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Mechanical vibration — Vibration of rotating machinery equipped with active magnetic bearings —

Part 1: Vocabulary

Vibrations mécaniques — Vibrations de machines rotatives équipées de paliers magnétiques actifs —
Partie 1: Vocabulaire

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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).

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This document was prepared by Technical Committee ISO/TC 108, *Mechanical vibration, shock and condition monitoring*, Subcommittee SC 2, *Measurement and evaluation of mechanical vibration and shock as applied to machines, vehicles and structures*.

This second edition cancels and replaces the first edition (ISO 14839-1:2002), which has been technically revised. It also incorporates the Amendment ISO 14839-1:2002/Amd. 1:2010.

The main change compared to the previous edition is as follows:

— the terms have been updated and revised to reflect how they are used in practice.

A list of all parts in the ISO 14839 series can be found on the ISO website.

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

Mechanical vibration — Vibration of rotating machinery equipped with active magnetic bearings —

Part 1: Vocabulary

1 Scope

This document defines terms relating to rotating machinery equipped with active magnetic bearings.

NOTE General terms and definitions of mechanical vibration are given in ISO 2041; those relating to balancing are given in ISO 21940-2; those relating to geometric characteristics such as coaxiality, concentricity and runout are explained in ISO 1101.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

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/

3.1 General terms

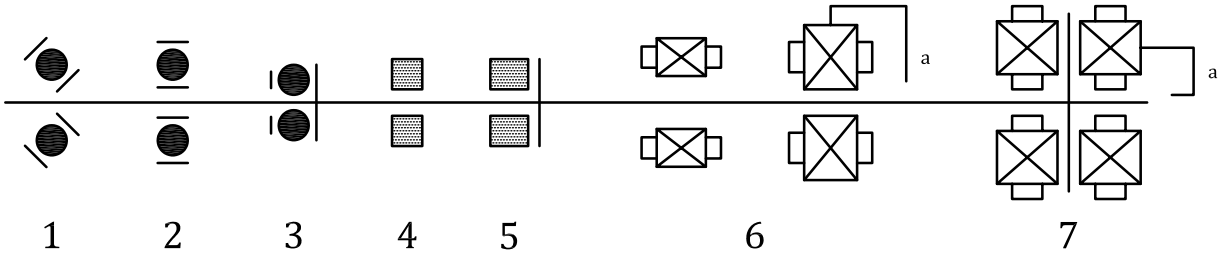
3.1.1
levitation
maintaining the position of a rotor by attractive or repulsive magnetic forces without mechanical contact

3.1.2
magnetic bearing
bearing which utilizes either attractive or repulsive magnetic forces for the *levitation* (3.1.1) and dynamic stabilization of a rotor

3.1.3
active magnetic bearing
AMB
means of supporting a rotor, without mechanical contact, using only attractive magnetic forces based upon servo feedback technology which normally consists of transducers, electromagnets, *power amplifiers* (3.5.3), power supplies and controllers

Note 1 to entry: For rotating machinery equipped with active magnetic bearings, the graphical symbols for bearings are shown in Figure 1.

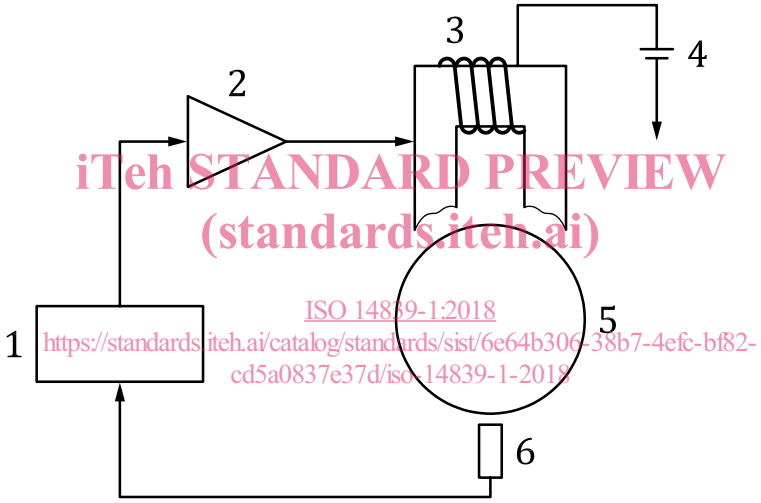
Note 2 to entry: The principle of an active magnetic bearing is shown in Figure 2.



Key

1 angular ball bearing
2 deep groove ball bearing
3 thrust ball bearing
4 radial bushing
5 thrust bushing
6 radial active magnetic bearing
7 axial active magnetic bearing
a With transducer.

Figure 1 — Graphical symbols for bearings



Key

1 controller
2 power amplifier
3 electromagnet
4 power supply
5 rotor
6 displacement transducer

Figure 2 — Principle of active magnetic bearing

3.1.4
passive magnetic bearing
means of supporting a rotor, without mechanical contact, using magnetic forces without feedback control

EXAMPLE *Permanent magnetic bearing* (3.1.5), *super-conducting magnetic bearing* (3.1.6).

3.1.5
permanent magnetic bearing
PMB
passive magnetic bearing (3.1.4) using one or several pairs of permanent magnets without feedback control

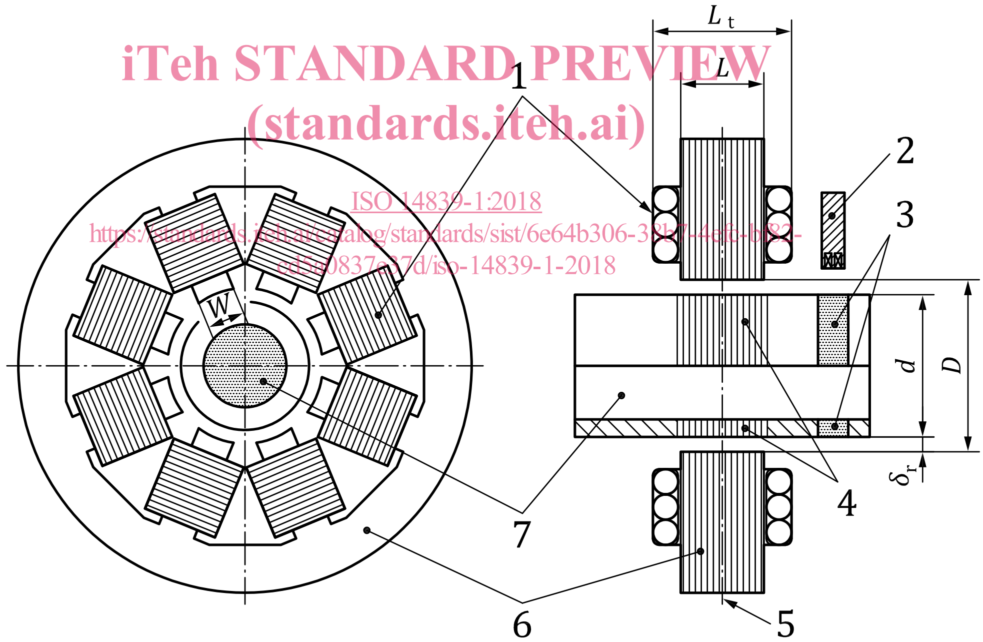
3.1.6
super-conducting magnetic bearing
SMB
passive magnetic bearing (3.1.4) using a pair of (high-temperature) super conductors and permanent magnets without feedback control, utilizing the so-called pinning force (attractive and repulsive forces)

3.1.7
hybrid magnetic bearing
HMB
bearing consisting of any combination of an *active magnetic bearing* (3.1.3) and *passive magnetic bearing* (3.1.4)

3.1.8
permanent-magnet-biased AMB
active magnetic bearing (3.1.3) in which the nominal (non-zero) or bias magnetic fluxes are established by one or more permanent magnets

3.1.9
radial magnetic bearing
magnetic bearing (3.1.2) which levitates a rotor in the radial direction and supports it against disturbances in the radial direction, such as unbalance forces, fluid forces or gravity

Note 1 to entry: See Figure 3.



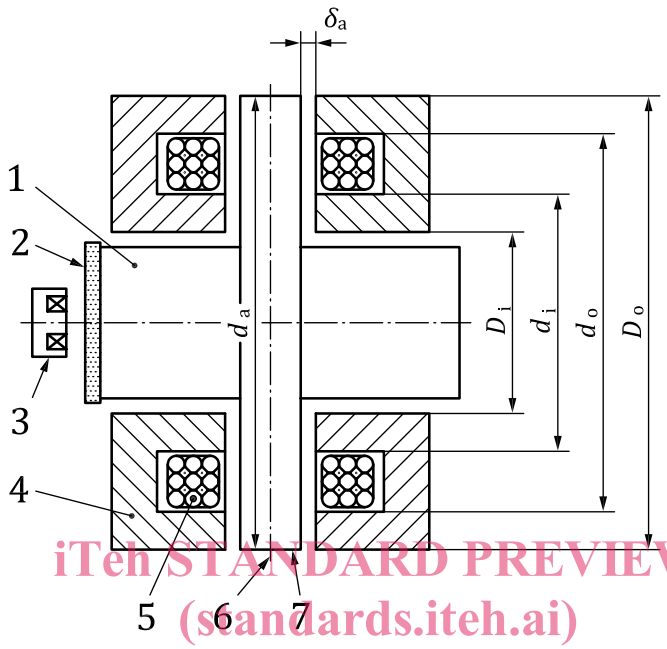
Key

1	radial coil	D	inner diameter of radial stator core
2	radial transducer	d	outer diameter of radial rotor core
3	radial transducer target	δ_r	nominal magnetic gap $(D - d)/2$
4	radial rotor core	L_t	total bearing length (including coil windings)
5	axial centre of radial AMB	L	effective length of radial bearing
6	radial stator core	W	width of a magnetic pole
7	shaft	A_r	area of magnetic pole ($A_r = WL$)

Figure 3 — Radial AMB assembly

3.1.10
axial magnetic bearing
thrust magnetic bearing
magnetic bearing (3.1.2) which levitates a rotor in the axial direction and supports it against disturbances in the axial direction, such as fluid forces or gravity

Note 1 to entry: See Figure 4.



Key

1	rotor	d_a	outer diameter of axial rotor disc
2	axial transducer target	D_o	outer diameter of outer pole of axial stator
3	axial transducer	d_o	inner diameter of outer pole of axial stator
4	axial stator core	d_i	outer diameter of inner pole of axial stator
5	axial coil	D_i	inner diameter of inner pole of axial stator
6	(clearance) centre of axial AMB	δ_a	nominal magnetic gap
7	axial rotor disc	A_a	area of the magnetic pole pair

$$A_a = \frac{\pi}{4}\left(D_o^{\,2} - d_o^{\,2} + d_i^{\,2} - D_i^{\,2}\right)$$

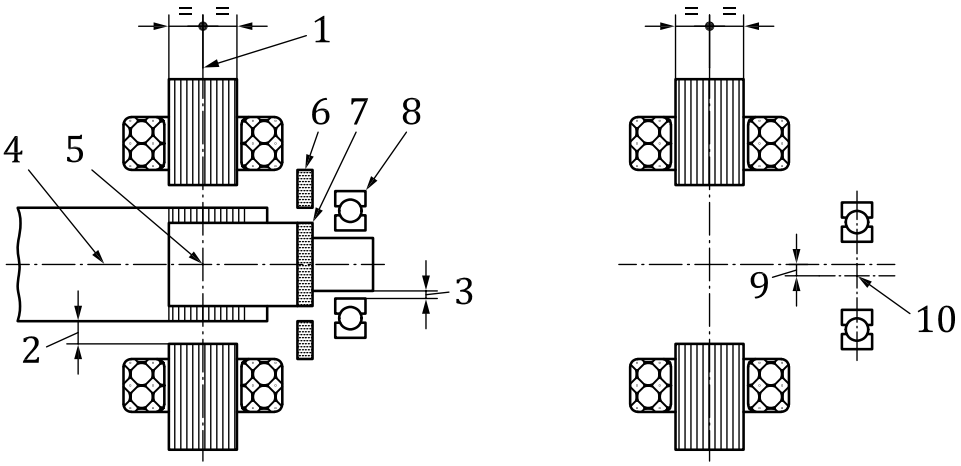
Figure 4 — Axial AMB assembly

3.1.11
nominal magnetic gap
distance between the magnetic materials of the rotor and the stator inside the *AMB* (3.1.3) when the journal centre of the rotor is located in the clearance centre of the bearing stator

Note 1 to entry: See δ_r in Figure 3 for radial AMB, and δ_a in Figure 4 for axial AMB.

3.1.12
clearance centre of a radial AMB
geometric centre of a radial bearing stator

Note 1 to entry: See Figure 5.



Key

1 axial centre of radial AMB
2 magnetic gap of radial AMB
3 radial clearance of touch-down bearing
4 journal (rotor) centreline of radial AMB
5 clearance centreline of radial AMB
6 radial transducer
7 radial transducer target
8 touch-down bearing
9 radial centre offset between radial touch-down bearing and AMB centre
10 radial centre of radial touch-down bearing

NOTE Similar consideration applies to a radial homopolar AMB.

Figure 5 — Centres and centrelines of radial heteropolar AMB

3.1.13
magnetic centre of a radial AMB
position of a rotor in a radial *AMB* (3.1.3) at which the net radial attractive forces exerted on the rotor go to zero for nominal currents or fluxes, and without any magnetic excitation or compensation forces

3.1.14
axial centre of a radial AMB
axial directional position of geometric centre of *stator core* (3.3.1)

Note 1 to entry: See Figure 5.

3.1.15
clearance centre of an axial AMB
clearance centre of a thrust AMB
axial position of the geometric centre of an (axial) thrust *AMB* (3.1.3) stator

Note 1 to entry: See Figure 4.

3.1.16
axial magnetic centre of an axial AMB
position of an *axial rotor disc* (3.2.2) in an axial *AMB* (3.1.3) at which the net axial attractive forces exerted on the rotor disc go to zero for nominal currents or fluxes, and without any magnetic excitation or compensation forces

3.1.17
clearance centreline of a radial AMB
line between the clearance centres of two radial *AMBs* (3.1.3) specified by the bearing stator configuration

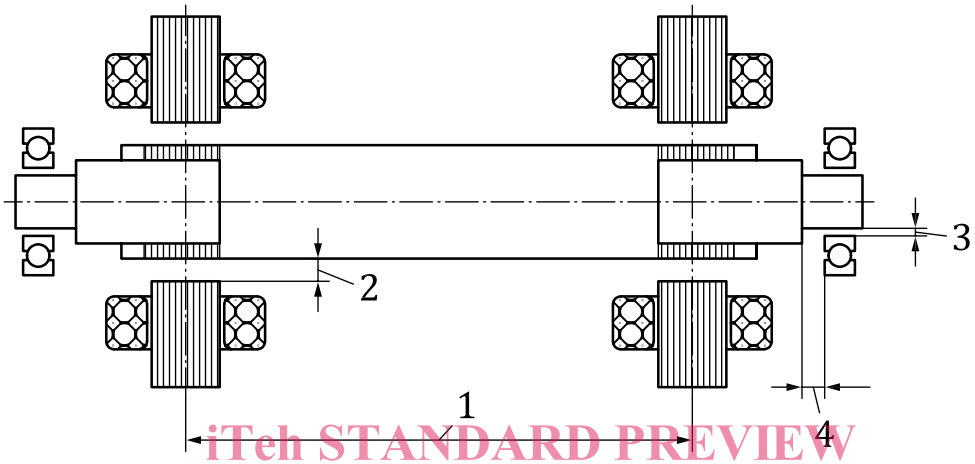
Note 1 to entry: See Figure 5.

3.1.18
journal centreline of a radial AMB
geometric centreline between the journal centres of a radial *AMB* (3.1.3) rotor

Note 1 to entry: See Figure 5.

3.1.19
bearing span between radial AMBs
axial distance between the axial centres of two radial *AMBs* (3.1.3)

Note 1 to entry: See Figure 6.



Key

1 bearing span between radial AMBs
2 magnetic radial clearance of radial AMB
3 radial clearance of touch-down bearing
4 axial clearance of touch-down bearing

Figure 6 — Heteropolar-type radial AMB

3.1.20
number of poles
sum of the south and north magnetic gap poles of an *AMB* (3.1.3)

Note 1 to entry: See Figure 7.

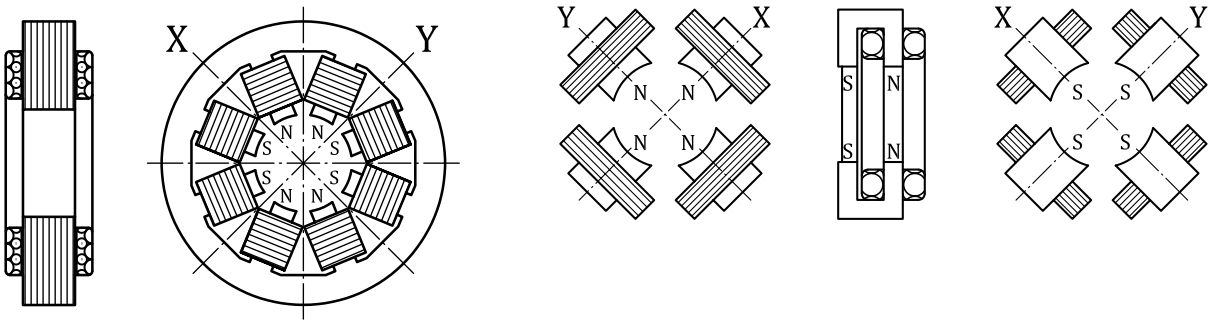
3.1.21
heteropolar-type radial AMB
radial *AMB* (3.1.3) in which the electromagnetic cross section has poles of different polarity, and the poles may have different polarity arrangements

Note 1 to entry: Polarity arrangements can be (N, S, N, S, ...), (N, S, S, N, ...), etc.

Note 2 to entry: See Figure 7 a).

3.1.22
homopolar-type radial AMB
radial *AMB* (3.1.3) whose electromagnet has more than one axial cross section, each having poles of a single polarity

Note 1 to entry: See Figure 7 b).



a) Heteropolar type (8 poles) **b) Homopolar type (8 poles)**

Key

X, Y control axes

Figure 7 — Number of poles of radial AMB

3.1.23
effective length of a radial magnetic bearing
pole face axial length of a radial bearing stator for which the radial electromagnet is able to generate an attractive force exerted on the rotor

Note 1 to entry: See Figure 8.

$L = L_1 + L_2$

a) Heteropolar type **b) Homopolar type**

Figure 8 — Effective length of radial magnetic bearing, L

3.1.24
projection area of a radial AMB
product dL of the radial bearing *journal diameter* (3.2.3), d, and the effective bearing length, L

Note 1 to entry: See Figure 3.

3.1.25
area of one magnetic pole
cross-sectional area, A, of a magnetic pole which can generate an attractive force exerted on the rotor

Note 1 to entry: This is different from the projection area as defined in 3.1.24.

Note 2 to entry: See A_r in Figure 3 for radial AMB, and A_a in Figure 4 for axial AMB.