

Human response to vibration - Measuring instrumentation - Part 1: General purpose vibration meters (ISO 8041-1:2017)

## EESTI STANDARDI EESSÕNA

## NATIONAL FOREWORD

See Eesti standard EVS-EN ISO 8041-1:2017 sisaldab Euroopa standardi EN ISO 8041-1:2017 ingliskeelset teksti.	This Estonian standard EVS-EN ISO 8041-1:2017 consists of the English text of the European standard EN ISO 8041-1:2017.
Standard on jõustunud sellekohase teate avaldamisega EVS Teatajas	This standard has been endorsed with a notification published in the official bulletin of the Estonian Centre for Standardisation.
Euroopa standardimisorganisatsioonid on teinud Euroopa standardi rahvuslikele liikmetele kättesaadavaks 24.05.2017.	Date of Availability of the European standard is 24.05.2017.
Standard on kättesaadav Eesti Standardikeskusest.	The standard is available from the Estonian Centre for Standardisation.

Tagasisidet standardi sisu kohta on võimalik edastada, kasutades EVS-i veebilehel asuvat tagasiside vormi või saates e-kirja meiliaadressile [standardiosakond@evs.ee](mailto:standardiosakond@evs.ee).

ICS 13.160

Standardite reprodutseerimise ja levitamise õigus kuulub Eesti Standardikeskusele

Andmete paljundamine, taastekitamine, kopeerimine, salvestamine elektroonsesse süsteemi või edastamine ükskõik millises vormis või millisel teel ilma Eesti Standardikeskuse kirjaliku loata on keelatud.

Kui Teil on küsimusi standardite autorikaitse kohta, võtke palun ühendust Eesti Standardikeskusega:

Koduleht [www.evs.ee](http://www.evs.ee); telefon 605 5050; e-post [info@evs.ee](mailto:info@evs.ee)

The right to reproduce and distribute standards belongs to the Estonian Centre for Standardisation

No part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying, without a written permission from the Estonian Centre for Standardisation.

If you have any questions about copyright, please contact Estonian Centre for Standardisation:

Homepage [www.evs.ee](http://www.evs.ee); phone +372 605 5050; e-mail [info@evs.ee](mailto:info@evs.ee)

EUROPEAN STANDARD

**EN ISO 8041-1**

NORME EUROPÉENNE

EUROPÄISCHE NORM

May 2017

ICS 13.160

Supersedes EN ISO 8041:2005

English Version

**Human response to vibration - Measuring instrumentation  
- Part 1: General purpose vibration meters (ISO 8041-  
1:2017)**

Réponse des individus aux vibrations - Appareillage de  
mesure - Partie 1: Instrument de mesure à usage  
général (ISO 8041-1:2017)

Schwingungseinwirkung auf den Menschen -  
Messeinrichtung - Teil 1: Schwingungsmesser für  
allgemeine Anwendungen (ISO 8041-1:2017)

This European Standard was approved by CEN on 22 April 2017.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN-CENELEC Management Centre or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and United Kingdom.



EUROPEAN COMMITTEE FOR STANDARDIZATION  
COMITÉ EUROPÉEN DE NORMALISATION  
EUROPÄISCHES KOMITEE FÜR NORMUNG

**CEN-CENELEC Management Centre: Avenue Marnix 17, B-1000 Brussels**

## European foreword

This document (EN ISO 8041-1:2017) has been prepared by Technical Committee ISO/TC 108 "Mechanical vibration, shock and condition monitoring" in collaboration with Technical Committee CEN/TC 231 "Mechanical vibration and shock" the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by November 2017 and conflicting national standards shall be withdrawn at the latest by November 2017.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

This document supersedes EN ISO 8041:2005.

According to the CEN-CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

### Endorsement notice

The text of ISO 8041-1:2017 has been approved by CEN as EN ISO 8041-1:2017 without any modification.

# Contents

	Page
<b>Foreword</b> .....	<b>vi</b>
<b>Introduction</b> .....	<b>vii</b>
<b>1 Scope</b> .....	<b>1</b>
<b>2 Normative references</b> .....	<b>1</b>
<b>3 Terms, definitions and symbols</b> .....	<b>2</b>
3.1 Terms and definitions.....	2
3.1.1 General.....	2
3.1.2 Frequency-weighted values.....	4
3.2 Symbols.....	6
<b>4 Reference environmental conditions</b> .....	<b>8</b>
<b>5 Performance specifications</b> .....	<b>8</b>
5.1 General characteristics.....	8
5.2 Display of signal magnitude.....	10
5.2.1 General.....	10
5.2.2 Resolution and refresh rate.....	10
5.2.3 Stabilization, measurement start and display times.....	11
5.3 Electrical output.....	11
5.4 Vibration sensitivity.....	11
5.5 Accuracy of indication at reference frequency under reference conditions.....	12
5.6 Frequency weightings and frequency responses.....	12
5.6.1 Parameters.....	12
5.6.2 Band-limiting filter.....	13
5.6.3 a-v transition filter.....	13
5.6.4 Upward-step filter.....	14
5.6.5 Overall frequency weighting.....	14
5.6.6 Tolerances.....	14
5.7 Amplitude linearity.....	15
5.8 Instrument noise.....	16
5.9 Signal-burst response.....	16
5.10 Overload indication.....	19
5.11 Under-range indication.....	20
5.12 Time averaging.....	20
5.13 Running r.m.s. acceleration.....	20
5.14 Reset.....	21
5.15 Timing facilities.....	21
5.16 Electrical cross-talk.....	21
5.17 Vibration transducer characteristics.....	21
5.18 Power supply.....	21
<b>6 Mounting</b> .....	<b>22</b>
<b>7 Environmental and electromagnetic criteria</b> .....	<b>22</b>
7.1 General.....	22
7.2 Air temperature.....	22
7.3 Surface temperature.....	23
7.4 Electrostatic discharge.....	23
7.5 Radio-frequency emissions and public-power-supply disturbances.....	23
7.6 Immunity to AC power-frequency fields and radio-frequency fields.....	24
7.7 Ingress of water and dust.....	24
<b>8 Provision for use with auxiliary devices</b> .....	<b>25</b>
<b>9 Instrument marking</b> .....	<b>25</b>
<b>10 Instrument documentation</b> .....	<b>25</b>

<b>11</b>	<b>Testing and calibration</b>	<b>25</b>
<b>12</b>	<b>Pattern evaluation</b>	<b>28</b>
12.1	General	28
12.2	Testing requirements	28
12.3	Submission for testing	29
12.4	Marking of the vibration meter and information in the instrument documentation	29
12.5	Mandatory facilities and general requirements	29
12.6	Initial instrument preparation	29
12.7	Indication at the reference frequency under reference conditions	29
12.8	Electrical cross-talk	30
12.9	Vibration transducer	30
12.10	Amplitude linearity and under-range indication	31
12.10.1	Electrical tests of amplitude linearity	31
12.10.2	Mechanical tests of amplitude linearity	32
12.11	Frequency weightings and frequency responses	33
12.11.1	General	33
12.11.2	Mechanical tests of frequency response	33
12.11.3	Electrical tests of frequency response	34
12.11.4	Conformance	35
12.12	Instrument noise	35
12.13	Signal-burst response	36
12.14	Overload indication	36
12.15	Reset	36
12.16	Combined axis outputs	37
12.17	AC electrical output	37
12.18	Timing facilities	37
12.19	Power supply	37
12.20	Environmental, electrostatic and radio-frequency tests	37
12.20.1	General	37
12.20.2	Expanded uncertainties for measurements of environmental conditions	38
12.20.3	Acclimatization requirements for tests of the influence of air temperature and relative humidity	38
12.20.4	Test of the influence of air temperature and relative humidity combined	38
12.20.5	Influence of surface temperature	39
12.20.6	Influence of electrostatic discharges	39
12.20.7	Radio-frequency emissions and public-power-supply disturbances	39
12.20.8	Immunity to AC power-frequency fields and radio-frequency fields	40
12.21	Test report	41
<b>13</b>	<b>Validation of one-off instruments</b>	<b>42</b>
13.1	General	42
13.2	Testing requirements	42
13.3	Test object	42
13.4	Submission for testing	43
13.5	Marking of the one-off instrument and information in the instrument documentation	43
13.6	Mandatory facilities and general requirements	43
13.7	Initial instrument preparation	43
13.8	Test procedure	43
13.9	Indication at the reference frequency under reference conditions	44
13.10	Test parameters	45
13.10.1	Vibration measurement chain for hand-arm vibration	45
13.10.2	Vibration measurement chain for whole-body vibration	45
13.10.3	Vibration measurement chain low-frequency whole-body vibration	46
13.11	Conducting the test	46
13.12	Instrument noise	47
13.13	Electrical cross-talk	47
13.14	Overload indication	47
13.15	Timing facilities	47

13.16	Test report	48
<b>14</b>	<b>Periodic verification</b>	<b>48</b>
14.1	General	48
14.2	Testing requirements	48
14.3	Test object	48
14.4	Submission for testing	48
14.5	Preliminary inspection	49
14.6	Marking of the vibration meter and information in the instrument documentation	49
14.7	Test procedure	49
14.8	Test parameters	50
	14.8.1 Vibration measurement chain for hand-arm vibration	50
	14.8.2 Vibration measurement chain for whole-body vibration	50
	14.8.3 Vibration measurement chain low-frequency whole-body vibration	50
14.9	Conducting the test	51
14.10	Test report	51
<b>15</b>	<b><i>In situ</i> checks</b>	<b>51</b>
15.1	General	51
15.2	Preliminary inspection	52
15.3	Vibration sensitivity (field calibration)	52
<b>Annex A (normative) Specification for field vibration calibrator</b>		<b>53</b>
<b>Annex B (informative) Frequency weightings</b>		<b>55</b>
<b>Annex C (informative) Realization of frequency weighting filters</b>		<b>74</b>
<b>Annex D (informative) Running r.m.s. time averaging</b>		<b>78</b>
<b>Annex E (informative) Vibration transducer characteristics</b>		<b>81</b>
<b>Annex F (informative) Tests for mounting systems</b>		<b>84</b>
<b>Annex G (normative) Instrument documentation</b>		<b>87</b>
<b>Annex H (normative) Phase response requirements for measurement of non-r.m.s. quantities</b>		<b>92</b>
<b>Annex I (informative) Guidelines for the estimation of the instrumental measurement uncertainty</b>		<b>100</b>
<b>Bibliography</b>		<b>106</b>

## 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](http://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](http://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](http://www.iso.org/iso/foreword.html).

This document was prepared by Technical Committee ISO/TC 108, *Mechanical vibration, shock and condition monitoring*, Subcommittee SC 3, *Use and calibration of vibration and shock measuring instruments*.

This first edition cancels and replaces ISO 8041:2005, which has been technically revised. It also incorporates the Technical Corrigendum ISO 8041:2005/Cor. 1:2007. The following main changes have been made:

- addition of an Introduction explaining the reasons for this revision;
- addition of a validation test for one-off instruments;
- revision and simplification of the verification test;
- addition of Annex I, which gives example estimates of the instrumental measurement uncertainty;
- correction of errors in formulae, numbers and figures.

A list of parts in the ISO 8041 series can be found on the ISO website.



## Introduction

Until 2005, when the previous edition of this document was published, measuring instrumentation for human response to vibration (vibration meters) normally consisted of a signal processing unit and a detachable vibration transducer. According to recent developments, however, part of the signal processing steps can be integrated in the transducer unit, so that the signal coming out of the transducer's sensing element and going into the signal conditioning unit is not accessible any more. These transducer units include, for example, IEPE and MEMS transducers.

Some of the test procedures specified in this document, however, presume that this point in the signal path is accessible (electrical input). Since such an input is not mandatory these tests can only be performed on a vibration meter having an electrical input or after some technical modifications to the instrumentation, e.g. internal access to signal paths. Or those tests can only be performed mechanically, which in certain cases requires modifications to some test procedures. Such modifications to test procedures, however, are beyond the present scope of this document.

Some of the test procedures specified in this document can only be performed if an electrical output is available, see for example [5.13](#). Since such an output is not mandatory these tests can only be performed on a vibration meter having an electrical output or after some technical modifications to the instrumentation, e.g. internal access to signal paths.

The verification test now specified in this document is practicable and has the objective of identifying an instrument which is adequately calibrated for the intended applications and is suitable for its purpose, at a cost reasonable for the calibration laboratory and affordable for the end user. Therefore, the verification test is strongly reduced in its extent compared to the full pattern evaluation, or validation, and only tests the most relevant characteristics of a vibration meter.

# Human response to vibration — Measuring instrumentation —

## Part 1: General purpose vibration meters

### 1 Scope

This document specifies the performance specifications and tolerance limits for instruments designed to measure vibration values, for the purpose of assessing human response to vibration. It includes requirements for pattern evaluation, or validation, periodic verification and *in situ* checks, and the specification of vibration calibrators for *in situ* checks.

Vibration instruments specified in this document can be single instruments, combinations of instrumentation or computer-based acquisition and analysis systems.

Vibration instruments specified in this document are intended to measure vibration for one or more applications, such as the following:

- hand-transmitted vibration (see ISO 5349-1);
- whole-body vibration (see ISO 2631-1, ISO 2631-2 and ISO 2631-4);
- low-frequency whole-body vibration in the frequency range from 0,1 Hz to 0,5 Hz (see ISO 2631-1).

Vibration instruments can be designed for measurement according to one or more of the frequency weightings defined within each of these applications.

Three levels of performance testing are defined in this document:

- a) pattern evaluation or validation:
  - 1) pattern evaluation, i.e. a full test of the instrument against the specifications defined in this document;
  - 2) validation of one-off instruments, i.e. a limited set of tests of an individual vibration measuring system against the relevant specifications defined in this document;
- b) periodic verification, i.e. an intermediate set of tests designed to ensure that an instrument remains within the required performance specification;
- c) *in situ* checks, i.e. a minimum level of testing required to indicate that an instrument is likely to be functioning within the required performance specification.

### 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.

ISO 2631-1, *Mechanical vibration and shock — Evaluation of human exposure to whole-body vibration — Part 1: General requirements*

ISO 2631-2, *Mechanical vibration and shock — Evaluation of human exposure to whole-body vibration — Part 2: Vibration in buildings (1 Hz to 80 Hz)*

ISO 2631-4:2001, *Mechanical vibration and shock — Evaluation of human exposure to whole-body vibration — Part 4: Guidelines for the evaluation of the effects of vibration and rotational motion on passenger and crew comfort in fixed-guideway transport systems*

ISO 5347 (all parts), *Methods for the calibration of vibration and shock pick-ups*

ISO 5348, *Mechanical vibration and shock — Mechanical mounting of accelerometers*

ISO 5349-1:2001, *Mechanical vibration — Measurement and evaluation of human exposure to hand-transmitted vibration — Part 1: General requirements*

ISO 16063 (all parts), *Methods for the calibration of vibration and shock transducers*

ISO/IEC Guide 98-3, *Uncertainty of measurement — Part 3: Guide to the expression of uncertainty in measurement (GUM:1995)*

IEC 61000-4-2:2008, *Electromagnetic compatibility (EMC) — Part 4-2: Testing and measurement techniques – Electrostatic discharge immunity test*

IEC 61000-4-3:2006, *Electromagnetic compatibility (EMC) — Part 4-3: Testing and measurement techniques – Radiated, radio-frequency, electromagnetic field immunity test*

IEC 61000-4-6, *Electromagnetic compatibility (EMC) — Part 4-6: Testing and measurement techniques – Immunity to conducted disturbances, induced by radio-frequency fields*

IEC 61000-6-2:2005, *Electromagnetic compatibility (EMC) — Part 6-2: Generic standards – Immunity for industrial environments*

CISPR 22:2008, *Information technology equipment — Radio disturbance characteristics — Limits and methods of measurement*

### **3 Terms, definitions and symbols**

#### **3.1 Terms and definitions**

For the purposes of this document, the terms and definitions given in ISO 2041, ISO/IEC Guide 99 and the following apply.

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

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

##### **3.1.1 General**

###### **3.1.1.1 vibration acceleration**

component of acceleration, where the axis of measurement is specified by application standards

###### **3.1.1.2 band-limiting frequency weighting**

component of a frequency weighting defined by the high- and low-pass band-limiting filters

###### **3.1.1.3 band-limited frequency range**

frequency range defined by the band-limiting component of a frequency weighting

###### **3.1.1.4 nominal frequency range**

frequency range of interest, as defined in the relevant measurement standard