

INTERNATIONAL STANDARD



3650

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION • МЕЖДУНАРОДНАЯ ОРГАНИЗАЦИЯ ПО СТАНДАРТИЗАЦИИ • ORGANISATION INTERNATIONALE DE NORMALISATION

Gauge blocks

Cales-étalons

First edition — 1978-07-15

iTeh STANDARD PREVIEW
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ISO 3650:1978

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UDC 531.711.51 : 681.2

Ref. No. ISO 3650-1978 (E)

Descriptors : block gauges, dimensions, dimensional tolerances, form tolerance, flatness, measuring.

Price based on 9 pages

FOREWORD

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Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council.

International Standard ISO 3650 was developed by Technical Committee ISO/TC 3, *Limits and fits*, and was circulated to the member bodies in January 1975.

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It has been approved by the member bodies of the following countries :

ISO 3650:1978		
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Gauge blocks

1 SCOPE AND FIELD OF APPLICATION

This International Standard specifies the most important dimensional and quality characteristics of gauge blocks with a rectangular cross-section and a length ranging from 0,5 up to and including 1 000 mm.

Deviations and tolerances are specified for four grades of accuracy, i.e. 00, 0, 1 and 2, and information concerning a "calibration" grade is given, thus providing for gauge blocks

used solely for measuring the lengths of other gauge blocks by comparison, as well as for gauge blocks used for a variety of measuring purposes.

2 NOMENCLATURE, TERMINOLOGY AND DEFINITIONS

2.1 Nomenclature of gauge blocks

See figure 1.

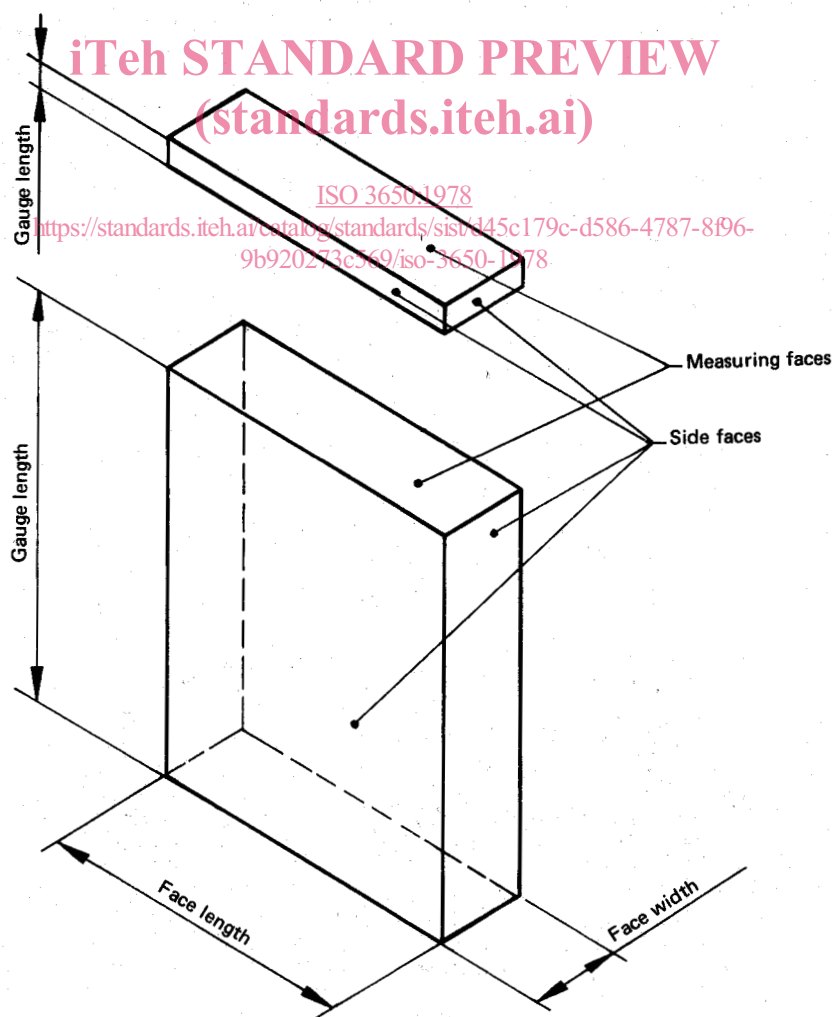


FIGURE 1 — Nomenclature

2.2 gauge block : A block of rectangular section, made of durable material, with one pair of plane, mutually parallel measuring surfaces.

NOTE — It is a characteristic of a gauge block that the measuring faces are made with such surface quality that they will adhere to measuring faces of other gauge blocks or to similarly finished plane surfaces. (Adhering is commonly described as "wringing"; see 2.7.)

2.3 length of a gauge block : The length of a gauge block at a particular point of the measuring face is the perpendicular distance between this point and a rigid plane surface of the same material and surface texture upon which the other measuring face has been wrung (see figure 2).

NOTES

1 The length takes into account one wringing.

2 Requirements for the conditions of measurement by interferometry and by comparison are given in annex B.

2.4 central length : The length of a gauge block according to 2.3, taken at the centre point of a measuring face.

2.5 deviation from flatness : The minimum distance between two parallel planes which just envelop the measuring face (see figure 3).

2.6 variation in length : The difference between the maximum and minimum lengths at any points on the measuring faces of a gauge block (see figure 4).

2.7 wringing : The property of the measuring faces of a gauge block enabling them to adhere to other similarly flat and well-finished surfaces by molecular forces.

3 BASIS OF MEASUREMENT

3.1 The unit of length, the metre, is defined as equal to 1 650 763,73 wavelengths in vacuum of the unperturbed radiation corresponding to the transition between the levels $2p_{10}$ and $5d_5$ of the krypton atom of mass number 86 (11th General Conference of Weights and Measures, 1960). In practice, this wavelength may be produced by means of a ^{86}Kr gas discharge lamp (Engelhard lamp) under specified conditions of operation.

3.2 When a gauge block of high grade is to be used as a reference standard of length, i.e. for transference of length to other gauge blocks by use of a comparator, then its lengths, as defined in 2.3, and located at the centre of the block, shall be measured in terms of wavelengths of light using the method known as interferometry (see annex B).

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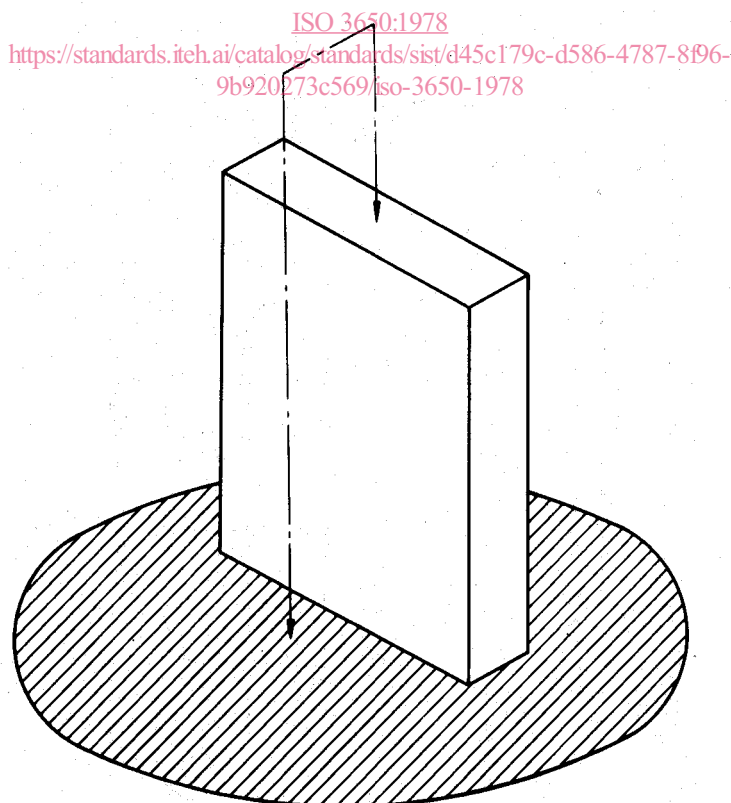


FIGURE 2 — Length of a gauge block

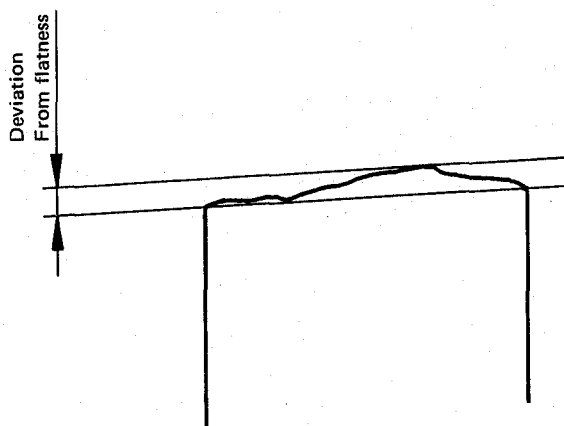


FIGURE 3 — Deviation from flatness (see table 3)

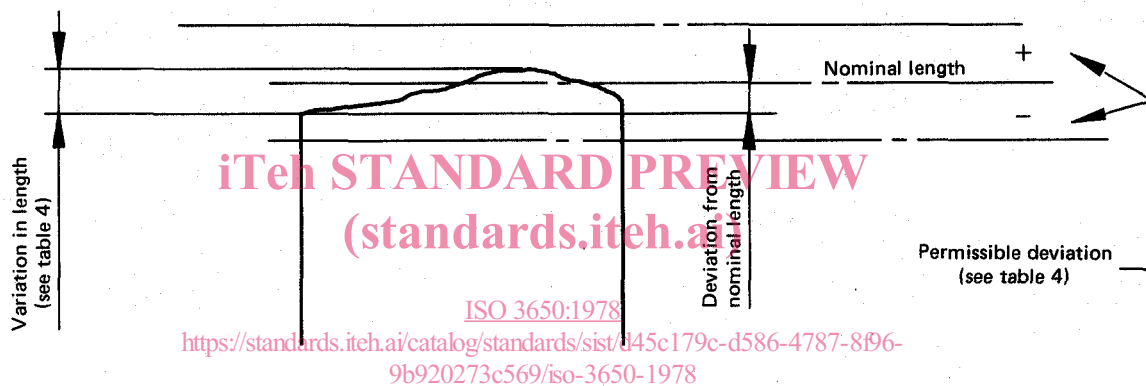


FIGURE 4 — Variations in length (see table 4)

3.3 The nominal length and measured length of a gauge block apply at the reference temperature of 20 °C and standard air pressure of 101,325 kPa (1 013,25 mbar).

NOTE — The effect on the length of a gauge block of variations from the standard air pressure encountered under normal atmospheric conditions may be ignored.

3.4 The lengths of gauge blocks up to and including 100 mm refer to the length of the gauge block in the vertical position, i.e. with the measuring faces horizontal.

The lengths of gauge blocks over 100 mm refer to the length of the gauge block in the horizontal position, the block being supported on one of the smaller side faces without additional stress by two suitable supports, each at a distance of 0,211 times the nominal length from the ends.

4 GENERAL DIMENSIONS, MATERIAL AND MARKING

4.1 General dimensions

The dimensions of the cross-section and their tolerances are given in table 1.

TABLE 1

Values in millimetres

Cross-section	Nominal length, <i>l</i>		Face length	Face width
	over	up to and including		
	—	10,1	$30 \begin{smallmatrix} 0 \\ -0,3 \end{smallmatrix}$	$9 \begin{smallmatrix} -0,05 \\ -0,2 \end{smallmatrix}$
	10,1	1 000	$35 \begin{smallmatrix} 0 \\ -0,3 \end{smallmatrix}$	

Where longer gauge blocks are provided with holes for coupling blocks together and for supporting the wrung joint, the dimensions and location shall be as shown in figure 5.

NOTE — Gauge blocks of nominal lengths below 1 mm may be made with sections other than 30 mm × 9 mm.

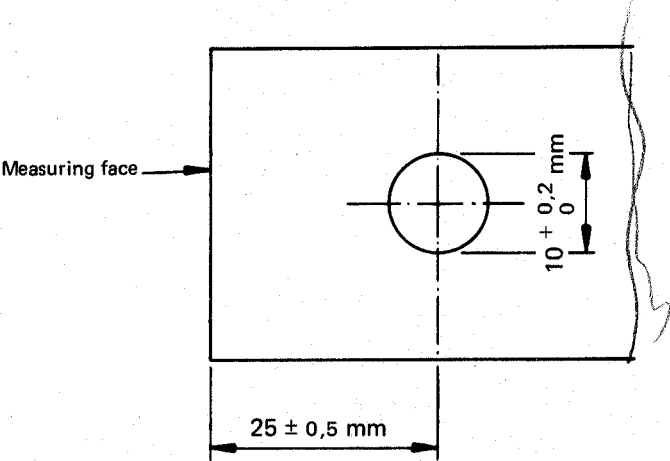


FIGURE 5 — Position of hole for coupling longer gauge blocks

4.2 Material

4.2.1 Gauge blocks shall be made of a wear-resistant material, capable of being worked to give a fine finish that will readily wring and which by nature, or when suitably treated, will be constant in length.

4.2.2 The coefficient of thermal expansion of steel gauge blocks in the temperature range 10 to 30 °C shall be within the limits $(11,5 \pm 1,0) \times 10^{-6}$ per degree Celsius.

If other materials are used, the manufacturer shall state the coefficient of expansion and its limits.

4.2.3 The surface hardness of the measuring faces of steel gauge blocks shall be not less than 800 HV.

4.2.4 When gauge blocks are made of materials other than steel, the physical properties of these materials (coefficient of expansion, modulus of elasticity, etc.) shall be given by the manufacturer and shall be taken into account as appropriate.

4.2.5 Dimensional stability of a material shall be confirmed by tests on samples over a period, during which the temperature of the samples shall be kept within the range 10 to 30 °C, and the influence of other forces such as vibration, shock and magnetic fields shall be avoided.

The maximum permissible changes in length are given in table 2; the period of test shall be sufficiently long for any change in length to be distinguishable from the accuracy of measurement of length.

TABLE 2

Values in micrometres (µm)

Grades	Maximum permissible change in length per year
00 0	$\pm (0,02 + 0,000 5 l)$
1 2	$\pm (0,05 + 0,001 l)$

l = nominal length in millimetres

4.3 Marking

Each gauge block shall be legibly and permanently marked with its nominal size, in figures at least 1,5 mm high, and with the name of the manufacturer, or a trademark.

Gauge blocks smaller than 6 mm nominal length may be marked on a measuring face but an area of 9 mm × 12 mm at the centre of the measuring faces shall be left clear of any marking.

Grades 00, 0 and “calibration grade” blocks shall be marked with a serial number.

It is desirable for gauge blocks of other grades also to be identifiable.

Gauge blocks of nominal lengths greater than 100 mm shall bear marks located $(0,211 \times l)$ mm from the measuring faces, indicating the support positions (see 3.4).

5 ACCURACY

5.1 General

Each gauge block shall conform to the requirements for accuracy appropriate to its grade, as given below.

The requirements for accuracy apply to an area of the measuring face omitting a border zone of 0,8 mm maximum, as measured from the side faces.

In this excluded border zone the surface shall not lie above the plane of the measuring face.

The requirements specified below are related in all cases to the definitions in clause 2, the basis of measurement in clause 3 and the conditions of measurement set out in annex B.

NOTE — In addition to the four grades for which deviations and tolerances are given in tables 3 and 4, a grade known as “calibration grade” is also recognized. Blocks of this grade are intended solely for calibrating other gauge blocks where it is the actual length of the block that is used in computations. For this reason it is therefore less important that it should be very close to nominal than that it should be accurately known. “Calibration grade” blocks are thus required to have a high quality of geometrical form but relatively large deviations from nominal length are permissible and these blocks shall comply with Grade 00 tolerances for flatness and variation in length and Grade 1 deviations from nominal length. Each block of this grade shall be supplied with a calibration certificate stating its measured length.

5.2 Flatness tolerance

5.2.1 Gauge blocks greater in nominal length than 2,5 mm

The deviation from flatness of each measuring face of a gauge block of nominal length greater than 2,5 mm shall not exceed the value given in table 3 for the appropriate grade. This requirement shall apply whether the gauge block is wrung to a rigid plane surface or is in the unwrung state.

5.2.2 Gauge blocks 2,5 mm in length or smaller

Gauge blocks 2,5 mm in nominal length or smaller shall be tested when wrung to the rigid plane surface of an auxiliary body with a thickness of at least 11 mm. With the gauge block in this condition, the deviation from flatness of each measuring face shall not exceed the value given in table 3 for the appropriate grade.

With the gauge block in the unwrung state, each measuring face shall be flat to within 4 μm .

5.3 Variation in length

The variation in length of a gauge block shall not exceed the tolerance given in table 4 for the appropriate grade (see figure 4).

TABLE 3

Nominal length mm		Maximum permitted deviation from flatness μm			
over	up to and including	Grade			
		00	0	1	2
—	150	0,05	0,10	0,15	0,25
150	500	0,10	0,15	0,18	0,25
500	1 000	0,15	0,18	0,20	0,25

5.4 Deviation from nominal length at any point

The deviation from nominal length, at any point, shall not exceed the tolerances for the appropriate grade given in table 4, i.e. any point on the measuring face of the gauge block must lie between two parallel planes whose distance apart does not exceed the tolerances specified in table 4 (see figure 4).

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TABLE 4

1	2	3	4	5	6	7	8	9	10
Range of nominal lengths mm		Tolerances and permissible variations, μm							
over	up to and including	Grade 00		Grade 0		Grade 1		Grade 2	
		Tolerances on nominal length at any point	Permissible variation in length	Tolerances on nominal length at any point	Permissible variation in length	Tolerances on nominal length at any point	Permissible variation in length	Tolerances on nominal length at any point	Permissible variation in length
—	10	$\pm 0,06$	0,05	$\pm 0,12$	0,10	$\pm 0,20$	0,16	$\pm 0,45$	0,30
10	25	$\pm 0,07$	0,05	$\pm 0,14$	0,10	$\pm 0,30$	0,16	$\pm 0,60$	0,30
25	50	$\pm 0,10$	0,06	$\pm 0,20$	0,10	$\pm 0,40$	0,18	$\pm 0,80$	0,30
50	75	$\pm 0,12$	0,06	$\pm 0,25$	0,12	$\pm 0,50$	0,18	$\pm 1,00$	0,35
75	100	$\pm 0,14$	0,07	$\pm 0,30$	0,12	$\pm 0,60$	0,20	$\pm 1,20$	0,35
100	150	$\pm 0,20$	0,08	$\pm 0,40$	0,14	$\pm 0,80$	0,20	$\pm 1,60$	0,40
150	200	$\pm 0,25$	0,09	$\pm 0,50$	0,16	$\pm 1,00$	0,25	$\pm 2,00$	0,40
200	250	$\pm 0,30$	0,10	$\pm 0,60$	0,16	$\pm 1,20$	0,25	$\pm 2,40$	0,45
250	300	$\pm 0,35$	0,10	$\pm 0,70$	0,18	$\pm 1,40$	0,25	$\pm 2,80$	0,50
300	400	$\pm 0,45$	0,12	$\pm 0,90$	0,20	$\pm 1,80$	0,30	$\pm 3,60$	0,50
400	500	$\pm 0,50$	0,14	$\pm 1,10$	0,25	$\pm 2,20$	0,35	$\pm 4,40$	0,60
500	600	$\pm 0,60$	0,16	$\pm 1,30$	0,25	$\pm 2,60$	0,40	$\pm 5,00$	0,70
600	700	$\pm 0,70$	0,18	$\pm 1,50$	0,30	$\pm 3,00$	0,45	$\pm 6,00$	0,70
700	800	$\pm 0,80$	0,20	$\pm 1,70$	0,30	$\pm 3,40$	0,50	$\pm 6,50$	0,80
800	900	$\pm 0,90$	0,20	$\pm 1,90$	0,35	$\pm 3,80$	0,50	$\pm 7,50$	0,90
900	1 000	$\pm 1,00$	0,25	$\pm 2,00$	0,40	$\pm 4,20$	0,60	$\pm 8,00$	1,00