INTERNATIONAL STANDARD

ISO 28927-4

First edition
2010-12-15

Hand-held portable power tools — Test methods for evaluation of vibration emission —

Part 4: Straight grinders

Machines à moteur portatives — Méthodes d'essai pour l'évaluation de l'émission de vibrations —
Partie 4: Meuleuses droites

Reference number
ISO 28927-4:2010(E)

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Published in Switzerland

Contents

Page

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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. 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.

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.

ISO 28927-4 was prepared by Technical Committee ISO/TC 118, *Compressors and pneumatic tools, machines and equipment*, Subcommittee SC 3, *Pneumatic tools and machines*.

This first edition of ISO 28927-4, together with ISO 28927-1, cancels and replaces ISO 8662-4:1994, of which it constitutes a technical revision. The most important changes are

— vibration measurement in three axes and at both hand positions;

— new transducer locations with improved definitions of the transducer positions and orientation are used;

— rotational speed is raised to no load free running speed;

— the test wheels are modified and the definition is improved.

ISO 28927 consists of the following parts, under the general title *Hand-held portable power tools — Test methods for evaluation of vibration emission*:

— *Part 1: Angle and vertical grinders*

— *Part 2: Wrenches, nutrunners and screwdrivers*[1)]

— *Part 3: Polishers and rotary, orbital and random orbital sanders*[2)]

— *Part 4: Straight grinders*[3)]

— *Part 5: Drills and impact drills*[4)]

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1) Replaces ISO 8662-7, *Hand-held portable power tools — Measurement of vibrations at the handle — Part 7: Wrenches, screwdrivers and nut runners with impact, impulse or ratchet action*. All screwdrivers and nutrunners except for one-shot tools now covered.

2) Replaces ISO 8662-8, *Hand-held portable power tools — Measurement of vibrations at the handle — Part 8: Polishers and rotary, orbital and random orbital sanders.*

3) Together with ISO 28927-1, replaces ISO 8662-4, *Hand-held portable power tools — Measurement of vibrations at the handle — Part 4: Grinders.*

— *Part 6: Rammers*[5)]

— *Part 7: Nibblers and shears*[6)]

— *Part 8: Saws, polishing and filing machines with reciprocating action and small saws with oscillating or rotating action*[7)]

— *Part 9: Scaling hammers and needle scalers*[8)]

— *Part 10: Percussive drills, hammers and breakers*[9)]

— *Part 11: Stone hammers*[10)]

— *Part 12: Die grinders*[11)]

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4) Replaces ISO 8662-6, *Hand-held portable power tools — Measurement of vibrations at the handle — Part 6: Impact drills.* Non-impacting drills now covered.

5) Replaces ISO 8662-9, *Hand-held portable power tools — Measurement of vibrations at the handle — Part 9: Rammers.*

6) Replaces ISO 8662-10, *Hand-held portable power tools — Measurement of vibrations at the handle — Part 10: Nibblers and shears.*

7) Replaces ISO 8662-12, *Hand-held portable power tools — Measurement of vibrations at the handle — Part 12: Saws and files with reciprocating action and saws with oscillating or rotating action*.

8) Together with ISO 28927-11 (to be published), replaces ISO 8662-14, *Hand-held portable power tools — Measurement of vibrations at the handle — Part 14: Stone-working tools and needle scalers.*

9) To be published. Replaces ISO 8662-2, *Hand-held portable power tools — Measurement of vibrations at the handle — Part 2: Chipping hammers and riveting hammers,* ISO 8662-3, *Hand-held portable power tools — Measurement of vibrations at the handle — Part 3: Rock drills and rotary hammers*, and ISO 8662-5, *Hand-held portable power tools — Measurement of vibrations at the handle — Part 5: Pavement breakers and hammers for construction work.* It also incorporates the Amendments ISO 8662-2:1992/Amd.1:1999, ISO 8662-3:1992/Amd.1:1999 and ISO 8662-5:1992/Amd.1:1999. Chipping and riveting hammers, rock drills and rotary hammers all covered.

10) To be published. Together with ISO 28927-9, replaces ISO 8662-14, *Hand-held portable power tools — Measurement of vibrations at the handle — Part 14: Stone-working tools and needle scalers.*

11) To be published. Replaces ISO 8662-13, *Hand-held portable power tools — Measurement of vibrations at the handle — Part 13: Die grinders*. It also incorporates the Technical Corrigendum ISO 8662-13:1997/Cor.1:1998.

Introduction

This document is a type-C standard as stated in ISO 12100.

When requirements of this type-C standard are different from those which are stated in type-A or -B standards, the requirements of this type-C standard take precedence over the requirements of the other standards for machines that have been designed and built according to the requirements of this type-C standard.

The vibration test codes for portable hand-held machines given in ISO 28927 (all parts) are based on ISO 20643, which gives general specifications for the measurement of the vibration emission of hand-held and hand-guided machinery. ISO 28927 (all parts) specifies the operation of the machines under type-test conditions and other requirements for the performance of type tests. The structure/numbering of its clauses follows that of ISO 20643.

The basic principle for transducer positioning first introduced in the EN 60745 series of European standards is followed, representing a deviation from ISO 20643 for reasons of consistency. The transducers are primarily positioned next to the hand in the area between the thumb and the index finger, where they give the least disturbance to the operator gripping the machine.

It has been found that vibrations generated by grinders vary considerably in typical use. The variation is largely due to the variances in the unbalance of the machine with the grinding wheel mounted. The unbalance also changes when the wheel is worn through the operation.

In order to provide a method that gives good measurement reproducibility, the procedure adopted in this part of ISO 28927 uses a test wheel of known unbalance mounted on a machine and run under no-load conditions. The unbalance for the different types of test wheels are chosen to give vibration values that are as far as possible in accordance with ISO 20643. The procedures of ISO 5349 (all parts) are required whenever exposure at the workplace is to be assessed.

Underestimation of the vibration for machines equipped with technical means to automatically reduce unbalances is taken into account by multiplying the vibration values of such machines with a correction factor of 1,3.

The values obtained are type-test values intended to be representative of the average of the upper quartile of typical vibration magnitudes in real-world use of the machines. However, the actual magnitudes vary considerably from time to time and depend on many factors, including the operator, the task and the inserted tool or consumable. The state of maintenance of the machine itself might also be of importance. Under real working conditions the influences of the operator and process can be particularly important at low magnitudes. It is therefore not recommended that emission values below 2,5 m/s^2 be used for estimating the vibration magnitude under real working conditions. In such cases, 2,5 m/s^2 is the recommended vibration magnitude for estimating the machine vibration.

If accurate values for a specific work place are required, then measurements [according to ISO 5349 (all parts)] in that work situation could be necessary. Vibration values measured in real working conditions can be either higher or lower than the values obtained using this part of ISO 28927.

Higher vibration magnitudes can easily occur in real work situations caused by the use of excessively unbalanced grinding wheels, worn flanges or bent spindles.

The vibration test codes given in ISO 28927 (all parts) supersede those given in ISO 8662 (all parts), which has been replaced by the corresponding parts of ISO 28927 (see Foreword).

NOTE ISO 8662-11, *Hand-held portable power tools — Measurement of vibrations at the handle — Part 11: Fastener driving tools* could be replaced by a future part of ISO 28927.

Hand-held portable power tools — Test methods for evaluation of vibration emission —

Part 4: Straight grinders

1 Scope

This part of ISO 28927 specifies a laboratory method for measuring hand-transmitted vibration emission at the handles of straight grinders. It is a type-test procedure for establishing the magnitude of vibration in the gripping areas of a machine fitted with a specified test wheel and run under no-load conditions.

This part of ISO 28927 is applicable to hand-held machines (see Clause 5), driven pneumatically or by other means, intended for grinding and surface finishing using straight grinding wheels type 1, tapered wheels type 4 and cylindrical plugs, e.g. of type 16 (cylindrical plug, tapered cone), 18 (cylindrical plug, flat end), 18R (cylindrical plug, rounded end) and 19 (cylindrical plug, taper-roll shaped), for use on all kinds of materials. It is not applicable to grinders used with wire brushes, nor is it applicable to die grinders where the inserted tool is mounted in a collet.

NOTE 1 Typical machines covered by this part of ISO 28927 are illustrated in Figures 1 to 3.

It is intended that the results be used to compare different models of the same type of machine.

NOTE 2 To avoid confusion with the terms “power tool” and “inserted tool”, “machine” is used hereinafter for the former.

2 Normative references

The following referenced documents are indispensable for the application 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 603-12:1999, *Bonded abrasive products — Dimensions — Part 12: Grinding wheels for deburring and fettling on a straight grinder*

ISO 2787:1984, *Rotary and percussive pneumatic tools — Performance tests*

ISO 4026:2003, *Hexagon socket set screws with flat point*

ISO 4027:2003, *Hexagon socket set screws with cone point*

ISO 4029:2003, *Hexagon socket set screws with cup point*

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

ISO 5349-2:2001, *Mechanical vibration — Measurement and evaluation of human exposure to hand-transmitted vibration — Part 2: Practical guidance for measurement at the workplace*

ISO 5391:2003, *Pneumatic tools and machines — Vocabulary*

ISO 17066:2007, *Hydraulic tools — Vocabulary*

ISO 20643:2005, *Mechanical vibration — Hand-held and hand-guided machinery — Principles for evaluation of vibration emission*

EN 755-2:2008, *Aluminium and aluminium alloys — Extruded rod/bar, tube and profiles — Part 2: Mechanical properties*

EN 12096:1997, *Mechanical vibration — Declaration and verification of vibration emission values*

3 Terms, definitions and symbols

For the purposes of this document, the terms and definitions given in ISO 5391, ISO 17066 and ISO 20643, and the following apply.

3.1 Terms and definitions

3.1.1
straight grinder
grinder where the handle, motor and the spindle are coaxially aligned

[ISO 5391:2003, definition 2.1.3.1]

3.1.2
test wheel
aluminium wheel geometrically similar to a real grinding wheel with holes on specified radii to give defined unbalances

3.2 Symbols

Symbol	Description	Unit
a_{hw}	root-mean-square (r.m.s.) single-axis acceleration value of the frequency-weighted hand-transmitted vibration	m/s^2
a_{hv}	vibration total value of frequency-weighted r.m.s. acceleration; is the root sum of squares of the a_{hw} values for the three measured axes of vibration	m/s^2
a_{hvmeas}	a_{hv} as measured during the test	m/s^2
a_{hvrat}	a_{hv} at rated no-load speed	m/s^2
$\overline{a_{hv}}$	arithmetic mean value of a_{hv} values of runs for one operator for one hand position	m/s^2
a_h	arithmetic mean value of $\overline{a_{hv}}$ values for all operators for one hand position	m/s^2
$\overline{a_h}$	arithmetic mean value of a_h values for one hand position on several machines	m/s^2
a_{hd}	declared vibration emission value	m/s^2
n_{meas}	measured no-load speed during the test with the test wheel mounted	r/min
n_{rat}	rated no-load speed is the maximum rotational-speed of the machine according to the speed marking of the machine	r/min
s_{n-1}	standard deviation for a test series (for a sample)	m/s^2
σ_R	standard deviation of reproducibility (for a population)	m/s^2
C_V	coefficient of variation for a test series	—
K	uncertainty	m/s^2

4 Basic standards and vibration test codes

This part of ISO 28297 is based on the requirements of ISO 20643 and corresponds to its structure in respect of clause subjects and numbering, except for the annexes.

Annex A presents a model test report, Annex B the means for determining the uncertainty, K, and Annex C specifies test wheel design.

5 Description of the family of machines

This part of ISO 28927 applies to hand-held machines intended for grinding and surface finishing using straight grinding wheels type 1, tapered wheels type 4 and cylindrical plugs type 16, 18, 18R and 19, for use on all kinds of materials. Machines equipped with a collet intended for inserted tools with a shaft are covered by ISO 28927-12. Typical machines are shown in Figures 1 to 3.

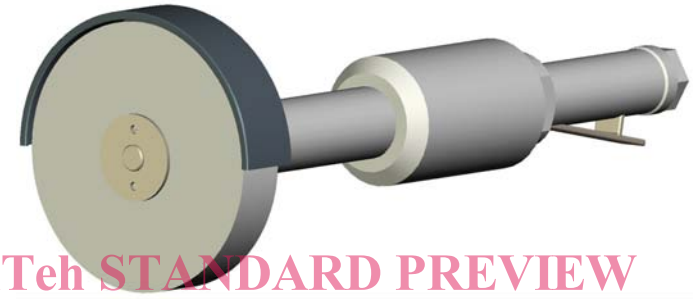


Figure 1 — Straight grinder with type 1 wheel

Figure 2 — Straight grinder with type 18R cylindrical plug

Figure 3 — Extended straight grinder with type 18R cylindrical plug

6 Characterization of vibration

6.1 Direction of measurement

The vibration transmitted to the hand shall be measured and reported for three directions of an orthogonal coordinate system. At each hand position, the vibration shall be measured simultaneously in the three directions shown in Figures 4 to 6.

6.2 Location of measurements

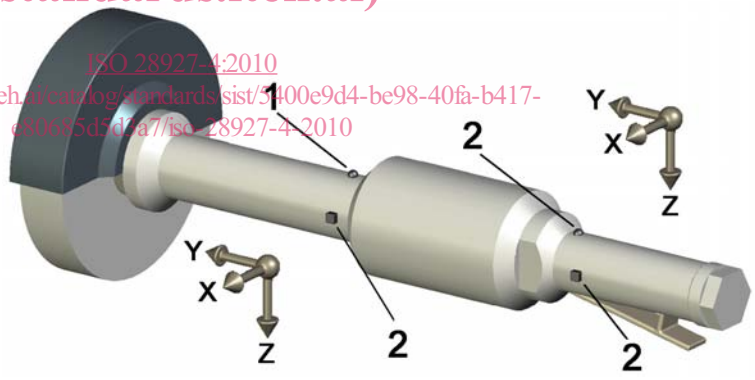
Measurement shall be made at the gripping zones, where the operator normally holds the machine and applies the feed force. For machines intended for one-hand operation, it is only necessary to measure at a single point.

The prescribed transducer location shall be as close as possible to the hand between the thumb and index finger. This shall apply to both hand positions, with the machine held as in normal operation. Whenever possible, measurements shall be made at the prescribed locations.

A secondary location is defined as being on the side of, and as close as possible to, the inner end of the handle where the prescribed location is found. If the prescribed location of the transducer cannot be used, this secondary location shall be used.

The prescribed or secondary location shall also be used on anti-vibration handles.

Figures 4 to 6 show the prescribed and secondary locations and measurement directions for the hand positions normally used for the different types of machines in this family.

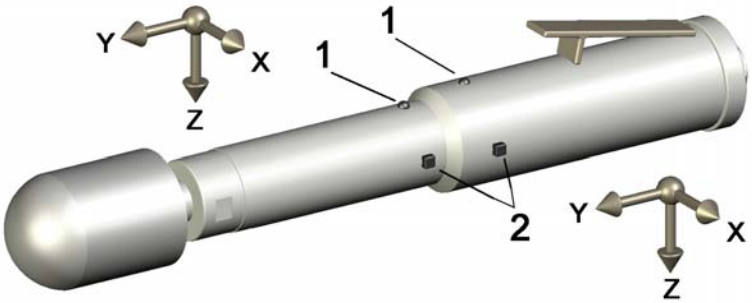


Key

1 prescribed location

2 secondary location

Figure 4 — Straight grinder with type 1 wheel

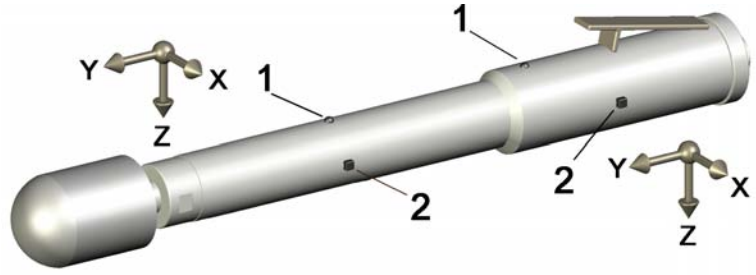


Key

1 prescribed location

2 secondary location

Figure 5 — Straight grinder with type 18R cylindrical plug



Key

1 prescribed location

2 secondary location

Figure 6 — Extended straight grinder with type 18R cylindrical plug

6.3 Magnitude of vibration

The definitions for the magnitude of vibration given in ISO 20643:2005, 6.3, apply.

6.4 Combination of vibration directions

The vibration total value defined in ISO 20643:2005, 6.4, shall be reported for both hand positions as applicable. It is acceptable to report on and carry out tests on the hand position having the highest reading. The vibration total value at that one hand position shall be at least 30 % higher than the other. This result may be obtained during a preliminary test carried out by a single operator during five test runs.

To obtain the vibration total value of the frequency-weighed acceleration, a_{hvmeas}, at the measured no-load speed for each test run, the result in each direction shall be combined using Equation (1):

$$a_{hvmeas} = \sqrt{a_{hwx}^2 + a_{hwy}^2 + a_{hwz}^2} \quad (1)$$

The a_{hvmeas} value for each test run is corrected to the frequency-weighed acceleration, a_{hvrat}, at the rated no-load speed using Equation (2):

$$a_{hvrat} = a_{hvmeas} \frac{n_{rat}}{n_{meas}} \quad (2)$$

where

n_{rat} is the rated no-load speed, i.e. the maximum rotational speed of the machine as marked on the machine;

n_{meas} is the measured no-load speed during testing.

7 Instrumentation requirements

7.1 General

The instrumentation shall be in accordance with ISO 20643:2005, 7.1.

7.2 Mounting of transducers

7.2.1 Specification of transducer

The specification of the transducer given in ISO 20643:2005, 7.2.1, applies.

The total mass of the transducers and mounting device shall be small enough, compared with that of the machine, handle, etc., so as not to influence the measurement result.

This is particularly important for low-mass plastic handles (covered in ISO 5349-2).

7.2.2 Fastening of transducers

The transducer or mounting block used shall be rigidly attached to the surface of the handle.

If three single-axis transducers are used, these shall be attached to three sides of a suitable mounting block.

For the two axes aligned parallel to the vibrating surface, the measurement axes of the two transducers — or the two transducer elements in a triaxial transducer — shall be at a maximum of 10 mm from the surface.

NOTE It is normally not necessary that mechanical filters be used for the measurements.

7.3 Frequency-weighting filter

Frequency-weighting filters shall be in accordance with ISO 5349-1.

7.4 Integration time

The integration time shall be in accordance with ISO 20643:2005, 7.4. The integration time for each test run shall be at least 16 s, so as to be consistent with the duration of machine operation defined in 8.4.3.

7.5 Auxiliary equipment

For pneumatic machines, the air pressure shall be measured using a pressure gauge with an accuracy equal to or better than 0,1 bar[12)].

For hydraulic machines, the flow shall be measured using a flow meter with an accuracy equal to or better than 0,25 l/min.

For electrical machines, the voltage shall be measured using a volt meter with an accuracy equal to or better than 3 % of the actual value.

The rotational speed shall be measured and reported with an accuracy better than 5 % of the actual value, using either a tachometer or frequency analysis of the measured vibration signal. When a tachometer transducer is placed on the machine, it should be small enough not to influence the vibration of the machine.

The feed force shall be measured with an accuracy equal to or better than 5 % of the actual value.

7.6 Calibration

The specifications for the calibration given in ISO 20643:2005, 7.6, apply.

8 Testing and operating conditions of the machinery

8.1 General

Measurements shall be carried out on new, and properly serviced and lubricated, machines. During testing, the machine shall be equipped and held in a manner similar to that when grinding (see Figure 7). If, for some types of machine, a warming-up period is specified by the manufacturer, this shall be undertaken prior to the start of the test.

The grinders shall be run under no-load conditions, equipped with the appropriate test wheel according to Table 1.

12) 1 bar = 0,1 MPa = 0,1 N/mm^2 = 10^5 N/m^2.