
End standards of length (gauge blocks)

Mesures de longueur à bouts plans (calibres à bouts plans ou cales étalons)



Foreword

The International Organization of Legal Metrology (OIML) is a worldwide, intergovernmental organization whose primary aim is to harmonize the regulations and metrological controls applied by the national metrological services, or related organizations, of its Member States.

The two main categories of OIML publications are:

- **International Recommendations (OIML R)**, which are model regulations that establish the metrological characteristics required of certain measuring instruments and which specify methods and equipment for checking their conformity ; the OIML Member States shall implement these Recommendations to the greatest possible extent;
- **International Documents (OIML D)**, which are informative in nature and intended to improve the work of the metrological services.

OIML Draft Recommendations and Documents are developed by technical committees or subcommittees which are formed by the Member States. Certain international and regional institutions also participate on a consultation basis.

Cooperative agreements are established between OIML and certain institutions, such as ISO and IEC, with the objective of avoiding contradictory requirements; consequently, manufacturers and users of measuring instruments, test laboratories, etc. may apply simultaneously OIML publications and those of other institutions.

International Recommendations and Inter-national Documents are published in French (F) and English (E) and are subject to periodic revision.

This publication – reference OIML R 30 (E), edition 1981 – which is under the responsibility of OIML TC 7/SC 1 *Measuring instruments for length*, was sanctioned by the International Conference of Legal Metrology in 1980.

OIML publications may be obtained from the Organization's headquarters:

Bureau International de Métrologie Légale
11, rue Turgot - 75009 Paris - France
Telephone: 33 (0)1 48 78 12 82 and 42 85 27 11
Fax: 33 (0)1 42 82 17 27
E-mail: biml@oiml.org
Internet: www.oiml.org

END STANDARDS OF LENGTH

(gauge blocks)

This Recommendation applies to « gauge blocks of rectangular section », which are measures of length in the form of rectangular plates or parallelepipedal rectangular blocks comprising two opposing, flat, mutually parallel, faces, called measuring faces, whose surface quality is such that they have the property of wringing to the corresponding faces of other gauges or plane datum surfaces.

It lays down the principal technical specifications relating to their intended use, their manufacture, their qualities, their inspection.

Intended use

Gauge blocks are intended to be used as :

- a) reference standards for transferring the dimension of the unit of length from the primary standards to gauges of lesser accuracy, and for the verification and calibration of measuring appliances,
- b) measures of length for the regulation and adjustment of indicating measuring appliances and for the direct measurement of the linear dimensions of industrial parts.

CHAPTER I

LENGTH - SHAPE - CONSTRUCTION - MATERIAL – INSCRIPTIONS

1 Nominal length

The recommended values of the nominal lengths of gauges are given in the annex.

2 Shape

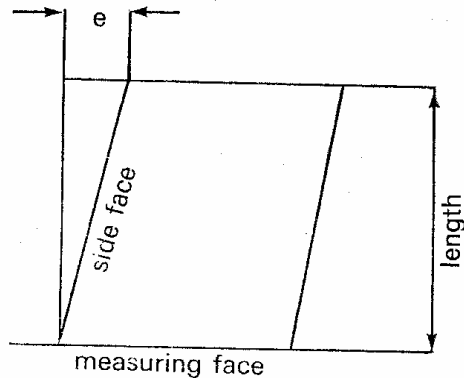
2.1. The plates and the cross-sections of the parallelepipedal blocks must be rectangles with sides as follows :

Nominal lengths mm	Sides mm			
from 0.9 to 10.1 inclusive.....	30	+ 0.0 – 0.3	9	– 0.05 ^(*) – 0.2
from 10.1 exclusive to 1000 inclusive.....	35	+ 0.0 – 0.3	9	– 0.05 ^(*) – 0.2

^(*) note : existing gauges which do not conform with these requirements but which have been found to conform with the tolerances 9 $\begin{matrix} -0.05 \\ -0.3 \end{matrix}$ as quoted in the first edition of I.R. n° 30 may be used.

2.2. The angles at the vertices of these rectangles (angles of the lateral faces) must be right-angles to within approximately ± 10 minutes.

2.3. The deviation from perpendicularity, with respect to the measuring faces and side faces of the parallelepipedal blocks, must not exceed the following values :



Nominal length mm				Deviation e μm
from 10 to 25 inclusive				70
25	exclusive	60	“	90
60	“	150	“	110
150	“	400	“	140
400	“	1000	“	180

3 Construction of the measuring faces

3.1. The surface condition of the measuring faces must be of high quality ; only insignificant scratches which do not detract from the wringing properties and do not affect the conditions of interferometric measurement may be allowed.

3.2. The edges and the corners of the measuring faces must be :
either rounded off over a width not exceeding 0.3 mm,
or chamfered with the join of the chamfer with the measuring face slightly rounded,
the width of the whole not exceeding 0.3 mm.

4 Material

4.1. Gauge blocks may be made of steel, or of any other material considered suitable.

4.2. The coefficient of linear expansion of the steel in the temperature range $+ 10\text{ }^{\circ}\text{C}$ to $+ 30\text{ }^{\circ}\text{C}$, must be within the limits $(11.5 \pm 1.0) 10^{-6}\text{ }^{\circ}\text{C}^{-1}$;

for other materials the manufacturer must indicate the coefficient of expansion.

4.3. For gauges made of steel the surface hardness of the measuring faces must not be less than HRC 62 or HV 800.

5 Inscriptions

5.1. Gauge blocks must bear the following inscriptions :

- gauges of 5.5 mm and less : the nominal length in mm,
- gauges of more than 5.5 mm : the nominal length and manufacturer's mark,
- gauges in classes AA and A (all dimensions) : set number or a mark identifying the set.

5.2. These inscriptions must be placed :

- gauges of 5.5 mm and less : on one measuring face ;
in this case, an area extending over the complete width of the middle of the measuring face, and at least 12 mm high, must bear no inscription,
- gauges of over 5.5 mm : on one wide lateral face.

5.3. On the lateral faces of gauges with a nominal length ℓ of over 100 mm, marks must be drawn at a distance of 0.211ℓ from the ends of the gauge.

CHAPTER II

METROLOGICAL PROPERTIES

6 Classes of accuracy

6.1. Five classes of accuracy are provided for gauge blocks : Cl. AA - Cl. A - Cl. B - Cl. C - Cl. D ^(*).

7 Stability ^(**)

7.1. The length of a gauge block must not vary, in one year, by more than :

class of accuracy AA : $(0.02 + 0.0002 \ell) \mu\text{m}$

A : $(0.02 + 0.0005 \ell) \mu\text{m}$

B,C,D : $(0.05 + 0.001 \ell) \mu\text{m}$

ℓ = nominal length in millimetres.

8 Flatness of the measuring faces

8.1. The deviation of flatness of the measuring faces ^(***) of gauge blocks must not exceed the values given in the following table ^(****).

Nominal length mm		Maximum permissible deviation of flatness μm			
from (excluded)	to (included)	Cl. AA – Cl. A – Cl. B – Cl. C and D			
	150	0.05	0.10	0.15	0.25
150	500	0.10	0.15	0.18	0.25
500	1000	0.15	0.18	0.20	0.25

^(*) In addition to these five accuracy classes, national regulations may recognize a « calibration class ». Blocks of this class are intended solely for calibrating other gauge blocks where it is the actual length of the block which is used in computation.

« Calibration class » blocks are required to comply with requirements of class AA for flatness and variation in length, but are expected to comply only with class B for deviation from nominal length. Each block of this « calibration class » must, according to point 11.4, be supplied with a calibration certificate stating its measured length, the order of calibration accuracy (point 10.1) being order 1.

^(**) The specifications concerning the stability of gauge blocks over a period of time apply only to gauge blocks which have not been subjected to abrupt changes of temperature, vibrations, impacts, as well as the influences of magnetic fields (except the earth's magnetic field).

^(***) For Gauge blocks of nominal length 2.5 mm and less, the values shown are valid where the gauge block is wrung onto a plane datum surface which is of a suitable quality .

^(****) These specifications do not apply inside a margin 0.8 mm avide bordering the measuring faces.

PERMISSIBLE DEVIATIONS μm												
Nominal length mm		Cl. AA		Cl. A		Cl. B		Cl. C		Cl. D		
		between the length of the gauge and its nominal value ±	variation in length	between the length of the gauge and its nominal value ±	variation in length	between the length of the gauge and its nominal value ±	variation in length	between the length of the gauge and its nominal value ±	variation in length			
over	up to and including	10	0.06	0.05	0.12	0.10	0.20	0.16	0.45	0.30	0.9	0.3
		25	0.07	0.05	0.14	0.10	0.30	0.16	0.60	0.30	1.2	0.3
		50	0.10	0.06	0.20	0.10	0.40	0.18	0.80	0.30	1.6	0.3
		75	0.12	0.06	0.25	0.12	0.50	0.18	1.0	0.35	2.0	0.4
		100	0.14	0.07	0.30	0.12	0.60	0.20	1.2	0.35	2.4	0.4
		150	0.20	0.08	0.40	0.14	0.80	0.20	1.6	0.40	3.2	0.4
		200	0.25	0.09	0.50	0.16	1.00	0.25	2.0	0.40	4.0	0.4
		250	0.30	0.10	0.60	0.16	1.20	0.25	2.4	0.45	4.8	0.5
		300	0.35	0.10	0.70	0.18	1.40	0.25	2.8	0.50	5.5	0.5
		400	0.45	0.12	0.90	0.20	1.80	0.30	3.6	0.50	7.0	0.5
900	500	0.50	0.14	1.10	0.25	2.20	0.35	4.4	0.60	8.5	0.6	
	600	0.60	0.16	1.30	0.25	2.60	0.40	5.0	0.70	10.0	0.7	
	700	0.70	0.18	1.50	0.30	3.00	0.45	6.0	0.70	12.0	0.8	
	800	0.80	0.20	1.70	0.30	3.40	0.50	6.5	0.80	13.0	0.8	
	900	0.90	0.20	1.90	0.35	3.80	0.50	7.5	0.90	15.0	0.9	
	1000	1.00	0.25	2.00	0.40	4.20	0.60	8.0	1.0	16.0	1.0	

8.2. The wringing of gauge blocks must comply with the following requirements :

- for gauge blocks in classes of accuracy AA and A wrung onto a glass or quartz flat, there must be no interference fringes or shadings when observed in a white light through the flat,
- for gauge blocks in classes of accuracy B, C and D shading in the form of white spots is tolerated.

9 Maximum permissible deviation in length

9.1. The deviation from nominal length and the variation in length of gauge blocks under the reference conditions (see point 10.2) must not exceed the values given in the table on the previous page ^(*).

CHAPTER III

VERIFICATION

The verification of gauge blocks shall be carried out in order to determine their length and to ensure that they comply with the provisions of Chapters I and II of this Recommendation.

10 Measurement of lengths

10.1. Five orders of calibration accuracy are laid down for the determination of the lengths of gauge blocks and correspond to the following maximum permissible errors :

order of calibration accuracy	1 : $\pm (0.02 + 0.0002 \ell) \mu\text{m}$ ^(**)
	2 : $\pm (0.05 + 0.0005 \ell) \mu\text{m}$
	3 : $\pm (0.10 + 0.0010 \ell) \mu\text{m}$
	4 : $\pm (0.20 + 0.0020 \ell) \mu\text{m}$
	5 : $\pm (0.50 + 0.0050 \ell) \mu\text{m}$

ℓ = nominal length in millimetres.

10.1.1. The length of gauge blocks in classes of accuracy AA, A, B, C and D must be measured with an accuracy at least equal to orders of calibration accuracy 1, 2, 3, 4 and 5 respectively.

The lengths of gauge blocks in classes of accuracy AA (and possibly A) and orders of calibration accuracy 1 (and possibly 2) must be measured by an absolute interferometric method based on the international definition of the metre and using either the wave-length of the primary defined radiation or the wave-lengths of secondary radiations recommended by the International Committee of Weights and Measures.

The lengths of gauge blocks of classes of accuracy and orders corresponding to lower accuracies than AA and A must be measured by comparison with reference standards of an appropriate higher order of calibration accuracy.

(*) These requirements do not apply inside a margin 0.8 mm wide bordering the measuring faces.

(**) Having regard to the current state of technology, the first order of calibration accuracy of measurement represents the limit of what one can expect to achieve with reasonable certainty.

10.2. Reference conditions on which the results of the measurement are based :

temperature.....: + 20 °C

atmospheric pressure.. : 101.325 kPa

position of the gauges :

- length less than or equal to 100 mm :
position vertical or horizontal,
- length over 100 mm :
position horizontal, the gauge resting with one of its narrow lateral faces on two supports, each one placed 0.211 ℓ (ℓ = nominal length) from its ends without additional forces influencing the length and variation in length of the gauge.

10.3. Corrections

10.3.1. If the conditions during measuring are different from the reference conditions prescribed in point 10.2, the corresponding corrections must be made to the results obtained.

10.3.2. When an absolute interferometric measurement is carried out, corrections must be made to the results obtained, taking account :

- a) the actual refractive index of the ambient air,
- b) the difference between the material and quality of finish of the plane datum surface to which the gauge is wrung, and the corresponding material and qualities of finish of the gauge.

10.3.3. When measuring by comparison, using a comparator, corrections must be made to the results obtained, taking into account :

- a) if the temperature during measurement is other than 20 °C, any difference in the coefficients of linear expansion of the material constituting the gauge and of the material of which the reference standard is made,
- b) any difference between the force applied by the comparator to the gauge and that which it applies to the reference standard.

10.4. Flatness – Wringing

The flatness and wringing qualities of the measuring faces of the gauges must be checked by an interferential method ; the wringing qualities may however be checked by any other methods capable of giving equivalent results.

CHAPTER IV

LIABILITY TO METROLOGICAL CONTROLS

11 Liability to metrological controls

When, in any country, gauge blocks are subject to State metrological controls, these controls must, according to the internal legislation of the country, include all or part of the following controls :

11.1. Pattern approval

11.1.1. Each pattern of gauge of each manufacturer will be subject to the pattern approval procedure, in particular in respect of the qualities of the material used.

11.1.2. No modification may be made to an approved pattern, without special authorisation.

11.2. Initial verification :

new gauges must undergo the initial verification tests and be calibrated.

11.3. Periodic verifications :

it shall be periodically verified that the measures in service retain their metrological properties.

11.4. Certificate of verification :

a certificate of verification shall be issued indicating in particular :

- the set number of the gauges verified,
- their class of accuracy ;

and for gauges used for reference standards

- the value of the central length of the gauge blocks,
- the order of calibration accuracy.

Nominal values of the length of gauge blocks (°)

Increments
mm

[illegible]

(*) Some nominal values are repeated to complete the series.

**Equivalents in French - Russian - English - German - Spanish - Dutch
of the terms used in this Recommendation**

Mesure de longueur à bouts plans (calibre à bouts plans ou cale étalon)

Плоскопараллельная концевая мера длины

Gauge block

Parallelendmass

Calibre prismático

(Parallel-) Eindmaat

Face de mesure

Измерительная поверхность

Measuring face

Messfläche

Superficie de medida

Meetvlak

Plan auxiliaire

Плоская вспомогательная пластина

Plane datum surface

Hilfsplatte

Plano de referencia

Referentievlak

Longueur d'un calibre à bouts en un point quelconque

Длина концевой меры в любой точке

Length of a gauge block at any point

Mass an beliebiger Stelle der Messfläche

Longitud de un calibre prismático en un punto cualquiera

Lengte op een willekeurig punt van het meetvlak

Longueur médiane d'un calibre à bouts

Срединная длина концевой меры

Central length of a gauge block

Mittenmass

Longitud mediana de un calibre prismático

Middenmaat

Ecart entre la longueur d'un calibre à bouts et sa longueur nominale

Отклонение значения длины концевой меры от номинального

Tolerance on the nominal length

Abweichung der Endmasslänge von der Nennlänge

Tolerancia de la longitud nominal

Afwijking ten opzichte van de nominale lengte

Ecart de planéité

Отклонение от плоскостности измерительной поверхности

Deviation of flatness

Abweichung von der Ebenheit

Desviación de planicidad

Afwijking van vlakheid

Variation de longueur

Отклонение от плоскопараллельности концевой меры

Variation in length

Abweichungsspanne

Tolerancia en la variación de longitud de un calibre prismático

Spreiding in de lengte

Adhérence des calibres à bouts

Притираемость концевых мер

Wringing of gauge blocks

Anschiebbarkeit

Adherencia de los calibres prismáticos

Geschiktheid tot aanschuiven

Ordre de précision des étalons de référence

Разряд образцовых мер длины

Order of calibration accuracy of reference standards

Genauigkeitsgrad des Bezugsnormals

Grado de precisión de los patrones de trabajo

Nauwkeurigheidsklasse van referentie-eindmaten

TERMINOLOGY

T.1 Length of a gauge block (at any point of a measuring face) :

length of the perpendicular from the point concerned to the opposite measuring face.

Note : When the length of a gauge is measured interferometrically, the opposite measuring face is replaced by the face of an adhering plane datum surface made of the same material and with the same surface quality as the gauge.

T.2 Central length of the gauge :

length of the perpendicular from the centre of one of the measuring faces to the opposite measuring face.

T.3 Variation in length (due to non-flatness and non-parallelism of the measuring faces) :

difference between the maximum length and the minimum length.

T.4 Deviation from the nominal length :

difference between the nominal length of the gauge and its length at the point where the absolute value of the departure from the nominal length is at its maximum.

T.5 Deviation of flatness of a measuring face :

distance between the two closest parallel planes between which the measuring face is contained.

T.6 Wringing :

property of the measuring faces of a gauge block of adhering, by sliding or by the application of pressure without any additional aids, to the measuring faces of other gauges or plane datum surfaces.

*

**

Note :

This Recommendation and the ISO Standard 3650-1978 still differ, mainly on the two following points:

- definition of length
- stability with time.

Both Organizations work together trying to eliminate these last differences.

Contents

<i>Foreword</i>	2
Chapter I, Length – Shape – Construction – Material – Inscriptions.....	3
Chapter II, Metrological properties	5
Chapter III, Verification	7
Chapter IV, Liability to metrological controls	8
Annex	10
Equivalents of the terms used in this Recommendation.....	11
Terminology	12