

INTERNATIONAL
STANDARD

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**Mechanical vibration and shock —
Free, mechanical impedance of the human
hand-arm system at the driving point**

*Vibrations et chocs mécaniques — Impédance mécanique libre du système
main-bras au point d'entrée*



Reference number
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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.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 10068 was prepared by Technical Committee ISO/TC 108, *Mechanical vibration and shock*, Subcommittee SC 4, *Human exposure to mechanical vibration and shock*.

Annex A is an integral part of this International Standard. Annexes B to F are for information only.

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Introduction

The mechanical impedance of the human hand and arm describes the motion of the hand-arm system in response to an oscillatory force impressed upon the hand. Such oscillatory forces occur, for example, during operation of a vibrating hand-held power tool. The mechanical impedance of the hand-arm system is required for the design and development of

- a) vibration-reducing and protective devices;
- b) test rigs with which to measure the handle vibration of power tools.

Knowledge of this impedance permits the mechanical power transmitted to the hands to be estimated, and assists in the description of the biodynamic properties of the hand-arm system. The establishment of standardized values for human hand-arm impedance will foster the development of effective vibration-reducing and protective devices, and meaningful test procedures.

The response of the hand-arm system when the hand grasps a vibrating object depends on several factors. The most important of these are:

- the direction of vibration with respect to the hand-arm system;
- the geometry of the object grasped;
- the forces exerted by the hand on the object;
- posture;
- muscle tone;
- anthropometric characteristics.

The forces exerted by the hand are usually described in terms of the grip force and feed force. The latter is often called the “thrust”, “push” or “press” force.

In this International Standard, the free, mechanical impedance at the driving point is employed to describe the dynamic response of the human hand-arm system to forced motion of the hand, as a function of frequency. The values of free impedance have been derived from the results of impedance measurements performed on groups of live, male subjects, by different investigators. Insufficient data are available from independent sources to specify hand-arm impedances for females.

The unexplained differences between the mean values of impedance reported in studies conducted independently, under nominally equivalent conditions, has dictated the form in which the standardized male hand-arm impedance is presented. A synthesis of measured values has been performed (see annex F). The most probable values of impedance

modulus and phase are defined, as a function of frequency, by upper and lower envelopes, which encompass the mean values of all accepted data sets at each frequency. The envelopes have been constructed from segmental cubic spline functions, and define, at each frequency, the range of accepted values of the male hand-arm impedance. The weighted mean of the accepted data sets, and standard deviation of the mean, are defined as a function of frequency, and represent the target values for all applications of this International Standard.

No impedance modulus or phase presented as a function of frequency in this International Standard corresponds precisely to the mean value measured in a single investigation involving human subjects, at all frequencies.

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Mechanical vibration and shock — Free, mechanical impedance of the human hand-arm system at the driving point

1 Scope

This International Standard describes the free, mechanical impedance of the human male hand-arm system at the driving point. Values of the free impedance, expressed as modulus and phase, are provided for three orthogonal, translatory directions of excitation that correspond to the x_h , y_h and z_h axes of the basicentric coordinate system for the hand defined in ISO 5349 and ISO 8727. The x_h , y_h and z_h components of free impedance are defined as a function of frequency, from 10 Hz to 500 Hz, for specified arm positions, grip and feed forces, handle diameters, and intensities of excitation. The components of free impedance in the three directions are treated as being independent (see annex F).

This International Standard may be used to define typical values of the free, mechanical impedance of the hand-arm system at the driving point, applicable to males under the circumstances specified. For each impedance component, the free impedance is defined at each frequency by three values, to reflect the range of values measured on male hands. The upper and lower values define the range of most probable values of impedance. The middle value represents an overall mean of the human data, and defines the target value for all applications. This International Standard may be provisionally applied to females.

Reference values of the free, mechanical impedance at the driving point are provided as a function of frequency for a specified grip and feed force in annex A. These impedance values are intended for the determination of the transmissibility of resilient materials, when loaded by the hand-arm system.

Mathematical representations of the hand-arm system that model the values of free impedance are also provided in annexes C to E.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 5349:1986, *Mechanical vibration — Guidelines for the measurement and the assessment of human exposure to hand-transmitted vibration*

ISO 8727:1997, *Mechanical vibration and shock — Human exposure — Biodynamic coordinate systems*