INTERNATIONAL STANDARD

ISO 532-1

First edition
2017-06

Acoustics — Methods for calculating loudness —

Part 1: Zwicker method

Acoustique — Méthode de calcul du niveau d'isosonie —

Partie 1: Méthode de Zwicker

Reference number
ISO 532-1:2017(E)

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html

This document was prepared by Technical Committee ISO/TC 43, *Acoustics*.

This first edition cancels and replaces ISO 532:1975, which has been technically revised.

A list of all parts in the ISO 532 series can be found on the ISO website.

Introduction

Loudness and loudness level are two perceptual attributes of sound, describing absolute and relative sensations of sound strength perceived by a person under specific listening conditions. Due to inherent individual differences among people, both loudness and loudness level have the nature of statistical estimators characterized by their respective measures of central tendency and dispersion determined for a specific sample of the general population.

The object of the ISO 532 series is to specify calculation procedures based on physical properties of sound for estimating loudness and loudness level of sound as perceived by persons with otologically normal hearing under specific listening conditions. Each procedure provides single numbers that can be used in many scientific and technical applications to estimate the perceived loudness and loudness level of sound, without conducting separate human observer studies for each application. Because loudness is a perceived quantity, the perception of which may vary among people, any calculated loudness value represents only an estimate of the average loudness as perceived by a group of individuals with otologically normal hearing.

ISO 532-1 and ISO 532-2 specify two different methods for calculating loudness which may yield different results for given sounds. Since no general preference for one or the other method can presently be stated, it is up to the user to select the method which appears most appropriate for the given situation. Some major features of each of the methods are described below to facilitate the choice.

The first method of this document describes the calculation of loudness and loudness level of stationary sounds and is based on DIN 45631:1991. The second method of this document covers the procedures for calculation of loudness and loudness level of arbitrary non-stationary (time-varying) sounds, including stationary sounds as a special case, and is based on DIN 45631/A1:2010.

This document also includes a program code for both methods leading to estimates of loudness and loudness level for stationary and time-varying sounds. An executable computer program is also provided for both methods. The applied software is normative for calculating loudness values, against which other implementations can be checked subject to stated tolerances, and provides additional functionality for the convenience of the user.

The method for stationary sounds in this document differs slightly from the methods included in the previous ISO 532:1975, method B, by specifying corrections for low frequencies and by restricting the description of the approach to numerical instructions only, thus allowing a unique software description. For reasons of continuity, the method given in this document is in accordance with ISO 226:1987 instead of the later revised version, ISO 226:2003.

Based on the general concept of the method for stationary sounds, the method for time-varying sounds incorporates a generalization of the Zwicker approach to arbitrary, non-stationary sounds. Of course, this generalization is compatible with the method for stationary sounds in that it gives the same loudness values as the method for stationary sounds if applied to stationary sounds.

The Moore-Glasberg method as implemented in ISO 532-2 is limited to stationary sounds and can be applied to tones, broadband noises and complex sounds with sharp line spectral components. The method in ISO 532-2 differs from those in ISO 532:1975. ISO 532:1975, method A (Stevens loudness), was removed as this method was not often used and its predictions were not accurate for sounds with strong tonal components. The method described in ISO 532-2 also improves the precision of calculated loudness in the low frequency range and allows for calculation of loudness under conditions where the sound differs at the two ears. It has been shown that this method provides a good match to the contours of equal loudness level as defined in ISO 226:2003 and the reference threshold of hearing as defined in ISO 389-7:2005.

NOTE Equipment or machinery noise emissions/immissions can also be judged by other quantities defined in various International Standards (see e.g. ISO 1996-1, ISO 3740, ISO 9612 and ISO 11200).

Acoustics — Methods for calculating loudness —

Part 1: Zwicker method

1 Scope

This document specifies two methods for estimating the loudness and loudness level of sounds as perceived by otologically normal persons under specific listening conditions. The first method is intended for stationary sounds and the second method for arbitrary non-stationary (time-varying) sounds, including stationary sounds as a special case.

The methods can be applied to any sound recorded as single-channel measurements using a microphone, or as multi-channel measurements, for example by means of a head and torso simulator (see Annex D). Since most important technical sounds are time-varying, a model of time-varying loudness is preferable.

The methods are based on the Zwicker algorithm.[14] The method for stationary sounds is provided for reasons of continuity and also offers the use of measured one-third-octave-band levels as input. The more general method for arbitrary sounds calculates the specific loudness pattern based on measured time signals by applying a signal processing model that is directly related to physiological and psychological characteristics of the human hearing system. Loudness is calculated from the specific loudness pattern. It has been shown that this method provides a good match to the results of many loudness experiments using synthetic and technical sounds.

No prior knowledge about the properties of the sound (e.g. broadband or narrowband noise, tonal content) and no user interactions are required for the fully automated application of the method.

The evaluation of the harmful effect of sound events is outside the scope of this document.

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 61260-1:2014, *Electroacoustics — Octave-band and fractional-octave-band filters — Part 1: Specifications*

IEC 61672-1:2013, *Electroacoustics — Sound level meters — Part 1: Specifications*

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 http://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/