INTERNATIONAL STANDARD

ISO 4386-1

Third edition
2012-10-15

Plain bearings — Metallic multilayer plain bearings —

Part 1: Non-destructive ultrasonic testing of bond of thickness greater than or equal to 0,5 mm

Paliers lisses — Paliers lisses métalliques multicouches —

Partie 1: Contrôle non destructif aux ultrasons des défauts d'adhérence d'épaisseur supérieure ou égale à 0,5 mm

Reference number
ISO 4386-1:2012(E)

COPYRIGHT PROTECTED DOCUMENT

ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

Published in Switzerland

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.

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 4386-1 was prepared by Technical Committee ISO/TC 123, *Plain bearings*, Subcommittee SC 2, *Materials and lubricants, their properties, characteristics, test methods and testing conditions*.

This third edition cancels and replaces the second edition (ISO 4386-1:1992), which has been technically revised.

ISO 4386 consists of the following parts, under the general title *Plain bearings — Metallic multilayer plain bearings*:

— *Part 1: Non-destructive ultrasonic testing of bond of thickness greater than or equal to 0,5 mm*

— *Part 2: Destructive testing of bond for bearing metal layer thicknesses greater than or equal to 2 mm*

— *Part 3: Non-destructive penetrant testing*

Plain bearings — Metallic multilayer plain bearings —

Part 1: Non-destructive ultrasonic testing of bond of thickness greater than or equal to 0,5 mm

1 Scope

This part of ISO 4386 specifies an ultrasonic testing method for determining bond defects between the bearing metal and the backing. The test can be performed on metallic multilayer plain bearings consisting of steel- or copper-based material backings lined with bearing metal based on lead and tin, with layer thicknesses greater than or equal to 0,5 mm. For cast iron backings, this part of ISO 4386 is applicable with restrictions.

The ultrasonic signal reflected by the bond interface between the bearing metal and the backing is used to determine bonding defects.

Ultrasonic testing is not possible on edge zones of sliding surface, flange sides, joint areas, oil holes, grooves, etc. in a range of less than half the diameter of the ultrasonic probe because of undefined reflections. The same applies to bearings with dovetail keying grooves at the bond. Ultrasonic testing of bond does not apply along the edges of the dovetails.

Evaluation of the bond on the visible transition from the backing to the bearing metal (on end faces or joint faces) is only practicable by the penetrant testing method specified in ISO 4386-3.

This part of ISO 4386 only describes in detail the pulse-echo method. Within the meaning of this part of ISO 4386, the ultrasonic method only permits a qualitative evaluation of the bonding and not a quantitative determination of the bond strength. The ultrasonic bond test differs only between bond and bond defect.

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 4386-3, *Plain bearings — Metallic multilayer plain bearings — Part 3: Non-destructive penetrant testing*

3 Symbols

The following symbol is used in this part of ISO 4386.

Ra Surface roughness

4 Test equipment

4.1 Ultrasonic instrument

Pulse-echo ultrasonic instrument using rectified A-scope presentation shall be used for the test. The instrument shall be fitted with a calibrated attenuator, reading in decibels, and adjustable time base ranges.

4.2 Probe

For the standard procedure, normal beam probes shall be chosen with size and frequency in relation to the thickness of the bearing layer, backing thickness and backing material. The typical range of diameters is from 24 mm for 2 MHz to 6 mm for 10 MHz probes. For layer thickness < 1 mm, testing with dual-element probes may be favourable.

4.3 Reference block

The time base range shall be adjusted, using a reference block corresponding to the thicknesses of the bearing to be inspected.

5 Preparation of test surface

The test surface shall have a surface roughness of $Ra \leq 5$ µm. After machining, remove dirt and oil using suitable cleaning agents.

6 Testing

6.1 General

Test plain bearings using either contact scanning, with light machine oil as a couplant, or using immersion scanning. Suppression and swept-gain functions shall be switched off. The preferred test is performed from the bearing metal side under consideration of the back-wall echo. Bearings with smaller diameters can be difficult to inspect by contact scanning from the bearing metal side because of limited access of the ultrasonic probe. In such a case, contact scanning from the back surface may be used.

6.2 Testing with a back-wall echo

General preconditions are:

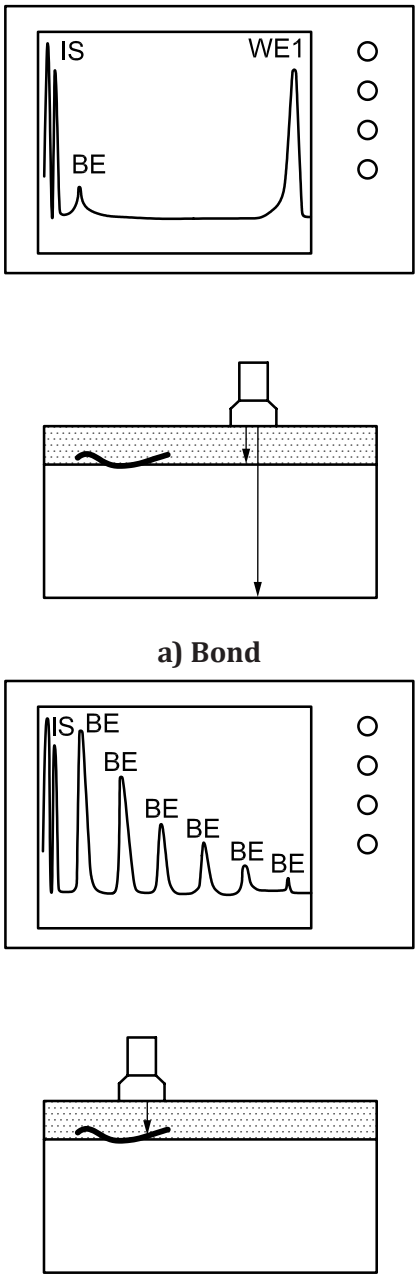
a) free access with the probe to the contact surface;

b) back-wall is always parallel to the bearing metal surface;

c) no hollow spaces within the backing material (drilled holes, channels, etc.).

The time base range and sensitivity shall be adjusted so that at least the first back-wall echo is visible on the right-hand side of the screen at approximately 80 % of full screen height. In Figure 1, the bond echo (BE) is on the left-hand side of the screen near the input signal (IS). If in doubt about having the first back-wall echo (WE1) on the screen, use a reference block for adjustment.

Bond defect is given when the back-wall echo breaks down and at the same time, the bond echo on the left-hand side of the screen increases and repeats multiple times (see Figure 1). The border of the detected defect area is on the middle of the probe diameter when the back-wall echo is reduced to its half height under the above-mentioned conditions.



Key

BE	bond echo
IS	input signal
WE_1	first back-wall echo

Figure 1 — Testing with a back-wall echo

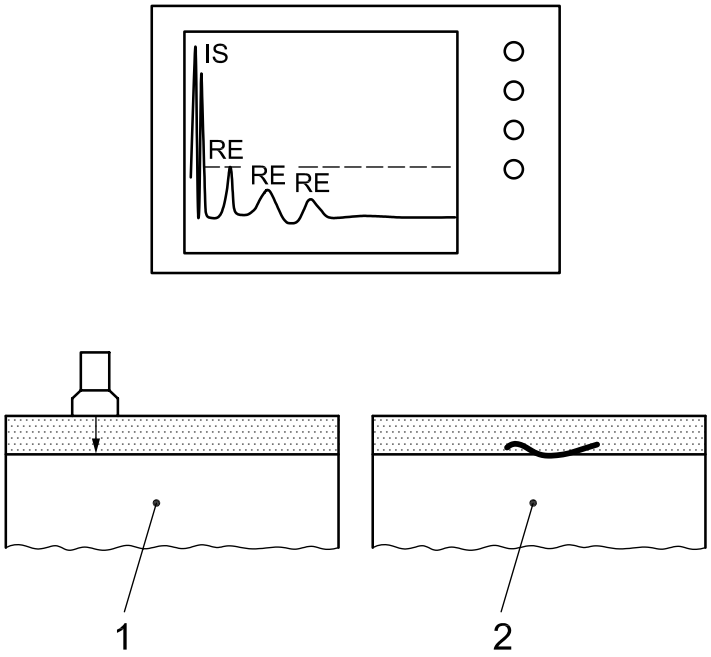
6.3 Testing without a back-wall echo

If the preconditions of 6.2 are not fulfilled, testing without back-wall echo becomes necessary.

Use a reference piece with good bond between similar backing material and similar bearing metal lining as the tested bearing. Adjust the reference bond echo to 20 % of full screen height; see Figure 2.

Bond is given when the echo signal of the tested plain bearing is similar to the adjusted reference bond echo; see Figure 3.

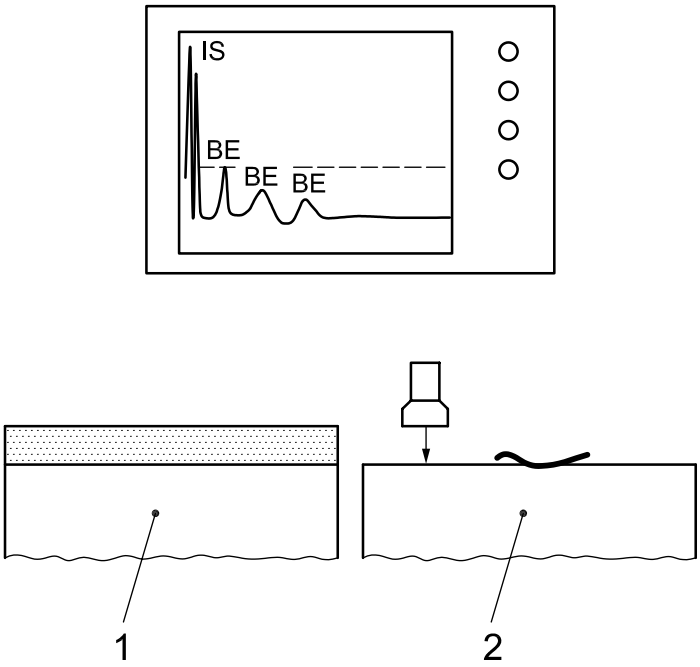
Defective bond is given when the bond echo on the plain bearing is significant above the reference bond height; see Figure 4.



Key

1 reference block
2 test object
IS input signal
RE reference echo

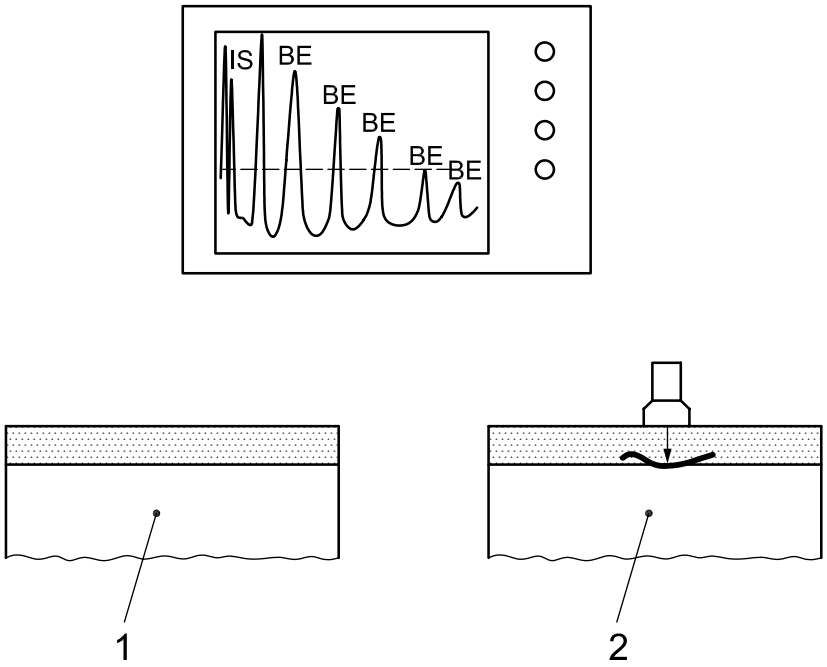
Figure 2 — Testing without a back-wall echo Display and adjustment of reference echo



Key

1	reference block
2	test object
IS	input signal
BE	bond echo

Figure 3 — Testing without a back-wall echo Display of bond



Key

1	reference block
2	test object
IS	input signal
BE	bond echo

Figure 4 — Testing without a back-wall echo — Display of bond defect

7 Test classes

The test shall be carried out in accordance with one of the following three classes, which are of increasing severity.

— Class 1: complete coverage of the testable area of the edge zones of the sliding surface at flange sides and joint areas; point-type coverage of the sliding surface.

— Class 2: complete coverage of the testable area of the edge zones of the sliding surface at flange sides and joint areas. In addition, complete coverage of the area of maximum loading (for example, in the case of a radial bearing with a bearing force acting vertically downwards, this would be in the range from 60° to 120° with respect to the sliding surface).

— Class 3: complete coverage of the testable area of the flange areas and sliding surface line-by-line. In order to cover all points, testing is carried out with an overlap of the lines of 20 % of the probe diameter.

8 Defect groups

As a guideline, Table 1 shows five different defect groups. The applicable defect groups shall be agreed between the customer and supplier in advance. It is recommended to define different defect groups for different regions of a bearing, depending on the kind, size and direction of the load (for example, defect group A for the high-loaded region and defect group B1 for the remaining regions of a journal bearing). Generally, defect group A should be reserved for high-loaded bearings and therefore the area of maximal loading.

Table 1 — Defect groups

Defect group	Max. dimension of single defects	Max. total defect
	mm^2	Percentage of bonding area[a], %
A	0	0
B1	$0{,}75b$[b]	1
B2	$2b$[b]	1
C	$2b$[b]	2
D	$4b$[b]	5

[a] The bonding area is the lined area of a journal bearing or a thrust plain bearing element.

[b] The width, b, in millimetres, represents in case of journal bearing, the functional cylindrical length and in the case of thrust segments or rings, the distance between the inner and outer diameter. The summary of single defects may not exceed the maximum total defect size.

9 Evaluation

9.1 General

The tests should be carried out by operators educated for ultrasonic testing.

When evaluating the test results in accordance with this part of ISO 4386, bond defects equal to or larger than half the probe diameter are normally estimated.

In case of any irregularities on bond surface of a bearing backing, the relevant area shall be collected and documented in the drawing before lining with bearing metal. This avoids misinterpretation during ultrasonic testing as a bond defect.

If the bond echo signal becomes diffuse and missing scanning contact can be excluded, this indicates porosities within the bearing metal. Such areas of porosity shall be regarded as defects due to the uncertainty of evaluation of the bond.

For inspection of the bearing, the following steps shall be considered.

a) After local repair work by a soldering procedure, the bond test shall be repeated in the respective area.

   On edge zones, the visible transition from the backing to the bearing metal shall be checked in accordance with non-destructive penetrant testing specified in ISO 4386-3.

b) Evaluation of defect distribution:

   detected bond defects on new lined bearings give additional information depending on its location and distribution:

   1) single bond defects in the flange side edge zone or in the corner between flange side - joint side: these defects are typically based on local temperature losses during the casting procedure. Usually these defects can be repaired by soldering procedure without any quality reduction;

   2) single bond defects on sliding surface: if repair work by soldering can be carried out, successful sufficient bond strength is given and no quality reduction is given;

   3) many bond defects distributed on sliding surface: many detected bond defects distributed on the total sliding surface and growing defects during the soldering procedure are indicators for low bond strength at all. Complete renewal of bearing metal lining is recommended.

9.2 Marking of defective areas

If possible, defective areas should be indicated by straight boundary lines. The location of the centre of the probe is decisive for determining the transition line between bond and no bond.

Isolated point-type defects shall be marked with a value equal to half the probe diameter.

If the distance between two or more defects is less than one tenth of the bearing width, *b*, these defects shall be regarded as one continuous defect.

9.3 Designation

With reference to this part of ISO 4386, the test class and the defect group shall be indicated as follows.

EXAMPLE Test Class 2, defect group B1 is designated as follows: **Test ISO 4386-1- 2 B1**

Bibliography

[1] ISO 6280, *Plain bearings — Requirements on backings for thick-walled multilayer bearings*

ICS 21.100.10

Price based on 9 pages