



**International
Standard**

ISO 16063-31

**Methods for the calibration of
vibration and shock transducers —**

**Part 31:
Testing of transverse vibration
sensitivity**

AMENDMENT 1

*Méthodes pour l'étalonnage des transducteurs de vibrations et
de chocs —*

Partie 31: Essai de sensibilité aux vibrations transversales

AMENDEMENT 1

**First edition
2009-08-15**

**AMENDMENT 1
2025-03**



COPYRIGHT PROTECTED DOCUMENT

© ISO 2025

All rights reserved. Unless otherwise specified, or required in the context of its implementation, no part of this publication may be reproduced or utilized otherwise in any form or by any means, electronic or mechanical, including photocopying, or posting on the internet or an intranet, without prior written permission. Permission can be requested from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

Published in Switzerland

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 document 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).

ISO draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). ISO takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, ISO had not received notice of (a) patent(s) which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at www.iso.org/patents. ISO shall not be held responsible for identifying any or all such patent rights.

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

For an explanation of 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 www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 108, *Mechanical vibration, shock and condition monitoring*.

A list of all parts in the ISO 16063 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

STANDARDSISO.COM : Click to view the full PDF of ISO 16063-31:2009/Amd 1:2025

Methods for the calibration of vibration and shock transducers —

Part 31: Testing of transverse vibration sensitivity

AMENDMENT 1

7.3

Add the following subclause at the end of Clause 7:

"7.3 Determination of the transverse sensitivity using elliptical orbits

Annex B shall be used for testing of transverse sensitivity using elliptical orbits."

Annex B

Add the following annex after Annex A, before the Bibliography.

Annex B (normative)

Testing of transverse sensitivity using elliptical orbits

This annex gives a brief insight into a method that can be used to test the transverse sensitivity of vibration and shock transducers in the bi-axial transverse directions by actuating the test set up exciters in the X- and Y- directions at any phase and amplitude as described in Formulae (B.1) and (B.2). A full description of a method that can be used is included in Reference [13].

$$a_X(t) = \hat{a}_X \cos(2\pi ft + \phi_X) \quad (\text{B.1})$$

$$a_Y(t) = \hat{a}_Y \cos(2\pi ft + \phi_Y) \quad (\text{B.2})$$

where

- $a_X(t)$ is the time-varying value of the X-axis acceleration;
- \hat{a}_X is the amplitude of the acceleration component along the X-axis;
- ϕ_X is the initial phase of the acceleration component along the X-axis;
- $a_Y(t)$ is the time-varying value of the Y-axis acceleration;
- \hat{a}_Y is the amplitude of the acceleration component along the Y-axis;
- ϕ_Y is the initial phase of the acceleration component along the Y-axis;
- f is the frequency of oscillation; and
- t is the time.

In general case, Formulae (B.1) and (B.2) describe an elliptical orbit motion in the X-Y plane and in those cases the transducer under test output is given by Formula (B.3).

$$V_T(t) = S_X \hat{a}_X \cos(2\pi ft + \phi_X) + S_Y \hat{a}_Y \cos(2\pi ft + \phi_Y) \quad (\text{B.3})$$

where

- S_X is the transverse sensitivity in the X-direction;
- S_Y is the transverse sensitivity in the Y-direction.

In addition, the expressions that describe the relationships between the magnitude \hat{V}_T and the initial phase ϕ of the output $V_T(t)$ and the amplitudes and initial phases of the X- and Y-axis accelerations are given by Formulae (B.4) and (B.5).

$$\hat{V}_T^2(t) = (S_X \hat{a}_X \cos \phi_X + S_Y \hat{a}_Y \cos \phi_Y)^2 + (S_X \hat{a}_X \sin \phi_X + S_Y \hat{a}_Y \sin \phi_Y)^2 \quad (\text{B.4})$$

$$\tan \phi = (S_X \hat{a}_X \sin \phi_X + S_Y \hat{a}_Y \sin \phi_Y) / (S_X \hat{a}_X \cos \phi_X + S_Y \hat{a}_Y \cos \phi_Y) \quad (\text{B.5})$$

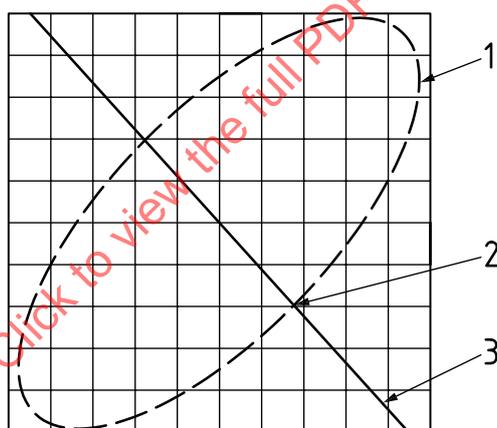
In Formulae (B.4) and (B.5), the magnitudes of the acceleration components, \hat{a}_X and \hat{a}_Y , the initial phases of the acceleration components, ϕ_X and ϕ_Y , the magnitude of the output, \hat{V}_T , and the initial phase of the output, ϕ , can be obtained by means of measurement. Formula (B.4) describes that the transverse sensitivities, S_X and S_Y , locate on a standard ellipse which is determined by the magnitudes, \hat{a}_X and \hat{a}_Y , and the initial phases, ϕ_X and ϕ_Y , of the X- and Y-axis accelerations as well as the amplitude of the output, \hat{V}_T . Formula (B.5) describes that the transverse sensitivities, S_X and S_Y , locate on a straight line passing through the origin, whose slope is given by Formula (B.6).

$$K = S_Y / S_X = -(\hat{a}_X \sin \phi_X - \hat{a}_X \cos \phi_X \tan \phi) / (\hat{a}_Y \sin \phi_Y - \hat{a}_Y \cos \phi_Y \tan \phi) \quad (\text{B.6})$$

Then the transverse sensitivity of the transducer under test can be determined by the intersection of the sensitivity ellipse that is expressed in Formula (B.4) and the sensitivity straight line that is expressed by Formula (B.5), as shown in Figure B.1. In addition, the formulae for the transverse sensitivity are given by Formulae (B.7) and (B.8).

$$S_T = \sqrt{S_X^2 + S_Y^2} = \hat{V}_T(t) \sqrt{1 + K^2} / \sqrt{\hat{a}_X^2 + 2\hat{a}_X \hat{a}_Y \cos(\phi_X - \phi_Y) K + \hat{a}_Y^2 K^2} \quad (\text{B.7})$$

$$\beta_T = \tan^{-1}(S_Y / S_X) = \tan^{-1}(K) \quad (\text{B.8})$$



Key

- 1 sensitivity ellipse
- 2 transverse sensitivity
- 3 sensitivity line

Figure B.1 — Transverse sensitivities determined by the intersection of the sensitivity ellipse and the sensitivity line

Circular orbit motion is a special case of the elliptical orbit motion where the acceleration components along the X- and the Y-axes have the same magnitude (i.e. $\hat{a}_X = \hat{a}_Y = \hat{a}_T$) and are in quadrature with each other (i.e. $\phi_X = 0$ and $\phi_Y = -90^\circ$ in Formulae (B.6), (B.7), and (B.8)). In this case, the transverse sensitivity S_T and its angle β_T can be obtained by using Formulae (B.9) and (B.10).

$$S_T = \sqrt{S_X^2 + S_Y^2} = \hat{V}_T / \hat{a}_T \quad (\text{B.9})$$

$$\beta_T = \tan^{-1} (S_Y/S_X) = -\phi \quad (\text{B.10})$$

Bibliography

Add the following at the end of the list of references:

[13] LIU Z, CAI C, YU M, et al. Testing of accelerometer transverse sensitivity using elliptical orbits. *MAPAN*, 2018, 33(3), 217-226. DOI: 10.1007/s12647-018-0255-7

STANDARDSISO.COM : Click to view the full PDF of ISO 16063-31:2009/Amd 1:2025