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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

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 15242-3 was prepared by Technical Committee ISO/TC 4, *Rolling bearings*.

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 of rotating rolling bearings is a complex physical phenomenon dependent on the conditions of operation. Measuring the vibration output of an individual bearing under a certain set of conditions does not necessarily characterize the vibration output 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 complicated further 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, which 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 this part of ISO 15242.

Vibration of rotating rolling bearings can be assessed by any of a number of means using various types of transducers and test conditions. No simple set of values characterizing 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 testing (e.g. as a manufacturing process diagnostic or an assessment of the product quality) is required to select the most suitable method for testing. 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 for the purposes of this part of ISO 15242.

This part of ISO 15242 serves to define the detailed method for assessing vibration of radial spherical and tapered roller bearings with cylindrical bore and outside surface on a test rig.



# Rolling bearings — Measuring methods for vibration —

## Part 3:

# Radial spherical and tapered roller bearings with cylindrical bore and outside surface

## 1 Scope

This part of ISO 15242 specifies vibration measuring methods for double-row radial spherical roller bearings and single-row and double-row radial tapered roller bearings, with a contact angle up to and including 45°, under established test conditions.

It covers double-row radial spherical roller bearings as well as single-row and double-row radial tapered roller bearings with cylindrical bore and outside surface.

## 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 reference document (including any amendments) applies.

ISO 286-2, *ISO system of limits and fits — Part 2: Tables of standard tolerance grades and limit deviations for holes and shafts*

ISO 554, *Standard atmospheres for conditioning and/or testing — Specifications*

ISO 558, *Conditioning and testing — Standard atmospheres — Definitions*

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

ISO 2041, *Vibration and shock — Vocabulary*

ISO 3205, *Preferred test temperatures*

ISO 3448, *Industrial liquid lubricants — ISO viscosity classification*

ISO 5593, *Rolling bearings — Vocabulary*

ISO 15242-1:2004, *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.

## 4 Measurement process

### 4.1 Speed of rotation

The default speed of rotation shall be  $15 \text{ s}^{-1}$  (900 r/min), with a tolerance of  ${}_{-2}^{+1} \%$ .

Other speeds and tolerances may be used by agreement between the manufacturer and the customer; e.g. it may be necessary to use a higher speed for bearings in the smaller size range [ $20 \text{ s}^{-1}$  to  $30 \text{ s}^{-1}$  (1 200 r/min to 1 800 r/min)] in order to obtain an adequate vibration signal. Conversely, it may be necessary to use a lower speed for bearings in the larger size range [ $7,5 \text{ s}^{-1}$  to  $10 \text{ s}^{-1}$  (450 r/min to 600 r/min)] to avoid possible roller, rib 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 <i>D</i>			Double-row radial spherical roller bearings		Single-row and double-row radial tapered roller bearings			
					Contact angle $\leq 23^\circ$		Contact angle $> 23^\circ \leq 45^\circ$	
	>	$\leq$	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	

Other axial loads and tolerances may be used by agreement between the manufacturer and the customer; e.g. depending on bearing design 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.

## 5 Measurement and evaluation methods

### 5.1 Physical quantity measured

The default physical quantity to be measured is vibration velocity,  $v_{r.m.s.}$  ( $\mu\text{m/s}$ ), in the radial direction.

### 5.2 Frequency range

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



Table 2 — Default frequency ranges

Speed of rotation		Low band (L) <sup>a</sup>		Medium band (M) <sup>a</sup>		High band (H) <sup>a</sup>	
		Default frequencies					
min.	max.	$f_{low}$	$f_{high}$	$f_{low}$	$f_{high}$	$f_{low}$	$f_{high}$
r/min		Hz		Hz		Hz	
882	909	50	150	150	900	900	5 000

<sup>a</sup> For rotational speeds other than the nominal 900 r/min, the frequency range should be adjusted in proportion to the speed. For practical reasons, frequencies lower than 50 Hz or higher than 10 000 Hz should not be used, unless agreed upon between the manufacturer and the customer.

NOTE 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.

The use of spectral analysis of the vibration signal is an alternative.

### 5.3 Peak measurement

Detection of peaks or spikes in the time domain velocity signal, usually due to surface defects and/or contamination in the test bearing, may be considered as a supplementary option by agreement between the manufacturer and the customer. Various evaluation methods exist depending on the bearing type and the application.

### 5.4 Testing sequence

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

For diagnostic purposes, performing multiple measurements with the outer ring in different angular positions relative to the pick-up is appropriate.

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

For test duration see ISO 15242-1:2004, 6.5.

## 6 Conditions for measurement

### 6.1 Bearing conditions for measurement

#### 6.1.1 Prelubrication

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

NOTE Some greases, oils and solid lubricants increase or decrease bearing vibration levels in comparison with the reference conditions in 6.1.2 and 6.1.3.

The following reference condition procedures (6.1.2 and 6.1.3) normally apply for bearings that are not prelubricated. However, they may also be used in cases of dispute regarding the source of unacceptable vibration levels.

### **6.1.2 Cleanliness of the bearing**

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

NOTE Some preservatives may meet the lubrication requirements (see 6.1.3) for vibration testing. In this case, it is not necessary to remove the preservative.

### **6.1.3 Lubrication**

Before testing, bearings shall be adequately lubricated with filtered oil (0,8 µm maximum filter), having a nominal viscosity in the range of 10 mm<sup>2</sup>/s to 100 mm<sup>2</sup>/s. Additional information is given in ISO 3448.

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

NOTE Other lubricant viscosities may be agreed upon between the manufacturer and the customer in order to suit the application.

## **6.2 Conditions of the test environment**

The bearings shall be tested at room temperature in an environment that does not influence the bearing vibration. Additional information is given in ISO 554, ISO 558 and ISO 3205.

## **6.3 Conditions for the test device**

### **6.3.1 Stiffness of the spindle/mandrel arrangement**

The spindle (including the mandrel) used to hold and drive the bearing inner ring shall be so designed and constructed that, except for transmittal of rotary motion, it represents essentially a rigid reference system for the inner ring axis. The transmission of vibration between the spindle/mandrel arrangement and the bearing inner ring in the frequency band used shall be negligible by comparison to the velocities measured (in cases of dispute, precise values shall be agreed upon between the manufacturer and the customer).

### **6.3.2 Loading mechanism**

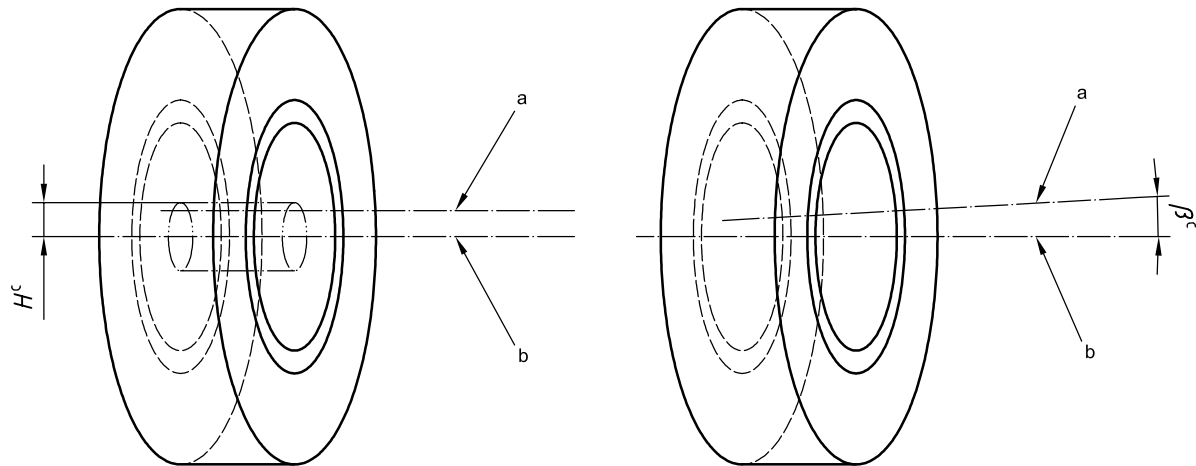
The loading system used to apply load to the bearing outer ring shall, ideally, be designed and constructed so that it leaves the ring essentially free to vibrate in all radial, axial, angular or flexural modes according to the bearing type.

### **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 outer 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 bearing under test.

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 3. See Annex A for a measurement description.



- a Axis of externally applied load.  
 b Axis of bearing inner ring rotation.  
 c See Table 3.

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

**Table 3 — Values for load axis deviation in relation to axis of bearing inner ring rotation**

Bearing outside diameter		Radial deviation from axis of bearing inner ring rotation	Angular deviation from axis of bearing inner ring rotation
$D$		$H$	$\beta$
>		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 pick-up and direction of measurement

The pick-up shall be placed and orientated as follows:

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

Once the pick-up position is determined, the maximum permissible axial deviation is:

- For outside diameter  $\leq 70$  mm:  $\pm 0,5$  mm.
- For outside diameter  $> 70$  mm:  $\pm 1,0$  mm.

**Direction:** Perpendicular to the axis of rotation (see Figure 3). The deviation from a radial axis shall not exceed  $5^\circ$  in any direction.

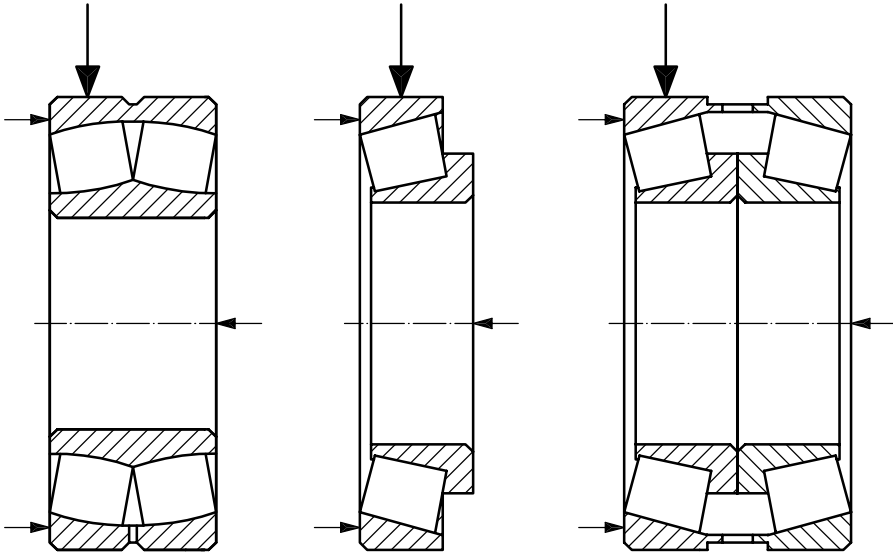
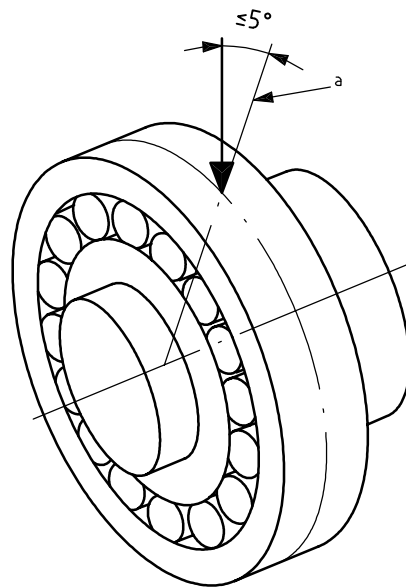


Figure 2 — Measurement — Pick-up default axial location



<sup>a</sup> In any direction.

Figure 3 — 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 grade f5, in accordance with ISO 286-2, with minimal geometric errors. This will ensure a sliding fit in the bearing bore.

**6.4 Requirements for the operator**

A competent operator shall ensure that vibration measurements are taken in accordance with this part of ISO 15242.

## Annex A (normative)

### Measurement of external axial loading alignment

The displacement of the loading tool shall be measured using two dial gauges, with an axial distance between them, mounted on a bar attached to the spindle shaft (see Figure A.1). The spindle shaft shall be rotated slowly and the dial gauges shall measure the radial run out of the loading piston.

The measured radial run out from the two dial gauges shall be corrected to the test bearing axial position, to enable comparison with the limits given in Table 3.

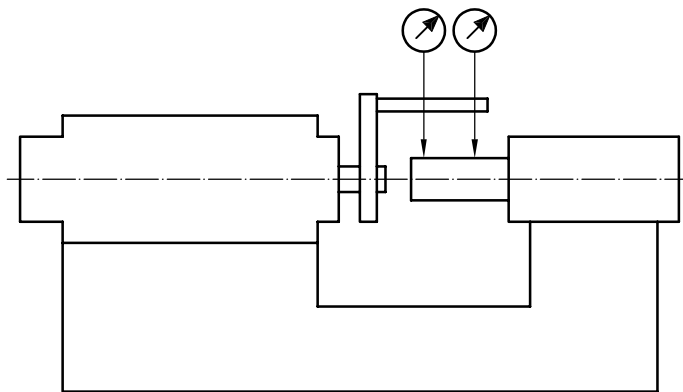


Figure A.1 — Measurement – External axial loading alignment

