INTERNATIONAL STANDARD

ISO 14839-4

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

Part 4:

Technical guidelines

Vibrations mécaniques — Vibrations de machines rotatives équipées de paliers magnétiques actifs — Partie 4: Lignes directrices techniques

Reference number
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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 14839-4 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*.

ISO 14839 consists of the following parts, under the general title *Mechanical vibration — Vibration of rotating machinery equipped with active magnetic bearings:*

— *Part 1: Vocabulary*

— *Part 2: Evaluation of vibration*

— *Part 3: Evaluation of stability margin*

— *Part 4: Technical guidelines*

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

Part 4: **Technical guidelines**

1 Scope

This part of ISO 14839:

a) indicates a typical architecture of an active magnetic bearing (AMB) system so that users can understand which components are likely to comprise such systems and which functions these components provide;

b) identifies the primary similarities and differences between AMB systems and conventional mechanical bearings;

NOTE This information helps AMB system users better to understand the selection process and implications of transition to AMB technology.

c) identifies the environmental factors that have significant impact on AMB system performance;

d) identifies the operating limitations that are unique to AMB systems and defines standardized methods of assessing these limitations;

e) identifies typical mechanisms for managing these limitations, especially rotor unbalance;

f) provides considerations for the design and performance of touchdown bearing systems;

g) defines a typical signal set for provision in an AMB system for proper system/process interface as well as condition and diagnostic monitoring;

h) details current best practices for monitoring, operation and maintenance to achieve highest operational system reliability;

i) identifies typical fault-handling practices;

j) recommends inspection and preventive maintenance processes for AMB systems.

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 1940-1, *Mechanical vibration — Balance quality requirements for rotors in a constant (rigid) state — Part 1: Specification and verification of balance tolerances*

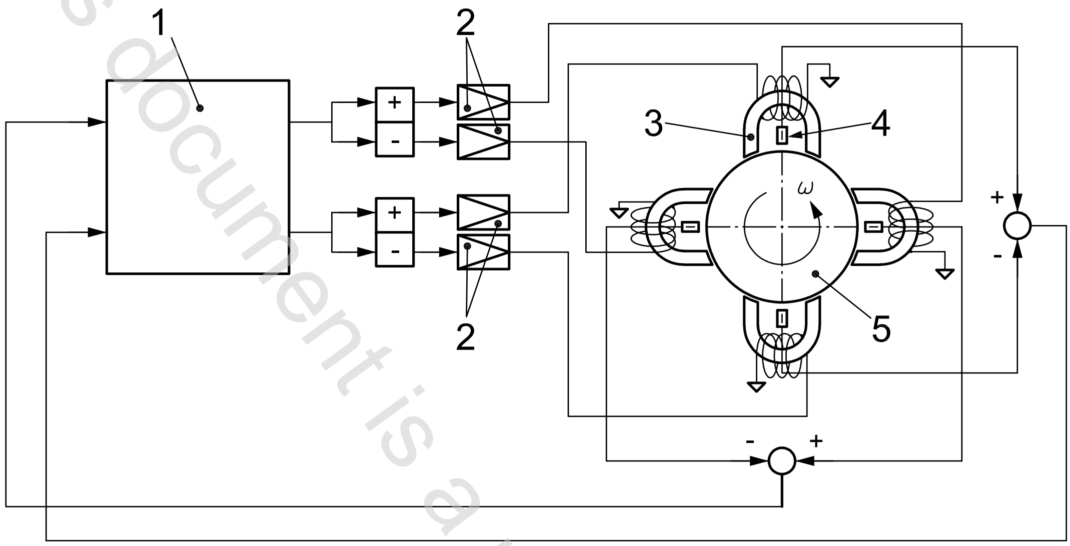
ISO 14839-1:2002 + Amd.1:2010, *Mechanical vibration — Vibration of rotating machinery equipped with active magnetic bearings — Part 1: Vocabulary*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 14839-1 apply.

4 Active magnetic bearing system architecture

Active magnetic bearings (AMBs) can be used as suspension elements in rotating machines in lieu of conventional types of bearings such as rolling element bearings and sleeve/journal bearings. AMBs support or levitate a shaft using an electromagnetic force controlled by a position feedback loop. A typical radial magnetic bearing actuator consists of electromagnets arranged at four directions around a rotating shaft as shown in Figure 1. In this case, there are two orthogonal control axes.



Key

1 controller

2 power amplifier

3 magnetic coil

4 displacement sensor

5 rotor with rotational angular frequency ω

Figure 1 — Schematic drawing of a magnetic bearing system

Key elements of the AMB are:

a) a displacement transducer that detects the displacement of the shaft from a reference position or setpoint;

b) a processor or controller that produces a control command signal based on the position error;

c) a power amplifier to convert the low level command signal to a control current;

d) an electromagnetic actuator that applies a control force to the shaft based on the use of a magnetic field.

Rotational drag losses are quite low in an AMB because the shaft is supported by a magnetic field without mechanical contact. The only drag losses are from eddy currents generated in the rotor and from windage. These losses are small compared with the friction drag of rolling element bearings and very small compared to the losses in sliding bearings. On the other hand, control of shaft position is not trivial. The magnetic force acting on the shaft from each electromagnet is an attractive force that becomes larger as the shaft gets closer to the actuator (see Figure 2). Thus it is passively unstable since a displacement from the equilibrium position results in a force pulling the shaft further from its equilibrium position. This force/displacement relationship is characterized by a negative stiffness.

