BS ISO 15242-2:2015

BSI Standards Publication

Rolling bearings — Measuring methods for vibration

Part 2: Radial ball bearings with cylindrical bore and outside surface

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National foreword

This British Standard is the UK implementation of ISO 15242-2:2015. It supersedes BS ISO 15242-2:2004 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee MCE/7, Rolling bearings.

A list of organizations represented on this committee can be obtained on request to its secretary.

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INTERNATIONAL STANDARD

ISO 15242-2

Second edition
2015-12-15

Rolling bearings — Measuring methods for vibration —

Part 2:
Radial ball bearings with cylindrical bore and outside surface

Roulements — Méthodes de mesurage des vibrations —

Partie 2: Roulements à billes radiaux, à alésage et surface extérieure cylindriques

Reference number
ISO 15242-2:2015(E)

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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.

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For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 4, *Rolling bearings*.

This second edition cancels and replaces the first edition (ISO 15242-2:2004), which has been technically revised. It also incorporates the Technical Corrigendum ISO 15242-2:2004/Cor 1:2010.

ISO 15242 consists of the following parts, under the general title *Rolling bearings — Measuring methods for vibration*:

— *Part 1: Fundamentals*

— *Part 2: Radial ball bearings with cylindrical bore and outside surface*

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

— *Part 4: Radial cylindrical roller bearings with cylindrical bore and outside surface*

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 this document, 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 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 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 part of ISO 15242 serves to define the detailed method for assessing vibration of radial ball bearings with cylindrical bore and outside surface on a measuring device.

Rolling bearings — Measuring methods for vibration —

Part 2:
Radial ball bearings with cylindrical bore and outside surface

1 Scope

This part of ISO 15242 specifies vibration measuring methods for single-row and double-row radial ball bearings, with a contact angle up to and including 45°.

It covers radial ball bearings with cylindrical bore and outside surface, except bearings with filling slots and three- and four-point-contact ball bearings.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. 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 2041:2009, *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 2041, ISO 5593 and ISO 15242-1 apply.

4 Measurement process

4.1 Rotational frequency

The default rotational frequency shall be 1 800 min^{-1} (30 s^{-1}). The tolerance shall be $^{+1}_{-2}$ % of the nominal rotational frequency.

Other rotational frequencies and tolerances may be used by agreement between the manufacturer and the customer, for example, it may be necessary to use a higher rotational frequency for bearings in the smaller size range (e.g. 3 600 min^{-1}) 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 (e.g. 700 min^{-1}) to avoid possible ball and raceway damage.

4.2 Bearing axial load

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

Table 1 — Default values for bearing axial load

Bearing outside diameter *D*		Single-row and double-row deep groove and self-aligning radial ball bearings		Single-row and double-row angular contact radial ball bearings			
				10° < Contact angle ≤ 23°		23° < Contact angle ≤ 45°	
		Default values for axial load					
>	≤	min.	max.	min.	max.	min.	max.
mm		N		N		N	
10	25	18	22	27	33	36	44
25	50	63	77	90	110	126	154
50	100	135	165	203	247	270	330
100	140	360	440	540	660	720	880
140	170	585	715	878	1 072	1 170	1 430
170	200	810	990	1 215	1 485	1 620	1 980

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

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.

Table 2 — Default Frequency ranges for default rotational frequency of 1 800 min^{-1}

Rotational frequency		Low band (L)		Medium band (M)		High band (H)	
		Nominal band pass frequencies					
min.	max.	f_{low}	f_{upp}	f_{low}	f_{upp}	f_{low}	f_{upp}
min^{-1}		Hz		Hz		Hz	
1 764	1 818	50	300	300	1 800	1 800	10 000

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. Common 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.

Table 3 — Examples of frequency ranges for non-standard 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	
3 600	3 528	3 636	100	600	600	3 600	3 600	20 000
900	882	909	25	150	150	900	900	5 000
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).

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

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

All bearings, except for single-row angular contact ball 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 angular contact ball bearings shall be measured in their foreseen axial load carrying direction only.

The greatest vibration reading for each frequency band shall be within the limits.

For diagnostic purposes, performing multiple measurements with the stationary ring in different angular positions relative to the transducer is appropriate. For measurement duration, see ISO 15242-1:2015, 6.5.

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 viscosity in the range of 10 mm^2/s to 100 mm^2/s, appropriate to bearing type and size.

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

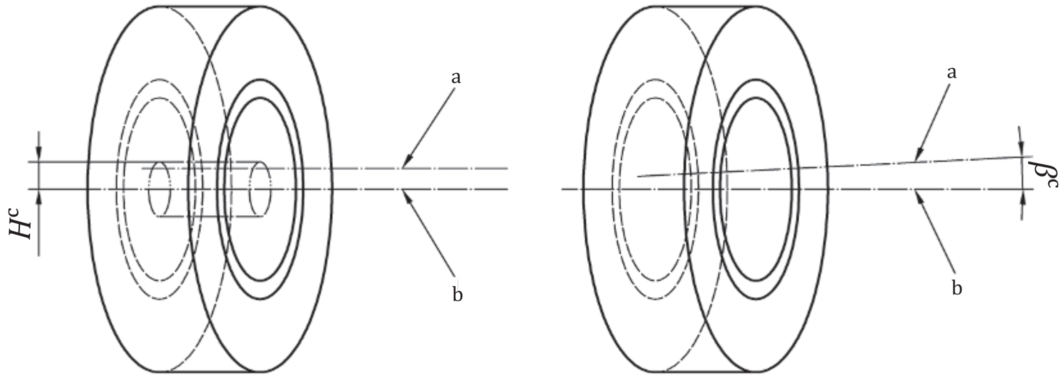
The loading system used to apply load to the measured ring shall be so constructed that it leaves the ring essentially free to vibrate in all radial, axial, angular or flexural modes according to the bearing type, as long as it allows normal bearing operations.

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 (see Annex A for a measurement description).



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

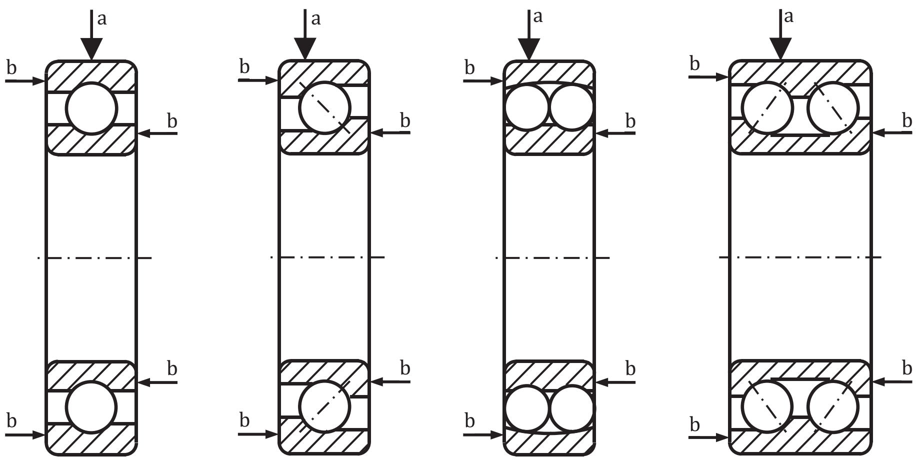
Table 4 — Values for load axis deviation in relation to axis of bearing inner ring rotation

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	°
10	25	0,2	0,5
25	50	0,4	
50	100	0,8	
100	140	1,6	
140	170	2	
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/ball contacts (for stationary outer ring. see Figure 2). The manufacturer shall supply this data.



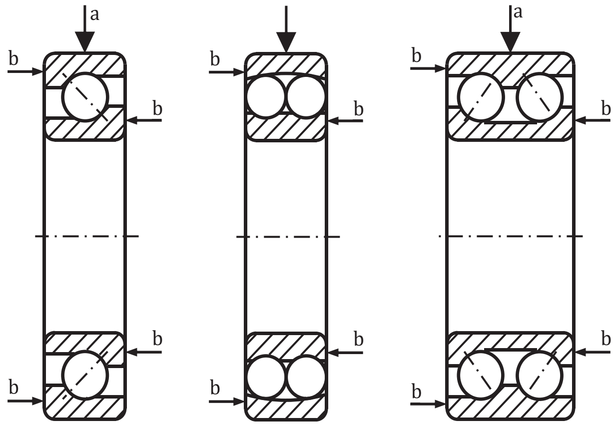
Key

a Location and direction of transducer.

b Direction of axial load.

Figure 2 — Vibration Measurement — Default transducer location

Alternative location (except for deep groove ball bearings): The centre of the stationary ring width (see Figure 3) (this may result in a different vibration signal).



Key

a Location and direction of transducer.

b Direction of axial load.

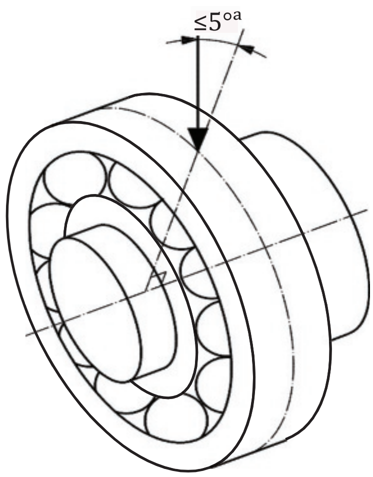
Figure 3 — Vibration Measurement — Alternative transducer location

Once the transducer position is determined, the maximum permissible axial deviation is as follows.

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 (see Figure 4). The deviation from a radial axis shall not exceed 5° in any direction.



Key

a In any direction.

Figure 4 — Deviation from a radial axis

6.3.5 Mandrel

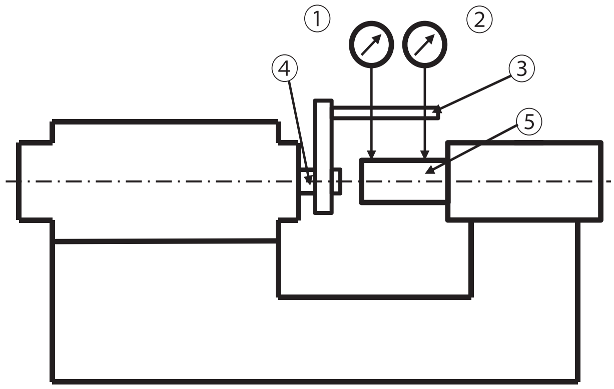
The cylindrical surface of the mandrel, on which the inner ring of the bearing is mounted, shall have an outside diameter to tolerance class f5, in accordance with ISO 286-2, with minimum geometric errors. This will ensure a sliding fit in the bearing bore. Radial and axial run-out shall be verified according to the measuring setup given in ISO 15242-1:2015, Annex C.

Annex A
(normative)

Measurement of external axial loading alignment

The displacement of the loading tool shall be measured using two dial indicators, with an axial distance between them, mounted on a bar attached to the spindle shaft. The spindle shaft shall be rotated slowly and the dial indicators shall measure the radial run-out of the loading piston.

The measured radial run-out from the two dial indicators shall be corrected to the test bearing axial position to enable comparison with the limits given in Table 4.



Key

①, ② dial indicator

③ bar for mounting dial indicators

④ spindle shaft

⑤ loading tool

Figure A.1 — Measurement — External axial loading alignment

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