Australian STANDARD

Acoustics — Methods for calculating loudness

Part 2: Moore-Glasberg method

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AS ISO 532.2:2019

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Acoustics — Methods for calculating loudness

Part 2: Moore-Glasberg method

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Preface

This Standard was prepared by the Australian members of the Joint Standards Australia/Standards New Zealand Committee EV-010, Acoustics Community Noise, to supersede AS 3657.2—1996, *Acoustics—Expression of the subjective magnitude of sound or noise, Part 2: Method for calculating loudness level.*

The objective of this Standard is to specify a method for estimating the loudness and loudness level of stationary sounds as perceived by otologically normal adult persons under specific listening conditions. It provides an algorithm for the calculation of monaural or binaural loudness for sounds recorded using a single microphone, using a head and torso simulator, or for sounds presented via earphones. The method is based on the Moore-Glasberg algorithm and can be applied to tones, broadband noises and complex sounds with sharp line spectral components, for example transformer hum or fan noise.

This Standard is identical with, and has been reproduced from, ISO 532-2:2017, *Acoustics — Methods for calculating loudness — Part 2: Moore-Glasberg method*.

As this document has been reproduced from an International Standard, a full point substitutes for a comma when referring to a decimal marker.

Australian or Australian/New Zealand Standards that are identical adoptions of international normative references may be used interchangeably. Refer to the online catalogue for information on specific Standards.

The terms "normative" and "informative" are used in Standards to define the application of the appendices or annexes to which they apply. A "normative" appendix or annex is an integral part of a Standard, whereas an "informative" appendix or annex is only for information and guidance.

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

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*.

A list of all parts in the ISO 532- series, published under the general title *Acoustics — Methods for calculating loudness*, 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 seeks 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.

This document is limited to calculation of loudness and loudness level of stationary sounds and the calculations are based on the spectral properties of a sound. The calculation method is based on Moore-Glasberg loudness calculation algorithms [14-17]. It starts by converting a specified signal spectrum into a series of sinusoidal components representing that spectrum. This series is then transformed into a specific loudness pattern by applying four consecutive transformations, each of which is directly related to physiological and psychological characteristics of the human hearing system. Loudness is calculated from the specific loudness pattern.

This document describes the calculation procedures leading to estimation of loudness and loudness level and provides an executable computer program and code. The software provided with this document is entirely informative and provided for the convenience of the user. Use of the provided software is not required for conformance with this document.

The Moore-Glasberg method is limited to stationary sounds and can be applied to tones, broadband noises and complex sounds with sharp line spectral components. The method in this document differs from those in ISO 532:1975. Method A of ISO 532:1975 (Stevens loudness[18]) 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 this document 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.

The Zwicker method in ISO 532-1 can be applied for stationary and arbitrary non-stationary sounds. The method for stationary sounds in ISO 532-1 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 ISO 532-1 is in accordance with ISO 226:1987 instead of the later revised version, ISO 226:2003.

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).

Australian Standard®

Acoustics — Methods for calculating loudness

Part 2: Moore-Glasberg method

1 Scope

This document specifies a method for estimating the loudness and loudness level of stationary sounds as perceived by otologically normal adult persons under specific listening conditions. It provides an algorithm for the calculation of monaural or binaural loudness for sounds recorded using a single microphone, using a head and torso simulator, or for sounds presented via earphones. The method is based on the Moore-Glasberg algorithm.

NOTE 1 Issues of binaural calculations are discussed in Annex A.

NOTE 2 Users who wish to study the details of the calculation method can review or implement the source code, which is entirely informative and provided with this document for the convenience of the user.

This method can be applied to tones, broadband noises and complex sounds with sharp line spectral components, for example transformer hum or fan noise.

NOTE 3 It has been shown (see Reference [15]) 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.

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*

IEC/TS 60318-7, *Electroacoustics — Simulators of human head and ear — Part 7: Head and torso simulator for the measurement of hearing aids*

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/

3.1
sound pressure level
L_p
ten times the logarithm to the base 10 of the ratio of the square of the sound pressure, p, to the square of a reference value, p_0, expressed in decibels

$$L_p = 10\lg\frac{p^2}{p_0^2}\,\text{dB}$$