INTERNATIONAL STANDARD

ISO 10817-1

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Rotating shaft vibration measuring systems —

Part 1:
Relative and absolute sensing of radial vibration

Systèmes de mesure des vibrations des arbres tournants —

Partie 1: Captage relatif et captage absolu des vibrations radiales

ISO 10817-1:1998(E)

Contents

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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 3.

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.

International Standard ISO 10817-1 was prepared by Technical Committee ISO/TC 108, *Mechanical vibration and shock*, Subcommittee SC 3, *Use and calibration of vibration and shock measuring instruments*.

ISO 10817 consists of the following parts, under the general title *Rotating shaft vibration measuring systems*:

— *Part 1: Relative and absolute sensing of radial vibration*

— *Part 2: Signal processing*

Annexes A and B of this part of ISO 10817 are for information only.

Rotating shaft vibration measuring systems —

Part 1:
Relative and absolute sensing of radial vibration

1 Scope

This part of ISO 10817 gives details of how to obtain reproducible measurement results in order to enable the monitoring and evaluation of shaft vibrations according to the ISO 7919 series. As such, it is concerned primarily with the measurement of shaft vibrations for large machines (e.g. steam turbine generator sets, gas turbines, industrial turbosets, hydraulic machines).

This part of ISO 10817 is applicable to radial vibration measuring systems on shafts, both for absolute and relative measurements. It covers the sensing device (i.e. transducer), signal conditioning, attachment methods and calibration procedures.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of ISO 10817. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of ISO 10817 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 683-1, *Heat-treatable steels, alloy steels and free-cutting steels — Part 1: Direct-hardening unalloyed and low-alloyed wrought steel in form of different black products.*

ISO 2041, *Vibration and shock — Vocabulary.*

ISO 4287, *Geometrical Product Specification (GPS) — Surface texture: Profile method — Terms, definitions and surface texture parameters.*

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

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

ISO 7919-1:1996, *Mechanical vibration of non-reciprocating machines — Measurements on rotating shafts and evaluation criteria — Part 1: General guidelines.*

ISO 7919-2, *Mechanical vibration of non-reciprocating machines — Measurements on rotating shafts and evaluation criteria — Part 2: Large land-based steam turbine generator sets.*

ISO 7919-3, *Mechanical vibration of non-reciprocating machines — Measurements on rotating shafts and evaluation criteria — Part 3: Coupled industrial machines.*

ISO 7919-4, *Mechanical vibration of non-reciprocating machines — Measurements on rotating shafts and evaluation criteria — Part 4: Gas turbine sets.*

ISO 7919-5, *Mechanical vibration of non-reciprocating machines — Measurements on rotating shafts and evaluation criteria — Part 5: Machine sets in hydraulic power generating and pumping plants.*

ISO 8042, *Characteristics to be specified for seismic pick-ups.*

ISO 16063-1, *Methods for the calibration of vibration and shock transducers — Part 1: Basic concepts.*[1)]

GUM:1995, *Guide to the Expression of Uncertainty in Measurement* (BIPM, IEC, IFCC, ISO, IUPAC, IUPAP, OIML).

IEC 60068-2-6, *Environmental testing — Part 2: Tests — Test Fc: Vibration (sinusoidal).*

IEC 60068-2-29, *Environmental testing — Part 2: Tests — Test Eb and guidance: Bump.*

IEC 60529:1989, *Degrees of protection provided by enclosures (IP Code).*

3 Terms and definitions

For the purposes of this part of ISO 10817, the terms and definitions given in ISO 2041 apply.

4 Shaft vibration measuring systems overview

A measuring system to evaluate the radial vibration of a rotating shaft can be thought of as consisting of several distinct subsystems: a transducer or transducers for either relative or absolute vibration measurement; a transducer signal-conditioning instrumentation and associated cabling; a phase reference to relate a position on the rotating shaft to the position of the measurement in the time domain (e.g. a shaft encoder); signal processing instrumentation to output the measurement in a specified format; and an output device to display the measurement. Figure 1 shows the interrelationship of these subsystems. ISO 10817-2 covers instrumentation requirements for signal processing and analysis.

The output signals from the measuring devices, S_{ext}, can be processed via specific systems and software packages which provide the quantities required for machine analysis and maintenance purposes. These systems and software packages are not part of this part of ISO 10817.

The relative motions are generally measured with non-contacting transducers. The absolute rotor motions can be sensed with non-contacting relative motion transducers in combination with an absolute motion detection made at the positions of the relative motion transducers. These absolute motion measurements could also be sensed by seismic transducers, e.g. shaft-riding transducers.

This part of ISO 10817 deals with the signal sensing block only, see Figure 1.

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1) Revision of ISO 5347-0.

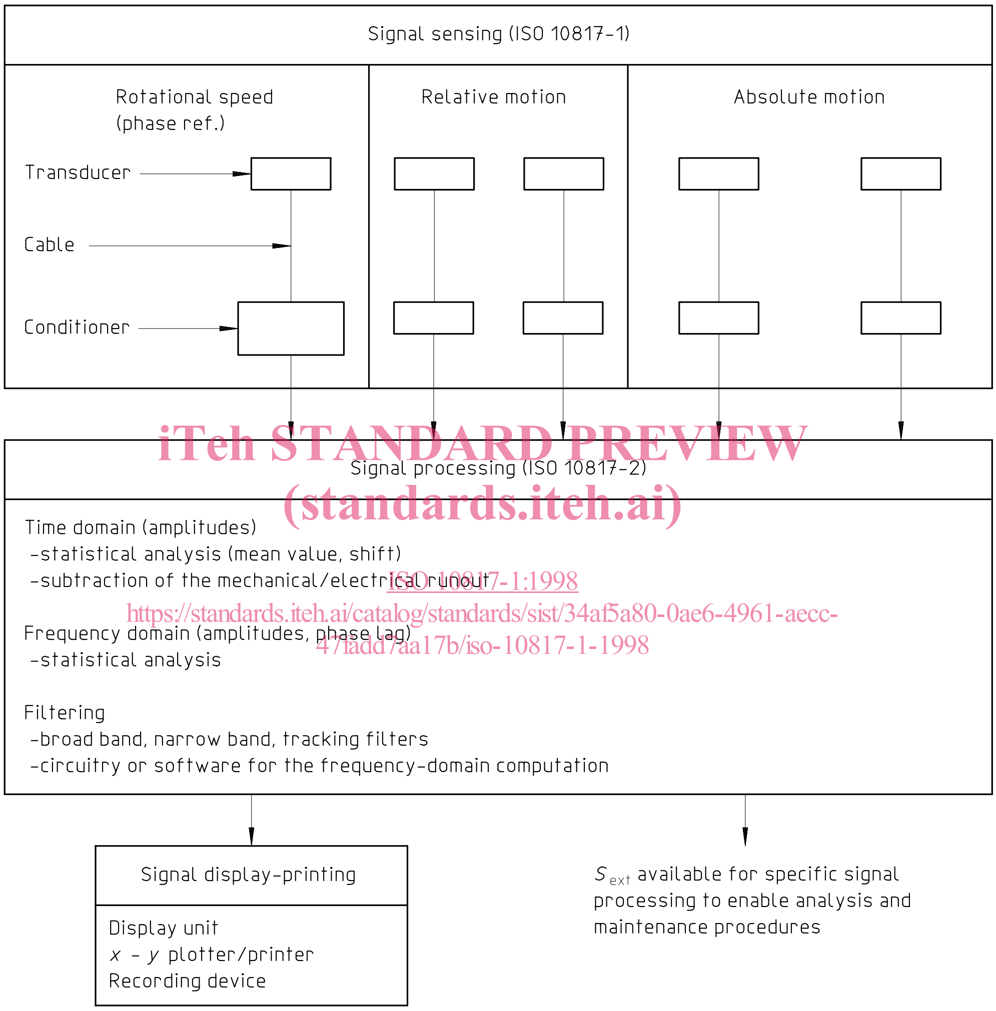


Figure 1 — Structure of rotating shaft measuring systems

5 Sensing systems

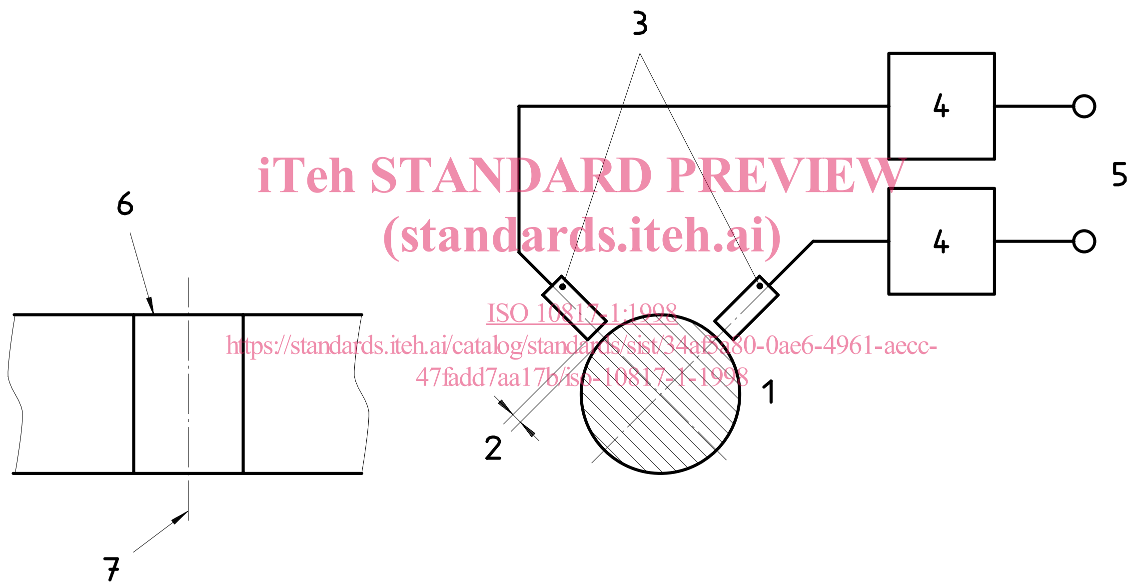
5.1 Relative shaft-vibration measuring systems

5.1.1 Introduction

Relative shaft-vibration transducers take advantage of changes in either the optical path length, inductance or capacitance between a position on a rotating shaft and a point removed from the shaft, usually in very close proximity to the shaft, to determine the relative displacements in time. This reference point (i.e. the location point of the relative shaft vibration transducer) often undergoes significant vibration from other sources. Seismic transducers placed at the location of the sensing element of the non-contacting sensor can be used to determine absolute vibration values (see 5.2).

5.1.2 General structure of the sensing systems

A shaft vibration sensing system according to the requirements of this part of ISO 10817 consists of relative displacement transducers, cabling and the appropriate conditioners (see Figure 2).

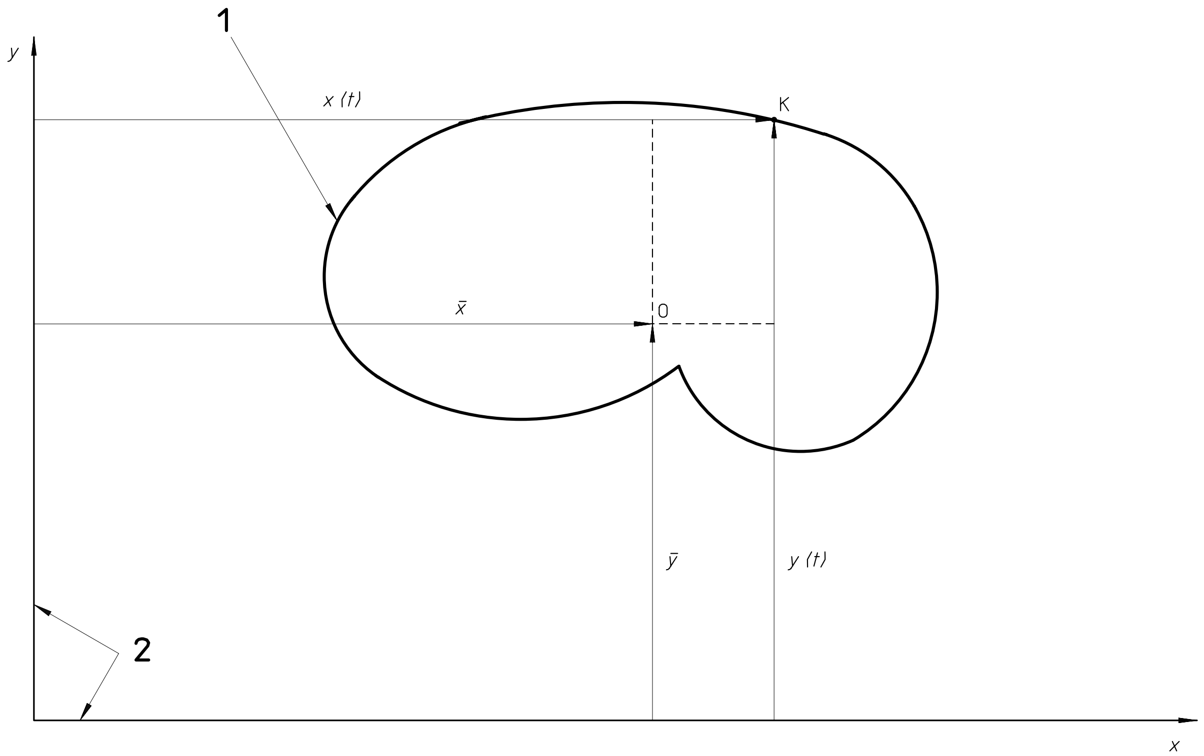


Key

1 Shaft
2 Transducer to shaft distance
3 Transducers
4 Conditioners
5 Signal outputs
6 Measurement track
7 Measurement plane

Figure 2 — Shaft vibration measuring system for measurements in one plane

Two orthogonal transducers are preferably required to determine the total dynamic motion and mean position of the shaft (see Figure 3). The two transducers are arranged in two perpendicular measurement directions in one measurement plane. Generally for one machine set there are several measurement planes which may have a pair of measuring devices for each plane. The system of all measuring devices belonging to one machine set is called a measuring system for shaft vibration.



Key

1	Kinetic orbit of shaft	K	Instantaneous position of shaft centre
2	Reference axes	$\bar{x}$, $\bar{y}$	Mean values of shaft displacement
O	Mean position of orbit	$x(t)$, $y(t)$	Time-dependent alternating values of shaft displacement

Figure 3 — Kinetic orbit of the shaft

Depending on the measurement method, a conditioner may be necessary between the transducer and the signal processing instrumentation. The conditioner may be either a self-contained unit or may be integral with the transducer or the signal processing instrumentation.

No requirements are given in this part of ISO 10817 for the indication instruments and the recording equipment.

5.1.3 Operating ranges

The user should select a transducer system which is at least compatible with the relevant part of ISO 7919 and/or the specification of the machine under evaluation. The output signal tolerances are given in clause 6.

5.1.4 Characteristics to be specified

The manufacturer shall specify the following:

— the range where the signal output is linear proportional to the gap between the target and transducer;

— the amplitude and phase response as a function of frequency where linearity is maintained (see 6.2);

— the overall size and thread of the transducer for each measurement range (tip diameter 5 mm, 8 mm and 18 mm, and thread M8×1, M10×1 and M20×1 are recommended);

— the cable length (5 m is recommended);

— the power supply (−24 V d.c. is recommended);

— the sensitivities (8 mV/µm for the 2 mm range and 4 mV/µm for the 4 mm range is recommended where applicable);

— the output signal mode (voltage-current);

— the maximum output signal;

— the output impedance and permissible load impedance;

— the classes of temperature;

— degree of protection [IP-67 (dust-tight and protected against the effects of temporary immersion) in accordance with IEC 60529:1989 is recommended].

NOTE The above are recommended industry standards in common use.

5.2 Absolute shaft vibration measuring systems

5.2.1 Introduction

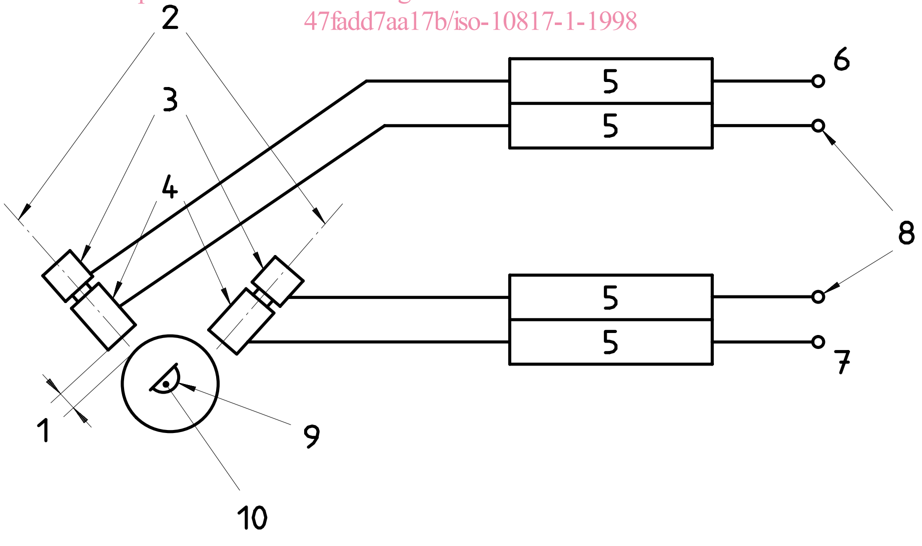
Two types of measuring systems are in use for the measurement of absolute shaft vibrations, as follows.

a) A combined absolute-vibration and relative-vibration measuring system using a seismic transducer and a relative shaft displacement transducer (non-contacting) mounted on the same structure. Their conditioned outputs are summed to provide a measurement of the absolute shaft motion.

b) A shaft-riding probe, where a seismic transducer is mounted on the shaft so that it measures directly the absolute shaft motion.

5.2.2 General structure of the sensing systems

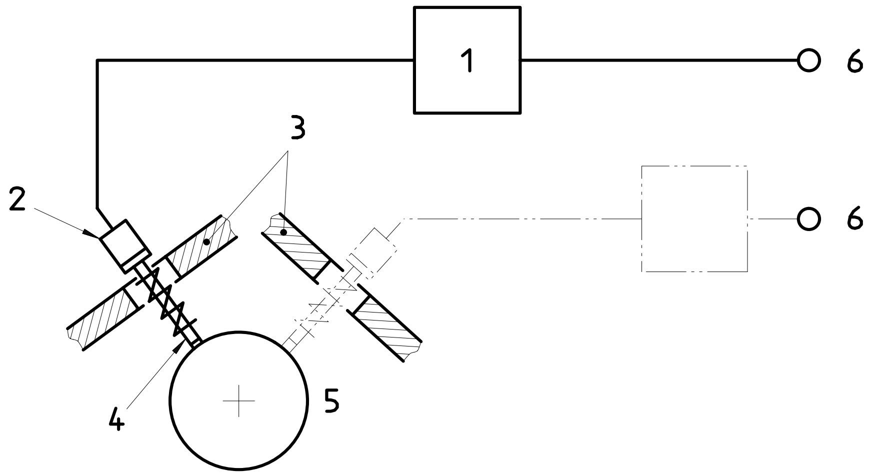
An absolute shaft vibration sensing system according to the requirements of this part of ISO 10817 consists either of two sets of seismic and non-contacting transducers (non-contacting measurement) or of two shaft-riders (direct measurement) and the appropriate conditioners (Figures 4 and 5).



Key

1 Transducer to shaft distance
2 Measurement axes
3 Seismic transducers
4 Non-contacting transducers
5 Conditioners
6 Direction 1
7 Direction 2
8 Signal outputs
9 Trajectory of absolute precession of the centre of the rotor section
10 Geometrical centre of the trajectory

Figure 4 — Absolute shaft vibration sensing system using a combination of non-contacting and seismic transducers for one measurement plane



Key

1 Signal conditioner
2 Seismic transducer
3 Machine structure
4 Shaft rider
5 Shaft
6 Signal outputs

Figure 5 — Absolute shaft vibration sensing system using a shaft-rider transducer assembly for one measurement plane

The two transducer assemblies are radially mounted in orthogonal measurement directions in one measurement plane. Generally at one machine set there are several measurement planes with one or two shaft sensing devices for each plane.

Depending on the measurement method, a conditioner may be necessary between the transducer(s) and the signal processing instrumentation. The conditioner may be either a self-contained unit or may be integral with the transducer.

5.2.21 Combined seismic and non-contacting sensing system

A combined seismic and non-contacting sensing device consists of two sets of transducers, each set fitted with one non-contacting type relative displacement transducer as described in 5.1 and one absolute seismic transducer mounted on a common rigid structure in close proximity with their sensitive axes in-line or parallel to ensure that both transducers undergo the same absolute structural motion. Their conditioned outputs are summed to provide a measurement of the absolute shaft motion.

The combined absolute shaft vibration sensing system has to have at least two outputs for each measuring direction:

a) the relative shaft vibration transducer displacement output, which is identical to that described in 5.1.1;

b) the output of the seismic transducer, which is proportional to the acceleration or velocity motion of the structure to which it and the non-contacting transducer are mounted.

The seismic transducer output shall be processed to provide a displacement signal (single integration in the case of velocity or double integration in the case of acceleration signal).

The seismic transducer placed at the location of the non-contacting transducer can also be used to determine the absolute vibration values according to the ISO 10816 series.