INTERNATIONAL STANDARD

**ISO 21940-32**

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# Mechanical vibration — Rotor balancing —

## Part 32: Shaft and fitment key convention

*Vibrations mécaniques — Équilibrage des rotors —*

*Partie 32: Convention relative aux clavettes d'arbres et aux éléments rapportés*



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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 21940-32 was prepared by Technical Committee ISO/TC 108, *Mechanical vibration, shock and condition monitoring*, Subcommittee SC 2, *Measurement and evaluation of mechanical vibration and shock as applied to machines, vehicles and structures*.



This first edition of ISO 21940-32 cancels and replaces ISO 8821:1989, of which it constitutes an editorial revision. The main change is deletion of statements relating to the implementation date, transition period and key convention usage in the past.



ISO 21940 consists of the following parts, under the general title *Mechanical vibration — Rotor balancing*:

— *Part 1: Introduction* [1)]

— *Part 2: Vocabulary* [2)]

— *Part 11: Procedures and tolerances for rotors with rigid behaviour* [3)]

— *Part 12: Procedures and tolerances for rotors with flexible behaviour* [4)]

— *Part 13: Criteria and safeguards for the* in-situ *balancing of medium and large rotors* [5)]

— *Part 14: Procedures for assessing balance errors* [6)]

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1) Revision of ISO 19499:2007, *Mechanical vibration — Balancing — Guidance on the use and application of balancing standards*

2) Revision of ISO 1925:2001, *Mechanical vibration — Balancing — Vocabulary*

3) Revision of ISO 1940-1:2003, *Mechanical vibration — Balance quality requirements for rotors in a constant (rigid) state — Part 1: Specification and verification of balance tolerances*

4) Revision of ISO 11342:1998, *Mechanical vibration — Methods and criteria for the mechanical balancing of flexible rotors*

5) Revision of ISO 20806:2009, *Mechanical vibration — Criteria and safeguards for the* in-situ *balancing of medium and large rotors*

6) Revision of ISO 1940-2:1997, *Mechanical vibration — Balance quality requirements of rigid rotors — Part 2: Balance errors*

— *Part 21: Description and evaluation of balancing machines* [7)]

— *Part 23: Enclosures and other protective measures for balancing machines* [8)]

— *Part 31: Susceptibility and sensitivity of machines to unbalance* [9)]

— *Part 32: Shaft and fitment key convention* [10)]



7) Revision of ISO 2953:1999, *Mechanical vibration — Balancing machines — Description and evaluation*

8) Revision of ISO 7475:2002, *Mechanical vibration — Balancing machines — Enclosures and other protective measures for the measuring station*

9) Revision of ISO 10814:1996, *Mechanical vibration — Susceptibility and sensitivity of machines to unbalance*

10) Revision of ISO 8821:1989, *Mechanical vibration — Balancing — Shaft and fitment key convention*

## Introduction

It is often impossible or economically unreasonable to balance rotors with fitments after they have been assembled; the rotor components which also may originate from different suppliers are therefore balanced separately. An appropriate balance tolerance is applied to each component so that, when shaft and fitment(s) are coupled together, the rotor assembly meets the required balance tolerance and/or vibration limit. For coupling the fitment(s) to the shaft, different methods are applied, a very common one uses keys. If, however, a different key convention has been used when balancing the shaft than that one used for balancing the fitment(s), it is quite likely that the rotor assembly has a balance error influencing its residual unbalance.

There are three methods, or key conventions, for balancing shafts and fitments coupled together with keys:

— full-key convention;

— half-key convention;

— no-key convention.

This part of ISO 21940 unifies the key conventions used throughout the world and gives instructions on a marking of components balanced in accordance with the key convention applied. When consistently used, it results in compatibility of shafts and fitments so that they can be balanced by different suppliers and, after being assembled, the balance tolerance and/or vibration limit for the rotor assembly is met.



# Mechanical vibration — Rotor balancing —

## Part 32: Shaft and fitment key convention

## 1 Scope

This part of ISO 21940 specifies one convention for balancing the individual components (shaft and fitments) of a keyed rotor assembly. This provides compatibility of all balanced components so that when they have been assembled the overall balance tolerance and/or vibration limit for the rotor assembly is met.

This part of ISO 21940 specifies that half-keys be used when balancing the individual components of a keyed rotor assembly. It also specifies a marking of the components balanced in accordance with the key convention used.

This part of ISO 21940 applies to rotors balanced in a balancing machine, in their own bearings or *in situ*. The key convention can also be applied when measuring the residual unbalance and/or vibration of rotors with keyways, but to which fitments have not yet been assembled.



In addition to applying to keys of constant rectangular or square cross-section mounted parallel to the shaft centreline, this part of ISO 21940 also applies to keys mounted on tapered shaft surfaces, to woodruff, gibhead, dowel and other special keys. The principle of the half-key convention is applied as is appropriate to the particular shape and location of the special key.



## 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 referenced document (including any amendments) applies.

ISO 1925, *Mechanical vibration — Balancing — Vocabulary*[1)]

## 3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 1925 apply.

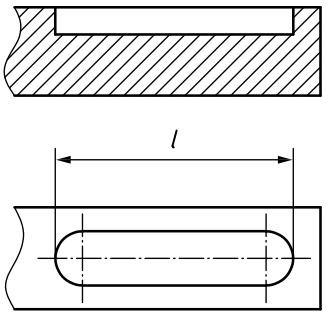
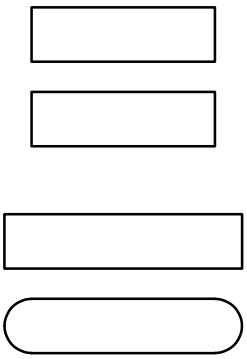
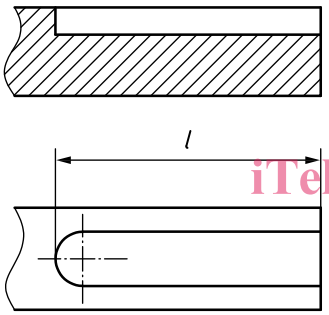
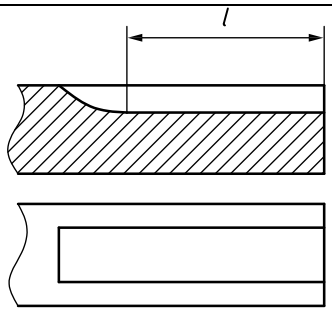
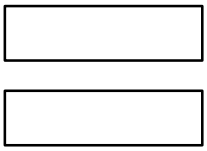
## 4 Half-key convention

This part of ISO 21940 specifies that the half-key convention be followed. According to this convention a half-key shall be used in the keyway of the shaft having one keyway while balancing the shaft without the fitment. A complementary half-key shall be used while balancing the corresponding fitment on a balancing mandrel, provided the mandrel has no keyways. If the mandrel has keyways, the methods described in A.1.3 shall be followed. If at one cross-section, shaft and fitment each have two keyways the methods described in A.1.4 shall be followed. The axial location of the centre of gravity of the half-key should be the same as that of the full key in the final assembly.

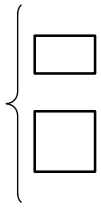
NOTE Table 1 shows examples of various types of shaft keyways and full keys of constant rectangular or square cross-section.

1) To become ISO 21940-2 when revised.

**Table 1 — Examples of types of shaft keyways and keys**

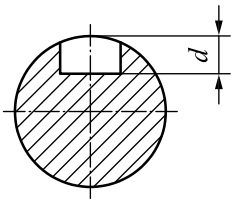
| Type | Configuration of keyway | Name of keyway | Configuration of key[a] | Name of key |
|---|---|---|---|---|
| A |   | Round/round end |  | Square/square end<br>Round/round end |
| B |   | Round/square end |  | Round/square end<br>Square/square end<br>Round/round end |
| C |   | Sled runner |  | Square/square end |

a Full-key cross-section



Rectangular

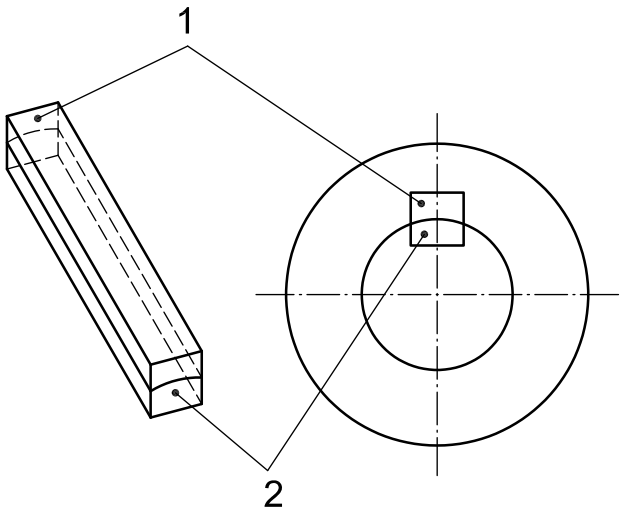
Square

*l* Length of the keyway

*d* Depth of the keyway

Practical considerations for making and usage of half-keys are given in Annex B. A contoured half-key set is shown in Figure 1.




**Key**

1 half-key for the fitment

2 half-key for the shaft

**Figure 1 — Contoured half-key set**



The use of the half-key convention provides a uniform method for balancing shafts and fitments joined together by keys. It eliminates balance errors and therefore unnecessary residual unbalance and/or vibration which can be caused by the use of different key conventions, and avoids the creation of an internal bending moment in the assembly (as would be caused by the use of full keys during balancing of the shaft). For more information on the differences between the key conventions, see Annex C.



## 5 Marking

**5.1** The end face of the shaft adjacent to the keyway shall be permanently marked with the letter H to indicate that balancing was performed using the half-key convention. Permanent marking using metal stamps or vibratory engravers is recommended, but a permanent or indelible ink may also be used.

If the shaft end face is too small for marking, the bottom of the keyway may be used.

**5.2** The face of the fitment adjacent to the keyway shall be permanently marked with the letter H to indicate that balancing was performed using the half-key convention. The letter should be readily visible when the fitment is joined to the shaft. Permanent marking using metal stamps or vibratory engravers is recommended, but a permanent or indelible ink may also be used.

**5.3** The marking of the shaft and the fitment with the letter H may only be omitted if confusion as to which key convention was used is unlikely.

**5.4** When balancing a replacement shaft or fitment, the known mating part of which has not been balanced using the half-key convention, it is permissible to balance the replacement component with the key convention of the existing mating part. In this special case, both components shall be permanently marked with an identification letter corresponding to the key convention used, as follows:

a) components balanced using the full-key convention (see C.1.2) shall be marked with the letter F adjacent to the keyway;

b) components balanced using the no-key convention (see C.1.4) shall be marked with the letter N adjacent to the keyway.

NOTE 1 For the fitment, the balancing procedures in accordance with the full-key convention and the no-key convention are identical. Marking is done as ordered.

NOTE 2 If fitments are balanced for being put on stock, these fitments may be marked either with F or with N. But since the full-key convention is in use more often, these fitments generally are marked with F.

## 6 Implementation of the half-key convention

All manufacturers of original parts and processed components shall comply with the half-key convention of balancing and mark each newly manufactured shaft and fitment with the letter H.

NOTE Some International Standards prescribe that the half-key convention be followed, e.g. IEC 60034-14[1].

Change-over of equipment in service to the half-key convention with proper marking of the shaft and fitment(s) during a repair balancing operation is encouraged. In any case, a marking shall be added (see Clause 5).

# Annex A
(normative)

# Specifications for the half-key convention

## A.1 Principal specifications for the half-key convention

**A.1.1** The specifications given in A.1.2 to A.1.4 apply to one cross-section.

**A.1.2** For a shaft with a single keyway, a half-key is required for the keyway.

**A.1.3** For a fitment with a single keyway, one of the following requirements shall be met:

a) when the mandrel has no keyway: use one half-key;

b) when the mandrel has two identical keyways 180° opposite each other: use one full key and one half-key of equal length;

c) when the mandrel has a single keyway:

— first use one half-key for balancing the mandrel, and

— then use one full key for balancing the mandrel/fitment assembly.



NOTE 1 Mandrel constructions using requirement a) or b) are preferred because they are inherently balanced.



NOTE 2 The balancing mandrel should have the same diametral tolerances as the shaft it is intended to simulate. The mandrel should also have correction planes on it to allow for unbalance correction, index balancing and biasing.

**A.1.4** If a shaft or fitment is provided with two equal keyways 180° opposite each other and two keys are used in the final assembly, it is permissible to balance without keys. This is in accordance with the specifications for the half-key convention. If the two keyways are not equal or are positioned other than 180° opposite each other, two half-keys are required for balancing the shaft and two more for balancing the fitment.

**A.1.5** Special keys, such as woodruff, gibhead or tapered keys, require individual consideration.

**A.1.6** If a full key is shipped with the shaft, its length is obvious and therefore permits determination of the proper half-key length for balancing the fitment (see also B.4). If no key is shipped with the shaft, the length of the half-key used originally for balancing the shaft is assumed to be the same as the length of the shaft keyway (see also Table 1, dimension $l$).

**A.1.7** Half-keys used for balancing should always be made of material having the same density as the final key. Unless specifically stated otherwise, it is to be assumed that final keys are made of steel; therefore, half-keys should also be made of steel.

**A.1.8** The half-key should be held in place on the shaft by a means that introduces negligible unbalance, e.g. fibreglass tape, but prevents the half-key from accidentally separating from the keyway.

## A.2 Special cases

**A.2.1** If the unbalance tolerances and/or vibration limits of certain assemblies are generous enough not to be exceeded by the change in key convention, or if a manufacturer has a limited number of users who require