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Mechanical vibration and shock — Mechanical mounting of accelerometers

Vibrations et chocs mécaniques — Fixation mécanique des accéléromètres

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Foreword

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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 of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 108, *Mechanical vibration, shock and condition monitoring.*

This third edition cancels and replaces the second edition (ISO 5348:1998), which has been technically revised.

The main changes compared to the previous edition are as follows:

— the theory of mass and stiffness influence on the frequency response obtained has been expanded;

— the frequency responses have been replaced by actual measurements and have been made more comparable;

— the influence of electrical loops has been added.

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

The method most commonly used for determining the vibratory motion of a structure or body is the use of an electromechanical vibration transducer, also called a transducer or a vibration sensor. These vibration transducers can be divided into the two broad classes: non-contacting and contacting transducers.

Non-contacting transducers are relative measuring transducers recording a motion in relation to a fixed space coordinate system. Typical examples are eddy-current probes, optical sensors and laser vibrometers. These transducers have no direct mechanical contact with the structure and are therefore not dealt with in this document.

Contacting transducers are mounted onto the structure by mechanical coupling. This includes, for example, piezoelectric, capacitive and piezoresistive accelerometers as well as seismic velocity transducers. These absolute measuring transducers record the motion by seismic forces from the space coordinate system onto which they are mounted. If such a transducer is mounted onto a structure, the properties of the mounting can significantly influence the frequency response of the structure as well as the vibration transducer. Very large measurement deviations can occur in case of lack of care in the mounting property, particularly at high frequencies.

Under certain circumstances the mass, geometry and mounting stiffness of the transducer can directly influence the measured vibration amplitude of the structure. This effect occurs for example if the masses of the transducer and the structure are in the same order of magnitude.

This document is concerned with the contacting type of seismic accelerometers and seismic velocity transducers which are currently in wide use. The concern with using such transducers is that the mechanical coupling between the accelerometer and the test structure can significantly alter the response of the accelerometer, the structure or both. This document attempts to isolate parameters of concern in the selection of a method to mount the accelerometer onto the structure.

In a basic sense, many aspects of velocity transducer mounting are similar to those of accelerometers, but they are not identical. Please refer to 6.2.1.

This document does not cover geophones.

Mechanical vibration and shock — Mechanical mounting of accelerometers

1 Scope

This document specifies the important technical properties of the different methods for mounting vibration transducers and describes recommended practices. It also shows examples of how accelerometer mounting can influence frequency response and gives examples of how other influences can affect the fidelity of the representation of actual motion in the structure being observed.

This document applies to the contacting type of accelerometer which is currently in wide use. It is applicable to both uniaxial and multi-axial transducers. This document can also be applied to velocity transducers.

This document enables the user to estimate the limitations of a mounting and consequent potential measurement deviations.

Transducer mounting issues are not the only problem that can affect the validity of acceleration measurement. Other such problems include, amongst others: transverse movements, alignment of the transducer, base bending, cable movement, temperature changes, electric and magnetic fields, cable whip and mounting torque. Issues other than mounting and their possible effects are outside the scope of this document.

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 2041, *Mechanical vibration, shock and condition monitoring — Vocabulary*

ISO 8042, *Shock and vibration measurements — Characteristics to be specified for seismic pick-ups*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 2041 apply.

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

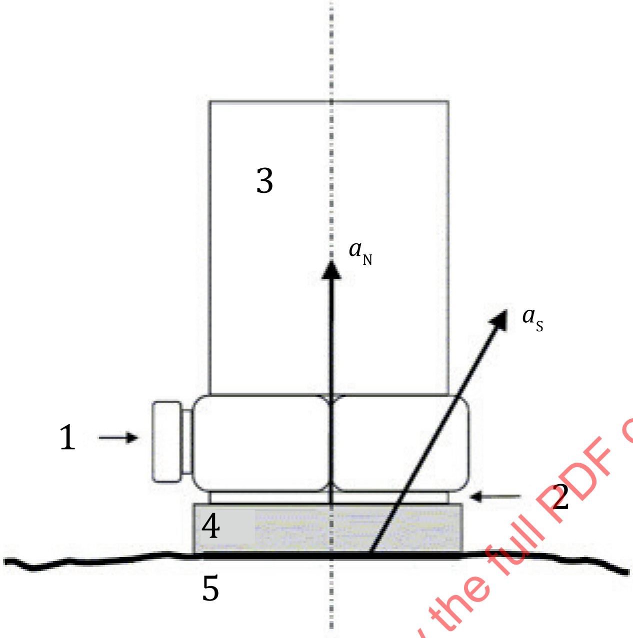
— ISO Online browsing platform: available at https://www.iso.org/obp

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

4 Basics

A vibration transducer is mounted on the surface of a structure in motion, as illustrated in the simplified diagram shown in Figure 1. Under ideal conditions, the vibration transducer supplies an electric signal at its output which is proportional to the magnitude of the mechanical acceleration input vector, a_N. The vector a_N is normally directed to the transducer base and measures the projection of the structure vibration acceleration vector, a_S, in the direction of the transducer nominal sensitive vectorial axis, a_N (measurement direction).

The vibration in the direction of the acceleration vector, a_S, on the structure is transferred into the measurement direction of the transducer via the mechanical mounting fixture. Frequency-dependent changes of the nominal vibration amplitude, a_N, of the transducer can occur due to the dynamic properties of the mounting fixture with its mechanical stiffness, damping and the transducer mass. The mechanical mounting therefore changes the usable frequency range of the transducer with regards to amplitude and phase for a given accuracy (see 6.2.1). This document is only applicable to the mounting of accelerometers which are mounted on the surface of the structure in motion, as shown in the simplified diagram in Figure 1.



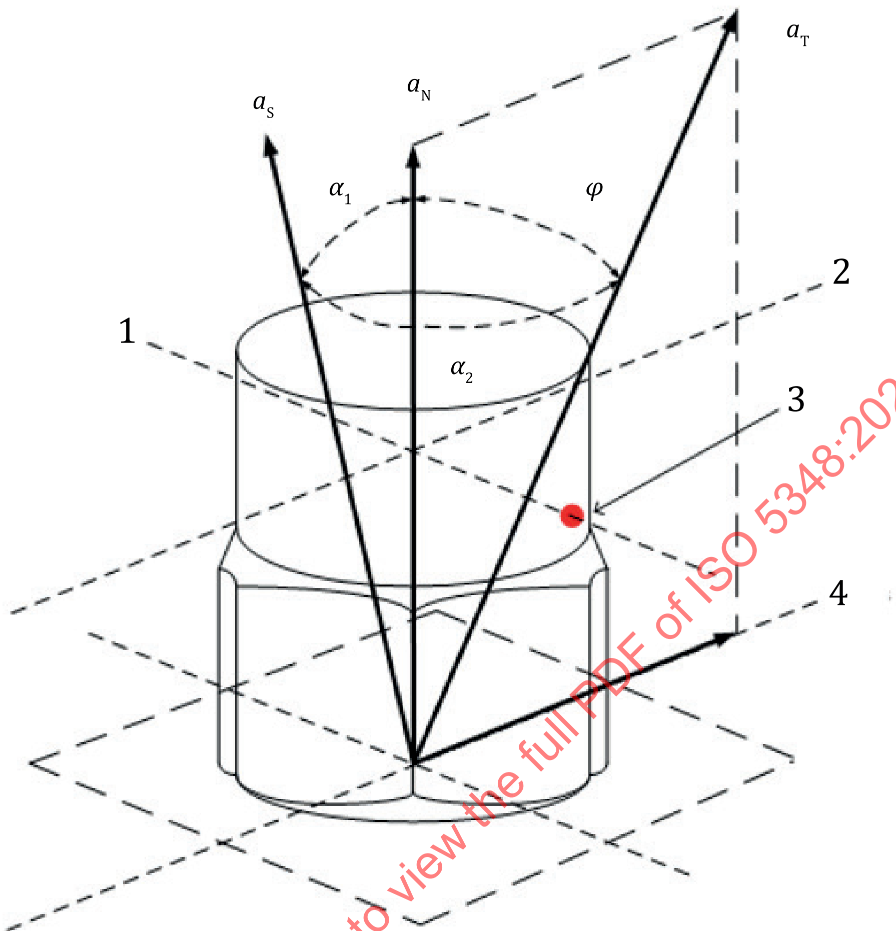
Key

a_N nominal vibration acceleration vector
a_S structure vibration acceleration vector
1 electrical connector
2 transducer base
3 transducer
4 mounting fixture
5 structure

Figure 1 — Mounting of an accelerometer

Often, the transducer vibration acceleration vector with the largest sensitivity is not parallel to the accelerometer nominal axis, as a_N is perpendicular to its coupling mounting area, as shown in Figure 1. This forms a cross axis sensitivity of the transducer; see ISO 16063-31. Cross axis sensitivity is maximal in one direction and ideally zero in a direction perpendicular to this in the mounting area. In some transducers on the market, a red dot marks the minimal cross axis sensitive direction. Mounting the transducer in this direction minimizes the cross axis sensitive effects of the transducer during a measurement, if large lateral acceleration magnitudes occur by proper alignment of the transducer.

Figure 2 illustrates the complex vectorial relationship between the structure vibration vector, a_S, the accelerometer nominal axis vector, a_N, the transducer vibration acceleration vector with largest sensitivity, a_T, and the angles φ, α_1 and α_2 in between them. The elimination of these alignment deviations usually requires a coordinate transformation. In this consideration, the projection of the structure vibration acceleration vector, $a_S = (a^S{}_X, a^S{}_Y, a^S{}_Z)$, to the transducer vibration acceleration vector with largest sensitivity, $a_T = (a^T{}_X, a^T{}_Y, a^T{}_Z)$, forms the output signal, u, of the transducer. But it is the magnitude in the direction of the accelerometer nominal axis vector, $a_N = (a^N{}_X, a^N{}_Y, a^N{}_Z)$, which is of interest.



Key

a_N	accelerometer nominal axis perpendicular to its coupling mounting area ($a^N{}_X$, $a^N{}_Y$, $a^N{}_Z$)
a_S	structure vibration acceleration vector ($a^S{}_X$, $a^S{}_Y$, $a^S{}_Z$)
a_T	transducer vibration acceleration vector with largest sensitivity ($a^T{}_X$, $a^T{}_Y$, $a^T{}_Z$)
φ	angle between a_N and a_T
α_1	angle between a_N and a_S
α_2	angle between a_S and a_T
1	axis of minimum cross sensitivity
2	axis of maximum cross sensitivity
3	red dot, assigning minimal cross axis sensitivity axis
4	cross sensitivity vector

NOTE For exact measurement of the structure vibration, the vectors a_S and a_N are ideally identical in amount and direction; see 6.1.1.

Figure 2 — Acceleration vector considerations for mounting the accelerometer

5 Characteristics to be specified by manufacturers of accelerometers

The technical characteristics of vibration transducers shall be specified in accordance with ISO 8042 in the data sheet or manual. From a multitude of information items, only a few are relevant for the mounting of transducers:

a) frequency response under well-defined mounting conditions, range of operation and best possible mounting;

b) mounting surface of the transducer: dimensions of the mounting surface, mounting options, thread dimensions, thread depths, sectional view of the mounting surface, material of the mounting surface, surface finish roughness, surface flatness, hole perpendicularity and tap class;

c) applicable recommended mounting torque and, as an option, the maximum permitted mounting torque;

d) geometric dimensions of the vibration transducer, including:

— position of the centre of gravity of the vibration transducer as a whole,

— position of the centre of gravity of the seismic mass of the vibration transducer;

e) pertinent mechanical characterisitics of the accelerometer, i.e.:

— total mass of the vibration transducer,

— material of the base,

— maximal transverse sensitivity and frequency at which it was determined;

f) first resonance frequency of the vibration transducer under mounting conditions;

g) temperature limitations of the transducer and the fastening device.

6 Considerations for selecting a mounting method

6.1 General considerations

6.1.1 Procedures

An accelerometer achieves optimal performance only if the following general procedures are followed:

a) The accelerometer shall perform as closely as possible the same motion as the structure at the accelerometer attachment.

b) The motion of the structure is changed as little as possible by the addition of the accelerometer, for example, by mass loading and reinforcement in the mounting surface area.

6.1.2 Conditions

In order to achieve the aforementioned ideal conditions, it shall be ensured that:

a) the accelerometer and its mounting are as rigid and firm as possible and the mounting surfaces are as clean and flat as possible;

b) distortions due to natural vibrations of the mounting are only very small (e.g. symmetrical mountings shall be aimed at);

c) the mass of the accelerometer and mounting are small in comparison with that of the dynamic mass of the structure (see ISO 2954).

6.2 Specific considerations

6.2.1 Frequency range of operation

The accelerometer shall be used well below its mounted fundamental resonance frequency to prevent amplitude distortions. In the case of undamped accelerometers (resonance magnification factor, Q, greater 30 dB) and mounting in accordance with manufacturer's recommendations, the following limit frequencies can be used for estimation of the amplitude deviations:

— the amplitude deviations of the transducer are mostly lower than 5 % for up to approximately 20 % of the resonance frequency of the transducer;

— the amplitude deviations are mostly lower than 10 % for up to approximately 30 % of the resonance frequency;

— the amplitude deviations are mostly lower than 3 dB for up to approximately 50 % of the resonance frequency.

NOTE 1 Special measurement methods exist, for example, in the rolling bearing condition monitoring that operates in the resonance range of the accelerometer.

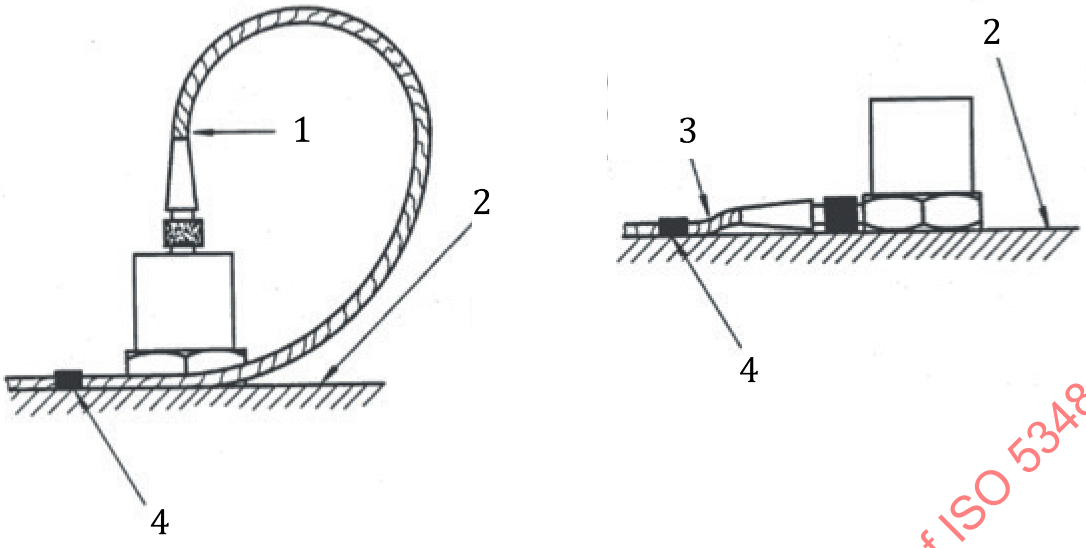
NOTE 2 For single-shock measurements, deviations of a few percent can be expected if the mounted fundamental resonance frequency is ten times greater than the inverse of the pulse duration.

NOTE 3 Electrodynamic vibration velocity transducers are mostly used above their resonance frequency.

6.2.2 Transducer cable

Relative movement of the cable to the transducer can lead to incorrect measurement signals, in particular in the case of stiff cables. Careful clamping and laying of the cables is required to avoid this problem (see Figure 3).

Loose, moving cables can introduce triboelectric effects for piezoelectric type transducers with charge output or impose dynamic response on the transducer not consistent with the motion of the tested surface.



a) Accelerometer with axial connector

b) Accelerometer with radial connector

Key

1 cable entry — do not stress
2 vibrating surface
3 cable entry — do not stress
4 fix cable to the surface

Figure 3 — Accelerometer with axial and radial connectors

6.3 Determination of the mounted fundamental resonance frequency

6.3.1 General

It is very useful, although difficult at times in practice, to accurately determine the mounted fundamental resonance frequency of the accelerometer mounted on a structure. The resonance frequency in the nominal measuring direction can vary widely from that in the lateral direction (which is usually lower). For multi-axial accelerometers, the resonance frequencies of the axes can vary considerably.

The following methods can be of use in determining the approximate resonance frequency, thus ensuring that an adequate margin exists between the resonance frequency and test frequency.

6.3.2 Vibration excitation method

A suitable electrodynamic vibration exciter with reference transducer can be used to assess the influence of the quality of mounting surfaces and materials. For this purpose, the materials under test are mounted between the armature of the vibration exciter and the transducer and its output signal as a function of the vibration frequency is measured.

For the method of determining the fundamental (resonance) frequency, see ISO 5347-22 and ISO 16063-32.

6.3.3 Shock excitation methods

For the method of determining the mounted fundamental resonance frequency by shock excitation, see ISO 16063-32. Beside ISO 16063-32, the following measurement technologies are also in use: the pendulum impact test, the drop test, a simple hammer blow and breakage of a pencil lead.

In the first case, the accelerometer is attached to a counterweight suspended from a pendulum while a similarly suspended weight acts as a hammer providing the blow.

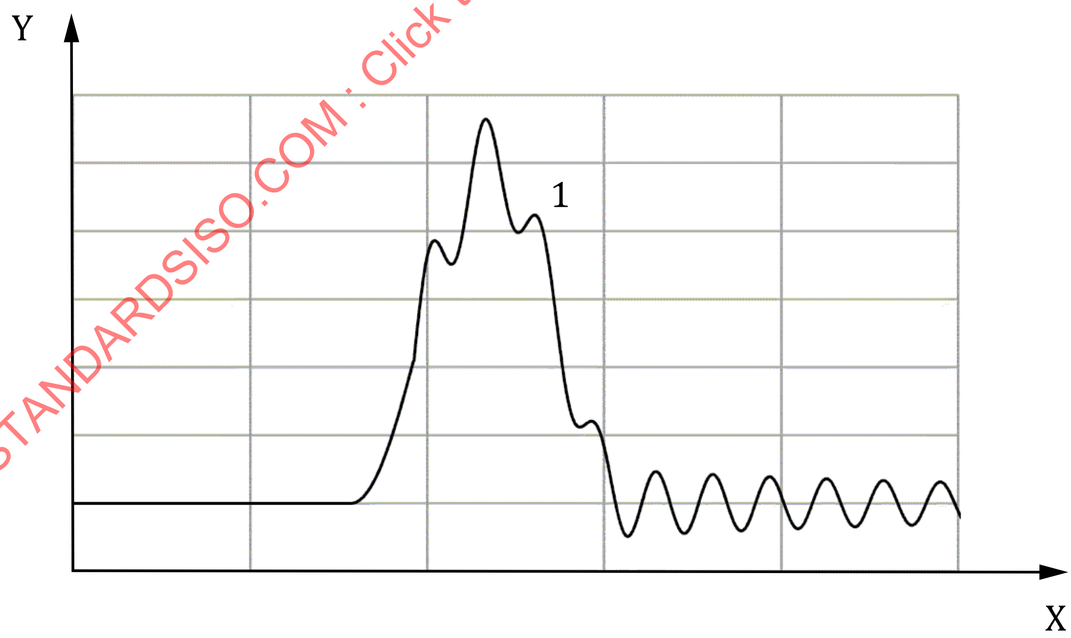
In the drop test, the accelerometer is mounted onto a hammer which is guided in its vertical fall onto a stationary anvil to provide the shock. The mounting of the accelerometer to the weight should be similar to the test body (actual structure under test) mounting. When it is impossible to represent the test body by the mass of the hammer or anvil in a realistic way, the weight should be made of the same material and of sufficient size to be a reasonable representation of the test body in terms of stiffness.

One hammer blow applied near the mounted accelerometer on the actual structure can provide the necessary information, if structural resonances in the test body can be disregarded.

The accelerometer output signal produced by the shock under suitable conditions has the resonance frequency superimposed (see Figure 4) in cases where the shock duration, t_S, is shorter than $5/f_{Res}$, where f_{Res} is the lowest mounted fundamental resonance frequency of the accelerometer.

Some experimentation is required with the energy of shock (i.e. the height from which the weight is released) and the stiffness of the impact surface (e.g. steel or lead lined) to obtain a suitable period of impact for displaying the resonance effects. The lowest resonance should be excited during the shock. The use of a suitable single-event recorder, for example, a storage oscilloscope, enables the frequency of the resonance ripple (i.e. of the oscillations) to be determined. These methods are particularly suited for high frequencies.

When repeated, consistently well-defined shocks can give additional information about the stability of the mounting.



Key

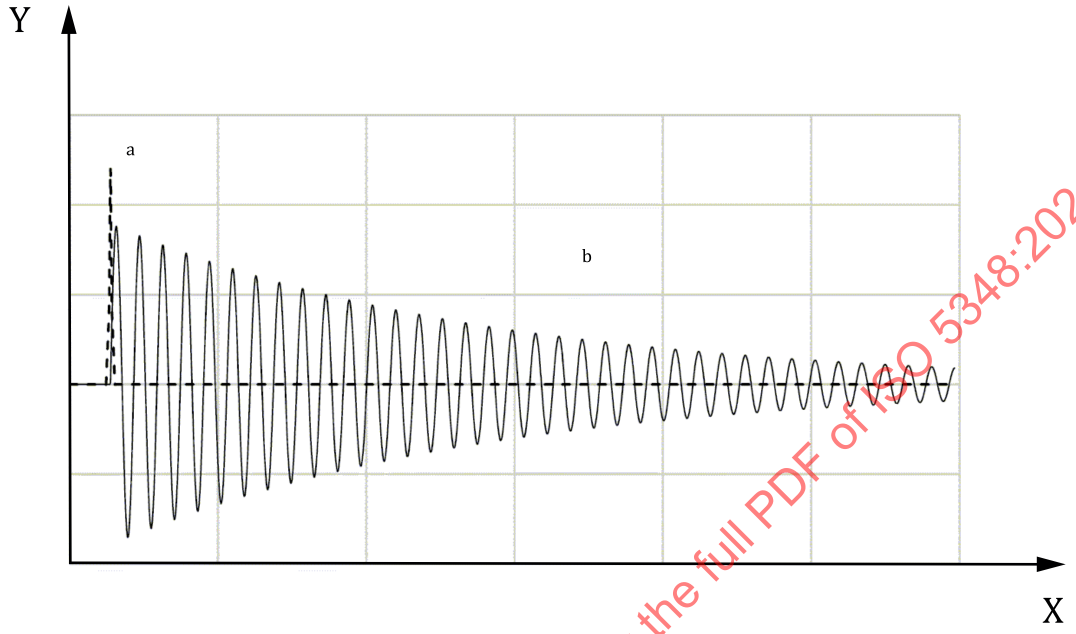
X time

Y acceleration

1 shock response with resonance ripple

Figure 4 — Accelerometer response to shock at shock duration $t_S < 5/f_{Res}$

A broadband shock response spectrum can be generated by breaking a pencil lead (preferably with a diameter of 0,5 mm and a hardness of 2H) in the direction of the sensitive axis of the accelerometer under test in the vicinity of the mounting area. For this purpose, a commercially available mechanical pencil is equipped with a plastic moulded part which specifies the breaking angle and prevents bouncing (see ASTM E976). Here the shock duration, t_S, is shorter than $1/f_{Res}$ and the accelerometer under test is excited in its lowest fundamental mounted resonance frequency[16], as shown in Figure 5.



key

X time

Y acceleromter output signal

a input shock pulse (approx. dirac pulse)

b typical impulse response of an accelerometer (resonance oscillation)

Figure 5 — Accelerometer response to shock (idealized illustration)

6.4 Recommendations for particular types of mountings

6.4.1 General

The mounting surface on the structure shall be carefully examined for smoothness and contamination and, if necessary, it shall be machined flat. The size of the contact area of magnets, adhesive mounting pads and other mounting parts should be at least as large as the mounting surface of the transducer. If possible, any lack of alignment between the sensitive axis of the accelerometer and the measurement direction shall be kept to a minimum; otherwise this can lead to deviations introduced by angular deviation and transverse sensitivity. These deviations can be particularly large if the transverse motion is much greater than the axial motion.

The higher the frequency to be measured, the higher the static mounting force and the stiffness of the mounting should be.

The masses of the transducer and fastening material and the resonant cable should be as low as possible in order to minimize the influence on the measurement object.

For vibration measurements on electrical machines, it can be necessary to mount the transducer in an isolated manner in order to prevent ground loops (see 8.3).

The condition of the mounting surface and method of mounting should be stated in reports.

In order to meet the manufacturer's specification, the recommended mounting method for the transducer should be used.

Table 1 provides an overview of criteria for the selection of mounting methods, based on best practices.

Table 1 — Criteria for the selection of mounting methods

Attachment fidelity	Resonance frequency	Static strength	Temperature resistance	Importance of surface preparation
	Stud or screw	Stud or screw	Stud or screw	Stud or screw
High	Cyanoacrylate or epoxy resin adhesive	Cyanoacrylate or epoxy resin adhesive	Magnet	Cyanoacrylate
↑	Sticky wax	Thin double-sided tape	Cyanoacrylate or epoxy resin adhesive	Magnet
	Thin double-sided tape	Magnet	Hand-held probe tip	Sticky wax
	Cyanoacrylate or epoxy resin adhesive with adhesive mounting pad	Sticky wax	Thin double-sided tape	Thin double-sided tape
	Thin double-sided tape with adhesive mounting pad	Hand-held probe tip	Sticky wax	Epoxy resin adhesive
Low	Magnet			Hand-held probe tip
	Hand-held probe tip			

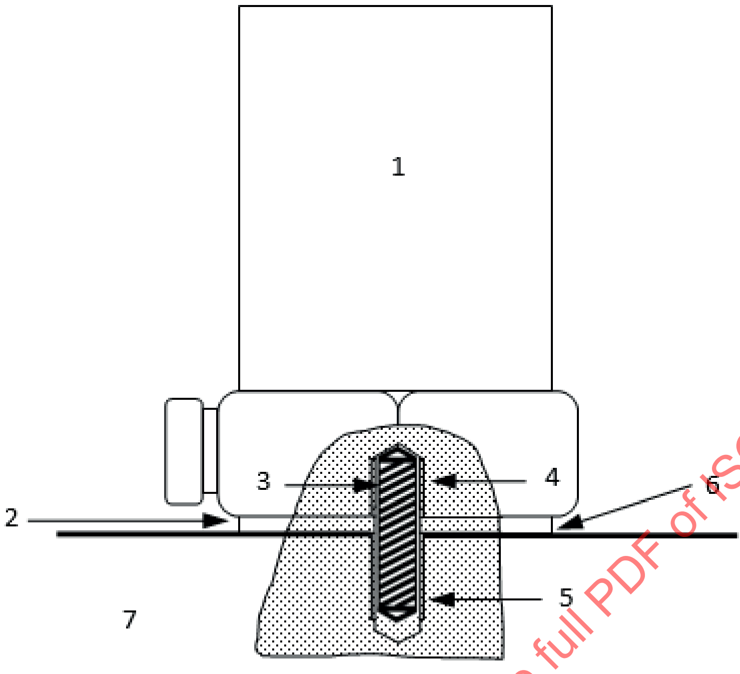
6.4.2 Stud mounting

6.4.2.1 The surfaces shall be clean, flat and machined smooth to manufacturer's tolerances if so specified. The axes of the stud mounting holes shall be perpendicular to the mounting surfaces.

6.4.2.2 The manufacturer's recommended mounting torque shall be used to obtain a firm fastening without damaging the accelerometer.

6.4.2.3 A thin film of oil or grease between the surfaces helps to achieve good contact and thus maximum stiffness of the mounting (see Figure 6).

6.4.2.4 The stud shall not bottom in the mounting hole, as rigidity can be lost due to a small gap between the surfaces. It can also deform the transducer bottom and influence its properties, or even damage the transducer.



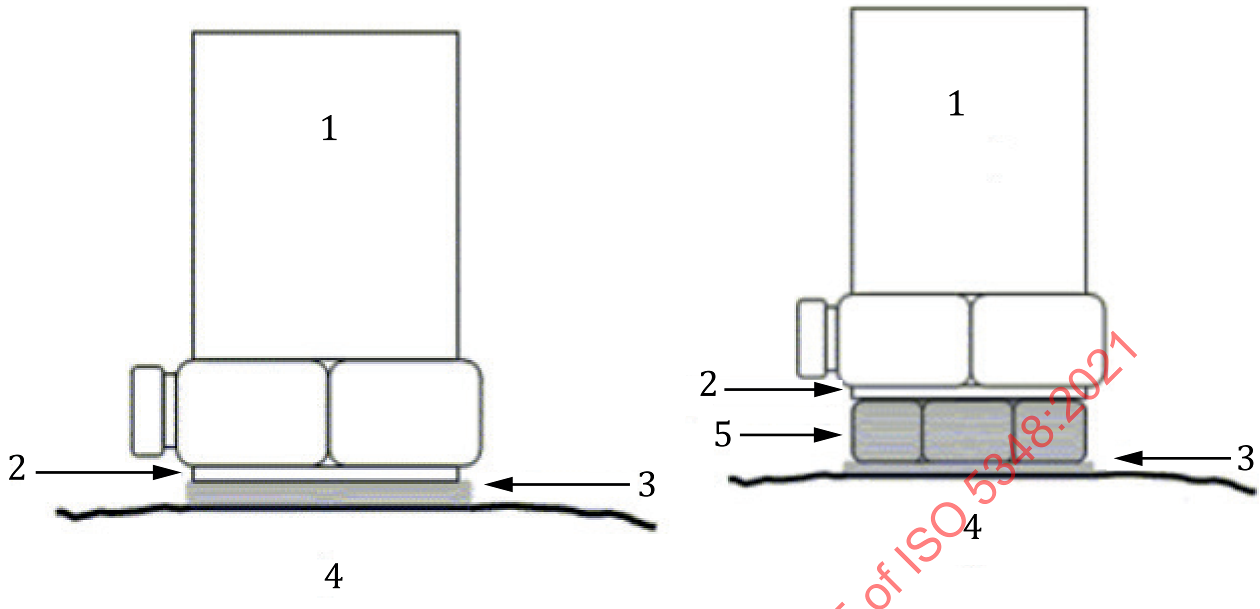
Key

1 transducer
2 transducer base
3 mounting stud
4 mounting thread inside the transducer
5 mounting thread inside the structure
6 mounting with oil film or grease
7 structure

Figure 6 — Stud mounting

6.4.3 Adhesive mounting

This method (see Figure 7) can be used when no other fastening is possible, when the structure cannot be drilled, when electrical isolation of the accelerometer is necessary, or when the surface flatness is insufficient. If the transducer is to be kept free from adhesive or easily detachable, a disc-shaped adhesive mounting pad is glued to the structure. This pad is threaded on one side and plane on its other side.



a) Transducer directly glued **b) Transducer on mounting pad**

key

1 transducer

2 transducer base

3 adhesive

4 structure

5 adhesive mouting pad, fixture

Figure 7 — Mounting by direct adhesive bonding or with an adhesive mounting pad

The surface shall be cleaned according to the adhesive manufacturer's recommendations. It is recommended to remove fat and oil from both mounting surfaces.

The bond shall be as thin as possible and shall just fill the gap between the transducer and the structure. The adhesive bonding process shall be carried out with corresponding contact pressure.

Hard adhesives such as two-component adhesives or hot-melt adhesives shall be used. Solvent-drying adhesives tend to remain soft internally, thus lowering the stiffness of the bond and consequently the resonance frequency.

Cyanoacrylate adhesives are only suitable for even and smooth surfaces. Epoxy resin-based adhesives with fillers can be used for uneven surfaces.

Thin double-sided tape is also suitable for fastening. Only film-based double-sided tapes with as low as possible thickness are recommended; thicknesses lower than 0,2 mm are customary. Foam-based tapes are generally unsuitable.

The ambient temperature during measurement is important for choosing suitable adhesives. Sticky wax should only be used at room temperature. The maximum application temperature of some cyanoacrylate adhesives is approximately 90 °C. Two-component adhesives or a different mounting option shall be used for higher temperatures. The ambient temperature during measurement is important for choosing suitable adhesives.

A bond should always exhibit a stiffness that is as high as possible. If the chemical properties and characteristics of the adhesive are known, the stiffness of the bond can be assessed as follows.

The mounted fundamental resonance frequency, f_c, can be estimated using Formula (1):

$$f_c = \frac{1}{2\pi}\sqrt{\frac{|K_c|}{m}} \tag{1}$$

where

K_c is the complex compressional stiffness of the bond;

m is the total mass, consisting of the mass of the transducer and any mounting adapters.

The complex compressional stiffness, K_c, of the bond can be estimated using Formulae (2) and (3):

$$K_c = E(1+j\eta)A/d \tag{2}$$

$$|K_c| = \frac{\sqrt{1+\eta^2}\cdot E\cdot A}{d}$$

$$|K_c| \approx \frac{E\cdot A}{d} \text{ for } \eta \ll 1 \tag{3}$$

where

E is the elastic (Young's) modulus of the adhesive;

η is the loss factor of the adhesive;

A is the surface of the bond;

d is the thickness of the bond.

j is the imaginary unit [√(-1)]

The transverse resonance frequency of the bond can be estimated using Formula (4):

$$f_s = \frac{1}{2\pi}\sqrt{\frac{|K_s|}{m}} \tag{4}$$

where

K_s is the complex shear stiffness of the bond.

The shear stiffness can be estimated by using Formulae (5) and (6):

$$K_s = G(1+j\beta)A/d \tag{5}$$

$$|K_s| = \frac{\sqrt{1+\beta^2}\cdot G\cdot A}{d}$$

$$|K_s| \approx \frac{G\cdot A}{d} \text{ for } \beta \ll 1 \tag{6}$$

where

G is the shear modulus of the adhesive;

β is the shear loss factor.

In order to increase the usable frequency range of the mounted accelerometer, the adhesive should generally be lightly damped (i.e. η or β less than 0,01) and hard (i.e. high E and G values) and the bond should be thin.

In order to remove the adhesive from the transducer, it is recommended to dissolve the bond with a suitable solvent and to separate the transducer carefully under the impact of shear forces from the bonding area. Adhesive residues remaining on the transducer may only be removed with solvents and under no circumstances with hard mechanical tools in order not to damage the mounting surface.

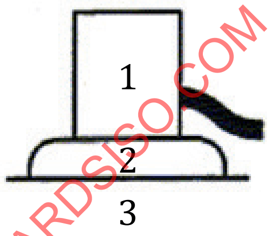
6.4.4 Magnets

Magnets are well suited for mounting of accelerometers during temporary measurements. Magnets with high clamping force, preferably made of rare-earth materials, should be used. The mounting surface shall be as smooth as possible to ensure direct contact over the widest area of the magnet. Both mounting surfaces should be in touch without any material in between. Care should be taken to ensure that the interface is such that rocking is prevented. Where isolation between the transducer and the unit under test is required, an isolation adapter between transducer and magnet is recommended. The prerequisite of the mounting with a magnet is a ferromagnetic structure. Alternatively, a ferromagnetic steel disc which is at least the size of the magnet can be glued onto the structure.

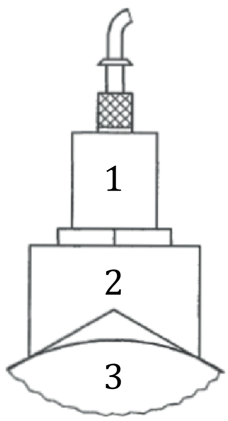
The quality of the surfaces of the structure and the quality of the magnet influence the frequency response of the transfer. A thin oil film can improve the motion transfer. Special magnets are provided for measurements on curved surfaces (see Figure 8).

The common magnetic materials often only allow for measurements up to approximately 80 °C, but magnets for higher temperatures are also available.

There is a risk when attaching the transducer to the magnet and when attaching the transducer and magnet combination to the structure that high damaging shock loads can occur. The shock load can be reduced by carefully sliding or rolling the magnet onto the transducer and structure.



a) Magnet for even surface



b) Magnet for curved surface

Key

1 transducer

2 magnet

3 ferromagnetic structure under test

Figure 8 — Mounting by a magnet

6.4.5 Quick mount

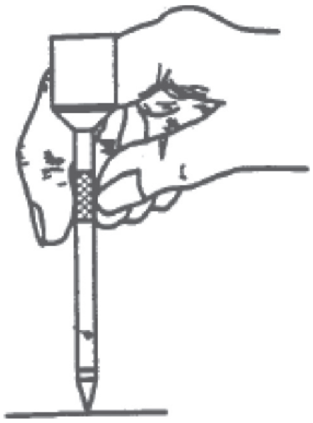
Quick mounts allow accelerometers to be fastened by easily manageable twist and lock or click and lock systems. Due to the various modes of action, this document does not explain quick mounts in detail.

Resonance frequency and amplitude limits should be determined experimentally or taken from the manufacturer's manual, for example.

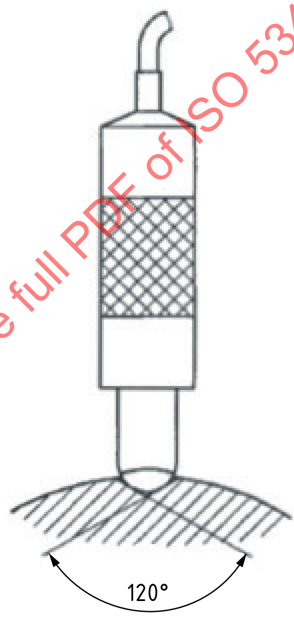
6.4.6 Probe

For vibration measurements on structures which do not permit the fastening of an accelerometer, probes are used which are screwed into the transducer base and pressed down by hand; see Figure 9 a).

Alternatively, a better solution is shown in Figure 9 b). The probe has a rounded tip which fits snugly into the counterbore that has been machined into the structure. The usable frequency range mostly extends up to a few hundred Hertz only. The measurement result is subject to strong subjective influences, in particular due to variations of measurement direction and contact pressure. Therefore, hand-held accelerometers should be used after careful evaluation of their suitability for the intended measurement or test.



a) Probe with tip



b) Probe with round tip in conical counterbore

Figure 9 — Hand-held probes

6.4.7 Conical bolting

Conical bolting represents a special design of screw fastening (see Figure 10). A 90° cone which ends in a threaded bolt is screwed into a respective mounting hole with 90° chamfer in the structure. The cone and threaded bolt can be firmly attached to the transducer base or designed as a mounting pad.

Transducers mounted with conical bolting can measure up to 10 kHz, but this needs to be verified in each case.

Conical bolting requires a high degree of concentricity for both faces fitting together.

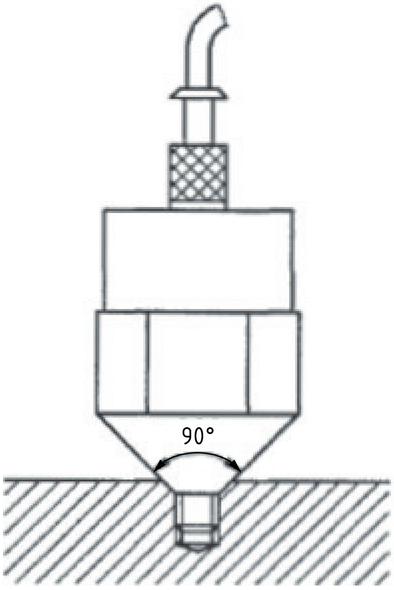


Figure 10 — Mounting by conical bolting

6.4.8 Low-percussion mounting devices for recording human exposure to vibration

Specially shaped adapters for measurement of vibration in the palm are given, for example, in ISO 10819. Hand-held and strap mounted adapters are shown in ISO 5349-2. An adapter shaped as a mounting disc for measurement of vibration on the seat pan or backrest of occupied seats is specified, for example, in ISO 10326-1.

6.4.9 Mounting by three-point support and ground spikes

For a three-point support, the vibration transducer is placed without particular measurements directly or with an adapter on a measurement object. This type of mounting is applied, for example, during measurement of human exposure to vibrations in buildings. Ground spikes are used for measurement of ground-borne vibration. These and comparable types of mounting are only used at low frequencies and low amplitudes (see ISO/TS 14837-31).

6.4.10 Wedge anchors

For mounting of accelerometers onto concrete and masonry, expansion anchors can be used which are fixed in a borehole with a screw, the head of which has a mounting hole. Threaded bolts placed by a powder-actuated tool can also be used. The thread is used for fastening the transducer. This type of mounting is used, for example, for measurement of vibration emissions in buildings and other building structures. It is only suitable for low frequencies (see ISO/TS 14837-31).

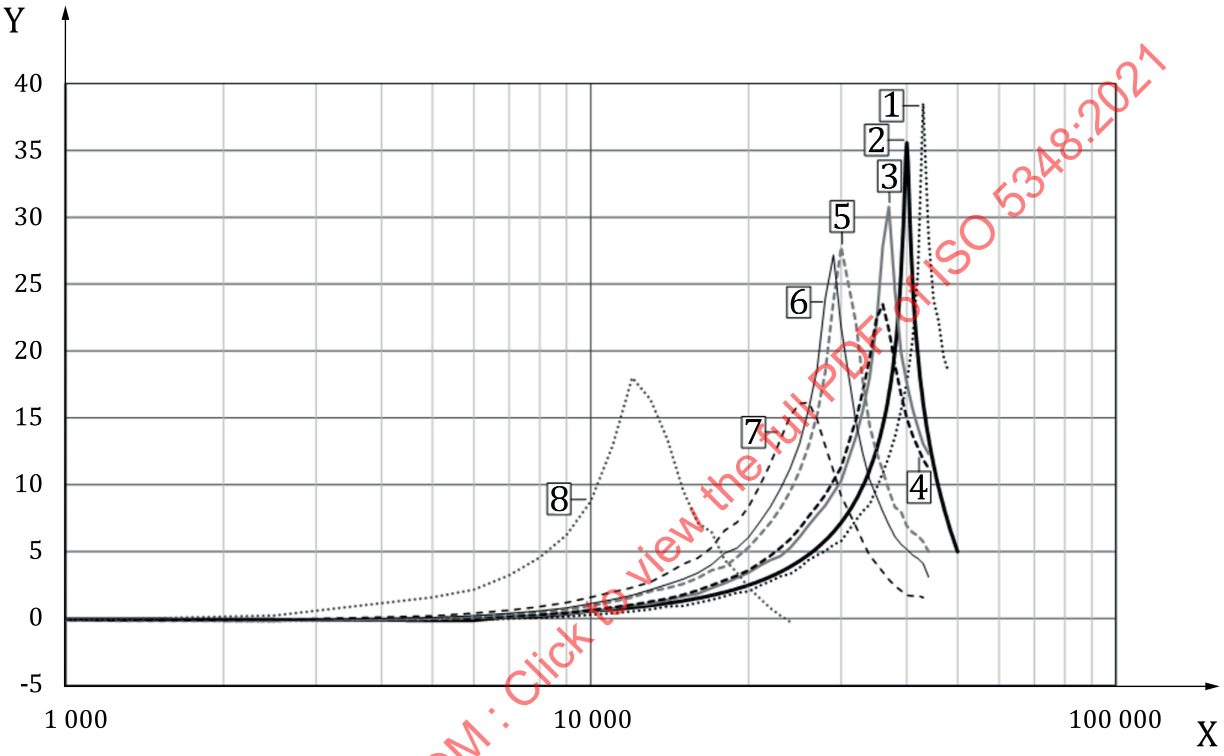
6.4.11 Mounting fixtures

Mounting fixtures, including electrical isolating studs, should be designed and manufactured of a suitable material, rigid, of minimum mass, with low moment of inertia and preferably have a symmetrical structure to the measurement direction. Brackets should be avoided if possible. When necessary, it is recommended that a small stiff metal cube be used, rigidly mounted to the structure, with machined surfaces drilled and tapped to accept stud mounting.

If the use of a complicated bracket is unavoidable, a test of its vibration modes and natural frequencies with the accelerometer mounted to it is desirable.

7 Typical frequency response for various types of mounting

Figures 11 and 12 show the frequency responses of accelerometers having a mass of 11 g and 27 g, respectively, for various types of mounting. In both cases, the bolted connection is the mounting with the highest mounted fundamental resonance frequency. All other mounting methods decrease the mounted fundamental resonance frequency and can prejudice the measurement. The resonance frequency shifts partly cause large changes of the frequency response in the working range of the transducer. The frequency response of the transducer in the working range is therefore dependent on the stiffness of the mounting. Normally, a decrease in stiffness of the mounting causes a frequency-dependent increase in the sensitivity coefficient in the upper working frequency range.



Key

1 stud mounted
2 cyanoacrylate glue
3 beeswax
4 thin double-sided adhesive tape
5 cyanoacrylate glue with mounting pad
6 beeswax with mounting pad
7 double-sided adhesive tape with mounting pad
8 magnetic mounting
Y logarithmic accelerometer output in dB
X frequency in Hz

Figure 11 — Measured frequency responses of an accelerometer having a transducer mass of 11 g for various types of mounting

