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ISO 28927-13

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

Part 13: **Fastener driving tools**

Machines à moteur portatives — Mesurage des vibrations au niveau des poignées —

Partie 13: Machines à enfoncer les fixations

Reference number
ISO 28927-13:2022(E)

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.

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 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 118, *Compressors and pneumatic tools, machines and equipment*, Subcommittee SC 3, *Pneumatic tools and machines,* in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 231, *Mechanical vibration and shock*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This first edition of ISO 28927-13 cancels and replaces ISO 8662-11:1999 and ISO 8662-11:1999/Amd 1:2001, which have been technically revised. The main changes compared to the previous edition are as follows:

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

— new transducer positions;

— improved definition of transducer positions and orientation.

A list of all the parts in the ISO 28927-series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

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 the 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. The 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 (all parts) 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.

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 will 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 workplace 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.

The vibration test codes given in the ISO 28927 (all parts) supersede those given in the ISO 8662 (all parts), whose parts have been replaced by the corresponding parts of ISO 28927.

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

Part 13:
Fastener driving tools

1 Scope

This document specifies a laboratory method for measuring the vibration at the handle of fastener driving tools. It is a type test procedure for establishing the vibration value on the handle of a hand-held power tool operating under a specified load.

This document is applicable to fastener driving tools driven pneumatically or by other means, using nails, staples or pins.

This document is applicable to tools with single sequential actuation, contact actuation, contact actuation with automatic reversion or continual contact actuation (see Figures 1 to 3).

This document is not applicable to tools operating in full sequential mode due to their much longer intervals in between individual actuations. However, to provide an indication for comparison of different tools of this type (see Figures 4 and 5), Annex C provides informative guidance.

NOTE Today current knowledge does not allow any conclusions regarding physiological and pathological effects between isolated shocks and continuous shock sequences, and their repetition rates.

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

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*

ISO 20643:2005/Amd 1:2012, *Mechanical vibration — Hand-held and hand-guided machinery — Principles for evaluation of vibration emission – Amd 1: Accelerometer positions*

ISO 28927-5:2009, *Hand-held portable power tools — Test methods for evaluation of vibration emission — Part 5: Drills and impact drills*

ISO 28927-5:2009/Amd 1:2015, *Hand-held portable power tools — Test methods for evaluation of vibration emission — Part 5: Drills and impact drills – Amd 1: Feed force*

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

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 5391:2003, ISO 17066:2007, ISO 20643:2005 and ISO 20643:2005/Amd 1, and the following apply.

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

— ISO Online browsing platform: available at https://www.iso.org/obp

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

3.1
fastener driving tool
stapler
power tool for driving nails/staples with one or more strokes

3.2
single sequential actuation
actuation mode which allows single driving operations via the trigger, after the workpiece contact has been operated, and further driving operations are only performed after the trigger has been returned to the non-driving position whilst the workpiece contact remains in the operating position

3.3
contact actuation
actuation mode which allows the tool to operate by operating the workpiece contact whilst the trigger is continually depressed and held

3.4
contact actuation with automatic reversion
actuation mode that is capable of *contact actuation* (3.3) or *continual contact actuation* (3.5) and reverts to single-sequential actuation, full-sequential actuation, neutral or off if the trigger is depressed for a specified period of time without operation of the workpiece contact

3.5
continual contact actuation
actuation mode in which the driving operations continue as long as the trigger and the workpiece contact remain in their operating positions

3.6
full sequential actuation
actuation mode which allows single driving operations via the trigger after the workpiece contact has been operated and further driving operations are only performed after the trigger and the workpiece contact have been returned to the non-driving position

Note 1 to entry: See ISO 11148-13:2017, 3.2.6, 3.2.7, 3.2.8, 3.2.9 and 3.2.10.

4 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; root sum of squares of a_{hw} values for the three measured axes of vibration	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
$a_{hv,3s}$	is the time averaged weighted single event vibration value normalised to one operation each three seconds	m/s^2
$a_{hv,max}$	is the time averaged weighted single for maximum continuous operation	m/s^2

Symbol	Description	Unit
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
s_{n-1}	standard deviation for a test series (for a sample, s)	m/s^2
σ_R	standard deviation of reproducibility (for a population, σ)	m/s^2
C_V	coefficient of variation for a test series	
N_{max}	maximum possible drive sequence	1/s
K	Uncertainty	m/s^2

5 Basic standards and vibration test code

This document is based on the requirements of ISO 20643:2005 and ISO 20643:2005/Amd 1:2012 and corresponds to its structure in respect of clause subjects and numbering except for the annexes.

Annex A presents a model test report and Annex B the means for determining the uncertainty, *K*.

6 Description of the family of machines

This document applies to hand-held machines intended for fastener driving tools.

Figures 1 to 5 show examples of typical fastener driving tools covered by this document.

Figure 1 — Pneumatic fastener driving tool

Figure 2 — Battery fastener driving tool

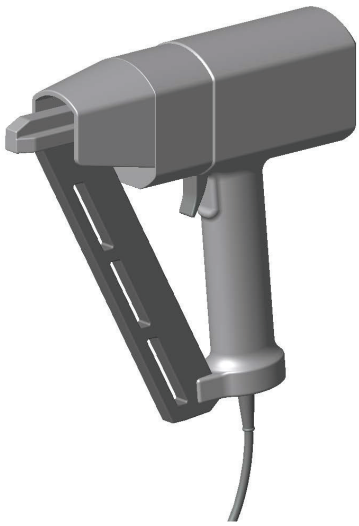


Figure 3 — Electric fastener driving tool

Figure 4 — Powder-driven (cartridges) fastener driving tool

Figure 5 — Gas fastener driving tool

7 Characterization of vibration

7.1 Direction of measurement

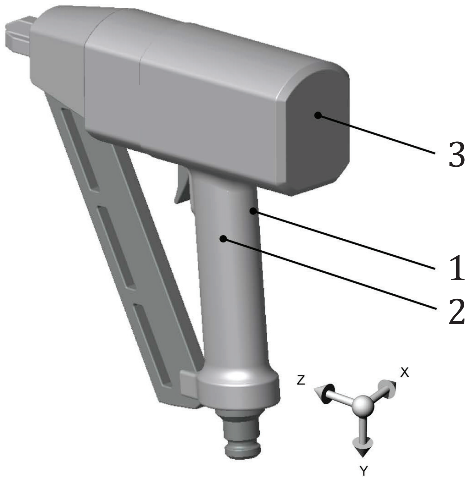
The vibration transmitted to the hand shall be measured and reported for three directions of an orthogonal coordinate system. At each hand position, the vibration shall be measured simultaneously in the three directions shown in Figures 6 to 10.

7.2 Location of measurements

Measurements shall be made at the gripping zones, where the operator normally holds the machine and applies the feed force. For machines intended for one-handed 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.

Tools of a mass of 2 kg or more may be operated using both hands, and so measurements shall be made in two positions. For tools without a side handle, the second-hand position is on the front housing, or — if that is not possible — on the housing, see Figures 6 to 10. For battery tools, the weight includes the standard battery.



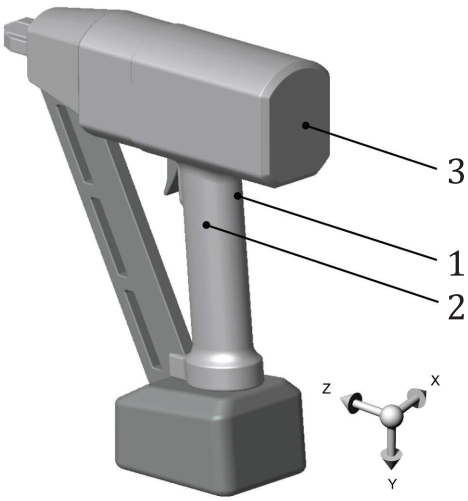
Key

1 prescribed location

2 secondary location

3 example of an additional location for a gripping zone

Figure 6 — Measurement locations — Pneumatic fastener driving tool



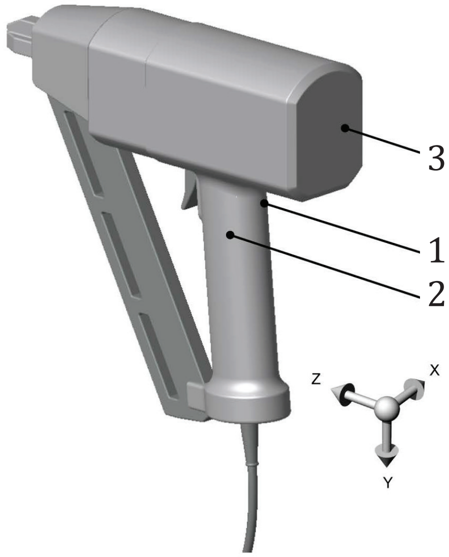
Key

1 prescribed location

2 secondary location

3 example of an additional location for a gripping zone

Figure 7 — Measurement locations — Battery fastener driving tool



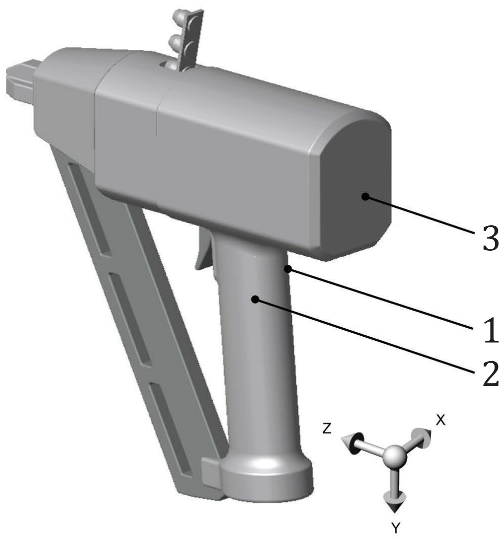
Key

1 prescribed location

2 secondary location

3 example of an additional location for a gripping zone

Figure 8 — Measurement locations — Electric fastener driving tool



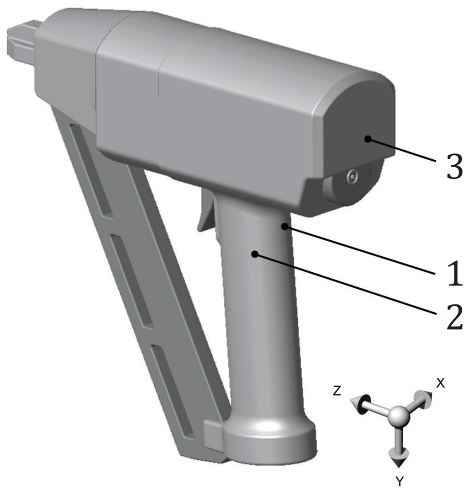
Key

1 prescribed location

2 secondary location

3 example of an additional location for a gripping zone

Figure 9 — Measurement locations — Powder-driven (cartridges) fastener driving tool



Key

1 prescribed location

2 secondary location

3 example of an additional location for a gripping zone

Figure 10 — Measurement locations — Gas fastener driving tool

7.3 Magnitude of vibration

The magnitude of vibration shall be in accordance with ISO 20643:2005 and ISO 20643:2005/Amd 1:2012, 6.3.

7.4 Combination of vibration directions

The vibration total value in accordance with ISO 20643:2005 and ISO 20643:2005/Amd 1:2012, 6.4, shall be reported for both hand positions, as applicable. It is acceptable to report and carry out tests on the hand position having the highest reading. The vibration total value at that hand position shall be at least 30 % higher than at the other. This result may be obtained under a preliminary test carried out by a single operator during five test runs.

To obtain the vibration total value, a_{hv}, for each test run, the results in each direction shall be combined using Formula (1):

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

The a_{hv} value for each operator shall be calculated as the arithmetic mean of the a_{hv} values for the five tests. For each hand position, the results from the three operators should be combined to one value, a_h, using the arithmetic mean of the three a_{hv} values.

However, there are some situations where triaxial measurement may not be possible or necessary. In such situations ISO 5349-1:2001 requires that an appropriate multiplication factor is applied to a single-axis measurement result to give an estimated vibration total value.

The multiplication factor used should be between 1,0 for highly dominant single-axis tools and 1,7 where the measured axis represents the vibration in all three axes. [A vibration axis is dominant when both non-dominant axis vibration values are each less than 30 % of the dominant axis vibration value (see ISO 5349-2)]. Where single-axis measurements are to be used, the single axis shall be the dominant axis.

EXAMPLE Initial measurements on a nailer show that the vertical axis vibration is dominant and that the vibration in the other axes is always less than 30 % of the acceleration in the dominant axis, $a_{\text{hw,dominant}}$. In this case the estimated vibration total value is given by

$$a_{\text{hv}} = \sqrt{a_{\text{hw, dominant}}^2 + (0{,}3 a_{\text{hw,dominant}})^2 + (0{,}3 a_{\text{hw,dominant}})^2}$$

$$= \sqrt{1 + 2 \times 0{,}3^2}\, a_{\text{hw,dominant}} = 1{,}086 a_{\text{hw,dominant}}$$

A multiplication factor of 1,086 (rounded to 1,1) is therefore appropriate. The estimated vibration total value will therefore be 1,1 times the dominant axis vibration value.

8 Instrumentation requirements

8.1 General

The instrumentation shall be in accordance with ISO 20643:2005 and ISO 20643:2005/Amd 1:2012, 7.1.

8.2 Mounting of transducers

8.2.1 Specification of transducer

The specification for the transducer given in ISO 20643:2005 and ISO 20643:2005/Amd 1:2012, 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 (see ISO 5349-2).

8.2.2 Fastening of transducers

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

In case of soft grip handles the resilient material shall be removed to attach the transducer on the rigid surface.

Ideally for triaxial measurements, integrated triaxial transducers should be used. 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 a maximum of 10 mm from the gripping surface.

8.2.3 Mechanical filter

It is normally necessary to use mechanical filters for measurements in accordance with this document to prevent dc shifts. For the application of mechanical filter see ISO 5349-2:2001, Annex C.

8.3 Frequency weighting filter

Frequency-weighting shall be in accordance with ISO 5349-1:2001.

8.4 Integration time

8.4.1 General

The integration time shall be in accordance with ISO 20643:2005 and ISO 20643:2005/Amd 1:2012, 7.4.

8.4.2 Contact actuation

Actuation shall be performed 10 times regularly distributed over an integral time of 30 s.

8.4.3 Continual contact actuation

The machine shall be set to 80 % of its maximum repetition speed of operation. If this is not possible, the machine shall be set to its maximum repetition speed of operation. The measurement shall be carried out over a duration of at least 8 s.

8.5 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[1)].

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

8.6 Calibration of the measurement chain

The specifications for calibration given in ISO 20643:2005 and ISO 20643:2005/Amd 1:2012, 7.6 apply.

9 Testing and operating conditions of the machinery

9.1 General

Measurements shall be carried out on a new, properly serviced and lubricated fastener driving tool.

The fastener driving tool shall be operated perpendicularly to the workpiece.

A suitable feed force shall be applied to ensure stable and smooth operation of the power tool and to give rated performance in accordance with the manufacturer's specification.

During the test, the power tool shall be arranged so that the operator can have an upright, or almost upright, posture and work with his forearm and upper arm at an angle between 100° and 160°. The operator shall be able to hold the power tool comfortably during the test. See Figure 11.

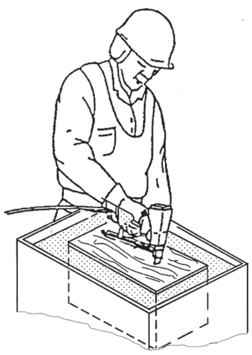


Figure 11 — Fastener driving tool — Working position of operator

1) 1 bar = 0,1 MPa = 10^5 Pa; 1 MPa = 1 N/mm^2.

9.2 Attached equipment, workpiece and task

9.2.1 General

The pressure of compressed-air-operated fastener driving tools shall be adjusted so that the fasteners used are driven into the workpiece. Special cases shall be reported. The pressure used shall assure proper function of the fastener driving tool.

Non-compressed-air-operated fastener driving tools which are equipped with an impact force adjustment shall be regulated using this device.

The power setting shall be adjusted to ensure that the fastener (staplers, nailers, etc.) are driven flush to the surface.

When a tool is designed to install fasteners in materials other than wood, the manufacturer's instructions shall be followed.

9.2.2 Pneumatic machines

The pressure of pneumatically powered fastener driving tools or other data related to the power supply shall be measured and kept constant during the test procedure. During testing, the pressure should be set according to the manufacturer recommendations such as the biggest fasteners are driven flush. The air pressure shall be measured and reported. For pneumatically driven tools, the air shall be supplied by a hose having a length of at least 2 m, which is attached to the power tool via a quick-action connector.

9.3 Operating conditions

During the measurement, the fastener driving tool shall operate with the longest fastener intended for the power tool. If the workpiece is made of pine wood then it should be free from knots and with a straight grain. The average bulk density shall be 0,42 g/cm^3 to 0,48 g/cm^3 and the average wood humidity shall be (12 ± 3) %. If the workpiece is made of steel then it should be using specifications in ISO 28927-5:2009 and ISO 28927-5:2009/Amd 1:2015, 8.4.1, Table 1. Drills without impact action. The thickness of the steel plate shall be at least 35 mm.

The thickness of the workpiece shall be at least 1,2 times the length of the longest fastener used. The point of insertion on the workpiece shall be at least 50 mm from the edge. When a tool is designed to install fasteners in materials other than wood, the manufacturer's instructions shall be followed.

The workpiece shall be supported by a bed of dry sand, with the grain of the wood in a horizontal position and so that the surface of the workpiece is on a level with the top of the sand. The sand bed dimensions shall be at least 600 mm × 600 mm × 400 mm. The workpiece shall be surrounded on all sides with a sand layer which is at least 120 mm wide. The surface of the workpiece should be arranged so that the geometric centre of the fastener driving tool is positioned approximately 1 m above the floor. See Figure 12.

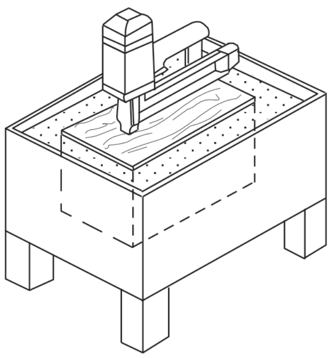


Figure 12 — Fastener driving tool — Test rig

If the workpiece is made of concrete then it should be using specifications in ISO 28927-5:2009 and ISO 28927-5:2009/Amd 1:2015, Table 2.

9.4 Operators

Three skilled operators shall each carry out one test series. A test series shall consist of at least five test runs. In each test run, stable operation shall be established. The vibration of the machine can be influenced by the operators. They shall, therefore, be skilled enough to be able to hold and operate the machine correctly.

9.5 Test procedure

9.5.1 Single sequential and contact actuation

Place the workpiece contact or the tool nose of the fastener driving tool against the workpiece.

Operate the fastener driving tool 10 times within 30 s. Each operation shall comprise an isolated single actuation, initiated by bumping for contact actuation tools.

Measure the time averaged weighted total vibration value, a_{hv}, during this time. The result is equivalent to the mean value (of 10) of the time averaged weighted single-event vibration value normalised to one operation every 3 s, $a_{hv,3s}$.

If the measurement is made using a larger number of operations, n, or a longer integration time, T, the total vibration value, $a_{hv,3s}$ is calculated according to the following Formula (2):

$$a_{hv,3s} = a_{hv} \sqrt{\frac{T}{3n}} \tag{2}$$

where

a_{hv} is the time averaged weighted total vibration value;

$a_{hv,3s}$ is the time averaged weighted single event vibration value normalised to one operation each three seconds;

n is the number of operations;

T is the integration time.

9.5.2 Continual contact actuation and continuous actuation

Place the work piece contact or the tool nose of the fastener driving tool against the work piece.

The machine shall be set to 80 % of its maximum repetition speed of operation. If this is not possible, the machine shall be set to its maximum repetition speed of operation. The measurement shall be carried out over a duration of operation of at least 8 s or maximum duration according to magazine size.

10 Measurement procedure and validity

10.1 Reported vibration values

Three series of five consecutive tests shall be carried out on each machine tested, using a different operator for each series.

The values (see also 7.4) should be reported as in Annex A.

The coefficient of variation, C_V, and the standard deviation, s_{n-1}, shall be calculated for each hand position for each of the three operators. The C_V of a test series is defined as the ratio of s_{n-1} to the mean value of the series:

$$C_V = \frac{s_{n-1}}{\overline{a_{\text{hv}}}} \tag{3}$$

with s_{n-1} identical to s_{rec} (see Annex B) and where the standard deviation of the i^{th} value, $a_{\text{hv}i}$, is

$$s_{n-1} = \sqrt{\frac{1}{n-1}\sum_{i=1}^{n}\left(a_{\text{hv}i} - \overline{a_{\text{hv}}}\right)^2} \tag{4}$$

where

$\overline{a_{\text{hv}}}$ is the mean value of the series in m/s^2;

n is equal to 5, the number of measured values.

If C_V is greater than 0,15 or s_{n-1} is greater than 0,3 m/s^2, then the measurements shall be checked for error before data are accepted.

10.2 Declaration and verification of the vibration emission value

The $\overline{a_{\text{hv}}}$ value for each operator shall be calculated as the arithmetic mean of a_{hv} values for the five test runs.

For each hand position, the result from the three operators should be combined into one value, a_{h}, using the arithmetic mean of the three $\overline{a_{\text{hv}}}$ values.

For tests using only one machine, the declared value, a_{hd}, is the highest of the a_{h} values reported for the two hand positions.

For tests using three or more machines, $\overline{a_{\text{h}}}$ values for each hand position shall be calculated as the arithmetic mean of the a_{h} values for the different machines on that hand position. The declared value, a_{hd}, is the highest of the $\overline{a_{\text{h}}}$ values reported for the two hand positions.

Both a_{hd} and the uncertainty, K, shall be presented with a precision determined in accordance with EN 12096:1997. The value a_{hd} is to be given in m/s^2 and presented by using two and a half significant digits for numbers starting with 1 (e.g. 1,20 m/s^2, 14,5 m/s^2); otherwise, two significant digits are sufficient (e.g. 0,93 m/s^2, 8,9 m/s^2). The value of K shall be presented with the same number of decimals as a_{hd}.

K shall be determined in accordance with EN 12096:1997, based on the standard deviation of reproducibility, σ_{R}. The value of K shall be calculated in accordance with Annex B.

The continuous load shall be calculated as follows from the maximum possible drive sequence $N_{\max}$ per second specified by the manufacturer:

$$a_{\text{hv,max}} = a_{\text{hv,3s}}\sqrt{3 \cdot N_{\max}} \tag{5}$$

11 Test report

A model of test report is given in Annex A.

In addition to the information required in ISO 20643:2005 and ISO 20643:2005/Amd 1:2012, the following information shall be given in the test report:

a) the type and dimensions of the fastener;

b) for compressed-air-operated fastener driving tools: operating pressure;

c) for non-compressed-air-operated fastener driving tools: typical value of the power supply and impact force adjustment;

d) a reference to this document, i.e. ISO 28927-13:2022;

e) specification of the hand-held machine (manufacturer, type, serial number);

f) declared emission value a_{hd} and uncertainty K;

g) instrumentation (accelerometer, integrators, recording system, hardware, software);

h) position and fastening of transducers, measuring directions and individual vibration values;

i) operating conditions and other quantities to be specified according to 9.2 and 9.3;

j) detailed results of the test (see Annex A);

k) number of fasteners driven during each test run.

If transducer positions or measurements other than those specified in this document are used, they shall be clearly defined and an explanation of the reason for the change in the position of the transducer shall be inserted in the test report.

Annex A
(informative)

Model test report for vibration emission of fastener driving tools

See Tables A.1 and A.2.

Table A.1 — General information and reported results

The test has been carried out in accordance with ISO 28927-13, *Hand-held portable power tools — Test method for evaluation of vibration emission — Part 13: Fastener driving tools*	
Tester:	
Measured by (company/laboratory):	Tested by: Reported by: Date:
Test object and declared value:	
Machine tested (power supply and machine type, manufacturer, machine model and name, mass):	Declared vibration emission value a_{hd} and uncertainty, K:
Measuring equipment:	
Transducers (manufacturer, type, positioning, fastening method, photos, mechanical filters if used):	
Vibration instrumentation:	Auxiliary equipment:
Operating and test conditions and results:	
Test conditions (test method used, size of socket or toolbit used, type of brake material, operator posture and hand position, photos):	
Measured blow frequency (for machines run freely)	Power supply (air pressure, hydraulic flow, voltage):
Any other quantities to report:	

Table A.2 — Measurement results for one machine

Date			Machine type:				Serial number:							Measured blow frequency:		
			Main handle (hand position 1)							Support handle (hand position 2)						
Test	Operator	Test run	a_{hwx}	a_{hwy}	a_{hwz}	a_{hv}	Statistics for operator			a_{hwx}	a_{hwy}	a_{hwz}	a_{hv}	Statistics for operator		
							$\overline{a_{hv}}$	s_{n-1}	C_V					$\overline{a_{hv}}$	s_{n-1}	C_V
1	1	1														
2	1	2														
3	1	3														
4	1	4														
5	1	5														
6	2	1														
7	2	2														
8	2	3														
9	2	4														
10	2	5														
11	3	1														
12	3	2														
13	3	3														
14	3	4														
15	3	5														
			a_h for hand position 1:							a_h for hand position 2:						
			s_R for hand position 1:							s_R for hand position 2:						

NOTE The a_{hv} and $\overline{a_{hv}}$ values are calculated according to 7.4 and 10.2, s_{n-1} and C_V are calculated according to 10.1, and s_R is calculated according to Annex B.

Annex B
(normative)

Determination of uncertainty

B.1 General

The uncertainty value, K, represents the uncertainty of the declared vibration emission value, a_{hd}, and, in the case of batches, production variations of machinery. K is expressed in m/s^2.

The sum of a_{hd} and K indicates the limit below which the vibration emission value of a single machine, and/or a specified large proportion of the vibration emission values of a batch of machines, are stated to lie when the machines are new.

B.2 Tests on single machines

For tests made on only a single machine, K shall be given by Formula (B.1):

$$K = 1,65\sigma_R \tag{B.1}$$

where σ_R is the standard deviation of reproducibility, estimated by the value s_R, given by Formula (B.2)

$$s_R = \sqrt{\overline{s_{\text{rec}}^2} + s_{\text{op}}^2} \tag{B.2}$$

or

$$s_R = 0,06a_{\text{hd}} + 0,3 \tag{B.3}$$

whichever is the greater.

NOTE 1 Formula (B.3) is empirical, based on experience giving a lower limit for s_R.

The calculations are performed on the hand position giving the highest value of a_h,

where

$\overline{s_{\text{rec}}^2}$ is the arithmetic mean value of the standard deviation from the results of five tests;

$s_{\text{rec}\,j}$ is the recorded standard deviation for operator j, identical to s_{n-1} according to 10.2, and with the $s_{\text{rec}\,j}^2$ value for each operator calculated using

$$s_{\text{rec}\,j}^2 = \frac{1}{n-1}\sum_{i=1}^{n}(a_{\text{hv}ji} - \overline{a_{\text{hv}j}})^2 \tag{B.4}$$

where

n is 5, the number of measured values;

$a_{\text{hv}ji}$ is the vibration total value for the i^{th} test with the j^{th} operator;

$\overline{a_{\text{hv}j}}$ is the average vibration total value of measurements on the j^{th} operator;

s_{op} is the standard deviation of the results from the three operators, i.e.

$$s_{\text{op}}^2 = \frac{1}{m-1}\sum_{j=1}^{m}(\overline{a_{\text{hv}j}} - a_{\text{h}})^2 \tag{B.5}$$

where

m is 3, i.e. the number of operators;

$\overline{a_{\text{hv}j}}$ is the average vibration value from the j^{th} operator (average of five tests);

a_h is the average vibration value from all three operators;

a_{hd} is the highest of the a_{h} values reported for the two hand positions.

NOTE 2 The value of s_r is an estimate of the standard deviation of reproducibility of testing performed at different test centres. Since there is currently no information on reproducibility for the tests defined in this document, the value for s_{r} is based on the repeatability of the test for individual test subjects and across the different test subjects, according to EN 12096:1997.

B.3 Tests on batches of machines

For tests on three or more machines, the K value shall be given as

$$K = 1{,}5\sigma_{\text{t}} \tag{B.6}$$

where σ_{t} is estimated by the value s_{t}, given by

$$s_{\text{t}} = \sqrt{\overline{s_R^2} + s_{\text{b}}^2} \tag{B.7}$$

or

$$s_{\text{t}} = 0{,}06a_{\text{hd}} + 0{,}3 \tag{B.8}$$

whichever is the greater.

The calculations are performed on the hand position giving the highest value of $\overline{a_{\text{h}}}$ and

where

$\overline{s_R^2}$ is the mean value of $\overline{s_R^2}$ for the different machines in the batch, with the s_{R} value for each machine calculated using Formula B.2, above;

s_{b} is the standard deviation of the test results for individual machines, i.e.

$$s_{\text{b}}^2 = \frac{1}{p-1}\sum_{l=1}^{\text{p}}(a_{\text{h}l} - \overline{a_{\text{h}}})^2 \tag{B.9}$$

where

a_{hl} is the single-machine emission for one hand position on the l^{th} machine;

$\overline{a_h}$ is the mean value of the single-machine emissions for one hand position;

a_{hd} is the highest of the $\overline{a_h}$ values reported for the two hand positions;

p is the number of machines tested (≥3).

Annex C
(informative)

Additional information for tools with full sequential actuation

C.1 General

Powder actuated tools and some gas and battery-operated tools can only work in full sequential actuation for technical reasons or because safety-oriented legislation exists that stipulates this mode of operation (e.g. EN 15895:2011+A1:2018 for powder actuated tools).

Due to their design and the fastening applications that they are used for, tools with full sequential actuation generate single shocks with low repetition rates (recoil). Each individual fastening operation consists of compressing the tool against the work surface, conscious actuation of the trigger and lift-off of the tool. This work cycle limits the maximum possible pulse repetition frequency to significantly less than 10 s^{-1}.

Current knowledge is not sufficient to allow any conclusions regarding physiological and pathological effects between isolated shocks and continuous shock sequences and their repetition rate. Therefore, in this annex only indications are given for testing of tools with full sequential actuation.

C.2 Testing and operating conditions

Tools for hard base materials such as steel and concrete should be tested at the energy level representing the most frequent operation and with a matching fastener on a suitable base material according to the manufacturer's specifications.

In testing, the maximum repetition rate as declared in the manufacturer's instructions for use should not be exceeded.

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