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Rolling bearings — Measuring methods for vibration —

Part 3: Radial spherical and tapered roller bearings with cylindrical bore and outside surface

Roulements — Méthodes de mesurage des vibrations —

Partie 3: Roulements à rotule sur rouleaux et à rouleaux coniques, à alésage et surface extérieure cylindriques

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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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For an explanation on 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 the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 4, *Rolling bearings*.

This second edition cancels and replaces the first edition (ISO 15242-3:2006), which has been technically revised. It also incorporates the Technical Corrigendum ISO 15242-3:2006/Cor. 1:2010.

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

— editorial changes have been made for clarification and removal of inconsistencies;

— figure keys have been updated for clarification.

A list of all parts in the ISO 15242 series can be found on the ISO website.

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Introduction

Vibration in rotating rolling bearings can be of importance as an operating characteristic of such bearings. The vibration can affect the performance of the mechanical system incorporating the bearing and can result in audible noise when the vibration is transmitted to the environment in which the mechanical system operates, can lead to damages, and can even create health problems.

Vibration of rotating rolling bearings is a complex physical phenomenon dependent on the conditions of operation. Measuring the vibration of an individual bearing under a certain set of conditions does not necessarily characterize the vibration under a different set of conditions or when the bearing becomes part of a larger assembly. Assessment of the audible sound generated by the mechanical system incorporating the bearing is further complicated by the influence of the interface conditions, the location and orientation of the sensing device, and the acoustical environment in which the system operates. Assessment of airborne noise that, for the purpose of ISO 15242 (all parts), can be defined as any disagreeable and undesired sound is further complicated by the subjective nature of the terms *disagreeable* and *undesired*. Structure-borne vibration can be considered the driving mechanism that ultimately results in the generation of airborne noise. Only selected methods for the measurement of the structure-borne vibration of rotating rolling bearings are addressed in the current edition of all parts of ISO 15242.

Vibration of rotating rolling bearings can be assessed by a number of means using various types of transducers and measurement conditions. No simple set of values characterizing the vibration of a bearing is adequate for the evaluation of the vibratory performance in all possible applications. Ultimately, a knowledge of the type of bearing, its application and the purpose of the vibration measurement (e.g. as a manufacturing process diagnostic or an assessment of the product quality) is required to select the most suitable method for measuring. The field of application for standards on bearing vibration is, therefore, not universal. However, certain methods have established a wide enough level of application to be considered as standard methods.

This document serves to define the detailed method for assessing vibration of radial spherical and tapered roller bearings with cylindrical bore and outside surface on a measuring device.

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Rolling bearings — Measuring methods for vibration —

Part 3: Radial spherical and tapered roller bearings with cylindrical bore and outside surface

1 Scope

This document specifies vibration measuring methods for double-row radial spherical roller bearings and single-row and double-row radial tapered roller bearings, with cylindrical bore and outside surface and a contact angle up to and including 45°, under established measuring conditions.

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 286-2, *Geometrical product specifications (GPS) — ISO code system for tolerances on linear sizes — Part 2: Tables of standard tolerance classes and limit deviations for holes and shafts*

ISO 1132-1, *Rolling bearings — Tolerances — Part 1: Terms and definitions*

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

ISO 5593, *Rolling bearings — Vocabulary*

ISO 15242-1:2015, *Rolling bearings — Measuring methods for vibration — Part 1: Fundamentals*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 1132-1, ISO 2041, ISO 5593 and ISO 15242-1 apply.

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

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

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

4 Measurement process

4.1 Rotational frequency

The default rotational frequency shall be 900 min^{-1} (15 s^{-1}), with a tolerance of $^{+1}_{-2}$ %.

Other rotational frequencies and tolerances may be used by agreement between the manufacturer and the customer, e.g. it may be necessary to use a higher rotational frequency for bearings in the smaller size range in order to obtain an adequate vibration signal. Conversely, it may be necessary to use a lower rotational frequency for bearings in the larger size range to avoid possible roller, rib and raceway damage.

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4.2 Bearing axial load

The bearing load shall be in the axial direction with default values as specified in Table 1.

Other axial loads and tolerances may be used by agreement between the manufacturer and the customer, e.g. depending on bearing design, rotational frequency and lubricant used, it may be necessary to use a higher load to prevent roller/raceway slip, or a lower load to avoid possible roller, rib and raceway damage.

Table 1 — Default values for bearing axial load

Bearing outside diameter *D*		Double-row radial spherical roller bearings		Single-row and double-row radial tapered roller bearings			
				Contact angle ≤ 23°		23° < Contact angle ≤ 45°	
		Default values for bearing axial load					
>	≤	min.	max.	min.	max.	min.	max.
mm		N		N		N	
30	50	45	55	90	110	180	220
50	70	90	110	180	220	360	440
70	100	180	220	360	440	720	880
100	140	360	440	720	880	1 080	1 320
140	170	540	660	1 080	1 320	1 440	1 760
170	200	720	880	1 440	1 760	1 800	2 200

5 Measurement and evaluation methods

5.1 Physical quantity measured

The default physical quantity to be measured is root mean square vibration velocity, v_{rms} (µm/s), in the radial direction.

5.2 Frequency domain

The vibration velocity shall be analysed in one or more bands with default frequency ranges as specified in Table 2.

Other frequency ranges may be considered by agreement between the manufacturer and the customer in those instances where specific ranges have greater importance to successful operation of the bearing. Commonly used examples are listed in Table 3.

Changing the frequency of rotation should always come along with a proportional change of the filter frequencies and acceptance limits and minimum measuring time. Examples are given in Table 3.

Narrow band spectral analysis of the vibration signal may be considered as a supplementary option.

Table 2 — Default frequency ranges for default rotational frequency of 900 min^{-1}

Rotational frequency			Low band (L)		Medium band (M)		High band (H)	
			Nominal band pass frequencies					
nominal	min.	max.	f_{low}	f_{upp}	f_{low}	f_{upp}	f_{low}	f_{upp}
min^{-1}			Hz		Hz		Hz	
900	882	909	25	150	150	900	900	5 000

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Table 3 — Examples of frequency ranges for non-default rotational frequencies

Rotational frequency			Low band (L)		Medium band (M)		High band (H)	
			Nominal band pass frequencies					
nominal	min.	max.	f_{low}	f_{upp}	f_{low}	f_{upp}	f_{low}	f_{upp}
min^{-1}			Hz		Hz		Hz	
1 800	1 764	1 818	50	300	300	1 800	1 800	10 000
700[a]	686	707	20	120	120	700	700	4 000

[a] In case of 700 min^{-1}, cut-off frequencies are rounded (not according to exact relation of the rotational frequency).

5.3 Measurement of pulses and spikes

Detection of pulses or spikes in the time domain velocity signal, usually due to surface defects and/or contamination in the measured bearing, may be considered as a supplementary option. Various evaluation methods exist.

5.4 Measurement

Double-row radial spherical and double-row tapered roller bearings shall be measured with the axial load applied from one side of the stationary ring and the measurement repeated with the axial load on the other side of the stationary ring. Single-row radial tapered roller bearings shall be measured in their axial load acceptance direction only.

In case of two inner or outer rings, they need to be clamped together to ensure repeatability.

For diagnostic purposes, performing multiple measurements with the stationary ring in different angular positions relative to the transducer is appropriate.

For acceptance of the bearing, the highest vibration reading for the appropriate frequency band shall be within the limits mutually agreed between the manufacturer and the customer.

Measurement duration shall be in accordance with ISO 15242-1:2015, 6.5.

For the default rotational frequency of the spindle of 900 min^{-1} the measuring time shall not be less than 1 s.

6 Conditions for measurement

6.1 Bearing conditions for measurement

6.1.1 Prelubricated bearings

Prelubricated (greased, oiled or solid lubricated) bearings, including sealed and shielded types, shall be measured in the as-delivered condition.

6.1.2 Non-prelubricated bearings

Since contamination affects vibration, the bearings shall be effectively cleaned, taking care not to introduce contamination or other sources of vibration.

NOTE Some preservatives meet the lubrication requirements for vibration measuring. In this case, it is not necessary to remove the preservative.

Non-prelubricated bearings shall be adequately lubricated with fine filtered oil, typically having a kinematic viscosity in the range of 10 mm^2/s to 100 mm^2/s, appropriate to bearing type and size.

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The lubrication procedure shall include some running-in to achieve homogeneous distribution of the lubricant within the bearing.

6.2 Conditions of the measurement environment

The bearings shall be measured in an environment that does not influence the bearing vibration.

6.3 Conditions for the measuring device

6.3.1 Stiffness of the spindle/mandrel arrangement

The spindle (including the mandrel) used to hold and drive the bearing shall be so constructed that, except for transmission of rotary motion, it represents a rigid reference system for the rotating axis. The transmission of vibration between the spindle/mandrel arrangement and the bearing in the frequency band used shall be negligible by comparison to the velocities measured.

6.3.2 Loading mechanism

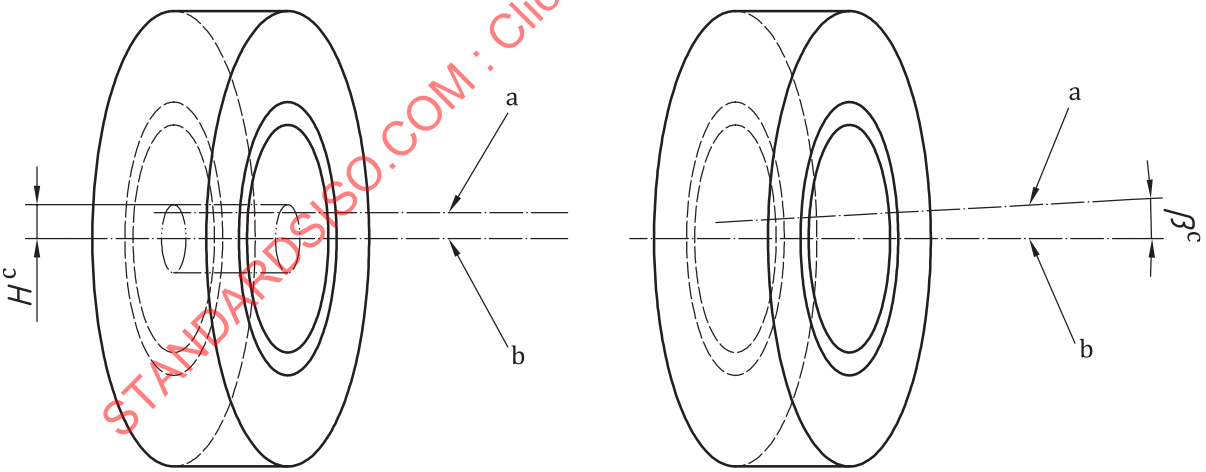
The loading system used to apply load to the measured ring shall be so constructed that it leaves the ring essentially free to vibrate in all radial, axial, angular or flexural modes according to the bearing type, as long as it allows normal bearing operations.

6.3.3 Magnitude and alignment of the external load applied to the bearing

A constant external axial load of the magnitude specified in 4.2 shall be applied to the stationary ring.

The distortion of the bearing rings, caused by contact with elements of the mechanical unit, shall be negligible in comparison to the inherent geometrical accuracy of the measured bearing.

The position and direction of the externally applied load shall coincide with the spindle axis of rotation within the limits given in Figure 1 and Table 4. The measurement shall be as described in Annex A.



Key

a Axis of externally applied load.

b Axis of bearing inner ring rotation.

c Radial and angular deviation of axis of applied load from axis of bearing inner ring rotation; see Table 4.

Figure 1 — Load axis deviation in relation to axis of bearing inner ring rotation

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Table 4 — Values for load axis deviation in relation to axis of bearing inner ring rotation

Bearing outside diameter D		Radial deviation from axis of bearing inner ring rotation H	Angular deviation from axis of bearing inner ring rotation β
>	≤	max.	max.
mm		mm	°
30	50	0,4	0,5
50	100	0,8	
100	140	1,6	
140	170	2,0	
170	200	2,5	

6.3.4 Axial location of the transducer and direction of measurement

The transducer shall be placed and orientated as follows:

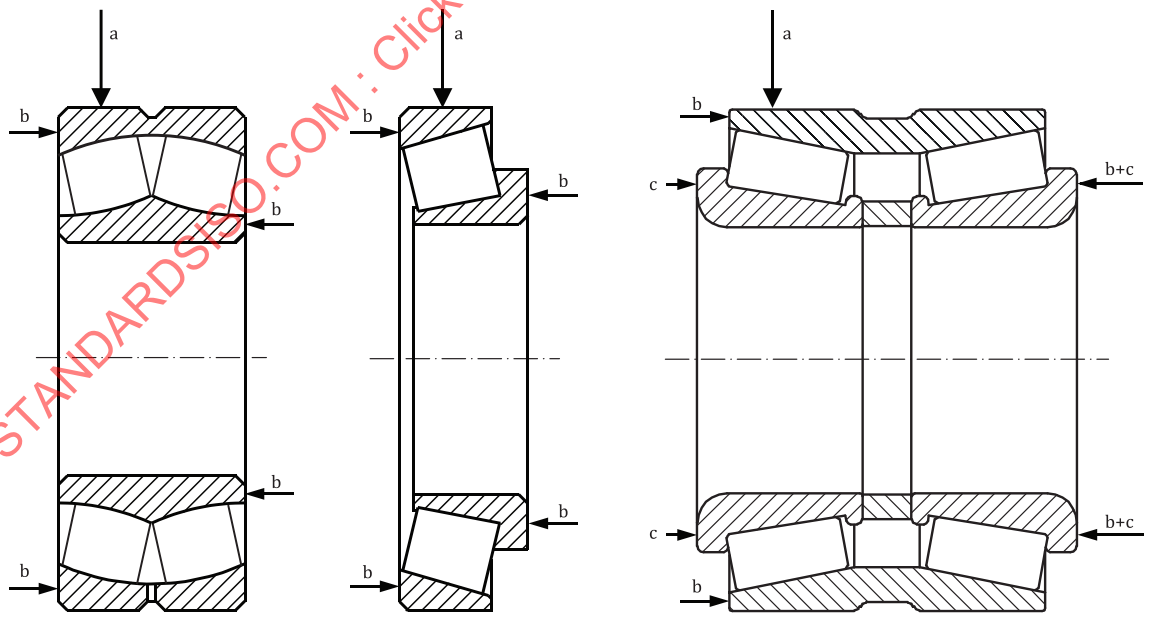
Default axial location: On the surface of the stationary ring in the plane corresponding to the middle of the loaded stationary ring raceway/roller contacts (for stationary outer ring, see Figure 2). The manufacturer shall supply these data.

Once the transducer position is determined, the maximum permissible axial deviation is:

— For outside diameter $D \leq 70$ mm: ±0,5 mm.

— For outside diameter $D > 70$ mm: ±1,0 mm.

Direction: Perpendicular to the axis of rotation (for stationary outer ring, see Figure 3). The deviation from a radial axis shall not exceed 5° in any direction.



Key

a Location and direction of transducer.

b Direction of axial load.

c Direction of axial load applied to keep the inner rings together.

Figure 2 — Vibration measurement — Default transducer location

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