Made in Germany

for more than 60 years

KOBA-step the Original

KOBA®

KOBA-step®

PRECISION STEP GAUGE

+

DATA-ANALYSIS SOFTWARE

=

A COMPLETE SYSTEM FOR MONITORING COORDINATE MEASURING MACHINES

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Step gauges for checking the accuracy of co-ordinate measuring machines

In industrial metrology, actual physical bodies of known length which can be contacted by mechanical sensors have an important part to play as reference standards when measuring geometrical parameters.
They have become particularly important for assessing the accuracy of two and three-axis co-ordinate measuring machines which employ mechanical sensors.
Checking the length measurements uncertainty has proved to be a highly informative and economical method for the acceptance testing and ongoing monitoring of co-ordinate measuring machines. In this case the step gauge can be used in an enormous variety of ways, giving, for example, the advantages of uni-directional and bi-directional targetting and of measurements from all the gauge faces along a line of measurement in succession while needing only a short time for preparation and measurement. Local errors can be detected in the co-ordinate measuring machine and characteristics can be derived for individual co-ordinate axes of the machine.

With the aid of the length measurement uncertainty, the manufacturer or user can specify and check the accuracy of a co-ordinate measuring machine to establish its suitability for length measurement. This fundamental task in metrology is of particular importance due to the fact that in practice the majority of measuring requirements are for the measurement of lengths.
"Length measurement uncertainty“ is defined by VDI/VDE guideline 2617, part 2.1 as the uncertainty with which a co-ordinate measuring machine allows the precisely known distance between two points on two mutually parallel gauge faces situated in succession along a line of measurement to be remeasured. Fig. 1 shows a measurement of this kind being made, taking as an example an individual parallel gauge block with an outside length L_e which is arranged obliquely in three dimensions and whose length is remeasured by successive contacts with the block with the probe head in positions I and II.

On the step gauge, spacings of different kinds for making test measurement are all available simultaneously, as follows:

- Outside dimension L_e e.g. with the probe head in positions I and II /Fig. 2)
- Inside dimension L_i e.g. with probe head in positions III and IV (Fig. 3)
- Rear-face to rear-face dimension L_s e.g. with probe head in positions III and V (Fig. 3)
- Front-face to front-face dimension L_s e.g. with probe head in positions VI and IV (Fig. 3)
- Positional length (L_p of a gauge face from the datum gauge face, e.g. with probe head in positions VI and 0 (Fig. 3)

The illustrations show only one of many options available for each type and size of spacing. In magnitude, the differences between the length value L_a indicated by the co-ordinate measuring machine or printed or displayed by its output processor and the true value L_r of the measurement uncertainty U.
What this means is that L_a can be both larger and smaller than L_r.
The value of the length measurement uncertainty is generally given in the form of a length-dependent formula: $U = A + K \cdot L \leqq B$.

A distinction should be made between the figure U_1 specified for one-dimensional test measurements along a co-ordinate axis (with terms A_1, K_1, B_1), the figure U_2 for two-dimensional test measurements made diagonally in a co-ordinate plane (with terms A_2, K_2, B_2) and the figure U_3 for three-dimensional test measurements made diagonally in the three-dimensional space defined by the co-ordinates (with terms A_3, K_3, B_3).

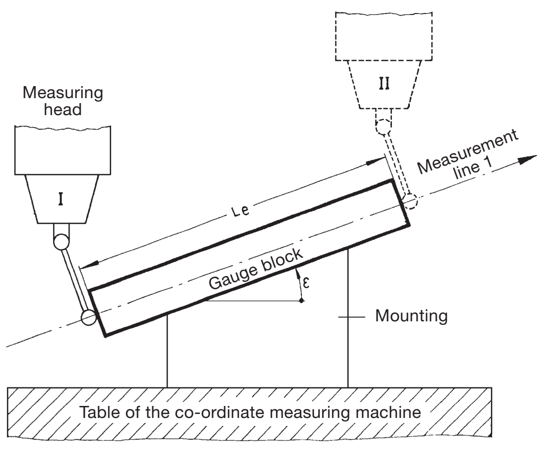


Fig. 1:
Individual gauge block arranged obliquely in three dimensions on the table of a co-ordinate measuring, showing an outside dimension machine L_e being measured.

Graphic representation and analysis

Length measurement uncertainty plot

For the purposes of graphic analysis, the differences $\Delta L = L_a - L_r$ which are found are plotted, with the correct signs, for the individual measured lengths and runs in a length measurement uncertainty grid (Fig. 4). The top and bottom boundary lines produce a funnel-shaped outline with the neck of the funnel measuring 2A (A = figure specified by manufacturer for length measurement uncertainty irrespective of length). 95 % of all the test measurements must lie within or on the boundaries. A quantitative analysis is made simply by counting the number of measurements which lie outside the boundary lines.

Gauge face position plot

With the step gauge it is also possible to test the positions L_p of the gauge faces as distances from the datum face. If the relevant length errors ΔL_p given by position measurement in line with VDI guideline 2617 Part 3 are entered in a plot, then it is possible to see both the position of the test length and also the sequence if for example the measurement points in a run are connected by straight lines. With a set of individual gauge blocks this is not possible because they do not have any true common reference point and are not situated on a measurement line.
For analysis use is made of a gauge face position grid (Fig. 5) (similar to the length measurement uncertainty grid). The outline is symmetrical and similar in shape to a butterfly with a width across the waist of 1A. The parameters in this case correspond to the appropriate figures A_1, K_1, B_1 and so on. As this grid is moved along the measured length L, at least 95 % of all the measurements must always lie within or on the boundary lines, meaning that all the measurement points must do so consistently whatever the position of the waist. This ensures that any pairing of two gauge faces (even from different runs) in the form of outside, inside or face-to-face dimensions will also lie inside the funnel of the length measurement uncertainty grid. Thus, the grid forms a combined graphic expression of both the equations given above for all points of measurement.

Comparison between the test standards gauge blocks and step gauges

Apart from the step gauge, the reference standards which lengths are known with the greatest accuracy are parallel gauge blocks. These however are relatively flexible and have to be mounted at the AIRY points (symmetrical spacing $a = 0.57735 \cdot L$) so that they are free of bending moments if this parallelism of the gauge faces is to be maintained. The gauge blocks for the individual test lengths can be individually placed one behind the other for shorter lengths and next to one another for longer lengths. However, when this is done there is no way of obtaining the different gauge points along a line of measurement which are desirable for measurement purposes.

Special features and advantages of the KOBA-step

The step gauge is of castellated configuration and in it a large number of forward and backward facing gauge faces are lined up along a single line of measurement. This line of measurement is the same for measurements between any faces and the position of the workpiece, that is to say the orientation of the carrying body, only has to be determined once to find this line. There are numerous possible combinations in various positions along the measurement line, that actual number of different interface dimensions for a step gauge with 26 castellations (= KOBA-step with a nominal size of 1020 mm) being 1326.
The special feature of the KOBA-step step gauge is the fact that the actual gauge points are situated on the neutral fibre of the carrying body and this means that there are no first-order changes in length if the state of bending changes.
The configuration of the carrying body and the fact that the line of measurement is situated on the neutral fibre prevents any increase in the distance between the gauge faces at the points where the carrying body is supported and prevents them from moving closer together at intervening points. In the KOBA-step step gauge, which is neutral in bending, cylindrical gauge blocks are fixed in position individually in an internal longitudinal groove formed in a rugged steel carrying body of square section (55 x 55 mm). The axis of the gauge blocks is situated on the fibre of the carrying body which is neutral in bending and they form a series of castellations. The arrangement which has been adopted provides excellent protection for the gauge faces. The strength of the carrying body and the fact that the lengths do not vary if there are changes in the bending to which it is subject mean that the KOBA-step step gauge can be mounted in a wide variety of fashions, e.g. cantilevered with so-called zero position support or with support at the Besselpoints.

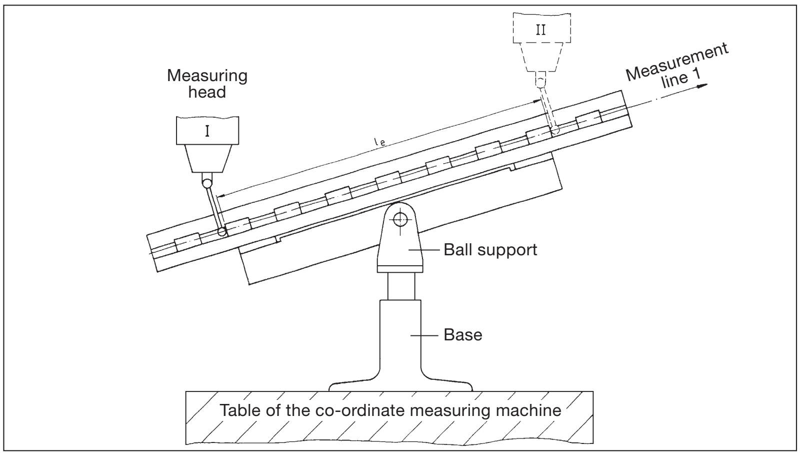


Fig. 2:
Castellated step gauge arranged obliquely in three dimensions on the table of a co-ordinate measuring machine, with an outside length L_e being measured

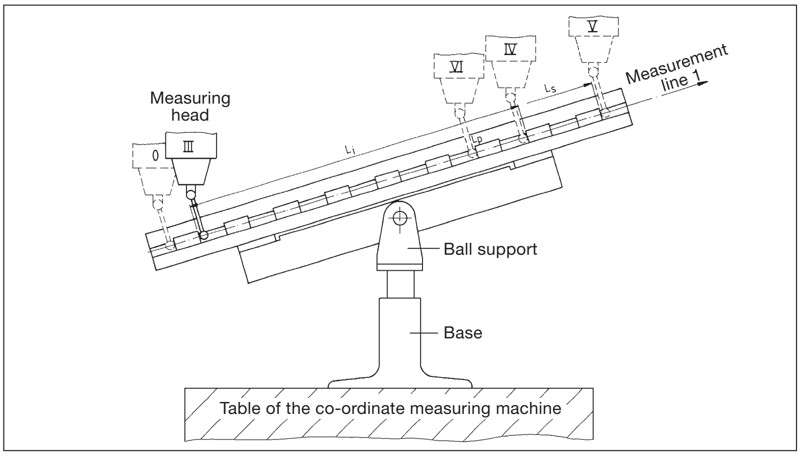


Fig. 3:
Step gauge arranged obliquely in three dimensions on the table of a co-ordinate measuring machine, showing measurement of an inside dimension L_i, of an outside dimension L_s or of the position L_p of a gauge face as a distance from the datum face

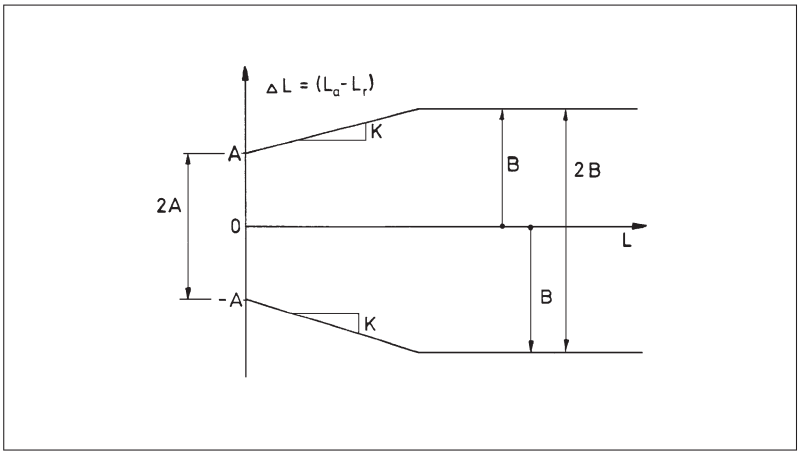


Fig. 4:
Length measurement uncertainty grid with funnel-shaped boundary lines, for the formula

$U = A + K \cdot L \leqq B$

with the possibility of different plots for U_1, U_2, U_3 which represent one, two and three-dimensional length measurement uncertainties

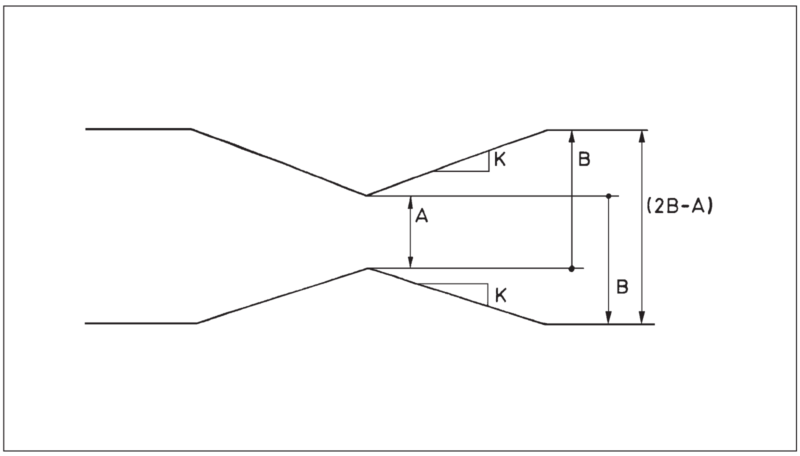


Fig. 5:
Sliding gauge face position grid of symmetrical butterfly-shaped confi-guration to represent the length measurement uncertainty

$U = A + K \cdot L \leqq B$

with the possibility of different plots for U_1, U_2, U_3 which represent one, two and three-dimensional length measurement uncertainties

Accessories

The range of accessories available which are needed for use with the step gauge, such as swivel support, and base allows the gauge body to be mounted on the co-ordinate measuring machine in such a way as to be free of torsion. A support of this kind produces a particularly stable connection between the step gauge and the table of the co-ordinate measuring machine (Fig. 7, 9 and 10).
The combination of the step gauge and its accessories produces a complete system for making an overall check on the co-ordinate measuring machine.
One particularly important point is that the procedure of checking the co-ordinate measuring machine can be carried out fully automatically under computer control.

Traceability

Since the acceptance or refusal of a co-ordinate measuring machine may depend on the outcome of the length measurement uncertainty test, it is advisable always to use officially calibrated testing equipment in order to avoid unpleasant surprises and wrong interpretations. The KOBA-step step gauge is available with both DKD calibration-certificate (German Calibration Service-DKD) and Works Calibration.
The length measurement uncertainties which can currently be achieved with the step gauge are
DKD: $U = 0{,}12\ \mu m + 0{,}6 \cdot 10^{-6} \cdot L)$ (length)
Works Calibration: $U = 0{,}3\ \mu m + 0{,}8 \cdot 10^{-6} \cdot L)$ (length)

Recalibration

As is normal with all measurement standards, the KOBA-step step gauge should be recalibrated after a certain period. We recommend the following recalibration intervals:
First recalibration after one to two years and each successive recalibration after two to three years.

Alignment of the KOBA-step

To define the position and orientation of the KOBA-step resp. the measuring line within the measuring volume, we recommend proceeding as follows:

As the carrying body with the fixed cylindrical gauge blocks has been designed symmetrically to both sides, one of the external side surface and the upper external surface at the end of the large U-groove can be used for the alignment.

Any points which are as large as possible can be sensed at the side surface and at the upper external surface likewise. Both planes so defined are squared off mathematically. A parallel line 27,5 mm to the side surface and 30 mm to the upper surface is the measurement line situated on the neutral fibre.

It is also possible to use both ends of the 7 x 10 mm interior groove for the alignment and proceed in a similar way as mentioned before. The distance from the wall of the groove and the floor of the groove to the line of measurement is 5 mm in both directions.

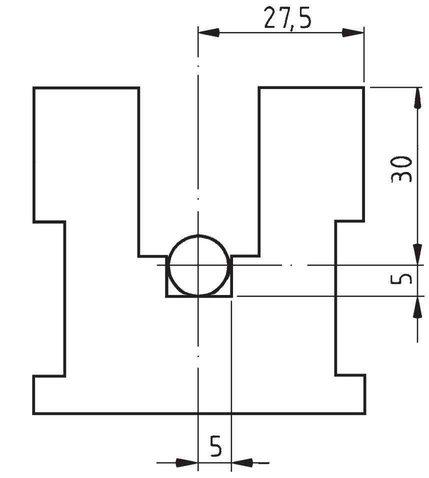


Fig. 6:
Alignment of the KOBA-step
at the contours or in the longitudinal groove.

Cross drills for easy contacting of the measuring faces.

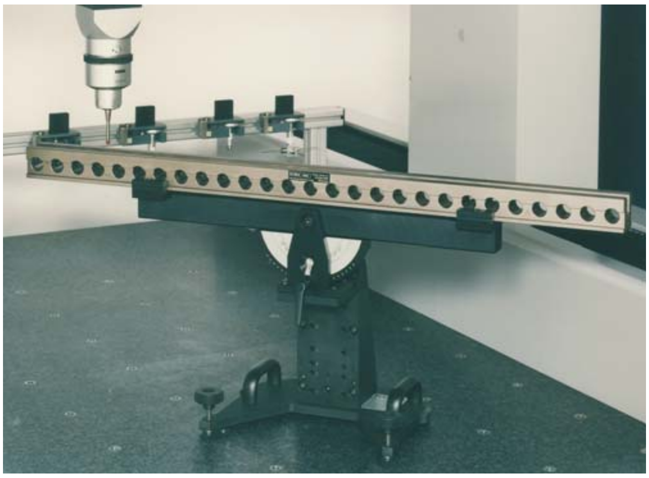


Fig. 7:
KOBA-step aligned horizontally along the X-Y plane diagonal, approx. 500 mm above the table, stylus probe vertical.
Accessory: Base and swivel support.

Fig. 8:
KOBA-step aligned along the X-axis (lying flat on the table with no accessories used), stylus probe vertical.

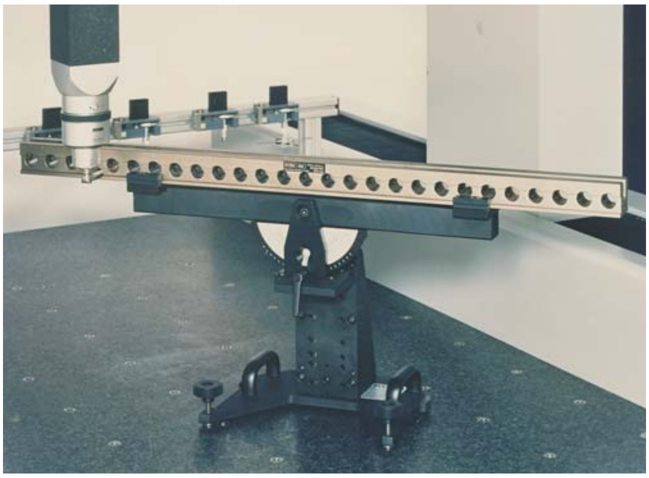


Fig. 9:
KOBA-step aligned horizontally along the XY-diagonal plane, same accessory as above, turned round 90°, stylus probe horizontal;
Contacting through crossdrills.

Fig. 10:
KOBA-step aligned vertically along the Z-axis
(standing in the base),
stylus probe horizontal.

Size 1 Size 2

Fig. 11:
KOBA-step vertically orientated along the Z-axis (standing in the base) stylus probe horizontal (not shown).
In this alignment also suitable to check height gauges.

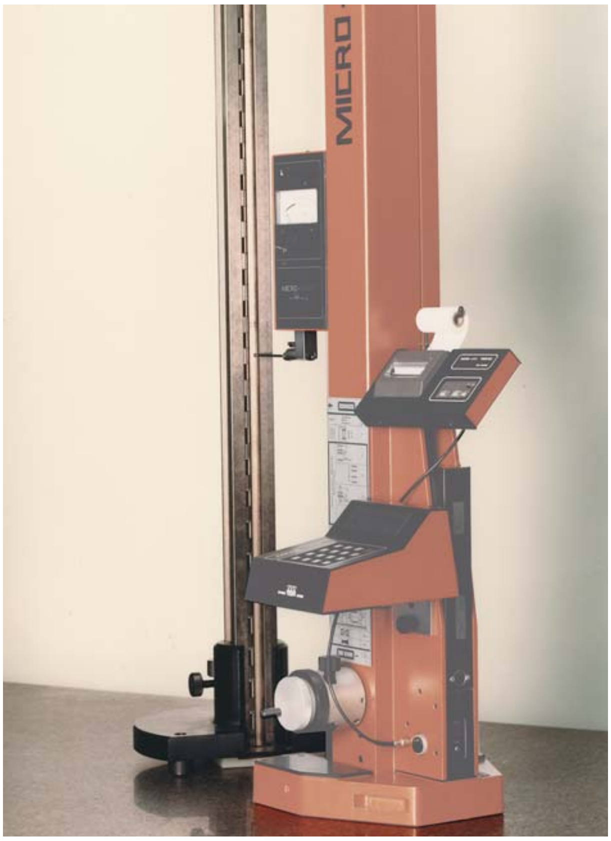


Fig. 12:
KOBA-step aligned vertically for checking height gauges.

Practical Use

Practical experience in using the KOBA-step step gauge for checking the accuracy of co-ordinate measuring machines and assessing and interpreting the results has demonstrated the usefulness and potentially high information yield of the “length measurement uncertainty“ method. The advantage lies in the fact that the measurement is carried out at precision gauge faces using the normal gauging procedure and in the main, the machine manufacturer's standard processing software. Since the unidirectional and bi-directional gauging of inside and outside dimensions, dimensions between similarly orientated surfaces, and successive dimensions from a given point occur even in the routine measurement of work pieces and since the measurements which have been obtained can be correlated with one another as desired even after the event, it is good idea to make full use of the opportunities offered by the step gauge. What is more, a series of measurements at all the gauge faces in succession provides a large amount of interrelated information and requires only a short time for measurement.
Since the length measurement uncertainty characteristic very much depends on the geometry of the co-ordinate measuring machine, the lines along which measurements are made should be as follows:

- 3 to 4 measurement lines which are diagonal in three dimensions (i.e. along the diagonals of an inscribed cube – at a gradient of approximately 35° – or along the diagonals of the cuboid representing the measured space).
- 2 diagonal lines of measurement in each co-ordinate plane (i.e. along the diagonals of a square – at a gradient of 45° – or the diagonals of a rectangle).
- At least one line of measurement parallel to each co-ordinate axis.

At least 18 suitable lines of measurement have to be selected in order to arrive at a complete definition of the 18 geometrical cuboid characteristics of the entire measurement volume.

It has to be stressed in particular that reliable measurement results for the complex system cannot be achieved unless the stylus probes are included.
Checking of the co-ordinate measuring machine without mechanically contacting, i.e.: without using a probe, will therefore not result in an comprehensive statement about the accuracy of the measuring machine.

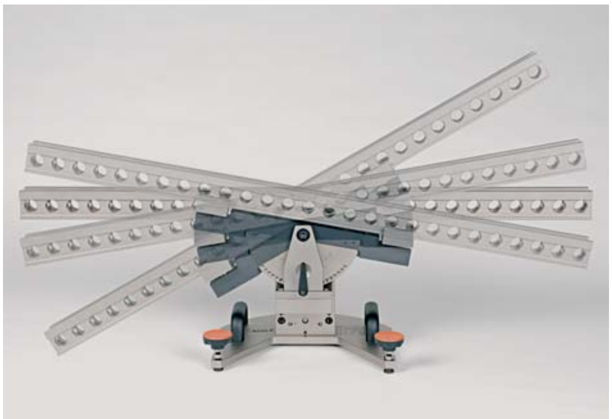


Fig. 13: KOBA-step with swivel support and base, illustrated at various angular inclinations (stylus probe not shown).

Fig. 14: KOBA-step, equipped with swivel support base Size 1 for accommodating 1020 mm length step-gauge (stylus probe not shown).

Another KOBA-step application area:

Conducting formal acceptance procedures and monitoring the precisions of machine tools and robotic dimensional-gauging systems

The step gauge KOBA-step may be used for checking the positioning accuracies of machine tools and articulated-arm robotic dimensional-gauging systems, an application area where they offer the same elegant approach and speed as in checking co-ordinate measuring machines. The accessory items required here are those described above, a swivel support and base.

Regular use of the KOBA-step for monitoring dimensional-gauging precisions of machine tools is essential to total quality assurance. Total quality assurance demands more than mere precision dimensional gauging of finished work and components; regularly monitoring the dimensional-gauging precisions of the machine tools employed in their fabrication is indespensable. Finished products must be machined to within prescribed dimensional tolerances if they are to pass final acceptance checks. Regular monitoring of machine tool dimensional-gauging precisions provides valuable information on the degrees to which work/component dimensional tolerances are being maintained in machining operations.

Fig. 15:
KOBA-step installed on a swivel support and base, shown here spanning the major diagonal of the work-space of a vertical milling machine equipped with a dimensional-gauging head.

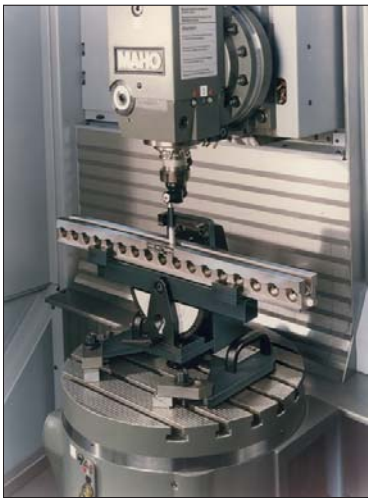


Fig. 16:
KOBA-step, shown here horizontally aligned along the X-axis of the rotary bed of a machine tool equipped with a dimensional-gauging head.

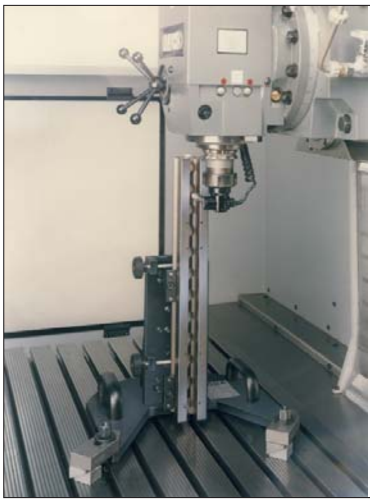


Fig. 17:
KOBA-step, shown here aligned vertically for checking the Z-axis of a machine tool equipped with a dimensional-gauging head.

Fig. 18:
KOBA-step, shown here installed on a flexible machining center for verifying its positioning accuracy (the center's dimensional-gauging head is integrated into its tool chuck).

Standard nominal lengths

nominal length mm	number of gauge faces	overall length	weight kg
420	22	480	6.5
620	32	680	9.5
1020	52	1080	15.0
1540	78	1600	23.0
2020	102	2080	30.0

The nominal length of a step gauge is the distance from the first gauge face to the last gauge face.
Special sizes on enquiry, at present available with length up to 2500 mm.

Following characteristics identical for all lengths listed:

Cross-section of holder: 55 x 55 mm

Cross-section of cylindrical gauge blocks: 10 mm diameter

Length of castellations: 20 mm

Space between castellations: 20 mm

Contents of sets

Set N° 5/420

Contents: 1 off Step gauge, nominal length 420 mm
2 off fixing clamps
1 off swivel support for 420 mm } housed in storage box
1 off Base size 1 housed in storage box

Set N° 5/620

Contents: 1 off Step gauge, nominal length 620 mm
2 off fixing clamps
1 off swivel support for 620 mm } housed in storage box
1 off Base size 1 housed in storage box

Set N° 5/1020

Contents: 1 off Step gauge, nominal length 1020 mm
2 off fixing clamps
1 off swivel support for 1020 mm } housed in storage box
1 off Base size 1 housed in storage box

Set N° 5/1540

Contents: 1 off Step gauge, nominal length 1540 mm
2 off fixing clamps } housed in storage box
1 off swivel support for 1540 mm
1 off Base size 2 } with 2 transport cases

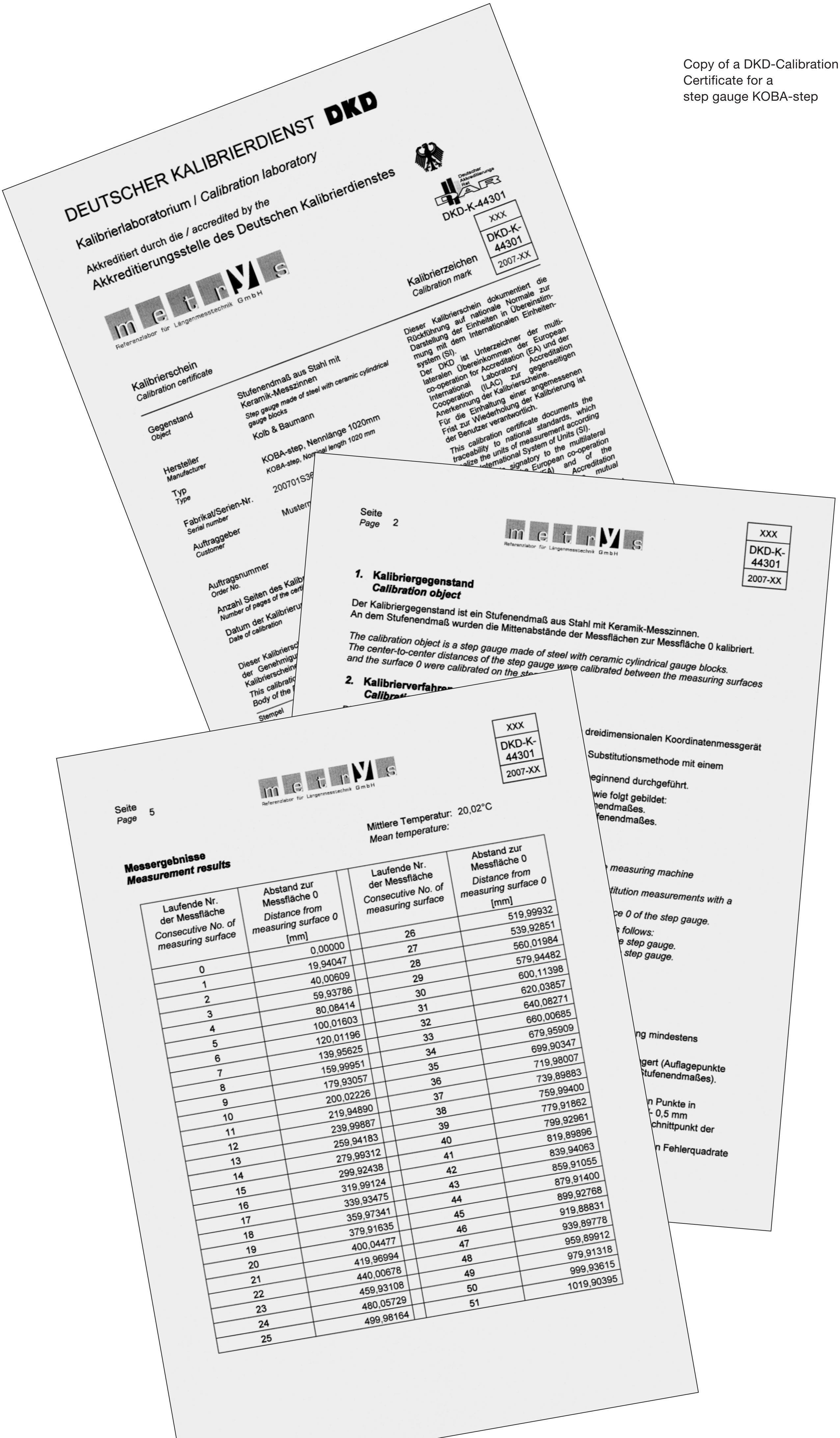
Set N° 5/2020

Contents: 1 off Step gauge, nominal length 2020 mm
2 off fixing clamps } housed in storage box
1 off swivel support for 2020 mm
1 off Base size 2 } with 2 transport cases

The step gauge KOBA-step can be aligned with all requested orientations – horizontally, vertically, diagonally and obliquely. With the swivel support angles can be set from −50° to +50° in steps of 5°. The base may be used as a holder for the swivel support as well as for the vertical alignment of the KOBA-step.

Where individual components are not required the compartments provided for them are left empty.

Copy of a DKD-Calibration
Certificate for a
step gauge KOBA-step



DEUTSCHER KALIBRIERDIENST **DKD**

Kalibrierlaboratorium / *Calibration laboratory*

Akkreditiert durch die / *accredited by the*
Akkreditierungsstelle des Deutschen Kalibrierdienstes

metrys
Referenzlabor für Längenmesstechnik GmbH

Deutscher Akkreditierungs Rat
DKD-K-44301

XXX
DKD-K-44301
2007-XX

Kalibrierzeichen
Calibration mark

Kalibrierschein
Calibration certificate

Gegenstand / *Object*: Stufenendmaß aus Stahl mit Keramik-Messzinnen / *Step gauge made of steel with ceramic cylindrical gauge blocks*

Hersteller / *Manufacturer*: Kolb & Baumann

Typ / *Type*: KOBA-step, Nennlänge 1020mm / *KOBA-step, Nominal length 1020 mm*

Fabrikat/Serien-Nr. / *Serial number*: 200701S36...

Auftraggeber / *Customer*: Musterm...

Auftragsnummer / *Order No.*

Anzahl Seiten des Kalibrie... / *Number of pages of the cert...*

Datum der Kalibrieru... / *Date of calibration*

Dieser Kalibriersch... der Genehmigu... Kalibrierscheine... This calibratio... Body of the ...

Stempel

Dieser Kalibrierschein dokumentiert die Rückführung auf nationale Normale zur Darstellung der Einheiten in Übereinstimmung mit dem Internationalen Einheitensystem (SI).
Der DKD ist Unterzeichner der multilateralen Übereinkommen der European co-operation for Accreditation (EA) und der International Laboratory Accreditation Cooperation (ILAC) zur gegenseitigen Anerkennung der Kalibrierscheine.
Für die Einhaltung einer angemessenen Frist zur Wiederholung der Kalibrierung ist der Benutzer verantwortlich.

This calibration certificate documents the traceability to national standards, which realize the units of measurement according to the International System of Units (SI). ... signatory to the multilateral ... European co-operation ... (EA) and of the ... Accreditation ... mutual

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XXX
DKD-K-44301
2007-XX

1. Kalibriergegenstand
Calibration object

Der Kalibriergegenstand ist ein Stufenendmaß aus Stahl mit Keramik-Messzinnen.
An dem Stufenendmaß wurden die Mittenabstände der Messflächen zur Messfläche 0 kalibriert.

The calibration object is a step gauge made of steel with ceramic cylindrical gauge blocks. The center-to-center distances of the step gauge were calibrated between the measuring surfaces and the surface 0 were calibrated on the ste...

2. Kalibrierverfahren
Calibrati...

... dreidimensionalen Koordinatenmessgerät
... Substitutionsmethode mit einem
... beginnend durchgeführt.
... wie folgt gebildet:
... endmaßes.
... fenendmaßes.

... measuring machine
... stitution measurements with a
... ce 0 of the step gauge.
... s follows:
... e step gauge.
... step gauge.

... ng mindestens
... gert (Auflagepunkte ... Stufenendmaßes).
... n Punkte in ... - 0,5 mm ... chnittpunkt der
... n Fehlerquadrate

XXX
DKD-K-44301
2007-XX

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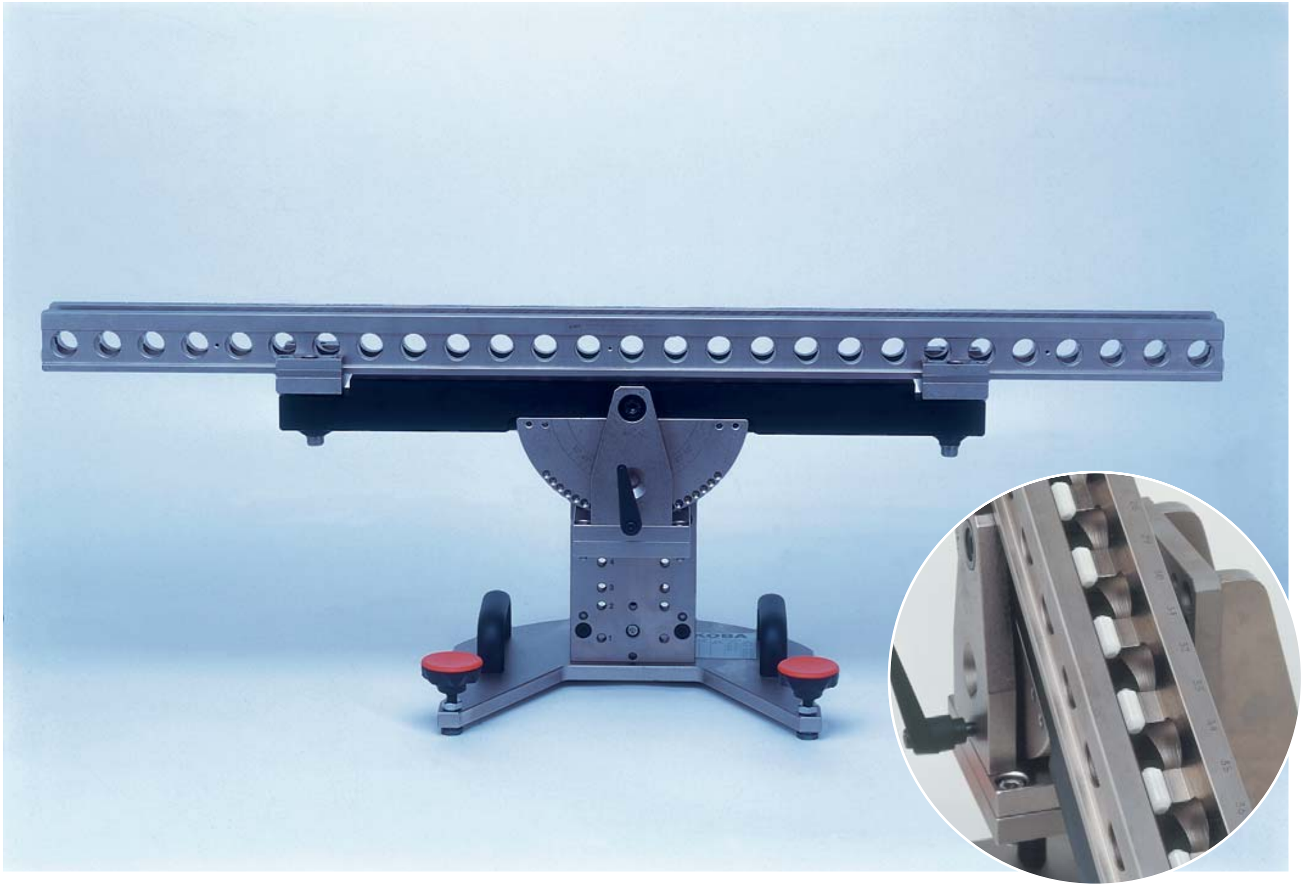
Mittlere Temperatur: 20,02°C
Mean temperature:

Messergebnisse
Measurement results

Laufende Nr. der Messfläche *Consecutive No. of measuring surface*	Abstand zur Messfläche 0 *Distance from measuring surface 0* [mm]	Laufende Nr. der Messfläche *Consecutive No. of measuring surface*	Abstand zur Messfläche 0 *Distance from measuring surface 0* [mm]
0	0,00000	26	519,99932
1	19,94047	27	539,92851
2	40,00609	28	560,01984
3	59,93786	29	579,94482
4	80,08414	30	600,11398
5	100,01603	31	620,03857
6	120,01196	32	640,08271
7	139,95625	33	660,00685
8	159,99951	34	679,95909
9	179,93057	35	699,90347
10	200,02226	36	719,98007
11	219,94890	37	739,89883
12	239,99887	38	759,99400
13	259,94183	39	779,91862
14	279,99312	40	799,92961
15	299,92438	41	819,89896
16	319,99124	42	839,94063
17	339,93475	43	859,91055
18	359,97341	44	879,91400
19	379,91635	45	899,92768
20	400,04477	46	919,88831
21	419,96994	47	939,89778
22	440,00678	48	959,89912
23	459,93108	49	979,91318
24	480,05729	50	999,93615
25	499,98164	51	1019,90395

Ideal

Standard design with gauge faces of ceramic



Advantages:

- corrosion resistant
- Stable in size
- less cleaning
- coefficient of expansion similar to steel
- wear resistance similar to carbide

Existing step gauges with cylindrical steel gauge blocks can be exchanged against ceramic. However, a re-calibration is necessary then.

Data-Analysis Software

An evaluation software designed to suit your requirements is available.
The software was developed by

ITI
Ingenieurbüro für Technik und Informatik GmbH
Ellerhoop 6
DE-22885 Barsbüttel
Tel.: 0 40 / 67 08 10 46 · Fax: 0 40 / 67 08 10 47
e-mail: iti-gmbh@t-online.de

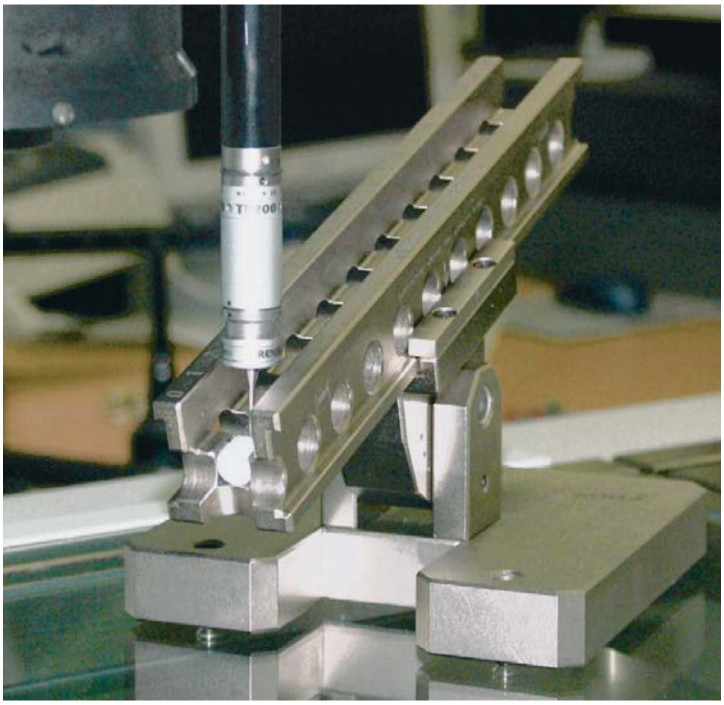
For further information please contact us direct.

KOBA-step *mini*

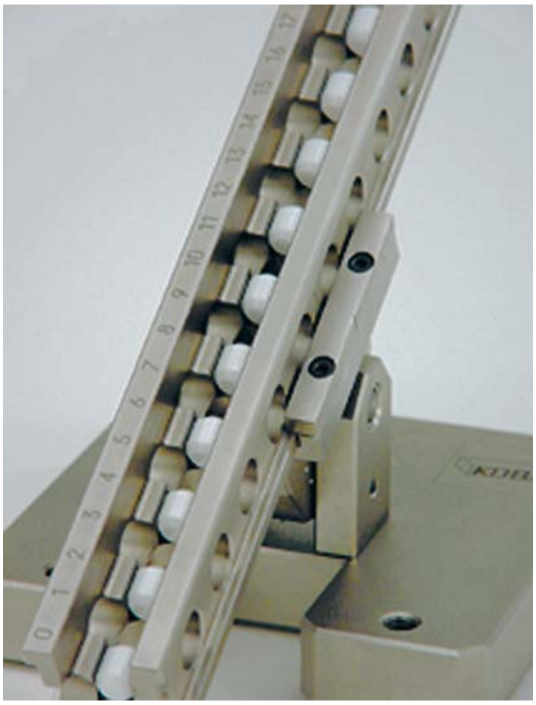
System for the calibration and monitoring of multi-sensor measuring instruments and coordinate measuring instruments of small measuring volume

Special features

The KOBA-step *mini* is a step gauge of the "KOBA-step" type but with harmoniously reduced cross-section and resized gauge block distance according to the measuring length and measuring task.
The methodical advantages such as embedding of the cylindrical gauge blocks in the neutral fibre of the carrying body and the good access from three sides have been maintained. The length and distances of the gauge blocks were reduced to 10 mm according to the total lengths which allow to recognize local errors of the measuring instrument.
The cylindrical gauge blocks are made of zirkonia ceramic thus free of corrosion and wear.
The system is completed by the swivel support included in the delivery and by which the KOBA-step *mini* can be mounted horizontally, vertically or in the volume.
The traceability to the National Length Standard is guaranteed by works calibration or through DKD or PTB.



KOBA-step *mini* on the measuring instrument positioned in the volume



Ceramic gauge blocks on the neutral fibre

Scope of supply:

KOBA-step *mini* with probing elements in zirkonia ceramic, base and swivel mechanism for positioning from 0° to 90° (horizontally or vertically) as well as aluminium storage case

Standard lengths

Nominal length mm	Number of castellations/ probing faces	Division mm	Overall legth mm
210	11/22	10	220
310	16/32	10	320

A brief review of the KOBA-step step gauge

For the first time, this gauge block combines the advantages which step gauges offer the user with the ability to meet the stringent metrological demands which a precision measurement standard has to meet:

- ▶ Available with various standard nominal lengths (210, 310, 420, 620, 1020, 1540 and 2020 mm) with even steps (castellation/gap = 10/10 mm, from 420 mm = 20/20 mm), also with different standard lengths and uneven steps (however, castellation = 10 mm, from 420 mm = 20 mm) for an optimal adjustment to the measurement task.
- ▶ Stainless finish guaranteed by special surface treatment.
- ▶ The gauge faces used are the specially machined end faces of cylindrical gauge blocks which are inset solidly into position in a groove by a special process.
- ▶ Gauge faces lapped for correct sensing.
- ▶ Carrying body specially aged for longterm stability.
- ▶ Solid connection between the cylindrical gauge blocks with gauge faces and the carrying body.
- ▶ Cylindrical gauge blocks deeply inset to protect them against damage, length 20 mm.
- ▶ Gauge faces conically reduced to 5 mm diameter, hence easy to clean.
- ▶ The centres of the gauge faces are located on the fibre of the carrying body which is neutral in bending. As a result changes in bending stress due to different horizontal or inclined or vertical orientations have an effect on the distances between the gauge faces which is so <u>small that it can be ignored completely.</u>
- ▶ Because of the configuration adopted, the bending characteristics in the two principal planes are identical, and it is therefore equally possible for the gauge block to be orientated with the groove facing upwards (e.g. for vertical quills) or to one side (e.g. for horizontal quills) or downwards (e.g. for underfloor measuring machines with vertical quills operating from below). The measurements to determine the position of the carrying body in space can be carried out on the precision-machined rectangular groove.
- ▶ The longitudinal grooves in the side faces allow a wide variety of orientations and mounting methods on the table of the machine.
- ▶ The material of the carrying body determines its expansion characteristics ($\alpha = 11{,}5 \cdot 10^{-6}/°C$).
- ▶ The accuracy required is of a standard not achieved hitherto and is ensured by the use of a special laser interferometer comparator which gives the precise position of each gauge face. The numerical value (Actual value according to the Calibration chart) representing the position is not generally a whole-number decimal and qualifies immediately to direct the co-ordinate measuring machine and resp. for the evaluation of the length measurement uncertainty.
- ▶ Additional reliability in everyday use because the length of each individual cylindrical gauge block is known and does not vary and must be re-measured accurately by the co-ordinate measuring machine itself with the step gauge in any position and orientation.
- ▶ Cross drills between the castellations for easy sensing of the measuring faces.

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