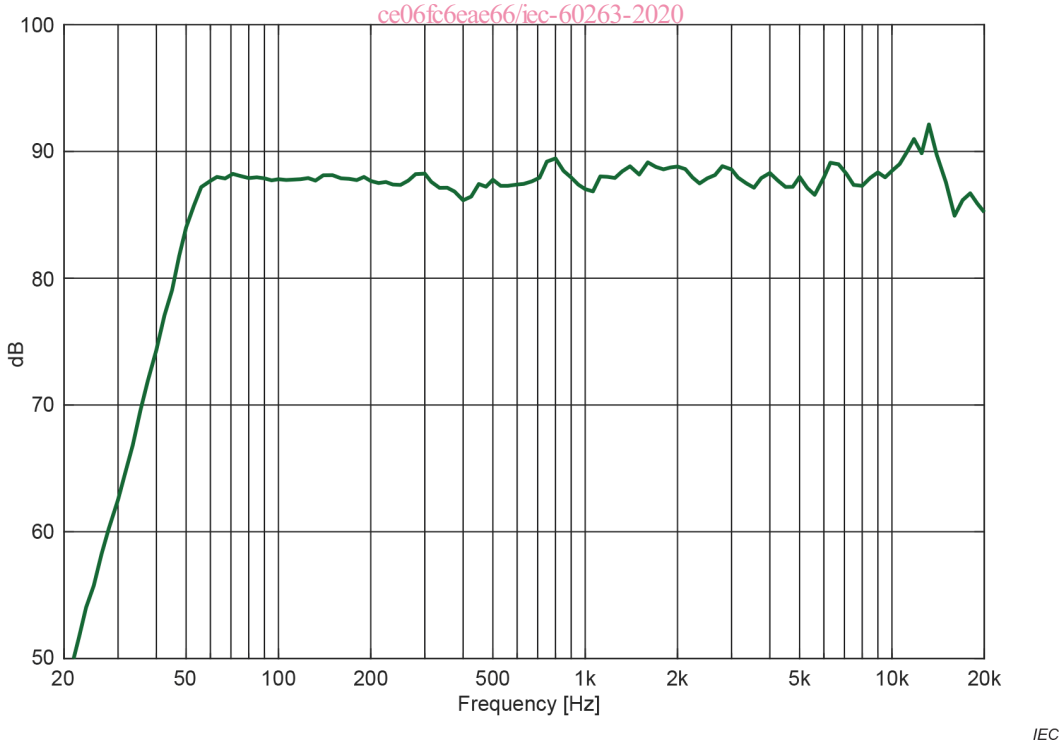

Figure A.3 – Example of the response of a loudspeaker with an aspect ratio of 25 dB/decade (dB re. 20 µPa)

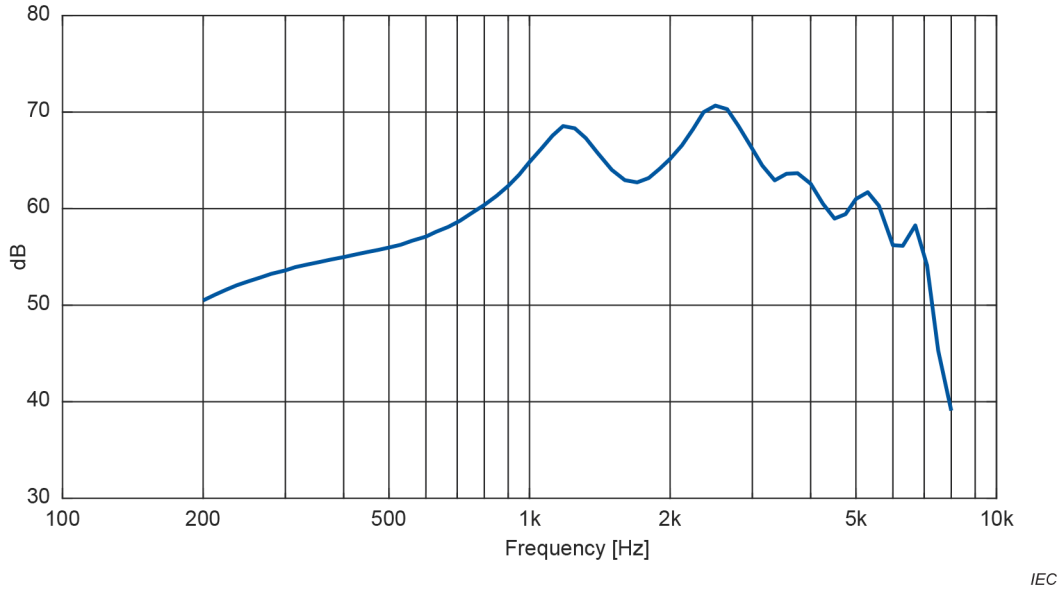

Figure A.4 – Example of the response of a hearing aid with an aspect ratio of 50 dB/decade

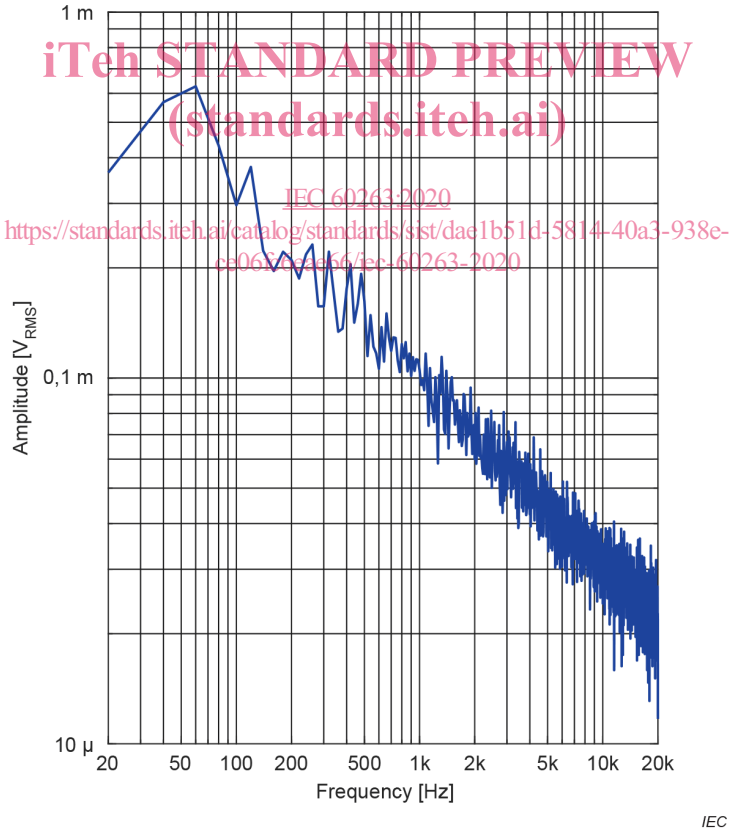

Figure A.5 – Example of the noise from a mobile communications device with an aspect ratio of 0,5 decades/decade (10 dB/decade)