INTERNATIONAL STANDARD

ISO 5347-9

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Methods for the calibration of vibration and shock pick-ups —

Part 9:
Secondary vibration calibration by comparison of phase angles

Méthodes pour l'étalonnage de capteurs de vibrations et de chocs —

Partie 9: Étalonnage secondaire de vibrations par comparaison des angles de phase

Reference number
ISO 5347-9:1993(E)

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.

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.

International Standard ISO 5347-9 was prepared by Technical Committee ISO/TC 108, *Mechanical vibration and shock*, Sub-Committee SC 3, *Use and calibration of vibration and shock measuring instruments*.

ISO 5347 consists of the following parts, under the general title *Methods for the calibration of vibration and shock pick-ups*:

— *Part 0: Basic concepts*

— *Part 1: Primary vibration calibration by laser interferometry*

— *Part 2: Primary shock calibration by light cutting*

— *Part 3: Secondary vibration calibration*

— *Part 4: Secondary shock calibration*

— *Part 5: Calibration by Earth's gravitation*

— *Part 6: Primary vibration calibration at low frequencies*

— *Part 7: Primary calibration by centrifuge*

— *Part 8: Primary calibration by dual centrifuge*

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— *Part 9: Secondary vibration calibration by comparison of phase angles*

— *Part 10: Primary calibration by high-impact shocks*

— *Part 11: Testing of transverse vibration sensitivity*

— *Part 12: Testing of transverse shock sensitivity*

— *Part 13: Testing of base strain sensitivity*

— *Part 14: Resonance frequency testing of undamped accelerometers on a steel block*

— *Part 15: Testing of acoustic sensitivity*

— *Part 16: Testing of mounting torque sensitivity*

— *Part 17: Testing of fixed temperature sensitivity*

— *Part 18: Testing of transient temperature sensitivity*

— *Part 19: Testing of magnetic field sensitivity*

— *Part 20: Primary vibration calibration by the reciprocity method*

Annex A forms an integral part of this part of ISO 5347.

Methods for the calibration of vibration and shock pick-ups —

Part 9:
Secondary vibration calibration by comparison of phase angles

1 Scope

ISO 5347 comprises a series of documents dealing with methods for the calibration of vibration and shock pick-ups.

This part of ISO 5347 lays down detailed specifications for the instrumentation and procedure to be used for comparison phase angle vibration calibration. It applies to rectilinear and working pick-ups.

The limits of uncertainty applicable are ± 3 % of reading.

2 Apparatus

2.1 Equipment capable of maintaining room temperature at 23 °C ± 3 °C.

2.2 Primary standard accelerometer, calibrated together with amplifier, uncertainty maximum ± 1°.

2.3 Oscillator, having the following characteristics:

— uncertainty for frequency: maximum ± 1 % of reading;

— frequency stability: better than 1 % of reading over the measurement period.

2.4 Power amplifier/vibrator combination, having the following characteristics:

— total distortion: 5 % max.;

— transverse, bending and rocking acceleration: 20 % max. of the acceleration in the intended direction at frequencies used;

— hum and noise: 40 dB min. below reading.

2.5 Phase-measuring instrumentation, having the following characteristics:

— frequency range: 20 Hz to 5 000 Hz;

— phase range: 0 to 90°;

— uncertainty specified: ± 1°.

2.6 Oscilloscope, for checking the waveform of the pick-up signal with a frequency range from 5 Hz to 5 000 Hz.

3 Preferred frequencies

Six frequencies, in hertz, equally covering the range, shall be chosen from the following series:

20; 40; 80; 160; 315; 630; 1 250; 2 500; 5 000.

Values chosen shall be the same as for the standard accelerometer calibration values.

The reference amplitude level of the primary standard accelerometer shall be chosen.

4 Method

Mount the primary standard accelerometer and the pick-up to be calibrated back-to-back on the vibrator head. The test set-up shall be as shown in figure 1.

Measure the phase angle difference between the two pick-ups.

The results shall be reported as phase angle as a function of frequency.

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.

A confidence level of 95 % shall be used.

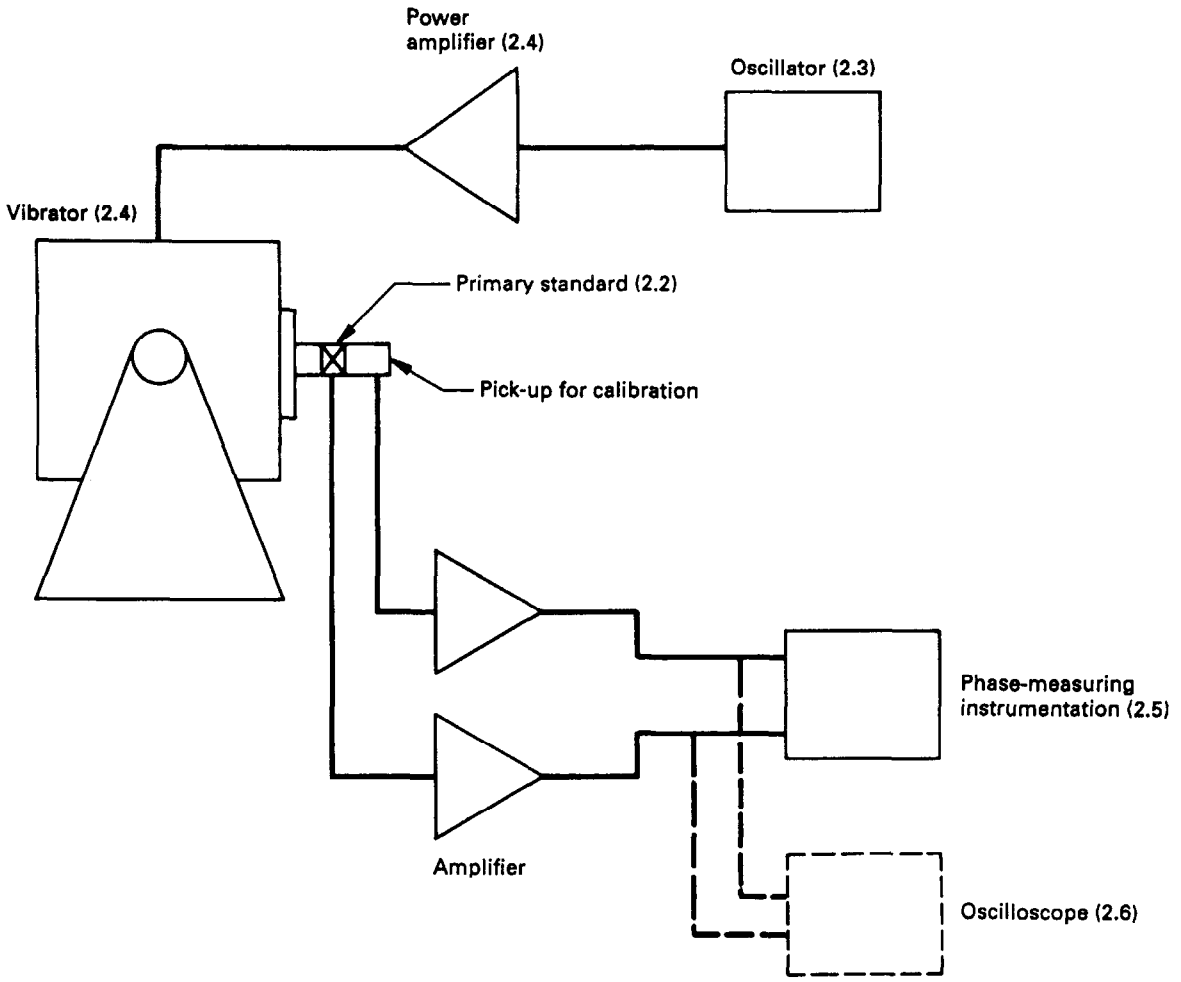

Figure 1 — Measuring system for comparison phase calibration method

Annex A
(normative)

Calculation of uncertainty

The total uncertainty of the calibration for the specified confidence level (for the purposes of this part of ISO 5347, CL = 95 %), X_{95}, shall be calculated from the following formula:

$$X_{95} = \pm \sqrt{X_r^2 + X_s^2}$$

where

X_r is the random uncertainty;

X_s is the systematic uncertainty.

The random uncertainty for the specified confidence level, $X_{r(95)}$, is calculated from the following formula:

$$X_{r(95)} = \pm t \left[\frac{e_{r1}^2 + e_{r2}^2 + e_{r3}^2 + \ldots + e_{rn}^2}{n(n-1)} \right]^{1/2}$$

where

e_{r1}, e_{r2}, etc. are the deviations from the arithmetic mean of single measurements in the series;

n is the number of measurements;

t is the value from Student's distribution for the specified confidence level and the number of measurements.

The systematic errors shall, first of all, be eliminated or corrected. The remaining uncertainty, $X_{s(95)}$, shall be taken into account by using the following formula:

$$X_{s(95)} = \frac{K}{\sqrt{3}} \times \Delta\phi$$

where

K equals 2,0 for the 95 % confidence level;

$\Delta\phi$ is the total phase angle uncertainty, in degrees, given by the following formula:

$$\Delta\phi = \phi_r + \phi_p + \phi_a$$

in which

ϕ_r is the phase angle uncertainty of the reference pick-up and the amplifier, in degrees;

ϕ_p is the phase angle measurement uncertainty of the phasemeter, in degrees;

ϕ_a is the phase angle uncertainty of the pick-up amplifier, in degrees.

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Descriptors: vibration, mechanical shock, transducers, sensors, tests, calibration.

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