INTERNATIONAL STANDARD

ISO 15242-4

Second edition
2017-08

Rolling bearings — Measuring methods for vibration —

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

Roulements — Méthodes de mesurage des vibrations —

Partie 4: Roulements radiaux à rouleaux cylindriques, à alésage et surface extérieure cylindriques

Reference number
ISO 15242-4:2017(E)

ISO copyright office
Ch. de Blandonnet 8 • CP 401
CH-1214 Vernier, Geneva, Switzerland
Tel. +41 22 749 01 11
Fax +41 22 749 09 47
copyright@iso.org
www.iso.org

Contents

Page

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.

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).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

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 15242-4:2007), which has been technically revised.

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 the parts in the ISO 15242 series can be found on the ISO website.

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 single-row and double-row radial cylindrical roller bearings with cylindrical bore and outside surface on a measuring device.

Rolling bearings — Measuring methods for vibration —

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

1 Scope

This document specifies vibration measuring methods for single-row and double-row radial cylindrical roller bearings with cylindrical bore and outside surface, under established measurement 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 1 800 min^{-1} (30 s^{-1}) for bearings with outside diameter up to 100 mm and 900 min^{-1} (15 s^{-1}) for outside diameters larger than 100 mm up to 200 mm. 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; 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 and raceway damage.

4.2 Bearing radial and axial loads

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

Other radial 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.

For bearings capable of taking axial load, an axial load of up to 30 N shall be applied on the outer ring to ensure a stable operation.

The method of applying the radial and axial loads is described in 6.3.3.

NOTE Default values for radial loads are resultant values. Actual values depend on load angle used (see Figure 3).

Table 1 — Default values for bearing radial load

Bearing outside diameter *D*		Single-row radial cylindrical roller bearings		Double-row radial cylindrical roller bearings	
		Default values for bearing radial load			
>	≤	min.	max.	min.	max.
mm		N		N	
30	50	135	165	165	195
50	70	165	195	225	275
70	100	225	275	315	385
100	140	315	385	430	520
140	170	430	520	565	685
170	200	565	685	720	880

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

Rotational frequency			Low band (L)		Medium band (M)		High band (H)	
			Nominal band 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
1 800	1 764	1 818	50	300	300	1 800	1 800	10 000

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

Rotational frequency			Low band (L)		Medium band (M)		High band (H)	
			Nominal band 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
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

Single-row and double-row radial cylindrical roller bearings shall be measured with the radial load applied in a radial direction on the stationary ring and perpendicular to the inner ring axis. An axial load may be necessary to ensure stable operation. If the axial load is used, it is applied from one side of the stationary ring. For double-row radial cylindrical roller bearings, the measurement should be repeated, if the design allows, with the axial load on the other side of the stationary ring.

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.

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.

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 measurement 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.

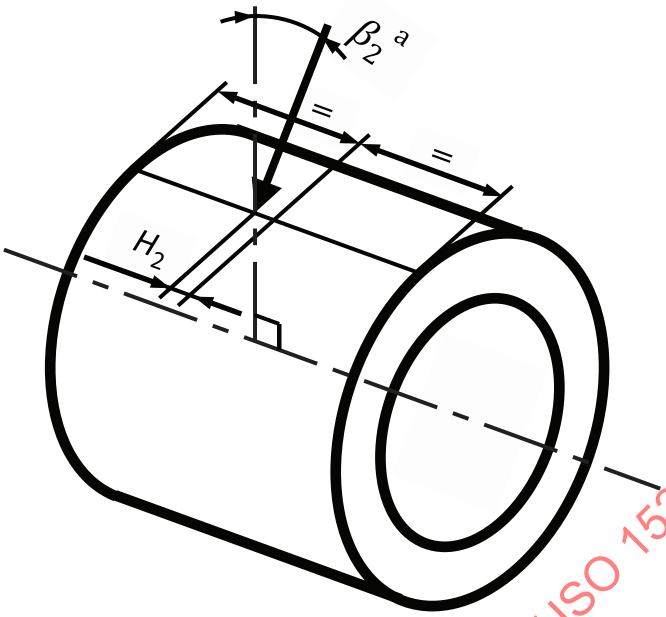
6.3.3 Magnitude and alignment of the external load applied to the bearing

A constant external radial load of the magnitude specified in 4.2 together with the recommended axial load, if applicable, 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 of the externally applied radial load shall coincide with the middle of the outer ring width. The direction of the externally applied radial load shall coincide with the axis perpendicular to the spindle axis of rotation. The position and the direction shall be within the limits given in Figure 1 and Table 4. The measurement shall be as described in Annex A.

The position and direction of the externally applied axial load shall coincide with the spindle axis of rotation within the limits given in Figure 2 and Table 5. The measurement shall be as described in Annex B.



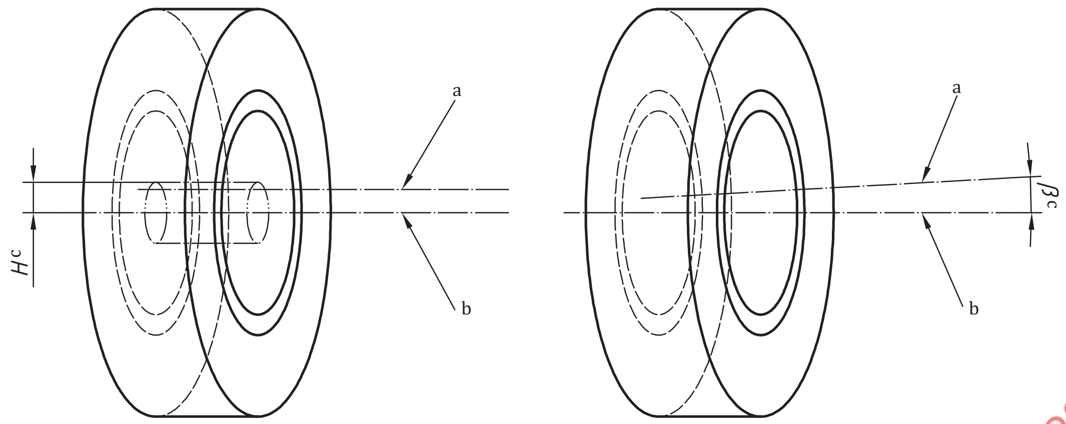
Key

a In any direction.

Figure 1 — Radial load direction deviation in relation to direction and axial position

Table 4 — Values for radial load direction deviation in relation to direction and axial position

Outer ring width		**Axial deviation from the middle of the outer ring width**	**Angular deviation from the axis perpendicular to the spindle axis**
C		H_2	β_2
>	≤	max.	max.
mm		mm	°
10	20	0,3	1
20	40	0,5	
40	70	1	



Key

a Axis of externally applied axial load.

b Axis of bearing inner ring rotation.

c Radial and angular deviation of axis of applied axial load from axis of bearing inner ring rotation (see Table 5).

Figure 2 — Axial load axis deviation in relation to axis of bearing inner ring rotation

Table 5 — Values for axial 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	70	0,6	
70	100	0,8	
100	140	1,6	
140	170	2,0	
170	200	2,5	

6.3.4 Location of the transducer and direction of measurement

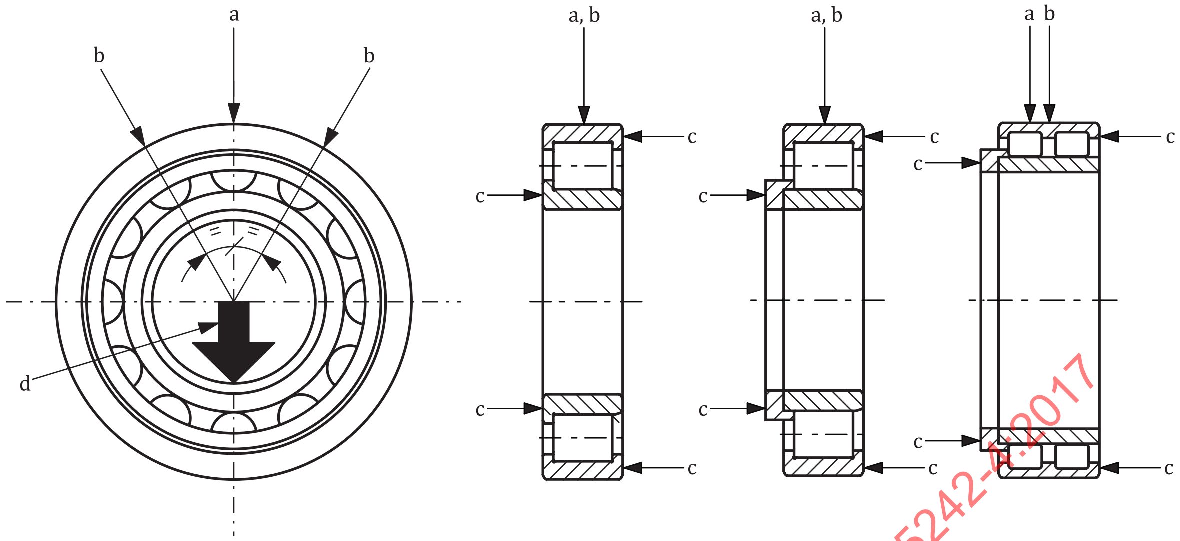
The transducer shall be placed and orientated as follows:

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 3). The manufacturer shall supply this data.

Alternative axial location: On the surface of the stationary ring in the plane corresponding to the middle of the stationary ring (for stationary outer ring, see Figure 4).

Default angular location: On the surface of the stationary ring in the plane corresponding to the direction of the resultant radial load (for stationary outer ring, see Figure 3).

The radial loads shall be applied in a manner that can be resolved into a single radial load as shown in Table 1.



Key

a Transducer location and direction.

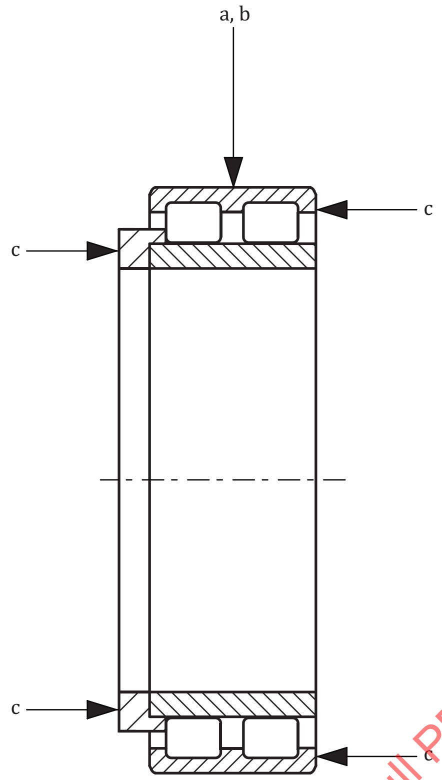
b Applied radial load.

c Axial load (if any) direction.

d Resultant of applied radial loads (see Table 1).

NOTE Other rib configurations can be measured in a manner agreed between manufacturer and customer.

Figure 3 — Vibration measurement — Default transducer location



Key

a Transducer location and direction.

b Applied radial load.

c Axial load (if any) direction.

Figure 4 — Vibration measurement — Alternative transducer location

Once the transducer position is determined, the maximum permissible axial and angular deviations are as follows:

Axial location:

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

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

Angular location:

— For all outside diameters: ±5°.

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