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Methods for the calibration of vibration and shock transducers —

Part 17:
Primary calibration by centrifuge

Méthodes pour l'étalonnage des transducteurs de vibrations et de chocs —
Partie 17: Étalonnage primaire par centrifugeur

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Foreword

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The committee responsible for this document is ISO/TC ISO/TC 108, *Mechanical vibration, shock and condition monitoring*, Subcommittee SC 3, *Use and calibration of vibration and shock measuring instruments*.

ISO 16063-17 replaces ISO 5347-7:1993.

Methods for the calibration of vibration and shock transducers – Part 17: Primary calibration by centrifuge

1 Scope

ISO 16063 comprises a series of documents dealing with methods for the calibration of vibration and shock transducers.

This part of ISO 16063 lays down detailed specifications for the instrumentation and procedure to be used for primary calibration of accelerometers using centrifuge calibration.

This part of ISO 16063 applies to rectilinear accelerometers with zero-frequency response, mainly of the strain gauge or piezoresistive type, and to primary standard and working transducers.

It is applicable for a calibration range from 10 m/s^2 to 20 000 m/s^2 (higher accelerations possible) at 0 Hz.

The limits of uncertainty applicable are ± 1 % of reading.

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 2041, *Mechanical vibration, shock and condition monitoring — Vocabulary*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 2041 apply.

4 Requirements for apparatus and environmental conditions

4.1 Calibration environment

The standard reference atmospheric conditions are: (23 ± 3) °C; and 75 % relative humidity max. The temperature, humidity and atmospheric pressure shall be measured and reported.

4.2 Balanced table or arm (rotational table)

The main component of the calibration apparatus consists of balanced table or arm which rotates about a vertical axis with uniform angular speed. For the calibration range from 10 m/s^2 to 100 m/s^2 the table/arm shall be level within ± 0,5°of horizontal. For ranges higher than 100 m/s^2, levelling is allowed to within ± 2°. The calibration apparatus shall be placed on a sufficiently heavy base which is sufficiently isolated from the floor vibration.

The rotational frequency shall be uniform within ± 0,05 % of the nominal value.

The transducers axis of sensitivity shall be aligned within ± 0,5°.

The radius of rotation to the centre of the transducer mass element shall be measured with an uncertainty less than ±0,15 %. If it is not possible, method 2 shall be obtained.

If the accelerometer is substituted by impedances not sensitive to acceleration, the hum and noise when the centrifuge is rotating at the calibration speeds shall be at least 0,5 % below reading.

The apparatus of the main component is illustrated by Figure 1.

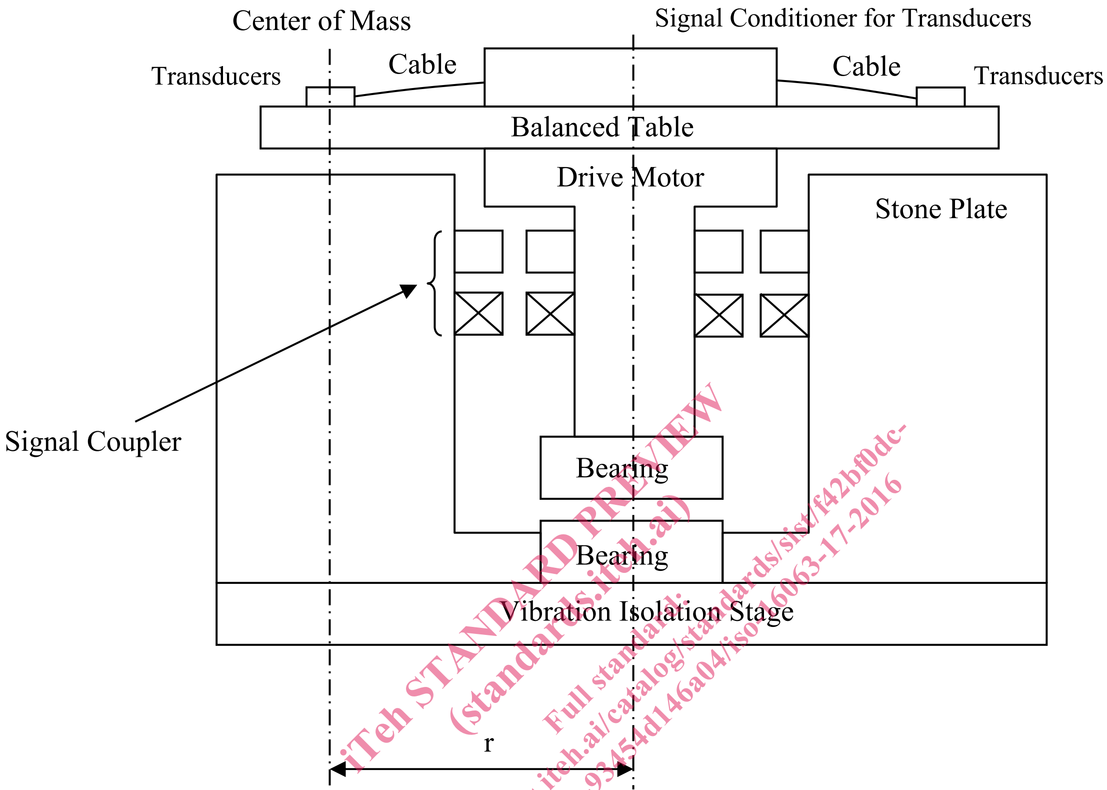

Figure 1 – Illustration of the apparatus of the main component

4.3 Rotational frequency measuring instrumentation

The relative expanded measurement uncertainty (k = 2) contribution of the measurement of rotational frequency shall be 0,05 % or less.

4.4 Voltage-measuring instrumentation

The relative expanded measurement uncertainty (k = 2) contribution of the voltmeter shall be 0,01% or less.

5 Preferred values

Six acceleration values, in metres per second squared, equally covering the accelerometer range, shall be chosen from the following series:10; 20; 50; 100; 200; 500 or their multiples of ten. The reference acceleration shall be 100 m/s^2 (second choice: 50 m/s^2).

6 Method 1 (with measurement of the radius of rotation)

6.1 Test procedure

Rotate the table or arm at different frequencies determined by calculation from the standard levels using the following formula:

$$a = 4\pi^2 n^2 r \quad (1)$$

where

n is the rotational frequency, in hertz;

r is the radius of rotation to the centre of the accelerometer mass element, in metres.

Measure the transducer output for every level.

Determine the reference calibration factor at the reference acceleration. Then determine the sensitivity for the other calibration amplitudes. The results shall be given as a percentage deviation from the reference calibration factor.

6.2 Expression of results

The calibration factor, S, in volts per (metre per second squared) [V/(m/s^2)], is given by the following formula:

$$S = \frac{V}{4\pi^2 n^2 r} \quad (2)$$

where

V is the transducer output, in volts;

n is the rotational frequency, in hertz;

r is the radius of rotation to the centre of the accelerometer mass element, in metres.

When the calibration results are reported, the total uncertainty of the calibration and the corresponding confidence level, calculated in accordance with Annex A, shall also be reported.

7 Method 2 (without measurement of the radius of rotation)

7.1 Test procedure

If the rotational radius cannot be measured with the specified uncertainty, the transducer can be rotated in two different positions, the radial distance between these to be measured with uncertainty maximum of ± 0,5 %.

Measure the two rotational frequencies giving the same pick-up output at the two positions.

7.2 Expression of results

The calibration factor, S, in volts per (metre per second squared), is given by the following formula:

$$S = \frac{V}{4\pi^2 n_2^{\ 2} \dfrac{\Delta r}{1-(n_2/n_1)^2}} \qquad (3)$$

where

V is the accelerometer output, in volts;

n_1 is the rotational frequency at the first accelerometer position, in hertz;

n_2 is the rotational frequency at the second accelerometer position, in hertz;

Δr is the distance between the two accelerometer positions, in metres.

When the calibration results are reported, the total uncertainty of the calibration and the corresponding confidence level, calculated in accordance with Annex A, shall also be reported.

Annex A
(informative)

Expression of uncertainty of measurement in calibration

A.1 Uncertainty analysis on Method 1

Components of uncertainty that contribute to the uncertainty of the measurement on Method 1 are listed in Table A.1. The combined standard uncertainty u_c can be expressed by

$$u_c = \sqrt{\sum_{i=1}^{10} (u_i)^2}$$

where u_i is uncertainty component in Table A.1 respectively.

The expanded uncertainty U shall be determined by multiplying u_c by coverage factor k, where a value of $k = 2$.