INTERNATIONAL STANDARD

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Forestry and gardening machinery — Vibration test code for portable hand-held machines with internal combustion engine — Vibration at the handles

Machines forestières et machines de jardin — Code d'essai des vibrations pour machines portatives tenues à la main à moteur à combustion interne — Vibrations au niveau des poignées

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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.

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 22867 was prepared by Technical Committee ISO/TC 23, *Tractors and machinery for agriculture and forestry*, Subcommittee SC 17, *Manually portable forest machinery*.

This second edition cancels and replaces the first edition (ISO 22867:2004), which has been technically revised. The scope has been expanded to include hand-held garden equipment. It also incorporates Technical Corrigendum ISO 22867:2004/Cor 1:2006.

Introduction

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

The machinery concerned and the extent to which hazards, hazardous situations or hazardous events are covered are indicated in the Scope of this document.

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 code specified in this International Standard is based on ISO 20643, which gives general specifications for the measurement of the vibration emission of hand-held machinery. It differs from ISO 20643 in the number of operators required to be involved in the test, with ISO 20643 requiring at least three operators and this International Standard only one. Another difference is that this International Standard primarily positions the transducers next to the hand in the area between the thumb and the index finger, where they present the least disturbance to the operator gripping the machine.

The determination of vibration characteristics is primarily used for

— manufacturer's declarations,

— comparing data between machines in the machine family concerned,

— development work at the design stage, and

— the estimation of the vibration risk considering the specific conditions (parameters).

The use of this vibration test code will ensure reproducibility of the determination of the vibration characteristics. Measurements made during particular operating modes are of interest for assessment of the vibration exposure, for example, over a typical working day.

The work cycles chosen for this test code are based on the following considerations of application:

a) chain-saws with an engine displacement of < 80 cm^3 are used for various operations, including felling, bucking and delimbing;

b) chain-saws with an engine displacement of ≥ 80 cm^3 are normally used for felling and bucking.

Delimbing will cause the saw to run at racing speed; therefore, racing is included only for saws with a < 80 cm^3 engine.

For brush-cutters, grass-trimmers, hedge-trimmers and pole-mounted powered pruners, the cutting mode (full load) is estimated to be valid only for short periods, and racing and idling are the two dominant modes. Moreover, the cutting mode has also been found to be diverse and not able to be performed under repeatable conditions.

For trimmers, the full-load and racing modes are integrated into a single mode, owing to the loading effect of the flexible line.

For brush-cutters, hedge-trimmers and pole-mounted powered pruners, it is not possible to simulate the full-load mode in a feasible way, since there are no constant load conditions comparable to those of chain-saws. Since the operating mode "racing" is the worst case, it is taken as being representative.

For garden-blowers, full load and idling are the two dominant modes.

In either of these cases, transport and other tasks between operations will cause the machine to run at idling. Experience has led to the conclusion that equal duration for the different working modes is a good estimation of daily exposure. The values obtained are values intended to be representative of the average of typical vibration magnitudes in real-world use of the machines. However, the actual magnitudes will vary considerably from time to time and will depend on many factors, including operator, task and cutting attachment. The state of maintenance of the machine itself might also be of importance.

Forestry and gardening machinery — Vibration test code for portable hand-held machines with internal combustion engine — Vibration at the handles

CAUTION — Some of the test procedure specified in this International Standard involves processes that could lead to a hazardous situation. Any person performing tests in accordance with this International Standard shall be appropriately trained in the type of work to be carried out. All national regulatory conditions and health and safety requirements shall be followed.

1 Scope

This International Standard specifies a vibration test code for determining, efficiently and under standardized conditions, the magnitude of vibration at the handles of portable hand-held, internal-combustion-engine-powered forest and garden machinery, including chain-saws (with the exception of high-handled chain-saws), brush-cutters, grass-trimmers, pole-mounted powered pruners, hedge-trimmers and garden-blowers.

Although the magnitudes measured are obtained in an artificial operation, they nevertheless give an indication of the values to be found in a real work situation.

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 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 6531, *Machinery for forestry — Portable chain-saws — Vocabulary*

ISO 7112, *Machinery for forestry — Portable brush-cutters and grass-trimmers — Vocabulary*

ISO 7293, *Forestry machinery — Portable chain saws — Engine performance and fuel consumption*

ISO 8041, *Human response to vibration — Measuring instrumentation*

ISO 8893, *Forestry machinery — Portable brush-cutters and grass-trimmers — Engine performance and fuel consumption*

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

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

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 6531, ISO 7112 and ISO 20643 apply.

4 Vibration quantities to be measured and determined

The quantities to be measured are the frequency-weighted accelerations in the three perpendicular directions, a_{hwx}, a_{hwy} and a_{hwz}.

The quantities to be determined are the vibration total values, a_{hv}, and the equivalent vibration total values, $a_{hv,eq}$, for each handle. See the calculations in Annexes A to E.

NOTE Mathematically, a_{hv} is the root sum of the squares of the three root-mean-square (r.m.s.) single-axis acceleration values of the frequency-weighted hand transmitted vibration values a_{hwx}, a_{hwy} and a_{hwz}.

5 Instrumentation

5.1 General

The vibration measurement system shall be in accordance with ISO 8041.

5.2 Accelerometer

The total mass of the vibration accelerometer giving the acceleration in the three directions at each measuring position shall be as low as possible, and shall not in any case exceed 25 g, including the mounting but excluding the cable. For further information, see ISO 5349-2:2001, 6.1.5.

NOTE The accelerometer is a sensitive element intended to pick up the vibration and to convert it into electrical signals. A tri-axial accelerometer will permit simultaneous measurements in the x, y and z axes.

5.3 Fastening of accelerometer

The accelerometer shall be mounted firmly on the handle by means of a fastening device, in accordance with ISO 5349-2.

For measurement on handles with resilient covers (e.g. cushioned handle), mount the accelerometer in accordance with ISO 5349-2:2001, 6.1.4.2, and perform one or the other of the following actions:

— remove the resilient material from the area beneath the transducers;

— fix the transducers using a force which fully compresses the resilient material.

Mountings shall be in accordance with ISO 5349-2:2001, D.2.2 and D.2.3; the method given in ISO 5349-2:2001, D.2.4, shall not be used.

5.4 Calibration

The accelerometer shall be calibrated in accordance with ISO 16063.

The whole measuring chain, including the accelerometer, shall be checked before and after a sequence of measurements using a calibrator which produces known accelerations at a known frequency. These *in-situ* checks shall be carried out in accordance with ISO 8041.

5.5 Speed indicator

The rotational frequency of the engine shall be measured with an accuracy of ±1,0 % of the reading. The speed indicator and its engagement with the machine shall not affect the operation of the machine under test.

6 Measurement direction and location

Measurements shall be made at each hand-grip at which the operator normally holds the machine. Measurements shall be made simultaneously in the three directions x, y and z.

The centre of gravity of the accelerometer shall be positioned at a maximum distance of 20 mm from the handle contour. One of the axes of the accelerometer shall be parallel to the axis of the handle.

The position of the accelerometer shall be as near as possible to the hand without obstructing normal grip.

NOTE The specific conditions for each type of machine are given in Annexes A to E.

7 Test and operating conditions of machine

Measurements shall be carried out on a new machine, featuring standard equipment as provided by the manufacturer, and with the fuel and oil tank(s) at least half-filled.

The engine shall be run-in prior to the test according to the manufacturer's recommendations. The engine shall be at a stable normal operating temperature before the test is commenced.

The carburettor shall be set, where applicable, according to the instructions of the manufacturer.

The engine speed for all test modes shall be kept constant to within ±3,5 r/s during testing. No alteration to the initial settings is permitted once measurements have commenced. If adjustment becomes necessary, the test shall be restarted after the adjustment.

The measured vibration of the machine is influenced by the operator. The operator shall therefore be skilled and able to operate the machine properly. The machine shall be held in a manner consistent with day-long use of the machine. Hand-held machines, except those suspended by harness, shall be held so that there is no contact with the operator's body during measurements.

A test to obtain the required data for a given operating mode shall consist of a minimum of four measurements, with a short break and a significant change (at least 20 %) of engine speed between measurements. Stable speed conditions (constant to within ±3,5 r/s) shall be obtained before testing is continued.

At least four separate periods of vibration data shall be obtained, totalling at least 20 s.

The measurements shall be continued until the validity requirements given in Clause 8 are fulfilled.

Each signal duration used shall be at least 2 s, during which the engine speed shall be maintained within ±3,5 r/s.

The collection of data for the different operating modes need not be carried out in any particular sequence.

NOTE The specific conditions for each type of machine are given in Annexes A to E.

8 Measurement and calculation

8.1 General

The following measurements and calculations shall be made and are generally performed in the sequence given here and as illustrated by Figure 1.

a) Measure the weighted acceleration of an operating mode in the three directions, $a_{hwx,J}$, $a_{hwy,J}$ and $a_{hwz,J}$, for the left and right handles, where J is the operating mode idling (Id), full load (Fl) or racing (Ra).

b) Calculate the root sum of squares of accelerations $a_{hv,J}$ of the three directions x, y and z for the operating mode selected.

c) Repeat a) and b) at least three more times.

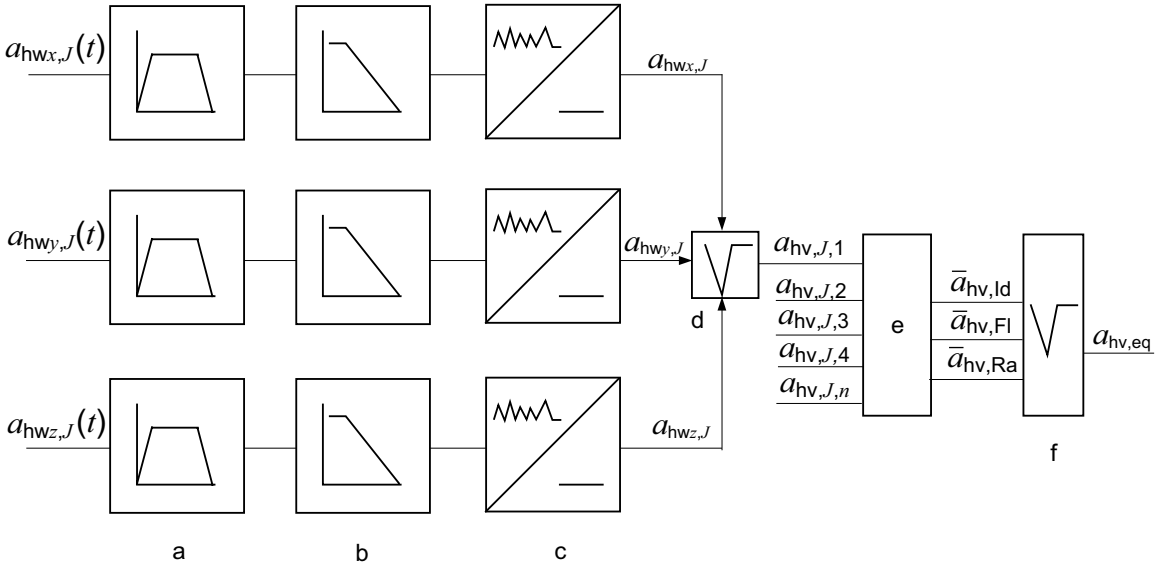
d) Calculate the arithmetic mean of the operating mode, $\overline{a}_{hv,J}$.

e) Repeat a), b) and d) until the coefficient of variation C_v and the standard deviation s_{n-1} comply with the requirements of 8.2.

f) Perform a) to e) for the remaining operating modes in accordance with the annex applicable to the type of machine.

g) Calculate the equivalent vibration total value, $a_{hv,eq}$, for each handle in accordance with the annex applicable to the type of machine.

h) Determine the declared value according to Clause 10.



a Band pass filter.

b Frequency weighting filter.

c Root mean square (r.m.s).

d See Note to Clause 4.

e Arithmetic mean for each operating mode.

f See Annexes A to E for calculation of $a_{hv,eq}$.

Figure 1 — Sequence of measurement and calculation of vibration data from the applicable operating modes

8.2 Validity of measured data

The measured data for every combination of handle and operating mode shall be considered valid when either

a) the coefficient of variation, C_v, of the consecutive weighted values is less than 0,3, or

b) the standard deviation, s_{n-1}, is less than 0,4 m/s^2.

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

If the measured values for a combination of handle and operating mode do not meet either criterion a) or b), then the non-complying combination shall be repeated until one or the other of these validity criteria is met.

The coefficient of variation, C_v, of a test series is the ratio between the standard deviation, s_{n-1}, of the series of measurement values and the mean value, $\bar{x}$, of the series:

$$C_v = \frac{s_{n-1}}{\bar{x}}$$

where

$$s_{n-1} = \sqrt{\frac{1}{n-1}\sum_{i=1}^{n}\left(x_i - \bar{x}\right)^2}$$

$$\bar{x} = \frac{1}{n}\sum_{i=1}^{n} x_i$$

where

x_i is the i-th value measured;

n is the number of measurement values.

9 Information to be reported

The following information shall be compiled and reported for all measurements made in accordance with this International Standard.

a) Machine under test:

1) description of machine, including engine displacement, manufacturer, type and serial number, type of cutting equipment (where applicable);

2) operating conditions, in accordance with Table 1.

b) Work piece, where applicable.

c) Instrumentation:

1) equipment used for the measurements, including name, type, serial number and manufacturer;

2) methods used to fasten accelerometers;

3) method used to calibrate the instrumentation system;

4) date and place of most recent calibration of accelerometer calibrator.

d) Vibration and other data:

1) location of accelerometer positions (a sketch may be included, if necessary);

2) measurement values and arithmetic mean values for each handle and cutting attachment (where applicable) in accordance with Table 1;

3) remarks, if any;

4) air temperature;

5) date and place of measurements.

Table 1 — Table for reporting determined vibration total values and calculation of their arithmetic means for each handle

Operating mode	Calculated data and validity criteria	Operating engine speed r/s	Specified handle				
			Test no.				
			1	2	3	4	n
Idling (Id)	$a_{hv,Id}$ (m/s^2)						
	$\bar{a}_{hv,Id}$ (m/s^2)		—	—	—		
	s_{n-1} (m/s^2)		—	—	—		
	C_v		—	—	—		
Full load (Fl)[a]	$a_{hv,Fl}$ (m/s^2)						
	$\bar{a}_{hv,Fl}$ (m/s^2)		—	—	—		
	s_{n-1} (m/s^2)		—	—	—		
	C_v		—	—	—		
Racing (Ra)[a]	$a_{hv,Ra}$ (m/s^2)						
	$\bar{a}_{hv,Ra}$ (m/s^2)		—	—	—		
	s_{n-1} (m/s^2)		—	—	—		
	C_v		—	—	—		
The vibration total values a_{hv} are determined and recorded, and their arithmetic mean, $\bar{a}_{hv}$, is calculated until the coefficient of variation, C_v, is less than 0,3, or the standard deviation, s_{n-1}, is less than 0,4. If C_v is greater than 0,15 or if s_{n-1} is greater than 0,3 m/s^2, the measurements shall be checked for error before the data are accepted. The calculation of arithmetic mean $\bar{a}_{hv}$ is based on at least four determinations of the vibration total value a_{hv}. The values for the arithmetic mean ($\bar{a}_{hv,Id}$, $\bar{a}_{hv,Fl}$ and $\bar{a}_{hv,Ra}$) are used to calculate the equivalent vibration total values $a_{hv,eq}$.							
[a] According to the test procedures for the specific machine type given in Annexes A to E.							

10 Declaration and verification of vibration values

The declaration shall include a reference to this International Standard. Deviations, if any, shall be indicated.

Equivalent vibration total values, $a_{hv,eq}$, calculated according to Annexes A to E, shall be used for the declaration of the vibration emission values. The uncertainty, K, shall also be given.

The total vibration value for the applicable operating modes (idling, full load and racing) shall be made available on request.

The uncertainty, K, to be associated with the declared equivalent vibration total value(s) is based on the standard deviation of reproducibility, σ_R, and the standard deviation of production, σ_p, where

$$K = \left(\sigma_R^{\,2} + \sigma_p^{\,2}\right)^{1/2}$$

Guidelines on σ_R are given in Annex F; its value shall be determined by the manufacturer, based on his experience of the production variation.

Annex A
(normative)

Chain-saws

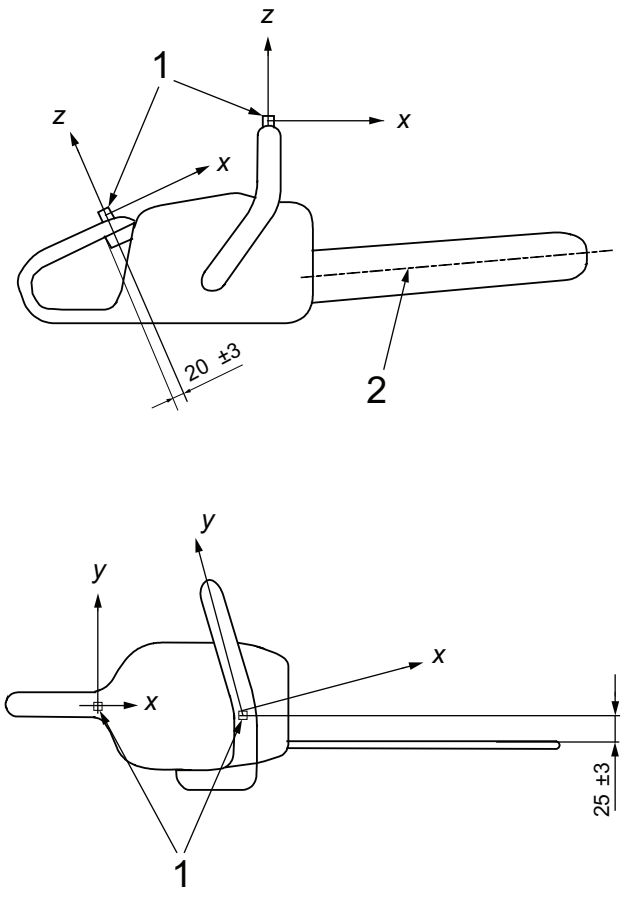
A.1 Measurement direction and location

The orientation and location of the accelerometers shall be in accordance with Figure A.1.

The accelerometer on the rear handle shall be located 20 mm ± 3 mm in front of the rear of the throttle trigger. If this distance cannot be obtained, the accelerometer shall be placed at the front of that portion of the handle intended to be grasped.

The accelerometer on the front handle shall be located 25 mm ± 3 mm to the left of the guide bar plane. If this distance cannot be obtained, the accelerometer shall be placed at the right end of that portion of the handle intended to be grasped.

Dimensions in millimetres



Key

1 accelerometer

2 guide bar centreline

Figure A.1 — Measurement direction and positioning of accelerometers on chain-saws

A.2 Chain-saw conditions and test timber

A.2.1 Chain-saw

The chain-saw shall be equipped with a guide bar as specified by the machine manufacturer and shall be of a length in accordance with Table A.1. All saw chains specified by the chain-saw manufacturer shall be tested.

The saw chain shall be new and shall be tensioned according to the instruction handbook.

A.2.2 Test timber

For cutting tests, sound timber shall be taken from freshly felled local hardwood. The timber shall not be seasoned or frozen. The cut shall be made in a part of the timber free from knots.

The width and shape of the log shall be correlated to the usable cutting length of the guide bar, as shown in Figure A.2 and in accordance with Table A.1.

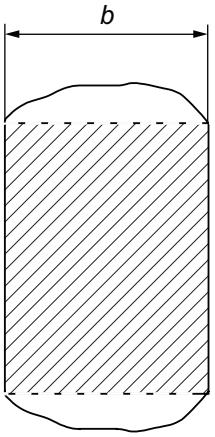


Figure A.2 — Test-log shape

Table A.1 — Width of test timber and usable cutting length of guide bar

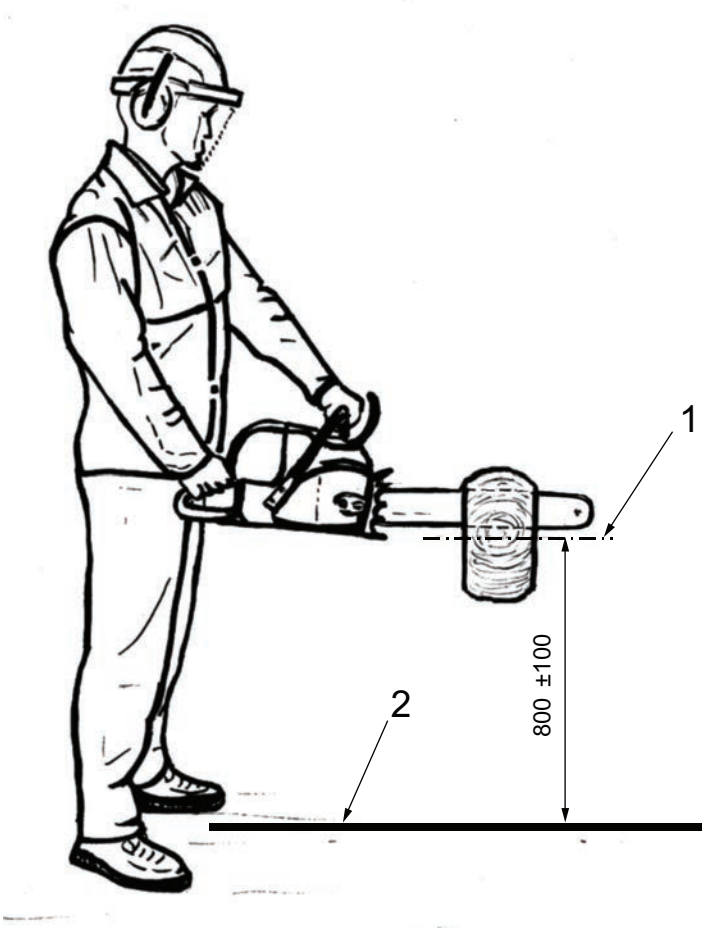
Engine displacement C	Usable cutting length of guide bar L	Width of timber b
cm^3	m	
< 45	0,25 to 0,4	(75 ± 5) % of L
$45 \leq C < 70$	0,30 to 0,5	(75 ± 5) % of L
$70 \leq C < 90$	0,40 to 0,55	(75 ± 5) % of L
≥ 90	$> 0,50$	$L - (0,1 \pm 10)$ % of L

A.2.3 Operating conditions

The machine shall be operated upright and with the guide bar nose protruding outside the test timber, in accordance with Figure A.3.

The log shall be horizontally and rigidly mounted on a stiff support so that its centreline is (800 ± 100) mm above ground level.

Dimensions in millimetres



Key

1 centreline of log

2 ground plane

Figure A.3 — Chain-saw position

A.3 Test procedure

A.3.1 General

The tests shall be carried out in the following operating modes:

a) for machines with an engine displacement of < 80 cm^3 idling, full load and racing;

b) for machines with an engine displacement of ≥ 80 cm^3 idling and full load.

During operation, the chain saw shall be held with the guide bar centreline horizontal and the guide bar plane vertical.

A.3.2 Idling

The idling speed shall be adjusted according to the machine manufacturer's instructions. Perform the measurements with the throttle trigger fully released. The saw chain shall not move during the test.

A.3.3 Full load

Perform the measurements during crosscutting and with the throttle fully open. The engine speed shall be kept at maximum engine power, determined in accordance with ISO 7293, by controlling the applied feed force on the handles.

The vibration measurements shall be taken in the middle third through the log with the complete bar tip free outside the log. The rotational frequency of the engine shall be controlled by the cutting force. There shall be no contact between the test timber and the engine/motor part of the machine or the spiked bumper, if provided. Only the bar and the saw chain shall come into contact with the test timber.

A.3.4 Racing

Perform the measurements at an engine speed of 133 % of the speed at maximum engine power, determined in accordance with ISO 7293.

If the engine has a speed limiter set below that speed, measure at the maximum speed achievable. If the engine does not run at a stable speed, carry out the test at the maximum possible stable speed; this speed shall not, however, be more than 8 r/s below the maximum speed as determined by the speed limiter. The engine speed shall be controlled with the throttle trigger.

A.4 Calculation of equivalent vibration total values

A.4.1 General

The equivalent vibration total values are determined by means of work cycles. These are composed of components of equal time duration where the components for chain-saws with an engine displacement of < 80 cm^3 are the idling, full load and racing modes and, for chain-saws with an engine displacement ≥ 80 cm^3, the idling and full load modes.

A.4.2 Chain-saws with engine displacement < 80 cm^3

The equivalent vibration total value, $a_{hv,eq}$, shall be determined from

$$a_{hv,eq} = \left[\frac{1}{3} \left(\bar{a}^2_{hv,Id} + \bar{a}^2_{hv,Fl} + \bar{a}^2_{hv,Ra} \right) \right]^{1/2}$$

A.4.3 Chain-saws with an engine displacement ≥ 80 cm^3

The equivalent vibration total value, $a_{hv,eq}$, shall be determined from

$$a_{hv,eq} = \left[\frac{1}{2} \left(\bar{a}^2_{hv,Id} + \bar{a}^2_{hv,Fl} \right) \right]^{1/2}$$

Annex B
(normative)

Brush-cutters and grass-trimmers

B.1 Measurement direction and location

Each accelerometer shall be located on the same side of a handle as the thumb of the hand grasping that handle; the orientation of the accelerometer shall be the same as that of the thumb.

— For machines with bicycle-type handles, the accelerometers shall be located 50 mm ± 3 mm outside the centre of the gripping areas, in accordance with Figure B.1.

— For machines with a rear handle and loop-type front handle, the accelerometer on the rear handle shall be located 20 mm ± 3 mm in front of the rear of the throttle trigger. If this distance cannot be obtained, the accelerometer shall be placed at the front of that portion of the handle intended to be grasped. The accelerometer for the front hand shall be located 50 mm ± 3 mm to the right of the centre of the gripping area. See Figure B.2.

— For machines with a rear handle and the front handle on the tube, the accelerometer on the rear handle shall be located 20 mm ± 3 mm in front of the rear of the throttle trigger. If this distance cannot be obtained, the accelerometer shall be placed at the front of that portion of the handle intended to be grasped, in accordance with Figure B.2. The accelerometer for the front hand shall be located 50 mm ± 3 mm in front of the centre of the gripping area or, if there is no designated gripping area, 250 mm ± 5 mm in front of the centre of the rear-handle accelerometer.

B.2 Adjustment of machine

The machine shall be equipped with all cutting attachments specified by the machine manufacturer.

For grass-trimmers with flexible lines, the length of the line shall be adjusted to the maximum length, with the guard in place.

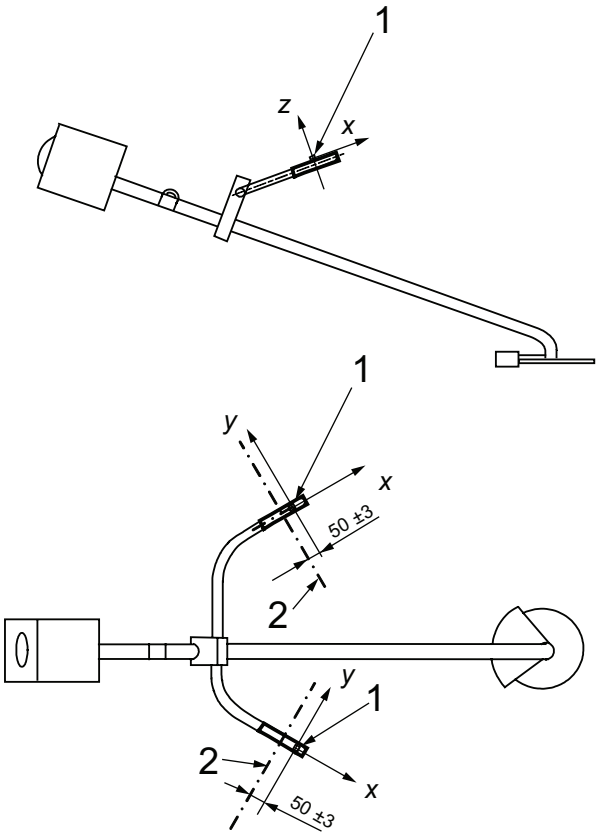
The machine shall be operated upright, as shown in Figure B.3. The machine shall be connected to the harness, if any, and held with both hands in a manner consistent with day-long use of the machine.

Machines with a harness shall have the suspension point adjusted so that it is vertically 775 mm ± 25 mm above the ground, and with the nearest point of the cutting attachment, H, vertically above the ground in accordance with Figure B.3.

Machines without a harness shall be held so that the rear end of the throttle trigger is vertically 775 mm ± 25 mm above the ground and with the nearest point of the cutting attachment, H, vertically above the ground in accordance with Figure B.3.

The specified distances shall be met with the tanks half-filled and with all recommended cutting attachments.

Dimensions in millimetres



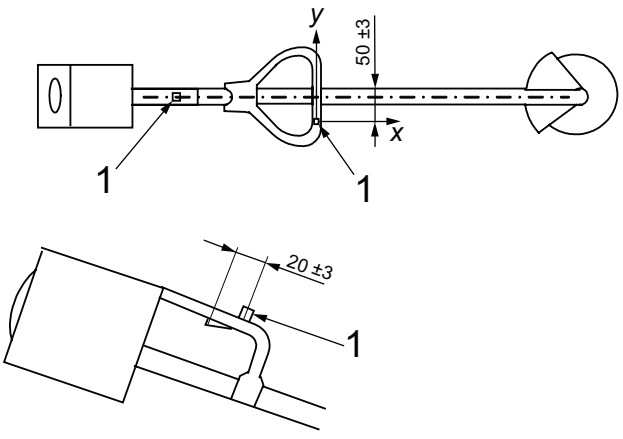
Key

1 accelerometer

2 centre of gripping area

Figure B.1 — Measurement direction and positioning of accelerometers on machine with right and left handles (bicycle-type handles)

Dimensions in millimetres

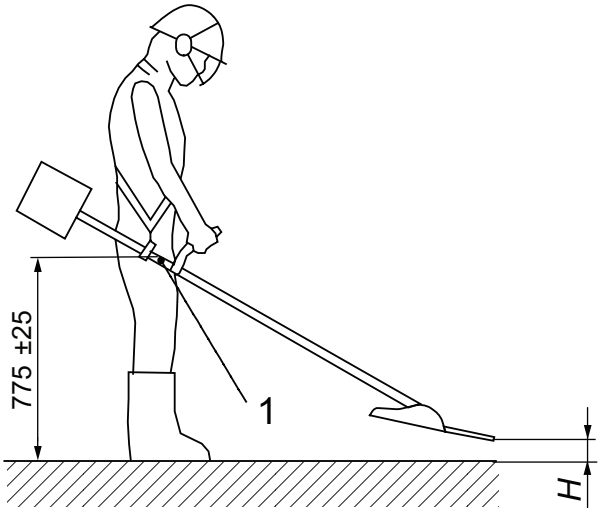


Key

1 accelerometer

Figure B.2 — Measurement direction and positioning of accelerometers on machine with rear and front handles (loop-type handle)

Dimensions in millimetres



H shall equal 300 mm ± 25 mm for brush-cutters and 50 mm ± 25 mm for grass-trimmers.

Key

1 suspension point

Figure B.3 — Operating position

B.3 Test procedure

B.3.1 General

The tests shall be carried out in the idling and racing operating modes, as follows.

B.3.2 Idling

The idling speed shall be adjusted in accordance with the machine manufacturer's instructions. Perform the measurements with the throttle trigger fully released. The cutting attachment shall not move during the test.

B.3.3 Racing

For brush-cutters, perform the measurements at an engine speed of 133 % of the speed at maximum engine power, as determined in accordance with ISO 8893.

For grass-trimmers, perform the measurements with the flexible line adjusted to the full usable length (see B.2) and with full open throttle. If the maximum speed exceeds 133 % of the speed at maximum engine power, the speed shall be controlled so that it is maintained at 133 %.

If the engine has a speed limiter set to below that speed, measure at the maximum speed achievable. If the engine does not run at a stable speed, carry out the test at the maximum possible stable speed; this speed shall not, however, be more than 8 r/s below the maximum speed as determined by the speed limiter. The engine speed shall be controlled with the throttle trigger.

B.3.4 Calculation of equivalent vibration total values

The equivalent vibration total values, $a_{hv,eq}$, are based on a work cycle composed of idling and racing with equal duration for each.

The equivalent vibration value, $a_{hv,eq}$, shall be determined from

$$a_{hv,eq} = \left[\frac{1}{2} \left(\bar{a}^2_{hv,Id} + \bar{a}^2_{hv,Ra} \right) \right]^{1/2}$$

Annex C
(normative)

Pole-mounted powered pruners

C.1 Measurement direction and location

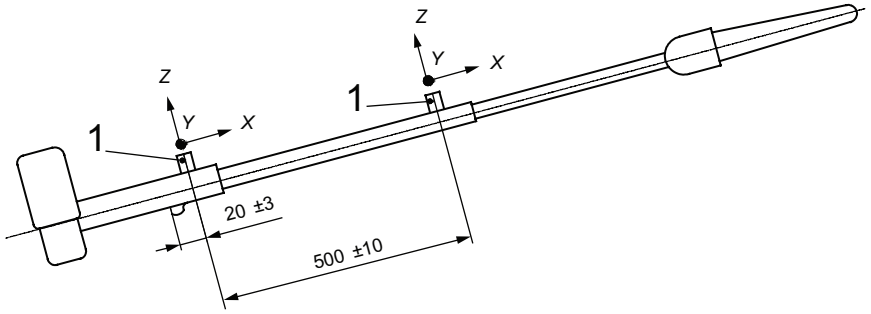
The orientation and locations of the accelerometers shall be in accordance with Figure C.1.

The accelerometer on the rear handle shall be located 20 mm ± 3 mm in front of the rear of the throttle trigger. If this distance cannot be obtained, the accelerometer shall be placed at the front of that portion of the handle intended to be grasped.

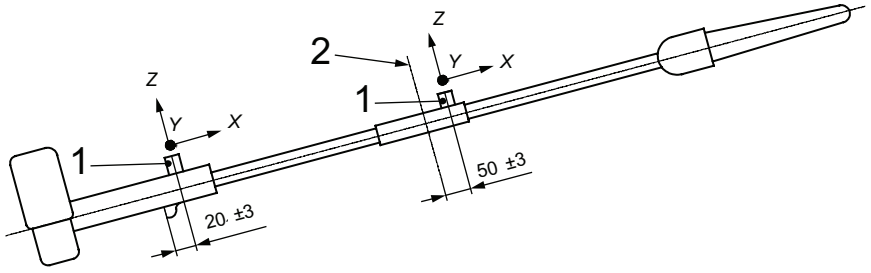
For machines with a specific grip for the supporting (upper) hand, the accelerometer position shall be 50 mm ± 3 mm forward from the centre of the gripping area. See Figure C.1 b).

For units with no specific grip for the supporting (upper) hand, the accelerometer position for this hand shall be 500 mm ± 10 mm from the centre of the rear handle accelerometer. See Figure C.1 a).

Dimensions in millimetres



a)



b)

Key

1 accelerometer

2 centre of gripping area

Figure C.1 — Measurement direction and positioning of accelerometers on pole-mounted powered pruner

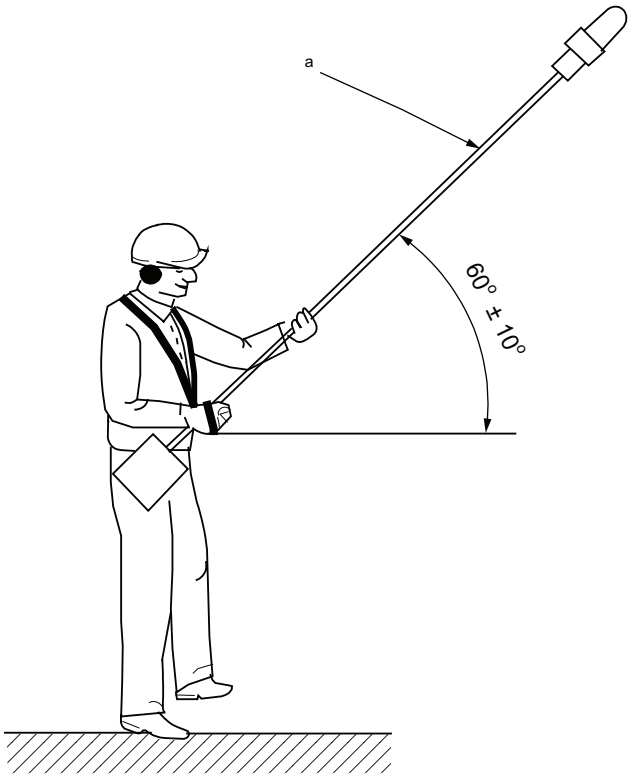
C.2 Adjustment of machine

The machine shall be equipped with each type of standard cutting attachment specified by the machine manufacturer.

The cutting device shall be lubricated, as applicable, and adjusted for best cutting performance in accordance with the manufacturer's instructions.

The machine shall be operated at an angle of 60° ± 10°, as shown in Figure C.2. The machine shall be connected to the harness, if any, and held with both hands in a manner consistent with day-long use of the machine. A harness shall carry no load from the machine during measurements.

Units with adjustable or different shaft lengths shall be measured at their maximum and minimum shaft lengths.



a Pole length adjusted to its shortest or longest position, if applicable.

Figure C.2 — Operating position

C.3 Test procedure

C.3.1 General

The tests shall be carried out in the idling and racing operating modes, as follows.

C.3.2 Idling

The idling speed shall be adjusted in accordance with the machine manufacturer's instructions. Perform the measurements with the throttle trigger fully released. The cutting attachment shall not move during the test.

C.3.3 Racing

Perform the measurements at an engine speed of 133 % of the speed at maximum engine power, as determined in accordance with ISO 8893.

If the engine has a speed limiter set to below that speed, measure at the maximum speed achievable. If the engine does not run at a stable speed, carry out the test at the maximum possible stable speed; this speed shall not, however, be more than 8 r/s below the maximum speed, as determined by the speed limiter. The engine speed shall be controlled with the throttle trigger.

C.3.4 Calculation of equivalent vibration total values

The equivalent vibration total values, $a_{hv,eq}$, are based on a work cycle composed of idling and racing with equal duration for each.

The equivalent vibration value, $a_{hv,eq}$, shall be determined from

$$a_{hv,eq} = \left[\frac{1}{2} \left(\bar{a}^2_{hv,Id} + \bar{a}^2_{hv,Ra} \right) \right]^{1/2}$$

Annex D
(normative)

Hedge trimmers

D.1 Measurement direction and location

Each accelerometer shall be located on the same side of a handle as the thumb of the hand grasping that handle; the orientation of the accelerometer shall be the same as that of the thumb.

— For machines with a rear handle and a loop-type front handle, the accelerometer on the rear handle shall be located 20 mm ± 3 mm in front of the rear of the throttle trigger. If this distance cannot be obtained, the accelerometer shall be placed at the front of that portion of the handle intended to be grasped. The accelerometer for the front hand shall be located 50 mm ± 3 mm to the right of the centre of the gripping area. See Figure D.1.

— For machines with lateral rear and front handles, the accelerometer on the rear handle shall be located 20 mm ± 3 mm in front of the rear of the throttle trigger. If this distance cannot be obtained, the accelerometer shall be placed at the front of that portion of the handle intended to be grasped, in accordance with Figure D.2. The accelerometer for the front handle shall be located 50 mm ± 3 mm forward from the centre of the gripping area, as shown in Figure D.2.

— For machines with a rear handle and the front handle on the tube, the accelerometer on the rear handle shall be located 20 mm ± 3 mm in front of the rear of the throttle trigger. If this distance cannot be obtained, the accelerometer shall be placed at the front of that portion of the handle intended to be grasped, in accordance with Figure D.3. The accelerometer for the front hand shall be located 50 mm ± 3 mm forward from the centre of the gripping area, as shown in Figure D.3 b). If there is no designated gripping area, the accelerometer for the front hand shall be located 500 mm ± 10 mm in front of the centre of the rear-handle accelerometer, as shown in Figure D.3 a).

D.2 Adjustment of machine

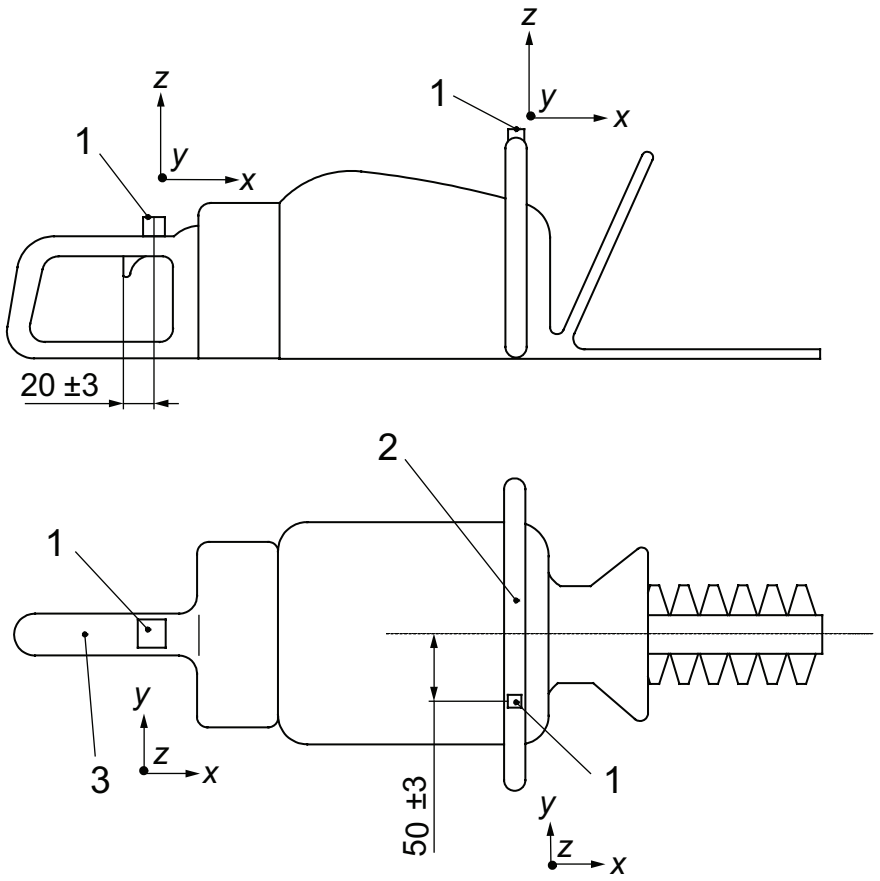
The machine shall be equipped with the cutting attachment specified by the machine manufacturer that gives the highest vibration value.

The cutting device shall be lubricated and adjusted for best cutting performance in accordance with the manufacturer's instructions.

Units with adjustable or different shaft lengths shall be measured at their maximum and minimum shaft lengths.

The machine shall be operated with the operator standing upright, with the machine held with both hands in a manner consistent with day-long use of the machine. Long-reach hedge-trimmers shall be held at an angle of 45° ± 10° and with the cutting attachment as far as possible in line with the shaft tube, as shown in Figure D.4. Other machines shall be held with the cutting attachment horizontal.

Dimensions in millimetres

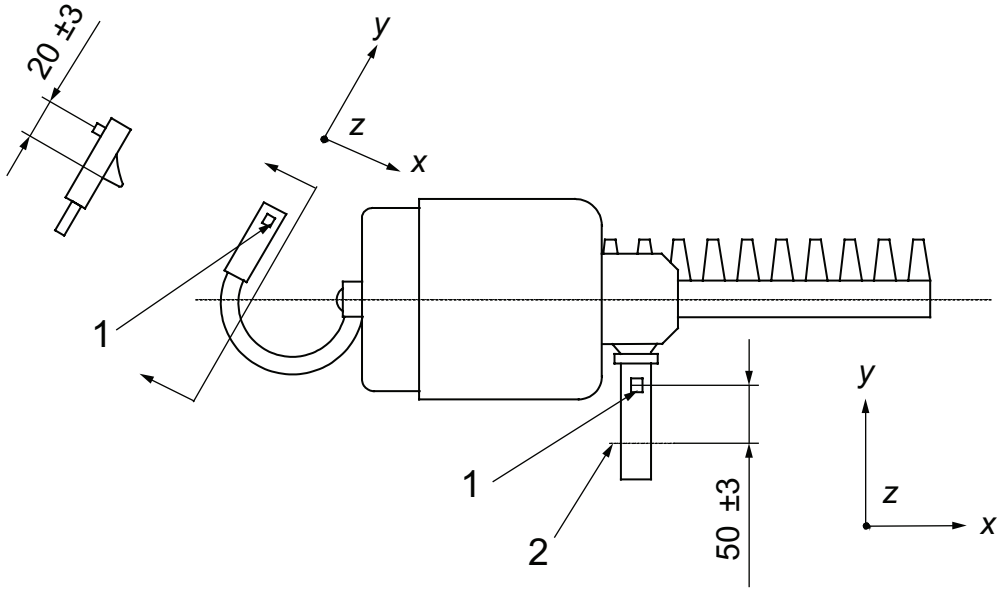


Key

1 accelerometer
2 front handle
3 rear handle

Figure D.1 — Measurement direction and positioning of accelerometers on machine with longitudinal rear handle and loop-type front handle

Dimensions in millimetres



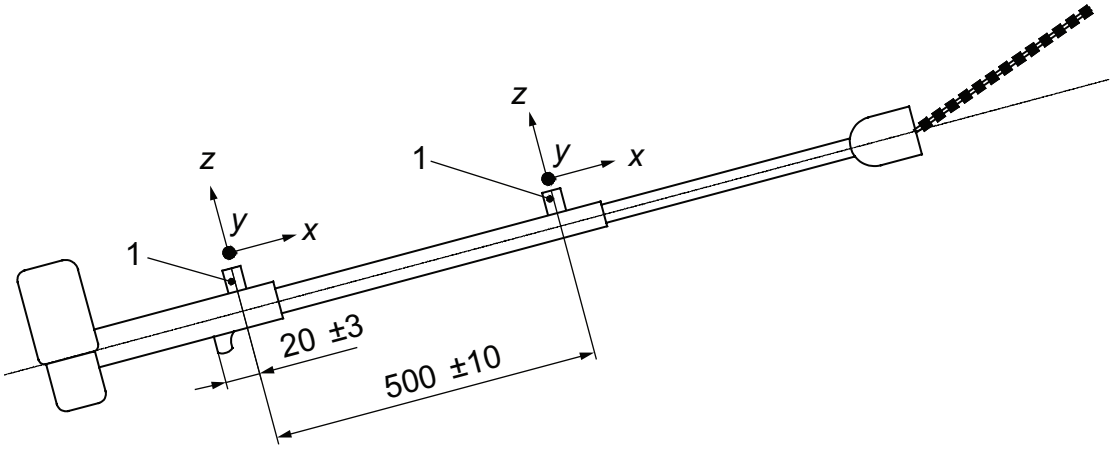
Key

1 accelerometer

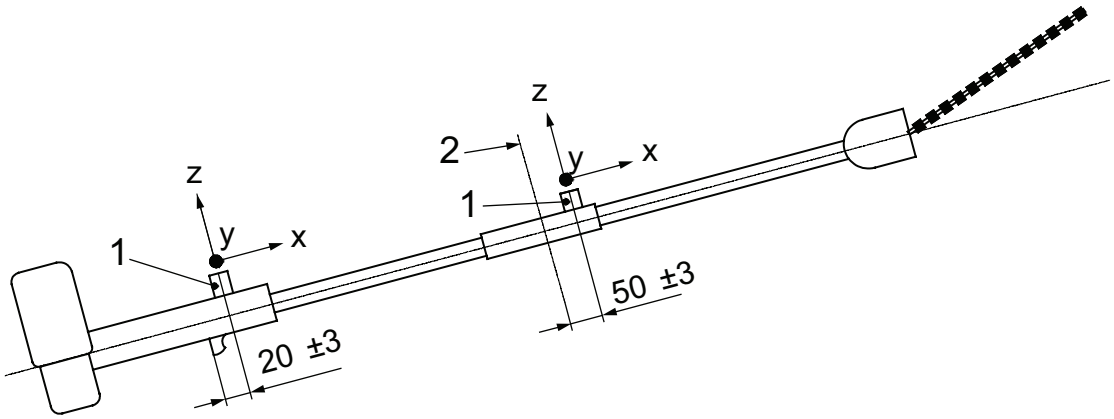
2 centre of gripping area

Figure D.2 — Measurement direction and positioning of accelerometers on machine with lateral rear and front handles

Dimensions in millimetres



a)



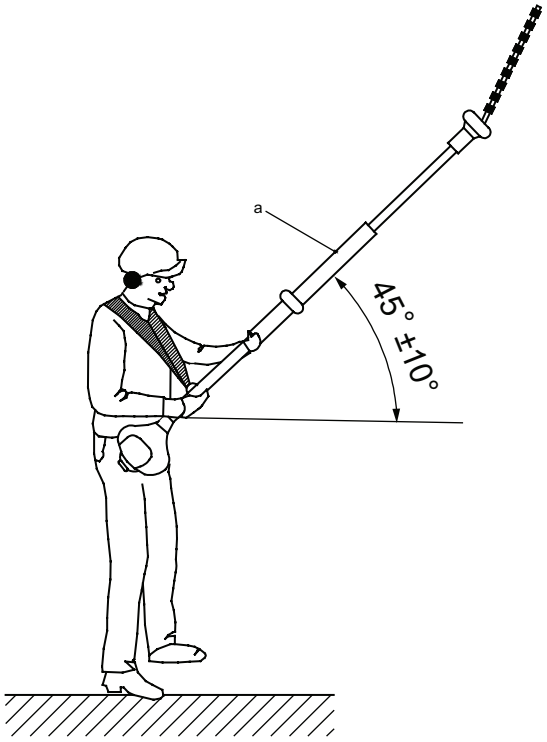
b)

Key

1 accelerometer

2 centre of gripping area

Figure D.3 — Measurement direction and positioning of accelerometer on long-reach hedge trimmer



[a] Pole length adjusted to its shortest or longest position, if applicable.

Figure D.4 — Operator position with long-reach hedge trimmer

D.3 Test procedure

D.3.1 General

The tests shall be carried out in the idling and racing operating modes, as follows.

D.3.2 Idling

The idling speed shall be adjusted in accordance with the machine manufacturer's instructions. Perform the measurements with the throttle trigger fully released. The cutting attachment shall not move during the test.

D.3.3 Racing

Perform the measurements at an engine speed of 133 % of the speed at maximum engine power, as determined in accordance with ISO 8893.

If the engine has a speed limiter set to below that speed, measure at the maximum speed achievable. If the engine does not run at a stable speed, carry out the test at the maximum possible stable speed; this speed shall not, however, be more than 8 r/s below the maximum speed, as determined by the speed limiter. The engine speed shall be controlled with the throttle trigger.

D.3.4 Calculation of equivalent vibration total values

The equivalent vibration total values, $a_{\mathrm{hv,eq}}$, are based on a work cycle composed of idling and racing with a duration of 1/5 for idling and 4/5 for racing.

The equivalent vibration value, $a_{\mathrm{hv,eq}}$, shall be determined from

$$a_{\mathrm{hv,eq}} = \left(\frac{1}{5} \bar{a}^2_{\mathrm{hv,Id}} + \frac{4}{5} \bar{a}^2_{\mathrm{hv,Ra}} \right)^{1/2}$$

Annex E
(normative)

Garden blowers/vacuums

E.1 Measurement direction and location

Measurements shall be carried out on a machine with standard equipment.

Each accelerometer shall be located on the same side of a handle as the thumb of the hand grasping that handle; the orientation of the accelerometer shall be the same as that of the thumb.

— For machine handles with a throttle trigger, the accelerometer shall be located 20 mm ± 3 mm in front of the rear of the throttle trigger. If this distance cannot be obtained, the accelerometer shall be placed at the front of that portion of the handle intended to be grasped. See Figures E.1 to E.3.

— For machine handles without throttle control, the accelerometer shall be located 50 mm ± 3 mm to the side of the centre of the gripping area. See Figure E.3.

E.2 Adjustment of machine

Machines with a harness shall be operated while connected to the harness.

Machines designed with two handles shall be held using both hands, with the right hand holding the rear handle.

Machines designed with one handle shall be held using the right hand in a manner consistent with day-long use of the machine.

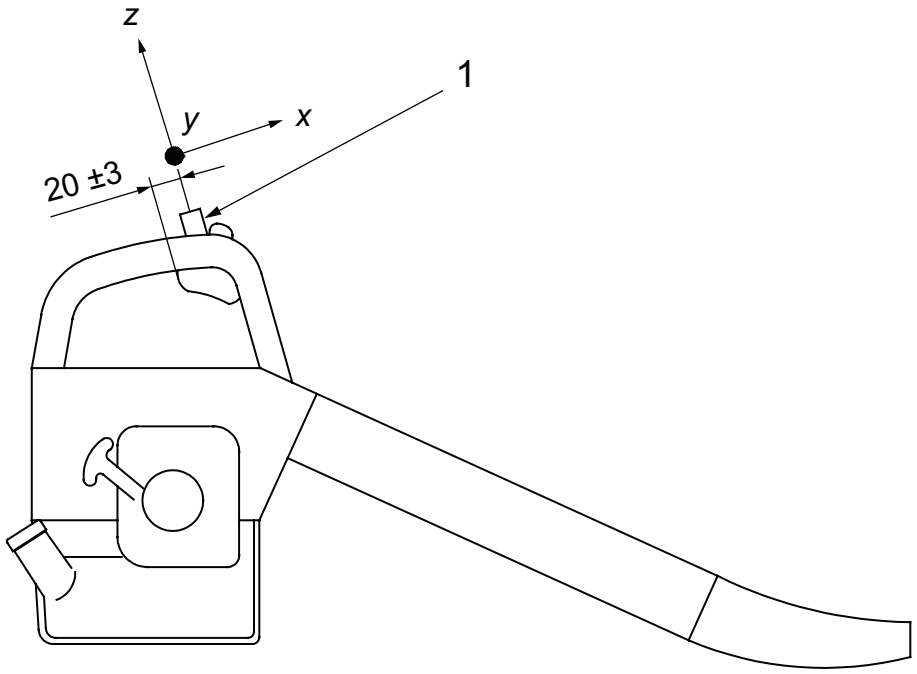
Machines connected to a harness shall be oriented so that the distance from the suspension point to the ground is 775 mm ± 25 mm.

Machines without a suspension point shall be oriented so that the distance between the lower side of the handle (the rear handle for machines with two handles) at the middle of the grip area and the ground is 775 mm ± 25 mm.

Backpack-mounted machines shall be oriented so that the distance from the lower edge of the back padding to the ground is 1 030 mm ± 25 mm.

All machines shall have the lowest point of the air nozzle 50 mm ± 25 mm above the ground.

Dimensions in millimetres

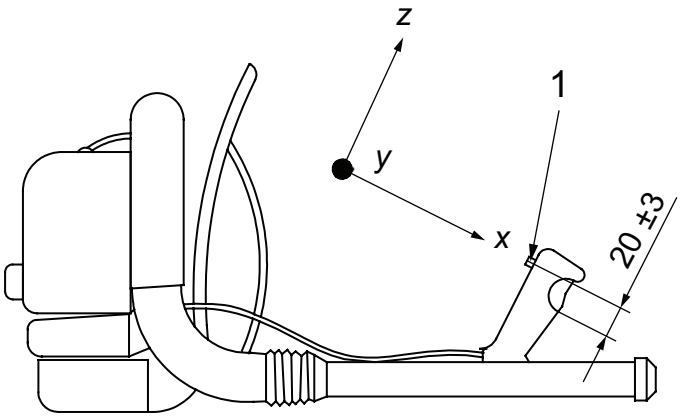


Key

1 accelerometer

Figure E.1 — Measurement direction and positioning of accelerometer on handheld blower with single handle

Dimensions in millimetres

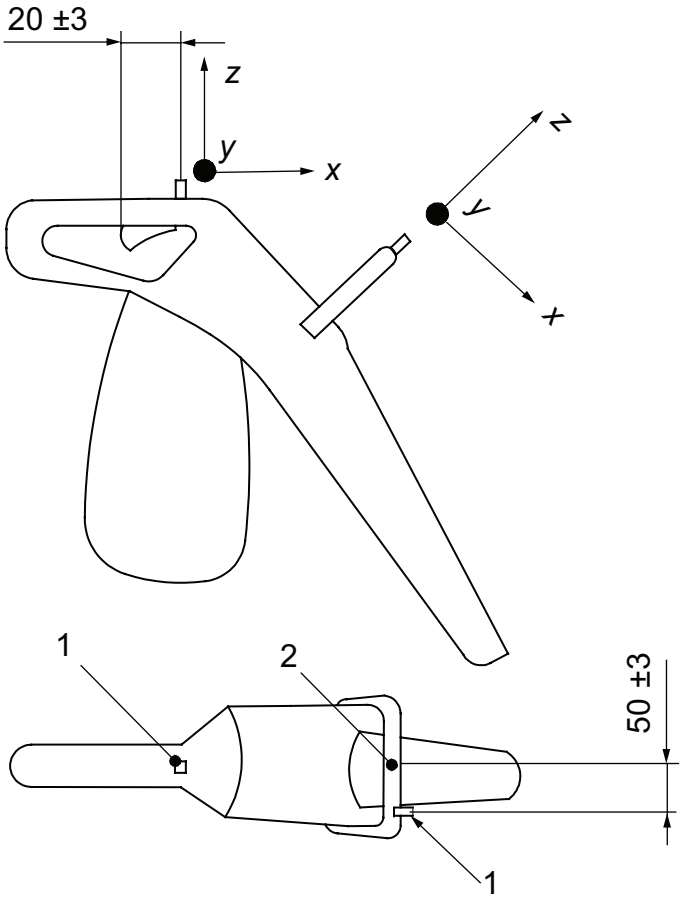


Key

1 accelerometer

Figure E.2 — Measurement direction and positioning of accelerometer on backpack blower/vacuum

Dimensions in millimetres



Key

1 accelerometer

2 centre of gripping area

Figure E.3 — Measurement direction and positioning of accelerometers on handheld blower/vacuum with dual handles

E.3 Test procedure

E.3.1 General

The tests shall be carried out in the idling and full-load operating modes, as follows.

E.3.2 Idling

The idling speed shall be adjusted in accordance with the machine manufacturer's instructions. Perform the measurements with the throttle trigger fully released.

E.3.3 Full load

Perform the measurements at the maximum engine speed achieved with the throttle fully open.

The engine speed shall be controlled with the throttle trigger.

E.3.4 Calculation of equivalent vibration total values

The equivalent vibration total values, $a_{hv,eq}$, are based on a work cycle composed of idling and full load with a duration of 1/7 for idling and 6/7 for full load.

The equivalent vibration value, $a_{hv,eq}$, shall be determined from

$$a_{hv,eq} = \left(\frac{1}{7} \overline{a}^2_{hv,Id} + \frac{6}{7} \overline{a}^2_{hv,Fl} \right)^{1/2}$$

Annex F
(informative)

Summary of results from "round robin" tests, 2007-2008, on a chain-saw, brush saw and grass trimmer

This annex summarizes (see Tables F.1 to F.3) test results in the form of average values, $\bar{x}$, and calculated standard deviation, σ_R, from these values. The tests were carried out during 2007 and 2008 at seven different laboratories. The aim was to evaluate the accuracy and repeatability of the measurement and reporting procedure given in the previous edition of this International Standard.

Table F.1 — Average values, $\bar{x}$, and calculated standard deviation, σ_R, from vibration measured on a chain-saw (m/s^2)

Vibration	Front handle		Rear handle	
a_{hv}	$\bar{x}$	σ_R	$\bar{x}$	σ_R
Idling	5,2	0,9	4,6	1,2
Full Load	4,0	1,1	5,2	1,8
Racing	4,5	1,5	5,8	1,3
Equivalent	4,6	1,0	5,3	1,3

Table F.2 — Average values, $\bar{x}$, and calculated standard deviation, σ_R, from vibration measured on a brush saw (m/s^2)

Vibration	Right handle		Left handle	
a_{hv}	$\bar{x}$	σ_R	$\bar{x}$	σ_R
Idling	3,4	0,8	2,9	0,6
Racing	4,1	1,0	2,6	0,2
Equivalent	3,8	0,8	2,8	0,4

Table F.3 — Average values, $\bar{x}$, and calculated standard deviation, σ_R, from vibration measured on a grass trimmer (m/s^2)

Vibration	Front handle		Rear handle	
a_{hv}	$\bar{x}$	σ_R	$\bar{x}$	σ_R
Idling	6,5	1,3	5,1	0,5
Racing	6,4	1,8	9,7	0,5
Equivalent	6,5	1,2	7,7	0,4

Bibliography

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

[2] ISO 12100, *Safety of machinery — General principles for design — Risk assessment and risk reduction*

[3] EN 12096, *Mechanical vibration — Declaration and verification of vibration emission values*

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